Chapter 11

The diversity of creative activity of men and women in Germany, France, UK and Italy on the basis of patents filed at the EPO in the period 1999–2013

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Abstract

Patent statistics are currently one of the research areas being intensively explored. Patent activity, measured by the number of patents, is one of the recognized measures of creativity and innovation, not only among countries and regions but also business entities. Patent statistics include a rich and detailed description of the patent, not only in terms of its content. This description includes information about the inventors of the patent, as well as the International Patent Classification (IPC). A new chapter in the exploration of patent statistics is their use to assess the creative diversity of patent activity for men and women. This variation applies not only to the total number of patents. It is crucial to indicate the areas of science, technology and the economy in which different patent activity for men and women appears. Therefore, in this study two main research tasks were formulated: analysis of the differences in the dynamics of changes in creative patent activity of men and women and identification of the diversity of creative accumulation of patent activity for men and women for the entire study period 1999–2103 in the countries under study: Germany, France, the UK, and Italy. In order to obtain uniform conditions for obtaining patent protection for the inventions of all inventors, the data source was the database European Patent Office (EPO).The diversity of accumulation of creative patent activity for men and women was achieved by using the IPC/NACE concordance table.

Key words: inventions and innovations, research and development, intellectual property, comparative analysis of countries

Introduction

Patent statistics is a diverse area of research exploration. In the literature, it is seen as a measure of: innovation (Griliches, 1990; OECD, 2005; Wisła, 2014; European Union, 2014), competition, specialization (RIS3 Guide, 2012), creativity (Fischer

and Varga, 2003), intellectual property, effects created by the outlays on research and development (R&D), and the level of technological advancement of countries, regions and individual traders. Patent activity is also recognized as a component of innovation potential. It can also serve as a measure of the creative involvement of women and men in building countries' innovative potential. In this study two research tasks were formulated: the first is to analyze the differences in the dynamics of changes in creative patent activity of men and women in selected countries. The second task is to identify the diversity of accumulation of creative patent activity for men and women for the entire study period in the selected countries. Patents are a legal protection granted for inventions, in particular as regards to the exclusive rights to their business use by developers. Individual countries have their own patent offices which grant legal protection in accordance with the laws which are valid in a given country regarding protection of intellectual property. For making a comparative analysis of patent statistics from different countries, it is necessary to preserve the identity of the legal principle of the rules for granting patents. This is possible thanks to the legal protection granted by the European Patent Office (EPO). Thus, the source of the data in this study was the EPO Patent statistics for the countries under study. In particular, information selected from the patent description such as: the IPC designation, and the list of inventors of each patent. The objects of the study of the diversity of patent activity were the countries belonging to the European Union that were seen as leaders in patent activity: Germany, France, the UK, and Italy. The research period adopted was 1999–2013 due to the availability of as complete patent specifications as possible, in particular relating to the inventors of patents obtained in the EPO. The first research goal was achieved through the use of a statistical tool – the average rate of change of the studied phenomenon in time (Freedman, Pisani, Purves, 2011). The second research goal was achieved by the use of the IPC/NACE concordance table (Okoń-Horodyńska et al., 2012).

11.1. Method of evaluating the creative diversity of patent activity for men and women

In this study two research tasks were formulated:

1. Analysis of the differences in the dynamics of changes in creative patent activity of men and women in selected countries.
2. Identification of the diversity of accumulation of creative patent activity for men and women for the entire study period in the selected countries.

The scope of the study was determined by the use of the EPO patent database, which was the source of the data, and the IPC/NACE concordance table (Okoń-Horodyńska et al., 2012), which was the tool used to achieve the second

objective. The study adopted the research period 1999–2013, due to the completeness of the descriptions provided in the EPO database, determined by the date of the grant of the patent. Since the source data does not specify separate information on gender, the number of women and men have been identified on the basis of male and female names identified in the description of the inventors.

Achievement of the first objective of the research the average rate of change was used (Freedman et al., 2011). Its use enabled the analysis and assessment of the dynamics of changes in patent activity of creative men and women in the given research period. The calculations of the average rate of change were made based on equations 1 and 2:

$$log_{\bar{y}_v} = \frac{1}{n-1} \times \sum_{i=2}^{n} log \frac{v_i}{v_{i-1}} \qquad \text{(Equation 1)}$$

where:

$\bar{y}_v$ – the geometric mean of the chain base indexes of the variable analysed over the entire study period,

v_i – the successive annual value of the time series of the variable analysed,

$\frac{v_{(i)}}{v_{(i-1)}}$ – the annual value of the chain base index of the variable analysed,

i – the successive values for chain base index,

N_z – number of elements in the time series of the variable analysed.

$$\overline{T}_v = (\bar{y}_v - 1) \times 100 \qquad \text{(Equation 2)}$$

where:

$\overline{T}_v$ – the average rate of change of the variable analysed throughout the study period,

$\bar{y}_v$ – the geometric mean of the chain base indexes of the variable analysed over the entire study period.

The procedure for calculating the average rate of change has been applied to the individual calculation of variables listed in Table 11.1.

Achieving the second objective of the research required the use of the IPC/NACE concordance table (Okoń-Horodyńska et al., 2012). This is based on the description of industries by NACE Subsections 1.1 (Table 11.2).

The limitations of the research method include the fact that the study concerned the analysis and assessment of the diversity of creative activity of men and women, so only individuals were taken into account in the description of the inventors. All other entities, such as companies, universities, research & development and other institutions were not taken into account. Another limitation is the accuracy of the concordance tables used. The point of their construction is to express one classification by describing another different classification. IPC describes areas of science

Table 11.1. Summary of the variables analysed, applied separately to relationships 1 and 2

Name of the variable analysed in the period 1999–2013	Type designation – v_i for the time series of the variable analysed	Designation of the average rate of – $\overline{T}_V$ for the variable analysed
Number of patents obtained in the EPO by Germany	v_{DE}	$\overline{T}_{DE}$
Number of patents obtained in the EPO by France	v_{FR}	$\overline{T}_{FR}$
Number of patents obtained in the EPO by the UK	v_{GB}	$\overline{T}_{GB}$
Number of patents obtained in the EPO by Italy	v_{IT}	$\overline{T}_{IT}$
Number of inventors from Germany for patents obtained in the EPO	v_{DET}	$\overline{T}_{DET}$
Number of inventors from France for patents obtained in the EPO	v_{FRT}	$\overline{T}_{FRT}$
Number of inventors from the UK for patents obtained in the EPO	v_{GBT}	$\overline{T}_{GBT}$
Number of inventors from Italy for patents obtained in the EPO	v_{ITT}	$\overline{T}_{ITT}$
Number of patents obtained in the EPO by women inventors from Germany	v_{DETW}	$\overline{T}_{DETW}$
Number of patents obtained in the EPO by men inventors from Germany	v_{DETM}	$\overline{T}_{DETM}$
Number of patents obtained in the EPO by women inventors from France	v_{FRTW}	$\overline{T}_{FRTW}$
Number of patents obtained in the EPO by men inventors from France	v_{FRTM}	$\overline{T}_{FRTM}$
Number of patents obtained in the EPO by women inventors from the UK	v_{GBTW}	$\overline{T}_{GBTW}$
Number of patents obtained in the EPO by men inventors from the UK	v_{GBTM}	$\overline{T}_{GBTM}$
Number of patents obtained in the EPO by women inventors from Italy	v_{ITTW}	$\overline{T}_{ITTW}$
Number of patents obtained in the EPO by men inventors from Italy	v_{ITTM}	$\overline{T}_{ITTM}$

Source: own report.

and technology, while NACE describes the classification of economic activities. Hence the difficulty of building concordance tables. In the literature more different types of concordance table are detailed. For the purposes of this study the above table was created whose mutual mapping spectrum of classification is the broadest.

In the cognitive layer of this study, we can specify the acquisition of new knowledge on the difference in the creative patent activity between men and women patent in the selected countries, based on the EPO patent database for the period 1999–2013, in the form of quantitative determination of: diversity and dynamics of changes in the patent activity and the diversity of the accumulation of patent activity in the individual NACE sections and technological areas.

Table 11.2. List of industries described by NACE subclasses 1.1

NACE Designation	Description
AA	Agriculture, hunting and forestry
BA	Fishing
CA	Mining and quarrying of energy producing materials
CB	Mining and quarrying, except of energy producing materials
DA	Manufacture of food products, beverages and tobacco
DB	Manufacture of textiles and textile products
DC	Manufacture of leather and leather products
DD	Manufacture of wood and wood products
DE	Manufacture of pulp, paper and paper products; publishing and printing
DF	Manufacture of coke, refined petroleum products and nuclear fuel
DG	Manufacture of chemicals, chemical products and man-made fibres
DH	Manufacture of rubber and plastic products
DI	Manufacture of other non-metallic mineral products
DJ	Manufacture of basic metals and fabricated metal products
DK	Manufacture of machinery and equipment n.e.c.
DL	Manufacture of electrical and optical equipment
DM	Manufacture of transport equipment
DN	Manufacturing n.e.c.
FA	Construction

Source: Eurostat, http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LS-T_NOM_DTL_LINEAR&StrNom=NACE_1_1&StrLanguageCode=PL [accessed 08.12.2014]. NACE Subsections were described in the concordance table with the appropriate IPC designation.[1]

11.1. Identification of the leading countries in the European Union in terms of patent activity

Selecting the leading countries required an examination of the patent activity of all EU countries in the given research period. The leading EU countries were selected on the basis of the share of patenting granted by the EPO per 1 million averaged population of each country throughout the study period. The results for this are shown in Figure 11.1.

According to the survey, the largest share of registered patents granted by the EPO was recorded in Germany 48.04%, followed by France 16.85%, Britain 12.67% and Italy 6.82% from all EU countries throughout the study period. The total value of the share of these countries is 84.38%, and the remaining 15.62% is the share of the other 24 EU countries. Thus, further studies included the selected group of four leading EU countries in terms of registered patents granted by the EPO.

1 The detailed description of the concordance table in this study with IPC designations is located at: Okoń-Horodyńska et al., 2012, pp. 31–39, 118–212.

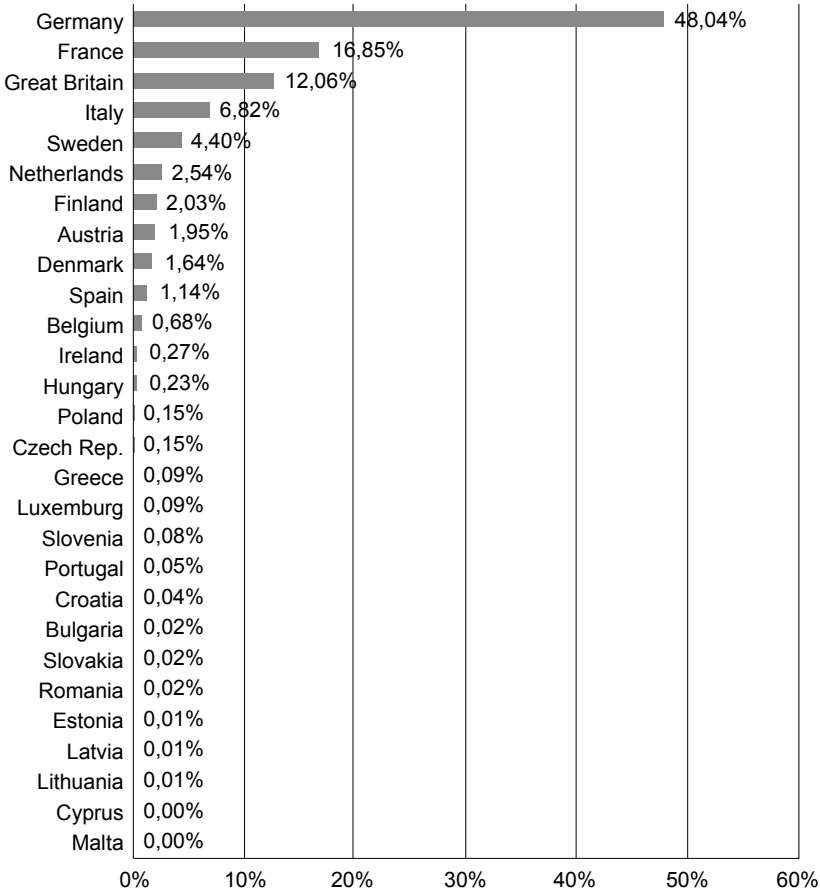

Figure 11.1. The share of applicants per 1 million inhabitants in the period 1999–2013
Source: own calculations.

11.2. The diversity of creative activity of men and women in the countries covered by the analysis

Creative patent activity was analysed and evaluated for Germany, France, the UK and Italy. The data source was the EPO Patent database. First the time series of annual values for the eight variables were identified (Table 11.3).

The most patents approved in the study period were received by Germany – 169 729 (Table 11.3), with the largest number of inventors – 417 133. The fewest

patents were granted to Italy – 23 133, with the smallest number of inventors – 44 136. For the listed variables (Table 11.4) the geometric mean and the average rate of change were calculated separately. The results are shown in Table 11.4.

Table 11.3. Number of patents and inventors obtained from the EPO

Year/country/ variable	Number of patents granted by the EPO				Number of inventors of patents granted by the EPO			
	v_{DE}	v_{FR}	v_{GB}	v_{IT}	v_{DET}	v_{FRT}	v_{GBT}	v_{ITT}
1999	7 740	2 920	2 443	1 034	18 594	6 087	5 208	1 919
2000	5 718	2 134	1 924	847	13 698	4 511	4 208	1 648
2001	8 423	2 808	2 068	1 002	20 465	6 044	4 598	1 925
2002	11 551	3 786	3 148	1 473	28 326	8 139	6 831	2 559
2003	13 719	4 674	3 888	1 877	33 667	10 050	8 929	3 339
2004	13 787	4 176	3 637	1 868	33 724	9 020	8 568	3 379
2005	12 631	3 498	3 197	1 598	31 136	7 637	7 593	2 934
2006	14 333	4 143	3 472	1 927	35 213	9 079	8 248	3 535
2007	11 450	3 616	2 902	1 561	28 460	7 971	7 164	2 872
2008	12 825	4 323	3 000	1 752	31 971	9 615	7 264	3 202
2009	10 791	3 691	2 509	1 542	26 830	8 280	6 302	2 832
2010	11 598	4 208	2 587	1 714	28 432	9 405	6 623	3 225
2011	11 985	4 237	2 706	1 772	29 673	9 771	6 526	3 390
2012	11 706	4 081	2 783	1 832	28 639	9 318	6 947	3 525
2013	11 472	4 189	2 702	1 972	28 305	9 731	6 561	3 852
Total	**169 729**	**56 484**	**42 966**	**23 771**	**417 133**	**124 658**	**101 570**	**44 136**

Source: own calculations.

Table 11.4. The calculated values for the average rate of change for the entire period 1999–2013

Variable	Average rate of change
$\overline{T}_{DE}$	2.85%
$\overline{T}_{FR}$	2.61%
$\overline{T}_{GB}$	0.72%
$\overline{T}_{IT}$	4.72%
$\overline{T}_{DET}$	3.05%
$\overline{T}_{FRT}$	3.41%
$\overline{T}_{GBT}$	1.66%
$\overline{T}_{ITT}$	5.10%

Source: own calculations.

As follows from the calculations (Table 11.4), the largest value for the average rate of change was recorded for $\overline{T}_{ITT}$, which amounted to 5.10%, which is Italian inventors of patents obtained in the EPO. This means that the number of inventors from Italy for patents obtained in the EPO increased throughout the study period, from year to year by an average of 5.10%. Italy also achieved the highest

average rate of change in the number of patents obtained in the EPO $\overline{T}_{IT}$, which amounted to 4.72%.This means that the number of patents at the EPO obtained by Italy increased from year to year by 4.72% on average. The lowest average rate of change was recorded for $\overline{T}_{GBT}$, which amounted to 1.66%, which is UK inventors of patents obtained in the EPO. This means that the number of inventors from the UK for patents obtained in the EPO increased throughout the study period, from year to year by an average of 1.66%. The UK also recorded the lowest average rate of change in the number of patents obtained in the EPO $\overline{T}_{GB}$, which amounted to 0.72%.This means that the number of patents at the EPO obtained by the UK increased from year to year by 0.72% on average.

The numbers of inventors for patents obtained in the EPO including the gender are shown in Table 11.5.

Table 11.5. The number of men and women who are the inventors of patents obtained in the EPO

Country	Germany		France		The UK		Italy	
Year/ variable	v_{DETW} [number]	v_{DETM} [number]	v_{FRTW} [number]	v_{FRTM} [number]	v_{GBTW} [number]	v_{GBTM} [number]	v_{ITTW} [number]	v_{ITTM} [number]
1999	721	17 808	522	5 537	299	4 671	200	1 684
2000	491	13 157	374	4 128	303	3 736	189	1 432
2001	884	19 509	594	5 425	304	4 089	181	1 704
2002	1 244	27 011	720	7 362	521	5 936	264	2 251
2003	1 626	31 931	906	9 066	720	7 669	400	2 856
2004	1 752	31 871	863	8 067	612	7 287	420	2 835
2005	1 573	29 470	809	6 774	615	6 235	336	2 492
2006	1 843	33 241	992	7 979	689	6 671	436	2 995
2007	1 603	26 741	832	7 070	621	5 685	362	2 404
2008	1 766	30 091	983	8 555	593	5 845	386	2 650
2009	1 516	25 220	870	7 355	603	5 087	355	2 361
2010	1 590	26 773	1 077	8 268	572	5 329	482	2 645
2011	1 708	27 911	1 009	8 725	579	5 486	491	2 842
2012	1 705	26 899	1 031	8 256	598	5 995	564	2 914
2013	1 785	26 484	1 025	8 681	606	5 677	661	3 150
Total	**21 807**	**394 117**	**12 607**	**111 248**	**8 235**	**85 398**	**5 727**	**37 215**

Source: own calculations.

The greatest number of women inventors for EPO patents was obtained for Germany, 21 807, and the lowest for Italy, 5 727, throughout the study period (Table 11.5). The greatest number of male inventors of patents obtained in the EPO was recorded for Germany, 394 117, and the lowest for Italy 37 215.The values for of the geometric mean and the average rate of change for female and male inventors of EPO patents obtained are shown in Table 11.6.

Table 11.6. Calculated values for the average rate of change of male and female inventors of EPO patents obtained in the period 1999–2013

Variable	Value of the average rate of change
$\overline{T}_{DETW}$	6.69%
$\overline{T}_{DETM}$	2.88%
$\overline{T}_{FRTW}$	4.94%
$\overline{T}_{FRTM}$	3.26%
$\overline{T}_{GBTW}$	5.18%
$\overline{T}_{GBTM}$	1.40%
$\overline{T}_{ITTW}$	8.91%
$\overline{T}_{ITTM}$	4.57%

Source: own calculations.

The highest average rate of change was recorded for Italian female inventors of EPO patents obtained, 8.91% (Table 11.6). This means that the number of female inventors from Italy for patents obtained in the EPO increased throughout the study period, from year to year by an average of 8.91%. The lowest average rate of change was observed for UK male inventors of EPO patents obtained, 1.40%. This means that the number of male inventors from the UK for patents obtained in the EPO increased throughout the study period, from year to year by an average of 1.40%.

11.3. Differentiation of the cumulative creative activity of men and women

The cumulative creative patent activity was analysed and calculated for the entire period of the study, based on the IPC/NACE concordance table (Okoń-Horodyńska et al., 2012) for each country in the analysis. The results are shown in Tables 11.7 and 11.8.

The NACE Subsection descriptions are given in Table 11.2.The highest number of male and female inventors throughout the study period was recorded in Germany, respectively 392 980 and 21 758, and the lowest in Italy, 37 136 and 5 717. Figures 11.2 and 11.3 show the accumulation of patent activity for men and women of the countries surveyed, over the entire study period, in particular areas of the economy.

The highest patent activity of female inventors (Figure 11.2), from all the countries surveyed, for patents obtained in the EPO, was noted in Subsection DG – Manufacture of chemicals, chemical products and man-made fibres, 45.56% of all women who are the inventors of patents. The second area is DL – Manufacture of electrical and optical equipment, which saw 19.95% of all female inventors.

Table 11.7. The number of men and women who are the inventors of patents obtained in the EPO in the whole period from 1999–2013 in NACE Subsections

Country	Germany		France		The UK		Italy	
NACE/ variable	Women [number]	Men [number]	Women [number]	Men [number]	Women [number]	Men [number]	Women [number]	Men [number]
AA	101	822	65	421	57	461	23	144
BA	13	129	32	181	23	277	16	46
CA	13	705	21	329	27	1 454	10	80
CB	0	0	0	0	0	0	0	0
DA	1 248	8 750	944	3 284	937	4 202	250	1 200
DB	367	6 144	133	1 430	105	933	102	1 363
DC	40	673	27	395	19	129	41	397
DD	43	1 231	18	190	8	88	8	126
DE	244	6 818	230	2 675	122	1 670	92	616
DF	119	1 344	175	1 121	48	506	26	164
DG	9 806	87 887	5 617	22 443	4 427	26 270	2 126	8 019
DH	161	3 155	136	1 932	50	973	109	806
DI	459	5949	319	2 310	78	1 120	76	791
DJ	908	25 971	390	6 882	103	3 130	273	2 904
DK	1 981	74 140	845	15 247	316	8 870	902	7 579
DL	4 126	93 856	2 786	33 586	1 676	27 488	1 036	6 783
DM	1 607	61 768	551	13 479	97	4 805	410	4 194
DN	248	5338	128	2047	56	1 292	117	911
FA	274	8 300	159	2 839	34	1 338	100	1 013
Total	**21 758**	**392 980**	**12 576**	**110 791**	**8 183**	**85 006**	**5 717**	**37 136**

Source: own report.

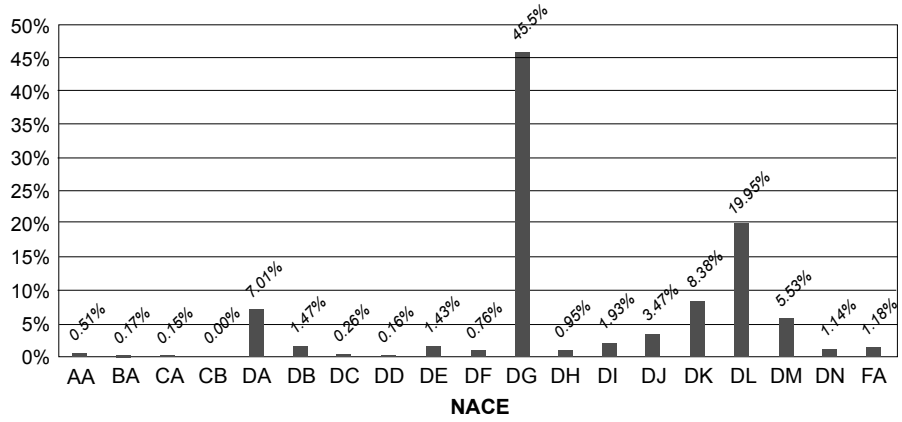

Figure 11.2. Accumulation of creative patent activity for women from all countries surveyed throughout the study period
Source: own calculations.

Men's patent activity is somewhat more diverse in terms of the spectrum of economic areas. The highest patent activity of male inventors (Figure 11.3), from all the countries surveyed, for patents obtained in the EPO, was noted in Subsection DL – Manufacture electrical and optical equipment, 25.84% of all men who are the inventors of patents. The second area is DG – Manufacture of chemicals, chemical products and man-made fibres, 23.11% of all men who are the inventors of patents. Other areas are DK – Manufacture of machinery and equipment n.e.c. and DM – Manufacture of transport equipment, where the share of male inventors are respectively 16.91% and 13.46%.

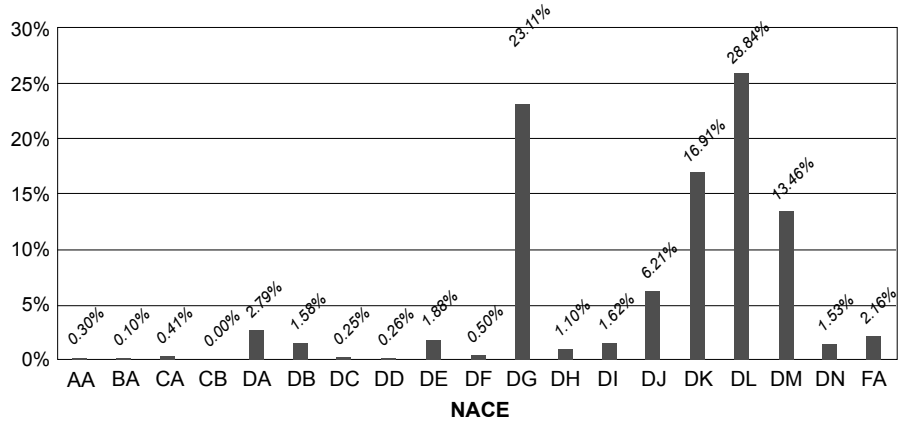

Figure 11.3. Accumulation of creative patent activity for men from all countries surveyed throughout the study period
Source: own calculations.

No patent activity at all throughout the study period, among both women and men, was noted in Subsection CB – Mining and quarrying of raw materials other than energy producing. Table 11.8 shows the results of calculation of the ratio of the number of women to the number of men in each NACE Subsection, in order to identify the sub-section in which the highest and lowest patent activity was recorded for men and women at the same time.

The higher the ratio of women to men (Table 11.8), the more women compared to men were involved in patent activity in the given NACE area. A value ratio greater than 1 indicates a greater number of women than men. In contrast, a value less than 1 indicates a greater number of men. The area of cooperation which marked the highest ratio of women to men in patent activity in Germany, France and the UK is DA – Manufacture of food products; beverages and tobacco, where it is respectively 0.143, 0.287 and 0.223.But the area for Italy is BA – Fishing, 0.348. The lowest value of the ratio of women to men in patent activity was recorded for Germany and the UK in CA – Mining and quarrying of energy for energy producing materials, 0.018, and 0.019, respectively, France 0.041 in the area of DM – Manufacture of transport equipment, and Italy 0.063 in the area of DD – Manufacture of wood and wood products.

Table 11.8. The number of men and women who are the inventors of patents obtained in the EPO in the whole period 1999–2013 in NACE Subsections

NACE/country	Germany	France	The UK	Italy
AA	0,123	0,154	0,124	0,160
BA	0.101	0.177	0.083	0.348
CA	0.018	0.064	0.019	0.125
CB	0	0	0	0
DA	0.143	0.287	0.223	0.208
DB	0.060	0.093	0.113	0.075
DC	0.059	0.068	0.147	0.103
DD	0.035	0.095	0.091	0.063
DE	0.036	0.086	0.073	0.149
DF	0.089	0.156	0.095	0.159
DG	0.112	0.250	0.169	0.265
DH	0.051	0.070	0.051	0.135
DI	0.077	0.138	0.070	0.096
DJ	0.035	0.057	0.033	0.094
DK	0.027	0.055	0.036	0.119
DL	0.044	0.083	0.061	0.153
DM	0.026	0.041	0.020	0.098
DN	0.046	0.063	0.043	0.128
FA	0.033	0.056	0.025	0.099

Source: own calculations.

Conclusions

Based on the analysis and the evaluation of the creative diversity of patent activity in Germany, France, the UK and Italy over the study period 1999–2013, the following conclusions may be formulated.

1. The largest increase in patent activity in the period 1999–2103, measured by the average rate of change in both the number of patents obtained in the EPO, as well as the number of inventors was reported for Italy. The number of patents increased from year to year by an average of 4.72%, while the number of inventors increased from year to year by an average of 5.10%.
2. The lowest average rate of change in the number of patents obtained in the EPO was recorded for the UK The number of patents increased from year to year by an average of 0.72%. Also, the lowest growth in the number of inventors was recorded for the UK. The number of patents increased from year to year by an average of 1.66%.

3. The number of female creators from Italy for patents obtained in the EPO increased most rapidly throughout the study period, from year to year by an average of 8.91%. The lowest average rate of change was observed for UK male inventors of EPO patents obtained, 1.40%. This means that the number of male inventors from the UK for patents obtained in the EPO increased throughout the study period, from year to year by an average of 1.40%.
4. In all the countries surveyed, the average rate of change in the number of women artists is positive and significantly higher than the average rate of change in the number of men who are inventors of patents granted by the EPO in the period 1999–2013.This means that women in the countries concerned exhibit significantly higher creativity than men in terms of patent activity.
5. The area of cooperation which marked the highest ratio of women to men in patent activity in Germany, France and the UK is DA – Manufacture of food products; beverages and tobacco, where it is respectively 0.143, 0.287 and 0.223. For Italy this area is BA – Fishing, at 0.348.
6. The area of cooperation, which recorded the lowest proportion of women to men in patent activity in Germany and the UK is CA – Mining and quarrying of energy materials, respectively 0.018, and 0.019, for France, 0.041, it is the area of DM – Manufacture of transport equipment and for Italy, 0,063, it is area DD – Manufacture of wood and wood products.

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