Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI)

Report on the Researchers' Survey (Sub-task 8.1: Collection of data on RRI benefits)

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1. Introduction

Background and aims of the study

This report presents the results gathered in task 8, sub-task 8.1, the collection of data on RRI benefits, which is dedicated to the prevalence of RRI benefits in Europe from the viewpoint of European researchers.

Methodology

In order to analyse the activities and attitudes towards Responsible Research and Innovation (RRI), two online surveys were conducted: In a first step, we surveyed researchers listed on the EC CORDA database, which was delivered by the Commission Services to the study team. This dataset contained contact details of researchers funded by the Horizon 2020 framework programme (including the European Research Council and Marie Skłodowska-Curie Actions). Before launching the first survey among these EU-funded researchers, the data were cleaned by the Fraunhofer ISI study team (deleting duplications, etc.). In a second step, Fraunhofer ISI generated a control group based on selected main characteristics of the EU researchers' group: country of work, gender and scientific discipline. But unlike the first group, this group of researchers had not received any EU research funding within the last five years. This was controlled by matching the EU database with the list of control group addresses but also by integrating a control variable at the beginning of the questionnaire (see below). We used the Scopus Author IDs to compile the control group. The control group approach aimed to analyse whether the EU funding context exerts an influence on the perceptions and concrete activities of researchers through its promotion of RRI.

The first survey - among the EU funded researchers - was launched on 17 November 2016 and reminders were sent in late November and then mid-December 2016. In total, 22,947 persons were contacted by e-mail, but 673 could not be reached. Of the remaining 22,274 persons, 3,117 responded actively to the survey request, a response rate of 14%. In total, 2,755 participants completed the survey (completion rate: 12.4%). The average process time for the survey was 15:57 minutes.

The second survey – among the control group – was launched on 14 March 2017. 25,968 identified researchers were contacted by e-mail. 8,245 persons could not be reached due to absence, retirement or an invalid/outdated e-mail address, resulting in a net sample of 17,723 persons. 1,264 researchers responded to the survey request, constituting a gross response rate of 7.1%. Of these, 945 participants answered at least half the questions in the survey, a net response rate of 5.3%. In total, 723 participants completed the survey (completion rate: 4.1%). The average process time of the respondents was 14:30 minutes.

As mentioned above, a filter question was positioned at the beginning of the control group survey in order to ensure that participants have not received any financial research support from the EU over the past five years. 417 respondents indicated that they had either received funding from the EU Framework Programme (FP7 or H2020), ERC Grants, EUREKA, COST or other EU research programmes. Consequently, this group was excluded from further analysis, leading to an adjusted de facto control group of 528 participants that factually had not received any EU funding.

Design of the questionnaire

The questionnaire used for task 8.1 was divided into seven sub-parts:

- Part I deals with core characteristics of the respondents' research,
- Part II is dedicated to awareness of the RRI concept,
- Part III asks about concrete RRI activities along the five main pillars of RRI (public engagement, gender equality, science education, open access, ethics),
- Part IV investigates the main drivers for conducting the respective activities,
- Part V relates to the perceived and expected benefits,
- Part VI deals with supporting and hindering factors for the implementation of RRI and
- Part VII investigates the general background of the respondents.

The last section also provided opportunities for comments or suggestions. The exact wording of the questions including the answer categories can be found in the Annex to this report, where the complete questionnaire is displayed.

The concrete formulation of the survey questions was based on several considerations. As RRI is a rather new policy concept that only entered the scene about five years ago, we first asked whether the respondents were familiar with the concept or not; and if so, what key terms they associate with the acronym "RRI". We used categories that are included in the 5 RRI keys on the hand, but added further terms as well from the relevant literature such as open innovation and corporate social responsibility (e.g. Lindner et al. 2016, pp. 75-140; Iatridis / Schröder 2016). Second, we asked the respondents whether they had already conducted concrete RRI activities, were doing so, or whether they intend to do so in the future. The core idea behind the collection of concrete activities is that, even if respondents are not familiar with the umbrella term "RRI", they might nevertheless already perform activities belonging to one of the five RRI pillars, i.e. gender equality, science education, open access, public engagement or ethics. When including types of "de facto RRI" (Randles et al. 2016), it is important to also capture those activities that constitute RRI but are not labelled "RRI". Furthermore, we are convinced that concrete activities allow a more reliable assessment of the diffusion of RRI than a purely subjective assessment. We asked for the benefits and risks too, but also for supporting and impeding factors as well as the main drivers and institutional support for RRI. The latter questions target the necessary framework conditions that may promote or hinder the dissemination of RRI among European researchers and are thus important when deducing tailored policy recommendations. The majority of the questions mentioned above serve as dependent variables (with the exception of familiarity with RRI and institutional incentives).

We added a number of independent variables to our questionnaire which we assume shape the perception of RRI benefits and influence the extent to which the respondents perform research and innovation responsibly. These variables (1) characterise the research itself and (2) the background of the researchers. The report considers cross-country differences, and explores gender differences but also the variations between scientific fields and the kind of research.

The concrete wording of the items used for the questionnaire was determined together with the dimension leaders, i.e. the team members responsible for each of the five specific RRI keys. Furthermore, a face-to-face meeting between the team members in charge of defining the metrics and indicators for RRI benefits and those conducting the

researchers' survey took place in Brussels to ensure a high level of concordance between the types of benefits identified so far in the MoRRI project.

Socio-demographic background

The following table summarises the main characteristics of the respondents whereas we distinguish between the EU funded survey group and the control group.

Table 1: Socio-demographic background of the respondents

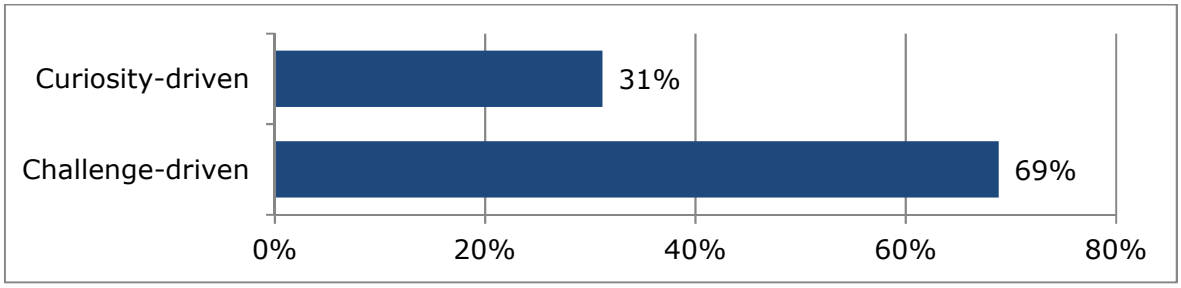
Criterion	EU Funded Researchers	Control Group
Gender		
Male	68.5%	75.2%
Female	31.5%	24,8%
Institutional Background		
Higher Education Institutions (HEIs)	46%	71.9%
Research Performing Organisations (RPOs)	15.3%	8.8%
Companies	26%	6.3%
Civil Society Organisations (CSOs)	5.9%	3.5%
Public Authorities	3.3%	2.0%
Scientific Disciplines		
Natural Sciences	34.4%	33.0%
Engineering Sciences	29.4%	18.0%
Social Sciences / Economics	11.4%	11.8%
Humanities	6.7%	9.5%
Medicine	6.3%	13.8%
Structural Sciences (Mathematics, Informatics)	5.6%	8.3%
Research experience (Years after Masters degree)		
Less than 5 years	14.2%	10.1%
Between 6 and 10 years	25.5%	19.6%
Between 11 and 20 years	33.8%	30.7%
More than 20 years	26.6%	39.5%

Main characteristics of the research activities

At the beginning of the questionnaire we asked the respondents to indicate the main driver of their research. For that purpose we provided a dichotomy: curiosity-driven research (which is typically used to describe basic research and which is primarily

motivated by a specific research question that a researcher has); and challenge-oriented research (which is dedicated to problem-solving and thus rather applied research). Overall, about two thirds of the EU-funded respondents say "challenge" is the main driver of their research. As expected, company researchers most frequently indicate a challenge-orientation of their research (93%), whereas higher education institutions rate the two types of research to the same extent.

Figure 1: Main driver of research (EU funded researchers) (N=3440)



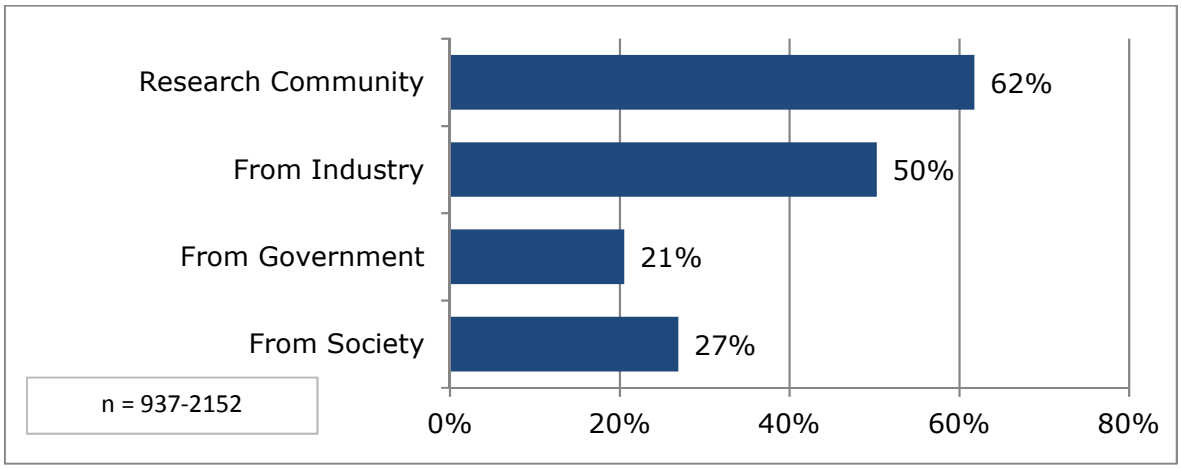
Contrary to our expectations, the differences according to the main driver of research are not significant throughout, but there are considerable differences regarding public engagement activities. Here, challenge-driven researchers are much more inclined to invest in citizen involvement than curiosity-driven researchers (see Annex). Of the eight items in the questionnaire within the public engagement category, seven show significant differences between the two groups[1].

EU-funded researchers who describe their own research as "challenge-driven" have, largely, also a more positive view of RRI than purely curiosity-driven researchers.

Corresponding to the results for the main drivers of research is the observation that the main recipients of the research results are not only other members of the research community, but especially industry actors to whom the research is addressed. Government bodies and societal actors are also relevant for one fifth and one fourth of the EU-funded respondents, respectively. Again, we find substantial differences between HEIs and companies, the former orienting research primarily to other members of the research community, the latter primarily to other companies. Furthermore, an important difference can be observed between male and female researchers: whereas female researchers direct their research more frequently at the research community and society, the opposite is true for men, who direct their research at industry (see Annex). This result might be explained by the low level of women in the STEM (Science, Technology, Engineering, and Mathematics) disciplines (European Commission 2016) whereas especially the engineering sciences show strong collaborations with industry.

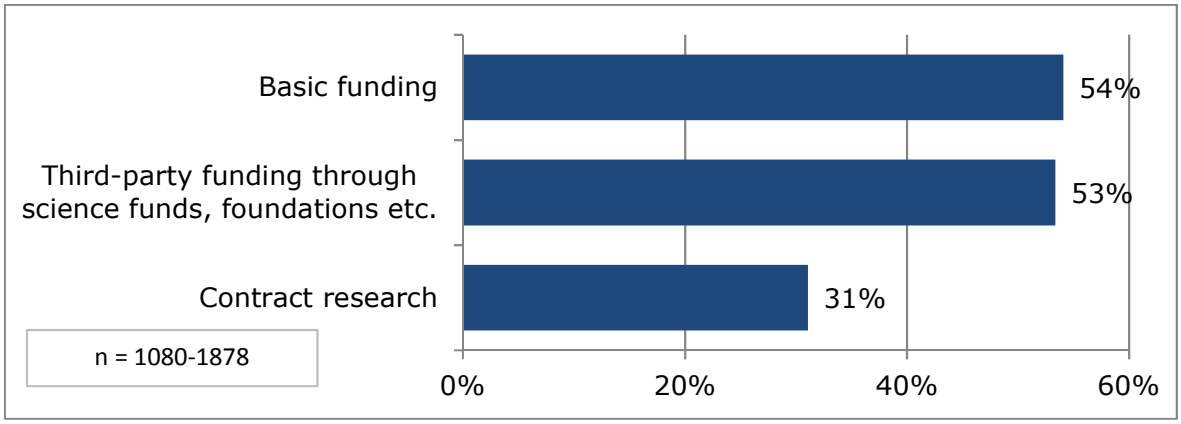
1 "I involve citizens in the following phase(s) of my research by / through determining what research should be performed; conducting the research (data collection, data analytics); discussing the consequences of research / its application (including technology assessment); communicating and disseminating the results of the project; commercialization / exploitation of results; I actively consider how my research and innovation results will be perceived and used; I engage with industry in my research work".

Figure 2: Main recipient user of the research results (multiple answers possible, EU funded researchers)[2]



The challenge-orientation as well as the variety of target groups is also reflected in the main source of funding. This consists of a broad mix of basic funds (own institutional funds), third-party funding and contract research, where the contracting authorities are government and agencies (48%) and companies (44%). CSOs play a minor role as research funders (4%).

Figure 3: Main source of research funding (multiple answers possible, EU funded researchers)



However, the main source of research funding does not make a significant difference regarding RRI activities or the perception of associated benefits.

2 According to the possibility to give multiple answers, the number of answers differs and the respective range is indicated.

Structure of the report

In this report (deliverable D9.1.a), we present the results

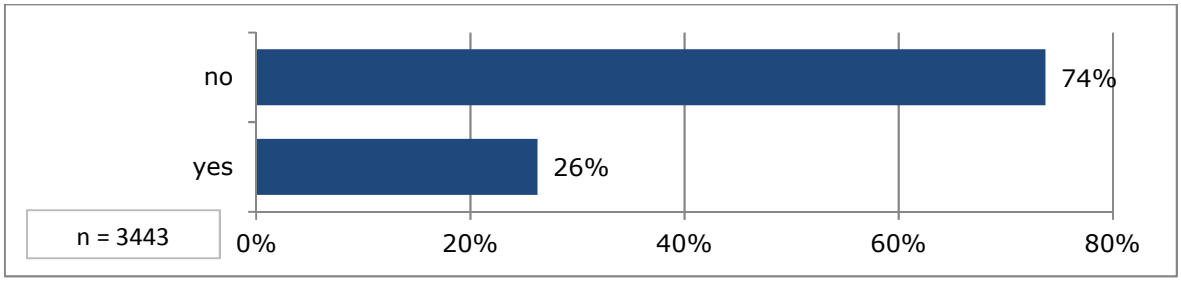
- thematically by RRI benefit (social, economic and democratic benefits),
- thematically by RRI dimension[3],
- and geographically by country and region.

Furthermore, we summarise the most important results and formulate tentative policy recommendations. A large part of the report is based on basic analyses applying univariate statistics for each of the survey questions. These basic statistics are synthesised using graphs. Additionally, bivariate analyses are undertaken in order to gain more insight into the complex interplay between the type of research, the organisational framework conditions and RRI activities and their perceived benefits. Such cross-tabulations are provided by gender, scientific discipline, years of research experience (years after master level), institutional background, country groups, research orientation, target group of research, research funding and institutional strategy. The Annex provides the full descriptive results.

2. Overall results

Before analysing the observed and expected benefits associated with RRI, we asked the respondents to what extent they had already heard about the concept of RRI. Given the fact that RRI was not introduced before the implementation of Horizon 2020 in 2014, it is remarkable that more than a quarter of the EU funded respondents are now familiar with it.

Figure 4: Have you ever heard about the concept "Responsible Research and Innovation (RRI)"? (EU funded researchers)

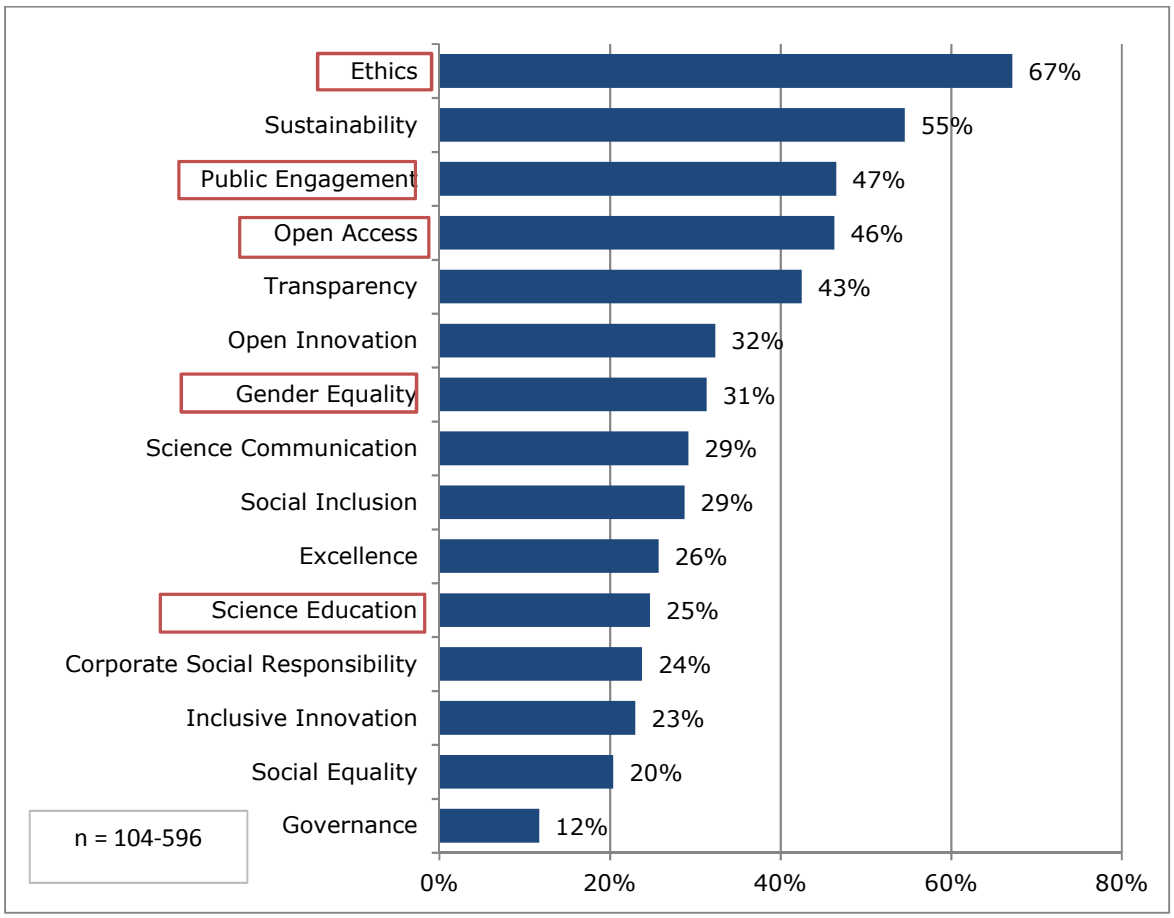


More interesting, however, is the fact that those who indicated they had heard about RRI do not associate it with the same dimensions that underlie the Commission's

3 Citizen engagement and participation of societal actors in research and innovation, science literacy and scientific education, gender equality in research and innovation and gender dimension in research and innovation content, open access to scientific knowledge, research results and data, research and innovation governance (including ethics). For the sake of brevity we use the terms "public engagement", "science education", "gender equality", "open access" and "ethics" in this report.

concept. Looking at the most frequently mentioned categories[4], only ethics, public engagement and open access are among the top five categories. Gender equality and particularly science education are rarely associated with the acronym "RRI". Instead, sustainability and transparency seem to be important properties of RRI according to the survey respondents (see Figure 4).

Figure 5: If yes, what are the five most important terms you associate with "Responsible Research and Innovation"? (EU funded researchers)



The fact that researchers value sustainability as an important key concept supports the approach of an EU policy expert group, who also considered sustainability (and social justice / inclusion as well) important RRI pillars (European Commission 2015). However, it should be kept in mind that RRI is a concept, which is not linked to specific disciplines, so that sustainability research should not be perceived as responsible per se. Science communication, a concept explicitly mentioned within the Science-and-Society (SaS) and/or the Science-in-Society (SiS) Programme, is mentioned far more frequently than science education.

4 The study team organized an internal group discussion process to determine the categories pre-set in the questionnaire. Furthermore, we used terms which are typically used within an industrial context as a proxy for RRI, i.e. corporate social responsibility. Further input was derived from literature (Lindner et al. 2016, pp. 75-140; Iatridis, Schröder 2016).

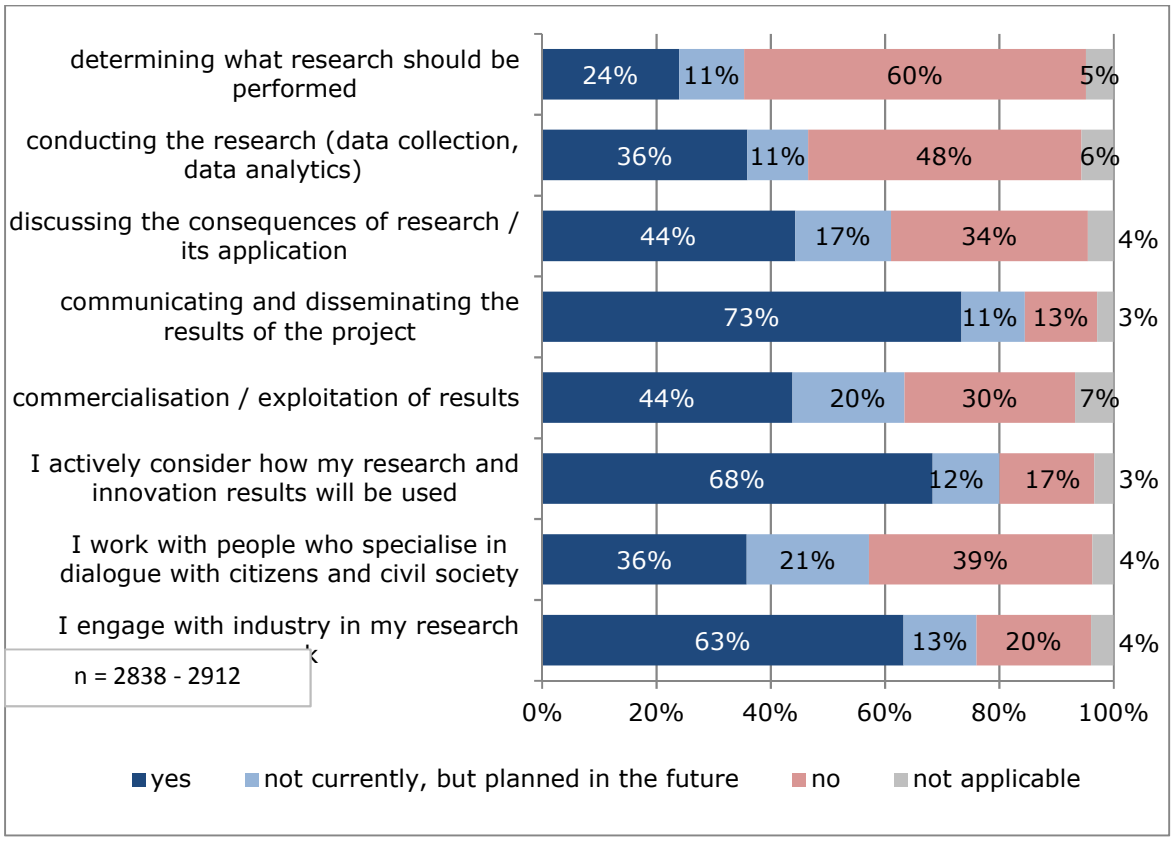
3. RRI by dimension

In this chapter, we analyse whether the respondents already conduct(ed) research and innovation responsibly or whether they intend to do so in the future, regardless of whether they are explicitly familiar with the concept of RRI or not. In the description of RRI activities, we follow the five main dimensions defined by the European Commission, i.e. public engagement, science education, gender equality, open access and ethics. The kind of activities we asked about were deducted from the dimension reports compiled in the course of the MoRRI project (Griessler et al. 2015, Meijgaard, Ravn 2015, Meijer et al. 2015, Wroblewski et al. 2015, Stilgoe, Lindner 2015, Talmon-Gros, Teichler 2015).

3.1 Public engagement

Figure 8 shows that one item dominates when asking the respondents in which phase of the research process they involve citizens: it is the communication and dissemination of research results and is indicated by about three quarters of the survey respondents. 44% indicate that they discuss the consequences of research and/or its application with citizens, and about a quarter states that citizens are involved in determining research content. Research Performing Organisations, CSOs and public authorities thereby show the highest probability of involving citizens in determining research content. Furthermore, this kind of involvement takes place primarily in the social sciences and economics. Besides actively involving citizens, the respondents frequently mention that they actively consider how the research and innovation results will be used (68%) and that they engage with industry (63%).

Figure 6: Public engagement activities (EU funded researchers)



The results of the multivariate analysis show that the research orientation strongly influences the degree of public engagement, i.e. challenge-oriented researchers conduct far more public engagement activities than curiosity-driven researchers (with the exception of working with people who specialise in dialogue with citizens and civil society. The latter is affected by the years of research experience; more experienced researchers invest more time and effort in public activities than those with less research experience do).

Engagement with industry is also influenced by years of research experience (researchers are more engaged with increasing experience), while we find a negative relationship between gender and industry engagement; women have fewer contacts to industry than men do, due to their scientific background: engineers show significant higher engagement with industry than other disciplines and humanities scientists a significant lower engagement This result is also in line with the results of many EU studies showing that women are strongly underrepresented in the business research sector and have smaller networks (European Commission 2003, 2006, 2016).

The most influential variable, however, is the organisational background: compared to universities, most of the other organisations, particularly public bodies and CSOs, invest much more time and resources in public engagement.

Finally, the scientific discipline also plays a role for some of the public engagement items: discussing the consequences of research / its application (including technology assessment) is important for medicine and the social sciences; communicating and disseminating the results of a project for these two disciplines and the humanities as well. The same holds true for "I actively consider how my research and innovation results will be perceived and used". The item "I work with people who specialize in dialogue with citizens and civil society" (e.g. mediators, communication companies, science museums) is only significant for the social sciences and the humanities, whereas engagement with industry shows a negative relationship with the humanities but a positive one with the engineering sciences.

3.2 Science education

When we look at science education, we find two dominant activities: to inform the wider public about research results through popular science books and articles in newspapers, magazines or blogs; and to inform the wider public through public lectures. Both items were selected by about 60% of the respondents. Less common is the development of science education material and concrete partnerships with schools, with only 23% indicating a respective activity.

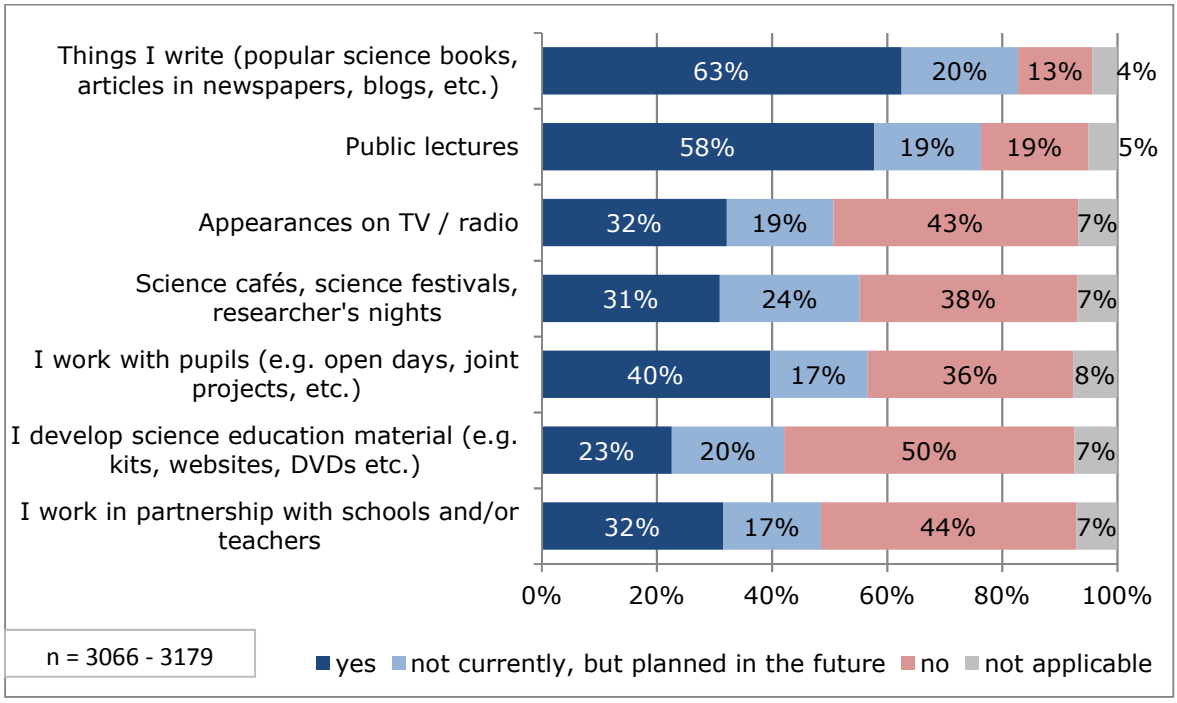
The multivariate analysis conducted for the various activities shows that especially the "years of research experience" are an important factor, which positively influences science education activities, i.e. the longer the research experience, the more inclined respondents are to conduct the respective activity. Since more experienced researchers are already established within the science system, we assume they have more opportunities to invest in such activities than less experienced researchers who still have to focus on research and advancing their academic/professional careers.

Besides years of research experience, the challenge-orientation of the research plays a role as well, at least for compiling popular science books, etc., and developing science education material.

Finally, the scientific discipline is important: researchers from the humanities, medicine and the social sciences are more likely to give public lectures than researchers from the structural sciences. The same holds true for appearances on TV /

radio that are particularly common for the humanities. Finally, researchers from medicine frequently work with school children, e.g. at open days, in joint projects, etc.

Figure 7: Science education activities (EU funded researchers)



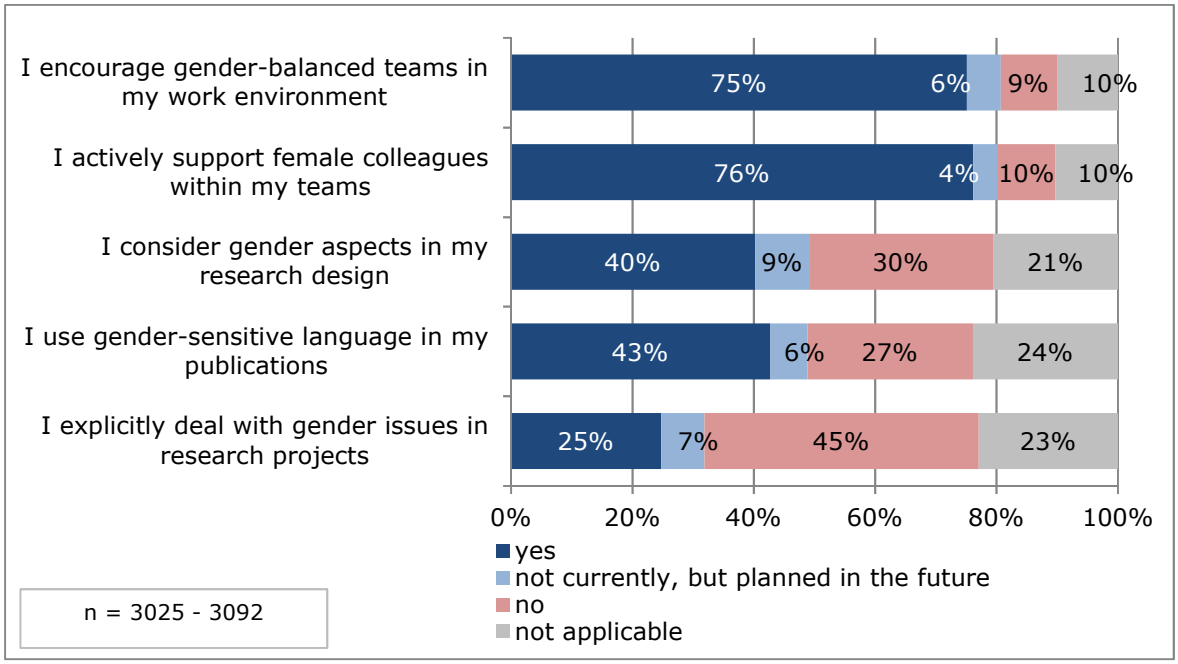
3.3 Gender equality

Figure 8 shows that two items dominate the gender equality activities, i.e. the encouragement of gender-balanced teams as well as particular support for women within teams. The results underline that ERA objective one[5] "gender equality in scientific careers" has the highest relevance among the respondents. The ERA objective three "gender-sensitive research and innovation" is, in contrast, not too widespread, especially the explicit integration of gender issues in research projects.

It is worth mentioning, however, that the two human-capital-related gender equality items are among the most frequently mentioned activities for the RRI concept used in this survey, which is based on the five keys defined by the European Commission. Only the use of open access publications (78%) or publicly available data (76%) are mentioned more often (see below).

5 http://ec.europa.eu/research/swafs/index.cfm?pg=policy&lib=gender

Figure 8: Gender equality activities (EU funded researchers)

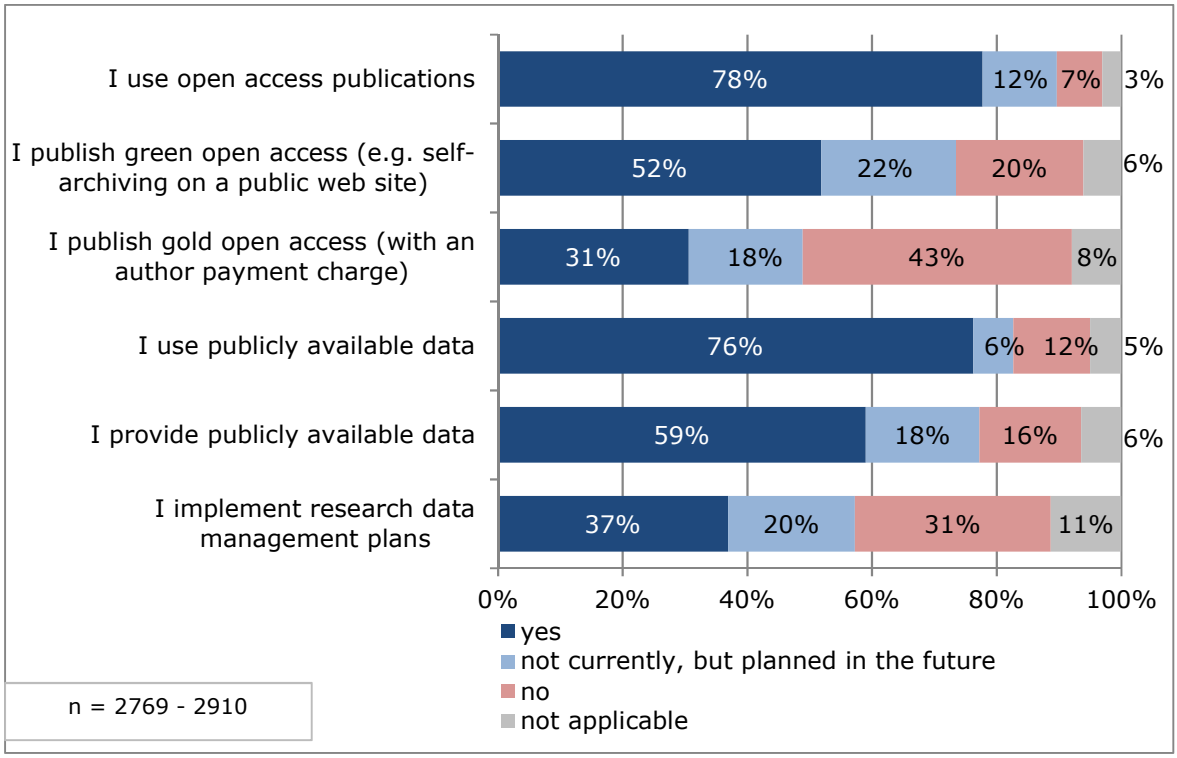


Looking at the results of the multivariate analysis, we find that female respondents indicate much more frequently than men that they support female colleagues and consider gender aspects in their research. There are no significant differences between men and women's use of gender-sensitive language. However, once again, we find important differences regarding the research experience: more experienced respondent groups (from 11 years within research onwards) are more inclined to support female colleagues and to promote gender-balanced teams than less experienced respondents. Finally, the scientific discipline influences the responses insofar as researchers from medicine, the social sciences and the humanities mention much more frequently than researchers from the structural sciences that they deal with gender issues in research projects or consider gender aspects in their research designs. The use of gender-sensitive language in publications is most common among the humanities and social sciences. Finally, predominantly researchers from medicine indicate that they encourage gender-balanced teams.

3.4 Open access

In Figure 11, we see that the use of open access publications as well as the use of publicly available data is most common among the respondents, whereas gold open access publications and research data management plans occur rather infrequently.

Figure 9: Open access activities (EU funded researchers)



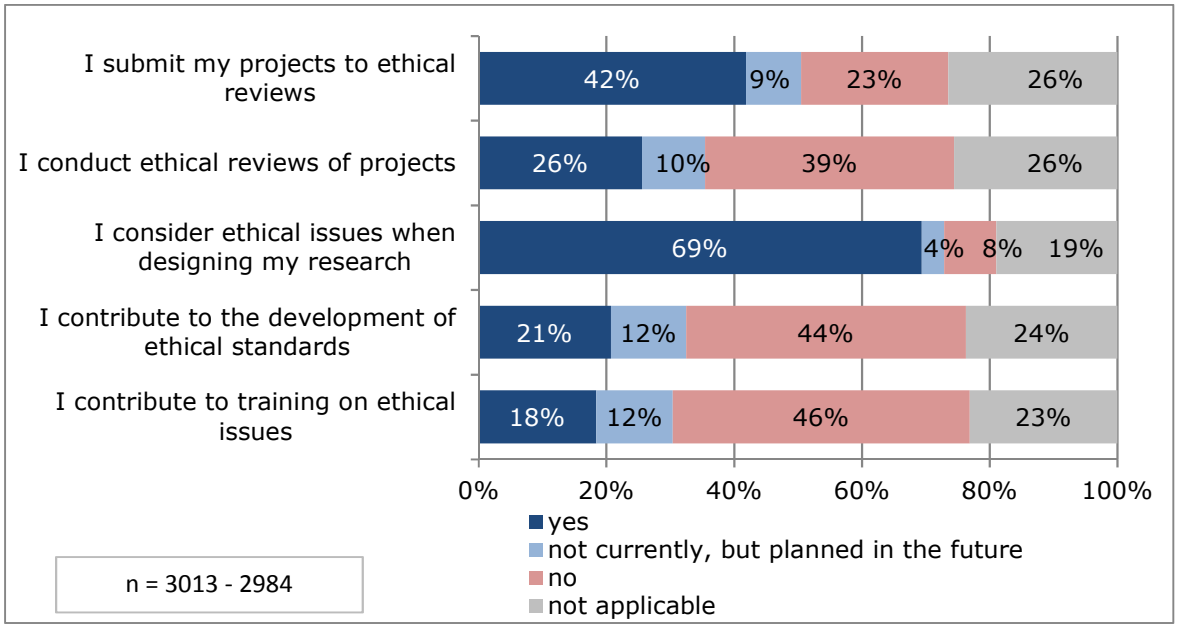
The use of open access is particularly widespread in all the groups with more than 5 years' experience within science, a result which is confirmed by a recent study which also shows an academic age effect (Berghmans et al. 2017). Furthermore, researchers from the natural as well as the engineering sciences use them less often than researchers from other scientific disciplines. The least experienced researchers are the least likely to publish green and/or gold open access. Researchers with a university background use this publication form most often. In contrast, university researchers use open data the least compared to public bodies, companies or CSOs.

3.5 Ethics

More than two thirds of the European researchers agree with the statement that they consider ethical issues when designing research and almost 42% indicate that they submit their projects to ethical reviews. However, we can find substantial differences between the scientific disciplines: whereas 87% of the medical scientists indicate that they submit their projects to ethical reviews, this only holds true for 32% of the structural scientists, followed by natural and engineering scientists (35%), humanities scientists (53%) and social scientists (60%).

Overall, we find numerous differences among the respondent groups for ethics. First of all, and as expected, the scientific discipline plays an important role: ethical issues are much more important for medicine, in particular, but in most cases also for the social sciences and the humanities than for the structural sciences. The challenge-orientation of research is important for conducting ethical reviews, considering ethical issues and contributing to ethical standards.

Figure 10: Ethics activities (EU funded researchers)



The high number of respondents who indicate that they contribute to the development of ethical standards and / or training on ethical issues can be partly explained by the scientific discipline, type of research and years of research experience: researchers with between 6 and 20 years research experience contribute less to standard development than those with the least or the most years of experience. And again researchers from medicine, the social science and economics as well as the humanities show a much higher inclination to indicate such a contribution than other researchers. Finally, respondents who define their research as challenge-driven have a higher probability of contributing to standards and training than purely curiosity-driven researchers.

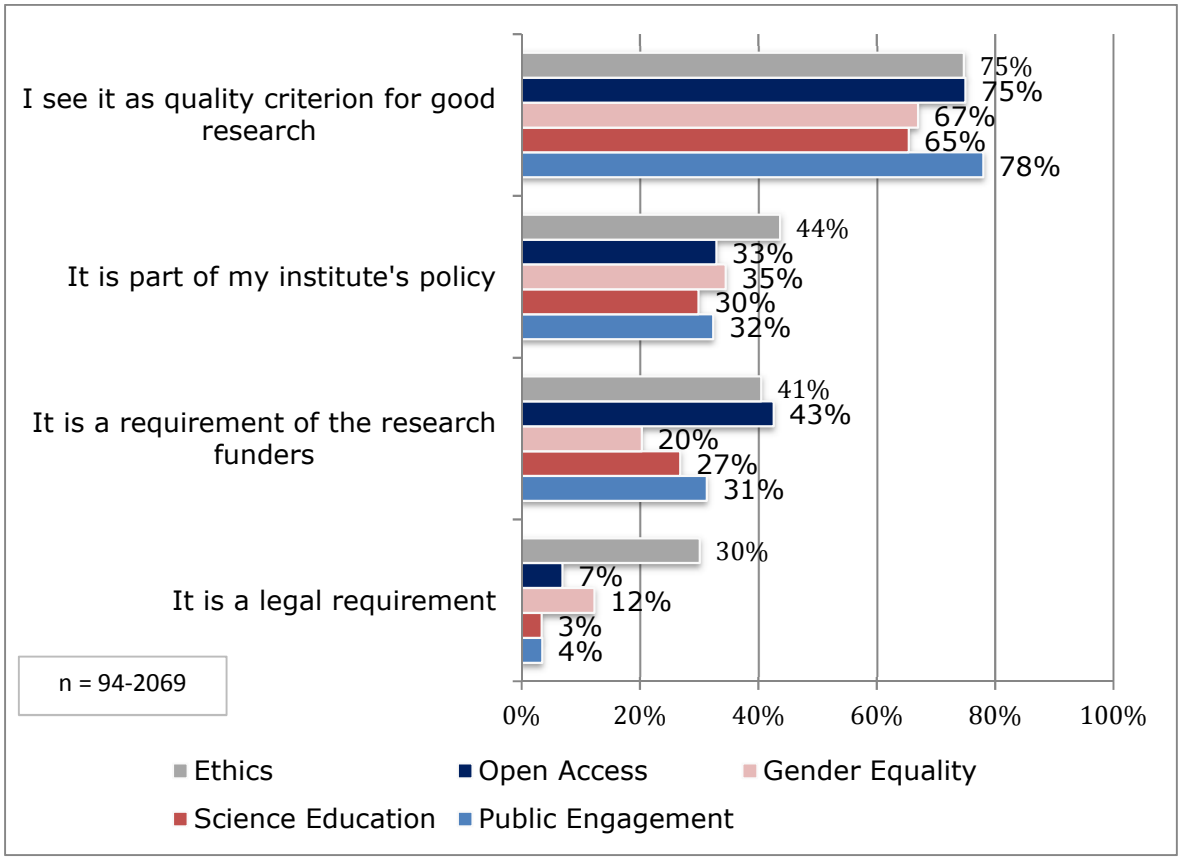
Women and men do not differ in their response behaviour, and the number of years of experience plays a role primarily with regard to ethical research design, i.e. the youngest group showing the lowest inclination to consider these aspects.

3.6 Main motives to undertake RRI

Substantial differences emerge when we look at the main motives for conducting different kinds of RRI activities. Generally, we see from Figure 11 that the perception that the respective activity is a quality criterion of good research dominates all five RRI dimensions. At least three quarters respond that a main motivation is ethics, open access and public engagement, whereas at least two thirds agree with this for the gender equality and science education dimensions.

Two other main drivers for practising research and innovation responsibly are the support given by the institute's policy (see also below) and the prospect of obtaining better access to funding. The latter is particularly important for ethics and open access, whereas institutional support plays a crucial role for ethics, in particular. In addition, legal requirements are the most important for ethics.

Figure 11: Main motives to conduct RRI activities (EU funded researchers)

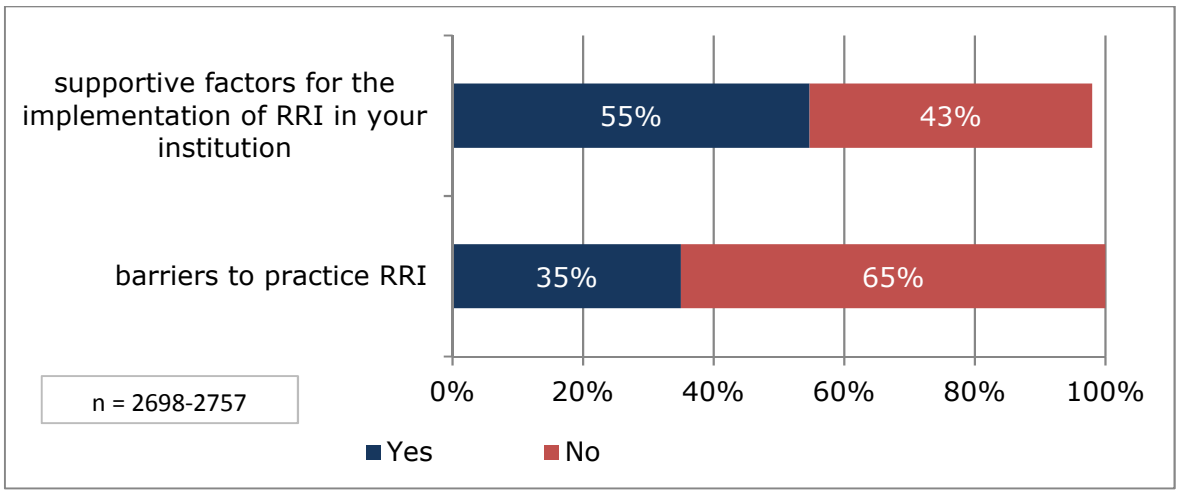


3.7 Barriers and supportive factors

In addition to the topics related to the occurrence of RRI activities, we asked the respondents whether they observed any barriers or supportive factors to practising research and innovation responsibly and if so, what kind of barriers or supportive factors they have encountered. In contrast to the section above on the main motives, we did not distinguish barriers and supportive factors along the five RRI keys as this would have resulted in an overwhelming complexity of the questionnaire and potentially fewer respondents willing to take part in the survey.

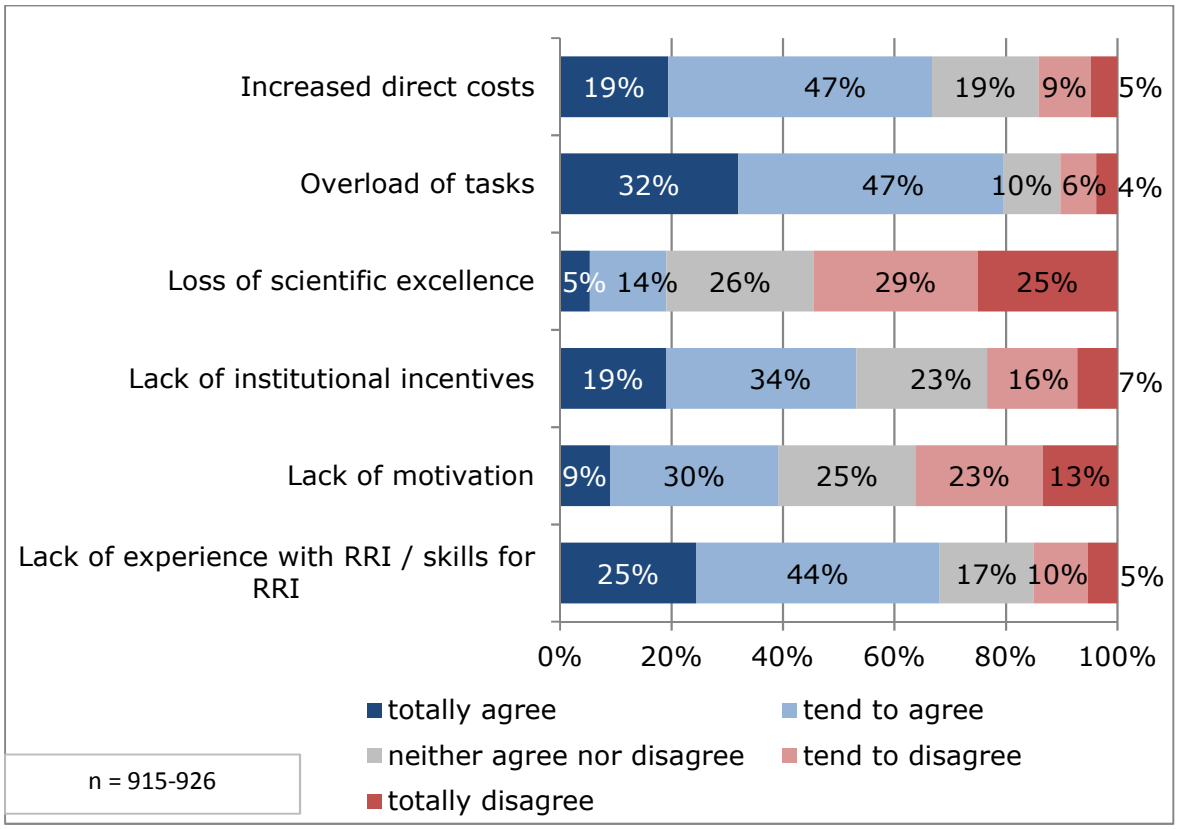
Overall, we can ascertain that the respondents perceive more supportive factors than hindering factors, as shown in Figure 12. Whereas more than half the respondents mention supportive factors, only slightly more than one-third mentions any barriers.

Figure 12: Do you observe any supportive factors for implementing RRI in your institution? Do you observe any barriers to practice RRI? (EU funded researchers)



Looking at concrete barriers, it becomes obvious that task overload is the most important one, followed by a lack of experience and skills and increased direct costs. On the other hand, the respondents hardly worry about a loss of scientific excellence (see Figure 13). A similar result emerged in the context of the ex-ante impact assessment of the Science in Society programme five years ago, where the strongest perceived risk was overburdening costs (Bührer et al. 2012).

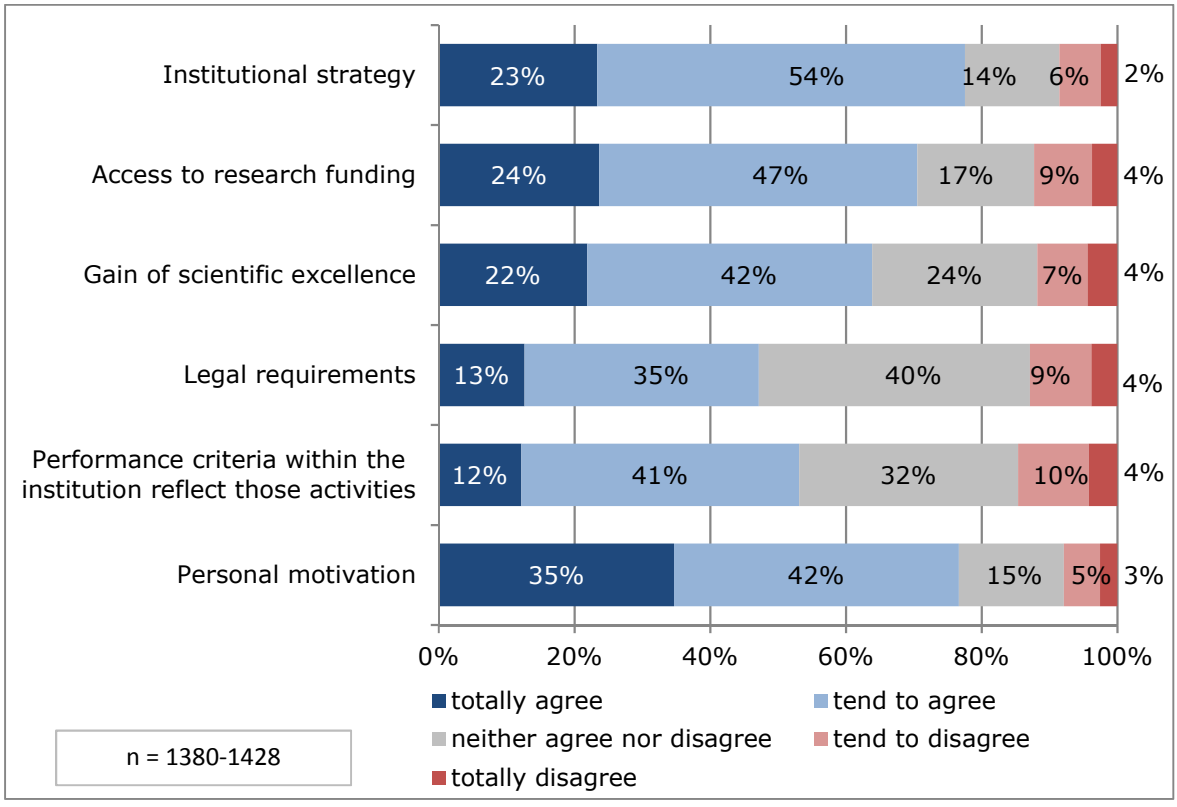
Figure 13: Observed Barriers (EU funded researchers)



Overall, women seem more inclined to perceive barriers than men, particularly regarding a lack of institutional incentives and experience / skills, but also a lack of motivation to deal with RRI. Also, researchers from the natural or structural sciences perceive more barriers for several items than other respondents (see Annex). Finally, curiosity-driven researchers indicate an overload of tasks more often than challenge-oriented researchers.

The most important supportive factors are, from the point of view of the respondents, personal motivation but also the institutional strategy, which can play a decisive role. As will be shown below, the existence of the respective institutional strategies has a positive influence on the extent of activities within the respective RRI dimension. An additional instrument promoting RRI is the prospect of better access to research funding. These results are in line with the personal main drivers described above and underline the crucial role that the institutional environment can play regarding the promotion of RRI.

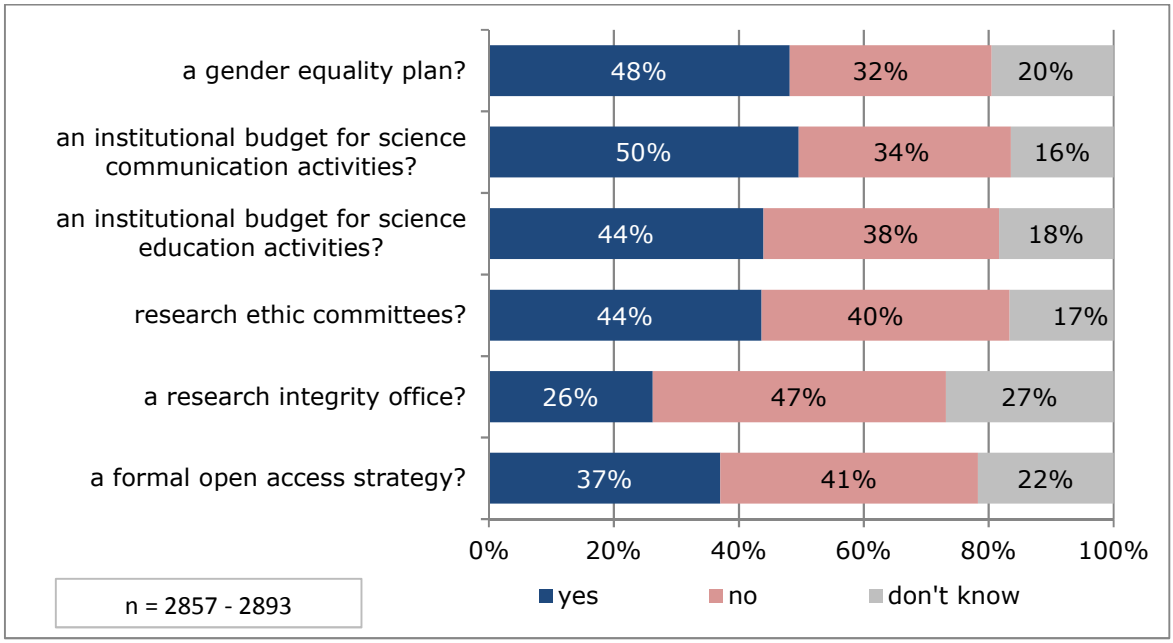
Figure 14: Observed supportive factors (EU funded researchers)



Finally, if a positive contribution to scientific excellence could or can be shown, this is also an important promotional factor for RRI (see Figure 14). In this regard, it is worth mentioning that one-third of medical researchers affirm they have already observed an increase in scientific excellence due to RRI (see Annex). For the humanities and social sciences, on the other hand, personal motivation plays a particularly important role.

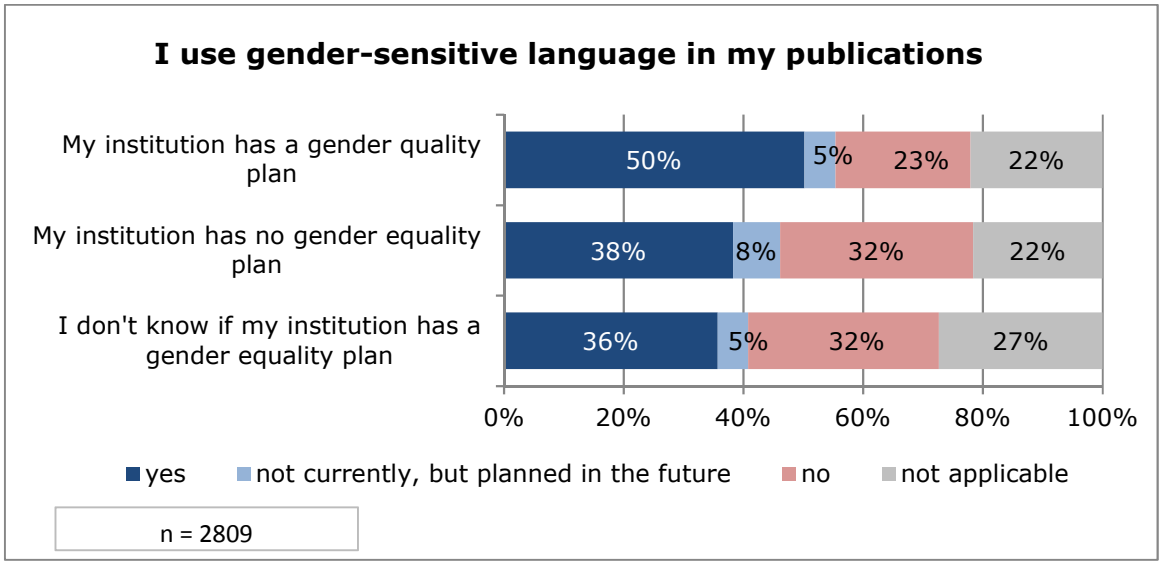
If we look at Figure 15, we can see that about half the respondents indicate a certain kind of institutionalised support for each of the RRI activities they conduct:

Figure 15: Existence of an institutional strategy (EU funded researchers)



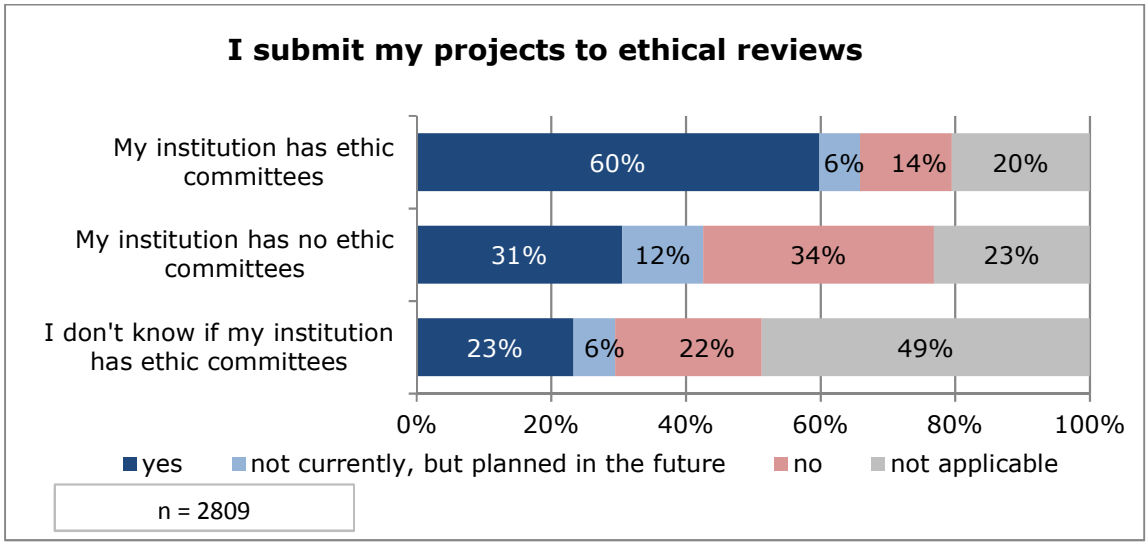
This support may exist in an institutional budget, in institutionalised units like committees or offices or in concrete overall strategies. However, it is worth mentioning that about one-fifth of respondents do not know whether institutionalised support exists or not. As shown more comprehensively in the Annex, the existence of an institutional strategy does indeed exert a positive influence on RRI activities for each of the five RRI pillars, but to a varying extent. The following figures present selected examples for the pillars gender equality and ethics as these two areas of RRI display the strongest relationships:

Figure 16: Gender equality and institutionalised strategy (EU funded researchers)



Within the gender equality dimension, we find the biggest differences for the use of a gender-sensitive language in publications, but also the other kind of activities (encouragement of gender-balanced teams, support for female colleagues, consideration of gender aspects within research design and addressing gender issues in research projects) that are positively influenced by the existence of an institutional strategy.

Figure 17: Ethics and institutionalised strategy (EU funded researchers)



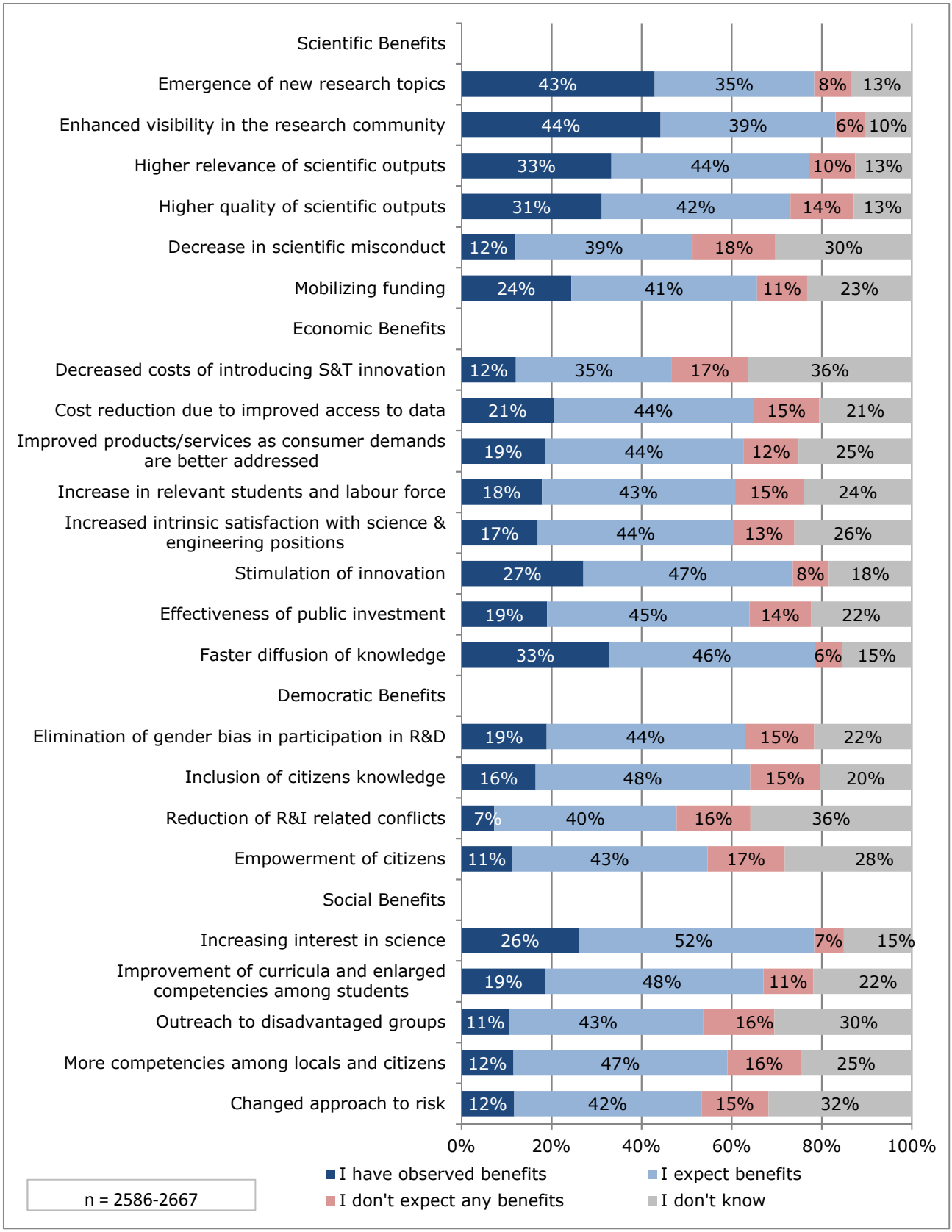
The same applies to ethics: all activities incorporated in the questionnaires can be observed more often if there are ethic committees in the institutions where the surveyed researchers work.

4. RRI by benefit

In order to obtain a realistic picture of RRI benefits, we asked the respondents: (1) whether they have already observed any benefits when conducting a respective activity in the area of gender equality, science education, open access, public engagement or ethics as the five main pillars of RRI, for example, when using open data repositories, (2) whether they expect respective benefits in the future or (3) whether they do not expect any benefits. Another answer category was "don't know". We follow the analytical benefit categories defined by the study team and already applied during the case studies (Wuketich et al. 2015). These categories are economic benefits, societal benefits and democratic benefits. In view of the main target group of the survey, researchers in Europe, we decided to add one additional benefit category, namely "scientific benefits", which has also been addressed in the MoRRI progress report D6, definition of metrics and indicators for RRI benefits (Woolley / Rafols 2016), namely RRI benefits for science. In the following chapter, we analyse to what extent benefits have already been observed for each category, are expected or not expected, and for which category the respondents show the largest uncertainty in giving a reliable answer.

Figure 18 shows that the respondents report scientific benefits most frequently, followed by economic benefits. Social as well as democratic benefits are mentioned less frequently. Even if the already observed benefits are less widespread within these two categories, the respondents still frequently expect benefits.

Figure 18: Overview of observed and expected benefits (EU funded res.)



This holds particularly true for an increasing interest in science, an improvement of curricula and enlarged competencies among students as well as an inclusion of citizens' knowledge.

Among the most important already observed scientific benefits are the emergence of new research topics and enhanced visibility in the research community. Regarding the economic benefits, the faster diffusion of knowledge is particularly highlighted.

Important factors which influence the perception of benefits are the research experience, the type of research (challenge or curiosity-driven, externally funded) and the institutional background, i.e. whether the respondents work for a university, a company, a CSO or a public body. More details are given below as the factors differ according to the benefit areas.

The expectation that no benefit will occur is most common for a reduction of scientific misconduct (18%), empowerment of citizens (17%) and decreased costs of introducing S&T innovation (17%).

However, generally it has to be stressed that a large share of respondents indicated that they are not able to assess any benefits, expressed by "I don't know".

The following sub-chapters discuss in more detail how the perception of benefits is influenced by the individual characteristics of the researchers and their respective institutional background.

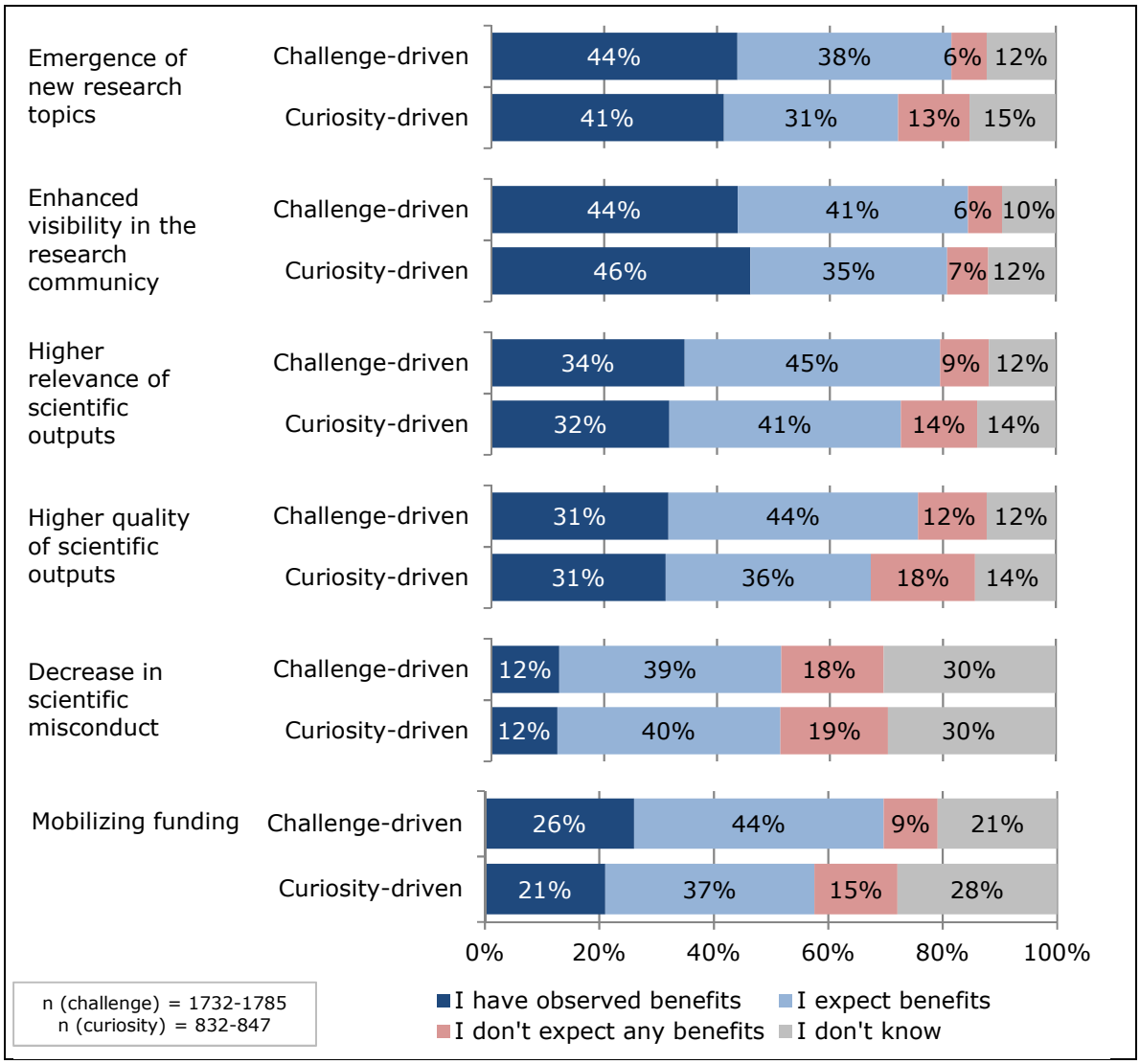
4.1 Scientific benefits

As already described above, a remarkably high share of respondents have already observed concrete scientific benefits or expect them in the future. When we look at the differences between challenge-oriented researchers and curiosity-driven researchers, we can state that the two groups of respondents show broadly the same answers regarding already experienced benefits, apart from the expectation that RRI eases the mobilisation of research funding (see Figure 19). Regarding expected benefits, however, challenge-driven researchers are more likely to indicate a respective future benefit. Correspondingly, curiosity-driven researchers are slightly more sceptical and indicate more frequently that they do not expect the respective benefit.

When we analyse the data in more detail, we can show that researchers from the humanities indicate scientific benefits more often than respondents from the other scientific disciplines do (see Annex). However, medical researchers think the most important contribution of RRI is to a decrease in scientific misconduct.

A multivariate analysis showed, however, that the differences between the scientific disciplines are not statistically significant. Instead the years of research experience have a strong impact on the perception of scientific benefits, i.e. more years of research experience mean more observed benefits. Additionally we can find that researchers who describe their research as challenge-driven do also report more benefits than the curiosity-driven researchers. Interestingly the statement "higher quality of scientific outputs" is primarily reported by researchers who are employed in a CSO.

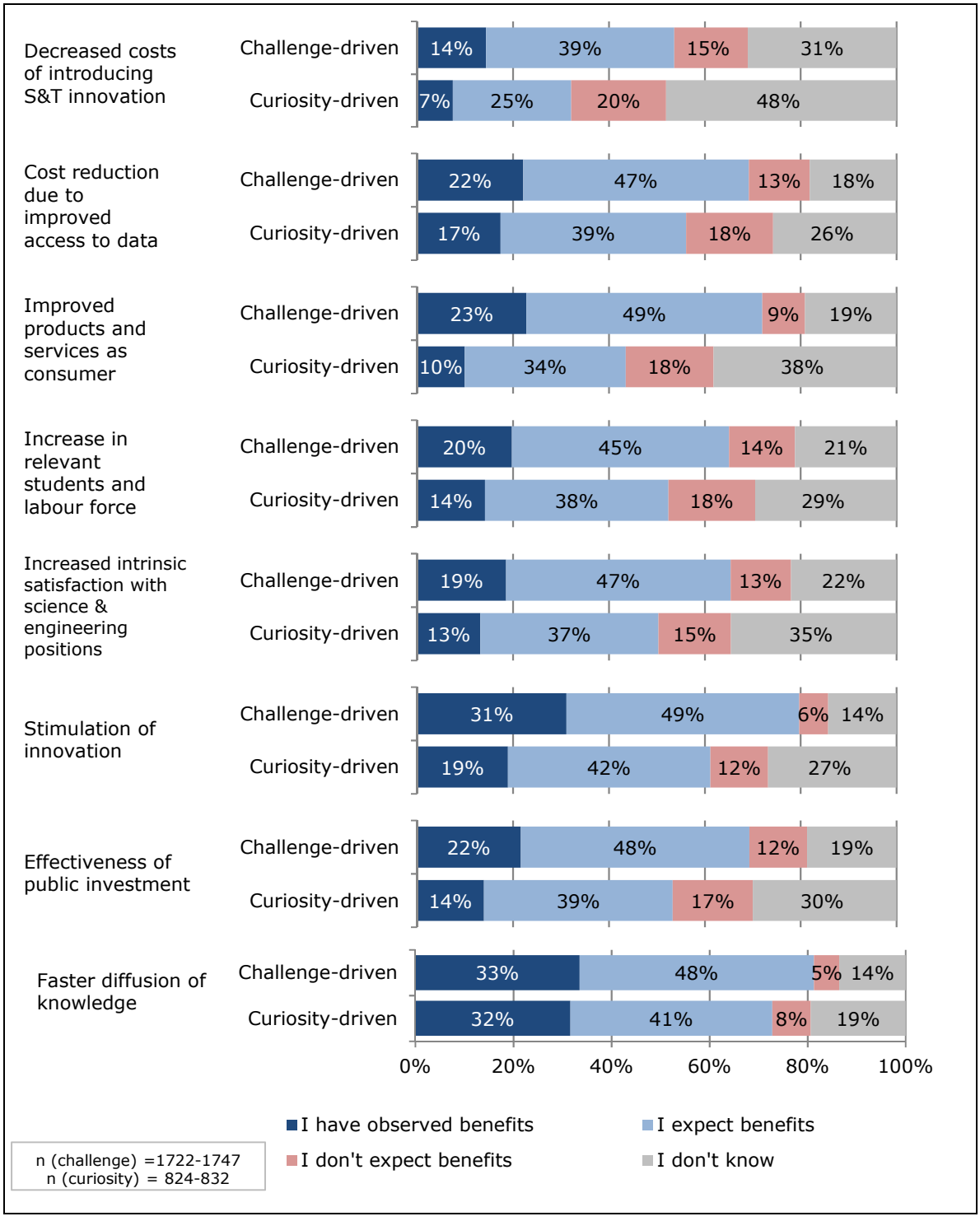
Figure 19: Scientific benefits by research orientation (EU funded researchers)



4.2 Economic benefits

In contrast to the results for the scientific benefits, challenge-oriented researchers identify different kinds of economic benefits more frequently than curiosity-driven researchers. This may be a result of the fact that primarily researchers from companies describe their research as challenge-driven. A rather positive result from the point of view of the "inventors" and promoters of the RRI approach is the fact that challenge-driven researchers expect not only general stimulation of innovation and faster diffusion of knowledge, but also improved products and services due to RRI, in fact 22% of this sub-group hold this view. Within the subgroup of curiosity-driven researchers, however, we noticed a very high share of "don't know answers", underlying that researchers primarily engaged in pure basis research are not very familiar with economic topics.

Figure 20: Economic benefits (EU funded researchers)



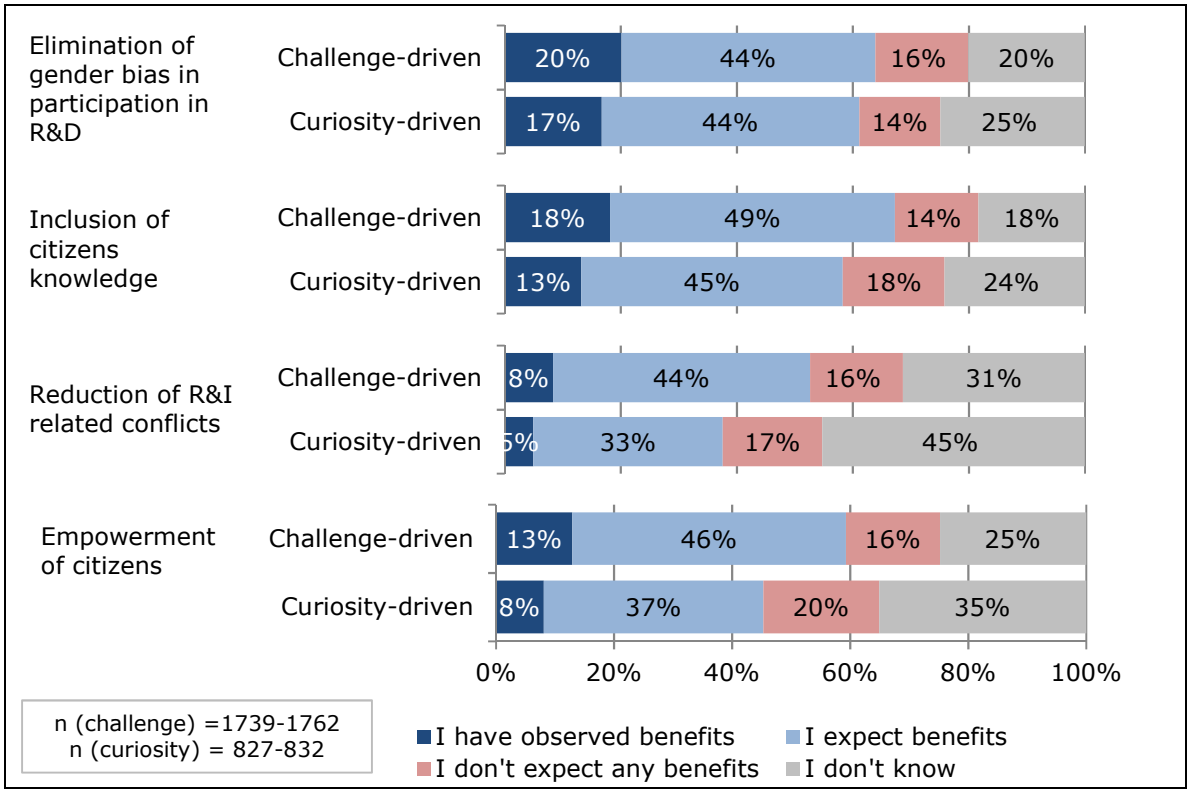
Regarding economic benefits, engineering scientists perceive the largest relevance of RRI concerning improved products and services, but also as the motor for an increased intrinsic satisfaction with science and engineering positions (see Annex), even if these results are not statistically significant. Instead, the organisational background plays a decisive role: respondents from companies but also public bodies

indicate most of the economic benefits listed in Figure 20 much more frequently than researchers from universities do.

4.3 Democratic benefits

As mentioned above, the researchers generally observe democratic benefits less frequently than scientific or economic ones. Among the most important democratic benefits are the elimination of a gender bias in participation in R&D and the empowerment of citizens. However, even if a concrete benefit could not yet be observed, almost half the respondents expect the respective benefit in the near future, particularly the challenge-oriented researchers. Looking at the details, we find that primarily researchers from the humanities and medicine expect democratic benefits.

Figure 21: Democratic benefits (EU funded researchers)

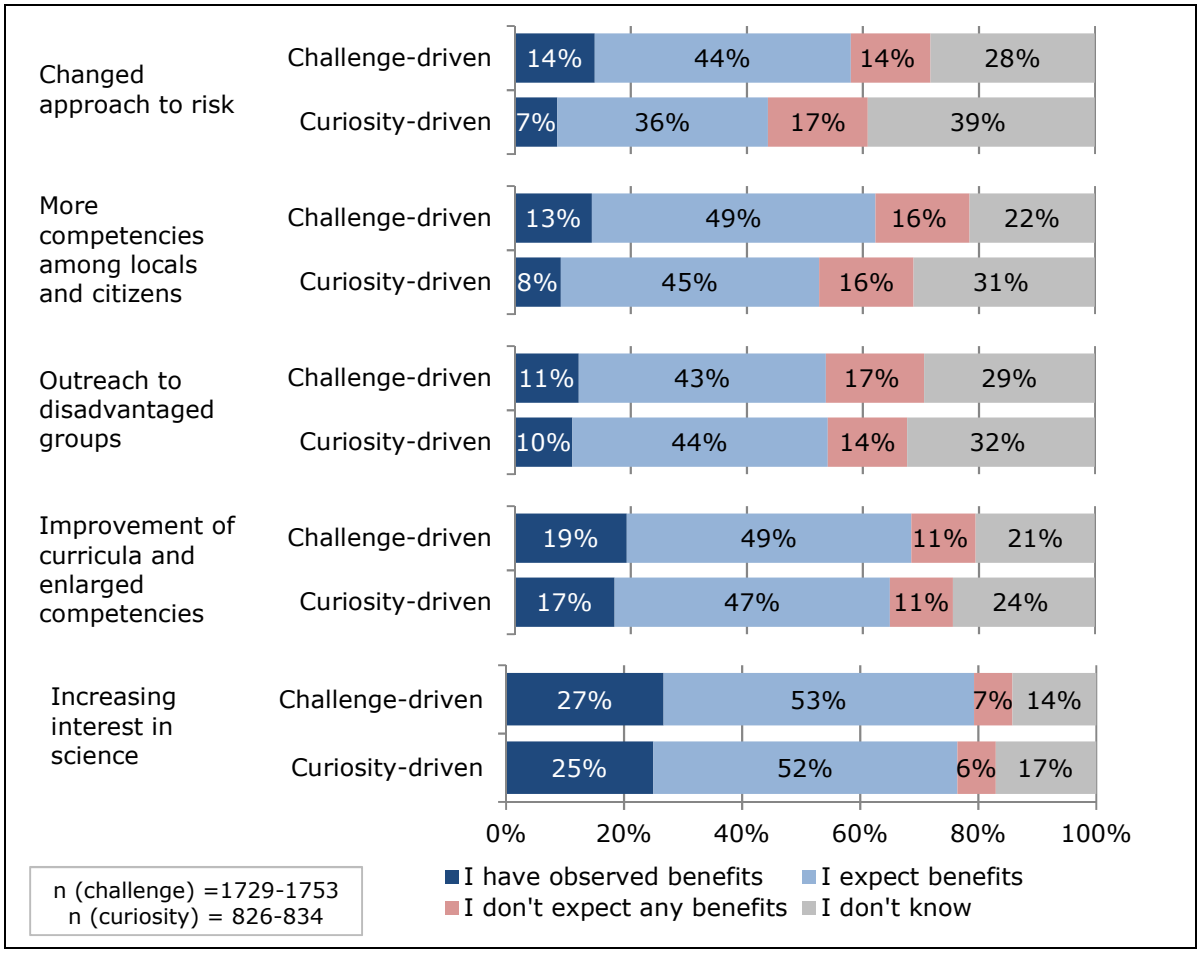


Moreover, democratic benefits are also primarily observed or expected by respondents from CSOs and public bodies, as shown by the multivariate analysis.

4.4 Social benefits

The fourth benefit category we asked about, social benefits, shows a similar distribution: already observed benefits are rather rare, except for the improvement of curricula and an increased interest in science.

Figure 22: Social benefits (EU funded researchers)



Social benefits are most frequently observed or expected by researchers from medicine, the humanities, the social sciences and economics. However, primarily natural scientists and medical researchers observe an increased interest in science. Besides, the challenge-orientation of research positively influences the perception of benefits.

5. RRI dimensions by country

For the country analysis, we assigned the respondents to the following country groups[6]:

- Nordic: Denmark, Finland, Sweden
- British Isles: UK, Ireland
- Central: Austria, Germany, France, the Netherlands, Belgium, Luxembourg

6 For this purpose we used a clustering developed in the course of the EU funded project "Regional Research and Innovation Strategies for Smart Specialisation (RIS strategies)".

- East: Hungary, Poland, Czech Republic, Slovenia, Slovakia, Estonia, Latvia, Lithuania
- South: Italy, Malta, Portugal, Spain
- South-East: Cyprus, Greece, Bulgaria, Romania

Overall, we found fewer differences between the countries than originally expected, as shown in the following sections. Additionally, if differences do occur, they are rather idiosyncratic and thus difficult to interpret. This result contradicts other studies showing that Nordic countries are pioneers in promoting RRI (see https://rritrends.res-agora.eu/; Mejlgaard; Griessler 2016). For the sake of brevity, the detailed results and figures for all the dependent variables (RRI activities, perceived benefits, supporting and hindering factors) can be found in the Annex.

5.1 RRI activities

When we compare the activities within the five RRI pillars (public engagement, gender equality, science education, open access and ethics), we see that countries assigned to the South-East group show the highest level of activities within the different RRI keys. For example, respondents from the South-East mention publishing articles in newspapers or holding public lectures most frequently, but the differences are still rather small. The most marked difference among the investigated country groups within science education is the fact that the East country group seems to be more engaged in collaborations with schools: these countries have the highest score on the statements "I work with pupils", "I develop science education material" as well as "I work in partnership with schools and / or teachers".

Regarding gender equality, the British Isles as well as South-East countries seem to be the most active, particularly regarding the active encouragement and promotion of women within their teams and / or work environments. In addition, gender-sensitive research and innovation and gender-sensitive language are most prevalent in these countries. Within the Nordic group, only gender-sensitive research and innovation is more widespread than in the other country groups.

For ethics, we only find minor differences among countries: the submission of projects to ethical reviews is most common in the British Isles, as is conducting ethical reviews. There is also a high level of activity in the South country group.

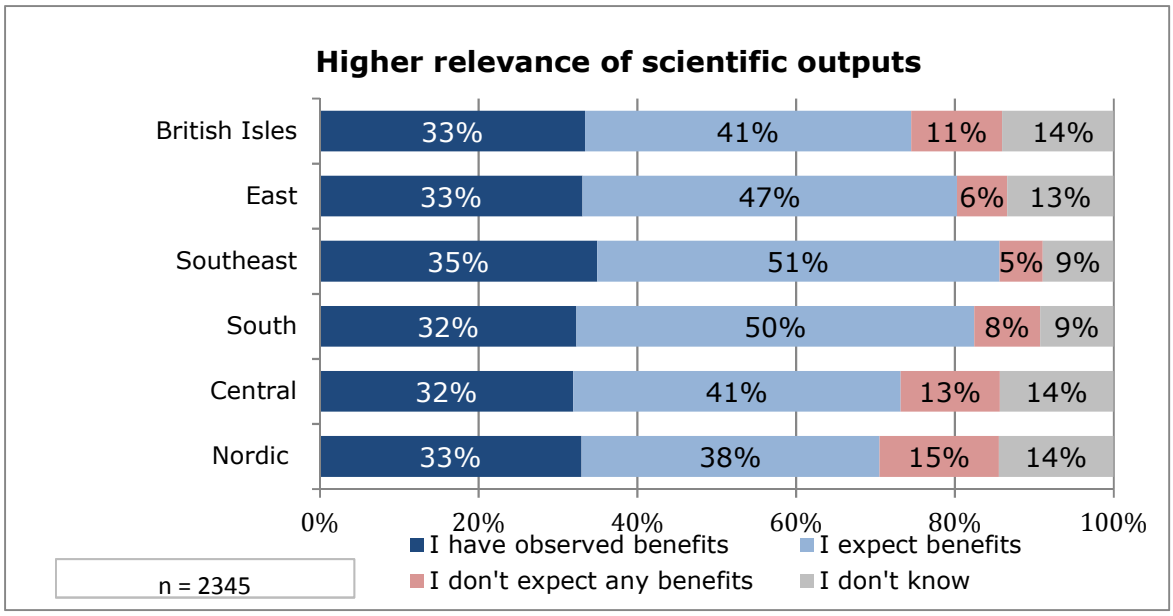
The different public engagement activities we asked about in our survey seem to be most frequent in East and South-East countries. The involvement of citizens happens in all phases of research, i.e. when determining what research should be performed (South-East), citizen support for data collection and data analytics (South-East, East), discussing the consequences of research (again both country groups), disseminating and communicating the results (East, South-East but also South) and commercialisation and exploitation (East, South-East, South). Engagement with industry is quite high in the South, the South-East and the Nordic countries.

For the open access pillar, we can identify the British Isles and, to some extent, the Nordic country group as forerunners in the field of open access publishing. Green and gold open access is most common in these two country groups. The use of publicly available data, in contrast, seems to be important in the East and South-East.

5.2 Observed and expected benefits

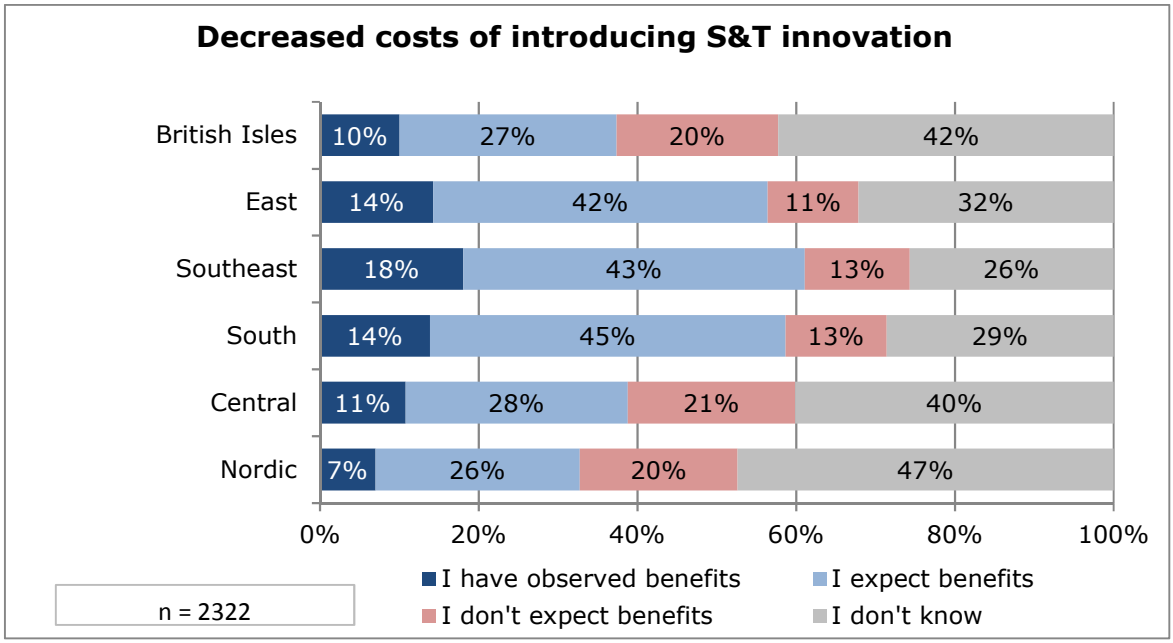
The perception of benefits is also (slightly) influenced by country. This is most apparent when looking at non-expectations of benefits rather than the positive conformations that a certain benefit has already been observed. For scientific benefits, for example, especially respondents from the Central and Nordic country groups mention much more frequently that they do not expect a higher relevance of scientific outputs. However, overall, positive perceptions are dominant in all country groups.

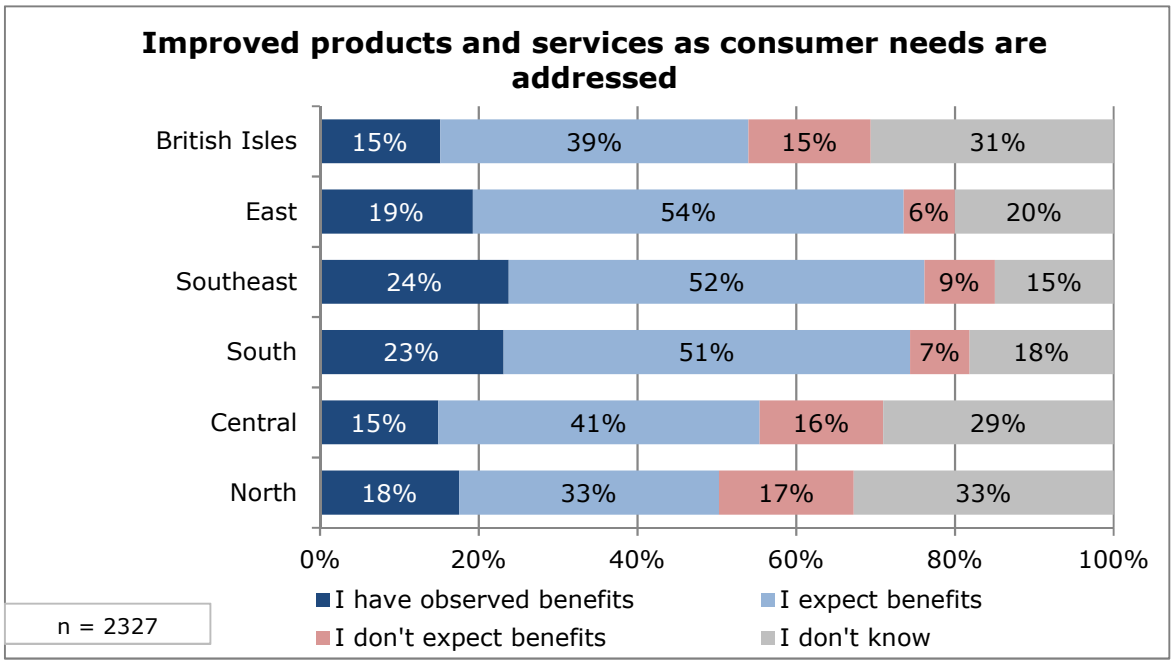
Figure 23: Scientific benefits (EU funded researchers)



The Central, Nordic and British Isle respondents are slightly more sceptical about the emergence of economic benefits too; specifically, that decreased costs of S&T introduction occur or that products and services are improved due to consideration of customer demands.

Figure 24: Economic benefits (EU funded researchers)



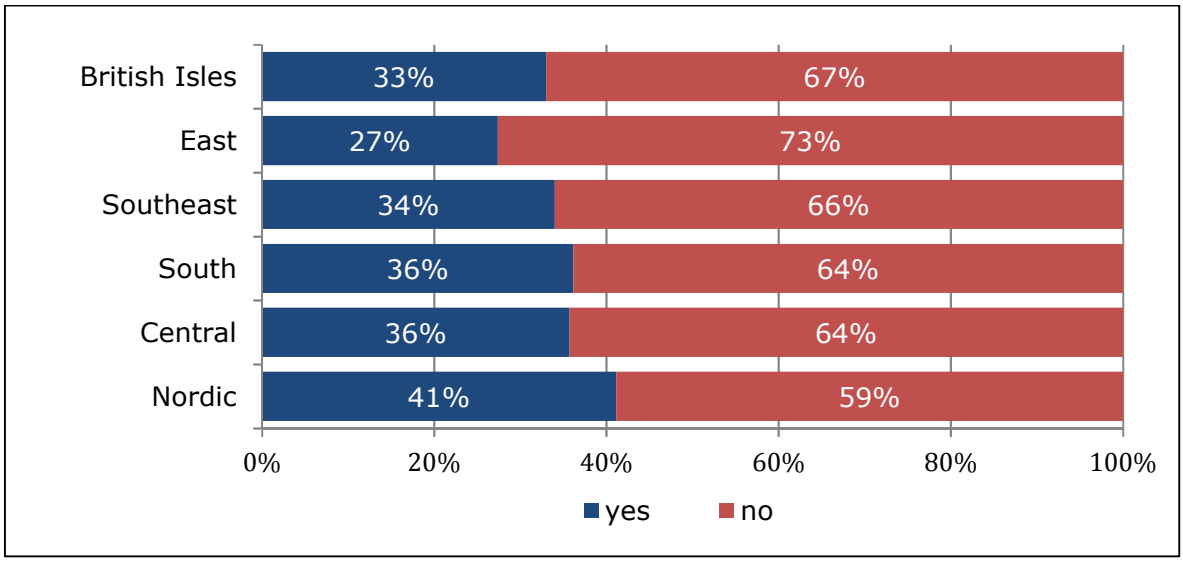


A similar picture emerges for the democratic benefits, although not as clearly as for the economic benefits: again, mainly respondents from the Central country group are sceptical about expecting concrete benefits (see Annex).

5.3 Promoting and hindering factors

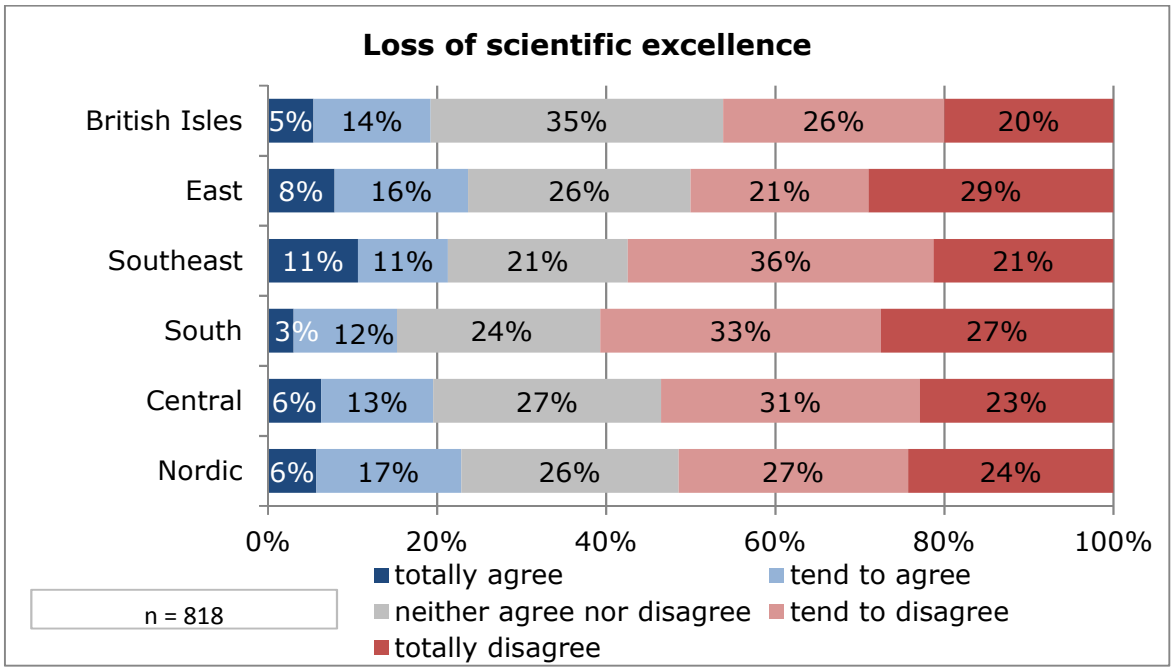
If we look at the perceived barriers, it becomes obvious that particularly respondents from the Nordic country group report them. Concretely, they complain about an overload of tasks, increased direct costs and a lack of motivation.

Figure 25: Observed barriers by country group (EU funded researchers) (N=953)



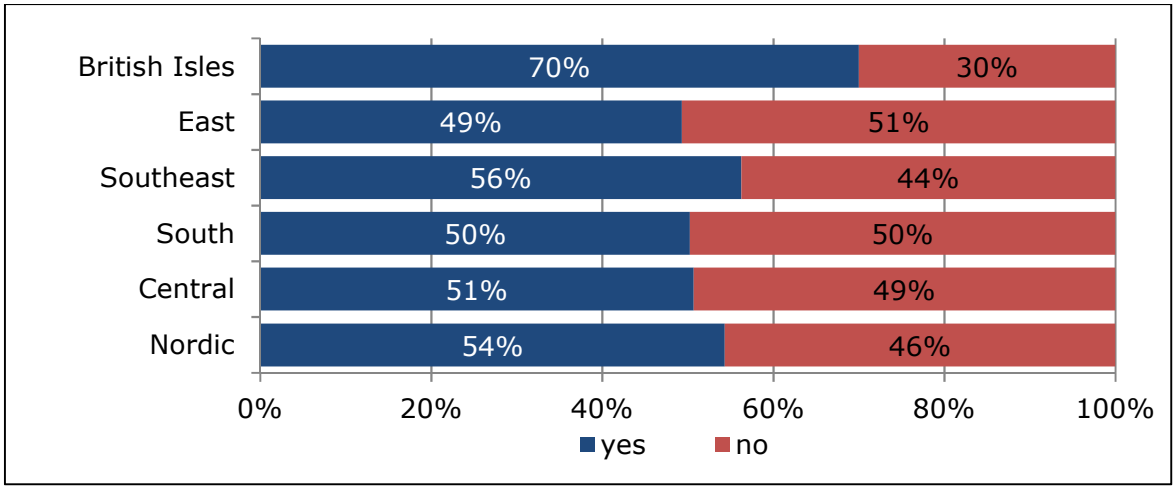
As already mentioned above, an overload of tasks and a lack of experience with RRI are generally the most salient observed barriers for the respondents. However, a lack of institutional incentives also plays a decisive role for respondents from the East country group. The fear of a loss of scientific excellence seems to be negligible among all country groups.

Figure 26: Observed loss of scientific excellence by country group (EU funded researchers)



Finally, we see that particularly the respondents from the British Isles frequently indicate the observation of supportive factors. Personal motivation (about one-third of "yes" responses), the existence of institutional strategies and access to research funding (about a quarter of "yes" responses) seem to be the most important factors across all country groups.

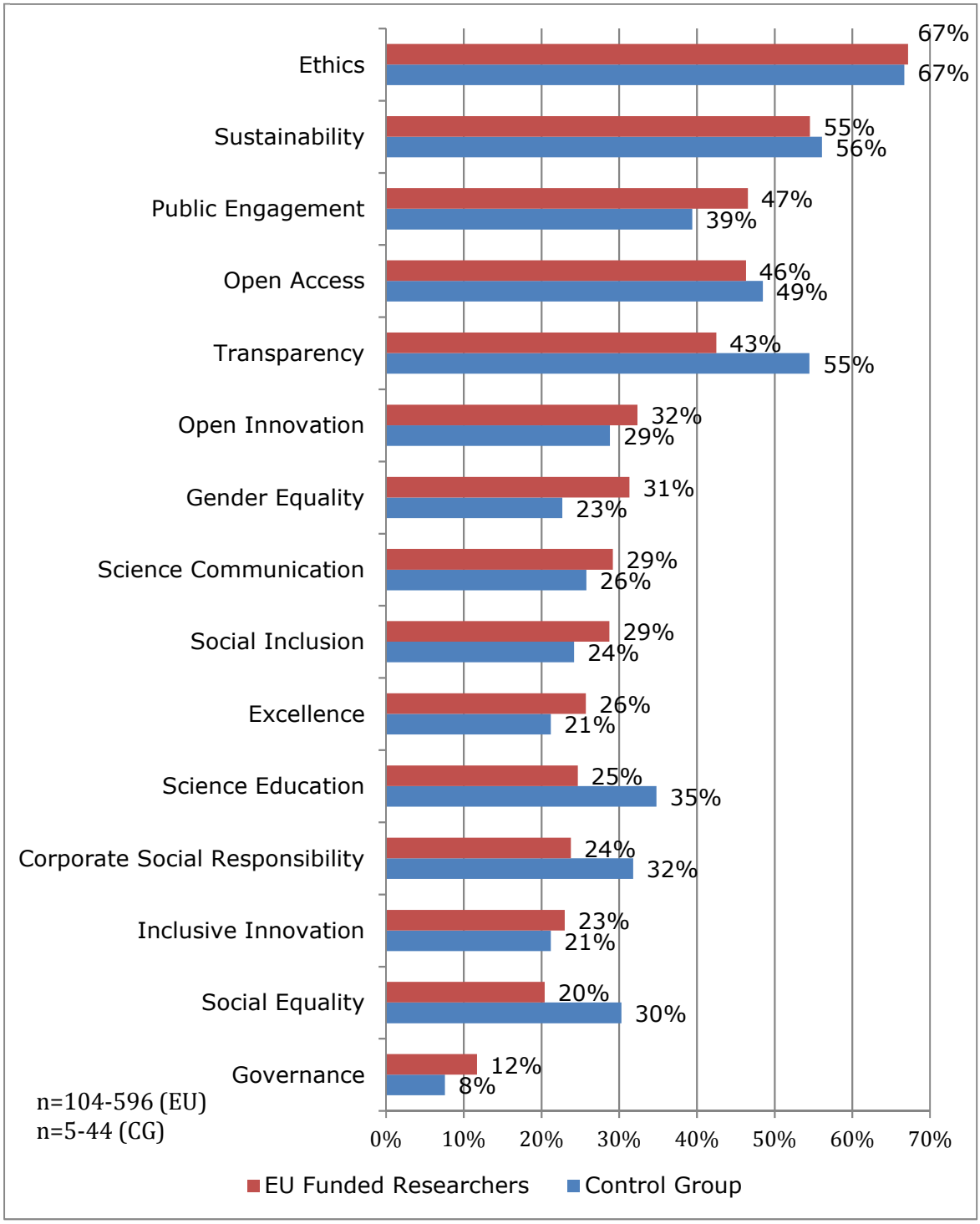
Figure 27: Observed supportive factors by country group (EU funded researchers) (N=1464)



6. Comparison with non-EU-funded researchers

The following section analyses whether our assumption that the receipt of EU funding leads to a stronger RRI orientation is substantiated. As mentioned at the beginning, however, we should take into account that, despite the careful compilation of the control group according to country, scientific discipline and gender, there are major differences between the control group and the EU-funded population. One of the most important differences is that the control group comprises university researchers to a much higher extent (ca. 70%) than the EU-funded researchers with less than half (46%) employed in a university setting. Accordingly, within the control group we find many more curiosity-driven researchers who orient their research primarily towards the research community. Furthermore, the control group respondents receive basic funding to a much larger extent than the EU-funded group. However, the fact that the European Commission funds RRI projects to a substantial extent presumably also influences the observed difference in the perception and practice of RRI. For example, within the control group, far fewer respondents are familiar with the concept of RRI compared to the EU-funded group: whereas about 26% in the latter group indicate that they have already heard about RRI, this is only true for 13% of the control group. In addition, the control group also associates different key notions with RRI: besides ethics, which is ranked first, more than half the control group mentions sustainability and transparency as important components of RRI. In contrast, gender equality is only associated with RRI by a minority of 23%, whereas about one-third of the EU-funded group made this connection.

Figure 28: Key terms of RRI according to the control group respondents



6.1 RRI activities

The low familiarity with RRI is also reflected by fewer activities undertaken within the five RRI pillars: whereas about one-third of the EU-funded respondents mention appearances on TV / radio, this is only the case for 17% of the control group. Furthermore, about 31% of the EU-funded researchers participate in science cafés, but only 20% from the control group.

There is a very marked difference regarding gender equality: whereas about three quarters of the EU-funded respondents indicate that they support female colleagues, only 60% or 67% from the control group report this behaviour. In addition, the consideration of gender aspects in research design is much lower for the control group than for the EU-funded researchers. The reason for these differences might be the fact that twice as many EU-funded respondents indicate that gender equality is a requirement of their research funders. There are also large differences for public engagement: EU-funded researchers indicate much more frequently a respective activity like involving citizens in discussing the consequences of research, communicating and disseminating results, but also engaging with industry. Again, EU-funded researchers indicate more frequently that this activity can be attributed to the requirements of research funders. The differences between the two survey groups regarding open access are not as marked; the only remarkable difference occurs regarding the implementation of data management plans, which again is required by the EU Commission.

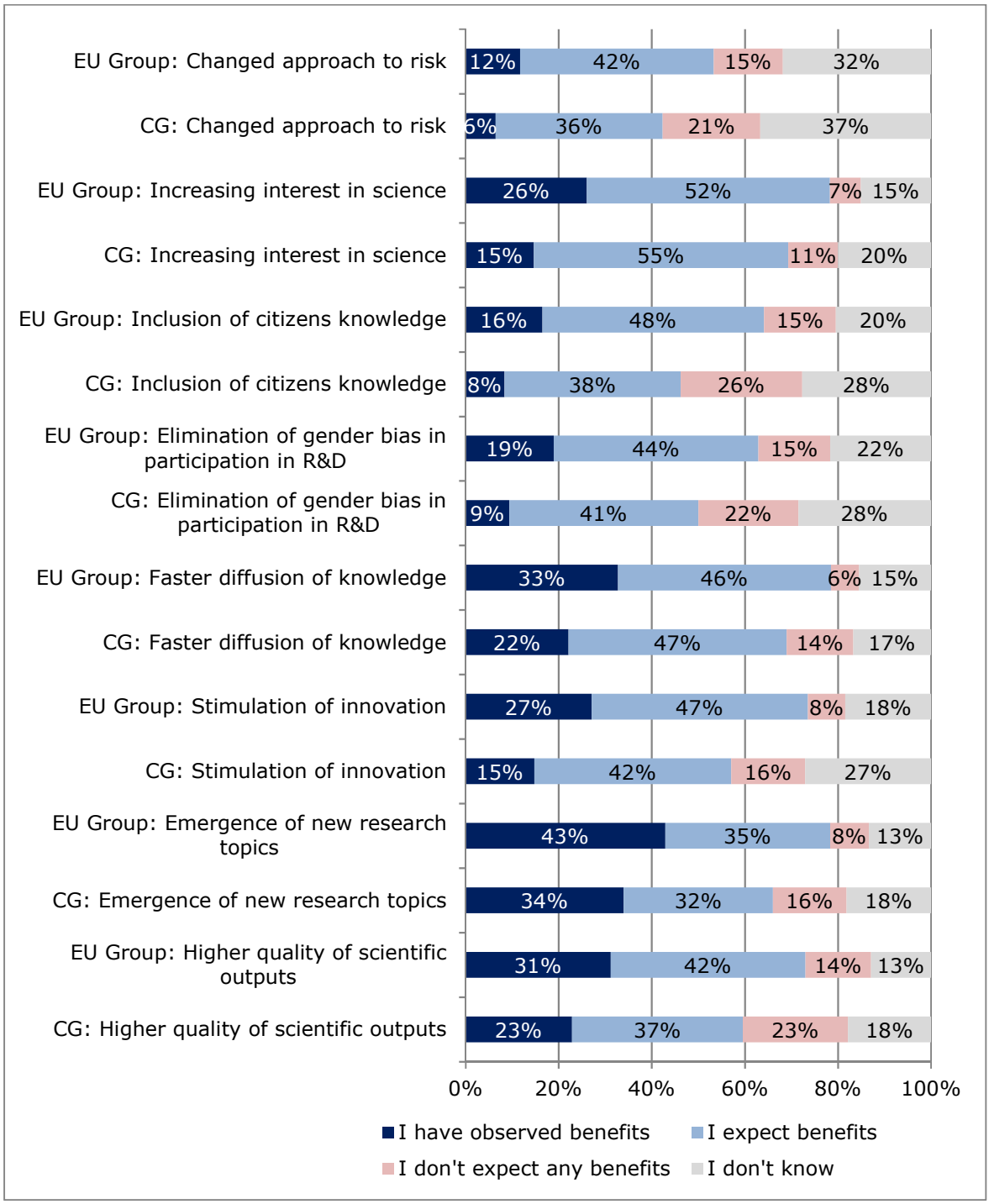
To summarise: by means of multivariate statistics we identified the following activities with the largest, statistically significant differences between the EU-funded and control groups: two out of seven science education activities (appearances on TV / radio; science cafés, science festivals, researcher's nights; three out of five gender equality activities (I encourage gender-balanced teams in my work environment; I actively support female colleagues within my teams; I consider gender aspects in my research design); one out of five ethical activities (I submit my projects to ethical reviews); seven out of eight public engagement activities (involvement of citizens in determining what research should be performed; discussing the consequences of research / its application (including technology; communicating and disseminating the results of the project; commercialisation / exploitation of results; but also: I actively consider how my research and innovation results will be perceived; I work with people who specialize in holding dialogues with citizens and civil society; I engage with industry in my research) ; but only one out of six open access activities (implementation of research data management plans).

This leads to the conclusion that public engagement, gender equality as well as science education are strongly shaped by the EU framework whereas this is less the case for ethics and open access.

6.2 Perceived RRI benefits

The control group is also less likely to indicate concrete benefits of RRI than EU-funded researchers. This is in line with the control group's degree of familiarity with RRI and lower RRI practice: even if, in most cases, more than 50% of the control group indicated an observed or expected benefit, the share of control group respondents who do not expect any benefits is substantially higher than the same share among the EU-funded researchers. This holds true for all four benefit categories, i.e. scientific, economic, democratic and social benefits, but the largest differences are for scientific and economic benefits.

Figure 29: Comparison of perceived benefits of RRI between EU-funded researchers and the control group



To give an example: while only 34% of control group respondents affirm the emergence of new research topics, this is the case for 43% of the EU funded researchers. Furthermore, 25% and 23% of the control group indicate a higher relevance and quality of the scientific outputs compared to 33% and 31% of the EU-funded survey participants. Finally, only 11% of the control group have already made

a positive experience with mobilising research funding through RRI, whereas this holds true for 24% of the EU-funded researchers.

The largest differences between the groups regarding economic benefits occur for the stimulation of innovation (15% vs. 27% observed benefits), effectiveness of public investment (8% vs. 19%) and faster diffusion of knowledge (22% vs. 33%).

All in all, the multivariate analysis confirms that the majority of the benefit items differs significantly between the EU-funded researchers and the control group: within the dimension "scientific benefits", five out of six benefit items are proved to be different (emergence of new research topics; enhanced visibility in the research community; higher relevance of scientific outputs; higher quality of scientific outputs; mobilizing funding) whereas especially the access to research funding underlines that EU-funded researchers did already have a respective positive experience.

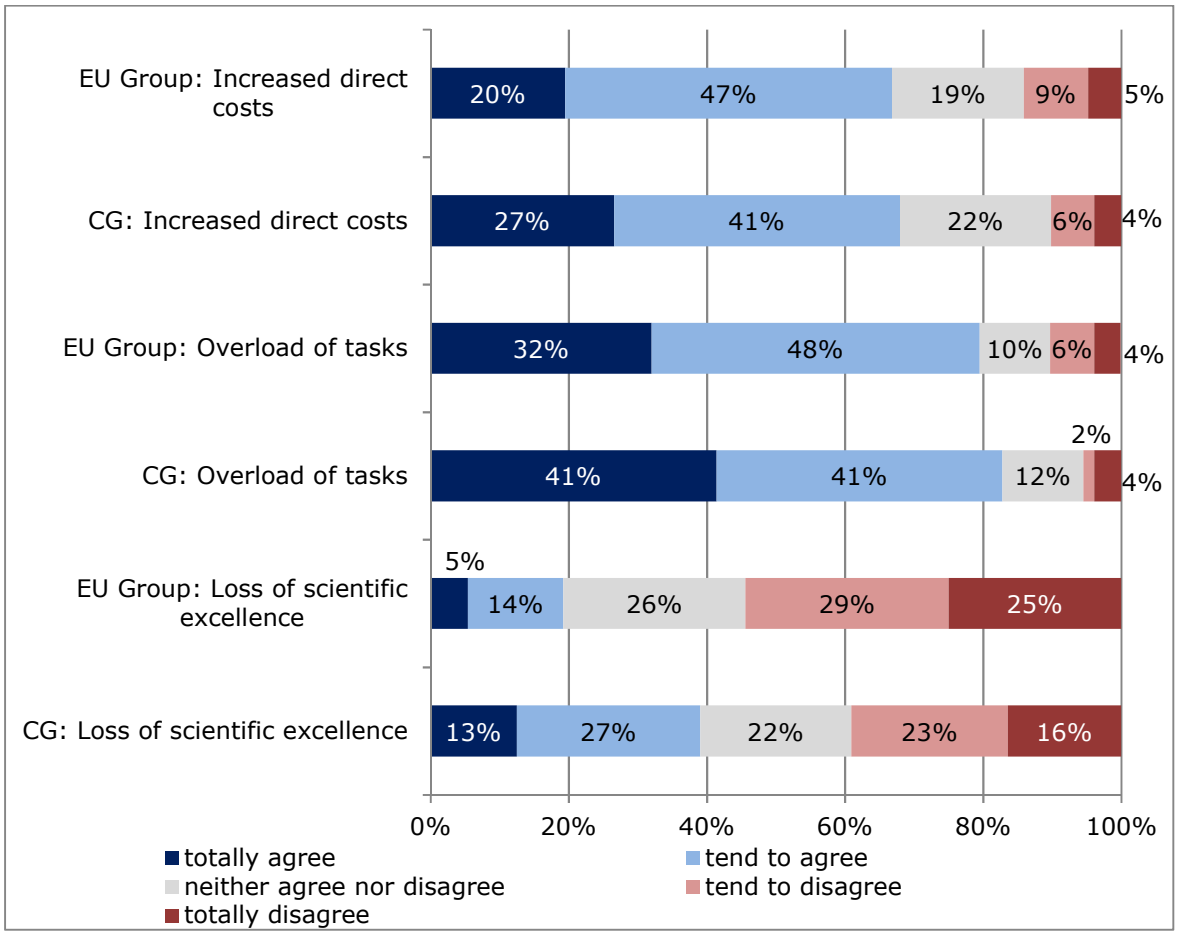
Regarding "economic benefits", six out of eight items show significant differences (decreased costs of introducing S&T innovation; improved products and services as consumer demands are better addressed; increased intrinsic satisfaction with science & engineering positions; stimulation of innovation; effectiveness of public investment; faster diffusion of knowledge).

Finally we can show that *all* democratic benefit items show significant differences between the two survey groups (elimination of gender bias in participation in R&D; inclusion of citizens' knowledge; reduction of R&I-related conflicts; empowerment of citizens) and three out of five social benefit items (changed approach to risk; outreach to disadvantaged groups; increasing interest in science).

6.3 Perceived supportive and hindering factors

Even if the overall distribution of observed barriers in terms of yes/no answers is more or less the same, the concrete barriers are mentioned much more frequently by the control group than by the EU-funded researchers. Particularly the overload of tasks plays a decisive role for the researchers from the control group.

Figure 30: Comparison of perceived barriers between EU-funded researchers and the control group



Supportive factors are generally less frequently observed by the control group (41% compared to 55% of the EU-funded researchers), but there are hardly any significant differences regarding the individual factors suggested in the questionnaire with one exception: more control group members confirm that legal requirements might support the implementation of RRI.

7. Discussion

The analysis of the two groups of researchers, one receiving funding from the EU and the other not, showed that the framework programme designed by the European Commission makes a difference to the practice of responsible research and innovation. Not only are EU-funded researchers more familiar with the concept of RRI, they also associate more benefits and supporting factors with it than researchers from the control group do. Furthermore, the EU-funded researchers are more likely to practise activities related to the five main pillars of RRI, i.e. open access, gender equality, science education, public engagement and ethics. Presumably this is a direct effect of learning through EU-related policies and requirements, as RRI was developed and implemented first by the EU and is not yet – at least not as an acronym – fully known within national research and innovation systems. Furthermore, we can assume that European research and innovation funding typically attracts researchers who engage (stronger) in applied, problem-solving and challenge-oriented research which, as

shown by this analysis, is more open towards RRI than pure curiosity-oriented research.

However, the control group's results also show that there is still a long way to go regarding the "universe" of researchers in Europe before RRI is more broadly known and accepted. In this regard, policy intervention should be aware that the most important barrier, from the point of view of the respondents, is a strong overload of tasks. This might be overcome by adopted institutional incentives, more staff in research organisations and reduced reporting duties. Lack of knowledge also acts as a barrier, but this could be overcome by intensified communication of RRI as a concept and particularly the communication of good practice examples. Good practice examples are, for example, illustrations of the advantage of gendered innovations[7] or the good practice examples collected by the EU-funded RRI tools project (Kupper et al. 2015).

The survey results confirm the impression that the institutional environment can positively influence the degree of RRI activities and the general attitudes towards more responsible research and innovation. Researchers working in an institutional environment that systematically supports the practice of RRI, for example, through funding incentives, dedicated staff in charge of RRI pillars etc., are more active in RRI practices than researchers who cannot rely on such structures. Thus, from the point of view of policy makers, active support of institutional changes might help the dissemination of RRI. As we saw from the survey results, the definition of success and/or eligibility criteria for research funding is a further mechanism that encourages a positive attitude towards RRI.

As expected, we find that challenge-oriented researchers are typically more RRI-aware than curiosity-driven researchers, especially regarding concrete practices, but also regarding the perception of the concrete benefits from RRI. Public engagement is the RRI pillar showing the strongest effect of the research orientation: challenge-oriented researchers conduct many more public engagement activities than curiosity-driven researchers. Unexpectedly, however, the main source of research funding (basic funding, third-party funding, and contract research) does not make a significant difference regarding RRI activities or the perception of the associated benefits.

Further factors which influence the practice of RRI and its perceived benefits are the research experience and the scientific discipline of the respondents. Especially for medicine, but in most cases also for the social sciences and the humanities, RRI issues are more important than for the structural sciences.

Another important result is that the longer the period spent working in research, the more the respondents are inclined to conduct a respective RRI activity. We assume that more experienced researchers have more opportunities than less experienced ones to invest in such kind of activities because they are typically already established within the science system, while "younger" researchers still have to focus on their research and the advancement of their academic/professional careers. One might consider changes within the national systems of performance-oriented resource allocation. If, for example, public engagement or science education activities were also recognised using the respective key performance indicators (and not only the number of publications and citations, etc.), this could support younger, not yet fully

7 http://ec.europa.eu/research/swafs/gendered-innovations/index_en.cfm?pg=home

established researchers, to address RRI issues without endangering their scientific careers.

A gender effect can be observed primarily within the gender equality pillar, i.e. women support female colleagues and also consider gender aspects in their research design more frequently than men. The use of gender-sensitive language shows no significant differences between men and women.

Generally, the respondents report numerous benefits which have already been observed, particularly scientific and economic ones. Even if concrete benefits have not yet been observed, the respondents are still quite optimistic that these benefits will occur in the future. This attitude also applies to the control group.

Overall, we ascertain that respondents perceive more supportive factors than hindering ones. Whereas more than half the respondents mention supportive factors, only slightly more than one-third mention barriers. From the respondents' viewpoint, the most important supportive factors are personal motivation and the institutional strategy, which can play a decisive role.

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