

European Integration and Position of Women in Business Enterprise Sector (BES)



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ABSTRACT

The purpose of this article is to describe gender gap in a field of research and development (abbr. R&D) and to investigate the changes after entry to EU. The research on gender gap is mainly focused on business enterprise sector. The paper presents comparative and descriptive statistics by using a secondary data and information across a period between 2004 and 2007. First part presents an overview of R&D personnel and R&D expenditures in each country. Consequently it compares three groups of countries. Next part investigates the honeypot indicators and the correlations between personnel and expenses on R&D. Due to using different base for calculation of personnel, diverse results of correlation were achieved. The results confirmed that statement mentioned in introduction is still valid after 6 years and entry to EU. The last part deals with the main findings regarding women researchers in business enterprise sector across European countries.

KEY WORDS: *generation gap, personnel of R&D, expenses on R&D, comparative study, honeypot indicator, correlations*

Introduction

According to report „Science, technology and innovation in Europe“, women as R&D personnel are still underrepresented. Especially, it is in Business Enterprise Sector (abbr.BES) with only 22,6% [3, p41]. One of

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the obstacles for women to enter in Science and Technology (abbr.S&T) is a stereotyped perception of S&T as a man's world [4].

In USA, one of the main rivals of European Union (abbr. EU), several programs were implemented to close gender gap (e.g. ADVANCE program of the National Science Foundation to support women at universities [6]. EU is aware of the importance of women in R&D. European platform of Women Scientist (abbr. EPWS) add that "to fully achieve Commission's objective of empowering people in inclusive societies, the consideration of gender is essential" (European Platform of Women Scientist, 2010, p.2). European commissar for Science and Research, Janez Potocnik said about the women's underrepresented that everybody should be concerned with it [EU Business, 2009].

Many studies look on a social aspect of gender gap. According to Zimmer et al (2007) male professors have at least 2 children, on the other side female professors are mainly single or divorced [7]. Women need to face a decision to choose career or private life. Studies propose several possibilities how to improve work life balance (e.g Šimková (2010) advises to increase salary to pay babysitter [10]).

This article looks at gender gap by explanatory variable "expenses on R&D". The result of ENWISE report presented by Velichova, indicates the less investment in research and development, the more female researchers are in this country [11]. ENWISE report was created to provide insight into the female scientists in EU pre-accession countries and Baltic States (Bulgaria, Czech Republic, Estonia, Hungary, Latvian, Litva, Poland, Rumania, Slovakia, and Slovenia). This article describes the situation of women researchers in business enterprise sector (BES) in chosen countries in period 2004 to 2007.

Methodology

The article examines the secondary data from EUROSTAT database by using the software R (project for statistical computing) and excel. The aim of this paper is to give an overview of women researchers mostly in business sector from a comparative perspective and descriptive analysis. The researchers are defined by EUROSTAT "as professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned [9].

They are one of three categories of R&D personnel (i.e. researchers, technicians and other supporting staff) “.

Comparative study is oriented on three groups of countries. One group is composed of countries that entered to EU in 1995 (Austria, Finland, Sweden) (hereafter abbr. as EU1995), countries that became members of EU in 2004 are in second group (Czech Republic, Estonia, Cyprus, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia) (hereafter abbr. as EU2004) and the last one consists of new members EU (Rumania, Bulgaria) (hereafter abbr. as EU2007). The review is restricted on the period 2004 to 2007 to discuss how the women's situation has changed in specific countries after entry to EU.

R&D personnel

All data about women's proportion on three diverse bases in chosen countries are shown in table 1.

Table 1: Women's proportion on three diverse bases

Geo/year	% of women on total R&D personnel		% of women researchers on total researchers in BES		% women researchers in BES to average population	
	2004	2007	2004	2007	2004	2007
CY	38,88%	38,36%	22,57%	22,38%	0,008%	0,010%
MT	27,77%	27,57%	19,46%	22,90%	0,011%	0,015%
EE	48,64%	46,73%	23,93%	32,41%	0,020%	0,039%
LV	54,25%	54,32%	50,55%	57,31%	0,012%	0,026%
LT	53,71%	54,51%	33,28%	28,86%	0,006%	0,013%
HU	47,43%	43,47%	23,76%	22,35%	0,013%	0,019%
CZ	34,62%	33,99%	19,25%	14,61%	0,022%	0,020%
PL	43,42%	42,61%	25,13%	25,46%	0,007%	0,008%
SK	43,44%	44,66%	32,28%	25,61%	0,013%	0,010%
SL	37,40%	38,72%	24,93%	25,89%	0,024%	0,037%
AT	29,53%	29,70%	12,59%	14,24%	0,032%	0,042%
FI	33,60%	34,72%	16,99%	17,31%	0,088%	0,087%
SE	n/a	35,63%	n/a	24,27%	n/a	0,093%
RO	45,06%	46,00%	41,49%	40,06%	0,018%	0,015%
BG	51,80%	50,81%	45,12%	38,47%	0,008%	0,008%

Source: own background research from EUROSTAT data

The further analysis of data by using function “Median”, demonstrate that percentage of women on total R&D personnel is higher in countries EU 2007 and EU 2004 than in countries EU 1995. It means that countries which are longer member of EU have less women representative in R&D. The results are same for percentage of women researchers on total researchers in BES (table 2). The results are opposite if same figures of women are calculated to average population of country. The female proportion in BES is seen to be higher in EU 1995 than in group EU 2004 and EU 2006 (table 2).

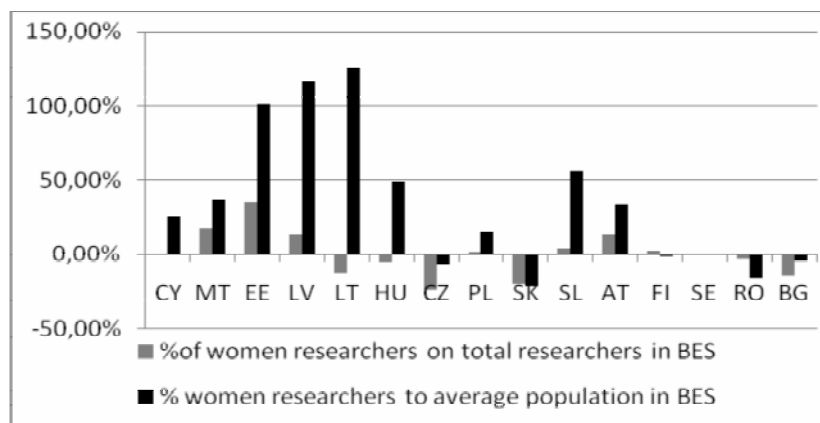
Table 2: Median

Median	% of women on total R&D personnel	%of women researchers on total researchers in BES	%women researchers in BES to average population
EU 2004	43,04%	25,53%	0,02%
EU 1995	34,72%	17,31%	0,09%
EU 2007	48,41%	39,26%	0,01%

Source: author's elaboration from the data in the table 1

The closer look on women's position expressed by percentage change between years 2004 and 2007, reflect that countries EU 2004 reached huge growth (e.g. in Lithuania, % of women researchers in BES to average population increased in 2007 by 125,4% in comparison to year 2004) except Slovakia and Czech Republic (table 3)

Table 3: % of women researchers in BES

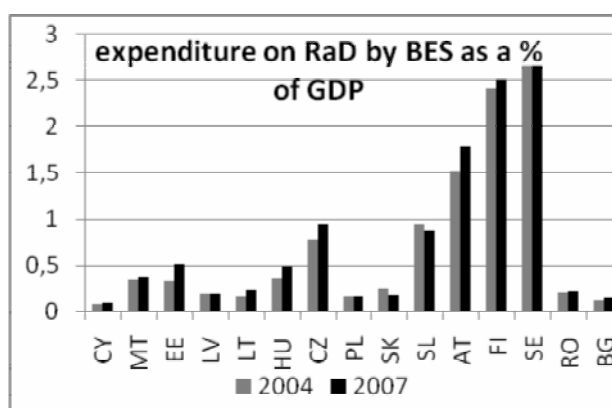


Source: author's elaboration from the data in the table 1

Expenses on R&D

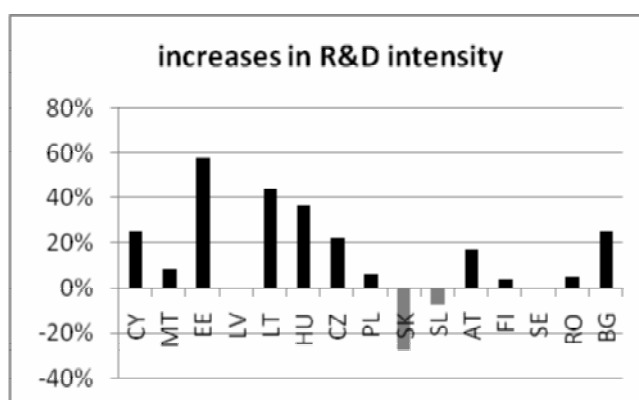
Despite the one of targets of Lisbon strategy (2%GDP invested by BES in R&D), the amount of expenditures for science and research in countries EU 2004 and EU 2007 does not reach 1% of GDP (see table 4). On the other side, countries EU 1995 overreach 1,5 %. The worst situation is in Cyprus where investment in R&D is less than 0,1% of GDP and the best situation is in Sweden with 2,66% of GDP in 2007.

Table 4: Comparison of expenditure by BES in 2004 /2007



Source: author's elaboration from the data

Table 5: Increased in R&D intensity



Source: author's elaboration from the data

The highest increases in R&D intensity (R&D expenditure by BES as a percentage of GDP) between years 2004 and 2007 were found in Estonia 57,58% (from 0,33% to 0,52% of GDP). The opposite situation appears in Slovakia, where R&D intensity decreased by -28% (from 0,25 to 0,18 % of GDP), in Slovenia by -7,45% (from 0,94 to 0,87% of GDP. Despite the fact that Sweden has the highest spending in R&D between chosen countries, decreasing happened as well in Sweden by -0,37% (from 2,67 to 2,66% of GDP). In summary, R&D intensity reached highest number in group EU 2007, after EU 2007 and EU 1995 is on the last position.

Honeypot Indicator

The impulse for the calculations of Honeypot indicators and correlation coefficients is one of results of Enwise report [8] which specifies that less investment in research and development, the more female researchers are in ENWISE countries. The research was conducted in 2001. For countries EU 2004 and EU 2007, it was before their entry to EU. The aim of author's analysis is to find out if this statement is still valid after 6 years and entry to EU.

The creator of Honeypot indicator is Marge Fauvelle. This indicator is "showing the rate of correlation between concentration of women/men and expenditure on science and research in separate sectors. It quantifies the loss of access to the financial support facing women scientists due to the fact that they are concentrated in the less funded sectors (government sector, education) and in the less supported scientific fields [1]".

The formula of Honeypot indicator is:

$$H = \frac{\{[\sum (O \times O_i)] - E \times E_p\} \times 100}{E \times E_p}$$

Where H is honeypot indicator, E is total expenditure on R&D, E_p = total % of female researchers, O= expenditure in each sector, O_i = % female researchers in each sector. There are 4 sectors: government, business enterprise sector, high education and non profit sector.

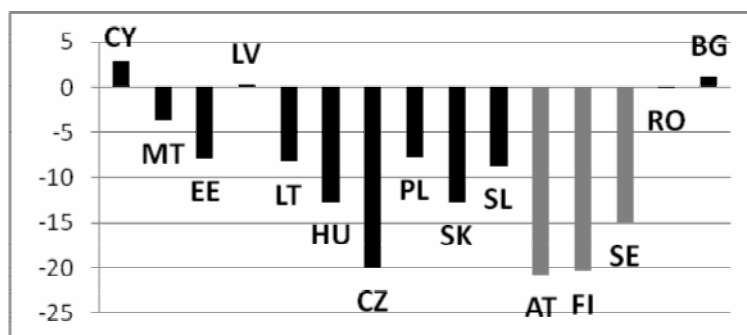
If $H > -10\%$, it indicates significant disadvantage for women in R&D.

If $H > 10\%$, it indicates significant advantage for women in R&D system.

This part of article compares the honeypot indicators of chosen countries in 2007 with results of ENWISE report. Indicators in Enwise report were calculated from data of the year 2001. The worst situations were in Czech Republic (H= - 16%), in Slovakia (H=- 15,05%) and Hungary (H= -9,96%). Only in Latvia and Bulgaria, the indicators reached positive values.

In this article, indicators are positive only for Cyprus, Latvia and Bulgaria. For the rest they are negative (table 6). Countries EU 1995 have worse results than EU 2004 and 2007. The better situation is in group EU 2007. In comparison with the results of Enwise, the situation worsens in each country between 2001 and 2007.

Table 6: Honeypot indicators



Source: author's elaboration from the data

Correlation Between Expenses and R&D Personnel

The final part of article analyses the relation between data mentioned above, between the number of women in the area of R&D and expenses on R&D. The honeypot indicators were calculated for all sectors, correlations are centred on BES.

Six correlations, illustrated in table 7, were executed to test Enwise statement. The significantly different results were obtained depending to the base to which the number of women was calculated. First method used the number of women calculated as a percentage on total R&D personnel (the correlation coefficients r_1 , r_2 , r_3 , r_4). Second method used the number of women calculated as a percentage on an average population (the

correlation coefficients r_5 and r_6). The correlation coefficients were not calculated for countries EU 2007 because of missing data.

According to mathematician Spearman's rank correlation coefficient, correlation below 0,3 is weak. Correlation is characterized as moderately strong with value between 0,3 and 0,8 and it is strong with value over 0,8.

In the case of coefficient of countries EU 1995, the analysis discovered strong positive correlation and coefficients approached to 1. Contrary, coefficient of countries EU 2004 reached very low values, even negative values in two cases. The correlation coefficient between % of women on total R&D personnel and expenses is $r_1 = -0,18473$ what is weak. For data of BES, the coefficient is $r_2 = -0,38174$. This moderately strong negative correlation means that in countries EU 2004, the percentage of women is decreasing with increased expenses in R&D.

In the case of counting number of woman researchers as a percentage of average population, the correlations are positive and moderately strong for EU 2004 ($r_5 = 0,616$) and strong for EU 2007 ($r_6 = 0,999$). It means that with higher expenses on R&D, number of female researchers expressed as % of average population arises.

Table 7: Correlations between two variables: R&D personnel and expenses in 2007

% of women on total R&D personnel and total expenses on R&D in 2007	
2004	$r_1 = -0,18473$
1995	$r_2 = 0,99953$
% of women researchers on total R&D personnel in BES and expenses on R&D in BES	
2004	$r_3 = -0,38174$
1995	$r_4 = 0,83542$
% of women researchers in BES to average population and expenses on R&D in BES	
2004	$r_5 = 0,61649$
1995	$r_6 = 0,99831$

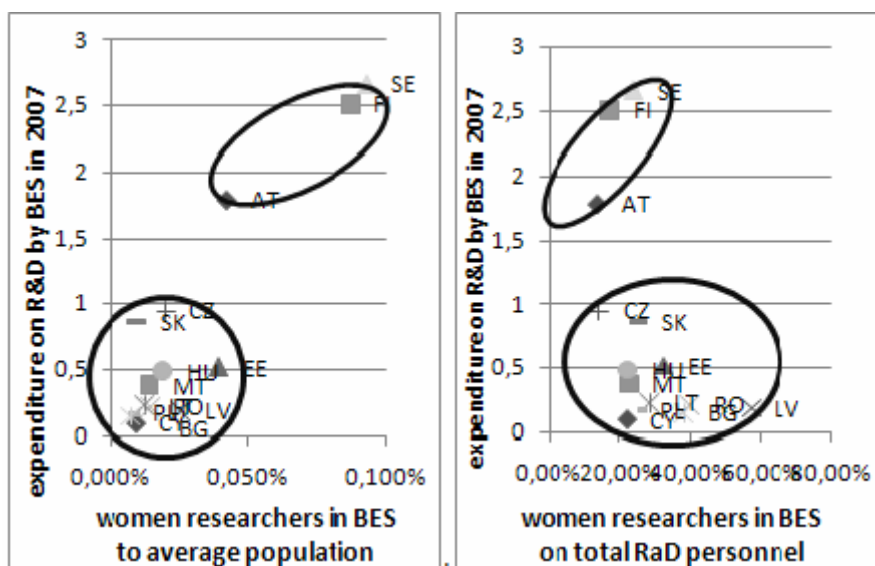
Source: author's elaboration from the data in the table 1,4,5

Tables 8 and 9 descriptively show relation between expenditure on R&D in 2007 and female researchers calculated by both methods. Tables outline that countries of one group are closer to each other.

In table 8 using first method, countries EU 1995 are on the left side at the top what expressed higher expenditure and low number of female researchers. Group EU 2004 is at the bottom in the same level of women scientist except Lithuania.

In table 9 using second method, countries EU 1995 are on the right side at the top what expressed higher expenditure and higher number of female researchers in BES to average population. Group EU 2004 is on the left side at the bottom with smallest number of women scientist.

Table 8 a Table 9:



Source: author's elaboration from the data in the table 1,4,5

Conclusion

Comparative research of this report has generated some insights into women's position in R&D in chosen countries of the EU. Countries which are older members of EU have less female researchers (to total R&D personnel). By contrast, opposite result was obtained by using second method of calculation number of female researchers (to average

population). Closer look on percentage of female representative on average population demonstrates that countries EU 1995 reached higher number in comparison with EU 2004 and EU 2007 (table2). Diverse results can be explained by the fact, that countries EU 1995 spend more on R&D what create more work position. Higher R&D spending permit pay more researchers included female representative.

Moreover, the reason of less female representative to total R&D personnel in countries EU 1995 can be attractiveness of higher salary (see last paragraph of this part). These possible explanations can be proved by further analysis.

In the case of expenses, countries EU 1995 spend the most and countries EU 2007 spend the least. However further analysis showed that new members are in progress and their R&D intensity increases. R&D intensity reached highest number in group EU 2007, after EU 2004 and EU 1995 is on the last position.

Honeyplot indicators which express relation between expenses and female researchers, reached negative values (except Cyprus, Latvia, Bulgaria). In 2007, they are negatively higher in comparison with the results in Enwise report from the year 2001.

In determining the relationship between expenditure and the number of female researchers in BES, negative correlations were indicated. In countries EU 2004, the percentage of women to total R&D personnel is decreasing with increased expenses in R&D. It confirms the statement of Velichova research conducted in 2001. Contrariwise, the number of female researchers on average population is increasing with arising of expenditure on R&D in countries EU 1995 as well in countries EU 2004. It demonstrates that using of diverse base for expressing number of women in research has various correlation coefficients. It is explained at the beginning of this part of article.

Graphical presentation of relations outlined that countries of one group are closer to each other. Countries of groups EU 2004 and EU 2007 are in the same level, however in comparison to EU 1995 they are in different position.

Negative correlation can be explained by attractiveness of remuneration. According to Fernández Polcuch [9], UNESCO specialist, in Latin America low salaries in a field of research reduce attractiveness for male representative. Higher expenses in R&D permit improve salaries of

researchers. Therefore better incomes attract more men and proportion of women representative decreases.

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