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ESGI

European Studies on Gender Aspects of Inventions- Statistical Survey and Analysis of Gender Impact on Inventions

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Project coordinator name: Prof. Dr. Ulrike Busolt

Hochschule Furtwangen University

1 Executive Summary

ESGI European Studies on Gender Aspects of Inventions- Statistical Survey and Analysis of Gender Aspects on Inventions

This document presents the main results obtained within the study “European Studies on Gender Aspects of Inventions” that ESGI has carried out for the European Commission under the Sixth Framework Programme between October 2006 and January 2009. The main objective of the project was the investigation of a possible gender impact on invention activities within the 27 European Union Member States. The project outcomes demonstrate to what extent female inventive activities are present within the European Union Member States and provide insights into the innovation climate of European research and development departments from a gender perspective. Furthermore, it suggests new and/or known equal opportunity policy measures to improve the working conditions for female scientists and researchers.

The structure of the project consisted of two parallel parts which merged into the third part, the gender impact assessment.

- **Data base creation and analysis, output-input comparison**: Based on a patent and inventor database from the European Patent Office, comprising the applications of EPO patents of the years 2001-2003, a comprehensive database analysis regarding the participation and contribution of female European inventors was conducted. This output data was compared with statistical data from Eurostat regarding the female participation in research and development as well as national innovation indicators.
- **Online-Survey:** To investigate gender patterns in innovation and invention and to gain insight into the innovation climate, an online-survey with heads of research and development departments from all European Union Member States was conducted.

- **Gender impact assessment and final report:** These two parts finally merge into the last part of the project, the gender impact assessment of the inventive activities of all 27 EU Member States.

The ESGI study focused on the following main questions:

> What is the current state of female participation and contribution among European inventors to patent applications filed at the European Patent Office?
>
> Are women proportionally represented as inventors compared to their representation as researchers in different institutional and economic sectors?
>
> How are these findings linked with a countries national innovation indicators?
>
> What gender-specific aspects in the innovation climate of institutions can be identified?
>
> Is there a gender impact in invention and innovation activities detectable?

Methodology and main results from the database creation, data analysis and data comparison

The ESGI inventor and patent database was created from PATSTAT and consists of 157645 patent applications to the European Patent Office with the priority years 2001, 2002 and 2003. The sample includes the data of 388844 inventors, of whom 360844 or 93% have a residential address in one of the European Union Member States. German inventors (47%) dominate the European patenting activities. The project developed an extended first name database, which proved to be an efficient tool for the gender assignment of the inventor's names in the ESGI inventor and patent database. A total of 334313 (93%) of all inventors with a residential address in the EU-27 were classified as either male or female.

> Women inventors are still a minority in patenting; only 8% of all European inventors are woman.

The most striking result is that women comprise only a small portion of all European inventors. While the share of women in 2001-2003 is only 8% (head count), the share of men is 92% (head count), which shows that only one in twelve European inventors is a woman. Women inventors are still a minority in patenting, which refers to the fact that horizontal segregation in innovation is very marked. However, national diversity is pronounced. While in almost all countries the share of women inventors is well over the European average of 8%, Germany (6%), Luxembourg (6%) and Austria (5%) stand out as the three least achieving countries. A comparison of the geographical distribution of inventors with the proportion of female inventors by country (head

counts) reveals that the proportion of female inventors is highest in countries where the overall patenting activity is lowest, whereas the number of inventors is lowest where the total patenting activity is highest.

Women's inventing activities are in line with their preference to work in technology fields like chemistry as well as medical and health related disciplines, while they invent less often in technologies like mechanical engineering, construction, and transporting.

The indicator "contribution", which refers to fractional counts, is generally lower than the female share of inventors, which refers to headcounts. The female contribution in 2001-2003 sums up to 6% only. Specific gender patterns across technologies are apparent, indicated by the comparatively high contributions of female inventors in chemistry and health related sectors on the one side, and the extremely low female contributions in transporting, physics and electricity on the other side. Given that the majority of patents applied for in the latter technology sectors, the under-representation of women inventors within these sectors is worryingly low. Moreover, our analysis reveals that, on average, women invent in larger groups than men.

The proportion of female inventors is higher in public research than in industrial research, but we observe a pronounced divergence between the output (inventors head counts) and input (researchers head counts) in all institutional sectors.

The business enterprise sector, where 88% of all patents and inventors originate dominates the patenting activities in the European Union. However, within this sector the proportion of female inventors is only 8% (head count), which has to be compared to a share of 18% female researchers (head count) in 2003. Whereas the proportions of female inventors in public research are 16% (head count), the proportions of female inventors within these sectors are between 21% (female engineers) and 29% (female natural scientists) (head count). The presence of a pronounced divergence between the output (inventors head counts) and input (researchers head counts) in all institutional sectors reveals that the potential of women researchers for intellectual property creation is not fully used.

For benchmarking purposes, we analyse the presence of women in research and inventing and link these findings with national innovation indicators related to "national systems of innovation". Out of the higher systems of innovation group the inventive performance of women is best in Finland and Denmark, followed closely by France, Belgium, Italy and the United Kingdom, all countries holding a leading position regarding the utilisation of their female human potential in the innovation process. On the other hand, the Netherlands, Germany and Austria are lagging far behind.

There is a negative link between the proportions of female inventors and the development of a country's national system of innovation. The absolute number of female inventors per million inhabitants is highest in Finland and Denmark.

The correlation between women's participation in invention and research (output-indicator, head counts) and the national expenditure on R&D for the business enterprise sector (input-indicator) in Purchasing Power Standard is negative (year 2003), indicating that the proportions of women inventors, similar to the proportions of women researchers, are higher in countries that spend less money on industrial research and development. We therefore find a negative link between the proportions of female inventors and the development of a countries national system of innovation. Furthermore the female inventors counts per million inhabitants (FIPMIN) are highest in Finland (72) and Denmark (58), closely followed by Germany (40) and Sweden (36).

The proportions of female inventors are highest in food production, chemistry and pharmacy.

Statistical analysis reveals that women's patenting activities are in line with their preference to conduct research in chemical and health related disciplines. Moreover, even in these sectors where the proportions of female researchers are found to be comparatively high there is still a worrying under-representation of women in patenting.

Methodology and main results from the online-survey

The sample of targeted persons for the ESGI online-survey was drawn from the EPO database (time span 2002-2004). A randomised, country stratified database of applicants corresponding to the patent activity of each country was generated. Due to Germany's leading position in European patent applications within the EPO database, the sample was dominated by German organisations (44%), so that the shares of the other countries were significantly lower. Altogether 3000 positive email-addresses of target persons – according to the sample design – were required.

To get an insight into the innovation climate in organisations who applied for EU patents, the online-survey contained questions regarding personal data on the interviewees (gender, age, professional position etc.), queries on information regarding the organisation (size, institutional and industrial sector) and innovation practices (patent activities, innovation measures and incentives to enhance innovation within the R&D department), as well as on personnel and company policy (working conditions, childcare facilities, measures of equal opportunity policy). Additionally, questions regarding gender differences were included across all question areas and the interviewees were asked about their personal opinions regarding reasons for the low number of female inventors.

To create the questionnaire, qualitative telephone interviews took place previously. After pilot-tests of the master online-questionnaire, it was translated into 18 European

languages. All translated versions were controlled and tested again and finally sent out at the end of September 2007. At the beginning of January 2008 the conduction of the survey was finished. After a data adjustment altogether 711 interviews could be analysed. The responses correspond more or less to the sample design with a clear predomination of German answers (46.4%) and a very high share of organisations from the Business Enterprise Sector (88%).

> The results of the ESGI European online-survey "Innovation and Gender" are affected considerably by the predominant German patent activities.

The analyses of the ESGI online-survey show that in European research and development an innovation climate exists, which does not advance the innovative potential of male and female researchers to an equal extent. At first, the results of our survey show a very low (14%) estimated average share of female scientists and engineers in European R&D departments in the Business Enterprise Sector (BES) – where most patents are generated. This figure is even lower than the European cross-sectoral average in the business sector that amounted to 18% in 2003 (source Eurostat; ESGI calculation in: ESGI D13, 2008:20). In this context is has to be taken into account that the relatively high share of German answers in the survey (46% of all responses) considerably affects the results. The average share of female scientists/engineers in German R&D departments amounts to only 11% and decreases the general average of the whole survey.

Notwithstanding the low share of female highly qualified staff in European R&D departments, most heads of R&D departments of the survey consider that a broad heterogeneity of researcher teams (including gender) contributes to the innovation processes.

> Despite the low share of female researchers in the surveyed R&D departments, most executives consider a broad heterogeneity of researcher-teams advantageous for innovation processes.

At the same time only a low number of these interviewees state that the "composition of researcher teams cannot/can hardly be influenced". The analysis of answers, which concern the corporate policy of the organisations and the personal opinion of the interviewees regarding the low number of female inventors show that first of all 73% of the interviewees think that "reconciliation of job and family duties" is at least to some extent problematic for women. At the same time 52% of all interviewees respond that they "cannot give an opinion" to the question to which degree they were satisfied with the childcare provided for their members of staff". Additionally, approximately a quarter of all heads of R&D departments are not familiar with different equal opportunity

measures and even 43% of the surveyed persons do not know about equal opportunity policies, such as gender mainstreaming or diversity management.

> The answers of the European heads of R&D departments reveal gender specific attributions to reconciliation of family and job duties for women. At the same time, background knowledge regarding real working conditions and frameworks for female researchers seems to be missing.

The survey also shows that many answers of the interviewees depend on their gender. Especially the perception and evaluation of female and male researchers and the answers regarding possible reasons for the low number of female inventors varies with gender of the surveyed persons. Altogether male interviewees understate innovation potentials of female researchers in comparison to the male colleagues, particularly regarding performed overtime work and motivating impacts of implemented measures to take part in innovation activities. Female interviewees show this gender specific distortion in their answers too, but women state overtime work and motivating impact of innovation measures for female researchers higher than male interviewees do. Notwithstanding the differences in the perception and evaluation of researchers by the gender of the interviewees, the analyses of the answers show that formalised innovation measures or measures that entail high learning effects for the individual employee, such as “further specialist training”, “workshops” and “support to take part in external innovation competitions”, are particularly advantageous for women. In this context, the analysis of the survey shows that honours awarded to researchers who invent are evaluated as (highly) motivating by more than half of female interviewees. Altogether it is noticeable that these measures unify and enhance the individual technical knowledge and that they are formalised structures, which hence entails that official communication paths have to be used to take part in these measures. At the same time these measures enhance the visibility of female researchers.

> The analyses of the answers show that interviewees evaluate female and male researchers differently depending on their own gender. Nevertheless, it appears that especially formalised innovation measures, as well as those that support the individual technical knowledge and enhance the ‘visibility’, have a high motivating impact on female researchers.

One reason for the low visibility of female researchers is presumably their higher share of part-time work, albeit nearly 80% of female researchers of this survey are in full-time employment. This means that the higher share of female researchers working part-time is apparently one, but not the only reason for the low number of female inventors. One can assume that the higher share of female part-time work reinforces gender stereotypes such as the unilateral attribution of reconciliation of family and job duties to women. This is exemplified by the special situation of female researchers in the chemical sector, where the share of highly qualified women is higher than in most other

industrial sectors, but the output-input ratio of female inventors and female researchers corresponds approximately to other sectors with lower shares of female researchers. It is noticeable that in chemistry more female researchers work part-time than in other sectors, but at the same time the gap of estimated overtime work performed by male versus female researchers is lower than the EU average for overtime work in this survey. The situation in the chemical sector is eminently special because of prospective regulations in the case of pregnancy and the fast development of the sector. Presumably this enhances the gender specific perception in this particular professional field as well as in technology and natural sciences in general.

Although part-time employment is an effective measure to re-involve female researchers in highly-qualified jobs after maternity leave, it reduces their presence at the work place and possibilities to invent, participation in networks and the visibility of women. Presumably it reinforces the gendered perception and stereotypical attitudes within male dominated R&D departments.

This survey of European R&D departments shows gender specific understatement in perception and evaluation of female performance of overtime work and motivation by innovation measures, as well as unilateral attribution of reconciliation of family and job duties on women and an altogether low awareness regarding equal opportunity policies. This substantiates the assumption that socio-cultural frameworks and organisational structures, especially an innovation climate which is advantageous predominantly to male researchers, prohibit that female researchers adequately develop their potentials and take part in inventive activities and patenting. Part-time work and the aforementioned factors seem to create a vicious circle that can hardly be broken, unless formalised and transparent measures, which promote individual researchers und which enhance the visibility of women (e.g. honours), are implemented within the organisations. To avoid a unilateral promotion of male researchers, gender monitoring of the effectiveness and participation rate has to be implemented within the quality management of the organisations.

Altogether the high share of executives who are not familiar with the promotion of equal opportunity policies is alarming. This shows that the policy of equal opportunity has not yet reached many supervisors in European R&D. Especially “Promotion of women” and “Measures to facilitate going back to work after maternity leave” should be interesting for most industrial sectors to enlarge the highly-qualified female staff and to enhance the commitment with the organisation.

Existing socio-cultural frameworks of gender are reflected in part-time work of women, general working conditions and innovation climate and they are additionally enforced in a male dominated field of R&D. This results in an innovation climate, which is more advantageous to male researchers, but disadvantageous to female

Conclusion

The scarcity of women in inventive activities within the EU means that their innovative potential is less likely to contribute to the technological knowledge creation in the European Union. In consequence, this may lead to biased technology development since personal and professional experience of men and women flows into design and production of technologies. We can assume that the unsatisfactory integration of human capital in the innovation process severely affects the goals of gender mainstreaming and excellence in science. Women are significantly contributing to European patents, yet their high potential is not fully integrated in the innovation process. Given that economic success mainly relies on innovation, women's under-representation in research and development in the European Union should be of special concern to European policy makers.

Intellectual property production is an important part of the innovation process in which inventors, being patent originators, are seen as central actors in the innovation process. Being an inventor means to gain intellectual recognition, advantages in accumulation of professional opportunities as well as contribution to the visible and marketable technical knowledge creation. Thus, the under-representation of women in patenting not only leads to biased technology development and personal disadvantages, but it furthermore implies an unacceptable loss of intellectual resources that could hamper the development of the European society in the long run.

The discrepancy between the high achievement of women in the education system on the one side and their lower contribution to the scientific knowledge creation and innovation process on the other side exhibits a striking deficit of gender equality. In failing to make the best use of their female scientific population, most countries are under investing in their human capital to assure gender equality in innovation. Moreover, the discrepancy displays a lack of efficiency, a productivity loss as well as a risk for the economic and societal development in Europe. For a globalised European economy, which increasingly focuses on sustainable development of its human resources, it is of greatest importance to entirely include women's potential for the growth and well-being of all European societies.

2 Publishable Results

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