National Cultural Diversity of Research Teams[6]

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Abstract
According to social categorization theory diversity has negative effects on group processes as it places a burden on communication and cohesion. From an information processing approach, however, diversity is considered as beneficial for groups broadening the available cognitive resources. The paper compares national cultural diversity of research teams, i.e. to what degree members of research teams come from different countries, across a set of 10 European countries and four academic domains (engineering, natural sciences, biology, and social sciences). It uses different measures of diversity which include species richness, evenness and disparity to different degrees. For all measures we find that the UK and Sweden have high cultural diversities of their research teams, whereas the Czech Republic, Hungary and Italy and at domain level the social sciences have low diversities. We then relate the diversity measures to the teams' research performance measured as journal publications but at the current level of calculations we fail to find a stable relationship.

Keywords
Research teams; human resources; cultural diversity; diversity measures; research performance

Introduction
Science is at the forefront of globalisation: 'Denationalizing science' has been the prevailing trend for some years (Crawford, Shinn, & Sörlin, 1993). Levels of international collaboration (European Commission, 2003; Narin, Stevens, & Whitlow, 1991; National Science Board, 2004) and personnel mobility (Lauriol, 2007; Moguérou & Di Pietrogiacomo, 2007) have increased significantly over the past twenty to thirty years, the latter trend introducing more cultural diversity into scientific organisations. Very little is yet known about the degree and differences (between academic domains, countries) of cultural diversity in research teams. Even less is known on its impact on the performance of scientific research teams, though it has been suggested that it may be a very influential trait in some work teams (Earley & Mosakowski, 2000).
This paper addresses this topic, conceptualizing national cultural diversity as the degree of multi-nationality of a research team (see in more detail below). It follows up topics in a previous paper (Barjak & Robinson, 2008) in which we found that post-docs in Europe are more likely to come from other countries than are PhD students. Moreover, our regression results showed that the most productive teams have a moderate level of cultural diversity of their PhD students, and that low as well as high levels of cultural diversity are accompanied by reduced publication productivity. The present paper extends these findings in several ways:

- Potentially more appropriate measures of cultural distance and diversity are introduced and compared to the Shannon indices.

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- The analysis is extended beyond the single domain of life sciences to include the social sciences, engineering and the natural sciences.
- The sensitivity of the results to team size and acculturation is investigated.

We do not, however, discuss the role of other types of diversity such as gender diversity or interdisciplinarity – this is left to future analyses. The paper first presents the state-of-the-art on cultural diversity in research teams and its impact on research productivity. Next we summarize the data and methods used in this paper and briefly discuss the diversity indices that are suitable for measuring team diversity as we understand it. Then, we present and discuss the results. The final section offers some conclusions and points to future research.

National cultural diversity and its impact on research productivity

Conceptualizing culture

We understand culture to mean any way of ordering and interpreting the environment at least partially shared in a group, with particular interest where this gives rise to adoption of particular patterns of behaviour.[7] Multiple and overlapping influences, such as nation, organization, work group, or any other form of grouping to which people may sense belonging, enable people to order their social environment, structuring what they think of it and – potentially – also how they behave.

So understood, the culture of a research group may be shaped by beliefs and practices stemming from the biographies of those who have joined it. Leading researchers but potentially also PhD students and post docs entering a research group bring with them cultural influences acquired in educational institutions and previous positions. Given that the prevailing structure of educational and higher educational organisations varies by nation, we expect that there is variation in research culture across nations, and that this national cultural variety - to be mapped here onto national cultural distance - is imported into research teams through mobility of research personnel.

National cultural distance

Several different conceptualisations of national cultural distance have been used in the past: the two most common conceptualisations are based on either a) value differences or b) language differences.

Ad a) The international business literature calculates distance measures that either use Hofstede's dimensions of national culture (Hofstede & Hofstede, 2005) or Schwartz's (1994) cultural values framework (see e.g. Barkema, Bell, & Pennings, 1996; Drogendijk & Slangen, 2006; Kogut & Singh, 1988; Morosini, Shane, & Singh, 1998; Ng, Lee, & Soutar, 2007). Though these empirical cultural distance studies contribute to explaining some international movements they have been criticized on conceptual and methodological grounds (Boyacigiller et al., 2003; Shenkar, 2001). Shenkar (2001) suggests, among other issues, to use measures of general cultural similarity instead of the Kogut-Singh and the like indexes. Such country clusters of cultural proximity have been developed (Ronen & Shenkar, 1985; Gupta, Hanges, & Dorfman, 2002) and these clusters perform well in explaining international business behaviour (Barkema et al., 1996).

Ad b) Another concept of cultural distance uses the linguistic distance between the language(s) of a country as the basic criterion (West & Graham, 2004). According to this approach culture can be considered as a system of shared meanings which are communicated and reproduced through language. The distance between languages is a reflection of their

[7] Similar conceptualisations are those by Williams (1983) "the works and practices of intellectual and especially artistic activity" and that by Bourdieu (1977): symbols and attribution of significance which give "regularity, unity and systematics to the practices of a group."

genealogical classifications and measured as the number of joint classifications (Fearon, 2003; West & Graham, 2004). This concept of linguistic distance also has some weaknesses. In particular, its influence on communication is small, if people are used to meet strangers, have a strong will to communicate, when the context of communication is simple, and if they are bi-lingual and have a common second language (Laitin, 2000).

The two approaches to measuring cultural distance have been used in cross-validations. For instance, West and Graham (2004) show that Hofstede's four dimensions of cultural values correlate with their measure of linguistic distance. The advantage of the language-based concept is its more general availability, though its relevance in academia may be questioned due to the importance of English as lingua franca.

The consequences of diversity

Research on groups in various settings has shown that diversity, i.e. differences among the members of a group in respect to a common characteristic, may have negative as well as positive effects on group processes and performance (Horwitz, 2005; van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998). Mainly two competing theories of the relationship between team diversity and team performance are put forth as explanations:[8]

1) The *social categorization approach* states that group members categorize themselves and others into similar in-group and dissimilar out-group members (van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998). People tend to trust in-group members more, and they are more willing to cooperate with them. A related argument is made by the *similarity-attraction paradigm:* this puts forth a positive effect of similarity of group members (low diversity) on team performance. Similarity in regard to immediately observable characteristics like age, gender, or race and in regard to attitudes and values increases interpersonal attraction and liking. It may increase the amount and quality of communication and lead less often to conflict (Horwitz, 2005; Williams & O'Reilly, 1998).

2) The second theory, often labelled as *information/decision-making*, stresses the positive effects of group diversity on the availability of information, knowledge, skills, abilities and contacts (van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998; Horwitz, 2005). These resources are mainly (but not exclusively) an attribute of job-related diversity resulting from differing functional expertise, education, or organisational tenure. Simonton stresses these positive effects of diversity and argues in his theory of scientific creativity that cultural diversity can also be one of its underlying bases: "cultural heterogeneity associates with creativity, whereas homogeneity correlates with stagnation." (Simonton, 2004, p. 133). In particular, he expects that heterogeneous groups are more creative than homogeneous groups: "The more diverse are the collaborator backgrounds and expertise, the greater the level of mutual stimulation. The upshot is group problem solving that is more creative." (Simonton, 2004, p. 155)

The large and multifaceted body of empirical research has shown that the reality is more complex than both theories expect and that there remain many uncertainties and ambiguities.

In particular, positive versus negative effects of diversity cannot be simply explained with job-related and demographic diversities (van Knippenberg & Schippers, 2007, p. 520).

A group's *diversity perspective*, that is how it makes sense of cultural diversity and how this shapes members' identities, relations and task accomplishments, has been suggested as an important moderator of cultural differences (Ely & Thomas, 2001).

Task complexity was suggested as another intervening variable: Thomas (1999) finds a better performance of culturally homogeneous groups than of heterogeneous groups on a rather

[8] For a more detailed discussion of both approaches and the supporting empirical evidence we refer to the reviews in (Horwitz, 2005; van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998).

complex task, whereas the opposite finding applied to the completion of simpler tasks. The latter study also found that a large distance between group members in the dimension of individualism/collectivism contributed to more group conflicts.

Different types of diversity might interact as suggested in the *faultline* concept (Lau & Murnighan, 1998).[9] Certain types of diversity, such as national cultural diversity as it is discussed in this article, may combine bio-demographic and job-related elements and lead to splits that supersede those from any other personality traits (Earley & Mosakowski, 2000).

Earley and Mosakowski (2000) also find evidence for a U-shaped relationship between national/cultural diversity and team performance, as both homogeneous as well as very heterogeneous teams are more successful in developing a team culture. Others rather support an *inverted* U-shaped relationship: Williams and O'Reilly suggest that positive effects may prevail at low levels of diversity, but that at higher levels, group cohesion may reduce to an extent which negates the positive effect (Williams & O'Reilly, 1998, p. 90). Van Knippenberg and Schippers (2007, p. 532) put forth that too heterogenous groups may loose the ability to communicate as they don't share common frames of reference any more. They point to several studies that support this argument. In our previous paper we also found a U-shaped relationship between cultural diversity and team productivity in life science research teams, indicating that very diverse teams were less productive than moderately diverse teams (Barjak & Robinson, 2008).

Data and methods

Data on research teams

The paper reuses data on research teams that were obtained in two consecutive studies for the European Commission. Both studies defined research teams as groups of people, scientists and non-scientists, some or all of whom are employed by a university, who work at the same location for a significant period of time to produce new scientific knowledge, such that the group is recognisable from outside the university as a distinct entity. Moreover, both studies used webometric techniques to build representative samples of university-affiliated research teams (at PhD-granting universities only) across the same set of 10 European countries:

- In NetReAct, the first study, we identified through internet searches a universe of 7,732 research teams in the life sciences, defined as International Standard Classification of Education ISCED 1997 category 42 (Unesco, 1997). The teams in the sample were drawn from this population by stratified random sampling. The stratification variable was the number of hyperlinks pointing to the team's internet homepage (inlinks), which was considered a readily available proxy for the research performance of the team. Previous research has shown that for academic organisations, the number of hyperlinks is related to research performance (see Thelwall, 2003).
- For the second study, RESCAR, we employed a slightly different approach: national correspondents in each of the ten countries collected from the internet the universe of departments or other substructures for research in the social sciences and engineering in the PhD-granting universities in their country. The categorization of departments used the Revised Field of Science and Technology (FOS) classification in the Frascati Manual (OECD Working Party of National Experts on Science and Technology Indicators, 2007). The universe consisted of about 3700 departments in the social sciences, 1800 departments in engineering, and 50 mixed departments (which could not be categorized). For each department/substructure in the universe the inlinks were collected and a sample

[9] Faultlines refer to "hypothetical dividing lines that may split a group into subgroups based on one or more attributes" (Lau & Murnighan, 1998, p. 328). See on faultlines also (Earley & Mosakowski, 2000; van Knippenberg & Schippers, 2007, p. 523; Li and Hambrick, 2005; Thatcher, Jehn, & Zanutto, 2003)

was drawn using random stratified sampling as in NetReAct. Next, the national correspondents harvested all research teams of the sample departments/substructures from the internet assembling a database of roughly 2400 teams in the social sciences, 2300 in engineering and 60 teams from mixed departments.

For the sample teams the names and email addresses of the team leaders were identified via the internet as well as some baseline information on the team structure. Teams then received an email with a link to the online questionnaire in summer 2005 (NetReAct) and spring 2007 (RESCAR) plus up to two reminders. Sample sizes and responses per country and domain are shown in Table 1.

Table 1: Teams by domain and country

Country of the team	Life Sciences		Engineering		Social Sciences	
	Sample	Responses	Sample	Responses	Sample	Responses
CZ	119	30	167	13	116	12
DE	271	60	531	69	411	28
ES	164	37	136	27	255	36
FR	225	56	589	106	387	29
HU	108	34	99	14	155	12
IT	186	52	289	37	307	28
NO	122	37	98	13	176	23
PT	123	44	130	25	137	15
SE	148	41	127	32	156	23
UK	307	77	227	26	207	17
Total	1773	468	2393	362	2307	223

The present analysis only includes the data of teams with less than 50 members, as we considered larger units not to be in line anymore with our definition of research teams.

Measuring diversity

Different authors before us have described diversity as a rather fuzzy construct combining different concepts (Harrison & Klein, 2007; Rousseau & Van Hecke, 1999; Stirling, 2007):
a) *Species richness* or variety stands for the number of different species *S* existing in a population.
b) *Evenness* or balance describes the relative abundance of each species in the population.
c) *Disparity* refers to the degree of difference between each of the species.

Claude Shannon is credited as inventor of the most popular diversity index (Shannon, 2001 – a reprint of the 1948 article), the Shannon-Index (see Table 2 on formulas). The index is scale invariant and takes into account species richness and evenness of a population, though it is mainly driven by evenness. It has been criticized for failing to meet the replication property, i.e. “the evenness of a community equals the evenness of any replication of that community” (Nijssen, Rousseau, & Van Hecke, 1998).

A different and simpler measure that puts a stronger effort on the species richness of a population is the mere number of species or the number of species divided by the number of objects in the population (Rousseau, 2007).[10]

Disparity is rather neglected in diversity measures and studies (Harrison & Klein, 2007). Stirling (2007) suggests a set of measures that partially remedy this weakness, which he calls variety-weighted disparity (= richness-weighted disparity in this paper’s terms) and balance-weighted disparity (= evenness-weighted disparity).

[10] The Rousseau suggestion was actually to calculate the inverse ratio N/S, but for reasons of scale and comparability to other indices, the ratio S/N seems preferable. As $N \geq S$ the index gets a maximum value of 1 and for $N \rightarrow \infty$ (theoretically) a minimum value of 0.

Table 2. Diversity measures[a]

Formula	Interpretation	Source
Error! Objects cannot be created from editing field codes.	Shannon-Index combining richness and evenness	(Shannon, 2001)
Error! Objects cannot be created from editing field codes., **Error! Objects cannot be created from editing field codes.**	Species richness, size-normalised species richness	(Rousseau, 2007)
Error! Objects cannot be created from editing field codes.	Richness-weighted disparity	(Stirling, 2007)
Error! Objects cannot be created from editing field codes.	Evenness-weighted disparity	(Stirling, 2007)

a The formulas depict cultural diversity indices with the following notation:
CDI: Cultural diversity index
N: Total number of observations
S: Total number of different species, that is countries/continents *i* and *j*
p_i, p_j: Proportion of S made up of the *i*th (*j*th) country/continent
k: Scores for measures of cultural characteristics.

Measuring cultural distance

For the diversity measures that included disparity values in the calculations we used the four measures provided by Hofstede and Hofstede (2005): power distance, individualism, masculinity, and uncertainty avoidance. As the data was not available for all countries, we made some approximations for missing countries; e.g. for Cyprus we used ¾ of the Greek and ¼ of the Turkish scores, for Latvia and Lithuania we used the Estonian scores, for the Soviet union we used the Russian scores etc. For five countries (Afghanistan, Albania, Angola, Cuba, and Paraguay) scores seemed not to be readily deducible from available scores and the countries were therefore not included in the cultural distance measures. The fifth measure in Hofstede and Hofstede (2005), long-term orientation, was for the same reason entirely excluded as only for a part of the country set data has been published.

Results

Cultural diversity measured through Shannon indices

In the previous paper we had operationalised cultural diversity as separate Shannon indices for PhD students and post-docs for the NetReAct dataset of life science teams; as species *S* we took the countries of origin of PhD students/post-docs as classified by the responding team leaders. We focused on this group of researchers, as they are young and mobile and should have moved recently, meaning that acculturation processes will probably not yet have levelled out the cultural distances. Using this operationalisation we get cultural diversity indices of 0.44 for PhD students and 0.59 for post-docs (see table 3). As to be expected, these values get smaller if we use the continent of origin instead of the country of origin, as the intra-continental variance is not taken into account anymore; the indices are reduced to 0.38 (PhD students) and 0.47 (post-docs) on average. If we extend the dataset beyond the life sciences and calculate the Shannon indices for both, the NetReAct and RESCAR datasets, we don't see any significant change for the PhD students, but the index for post-docs is further reduced to 0.41. This indicates that at the level of post-docs the life sciences are more culturally diverse than engineering and the social sciences. In addition, in this final dataset there is no significant difference between cultural diversities for PhD students and post-docs anymore.

Table 3. Cultural diversity indices (Shannon) for PhD students and post-docs and different operationalisations of the species attribute[a]

	PhD students				Post-docs			
	Mean	95%-confidence interval		N	Mean	95%-confidence interval		N
		lower bound	upper bound			lower bound	upper bound	
NetReAct dataset[b]	0.44	0.39	0.49	373	0.59	0.52	0.66	220
NetReAct dataset[c]	0.38	0.34	0.42	373	0.47	0.41	0.53	220
NetReAct & RESCAR dataset[c]	0.39	0.36	0.41	816	0.41	0.37	0.45	406

a Teams with 50 or more team members and teams with less than 2 PhD students or post-docs were excluded.
b Species S are operationalised as countries of origin.
c Species S are operationalised as continents of origin.

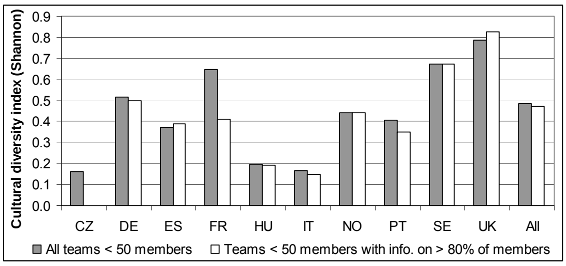

Figure 1. Cultural diversity indices (Shannon) for research teams by country

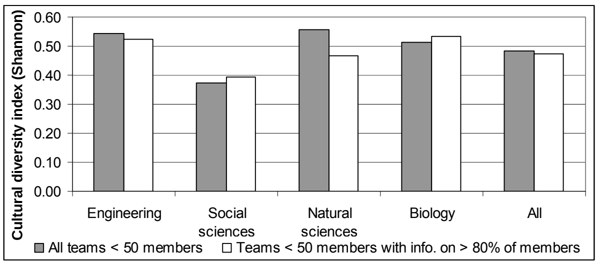

Figure 2. Cultural diversity indices (Shannon) for research teams by academic domain[a]

a Academic domains were classified based on field information from the teams. Teams could allocate themselves in more than one domain and five domains (agriculture, medicine, biomedicine, humanities, others) are not shown due to low case numbers. Hence cases don't add up to the total.

The next analytical step consisted in calculating one Shannon cultural diversity index per team including all team members for which information on the continent of origin was available: up to 5 PhD students, up to 5 post-docs and the heads of the research teams. As the majority of teams listed more members, this information on the country of origin did not extend to the entire team. We tried to remedy this by including only teams for which information on all academic team members (principal investigators, PhD students, post-docs, and other researchers) was available. However, this reduced the number of teams from 879 to a mere 140 with fewer than 10 teams in four out of ten countries. Hence, we decided to include all teams, for which information on more than 80% of the team members was available. Though the number of teams is also reduced by 70%, we get nearly identical cultural diversity indices per country and academic domain as for the full set of teams (see Figures 1 & 2). Only for the Czech Republic and France we see a notable change in the index explained by the vast reduction of cases. Large cultural diversities can be found in the UK and Sweden, whereas in the Czech Republic, Hungary and Italy they are small. Teams in the social sciences also have lower diversities than teams in the other three academic domains. These results raise our confidence that the Shannon indices properly represent team diversities though the information on the country of origin was available only for a part of the team. As the information on the continent of origin was only collected for up to 11 members per team (5 PhD students, 5 post-docs, and the team leader) this means that maximum team size is effectively 13 for the teams shown with the white columns compared to 49 for the shaded columns. Still, the diversity indices are virtually the same on both sides.

Further cultural diversity indices

A second operationalisation of diversity limits the concept, as suggested by Rousseau (2007) to mere species richness, thus eliminating the effect of evenness which may arguably not be important from the perspective of improved group effectiveness. Calculating species richness as the number of continents of origin per research team (based on the team members for which this information was available) and the normalised rate as divided by all team members, we get a similar picture as before and the values correlate with the Shannon indices: Pearson $r_{Shan/SR}$ = 0.96 for the Shannon index and the total number of continents per team (species richness SR) and $r_{Shan/NSR}$ = 0.62 for the Shannon index and the number of continents per team member (normalised species richness NSR). The picture is also quite similar for countries and academic domains: the UK, Sweden and France have above average species richness, that is 2.4-2.8 different continents represented in their teams (see Table 4); teams in the Czech Republic, Hungary and Italy are more homogenous with only 1.4 continents on average (Spain 1.8); the social sciences are also more homogenous than the other domains (1.8 continents compared to more than 2, see Table 5).

Table 4. Species richness indices for research teams by country

	Total no. of continents per team				Average no. of continents per team (S/N)			
	Mean	95%-confidence int.		N	Mean	95%-confidence int.		N
		lower	upper			lower	upper	
CZ	1.35	1.16	1.54	40	0.24	0.20	0.27	40
DE	2.14	1.99	2.30	139	0.33	0.31	0.35	139
ES	1.79	1.61	1.96	89	0.29	0.25	0.32	89
FR	2.37	2.22	2.52	139	0.38	0.36	0.41	139
HU	1.39	1.20	1.58	51	0.26	0.22	0.29	51
IT	1.38	1.25	1.51	92	0.26	0.23	0.29	92
NO	1.89	1.69	2.10	66	0.37	0.33	0.42	66
PT	1.91	1.69	2.13	68	0.31	0.28	0.34	68
SE	2.44	2.23	2.65	89	0.38	0.34	0.42	89
UK	2.77	2.57	2.98	106	0.40	0.36	0.43	106
All	2.05	1.99	2.12	879	0.33	0.32	0.34	879

Table 5. Species richness indices for research teams by academic domain[a]

	Total no. of continents per team				Average no. of cont. per team (S/N)			
	Mean	95%-confidence int.		N	Mean	95%-confidence int.		N
		lower	upper			lower	upper	
Engineering	2.17	2.05	2.29	252	0.33	0.31	0.35	252
Social sciences	1.80	1.66	1.93	202	0.32	0.30	0.35	202
Natural sciences	2.22	2.07	2.37	169	0.35	0.32	0.37	169
Biology	2.13	2.02	2.23	353	0.33	0.32	0.35	353
All	2.05	1.99	2.12	879	0.33	0.32	0.34	879

a Academic domains were classified based on field information from the teams. Teams could allocate themselves in more than one domain and five domains (agriculture, medicine, biomedicine, humanities, others) are not shown due to low case numbers. Hence cases don't add up to the total.

The third operationalisation of cultural diversity followed suggestions in Stirling (2007) and included a measure for disparity. We calculated two diversity indices, one measuring richness-weighted disparity and the other one measuring evenness-weighted disparity. The disparity was calculated as the average Euclidean distance between the team members' countries for a set of four criteria according to Hofstede and Hofstede (2005). As the data on the countries of origin of the team members, that was required for calculating the cultural disparities, was only available for the Biology teams (the NetReAct dataset), the disparity indices are limited to this dataset. Both indices correlate with the Shannon diversity index (Pearson $r_{Shan/RWD}$= 0.73, $r_{Shan/EWD}$ = 0.62) and the total number of species (Pearson $r_{SR/RWD}$= 0.75, $r_{SR/EWD}$ = 0.58), but not with the average number of species per team (Pearson $r_{NSR/RWD}$= 0.09, $r_{NSR/EWD}$ = 0.06). The cultural diversity values averaged over countries are again very similar to the previous operationalisations (see Table 6).

Table 6. Richness-weighted and evenness-weighted disparity indices for life science research teams by country (Hofstede's cultural measures)

	Richness-weighted disparity				Evenness-weighted disparity			
	Mean	95%-confidence int.		N	Mean	95%-confidence int.		N
		lower	upper			lower	upper	
CZ	155.3	43.5	267.1	23	16.1	6.0	26.3	23
DE	606.3	449.9	762.8	56	43.4	34.4	52.5	56
ES	376.4	152.3	600.6	36	26.1	13.8	38.4	36
FR	483.7	334.5	633.0	45	36.3	26.8	45.8	45
HU	196.3	64.8	327.7	28	24.2	8.7	39.7	28
IT	225.0	110.0	340.1	45	21.9	11.8	32.0	45
NO	375.6	208.6	542.5	36	34.7	23.5	45.9	36
PT	401.0	184.6	617.4	36	31.4	17.3	45.6	36
SE	1214.5	926.6	1502.4	39	84.0	63.9	104.1	39
UK	1106.2	886.8	1325.5	66	69.0	56.8	81.3	66
All	577.6	507.5	647.6	410	42.1	37.7	46.5	410

Table 7. Correlations between different cultural diversity measures and research output

Variable	Est. no.	Dimension	OUTPUT (Model = negbin)		ZOUTPUT (Model = OLS)		Cases
			b	t-ratio	b	t-ratio	
Shannon index (PhD students)	1	linear	-0.087	-0.644	0.050	0.415	198
	2	linear	0.492	1.313	0.536	1.662+	198
		squared	-0.435	-1.555	-0.375	-1.571	198
Shannon index (post-docs)	1	linear	-0.118	-0.939	-0.150	-1.284	198
	2	linear	-0.685	-1.954+	-0.436	-1.405	198
		squared	0.450	1.785+	0.225	1.029	198
Shannon index (entire team)	3	linear	0.131	1.206	0.077	0.919	597
	4	linear	0.024	0.084	0.068	0.313	597
		squared	0.095	0.400	0.007	0.042	597
Total no. of continents per team	5	linear	0.079	1.729+	0.040	1.156	597
	6	linear	0.016	0.092	0.049	0.374	597
		squared	0.013	0.382	-0.002	-0.067	597
No. of continents per team member	7	linear	-0.645	-2.372*	0.048	0.237	597
	8	linear	0.349	0.0412	0.671	1.050	597
		squared	-1.202	-1.243	-0.712	-1.028	597
Richness-weighted disparity (Hofstede)	9	linear	0.982E-04	1.235	0.133E-04	0.185	363
	10	linear	0.306	1.655+	0.831E-04	0.483	363
		squared	-0.109E-06	-1.609	-0.278E-07	-0.447	363
Evenness-weighted disparity (Hofstede)	11	linear	0.002	1.308	0.196E-03	0.179	363
	12	linear	0.004	1.473	0.984E-03	0.435	363
		squared	-0.119E-04	-0.963	-0.449E-05	-0.398	363

Relationship between cultural diversity and team performance

In a next step of analysis we related the different national cultural diversity indices to measures for the research output of the teams in the dataset. The multivariate models included a set of control variables for the country, academic domain, age and size of the teams, as well as the gender, level of recognition, and experience of the team leaders. These control variables are not shown or discussed in the paper due to the length restrictions, but the results can be obtained from the authors upon request.

The regression results in Barjak and Robinson (2008) showed that the most productive teams had a moderate level of cultural diversity of their PhD students, and that high cultural diversity is accompanied by reduced publication productivity. This result can also be seen in Table 7 (estimations no. 2 for the OUTPUT variable), though it is not significant due to a smaller number of cases and slightly different set of control variables. In contrast to the previous estimation, we also get a significant non-linear (U-shaped) relationship for post-docs. The contrary results for PhD students and post-docs already suggests the results that we then see for the other indices that are based on these categories and the team leaders and partially a larger set of academic domains: few of them show any relationships to the explained variables. There is a positive coefficient for the total number of continents per team (est. no. 5) but a negative coefficient for the average number (total number divided by team size, est. no. 7). Finally there is a nonlinear relationship between the richness-weighted disparity and the output of the teams (est. no. 10). However, these findings only appear in the negative binomial models with the total number of journal articles as the dependent variable. If we normalise the number of publications by dividing it through the total of academic team members we don't get significant results for any of the latter operationalisations of national cultural diversity.

The role of acculturation processes

People may have been born in one country but obtained their formal academic education in another country and thus be socialized to its (assumedly different) culture.[11] As a final issue we looked at the role of acculturation and its effects. We did this by comparing diversity measures for the continents of origin of the team members with the same measures for their continents of last degree (the PhD for team leaders and post-docs). We find that the measures are correlated, but not as highly as we expected: the Pearson correlation coefficients for the Shannon-Indices and the species richness measures are between 0.72 and 0.76. For the total of teams, the average diversity is slightly reduced, i.e. the teams are more homogeneous. This means nothing else but that the number of people who was born outside of the ten countries but studied and remained in these countries is higher than the number of people who were born there, studied abroad (in another continent) and came back after their studies. Or shortly: we count more immigrants than remigrants. This is the case across all academic domains and for Sweden, the UK, Norway, France, Germany and Hungary. For the Czech Republic, Italy and Portugal it is vice versa: the diversity measures based on the country of last degree are higher than those based on the country of origin. For Spain there are contradictory results. Using these slightly different diversity measures in estimations nos. 3-8 we get nearly identical results to those shown in Table 7.

Summary and conclusions

The paper analysed the national cultural diversity of research teams in a set of different academic domains and European countries. It discussed the construct of national cultural diversity and its possible effects on the performance of research teams and used different

[11] We owe this suggestion to one of the reviewers.

operationalisations of the construct which to different degree incorporate the fundamental constituents species richness, evenness and disparity.

Our analysis produces quite clear findings in regard to the differences between countries and academic domains:

- Among the ten countries of our analysis, the UK and Sweden have above average cultural diversities of their research teams, whereas the Czech Republic, Hungary and Italy have below-average diversities. For the other countries the results vary, with France more often above and Spain below the average and Germany, Norway and Portugal close to it. An explanation of this finding would require a deeper investigation of the influences on team composition and staff acquisition policy that was not part of the analysis.
- Comparing the academic domains we see that the social sciences have less culturally diverse teams than the other investigated domains, engineering, the natural sciences and biology. However, this can at least partially be explained by the smaller team sizes in the social sciences: Figure 2 and the right-hand side of Table 5 show that the differences between social sciences and other domains are reduced when we compare only smaller teams or take team size into account in the diversity measure.

Team size hence plays a role in explaining the cultural diversity measures, but it is limited as we have seen in figures 1 and 2.

From a methodological perspective it is interesting to note that the different indices of cultural diversity are correlated. The exception is the normalised species richness (no. of continents per team member) which is not related to either one of the measures based on disparity.

The relationship between cultural diversity and research performance measured as journal articles published by the teams is a lot less clear than expected according to our previous work (Barjak & Robinson, 2008). The reasons for this result still need to be investigated in more detail. One possible explanation could be the endogeneity of cultural team diversity: the better the publication performance of research teams, the more visible they are abroad and the easier it will be for them to acquire team members from abroad. This suggests that a different estimation approach might be more appropriate, for instance a 2SLS approach in which cultural diversity is first regressed on a set of explanatory variables and the residuals of this regression are then used in the second stage regressions for team performance. Another possible explanation would be that publications are not the best indicator to measure the effects of national cultural diversity – the different approaches that we discussed see effects of diversity on group communication and cohesion, and on information and decision-making. However, we did not measure either of these variables which stand between diversity and research performance.

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