R&D MANAGEMENT

How diversity contributes to academic research teams performance

Petra De Saá-Pérez[1], Nieves L. Díaz-Díaz[2], Inmaculada Aguiar-Díaz[3] and José Luis Ballesteros-Rodríguez[4]

[1]Facultad de Economía, Empresa y Turismo, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria 35017, Spain. pdesaa@dede.ulpgc.es
[2]Facultad de Economía, Empresa y Turismo, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria 35017, Spain. ndiaz@defc.ulpgc.es
[3]Facultad de Economía, Empresa y Turismo, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria 35017, Spain. iaguiar@defc.ulpgc.es
[4]Facultad de Economía, Empresa y Turismo, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria 35017, Spain. jballesteros@dede.ulpgc.es

The objective of this paper is to analyse how the job-related diversity in academic research teams influences their scientific performance. To achieve that objective, an empirical study of a university's research teams was carried out during the years 2006–2009. The results reflect a non-significant effect of functional diversity on research teams' performance, whereas status diversity affects in a positive and significant way. However, educational diversity has a significant negative impact when a certain threshold is exceeded. The effect of institutional diversity presents an inverted U-shaped relation with the number of published articles by the research teams. The results reveal that the relationship between diversity and research performance may not be a simple and direct one because its effect could depend on the organisational context and the type of diversity attributes.

1. Introduction

Currently, the university just like any other organisation faces important challenges. One of them is to learn to manage its own knowledge in order to improve its research capacity. The decision to promote research by fostering the integration of individual knowledge of academics in research teams becomes an important strategic question (Stvilia et al., 2011; Hinnant et al., 2012). Thus, the creation of research teams has become an important mechanism for the generation of knowledge, as they are considered to be the basic unit of the research system in many disciplines (Perianes-Rodríguez et al., 2010).

The diversity in the composition of the research team is going to determine their performance. Thus, previous papers have found that job-related diversity is one of the most important variables for team performance when the team perform complex and non-routine tasks (Chi et al., 2009). This kind of diversity refers to the heterogeneity of team members' organisational tenure, educational level and experience (Pelled, 1996; Chi et al., 2009). This diversity can increase team task-related knowledge, skills and

abilities as well as provide different perspectives and sources of information, all of which help promote knowledge generation among team members. However, despite the potential positive effect of these attributes of diversity, a greater diversity could also create conflict and distrust when communication and interaction problems arise between the team members (Østergaard et al., 2011). Along this line, Van Knippenberg and Schippers (2007), Ali et al. (2014) and Tsai et al. (2014) highlight the relevance of exploring the existence of a non-linear relationship between diversity and performance.

While recognising the strategic importance of the research teams at the university, there are still few papers focusing on analysing how the different diversity attributes can influence academic team in terms of research performance (Stvilia et al., 2011). Thus, this paper aims to analyse how the diversity in academic research teams influences on their scientific performance. More specifically, this paper considers the job-related attributes because of the value of heterogeneity among team members on this attributes is higher when it comes to creative and intellectual work like the academic research team (e.g., Webber and Donahue, 2001; Tsai et al., 2014).

Given this focus, this study offers several contributions to the extant literature by highlighting the relationship between diversity and performance in academic research teams in a university context. As Richard et al. (2003) and Tsai et al. (2014) indicate that this relationship may not be a simple and direct one because the effect of diversity on performance could depend on the organisational context in which it occurs, and also, contextual differences may result in variations in the relationship. The analysis is based on 149 teams belonging to different areas of knowledge of a university during the years 2006–2009. Second, it also considers the existence of non-linear relationship between some diversity attributes of the academic research teams and the number of scientific publications.

The paper is organised as follows. Section 2 establishes the theoretical framework and sets out the hypotheses, whereas Section 3 explains the methodological aspects. After that, the main results of the empirical analysis are summarised in Section 4. Finally, the conclusions are presented and discussed in Section 5.

2. Theoretical background and hypotheses

2.1. Research groups' performance

Organisational performance can be defined as the extent to which organisations achieve their objectives (Sousa et al., 2010). In the current context, its measurement has become a priority for all types of organisations, including the universities. Thus, '[. . .] business-related concepts such as "efficiency" and "performance measurement" have invaded the academic lexicon' (Sousa et al., 2010, p. 1440). This study focuses on scientific research groups at universities that represent a type of research unit characterised by being '[. . .] relatively autonomous in their decision-making processes' (Ryan and Hurley, 2007, p. 346). The research groups' goal is the generation of new knowledge, but it is also their main output, which can take different forms like articles, books, patents, consultancies or staff training (García-Aracil et al., 2006). Thus, researchers can be defined as knowledge workers, employed in the generation of knowledge. They '[. . .] apply their valuable knowledge and skills (developed through experience) to complex, novel and abstract problems in environments that provide rich collective knowledge and relational resources' (Swart, 2007, p. 452, as cited Harney et al., 2014, p. 2220).

Although the outputs of research groups can take different forms, universities research quality systems typically focus on publications as the most important indicator of performance because they are linked to universities' objectives (García-Aracil et al., 2006; Sousa et al., 2010). At universities, research quality systems establish the rules for what is considered adequate research output. As García-Aracil et al. (2006, p. 214) state, '[. . .] in the academic world, it can be argued that research activity only becomes "a work" when it takes on the conventional, physical form of a published paper or its equivalent'. Therefore, research performance is often measured by the publications gotten throughout the career (Sabharwal and Hu, 2013).

Publishing is a relevant dimension of scientific activity because it is considered a requirement for promotion and a way to get competitive research funds, encouraging research groups' members to obtain more publications. Moreover, publishing is considered a source of esteem for researchers because the publications are the reflection of their excellence and give peer recognition (Sabharwal and Hu, 2013; Gans et al., 2014). Thus, within the scientific community, most highly regarded researchers are those with a larger number of publications, enabling them to get positions that offer higher wages or getting higher levels of non-pecuniary benefits like research freedom (Sauermann and Roach, 2014). In addition, researchers can consider publishing as mechanism to transfer knowledge to the scientific community and the society because publications are a valuable input for follow-on

research. In this sense, they are often considered a measure of scientists' research ability and may have a higher impact on the advancement of science (Sorenson and Fleming, 2004; Sauermann and Roach, 2014).

2.2. Diversity and performance: theoretical approaches

Diversity is defined as 'the distribution of differences among the members of a unit with respect to a common attribute' (Harrison and Klein, 2007, p. 1200). The relationship between diversity and performance has been addressed from different theoretical approaches, the Similarity-attraction paradigm and the Cognitive resource diversity theory being the most accepted (Horwitz, 2005). In this vein, both perspectives must be considered in order to analyse the relationship between diversity and performance (Horwitz and Horwitz, 2007).

The Similarity-attraction paradigm is based on the idea that similarity among the members' characteristics promotes mutual attraction between team members (Byrne et al., 1986; Horwitz, 2005), which may affect cohesion and social integration of group members (O'Reilly et al., 1989). In this sense, heterogeneous teams would show signs of internal tensions and high relationship conflict, all of which adversely influence the team's productivity. By contrast, in homogeneous teams, the similarity of characteristics between individuals could promote mutual attraction, which would improve productivity (Horwitz, 2005; Van Knippenberg and Schippers, 2007).

Otherwise, the Cognitive resource diversity theory states that diversity has a positive impact on the team's performance because of the unique combination of cognitive resources that members bring to the team (Hambrick et al., 1996). Thus, when the differences between team members are discussed in terms of knowledge or skills, diversity issue is focused on aspects related to cognitive traits of individuals (Dahlin et al., 2005). These diversity aspects are closely linked with the exchange of information and feedback, helping to explain the positive impact of diversity on the team's performance (Van Knippenberg et al., 2004). Therefore, cognitive diversity may be the most relevant to analyse its effects on scientific performance, as it provides different perspectives, ideas and styles of thought required to carry out creative processes (Williams and O'Reilly, 1998). The diversity provides research team with a larger pool of knowledge resources that may be helpful in dealing with scientific problems, which requires a more creative view (Van Knippenberg and Schippers, 2007).

2.3. Diversity attributes and research team performance

As Van Dijk et al. (2012, p. 39) state '[. . .] Diversity may concern differences in demographic characteristics, such as age, gender, ethnicity; job-related characteristics, such as functional background or organizational tenure; deeper psychological characteristics, such as personality, attitudes, and values; or other attributes'. This definition allows to identify the three main types of diversity attributes: demographic, job-related and psychological.

However, most of papers addressing the relationship between diversity and performance have focused on demographic and job-related diversity (Van Dijk et al., 2012). Thus, Horwitz and Horwitz (2007) divided diversity into bio-demographic and task-related characteristics. The former refers to innate characteristics of individuals that are readily observable and categorisable (e.g., age, gender and race/ethnicity), whereas the latter refer to attributes that individuals acquire over time (e.g., functional expertise, education and organisational tenure). Most researchers agree in similar ways of categorisation of diversity, but labelling the resulting categories with slightly different names such as relations-oriented and task-oriented diversity (Joshi and Roh, 2009) or less job-related and highly job-related diversity (Pelled, 1996).

According to the Similarity-attraction paradigm, demographic attributes are immutable and are associated with processes of social categorisation (Van Knippenberg et al., 2004), which are manifested in negative attitudes towards those who are considered 'different', which can adversely affect the team's performance (Horwitz, 2005; Joshi and Roh, 2009). Nevertheless, there is a certain degree of agreement that job-related diversity attributes, compared with demographic attributes, have a greater impact on the team's performance (Pelled, 1996; Chi et al., 2009). In this sense, Horwitz and Horwitz (2007, p. 992) state '[. . .] task-related diversity, such as dissimilarity in functional expertise and education, was found to improve team performance'. Moreover, this level of agreement between researchers is greater when it is considered the influence of job-related diversity on teams that perform complex and non-routine tasks (Pelled, 1996; Webber and Donahue, 2001; Van Dijk et al., 2012). Jackson et al. (1995) also conclude that the value of heterogeneity among team members is clearest when it comes to creative and intellectual type of work. In the cases of complex tasks, the

diversity that teams need in terms of information, knowledge and perspectives will be obtained more from job-related diversity rather than from demographic diversity (Martins et al., 2012; Van Dijk et al., 2012). These authors believe that this kind of diversity, which they call cognitive diversity, is particularly important for knowledge-based tasks. Thus, it can be stated that teams' research capacity can be enhanced by the diversity of its members as it promotes the creation and application of knowledge. Therefore, according to Cognitive resource diversity theory, it is predicted that a generally positive effect of job-related diversity attributes on scientific performance of university research teams.

However, despite the potential positive effect of these attributes of diversity, it should be noted that the presence of very high levels could decrease cooperation, coordination and cohesion among team members, which in turn could reduce scientific performance (Milliken and Martins, 1996; Østergaard et al., 2011). An excess of heterogeneity could imply frequent misunderstanding, inefficient and time-consuming conflict, and ultimately result in inferior performance (Lettl et al., 2009). In this vein, Wenger (2000) considers that in order to learn, there should be a diversity of experiences and expertise among team members, but if such diversity is excessive, it can hinder interaction and learning. This is particularly critical in academic research teams where 'the degree to which members possess unique versus shared knowledge can vary depending on a science team's composition and can influence their ability to make connections to one another's ideas and perspectives' (Salazar et al., 2012, p. 536).

Therefore, there are conflicting arguments regarding the effect of diversity on team performance depending on the theory considered. Moreover, the empirical results present contradictory findings. In this sense, Van Knippenberg and Schippers (2007), Ali et al. (2014) and Tsai et al. (2014) point out that some recent papers explore the existence of a non-linear relationship between diversity and performance. Specifically, it can be assumed that there is an inverted U-shaped relationship between them. Diversity attributes that imply differences in information foster creativity and facilitate new knowledge generation, which is a key element for academic research teams. Nevertheless, when reaching high levels, diversity may produce inaccurate communication, ineffective decision-making processes and conflict in the team. Therefore, diversity has a positive effect on research team performance but '[. . .] beyond a certain point, knowledge heterogeneity may have a damaging effect on innovation due to a lack of mutual understanding across working areas, overloads in processing complexity, ambiguity in the variety of knowledge, or costs in interpersonal knowledge coordination' (Tsai et al., 2014). When there are high levels of diversity, '[. . .] lack of a common frame of reference may get in the way of fully appreciating all group members' contributions' (Van Knippenberg and Schippers, 2007, p. 532).

Nevertheless, it is necessary to identify which attributes will be considered (Harrison and Klein, 2007) because as Webber and Donahue (2001, p. 142) point out '[. . .] diversity attributes may operate differently to impact work group outcomes'. In this study, the focus will be on job-related attributes, which have been less studied than demographic attributes (Martins et al., 2012) and that 'tends to be associated with differences in knowledge and perspectives gained through formal education, training, or functional role-related experience' (Van Dijk et al., 2012, p. 40). Following Horwitz (2005) and Joshi and Roh (2009), in the following sections, the arguments and specific hypotheses for functional, status, educational and institutional attributes will be presented.

2.3.1. Functional diversity

Functional diversity reflects the different perspectives, abilities and experiences developed by the team members during their professional career (Bell et al., 2011). The greater the functional diversity of a team, the easier to distribute the different roles between team members, which means better information and understanding of the tasks to be carried out. Teams made up of members with diverse professional experience, who have more perspectives and abilities than the homogenous teams, should obtain better performance. This is because the greater diversity, the better the allocation of functions between team members (Bell et al., 2011). Therefore, functional diversity influences the distribution of tasks and the use of work methods, all of which have a positive effect on the team's performance (Bell et al., 2011). On the basis of these considerations, the following hypothesis is proposed:

H1: *There is a positive relationship between functional diversity of academic research teams and their scientific performances.*

2.3.2. Status diversity

Different levels of academic status or seniority achieved by the research team members may also influence the dynamics and team performance. 'Seniority of individual team members is generally conceptualised in terms of the social-hierarchical status

of an individual within a broader external group or social network' (Stvilia et al., 2011, p. 273). Seniority is an important characteristic of the research teams' members because it can influence the production of knowledge. According to Hinnant et al. (2012, p. 250) '[. . .] the role of seniority within many academic disciplines is thought to translate into higher levels of research productivity and, ultimately, a greater level of impact of the research outcomes themselves'. Therefore, status diversity is a distinctive feature of the more solid and integrated teams, in which there is a high level of communication and interaction among all the members (Martín-Sempere et al., 2008; Stvilia et al., 2011). This could be due to a strategy within the team aimed at encouraging the learning process and academic consolidation of younger scientists (Bozeman and Corley, 2004). Along the basis of these considerations, the following hypothesis is proposed:

H2: *There is a positive relationship between status diversity of academic research teams and their performances.*

2.3.3. Educational diversity

The greater the educational diversity of the research team members, the greater the probabilities that the team can generate new ideas, which let them develop their scientific performance (Wenger, 2000; Østergaard et al., 2011). Greater educational diversity will create a broader base of knowledge on which to determine how to work (Bell et al., 2011). When the performance criteria are creativity and innovation, a high educational diversity can contribute to their achievement, although that creativity process will need to converge first before it is implemented. However, this convergence may take so much time that it reduces efficiency and therefore make such diversity not as beneficial (Bell et al., 2011). In this sense, Dahlin et al. (2005) found that increasing educational diversity has a positive effect on the range and depth of information used for the teams except in the most diverse teams. Along these lines, Østergaard et al. (2011, p. 503) state that '[. . .] educational diversity will enhance the information use, while too much diversity will reduce the ability to diffuse the information between employees', increasing the costs of coordination and communication.

In the case of academic research teams, '[. . .] disciplinary differences in training, education, tools, approaches, and conceptual frameworks among team members are also sources of heterogeneity. Rigid adherence to these discipline-specific ways of conducting science can limit the ability of team members to recognise the value of alternative approaches [. . .] and inhibit the willingness to integrate knowledge' (Salazar et al., 2012, p. 531). Based on these considerations, the following hypothesis is proposed:

H3: *There is an inverted U-shaped relationship between educational diversity of academic research teams and their performances.*

2.3.4. Institutional diversity

Collaboration has an important role in acquiring and transferring knowledge among academics (Bozeman and Corley, 2004). As Ynalvez and Shrum (2011, p. 205) point out, '[. . .] scientific collaboration is a form of interaction among producers of knowledge, allowing effective communication and exchange; sharing of skills, competencies and resources; working, generating and reporting findings together'. For example, Stvilia et al. (2011) found that more interdisciplinary groups perform better than other teams. Some authors argue that collaboration and outcomes of research activity may be associated with physical and social proximity between researchers. According to Hoegl and Proserpio (2004), physical proximity creates the possibility of finding collaborating partners in research as it encourages communication, coordination, mutual support, effort and unity.

Although, institutional diversity between multi-university researchers may contribute to the exchange of information, the creation of knowledge and may have potential benefits based on a greater scientific congruency, it can also create cultural conflict that reduces communication and coordination (Stvilia et al., 2011; Hinnant et al., 2012). Those problems, in turn, can lead to reduced research outcomes. In this sense, Cummings and Kiesler (2005) found that teams with more members from different universities had more problems of coordination and less performance. Moreover, this type of job-related diversity can distract time and effort to overcome differences regarding how the research process should be developed due to the different underlying institutional norms that may exist (Cummings et al., 2013). Based on these considerations, the following hypothesis is proposed:

H4: *There is an inverted U-shaped relationship between institutional diversity of academic research teams and their performances.*

3. Methodology

3.1. Sample

In order to analyse the effect of academic research teams' diversity on their performance, an empirical

study was carried out using as sample the existing groups in a Spanish University during the years 2006–2009. In Spain, in article 40.2 of the Organic Law of Universities of 24 December 2001, research groups are mentioned as being the basic units for undertaking research. Thus, the research groups are taken as a community of researchers who work together in the approach and development of research activities.

The annual reports published by the university were the source of information used for the empirical study. For the period between 2006 and 2009, the number of groups for each year was 149, 152, 160 and 156. Specifically, the number of observations reached 617 in the period. This upward trend reflects the new creation of groups over the period of analysis. In each of the years of the period studied, the sum of groups' members made a total of 1,279, 1,331, 1,401 and 1,479 researchers. The research groups at this Spanish University are characterised for being made up of 71.56% PhD, 61.14% of researchers are men, 82.87 of the members of the teams are teaching staff, 53.35% of researchers are public servants and the groups have 4.93% of researchers from other universities. These groups belong to different knowledge areas: humanities (an average of 34 groups); social science (49); experimental (51); technological (23) and health science (36).

3.2. Variables

3.2.1. Dependent variable

3.2.1.1. Scientific performance. It is measured by the number of published articles per research team each year of the study period (e.g., Stvilia et al., 2011; Cummings et al., 2013). In order to analyse differences in the effect of the explanatory variables in terms of the scope of the publication, another two dependent variables that reflect scientific performance at a national and international level were set (e.g., Bonaccorsi and Daraiao, 2003; Ynalvez and Shrum, 2011). In the Spanish context, publications in international journals is relevant for promotion as their standard is perceived to be more rigorous, but publications in local journals is considered more useful for national development.

3.2.2. Explanatory variables

The explanatory variables are the job-related diversity attributes of research teams. Specifically, functional, educational, institutional and status diversity have been considered. In this study, as all the variables are categorical in nature, the Shannon–Weaver entropy index is used to measure the variables (Østergaard et al., 2011). This index is calculated using the following equation:

$$Diversity = \sum_{i=1}^{n} p_i \left(\ln \frac{1}{p_i} \right)$$

where p_i is the probability of each category of the variable. A higher value of the index reflects a greater diversity because diversity increases as the number of members belonging to different categories increases. Diversity attribute is null when in relation with one specific characteristic, all team members belong to the same category.

3.2.2.1. Functional diversity. Functional diversity is measured by the entropy index over the percentage of teaching and non-teaching staff (e.g., laboratory technicians, support staff, etc.) in each team every year.

3.2.2.2. Status diversity. Status diversity is measured by the entropy index based on the percentage of public servants research team members and non-public servants in each team every year.

3.2.2.3. Educational diversity. Educational diversity is measured by the entropy index based on the percentage of members holding and not holding a PhD in each team every year.

3.2.2.4. Institutional diversity. Institutional diversity is measured by the entropy index based on the percentage of researchers from this university and from other universities in each team every year.

3.2.3. Control variables

The literature review and the consideration of the study context suggest the need to control for several variables in order to establish the robustness of the results.

3.2.3.1. Team size. The size of the team is measured including the number of team members every year.

3.2.3.2. Team size tendency. The tendency of the research team size is considered through two dummy variables. The first one takes the value of 1 if the number of a team members increases from 1 year to the next, and 0 if otherwise. The second one takes value 1 if the number of a team member decreases from 1 year to the next, and 0 if otherwise.

3.2.3.3. Gender diversity. Gender diversity is measured by the entropy index over the percentage of women and men in each research team every year.

3.2.3.4. Research institute or centre. This variable takes the value of 1 if the team belongs to a research institute or centre, and 0 if otherwise.

3.2.3.5. Knowledge area. The area of knowledge, which the research teams are linked to, is considered through four dummy variables, which takes a value of 1 if the team belongs to a specific knowledge area: social sciences area, humanities area, experimental area, technological area and health science area.

3.2.3.6. Year. Dummy variables will be included in the models for the study period of 2006–2009.

Descriptions of all the variables are summarised in Appendix A.

3.3. Econometric specification

The hypotheses regarding the relationship between job-related diversity of academic research groups and their performance are tested by specifying the following econometric model:

$$\begin{aligned} Performance_i = {} & \beta_0 + \beta_1 Func\_diver_i \\ & + \beta_2 Educational\_diver_i + \beta_3 Educational\_diver_i^2 \\ & + \beta_4 Status\_diver_i + \beta_5 Institutional\_diver \\ & + \beta_6 Institutional\_diver_i^2 + \beta_7 Teamsize_i \\ & + \beta_8 Teamsize_i^2 + \beta_9 Teamsizeincrease_i \\ & + \beta_{10} Teamsizedecrease_i + \beta_{11} Gender\_diver_i \\ & + \beta_{12} Institute/Centre_i \\ & + \beta_{13-15} knowledgeArea_i + \varepsilon_i \end{aligned}$$

$$i = 1, \ldots\ldots 617$$

Because the dependent variable is a non-negative, integer count variable, a negative binomial model is estimated. For such data, count models provide an econometric improvement over the classical linear (ordinary least squares) regression models because this type of data violates one of the main assumptions of the classical linear regression model. The analysis of the dependent variable reveals the existence of teams that do not present publications, which means over-dispersion. Therefore, a negative binomial model is estimated, and the Lagrange multiplier test of over-dispersion was conducted to test this assumption. The results revealed that a negative binomial model provides a significantly better fit than the Poisson model. Moreover, cluster-robust standard errors by the team were considered.

4. Results

4.1. Descriptive statistics

This section summarises the results of the descriptive analysis. Table 1 shows that the average number of articles published by the research groups in the years 2006–2009 is 3.95, being the mean for international publications (2.13) slightly above than the national publications (1.82). In both cases, slight dispersion is detected, partly due to the existence of research teams without publications in those years.

With respect to diversity, the range of these variables is from 0 to 0.69, which indicates that in all the analysed attributes, there are research groups that have no diversity and also groups with great heterogeneity for the different job-related attributes considered. As shown in Table 1, on average, the greatest team diversity is related to the researchers' status that makes it up with a 0.56, followed by educational diversity (0.45). Third, functional (0.31) and finally institutional diversity has the lowest value (0.12). In all diversity variables, a slight dispersion is observed.

Regarding the control variables, the number of team members ranges from 3 to 57, with an average of 8.89. In 28.84% of the research teams, there was an increase in their membership, whereas in 15.07% of them, there is a reduction in the number of researchers during the study period. In addition, the data show that 15.72% of these research teams are linked to a research institute or centre. Finally, knowledge area distribution reflects predominance in the experimental and social science areas, where each one of them includes more than 30% of the research teams in this university. Of the teams, 23.66% belongs to the area of health science, followed by 21.88% belonging to humanities. Finally, there is the technological area, whose research teams represent 14.75% of the total in the period 2006–2009.

Table 2 presents the correlation matrix where significant correlations are observed between the variables of research groups' diversity and their performances. Specifically, there is a positive and significant correlation between functional and status diversity with the number of articles published by the research teams. Regarding the explanatory variables, there are no multi-collinearity problems as the Variance Inflation Factor (VIF) values (not reported) are less than five in all cases.

Table 1. Descriptive statistics (2006–2009)

	Mean	SD	Median	Minimum	Maximum
Number of articles	3.95	5.47	1	0	63
Number of national articles	1.82	3.24	0	0	28
Number of international articles	2.13	3.67	0	0	42
Functional diversity	0.31	0.28	0.37	0	0.69
Educational diversity	0.45	0.26	0.58	0	0.69
Status diversity	0.56	0.18	0.63	0	0.69
Institutional diversity	0.12	0.20	0	0	0.69
Team size	8.89	5.50	7	3	57
Team size increase	28.84	45.34	0	0	1
Team size decrease	15.07	35.80	0	0	1
Gender diversity	0.50	0.22	0.59	0	0.69
Research institute or centre	15.72	36.42	0	0	1
Social sciences area	31.44	46.46	0	0	1
Humanities area	21.88	41.37	0	0	1
Experimental area	33.38	47.19	0	0	1
Technological area	14.75	35.48	0	0	1
Health sciences area	23.66	42.53	0	0	1

4.2. Diversity and performance in academic research teams

Table 3 shows the results of the estimated econometric models. Model I analyses the effect of research groups' diversity on their number of publications, whereas models II and III do the same analyses considering the national or international character of their publications, respectively.

The results of model I show that the influence of functional diversity on research teams' performance is non-statistically significant; therefore, H1 cannot be supported. With regard to status diversity, it affects in a positive and significant way on the performance of research teams (model I), supporting H2. However, the effect of educational diversity is statistically significant and negative from a certain level of this attribute on. The threshold is an educational diversity level of 0.12. Consequently, research team's performance is reduced when its educational diversity is increased over that level. These results allow to partially accept H3. Finally, the effect of institutional diversity is in line with the H4 that establishes an inverted U-shaped relationship between this diversity attribute and the number of published articles by academic research teams. Thus, greater institutional diversity is positive up until a certain level, from there the relationship reverses, resulting unfavourably for the team's performance. In particular, the threshold of this relationship is at a diversity level of 0.21.

In order to analyse whether the academic research teams' diversity has the same impact on the national or international publications, models II and III were estimated. The results for the model of national articles (model II) are similar to the model including all the publications. However, the results of the model estimated for the international articles (model III) present one difference. There is a positive effect of functional diversity on publishing more international articles as proposed in the theoretical arguments.

Therefore, job-related diversity in the academic research teams increases their performance (e.g., status), although in some case, this effect is found up to a certain level (e.g., institutional). Diversity also has a negative effect on the team's performance about a certain level (educational and institutional attributes).

With respect to control variables, the results show that the research team size has a non-linear (U-inverted) relation with the publication of articles. The increase of team size favours performance to a certain level; from there on, an increase in the number of researchers decrease performance. The results also show that the growing tendency in the team's size has a positive effect on publications. The declining tendency in the team's size is positive and significant only in the case of international articles. Gender diversity has a positive effect on the number of scientific publications, although loses its statistical significance when the international publications are considered. In another vein, belonging to an institute or research centre is not significant in

Table 2. Correlations matrix

Variables	Correlations															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Number of articles	1															
2. Number of national articles	0.75†	1														
3. Number of international articles	0.81†	0.24†	1													
4. Functional diversity	0.17†	0.06	0.20†	1												
5. Gender diversity	0.15†	0.17†	0.08**	0.22†	1											
6. Educational diversity	–0.00	–0.01	0.00	0.45†	0.10†	1										
7. Status diversity	0.16†	0.14†	0.11*	0.30†	0.09**	0.26†	1									
8. Institutional diversity	0.04	0.06	0.00	0.11*	0.02	0.12*	0.04	1								
9. Team size	0.31†	0.15†	0.33†	0.37†	0.16†	0.33†	0.21†	0.21†	1							
10. Team size increase	0.12*	0.07	0.11*	0.17†	0.04	0.16†	0.08**	0.13†	0.23†	1						
11. Team size decrease	0.03	0.02	0.03	0.04	–0.00	0.04	0.03	0.07	0.06	–0.26†	1					
12. Research institute or centre	0.02	–0.14†	0.16†	0.07	–0.05	0.03	0.01	–0.07	0.07	0.05	–0.08**	1				
13. Humanities area	–0.04	0.08	–0.14†	0.03	0.07	0.10**	0.03	0.23†	0.07	0.08**	–0.00	–0.21†	1			
14. Social sciences area	0.02	0.12*	–0.07	–0.18†	0.16†	–0.09**	0.02	–0.02	0.00	–0.01	0.02	–0.29†	–0.04	1		
15. Technological area	–0.08**	–0.09**	–0.04	–0.00	0.19†	0.21†	0.14†	–0.07	0.09*	0.03	0.00	0.20†	–0.07	–0.28†	1	
16. Experimental area	–0.10*	–0.21†	0.02	0.06	–0.07	–0.00	–0.14†	–0.05	–0.04	0.00	0.00	0.26†	–0.29†	–0.36†	–0.06	1

*$P < 0.01$; **$P < 0.05$; †$P < 0.001$.

Table 3. Diversity and productivity of research teams of a Spanish University (2006–2009)

Dependent variables	Model I		Model II		Model III	
	Number of articles		Number of national articles		Number of international articles	
	β	SE	β	SE	β	SE
Functional diversity	0.3881	(0.2766)	0.1050	(0.3598)	0.7578**	(0.3187)
Status diversity	1.0498***	(0.3405)	1.3035***	(0.5135)	0.7539*	(0.3943)
Educational diversity	0.6443	(0.8610)	1.0702	(1.2348)	0.2400	(1.0100)
Educational diversity 2	–2.6826**	(1.2316)	–3.1571*	(1.7850)	–2.6016*	(1.4507)
Institutional diversity	2.7480***	(1.0773)	2.5705*	(1.5189)	2.9164**	(1.2454)
Institutional diversity 2	–6.4071***	(1.9543)	–5.2877*	(2.7890)	–7.1931***	(2.2460)
Team size	0.1246***	(0.0284)	0.1225**	(0.0514)	0.1625***	(0.0300)
Team size 2	–0.0017***	(0.0005)	–0.0024*	(0.0013)	–0.0022***	(0.0005)
Team size increase	0.2749***	(0.0958)	0.2612*	(0.1341)	0.3312***	(0.1277)
Team size decrease	–0.0939	(0.1100)	–0.0410	(0.1617)	0.2618**	(0.1322)
Gender diversity	0.7264**	(0.3211)	1.4794***	(0.5406)	0.0866	(0.3484)
Research institute/centre	0.2315	(0.1672)	–0.6131**	(0.2786)	0.5730***	(0.1792)
Humanities area	–0.1708	(0.1546)	0.0662	(0.2177)	–0.5999***	(0.2013)
Experimental area	–0.3928**	(0.1748)	–0.7592***	(0.2700)	–0.1630	(0.1798)
Technological area	–0.2734	(0.2037)	–0.0837	(0.3200)	–0.4028*	(0.2086)
Health science area	–0.1961	(0.1822)	0.0193	(0.2415)	–0.4501**	(0.2186)
Year 2007	0.0006	(0.0958)	–0.0747	(0.1445)	–0.1026	(0.1194)
Year 2008	–0.0992	(0.0920)	–0.2012	(0.1512)	–0.1558	(0.1198)
Year 2009	–0.0102	(0.1144)	–0.2260	(0.1699)	0.0051	(0.1314)
Intercept	–0.1765	(0.2900)	–1.2648**	(0.5198)	–0.5831**	(0.2936)
Wald statistic	159.15***		141.77***		156.45***	
Log likelihood	–1,430.31		–1,077.2746		–1,016.70	
N° of observations	617		617		617	

*$P < 0.10$, **$P < 0.05$, ***$P < 0.01$.
Robust standard error in parentheses. The models are estimated using negative binomial models. The models have been estimated with STATA 11.
SE, standard error.

model I; this could be due to different signs in the case of national articles (negative) and international (positive). Finally, the areas of knowledge do not result significantly in model I with the exception of the experimental areas, which present a negative effect in relation to the health science area (omitted). The results show a smaller performance in humanities and technology areas in relation to health, when the international publications are analysed.

To analyse the robustness of the results, two additional analyses that consider other methods of estimation were carried out. First, model I is estimated with clusters at group and year level (Petersen, 2009; Thompson, 2011). Second, in order to control for unobservable heterogeneity, model I is also estimated, implementing a negative binomial panel model. The results of model IV as well as those of model V do not differ from those obtained for model I (see Table 4). The effect of functional diversity on research teams' performance is non-statistically significant, whereas status diversity affects in a positive and significant way. Moreover, the effect of educational diversity is statistically significant and negative from a certain level of this attribute on. Finally, institutional diversity presents an inverted U-shaped relation with the number of published articles by academic research teams. These analyses provide important robustness to the results.

5. Conclusions

This paper has sought to deepen the study of academic research teams and their performances within

Table 4. Robustness analysis: diversity and productivity of research teams (2006–2009)

	Model IV		Model V	
	Number of articles		Number of articles	
	β	SE	β	SE
Functional diversity	0.7379	(1.2854)	0.2297	(0.2493)
Status diversity	2.3470**	(1.1536)	0.5917*	(0.3606)
Educational diversity	4.3265	(3.7495)	0.5258	(0.7376)
Educational diversity 2	–12.4177**	(5.1738)	–2.2471**	(1.0782)
Institutional diversity	15.242**	(6.2702)	1.9132**	(0.8781)
Institutional diversity 2	–32.0107***	(10.5080)	–5.0611***	(1.7686)
Team size	0.5573***	(0.1754)	0.1056***	(0.0256)
Team size 2	–0.0072*	(0.0040)	–0.0012**	(0.0005)
Team size increase	0.8492**	(0.3356)	0.1630**	(0.0809)
Team size decrease	0.6931	(0.8881)	0.0688	(0.1003)
Gender diversity	1.4177	(1.0088)	0.4960*	(0.2868)
Research Institute/Centre	0.4187	(0.4789)	0.2742*	(0.1672)
Humanities area	–1.5461**	(0.7396)	0.2733*	(0.1686)
Experimental area	–1.7704**	(0.7453)	–0.1568	(0.1581)
Technological area	–1.6421**	(0.6541)	–0.2215	(0.1913)
Health Science area	–0.9774	(0.7498)	0.0251	(0.1619)
Intercept	0.0398	(1.1348)	0.2573	(0.3376)
Wald statistic	10.42***		99.34***	
Log likelihood			–1,365.2591	
N° of observations	617		617	

*$P < 0.10$, **$P < 0.05$, ***$P < 0.01$.
Robust standard error in parentheses. The model IV has been estimated with clusters at group and year level, whereas model V has been estimated using a negative binomial panel model. The models have been estimated with STATA 11.
SE, standard error.

the university. To this end, how the job-related diversity can influence their scientific performance has been analysed. The results show that some task-related attributes of the research teams affect their number of publications in a linear way and other in a non-linear one.

The results show a non-significant influence of functional diversity on academic research performance. As Bell et al. (2011) highlight, previous works have found that this attribute of diversity has low significance. However, functional diversity is important for the international publications, which suggest that to count on non-teaching staff within the teams, such as research assistants, technicians, etc., becomes essential to publish abroad and facilitates the distribution of tasks and working methods within the team (Bell et al., 2011). Results also reflect that when there is high-status diversity in the research teams, that is, a greater disparity of consolidated and non-consolidated members, this has positive effects on the number of publications obtained both at national and international levels. This is due to the intention of the team to mentor and train the young scientists, through the exchange of ideas and knowledge among the less and more experienced members (Bozeman and Corley, 2004), thus permitting the creation and development of new knowledge that materialises into scientific publications.

The results also reveal that educational diversity does not seem to affect the teams' performance up to a certain point. However, above that level, more diversity can reduce the number of publications. Similarly, Dahlin et al. (2005) find a non-linear relationship (U-shaped) between educational diversity and the range and depth of information used for the teams. This can be explained by the coordination and communication problems that hinder the diffusion of information between research team members (Dahlin et al., 2005; Østergaard et al., 2011).

Finally, in relation with institutional diversity, the inclusion of external researchers to the university appears to have both positive and negative effects on

the research teams' performance. On one hand, it contributes to the exchange of information and the creation of knowledge, but on the other hand, it also creates cultural conflicts that reduce communication and coordination as diversity increases (Bozeman and Corley, 2004; Cummings and Kiesler, 2005; Cummings et al., 2013). These results are in line with previous papers that propose to consider the existence of a non-linear relationship between diversity and performance (Van Knippenberg and Schippers, 2007; Ali et al., 2014; Tsai et al., 2014). Although the non-linear relationships between diversity and performance require more empirical research, the results of this paper stand in line with findings of research done in Western culture context (Tsai et al., 2014). Nevertheless, these results could stand in contrast with findings of similar research contextualised in Eastern culture (e.g., Tsai et al., 2014). These authors point out that in a more individualist culture (such as many Western contexts), team members may focus on their own contribution to the common goal, resulting in a different relationship between job-attributes diversity and team performance.

To summarise, it seems that a balance is needed between the positive effects that a more diverse composition of the academic research team members may have on performance and the negative effect that it can cause. Diversity can encourage exchange of information, intellectual debate and knowledge creation; nevertheless, it can also produce communication and coordination problems among team members. Too much disparity can lead to the breaking up of the team when the members stop communicating and collaborating or even block the effort of the others (Østergaard et al., 2011; Stvilia et al., 2011), whereas excessive homogeneity can limit the access to other resources and leaves the team at a standstill by not generating new ideas and knowledge (Stvilia et al., 2011). Therefore, in order for the teams' members to interact to create, discuss, modify and apply new ideas to increase their level of publications, they must understand the mixed effects of diversity on their scientific performance (Østergaard et al., 2011; Salazar et al., 2012) as well as recognise the team processes that explain knowledge sharing (Van Knippenberg et al., 2004; Van Dijk et al., 2012).

This paper contributes to the field in several ways. First, it makes an important contribution to previous literature because it considers that different types of job-related diversity have different effects on research team performance, given evidences to a relationship that according to Van Dijk and Van Engen (2013, p. 224) '[. . .] appears to be ambiguous and, hence, not easy to disentangle'. Moreover, previous papers predominantly suggest positive linear relationships between team diversity and their performance. However, according to the suggestions of Webber and Donahue (2001), Van Knippenberg and Schippers (2007) and Ali et al. (2014), to deepen the analysis of a non-linear relationship, this study has revealed the existence of non-linear (inverted U-shaped) relationship between some diversity attributes of the academic research teams and their performances. As Van Knippenberg and Schippers (2007, p. 532) highlight, 'The evidence for curvilinear effects of diversity thus is far from straightforward'. Second, while there is a host of studies pertaining to team diversity, such papers have typically focused on top management teams or on firms' employees, being scarce in studies highlighting the relationship between diversity and performance in academic research teams. This paper focuses on scientific research teams in the context of a university. The relationship between diversity and performance may not be a simple and direct one because that effect could depend on the organisational context in which it is place (e.g., Richard et al., 2003). As Webber and Donahue (2001) argue, the type of team may affect the relationship between diversity and performance because '[c]ontextual differences may result in differences in contingent effects between diversity and innovative outcomes' (Tsai et al., 2014). It is necessary to consider the type of team as an important contingent variable that could explain the inconclusive results of previous studies (Webber and Donahue, 2001). Third, most previous papers that analyse the effect of diversity on team performance have mainly been conducted in the US context (Chi et al., 2009). Therefore, this study extends the empirical findings of that relationship into a different cultural setting and a different type of organisation. Thus, the analysis is based on the 149 research teams belonging to different areas of knowledge of a university during the years 2006–2009, which enabled to extend the analysis to a larger sample.

This work has important practical implications as it may help the academic research teams to determine what their optimum composition should be in order to improve their scientific performance. Because job-related attributes have a direct influence on performance, such aspect should be among the most important factors when deciding whether it is appropriate to include a new member in the research team.

However, the results should be interpreted with caution as they reflect the reality of a Spanish University. Thus, it would be interesting to replicate the study in other university contexts in order to verify the consistencies of the findings made and their possible extrapolation. As Tsai et al. (2014) point out, the relationship between diversity and performance could

be affected by cultural aspect of the study context. Although there are some studies that have analysed these relationships within a business context, further studies would be necessary to analyse these relationships in the context of other organisations (e.g., universities) and in other cultures.

Furthermore, in this study, the number of publications has been used as a dependent variable, but it realises that this measure represents only one facet of scientific performance so that in future researches, it will try to improve this measure with other quantitative and qualitative indicators (e.g., citations or impact factor). Moreover, further research related to the internal dynamics of teams as well as the history of intergroup relations such as the pattern of conflict and communications, the motivation of member for joining the teams, and so on, should be considered.

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Petra de Saá-Pérez is a Professor of Organizational Behaviour and Managerial Skills at the University of Las Palmas de Gran Canaria (Spain). She received her PhD in Management from this university in 1999, and her areas of academic interest include the strategic management of human resources and their influence on organisational capabilities development. She is the author of several publications, including books, book chapters and papers in journals.

Nieves L. Díaz-Díaz is an Associate Professor of Finance at the University of Las Palmas de Gran Canaria (Spain). She holds a PhD in Business

Administration in 2003 from the same university. Her research interests concern knowledge management, innovation, corporate finance and ownership structure. She is the author of several publications, including books, book chapters and papers in journals.

Inmaculada Aguiar-Diaz is an Associate Professor of Finance, Coordinator of the Master in Banking and Finance and Director of the 'la Caixa Chair of Banking and Finance Studies at Las Palmas de Gran Canaria University' (Spain). She received her PhD in Business Administration in 1987. Her research includes two big lines: the first is related to corporate finance and the second is about knowledge management and firm innovation.

José Luis Ballesteros-Rodríguez is an Associate Professor of Organization at the University of Las Palmas de Gran Canaria (Spain). He holds a PhD in Business Administration in 2008 from the same university. His research interests include tourism management, knowledge management and human resources. He has a specific interest in individual and organisational effects on scientific research performance.

Appendix A. Definition of variables

Variable		Description
Dependent Variable		
Performance	N° of articles	Number of published articles per research team every year of the study period.
	N° of national articles	Number of national published articles per research team every year of the study period.
	N° of international articles	Number of international published articles per research team every year of the study period.
Independent variables		
Functional diversity		The entropy index over the percentage of teaching and non-teaching staff in each team every year.
Status diversity		The entropy index based on the percentage of existing public servants and non-public servants in each team every year
Educational diversity		The entropy index based on the percentage of members holding and not holding a Ph.D. in each team every year.
Institutional diversity		The entropy index based on the percentage of researchers from this university and from other universities in each team every year.
Control variables		
Team size		Number of team members every year.
Team size increase		Dichotomous variable that takes the value of 1 if the number of members of a team increases from one year to the next and 0 otherwise.
Team size decrease		Dichotomous variable that takes the value of 1 if the number of members of a team decreases from one year to the next and 0 otherwise.
Gender diversity		The entropy index over the percentage of women and men in each research team every year.
Research Institute or Centre		Takes the value of 1 if the team belongs to a research institute or centre and 0 otherwise.
Knowledge area		Social Sciences area: Takes a value of 1 if the team belongs to social science area.
		Humanities area: Takes a value of 1 if the team belongs to humanities area.
		Experimental area: Takes a value of 1 if the team belongs to experimental area.
		Technological area: Takes a value of 1 if the team belongs to technological area.
		Health Sciences area: Takes a value of 1 if the team belongs to health science area.
Year		Dummy variables for the study period: 2006–2009