

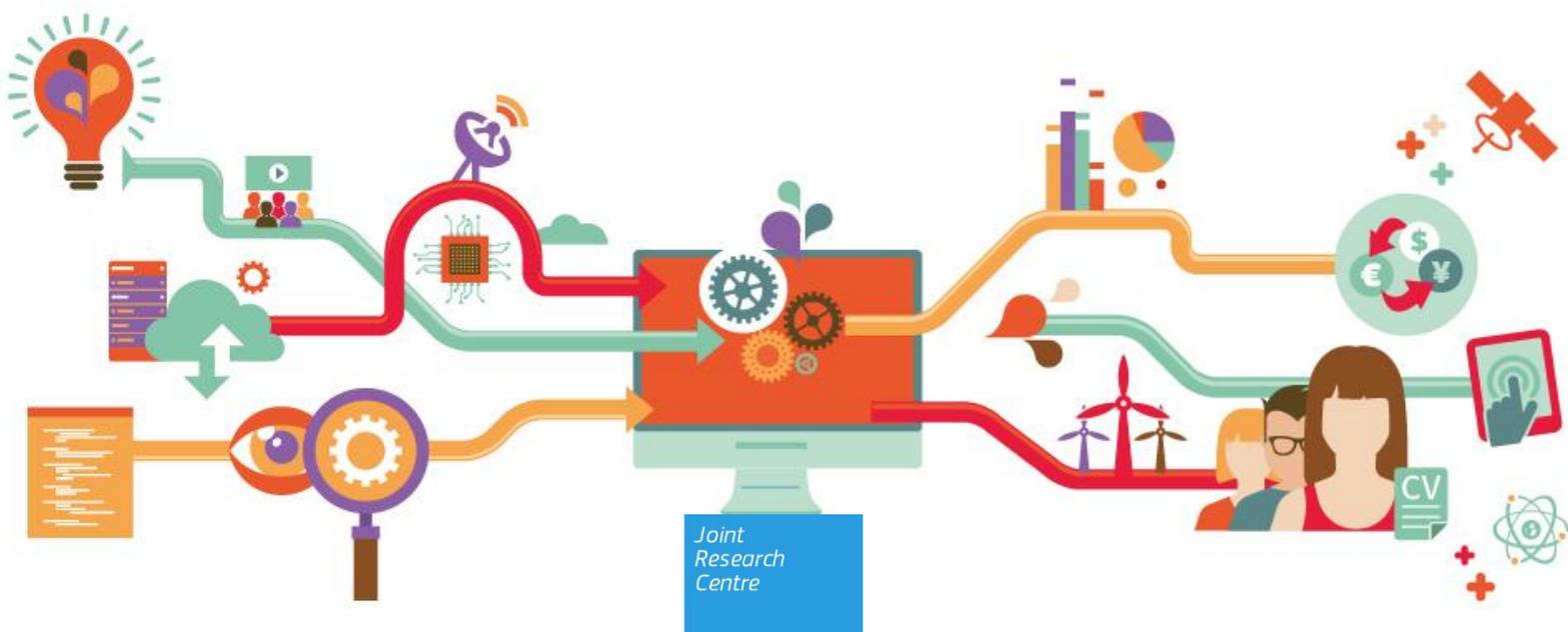
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Diversity in one dimension alongside greater similarity in others: Evidence from FP7 cooperative research teams

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Diversity in one dimension alongside greater similarity in others: Evidence from FP7 cooperative research teams^{1,2}

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Abstract

Although diversity between team members may bring benefits of new perspectives, nevertheless, what holds a team together is similarity. We theorise that diversity in one dimension is traded off against diversity in another. Our analysis of collaborative research teams that received FP7 funding presents robust results that indicators of diversity in several dimensions (diversity of organizational form (universities, firms, etc.), diversity in nationality, and inequality in project funding share) are negatively correlated with each other.

Keywords: diversity, collaborative teams, FP7 research funding.

JEL Classification: O30; M14; O19

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'Birds of a feather flock together'

'Opposites attract'

[popular proverbs]

1. Introduction

When it comes to the issue of cooperative teams, which of the two preceding proverbs is more true? Do teams seek members that are different or similar? The answer, as the reader might have guessed, is probably both. Researchers have reconciled these two proverbs by showing that there are curvilinear effects of diversity (in terms of variable x) on team formation and performance – that too much diversity (in terms of x) might become a liability above a certain threshold. Hence, diversity of teams is sensitive to the 'too much of a good thing' effect (Pierce and Aguinis, 2013). However, we take a different approach to reconciling the two opening proverbs, and shed new light on the phenomenon by showing how heterogeneity in terms of variable x is associated with greater similarity in the others (e.g. variables y and z). For example, I might have more patience for the eccentricities of my family members than similar eccentricities from friends or colleagues – simply because my family members are otherwise very similar in a large number of ways. Another example would be that age differences between team members are easier to accept if the team members have otherwise similar backgrounds.

We therefore present a new mechanism by which 'too much' diversity can affect team structure, which is distinct from the well-known 'too much of a good thing' effect. Whereas the 'too much of a good thing' effect is unidimensional, we show that diversity in one dimension is negatively related to diversity in other dimensions. In this paper, we argue that diversity in one domain increases the probability of observing similarity in the others. More specifically, we focus on a rich data source on FP7 European collaborative research projects and look at inter-relations between 3 indicators of team diversity: number of organizational forms, number of countries represented, and concentration of project cost share between team members. Our theoretical predictions receive robust support from a large and comprehensive dataset on collaborative research teams.

2. Theoretical background

Teams can be diverse in many ways: different educational backgrounds, different genders, different ethnicities, different ages, different nationalities, different levels of industry experience, etc. Previous research looked at how team performance depended on team diversity in specific dimensions. The early literature sought to answer whether diversity is good or bad for performance – whether it be diversity in education or gender or experience etc. Early investigations applied linear regression models to see if the relationship was positive or negative (Bantel and Jackson, 1989; Ucbasaran et al., 2003; Chandler et al., 2005; Chowdhury, 2005; Foo et al., 2005; Amason et al., 2006; Vanaelst et al., 2006).

The next generation of investigations found that the relationship was curvilinear – that a moderate amount of diversity was good, but that above a certain threshold the gains to diversity were smaller than the costs (Horwitz and Horwitz, 2007; Ostergaard et al., 2011).

Diversity can have a positive effect on team performance, if the team members do not all possess duplicates of the same skill-sets, but complement each other and can pool their skills together to enhance their team capabilities at problem solving. However, too much diversity can mean that team members lack the common tacit knowledge that facilitates communication. Similarity engenders a sense of connection and belonging, while ties between nonsimilar individuals are more likely to be dissolved (McPherson et al., 2001).

Our key critique of the literature on team diversity is that the different indicators of diversity are assumed to operate independently of each other. One dimension is considered at a time. We contribute to the literature by taking a new approach towards conceptualizing diversity, as well as presenting supporting evidence.

Our paper can help to explain why literature reviews and meta-analyses suggest that the previous investigations into diversity in entrepreneurial teams and management teams have provided mixed and inconclusive results (Webber and Donahue, 2001; Harrison and Klein, 2007; Horwitz and Horwitz, 2007) – i.e. because their models of diversity neglected the interdependence of these dimensions of diversity, and were thus mis-specified. Including several different indicators of diversity in a linear regression model (where the dependent variable is team performance) will not reveal the relationships that exist between the diversity indicators themselves. Instead, we go beyond the usual finding that the performance effects of diversity are likely to be curvilinear within individual dimensions of diversity (as emphasized by the existing literature surveyed above), and instead show that the different dimensions of diversity should not be taken as independent but that they are inter-related.

Our approach has implications for how team diversity should be conceptualized. In the context of research teams, for example, our framework would predict that interdisciplinary research teams will have less diversity in terms of country and organizational form of its participants than a single-discipline research team, because the diversity in disciplinary focus is compensated for by reduced diversity in the other domains. Similarly, collaborative research projects that include universities, firms, and other organizational forms would probably be more likely to be located in the same country or region, to better manage the difficulties in communication that arise when agents are heterogeneous (in terms of organizational form). Our framework would also predict that, for more academic projects that include only universities (as organizational forms), these projects are more likely to be international.

We therefore posit a broad hypothesis:

Hypothesis 1: Diversity in one dimension is observed alongside greater similarity in others

More specifically, Hypothesis 1 is tested in the context of our dataset, where team diversity is measured in terms of organizational form (university, firm, etc), number of countries, and members' share of the total project's cost. For example, diversity in terms of organizational form might need to be compensated for in terms of less diversity in terms of participant countries (to ensure that participants have a shared tacit knowledge base and cultural background to facilitate communication), as well as less diversity in terms of member's share of total project cost (i.e. where less diversity in terms of project shares means that

funding is relatively evenly distributed, with participants having roles in the project that are more equally matched). We therefore investigate the following sub-hypotheses:

Hypothesis 1a: Diversity in terms of organizational form is negatively correlated with diversity in terms of participant countries;

Hypothesis 1b: Diversity in terms of organizational form is negatively correlated with diversity in terms of members' share of the total project's cost;

Hypothesis 1c: Diversity in terms of participant countries is negatively correlated with diversity in terms of members' share of the total project's cost.

3. Data

3.1 Database description

While most research into team diversity and performance has focused on top management teams or entrepreneurial new venture teams, we focus on collaborative research teams. Collaboration is increasingly important for scientific research (Jones et al., 2008) as well as for innovation and technological development (Hoekman et al., 2013), and there is lots of policy interest in collaborative research projects. However, to date, not much research has focused on collaborative research teams.

Our data covers the universe of successful applications to the European Union's Seventh Framework Programme for Research and Technological Development (FP7), which was set up to provide funding for research and technological development in the European Research Area. FP7 was the EU's main policy instrument for funding European research over the period 2007-2013, and its budget was in excess of €50 billion. The majority of FP7 funds were allocated to the block of activities labelled "Cooperation," that are dedicated for the purposes of the funding of collaborative research projects. This programme was subsequently divided into 10 thematic areas, the largest of which were Information & Communication Technologies (€9.11 bn), Health (€6.05 bn), and Transport (including aeronautics; €4.18bn) (European Commission, 2006).

Our data focuses on collaborative research teams that successfully applied for FP7 funding. Teams that did not get FP7 funding are not included in our dataset. To the extent that our hypotheses require an indicator of team performance, our indicator of performance would be that all the teams in our database were successful in obtaining FP7 funding, because only a small share of applications will succeed. However, considering that FP7 funding was awarded on many criteria, receipt of FP7 funding (and hence inclusion in our dataset) is a potentially opaque indicator of performance (although it can also be argued that survival and success in business environments is an opaque and multifaceted criterion). Nevertheless, given our focus on the role of diversity in the structure of collaborative teams, we argue that the performance outcomes are of secondary importance for our present purposes. Indeed, focusing on the composition of teams and investigating the frequency of teams that are formed, without necessarily linking this to team performance is, in itself, a worthwhile avenue for research (Ruef et al., 2003).

An advantage of our dataset is the comprehensive coverage of successful FP7 applications, which means that we have a large number of observations. Our raw data contains

cooperative teams of vastly different sizes – from one or two members to over a hundred (see Appendix A1). However, having a large number of observations in our dataset will allow us to crucially narrow down our scope to focus on teams composed of the same number of members. In our analysis, we focus exclusively on teams with 8 participants, for several reasons. First, Appendix A1 shows that a team size of 8 is the most frequently-observed team size (if we ignore 'teams' of one or two members). Focusing on teams of size 8 will therefore give us a large yet manageable number of observations. Our main results from a sample of 8,464 observations compares favourably to previous investigations of (different-sized) entrepreneurial teams that have samples of 200 or lower (see the review in Coad and Timmermans 2014 Table 1). Focusing on teams of 8 will also be relevant for other research contexts, such as top management teams that might be composed of 8 individuals. Second, a practical reason is that, unlike smaller team sizes of e.g. 2 or 3 participants, a team size of 8 is sufficient to allow for indicators of diversity (such as integer counts or Herfindahl indices) to cover an interesting range of possible values. Third, restricting all of our observations to teams with the same number of participants will mean that our observations are closely comparable. Indeed, diversity indicators are not invariant to the number of team members (Coad and Timmermans, 2014), and we wish to avoid any spurious results that might emerge from comparing diversity indicators from teams of different sizes. Nevertheless, to ensure that our results hold for different team sizes, in further analysis we check that our results hold for alternative team sizes (see the robustness analysis below).

Our data consists of collaborative research teams that obtained FP7 research funding in the time window 2007-2013. Each projects then lasted up to 6 years. Although we cannot rule out that the same collaborative team participated in two subsequent projects during this time window, nevertheless for simplicity we treat our dataset as a cross-section.

3.2 Indicators of diversity

3.2.1 Diversity of organizational form

FP7 participants can have a variety of different organizational forms: university, private firm, public body, or Public Research Organization. Table 1 shows that the two most common types of organizational form are universities (34% of cases) and firms (39% of cases). As our indicator of the diversity of organizational forms, we simply take an integer count of the number of distinct organizational forms (Stirling, 2007). This simple indicator is easy to understand, and it is an informative indicator of diversity for our purposes because our observations relate to teams of the same size. The minimum value is 1 (if all team members are of the same organizational form, e.g. all are universities or all are private firms) up to a possible maximum of 5.

Table 1: Frequencies of types of organizational form

	Number	Frequency (%)
Higher or secondary education establishments (i.e. 'universities')	2,887	34.1
Private commercial (i.e. 'firms')	3,269	38.6
Public body	220	2.6
Research organisations	1,911	22.6
Other	177	2.1
Total	8,464	100

Note: for collaborative projects of teams with N=8

3.2.2 International diversity

This indicator relates to the number of different countries represented by the 8 project members. (Countries refer to the organizations involved rather than the nationalities of the individuals involved.) The number of countries represented is potentially large: although there are restrictions on the nationality of the FP7 project coordinators (which should be European nationals, although there are some exceptions), nevertheless non-coordinating members can come from any country in the world. Again, this is a simple integer count variable of the number of distinct countries. The minimum value is 1 and the maximum value is 8.

3.2.3 Project cost diversity

Collaborative teams vary in terms of their share of the total project cost. As a further indicator of team member heterogeneity, we analyse the information on the share of the total project cost that is distributed to each project member. The project cost share is a continuous variable that ranges from 0 (for a very large number of members with an atomistic share each) to 1 (where one member basically accounts for all of the project cost). Instead of taking an integer count variable (as before), we take the Herfindahl index which is a meaningful indicator of diversity that has been used in previous research (e.g. Foo et al., 2005; Beckman et al., 2007). We calculate the Herfindahl-Hirschman index (HHI) as follows (Beckman et al., 2007, p157):

$$HHI = \sum_{i=1}^n P_i^2$$

where the number of project members $n=8$ and P_i is the project cost share. Our indicator of project cost diversity based on the HHI index is similar to the two previous diversity indicators described above, in that low scores correspond to cases of low diversity (i.e. where all members get the same cost share) whereas large scores correspond to cases of high diversity (i.e. where there is much inequality in the project cost shares across members, with one member getting a large share).

Table 2 provides summary statistics for our diversity indicators. The first two indicators are discrete while the third is continuous. Collaborative research teams vary considerably according to these three indicators.

Table 2: Summary statistics on our diversity indicators

	Mean	Std. Dev.	Median	Min	Max
No. organizational forms	2.803	0.714	3	1	5
No. Countries	5.251	1.241	5	1	8
HHI project cost share	0.189	0.064	0.170	0.126	0.740

Note: for collaborative projects of teams with $N=8$. 8,464 observations.

We also tried to investigate diversity according to disciplinary theme, to investigate the structure of interdisciplinary teams. However, in our dataset, all members of a project are listed under the same project-specific theme, that is the same for all project members. Therefore we could not investigate heterogeneity in research themes. Relatedly, one might wish to investigate diversity according to industry affiliations, but upon closer reflection, the problem here would be that industry affiliations are only allocated to firms and not to other organizational forms (such as universities or public research organizations).

3.3 Control variables

In contrast to the majority of research in entrepreneurship and management on the diversity of collaborative teams, we do not pool together teams of different sizes. This way, each collaborative team has the same range of possible values for the diversity indicators, and are also closely comparable because of their same size. As a consequence, we don't include team size variables as controls.

In subsequent regressions, we include some control variables that are observed at the project-level (and not at the team-member level). First, we control for the potential role of the total project cost on team diversity, because projects with larger budgets might be more supportive environments for diversity between team members (e.g. well-funded projects might allow diverse team-members to come to an agreement more readily than if they are under financial pressure). Total project cost has a mean of 3,191,592 EUR and a standard deviation of 2,016,993 in the case of 8-participant teams. Second, we control for the project duration, because projects with longer duration might be more amenable for higher levels of diversity (if team members are not pressurized by time constraints to reach agreements with their diverse collaborators). Total project duration has a mean of 36.25 months and a standard deviation of 10.22 in the case of 8-participant teams.

4. Analysis

We begin with a correlation analysis, where we compare indicators of diversity in a pairwise manner, without seeking to explain any one particular indicator (by taking it as dependent variable). We follow with multivariate regressions, that can include all three indicators of diversity in the same analytical framework, as well as some control variables.

4.1 Correlation analysis

Table 3 presents the correlation coefficients for the relationships between the different indicators of diversity. In all cases, the Pearson correlation coefficients (lower triangular cells) are significantly negative. Further results from Spearman's rank correlation coefficients (that are more robust to outliers and to non-Gaussian-distributed variables) are also all significantly negative (upper triangular cells).

Figure A2.1 in Appendix 2 provides graphical evidence to complement the correlation analysis in Table 3. Figure A2.1 shows that, in each case, the indicators of diversity are negatively correlated between themselves.

Taken together, we observe negative pairwise correlations between diversity of organizational forms, diversity of participating countries, and diversity of project cost share. We therefore have strong support for Hypotheses 1a, 1b and 1c.

Table 3: Correlation matrix for the relationships between the three different types of diversity

	No. Org. forms	No. countries	HHI project cost share
No. Org. forms	1	-0.0245 0.0243	-0.0722 0.0000
No. countries	-0.0477 0.0000	1	-0.1064 0.0000
HHI project cost share	-0.0271 0.0126	-0.0932 0.0000	1

Note: Lower triangular cells: Pearson correlation coefficients (in bold), and associated p-values.
Upper triangular cells (and in italics): Spearman's rank correlation coefficients (in bold), and associated p-values.
8464 observations in all cases.

All teams included in the analysis so far all have the same team size (8 members). The robustness of the results can be investigated by repeating the analysis with teams of 7 or 9 members instead of 8 (because 7 and 9 are the next-highest-frequency groups, see Appendix 1). The results are presented below in Tables A3.1 and A3.2 in Appendix 3. In all cases, the correlations are negative and significant. (In Table A3.1, the Pearson correlation between HHI project cost share and number of organizational forms is only significant at the 10% level, although the Spearman rank correlation is much more significant.)

4.2 Multivariate regressions

We pursue our investigation by applying multivariate regressions, where we can include all three indicators of diversity in the same analytical framework, as well as controlling for the potentially confounding influence of other variables.

The regression results reported here take the diversity of organizational forms as the dependent variable (rather than any of the two other diversity indicators), because the skewness and kurtosis statistics show that it is the diversity indicator that is closest to the Gaussianity requirement for least-squares estimation. (In further robustness analysis, however, we verify that our main results hold when taking the two other diversity indicators as the dependent variable.) Regressions are estimated using Ordinary Least Squares, and for extra precision in our inference, standard errors are obtained after 500 bootstrap replications.

Table 4 shows the regression results. Each of the three diversity indicators are significantly negatively related to each other, across the different regression specifications (that vary according to team size and inclusion of control variables). Table 4 therefore offers support to Hypotheses 1a, 1b and 1c.

Table 4: Regression results with diversity of organizational forms as the dependent variable.

	teams of 7		teams of 8		teams of 9	
	(1)	(2)	(3)	(4)	(5)	(6)
No. countries	-0.055*** (0.009)	-0.038*** (0.009)	-0.029*** (0.006)	-0.023*** (0.007)	-0.025*** (0.006)	-0.017*** (0.006)
HHI project cost share	-0.338** (0.167)	-0.594*** (0.163)	-0.358** (0.147)	-0.385*** (0.144)	-0.737*** (0.159)	-0.893*** (0.172)
Project cost		1.97e-08*** (4.51e-09)		2.56e-08*** (4.80e-09)		1.72e-08*** (4.19e-09)
Project duration		-0.010*** (0.001)		-0.004*** (0.001)		-0.007*** (0.001)
Constant	3.062*** (0.0584)	3.329*** (0.0671)	3.024*** (0.0463)	3.059*** (0.0575)	3.247*** (0.0479)	3.419*** (0.0568)

Observations	7,217	7,217	8,464	8,464	8,847	8,847
R-squared	0.007	0.019	0.003	0.007	0.007	0.012

*Note: Team sizes of 7, 8 and 9 team members are considered, albeit separately. Standard errors (in parentheses) are obtained after 500 bootstrap replications. Key to significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

In each of the three cases, we observed a significant negative correlation between diversity in one domain, and diversity in another. This finding is reminiscent of the negative correlation that is visible in Pandza et al. (2011, Figure 4), although the authors do not comment on this negative correlation, or provide any theoretical interpretation.

5. Conclusion

We began by theorising about the benefits and drawbacks of diversity. If a team is diverse in one area, it might seek to compensate by having greater similarity in other areas. For example, interdisciplinary teams might seek similarity in other dimensions such as age, cultural factors, or geographical base. Our paper therefore carries implications for the choice of innovation partner – if the partner is very different in certain aspects, then it would be prudent to seek similarity in others.

Previous research found curvilinear effects – positive effects of diversity on performance for low values of diversity, but negative effects for high values of diversity. Hence, there exists an optimum amount of diversity, found at the inflexion point on the curve of performance across the range of diversity. This can be generalized as the 'too much of a good thing' effect (Pierce and Aguinis, 2013). In contrast to the previous literature on the optimal amount of diversity in any single diversity dimension, our results suggest that this optimum amount of diversity depends on the amount of diversity in other dimensions. More specifically, we suggest that the optimum amount of diversity on one dimension is negatively related to the level of diversity in another dimension. Our analysis shows that all of our hypotheses are strongly supported, and our results are robust across regression specifications.

Our empirical investigation is not without limits. First, our dataset does not include team-level performance outcomes (beyond the observation that our data focuses exclusively on successful FP7 applications). Second, a possible limitation of our dataset concerns whether 'political' considerations (e.g. whether evaluators look favourably on projects that include members from less developed European countries) might influence team formation and funding chances, beyond purely 'meritocratic' concerns. Third, our analysis is undertaken on data that is essentially cross-sectional in structure – it would be interesting to see how team composition and diversity changes over time (e.g. some individual characteristics cannot be changed (e.g. gender, ethnicity) while others change automatically (age) and still others can be manipulated by the individual (e.g. experience, preferences or team roles)). It is also

worth investigating the effect of time on team diversity (Steffens et al., 2011; Kaiser and Mueller, 2015). Do teams become more diverse over time? Do individuals make efforts to compensate, and seek to 'specialize' and complement each other in certain dimensions, thus altering the team-level diversity over time? Future work could investigate these issues in more detail.

Future work could use data from other contexts, such as the startup of commercial new ventures. With regards to FP7 funding, future work might fruitfully compare recipients of FP7 funding with research teams that applied but were not successful in obtaining funding, to see if the characteristics of successful teams are different from those of unsuccessful applicants. Future work might also investigate the effects of diversity on more conventional indicators of team performance, when 'excessive' or 'disproportionate' diversity in one dimension can be traded off against increased similarity in other dimensions, to boost overall performance. Finally, future research might also focus on the interdisciplinary nature of cooperative teams (because our data did not allow us to investigate the role of diverse disciplinary backgrounds within research projects).

To conclude, we suggest a new framework for thinking about the costs and benefits of diversity for team structure and performance. While previous papers that highlighted the curvilinear relationship between diversity and performance (with benefits eventually leading to higher costs as diversity increases), our results suggest that high levels of diversity in one dimension need not necessarily be a liability if they can be offset by sufficient similarity in other dimensions. In the context of pan-European FP7 collaborative research projects, one possible strategy for enhancing the inclusion of lagging regions in international collaborative teams (c.f. Hoekman et al., 2013) is to ensure that they are otherwise similar to their team partners (in terms of project share, organizational form, and possibly also in other dimensions).

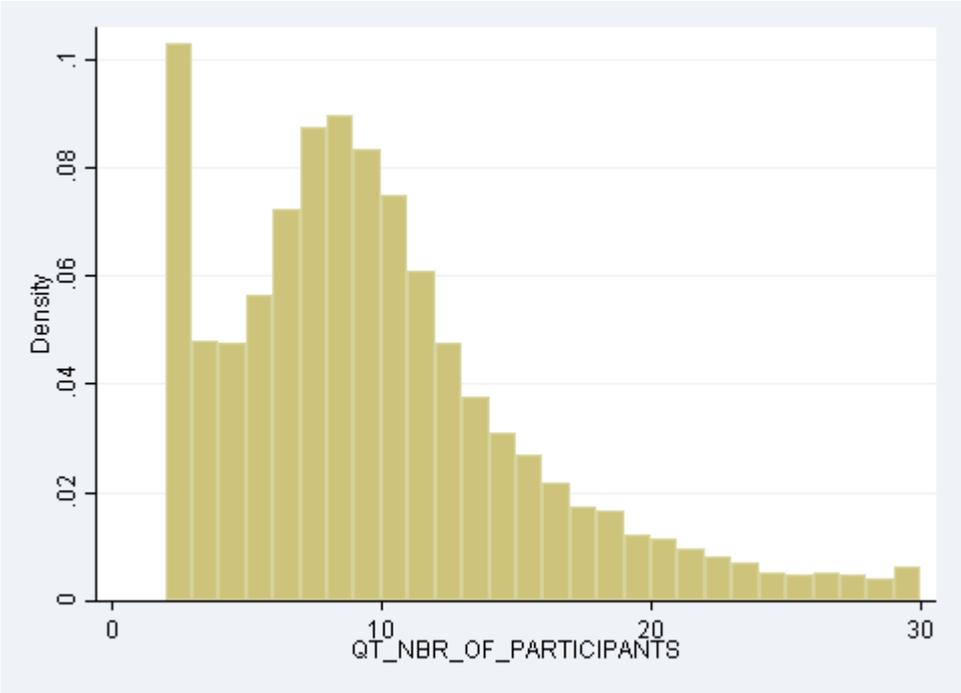
References

- Amason, A.C., Shrader, R.C., and Thompson, G.H., (2006). Newness and novelty: Relating top management team composition to new venture performance. *Journal of Business Venturing*, 21: 125-148.
- Bantel, K. and Jackson, S., (1989). ".Top management and innovations in banking: Does the composition of the top team make a difference? *Strategic Management Journal*, 10: 107-124.
- Beckman C.M., Burton M.D., and O'Reilly C., (2007). Early teams: The impact of team demography on VC financing and going public. *Journal of Business Venturing*, 22, 147-173.
- Chandler, G.N., Honig, B., and Wiklund, J., (2005). Antecedents, moderators, and performance consequences of membership change in new venture teams. *Journal of Business Venturing*, 20(5), 705-725.
- Chowdhury, S., (2005). Demographic Diversity for building an effective entrepreneurial team: is it important? *Journal of Business Venturing*, 20, 727-746.
- Coad, A., and Timmermans, B., (2014). Two's Company: Composition, Structure and Performance of Entrepreneurial Pairs. *European Management Review*, 11 (2), 117-138.
- Eisenhardt, K., and Schoonhoven, C.B., (1990). Organizational Growth: Linking Founding Team, Strategy, Environment, and Growth among US Semiconductor Ventures, 1978-1988. *Administrative Science Quarterly*, 35: 504-529.
- Foo, M.D., Wong, P.K., and Ong, A., (2005). Do others think you have a viable business idea? Team diversity and judges' evaluation of ideas in a business plan competition. *Journal of Business Venturing*, 20, 385-402
- Harrison, D.A., and Klein, K.J., (2007). What's the difference? Diversity constructs as separation, variety, or disparity in organizations. *Academy of management Review*, 32(4), 1199-1228.
- Hoekman, J., Scherngell, T., Frenken, K., and Tijssen, R., (2013). Acquisition of European research funds and its effect on international scientific collaboration. *Journal of Economic Geography*, 13, 23-52
- Horwitz, S.K., and Horwitz I.B., (2007). The effects of team diversity on team outcomes: a meta-analytic review of team demography. *Journal of Management*, 33 (6), 987-1015.
- Jones, B.F., Wuchty, S., and Uzzi, B., (2008). Multi-university research teams: Shifting impact, geography, and stratification in science. *Science*, 322 (5905), 1259-1262.

- Kaiser, U., and Müller, B., (2015). "Team heterogeneity and its development over time". *Small Business Economics*, 45(4), 787-804.
- McPherson, M., Smith-Lovin, L., and Cook, J., (2001). "Birds of a feather: Homophily in social networks". *Annual Review of Sociology*, 27: 415-444.
- Ostergaard, C.R., Timmermans, B., and Kristinsson, K., (2011). Does a different view create something new? The effect of employee diversity on innovation. *Research Policy*, 40, 500-509.
- Pandza, K., Wilkins, T.A., and Alfoldi, E.A., (2011). Collaborative diversity in a nanotechnology innovation system: Evidence from the EU Framework Programme. *Technovation*, 31, 476-489.
- Pierce, J.R., and Aguinis, H., (2013). The Too-Much-of-a-Good-Thing Effect in Management. *Journal of Management*, 39 (2), 313-338.
- Ruef, M., Aldrich, H.E., and Carter, N.M., (2003). The structure of founding teams: homophily, strong ties, and isolation among US entrepreneurs. *American Sociological Review*, 68, 195-222.
- Steffens, P., Terjesen, S., and Davidsson, P., (2012). Birds of a feather get lost together: new venture team composition and performance. *Small Business Economics*, 39(3), 727-743.
- Stirling, A., (2007). A general framework for analysing diversity in science, technology, and society. *Journal of the Royal Society Interface*, 4, 707-719.
- Ucbasaran, D., Lockett, A., Wright, M., and Westhead, P., (2003). Entrepreneurial Founder Teams: Factors associated with Member Entry and Exit. *Entrepreneurship Theory and Practice*, Winter, 107-126
- Vanaelst, I., Clarysse, B., Wright, M., Lockett, A., Moray, N., and S'Jegers, R., (2006). Entrepreneurial team development in academic spinouts: An examination of team heterogeneity. *Entrepreneurship Theory and Practice*, 30(2), 249-271.
- Webber, S. and Donahue, L., (2001). "Impact of highly and less job-related diversity on work group cohesion and performance: A meta-analysis". *Journal of Management*, 27: 141-162.

Appendix 1: frequencies of different team sizes of FP7 collaborative projects

Figure A1.1: histogram of the frequencies of different team sizes.



Note: Beyond the peak at 2 participants, there is a second peak at 8 participants.

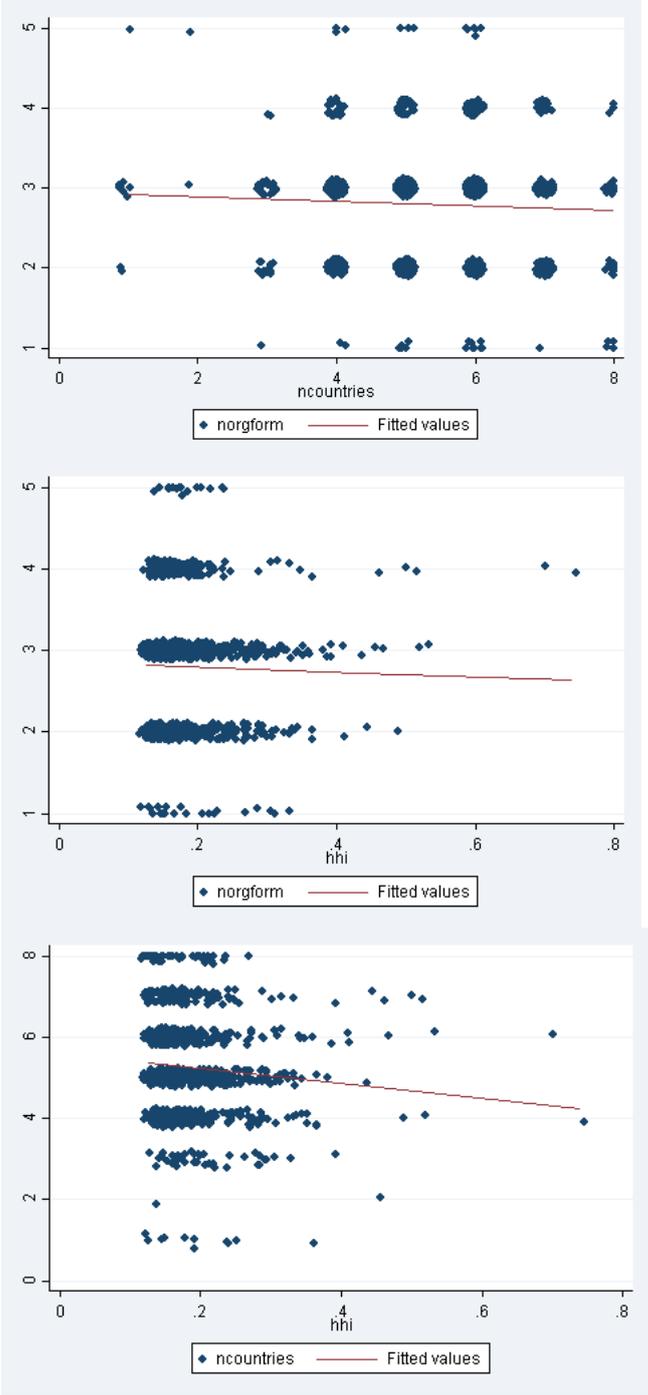
Table A1.1: frequencies of different team sizes.

No. participants	Freq.	Percent
1	13,182	52.23
2	1,217	4.82
3	566	2.24
4	563	2.23
5	668	2.65
6	853	3.38
7	1,031	4.09
8	1,058	4.19
9	983	3.9
10	886	3.51
11	717	2.84
12	561	2.22
13	444	1.76
14	367	1.45
15	318	1.26
16	259	1.03
17	206	0.82
18	198	0.78
19	142	0.56
20	135	0.53
21	114	0.45
22	96	0.38
23	82	0.32
24	61	0.24
25	58	0.23
26	63	0.25
27	56	0.22
28	48	0.19
29	37	0.15
30	36	0.14
31	24	0.1
32	26	0.1
33	15	0.06
34	15	0.06
35	19	0.08
36	12	0.05
37	10	0.04
38	11	0.04
39	22	0.09
40	9	0.04
41	6	0.02
42	8	0.03
43	3	0.01
44	4	0.02
45	7	0.03
46	5	0.02
47	3	0.01
49	3	0.01
50	3	0.01
51	2	0.01
53	2	0.01
54	2	0.01
55	1	0
56	1	0
57	3	0.01
59	2	0.01
60	1	0
65	1	0
66	1	0
67	2	0.01
69	1	0
70	2	0.01
71	1	0
77	1	0
79	1	0
98	1	0
99	1	0
114	1	0
Total	25,237	100

Note: Although the mode is a 'team' size of 1, nevertheless a sole participant can hardly be considered to be engaging in collaboration.

Appendix 2: pairwise scatterplots of the relationships between diversity indicators

Figure A2.1: scatterplots with the negatively-sloped linear fit



Note: scatterplots with the negatively-sloped linear fit for the correlations between number of organizational forms and number of countries (top); number of organizational forms and project cost HHI index (centre); and number of countries and project cost HHI index (bottom). Scatterplots drawn using Stata 14's "jitter" option, which adds spherical random noise to the data before plotting to avoid having datapoints plotted on top of each other.

Appendix 3: Correlation matrices for teams of 7 and 9 members

Table A3.1: correlation matrix for the relationships between the three different types of diversity.

	No. Org. forms	No. countries	HHI project cost share
No. Org. forms	1	-0.0661 <i>0.0000</i>	-0.0638 <i>0.0000</i>
No. countries	-0.0793 <i>0.0000</i>	1	-0.1446 <i>0.0000</i>
HHI project cost share	-0.0212 <i>0.0715</i>	-0.1330 <i>0.0000</i>	1

Note: Lower triangular cells: Pearson correlation coefficients (in bold), and associated p-values.

Upper triangular cells (and in italics): Spearman's rank correlation coefficients (in bold), and associated p-values.

This table focuses on teams of 7 members only: 7217 observations in all cases.

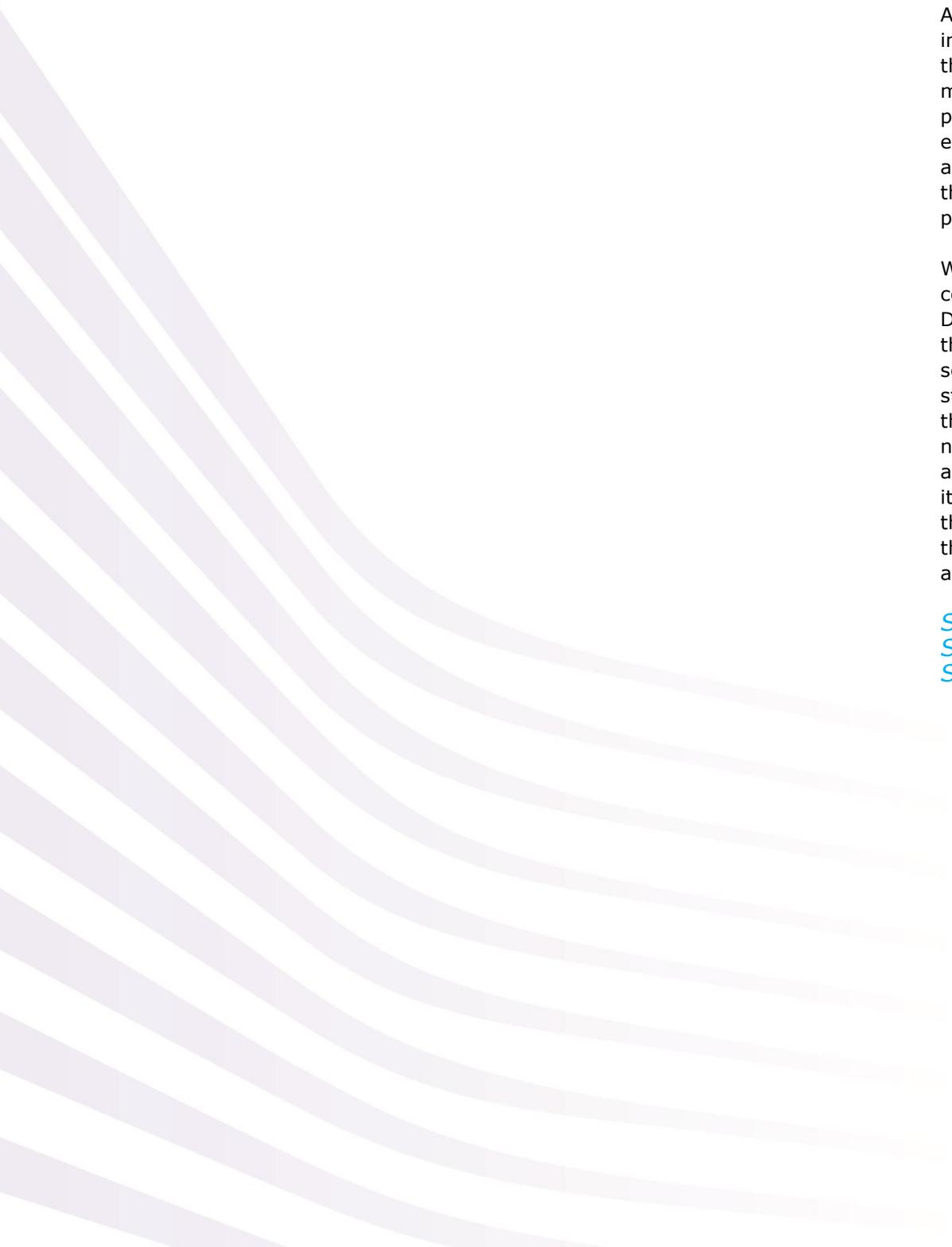
Table A3.2: correlation matrix for the relationships between the three different types of diversity

	No. Org. forms	No. countries	HHI project cost share
No. Org. forms	1	-0.0337 <i>0.0015</i>	-0.1039 <i>0.0000</i>
No. countries	-0.0413 <i>0.0001</i>	1	-0.1323 <i>0.0000</i>
HHI project cost share	-0.0671 <i>0.0000</i>	-0.0887 <i>0.0000</i>	1

Note: Lower triangular cells: Pearson correlation coefficients (in bold), and associated p-values.

Upper triangular cells (and in italics): Spearman's rank correlation coefficients (in bold), and associated p-values.

This table focuses on teams of 9 members only: 8847 observations in all cases.



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