Meta-analysis of gender and science research

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Topic report
Gender and Scientific Excellence

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Introduction and conceptual framework

The literature on gender and scientific excellence collected in the Gender and Science Database (GSD) shows that women scientists encounter more problems than their male counterparts:

- in achieving the excellence that they are potentially capable of, given their results in comparison with males in the early stages of their careers;
- in seeing the excellence they achieve recognized by their colleagues of both sexes.

These facts reveal a serious problem. They indicate the unnecessary waste of a very scarce human resource, namely talent; and they may determine a bias of the entire scientific enterprise in favour of topics, operational styles and approaches associated with the male sex.

Why is it that few women reach excellence? Why is excellence in women not easily recognized?

Finding answers to this question is very important to women and to society.

It is important to women because the relative scarcity of feminine excellence in the sciences has been advanced as proof of feminine inferiority, damaging the self-esteem of countless women in the past. The concept of feminine inferiority in Europe and in other countries - but by no means in every country - has been deeply revised by the scientific community and by the majority of the population because some excellent women, such as Marie Curie or Rita Levi Montalcini, proved beyond any doubt that women were indeed perfectly able to achieve scientific excellence and to make fundamental scientific discoveries. The implication of this fact is twofold: first, there are forces that in the past prevented women from contributing to science as they would have otherwise; second, these forces may still be active. To understand them and to counteract them is necessary in order to enhance scientific advancement, and benefit society as a whole.

The aim of this Report is to summarize the answers provided in the literature collected in the GSD and to connect these results with the most important contributions in the international literature.

To this effect, in preparation for the present report, all the abstracts in the GSD, published exclusively in Europe, indexed under “excellence” have been reviewed and several publications, according to their relevance and interest, have been selected, despite some language constraints (the team could read English, Italian, French and Spanish). Abstracts and publications in English printed outside of Europe have also been reviewed.

A key assumption of this Report is that, at birth, the proportion of women with the potential to be excellent scientists is the same as the proportion of men. This assumption is supported by ample scientific evidence, substantiated by the fact that many important discoveries are the result of the fundamental intuition of great women scientists. The fact that fewer women than men are recognized as excellent scientists indicates that many more could be. It is perfectly possible that not all the males who are potentially capable of becoming excellent scientists do so. This is also a waste of talent. Organizing the scientific community so that no talent is wasted is one of the aims of European science policy.

At the same time, this Report also assumes that the different life courses of men and women and their different position in the social fabric produces a gender difference – a difference in sensibilities, interests, tastes and intellectual styles that may be reflected in the different approach of men and women to the production of knowledge. The human is made up of two overlapping halves, the masculine and the feminine. There is a delicate balance to be preserved between the equality of both sexes in capabilities and rights and gender differences that are worthy of consideration. To upset this balance means running two opposite risks, the assimilation of women to men on the one hand, and the acceptance of women’s traditional social inferiority on the other.

That women in the top layer of the scientific profession are scarce is a known fact documented in detail by the Report on Vertical Segregation of this research project. The fact that scientific excellence is not as easily recognized in women scientists as in men emerges in different strands of literature: it emerges from biographical studies of women scientists of the past, from sociological studies of scientists who are still active, and from the direct testimony of women scientists. It is legitimate to ask whether achieving excellence and having it recognized is easier today than it was in the past. The answer is that in the last decades there have been positive changes for women, but that more changes are still needed in the processes that lead to excellence and to its recognition if men and women are to be on an equal footing with respect to the possibility of belonging to the top tiers of scientific institutions.

An indicator of the problem and of its persistence is given by calculating women's presence in the public institutions whose mission is to recognize scientific excellence, the National Academies which, under various names, are present in most countries. Table 1 below presents the evidence collected by the Rapporteurs by searching the appropriate websites.

Table 0.1 Women scientists in the National Academies of some OECD countries

Name/Country	Governing bodies			Membership		
	Total	Women	%	Total	Women	%
Academia Europaea	28	5	17.9	2,161	171	7.9
Accademia Nazionale dei Lincei (Italy) *	9	1	11.1	354	8	2.3
The Academy of Athens	5	0	0.0	44	2	4.5
The Academy of Sciences of Lisbon				70	3	4.3
The Academy of Sciences of the Czech Rep	17	2	11.8			
The Austrian Academy of Sciences	4	1	25.0	680	40	5.9
The Bulgarian Academy of Sciences	12	2	16.7			
The Danish Academy of Sciences	7	2	28.6			
The Estonian Academy of Sciences	8	0	0.0	57	1	1.8
The German Academy of Sciences Leopoldina	18	3	16.7			
The Hungarian Academy of Sciences *	11	1	9.1	296	12	4.1
The Latvian Academy of Sciences	6	0	0.0			
The Lithuanian Academy of Sciences	9	0	0.0			
The Polish Academy of Science	29	0	0.0	162	5	3.1
The Royal Academies for Science and the Arts of Belgium	11	1	9.1			
The Royal Irish Academy	31	5	16.1	515	46	8.9
The Royal Netherlands Academy of Sciences and Arts	29	4	13.8			
The Royal Society of London ***	21	4	19.0	1,361	75	5.5
The Royal Swedish Academy of Sciences	15	6	40.0	595	29	4.9
The Slovakian Academy of Sciences	15	4	26.7			
The Slovenian Academy of Arts and Science *	4	0	0.0	83	4	4.8
The Spanish Royal Academy of Sciences				54	2	3.7
L'Académie des Sciences de l'Institut de France	26	0	0.0	580	25	4.3
The Academies of Arts, Humanities and Sciences of Canada	16	4	25.0			
Social Science Research Council U.S.A.	14	5	35.7			

The data in the table give a quantitative indication of the problem. Fewer than one in ten, and often fewer than one in twenty members of the National Academies who are recognized as excellent is a woman. Why is this so?
It is by no means easy to determine why it is that women do not reach scientific excellence. It appears from the literature that women encounter difficulties in their path towards excellence at many different levels:

- **A general level:** women do not reach excellence in science for the same set of reasons that prevents them from achieving apical positions and recognition in other socially and publically prominent careers, such as politician, judge or engineer.

- **A level specific to science as a whole,** including all its disciplines. This is in part related to the way science is organized as a hierarchical community with its own rules and parameters (publication, peer review, and so on).

- **A level specific to each science,** where women's loss of pace is linked to the particular rhetoric of that discipline – in the humanities, the quality of the written text; in mathematics, the quality of the equations; in laboratory science, the lack of precision or of abstraction.

- **A level specific to each country,** related to the way the academic system works and how promotion, funding and teaching loads are determined.

- **A level specific to each individual personal history,** where components of each of these levels interrelate with each other and with other personal individual characteristics, bringing about the reason why each single gifted woman fails to achieve the position in the hierarchy of science she might have reached had she been born a man.

This seems to indicate that some general force is at work at many levels, and on the other hand, that this general force translates itself in specific mechanisms at each level.

The literature collected by the GSD does not provide an unequivocal answer to the two questions of why not enough women achieve excellence and why their excellence may go unrecognized. It rather provides a wealth of suggestions and insights regarding where the sources of the problems may lie.

The Report is structured as follows: after this introduction, part 1 provides the conceptual background to the study. It defines and clarifies the concept of scientific excellence, in order to understand how scientific excellence is produced. This is done by looking at the definition of excellence and at the models used to describe excellent production.

Part 2 offers an in-depth analysis of seven specific issues that emerged in the literature and that are of particular relevance to the issue of why women may not fully achieve scientific excellence. The issues are:

1. **Honour**
2. **Homosociability**[2]
3. **Gatekeeping**
4. **Feminine invisibility and other psychological interactions between the sexes**
5. **Peer evaluation**
6. **Excellence and leadership**
7. **Standpoint bias**
8. **Excellence in the natural sciences versus other disciplines**
9. **Excellence in gender studies and research**

The third part deals with the issue of measuring scientific performance and assessing scientific excellence. It discusses the problems relating to the bibliometric tools used to evaluate excellence and the possible existence of gender bias in their formulation and in their use.

The last part analyzes the GSD with respect to the topic "excellence" and surveys the National and the Country group reports to describe the status of research on gender and excellence in Europe, indicating the main gaps. It also draws some attention to the issue of what was learnt from the literature on the lives of excellent women scientists, and presents elaborations from the database. Finally, in the conclusions, the report attempts to summarize the arguments, identify the gaps and prospective lines of inquiry and contribute general ideas for policymaking with regard to excellence.

Boxes are used throughout the text to examine specific issues. Sometimes, the box contains abstracts from the GSD or an article or other scientific work considered of particular significance in illustrating what is discussed in the text. Issues that are of relevance to excellence but were dealt with in other Reports of this project (e.g., the stereotype of the excellent scientist, the biological basis in excellence potential or lack thereof, the personality traits of the excellent scientist) have been omitted from the discussion. References and Appendices conclude the Report.

[2] Homosociability is defined as the fact that people feel more comfortable in the presence of others who are like themselves.

Part 1. What is excellence?

1.0 Introduction

In this part, the Report focuses on the definition of scientific excellence and on the main models presented in the literature to explain why women do not attain it. The definition of scientific excellence is elusive (Ortega in Garcia de Leon, 2005)[3]. The scientific community acts as if excellence were an obvious quality, and seldom feels the need to define it clearly. It defines it clearly only within a scope of a specific discipline (e.g., medicine), which does not help to explain why women scientists encounter difficulties in achieving excellence across disciplines. Contributions in the literature (Addis and Brouns, 2004) underline the need to engage in a critical reflection on the concept of excellence as well as on the processes and procedures that lead to the creation and recognition of excellence. The fact that women scientists do not achieve excellence at the same rate as would be predicted by their results in the earlier stages of their scientific career is the product of a number of social processes within and outside the scientific community.

1.1 Excellence: an elusive definition

Reading the literature in the GSD, as well as the rest of the English language literature, does not provide one clear and consensual definition of what constitutes scientific excellence, nor has it provided many different and opposing definitions of scientific excellence that can be compared.

The scientific community seems to act as if the meaning of scientific excellence were obvious and agreed on by all participants of the scientific enterprise. It behaves as if scientific excellence were an uncontested terrain and the procedures and criteria that lead to the selection of the top layer of scientists who are considered excellent were given, known, and unproblematic (Addis and Brouns, p. 27).

If this were true, the fact that women are so scarce in the upper scientific echelons would not be a problem; it would be the obvious result of the absence of women scientists who fulfil the requirements for occupying positions of excellence. Philosophers of science and feminist scholars have questioned this phenomenon and have begun to analyze the procedures and criteria leading to recognized excellence in order to ascertain the factors that play against women on the path to recognized excellence. Even in this literature, however, clear answers to the question “what does scientific excellence mean and why do women not achieve it?” have not yet emerged. This is also reflected in the title of one of the important contributions along this line, the Report “Gender and Excellence in the Making” (Addis and Brouns 2004), which is further discussed at a later stage. In this Report, the processes that lead to excellence are the object of enquiry, rather than excellence *per se*: it provides a procedural approach to excellence.

In the literature, rather than positive definitions of scientific excellence, one usually finds a set of circular references between the concept of scientific excellence and the criteria used to define it. For lack of clear and comparable definitions of excellence, in this Report we resort to a reconstruction of the definition of the concept of excellence out of two specific items where excellence is defined. The two chosen items are not the only possible ones from which a definition of excellence can be extracted. They are two typical examples out of many, singled out because of their relevance and relative clarity and completeness in comparison with other similar items.

The first item chosen is an excerpt from the opening speech of the annual meeting of the U.S.A. National Academy of Science given by its President, Bruce Alberts, in 2006. This is a typical example illustrating the

[3] Academic excellence is a concept that is hard to frame. The same occurs with the concept of charisma, which for decades has driven sociologists and anthropologists mad, without managing to completely demarcate it. There are other terms which define the aura surrounding social subjects who stand out from the rest of the crowd, such as “prestige”, “charm”, “genius” and so on, to which we have now added specific labels such as “man of power”, “leader of opinion”, “intellectual”, among others. Let us admit, along with Gabriel Tarde, that a large part of social life is based on the way in which subjects and classes imitate their superiors (Tarde, 1985), or let us agree with Pierre Bordieu who, inverting the Tardian argument, claims that the superior social groups are the ones seeking to create a distinction by means of cultural and social uses, learnt only from a long classist enculturation (Bordieu, 1988). These mechanisms, which can ultimately be reduced to one alone, were branded “distance” by Tarde and “distinction” by Bourdieu, and are basic and elementary in order to understand excellence as a social category..[…] (Ortega, in Garcia de Leon 2005, p. 59)

usage of circular reference between excellence and the criteria by which it is recognized. The question of what is excellence is spelled out loud and clear, with the answer also being very clear, albeit circular:

> *What has emerged from our [the N.A.S.]) long evolutionary process is an institution with four types of functions. These are:*
> *1)* ***Validating*** *scientific excellence,*
> *2)* ***Maintaining*** *the vitality of the scientific enterprise,*
> *3)* ***Applying*** *the judgments of science to public policy, and*
> *4)* ***Communicating*** *the nature, values, and judgments of science to governments and to the public.*
> *Let me briefly describe each of these functions in turn.*
> *I begin with our validation role.* ***What is excellence in science? Excellence is measured in part by the prizes and awards that are given to scientists. In particular, our 2,100 members are living examples of how we define excellence in science.***[4] *Each of us serves as an important role model — both for younger scientists and the public. For this reason, election to the Academy is a responsibility, as well as* ***an honour***[5]*.*
> *Very often, election to the Academy provides a* ***recognition***[6] *that will thrust the selected scientist into a* ***new leadership role***[7]*. This is particularly true for institutions that contain few Academy members, or in places where the scientific base is relatively weak.*
> *Like it or not,* ***the election of the new members tomorrow will profoundly affect many future resource allocations for science across the United States***[8]*. In short, who is — and who is not — a member of the National Academy of Sciences is a matter of considerable importance for the future of science in our nation.*
> *We cannot dismiss this very important fact.*

Four concepts, (text underlined by the Rapporteur), stand out in this definition of excellence:

- Excellence is measured by the prize it receives;
- Who is and who is not chosen as excellent is very important for the future of science;
- Excellence has to do with leadership;
- Excellence has to do with recognition of honour.

The second item we chose to use is the Working Programme 2010 of the European Research Council, transmitted for adoption to the Commission on April 2, 2009[9] (ERC, 2009). This document, which is of utmost importance to the European Union Science policymaking concerning excellence, declares that:

> "*The fundamental principle for all ERC activities is that of stimulating investigator-initiated frontier research across all fields of research, on the basis of* ***excellence***[10]*. Awards will be made and grants operated according to simple procedures that maintain the focus on* ***excellence***[11]***,*** *encourage initiative and combine flexibility with accountability*"**.**

It then proceeds to define excellence in terms of the requirements that makes an applicant eligible for the two kinds of grants that the ERC gives, i.e.:

a) The ERC Starting Independent Researcher Grants, which aim to provide critical and adequate support to the independent careers of excellent researchers (p.11)
b) the ERC Advanced Investigator Grants (ERC, the objective of which is to encourage and support excellent, innovative investigator-initiated research projects by leading advanced investigators (p. 22)

The eligibility criteria for the ERC Advanced Grants, i.e., those reserved for senior researchers, are:

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[4] Underlining by the Rapporteur
[5] Underlining by the Rapporteur
[6] Underlining by the Rapporteur
[7] Underlining by the Rapporteur
[8] Underlining by the Rapporteur
[9] This work program is published on the ERC website at **http://erc.europa.eu**
It can also be downloaded from the CORDIS page on http://cordis.europa.eu
[10] Underlining by the Rapporteur
[11] Underlining by the Rapporteur

“Normally 10 publications as senior author (or in those fields where alphabetic order of authorship is the norm, joint author) in major international peer-reviewed multidisciplinary scientific journals, and/or in the leading international peer-reviewed journals and peer-reviewed conferences proceedings of their respective field.

Normally 3 major research monographs, of which at least one is translated into another language. This benchmark is relevant to research fields where publication of monographs is the norm (e.g. humanities and social sciences).

Other alternative benchmarks that may be considered (individually or in combination) as indicative of an exceptional record and recognition in the last 10 years:

- *Normally 5 granted patents*
- *Normally 10 invited presentations in well-established internationally organised conferences and advanced schools*
- *Normally 3 research expeditions led by the applicant*
- *Normally 3 well-established international conferences or congresses where the applicant was involved in their organisation as a member of the steering and/or organising committee*
- *International recognition through scientific prizes/awards or membership in well regarded Academies”*

The ERC then proceeds to establish a two-step evaluation procedure, along which the applicant, the project, and the research institution are evaluated according to scale of points from 1 to 4, as:

1. **Outstanding**
2. **<u>Excellent</u>**
3. **Very Good**
4. **Non-competitive**[12]

Here again, excellence is not defined in so many words, but by the standards that must be met to demonstrate that excellence has been achieved. It is the standards that define excellence. Why these standards are good standards to measure excellence remains obscure.
In the same text, the twin concepts of leadership and recognition are introduced. For starting grants, the applicants should describe as follows their scientific leadership potential:

> ***1(a) Scientific leadership potential**: A description of the applicant's scientific leadership potential should include:*
> *• A presentation of the content of early scientific or scholarly achievements of the applicant to his or her own research field, demonstrating the applicant's qualifications and potential **<u>to go significantly beyond the state of the art;</u>***
> *• The **<u>recognition</u>** and diffusion that these early contributions have received from others **<u>(publications, citations or appropriate equivalents/additional funding/ students/international prizes and awards/ institution-building/other);</u>***

and for advanced grants the applicants should provide their scientific leadership profile:

> ***1(a) Scientific leadership profile**: A description of the applicant's scientific leadership profile should include:*
> *• a presentation of the content and **<u>impact</u>** of the major scientific or scholarly contributions of the applicant to his or her own research field and/or neighbouring research fields, demonstrating the applicant's capacity to go significantly beyond the state of the art, and, if applicable, their wider societal impact;*
> *• the international **<u>recognition</u>** and diffusion that these major contributions have received from others (**<u>publications, citations or appropriate equivalents/additional funding/ students/international prizes and awards/ institution-building/other</u>**);*
> *• evidence of efforts and ability to inspire younger researchers towards high quality research (highlights of research mentoring record, information on the careers of supervised graduate and post-doctoral students, etc.);*

[12] It is interesting to note that “Excellent” in this scale is only the second-highest evaluation. The highest evaluation is “Outstanding” which is the exact English translation of the Latin (*ex*=out of; *celsus*=standing high). It is better to stand out in the new common language of science, English, rather than in old one, Latin.

• *where applicable*: ***proven ability to productively change research fields and/or to establish new interdisciplinary approaches***

In this text, the same concepts that emerge are:

a) Impact
b) Recognition
c) Originality (go beyond the state of the art, establish new interdisciplinary approaches)
d) Leadership (to productively change fields).

There is only one scientific field where it was possible to find a positive definition of scientific excellence. In medicine, excellence is defined by referring to the primary aim of the discipline, namely to improve health and prolong life. For example, some of the main awards for excellence in medicine are given in the U.S.A. by the Lasker Foundation[13], whose mission is:

> *"…to foster the prevention and treatment of disease and disabilities* ***by honouring excellence in basic and clinical science****, by educating the public, and by advocating for support of medical research" […] "it* ***honours*** *with the Basic Medical Research Award scientists whose fundamental investigations have led to techniques, information, concepts contributing to the fight against the major causes of disability and death, and to the prolongation of the prime of life, and with the Clinical Medical Research Award investigators whose achievements have improved the clinical treatment of patients, helping to prolong the prime of life, and alleviating or eliminating major causes of disability and death".*

It is possible for us at this point to attempt to derive a positive definition of scientific excellence from the texts quoted above and in similar works. This positive definition of excellence would be along the following lines:

> **Definition 1:** ***Scientific excellence is the ability of a scientist or an institution to impact on a field of study producing a major change, leading other scientists towards asking new questions and producing new, important and useful contributions to knowledge, using new methodologies. The quality of excellence must be proven by a number of means, (such as publications, citations, funding,and students) and recognized by the peers by the bestowing of various honours, prizes and other awards.***

However, the most important contribution on the topic of Gender and Excellence, the Report *Gender and Excellence in the Making* (Addis and Brouns, 2004), deliberately voids giving any such positive definition. Rather than a definition, the introduction gives us a critical viewpoint, as follows (p. 27):

> Critical viewpoint: *"During the workshop* ***the pursuit of excellence was described by many participants as a set of practices framed within a 'discourse',*** *used by the scientific community to organize its self-governance [...] The workshop frequently discussed the validity of existing definitions and methods for measuring scientific excellence, in connection with the variety of scientific practices, interdisciplinary research, and mainstream versus periphery in terms of issues, methods and location. [...] The discourse about what characterizes excellence is generally not subject to scientific evaluation, and the actual practices in each branch of science are often quite idiosyncratic.* ***It is assumed that the scientist in each field somehow acquires, from his or her environment, a notion of what excellence*** *is, and that there is no need for a critical evaluation of the concept and of its correspondence with actual practices. There is a dominant characterization [of excellence] the one adopted in the natural sciences, which produced standards that have been easy to adopt more generally but has been criticized as rather limited and prone to reductionism"*

In other words, according to this interpretation, the characterization of excellence as presented in definition 1 is precisely the notion of excellence which the scientist in each field supposedly somehow acquires. According to the authors of the Introduction to the *Gender and Excellence in the Making* (Addis and Brouns, 2004) it cannot be adopted *sic et simpliciter* without running the risk of positivistic reductionism.

The reason is clear: definition 1 is phrased in terms of an existing ability, something that a scientist either has or does not have, something intrinsic to the single scientist, like his or her hair colour. The critical viewpoint instead sees the existence of excellent scientists, i.e. excellence, as the result of a set of practices that

[13] http://www.laskerfoundation.org/about/index.htm

determines the positioning each individual scientist reaches within the network and the hierarchy of his or her field. In the critical view, excellence is a set of practices functional to the governance of the scientific community, i.e. to the allocation within the scientific community of resources and decision power. Decision power: some people feel that they are more able than others to make the right decision, i.e. to lead, and they persuade the rest of the people of this fact, thus becoming leaders. This process is heavily gendered: historically and psychologically, men are more inclined to lead, women to follow. One of the great social changes of our times is that more women now than in the past feel that they have the ability to lead; there is a sense that on the whole, men are less happy than women with the proposed change in roles and in power.

Box 1.1. An example of the critical approach to excellence from GSD

Beaufays, S. 2007, 'Alltag der Exzellenz. Konstruktionen von Leistung und Geschlecht in der Förderung wissenschaftlichen Nachwuchses' in R. M. Dackweiler, ed. Willkommen im Club?: Frauen und Männer in Eliten, Westfälisches Dampfboot, Münster, pp. 145-165 (Daily routine of excellence. Construction of performance and gender in young scientists' promotion).

The contribution of women's and gender studies shows that scientific performance emerges in social processes of appreciation and recognition and is therefore never free of power relations; thus, it forms no objective basis for a fair competition to attain rare top-level positions in this social action field. In order to illustrate this argument – based on the question of how power as a social construction develops in social practice – this work uses both a theoretical and an empirical approach. First the work clarifies from a sociological perspective some concepts of P. Bourdieu,such as the social dimension of performance.Then, the study introduces statistically well-documented disparities between women and men in relation to participation opportunities in scientific work. Also,the central findings of an empirical study on the conditions of young scientists' careers are presented.
Finally, it shows that in order to gain visibility and be recognized in the scientific field, the self-assessment of young scientists, on the one hand, and on the other, a pre-understanding of mentors for appreciation of their staff are of central importance. Self-images of young scientists and promotion practices of mentors are identified as reflecting the 'illusion' (Bourdieu) of the scientific field, In this illusion, and also in the practical sense of the scientific field, recognition mechanisms are embedded, hindering women on their way towards a scientific career.

There is no contrast between definition 1 and the critical viewpoint. We can ask why, given that there are no biological impediments, so few women develop the *ability to impact a field of study producing a major change, leading other scientists towards asking new questions or producing new results using new methodologies,* and so on, i.e. why so few women become excellent. The answer is in the social practices that lead to excellence, in the procedures. Excellence is procedural, not substantive. Excellence does not exist *per se*, regardless of the practices that create it. The fact that we can define it does not give it autonomous existence. Hence, we may hope to change the practices in such a way that a feminine scientific excellence, or better, a different scientific excellence embracing both genders, will begin to emerge and be recognized.

Definition 1 is of some use: it suggests where, in the procedures, the most problematic aspects may be located: in **measuring impact**; in the relations between femininity, masculinity and **leadership**, and in the importance of the conferment of **honour** in relation to gender.

However, a correct understanding of excellence and of the processes whereby excellence may be achieved is essential in order to develop effective policies. If we identify excellence with the existing top layer of the academic hierarchy and design policies allocating resources mainly to this top layer, then the quest for scientific excellence may boomerang, slowing down women's integration into science. The quest for excellence should not be used to perpetuate old mechanisms of cronyism, lack of transparency in cooptation mechanisms, and gatekeeping that systematically favours male homosociability. This would prevent the achievement of excellence by the European scientific community as a whole. If, instead, the quest for excellence is interpreted correctly as a process that should be free of gender biases and if the requirements of excellence are defined in such a way as to encompass the different lives of men and women, such a policy would be able to tap misused intellectual resources of many potentially excellent women scientists in Europe.

1.2. Managerial origins and relations with the gender-studies epistemic community

As noted by Sven-Eric Leadman (in Vetenskapsrådet, 2006), “the concept of excellence in science is at the same time of ancient and of recent origins. Scientific endeavours have always been valued in different ways, but to talk of ‘excellence in science’ as a homogeneous concept open to different kinds of evaluations and even quantifications is a novelty”.

The noun “excellence” exists in the English language since the 14th century. The definitions provided by various online dictionaries and thesauri describe it as “being the best of a kind”, and define excellent as: “very good of its kind: eminently good” (http://www.britannica.com/bps/dictionary?query=Excellence)[14].

The concept of ‘excellence’ is therefore defined as an order, and the set among which what is ‘excellent’ is chosen appears to be an important feature of the concept.

On the website of the Nobel Foundation, the organization which awards the prize which is commonly considered the highest mark of excellence, and which has been operating for some time, the word ‘excellence’ was seldom found or defined, even if the word ‘excellence’ does sometimes appear in the biographies of the scientists who have been awarded the prize. In the original formulation, the Nobel Prize does not promote “excellence”, but rather “achievement”. It appears, therefore, to consider the importance of the result, rather than the order of the people. There are other subtle differences between the two concepts: “achievement” is absolute, “excellence” is relative. The term of comparison for achievement is the prior state of nature, against which one achieves a result. The term of comparison for excellence are other people; excellent is the one who stands out with respect to the others. The fact is that one person’s achievement does not prevent others from achieving as well: maybe achieving something else less important, but nonetheless achieving. Excellence, on the other hand, is not a matter of degree; you are more excellent, I am less excellent. In the case of “achievement”, we are running different races, each to his or her own, and we all finish. In the case of “excellence”, we are all running the same race, and if one wins, the others lose[15]. This is, of course, true within the boundaries of what constitutes a field. The most excellent scientist in the field of physics is incommensurable with the most excellent in the field of biology, for example. If we were to fraction the fields into subfields, we could ascertain who is most excellent in each subfield. If we join two fields to make one, we go from having two different rankings, each with two excellent scientists at the top, to having only one ranking of excellence with one scientist at the top. There are scientists who speak of a pecking order of the sciences, with physics at the top, and even of the fact that in recent years, the pre-eminence achieved by nuclear physics as a consequence of unleashing atomic energy has been challenged by biology, since the genome sequence and related advances hint at more important progress to come.

Why, in the last decades of the twentieth century, do we witness this novelty, the growing interest in fostering scientific excellence?

One possible explanation is that the term was borrowed by one of the most influential epistemic communities of recent decades, the managerial community. The widespread usage of the term in recent years may be connected with the influential In Search of Excellence, an international bestselling book written by McKinsey consultants Tom Peters and Robert H. Waterman, Jr.. First published in 1982, it is one of the most bought business books ever, selling 3 million copies in the first four years, and was the most widely borrowed library book in the United States between 1989 and 2006 (WorldCat data). The book explores the art and science of management used by leading 1980s companies with records of long-term profitability and continuing innovation (see Box 1.2). The authors derive from the study of these companies eight characteristic criteria, and they propose procedures to gauge, if not to measure, whether other companies are acting in conformity with the excellence criteria. This derivation cannot be proved scientifically: correlation is not causation. However, there is a strong correlation between the proliferation of works on excellence in management and in science.

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[14] Wikipedia definition is: **Excellence** is the state or quality of excelling. This is a tautology, but, quoting the economist Don Patinkin, what is and what is not a tautology depends on how fast one thinks.

[15] Excellence is naturally controversial, from the moment in which, being a scarce commodity, all subjects who deem themselves equal aspire to it, and yet its constitution is one of a commodity that can be possessed to an equal extent by all. (Ortega in Garcia de Leon, 2005, p. 59.)

Box 1.2 Peters' and Waterman's Eight Attributes of Excellence

Peters and Waterman looked at some of the best-managed companies in the United States and found that they had a lot of things in common. They compiled a list of eight qualities that they believed to be present in the companies. Although not all eight were present in every company, these qualities regularly stood out. Strive to develop these qualities within your organization.

1. *A Bias for Action: Company gets things done; increases knowledge, interest, and commitments.*
2. *Close to the Customer: Customer satisfaction is very important throughout all the roles that the business plays.*
3. *Autonomy and Entrepreneurship: Encourage risk-taking and innovation.*
4. *Productivity Through People: Everyone is respectful and enthusiastic towards each other. This creates an atmosphere that enables good work.*
5. *Hands-on, Value-Driven: Company philosophy and values are discussed openly. Leaders in the organization are also positive role models.*
6. *Stick to the Knitting: Company focuses on doing what it does best.*
7. *Simple Form, Lean Staff: Authority is shared as much as possible between the employees.*
8. *Simultaneous Loose-Tight Properties: There is good planning and controlling that still allows for worker autonomy and a less rigid atmosphere.*

There has been endless debate and criticism on the scientific value of their findings. Some of the companies used as models went bankrupt not long after the book was published. Different criteria and different procedures to assess excellence have been proposed as modifications or alternatives to the proposals by Peters and Waterman. Two words often associated with excellence in this debate are "quality" and "leadership": a company achieves excellence by taking the leadership in producing. The topic is still very important in the U.S.A. The Baldridge National Quality Program, for example, is a foundation which formalized the criteria for excellence of companies, devised a scoring method and encouraged firms to apply these criteria as a tool to improve performance. Its mission is to give awards to those firms who improve their performance in the quest for excellence.
An interesting testimony of the relationship between managerial science and the quest for excellence comes from the following excerpt, taken from the Report on Metrics for Scientific Excellence at Los Alamos national Laboratory, an U.S.A. establishment that deals with science and technology applied to national security issues.

> *"The Los Alamos Fellows are committed to excellence in science and technology. Excellence and technical credibility have been at the heart of the Laboratory's identity, making our national security mission possible. We are heartened by the dedication to excellence expressed by the LANS leadership team, and want to help them identify appropriate tools to manage for excellence.* ***Metrics are important because, when evaluated carefully and meaningfully, they change behavior at all levels****.* ***Metrics are the tools that allow the Director to require accountability from management and staff. It is an axiom of management that one can manage what can be measured. Although quantifying excellence can be elusive, metrics of excellence are essential.*** *The Los Alamos Fellows have therefore assembled a task force to recommend metrics for excellence…"*[16]

This quotation is remarkable because it is one of the few instances in which people who are in favour of the use of metrics justify it with the will to modify some people's behaviour according to the lines dictated by management such as a power operation. Managerial techniques are extremely effective in dealing with the production of standardized objects. In her contribution, J. Beavin Bavelas objects to the idea that they can be applied successfully to the earlier stages of a research, when creativity and fundamental intuitions, rather than rigor and orderly delivery, are needed. This by no means denies that the latter qualities are also needed to produce the final result.

We may ask why and when the quest for excellence moved to this side of the Atlantic. One hypothesis is precisely that a determining factor was a commendable desire to compete with the U.S.A. and grow at the same rate. According to some observers, the European economy in the last decades of the twentieth century lagged behind the American economy in terms of innovation-related productivity. There was a consensus in

[16] Fellows' Report on Metrics for Scientific Excellence at Los Alamos May 7, 2006 LA-UR-06-3393

the economic profession regarding two stylized facts causing the relative decline of Europe with respect to the U.S.A: first, the excessive regulation and public intervention in the labour market via welfare state institutions, and second, the possibility for U.S.A. based companies to apply to production the results of scientific and technological advancement produced by the research system (academia, dedicated centres and laboratories, research and development within the companies). The leadership of the U.S.A. in the new information technologies was proof of this superiority. The term 'excellence' was thus adopted as a catchword to indicate science policies aimed at improving the quality of European research to fill a perceived gap in leadership and competitiveness of European companies - particularly those operating in the field of Science and Technology- with respect to the U.S.A.[17]

The feeling, on this side of the Atlantic, was that the results of American science and technology derived from a competitive system – competitive in the economic sense of the word. Universities and research centres were acting as maximizing agents competing for students and for private as well as for public funds; academics were competing for open positions. The pressure to outperform other institutions and other academics, together with the possibility of reaping the economic rewards of one's discoveries, was fuelling American scientific superiority. An interesting account of the U.S.A. system along these lines is presented by Furedy in his contribution to the book "Scientific Excellence" edited by Jackson and Rushton (1987) , which contrasts it with the Soviet and Eastern European systems of the times.

Furedy does not deal with the Western European research system. However, many practitioners of both systems agree that, compared with the U.S.A., European systems were, and still are, public and administered. Competition for good students is limited by national and linguistic boundaries. Funds and positions are allocated not only according to scientific merit but also according to a number of political criteria, which are different in each nation. Academics and other researchers have fewer economic incentives to perform – again, more so in some countries than in others – but are generally less subject to competitive pressures, and there is a large enough consensus, at least in some fields (e.g. economics), that this is the reason why Europeans are not as scientifically productive as researchers in the U.S.A. There are, of course, dissenting opinions on the causes and remedies for this situation. According to one line of thought, however, in order to upgrade the research systems, elements of competition should be introduced in the European systems, mimicking the competitive pressures that the private system provides in the U.S.A. The first outcome of this approach was the British R.A.E. (Research Assessment Exercise) originating in the "revolutionary conservatism" of Margaret Thatcher (Rees, 2004).

This association of "excellence" with the culture of management and with the pro-market competition ideology generated a certain diffidence in some areas of academia towards the word and associated policies. In particular, there was and there is an epistemic community originating after the feminist wave of the 1970s, which includes women's studies, gender studies and feminist studies[18]. This community felt threatened by this call for economic productivity and for the strengthening of the hierarchical structuring of the scientific community. Making women visible in all disciplines was, and still is, a theoretical need, which does not need to be immediately linked with economic productivity. Inclusiveness and egalitarianism were, and still are, basic values motivating many feminist scholars engaged in women's and gender studies and they are values which go against the grain of the value of selecting and giving resources only to the best. This, among other factors, implied that no attempt was made to recognize excellence in women's and gender studies. Scholars complained because no specific panel for gender studies was introduced in the R.A.E.; moreover, in this leading experience of centralized excellence management, interdisciplinarity, which is an important part of innovative technological development as well as a feature of studies aiming to understand gender relations, was not much rewarded in the structure of the R.A.E. (Rees in Addis and Brouns, 2004).

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[17] The choice of the word was perhaps a bit unfortunate from the gender viewpoint in the English-speaking world: "**Excellent Women"** is the title of a famous novel by Barbara Pym, first published in 1952, and generally acclaimed as the funniest and most successful of her comedies of manners. The phrase, "excellent women", is used ironically in the book as a condescending reference to the kind of women who perform menial duties in the service of churches and voluntary organizations. Very few readers of the Pym book may be inclined to use as a role model the women portrayed by Pym as excellent.

[18] From the methodological point of view, women's studies aim to make women visible as a subject of study; gender studies aim to understand relations among people of both sexes, and feminist studies make an explicit ideological choice in favour of policies that empower women. Some information about sex differences is needed as a basis for gender studies and for feminist studies. However, a feminist standpoint may or may not be taken to study women and to study gender.

Box 1.3 *Between the Ivory Tower and the Academic Assembly Line. Abstract of Barry, J., Chandler, J. & Clark, H. 2002 (from the GSD)*

This paper considers the impact of managerialism and the reactions it has engendered in university life. It examines the degree to which institutions of higher education in the UK have in recent years been subjected to what some commentators have seen as a managerial assault, alongside economic pressures to restructure and reform, and explores the reactions of academic and administrative staff in middle and junior levels through a case study of two universities. Consideration is given to attempts to introduce managerial controls, including the setting of targets, appraisals and peer review, as well as to the resistances which followed. It is argued that the notion of resistance to domination and control has been underplayed in the literature of organization and management. In exploring its various manifestations it is shown that managerialism is not fully embedded in university life and that matters are far from settled. It is contended that those engaged in academe in middle and junior levels of the organizational hierarchy are actively seeking to keep alive the craft of scholarship by mediating and moderating the harsher effects of the changes through supportive or transformational styles of working.
Downloaded on 16/12/2002, Available at:
http://www.blackwellpublishing.com/journal.asp?ref=0022-2380.

One of the issues that requires reflection is whether this diffidence was warranted and still is warranted, or whether, and how, it is possible to pursue a policy in favour of excellence that increases women's presence in science and that allows for the excellence of both women and men.n science.

1.3 Procedural approaches to scientific excellence: models of excellence formation

It often occurs that by using the "gender" lens to analyze a social phenomenon, and by attempting to explain the difference in relative outcomes of men and women, the social scientist is able to understand some aspects of a social structure that were hitherto unknown[19]. The scarcity of women who achieve full excellence is the final outcome of the set of processes that involve both sexes. Making an easier path for women who have the potential towards full excellence requires understanding the entire career process of women and men scientists.

The attempt to understand why women do not achieve excellence at the same rate as men has produced three main models which describe the process through which excellence is achieved, or its mirror image, the process through which excellence is not achieved. Although none of these models tells the full story, each provides important insights into the functioning of the scientific community[20]. They are:

- the "pipeline" model
- the "threshold of selection" model
- The "life course" model

All three models are described below.

1.3.1. The pipeline model

The first model, in chronological order, is the so-called ***pipeline model.*** A search of the keyword "pipeline" brings up 88 entries in the GSD (as of February 2010).The model was first introduced by Sue Berryman in a report commissioned by the Rockefeller Foundation titled *Who will do science? Minority and Female attainment of science and mathematics degrees: Trends and Causes* (1983). She introduced the term 'pipeline' as a conceptual metaphor to help outline the representation of women and ethnic minorities in

[19] This was noticed in the introduction to Carabelli et al. (1999)

[20] Some important approaches to the study of the scientific community are not gendered. For example, the pioneer approach by Bruno Latour which conceptualizes scientific communities as networks has not yet been subject to gender analysis.

America (Asian, Black, Hispanic, Indian) among B.A, M.A and PhD degrees in quantitatively based disciplines.

In the words of Berryman herself, the core of the ***pipeline model*** approach is based on the fact that "at any given degree level, a group's share of quantitative degrees reflects two factors: persistence in the pipeline and field choice. To assess persistence we trace the progress of cohorts through the educational pipeline. All subgroups lose members as they progress through the system; the issue is whether at particular points in the process a subgroup loses more or fewer than all other groups". (Berryman, 1983, p. 12).

The finding of the analysis is that there is a pool of mathematical talent that is determined and present at an early career stage (12^{th} grade) and that different subgroups are lost at different stages: e.g., blacks are lost uniformly along the pipeline; women are lost disproportionately at the penultimate stage, i.e., the level prior to PhD.

The key point that the ***pipeline model*** underlines effectively is that the further along the pipeline one looks, the fewer women one finds. The pipeline is a metaphor suggesting that they are leaking out. Hence, the implication of the metaphor is that, in order to increase the representation of women in science, policies must be devised to "block" the leakage at the points in which the pipeline loses more women than men. It is based on an empirical analysis of gender differences across the entire process of becoming a scientist rather than on discrete educational and career stages.

Berryman worked on data as regards degrees obtained by the various groups, up to the PhD stage. She did not study the scientific career, i.e. the last stage of the pipeline that goes from PhD to full professor by way of postdoctoral fellow, untenured member of a faculty, tenured assistant, associate, and finally full professor in the U.S.A. Further studies used her methodology to study scientific career. Particularly relevant are the contributions of Berg and Ferber (1983), Broder (1993) Kahn (1993).

By conceptualizing the scientific career as the final section of a pipeline, this model concisely and visually describes where leakages occur, leading to shortages in supply. It raises questions concerning the number of women travelling down the pipeline and how slowly they progress along it, successfully capturing the political concerns about women's entry rates and the emerging focus on their progression. It prompted an analysis to establish where the points of greatest "leakage" were, supporting the argument that the point at which women were exiting scientific careers coincided with greater family responsibilities (Rees, 2001).

Box 1.4 The Matthew and the Matilda Effect

The concept of pipeline was introduced in the literature by Berryman. However, Joe Alper brought additional life to the metaphor with his article in Science (1993) where he summarized studies on why the pipeline is leaking women, and by writing in a magazine with a much greater readership, he introduced the work of Berryman and the metaphor to a wide public. Therefore it is not unusual to see Alper referred to as the father of the metaphor (Højgaard and Søndergaard, 2002). This is an instance of the combined working of two effects, the "Matthew effect"[21] and the "Matilda effect" in citation.

The Matthew effect was introduced by Robert Merton (1968)f, and with reference to the Gospel where it is said: "For to all those who have, more will be given, and they will have an abundance; but from those who have nothing, even what they have will be taken away" (Matthew 25:29, New Revised Standard Version).

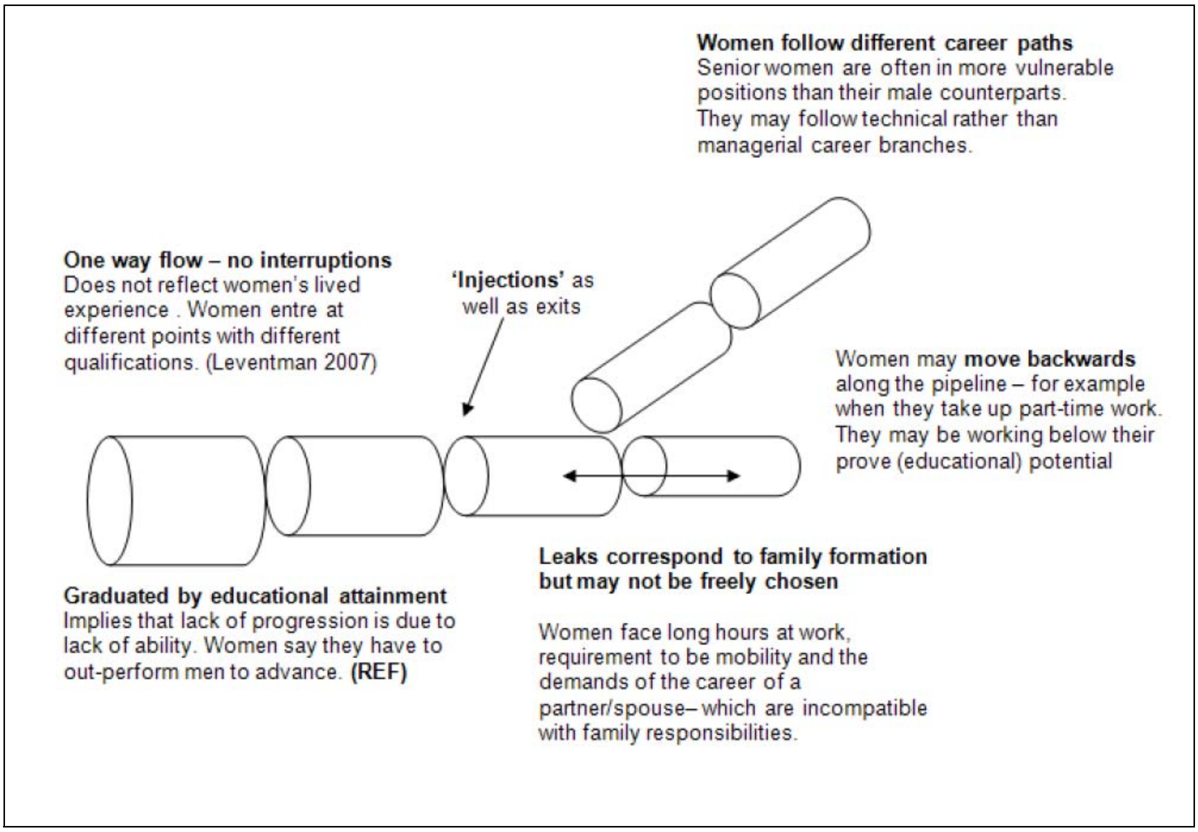
The Matthew effect manifests itself in two areas, funding and citations. In funding, projects of the same quality receive more funding if they include an eminent scientist. Evaluators tend to overestimate the accomplishments of scientists with an established reputation, whereas unknown researchers meet more reserve. In citations, the work of two authors is credited to the one who is already better known. A gender variation of the Matthew effect was also identified, and labelled the Matilda effect: achievements of female researchers are frequently attributed to their male colleagues or otherwise minimized and underestimated. (Rossiter, 1993; Stamhuis, 1995) as reported in Addis and Brouns, 2004 (p. 19). Berryman is female and relatively less known, Alpers is male and relatively more known. Berryman's metaphor reached the mainstream via Alpers, showing the working of a form of gatekeeping.

Excellence can be defined as the final section of the scientific pipeline, with the provision that the pipe becomes narrower and narrower along the way. Every time the pipeline narrows, some people leak out. The number of women who leak out at every step is greater than the number of men. The repetition of this biased leaking creates a cumulative effect. At the end of the pipeline, mostly men and only a few women are left.

In subsequent literature, various aspects and various segments of the pipeline have been explored. Men and women, it was found, are fluids of different density judging by the way they flow in the pipeline. The educational pipeline is often referred to as beginning at the level of elementary school where boys and girls choose maths and science courses. The pipeline continues through high school to bachelor and master's degree level, ending with a PhD in science (Berryman, 1983; Anders, 2004; Atkin and Green and McLaughlin, 2002; McDonnell, 2005) Another set of studies focuses on the career pipeline which runs though the different levels starting at post-doctorate level, where career tracks begin, ending at the very top with a full professorship (Langberg, 2005; Preston, 2004; Sonnert and Holton, 1995; ETAN, 2000; Mählck, 2003). Some studies combine the educational pipeline and the career pipeline (Blickenstaff, 2005; Ivie and Ray, 2005 Pell, 1996). Only a few studies include scientific research in the industry and governments. We can therefore speak of one original ***pipeline model*** and of a set of models that follw the pipeline approach and that derive from or relate to the original .

The figure below provides a graphic description of the pipeline theory as well as a summary of the main exceptions and critiques that have been brought forward to complete or to modify the pipeline view[22].

Figure 1. Critiques of the pipeline model



Some authors (e.g., Lone Svinth) explicitly criticize the ***pipeline model*** for being an inadequate metaphor of the actual events determining the relative lack of women from the range of the excellent, not corresponding therefore to the actual experience of women**.** Women, and people in general, may enter the pipeline at different stages, not just at the beginning, as the model implies. People, and women more than men, may flow backwards in the pipeline as a result of accepting jobs below their qualification due to family mobility. Women must outperform men in order to overcome the gender bias.

[22] Taken from The Anglo-Saxon country group report of the Gender and Science meta-analysis project

Although these are all valid criticisms, it may be also noted that no metaphor can, due to its own nature, completely correspond to its object. A metaphor asserts that something is similar to something else in important, yet not all aspects. The ***pipeline model*** corresponds rather well to the ideal type in the mind of the authorities who organize the education and science sector, who envision a path of formation that resembles a pipeline through various stages of school and academic career. It may very well be that the pipeline was designed paying no heed to the specific lifecycle of women, in a state of gender blindness that resulted in young women being treated as if they were young men.

Particular attention is given to the joints of the pipeline, i.e., to the discrete jumps of both men and women from one career level to the next, thus providing a useful tool for monitoring and policy design. It shows that the flows along the pipeline are tailored to the career history of men, overlooking women's different life courses. Women should flow in the pipeline as if they were young men. Since they have another lifecycle, their behaviour cannot be well described by the pipeline. It is women who are more likely than men to exit and re-enter the pipeline because they have taken maternity leave; it is women who are more likely than men to flow backwards, and are sometimes found at a lower level than they had previously been because they pay a penalty for maternity; the metaphor of the pipeline allows researchers to appreciate the fact that the pipeline as it is fits more closely to men's lifecycles than to women's, thus becoming a source of bias. This observation is particularly important because it can be reversed. An educational and career system designed as a pipeline favours male researchers as it is adjusted to their lifecycle. A different organization of the educational system and of the career progression path, allowing for entries at different times, allowing for leaving and re-entering, might provide a structural underpinning to gender equality in science and therefore act as a stepping stone for women to achieve full excellence.

The ***pipeline model*** has one advantage: stretching the metaphor, it allows us to understand clearly that the problem of the missing women may derive from two different sources, both of importance. The first source of the problem are the faulty pipes; the second is the behaviour of the fluid. The pipes are the norms governing the academic structure and the obstacles that women more than men encounter within the system: invisibility, discrimination, double standards, marginalization and so on. The fluid are men and women, and the different choices women make in favour of other pursuits, chiefly childrearing and other family engagements which are privately and socially valued.

1.3.2 The "threshold of selection" model

A second model is the "threshold of selection" model, or selection model, first proposed in the Report *Gender and Excellence* (Addis and Brouns, 2004) and revised in Addis (2008). The Report contains the results of the workshop 'Minimizing gender bias in the measurement of scientific excellence', held at the European University Institute (EUI) in Florence in October 2003.[23]

The rationale for the workshop was developed from two observed trends: first, the increased formalization of systems of evaluation in some (but not all) countries of the European Union (and elsewhere), itself part of a broader emphasis on accountability; second, a direct focus on the general under-representation or under-promotion of women in science (albeit with variation according to institutional sector, level, and scientific field). The organizers were aware of the fact that processes which give rise to inequalities in scientific careers across different social groups are multi-faceted. More will be said about other contributions to the Workshop later in this Report.

The introduction to that Report provides a synthetic graphical summary of the many contributions made to it, which identify the "threshold of selection" model of the production of excellence and proceed to deconstruct it adopting a gender perspective.

The aim of the model is to show that there is very little that is natural and very much that is social in the process of excellence definition. Consequently, the definition of excellence can be changed so as to include women, without expecting them to live and behave as men.

[23] The workshop was jointly organised by the Women and Science Unit of the European Commission's Research DG, headed by Nicole Dewandre, by the Women and Science Network of the European Commission's Joint Research Centre of Ispra, led by Delilah Al-Khudhairy, and by the Robert Schuman Centre for Advanced Studies of the European University, directed by Helen Wallace, which at the time operated the Interdisciplinary seminary of Women's studies, convened by Dawn Lyon.

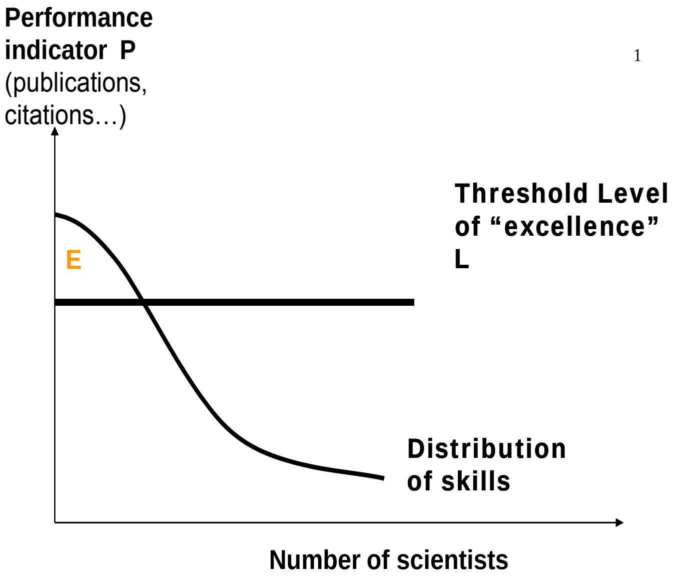
The model is built summarizing the evidence reported by the contributors to the volume regarding the problems women encounter in achieving excellence, i.e.:

a) The small number of women among scientists affects the F/M proportion among the “excellent” scholars creating an unfavourable stereotype.
b) The definition of indicators is problematic, because:
    - Indicators of performance are artefacts that measure only approximately the true ability to produce new and useful knowledge. In this gap between indicator and true performance, there is room for bias due to homosociability or the desire for power. Indicators that bias in favour of males are used, rather than indicators that might bias in favour of women.
    - Personality traits which are systematically different between men and women such as risk aversion or competitiveness may affect the indicator without affecting true ability.
c) Since there is room for bias, due to homosociability, gatekeepers have discretionary power. Therefore it is important who the gatekeepers are.
d) Women and men are attracted to different research topics; gatekeepers of only one sex will favour some topics while questions of greater interest to the other sex will not be fully investigated, thus establishing a bias in knowledge.
e) In some countries, institutionalized boundaries of the discipline create conservativeness and problems for borderline, interdisciplinary and very original work. The work on gender issues was often interdisciplinary and therefore disregarded in each field while an independent Gender Studies field was not institutionalized. Interdisciplinary work falls between the boundaries of the fields.
f) The repeated application of a small biased standard creates a large bias at the end of many cycles.
g) Once the unfavourable stereotype is established, this is likely to lead to double standards. A person who belongs to the group stereotyped as less competent will have to perform better in order to be recognized as "excellent". Hence, women must be better than men to achieve the same rank.
h) Such setting of double standards is easier if the standards are fuzzy. If neither the judges nor the judged know exactly what is it that is being measured or how, it is easier to set higher standards for one group, such as women.

The selection model is built starting from the consideration that “excellence” to many scientists, both male and female, appears as a fairly simple concept, presumably corresponding to an objective and easily measurable variable. It assumes that talent is distributed among people so that some have more, some less, according to some statistical distribution. Some people reach a given level or threshold established by the scientific community, which can be measured more or less objectively to create a ranking of “excellence”. They receive salaries and resources to carry out research accordingly, as well as positions of responsibility and various awards and honours, up to the Nobel Prize, given to the scientists at the highest rank.

This scheme is illustrated in Graph 1 below.

Graph 1. A simple model of excellence



Source: Addis (2008)

The number of people engaged in science is measured on the horizontal axis while performance is measured on the vertical axis by an indicator, P, such as publications or other quantifiable indicators, impact factors, H values, university of graduation, and so on. The indicator is accepted by consensus in the scientific communities and thus depends on the preferences of the gatekeepers.

The curved line represents the distribution of the skills which are relevant to being a good scientist. The straight line represents a given level of the indicator variable L.

If PS is the value of the indicator P, for example publications, associated to a given scientist, S, and if LP is the threshold level of the indicator P agreed on by the scientific community as that threshold of excellence, then:

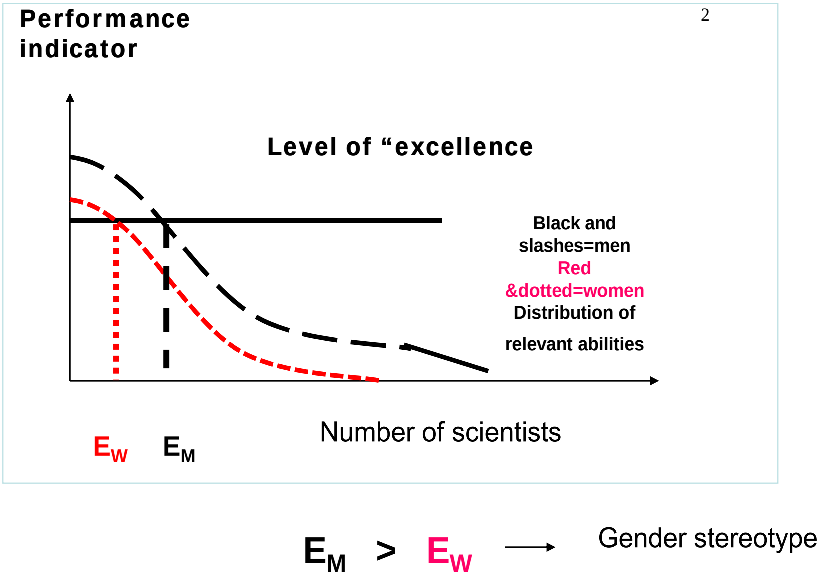
PS > LP ==> ES

In other words, when the scientist S is above the "excellence" threshold L then that scientist is considered "excellent", ES. The area E under the curve represents the number of publications by excellent scientists, i.e. the "excellence" produced.

If this simple scheme were correct, the only remaining issue would be to find good indicators and agree on their merit as well as the relative weight of different indicators P. Then we would be able to compare and rank scientists, and decide who is and who is not in the "excellent" category.

If people were all identical, or if there were an equal number of men and women with the same distribution of skills, then the simple model in graph 1 would apply. But this simple version of the selection model falls apart if we bear in mind the fact that there are people of two sexes. Let us consider first the difference in number of men of women participating in scientific activity. If, for whatever reasons, women participate less in scientific endeavours, the situation changes, as described by Graph 2.

Graph 2. Low women's participation (high men's participation) generates stereotypes



Source: Addis (2008)

The small dotted curve represents the distribution of abilities of women. It has the same shape as the large dotted curve that represents the distribution of abilities of men, because men and women potentially have the same abilities. Women's distribution lies below men's distribution because a number of women, those represented by the gap between the two lines, have dropped out of science to do something else. They have dropped out in the same percentage at all levels of abilities (the distance between the two curves is the same along the entire way). This part of the model is also coherent with the pipeline model, even though it highlights different aspects of the process according to which scientists are produced and selected.

As the graph illustrates, for purely statistical reasons, even if abilities relevant to the production of excellent scientific work are distributed equally among the sexes, a low F/M ratio in the population of scientists produces a low F/M ratio among the "excellent" scholars, implying that the number of "excellent" men, $E_{M,}$ is larger than the number of "excellent" women E_W.

If F/M < 1 =====> $E_M > E_W$

What happens in consequence is stereotyping: if it is customary to find more men than women among excellent scholars, then masculinity is apt to become a sign of excellence. The stereotype that men are better than women at doing science is born.

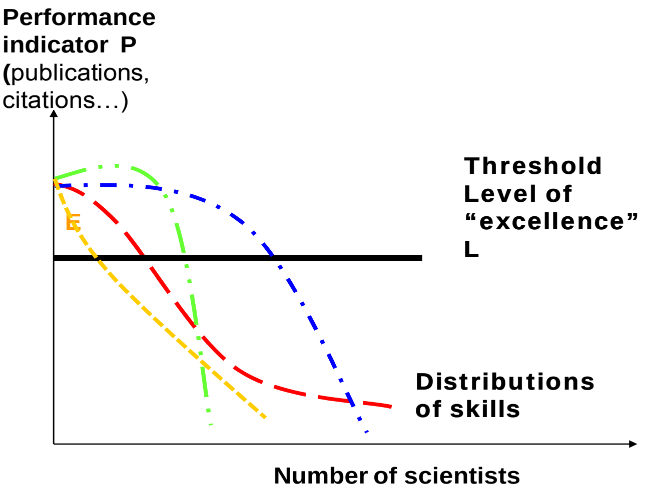
Stereotyping is a concept very akin to the concept of statistical discrimination. The latter was introduced by Thurow (1975) in Labour Economics. According to the statistical discrimination model, collecting information is costly. If being a man increases the likelihood of being excellent, rational employers saving on information costs are going to prefer men and select men for a position which requires excellence unless women with overwhelmingly higher qualifications are available. Between two people who are alike in all other regards, the male will be chosen. A cycle of statistical discrimination starts even if abilities are distributed equally among the sexes. Women who devote themselves to science and have the same potential as their male colleagues do not get the same opportunities to develop this potential: they have to prove themselves as better than men.

A further question raised in this model is the appropriateness of indicators. Indicators are estimates of a true skill, which can be measured only by its outputs. What skills are measured by the curve in graphs 1 and 2?

Presumably, abilities relevant to producing the indicator of excellence P. Each different P (publications, journal of the publications, university of graduation, and so on) is the result of the application of more skills than one. In the case of publications, for example, many characteristics of a human being contribute to producing publishable work: ability to write, numeracy, knowledge of the subject matter, original thinking, choosing a “hot” topic, and so forth. Different observers may disagree on which of these characteristics is more relevant. Some believe that originality is more important than precision, others believe it is the other way round. It is important to remember that we cannot measure the skills and their distribution directly. All we can measure is the distribution of the performance indicators and assume that the distribution of the skills is the same as the distribution of the indicator. By definition, a good indicator is one distributed in exactly the same way as the skill we are interested in, but no indicator is the skill itself.

As shown in graph 3, the level indicated by the black threshold (e.g., number of publications) may be obtained using different amounts of different skills (yellow and dotted line, precision; green and slashed line, originality; blue and dotted and slashed line, depths of knowledge, and so on), each with its own distribution. The line that represents the distribution of abilities in the simplistic model, therefore, does not exist *per se*: it is the aggregate of many different skills and as an aggregate, it represents only the skill to produce the indicator P.

Graph 3. Which skill are we looking for among the many needed to produce a given level of P?



Source: Addis (2008)

Obtaining a lot of publications, however, is not the true aim of the selection process, nor should it be. The true aim of the entire selection process for excellence is and should be the search for the ability to produce new and useful knowledge, and P, the number of publications, is only an approximation of this ability. If two people led very different lives, the same number of publications may indicate very different levels of ability to produce new and useful knowledge. It makes no sense to compare two people, for example, one male and the other female, or one white, with an entirely western education, and the other from a less highly regarded ethnic group and less prestigious educational system, by the number of publications. The number of publications is a good indicator of capability if two people are alike. If they are different, it may very well be that a person who led a more difficult and interesting life, but has fewer publications, may contribute to knowledge more than a person who has had the same experiences as many other people, and has more publications. This leaves open the possibility that perhaps men and women should not be compared with men as regards number of publications, to see who is excellent, but that men should be compared with men and women with women; or that appropriate “correcting weights” and policies should be developed to evaluate two sexes with different life cycles.

The aim of the selection process is to screen for people able to produce new and useful knowledge, but it is not always self-evident what is new or what is useful. Who decides what is new, and who decides what is useful? Gatekeepers are powerful because they are in charge of defining what is new and useful. A gender analysis of the gatekeeping mechanism is provided by Husu (2004), Linkova (2004), and for specific gatekeeping mechanisms such as editorial boards of journals, by Addis and Villa (2003) and D'Amico and Di Giovanni (2000).

If there are subjective elements in judging, the implication is that different gatekeepers may favour different skills and different indicators. Therefore, who the gatekeepers are is of utmost relevance. It is not true that anyone in the position of judge would make the same choice regarding who is excellent. Selection for excellence is not a neutral, natural process that always gives the same result, like a chemical reaction. It is a social process that involves power for some to accomplish what they want to do – provide answers to some questions – while others are denied the same power. It is a political process: to decide who gets what.

The deconstruction of the simplistic selection model continues by identifying the role of disciplinary boundaries in defining who is admitted in the selection process. One enlightening example of the role that boundaries play in defining who can be excellent is the discipline of Economics. As pointed out by Julie Nelson (1996), the borderlines of Economics tend to be defined by the methodology rather than by the object of study, and crossing borders with some disciplines (physics) is approved while intermingling with other disciplines (sociology) is frowned upon. This implies that there is a hierarchy among disciplines, with mathematically formalized hard sciences on top and verbal soft sciences below.

Box 1.5 Hard versus soft sciences: a gendered distinction

Hard science and Soft science are colloquial terms often used when comparing fields of academic research or scholarship, with "harder" being perceived as more scientific, rigorous, or accurate. For example, fields of the natural sciences or physical sciences are often described as hard in contrast to soft social sciences. The hard sciences are characterized as relying on experimental, empirical, quantifiable data or the scientific method, and focusing on accuracy and objectivity. When soft science is used to refer to a natural science, it is usually used pejoratively, implying that a particular natural science topic described as "soft" does not belong to the field of natural science. Different approaches to the scientific method can be distinguished by the research they term "soft science" and what they consider "hard." The issue is important to the philosophy of science (which does not always support the possibility of drawing a distinction between "hard" and "soft") and to science studies and the sociology of science (which study scientists' implicit perceptions of research and methods). In her seminal work 'Economics and Ideology', Julie Nelson presents a feminist analysis of the distinction. Softness and femininity are often associated, in the same way as hardness and masculinity. Softness is perceived as a good and desirable quality in the stereotypical woman while it is considered a bad an undesirable quality in the stereotypical man. Therefore, women who have the qualities to pursue "hard" science have incentives to hide this personality trait in order not to be thought of as unfeminine. Men are given incentive to leave the "soft" fields of knowledge so as not to appear unmanly. Or, if they accept to stay, they may require an extra perch in the hierarchy to confirm their manhood. This explains why in the more feminized sector there is an even higher vertical segregation with men occupying the top managerial positions.
Source: Southern Countries Group Report

Additionally, in some academic systems, for example in the British R.A.E. (Rees, 2004), borderline work stranding two disciplines is often disregardedin both: there is no panel that can evaluate interdisciplinary excellence, notwithstanding the fact that many pivotal discoveries in recent years have been made by scientists stranding between two or more disciplines. The rigid delimitation of boundaries creates other biases: in systems like the Italian one, where hiring is strictly compartmentalized by subject, the historians of science and of each discipline discover that they are marginal as historians and marginal as practitioners of the specific discipline they study. Interdisciplinary work, which some consider more and more vital in order to increase knowledge in this era of specialization, runs the risk of becoming less visible because, in the quest for excellence, it may fall into the cracks between disciplines if, for example, the impact factor of only one discipline is taken into account. New approaches and new fields or subfields may encounter greater difficulties in being classified as "excellent", precisely because of their diversity and novelty. Instead, small variations on some consensus truth will often be able to link to a web of existing literature that will produce more citations. The quest for excellence, in this case, may lead to conservatism and narrow-mindedness rather than to better science.

In the selection model, as well as in the ***pipeline model***, cumulative effects are at work. The level of excellence is only the last of a series of subsequent applications of a standard, determined by the gatekeepers over a population of applicants. If there is a small bias against one group in each subsequent application, the effect snowballs: members of that group will become proportionally scarcer and scarcer on the way to the top. The cumulative effect of small biases is described in Graph 4.

Graph 4. Cumulative effects of a small bias

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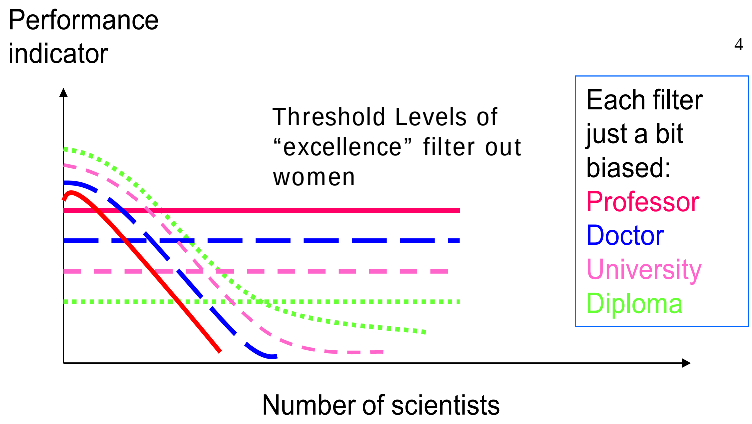
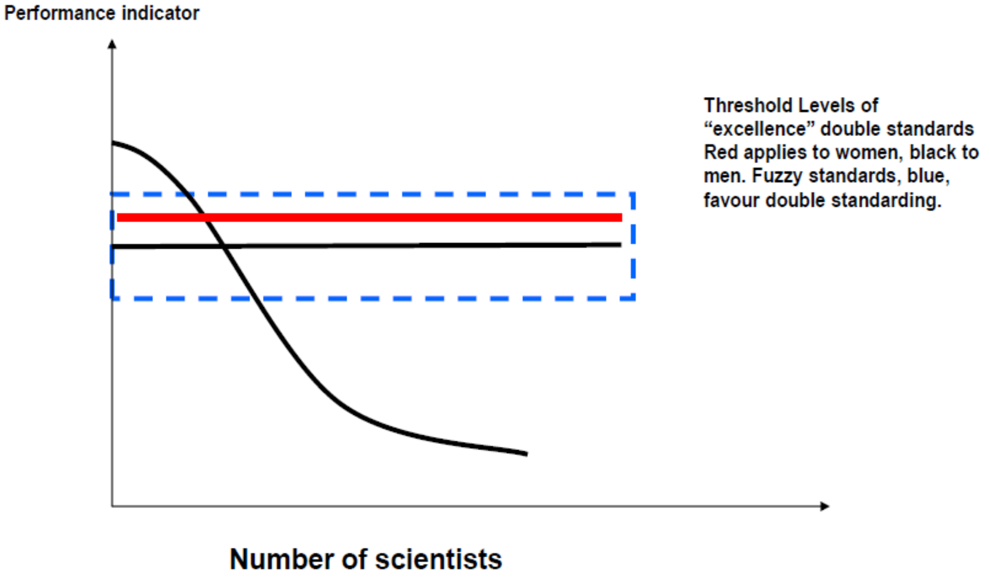


Source: Addis (2008)

The graph illustrates two more mechanisms whereby women are prevented from achieving excellence: double standards and fuzzy standards. In the selection model, the threshold of excellence is a standard that is applied to see who is excellent and who is not at any stage. There is evidence of the fact that the standard applied to men and women is not the same: the standard applied to women to qualify as excellent is higher. This fact is known in the literature as “double standard”.

It is easier to apply a double standard if the standard is fuzzy, i.e., unclear to those in charge of the judgment and unclear to those who should pass the standard. The horizontal dotted line in Graph 5 represents fuzzy standards, i.e. standards that may be or appear higher for women than for men, reducing the number of women among those considered "excellent".

Graph 5. Fuzzy standards may help discrimination



Source: Addis (2008)

Clearly, according to the selection model, different people may be deemed "excellent" depending on the opinions of the judges and the criteria they use. The definition and creation of excellence becomes a contested terrain, and its attribution may well be related to gender relations in the scientific community and in society at large. Gender relations include the unequal sharing of resources and of decision power between men and women.

The fact that the process of production of excellence does not correspond to the simplistic model in Graph 1 has important implications for policies oriented towards producing excellent research. It shows that production of excellence means both encouraging women to participate in the quest for excellence defined as it is defined today, and changing the notion of excellence, and the gatekeeping processes in such a way as to enable many more women scientists to become fully excellent.

1.3.3 The life-course model of Xie and Shaumann

A methodologically more sophisticated approach has been followed by the proponents of the third model, the "transition" or **"life-course" model**. This model, which has been regarded as a major innovation in the empirical analysis of gender differences emerging in the process of becoming a scientist, has been proposed by its author as an explicit alternative to the pipeline model by Xie and Shaumann (2003), which studies the fields of science and engineering in the U.S.A.

Xie and Shaumann offer a set of empirically derived explanations for what they call "attrition" and they claim that their findings contradict the pipeline metaphor.

They do so by following a life-course perspective and using rigorous multivariate demographic methods. They employ seventeen different sets of microdata from multiple longitudinal and census sources to predict gender differences. The life-course perspective proposes that life transitions are interdependent across education, family and work domains, and that later transitions are contingent on (but not determined by) earlier transitions.

Thus, according to Xie and Shaumann, it is possible to consider the problem of attrition in its wider context, instead of studying the science pipeline as operating in a social vacuum. To track this multidimensional and dynamic process, Xie and Shaumann concatenate a set of limited longitudinal datasets that enable the construction of synthetic cohorts that can be followed from middle school to post-degree career years. They begin in the middle and secondary school years by using six datasets to compare gender patterns of mathematical and scientific performance. They find that gender differences in mathematical ability are minimal except at the upper extreme of the distribution, but that male students participate more in scientific curricula.

The authors find considerable gender differences among high school seniors in expectations to major in science and engineering in college, with a ratio of 2 males to 1 female, and that after entering college, women are more likely than men to enter a science and engineering major after starting a non-science major. They track post-BA and MA degree career paths and show that while women are more likely to major in some biological sciences, the majors in these fields are overall less likely than other science majors to pursue science or engineering careers. Controlling for major, women are 25% as likely to work in science and engineering careers. Finally, all else equal, married women and those with children are less likely to continue science and engineering careers. Hence gender segregation by major (biology versus engineering/physics) and familial roles hinder women's career progression. The authors also employ microdata from the U.S.A. census and five more datasets to examine four post-degree career patterns, i.e. employment, geographical mobility, research productivity, and the status of immigrant scientists and engineers.

One important finding, thus, is that an increase in female participation in science and engineering careers over time is accompanied by a continual disadvantage in employment and positional status for married women and women with children. This disadvantage also affects geographic mobility in the early career, although dual career marriages appear to have no effect on women's geographic mobility. According to their findings, the most disadvantaged in employment and positional status are married, foreign-born women scientists.

Earlier literature based on limited cross sectional samples and mostly bivariate analyses repeatedly raised concerns regarding the persistent lower productivity of women scientists. These cohort-based multivariate results challenge the so-called productivity puzzle: here, research differences in productivity are negligible once we control for life course variables. In a substantive review, Ross agrees with the authors that their effort, unlike the pipeline model, should be recognized as rigorous sociology that has entered a contentious debate and provided the last word.

The UK Country Report prepared within the framework of the Meta-analysis project also introduces a so-called "preference model". The most influential of these theories belongs to Hakim (1991, 2002, 2004), who in her book Preference Theory, claims that in science, as in other sectors, it is women's own choices regarding their employment and lifestyles which is the key source of their under-achievement in their careers and accounts for most of the differences in women's and men's labour market outcomes. The theory proposes that groups of women give paid employment different priority and it categorizes them into three distinct groups: a) 'adaptive women', non-career orientated women who wish to combine work and family or who have un-planned careers; b) 'work-centred women' for whom employment is the main priority, and c) 'home-centred women', at the other end of the spectrum, who make family their central and only concern.

This is at best a simple description: it does not account at all, for example, for the cross-country differences in participation in science; therefore we will not introduce it as a model. It is reminiscent of the thesis exposed in Jonathan Cole's book, Fair Science: Women in the Scientific Community (1987), first published in 1979. Cole makes a distinction between two kinds of stratification processes in science, a process of discrimination and a process of self-selection (1987, p. 13). He argues that unequal numbers of men and women in the sciences are not sufficient evidence of gender discrimination because unequal numbers can result from a process of self-selection (1987, p. 13). It is possible that women are under-represented in the sciences simply because they do not pursue careers in the sciences or they are not sufficiently persistent in this pursuit. Cole defines discrimination as "residual sex inequality" (1987, p. 50). By this he means that discrimination is the amount of inequality that cannot be explained by gender differences in scientific education and productivity. Cole assumes that, insofar as there are gender differences in scientific education and productivity, they result from processes of self-selection. This assumption functions as a default entitlement in his study since he does not present any evidence to support it.

The analysis provided by Xie and Shaumann puts an end to these debates and to these models as valid contenders for an explanation. After Xie and Shaumann's book, thesis like Hakim and Cole's must be put to rest because evidence has been provided disproving them. In this Report, therefore, they do not concur as explanations. The effort made by these two authors is indeed impressive. It allows them to fully exploit the methodologies of microdata analysis that have been developed by economists, sociologists and statisticians to study the transitions during the life-course. The technology is coeval with the availability of fast and reliable computers and programmes.

It is a bit confusing to this Rapporteur that Xie and Shaumann present their findings as contradictory, rather than complementary, to the pipeline model. In 1983, when the pipeline model was invented, it was technically impossible to use what the authors call a life-course approach and, in labour economics, is known as transitions approach. The approach is based on the possibility to estimate by logit and probit regressions the likelihood that an individual with given characteristics will in fact undertake a given transition or passage from one status to another.

Xie and Shaumann's monumental and truly excellent work has many great merits, the three most important of which are:

a) It enlightens the fact that women's life-course adapts less successfully to the pipeline than men's life-course. This fact is in itself a disadvantage for women in their path towards excellence.
b) It confirms, if there were any doubts, that in controlling for other characteristics, women's scientific productivity is the same as men's[24].
c) It clearly measures the effects that marriage and children have on the scientific careers of men and women.

1.4 Conclusion to part 1

In Part 1, the Report presents a definition of "excellence", as derived from what is implied in documents written by people and agencies whose mission it is to foster excellence. The definition as such is rarely present in its direct form in the literature. As noticed by the "Gender and excellence in the making" Report, (Addis and Brouns, 2004) the scientific profession seems to treat excellence as if it was a natural given, to be understood implicitly by all involved. Excellence is, instead, but the final result of procedures that place scientists and scientific institutions in different positions within the network and the hierarchy of their fields. This leaves open the possibility that such processes may be biased against women. In order to understand why women do not achieve excellence at the same rate as men, it is necessary to refer to the processes that prevent women from becoming fully-integrated into science.

Part 1 presented three main models which describe these processes. Each of them corresponds to a different main hypothesis of why women do not achieve excellence at the same rate as men. According to the "pipeline" model, the flow of people who have the potential to become excellent scientists is slowed down by leaks along the path that leads to science. At each passage to a further step in their scholastic and professional career, women abandon the path flow that leads to scientific careers and to the highest echelons of the scientific profession. According to the "selective threshold" model, subsequent standards are applied to each passage to a higher level of a scientific career. These standards may be gender-biased in many different ways: double standards, fuzzy standards, standards of total commitment that women do not wish to fulfil. The repeated application of standards that are slightly biased eliminates many women on the way up. The "life-course" model provides a detailed statistical analysis of the interplay between the personal characteristics of men and women and their path up along the scientific career, from elementary school to academia and research. It therefore enables the consideration of choices by the agents as well as the characteristics of the scientific pathway.

In a rather well-known article, Sonnert and Holton (1996) make a distinction between "supply" and "demand" models of gender discrimination in general, and in science in particular. "Demand" models are the traditional discrimination models which indicate the origins of inequality in the demand for workers or in this case, for scientists of both sexes. In demand models, it is employers who prefer not to hire women, or co-workers who prefer not to work with women, or internal modes of organization that reject women's presence indirectly. In the "supply" models, it is the characteristics and the choices of women themselves that affect the outcome: it is women who choose to study less marketable subjects, to have children rather than not, to work fewer hours because of other commitments. Both kinds of models have their advantages. The "demand" models lead to policies requiring that the necessary change to integrate women be brought about by the system, not by the women. The "supply" models are unwilling to represent women as victimized, but rather as agents that make choices leading to the existing outcomes. It therefore uses microdata containing information regarding people's characteristics to describe in full what these choices are and what the result would be if they were not made

Demand and supply are both explanations of the outcomes: they are, as in economics, complementary explanations rather than exclusive explanations. We may of course believe that demand forces are stronger than supply forces or vice versa in any given period or sector, although in the end, both are needed to fully understand processes. Of the models presented in this part, Model 2, the "selection threshold" model, is

[24] Controlling here is used in the statistical sense of "taking in account all of the characteristics of men and women".

unabashedly a demand model, although it has one supply element in the initial choice of some women not to participate; the life-choice model is mostly a “supply” model, although it is extremely useful because it allows us to fully understand the outcome as not naturally given but the result of choices made by all agents. The pipeline model, which allows for both demand and supply elements in equal measure, being the first model to be introduced, has more trouble incorporating many of the findings of subsequent research on excellence, such as the role of personal choices and the role of biased measuring. At the present stage, each of the models provides useful insights for the understanding of scientific excellence.

Part 2. Focal points of debate, 1980-2009

2.0 Introduction

The difficulties women encounter in achieving scientific excellence are subject to the many aspects of gender and science that have become objects of other Reports within the Meta-analysis of Gender and Science Research project. They are related to the existence of stereotypes, to conflicts between the feminine identity and the identity of scientist, to the way science is organized as a labour activity, to the existence of horizontal and especially of vertical segregation. The methodological proposal framing the Meta-analysis project justified the need for a separate Topic Report on Gender and Excellence, independently of the other Topic Reports, by making reference to two distinct concepts that are exclusively related to gender and scientific excellence. The first concept was described as follows:

> *1) **the ways in which scientific excellence is defined and measured**, which includes issues such as the masculine character of the prevailing model of success, **the emphasis given to scientific production through publications and the bibliometric measures used to measure productivity for research personnel.** As stated in several studies (Bailyn, 2003; Knights and Richards, 2003), the ideal scientific career is based on a **masculine model of success, based on long working hours, an uninterrupted scientific career, and an active participation in extra activities** such as expert panels and assessment committees. Thus, an ill-designed meritocratic system strengthens unequal starting points and has particularly damaging results for many women and some men who do not meet the model of success defined as standard.*

This first concept has already been examined in Part 1 of the Report, as far as the definition of excellence is concerned, and will be investigated again in Part 3 with regard to the consequences, for women and from the gender viewpoint, of the growing use of scientometrics tools in evaluation procedures and the male masculine model of success.

In Part 2 we explore the second concept, which was described as follows in the Methodology document:

> *2) **The specific procedures for assessing scientific excellence**: this concept describes the ways in which the scientific merit of the academic contributions is evaluated. It refers, essentially, to **peer-evaluation,** of which bibliometrics is a tool. The system of peer evaluation is based on the idea that the scientific community is best prepared to judge other scientists (peers). However, it makes the assumption that the evaluators are free of social prejudices and issue judgments that are totally objective (EC, 2004). In this sense, leading contributions such as Wenneräs and Wold's (1997), for example, make it clear that the peer evaluation system cannot be considered as fully gender-neutral. A number of issues relating to this second concept appear in the literature of the Gender and Science database.*
> *Guetzkow et al. (2003) and Roper (1996) have analyzed **homosociability** as regards the evaluation of scientific excellence and selection processes. The authors confirm that in scientific evaluation processes, the evaluators prefer candidates and approaches in subjects that are similar to their own. The notion that a person's work can be evaluated independently from the life of the person is untenable: it means in practice that women are expected to live the same lives as men. The idea that the evaluation of academic work can be independent of the evaluator is also untenable. In the same way, the IUPAP International Conference on Women in Physics stated that selection and promotion processes are not transparent and may prejudice women. In other words, in all likelihood there is going to be a **standpoint bias** unless appropriate measures are taken to identify and correct it. [...] The process of **'gatekeeping'** is one of the core concepts for analysing the social construction of scientific excellence. Lewin (1947) introduced the concept of gatekeeping as the process that controls or influences entry into a particular field, to its resources, to its information, defining its standards, its agenda and external image. According to Merton (1996), one of the roles of scientists is gatekeeping and this process shapes scientific work in all its angles. As an example, we could take the selection process of scientists for the evaluation panels or the editorial committees of scientific journals, processes that are not always transparent or democratic, since the names come from members already in these teams (Griffin, 2004). In general, the gatekeepers of scientific research in Europe are middle-aged male academics (Osborn et al., 2000). This affects the professional mobility of male and female scientists and reproduces gender bias, since the gatekeeping*

*processes include the processes for recruiting new gatekeepers. Gatekeeping processes restrict women's possibilities, not simply from participating in informal networks, but more fundamentally, from doing research, from publishing, from receiving citations – to stress the most relevant symbols of status and performance in science. In addition, **psychological interaction between men and women** and people of the same sex are in general different, and they remain different also in science. Men and women perceive men and women differently, as summarized by Foschi (1989, 2004). Along this line, some authors (Addis, 2004; Hearn, 2004) stress the need to take **'honour'** into account in order to analyze gender relations in academic debates or in competition for obtaining a highly prestigious post. When a man competes with another man, the value of gaining reputation and honour is great and if he loses, the value of the loss is relatively small. However, when a man competes with a woman, the value of winning is small, but if he loses, the value of the loss of prestige and honour is extremely large. Assuming this relationship, a man has a chance to gain greater honour competing with another man and thus, women are excluded from these interactions and from intellectual debate. They continue missing the opportunity to gain reputation and honour and this leads to the progressive marginalization of women.*

It can be inferred from the words underlined in the text above that this second concept refers to some specific aspects of the processes and procedures producing excellence. In the literature on excellence, we cannot speak of temporal trends in the debate, although we can speak of these specific and problematic aspects, which are, during the entire period studied, the focal points of the discussion on excellence. They are:

1. **Peer evaluation**
2. **Homosociability**
3. **Standpoint bias**
4. **Gatekeeping**
5. **Psychological interactions between men and women**
6. **Honour**

To these six points we have added a few more on the basis of the analyzed literature. The first is the issue of leadership, which is also a psychological interaction. This issue has already emerged in our definition of scientific excellence. Then there are two issues that were raised in recent contributions, and in particular in the Report *Reaching for scientific excellence in gender research* (Vetenskapsradet, 2006). These are the issues of excellence in the natural sciences versus other disciplines, and of excellence in gender research. They are the main focal points that emerged from the debate and are the objects of this Part 2. They must be conceptually and empirically clarified before discussion on bibliometrics. Understanding these aspects enables one to get a better grasp of the advantages and disadvantages of the growing use of bibliometrics on women and gender. The order in which the Report exposes them is not the same as the one in the list above, for reasons of clarity of exposition.

2.1 Honour

According to the definition of excellence in Part 1, at the core of scientific excellence there is a new, important and useful contribution to knowledge and this contribution must be recognized and **honoured** by other scientists in the same field. It is therefore useful to discuss the concept of honour and of honour-giving in general and when applied to science. Scientific excellence is not just a hidden quality of the single scientist. It is a quality of the scientist in relation to a network of other scientists, constituting a set of institutions, such as universities, research centres and journals. Each country has its own specific institutions which are meant to comprise the excellent scientists. They have slightly different names and functions, and some are more important than others. The Royal Academy of Sweden, for example, is the body in charge of awarding the Nobel Prize, even if the American National Academy of Science and the Academies of other countries could well be considered more important in terms of scientific output or financial capacity of the research projects of the members. Becoming a member of one of these bodies is an honour, as observed by the president of the NAS quoted in Part 1.

We have already mentioned that in many biographies of women scientists of the past, we found evidence that at the time, some women who had achieved the goal of science, i.e. had contributed new and important knowledge, were not adequately recognized by their peers. They have been denied the honour they deserved, or they received it much later than they should have. Many instances of this fact can be found in the biographies of great women scientists of the recent past, such as Barbara McClintock or Lise Meitner. The situation has clearly changed in present times, although women are still a minority in the top tiers of those who are honoured, as shown by the small number of women in the National Academies of various nations reported in table 0.1. However, some of the forces that were responsible for the lack of recognition in the past are still at work and they need to be identified and culturally defeated. In the task of rethinking what scientific excellence is, some scholars have also asked what honour is and what effects honour may have on people of both sexes, i.e., what honour is from a gender viewpoint.

Honour is a very old and much gendered concept. In the classic Dictionary of the English Language (1755), Samuel Johnson put forward several definitions of the term. One meaning was "nobility of soul, magnanimity, and a scorn of meanness"; another meaning was related to "reputation" and "fame", to "privileges of rank or birth", and thirdly, a "respect" of the kind which "places an individual socially and determines his right to precedence." Honour is presented therefore not so much as a function of moral or ethical excellence, but as a consequence of power. Finally, with regard to women, Johnson defined a fourth meaning, defining honour as synonymous with "chastity" or "virginity", or in the case of a married woman, "fidelity". Though history may not be an exact science, it is an important one. Meanings and usages of the past have permeated the present via a number of cultural codes, from religions to literatures to science itself, which has taken on its present shape because of its history.

This very complete set of definitions reminds us that the honour of a woman used to be very different to the honour of a man. The honour we are referring to when we mention the honour that is given to excellent scientists by other scientists is the masculine variety of honour. We are speaking of the reputation and fame that places the excellent scientist socially and determines his right to “precedence” with respect to other scientists.

Anthropologists define an honour-shame complex as a social code in which men are bearers of honour, are shamed if they do not behave themselves, and make their women behave according to a particular code. This code requires men to be ready to fight in defence of their property and their kin, and avenge real or perceived wrongs.

It is possible to contrast cultures of honour with cultures of law. In a culture of law there is a body of laws which must be obeyed by all, imposing punishments on transgressors. A culture of law incorporates an unwritten social contract: members of society agree to give up some aspects of their freedom to defend themselves and retaliate against grievance on the understanding that transgressors will be apprehended and punished by society. This requires a society with the structures needed to enact and enforce laws. According to anthropology, cultures of honour typically appear among nomadic peoples and herdsmen who take their most valuable property with them and risk having it stolen, without any recourse to law enforcement or government. In this situation, inspiring fear becomes a better strategy than promoting friendship, and cultivating a reputation for swift and disproportionate revenge increases the safety of one's person and property. Thus, the original meaning of the word honour in a man appears connected more to power, willingness and ability to fight than to magnanimity.

According to the honour code, fighting is a means to uphold honour. Winning a fight brings more honour than losing one, although losing a fight with a peer, i.e. a man of similar standing, conducted within the limitation of the code, does not imply a loss of honour. Fighting against a woman transcends the limits of the code. An honourable man does not fight against a woman. In the honour code, a woman is radically different, if not inferior. She has the right not to bear arms, and in charge of her defence are her male relatives. So if she is assaulted and raped, this is, first and foremost, an act of defiance towards her male relatives. Fighting a woman is heinous. Fighting with a woman and losing the fight is the ultimate dishonour.

These are not ancient concerns that no longer apply to our lives. In the recent debate about whether to allow American women soldiers to participate in front-line combat – a role that offered further career possibilities – it was argued that the perspective of losing to a woman could make enemy combatants much less inclined to surrender.

In the Report *Gender and excellence in the making* (Addis and Brouns, 2004) Addis uses the concept of honour to explain the reason why women appear to fall out of the loop of scientific communication. The authors start by observing some small pieces of evidence, such as:

a) In a piece of research regarding the gender composition of scientific journal editorial boards, it was noticed that some important scholars were members of so many scientific editorial boards that it was clear that their participation was not only a way of honouring them, but also brought honour to the journal.

b) In informal exchanges, for example during social events, the interaction between two male scholars in the same field differs from that of two scholars of different sexes. If two scholars of the same sex initiate a conversation, the topic is most often about their field. They exchange information about their credentials (where they got their PhD, who their friends are). When people of different sex interact, there is a tendency for the topic of conversation to be what it would be if she was merely a wife and mother: how the children are, travelling and so on. The gender identity often prevails over the professional identity.

c) In seminars where scientific papers are presented, the interactions are often gendered. Women in the public are less inclined to make critical observations. When women are speakers, they do not tend to be attacked as viciously as their male colleagues would be. This sometimes may imply that their work falls on an embarrassing silence. This is, of course, a problem: in seminars, response, even if critical, can be better than no response at all: worse for the speaker, but better for his or her research.

d) In informal interactions, junior scholars often jostle for the chance to be near and exchange ideas with scholars of higher status, as any conference-goer can testify.

People behave as if any scientific interaction was similar to engaging in a confrontation to gain honour, with its own risks and rewards. There is a risk in questioning a scholar of higher status in a seminar or presenting an opposite viewpoint in an informal debate: the risk of losing the argument, of losing face, of losing some academic honour by looking like a fool in the eyes of the colleague. There is a reward, which is the possibility of coming out on top, appearing smart in the eyes of the other, possibly more important colleague. But these interactions are gendered.

By entering into a conversation with another male scholar, a male scholar runs the risk of losing, or the reward of winning the argument. The gain of winning is higher, the higher the status of the other male scholar in the profession. The loss of honour would be lower, the higher the status of the other scholar in the profession. Nobody minds to be made a fool of by a Nobel Prize winner.

Entering into a conversation with a female scholar produces a significantly different pay-off matrix. For a male scholar, coming out on top in the exchange would mean a small reward in terms of honour gained, because everybody knows that it is easy to beat women. Losing to a woman, conversely, would result in a major loss of honour. A male scholar acting rationally is not interested in entering into a scientific exchange with a woman if a scientific exchange with a man is available. He risks losing more and gaining less. Homosociability is the product of the honour game. Men are more interesting partners of scientific exchange than women. Women, more than men, remain out of the loop of information.

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A scientific career can be described as a very long series of formal and informal interactions. The winner of each of these ritualized small matches gains honour. A Nobel Prize requires an excellent publication record, but also a very long series of victorious interactions of this kind. By not entering into these interactions, women miss the opportunity to gain reputation and honour. In addition, in each of these matches, information is exchanged on the object of the contest, which is the scientific content of the field. Being excluded from or being given limited access to such intellectual contests will, over time, result in the progressive marginalization of women. People who become completely marginalized are not even worth talking to. They have no useful information to share and there is no honour to be gained by winning an intellectual match[25]. Lesser people do not deserve to enter into any kind of discursive interaction.

A similar mechanism induces the scarcity of women on editorial boards of journals. Suppose you are in charge of running a journal. Being on the board with an important member of the profession gives you the chance to interact with him in a general meeting of the journal. In addition, boards are about letting the world know that very honourable people do not disdain to interact with you as a member of the overall management of the journal, therefore showing that you too are worthy. There is not much honour to gain by letting the world know that a woman, who despite the fact of having written some good papers is still a woman and therefore needs to be understanding of other people's shortcomings and willing to engage in discursive interaction with you. There is, on the other hand, a lot to lose if you really have to interact with this woman, who is good and thus may just make you look like a fool.

[25] An indirect confirmation of this theory came to me by no other than Bernadette Chirac, the wife of the French president, and also a politician. She recently said in an interview, speaking of Hillary Clinton: "I admire her very much; she is a real professional politician. When she enters a room she immediately understands who is worth talking to".

We can represent the situation with a pay-off matrix. The content of the four central squares, a), b), c), and d), indicates the relative size of the gains and losses of honour in the scientific interaction with a scholar who is male or female, on average.

Figure 2.1 Payoff Matrix of a simple honour game

	Interaction with a woman	Interaction with a man
Honour - gains from winning	a) SMALL	b) LARGE
Honour - losses from losing	c) LARGE	d) SMALL

One of the results of this analysis is that if a woman is really very good, then a strategically-minded male will avoid interaction with her because the probability of finding himself in situation c) is particularly high. One extension of this model would attach a probability of losing and of winning to each interaction.

Summarizing the findings on honour:

a) Honour is an important component in the production of excellence. Excellent scientists are honoured by their peers; they enter into a network of exchange of honours with their peers.
b) The position of men and women with respect to honour is different, i.e. honour is a gendered construct.
c) Modelling scientific interactions as interactions that aim to obtain scientific honour, and coupling it with the concepts of the honour code (fighting against a woman does not bring honour, and defeat in a match with a woman implies a greater loss of honour than a defeat in a match with a man) may explain why women are not as integrated as men in scientific networks.
d) The pursuit of honour is one of the factors that produces homosociability.

2.2 Homosociability and the development of social capital

The concept of homosociability is useful when exploring gender and other kinds of biases. Homosociability is the term given to label the sense of comfort that people feel in the presence of others who are like themselves. If gatekeepers can identify with candidates because they come from a similar social group or background, then they are likely to perceive them more positively than those who come across as strange. They accentuate the positive characteristics, and gloss over the negative characteristics of people who remind them of themselves (Burton 1991).

Research in the field of management studies shows that a form of homosociability by male employers and employees is often a key issue in the construction and maintenance of the gendered labour market, especially in senior-level jobs (Ibarra 1993, 1995). Male homosociability encompasses the formal old boys' networks and informal clubs or meetings, as well as humour and banter on gendered or sexually-charged issues.

In an important contribution (*The Gender of Social Capital and Director Recruitment to Corporate Boards*), D.F. Izraeli and I. Talmud (1998) connect the issue of homosociability with the concept of social capital formation and social networking. They develop a number of issues that in their work is referred to empirically as Boards of Corporations, but which is theoretical in nature and, as such, may be applied equally to the formation of any group of top executives, including the members of boards governing universities, departments, and the national Academies in charge of defining and recognizing scientific excellence.

In their own words, Izraeli and Talmud unpack and decompose the gender subtext of current theories of social capital accumulation and social network formation and interaction. They highlight the gender implications of social capital in order to understand the structural and institutional processes that affect women’s appointment to boards and their perceived performance. Their starting point is the work of Nahapiet and Ghosal (1998), who showed that social capital is a key component that assists in the formation of human capital. Izraeli and Talmud show that, in contrast to Nahapiet and Ghosal, who are primarily interested in the processes according to which social capital assists in the production of intellectual capital, their main concern is the relationship between gender and social capital, which is not discussed by Nahapiet and Ghosal. They ask how gender affects the access to and the value of social capital, and how the conditions for social capital formation have different implications for men and women. They demonstrate that a network model of recruitment processes to the board and performance on the corporate board is useful for three reasons:

1) Network theory focuses on social relations rather than on individuals, and gender theory assumes that "masculinity" and "femininity" are not individual attributes, but rather embedded relations;
2) It enables us to link micro-level processes and the institutional nature of both gender and the corporation;
3) Social networks are the crucial means by which control over corporate events, information benefits, and groups identities are facilitated and transferred. Network theory is useful then for portraying how gendered corporate board identity and relations are constituted and maintained (White, 1992).

It is a known fact that studies of board composition (Westphal & Zajak, 1995) reveal a strong propensity for 'homosocial reproduction', specifically in the case of men selecting men. They reveal that directors are recruited (by men) from a relatively narrow, fairly well-defined pool, made up primarily of white, educated males. For example Burke (1994) notes that, at least until recently, board members in North America were appointed exclusively at the request of the CEO, and CEOs tended to appoint other CEOs on whom they could count for support.

Izraeli and Talmud provide two possible theoretical explanations for the strong propensity for homosocial reproduction among men in positions of power. One approach emphasizes the functional importance of homogenous work groups for effective performance, especially under conditions of high uncertainty where trust and good communication are at a premium. The second points to homosociability as a strategy for dominant groups to sustain their position of dominance. In the first, homosociability serves to promote the rational goals of the organization. In the second, it serves the interests of hegemonic groups to reproduce the power structure.

The first approach, best represented by Kanter in her (1977) study of *Men and Women in the Corporation*, explains the propensity for 'homosocial reproduction' as a response to the need for trust, a facet of what Nahapiet and Ghosal (1998) term as relational social capital. Social homogeneity is functional for building trust and facilitating communication. Maleness provides managers with a crucial tacit resource in the quest for sameness. Thus uncertainty, the need for communication and trust, provide incentives for men to "clone" themselves in their own image, guarding access to power and privilege to those who fit in, to those of their own kind – in short, to other men (Savage and Witz, 1992: 16)

The need for trust as an incentive for homophily is, on the surface, a gender-neutral theory. Presumably then, women who achieve positions of influence in organizations will give preference to other women in promotion. Alternatively, men in female-dominated organizations will more likely be excluded from powerful social networks than men in male-dominated organizations. Neither contention, however, holds up in fact. Men who enter female occupations, such as teaching, are moved up a "glass escalator" to senior positions in the school system. In a study of tokenism on shop floor union committees, Izraeli found that token men in female-dominated groups felt more influential than men in male-dominated groups. The sameness hypothesis hides a male bias – the preference is not for sameness but for others who are perceived to be powerful and trustworthy. Furthermore, although homophily may ease the likelihood of the creation of social closure, sameness need not be based on gender criteria. Demographic and structural changes can dramatically modify the social base for closure.

The second approach which appears in the works of numerous feminist researchers (e.g., Reskin, 1988) views the attribution of gender difference as part of a strategy to preserve male dominance by excluding women from centres of power. Although the number of men who are part of the hegemonic group is quite small, the majority of men gain from its hegemony, since they benefit from the patriarchal dividend, the advantage men in general gain from the overall subordination of women (Connell,. 1995:79.). Men have an incentive to preserve their advantage and are able to do so because they control the rules for distributing valued resources.

The privilege of the dominant group rests on two principles: the fact that it is perceived as different from outsider groups, and its devaluation of these groups. The devaluation of the outsider group's value in turn arouses expectations from members of this group. Through a series of interaction processes, beliefs about women's lesser value "affect behaviours and reactions in a way that becomes self-fulfilling, shaping the resulting power and prestige order", resulting in women's disadvantage in social networks and hierarchies without any assumption regarding the individual abilities of men and women. These matters are argued in greater depth in Izraeli and Talmud (1998). Griffin (2004) points out that, as shown by Guetzkow, Lamont and Maillard (2003), there is a "homosocial pattern in reviewers' preferences" i.e., they are interested in and positively evaluate research proposals and articles similar to their own work.

Summarizing the findings regarding homosociability, bias arising from homosociability – i.e., the fact that people feel more comfortable in the presence of others who are like themselves – was documented in the literature in general for the top echelons of many professions, and in surveys on people's preferences. Although more research is needed, there are many reasons to believe that homosociability is present in academia and other research organizations. A homosociability bias is likely to interfere with a woman's path towards becoming an excellent scientist. This may be one of the reasons why women scientists have trouble achieving excellence.

2.3 Gatekeeping

Excellent scientists achieve their position at the top of their field by proving they are to pass the multiple gates that mark the passage between the stages of a scientific career. Each of these gates, or junctions of the pipe, or settings of new thresholds, was manned by other scientists, whose task it was to screen the flow of people and let only a few in. These gatekeepers were sometimes his or her peers but most often, his or her seniors and superiors in age and rank.

The fact that science is made up of gates and that at each of these gates there are keepers whose task it is to allow passage to only to select few is a fact known by every student beyond compulsory education, who must pass examinations with good grades to be able to apply for better schools and so on. According to a sociologist who pioneered the study of the research communities, R. Merton (1973), the four roles of the scientist are researcher, teacher, administrator and gatekeeper. By letting in some people and some ideas only, and refusing access to other people and ideas, gatekeepers influence the definition of each field, the ranking of scholars within it, the allocation of resources to different research agendas, the flow of information, the setting of standards, the development, the agenda and the external image of a scientific community.

The following activities are typical of the gatekeeping function in science:

- **Hiring junior scientists and colleagues**
- **Allocating research funds among applicants**
- **Deciding which papers are worth publishing in journals**
- **Admitting colleagues to honour societies or awarding prizes for excellence**

Gatekeeping functions in two ways: on the one hand it is a mechanism of exclusion and control over the people who are outside the gates and want to come in, and on the other, it is a mechanism of inclusion and empowerment for the gatekeepers themselves.

The first of the mechanisms is obvious: if I wish to become part of a club or an institution to which you hold the keys of the gate, I will behave in such a way that you may approve of my behaviour and my ideas. There is strong pressure for those outside the gates to conform to the norms imposed by the gatekeeper.

People who create an association among themselves and establish the criteria of inclusion and exclusion to their association, by this very act acquire power with respect to others who would like to be part of the association but may be prevented from doing so by the founders. This is the basic mechanism that generates insider/outsider dynamics. It is the basic principle whereby a full democracy is determined not only by the right of each citizen to vote for Parliament, but also by the complementary right of each citizen to be a candidate to Parliament and therefore have access, if he or she has the necessary capacity, to the institutions of political power. When Mr Nobel and the Royal Academy of Sweden decided to award the Nobel Prize, they became the most powerful Academy of Science, compared to Academies of Science of countries of similar size.

Box 2.1 Origins and use of the term "gatekeeping"

Kurt Lewin was apparently the first to use the term "gatekeeping" to describe a wife or mother as the person who decides which foods end up on the family's dinner table (Lewin, 1947). The gatekeeper is the person who decides what shall pass through each gate section, of which, in any process, there are several. Although he applied it originally to the food chain, he then added that the gating process can include a news item winding through communication channels in a group. This is the point from which most gatekeeper studies in communication are launched. It was then White (1961) who appropriated Lewin's comments and turned them steadily towards journalism in 1950. In the 1970s, McCombs and Shaw took a different direction when they examined the effects of gatekeepers' decisions. They found that the audience learns how much importance to attach to a news item from the emphasis the media place on it. McCombs and Shaw pointed out that the gatekeeping concept is related to the newer concept, agenda-setting (McCombs et al, 1976). The gatekeeper concept is now 50 years old and has seeped into the language of many disciplines, including gatekeeping in organizations.

There is one fundamental difference between gatekeeping to scientific institutions and the formation of democratic political institutions.

In democracy, those who are to become powerful are elected by their peers. Although the incumbents may have an advantage, it is the peers, inside and outside of the gates, who vote in any election. At each new election the gates disappear, and each and everyone can become candidates and voters.

In science as in democracy, everybody has the right to enter according to his or her capacity, but in science that differs from democracy, the selection mechanism is not election, it is co-optation from above. Who among the graduate students is to become a professor at Harvard is not the result of an election where other graduate students have a vote. It is the result of a process of co-optation where professors choose who among the graduate students is to become a professor, and so on. Members of National Academies are chosen by current members of the National Academy. The process works from above, similarly to the process by which another ancient institution, the Catholic Church, chooses its leadership, the cardinals and the pope. In the electoral process the choice is highly personal. In the co-optation to the Catholic Church it is also extremely personal. Personalized choice depends on the tastes of the person who does the choosing, and very often, as we discussed under "homosociability", there is a recognized tendency for people to choose similarity over dissimilarity. Therefore, in elections, networks of similarity, of kinship, of geography, of ethnicity, of professional or religious affiliation may taint the choice of one candidate over another, rather than an abstract evaluation of the abilities of the available candidates. There is ample evidence that the same is true for co-optation mechanisms.

There is a mechanism which attempts to de-personalize the co-optation. It is the mechanism according to which the choice is subject to a predetermined standard: all those who make the standards are accepted within a community. The use of a predefined standard such as bibliometrics in hiring procedures may be considered as a means to de-personalize the processes of scientific cooptation.

Among the important evidence found in the literature on gatekeeping, one must cite the seminal study of Wennerås and Wold (1997), which revealed the presence of gender bias and other biases due to homosociability among the gatekeepers in Sweden when selecting postdoctoral fellowship applications. They proved that the Swedish MRC (Management of Research Committee) evaluated applicants according to three factors; scientific productivity, contact with evaluator (read challenge or nepotism) and gender. The female applicants had to be 2.6 times as productive as their male competitors in order to be regarded as equally productive as the male applicants. When it came to having an acquaintance on the board, an applicant who did not have one needed to be 2.4 times as productive as one who did in order to be considered equal in merit. This was the first ever analysis of peer-review scores and the system was exposed as being riddled with prejudice. The policy of secrecy in evaluation was the order of the day. The authors correctly claimed that the credibility of the academic system would be undermined in the eyes of the public if it did not allow scientific evaluation in its own scientific evaluation system. Their findings were then confirmed with some qualifications by Sandstorm and Hallsten (2004). Also noteworthy was the research on gatekeeping in Finnish academia by L. Hush, summarized in her contribution to the Report *Gender and Excellence in the Making* (Addis and Brouns, 2004).

Besides human beings, techniques may be a gatekeeping device. The study of maths or methodology is pursued along ethnic and gendered differentiated lines, as documented by Ayalon (2004, see box).

> *Box 2.2 Math as a Gatekeeper: Ethnic and Gender Inequality in Course Taking of the Sciences in Israel.*
>
> *Using multi-level analysis on a sample of Israeli academic-track twelfth-graders in 1989, the article examines between-school variation in gender and ethnic inequality in course-taking in two academic fields: physics and biology. A multilevel analysis of 19,743 Israeli twelfth-graders reveals the main findings of the article that: 1) the sciences are taken less often by underprivileged Jewish ethnic group students and this inequality is more acute in schools that use maths as a filter, and 2) physics is taken more often by males and biology by females, and gender typing is particularly prominent in maths-oriented schools. The social implications of the findings are discussed.*
> ***Abstract** of Ayalon, H. 2004 American journal of Education, vol. 104, no. 1, pp. 34-56.*
> *Source GSD*

Since publications are one of the most widely used indicators of scientific excellence, and all the more so since the introduction of computerized bibliometrics, editors of scientific journals are among the most important types of gatekeeper. The role and the composition of editorial boards of Italian economics journals were studied by Addis and Villa (2003) and reported in *Gender and Excellence in the Making (Addis and Brouns, 2004)*. Addis and Villa noted that there are at least 3 kind of reasons why boards are important in the making of scientific excellence:

- Board meetings provide an important opportunity to contact colleagues, to exchange information about opportunities, opinions about issues, and to gain awareness of recent research to the benefit of members' own research. Editorial boards members are in a better position, with regard to other academics, to set research agendas and learn about new ideas and research trends. Becoming a board member helps one to become a better scientist, and therefore enhances one's career.
- Editorial boards are self-perpetuating bodies. Members are chosen because they have good relations with those who choose them. Active board members, who solicit manuscripts and manage the screening process through contacts with the referees, act as a node in the crucial network through which research turns into publications. Their visibility increases as they have reason to contact people, who consequently become aware of their presence in the profession. Thus, membership on editorial boards is both an indicator of successful networking and a means of enhancing it further.
- Members of editorial boards have the power to decide what is worth publishing. This is particularly obvious when there is no refereeing process – as is still the case in some Italian journals. They can, however, influence the process, even when a double-blind refereeing process is used. They are aware of the fact that a manuscript is more likely to be accepted if sent to referee Y rather than to referee X, because they know the research interest of the referee and the topic of the paper and may be aware of existing relations between the author and the referee, or simply the views and personality traits of the referee. Even editors striving for maximum transparency and fairness still have the power to select referees, and being a referee is a sign of status in the profession, as witnessed by the common practice to report in CVs: "referee for such and such a journal". Colleagues will therefore treat members of editorial boards with due respect. They become an asset for their friends, colleagues, network and school of thought. Being present on a board is an indicator of high status, and also increases one's status (Roediger, 1987).

In their research work, which was limited to economics journals in Italy, Addis and Villa studied the membership of the editorial boards of 36 economics journals, published in Italy from 1970 until 1996. They determined the number of men and women among them, analyzed their distribution across different kinds of boards, roles and fields, and compared this figure to the presence of women in the profession. They also informally interviewed people who were members of boards, in order to better understand their operating mode. They found the following:

a) Boards are of different rank. Although not all journals have all three kinds of boards, they can be identified as Top Boards (usually under the name of "Scientifico"), Middle Boards (usually "di Direzione") and Lower Boards (usually "Redazione") and two professional figures, the Director and the Editorial Secretary. Lower boards are where the actual work of writing letters to authors, calling people up, soliciting manuscripts and checking proofs takes place. Young members of the profession are admitted to this board and one of the members is the editorial secretary. This person may be a young member of the profession or a professional secretary. If she is a professional, she will work full or part time in an office under the orders of the director of the journal. Middle boards are a network of established academics who make up the intellectual core of the journal. Top Boards are about honour. People are called to the Top Board because they are very prominent members of the profession – foreign professors, Nobel-Prize-level scholars or public personalities, ministers, prime ministers, head of parties or trade unions. They are not asked to perform any task, just to bear witness to the quality of the enterprise, and, in doing so, to be flattered by the fact that their presence demonstrates such quality: honour and excellence are the issues. Some journals conflate the tasks of two or three boards into one.

b) Women are absent in Top Boards, almost absent in Middle Boards, and allowed only in Lower Boards. At the end of the period considered, women's presence had reached a level of approximately 20%, as in the academic profession, in only 5 journals out of 36. There were 11 journals which had no women at all, and 14 more which had taken women on only as editorial secretaries, not as academics. In 6 other journals women were on the boards in a marginal position (only in lower boards).

c) The journals that included women were clustered in the fields that J. Nelson defines as "soft" (history, history of thought, development) as opposed to the "hard" fields (theory, intended as mathematical modelling of economies, econometrics). This reflects a distribution of women academics among fields. Women were overrepresented in the fields considered "soft" and under-represented in the "hard" fields. It appears that men and women have different research interests and prefer to study different topics. It is this difference that creates a bias in the contents of the discipline. The issue here is not, or not only, that women may network better with other women, a fact that has been proved in the literature, (Ferber and Teiman, 1980, 1981), but that this difference in interests implies that some questions are deemed less important to investigate owing to the sex of the proponent of the inquiry.

d) The journals where women were found were often among the less hierarchical, in that they used just one or two kinds of boards, although there were exceptions.

e) The trend in the period considered was of professionalization, with professional editorial secretaries replacing young academics. These secretaries were all female. No woman had ever been Direttore, i.e., editor in chief of a journal.

f) A second trend was for a few journals to open up towards the English-speaking world presumably in order to attain higher status for the journal. This was achieved by publishing in English alone a mixture of Italian and English articles, or by including English abstracts. When such restructuring took place, we found instances in which women academics were dropped from the boards while English-speaking academics were called in. Furthermore, women secretaries, often with an English surname, were hired.

g) In contrast to this minimal presence of women, we noted the omnipresence of men. There were quite a few instances in which male economists were simultaneously active on the managing boards of two or more journals. Sorting the data by name, we found 1 man present at the same time in 6 journals, 1 man in 5 journals, 10 men in 4 journals, and 29 in 3. While being present in 2 journals is almost commonplace among this group of men, it is totally non-existent for women.

They concluded that:

> *"...consistent with the view that the selection of members of the two sexes does not reflect the relative scientific ability or publication records of the researchers. As a matter of fact, board membership is the result of a process of pure cooptation, i.e. discretionary selection from above. There are no standard procedures of curriculum evaluation to decide who deserves to serve on a board. Our findings are also consistent with the hypothesis that value judgements based on traditional notions of gender are at work in the selection of new board members, and that women are not yet treated equally. This further suggests that evaluations of women continue to be influenced by value judgements based on traditional gender notions (sexism) that would, in turn, be expected to influence not only the demand of women economists by research institutions (as in traditional discrimination), but their supply as well."... "This process of selection based on gender stereotypes rather than on scientific merit keeps women at the margin of the network, hinders their professional development, and prevents them from achieving their full scientific potential. The supply of suitable women for high ranking positions decreases as a result. Thus, the gender gap in economics acquires a supply side as well as a*

demand side component. The journals, in turn, are to a great extent deprived of women's intellectual contribution, which prevents the journals from achieving the highest possible scientific quality, and the discipline from achieving greater objectivity."

A similar analysis was performed by D'Amico and Di Giovanni (2000) on Italian psychology journals, with similar results. Summarizing the findings on gatekeeping, we may say that sociology of science explains the important role that gatekeepers play in the making of the scientific community and in the processes leading to the creation of excellent scientists. Among the gatekeepers at all stages and particularly in the later steps along the scientific path – those leading to excellence -- women are needed on two different grounds:

a) To guarantee the impartiality of the judgements.
b) To provide women scientists with a privileged position in the network of scientific exchange, increasing their access to new and important knowledge.

2.4 Psychological interactions: invisibility, double standards and other effects of being female

Among the factors that prevent women scientists from achieving the levels of excellence reached by male scientists with comparable characteristics, one can include the fact that they are women, i.e. human beings contained in a female body.

Two contributions in the literature on gender and excellence stand out with respect to this theme: Goldin and Rouse (2000) and Foschi (2000, 2003, 2004). In their article, *Orchestrating impartiality*, Goldin and Rouse took advantage of the fact that sometimes during the 1970s, orchestras would use a physical screen during auditions to conceal the candidate's identity and ensure impartiality, and thus ascertain what this change implied for women's outcomes.

They collected, from orchestral management files and archives, a sample of auditions carried out by eight major orchestras. These records contain the names of all the candidates and identify those who went on to the next round, including the ultimate winner of the competition. There was a strong presumption that discrimination had limited the recruitment of female musicians, especially by the great symphony orchestras. Not only were their numbers extremely low until the 1970s, but many music directors, ultimately in charge of hiring new musicians, publicly disclosed their belief that female musicians had poorer musical talent.

Their analysis of the audition and roster data indicated that indeed, hiding the sex of the candidate had a strong positive effect on the probability that women were hired. They found that the screen increased by 50 percent the chance of a woman to advance from the preliminary rounds and increased by several-fold the likelihood that a woman would be selected in the final round. The switch to blind auditions explained 30 percent of the increase in the proportion of women among new recruitments and possibly 25 percent of the increase in the percentage of women in the orchestras from 1970 to 1996.

The implications of their findings are considerable for hiring processes in which it is not possible to conceal the femaleness of the applicant, such as applications to scientific fellowships and professorships. There is the presumption, however, that a similar bias against feminine impersonation may have worked, and still may work, against women when speaking in scientific seminars or attending interviews, a feeling reinforced by the existence of many training courses that teach women to downplay their femininity (dress codes, attitudes) and look more "masculine" when seeking a certain kind of stereotypically male job.

The work by Foschi focuses on two issues: double standards and women's "invisibility". The first issue concerns occurrences of gender bias in settings where individuals are engaged in the completion of a valued task, either by themselves or as members of a team. Examples are: carrying out scientific research, designing an architectural project and organizing a fund-raising event. Many practices contribute to gender bias in those settings; the bias, in turn, serves to maintain other gender inequalities (e.g., the uneven representation of men and women in many occupations and professions, and in most cases, the gap in their salaries).

These practices often vary in the form they take and in the intensity with which they are applied - but they all have in common that they place women at a disadvantage in comparison with men. The kinds of practices that have been identified are:

a. Gender differences in performance evaluation when the quality of the outcome leaves room for interpretation.
b. Gender differences in the number of opportunities granted to complete a task.
c. The inclusion of factors unrelated to competence when assessing women but not when assessing men (such as considerations regarding marriage and parenthood).
d. Different levels of encouragement for men and women after members of both groups have completed the same task with the same level of proficiency.
e. The use of different competence-standards for men and women when assessing the same (or highly similar) successful performance by both sexes.

It is useful to distinguish two processes at the core of these practices:

- In some cases, the bias modifies <u>how a given performance is evaluated</u> – that is, the bias affects whether the outcome is judged to be either a success or a failure, depending on the performer's sex category.
- In other cases, the bias has an effect on <u>how much competence is inferred</u> from performances by men and women which have already been evaluated as either successful or unsuccessful.

The first process concerns units of performances; the second affects an assessment that is more global in nature.

The evidence Foschi presents derives from two types of experimental designs. In one case, participants work in pairs, sometimes of the same and sometimes of the opposite sex, to solve a perception task as a team (Foschi, 2003). In the other, participants review files of applicants for junior positions in various engineering jobs and make hiring recommendations regarding these candidates (Foschi, Lai and Sigerson, 1995). In the first type of experimental design, participants assess the relative competence of themselves and their partner as they perform a task together; in the second design, participants are assessors of other performers but are not themselves performers of the task in question. Results show clear support for the hypothesis of the presence of double standards, of all the kinds described.

As a result of her research, Foschi proposes two strategies for blocking double standards. Both consist of making changes to the scope conditions. One strategy involves increasing the assessors' accountability; the other, providing explicit standards rather than allowing assessors to generate and use their own.

The use of double standards, according to Foschi, is not necessarily deliberate or conscious. In a related experiment, Foschi shows that both men and women find it easier to remember the content of a short CV exposition if the exposition, of identical content, is given by a man than if it is given by a woman.

Summarizing the findings on how being female may affect the pursuit of excellence, there are three points that stand out:

a) Both sexes find it harder to believe in women's competence, men more so than women. The presumption that women are less able may be at work either conscious or unconsciously in assessors of either sex.
b) For this reason, impartiality in judgement is not the usual outcome in a screening process involving applicants of both sexes, and explicit policies taking this into account should be devised.
c) Measures must be taken to ensure that gender bias is minimized in procedure selection towards excellence.

2.5 Peer review between necessity and myth

The title chosen for this section refers to the fact that, on the one hand, some form of peer review is a necessity given that resources to do science are scarce and must be allocated. On the other hand, research shows that there are some myths surrounding the peer review process that require closer inspection in order to understand the process properly.

The first is the myth of peer reviewing as the guardian of the autonomy of science. According to this view, autonomy of science with respect to religion, industry or politics would be guaranteed by the practice of peer evaluation. Allocation is ultimately a political decision. An important contribution in this respect comes from the European Science Policy Briefing issued after the Consensus Conference on the theory and practice of research assessment, held in Capri in October 1996. In the briefing, it is reported that:

> *"In its consideration of macroallocation issues, the working group concluded that the decision to allocate funds to particular fields at a national level must be at least in part a political one; only an overarching publicly accountable body such as the government is empowered to make such decisions on behalf of the populace. However, though a political decision, it should not be merely a politician's decision: it must be an informed decision, whereby all relevant factors are taken into account and a reasoned and justifiable conclusion reached. The onus is on the politicians to develop a stable framework of priorities, in line with a country's financial wherewithal and societal priorities, while the scientific community develops and delivers programmes of research in line with this framework".*

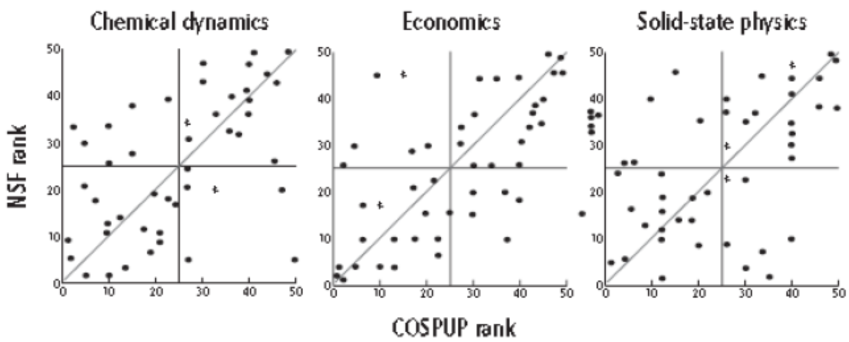
Peer review is only conducted after the decision to allocate funds to various branches of science has been taken.

The second myth is that peer evaluation guarantees impartiality. An important contribution on the issue was made by L. Langfeldt (Vetenskapsrådet, 2006). She reviews the main empirical studies in the literature on peer review (Mahoney, 1977; Cole et al., 1981; Ceci & Peters, 1982; Chubin & Hackett, 1990; Cicchetti, 1991; Travis & Collins, 1991), and she shows that:

- Different reviewers often have substantially *different assessments* of the same research (regarding both applications and manuscripts) *in all fields*.
- Different kinds of *bias* may affect reviews.

Empirical evidence to this effect is provided by the results of a study published in the journal *Science* in 1981 by Cole, Cole & Simon. Three subject areas were chosen: chemical dynamics, economics and solid state physics, each with 50 applications for research grants from the National Science Foundation (NSF). The NSF had ranked the applications in the normal way, using groups of peers, and had accepted half of the applications. Afterwards, the NSF Committee of Science and Public Policy (COSPUP) asked other groups of peers to rank the same applications. The rankings can be compared in the Figure below, with the original NSF rank on the Y-axis and the new rank on the X-axis. If the two peer review processes had reached the same ranking, all the dots would have been positioned along the green line. This, however, was not the case. Instead there are a number of applications where the funding decisions would have been reversed if the new ranking had been used.

Figure 2.2. NSF rank vs. COSPUP rank from Cole et al., 1981



Source: Cole, Cole & Simon, 1981, "Chance and Consensus in Peer Review", *Science*, pp. 881-886

The third myth is that the reviewers are in fact peers. While the concept of peer review is, in theory, clear and difficult to object to, the definition of who is and who is not a peer is, in practice, a strategic decision that may have important consequences in deciding who gets to be published and who is granted the resources to continue with his or her research programme. The reference to peers seems to refer to a democratic process, where the first among equals is chosen. The process of peer review instead is often a process of evaluation from above, not by peers, but by seniors.

As mentioned in the discussion on gatekeeping, the editor of a journal who distributes articles for peers to evaluate is not a peer. He (or she) is in a position of power and can influence the publication processes in direct and indirect ways. The various steps of this influence are well described in Roediger (1987), who invokes, together with the function of gatekeeper, the positive function of talent scout, actively searching in meetings and professional conferences papers that would make a good submission to their journal. The editor is both a gatekeeper and a leader.

One issue of relevance is the definition of who counts as a peer. Who are the peers of a new and different field of study? Are male scientists ever true peers of female scientists, and vice versa? How does the process of peer review deal with the problem of different standpoints in science?

As observed by Griffin (2004), when projects were presented by those engaged in women's studies, gender studies or feminist studies (WGF), mostly female groups of scholars, they often found that their projects were rejected under the claim that the absence or scarcity of men in the project did not guarantee equality or neutrality. Projects presented by mostly male groups never receive this kind of comments unless explicitly specified by the rules. WGF studies are seen as biased, male-only projects are seen as normal. Even when it was explicitly specified that European project should have a gender dimension, there was no enforcement and the requirement only received lip service or was circumvented. In some sectors of the scientific community, WGF were initially met with and still come up against active hostility. In particular, feminist research, according to Griffin, by its very nature claims that knowledge is situated and comes from a standpoint, instead of being disinterested and universal. This, according to Griffin, is a form of honesty, while the position that research is universal and disinterested masks the existence of inequalities and power. If this is the case, when a feminist research proposal is evaluated by a scholar who believes in universality and disinterestedness, is it really evaluated by a peer? Or should it not be imperative that these projects be evaluated by other feminists or at least WGF scholars? Yet, this autonomy was not granted to WGF studies and consequently, WGF studies were channelled and confined to become a subfield of sociology, losing the critical disruptive power that they would have had if made autonomous and transversal to many disciplines.

This process, according to Griffin, prevented the full formation or, more accurately, the institutionalization of WGF as an "epistemic culture" in the sense described by Knorr-Cetina (1999). And, according to Griffin, scientific excellence is only defined within an epistemic culture. The consequences of this lack of autonomy were twofold:

> a) That excellence in WGF studies remains undefined and hostage to the judgment of people who are not peers because they work in other fields and with other, sometimes hostile, agendas.
> b) That funds are allocated between WGF projects and other projects on the basis of political bargaining that tries to satisfy to some extent those involved, a process which has everything to do with power and nothing to do with consideration of intrinsic merit and excellence in the proper field.

Therefore, Griffin concludes that "assessment of scientific excellence, far from being an exercise in disinvested and disinterested judgements, is one of situated decision making, reproducing the cultures from which it emanates. To the extent that these cultures are hostile to feminist research, this hostility will be reproduced in judgements of scientific excellence made". To change that, not only do feminists have to be included in the judgement processes, but measures to promote women in all disciplines have to move beyond lip service and be enforced. In addition, a field of WGF studies must achieve its own autonomous status as a branch of social science parallel to, but independent from, sociology.

As Langfeldt (Vetenskapsrådet, 2006) concludes, "peer review processes contain contrary objectives. On the one hand we want the processes to be fair. We want equal treatment of evaluees and no arbitrariness in the outcome. To obtain this we need to emphasize rigour and thoroughness. On the other hand, policy priorities – such as strengthening weak or important areas and encouraging scholarly pluralism or groundbreaking and non-conventional research – are often important. But these are contrary objectives, since thorough and stringent review processes tend to promote uncontroversial and safe projects. Less thorough processes may more easily support unconventional and controversial research and scholarly pluralism – both as a result of more randomness and the fact that the outcome more easily departs from the opinions of the majority."

2.6 Excellence and leadership

According to Definition 1 provided in Part 1, one important component of scientific excellence is the ability to lead other scientists towards a new and productive path of enquiry. Contemporary Science is no longer – if it has ever been – an activity of single great thinkers who produce written ideas. Rather, it has more and more to do with the capacity to manage a scientific project, from obtaining financing through to coordinating a group of people and producing and distributing the results in many forms (publications, scientific meetings, patents).

The excellent scientist is a leader who has a vision of the project and the capacity to make it happen. This requires leadership ability in at least three different aspects: scientific leadership, relational leadership, and administrative leadership. Scientific leadership ability implies that the excellent scientist knows his or her own chosen field but is also able to cross-fertilize it with other fields making connections with new ideas, and is capable of original thinking. Relational leadership is the psychological ability to relate with other scientists, persuading them of the value of his or her proposals and to think along the same innovative lines, contributing to his or her project rather than working on their own. A leader is made by his or her followers. Administrative leadership is a managerial activity: a large scientific project is a project like any other and requires organizing, motivating and coordinating a team of workers towards an end and working to deadlines. It requires managerial skills similar to those needed to lead a project to build a road or to run a department store.

Do qualities of leadership differ between men and women? Is it true or false that men are better endowed than women with what in the American literature is known as “the right stuff” to lead? Or is this yet another false and outdated cliché: leadership was masculine when all leaders were male; as women enter the public sphere, two things happen: they learn the masculine ropes and they also change the old leadership style?

Research on leadership originally focused on the characteristics of the leader. The evolution of these studies has shown that, as observed by Peter Drucker, a leader is such because he or she has followers: leadership, therefore, is a bilateral relationship, or more precisely, a set of bilateral relations.

Recent situational theories of leadership contend that the effectiveness of leader behaviour depends on contextual variables, such as the nature of the task and the characteristics of the followers (Chemers, 1997). Historically, leadership has been construed as a primarily masculine enterprise and earlier theories of leadership have focused on the desirability of stereotypically masculine qualities in leaders of both sexes.

It is now recognized, also on account of the contribution of women and gender studies, that stereotypically feminine qualities such as the fostering of cooperation, the propensity towards mentoring and a non-controversial style of problem-solving are important qualities of leadership besides more masculine qualities such as assertiveness. The seminal work on women in the organization is the classic “Men and Women of the Organization” by Rosabeth Moss Kanter (1977).

It must also be noted that managerial work in the last fifteen to twenty years has changed dramatically. Women’s increasing participation in the labour force, higher levels of accumulation of human capital by women, technological changes both in the core business of many firms and in management technology (the introduction of cell phones, word processors, e-mail and teleconferencing has greatly altered the content of management jobs) are all changes that imply that what was learnt about male and female styles of leadership fifteen years ago has probably already changed.

Box 2.3 Gender in leadership studies

Vecchio (2002) provides a review of some of the research relevant to the debate on female advantage.

A.H. Eagly, L.L. Carli in The Leadership Quarterly, 14 (2003), address some of the basic questions that demand attention in relation to these arguments:
(a) whether men and women behave differently in leadership roles,
(b) whether women receive prejudiced evaluations as leaders and potential leaders,
(c) whether leadership by women might be more effective or meet the needs of organizations more successfully than leadership by men.

Lipman-Blumen (1996) notes that while in the past, leaders based their authority mainly on their access to political, economic or military power, in post-industrial societies, leaders share power far more and establish many collaborative relationships. Hammer & Champy, 1994 and Senge, 1990 assert that contemporary good leadership encourages teamwork and collaboration and emphasizes the ability to empower, support and engage workers. Trade books such as Goleman, Boyatzis, & McKee, 2002, p. 221 urge managers to put people first by using ‘‘resonance-building styles. . .that support commitment, involvement, active pursuit of the vision, and healthy, productive work relationships’’ Other writers of popular books on leadership have argued that effective leadership is congruent with the ways that women lead

(Book, 2000; Helgesen, 1990; Rosener, 1995). For instance, Rosener (1995) labelled women's leadership as interactive, involving collaboration and empowerment of employees, and men's leadership as command-and-control, involving the assertion of authority and the accumulation of power.

These contemporary approaches to leadership not only recommend a reduction in hierarchy but also place the leader more in the role of coach or teacher than previous models of leadership. Although the specifics of these views vary, most such discussions emphasize that leader's roles are changing to meet the demands of greatly accelerated technological growth, increasing workforce diversity, intense competitive pressures on corporations and other organizations and a weakening of geopolitical boundaries.

The gradual erosion of female disadvantage would be consonant with the emphasis of many popular mass-market management books on traditionally feminine communal behaviour, which involves creating a sense of community, empowering subordinates and communicating and listening effectively. Leadership is not only an innate capacity: it can be cultivated. An interesting project described in box 2.4 aimed specifically to study leadership skills as applied to scientific research projects.

Box 2.4 Presentation of a project to learn how to lead scientific projects

The project, with principal investigator Martin Chemers, is funded by the NIH, (National Institutes of Health) and aims at assessing science inquiry and leadership skills particularly by under-represented minority students, to support biomedical research career. The research questions are:

1. *How do program activities, particularly research participation and mentoring, influence:*
    a. *students' skills in science inquiry and teamwork?*
    b. *their beliefs in these abilities?*
    c. *their stage-appropriate career outcomes?*
2. *Are these influences similar for minority and non-minority students?*

The study starts from the consideration that successful science careers demand high ability both in the scientific inquiry process and in scientific leadership and teamwork. Scientific inquiry skills can be thought of as the ability to design and carry out research studies by applying scientific tools and procedures to address a research question. In the scientific leadership and teamwork skill set, we include establishing and communicating vision, developing and using resources, developing and implementing action plans, and leading and participating in group processes such as decision-making and delegation. These skills are studied by observing sets of students from high school, community college, undergraduate, and graduate levels. An Alumni Retrospective Survey will involve alumni from science support programs and a comparison group of science graduates who did not participate in formal programs. These responses, as well as qualitative information from current program participants, faculty and staff, and from field observations will provide the foundation for developing simulations that serve both as performance-based assessments and as educational experiences.

Simulations are standardized assessments in which program participants, either individually or in teams, perform tasks designed to contain key elements of the research process such as framing hypotheses, interpreting results, etc. In the COSMOS Simulation and Survey, high school students recruited because of their high abilities in science and mathematics will participate at the beginning and end of their four-week residential programs during summer 2006 and 2007 In the Undergraduate Simulation and Survey, undergraduates involved in science support programs and a comparison group not involved in those programs will participate in the simulations at the beginning and end of the 2006-07 academic year. One-year follow-up surveys will document academic outcomes and career interests.

In addition to the scientific contribution of this study, assessment tools and simulations will be useful for relevant programs. They can be embedded as learning objects in the program activities themselves, serving both to evaluate education needs and to develop skills. The research will inform program designers as they consider the length of research experience, complementary *activities, and new models for building research into broader educational settings.*

Summarizing the findings on the relationship between scientific excellence and leadership, it is found that:

a) Leadership ability, an important characteristic of the excellent scientist, was considered masculine when men only were in leadership positions;
b) As women enter the field of management, on the one hand they learned how to lead like men, and on the other, they produced a re-evaluation of some more "feminine" ways to lead and coordinate;
c) Leading a scientific project can be considered a specific, highly-specialized managerial ability that can and should be taught to men and women.

Connected to the issue of leadership is the issue of the model of success, which may differ in men and women. Some interesting research in this respect has been carried out by Czech authors, as illustrated in the box below.

Box 2.5 The masculine model of success

Linková, M., 2009. "Ne každý úspěch se počítá: Excelence a genderování vědecké dráhy v přírodních vědách" (Not every success counts: Excellence and gendering scientific paths in natural sciences). Pp. 73-100 in Stöckelová, T. (ed.) Akademické poznávání, vykazování a podnikání: Etnografie měnící se české vědy (Making, administering and enterprising knowledge in the academy: Ethnography of Czech science in flux). Prague: SLON.
The chapter looks into how female and male researchers in natural sciences define success. The author analyses the notions of success among individuals variously posited in the academic hierarchy. The author argues that the normativity of the concept of excellence has an impact on which notions of success result in a visible progress up the career path and that such a notion of success is not interesting or acceptable for all researchers. In conclusion, the author explores the issue of whether and how the concept of excellence is gendered and what impact this may have on science and society.

Lorenz-Meyer, Dagmar. 2009. "Tři mody genderového jednání v akademickém výzkumu" (Three Modes of Gendered Behaviour in Academic Research). Pp. 101-133 in Stöckelová, T. (ed.) Akademické poznávání, vykazování a podnikání: Etnografie měnící se české vědy (Making, administering and enterprising knowledge in the academy: Ethnography of Czech science in flux). Prague: SLON.
Dagmar Lorenz–Meyer examines the triple figuration of gender in a natural science institution which emerges in various situations to disappear in others and which can be mutually inconsistent. The author captures the "commonsensical" gender which naturalises the idea of the binary sex while denying any role of gender in epistemic practices; "sexualized" gender which surfaces when women exceptionally exit the mono-gender of the research profession or when female researchers are sexualized, for example in public space; and finally the implicit "uncertain/partial" gender through which the author interprets the ways in which women relate to entities they research and their own professional paths and they ways in which they constitute their belonging to science. This (minimally) triple figuration of gender in science problematises our efforts to address the issue of "women and science" as an issue of "harmonising" working and family lives.

2.7 Standpoint bias

"Standpoint bias" is the bias that derives from the particular position of the knower in society and in history. The concept of "standpoint bias" is related to the concept of "situated knowledge". Important strands of feminism hold that all knowledge is situated, i.e., it depends on the particular position of the knower, on his/her interests, on his/her aims. It is therefore possible to deconstruct theories to show the relations between the knower and the theory, and, by doing so, to open paths for new knowers and new knowledge.

What we conventionally call "science" appears here as just one of many possible forms of knowledge, historically and socially contingent. This leaves open the question of whether there are privileged viewpoints, i.e., whether and how we can claim that one scientific theory (including the theory that all knowledge is situated) is superior to another.

We attempt here to summarize in a few paragraphs an important debate on which thousands of pages have been written. The pivotal contribution is the work of Sandra Harding in *Whose Science? Whose Knowledge?* (1991). Harding argued that diversity among inquirers is an epistemic advantage to a community of inquirers. According to Harding, epistemic advantage accrues not to just any kind of diversity but to diversity with respect to the social positions of inquirers and participants in their studies. Harding's feminist standpoint epistemology advances the claim that those who are unprivileged with respect to their social positions are likely to be privileged with respect to gaining knowledge of social reality. According to Harding, unprivileged social positions are likely to generate perspectives that are "less partial and less distorted" than perspectives generated by other social positions (Harding 1991, p. 121; see also pages 138 and 141). This has been labelled a thesis of “epistemic privilege”. The thesis of epistemic privilege is connected to a particular conception of objectivity, "strong objectivity," which is the view that objective research starts from the lives of unprivileged groups (Harding 1991, p. 150; see also page 142). Diversity with respect to social positions is beneficial for knowledge-seeking communities because there are many ways of being unprivileged. As Harding explains, "the subject of feminist knowledge – the agent of these less partial and distorted descriptions and explanations – must be multiple and even contradictory" (1991, p. 284).

The thesis of epistemic privilege works on the assumption that there is a standard of impartiality that enables one to judge some socially grounded perspectives as "less partial and distorted" than others. The situated knowledge thesis seems to undermine this assumption by suggesting that all knowledge claims are partial in virtue of being grounded on a particular perspective on social reality.

As Helen Longino (1999) explains, in order to argue that some socially grounded perspectives are better than others, a standpoint epistemologist would have to be able to identify privileged perspectives from a non-interested position, but according to standpoint epistemology, there is no such position (1999, p. 338; see also Hekman 2000, p. 24).

Louise Antony (1993) calls the tension between the thesis of epistemic privilege and the situated knowledge thesis a "bias paradox" (1993, pp. 188-189). In claiming that all knowledge is partial, feminist standpoint epistemology challenges the very notion of impartiality. But by undermining the notion of impartiality, feminist standpoint epistemology is in danger of losing its critical edge (Antony 1993, p. 189).

Harding is aware of the bias paradox. Instead of abandoning either the thesis of epistemic privilege or the situated knowledge thesis, she tries to solve the bias paradox by introducing a distinction between cultural and epistemological relativism. She claims that "a strong notion of objectivity requires a commitment to acknowledge the historical character of every belief or set of beliefs – a commitment to cultural, sociological, historical relativism" (Harding 1991, p. 156). And she adds that "it also requires that judgmental or epistemological relativism be rejected" (Harding 1991, p. 156). Harding is reluctant to say that the goal of scientific inquiry is truth or empirical success. Instead, she suggests that scientific inquiry should progress "away from falsity rather than toward truth" (1991, p. 185).

Harding’s “epistemic privilege” theory completely overturns the conventional idea that the best science is producedcan be produced by totally devoted white men in white coats with a lot of money to spend on experiments. Yet it is perhaps too radical a theory, denying science its autonomy as a set of social practices. It is also problematic for women to lose the critical edge given by the idea that all knowledge is situated, in exchange for the privilege of being able to know more because they are not the dominant group.

The concepts of this debate may be utilized to more pragmatic ends. If one accepts the idea that knowledge is situated and the idea that the epistemic advantage belongs to the scientific elite, it can then be deduced that the scientific elite must be as plural as possible, inclusive of both genders and ethnically and culturally diverse to produce science which is less prone to standpoint bias than otherwise. One must therefore strive to foster diversity and plurality in scientific excellence.

2.8 Excellence in the natural sciences versus other disciplines

An important contribution concerning gender and excellence is the Vetenskapsrådet 2006 Report, *Reaching for scientific excellence in gender research*. The Report is further proof of the fact that by studying an issue under the gender lens, it is often possible to acquire a better understanding of the entirety of the issue at stake. In this case, the study of excellence in gender research helps to understand the difference in achieving excellence in the various branches of knowledge. The issue has been raised by Agnes Wold who introduces the issue with reference to the work of Charles Snow, "The two cultures", and claims that:

> *"The natural sciences, including technology and medicine, all share a positivist view on science. Such a view is characterized by a belief in objective truth, measurable data, and the overall beneficial effects of scientific development. These beliefs contrast with the view held in the humanities, according to which truth is relative and scientific development is not always positive. In contrast, the natural sciences pay no respect to disciplinary boundaries and have no respect for "theory", which is considered inferior to data. In my opinion, the firm placement of gender studies in the non-positivist area of the sciences results in an incapacity to understand and incorporate the most vital developments in gender medicine." (p. 32)*

These are quite strong claims. There are many natural scientists who would not agree with the claim that they have no respect for theory – e.g. theoretical physicists – and the link between theory and data is certainly more nuanced than inferior/superior. A good theory should encompass all the data, but data without any theory are just a mess with no possibility of interpretation. Her aim is to give Gender Medicine (see Box 2.6 below) of which she is a practitioner, a firm place within the natural sciences. This is understandable: Gender Medicine must be evidence-based.

> *Box 2.6: Gender medicine – what are the questions?*
>
> *Gender medicine can be regarded as a discipline that investigates the intersection between society and human biology. According to my view, at least three areas can be considered central to gender medicine:*
> *1. Studies of how society's gendered structure affects the health of men and women.*
> *2. Studies of how medical practice – including research and teaching – is affected by gender stereotypes and by women's lower societal value compared to men's.*
> *3. Studies on how medicine acts as a conveyer of patriarchal ideology, by transforming common prejudice and patriarchal ideas in society into pseudo-biology, thereby providing a pseudoscientific support for men's dominance over women and restriction of women's power and freedom.*
> *Source: A.Wold, "Who are the peers?" (Vetenskapsrådet, 2006) p. 39*

Wold attributed to the Natural Sciences a positivist approach to science. Quoting her:

> *"Positivism consists of a number of beliefs:*
> *1. Objective truth exists.*
> *2. Objective science uncontaminated by the researcher's views can be achieved (although with difficulty).*
> *3. Scientific development is basically positive (even if science can be misused).*
> *4. Data have precedence over theories. Theories are temporary constructions of little value until proven by data.*
> *5. All (natural) sciences are part of one single science. Departments, subjects etc. are only administrative units (mainly constructed for teaching purposes) that carry little emotional value.*
> *6. Science is international. Publication in national journals or books does not count.*
> *7. The quality of science is determined by:*
> *a. the quality of the science conducted*
> *b. the importance of the problem solved (relevance).*
> *8. The quality of science is reflected (although imperfectly) by the impact of the journal in which it is published.*
> *9. Truth will show up in the end. Scientific fights will be solved by themselves because nature will show who was right and who was wrong."*

Positivism as a philosophy of science born in the eighteenth century probably has little to say about impact factors. However, Wold draws attention to a set of real differences that exist in the practices of different branches of knowledge, which create differences in the evaluation of excellence and in the usefulness of methods to evaluate excellence, such as bibliometrics, in the different areas. For example, the assertion in 6) that “Science is international, publication in national journals or books does not count” marks a clear difference between natural sciences, social sciences and the humanities. Studies on the national literature of a non-English-speaking country conducted only in English are of very little interest. Also, studies on the economic circumstances of a non-English speaking region should not be devalued with respect to those published in English. The fact that is underlined here is that the object of the natural sciences (nature) is the same all over the world, and what Wold identifies as “nature” does not behave differently according to geography or history. The humanities and the social sciences, due to their very object, must instead deal with geographical and historical peculiarities. If this is the case, there is no reason why only international publications should matter.

International publications, moreover, often refer to British and North American journals, or journals in other languages that are published in English. An article published by an Argentinian in a Spanish journal hardly counts as an “international” publication according to the commons view flected in Wold’s points.

Even the issue of relevance has a different reading in natural sciences, in social sciences and in the humanities. Natural scientists, as Wold herself testifies, seem to have a firm grasp of what is relevant and what is not, which means of course that among natural scientists consensus about what constitutes relevance appears to be easier to develop. We have already made the point in the first part that medicine, where it is relatively easier to calculate benefits to patients, is the discipline that provides a clearer definition of excellence for scientists to go by.

What is relevant in humanities is more difficult to define. Is a comprehensive study of Shakespeare more relevant than a comprehensive study of a lesser known poet, who may nevertheless be among the 20 best poets in Italian, just because Shakespeare is more relevant than anybody in the most relevant of languages? Thus, even in literature some studies may be irrelevant: what about a poet so minor that only five people have ever heard of her? Where do we draw the relevance line?

What about point 2, which claims that objective science uncontaminated by the researcher’s views can be achieved? Vested interests may also be at play in the natural sciences if the researcher is financed by a company or hopes to profit from the patents he or she will be able to produce. In social sciences, however, the interests of the researcher are present by definition, since any researcher belongs to a social group, class, gender, and ethnicity. This “situation” of the natural science researcher may be somewhat reduced by provisions that require disclosure of conflicting interests, forbid acceptance of any other source of financing for publicly-funded researchers, and impose that patents belong to the research institution rather than to the researcher. These practices are present nowadays in many publicly funded research institutions. Scientific methodology (accurate measurement, test of hypotheses, and so on) is another step towards reducing, if not eliminating, pre-existing opinions of the researcher.

The “situation” of the social scientist is much more difficult to reduce. Although the ability to see issues from other people’s viewpoints is the mark of the great thinker, because it is the only position that allows all the facets of an issue to be perceived and dealt with, there are no rules that can distance an economist dealing with the issue of inflation from the fact that he or she is either in debt, owns either positive or negative assets, and works either for a research centre of a private party, be it a bank, a trade union or an industry, or for a public institution.

The heuristic value of much work in the humanities is closely linked to the author’s ability to provoke emotions in the reader. The artist, the writer, the historian or art critic are able to stir emotions in the reader. The experience of these new emotions increases the capability of the reader to understand the surrounding world. This empathy between the author and the reader requires a degree of similarity between them. The situation of one of them (the author) becomes to a certain extent the situation of the other (the reader). By reading “Lolita”, one can, to a certain extent, experience the world from the point of view of a child rapist. By reading “Reading Lolita in Teheran”, we can understand how Iran under the ayatollahs’ regime is perceived from the point of view of a woman whose education is very similar to our own, citizens of the “western” world. Detachment and absence of “situation” and viewpoint are not a valuable currency to buy the kind of knowledge that is acquired by studying literature, history and literary criticism.

As Wold points out, the practice of “laboratory science” is very different from other scientific practices:

> *“The natural sciences, medicine and technology are organized similarly and have a similar view on science and scientific excellence. They are sometimes called “laboratory sciences”, although they are often not carried out in the laboratory. Medicine is not. Mathematics and parts of theoretical physics are purely theoretical. Still, the organization and ideology is very similar in all*

natural sciences. The basic unit in the natural sciences is the research group, which may hold anything between 2 and 20 people. The research group is headed by a "principal investigator", whose job is somewhat similar to that of running a small family firm. Thus, the size of the research group depends almost entirely on the ability of the principal investigator to raise funding. The research group may contain PhD students, post-docs and technicians. There is mutual loyalty between the principal investigator and those employed in the research group, because the staff depends on him or her for funding and guidance, while he or she depends on the ability of the research staff to carry out the laboratory work. On the contrary, the research group has little loyalty or sense of belonging to a certain department or even discipline, because most university departments today do not provide financial support to their researchers. The research group is mainly externally funded and, hence, freely movable."

No doubt this description applies to Wold's discipline and work environment. If the laboratory is indeed the organizational unit, and especially if it is, as Wold describes, financed from outside the host institution, this creates a structural framework that shapes the production of excellence: the scientist who is not able to secure funding and to become a principal investigator cannot possibly rise to a position of excellence in laboratory science. Therefore, the path to excellence in these disciplines has some clear temporal patterns, and it is the product of a more solid line of consensus building, reputation building, and continuous hard work.

In non-laboratory disciplines, where the individual production is still the main form of output, and a good paper contains an original intuition or elaboration borne out of reading and thinking, the possibility of achieving excellence at different stages in a lifetime or in a career is higher than in laboratory sciences. Youth is certainly an advantage for original thinking and yet many Nobel prizes in Economics were given for work done carried out when the authors were in their fifties or over.

Wold provides no evidence that the path to excellence in mathematics and theoretical physics, which are organized in a fashion which is more similar to philosophy or political science (individual researchers, teams connected only by shared interests and the occasional conference), is more similar to laboratory science than to social sciences.

The discussion of Wold's contribution leads to the conclusion that the path to excellence and the tools to measure and recognize excellence may be different in the laboratory sciences, in the natural sciences which are not organized by laboratories, in the social sciences and in humanities. The extent to which this is true and the best ways to measure and recognize it in each subdiscipline may be a worthwhile object of future research.

2.9 Excellence in gender research

In October 2005, the Swedish Research Council's Committee for Gender Research, in collaboration with the Swedish Secretariat for Gender Research and the Nordic Institute for Women's Studies and Gender Research (NICK), organized the conference "Reaching for excellence in gender research" in Saltsjöbaden. One of the main goals of the conference was to discuss how gender research should relate to and deal with the concept of excellence and how excellence in gender research should be defined. The proceedings have been published in Vetenskapsrådet report in 2006.

The contributions of prof. Liedman on excellence in the history of science and of Agnes Wold on excellence in the natural sciences versus other sciences have already been cited in this Report. Another important contribution is provided by prof. Nina Lykke. Prof. Lykke works on the basis provided by the *Gender and excellence in the making* (Addis and Brouns, 2004) report summarizing its central message as follows:

Going beyond the question of under-representation in general, the report asks whether women, in as high a degree as men, can reach the highest levels of recognition in the academic system, i.e. recognition for excellence, or whether different kinds of biases and structural problems prevent it. Moreover, the report forcefully suggests that it is crucial to question the system (the definitions and ways of measuring excellence) rather than the women.

"Criteria of excellence are not – so the report says – universal, value- and gender- neutral. If women are not recognized as excellent in as high a degree as men, the problem lies rather with the definitions than with the women. Or, to rephrase the message of the report: women should not only be integrated at the rank-and-file levels of science, but they should be given full

opportunity to reach the highest levels of recognition. Women should be given the full opportunity to achieve scientific excellence and to be fully recognized for their achievements of scientific excellence."(Vetenskapsrådet 2006, p. 64)

It then goes on to claim that:

"The report underlines that decisions about who is excellent and who is not are situated and context-related. Assessment criteria are socially constructed. So I will expand the argument of the report and suggest that if gender research does not fit the criteria for excellence, it does not necessarily mean that the problem lies within gender research. What should be scrutinized are perhaps the criteria." (p. 65)

Following this same line, prof. Lykke goes on to ask the following questions: How does gender research perform in today's academic landscape? Does it perform well in terms of excellence and quality? Can its performances be improved? If the answer to the last question is yes – in what ways can they be improved?

The first important issue that Lykke takes on is how to define gender research. She uses the classifications introduced by H. Ganetz (2005). According to Ganetz' analysis, the following three levels have to be taken into account:

I. Gender aspects – i.e. a gender dimension, understood as some kind of gender-analytical and gender-reflexive approach, is included, but only as a minor concern.
II. Gender perspectives – i.e. a gender-analytical and gender-reflexive approach is included as one line of inquiry among other equally prioritized analytical angles.
III. Gender-focused research – i.e. theoretical, methodological, epistemological and empirical reflections on gender are a primary focus and pivot of the research, and the research questions are systematically informed by the decades-long tradition of theorizing gender, gender identities and power-laden gender relations as well as by the equally long tradition of reflecting on methodological approaches to the analysis of gender issues.

On this third level of gender focused research, Ganetz identifies two branches:

a) One is disciplinary gender-focused research, which pursues questions of gender and gender relations within the theoretical, methodological and empirical framework of a discipline – history, psychology, literature, biomedicine, economics, etc.
b) The other is interdisciplinary gender-focused research, which constructs problems, analytical approaches and theoretical reflections while going beyond the borders of the disciplines.

To this taxonomy, mutuated by Ganetz, Lykke adds that the last category of gender-focused research, b), can be divided into the following three levels:

1. *Multi-disciplinary gender-focused research* – the empirical, analytical, methodological and theoretical approaches are defined within the framework of the disciplines, but the different disciplinary ways of working are added to each other, creating a more complex picture.
2. What Lykke calls *interdisciplinary gender-focused research*, **stricto sensu**, thus limiting the meaning of "interdisciplinary" to situations where disciplinary boundaries are questioned and new synergies are created in terms of both empirical, analytical, methodological and theoretical approaches.
3. *Trans-disciplinary gender-focused research* – the empirical, analytical, methodological and theoretical approaches go beyond disciplinary outlooks in the sense that they are defined on the basis of earlier gender research, conducted beyond disciplinary boundaries and with no relation to a specific discipline. An example is the classic discussions of the concepts of gender and its relationship to sex. Another example is current debates on intersectionalities of gender, race, ethnicity, sexuality, class, nationality, and so on. No particular discipline can be said to have a privileged access to the construction of these problems and the theorization of them.

According to Lykke, excellence can, in principle, be reached at all levels, even the first two: gender aspects and gender perspectives. But, in her capacity as a gender expert and gatekeeper for this new field of research, (she has held, among others, the position of Managing Director of the European gender research association AOIFE -Association of Institutions for Feminist Education and Research in Europe for almost five years) she underlines the need for strict criteria for evaluation, which in her opinion are necessary even on the first two, basic levels.

She therefore requests that it be a primary and unavoidable prerequisite for excellence in gender research that researchers must explicitly account for:

1) How they are doing gender research in terms of theories and methodologies.
2) Why they choose to integrate gender the way they do.
3) Why, for example, it is not relevant to take gender more thoroughly into account.

A second requisite she puts forward is that, even on the two basic levels of gender aspects and gender perspectives, a researcher can document that s/he has a general knowledge of the field and uses gender research literature that is relevant to her/his definition of the gender aspects or gender perspectives included in her/his research. She then goes on to make her recommendations for fostering excellence in gender research:

> *"First of all, I recommend that gender experts strictly evaluate the expertise in gender theory, methodology and analysis of applicants who indicate that their projects have a gender dimension. Gender experts should be used as evaluators on all levels, even on the basic levels of gender aspects and gender perspectives. Secondly, I recommend that the Committee for Gender Research and the Swedish Research Council use the instrument of Gender Impact Assessment Studies, which was developed by the Women and Science Unit of the European Commission a few years ago (cf. EU Commission 2001: EUR 20017, 20018, 20019, 20020, 20021, 20022; see also the article on the Gender Impact Assessment of EU's Life Science research program: Klinge and Bosch 2005)".*

The solution proposed by prof. Lykke privileges the autonomy of gender research as a field. It may be a good solution where gender studies are sufficiently institutionalized, with their own chairs and their own sources of funds, as they may be in Sweden.

However, some problems are still left open by this proposal. For example, where gender studies are not as institutionalized, it remains undefined who is going to be the judge verifying that the prerequisites for excellence in gender research are indeed fulfilled. What about research that is deemed excellent as gender studies but falls short of the standards of excellence in the original discipline? The researcher on gender has double the burden to be excellent twice, in her own fields of origin and in gender studies. This, in turn, is not a good recipe to attract scholars to a field that becomes twice as difficult.

Lykke's contribution sheds light on important problems. In many countries there are scholars who, having produced excellent research on gender issues, are still considered marginal in their own original discipline. Future research should more specifically address the problem of how to define and recognize excellence in gender studies, and how to give appropriate recognition to excellent scholars who have produced excellent work on gender within their discipline. The mainstreaming of gender into all research fields should also affect how excellence in each field is defined and discovered, which has not yet occurred in most countries.

2.10 Conclusions to Part 2

In this second part, the Report presents the research conducted in the period considered by the GSD on six aspects of the processes that lead to scientific excellence. These aspects are:

1. the existence of a fight for **scientific honour**, that seems to arouse greater interest in the male than the female sex, and may be the cause of women falling out of the networks of information exchange of each field;
2. the existence of **homosociability**, that favours cooptation of similar people by similar people;
3. the existence of **gatekeeping** processes, which are meant to select some people to enter and others to remain outside of scientific activity;
4. the existence of **psychological interaction** between the sexes that generates male dominance: men are given preference to women when the gatekeepers are men and also when the gatekeepers are women, although to a lesser extent. Women are devalued or more invisible. It is essential to note that the existence of this male dominance implies that homosociability is gender biased: men favour other men over women more that women favour other women over men;
5. the **peer review** system, and what it entails from the gender viewpoint;

6. the issue of **leadership** and the existence and extent of masculine and feminine leadership qualities according to leadership studies;
7. knowledge is situated, and this may therefore create **standpoint biases**. If only one subset of people are chosen to produce knowledge, this knowledge is going to intensify the bias induced by their capacity and aims; reducing the bias in knowledge implies a plurality of knowers, different in race, ethnicity and social position;
8. there are considerable differences between natural sciences, laboratory sciences, social sciences and humanities in the way scientific practice is organized. Because of these differences, the processes leading to the production and recognition of excellence may vary in the different disciplines;
9. the issue of what constitutes excellence in gender studies needs to be investigated further, taking into account the need for a specific recognition of excellence in gender research and the fact that gender can be approached within many different disciplines.

Part 3. Measuring scientific excellence

3.0 Introduction

How can excellence be measured? Are the tools to assess scientific performance fair and objective? Are they gender-blind, gender-neutral and gender-unbiased? We turn here to the main question asked in the Methodology paper as discussed at the beginning of Part 2. This Part 3 examines the issue of bibliometrics in relation to gender as it emerged in the literature collected in the GSD and in relation to the existing literature in the wider debate about scientific evaluation and its appropriate uses. Summarizing the findings, the literature shows that:

a) **bibliometrics is gender-blind**, i.e., it does not differentiate among scientists of different sex, and this may be turned to the advantage of women because it gives a clear standard according to which men and women scholars can be compared, helping to minimize bias deriving from women's "invisibility";
b) **bibliometrics is gender-biased,** because it has some shortcomings which appear more evident in relation to its application to scholars of the two sexes. These shortcomings are the bias in favour of the past and the bias in favour of position in the network of relations, **i.e. bibliometrics reflects the bias in the system;**
c) one should distinguish between bibliometrics *per se* and ***the use of bibliometrics***. **The use of bibliometrics is often not gender-neutral** because bibliometrics is associated to elitist strategies in the allocation of scientific resources which may work against women's integration in science. **There is no reason, however, why it should always be so**.

These findings are not universally accepted. There are authors who disagree or who use the language differently. For example, the two concepts "gender-blind" and "gender-unbiased" are sometimes confused. In what follows, a full explanation of these findings and clarification in the use of the terminology are given.

3.1 Bibliometrics and the culture of scientific evaluation

Measuring scientific performance is the field studied by a discipline called scientometrics, the main branch of which is bibliometrics, i.e. the study of publications and citations. The various indicators developed in recent years are based on counting the number of publications, inferring the quality of the publications by the ranking of the journals in which the articles appear, and/or by counting the number of citations that an article or an author receives. In more sophisticated bibliometric indicators, the counting is measured by other factors such as the age of the person, modes of publication in their respective field of science, and so on.

Scientometrics is the general name given to the science of measuring and analysing scientific output. In practice, most scientometrics is done using bibliometrics which is a measurement of the impact of (scientific) publications, but scientometrics may include counting patents or, in some specific fields, counting effectiveness such as the number of people cured or the economic costs saved.. Methods of research include qualitative, quantitative and computational approaches. Journals in the field include Scientometrics, Journal of the American Society for Information Science and Technology (JASIST) and Social Studies of Science as well as the electronic journal CyberMetrics, International Journal of Scientometrics, Informetrics and Bibliometrics. The International Society for Scientometrics and Infometrics (ISSI), founded in 1993, is an association of professionals in the field.

Bibliometrics is the branch of scientometrics that studies the measuring of published texts. Citation analysis and content analysis are commonly used bibliometric methods. Content analysis in bibliometrics is quantitative, not qualitative: it entails counting the number of times a word or a proposition appears in a text. Many research fields today use bibliometric methods to explore the impact of their field, the impact of a set of researchers, or the impact of a particular paper.

Historically, bibliometric methods have been used to trace relationships among academic journals. Data from citation indexes can be analyzed to determine the popularity and impact of specific articles, authors and publications. Using citation analysis to gauge the importance of one's work, for example, is becoming a significant part of the tenure review process. Information scientists also use citation analysis to quantitatively assess the core journal titles and importance of publications in particular disciplines, interrelationships between authors from different institutions and schools of thought, and related data about the sociology of academia. Some more pragmatic applications of this information include the planning of retrospective bibliographies, giving some indication both of the age of the material used in a discipline and the extent to which more recent publications supersede the older ones, indicating through high frequency of citation which documents should be archived, comparing the coverage of secondary services which can help publishers gauge their achievements and competition, and aid librarians in evaluating the effectiveness of their stock.

The use of bibliometrics is not new (the Science Citation Index began publication in 1961). However, it has become much more widespread and important since the digital revolution. Once counting citations had to be done manually: nowadays screening of text by computer and automated algorithms are making it more useful, versatile, and widespread. Other bibliometrics applications include: creating thesauri, measuring term frequencies, exploring grammatical and syntactical structures of texts and measuring usage by readers.

The information revolution has made bibliometrics tools much easier to craft, to extend and to use. It also originated a heated debate on the advantages and limitations of bibliometric tools in research evaluation. The debate is not limited to the issue of gender in relation to bibliometrics, but verges on the general effects that the application of bibliometric tools may have in guiding science.

Supporters of bibliometrics claim that the use of indicators is an objective and therefore unbiased method of selecting one scholar over another; superior to pre-existing forms of assessment such as the letter of recommendation. With respect to gender, some authors have disputed whether bibliometrics is a proper tool to compare men's and women's performance.

Opponents of bibliometrics note that:

a) It stresses the factor of quantity of publications and time devoted to presence in networks rather than the originality and importance of the content. Therefore it uses time as the main ground for competition between academics, to women's disadvantage (Van Possum, W. & Hicks, E., 1993).
b) The emphasis on bibliometrics is coeval with women's attempt to enter academia, and therefore dubious as a power operation meant to contrast their advancement (Thomas, 2007).
c) It stimulates more publication at the lower end of the range of journals, rather than on the frontier where advances happen (Butler 2003).

Many commentators point out that the temporary profile of impact of meaningful papers may vary a lot: the repercussions of some papers are considerable soon after publication, but then rapidly fade, while other seminal papers take a long time to build up momentum, and are later revealed to be of long-term importance.

In Europe, the issue of evaluation was introduced by a "Consensus Conference on the theory and practice of research assessment" that was held in Capri in 1996. The conference, organized by the European Science Foundation, put the use of bibliometrics in the context of a broader culture of evaluation needing to include other methods of evaluation, when it concluded that:

> *"Finally, although assessment of quality (particularly in basic sciences) is an essentially qualitative process, we increasingly seek to look at methods of quantification and other "objective" aids. The use of such "devices" as citation indices needs to be incorporated with discretion. They are not an automatic panacea for problems which may arise in the peer review process".*

Fifteen years down the line, the feeling is that the use of quantitative bibliometric measures, because of its ease of use, has gained important grounds and has become in practice synonymous with research evaluation tout court.

An important contribution on the issue of gender and bibliometrics came from the International Conference "Sesgo de género y desigualdades en la evaluación de la calidad académica" (Gender bias and inequalities in the assessment of academic quality) organized by Maria Jesus Izquierdo as head of the "Observatori per a la Igualtat de la Universitat Autònoma de Barcelona". In an article with the same title (Izquierdo, Leon and Mora (2008)) she, together with two co-authors, exposes the main results of the activities of this 1st International Congress of gender bias and inequalities in the evaluation of academic quality. She starts from the consideration that the evaluation of academic quality depends on the desired model of scientific activity, scientific community and science that one has in mind. She makes reference to the work of Brouns (2004), where Brouns distinguishes between the Olympus (more masculine than feminine) and the Agora (more feminine than masculine) models of doing science.

Olympus Model	Agora Model
Neutrality	Engagement
Autonomy	Heteronomy, linkage
Competitiveness	Cooperation
Exclusivity	Conciliation

If one is striving for an Olympus model, evaluators are chosen only from the narrow epistemic community; if one prefers the Agora model, then interdisciplinary evaluation is required and evaluators who come from other disciplines are a valuable tool as well. In the Olympus model, the absence of women among the evaluators does not create a problem; in the Agora model it definitely does. Believers in the Agora model include the positive evaluation of teaching; the Olympus model may care only about the evaluation of publications activity. Izquierdo goes on to distinguish between competitive excellence and sufficient excellence, arguing that funds should be allocated according to criteria of sufficient excellence, rather than competitive excellence, i.e. giving resources to anybody who passes a predetermined standard, sufficient to guarantee results, and not just to the highest-ranking individuals of teams, in order to guarantee plurality, diversification and novelty in scientific production.

3.2 The use of bibliometrics in different institutional settings

We already mentioned in part 1 that the European quest for scientific excellence may have originated in the attempt to reach the same level of scientific and economic productivity as the U.S.A. Bibliometrics was born in the United States and is widely used in scientific evaluation on that side of the Atlantic.

However, there are reasons to believe that the effects of using bibliometrics in the two systems of research, European and American, may be different. More generally, we may reflect upon what happens when bibliometric tools are embedded within different institutional practices, along the lines suggested by John Furedy in his enlightening reflection on “Melding Capitalist versus Socialist Models of Fostering Scientific Excellence”, (1987). It is useful to distinguish between private, decentralized, market-financed research systems and public, centralized, tax-financed academic and research systems. The archetypal model of a private and market-oriented academic and research system is the U.S.A. Universities there can be private for profit, private non-profit or public (state level) entities. Financing of research activities comes from five main sources:

a) Private enterprises that finance research in order to make economic use of the results.
b) Private foundations that finance research in the interest of the general public.
c) The government, which finances research out of taxpayer money because research and education are technically the classic “public good”, i.e., a good that has a value for the community over and above what would be reflected in its market price.
d) Students' tuition fees, which make up a small percentage of the total funding, but are supposed to represent an important mechanism of orientation of the entire system. The best universities attract the best students and are able to request higher tuition fees because the value of what they teach is higher. This role of student’s choices is sometimes considered more important by observers in non-market systems, where students are allocated on the basis of geographical consideration, than by academics in the U.S.A.

In a market-oriented system, universities and other research entities have their mission, defined in terms of producing the best science but also in terms of serving a particular subset of users. Governance, hiring processes and careers, are decided autonomously by the governing bodies of the universities, which may differ according to the statutes of each university. Evaluation is ex post: if a university does a good job educating students and producing research, then besides attracting brighter students, who may be willing to pay higher tuition fees, it will also receive private money by enterprises and foundations. The market price of a researcher, i.e., the wage required to hire a given scientist, may vary because it can be the object of a private deal between the perspective employee and the dean or committee in charge of hiring. In this context, those in charge of recruitment need an indicator to literally evaluate the worth of a scientist. The mandate of the hiring authority is not to hire the single best person: it is to find the best combination of talents at the lowest cost. This may be achieved for example by hiring one costly superstar or two average people for the same cost, according to the evaluation of the didactic and research needs, including the needs for diversification. The final judge of the result is “the market”, i.e., the students that are willing to pay a higher tuition, the alumni that are willing to make donations, the firms which are willing to hire the university scientists for their research needs and in the end, the success of the applications to the public funding

bodies. In this context, bibliometrics shortcomings indicated by Feller are mitigated by the broad scope of the process: bibliometric tools work mainly as carriers of information, not as screening devices.
The situation is very different in public and centralized systems, which are typical of many European countries. Centralized systems have standardized wages, standardized labour contracts, standardized procedures for hiring, and usually low student territorial mobility. The majority of funds for research come from directly the government and not by the process of applying to specialized agencies. The link between private enterprises and universities is weak. Private foundations with the mission to finance research are small. Students' tuition is standardized and subsidized: a portion of the funds are given directly to universities in proportion to the number of students enrolled and in good standing. Other political criteria, such as intervention of the local political authorities, may be used in the allocation of funds. Since the university system is part of the public administration, notwithstanding the tight legislation and regulations to avoid them, nepotism in the hiring system and corruption have not been eradicated.

Therefore, in these systems the proposal has been put forward to use bibliometric tools as the main criteria both for hiring and allocating research funds, i.e., to play the role that in the market system is played in competition for funds and students among independent universities.

The reasoning is as follows: our systems are less effective in producing science than the U.S.A. market-oriented system because the incentive to do well is not aligned correctly in favour of giving monetary rewards and other perks to the most productive scientists. Let us measure excellence more accurately, let's distribute funds on the basis of bibliometrics and let's hire according to bibliometric scores and other tools, and our science system will become less corrupt and more productive.

In a centralized system, a small panel is in charge of assessing the value of the research of an entire discipline. This is a very powerful position. Like all systems governed by "enlightened autocrats", this system is as good as the people who are selected or nominated at its top. Since we know that gender-biased gatekeeping, feminine invisibility, and homosociability exist, there is good reason to expect that such panels will be gender-biased. In this system, introducing strict bibliometric standards may be one way to diminish, rather than increase, gender bias: to add the bias implicit in the bibliometric standards, to avoid the bias linked to feminine invisibility and homosociability.

According to some approaches present in the literature *(Fletcher, C., Boden, R., Kent, J. & Tinson, J. 2007*) the centralized assessment by publications rate becomes a power operation, a way to submit to a central authority. The (masculine) will to power presents itself as a will to produce a particular order which is supposedly the best in absolute terms. This frequently corresponds to the will to place the interest of one group above the interest of some other group in a population.

BOX 3.2 'Performing Women: The Gendered Dimensions of the UK New Research Economy'

This article explores the development and maintenance of familiar gendered employment patterns and practices in UK universities, which are exemplars of new modes of knowledge production, commoditization and marketization. After discussing in detail the evidence of gender discrimination in UK higher education and the changes in the academic labour process consequent to the incorporation of universities, at least at the policy level, into the 'knowledge economy', institution-specific data is used to highlight the gendered aspects of the research economy from the three intermeshing perspectives of research culture, research capital and the research production process. This nexus is constructed in such a way as to systematically militate against women's full and equal involvement in research. Lack of transparency, increased competition and lower levels of collegiate activity coupled with networking based on homosociability are contributing to a research production process where women are marginalized.
Abstract of Fletcher, C., Boden, R., Kent, J. & Tinson, J. 2007, Gender, Work & Organization, vol. 14, no. 5, pp. 433-453, GSD.

In this context, the role of bibliometrics would not be only to carry information regarding the capabilities of different scientists and institutions. It would bear the full weight of the allocation and evaluation process.

To use an economic metaphor, an agent that goes to the market and maximizes his or her utility under the constraint of his income will not always buy the goods at lower prices or the goods at higher prices. He or she will make a sophisticated operation, buying relatively more of one good that is low priced and relatively less of another good that is high priced, searching among the sellers of the same good who has the lowest price, but trying not to waste too much time and energy searching, giving up some goods altogether in order to be able to buy something he or she likes more, and always taking in account his or her tastes. We cannot substitute this delicate and flexible operation by saying: always buy some of this given list of goods, always from the seller that has the lowest unitary price. Mimicking the market this way would not do: the choice process is an active process, not easily substituted by an algorithm.

Using bibliometric indicators to mimic the allocating functions of the market may introduce one further degree of rigidity in systems that are already fairly rigid and prevent institutions from pursuing some balance among the sexes in hiring and in the allocation of funds, taking informally into account the extra burdens that individuals, and women as individuals, may encounter, such as having children.

It must be added that there is no evidence at this point that the attempt to stimulate scientific productivity by using bibliometrics works. The Australian experience (Box 3.3) indicates that the change in behaviour obtained by introducing strict bibliometric formulas in the evaluation processes only produced an increase of publications at the low end of the scale.

Box 3.3 Modifying publication practices in response to funding formulas

The reaction of Australian academics to the use of one performance measure, raw publication counts, can be starkly illustrated using data from the Science Citation Index. The mid-1990s saw the first distribution of research funds to Australian universities based on a formula encapsulating a number of performance measures (graduate student numbers or completion rates, research income, and publications). Many universities reinforce the sector-wide signals by allocating the money they receive under these programs back to the departments, or even individuals, who 'earn' them. The reaction of Australians to these signals is entirely predictable – their publication output has increased dramatically in the last decade. But as quality is paid scant regard in the measures, there is little incentive to strive for the top journals, and this paper shows that the biggest increase has been in those journals at the lower end of the impact scale.

Butler L. Research Evaluation, Volume 12, Number 1, 1 April 2003 , pp. 39-46(8)

Finally, the attempt to align the incentives correctly so that people choose to be more productive in science should not be confused with the legitimate attempt to weed out incapable or lazy male (or female) scientists. The carrot and the stick are two very different tools, especially if applied to very different donkeys. The attempt to use the stick, i.e. punishment as a consequence of not enough publications or citation, is very different from the use of the carrot, i.e. establishing perks and prizes for the highest achievers. The attempt to weed out the incapable and lazy scientists of both sexes may have the undesirable effect of also weeding out capable and proactive female scientists who are not willing to sacrifice the time they spend with their children and family, and other social and cultural interests. This is the oldest of the feminist issues: a large part of the time that parents spend with their family is not leisure. It is the most important and vital part of a person's life and of societal life. The market values this time at its opportunity cost – the wage a parent gives up if s/he stays at home, the wage the family has to pay to a substitute care-giver – but the market does not take in account all the positive externalities to society. The quest for competition could lead to unintended deterioration of human capital of future generation and present-day social capital. These latter two are produced by people – men, but especially women – in an important part of their so called "leisure" time. It is a very risky business to provide too many incentives for the most intelligent of our women and men to have to relinquish spending time educating their children in favour of doing science.

BOX 3.4 Gender and British RAE

In an important contribution T. Rees (2004) points out the problems that the British RAE might create for women scientists:

- *Since the RAE is organized in panels, interdisciplinarity is penalized. Interdisciplinarity is a necessity in gender studies. Although panels are instructed to ask the panel of another discipline their opinion on the contents of a given publication, then the fund allocation is by the panels, so in a sense, interdisciplinary work takes the money of one discipline to the other discipline*

- *Panels are made up of senior academics. Women do not get to be senior academics, as illustrated by the famous scissor graph.*
- *Publications must be a steady flow: if a scholar "misses" one turn of RAE in the years she is having children, and it is not returned for that RAE, the results are career blighting.*

At the present time, RAE does not have an interdisciplinary panel or a gender study panel. Scholars in gender studies have chosen to bear a triple burden: the burden of having to conform to the social norms of femininity, including maintaining an acceptable level of domestic production of welfare; the burden of living up to the standards of their chosen profession, and the burden of adding to the regular performance as physicists, physicians or philosophers their research on gender issues. This implies that scholars in gender studies are practically forced to be second-rate scholars in their original discipline. Unless they are extremely gifted individuals, they cannot possibly compete with male colleagues who are able to focus only on living up to the standards of their chosen profession. For this reason, it is extremely important that wherever an assessment exercise is attempted, an interdisciplinary panel and/or a gender studies panel is consulted.
In the same article, Theresa Rees reports that the RAE is supported by the vast majority of British academics. This would not make the assessment gender-fair. The literature also reports evidence of an opposition to a managerially-oriented conception of scientific evaluation.

As a starting point of our analysis of gender and bibliometrics, we will discuss the particularly interesting contribution made by an important bibliometrics scholar, Irwin Feller. In Feller (2004), the author provides a particularly useful framework of analysis. When describing his contributions, we must note that he uses the term "gender bias" as if referring to "gender bias against women". Gender is a bidirectional relation and therefore it can be masculine or feminine, a point that will be useful in the discussion in part 3.2. There is nothing wrong in this use, since gender bias is most often against women. However, it is worth bearing in mind that gender bias in favour of women is also possible.

Feller underlines two points:

a) **The need to distinguish between bias present in the system and bias present in the indicator** of performance (p. 36). The two are not the same. In a perfect situation, we wish for an unbiased system and unbiased indicators. We may instead be in a situation where there is bias in the indicator, but not in the system, or bias in the indicator as well as in the system. The fourth possibility, of a biased indicator in an unbiased system, is probably rarer.

b) **The need to distinguish between performance and excellence, or quantity and quality of research produced** (p. 38). Although a suitable mass of scientific output is a precondition for excellence, excellence is not just the total sum of past performances: there is an element of originality and innovation of a given scientific product that may not be captured by bibliometric tools, especially soon after the research has been produced. We may add to this that it is also important to distinguish between the institutional context in which bibliometric tools are embedded, such as a free market systems, governed from the bottom up with judgment ex post (the center gives the scientist the money, s/he uses it as s/he wish, the results are evaluated)), or a centralized systems governed from the top down, with judgment ex ante, (permission by the center before every minor expenditure)

In relation to point a), **distinguishing between bias present in the system and bias present in the indicator,** Feller addresses the question of whether metrics of scientific performance and of assessment of scientific excellence are gender-biased. The paper is purposively methodological in tone because it seeks to clarify conceptual and measurement issues that at times are conflated in contemporary scholarship and policy documents. In order to clearly distinguish the analytical problem, he presents a two-by-two matrix of possibilities. On the horizontal axis of the box, he measures the presence or absence of gender bias in the academic system; on the vertical axis he indicates the possibility that the metric by which performance is measured is biased. This scheme originates four possibilities, as below:

Figure 3.1 Feller's Scheme

Horizontal dimension: Academic system and evaluation system is **biased against women**

	No	**Yes**
No	A UNBIASED METRIC UNBIASED SYSTEM	B BIASED SYSTEM BIASED METRIC
Yes	C UNBIASED METRIC BIASED SYSTEM	D BIASED METRIC UNBIASED SYSTEM

Vertical dimension: Measures of scientific excellence are **biased against women**
Source: Feller (2004)

The most important device used by peers when reviewing research results, which most academics are willing to recognise as 'unbiased', is some measure of the number of published articles and books and of their influence, measured by the number of citations they receive and the **impact factor ranking** of the journal where a scholar publishes.

Feller labels these bibliometric indicators "unbiased". However, he maintains that there is a tension between unbiasedness, reliability and validity. Indicators that are measured easily and unequivocally – and provide a reliable way of counting – are not necessarily the most valid and reliable tool to assess the present importance or to predict the future performance of an academic. In other words, bibliometrics are not necessarily the best indicator of scientific quality, as argued by Feller in this paper. A clearer interpretation of Feller's reasoning can be achieved by replacing what he labels "unbiased" with some other term, say, "gender-insensitive". Feller wishes to point out that the application of the metric *per se* does not favour one sex over the other. Feller recognizes that the use of these so-called "unbiased" indicators will reflect the bias in the system, rather than making the system gender-unbiased. This Rapporteur would like to argue, however, that the label "unbiased" is not an adequate label, and that the scheme presented by Feller may be used to the scope of generating unbiasedness in the system.

Feller points out that what can be measured is not the full potential of quality but only representations of quality. Bibliometrics are used as a proxy for excellence, quality, and ability. The quantitative is a reduction of the qualitative, which is not easily measured in an objective manner. Counting the number of words written by a scholar does not make it possible to gauge the importance of somebody like John Nash, who is famous only because of a few early papers, or to distinguish between Wittgenstein and any prolific college teacher, let alone between Einstein and another young physicist if the count of citations is made one year after publication. Great discoveries take time to mature in the profession. It was calculated that different disciplines have a different average time to peak citation number and even the shape of the distribution of citations changes according to the effective "quality" of the paper.

In addition, Feller observes that the connection between short-term publication and long-term scientific impact is rather weak: there are papers that show the same citation path for a few years, then one declines and the other keeps going up. Thus, early measures may not be an accurate predictor of the long-term impact of a scientific discovery: each measure is good for its own time, rather than being taken as a predictor of the future performance of the person or of the total overall cumulative importance of the research reported. Furthermore, there is evidence that the use of indicators causes opportunistic behaviour: exploiting the discrepancy between the fact and the indicator used to measure it, scientists and universities tried to enact policies which, without really improving the quality of research, led to greater numbers of publications.

According to Feller, the present situation can be better described as under letter C of his frame, i.e. a situation in which an unbiased metric applied to a biased system perpetuates bias. Other scholars believe instead that the situation is as under letter B, biased metric applied to a biased system. He therefore recommends working towards building more reliable and valid bibliometric tools (an expanded set of metrics, Feller, p. 38) and to make a clearer distinction between measurement of performance and assessment of excellence. This recommendation somehow diverges from the thesis that bibliometric tools are already unbiased.

This Rapporteur is among those who believe that situation is as under letter B, and will now argue her disagreement. The assertion that bibliometric indicators are gender-unbiased appears somewhat tautological: any metric that is applied uniformly is in itself unbiased. Height in centimetres would be an unbiased metric of excellence. If it were used, women would be at great a disadvantage because they are, on average, shorter than men, but the meter used to measure everybody is the same, and therefore certainly unbiased. To assert this kind of unbiasedness is almost meaningless. Those who assert that bibliometrics is biased claim that measuring excellence with bibliometrics is a practice that produces bias against women, in the same sense as using height in centimetres would be biased. The problem is that bias is not the precise term we are looking for: the appropriate term for the fact that citation count, exactly like the meter, treats men and women equally, is to define it as **gender-blind.** In this context, gender-blindness is a characteristic of the tool; it is a description, not a judgement.

A counterfactual example may be used to clarify this concept. What could be a biased metrics? One may perhaps decide to measure excellence of men in centimetres and excellence of women in eleven millimetres, and then use the resulting absolute numbers to decide who is excellent. This is what is done when double standards of competence are used (see the discussion on Foschi in part 2). This is using a biased standard. The standard is biased because it gives us a number which makes the estimate deviate from the true estimate of excellence. The definition of *biased* in statistics refers to an indicator which gives us an estimate of a parameter of a distribution (e.g., the mean or the variance) which is systematically too high or too low. The situation would be much the same as if the number of articles was used as a standard for men, the number of books for women. A gender-blind indicator would be gender-biased if it gave us a measure of excellence that is systematically always below or always above true excellence. This is in fact the case, as discussed in part 3.3.

3.4 Gender-bias can go two ways: in favour of men and against women, and/or vice versa.

The distinction introduced by Feller between "bias in the metric" and "bias in the system" is very useful in the discussion of policies. His scheme admits four possibilities, one of which is that gender bias is compounded: a metric of excellence biased against women (number of publications and citations) is used together with standards biased against women (women scientists need to have more books and articles published and cited to advance in their careers). This is situation B of the Feller scheme.

Considering the probabilities of each of the four "states of nature" presented in the Feller scheme, and by attaching the same probability to each of the events, it is apparent that the outcome gender bias is the most likely of the four combinations: the only unbiased situation that may occur is situation A, no bias in the metric and no bias in the system. Instead, the outcome gender bias occurs in situations B, C and D. The scheme disproportionally diminishes women's chances of equal opportunities. Only if both the system and the metrics are unbiased will they have equal opportunities. According to Feller's analysis, since we already have unbiased metrics, we need to rid the system of bias: we are in situation C (bias against women) and we need to move to situation A (no bias for either sex).

In a policy geared towards equal opportunities, biased standards such as double standards, which disadvantage women, should be eliminated. Everybody agrees on that. But what about biased standards that give advantage to women? We can discuss the possibilities using Feller's own scheme, considering, along the vertical dimension, the possibility of a metric **biased against men** and analyzing the results of his envisaged situations:

Figure 3.2 Addis's modification of Feller's Scheme.

Horizontal dimension: Academic system and evaluation system are biased **against women**

	No	Yes
	A UNBIASED METRIC UNBIASED SYSTEM **OUTCOME: NO GENDER BIAS**	B BIASED SYSTEM FM BIASED METRICS FW **OUTCOME: GENDER BIAS AGAINST MEN OR AGAINST WOMEN, OR NO GENDER BIAS. ACCORDING TO THE RELATIVE SIZES OF THE BIAS**
	C UNBIASED METRIC BIASED SYSTEM FM **OUTCOME: GENDER BIAS FAVOURS MEN**	D BIASED METRIC FW UNBIASED SYSTEM **OUTCOME: GENDER BIAS FAVOURS WOMEN**

Vertical dimension: Measures of scientific excellence are biased **against men**.

Note: FM reads "Favours Men" and FW reads "Favours Women"

In this modified scheme, there are still four possible situations. Situation A still gives an outcome of unbiasedness for both sexes. The other three situations are as follows: situation C is biased against women, situation D is biased against men, and situation B can be biased either against men or against women, or can be set in such a way as to achieve unbiasedness by balancing bias against women in the system and bias against men in the metrics. The overall situation in this second scheme is much more encouraging for women. If we attach the same probability to each of the events, the situation is balanced among the two sexes. There are two states in which the final outcome is biased against each sex situation A, which is unbiased, and situation B, which can be made unbiased. By using a policy that biases the metrics in favour of women, we have achieved a much fairer situation, where the probabilities of women achieving equal opportunities increase dramatically.

There is another policy opportunity that clearly emerges from his scheme: that of **amending the metric in favour of women so as to achieve a status of no gender bias in situation.** This is, essentially, the reasoning underlying all the "quota" proposals, i.e., the proposal for an equal, or roughly equal, percentage of people of each sex in a given position. Imposing a quota is tantamount to amending the results of the applications of the metric by a factor. The factor is not arbitrarily defined, as it would be in a handicap system, but is variable. The factor is selected so as to ensure that the quotas are met.

If the following two conditions are met:

a) one disagrees with Feller and believes that the present situation is a situation of type B, not type C; i.e., if one believes that there is bias in favour of men in the metrics used (if one believes that **bibliometrics is inherently biased** because in order to produce as many articles as men, women would have to give up the traditional maternal role towards their children, which they wish to keep), reinforcing the bias existing in the system, or if
b) there are reasons to believe that innate persistent factors lead to situation B (again, where **bibliometrics is biased**), for example, because there are innate and unreasonable motives which cause men and

women overlook women's performance and notice only men's performance; (see the discussion on Golding and Rouse and Foschi in part 2), or because there is a certain behaviour, such as taking pleasure in competing, that makes men more likely to acquire information (Addis, 2004),

then, as a consequence of the conditions in 1) and 2), a reasonable policy option would be to use a metrics that produces a bias in favour of women in order to produce overall freedom from gender bias. The extreme version of a bias in favour of women is to allot to women 50% of the quota of positions in a given academic body; but this leaves open the question of the criteria that should be followed to select these women, which are not necessarily the same as for men, and of who would be in charge of selecting them.

Are there other means to introduce a pro-women bias in metrics? Yes. For example, one might propose weighing bibliometric citation scores by a parameter in favour of women. This parameter can be derived from the overall position of women in the system, so that it will disappear as women reach parity. As long as there are fewer women at the top of science and at the core of the system, women's articles will receive a proportional bonus for being cited. This bonus will disappear when men's and women's positions at the top are at an approximate par. The same bonus may be applied to male scientists in fields in which they are in a disadvantaged position.

Other simpler policies to redress systemic bias are, of course, quota systems in hiring scientists, reserved portion of scientific funds, or different rankings for men and women scientists and proposals (there are two different races and two different rankings of winners, men and women, as in the Olympics). These policies are adopted when it is acknowledged that it is impossible to achieve a situation of type A, and therefore a situation B with bias in favour of women is the only possible option

3.5 Excellence, performance and bibliometrics

With relation to point b) raised by Feller (2004) (i.e., **distinguishing between performance and excellence or, quality and quantity of research produced,** Feller points out that the existence of a difference between quantity and quality may be the source of at least five sources of bias in metrics:

a) **The number of pages published alone cannot be an indicator:** there are authors of very few pages, such as Wittgenstein or Sraffa, who did not publish much but had a great impact in their field, as shown by citations. This particular limitation of bibliometrics does not appear gender-biased against women. In fact, there are a few examples of female authors in the same league, such as Carla Lonzi or Valeria Solanas.

b) **The time pattern of influential papers is not uniform:** a paper may be much quoted soon after publication and then disappear, while another paper published at the same time may flourish only after a few decades, but then grow even larger, as was the case with the work of John Nash. Similarly, this source of bias does not appear to be gendered: even women's papers may have different patterns than men's and than other women's.

c) **Counting pages or citations is useful in the situation of "normal science", but it does not perform well in the presence of large or small "paradigm shifts".** It is common knowledge that Thomas Kuhn interpreted the history of science as a sequence of the accumulation of quantities of more detailed knowledge on the same theoretical structure, to the point where the need to explain one new fact hitherto overlooked leads to a scientific revolution, i.e. a shift of theoretical paradigm. Entire paradigm shifts are a fairly rare and important phenomenon, but subsequent research has shown that in each sub-branch of science, there are a number of minor new intuitions that are not the mere result of a very accurate statistical analysis of all the available data. They involve the reconstruction of a chain of events that must be coherent with the statistical properties of the data, but that go beyond what can be described by the statistics. For example, the introduction of new categorizations is not always obvious in data, until one decides to search for them. Think of the biological concept or receptor on a cell's surface, or of the groupings of welfare states in regimes. The citation count fails to distinguish between the old paper, which received a lot of citations, and the new paper on the same topic, which may have completely subverted the topic of the old paper but is not yet widely known, thus creating a bias in favour of old work and against innovative work. This may be a source of gender bias in the aggregate, since women are late-comers to science, but should not create a bias between two individuals of different sex but of the same cohort.

d) **There is evidence of opportunistic behaviour**, i.e., the tendency of individuals and institutions to quote themselves, their institution or their friends, which may bias the true relevance of a body of work. This bias of bibliometrics is probably gender-neutral, unless we believe that there is a systematic difference between people of the two sexes to brag about their work.

e) As reported by Feller and shown by Etkowitz, Kemelgor and Uzzi (2000), **citations appear as a by-product of participation in larger networks,** not only of intrinsic scientific quality. Two papers with the same intrinsic value may receive different bibliometric scores because their authors are in a different position in the scientific network. Two authors who have the same intrinsic value may have different citation scores because their institutions have different positions in the scientific network. This is also a serious source of gender bias for citation counts. By devoting less time to networking, or by being victimized by the innate psychological biases against feminine competence (as shown by Goldin and Rouse (2000), performance embodied in women is more poorly rated), women are less visible and less remembered than men with the same characteristics, as shown by Foschi (2000), and therefore may end up being penalized by the citation indexes[26].

What we can conclude about bibliometrics from this analysis is that:

- **It is gender-blind,** because it makes no distinction between whether it is counting publications and citations of a man scientist or of a woman scientist. In many situations, gender-blindness is a problem. In a metric standard, gender-blindness may be useful because it provides a measuring tool that is able to show when the treatment given to women is blatantly unfair.

- **It is gender-biased against women,** because out of five known limitations of bibliometrics, two are gender-unbiased but at least two others are gender-biased. Bibliometrics is a tool that is gender-blind and gender-biased.

Does this mean that women should oppose its use? Not necessarily, because the advantages of gender-blindness, in this case, may overcome the disadvantages of voluntary gender-biasedness against women.
The metric is biased. The system is biased, as Feller himself recognizes. We are in situation B, not in situation C.

The title “Minimizing the gender bias” was chosen to remind us that, in deciding to use bibliometrics, we may be choosing the lesser of two biases.

3.6 The use of bibliometrics for resources allocation

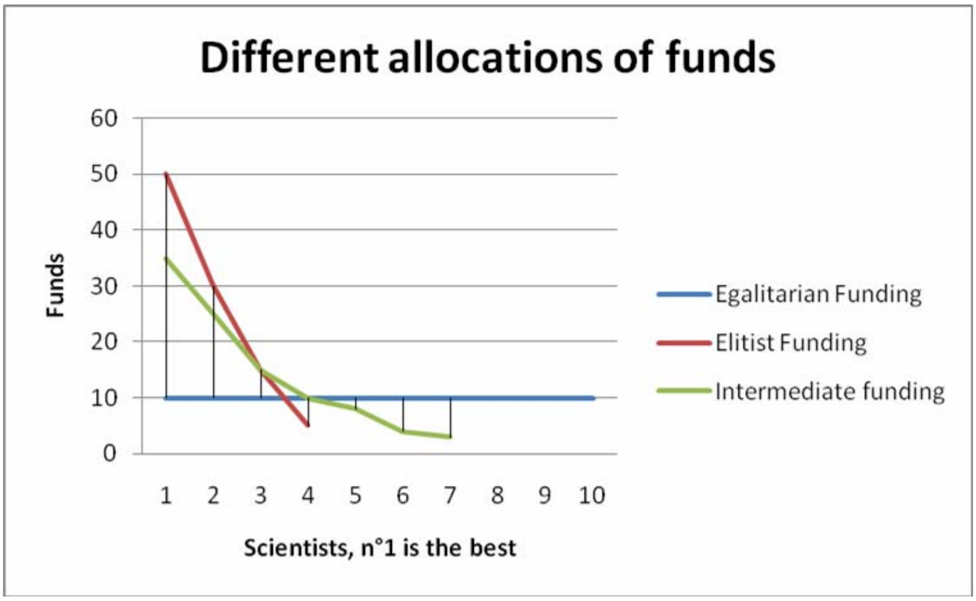
Bibliometrics produces a scale to rank individual scientists and /or scientific institutions. It is not able, however, to give us a unique formula to allocate scarce scientific resources. Whatever the bibliometric ranking, the authority in charge of assigning funds can choose among a number of allocation criteria. We can define two polar extremes of allocation of research funds: an **egalitarian** strategy and an **elitist** strategy, both of which are implemented making use of bibliometric scores.

In an **egalitarian allocation,** many or most of the applicants for research funds receive at least some of the total resources to pursue their own projects, as long as they have produced a certain number of publications: for example, if there are 10 applicants and 100 million in funds, each will receive 10 million. In a more **elitist allocation**, a few or a single scientist will receive all the funds: for example, out of 10 applicants, only the 4 with the best bibliometric scores receive funding and share the 100 million, in which case the funds are distributed so that the first gets 50 the second 30 and the fourth gets less than 10. The other six receive 0 funding. There are many possible intermediate allocations, more or less egalitarian or elitist.

This very simple graph describes the different situations.

[26] We wish to add to these points raised by Feller one more fact along the same lines, which is that, as shown by Ferber (X), men and women both tend to quote disproportionately more men, but men much more so.

Graph 3.1 Different allocations of funds



The graph represents three possible ways in which 100 units of funds may be allocated among 10 scientists. In the egalitarian allocation, everybody receives 10 units of funds, i.e., the average. In the elitist allocation, only the first four scientists receive funds, the fourth below average, while the other six are excluded from science. In the intermediate allocation, illustrating one of many possible intermediate allocations, the first seven scientists receive some funds and the last three are excluded.

If women scientists are not in the top positions, an elitist allocation of funds may damage them further, unlike an egalitarian allocation. If we assume that in either of the allocations, resources given to science are the same amount, in the end the same number of scientists, more or less, will be hired. The difference is that in the **egalitarian allocation** each scientist will follow his or her own agenda, and hire only the 10% who did not receive autonomous funding. In the **elitist allocation**, the top 10% of the scientists who receive all the funding can then hire the other 90% of the scientists to pursue the top scientist's research agenda.

Each formula of allocation (of which there is an infinite number, all of them with reference to the same bibliometric index) will have its own effect on the evolution of science, determining which scientific projects will be undertaken, which ideas will survive and which will have to wait before being tested.

Which allocation is better, egalitarian or elitist? It is a debatable issue. We are in the presence of some trade-offs. There is the usual trade-off between potential high risk and potential high reward, well known from the behaviour of assets in financial markets. If we give all the funds to the best scientist and if he achieves his goals, then we might have produced the best science; if he fails, then we have lost everything. So we had better be sure that he is indeed the best scientist. If we share the money out, the probability that all the scientists who received funding will fail may be smaller than the probability that a single one will fail, but the probability that at least some of them fail may be higher, and thus some of the money will be wasted. So everything hinges on how high the probability is that the single best scientist will fail, and how high the probability is that a given percentage of many scientists will fail. We know very little about these probabilities.

There is also a second trade-off between pursuing many different research projects and therefore fostering many original ideas, or gambling all the money on the success of a few projects which are supposed to be "the best" under some or other parameter.

The allocation chosen does not depend on bibliometrics. This is the point that needs to be stressed. One can use bibliometrics to make many different allocations, some more and some less egalitarian or elitist. However, if the allocation is going to be elitist, then a mistake is going to be quite costly. If all the resources go to the top one person and he fails, the damage is going to be quite large. Therefore it is worth the public authority's while to invest many resources in the production of good bibliometric indicators and in the selection processes. If, instead, the allocation is going to be egalitarian, some resources may be wasted on unworthy scientists, but some will go to worthy scientists. There is always some waste, but the risk of wasting the entire amount is smaller. In this case, it is not worth spending a large share of the total resources on the production of bibliometric indicators.

This fact creates a first association: preference for production and use of bibliometrics and other indicators goes together with preference for elitist strategies. Preference for a science policy that values a plurality of approaches, ideas, and projects, even at the expense of some waste, goes together with scarce enthusiasm for bibliometrics.

The word “excellence” is often used by those favouring an elitist distribution of funds: this is the allocation criterion that, in this opinion, most favours “excellence”. A science policy that values a plurality of approaches also favours the creation of a plurality of epistemic communities, each with its own criteria and rules for “excellence”.

A spurious connection is created between *excellence/elitist allocation/bibliometrics*, on the one hand, and *non-excellence/egalitarian allocation/no-bibliometrics*, on the other. This association is false and simplistic. Scientific production is not one-dimensional, from bad science to good science. It is multi-dimensional: there are original thinkers and innovators. Egalitarian allocation produces a plurality of approaches, many of them original, which is the best guarantee for scientific advancement. It may well be that an egalitarian allocation produces as much or more “excellence” than the elitist strategy. And bibliometrics itself can be used for any policy, not necessarily an elitist one.

This discussion obviously has a gender dimension: in a situation where, as shown by the Vertical Segregation Report, women scientists are scarce at the top, the elitist strategy risks perpetuating women’s lack of funding and absence from scientific activity. The fact that the elitist allocation of funds may go against funding women’s scientific activity is a by-product of this strategy.

It is a by-product that is very seldom explicitly mentioned. This may be due to the phenomenon of “feminine invisibility” or to the fact that if somebody mentioned it, he or she would appear to be assuming that women are less “excellent” then men, and therefore may come across as antifeminist. But there is no escaping reality. The results of the Report on vertical integration show that more egalitarian choices in distributing funds would favour women and pluralities of approaches and that equating excellence with elitist funding policies would damage women scientists.

Bibliometrics, which we have shown to be gender-blind and gender-biased, is also in itself **gender-neutral** as it does not necessarily prescribe an elitist allocation strategy over a more egalitarian one. **The use that is made of bibliometrics in support of elitist strategies** is not gender-neutral. It has been gender-positive for men and gender-negative for women.

Box 3.1 The quest for scientific excellence by imposing bibliometric standards and the selection of new ideas.

One can consider the production of new ideas to be subject to the same evolutionary laws that govern biology and economic growth (Beinhocker, 2006). This law can be summarized at the highest level of generalization as a continuous repetition of a sequence made up of two fundamental steps:

Sequence one

- *First step, replicate with mutations and differentiations in new forms.*
- *Second step, apply environmental pressure to select the fittest among the new forms.*

Sequence two

- *First step, repeat from step one starting with the forms that survived sequence one.*
- *Second step, apply environmental pressure to select new forms.*

The quest for scientific excellence by imposing bibliometric standards may be interpreted as the will to apply a selective pressure to favour the development of selected strands of new ideas. If the selective pressure is too strong, it will allow only a few uniform ideas to survive and then mutate into new forms. If it is too weak, it will not produce the specialization that is needed to produce more refined forms.

3.7 Conclusions to part 3

Bibliometrics is a tool of measurement which is not free of gender bias. It is biased in favour of mature scientific productions, and thus of established scholars and fields, where men are more numerous; of quantity of production, and thus of long hours of work and total mental dedication, that some women may not be willing to give; of central location within a network, which women may not be able to achieve because of other biases in the system.

It has the advantage, however, of being gender-blind, and therefore minimizing other forms of more direct gender bias due to homosociability and women's "invisibility".

Issues that need to be considered are also whether bibliometrics is used to advance a centralized system, where few people have all the resources, or decentralized systems of research funding, where resources are spread among many researchers, and whether bibliometric is used in systems that are publicly funded or in systems where the research entities are private foundations. In the second kind of system, bibliometrics is a legitimate tool to gather information; in the public system there may be rigidities that make the use of bibliometrics suboptimal.

One important gap in the research on bibliometrics from the economist's point of view is the issue of the effects of financing journals and books on scientific production. Journal and book production does not happen in the economic void. Each journal or book has an editor. Sometimes, these editors are public not-for-profit entities such as Universities or Foundations, which aim only at scientific eminence; sometimes they are private agents after a market profit from sales of the books and journals; other times the editors may be, or may be subsidized by, other private entities which expect to make a profit from other related activities, such as pharmaceutical companies for medical journals, banks for economic journals, and other corporations.

Each of these formats may produce biases of a different kind. The first type of editors, who have attained editorship by a process of cooptation from scholars who preceded them, may produce editorial boards which are quite conservative; the second kind may produce editorial boards that favour publication on topics which have a large, rather than specialized, audience; the third may produce a bias in favour of topics which are relevant to the subsidizer, so that scientists working on those topics will be able to attain a better publication record. The bibliometric score of a person may be affected by the fact that he/she works in a subfield where there are many journals, rather than few. The autonomy of science should be guarded against these intrusions.

Part 4. The GSD and excellence: a descriptive and quantitative analysis

4.0 Introduction

The first three parts of the report analyzed the literature in the GSD in relation to the topic of excellence with reference to the concepts that were put forward in the proposal for the project. The central theme was excellence. In the fourth part, the central theme is the GSD itself, taking the database as a whole and analyzing it to see what kind of works it contains and how they can be grouped in categories and analyzed. It also provides a statistical analysis of the database to check what trends and regional or national peculiarities may emerge and it reviews the country group Reports to identify any other regional or national peculiarities and contributions which were not incorporated in the discourse of the first three parts.

4.1 Sources of understanding on excellence in the GSD

An analysis of the database shows that our understanding of excellence is often the by-product of studies with other aims, rather than a special field of research. Understanding excellence is definitely an interdisciplinary subject: it requires competencies in biology, psychology, history, sociology, statistics, economics and philosophy, besides some knowledge of policymaking if any action is to be undertaken regarding the issue.

The GSD contains three main sources of information related to excellence and indexed by the keyword excellence. They are:

> **1) Studies in sociology, statistics or labour economics on women's scientific careers.** Examples of these are the studies which produced the three models we have reviewed in part 1. There are a host of sectoral studies or national studies with data collections and statistical analysis produced by many single scientists or groups of women scholars who have undertaken studies on the academic and research system of their country and of their discipline in an attempt to understand their own difficulties. These scholars used the methodological tools of their own professional trade, making use of economics, sociology and statistics to describe and interpret the situation Some of these studies have been undertaken thanks to the financing given by the European Institutions. A pioneering contribution to this strand of studies comes from an Italian male sociologist, M. Vianello, who focused on the women of the elite and coordinated European research projects on the topic. Among the most influential work in the field, mention must be made of: Wenneras and Wold (1997); Osborn, M.; Rees, T.; Bosch, M.; Ebeling, H.; Hermann, C.; Hilden, J.; McLaren, A.; Palomba, R.; Peltonen, L.; Vela, C.; Weis, D.; Wold, A.; Mason, J. & Wenneras, C. (2000) (also known as the ETAN report), and Palomba, R. (2000).

Parts 1, 2 and 3 of this Report are mainly based on this strand of the literature. For policy implications, this strand of literature concludes that the process of integration of women into sciences requires a change in the **social practices of science and surrounding science:** for example, how laboratories are organized, how time taken out for family is accepted, to what extent child and elderly care is available, how discrimination is eliminated, how evaluation is conducted and how the structures are adapted to fit women's needs. **The prediction** of this strand of studies is that if these practices are changed, then we will achieve equality between the sexes in the number of excellent scientists.

> **2) Epistemological research by feminist scholars.** In the seventies, a group of feminist scholars and scientists first provided a critique of science at the most general level, interpreting science as a gendered activity practiced mostly by males, and thus incorporating at its core some concepts and attitudes of domination of nature and of other human beings that are commonly associated with masculinity (Donini, 1991; Ribas, 1996; Pisier & Varikas, 2004; Barral et al, 1999; Ahlqvist, I., 1999). According to some of these studies, concerns and attitudes associated with femininity, such as empathy, respect for emotions, attachment and harmony, have been marginalized together with the women who express them. The problem, for these scholars, is not incorporating women into science as it is, but transforming existing science by introducing women and their specificities. If their critique is true, and depending on the extent that it is true, it provides a background and a source of hypotheses on why women do not reach excellence: women do not reach excellence, and are not recognized if they do achieve it, because of **a fundamental mismatch between women's perceptions of reality and the way reality is described by science today.**

If one accepts this radical result, it is not surprising that women are under-represented among the excellent scientists. It is also unacceptable, unnecessary or unfair, and needs to be changed. Nonetheless, given present-day gender relations and present-day science, it would be impossible that women were considered as excellent as men: the fundamental notions of science and the relative positions of men and women in society would both have to change in order to allow equal opportunities and factual equality in scientific excellence. If this result – which is of course controversial but definitely present in the literature – is accepted, then the process of integrating women requires more than just a change in the social practices in and around science: it requires a total change of conceptual landscape, of basic methodological approaches, of some basic tenets of science such as the complete separateness between the scientist and his object of study. **The prediction** of this strand of studies is that if these practices were changed, then we would achieve equality among the sexes in the number of excellent scientists, and also a total change of intellectual landscape in science. This approach may well be true: we will only know whether it is true if and when it happens. Finally, the third strand in the GSD consists of:

3) Biographical and historical studies. An important source in order to understand the peculiar obstacles women encounter in their scientific activities was:

a) the life stories of excellent women scientists of the past, conducted by other scholars, and

b) the narratives provided by the excellent scholars themselves on their lives and experiences. Examples of type a) in the GSD database are: Gonçalves, 2007; Sretenova, 2003; Sanchís, 2002; Martínez Pastor, 2003; Perdomo Reyes and Santana de la Cruz, 2004; Govoni, 2000, and many others. This was just one of the many instances in which an ideological standpoint ends up producing new scientific knowledge. The study of the lives of previously unrecognized women scientists has been one important source of **hypotheses** on why women's excellence is not recognized. The biographies of excellent, recognized and unrecognized, women is an important first source of information regarding the paths that may lead women to recognized or unrecognized excellence. In a sense, these biographies represent **case studies of scientific excellence** and the study of this material is subject to the same advantages and limitations of the methodology based on case studies. The direct voice of women scientists was offered by those who have become important enough to write autobiographies or books about other excellent women scientists. An important example is Rita Levi Montalcini, who wrote many books based on her own personal experience and on the importance of women scientists of the past (Levi Montalcini, Tripodi & Ferri, 2008). She also created a foundation to help educate women into science, especially women in developing countries.

Box 4.1 Rita Levi Montalcini

Born in Turin in 1909 to a Sephardic Jewish family, together with her twin sister Paola, she overcame the objections of her father – who believed that "a professional career would interfere with the duties of a wife and mother" – and enrolled in the Turin medical school in 1930, studying with Giuseppe Levi. After graduating in 1936, she went to work as Levi's assistant, but her academic career was cut short due to the subsequent introduction of laws barring Jews from academic and professional careers.

During World War II, she conducted experiments from a home laboratory set up in her bedroom, studying the growth of nerve fibres in chicken embryos, which laid the groundwork for much of her later research.

In September 1946, Levi-Montalcini accepted an invitation to Washington University in St. Louis, under the supervision of Professor Hamburger, where she spent thirty years. It was there that she did her most important work: in 1952, she isolated the nerve growth factor (NGF) from observations of certain cancerous tissues that cause extremely rapid growth of nerve cells. She was made a full professor in 1958, at the age of 49. In 1962, she established a research unit in Rome, dividing the rest of her time between Italy and St. Louis. In 1986, she received the Nobel prize for the discovery of NGF.

On August 1, 2001 she was appointed Senator for Life by the President of the Italian Republic. On April 28–29 2006, Levi-Montalcini, aged 97, attended the opening assembly of the newly-elected Senate, at which the President of the Senate was elected; she declared her preference for the centre-left candidate. She has been frequently insulted in public and on blogs since 2006 both by some centre-right senators and far-right bloggers *for her age and Jewish origins. Levi-Montalcini is currently the oldest living and the longest-lived Nobel laureate*.

The Gender and Science database under the keywords "biography", "biographies" or "life story" lists a total of 35 contributions which describe the biographies of single women scientists or groups of them. A further 236 are listed under the keyword "story", many of which are biographies. There are books and articles devoted to reconstructing the life of one single woman scientist (Oralalp, F., 1995; Gümüşoğlu, F., 1996; Babini, V. & Lama, L., 2000; Sanchís, R., 2002; Martínez Pastor, J. I., 2003; Perdomo Reyes, I. & Santana de la Cruz, M., 2004; Gonçalves, M., 2007; Sretenova, N., 2003) and there is there is a conspicuous amount of publications which collect a series of biographies in a specific discipline (Fernández, M. D., Uskola, A. & Nuño, T., 2006) or in science overall (Alic, 1989; Witkowski, 2008). Comparing them provides important analytical hints on the reasons why women do not reach excellence in science (Sesti, 1996, BOX).

Box 4.2 Biographies of women scientists as a means to discuss the relationship between gender and excellence.

Abstract of Sesti, S. 2003, La scienza invisibile. Una ricerca sul rapporto delle donne con la scienza (The invisible science. A research on the relationship between women and science).Source GSD

In this paper, Sara Sesti analyses the biography of famous women scientists in order to answer two fundamental questions. The first aims to ascertain the reasons why women's representation in scientific research is so low. The second question focuses on the way in which female researchers have expressed their diversity in doing scientific work in recent centuries. The author sets out to determine the existence of a specifically female approach to the creation of new knowledge. The biographies she quotes are those of Italian women scientists who lived between 1878, the year in which the first academic degree was awarded to a woman in any scientific field, and 1969, the year in which access to Italian universities was liberalised, thus marking the beginning of the modern Italian university system. She also examines the biographies of some of Europe's most prominent women scientists. The so-called "humanities" are not included in her classification. Personal and private details are described only briefly, as the author is more concerned with the existence of a feminine approach towards scientific knowledge with regard to two aspects: 1) the importance women scientists attach to language, both through the powerful use of the spoken word and as a way of explaining research contents, and 2) the importance they attach to methodology defined as the practice of methodical calculations, rather than methodology as pure technique. The author maintains that the factors that prevent women scientists from reaching the upper echelons of the scientific hierarchy are closely related to the strict, severe and competitive structure in the organisation of scientific research. This structure induces women to abandon their scientific careers because of "women's poor attitude toward conflict" together with the penalisation women experience due to differences in the division of domestic work.

An important and original contribution comes from the work of A. Durakbaşa (1995,) who presents her own reflections on the importance of recovering the forgotten stories of women scientists' lives, using as a starting point her own emotions when reading the autobiography Halide Edip, a Turkish scientist. This is an example of the use of the feminist approach called "start with oneself", where one's emotions and one's situated knowledge are used as a springboard to further knowledge. The approach is definitely different from the standard scientific methodology (collect enough data to be able to say that your claim is objective and universal). Although the scientific method has its great merits, this highly subjective approach yelded numerous generalizable insights in the social sciences.

The relation of women to scientific excellence has changed in the last three decades as a result of the advances that women have made in society and the efforts of women's movements which have strived for equal opportunities. When describing the contemporary situation, the risk is to reflect only the forces that were hindering women in the past, forces which still pose an obstacle for women in their scientific careers and prevent them from achieving excellence. But these forces have lost strength in the recent past and many more women than before have been able to reach top positions in science. However, the study of their path is still under way, since the path to excellence develops throughout a lifetime and these women are now reaping the fruits of a career that took advantage of the results of the advances of the last three decades. These women, who might have been in their twenties or thirties around 1975, are now in their sixties and seventies. They are now at the age at which excellence achieved becomes apparent and receives honours, at which senior positions in directing research projects and admittance to National Academies become a reality.

The work conducted on these women and on their careers is still scant. One important exception is the study of the factors determining the success of excellent scientists presently living, carried out by Garcia de Leon et al. (2005). Her group collected interviews from the women admitted to Spanish Royal Academy, the body that bestows the maximum honour on a Spanish scientist, and produced a sociological interpretation of the results. The interpretation makes use, among others the concepts, of "social and cultural capital" mutuated by the sociological works of Pierre Bourdieu, and of the general analysis conducted on gender in the elites as developed in the work of Mino Vianello.

The analysis is based on twenty-five members of the Academy, seven of whom were women; a comparison of the answers to various sets of questions provides insights into the different opinions of scientists who are still active, in particular concerning the problems posed by gender differences in the two sexes.

"The male members of the Reales Academias do not feel or think that there is a gender problem (following the logic of the traditional masculine privilege). In general, they think that the factor time alone will correct the enormous gender imbalance by infra-representation of women in the Reales Academias. This is what we have criticized in many researches with the neutral and ironic expression of "time effect", which constitutes a commonplace and an easy and comfortable way out of the problem. It is a process of evolution and social change that does not require measures of positive action […]"

In their contribution to this book, Ortega, Gonzales Alcantud and Blanco Corujo situate the problem of excellence within the general crisis of the deconstruction of scientism that occurs in post-modernity. Modernity was scientific, solid and masculine; post-modernity appears as liquid (in the sense of Baugman), critical and feminine. The question of excellence is situated in the context of the change in science: academies were born with the reorganization of science and society that took place after the French Revolution. Academies and the concept of excellence are now undergoing further change after the media revolution, with the new media acting both to legitimize and delegitimize science as an autonomous system – legitimizing it with the stamp of mass fame, and in doing so, delegitimizing the scientific institutions as an autonomous system of power. They deal with the issue of the relationship between natural and social science, and with the delicate problem of social science attempting to link with natural science in order to find an escape from pure ideology and from public opinion.

The study also addresses the issue of the relationship between science and social science, with the delicate problem of social science looking for an escape from ideology, by linking it to the natural sciences. The book describes in very witty terms the process whereby we assist in the development of a significant duality of personality in professional women, a dual identity, determining a serious problem of gender identity, reflecting the tension of being torn between the two identities of "totally woman" and "totally professional".

"Whilst for professional women this double identity entails a continuous choice between what to do with her time, what to wear and how to act, for professional men, this tension resolves itself in having to choose whether to wear pants and a grey jacket or a pale blue suit, and afterwards quick, down to work. Part of the stress and of the social sovraselection (sic) which is required of professional women is due to this quasi-schizophrenic behaviour socially imposed on women."

Scientific excellence is interpreted in this work as one of the articulations of the more general process of social reproduction, i.e., mechanisms of selecting roles, preserving and reproducing a society which is unequal and articulated in social classes.

"By means of our investigations we observed that patriarchy, the social system of male domination, imposes on women as if there were natural, very restrictive conditions of access to the high professional positions, and in general to the power that they usually hold."

These very restrictive conditions include the triple filter that women have to undergo to enter the Academias: First, the same filter as men whereby they must achieve as much as men do; second, the filter that imposes that they behave like men, and third, to bear the burden of being lonely and pioneers of their sex in the Academia.

The interviews show that women need to possess some extra “capital” in order to pass the triple filter. To begin with, they possess what Garcia De Leon labels “affective capital”, an excellent climate in their original family, often already marked by a vivid interest in science and culture, and supportive of their daughter’s intellectual endeavours. Second, the initial affective capital is duplicated by homogamic mating, i.e. the choice of sentimental partners or husbands working in the same field, a fact that acts as a multiplier of scientific relations. To these two, the women who become excellent must add the same intellectual potential and economic and material conditions that favour the ascent of male scientists, and that constitute what Bourdieu labelled social and cultural capital.

Comparing the interviews and the biographies, Garcia de Leon and her group find that men who enter the Spanish Royal Academy may have: a) a less favourable social origin than women; b) an achieved level of economic, social and cultural capital that is lower than women; c) either a situation of uniqueness (being an only child, being orphaned) or some other biographical situation that tends to “single out” the scientist and acts as catalyst of forces that push towards excellence.
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4.2 A meta-reading of excellent women scientists’ biographies

Women scholars coming of age in the seventies found the history books sorely lacking in reference to women’s contributions to society and to science, and to narratives of the few excellent women’s lives. Feminist scholars in many fields decided to dedicate themselves to the study of the history of their discipline rather than its theoretical core, and produced a stream of biographies of excellent women predecessors in many fields. The aim of this work was to honour the memory of the excellent women of the past, rescuing them from oblivion, in order to demonstrate the tendency to conceal or diminish women’s contributions present in mainstream male-dominated sciences, and to reassure present and future generations of women that they are just as capable as men of doing science, providing at least a literary “role model” where real ones where lacking. A recent publication by the European Commission (EC 2009) presents brief portraits of the lives and work of forty-one excellent European women scientists. The fact of being represented in this literature is a proof of excellence: biographies were used to create excellence and to make women aware of the possibility of becoming excellent.

The use of biography as a device to demonstrate and to teach is ancient: in the Catholic world, under the name of “agiography”, buttressed-up narratives of the lives of the saints and the martyrs, male and female, has always been a main rhetorical strategy to teach young people what virtue is all about. Agiography was also meant to reassure each Christian that both men and women were indeed capable, through a variety of strategies, to achieve exceptional lives of sainthood or martyrdom. The saints are the excellent Christians that deserved the highest prize: Paradise. In standard high-school curricula, the lives of excellent writers, poets, philosophers and sometimes also scientists are taught together with the contents of their work. This is certainly an important means to contextualize the work of each of them in the historical period in which they lived, yet there is value also in the biographies alone: in the lives of eminent people, “the personal is political”, there is an implicit or explicit relationship between the life story and the excellence achieved. So the facts in the lives of excellent women scientists are related to the excellence achieved. Scholars in the history of science explicitly discussed the issue of writing biographies of excellent women in science and the problems relating to it. Paola Govoni (Govoni, 2000) reports on a three-day meeting held at Newham College to discuss precisely the importance of studying the biographies of excellent women scientists.

The biographies of excellent women scientists are one of the main sources of information describing how they coped with the difficulties they encountered on the path to the top. They draft the template of the relationship between women scientists and excellence, and they have become a source of hypotheses that led social scientists to look for data to study women’s relation to science. When they are considered together, there is the feeling that there are circumstances that recur in their lives with some regularity, although of course not in all of them. It is also possible to ask how young women who may wish to start a scientific career ultimately perceive the general image that excellent women scientists project. To answer this question it is necessary to provide a meta-reading of what feminine excellence in science looks like according to this strand of literature.

What Garcia de Leon (2005) attempted was a meta-analysis of the biographies of men and women in the Royal Academy. A similar elementary meta-analysis can be attempted by re-reading all of these biographies. The existence of the GSD database makes it relatively easy to gather information on these studies. A methodical and systematic meta-analysis of the lives of women scientists could be an important spin-off of the present project.

To give an example of what could be found, it is observed that there are a number of regular occurrences that make the lives of the excellent woman scientist different to the lives of excellent men scientists, as represented in table 4.1 below.

TABLE 4.1 Some recurring characteristics in the biographies of women scientists

	Women scientists	Men scientists
1	Have a mentor in the family, often the father	Mentor in or outside the family, sometimes no mentor
2	Network of male scientists	Network of other male scientists, but sometimes solitary geniuses.
3	Interactions with other members of their families (partners, children) often examined as a source of hindrance	Interaction with other members of their family not mentioned until rediscovered by feminists, and source of support
4	Difficulty in being accepted in the profession, often posthumous recognition	Some difficulties for a single scientist, but in general easier; and often leading position in their field, especially towards the end of life.
5	Betrayal and misappropriation of their results by colleagues	Although sporadic cases of betrayal and misappropriation are reported, in general the problem may arise due to a misunderstanding of the importance of the discovery, not betrayal
6	Negative effects of their activity on health or family life	Some positive effects connected with the acquisition of status and money.
7	No scientific opponents and scarce followers	Opponents to other scientists in debates, founders of schools or institutions
8	Feminine differences (no patenting, refusal to work on the bomb...)	Women who openly express their difference in values from men.

The results are derived by the readings of a number of biographies. However, they can be derived by just looking at the lives of a handful of women, chosen among those who are arguably the most important and best-known. They are, in chronological order: Hypathia of Alexandria, Maria Sklodowska Curie, Lise Meitner, Rosalind Franklin, and Rita Levi Montalcini. To demonstrate this claim, the following is a sketchy analysis of their biographies, meant to underline the existence of empirical regularities, to be pursued in further, more systematic research.

Hypathia is the archetypal excellent woman scientist of the past. An enormous amount of work has been produced on her biography. The GSD contains five independent works on her, together with some translations. She recently became the heroin of a film, *Agora*. It is common knowledge that Hypathia paid with her life her devotion to science and her opposition to Christianity. Her figure stands in the background, as if to show that anything is an improvement on her fate.

Box 4.3 Hypathia

Hypathia was born between 350 and 370 and died in 415. She was a Greek scholar from Alexandria in Egypt, considered the first notable woman in mathematics, who also taught philosophy and astronomy She lived in Roman Egypt and was killed by a Christian mob who falsely blamed her for religious turmoil. A Neo-Platonist philosopher, she belonged to the mathematical tradition of the Academy of Athens and was a follower of Plotinus.

She was the daughter of Theon, who was her teacher and the last known mathematician associated with the Museum of Alexandria. She travelled to both Athens and Italy to study, before becoming head of the Platonist school at Alexandria in approximately 400. According to the 10th-century Byzantine encyclopaedia, the Suda, she worked as a teacher of philosophy, teaching the works of Plato and Aristotle. It is believed that there *were both Christians and foreigners among her students.*

Her contributions to science are reputed to include the charting of celestial bodies and the invention of the hydrometer, used to determine the relative density and gravity of liquids. Her pupil Synesius, bishop of Cyrene, wrote a letter defending her as the inventor of the astrolabe, although earlier astrolabes pre-date Hypathia's model by at least a century - and her father had gained fame for his treatise on the subject.

Believed to have been the reason for the strained relationship between the Imperial Prefect Orestes and the Bishop Cyril, Hypathia aroused the wrath of a Christian population eager to see the two reconciled. One day in March 415, during the season of Lent, her chariot was waylaid on her route home by a Christian mob, possibly Nitrian monks led by a man identified only as Peter, who is thought to be Peter the Reader, Cyril's assistant. The Christian monks stripped her naked and dragged her through the streets to the newly Christianised Caesareum church, where she was brutally killed. Some reports suggest she was flayed with ostraca (potsherds) and set ablaze while still alive, though other accounts suggest those actions happened after her death.

In 1843, German authors Soldan and Heppe argued in their highly influential History of the Witchcraft Trials that Hypathia may have been, in effect, the first famous "witch" punished under Christian authority. Most recently she was the object of a film that somewhat popularized her story.

As Hypathia is the first, Maria Sklodowska is probably the greatest woman scientist of all times. She was the daughter of two scholars and married a colleague and co-author Pierre Curie, under whose name Maria Sklodowska is best known. Marie Curie’s image has two important characteristics: she was a mother, and the mother of a female child who followed in her footsteps and also obtained the Nobel Prize, and she was awarded the Nobel Prize, albeit at first with her husband and with another physicist. However, she was ostracized during the last part of her life, both because of the disgrace of being a widow and being ferociously attacked by the press over her relationship with a younger colleague, and because of the health consequences of her scientific activity on her own body.

In comparison with Hypathia, Marie Curie had an easy life. She was denied a job in Poland but flourished in France by forging a close alliance with one other important scientist, her husband. After his death, she was made to feel uncomfortable by the hostility shown towards her by the French public opinion for her ethnic origins and for her personal life choices. She died, not as a result of a persecution, but still as a consequence of her devotion to science: of radiation exposure.

Box 4.4 Marie Skłodowska Curie

***Maria Skłodowska**, also known as **Marie Curie** (Warsaw,* 1867 - Passy, 1934*), was the first woman to receive a Nobel Prize in physics. The only other one is Marie Goeppert-Mayer. She began her studies in Poland with her parents, well-known scholars and teachers. The family had lost their property and fortune owing to patriotic involvements in Polish national uprisings, making it harder for her and her siblings to further their education. Maria reached an agreement with her sister, Bronisława, that she would give her financial assistance during Bronisława's medical studies in Paris, in exchange for similar assistance two years later. In connection with this, she took a position as governess, and then she reached her sister, proceeding with her studies in physics, chemistry, and mathematics at the Sorbonne. She tried to go back to Poland in 1894 but she was denied a place at Kraków University merely because she was a woman. Then she returned to Paris where in 1895, she and colleague Pierre Curie married. In 1896, Henri Becquerel discovered that uranium salts emitted rays that resembled X-rays in their penetrating power. She used a new technique, the electrometer, and discovered that uranium rays caused the air around a sample to conduct electricity. She proved that the radiation was not the outcome of some interaction of molecules, but had to come from the atom itself.*

In July 1898, Skłodowska–Curie and her husband published a paper together, announcing the existence of an element which they named "polonium". On 26 December 1898, the

Curies announced the existence of a second element, which they named "radium" for its intense radioactivity – a term that she coined. The Curies undertook the arduous task of separating out radium salt by differential crystallization. From a ton of pitchblende, one-tenth of a gram of radium chloride was separated in 1902. By 1910, Skłodowska–Curie, working on without her husband, who had been killed accidentally in 1906, had isolated the pure radium metal.

In an unusual decision, Marie Skłodowska–Curie intentionally refrained from patenting the radium-isolation process, so that the scientific community could do research unhindered.

In 1903, the Royal Swedish Academy of Sciences awarded Pierre Curie, Marie Curie and Henri Becquerel the Nobel Prize in Physics. In 1911, it was revealed by the press that during 1910–11, Skłodowska–Curie had had an affair that had lasted about a year with physicist Paul Langevin, creating a wave of xenophobic hostility against her. In her later years, Skłodowska-Curie headed the Pasteur Institute and a radioactivity laboratory created for her by the University of Paris. She died on 4 July 1934 at the Sancellemoz Sanatorium in Passy, in Haute-Savoie, eastern France, from aplastic anaemia, almost certainly contracted from exposure to radiation. Her papers from the 1890s are considered too dangerous to handle. Even her cookbook is highly radioactive. They are kept in lead-lined boxes, and those who wish to consult them must wear protective clothing.

Sixty years later, in 1995, in honour of their achievements, her remains and those of Pierre Curie were transferred to the Paris Panthéon. She became the first – and so far only – woman to be honoured in this way. If the work of Maria Skłodowska–Curie helped overturn established ideas in physics and chemistry, it has had an equally profound effect in the societal sphere. In order to attain her scientific achievements, she had to overcome barriers that were placed in her way because she was a woman, in both her native and her adoptive country.

Lise Meitner also was denied appropriate professional positions. Besides discrimination for being a woman, she faced persecution for being Jewish. She suffered the undervaluation and even betrayal of some of her close associates. Lise Meitner's biography is a recognized example of betrayal and misappropriation. The Nobel Prize for the discovery she contributed to was given to the man who worked with her, even though Hahn had not been able to provide the theoretical explanation of the results he had obtained in commonly planned experiments. She also is remarkable for her resounding no to the proposal to work in the U.S.A. on the atomic bomb, notwithstanding the fact that, because of her Jewish origins, she had excellent reasons to be an enemy of Hitler, whose policies had, in very practical terms, ruined her life.

Box 4.4 Lise Meitner

***Lise Meitner** (1878 - 1968) was an Austrian-born, later Swedish physicist who worked on radioactivity and physics. Inspired by her teacher, physicist Ludwig Boltzmann, Meitner studied physics and became the second woman to obtain a doctoral degree at the University of Vienna in 1905. She continued her studies in Berlin, where Max Planck allowed her to attend his lectures, an unusual gesture. During the first years she worked together with chemist Otto Hahn and discovered with him several new isotopes. She worked without salary as a "guest" in Hahn's department of Radiochemistry. It was not until 1913, at 35 years of age and accepting an offer to go to Prague as associate professor, that she obtained a permanent position at KWI.*

In 1923, she discovered the cause, known as the Auger effect, of the emission from surfaces of electrons with 'signature' energies. The effect is named after Pierre Victor Auger, a French scientist who independently discovered the effect in 1925.

When Adolf Hitler came to power in 1933, Meitner was acting director of the Institute for Chemistry. All other Jewish scientists were dismissed or forced to resign from their posts. She remained until 1938. After the Anschluss, she was lucky to escape in July 1938. She went to Stockholm, where she took up a post at Manne Siegbahn's laboratory, despite the difficulty caused by Siegbahn's prejudice against women in science. Here, she established a working relationship with Niels Bohr, who travelled regularly between Copenhagen and Stockholm.

Hahn and Meitner met clandestinely in Copenhagen in November to plan a new round of experiments, and they subsequently exchanged a series of letters. By employing the existing "liquid-drop" model of the nucleus, Meitner and Frisch were the first to articulate a theory of how the nucleus of an atom could be split into smaller parts: uranium nuclei had split to form barium and krypton, accompanied by the ejection of several neutrons and a large amount of energy. Meitner also first realized that Einstein's famous equation, $E = mc^2$, explained the source of the tremendous releases of energy in atomic decay, by the conversion of the mass into energy. Hahn claimed that his chemistry had been solely responsible for the discovery, although he had been unable to explain the results.

This discovery lead to Einstein's letter to Roosevelt, but Meitner turned down an offer to work on the project at Los Alamos, declaring "I will have nothing to do with a bomb!" Meitner is often mentioned as one of the most glaring examples of women's scientific achievement overlooked by the Nobel committee. In 1944, Hahn received the Nobel Prize for Chemistry for the discovery of nuclear fission. Many historians who have documented the history of the discovery of nuclear fission believe Meitner should have been awarded the Nobel Prize with Hahn. A 1997 Physics Today study concluded that Meitner's omission was "a rare instance in which personal negative opinions apparently led to the exclusion of a deserving scientist" from the Nobel.

Source: Ryan, S. 1996, 'Lise Meitner: et historisk studium av en kvinnelig fysikers begrensede karrierevalg', Kvinneforskning, vol. 20, no. 2, pp. 66-75.

Rosalind Franklin is another (in)famous instance of misappropriation and betrayal by colleagues. The fact that she died of ovarian cancer at the age of 37 is a coincidence most likely not related to her scientific activity, but still casts a disquieting light on the consequences of being scientifically excellent on the health and femininity a scientist.

Rosalind Franklin experienced a similar fate: her discoveries, in part due to her unfortunate and untimely death, and because of the "Matilda" effect, passed down in science history as productions of her male associates.

Box 4.6 Rosalind Franklin

Rosalind Franklin: (1920-1958). English biophysicist and X-ray crystallographer who contributed to understanding the compositions of DNA and viruses. Her most noteworthy work is that on the x-ray diffraction images of DNA which were an important influence on Crick and Watson's 1953 hypothesis regarding the structure of DNA.

Franklin was not eligible for nomination to the Nobel Prize subsequently awarded to Crick and Watson in 1962 as she died at the age of 37 of complications arising from cancer of the ovary. However, there has been much dispute amongst the scientific community as to her contribution to the 1953 award winning hypothesis; Crick and Watson's employed her research without her knowledge or permission.

Two quotations from Franklin, interesting from the gender viewpoint, according to Wikipedia are:
"In my view, all that is necessary for faith is the belief that by doing our best we shall succeed in our aims: the improvement of mankind."
"Science and everyday life cannot and should not be separate."

Source: Rosalind Franklin: The Dark Lady of DNA. New York: HarperCollins, 2002.

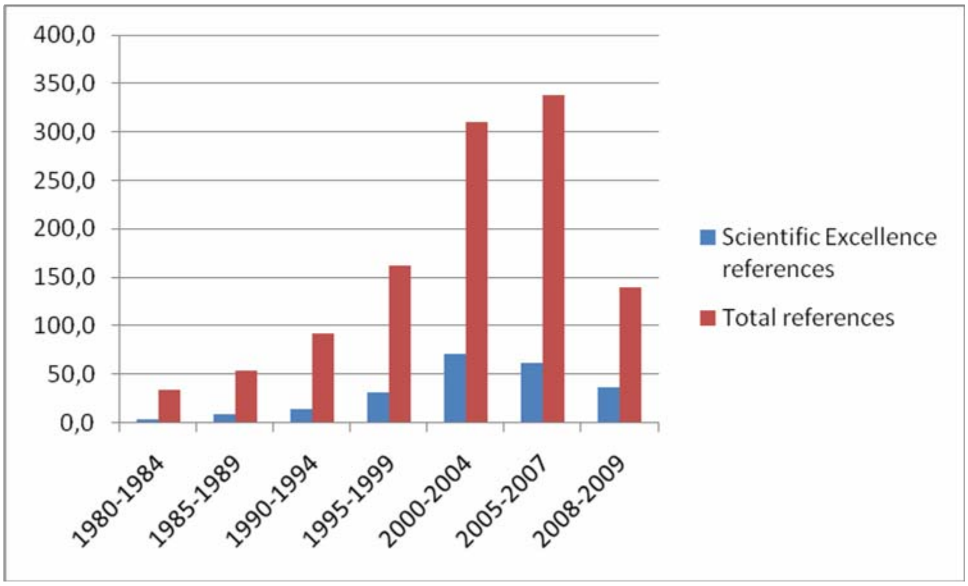
We have already discussed the model represented by Rita Levi Montalcini working in her own bedroom vivisecting baby chicks to study the growth of their neurons.

The short survey of this section meant two show: a) that a further effort in meta-reading biographies of past and present excellent women scientists may be conductive to the discovery of empirical regularities; b) that the image of women scientists that was discovered in the one important strand of the literature, the biography studies of the past, although extremely important to make new generations of women understand that they may be excellent scientists, may give an image of the lives of women scientists that stresses the negative aspects of the choice, and c) that new inquiries on how excellent women scientists fare today, showing that they have an easier time achieving their goals and that they are supported by the scientific community are needed to correct this "undue hardship" image, if we wish more women to undertake the path towards excellence.

4.3 Statistical analysis of the database

Scientific excellence entries recorded in the GSD show a slow but constant increase throughout the 1980s and 1990s, with a more marked increase starting around 1995-1999 that peaked in 2005-2007, as reflected in graph 4.1 below. The distribution over time follows approximately the same distribution as in the total GSD entries.

Graph 4.1 Excellence entries and total GSD entries, by groups of year



Out of the 4,594 entries in the GSD database, 900 have been classified as dealing with the topic of 'scientific excellence'. Comparatively speaking, the topic of scientific excellence is not one of the issues that receives the most attention within the gender and science debate. It is the second least studied in the GSD database after 'pay and funding', and takes up approximately 20% of total entries (Table 4.2a).

Table 4.2a Number of GSD entries by topics (absolute values)

Presence of topics in publications	HS	VS	PG	SI	LA	SE	RC	PE	Total
Number of publications	1.965	2.035	571	2.458	1.483	900	1.434	1.296	4.549

Table 4.2b shows us the likelihood of topics being associated with each other in the GSD. For 'scientific excellence', we note that the topic that is most likely to be studied in conjunction with excellence is 'pay and funding' (39.2%), followed by 'policies towards gender equality' (26.1%) (horizontal line). We also note that of the all the topics associated with 'scientific excellence', 'stereotypes and identity' (58.7%) is most likely to be associated with 'scientific excellence' (vertical line). Also 'horizontal' (54.2%) and 'vertical segregation' (56.1%) have a relatively high degree of association.

Table 4.2b Presence of topics in entries (%)

Presence of topics in publications	HS	VS	PG	SI	LA	SE	RC	PE	Total
Horizontal segregation	100.0	57.1	59.7	49.1	47.3	54.2	36.3	48.5	43.2
Vertical segregation	59.1	100.0	77.9	36.0	68.0	56.1	30.2	54.8	44.7
Pay and funding	17.4	21.9	100.0	10.7	20.8	24.9	10.9	20.0	12.6
Stereotypes and identity	61.4	43.4	46.1	100.0	46.5	58.7	64.2	45.0	54.0
Science as a labour activity	35.7	49.5	54.1	28.1	100.0	39.2	23.1	32.8	32.6
Scientific excellence	24.8	24.8	39.2	21.5	23.8	100.0	24.6	26.1	19.8
Gender in research contents	26.5	21.3	27.5	37.4	22.3	39.2	100.0	34.3	31.5
Policies towards gender equality in research	32.0	34.9	45.4	23.7	28.7	37.6	31.0	100.0	28.5

Table 4.2c Number of topics in GSD entries (%)

Number of topics by publication	HS	VS	PG	SI	LA	SE	RC	PE	Total
1	3.4	3.7	3.0	14.0	8.2	5.6	15.3	10.2	22.6
2	24.8	24.4	10.3	31.7	21.4	12.0	28.8	20.9	32.2
3	27.2	28.7	19.1	21.1	24.3	21.3	20.2	23.1	21.2
4	20.8	20.7	21.9	15.3	20.8	25.7	14.8	17.6	12.7
5	12.2	11.4	17.9	9.1	12.2	15.9	8.6	12.0	6.2
6	5.5	5.3	10.9	4.1	5.2	7.8	5.0	7.0	2.5
7	3.8	3.5	8.9	2.8	4.7	6.7	4.1	5.6	1.6
8	2.3	2.3	8.1	1.9	3.1	5.1	3.2	3.5	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

4.3.1 Geographical distribution

Entries dealing with scientific excellence are spread across all GSD countries. The country with the highest number of excellence entries is Sweden (222), followed by the UK (167) and Germany (124). Looking at the percentage of excellence entries over total entries, also Denmark and Finland score a relatively high proportion of entries dealing with scientific excellence (11,4% and 12,9%) respectively).

Table 4.3 Excellence entries and total GSD entries, by countries

Country	Excellence entries	% GSD publications in SE
Austria	104	11.6
Belgium	66	7.3
Bulgaria	45	5.0
Croatia	9	1.0
Cyprus	40	4.4
Czech Republic	64	7.1
Denmark	103	11.4
Estonia	52	5.8
Finland	116	12.9
France	85	9.4
Germany	124	13.8
Greece	62	6.9
Hungary	78	8.7
Iceland	11	1.2
Ireland	50	5.6
Israel	4	0.4
Italy	78	8.7
Latvia	51	5.7
Lithuania	54	6.0
Luxembourg	47	5.2
Malta	60	6.7
Netherlands	76	8.4
Norway	33	3.7
Poland	67	7.4
Portugal	55	6.1
Romania	52	5.8
Slovakia	80	8.9
Slovenia	50	5.6
Spain	86	9.6
Sweden	222	24.7
Switzerland	11	1.2
Turkey	34	3.8
United Kingdom	167	18.6
Total	2,236	

The high number of entries in Sweden corresponds to a high presence of interest in the entire Northern group, followed by the Southern group in number of entries.

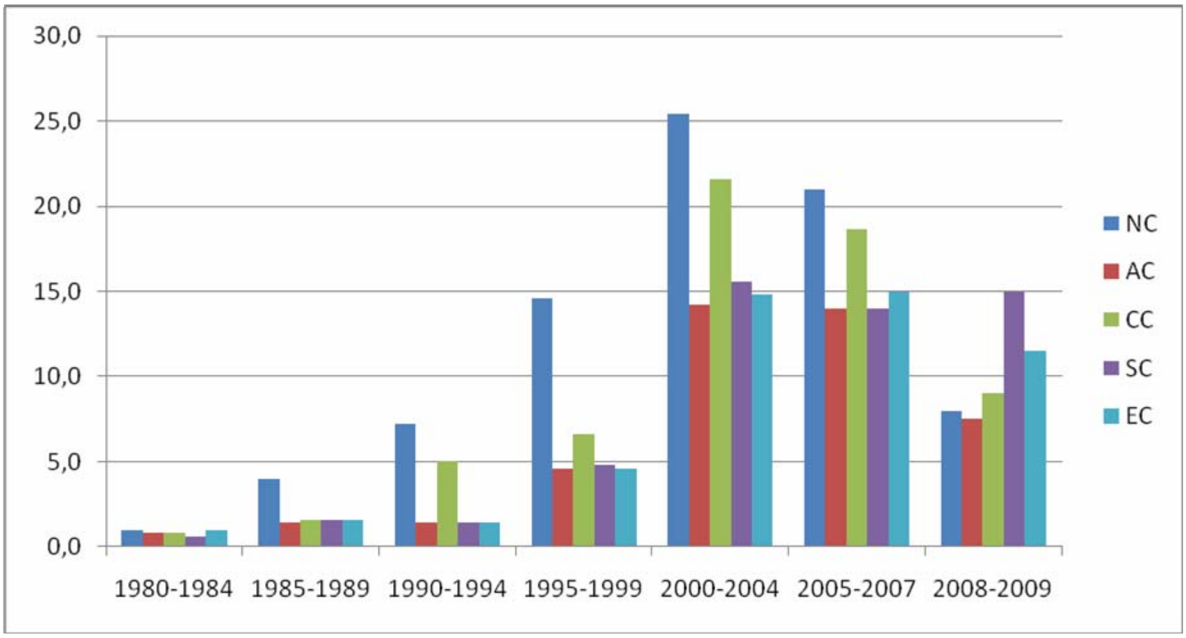
Table 4.3a Excellence entries by country groups

Country groups	Exc entries
Continental C.	252
Southern C.	192
Eastern C.	185
Northern C.	340
UK and Ireland	169

4.3.2 Distribution of excellence entries over time

Besides the graph in the introduction, we can distinguish the time trend of the interest in studying excellence in different areas of Europe. Graph 4.2 below shows the distribution of excellence entries over time across the different country groups. We note that in the Nordic countries, scientific excellence was already being studied in the 1980s and on average, always more than the rest of the geographical groups. In Southern and Eastern European countries, this subject entered the scientific debate at a later stage, although with increasing force.

Graph 4.2 Excellence entries by year and country group



4.3.3 Other GSD Subtopics

The GSD enabled excellence entries to be tagged according to three subtopics: i.e. whether the entry dealt the issue of:

a) the definition of excellence; and/or
b) scientific productivity; and/or
c) institutional practices of evaluation

The distribution of excellence entries across these subtopics shows that all three have been analysed in scientific literature with approximately the same intensity and with a similar distribution over time, with the subtopic of scientific productivity being relatively more studied (394 entries), followed by definition of excellence (373) and practices of evaluation (356).

The table below illustrates the distribution of subtopics across GSD groups of countries. We note that in the Nordic countries, the number of excellence entries dealing with institutional practices of evaluation (102) and definition of excellence (74) are significantly higher than those of the other groups of countries, while in the Anglo-Saxon countries the proportion of scientific productivity entries is higher than in the rest of the GSD groups.

Table 4.4 Excellence entries by subtopics, all GSD countries

Country Groups	Definition of excellence	Scientific productivity	Institutional practices of evaluation
Nordic Countries	74	29	102
Anglo-Saxon Countries	17	34	56
Continental Countries	54	59	70
Southern Countries	27	59	54
Eastern Countries	18	70	49

4.3.4 Methodological approaches

From the point of view of the methodological approach followed by entries dealing with scientific excellence, we note that the conceptual approach is followed by over half of relevant entries (50.4%), a value that is above the total GSD value. Only the topic of ‘gender as research content’ has a higher likelihood of being examined through a conceptual approach. Scientific excellence entries also tend to be more concerned, relatively speaking, with the building of gender indicators (5.2%, more than twice the GSD average). This denotes that the topic of excellence is closely connected with its definition and measurement.

Table 4.5 GSD entries by methodological approach and topic

Methodological approach	HS	VS	PG	SI	LA	SE	RC	PE	Total
Conceptual	38,6	32,4	43,6	45,1	28,1	50,4	68,3	42,9	39,1
State-of-the-art	38,5	42,9	39,4	34,7	39,7	38,2	46,9	51,9	40,4
Compilation of statistics	31,8	33,3	32,0	14,7	25,8	18,1	11,9	25,9	20,7
Building gender indicators	3,7	3,7	6,3	2,6	3,2	5,2	4,2	5,6	2,8
Empirical research. Quantitative techniques	28,2	27,4	30,8	27,7	31,7	25,7	14,9	21,3	26,7
Empirical research. Qualitative techniques	32,3	34,3	24,3	34,4	45,0	32,0	25,0	29,6	31,5

4.4 Conclusions to Part 4

In this fourth part, the Report analyzes the GSD using the presence of “scientific excellence” as a category to analyze the database itself. First, it is noted that a large proportion of the entries in the GSD database that have “excellence” as a keyword are the biographies of excellent women scientists. They are indeed a source of information and on some regularity, which have been collected in table 4.1. The biographies of women scientists may have an ambiguous message. On the one hand they show that women can be as excellent scientists as men. On the other hand, they show that for women it is often much harder to be scientists. An important cultural operation would be to write the biographies of today’s excellent women scientists in the light of the satisfaction and happiness, instead of the hardship, that being a scientist has brought to their lives. Second, a statistical analysis of the database is performed, which shows that the topic of “excellence”, scarcely present in the literature of the last century, has picked up in the last decade in all countries. Interest in excellence appears particularly strong in the Nordic group of countries. It is a field where analysis is mostly conceptual and there is little construction of indicators of excellence, compilation of statistics or quantitative techniques used to discuss it.

General conclusions

The first three parts of this Report present the major findings on the topic “scientific excellence” as they emerge in the literature collected in the GSD. In the fourth part, it deals with the GSD itself.

In the first part, the Report defines scientific excellence and presents three different models that describe how excellence is produced. The three models are the “pipeline model”, the “threshold of selection” model, and the “life-course” model. The three models are not mutually exclusive. Each sheds some light on the procedures by which scientific excellence is attained, giving different weight to supply and demand factors for men and women scientists and men’s and women’s life choices.

In the second part, the Report explains and clarifies the nine most important themes on which the debate is focused, which are needed to understand the processes of excellence formation.

In the third part, the Report analyzes the problem of how excellence is measured, to assess whether the newly introduced tools of bibliometrics are gender biased or whether they can be used for an unbiased evaluation of scientists.

In the fourth part, the Report studies the GSD, which is at the basis of the Gender and Science Meta-analysis project, describing the role played by biographies in defining women’s scientific excellence and presenting a quantitative assessment of the importance of this topic in the database.

Below is a summary of the findings of this Report .

Excellence was defined in part 1 as:

The ability of a scientist or an institution to impact on a field of study producing a major change, leading other scientists towards asking new questions and producing new, important and useful contributions to knowledge, using new methodologies. The quality of excellence must be proven by a number of means, (such as publications, citations, funding, and students) and recognized by the peers by the bestowing of various honours, prizes and other awards.
.
The Report shows that this ability is the result of processes and relations which are heavily gendered. These processes have been described by the three models reviewed. The report concluded that there are supply and demand factors affecting the procedures that produce excellence. Among the supply factors we can count the fact that men enjoy the competitive aspects of science as a game where honour is the prize, and therefore are keener to participate in scientific tournaments, and the fact that women choose other activities linked to domestic production of welfare.

Demand factors are the requests for scientific activity made by other scientists and by scientific institutions, which are often biased in favour of the male sex. What we call discrimination is the preference given to a man over a woman with the same qualification to be hired by a scientific institution or to receive funds for a scientific project. When demand for women scientists is lower than for men with the same qualifications, discrimination occurs. The literature identified the existence of some practices which keep the demand for women scientists low. Stereotyping, double standards, fuzzy standards, honour games, homosociability, gatekeeping, psychological interactions that make women less visible than men and definition of the boundaries of disciplines unfavourable to women’s interests are all practices that represent demand factors keeping women’s presence among the excellent scientists low.

According to the definition, leadership ability is needed to achieve excellence. Whether there is a masculine and a feminine style of leadership, and what their relative merits are, is an open issue in the management literature. Leading is a skill that can and should be learnt.

The epistemological debate on gender and science produced one important result: the awareness that all knowledge is situated. This implies that science requires a plurality of viewpoints. The absence of women from the leaders of science produces a science which is incomplete, because some paths of research are not followed, and this incompleteness undermines its objectivity.

One important issue of debate with respect to excellence is the issue of its measurement. The digital revolution produced a new discipline, which provides quantitative indicators to assess scientist’s performance. From women's viewpoint, bibliometrics has its advantages and its disadvantages. Three main points are of relevance:

- Bibliometrics is gender blind, and this gender blindness may be an advantage when any of the practices mentioned above may be affecting outcomes negatively for women.
- Bibliometrics has some limitations, of which we identified five. Three of them are gender neutral, but two may give rise to gender bias against women.
- Bibliometrics is often associated with an elitist distribution of funds. An elitist distribution of funds concentrates all the funds available for research in the hands of few top scientists. Since women scientists are few at the top, the elitist distribution, not the use of bibliometrics *per se*, may interfere with women scientists receiving the funds they need to achieve their potential excellence.

The GSD, with respect to excellence, shows that one privileged approach to the study of gender and scientific excellence were the biographies of excellent women scientists. Credit must be given to these biographies for having conferred on these scientists the honour they deserve, and having made future generations of women aware of the fact that they may have the potential and the ambition to become excellent scientists. They have a problematic side effect: that the lives of excellent scientists were exceedingly hard and therefore may discourage some to follow. More work is needed showing the positive and pleasurable aspects of the lives of contemporary women scientists.

Finally, the GSD shows that excellence is a topic that has received increasing attention in the last decade, in particular by scholars located in the Nordic countries.

Although it is improper to talk of "gaps" in the research on excellence, it is certainly true that research on gender and excellence is still at an early stage. Important research efforts could be made to measure the effects of the social practices mentioned above, country by country and at the different levels (country level, discipline level, and so on) at which they operate, and to provide a more solid ground for policies that foster feminine excellence in science.

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