Mobilisation for Public Engagement: Benchmarking the Practices of Research Institutes

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Abstract

Studies on scientists' practices of Public Engagement (PE) have pointed to variations in PE between disciplines. If variations found at the individual level are reflected at the institutional level, then research institutes (RIs) in Social Sciences (and Humanities) should perform higher in PE and be more involved in dialogue with the public. Using a nearly complete sample of research institutes in Portugal 2014 (n=234, 61% response rate), we investigate how public engagement varies in intensity, type of activities and target audiences across scientific areas. Three benchmark findings emerge. Firstly, the Social Sciences and the Humanities profile differently in PE between themselves and from other sciences. Secondly, the Social Sciences overall *perform* more PE activities, but the Natural Sciences *mobilise* more effort for PE. Thirdly, while the Social Sciences play a greater role in civic public engagement, the Natural Sciences are more likely to perform educational activities. Finally, this study shows that the overall *size* of RIs, available *PE funding* and *PE staffing* are contributing factors to the culture of outreach and public engagement at the institutional level.

Keywords: public engagement, outreach, science communication, research institutes, performance, mobilisation

1. Introduction

There is a widely entertained, societal obligation on the part of scientific institutions to serve society with social impact and to engage citizens in research policy (Ziman, 1984, 173ff.). This is also evidenced in recent policy documents (e.g. the European Union Framework Programme for Research and Innovation defines tackling societal challenges through research as one of the main priorities for Europe in the next decade (RRI, 2013)), and by procedures of research funding bodies that require plans for engaging society with the results of the funded research. As a result, universities and scientific institutions face an imperative to facilitate 'pathways to impact' for their research as this can be an important factor in determining funding beyond serving society (see for example the Research Excellence Framework (REF) (2014) in the UK).

To solve societal problems with research is one thing, to talk about research in a wide and public manner is another. The latter need has resulted in a growing interest in enhancing the communication function of scientific institutions: many have now press, PR or communication offices that support relationships with the media, policy makers and the wider public. And, while this is becoming general practice at the level of universities and at large scientific organisations (Neresini & Bucchi, 2011), little is known about what is happening at the level of research units, i.e. research centres and institutes (henceforth RIs) within or outside universities. Various attempts have been made to measure individual scientists' Public Engagement (henceforth PE) activities, individual behaviour and motives for doing so (e.g. Royal Society, 2006, Poliakoff & Webb, 2007, Kreimer et al., 2011, Jensen, 2011), but the examination of the organisational practice of PE has hitherto received little to no attention with the exception of an exploratory study presented by Neresini & Bucchi (2011). Public communication remains a minority pursuit among active scientists (e.g. Jensen, 2011); institutions themselves do not seem to recognise public communication as part of the research activity (Cassini and Neresini, 2012).

This study is the first to map a national pattern of nation-wide institutional responses to demands for public engagement and the first to benchmark these activities on the meso level of research institutes. We are mapping what RIs are doing and whether variations exist in PE

practices across scientific areas, after controlling for the resources that are made available. We must assume that the culture of public engagement in any nation operates on several levels and each level constitutes a context for the practice of the others - the practices at the university level are not necessarily reflected across research institutes, the same way that the activities reported by institutes do not represent the engagement at the level of individual researchers. PE activities of individual scientists as reported by previous studies concentrate on a minority of researchers (e.g., in the Jensen's study (2011), the most active 5% accounted for 50% of PE activities of French Centre National de la Recherche Scientifique (CNRS). Also, there are PE activities in RIs with little involvement of individual researchers as these activities might be outsourced or delegated to specialist staff, or there are PE activities of individual researchers, but little evidence of RIs' mobilisation of such efforts. We investigate the variations that exist in the PE practices of RIs independent of what individual researchers and the university level might contribute.

Hypotheses on Public Engagement (PE) of Research Institutes (RIs)

In order to structure our investigation, we frame a number of hypotheses on intensity, type of PE activities and target audiences of RIs, based on variations of PE practice found at the level of individual scientists.

Intensity of PE. Studies on scientists' PE activities show that PE intensity varies across scientific areas. For example, Jensen & Croissant (2007) have shown that between 2004 and 2009, chemists (46.7%) and biologists (45.2%) from the CNRS were less likely to get involved in public engagement, while social scientists (84.8%) and environmentalists (75.8%) were the most engaged. Similarly, Kreimer's et al. (2011) showed that among Argentina's researchers, social scientists were the most likely to be active and biologists the least. This evidence about individual

scientists, leads us to expect that intensity of PE will vary across RIs, with the Social Sciences and the Humanities also being more active in Portugal (Hypotheses 1).

Type of PE activities and target audiences. Previous studies found that chemists and biologists were more active at schools and 'open door' events, while social scientists were more active in civic activities such as conferences, press, radio and TV programmes (Jensen, 2011) and speeches to NGOs (Kreimer et al. 2011). Moreover, the various public issues involving science (e.g. nuclear power, biotechnology or nanotechnologies) require dialogue with the public (Wynne, 2001), a role that is often played by social scientists. Based on this, we expect variations at the level of institutes, in particular RIs in the Social Sciences and the Humanities being more involved in two-way communication activities than other sciences (Hypotheses 2).

In the same way, it is reasonable to expect that target audiences for the different sciences will vary. In particular, the Social Sciences and the Humanities will be more likely to address audiences in the context of civic engagement such as stakeholders, while the Natural Sciences will lean more towards engagement with educational audiences such as schools, but not exclusively so (Hypotheses 3). We examine institutional PE in six scientific areas following OECD practice – (1) Natural Sciences, (2) Engineering and Technology, (3) Medical and Health Sciences, (4) Agricultural Sciences, (5) Social Sciences, (6) and Humanities, according to what we call *performance*, i.e. the amount of activities carried out by RIs, and *mobilisation*, i.e. the likelihood of RIs performing a higher than median level of PE activities, i.e. a measure of eccentricity. Against this backdrop, we tested the following hypotheses on the variations of PE across RIs:

H1 (intensity)*:* The intensity of PE activities varies across scientific areas.

H1a: The overall performance of PE activities varies across different scientific areas, with RIs in the Social Sciences and the Humanities performing higher than RIs in the Natural Sciences.

H1b: RIs in different scientific areas mobilise differently into PE activities.

H2 (type of activities)*:* Different scientific areas show different profiles of PE activities.

H2a: Different scientific areas perform different types of PE activities, with RIs in Social Sciences and the Humanities being more involved in more two-way PE activities.

H2b: RIs in different scientific areas mobilise differently into different types of PE activities.

H3 (target audiences): Different scientific areas cultivate different audiences.

H3a: Different scientific areas address different audiences with RIs in the Social Sciences addressing more civic audiences and RIs in the Natural Sciences addressing more educational audiences.

3. Data and data analysis

An online survey was conducted during October/November 2014 in Portugal. The population comprised all non-profit public or private RIs of all sizes and scientific areas. No complete list of the Portuguese RIs existed, so we compiled a list from two sources to improve coverage[i]. This resulted in a sampling frame of N=386 RIs. This frame covers more than 80% of all Portuguese RIs. A total of n=234 RIs completed the survey (response rate of 61%)[ii]; several reminders were sent, and individual phone calls solicited respondents in RIs. The final sample is unbiased across research areas as shown in Figure 2 (Chi^2, $p>0.05$).

Our survey asked 43 questions on aspects of PE including staffing, policies, rationales,

barriers to PE, activities and audiences. This study will focus on activities and audiences. We collected one questionnaire for each RI, which was completed by the communication-PR-press officer, RI administrator, or any staff member with an overview of PE activities who could speak for the RI. In our study, 47.4% of the respondents were directors/coordinators of the research institutes, 18.8% were 'management/administrative' staff, 17.4% were researchers, 9.9% were communication staff, and 6.6% were 'other' (e.g. vice-directors at RIs/professors, PhD students, and postdoctoral fellows). We used the term 'public communication' to refer to any type of PE activity engaging a non-specialist public. The questionnaire was completed in English and administered via *Qualtrics* software.

Dependent variables

Our dependent variables are PE activities, classified into *12 events* and *13 channels.* We asked respondents to estimate counts for each activity. Respondents were asked '*Roughly, how many times in the past 12 months has your research unit engaged in the following events, either as organisers or contributors*?'

Events included: public lectures, public exhibitions, Open Days, science festivals/fairs, the National Science Week, science cafes/debates, FamLab/Researchers' night, *Ciencia Viva* projects[iii], Citizen Science, participatory events in policy-making, workshops with local organisations and talks at schools. *Channels* included: interviews for newspapers, interviews for the radio, interviews for the TV, Other TV (shows/programmes), press conferences, press releases, newsletters, brochures/non-academic publications, articles in magazines/newspapers, multimedia, popular books, policy papers and materials for schools. In addition, we asked about seven *new media channels* to understand how digital communication is entering the game. These included: website updates, facebook, blogs, twitter, google+, youtube, and podcasts. Respondents replied on a rating scale: *Never*, *a few times per year*, *monthly*, *weekly*, *daily*, and *Don't know*.

Audiences were rated with four options *(never, occasionally, frequently, Don't know),* on the question '*how often has your research unit engaged with'* general public, schools, students outside teaching, members of local municipalities/councils/associations, delegates from industry, governments/policymakers, non-governmental organisations (NGOs), and media and journalists.

Index construction and binary variables: we report the dependent variables (PE activities) in two ways. First, we simply count RIs' activities as reported (*performance*, *H1a*). Second, in order to compare the mobilisation effort across RIs (*mobilisation*, *H1b*), we constructed an index for *event making* and for *channelling.* Twelve 'event' and thirteen 'channel' counts, which were not normally distributed, were recoded into bands and then scored on one dimension using multivariate correspondence analysis (MCA). *Event making* and *channelling* are reliable indexes (respectively, Cronbach Alpha = 0.830 and 0.834), which means, scoring high on one event or channelling activity is generally associated with scoring high on others as well. Furthermore, we recoded both indexes into *binaries* for *low* (=0) and *high* (=1) PE intensity using a 65/35% split. And we created *threshold binaries* for each PE activity using either median split for *low (=0)* and *high (=1)* or *yes/no* as criteria, according to frequencies of activities (for example, public lectures (Mean=15.8, Median=6) were recoded into high/low; the National Science Week (Mean=0.55, Median=0) was recoded into yes/no activity). We can thus model for overall PE intensity integrating many types of activities as well as for each type of activity; and for each of these indicators we assess the likelihood of being a high performing RI using binary logistic regression establishing the odds of a RI being a 'high performer'.

In this system of indicators, we examine the following model: how does scientific area affect the PE activity of RIs controlling for the overall *size* of the RI (number of researchers), the funding available for PE (*PE funding*), and the staff dedicated to PE activities (*PE staffing*) (Figure 1).

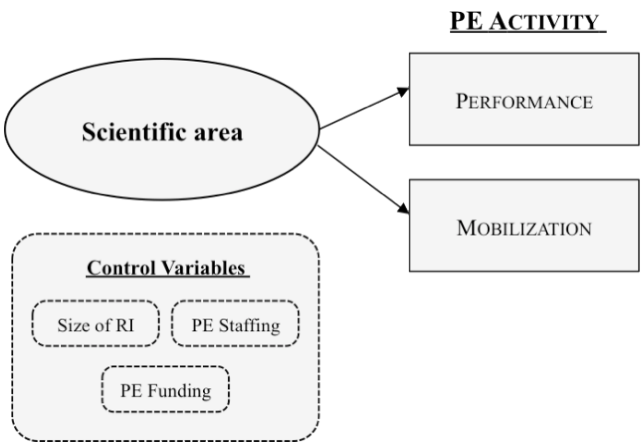


Figure 1. Conceptual model showing the hypotheses tested.

Independent variables

'Scientific area' is our main predictor. RIs were classified into (1) Natural Sciences, (2) Engineering and Technology, (3) Medical and Health Sciences, (4) Agricultural Sciences, (5) Social Sciences, (6) and Humanities.

Control variables. Neresini & Bucchi's (2011) exploratory study on indicators for PE concluded that size (given by number of employees) did not matter for most PE activities organised by research institutions; given the different focus of our study, we wanted to control for the size of RIs given by the total number of researchers working in the RIs. 'Size' was ordinally coded 1 for <=31, 32-60 (=2), 61-138 (=3) and >=139 (=4). We also control for 'PE staffing' coded =1 for RIs with staff dedicated to PE tasks and coded =0 for RIs without dedicated PE staff; and 'PE funding' for the amount of funding available for public engagement activities,

coded ordinally 1 for *none, <1%* (= 2), *1-5%* (= 3), *6-10%* (=4), *>10%* (=5), and *Don't know* (=6).

Statistical analyses

We examine contingency tables and Pearson's Chi^2 for associations between PE activities and the factors that affect RIs' overall *performance***.** We also use binary logistic regression (Pampel, 2000) to model the likelihood of RIs being above median performers, using the performance of the Humanities as the reference category. We call this analysis the *mobilisation* and for this we report odd changes [100*(exp(B)-1)], Nagelkerke's R^2 and the predicative accuracy of the model. We examine patterns in PE mobilisation across RIs in the six scientific areas (figure 5).

	RIs contacted Sampling frame		**RIs responded Sample**		**Resp. rate**	**Active in PE (N=210, 89.9%)**	**PE activ. Total counts**		**Researchers Total counts**		**PE activ. per researcher**
	N	**%**	**N**	**%**	**%**	**%**	**N**	**%**	**N**	**%**	**N**
Soc Sci	98	25.5	59	25.2	60.2	91.5	4475	29.1	3855	16.4	1.2
Hum	66	17.2	41	17.5	62.1	90.2	3253	21.2	4791	20.4	0.7
Nat Sci	94	24.5	56	23.9	59.6	94.6	3131	20.4	5281	22.4	0.6
Med & Health Sci	45	11.7	29	12.4	64.4	82.6	2117	13.8	3676	15.6	0.6
Eng & Tech	67	17.4	41	17.5	61.2	82.9	1508	9.8	5100	21.7	0.3
Agri Sciences	14	3.6	8	3.4	57.1	100	871	5.7	830	3.5	1.0
Total	**386**	**100**	**234**	**100**	**61**	**89.9**	**15355**	**100.0**	**23533**	**100.0**	**0.7**

Caption Figure 2. Summary of the main survey results by scientific area. PE activity counts refer to the number of events and traditional channels; new media channel activities are not included here, given their different nature. Figures are report estimates to be interpreted carefully.

4. Results

In 2013 and 2014, most RIs in Portugal communicated with the non-specialist public (89.8%), 10.2% did not. Lack of resources (funding, staff) (50%), not priority (25%) and lack of enthusiasm, skills or time of researchers (16.7%) were mentioned as the main reasons for not undertaking public communication. A total of 15,355 PE activities were reported (including channels and traditional events), which amounts to 66 activities per RI per year, 42 activities per day across the country and close to one (0.7) activity per researcher per year. Without stretching the accuracy of this overall performance estimate, it can serve as a baseline for future comparisons.

Events

Amongst the public events that RIs organise and participate in, public lectures are most frequent *[we report % of RIs participating, Mean frequency across RIs, and Range Min-Max]* (76.1%, 14, 0-269) followed by talks at schools (60.8%, 6.2, 0-75), workshops with local organisations (61.7%, 3.9, 0-45), public exhibitions (56%, 3.0, 0-75), science cafes (29.3%, 1.6, 0-30), science festivals and fairs (34.6%, 1.5, 0-100), *Ciencia Viva* projects (42.3%, 1.5, 0-25), participatory events on policy issues (26.8%, 1.5, 0-24), and Open Days (50.2%, 1.3, 0-12). RIs also reported participation in annual events: the National Science Week (34.9%), FamLab and Researchers' night (25.4%), and Citizen Science projects (15.8%).

Channels

The channels most used by RIs are interviews for newspapers (65.9%, 9.0, 0-280), articles in magazines/newspapers (51.2%, 5.8, 0-250) and newsletters (41%, 4.6, 0-100). Less frequently used are press releases (42%, 3.9, 0-50), radio interviews (57.1%, 3.0, 0-37) and TV interviews

(50.7%, 2.7, 0-36). Press conferences and policy briefings are the least used channels (10.2%, 0.4, 0-15; 11.7%, 0.4, 0-10, respectively).

New media channels are not yet much in use. 44% of RIs use Facebook on a weekly or daily basis (42% do not use at all); 49% of RIs update their website at least weekly. However, the vast majority of RIs have not yet used new media channels: 78% do not use blogs, twitter (80%), google+ (84%), Youtube (68%) and podcasts (89%). Given the different nature of new media channels and traditional channels (e.g. a posting a message on twitter or facebook requires a different effort from writing an article for a newspaper), and given the limited use by RIs of new media channels, we do not consider new media further in our analysis of PE mobilisation. Also, new media channels such as the use of twitter, google+, youtube and podcasts are not associated with scientific areas; the relative absence of their use is nearly universal.

Audiences

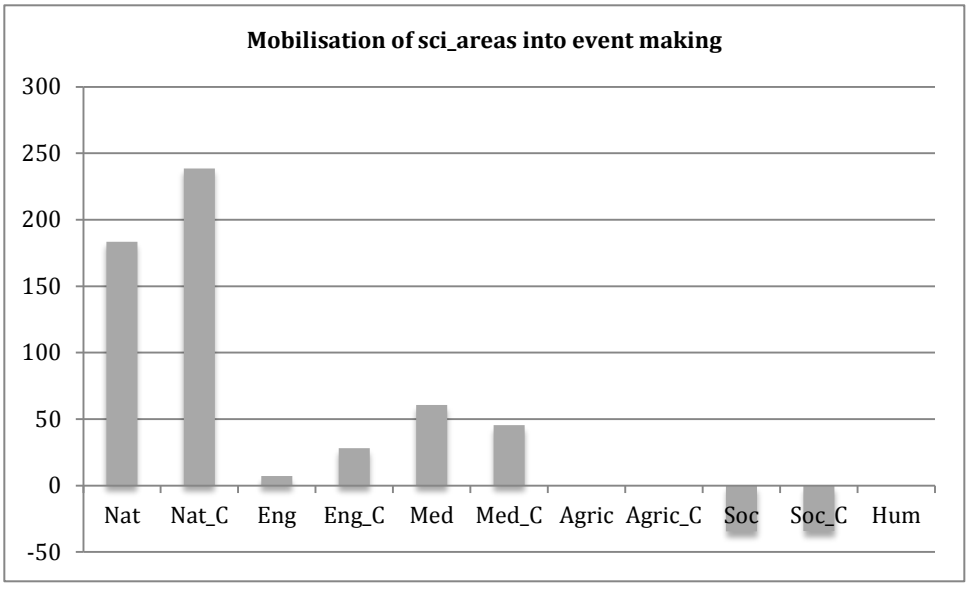
Audiences most frequently addressed are students outside teaching [*we report % frequently*] (50.2%), schools (49.8%) and the general public (43.0%). Governments and politicians, and NGOs are less often the target of activities (13.0% and 17.6%, respectively). This shows that educational and civic audiences are more often addressed than political and commercial stakeholders.

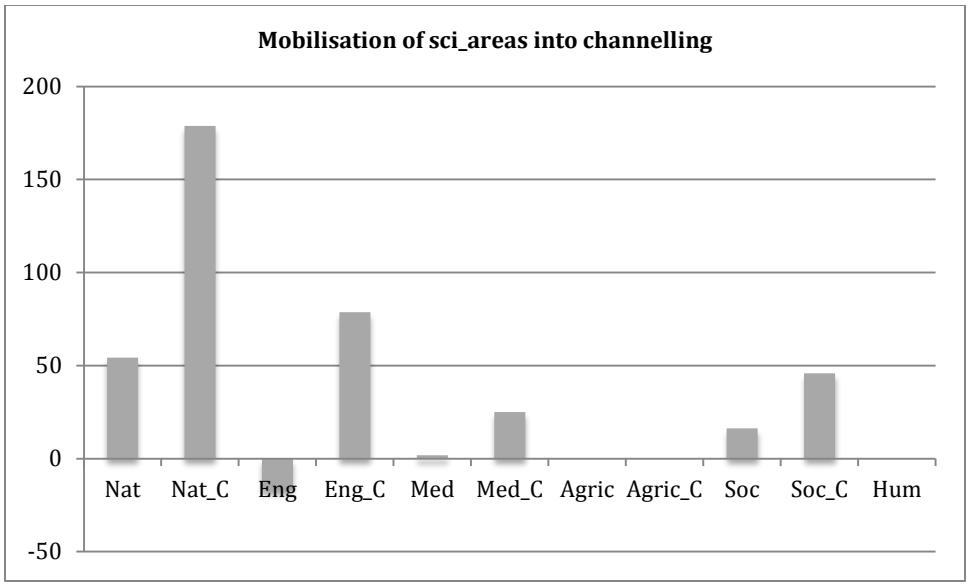
Differences in Intensity of PE activities by scientific area: Performance and Mobilisation

PE overall performance. Figure 2 shows that the total counts of PE activities vary across RIs in different scientific areas: the Social Sciences and Humanities are at the forefront with 4,475 and 3,253 activities (29% and 21.1% of total activities) while Engineering and Technology, and

Agricultural Sciences engage the least (10% and 5.6% of total activities, respectively). This confirms our *H1a:* The overall performance of PE activities is a matter of scientific area.

PE mobilisation. Figure 3 shows no significant results for *channelling* (all confidence intervals (CI) overlap the 0=line, even after controls). The Natural Sciences excel on *event making* as compared to the Humanities (Odds (95% CL) = 2.847 (1.179-6.877), p=0.020). This effect is accentuated when controlling for size, PE funding and PE staffing (OR (95% CL) = 3.988 (1.528-10.405), p=0.005). All other areas do not differ from the Humanities in *event making* or *channelling*. This establishes a curious paradox: while overall the Social Sciences and the Humanities perform more PE events, the Natural Sciences are more likely than the Humanities to mobilise high performers for PE events. This confirms our expectation *H1b* that there is variation in the mobilisation effort across different sciences: the Social Sciences and the Humanities are more active overall, but the activities performed are more accentuated in some RIs in the Natural Sciences, which are high performers. Indeed, groups of RIs can do fewer activities overall, and concentrate them in a subset of institutes. This finding shows that a lower overall performance can go together with greater mobilisation across all institutes (in a given scientific area).





Caption Figure 3. Mobilisation of scientific areas into event making and channelling controlling for PE staffing and PEfunding. Figures correspond to the Odds % and Humanities as reference category. For this analysis, we have excluded the Agricultural Sciences (n=8) given the small number and the presence of an outlier RI. In both charts, for each scientific area, we present the PE mobilisation before and after controls (e.g. Nat and Nat_C).

Differences in types of PE activities and PE audiences: performed and mobilised portfolios by scientific area

Performed portfolios

Figure 4 gives the total *performance* of PE activities by scientific area. It shows that the type of activities carried out by RIs in different scientific areas varies, confirming our hypothesis *H2a*.

Main scientific area	Nat Sci	Eng & Tech	Med & Health Sci	Agric	Soc Sci	Hum
Ciencia Viva Projects (N=317)	56%	11%	11%	11%	9%	3%
Science Week (N=101)	41%	18%	16%	9%	10%	7%
Talks at schools (N=1290)	40%	10%	12%	3%	19%	16%
Materials for schools (N=232)	37%	7%	10%	1%	30%	16%
Other TV (N=313)	36%	8%	15%	4%	34%	3%
FameLab, Researchers' night (N=75)	36%	12%	12%	9%	23%	8%
Science Cafes/debates (N=334)	33%	5%	8%	2%	17%	34%
Multimedia (N=341)	28%	11%	9%	2%	36%	14%
Festivals/Fairs (N=315)	27%	7%	20%	5%	37%	5%
Open days (N=262)	26%	17%	12%	8%	17%	19%
Delib. policy-making events (N=322)	25%	6%	13%	7%	44%	6%
Press releases (N=791)	24%	10%	20%	5%	28%	14%
Workshops by local organiz. (N=820)	22%	9%	8%	6%	36%	20%
Interviews TV (N=561)	19%	13%	23%	8%	28%	9%
Pub exhibitions (N=632)	19%	12%	7%	2%	31%	29%
Policy papers (N=81)	19%	0%	6%	9%	64%	3%
Interviews Radio (N=621)	18%	10%	13%	6%	39%	14%
Citizen Science (N=151)	17%	1%	14%	17%	44%	7%
Articles in magaz/newsp (N=1189)	16%	7%	3%	3%	45%	25%
Brochures/leaflets/publications (N=643)	14%	6%	8%	6%	24%	43%
Pub lectures (N=2926)	13%	7%	19%	3%	25%	33%
Interviews Newsp (N=1853)	13%	21%	20%	15%	22%	9%
Popular books (N=133)	11%	4%	4%	4%	27%	51%
Newsletters (N=974)	6%	8%	11%	2%	40%	34%
Press conf (N=77)	3%	4%	14%	25%	46%	9%

Caption Figure 4. This table shows the distribution of performed activities across RIs in the six research areas. For each activity we give the total counts in the first column (N= 234) which is the basis for 100% for each respective row. Percentage in each bar refers to estimated counts of activities for each scientific area relative to the total. The row percentage allows for direct comparison of the differences between scientific areas on each PE activity. We highlight the ten most frequent activities in each scientific area to show the pattern of PE activity for the different areas.

We observe a pattern emerging for the different scientific areas both in types of activities and audiences. The Natural Sciences perform higher than other scientific areas on *Ciência Viva* projects (56% of all reports), the National Science Week (41%), talks at schools (40%), materials for schools (37%), TV programs (36%), FamLab and Researchers' night (36%), science cafes

(33%) and Open Days (26%). However, they participate in fewer press conferences (3%) and produce fewer newsletters (6%) than any other sciences. Engineering and Technology perform low overall, and engage in newspaper interviews (21%), the National Science Week (18%) and Open Days (17%). The Medical Sciences are more likely to use media channels: TV interviews (23%) and interviews for newspapers (20%), press releases (20%) and to participate in TV programs (15%). However, they write fewer popular books (4%), articles for magazines (3%) and policy papers (6%). The Agricultural Sciences participate more in press conferences (25%), interviews in newspapers (20%), citizen science (17%) and *Ciência Viva* projects (11%). Otherwise, Agricultural Sciences perform low. The Social Sciences are most likely to produce policy papers (64%) and magazines/newspapers articles (45%), and organise more deliberative policy-making events (44%), workshops/events with local organisations (36%) and press conferences (46%). They are less likely to participate in *Ciência Viva* projects (9%), the National Science Week (10%), science cafes (17%), Open Days (17%), and talks at schools (19%). The Humanities organise the most science cafes/public debates (34%), public lectures (33%) and public exhibitions (29%), and produce by far the most popular books (51%) and brochures/leaflets (43%). By contrast, they are less likely to be involved in *Ciência Viva* and Citizen Science projects (3% and 7%, respectively), TV programs (3%), festivals/fairs (5%) and in writing policy papers (3%).

Mobilised portfolios. We apply binary logistic regression analysis to test hypotheses *H2b* and *H3a*. Our dependent variables 'events' and 'channels' are binary variables with *high* (=1) and *low* (=0) or *yes* (=1) and *no* (=0) activity, and 'target audiences' are binary variables with *never/occasionally* (=0) and *frequently* (=1). Figure 5 shows the characteristic mobilisation pattern across RIs comparing scientific areas, before (Model 1) and after controlling for size, PE funding and PE staffing (Model 2). Here we are only indicating statistically significant regression effects. Significant results are highlighted in the table, and indicate that a research area is more

likely to be characterised by RIs with *high PE engagement*, or which *frequently* address a target audience. For example, RIs in the Natural Sciences and Engineering and Technology are more likely to organise many Open Days (i.e. the likelihood to have high performers on that activity in their ranks) compared to the Humanities, and RIs in the Social Sciences are more likely to frequently address NGOs, compared to the Humanities.

Most activities show associations with scientific area, confirming our expectation *H2b* that scientific areas mobilise differently into different types of PE activities. The exceptions are school talks, citizen science projects and interviews in newspapers, radio and TV, press conferences and press releases, brochures, multimedia and activities for schools where there are no significant variations from the Humanities. More specifically we identify the following portfolios:

Natural Sciences: RIs in Natural Sciences are more likely to have high performers on open days, festivals and fairs, the National Science Week, *Ciência Viva* projects, and in European initiatives such as the FamLab or the Researchers' night, and are more likely to frequently address schools. When control variables are added to the model, the likelihood of addressing the general public increases, meaning that resources and size make a difference for the Natural Sciences in addressing the general public (note that the general public is the main target audience for RIs for the Humanities with 70% frequently addressing the general public, model 2 explains 28% of the variance with 18% improvement over model 1 after controls).

Engineering and Technology: RIs in Engineering and Technology are more likely to undertake fewer public engagement activities overall, but the likelihood of them having higher participation in certain activities such as Open Days, festivals and the national science week increases when control variables are added. In addition, they are less likely to frequently address the general public, and more likely to address members of industry if resources are made available (the improvement in the model was only 1%, meaning that industry is already a main target audience for Engineering and Technology RIs).

Medical Sciences: RIs in the Medical Sciences are more likely to participate in the National Science Week and *Ciência Viva* projects, to organise more workshops with local organisations (Odd high versus low) than the Humanities. The likelihood of communicating frequently with the media and journalists increases when control variables are added (model 2 explains 28% of the variance, an increase of 21% from model 1 after controls).

Agricultural Sciences: RIs in the Agricultural Sciences tend to participate/organize more deliberative policy-making events (11.9 times more likely to do more policy-making events than the Humanities, considering that 14% of RIs in the Humanities participate in policy-making events).

Social Sciences: RIs in Social Sciences are more likely to participate/organise more deliberative policy-events (3.9 times higher than Humanities) and write more policy papers (9.7 times higher). They are also more likely to frequently address NGOs, and the likelihood increases when control variables are included (16 times higher).

	high or Y/N	Nat	Eng& tech	Med	Agric	Soc	Hum	Mod 1	Mod 2		
							% of act.	Change%	Nagelkerke R^2	change%	Diff %
Events											
Pub lectures	>6						68.6	6%			
Pub exhibitions	>1			*			61.1	6%	0.154	15%	9%
Open days	y/n	*					38.9	13%	0.166	17%	4%
Festivals/Fairs	y/n	*	C				22.2	9%	0.155	16%	7%
Science Week	y/n	*	C	*	*		16.7	16%	0.258	26%	10%
Science Cafes/debates	y/n		*				44.4	6%	0.132	13%	7%
FameLab, Res' night	y/n	*					13.9	11%	0.265	27%	14%
Ciencia Viva	y/n	*	*	*	*		19.4	18%	0.278	28%	10%
Delib. policy-making	y/n	C		C	*	*	13.9	4%	0.169	17%	2%
Workshops by local orgs	>2						50.0	9%	0.155	16%	7%
Talks at schools	>3						47.2				
Citizen Science	y/n						11.1				
Channels											
Interviews for newsp	>3						41.7				

Interviews for radio	>1						38.9				
Interviews for TV	>1						36.1				
Other TV	y/n	*					11.1	7%	0.168	17%	10%
Press conf	y/n						11.1				
Press releases	y/n						36.1				
Newsletters	y/n						47.2	5%			
Brochures/publications	y/n						44.4				
Articles in magaz/newsp	>2			*			50.0	7%	0.168	17%	10%
Multimedia	y/n						30.6				
Popular books	y/n						30.6	6%			
Policy papers	y/n					*	2.8	16%	0.230	23%	7%
Materials for schools	y/n						33.3				
Website update	At least weekly						69.4	7%			
Facebook	"					*	58.3	6%	0.510	51%	45%
Blogs	At least monthly	*	*	*		*	27.8	19%	0.349	35%	16%
Twitter	"						8.3				
Google+	"						11.1				
Youtube	"						11.1				
Podcasts	"						0.0				
Audiences											
General Public	Freq.		*				69.4	6%	0.284	28%	22%
Schools	Freq.	*					47.2	8%	0.138	14%	6%
Stud_outside_teach	Freq.						58.3				
Local munic/councils/assoc	Freq.				*		27.8	7%	0.156	16%	9%
Industry	Freq.		C				8.3	4%	0.068	7%	3%
Gover/policy-makers	Freq.						0.0				
NGO	Freq.					*	5.6	16%	0.232	23%	7%
Media/Journalists	Freq.			C			16.7	8%	0.287	29%	21%
Activities varying from Hum		14	12	8	4	7					

Caption Figure 5. Profiling the mobilisation effort of scientific areas into activities and audiences. The colours show significant associations between scientific areas with types of PE activities and target audiences; the reference is always the Humanities. Dark grey means more likely than the Humanities to be a high activity RI and to frequently address an audience; and light grey means less likely to do 'high' in activities and to frequently address an audience; (*) indicates a significant association both before and after control; 'C' indicates an association only after

control; and a coloured empty cell shows an association before controls. For example, RIs in Social Sciences are more likely to produce policy papers than RIs in Humanities; note only 2.8% of RIs in Humanities produce any policy papers. Model 2 after controlling for PE staff and PE resources explains 22% of the variance with 6% improvement in prediction over Model 1; which means that resources make little difference for policy papers across RIs in different scientific areas.

5. Discussion

In this study, we examined the Public Engagement (PE) practices of Research Institutes (RIs) in Portugal in 2014 using a whole population sample. Based on previous studies on individual scientists' PE practices, we tested hypotheses on variations in PE practices at the institutional level across scientific areas.

The principal result of our investigation is that we can indeed confirm differences in the intensity of PE activities across scientific areas both in terms of overall *performance* and *mobilisation* of PE: RIs in the Social Sciences and Humanities perform more PE activities overall (both events and traditional channels), but RIs in the Natural Sciences are more likely to mobilise high performers for PE events. This means that although RIs in the Social Sciences and Humanities put on more events, their efforts are more equally distributed, while the Natural Sciences, despite performing fewer events, count the top performers amongst their crowd. No differences were found in the mobilisation of channels across scientific areas, meaning that institutions mobilise channels equally.

Secondly, the type of PE activities varies across scientific areas. Despite complex profiles, RIs in the Social Sciences are more involved in two-way activities such as deliberative events and workshops with local organisations; the Natural Sciences are more involved in educational activities such as Open Days, the National Science Week, festivals and fairs, talks at

schools, FamLab and Researchers' night. The Humanities are in between, engaging in both one-way educational and two-way deliberative activities; they are most likely to undertake public lectures and public exhibitions, science cafes, workshops by local organisations, and to produce newsletters, non-academic publications/brochures, and popular books. This also marks a different pattern of PE between the Social Sciences and the Humanities, as we shall discuss further.

In terms of mobilisation efforts for activities and audiences, compared to the Humanities the Natural Sciences mobilise high performers into Open Days, festivals/fairs, science week, FamLabm, *Ciência Viva* projects and address schools frequently; Engineering and Technology have low PE performance overall, and so are less likely to have high participation in any PE activities; the Medical and Health Sciences mobilise high performers into the National Science Week, *Ciência Viva* projects, and frequently address the media and journalists; the likelihood of the Agricultural sciences ranking as *high performance* in deliberative events and frequently addressing local organisations is higher than the Humanities. The likelihood of the Social Sciences ranking as *high performance* in deliberative events, writing policy papers, and addressing NGOs is also evident compared to the Humanities.

Furthermore, our analysis shows that the performance of RIs in some PE activities is sensitive to size and resources available. For example, controlling for size, PE staff and PE funding, the use of facebook and blogs by RIs increases in all areas, except for the Agricultural Sciences, suggesting that RIs may not be using new media channels due to the lack of resources and institutes being small in size. Similarly, the availability of staff and resources and overall size increase the likelihood of RIs in the Medical Sciences communicating frequently with the media and journalists and RIs in the Social Sciences and the Natural Sciences communicating frequently with the general public.

Our present aim is not to evaluate which research area is doing the 'best' at engaging the public, we would nevertheless like to bring two considerations to the discussion to initiate a critical conversation on the involvement of different scientific areas in PE. Firstly, research in the

Social Studies of Science tends to collapse the Humanities and Social Sciences into one for analytical purposes, we show that in terms of public engagement they profile differently and therefore should be treated separately. They organise and participate in different public engagement activities, and address different audiences. In fact, when comparing PE activities, it is the Agricultural Sciences that show a profile of PE activities most similar to that of the Humanities (though this might be an artefact of the small sample size).

Secondly, public engagement practices at RIs seem to emerge as a spectrum of activity, with the Social Sciences and Natural Sciences having well-defined profiles on opposite sides of a continuum -- at one extreme we have the Natural Sciences performing mainly **educational and one-way, mono-logical PE activities** and thus addressing audiences in educational contexts. At the other extreme we have the Social Sciences engaging in more **civic and two-way, dialogical PE activities** and more frequently addressing audiences in a civic context. The Humanities and Medical Sciences have profiles between these two poles, performing a mix of activities, with lower intensity (except the Humanities which perform very high), and focussing on specific audiences including the general public, industrial and political audiences. Engineering and Technology, and the Agricultural Sciences, with lowest overall performance, are also located in this middle ground. Our study shows that RIs in different scientific areas are serving different audiences by performing and mobilising different PE activities: the Social Sciences are more likely to engage in dialogical approaches of communication directed at more specialised audiences, the Natural Sciences are more likely to perform an education/outreach role by engaging in more mono-logical activities.

In conclusion, our research in Portugal sheds new light on the factors that facilitate PE at the institute level. We show that scientific area is a good predictor of PE and that size, available PE funding and PE staffing moderate the likelihood of a RI being a high performer in some public engagement activities and in addressing some audiences. Available resources and size

make a difference in particular in the use of new media channels, when engaging the wider public and in engaging the mass media.

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[i] One list was provided by the *Fundação para a Ciência e Tecnologia (FCT)* (the Portuguese research funding agency, which funds most of the research in Portugal) and comprised 318 RIs. All these research units had gone through a process of evaluation in 2008 and received annual funding from FCT for the period 2007-2014. This list was complemented using data from the *Direcão-Geral de Estatísticas do Ensino Superior (DGEES)* on other research institutes, mostly smaller and non-FCT funded, which were active in 2011. As the DGEES information is provided by the RIs themselves, it is possible that other research units exist, and being that the case, we expect them to be university units very small in size..

[ii] Initially the list contained 406 research institutes, but as these lists were out of date 20 had ceased their activities by the time we implemented the survey or had joined existing institutes.

[iii] *Ciencia Viva* was a main national initiative created in 1996 in Portugal aimed at mobilising the scientific community and RIs to strength relationships with the public and schools. Among many others, it supports RIs' projects of public engagement.