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## **European Studies on Gender Aspects of Inventions - Statistical Survey and Analysis of Gender Impact on Inventions (ESGI)**

### **1 Objectives and scope of the ESGI project**

The ESGI-project, European Studies on Gender Aspects of Inventions - Statistical Survey and Analysis of Gender Impact on Invention, runs from October 2006 to January 2009. This specific support action is financed by the European Commission in the Sixth Framework Programme FP 6 and focuses on gender impacts on inventions. It assesses gender aspects in inventive activities of all 27 European Union Member States and investigates the innovation climate of European research and development (R&D) departments. The structure of the project consists of two parallel parts: 1) A gendered secondary patent database analysis of a database from the European Patent Office to investigate the proportion of female inventors in different institutional and economic sectors (output-indicator). Furthermore the findings will be benchmarked with statistical information on the participation of researchers as well as economic data (input-indicator) to investigate the input-output relation. 2) An online-survey exploring the innovative climate, regarding gender aspects, in Research and Development (R&D) departments of European patent applicants. These two parts merge into the last part of the project, the gender impact assessment of the inventive activities of all 27 EU Member States.

Until now, the knowledge base on gender aspects on inventions and the participation of women in patent applications in Europe was fragmentary. Thus, the ESGI project delivers the missing knowledge base regarding the participation of women and men in inventive activities. By benchmarking all European Union Member States the project will reveal efficient tools and political strategies to increase the contribution of women in invention and patent creation and thus contribute to the EU gender mainstreaming policy and the goal of gender equality. The outcomes of the ESGI project highlight women's inventive achievement and the contribution of female researchers and engineers to the creation of technological knowledge in the European knowledge-based society.

### **2 Innovation, patents and women inventors in the European knowledge-based society**

Benchmarking of research productivity is often done by analyses of output-indicators like scientific publications and prizes, public research funding and patents. The creation, exploitation and commercialisation of new technologies are vital factors for countries to stay competitive in the modern marketplace. Based on a strong relation between patents and R&D activities, patents are seen as key measures of innovative output of countries and organisations. Moreover, in the ESGI research project patents are used as indicators for the successful inventive achievement of researchers. Statistics from the European Commission on researchers and scientists are broken down by gender since many years; however patent statistics do not provide gender disaggregated data until now, leading to a severe lack of quantitative data on gender aspects of inventions. Even though it is known that many women are responsible for outstanding inventions, the knowledge base on female inventors who participate in European patent applications, was fragmentary before the ESGI project started

(Kugele, 2008). The historically constructed male image of engineering systematically has masked out women's contribution to technological development. Wajcman (2004: 32) points out that historically the prototype of an inventor is described to be of male gender. Consequently, many inventions of women were documented under the name of a man in the patent offices. The few quantitative pilot studies, which have been conducted before show low proportions of female inventors in Germany and Europe (Greif 2005, Naldi and Parenti, 2002).

Innovation and the creation of economic value from technological knowledge have become central strategies to transform the European Union into the most competitive and dynamic knowledge-based economy in the world by the year 2010 (Lisbon Strategy). Considering that economic success basically relies on innovation, women's under-representation in science and technology in the European Union is of special concern. Since there is a shortage of highly trained and qualified personnel, more researchers are required to reach the ambitious goals of the Lisbon Strategy. Europe needs to incorporate the full range of innovative and inventive potential of the society; therefore it is necessary to strengthen the role of women in research and development. For that reason it is essential to broaden the knowledge base regarding working conditions and the innovation climate in which female and male scientists and engineers are developing inventions in their departments.

Empirical evidence shows that the diversification of the workforce and the incorporation of gender in the creation of technological knowledge are conducive to innovation and economic success (Bührer and Schraudner 2006). By contrast, uniformity is seen as a severe hindering factor (Matthies 2006). Even though the proportion of women in higher education has risen significantly in the EU, pronounced horizontal and vertical segregation in education and employment is present. Women are especially under-represented in industrial research where in 2003 only 18% of all researchers were women (EC 2006:28).

This study is based on the assumption that the development and output of technological knowledge are socially constructed processes, which are embedded in a wide field of institutional, structural and cultural realities (Blättel-Mink 2005). Science and technology development are closely related with access to funding, resources, power as well as gender issues. As research shows, inventions do not take place in genderneutral environments, but in "gendered organizations" (Acker 1992). The gender specific connotation of technology and science (Sagebiel 2007) was confirmed by various studies, which pointed out that working conditions of female scientists and engineers are hindering for their research activities and their career (Ding et al 2006). Thereby different reasons for a low number of female scientists or engineers, from open exclusion to subtly discrimination, are detected. The question is why in research and development departments in which high innovation and patent activities are economically necessary, women do not fully achieve their inventive potential.

### **3 Empirical results of the ESGI project**

#### **3.1 Input-output gap between proportions of female researchers and female inventors is marked**

The empirical results on female and male inventors are based on the European comparative secondary database analysis of patent applications to the European Patent Office. Patent databases do not provide the gender of the inventor; as a consequence a comprehensive, multi-stage first name assignment procedure was carried

out to assign the names of the European inventors to male and female gender. By application of a first name database and by the assistance of native speakers altogether 93% of all European names were classified as male or female.

Are women proportionally represented as inventors, regarding their participation as researchers, throughout the European Union Member States? To investigate this question all inventors were assigned to institutional and economic sectors. Approximately 90% of all patent inventors invent in industry, while only 10% come from the government, private, non-public and higher education sectors. But as our results show, the success of female inventors in the public sectors is generally higher than in industry. If we focus on industry, we find a severe under-representation of female inventors. In 2003, 8.1% of all inventors from EU-27 in industry were women (91.9% men), but the proportion of women researchers in EU was more than twice this value and reached 18.0%. By benchmarking the European Union Member states we find pronounced differences. Overall, the proportions of female inventors are highest in the new European Member States, in some countries reaching up to 28%. By contrast in Germany, where nearly 50% of all European inventors reside, the proportion of female inventors is only 6.2% and compares to a low proportion of only 11.6% female researchers in 2003. Statistical regression analysis shows a positive correlation between the proportions of female inventors and the proportions of female researchers ( $r^2=0.62$  at 5% level), meaning that the higher the value for female researcher the higher the value for female inventors. Focusing on economic sectors we observe that women's inventing activities are in line with their preference to work in chemistry and health related disciplines as well as electricity/optics. By contrast female inventors are more severely under-represented in all economic sectors like transporting and machine construction. The described differences in the inventive performance of women therefore follow the horizontal segregation in education and employment of scientists in these fields.

According to innovation literature, the number of patent applications per million inhabitants is an important indicator for R&D output. Statistics provide evidence for a positive correlation between financial R&D input and patent output, showing that higher the R&D expenditure (GERD) is, higher is the number of patent applications produced by a country (Felix, 2006). Figure 1 cross references the proportions of female inventors with the number of European patent applications per million inhabitants at the national level for the year 2003. As a result we find a statistically negative correlation between these two variables with  $r^2=0.45$  at 5% level. From figure 1 we can see a pattern emerging where the highest proportion of women inventors are to be found in the countries with the lowest general patent activities, whereas the lowest proportion of women inventors are to be found in the countries with the highest general patent activities. Detailed results can be found in the following publication: Kugele (2008)

Our main findings suggest the hypothesis that more advanced national systems of innovation spend more money on R&D and have more patent applications and involve proportionally fewer female researchers and proportionally fewer inventors.

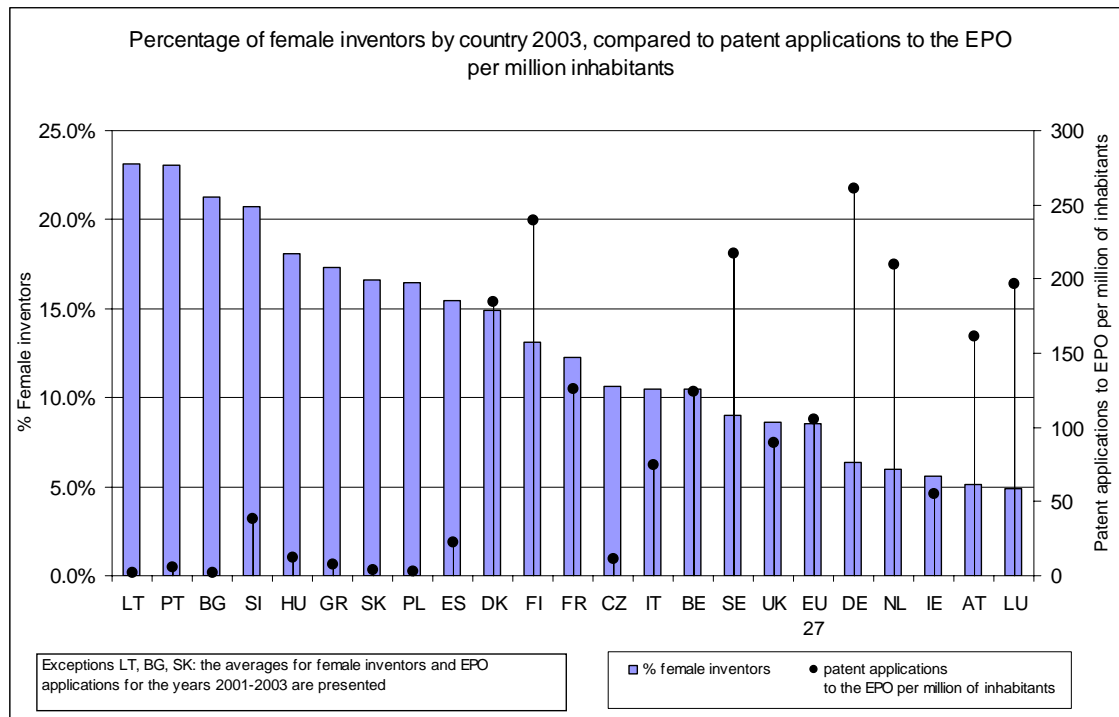


Figure 1: Proportion of female inventors compared to number of EPO patent applications by country, 2003 (data source patent applications p. mio. inhabitants: Eurostat)

### 5.3 Results of the online-survey “Innovation and Gender”

The main question of the survey is which innovative climate, in special consideration of the category gender, exists in European organisations, which applied for patents. To get an answer to this aspect the questionnaire focused on personal data of the heads of R&D departments, structural data of the organisation, the status of female scientists and engineers as well as questions related to the innovation management and personnel policies. Within three months 700 heads of R&D departments from European organisations took part in the ESGI online-survey.

The analysis of the data shows that organisations of various sizes differ regarding their innovation systems. In big sized organisations a superior grade of implementation of systematic innovation measures is notable. They more often invest in structural and personal measures to encourage innovation processes like Intellectual Property Management and further trainings of the employees. These measures can be conducive to assure and control a knowledge transfer on high level. In contrast the smaller organisations rather provide a special climate for their members of staff in which certain scopes for researchers exist. The researchers have to seize a chance to be creative and to invent with less structural support and with few possibilities to take part in further trainings, but they can enjoy a certain liberty to use unconventional methods. At the same time the analysis of the data showed that female scientists and engineers benefit from rather structured encouragement of the staff within their department and overall by the personnel policy. Taking into account other studies (Matthies 2006), structural measures are considered to be a possibility for women scientists to prevent at least partly the dependency on male dominated informal networking.

Another interesting point of the analysis is that most female high-qualified staff can be found in those R&D departments, where the heads of departments are women. At the same time those organisations are the biggest ones and they implemented more

often measures of equal opportunity policies. This alludes to another important result of the analysis of the survey. The heads of R&D departments show a significantly high gendered perception – especially in answers regarding extra hours of the male and female researchers and their grade of motivation by implemented measures to encourage innovation. Whereas male interviewees assess lower motivation and lower engagement of the female staff, women heads of R&D departments appraise male and female scientists as having the same willingness to perform. Likewise gendered perception can be detected in the attitude of the interviewees regarding the reasons for the low number of female inventors. According to female and male interviewees, the most important reason for the small number of female inventors is the small number of female students in natural science and technology. Men consider that nearly up to 70% and women approximately to 55%. The second important reason is the poor reconciliation of family and job duties. 50% of women and 40% of men consider this reason to be of (great) significance. And while 50% of women say that general organisational structures are of great significance only 30% of men agree with that. Probably because of the perception of difficult conditions for women in science and technology one third of the female interviewees agree that women and men have different career ambitions, while only one quarter of the interviewed men do this. Altogether female heads of R&D departments more often stated social and organisational reasons for the low number of female inventors than men do.

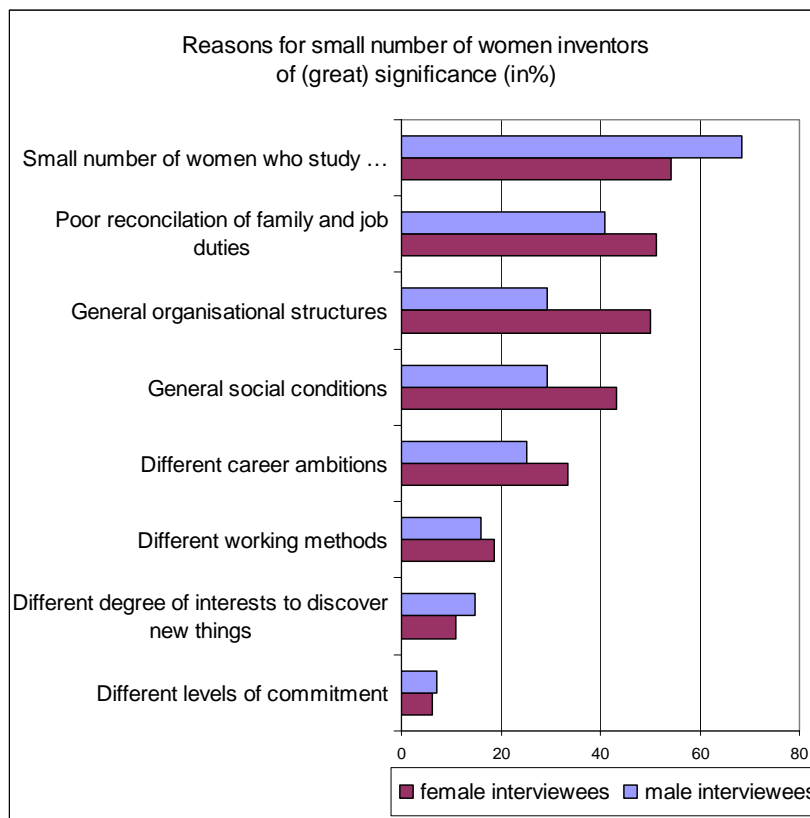


Figure 2: Attitudes of male and female heads of R&D departments regarding the reasons for small number of women inventors

The reasons for the gendered perception can be on the one hand gender specific mental patterns and prejudice and on the other hand different working conditions and innovative climate in those departments where the share of female interviewees and the percentage of female scientists/engineers are relatively high. Presumably both phenomena have an impact. This affirms that innovation and invention take place in

„gendered“ environment. Regarding the current state of the analysis it is assumable that male and female researchers are encouraged and/or restrained in different ways.

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