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European Research Council: excellence and leadership over time from a gender perspective

Núria Bautista-Puig [1,2], Carlos García-Zorita[1,2] and Elba Mauleón[1,*]

[1]Research Institute for Higher Education and Science (INAECU), University Carlos III of Madrid, Madrid 28903, Spain and [2]LEMI (Laboratory on Metric Information Studies), Department of Library and Information Sciences, University Carlos III of Madrid, Madrid 28903, Spain

*Corresponding author. Email: elba114@hotmail.com

Abstract

European Research Council Grants (ERC) have become the most important vehicle for funding scientific research in the EU. Since their creation in 2007, they have provided funding for around 7,000 of the nearly 70,000 proposals for research projects submitted. With a success rate of about 11%, these Grants are highly competitive. Despite major advancement of women's participation in research activity, women overall remain the minority in Science, Technology, Engineering and Mathematics (STEM disciplines). Against that backdrop, this article analyses men's and women's presence in ERC Grants. The gender balance in the ERC Grant, have been examined in three dimensions: Excellence Awarded; Scientific Leadership Position; and Time Series Evolution. The results show that female presence is lower than men as submitted (26% vs 74%), granted (22% vs 78%), expert panel members (28% vs 72%), and as a panel chair (26% vs 74%). State-space prediction of the future pattern of these grants shows that time has no clearly beneficial effect on women's participation as applicants, granted, expert panel members or panel chairs, particularly in the area of Physics and Engineering.

Key words: women in science; gender gap in research funding; peer review; research grants; European Research Council (ERC)

1. Introduction

European Research Council (ERC) Grants have become the most important vehicle for funding individual scientific research in Europe (Heldin 2008; Nedeva and Stampfer 2012; Neufeld, Huber and Wegner 2013; Zecchina and Anfossi 2015). In its slightly over 10-year history, this body has fostered scientific excellence in Europe through the competitive funding of frontier research projects in all areas of knowledge (Heldin 2008; Luukkonen 2012; Cruz-Castro, Benitez-Amado and Sanz-Menéndez 2016). Despite its short life, the ERC has infused energy into the European research environment and enhanced the reputation of European research, while affording researchers opportunities for international geographic and institutional mobility (Nedeva and Stampfer 2012; Luukkonen 2014). The ERC has also contributed to the establishment of the European Research Area (ERA), deemed by many to be the backbone of Europe's knowledge society (König 2016). Since its creation in 2007, it has provided funding for over 7,000 of the nearly 70,000 proposals for research projects submitted. The €13.1billion allocated under the H2020 Framework Programme to fund ERC Grants account for 17% of the overall programme budget (European Commission 2018).

The ERC provide different types of grants. Starting Grants (StGs), in place since the outset in 2007, are intended for researchers with 2–7 years of experience since earning their PhD. They are designed to support excellent researchers at the stage of their incipient careers when they are transitioning to the creation of independent teams. The Consolidator Grants (CoGs) created in 2013 target researchers with 7–12 years of experience since they earned their PhD. They aim to consolidate independent teams in a position to handle funding for ambitious research on the frontiers of any scientific discipline. The Advanced Grants (AdGs) instituted in 2008 are intended for established researchers with their own teams and programmes. Their purpose is to fund ground-breaking research projects able to advance knowledge and break the ground for new areas of research in their respective lines of work. These calls are restricted to researchers with over 10 years of experience and proven leadership skills, a consolidated research career and a history of broadly acknowledged scientific achievement. AdGs are an opportunity to implement innovative, pioneering, and high-risk projects with high potential for success. As the calls themselves specify, AdGs aim to obtain major breakthroughs that cross the boundaries of any given discipline.

In addition to those three types of grant, the ERC has other funding lines: synergy (SyG) and proof of concept (PoC) grants. The SyG line was launched in 2013 to support multi-disciplinary research that cannot be conducted by a single researcher. PoC grants were instituted in 2011 to explore the commercial potential of the results of frontier research stemming from ERC-funded projects.

One feature that distinguishes ERC Grants from other research funding programmes is that the principal investigator is free to choose the subject of study: no topic is strictly off-limits. ERC Grants, awarded to specific researchers after appraising their proposals, allow highly promising investigators the freedom to assume risks with no need to hew to strategic lines or priority areas (Antonoyiannakis and Kafatos 2009). That constitutes a counterpoint to all other research calls in the successive framework programmes. The ERC Grants entail a move from the top-down perspective in which research subjects are defined under priority lines of action with which researchers must align their projects, to a bottom-up approach in which they propose studies that need not match any pre-established subject or strategic line (European Commission 2018).

The ultimate objective of ERC Grants (European Research Council 2018) is to further research of the highest quality and attract the best researchers to European institutions and retain them there. The sole criterion considered in the assessment process is scientific excellence, both as regards the research project and its principal investigator, although excellence is not an issue readily determined (Rees 2011; Schiffbaenker and Haas 2018).

In candidacy evaluation, the reviewers sitting on the ERC panels must judge scientific quality independently of their appraisal preferences to guarantee scientific excellence. The ultimate aim of ERC candidacy evaluation is not only to fund the best research, but in the long run to strengthen and substantially shape Europe's research system. It pursues the improvement of Research and Development and Innovation (R&D + I) quality and decision-making credibility (Sandström and Hällsten 2008) by enhancing the rigour and validity of the knowledge stemming from ERC-funded projects (Luukkonen 2014). The use of peer review in this assessment process may be subject to certain imperfections, however. The fact that panel experts form part of the system evaluated (Martin 2000) may exert social and political pressure on the scientific community (Langfeldt and Kyvik 2011), insofar as expert subjectivity and the possible existence of tense interpersonal relationships may have an adverse impact on the impartiality of project evaluation (Morley, Leonard and David 2002). In another vein, although a bottom-up approach has been adopted, i.e. no priority research areas are established that condition candidacy evaluation, the most innovative projects may be at a disadvantage. Experts' observed tendency to favour established over emerging areas (Langfeldt and Brofoss 2005; Luukkonen 2012) may translate into ongoing loyalty towards a given circle of known scientists (Luukkonen and Stahle 1990; Travis and Collins 1991; Heinze 2008). The ERC seeks to fund projects headed by excellent researchers with a view to more dynamic and creative research in Europe, furthering innovative, high-risk but at the same time potentially cost-effective research. That intention may be countered, however, by a certain tendency among reviewers to favour proposals with a higher likelihood of success in terms of research findings and their application and to view more innovative proposals involving some degree of risk with greater apprehension (Langfeldt 2001; Lamont 2009; Luukkonen 2012; Scherngell et al. 2013). Moreover, with social demands calling for substantiation of the applicability of publicly funded research to a country's needs, decisions around resource allocation are being ever more critically questioned (Schroter, Groves and Hojgaard 2010).

In addition to the limitations inherent in peer review (Campanario 2002; Lee et al. 2013) to which ERC processes are not immune (Van den Besselaar, Sandström and Schiffbaenker 2018), studies on gender bias in the peer-review process (Kaatz, Gutierrez and Carnes 2014), both as regards publication of research findings (Budden et al. 2008; Helmer et al. 2017; Schmaling and Blume 2017; Seeber and Bacchelli 2017) and for obtaining research funding (Wenneras and Wold 1997; Bornmann and Daniel 2005; Bornmann 2007; Bornmann, Mutz and Daniel 2007; Lortie et al. 2007; Ley and Hamiltom 2008; European Commission 2009; Husu and Cheveigné 2010) have risen to ever greater prominence in the scientific literature. Women's lower success rates in peer review processes may contribute to the consolidation of gender bias in science, favouring the persistence of this problem, such as the 'leaky pipeline' (Berryman 1983; Alper 1993; Blickenstaff 2005; Good, Aronson and Harder 2008; Ceci et al. 2014), the 'sticky floor' (Tesch et al. 1995; Booth, Francesconi and Frank 2003; Zhuge et al. 2011), 'glass ceiling' (Hymowitz and Schellhardt 1986), 'occupational segregation' (Light 2013; She Figures 2015 2016), the 'Matilda effect' (Rossiter 1995; Fassa, Kradolfer and Paroz 2012), the 'old boys' club' (Case and Richley 2012), the 'scissor diagram' (ETAN 2001; Mauleón, Bordons and Oppenheim 2008), 'getting stuck' (Fusulier, Barbier and Dubois-Shaik 2017), and the 'gender funding gap' (Bornmann, Mutz and Daniel 2008; Bedi, Van Dam and Munafo 2012; Mutz, Bornmann and Daniel 2012; Eloy et al. 2013; Head et al. 2013).

To palliate such situations and limit gender bias in science, European institutions have made enormous efforts to ensure the inclusion of the gender perspective in their framework research programmes and guarantee women's equitable and unrestricted participation in all scientific disciplines at all levels. The VII Framework Programme (2007–13), for instance, sought women's active participation in science from two perspectives: furthering their presence in research teams at all levels, and favouring gender balance in decision-making positions as review panel experts and scientific advisors on academic hiring and promotion committees. The H2020 Programme (2014–20) takes those two measures one step further, fostering the inclusion of the gender perspective as an overarching dimension in research, whereby its presence is studied in all the stages of research: the definition of scientific-technical research priorities for research problems, theoretical and explanatory frameworks, methods, data collection and interpretation, conclusions and possible applications, and technological developments. Another important feature is the inclusion of gender training as part of project costs. The ERC, in turn, created the Gender Balance Working Group in 2008 to build the gender perspective into all levels of ERC evaluation. The group's objectives focus primarily on identifying and eliminating gender bias in evaluation, improving the gender balance in successive ERC calls and seeking a gender balance among panel experts.

2. Objectives

This study aims to analyze ERC Grants in order to detect gender disparities in grant getting through analytical metrics. The analysis is twofold: (1) to compare male and female success rate; and (2) to analyze panel member composition. In keeping with that objective, the study addresses the dimensions set out below:

2.1 Gender balance in awarded excellence

The aim is to identify the existence of vertical and horizontal segregation. The research questions explored in connection with ERC applicants and granted were:

- What is the male and female presence by research area and type of grant?
- What is success rate for male and female applicants by research area and type of grants?
- Is a glass ceiling in place that prevents women from obtaining the highest category grants?

2.2 Gender balance in scientific leadership position

This dimension entails an analysis of the presence of men and women in ERC grant review panels, in which the following issues are addressed:

- What is the gender composition of review panels?
- Are panel chairs distributed equally between men and women?

2.3 Gender balance time series and future trends

A state-space (SS) model was used to estimate trends in the number of women granted and panel members over time. The questions posed in the analysis of the time series and future predictions were as follows:

- Can SS model predict future trends in ERC Grants? What will the male/female ratio by research area be in 2020?
- Is a 60/40 distribution foreseeable?

3. Materials and methods

This research analyses all applications submitted to the ERC in the first 10 years of its existence (2007–16). 65,778 applications were submitted and 7,154 (10.88%) were granted. Both the submitted and the granted applications have been analyzed in this article.

Whilst for these grants researchers need not model their projects to any specific line or field, the ERC defines three major areas in which candidates are evaluated. Each area and panel is allocated a specific budget, largely determined on the grounds of the applications submitted in each call. The areas include Life Sciences (LS), with nine panels or subareas; Physical Sciences and Engineering (PE) with ten; and Social Sciences and Humanities (SH) with six. Those 25 review panels organize and evaluate candidates' projects and CVs. This article addressed all 25 subareas to identify gender-based differences in number of applicants and granted, along with the gender composition of review panels. The study focussed on three types of grants: StGs, CoGs and AdGs. All three are individual, i.e. they fund projects headed by a single researcher. The Synergy and Proof of Concept Grants were excluded, the former primarily because they support projects headed by two to four researchers and the latter because they target researchers who have already been granted an ERC grant, whether ongoing or concluded, and wish to explore project potential. In other words, they are more market-oriented than the StGs, CoGs, and AdGs.

This study analyzed possible gender differences in the distribution of men and women by type of grant (vertical segregation) and by scientific-technical area (horizontal segregation). It also explored the composition of the expert panels that evaluate the applications submitted to the ERC.

- The indicator implemented to evaluate the horizontal segregation was the Gender Parity Index (GPI). The formula [1] used for the GPI was:

$$\text{GPI} = \frac{\text{Number of women}}{\text{Number of men}} \quad [1]$$

  The GPI is the number of women divided by the number of men in a given area. When the ratio is less than 1, women's presence is lower than men's. A value of 1 denotes gender parity. Value greater than 1 indicates a disparity in favour of men. For instance, a value of 0.30 in the GPI means that in the area or level for which it was calculated, for each 100 men there are 30 women.
- The indicator used to analyze vertical segregation was the Glass Ceiling Index (GCI). The formula [2] used for calculating the GCI was:

$$\text{Glass Ceiling Index (GCI)} = \frac{\left(\frac{\text{Total women (StG+CoG+AdG)}}{\text{Women AdG}}\right)}{\frac{\text{Total Men (StG+CoG+AdG)}}{\text{Men AdG}}} = \frac{\text{AtAdG(women)}}{\text{AtAdG (men)}} \quad [2]$$

where the term 'AtAdG' measures the 'Access to Advanced Grants' in terms of the number of granted women (men) needed to access to an AdG. In this sense, we can interpret the CGI as a measurement of necessary effort calculated by the (foreseeable) number of women needed for each man who gets an AdG. For example, if for the women it is necessary to grant 6 individuals for each AdG obtained (AtAdG(w) = 6) and for men only 3 (AtAdG(m) = 3), then the glass ceiling can be established in the barrier of 2: it costs (in terms of individuals' effort) two times more than for men to achieve the same objective. In theory, the value of CGI will be strictly greater than zero (CGI>0), and because it is a quotient it can be in the range $1 \leq \text{CGI} \leq 1$. But in practice, hence calling it 'glass', it will always be greater than 1.

- To measure the annual evolution and growth in time series analyzed, the Cumulative Average Growth Rate (CAGR) was calculated, using the following equation [3]

$$\text{CAGR} = \left(\sqrt[n-1]{\frac{X_n}{X_1}} - 1\right) \cdot 100 \quad [3]$$

  Where X_1 and X_n correspond, respectively with the values that were obtained in the first and last period of the study. The formula is equivalent to that of the Compound Average Growth Rate which is frequently used in finance and like those used in other areas of the economic and social environment to measure average growth in time series (United Nations-ESCAP 2015).
- This study also analyzed the future of women's and men's presence in the number of grants applied for and granted, as well as on expert panels using the SS model. The aim was to predict composition through the end of the H2020 Programme. Such

dynamic models are based on the state of a dynamic system (or state variables), in which knowledge of the variables at time t_0 together with knowledge of the input data $t \geq t_0$ suffice to determine future values (Domínguez et al. 2006). To describe a system, different models can be used. The most usual are input/output models and state space models. Input/output model let only model the relationship between an input and output. On the other hand, state space models let to model systems with multiple input and output being more flexible to our purposes. The state variable can be understand as the 'memory function' of the system, for it summarizes all past information. In this sense, space state models are looking for a more depth description of the system because it not only characterizes the input–output relationship between two signals but the combined behaviour of all the inputs and state variables in the system, in our case the indicators inside of the system (Ogata 1995).

As applied here, the model was defined by the following equation system [4]:

$$\begin{cases} x_{k+1} = Gx_k + Hu_k \\ y_k = Cx_k \end{cases} \quad [4]$$

where x_k is the input vector (i.e. number of Submitted), y_k the output vector (i.e. Granted), and G, H and C are matrices.

For a system with two state variables and one input the transition between states in two consecutive cycles can be expressed by the following equations (Ogata 1995) [5a, b]:

$$x_1(k+1) = g_{11}x_1(k) + g_{12}x_1(k+1) + h_1u(k) \quad [5a]$$
$$x_2(k+1) = g_{21}x_1(k) + g_{22}x_1(k+1) + h_2u(k) \quad [5b]$$

Or expressed in a matrix notation [6]

$$\begin{pmatrix} x_1(k+1) \\ x_2(k+1) \end{pmatrix} = \begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{pmatrix}\begin{pmatrix} x_1(k) \\ x_2(k) \end{pmatrix} + \begin{pmatrix} h_1 \\ h_2 \end{pmatrix}u(k) \quad [6]$$

For the models calculated, a 95% confidence interval has been added with R software (R Core Team 2019) by using 'loess' method on each time series. The packages used were ggplot2 (Wickham 2016) and ggpubr (Kassambara 2018).

The data source was the ERC's Information Service and documents on the Council's website. The ERC also furnished anonymized data on applications and granted for this study. The data were processed and standardized by area, year of application, and type of grant. The ERC website data on expert panel membership, which specifies full names and surnames, were gathered and processed by area, year of application and type of grant.

The findings are reported in terms of the three dimensions considered: Gender balance in Awarded Excellence, Gender Balance in Scientific Leadership Position, and Gender Balance in Time Series Evolution.

4. Results

4.1 Gender balance in awarded excellence

4.1.1 Number of submitted s vs granted by research area

From the total of 65,778 applications submitted to the ERC in the period 2007–16 (Table 1), 7,154 were granted (10.88%). Whilst ERC Grants are not subject to priority lines of research to which candidates must adapt, applications are grouped under three major headings. Physical Sciences and Engineering (PE) accounted for 44.76% of the applications submitted, Life Sciences (LS) for 33.67%, and Social Sciences and Humanities (SH) for 21.58%.

Men signed 74.1% of the applications and were granted 77.6% of the grants whilst the figures for women were 25.9% and 22.4%, respectively. At 17%, the proportion of women applicants was lowest in PE, where they were granted 16.5% of the grants, whereas in SH 37.3% of applicants and 34.8% of granted were women. As the data show, women were under-represented in PE, which accounted for the largest number of grants, and had a greater presence in SH, the area with fewest granted (Table 1).

However, when comparing the results of submitted with those of granted, it is observed that gender differences are maintained in practice in PE, while they increase in LS (from 39.2 differential points to 53.8) and in SH (from 25.4 to 30.4).

These grants are highly competitive, as substantiated by the success rate was 10.87%. That rate varied by area and applicant researcher sex, however: it was highest in LS, with half a percentage point above the mean, and lowest in SH. By researcher sex, men exhibited a success rate of 1.98 points higher than women. The widest gap between the male and female rates was observed in LS, where the value for men was nearly 4 points higher. PE was the area where the female success rate was highest (10.66%) and closest to men's, which was just 0.38 points higher (Table 1).

In the 10 PE subareas, the success rate for female applicants ranged from 13.8% in Systems and Communication Engineering (4.09 points higher than men in this subarea) to 8.14% in Synthetic Chemistry and Materials (4.15 points lower than men in this subarea). In LS, the success rate for female applicants was systematically lower than men's in all eight subareas and lower than the overall rate for LS. The female success rate varied from 10.8% in Evolutionary, Population, and Environmental Biology to 7.7% in Immunity and Infection. SH was the area with the highest proportion of applications submitted by women, whose success rate at 9.2% was slightly lower than the 10.88% overall ERC rate. The highest rate in Social Sciences and Humanities was observed for subarea 6. The Study of the Human Past, with 11.2%, and the lowest for Individuals, Markets & Organisations, with 11.18% (Supplementary Data I).

StGs were the type of individual ERC grant with the highest percentage of applicants, 54.46%, compared to 29.49% for AdGs and 16.05% for CoGs. By number of granted, 48.14% went to researchers with post-doctoral experience of 2–7 years (StG), 18.19% to those with 7–12 years' experience (CoG), and 33.67% to those with at least 10 (AdG). That disparity in the distribution can be partly attributed to the dates when each programme was introduced, as noted in the introduction (StGs in 2007, AdGs in 2008, and CoGs not until 2013). The female was consistently lower than the male success rate for all types of grant. The highest success rate among women was 12.32%, in CoGs, and the broadest divide between the two sexes was in StGs, where men's rate was nearly 2 percentage points higher (Table 2).

The distribution by gender and type of grant graphed in Figure 1 shows that the percentage of women beneficiaries declines as the prestige of the grant rises. Women were granted 26.66% of the StGs and 27.52% of the CoGs, values that dropped by nearly half for the AdGs, to 13.62%. The resulting graph, confirmed women's under-representation in the highest category.

Table 1. Number of submitted and granted by research area and gender

Research area	No. submitted (brackets = %)			No. granted (brackets = %)			Success rate (%)		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Physical Sciences and Engineering	24,430 (83.00)	5,009 (17.00)	29,439 (44.76)	2,697 (83.50)	534 (16.50)	3,231 (45.16)	11.04	10.66	10.98
Life Sciences	15,413 (69.60)	6,733 (30.40)	22,146 (33.67)	1,939 (76.90)	583 (23.10)	2,522 (35.25)	12.58	8.65	11.39
Social Sciences and Humanities	8,896 (62.70)	5,297 (37.30)	14,193 (21.58)	914 (65.20)	487 (34, 80)	1,401 (19.58)	10.27	9.19	9.87
Total	48,739 (74.10)	17,039 (25.90)	65,778	5,550 (77.60)	1,604 (22.40)	7,154 (10.88)	11.39	9.41	10.87

Table 2. Number of submitted and granted by type of grant and gender

Type of grant	No. submitted (brackets = %)			No. granted (brackets = %)			Success rate (%)		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
StG	24,734 (69.05)	11,087 (30.95)	35,821 (54.46)	2,526 (73.34)	918 (26.66)	3,444 (48.14)	10.21	8.28	9.61
CoG	7,557 (71.58)	3,000 (28.42)	10,557 (16.05)	943 (72.48)	358 (27.52)	1,301 (18.19)	12.48	11.93	12.32
AdG	16,448 (84.78)	2,952 (15.22)	19,400 (29.49)	2,081 (86.38)	328 (13.62)	2,409 (33.67)	12.65	11.11	12.42
Total	48,739 (74.10)	17,039 (25.90)	65,778	5,550 (77.58)	1,604 (22.42)	7,154	11.39	9.41	10.88

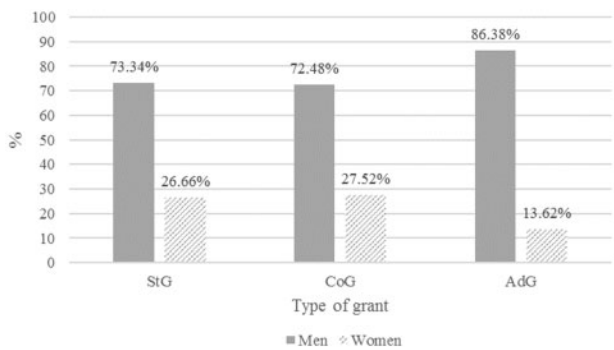

Figure 1. Distribution men and women by type of granted (StG, CoG y AdG).

The data for all three major areas into which applications to the ERC fit this tendency (see Supplementary Data II). In PE, for instance, women accounted for 21% of the StG granted and for 20% of the CoG granted, whereas just 8% of the AdGs, the grants of highest prestige, went to women. Those values are indicative of vertical segregation, with the percentage of women declining as the in the highest category of grant.

4.1.2 Gender parity index

As noted in the methodology, this index measures the proportion of women and men by area, where 1 is a value that denotes parity and values less than 1 means women's under-representation. Further to Table 3, the values for women granted, women panel members, and women panel chairs were consistently less than 1, ranging from a minimum of 19 women who are panel chairs for every 100 men chairs in PE, to 62 women who are panel members for every 100 men panel members.

4.1.3 Glass ceiling index

This index was calculated by comparing the effort that women (and men) granted an ERC-grant have made to obtain the highest prestige grant (AdG). For the full period analyzed, the GCI was 1.66, denoting the existence of an intangible glass ceiling in the ERC that stifles women's research careers and compels them to strive more than one-and-a-half times what men do. By research area, the index was highest in PE, at 2.22, followed by LS at 1.66 and SH at 1.75 (Table 4).

4.2 Gender balance in scientific leadership position

4.2.1 Number of men and women as expert panel members and panel chair by research area

In the period analyzed (2007–16), the ERC convened a total of 7,243 experts to evaluate candidacies, 71.93% of whom were men and 28.07% women. A closer analysis of women's presence on review panels identified uneven distribution by areas. The highest percentage of women was found in SH (38.1%) and the lowest in LS (18.72%). Of the 583 panel chairs appointed in the period studied, 74.1% were men and 25.9% women, two points lower than the percentage of women panel members. By area, the lowest number of female chairs was observed in PE, which at 16.06% was nearly 10 points lower than the mean. Women served as chair in 32.08% of the LS panels, the highest value and 6 points over the mean (Table 5).

4.2.2 Number of men and women as expert panel members and panel chair by type of grant

The percentage of women sitting on review panels was found to decline as the prestige of the grant rose, with 29.53% for StG panels

Table 3. GPI (granted, panel members, panel chairs) by research area

Research area	GPI_ granted	GPI_ panel member	GPI_ panel chair
Life Sciences	0.30	0.47	0.47
Physical Sciences and Engineering	0.20	0.23	0.19
Social Sciences and Humanities	0.53	0.62	0.45

Table 4. GCI by research area

Research area	GCI
Life Sciences	1.66
Physical Sciences and Engineering	2.22
Social Sciences and Humanities	1.75

and 25.19% in AdG panels. As the data in Table 6 show, women accounted for around 25.9% of panel chairs in all categories.

As can be deduced from the data in Table 6, the success rates of men and women are similar, around 8 men for every 100 members who chair the panels, as opposed to a proportion of just over 7 women. The analysis by type of scholarship shows a similar behavior in the distribution between men and women in the panels of StG and CoG, while in the Adg panel the presence of women is slightly higher than men.

4.3 Gender balance time series and future trends

This third dimension was analyzed using the CAGR and the SS model.

4.3.1 Cumulative average growth rate

The CAGR for ERC submitted declined by 2% overall and by 4.43% for LS, while for SH it rose by 3.5%. The CAGR for women was lower than for men in all areas, an indication that women applied for ERC Grants increasingly less frequently than men.

The CAGR for ERC granted show a positive growth (13.4%), with PE and SH growing at higher than the mean rate. Women had a higher CAGR than men in LS (15.33% vs 10.34%) but lower in PE (12.53% vs 14.37%) and SH (11.62% vs 18.6%). By type of grant, the CAGR for women was higher than for men in all categories, with the greatest difference in CoGs (women's 5.54% vs men's −1.7%; Table 7).

The data in Table 8 on panel experts and chairs by area and type of grant show that the number of reviewers grew in all areas, particularly in SH (up 18.22%). The CAGR for female was higher than for male membership in all research categories. The CAGR for panel chairs was lower among women only in LS (14.93% compared to 16.65%). Women's presence as panel members and chairs grew at a faster pace than men's in all three types of grant, particularly as members of AdG review panels and chairs of CoG review panels.

4.3.2. Time series evolution of applicants, granted, panel members, and panel chairs in 2020

As noted in the methodology, the SS model was applied to predict trends in ERC grant applications and granted and panel membership and chairs 4 years into the future.

4.3.2.1 Submitted and granted. Further to the State Space model for 2020, women's interest in applying for ERC Grants would grow in all areas, most prominently in SH, with the percentage of female applicants rising from 42.36% in 2007 to 57.48% in 2020. In PE, presently the area with the lowest percentage of women, the trend would not appear to reverse before 2020. In contrast, some improvement would be expected in LS, with the percentage of women applicants growing from 36.17% in 2007 to 54.18% in 2020. In terms of granted, women's share would be expected to grow most in LS, from 21.3% in 2007 to 74.18% in 2020. In this respect also, PE would be the area with poorest future performance, with the lapsing of time having no beneficial effect on the proportion of women granted ERC grants (Figure 2).

4.3.2.2 Review panel membership and chair composition by gender. Women's presence on review panels would be expected to grow substantially in LS and SH by 2020, from 26.51% to 42.24% in the former and 35.09% to 67.16%% in the latter. In PE, women's presence would again remain essentially unchanged, at around 21.15%. A similar pattern is predicted for panel chairs, with female presence rising in LS from 28% to 31.11% in 2020 and SH from 40% to 67.06% (Figure 3).

5. Discussion

This study analyzed the grant applications to the ERC in its first 10 years of operation (2007–2016), covering the gender composition of all the grants applied for (n = 65,778) and granted (n = 7,154) as well as of the review panels. These calls are the most prestigious not only in Europe, but worldwide, for they support innovative, high-risk research at the frontiers of science (Thomas and Nedeva 2012; Cuntz 2016). Since its inception in 2007, the ERC has had a substantial impact on Europe's research scenario. Its grants may be applied for by researchers anywhere in the world, provided they work at least half of the time covered by the grant in a European host institution. ERC Grants afford the greatest possible visibility to the institutions hosting research funded by the Council and position the principal investigators granted and place the institutions, regions, and countries where the project is implemented in the international limelight. ERC Grants provide funding of around €2 M over a 5-year period, a figure wholly unthinkable in national or regional calls for research projects. For that reason, many national, regional, and even institutional programmes are in place to help applicants submit their proposals to the ERC. The Council receives around 6,000 applications yearly, rigorously reviewed for scientific excellence as the sole criterion (Luukkonen 2012, 2014).

According to the present findings, scantly 10.88% of the projects submitted is awarded funding. The success rate varies, however, by type of grant (StG, CoG, and AdG) and applicant gender. At the EU-level, the funding success rate for receiving national, publicly managed research funding was higher for men than for women by 3.0 percentage points (She Figures 2018 2019). Regarding our results, women have a success rate in ERC grants of 9.41% vs

Table 5. Distribution of panel members and panel chairs: gender composition by research area

Research area	No. panel members (brackets = %)			No. panel chairs (brackets = %)		
	Men	Women	Total	Men	Women	Total
Physical Science and Engineering	1,704 (68.08)	799 (31.92)	2,503 (34.56)	183 (83.94)	35 (16.06)	218 (37.39)
Life Sciences	2,397 (81.28)	552 (18.72)	2,949 (40.72)	163 (67.92)	77 (32.08)	240 (41.17)
Social Sciences and Humanities	1,108 (61.90)	682 (38.10)	1,790 (24.71)	86 (68.80)	39 (31.20)	125 (21.44)
Total	5,210 (71.93)	2,033 (28.07)	7,243	432 (74.10)	151 (25.90)	583

Table 6. Distribution of panel members and chairs: gender composition by type of grant

Type of grant	No. panel members (brackets = %)			No. panel chairs (brackets = %)		
	Men	Women	Total	Men	Women	Total
StG	2,122 (70.47)	889 (29.53)	3,011 (41.57)	162 (73.64)	58 (26.36)	220 (37.74)
CoG	965 (69.23)	429 (30.77)	1,394 (19.25)	72 (76.60)	22 (23.40)	94 (16.12)
AdG	2,123 (74.81)	715 (25.19)	2,838 (39.18)	198 (73.61)	71 (26 .39)	269 (46.14)
Total	5,210 (71.93)	2,033 (28.07)	7,243	432 (74.10)	151 (25.90)	583

Table 7. Cumulative average growth rate (CAGR) for applications and granted by research area and type of grant

Research area	Submitted (%)		Granted (%)	
LS	Women	−5.56	Women	15.33
	Men	−3.84	Men	10.34
	Total	−4.43	Total	11.56
PE	Women	−4.71	Women	12.53
	Men	−1.85	Men	14.37
	Total	−2.40	Total	14.01
SH	Women	2.88	Women	11.62
	Men	3.95	Men	18.60
	Total	3.50	Total	15.47
Total	Women	−3.01	Women	13.09
	Men	−1.59	Men	13.62
	Total	−2	Total	13.40

Type of grant	Submitted (%)		Granted (%)	
StG	Women	−11.32	Women	4.41
	Men	−14.21	Men	2.35
	Total	−13.27	Total	2.94
CoG	Women	−15.97	Women	5.54
	Men	−13.74	Men	−1.70
	Total	−14.38	Total	0.11
AdG	Women	3.38	Women	1.83
	Men	0.94	Men	−3.12
	Total	1.31	Total	−2.46

11.39% from men. This goes in line with other research that analyzed the gender gap in process of grant getting. The success rate for the Research Councils, Innovate UK (UKRI) Grant show differences by gender and research area as have been detected in ERC Grants (Research Councils 2018). The lowest female success rate can be found in Life Science (20.6 in UKRI Grants and 8.65 in ERC Grants) and the highest is observed in Social Science and Humanities (33.4 UKRI Grants and 9.19 in ERC Grants). The unequal distribution of women and men by areas and type of grant detected here infers that the ERC is subject to situations highlighted in studies on women and science known as vertical and horizontal segregation. This study also identified other circumstances that tend to relegate women to the lower ranks of science, in this case, to the lowest category of grants. Other metaphors used in the literature and identified in this study include the 'glass *ceiling*', synonymous with the concrete wall or 'sticky floor' (Ridgeway 2001; Hosmalin 2017), and the 'leaky pipeline' (Trevino, Balkin and Gomez-Mejia 2017). Regarding gender imbalance in grant getting, Van den Besselaar and Sandström (2015) suggest that there are a several of non-academic factors, such as the gender of the candidate or quality grant getting at the early career, that have a high 'symbolic value'.

Table 8. Cumulative average growth rate (CAGR) for panel members and chairs by research area and type of grant

Research area	Panel Members (%)		Panel Chair (%)	
LS	Women	21.51	Women	14.93
	Men	15.55	Men	16.65
	Total	17.38	Total	16.18
PE	Women	17.23	Women	16.65
	Men	16.81	Men	15.53
	Total	16.90	Total	15.82
SH	Women	20.85	Women	16.65
	Men	16.57	Men	14.31
	Total	18.22	Total	15.30

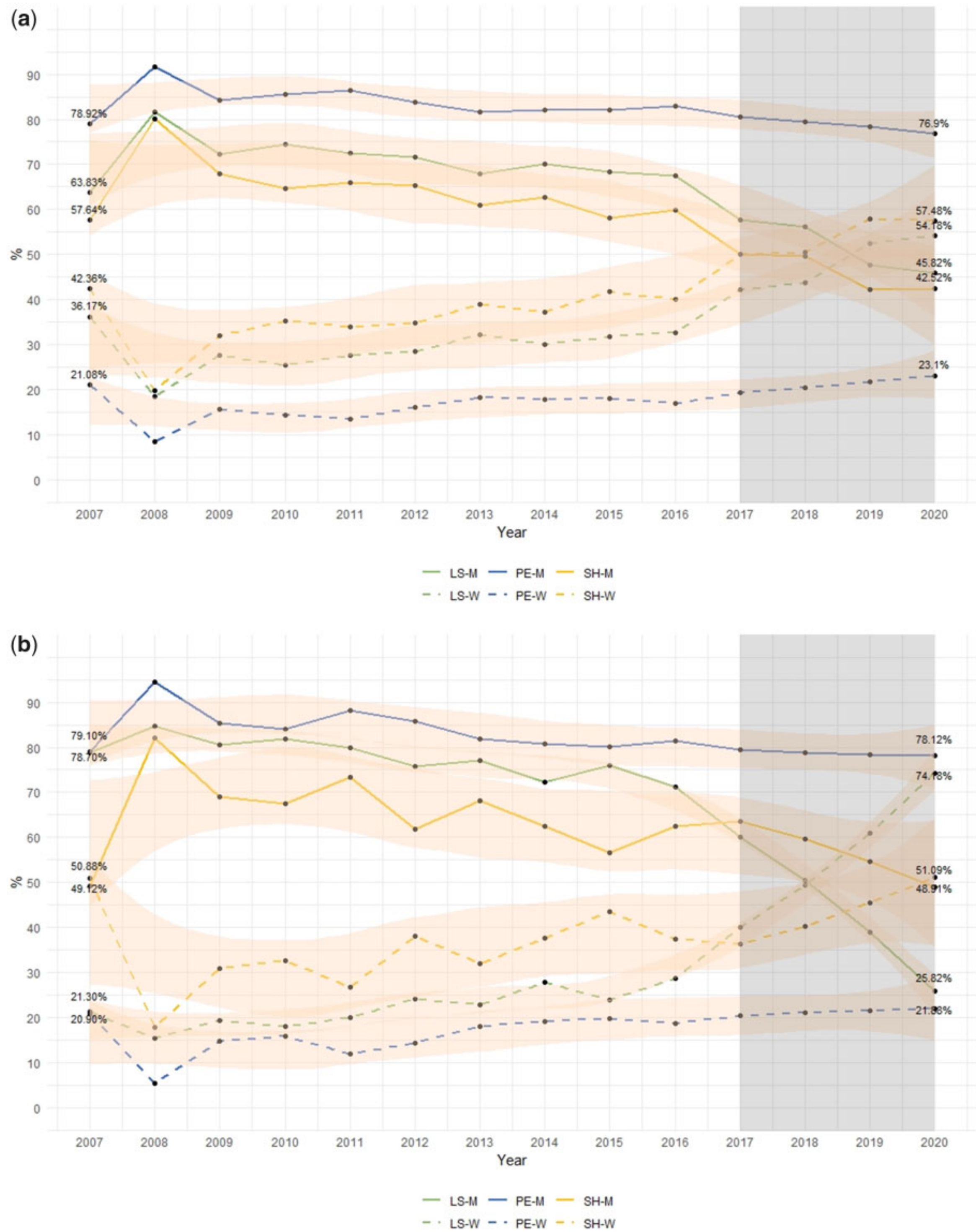

Figure 2. Gender balance time series for applicants (a) and granted (b) and predictions for 2020. (With local adjust by using method 'loess'. IC = 95%).

This have a strong impact on the applicants score, favouring men. In (Witteman et al. 2009) points that gender gaps in grant funding can be attributable to a less favourable assessment of women, not based on the quality of the project presented. However it is very difficult to obtain solid conclusion if success rate are linked with to evaluations of female researchers or their research (Head et al. 2013). Such situations have been detected despite the enormous efforts made by the ERC and its Working Group on Gender Balance to identify and remove any potential gender bias in ERC evaluation procedures. Created in 2008, the working group has formulated two equality plans (ERC Gender

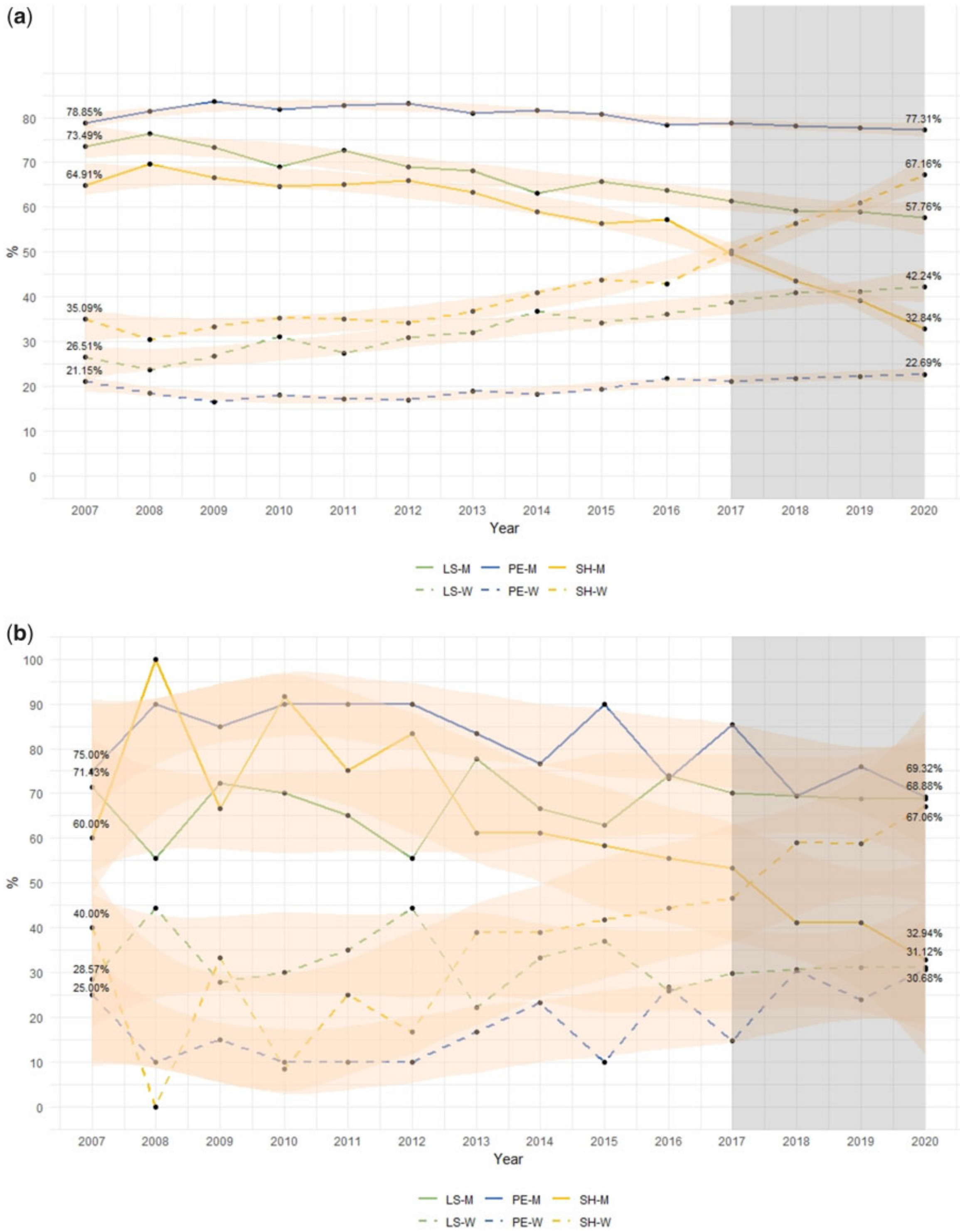

Figure 3. Gender balance time series for review panel membership (a) and chairs (b) and predictions for 2020. (With local adjust by using method 'loess'. IC = 95%).

Equality Plans 2007–2013 and 2014–2020), geared essentially to improving gender balance among ERC candidates and granted as well as among the peer reviewers on ERC expert panels. The ultimate objective is to eliminate the effects the gender funding gap may have on scientific excellence (Jayasinghe, Marsh and Bond 2001; Van der Lee and Ellemers 2015). The present findings contribute to establishing women's profile in the ERC and determining whether the Council is successfully rising to the respective challenges.

5.1 Is the gender balance improving for ERC grant applicants and granted in the various fields of research and types of grants?

Twenty-six percent of the ERC grant applications received by the ERC in the 10 years analyzed were submitted by women, compared to 74% by men. The percentage of women applying for ERC Grants is lower than the percentage of women earning doctorates in Europe (47% of the total in 2012) and of the share of women (33%) working out of universities or public research bodies in the EU-28 that same year, and below the presence of women in academic staff in Grade A and B (Full professor, Associate Professors and Senior researchers) (She Figures 2015 2016). Explaining the scant number of female applicants is no easy task. Women's recent enlistment in science is an argument often wielded to justify their paltry presence in candidacies for scholarships, prizes, and prestigious grants. Further to that reasoning, it is only a matter of time before the ratio of female to male applicants for ERC grants will level out or at least rise to the proportion of women eligible to apply.

The low rate of female applicants for ERC Grants detected in this study is consistent with earlier analyses of applicant and success rates by gender (Pohlhaus et al. 2011; Beck and Halloin 2017). Bazeley (1998) analyzed applications submitted to the Australian Research Council in 1994 in physics, engineering, psychology, history, health, and social studies. Only 11.4% of the grant applications were submitted by women, even though, as the author stressed, they accounted for 34.7% of the positions in the Australian university system that year.

Of the 7,154 investigators who benefited from ERC Grants since 2007, 22% were women and the remaining 78% men. According to the findings of this study, grants to men, with a CAGR of 13.62%, grew 0.53% faster those to women, with a CAGR of 13.09%%. Even if that difference were inverted in women's favour, it would not be until 2089 that they would earn grants in a proportion similar to their 33% presence in Europe's public research sector (in 2012). In other words, reaching that percentage would take 74 years even with a hypothetical inversion of the growth rate in women's favour. The time needed to reach that 33% varies substantially by area, however. In PE, the CAGR for women granted was 12.53% compared to 14.37% for men, for a 1.84% difference. Inverting the difference in women's favour would mean reaching a 33% share of PE grants for women by 2040, or in just 25 years.

Given the international reach of the ERC calls, the present findings support the premise that women's under-representation in Science, Technology, Engineering and Mathematics (STEM) is worldwide (Burke and Mattis 2007; Cheryan et al. 2017; Stoet and Geary 2018). The figures are likewise indicative of clear horizontal segregation by areas, with greater female presence in SH and LS, a result consistent with most of the earlier studies that analyzed that parameter (Ceci et al. 2014; Su and Rounds 2015). The area with the lowest percentages of women applicants and granted is PE, a finding likewise in step with earlier reports of scant female presence in engineering, physics, and mathematics in terms of both applications and granted (Wang and Degol 2017; Holman, Stuart-Fox and Hauser 2018). According to the SS model results, this pattern will not begin to revert before 2020, with no change predicted for women's presence in PE.

The variation in eligibility requirements for the three types of grants in terms of years of experience provided the grounds for analyzing women's presence in different stages of their careers. The data revealed the existence of vertical segregation, characterized by women's lesser presence in grants with the most demanding requisites, which may be a proxy for their position in scientific hierarchies (Wirth 2001). Vertical segregation is argued to be due to the leaky pipeline effect, i.e., women's higher rate of attrition during their scientific careers (Blickenstaff 2005), or to factors that keep them bound to positions of lesser scientific prominence, known as the '*sticky floor*' (Wirth 2002). Women's lesser presence in the upper ranks of their profession, detected in nearly all areas, disciplines and countries (Molinari et al. 2002; Alba et al. 2003; APSA 2005; Ionescu, Alexe and Petrescu 2008). The results observed in the three areas analyzed here are consistent with the two models proposed by Palomba (2000) to describe women's scientific careers in Europe. In the first, which the author calls 'overtaking', found in countries such as Belgium, Finland, France, Ireland, Italy, Spain, Sweden, and the UK, the percentage of women in the early years of their research careers is similar to the proportion of female under- or post-graduates. That model was observed here in the SH area, in terms of both applications and granted. Palomba's second model, called 'impossible pursuit', exists in countries such as Austria, Denmark, Germany, Greece, and the Netherlands. In it, the diagrams (see Fig. 1 and similar graphs in Supplementary Data II) depicts a much broader divide, in which it is nearly impossible for women to recover or even retain the numbers reached during undergraduate or doctorate studies. The impossible pursuit model was identified here in LS and PE. The segmentation inherent in that situation can be attributed to the interaction of a number of factors that favour '*glass ceiling*', obstructing women's access to scientific decision-making (Wirth 2001; Hosmalin 2017). The '*glass ceiling*' has been described as an invisible but impenetrable overhead surface that thwarts women's careers and prevents them from advancing to the highest positions (Sonnert and Holton 1995; Mueller, Wright and Girod 2017).

5.2 Has a gender balance been reached in review panel membership and chairs?

In the period analyzed (2007–2016), the ERC convened a total of 7,243 experts to evaluate candidacies, 71, 93% of whom were men and 28, 07% women. The experts sitting on review panels are appointed by a selection committee consisting of scientists, researchers and academics of international renown. They are chosen solely on the grounds of their scientific merit and do not represent specific organizations or stakeholders (Luukkonen 2012). The ERC's mission is to promote excellent, ground-breaking research by European scholars and its ultimate aim is to stimulate scientific excellence by supporting and encouraging the very best, truly creative scientists, scholars, and engineers to be adventurous and take risks in their research (European Commission 2011). The ERC's medium term gender equality objective is to establish a gender balance among the peer reviewers on all its panels, as well as among panel chairs (ERC Scientific Council gender equality plan 2014–2020).

The CAGR for women's presence on review panels overall is 19.95%, compared to 16.3% among men. These global values reflects different patterns by research area (see Table 8). If these theoretical growth rates were maintained. Women would attain 33% representation in 2 years. In contrast, it would take 12 years, or until 2028, to reach a 60:40 ratio on review panels. At the present growth rates, that ratio would be attained in Life Sciences by 2020, but not until 2261 in physics, a total of 246 years. Women's participation on review panels is higher than the percentage of women granted in all areas and for all types of grant. In other words, their presence as reviewers is greater than as granted. That fact suggests that they engage in review processes calling for very high scientific excellence that would at least qualify them to apply for the highest prestige grants, the AdGs.

The CAGR for women panel chairs is 16.1% and for men, 15.7% (for values by research area, see also Table 8). As in the case of review panel membership, these values vary by area and type of grant. In LS, the CAGR for women's position as panel chair is 14.93% and 16.7% for men, for a 1.72% difference. If that difference were inverted in women's favour, their current presence would be retained, but at that growth rate, it would never reach 33%. In LS, the CAGR for women's position as panel chair is 16.7% and 15.5% for men, for a 1.12% difference. Maintaining the present growth rate would translate into a 33% female presence in 2048, i.e., in 33 years.

6. Conclusions and future lines of research

As Thomas König (2017), notes, in the 10 years since its inception, the 'European Research Council has become the most revered instrument in European science policy and one of the world's most important focal points for the funding of scientific research'. In addition to narrating how the ERC was created and developed, König (2017) examines its achievements and future challenges. In an earlier text he posed questions around European science policy, funding and the diversity or gender quota, 'particularly in the Advanced Grant Scheme' (König 2016).

In light of the role of ERC research funding in consolidating the ERA, the system cannot afford to be plagued by situations such as those described here, which must not be allowed to pervade and even less to crystallize in its structure. That will call for more positive action to attract women and raise the number of female applicants, while at the same time committing to quality in the selection process to retain women in science. One suggestion in that vein would be for the ERC to invite many of its female reviewers to submit applications for AdGs, the type of grant where the proportion of women was found here to be smallest. The present data further infer that the measures adopted by the ERC's Working Group on Gender Balance have a more visible effect on balancing review panel membership than on gender equality among ERC grant applicants and granted.

This study attests to the utility of indicators deriving from an analysis of ERC Grants to ascertain and monitor men's and women's participation in these calls, both as granted and as panel reviewers and chairs, as well as to identify future trends. The findings show that grants are not equitably distributed, with women participating more intensely in the initial StGs than in the more prestigious AdGs in all areas, with a greater presence in social sciences than in physics and occupying a growing proportion of review panel seats but not chairs. Dissemination of the findings of studies of this nature should contribute to heightening sensitivity to the gender dimension in ERC calls. Moreover, to fund the highest quality research the ERC must guarantee the principle of equal opportunities. The situation described merits the attention of decision-makers responsible for funding these grants.

Supplementary data

Supplementary data is available at *Research Evaluation Journal* online.

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