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Are STEM from Mars and SSH from Venus?
Challenging disciplinary stereotypes of research's social value

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Abstract

There is a reasonably settled consensus within the innovation community that science, technology, engineering and mathematics (STEM) research is more 'useful' to societies than other kinds of research notably social sciences, humanities and arts (SSHA). Our paper questions this assumption, and we seek to empirically test whether STEM researchers behave in ways that make their research more useful than SSHA researchers. A critical reading of the discussion around SSHA supports developing a taxonomy of differences: this is tested using a database covering 1,583 researchers from the Spanish National Research Council (CSIC). Results do not support that SSH researchers behave in ways that are less useful than STEM researchers, even if differences are found in the nature of their transfer practices and their research users. The assumption that STEM research is more useful than SSH research needs revision if research policy is to properly focus on research useful for society.

Keywords: research policy; user engagement; knowledge transfer; research utilisation; social sciences and humanities.

1. Introduction

Is science, technology, engineering and mathematics (STEM) research more useful to society than other kinds of research, notably social sciences, humanities and arts (SSHA)? A recent provocation in *Nature* suggested that social science researchers were primarily concerned with disciplinary disagreements rather than contributing to solving contemporary societal problems (Van Langenhove 2012). Research policy discourse of late certainly seems to assume that is true (Nightingale and Scott 2007), and in this paper we explore the extent to which this assumption is valid.

We begin by arguing that debate has been too constrained by the search for output and impact indicators: problems in finding suitable indicators have been used to draw the inference that this means the research has no impact. However, inspired by other research (e.g. Bate 2011; Hughes et al. 2011) we note that the well-documented existence of engaging behaviours by researchers in social sciences and the humanities (SSH) implies relationships with users, and users imply utility. We therefore argue that if SSHA research were less useful than STEM, then you would expect to see different kinds of behaviours by these researchers. In this paper, we develop a framework for considering what kinds of different behaviours there may be, and empirically test that question of different engagement behaviours with a dataset of Spanish researchers.

Our paper starts from the widely noted position that good indicators for measuring the impact of arts and humanities research are missing (*cf.* AWT 2007; British Academy 2008; Crossick 2009; Algra et al. 2011; Bate 2011) and that over-simplistic indicators for social sciences and humanities might cause an important damage in these areas (Donovan 2005; British Academy 2008). This is not to say that indicators do not exist, but that they do not fulfil Van Vught and Westerheijden's definition of allowing transparency and comparability between disciplines (2010). A failure to find appropriate 'transparent' impact indicators for SSH research has been elided with a belief that this means that SSH research does not have an impact, and that it is therefore not socially useful or relevant (Hessels et al. 2009). As a result, a range of governments are starting to focus their research on research that can drive economic growth (Kaiser and Prange-Gstöhl 2010; DG RESEARCH 2011), including in the UK (the Impact agenda), Ireland (Research Prioritisation), and the Netherlands (the Top Sector policy).

This raises the risk that STEM subjects are assumed to be more socially useful: Europe's original plans for Horizon2020 included humanities and the arts only insofar as they contributed to improving security. Ireland's Research Prioritisation exercise saw humanities research drop to the third tier of funding eligibility, being described as exclusively pure research, behind priority and facilitating fields. In the Netherlands, the only Top Sector applicable to the humanities was the creative industry sector. As argued more generally by O´Neill (2011: v) '*some held that in straitened times all public funding should go to research in science, technology, engineering and medicine.*'

When combined with Van Langenhove's argument that social science research makes no useful contribution, this adds up to a powerful prescription to slash funding to social sciences fields. We contend that there is a clear link between a failure to develop transparent (i.e. comparable) indicators and this threat to funding for the 'softer' disciplinary areas. Social utility has to date been defined in terms of things that can be measured like licenses, spin-off activities and R&D contracts, and then those have been measured (Molas-Gallart and Castro-Martínez 2007; Benneworth and Jongbloed 2010). It is true that in measurement terms, SSHA research appears less useful than STEM research in having fewer of these particular activities (mainly licenses and spin-off creation). But it still seems to us to be stretching the logic to then argue that this makes SSHA systematically less societally useful than STEM.

Our point is to sidestep this assumption, and argue that if SSHA is systematically less useful than STEM research for society, then that should be visible in the comparative behaviour of STEM and SSHA researchers. Although measuring behaviour is as partial as using particular output measures, we argue that behaviour indicates the existence of relationships with users, implying the existence of users, which indicates an impact arising from that research. If SSHA and STEM academics behave similarly in their research practices towards users, this suggests that there are users for both STEM and SSHA research – even if the use transactions are not easily measured.

Therefore, we here ask our preceding question as a means to ask the question of whether the now-widespread belief that STEM research is more useful than SSHA research is justified, or is it just that STEM's use is more easily captured in measurable data. This paper therefore seeks to make an important contribution to an intractable innovation policy question with increasing practical urgency, and also to deeper scientific debates concerning knowledge exchange, usability and societal development.

The structure of the paper is as follows. In section 2 we classify disciplinary differences distinguishing those that affect social utility of their research from those that do not. In section 3 we identify some stylized facts regarding SSHA research differences which might account for – from the theory – why this systematic disadvantage and bias afflicts social sciences, humanities and arts. We then formulate hypotheses which are suitable to experimental testing. In section 4 we present an overview of the data and methodology for this study and we set out the variables used to test the hypotheses and their descriptive statistics. On the basis of the results about differences presented in section 5, in section 6 we provide a discussion of them and offer some implications and policy recommendations.

2. Social Sciences, Humanities and Arts context in the science system

Our diagnosis of the current policy assumption is that it reflects a focus on university-industry interactions and other easily measured outputs. This undoubtedly suggests that returns to public investments in research are clearly higher for STEM subjects. Policy-makers have internalised this message and sought to increase and concentrate funding on areas that bring the greatest economic returns (*cf.* Leisyte and Horta 2011; Kaiser and Prange-Gstöhl 2010). But at the same time, the total number of spin-off companies created from all fields of research is always very low, as are their long-term survival rates and employment creation records. Research creates public value in many more ways – with commensurate benefits to the public purse – than a purely narrow economic focus suggests (Pavitt 1991; Nightingale and Scott 2007). We therefore ask whether – taking a much broader definition of utility:

> "Is social science, humanities and arts research different to science, technology, engineering and mathematics research in ways that make it systematically less useful to society?"

There is extensive research that SSHA does have real impact in society: for the sake of brevity, we restrict our discussion to Spanish and British examples. In Spain, the SIAMPI project identified extensive impacts where clear public benefits were created, including culture and heritage, neatly illustrated through examples from road and public safety. Public prosecutors worked with philosophy researchers at CSIC to provide deep understandings of the roots of driver behaviour in designing their strategies for dealing with traffic offenders. Work between police forensics research laboratories and the linguistic research group of CSIC contributed to increasing arrest and prosecution rates (Spaapen et al. 2010). However, as noted in the SIAMPI report, whilst the preservation of the cultural heritage is a valuable impact, the assessment of its value depends on how far popular demand for these goods is accounted for in the impact assessment (Spaapen et al. 2010).

In the UK context, there is a wealth of evidence that humanities research produces societally useful outputs (Hughes et al., 2011). Jonathan Bate's edited collection "The public value of the humanities" assembled 22 case studies of how particular research projects led to public outputs. In many of the cases the authors were able to enumerate these benefits: a more vivid example was a piece of film research that led to a 3 hour TV series watched by over a million viewers (Toulmin 2011). In the UK more generally, the national (statutory) Higher Education Business and Community Interaction Survey (HEBCIS) collects a suite of engagement activities counting attendances at lectures, exhibitions and museums run by universities.

SSHA clearly produces benefits in terms of things that users value, clearly a kind of social utility. How can we interpret the fact that, although SSHA research creates social impacts, as eminent a public scientist as Van Langenhove can criticise their generic lack of utility? Part of this is the notion of difference, that STEM is different from SSHA. We distinguish here two separate hypotheses:

- STEM research produces different kinds of outputs to SSHA research (more measurable, *cf.* Nightingale and Scott 2007; Hessels et al. 2009)
- STEM produces more useful outputs to SSHA research (more valuable, *cf.* Van Langehoven 2012)

We argue that although there is evidence that there is a difference in measurability, this has been elided across to be a difference in value. We therefore seek to test the two hypotheses, that STEM is more measurable than SSHA and STEM is more useful than SSHA. However, this raises the problem of the interdependence of measurability and outputs (which have to be measured). To address that issue, we use behaviours as a proxy for use. We argue that if researchers are engaging, they are engaging with 'users'. In turn the existence of users implies that someone finds the research useful. If STEM was really more useful to society than SSHA, then we would expect to find that STEM researchers were more engaged than SSHA researchers and Hughes et al. (2011) suggest that this is not the case.

3. Differences in the research and transfer practices

This then raises the issue of how would behaviour differ between STEM and SSHA researchers? We take as broad a perspective as possible of where those behavioural differences might lie, to avoid inadvertently excluding some kinds of engagement behaviour which do not fit with our preconceptions. We have elsewhere undertaken a review of all the claims that are made about SSHA researcher behaviour and how it differs from STEM researcher behaviour (Olmos-Peñuela et al. 2012). It is important to stress that this is not founded on a single model of *how* research produces impact. Rather it is an attempt to systematically classify areas where we might expect to find behavioural differences that might reduce the likelihood of a SSHA researcher having relationships with users.

In contrast to Olmos-Peñuela et al. (2012), and following our preceding argument, we classify these differences according to whether they imply that STEM is more useful, or simply differently useful:

- There are differences in behaviour which imply that STEM is more useful than SSH research: differences in behaviour here support the hypothesis that STEM is more useful than SSH.
- There are differences in behaviour which implies that STEM has a different way of making a societally beneficial contribution to SSH research: differences here support the hypothesis that SSH is differently useful to STEM.

We classify the eight claims about difference that are made as the first four suggesting that STEM is more useful to SSH, and the last four that STEM is differently useful to SSH. For each we give a brief explanation of the claim made, and derive a hypothesis in each case that SSH researcher behaviour is different to STEM researcher behaviour.

M1. SSH is more oriented towards national / regional audiences.

M2. SSH research tends to be less universal and to have smaller audiences.

M3. SSH research cannot give answers but only insights into problems.

M4. Lack of visibility of the contribution SSH makes to social development.

D1. SSH research does not need to try to be useful to be useful.

D2. SSH researchers collaborate less with business users who are a homogeneous and visible group.

D3. SSH users are government and community users rather than firms.

D4. SSH research works less with users who can publicly legitimate the value of that research.

SSH tends to be more oriented to national / regional audiences

The first claim made is that SSHA are far more particular and specific than STEM, the latter producing universal laws and explanations. SSHA activities are especially important at closer geographical levels (British Academy 2004) and highly oriented towards regional or specific cultural communities. As noted by Edgar and Pattison (2006: 97-98):

> '*The humanities still speak to specific communities, unlike the natural sciences that at least aspire to speak to a universal humanity... [humanities] still appear to speak in the voice of particular communities and about issues that concern particular communities*'.

The SSHA research is very often strongly context-oriented and not easily extrapolated to other regions or communities. A critical reading of Bate's book (2011) "The public value of the humanities" demonstrates a broad spectrum of research topics, each one confined to a very specific research and specific audience. Conversely, STEM knowledge can be used in generating knowledge '*rooted in discovering increasingly and predictive universally applicable insights*' (Bakhshi et al. 2008: 15). According to this, we posit:

Hypothesis 1: *The rate of involvement with national users compared to international users is higher for SSH researchers than for STEM researchers.*

SSH tends to be less generalizable and have smaller potential audiences

The second claim made about SSHA research is that individual pieces of research are not easily scalable; so a research project produces an exhibition that attracts a number of visitors but then the public life of that knowledge ends (Bakhshi et al. 2008) compared to STEM research. Here the claim is that SSHA research is intrinsically less useful because there are fewer potential users, meaning smaller impacts and audiences than for STEM research with its universalist possibilities (Bakhshi et al. 2008). Indeed, Hughes et al. (2011) find that UK arts and humanities researchers reported more often that their research was irrelevant for external organisations. Likewise, the SIAMPI project illustrate this characteristic through the example of the discovery, translation and publication of Spanish 16th century music and the limited type of audience interested on it (Spaapen et al. 2010). Hence our hypothesis is that SSH researchers feel that few non academic entities are interested in their specific research, that is:

Hypothesis 2. *SSH researchers experience a lower demand for their research than is correspondingly the case for STEM research.*

SSH does not give concrete answers but insights into problems

One of the key problems is that different SSHA disciplines purport to be able to talk authoritatively about the same subjects but different fields have quite different ways of looking at those subjects. The great example is economics, where one's theoretical perspective produces wildly differing interpretations of similar events, a very confusing message for policy makers, and clearly contrasting with STEM research's clear laws and universals. Some subjects use hermeneutic, inductive approaches, as noted by Bakhshi et al. (2009: 110): '*the arts and humanities develop and re-evaluate earlier ideas and sources of evidence, viewing them from new perspectives and new contexts.'* For the public, the STEM disciplines give hard answers to questions without this grey area for interpretation and are regarded as authorities in their fields. Conversely, SSHA researchers become one voice amongst many in a crowded global marketplace of ideas, with opinions as equal to those of think-tanks or lobbyists.

Therefore the claim is that SSHA disciplines talk less authoritatively about the world, reducing the utility of their knowledge by being contingent and disputed rather than universal and established. Of course, it could also be claimed that SSHA's subject domain is more complex and less knowable, and a diversity of approaches provides depth in understanding the issues and problems. But there is still circulating a set of claims that SSHA is more akin to opinions whilst STEM research is more authoritative. We would expect SSH researchers to feel more threatened by having to test the validity of their research compared to STEM. Thus, we suggest the following hypothesis:

> **Hypothesis 3.** *SSH researchers have less interest in checking the validity and applicability of their research than STEM researchers.*

The lack of visibility of SSH's contribution to social development

The last difference claim that implies that STEM research is more useful than SSHA research is the lack of visibility of SSHA research that leads to its under-utilisation: SSHA disciplines are too often too far from their eventual users which reduces the visibility of their research output. This claim is a version of the argument that SSH research is more theoretical and relates more exclusively to solving theoretical rather than practical problems. Based on Frascati Manual classification of basic/applied research (OECD, 2002), Gulbrandsen and Kyvik (2010) found in Norwegian universities that a larger proportion of humanities academics than other research classified all their activities as 'basic'.

An alternative categorisation is the Stokes Quadrant Model (1997)[1] that classifies research along two dimensions: theoretical excellence and practical relevance, and used in previous studies (Abreu et al. 2009; Hughes et al. 2011). Hughes et al. (2011) find that academics from arts and humanities describe their research as basic, with a higher orientation to the pursuit of fundamental understanding (Bohr Quadrant) compared to the rest of the areas. Then, we would expect to find STEM researchers located in the Edison or Pasteur Quadrant, that is more concerned with considerations of use and relevance whilst SSH researchers to be more oriented to basic and excellent research which corresponds to the Bohr Quadrant. We therefore posit the following hypothesis:

Hypothesis 4. *SSH researchers are more concerned with the pursuit of fundamental understanding whereas STEM researchers are more focused on considerations of use***.**

There is of course here a counter-claim, namely that SSHA do not readily fit into to a simple STEM-derived technology transfer or knowledge transfer model (Hartley and Cunningham 2001; Bakhshi et al. 2009; Jaaniste 2009). The dominant model focuses on narrow indicators only counting formalized and transactional activities. However, these institutionalized knowledge transfer activities (Geuna and Muscio 2009) only represent a fraction of universities' full suite of interactions with and impacts upon society (D'Este and Patel 2007; Perkmann and Walsh 2007) and ignore more informal collaborations. Tacit knowledge plays a more prominent role in SSHA than it does in STEM (AHRC 2009: 15) hence, they are characterised by a lower codified research (Pilegaard et al. 2010) and a higher relevance of personal contacts between researchers and users (British Academy 2008). Indeed, SSH is dominated by informal collaborations that do not leave an audit trail (Castro-Martínez et al. 2011). Conversely, STEM research gives tangible products or technologies that require formal intellectual property recognition protection. Therefore, in a context where science's contribution is measured through narrow transactional indicators, SSH is dominated by informal collaborations and STEM researchers are more likely to use formalized interactions, we propose the following hypothesis:

Hypothesis 5. *SSH researchers use a lower proportion of formal pathways to interact with non academic actors compared to STEM researchers.*

SSH's usefulness is delivered by SSH not trying to be useful

One claim often made by SSH's advocates is that unlike STEM disciplines, social sciences and humanities are claimed to have a higher purpose beyond the direct and visible application to economic growth. They provide a lens enabling society to understand about generic and fundamental questions about the past, the present and the future, and about the ethical and cultural values that shape society (*cf.* Bigelow 1998, cited in Bullen et al. 2004; British Academy 2004; Spaapen et al. 2010). SSH researchers are '*opinion-makers and are called upon everyday media as experts*' (Stannage and Gare 2001: 111) to address issues such the crisis, unemployment, immigration, and other social problems (Kyvik 1994; 2005; Bentley and Kyvik 2011). Conversely, STEM research is more weakly linked to current events or to understanding a contemporary social phenomenon: consider the recent discovery of the Higgs Boson – the event was its discovery and all media engagement depended on when it was found. According to previous studies, SSH researchers should be more engaged in popularisation activities such as radio, television, press and conference activities whereas STEM researchers are more represented in institutional activities such as "open door" events (Jensen and Croissant 2007: 4). Consequently we posit:

Hypothesis 6: *SSH researchers spend more time in popularisation activities than STEM researchers.*

Business users are a more homogenous and visible group than government or community

Another claim that arises about differences between areas is related to the non academic actors with whom researchers collaborate. STEM tends to have a greater common form of engagement, via firms, whilst the contributions of SSHA are more diverse, coming through different kinds of contributions through the public and voluntary sectors as well as direct with publics through engagement. Cassity and Ang (2006) argue that humanities are generally removed from interactions with the industry, as *industry* is a term usually associated with manufacturing. Our argument is that SSHA appears to be less useful because of having a less singular form of engagement, with diverse groups, whilst STEM subjects benefit from having collaboration activities which are more homogenous and therefore more amenable to aggregation by policy makers. Hence, the hypothesis proposed is:

Hypothesis 7. *SSH researchers collaborate less with firms than STEM researchers.*

SSH research users tend to be government or community users

A simple way of expressing this claim is the frequently evoked image of the humanities as an ivory tower, and SSHA is disconnected from society. There being no interaction between academics and non academics in these disciplines, then SSH disciplines make no socio-economic contribution. However, that is an assumption apparently deriving from technology transfer and knowledge transfer studies, primarily focused on university-industry relationships rather than a wider set of users (Hughes et al. 2011). The range of potential users of academic research can be expanded to all science-society interactions including non private economic agents such as government agencies and non profit organisations (hereafter NPOs). Indeed, evidence suggests many collaborations between SSHA researchers and industry – mainly creative industries – (Hughes et al. 2011), public bodies and the charitable sector (Gascoigne and Metcalfe 2005; Castro-Martínez et al. 2011; Hughes et al. 2011). This is a very diverse 'set' of users varying in terms of their economic power, their ability to engage academics, academics interest in and motivation to work with them. From this literature, we posit:

Hypothesis 8. *The frequency of collaborations with non economic agents compared to private sector is higher for SSH researchers than for STEM researchers.*

SSH research works less with users who can publicly legitimate the value of that research

This last claim is related to differences in the legitimacy of working with different kinds of user, in terms of how dependent the publically valued outcome (a new product or service) is on the research. The claim is STEM research works more with firms, and there is a public legitimacy for firms working with universities demonstrates its value. SSH research, by contrast, works more with government, and that is not seen as legitimating that research's public value. This is a function of the optionality of the input and the dependency of the public outcome on the research. Firms work with universities to solve problems, and without those solutions, an innovation project may fail, and the economic benefits may not be realised, what Beyer (1997) calls an instrumental use. Conversely, governments work with universities to validate and test their ideas and policies, characterised by Beyer (1997) as conceptual and symbolic forms of use (*cf.* Amara et al. 2004 for an example from Canadian government agencies). STEM research's use is seen as validated by 'independent' third parties (firms) being dependent on it, whilst SSH research is 'only' used by government for confirmation and hence lacks this external imprimatur. Consequently, there may be a natural tendency within government to regard evidence of their working with SSH as less legitimate as proof of its utility than firms working with STEM researchers. This is a difference in perception that arises because of a difference in the nature of the users' wider public legitimacy, not a difference in the value of that research to the user or to publics more generally. To capture this, we suggest the following hypothesis:

> **Hypothesis 9.** *SSH researchers use fewer pathways working with 'instrumental' users on their research (firms) than STEM researchers and more pathways working with 'symbolic' users of their research (government agencies).*

Our argument is that these claims are clearly overlapping and provide a means to identify whether SSH researcher behaviour does differ from that of STEM researchers and in which areas. Therefore, although some of the hypotheses might seem obvious, what is important is the composition of the ways in which behaviour difference in aggregate varies between the two groups. A full summary of these nine hypotheses is presented in the table provided in Appendix 1. The hypotheses are tested using a database of Spanish researchers working at the Spanish National Research Council (CSIC). In order to better frame the testing process, we now provide an explanation of the variable construction and the dataset.

4. Data and methodology

4.1. Database considerations

We present an exploratory study in which, from theoretical readings about the discussion around SSHA research, we propose a number of hypotheses about SSHA and STEM differences that we want to evaluate. In terms of choosing a suitable database, there are a number of studies which have generated material that would potentially be suitable for a study. The AHRC in the UK has been leading in terms of funding research into this area specific to arts and humanities research. Hughes et al. (2011) analysed their existing database which captured the behaviour and reported activities of more than 22,000 academics, 3,650 of those academics in the arts and humanities sectors along with a database of user reactions and interviews with key respondents. This and other databases provide an interesting source of material for comparative work with the eventual database chosen.

In this paper, we are exploring a series of novel propositions which together add up to an experimental way of considering social sciences, humanities and arts research impact. The point of this is to explore whether our approach – attempting to develop hypotheses for social sciences, humanities and arts research's impact theoretically and then to test them – is a feasible way of proceeding. In practical terms this imposes the requirement of using a database that is readily accessible, and therefore we have chosen one to which we already have access because of the team's involvement in its construction.

Our final choice has been a recent database assembled by two institutes[2] from the CSIC in the framework of the IMPACTO project, commissioned by the CSIC. The objective in creating this database was an empirical study of the researchers working at CSIC institutes and their interaction with societal partners. The database records responses from CSIC researchers across all of its scientific domains. The questions covered research characteristics and researchers' collaborations with non academic agents. We are aware about the limitation of using an extant database that does not necessarily completely fit with the aims of our study. Nevertheless, we contend that this is reasonable for an exploratory study, and that further research should start by creating a more specific database. The database also has the advantages of being recent, dating to 2011, being very rich in data and accessible. This database excludes arts disciplines: the empirical analysis is focused on social sciences and humanities.

4.2. Population and data collection

The empirical study is focused on the CSIC, the largest public research organisation in Spain. In 2011, CSIC had 135 centres and institutions distributed throughout Spain[3] (CSIC 2012). CSIC is divided in eight main areas of knowledge[4] and staff are employed as civil servants, contract workers and research fellows, who are scientific staff, technicians or administrators.

This database considers scientific researchers with a doctoral degree and the right to act as principal researchers and enter into contracts with other entities (civil servants[5] or contract workers). The CSIC Human Resources Department identified, at 30th November 2010, a total of 4,240 researchers meeting these requirements. Sampling followed a proportional stratification by areas of knowledge and professional categories[6].

Data was gathered via an online questionnaire, with an invitation mail, a reminder mail and then a final reminder telephone call. Data collection took place between 7th April 2011 and 24th May 2011. The final database covers 1,583 researchers, 37% of the population. The population and sample distribution by area of knowledge is reported in Table 1.

[Table 1 about here]

The questionnaire was developed from a literature review on the effects of public research, built on conceptual foundations analysing the role of public research in business R&D and innovation processes (Cohen et al. 2002; Schartinger et al. 2002), with a special emphasis on those studies that reflect different transfer mechanisms and their impacts (Cohen et al. 2002). Empirical studies about researchers' interaction with non academics were also included. Following the theoretical and empirical review, five main conceptual dimensions have been identified and included in the questionnaire: researchers' profile and their research activity; researchers' relationships with non academic actors; barriers to establishing relationships; engagement activities; and results of researchers' relationships with non academic actors. In the following section we present the variables used from the questionnaire to test the hypotheses proposed.

4.3. Variables and test considerations

To test the hypotheses proposed, we use a number of variables constructed from the CSIC questionnaire. The detailed definitions of the variables are presented below in Table 2.

[Table 2 about here]

All the variables used to test the hypotheses are ordinal or continuous variables except for the variable referred to the Stokes Quadrant. Therefore, for ordinal and continuous variables (distributions not matching with a normal distribution) we use the Mann Whitney test (U) to statistically assess whether there are differences in the sampling distribution of the different variables for SSH and STEM areas. For the categorical variable [Stokes Quadrant] we use the independency Chi Square test (χ^2) to assess whether there are similarities between SSH and STEM researchers in their distribution between the four categories proposed by Stokes (1997): Unnamed, Edison, Bohr and Pasteur.

5. Empirical results

5.1 Descriptive statistics

The descriptive statistics of the variables used in this study corresponding to all areas are reported in Table 3. The weight of SSH researchers in the whole sample is 7.4%. More than half of the researchers are positioned in the Bohr Quadrant (research highly inspired by fundamental understanding and lowly by consideration of use), followed by the Pasteur Quadrant with 22.2% and Edison Quadrant with 9.7%. For the average percentage of time spent by the researcher on popularisation activities, it is 4.04%, with a standard deviation of 6.63.

Moreover, more than 80% of the respondents declare that checking the validity or practical application of the research developed is an *important* or *very important* motivation to establish relationships with other entities. Likewise, more than half researchers report as *quite* or *a lot* the extent to which the little interest of other entities about their research is an obstacle to establish relationships with them.

Related to collaboration with non academic entities, on average 43% of pathways of collaboration are formal, with a standard deviation of 17.94 and on average, 72% of the collaborations are with national entities, with a standard deviation of 21.92. Slightly less than one quarter of the respondents do not collaborate with firms over the last three years whereas almost 15% do it seven times or more. Indeed, the most frequent case is to collaborate with firms one to three times in the considered period.

For the rate of collaborations with non economic agents in comparison with firms, we find on average that the ratio of researchers´ collaborations with government agencies and NPO is respectively 1.18, with a standard deviation of 0.71; and 0.84, with a standard deviation of 0.52.

Finally, on average, the respondents score 2.60 and 4.15 of a possible maximum of 14 on the variety index of collaborative activities with 'instrumental' users and 'symbolic' users, respectively.

[Table 3 about here]

5.2. Statistical tests

To empirically test the hypotheses formulated, we apply the independence Chi Square test (χ^2) to assess the hypothesis 4, that is, the independence or not between SSH researchers and STEM researchers in their position in the Stokes Quadrant. The null hypothesis here is that there is independency between the two groups and is rejected if the *p-value* < .05. A Mann Whitney test (U) is applied for hypotheses 1 to 3 and 5 to 9 to know whether there are statistical significant differences between SSH and STEM. Note that for these hypotheses the null hypothesis is that there are no differences between SSH and STEM and is rejected if the *p-value* < .05. Results are presented in Table 4.

Are STEM disciplines more useful than SSH disciplines?

The first set of hypotheses tested is related to whether STEM is more useful than SSH research. For the variable H1 [National Orientation] there is evidence that there are differences in favour of the national orientation of SSH research: we reject the null hypothesis about the more regional or national orientation of SSH as the *p-value* is 0.00. This is the only piece of evidence that suggests that SSH research might be less useful than STEM, by being more oriented to primarily national users compared to international users. For the remaining three utility indicators, there is no evidence to reject the hypotheses that SSH and STEM researchers' behaviour is similar.

For the variable [User Demand] measuring researchers' perception of the interest of users about their research, we cannot reject the null hypothesis (H2) as the *p-value* is 0.35. The literature predicted that SSH researchers would feel less interest or demand from users than STEM researchers in their research (*cf.* Hughes et al. 2011); nevertheless, this is not supported by our evidence and we have to move towards rejecting this hypothesis.

For hypothesis H3 [Check Validity] we cannot reject the null hypothesis of differences between areas as we obtain a *p-value* of 0.57. From our review, our starting hypothesis was that SSH researchers would be less interested in validating their research with users than STEM researchers. As SSH researchers conduct research regarded as less authoritative, we expected that they would be less interested than STEM researchers in checking the applicability of their research; however, our data does not support this assumption.

The result of the χ^2 test corresponding to the variable [Stokes Quadrant] [7] indicates that we cannot reject the null hypothesis about independence in the research orientation (H4) as the *p-value* is 0.62. Previous studies found differences between humanities and arts, and STEM, the former being more oriented to fundamental understanding (Gulbrandsen and Kyvik 2010) and the latter more concerned with the use and relevance of the research (Hughes et al. 2011). However, contrary to what was expected, our data do not support differences in the way in which researchers orientate their research. Indeed, based on this result, we cannot assert that the lack of visibility of SSH research is due to differences in the way they conduct or orientate their research. Differences from previous studies could potentially be due to the fact that our analysis includes only social science disciplines (excluding arts disciplines). Nevertheless our data results move us to rejecting the idea of a difference between SSH and STEM in terms of research orientation.

Are SSH disciplines differently useful to STEM disciplines?

For the variables suggesting that STEM research is differently useful to SSH research, the following results are found. We analyse the variable [Formality] to test H5, whether SSH and STEM researchers used similar pathways to engage with users. Our data supports the view that SSH researchers tend to use few formalised activities to collaborate with non-academic actors (Castro-Martínez et al. 2011). This is unsurprising: SSH research often does not need confidentiality agreements, licensing or patent protection, nor does it require exclusivity as it does not lose value when they are shared. Conversely, it is more usual the use of formal agreement to protect STEM research output though patent and licenses.

The result of testing H6 [Popularisation] indicates that we can reject the null hypothesis (*p-values* = 0.00) and that SSH researchers spend significantly more time in these type of activities than STEM researchers. This result is in line with what the literature predicts and some previous studies (Kyvik 1994, 2005), implying that SSH researchers are willing to disseminate their research beyond the academia and to integrate it into public life. Indeed SSH disciplines have historically been more involved in dissemination, whilst for STEM, engagement in these activities is a more recent phenomenon.

On the other hand, the first null hypotheses related to differences in the type of users propose that there are differences between areas in researchers' collaborations with different users. We test this through H7 [Firms] and H8 [Government Agencies] and [NPO]. Mann Whitney test results indicate that for all three variables we can reject the null hypotheses about differences between areas as the *p-value* is 0.00. The literature predicts that SSH researchers collaborate less with firms, and more with non economic agents than STEM researchers, which is confirmed by our empirical data, indicated by the means for SSH and STEM presented in Table 4 for these variables. This does not mean that SSHA have no role to play in the knowledge economy and for cultural and creative industries this is not the only way their results find users (OECD 2005; European Commission 2010). Of course these results should be nuanced in the context of the knowledge economy, where SSHA is involved in corporate development, for example through research around the concepts of organizational learning, organisational management and human resources, essential in the knowledge based economy. Likewise humanities and arts are also increasingly important in the emerging cultural and creative sectors (European Commission 2010).

Finally, the second null hypothesis related to differences in users in their diversity of interactions with 'instrumental' users and 'symbolic' users. Results indicate that we can reject the null hypothesis H9 as we obtained a *p-value* $< .01$ for both variables [Instrumental Users] and [Symbolic Users]. The literature suggested that STEM users are strongly engaged with 'instrumental' users and SSH researchers with 'symbolic' users. That was confirmed by the empirical evidence, although there are of course high profile examples where this is not the case.

[Table 4 about here]

6. Conclusions

The results as presented above – with the necessary caveats that they are at best exploratory - give an interesting insight into the nature of the differential utility of SSH and STEM research. The first point is that the evidence does not support the claim that SSH researchers behave in ways that are less useful than STEM researchers. They feel as much demand from users, they are willing to work with users around testing the validity of their findings, and they are certainly not more blue skies when measured in terms of the Stokes classification. They do have a much higher orientation towards national (and regional) users than STEM researchers, but that does not conclusively demonstrate that SSH research has less use because of the other indicators that suggest that although more oriented to national communities, they are just as user-oriented.

Indeed, one then conceivably could argue that social sciences and humanities research does more to create national impact, something increasingly important in times of crisis. The conclusion of this would be that it would make sense for policy-makers to invest more in SSH research than in STEM research to drive recovery because that investment would be more likely to create national benefits. Of course, we would draw back from making that argument because of our research's exploratory nature, but we do believe that this counter intuitive finding is suggestive of more research being needed in this area more generally.

The second finding relates to the where the material differences between STEM and SSH research do lie: clearly, STEM and SSH are characterised by different kinds of usability. SSH researchers tend to use less formal pathways to engage with users, and it is formal pathways that are more easily tracked and measured. SSH researchers are far more likely to get involved in popularisation activities than STEM researchers, participate in reach-out activities for a mass 'public' audience. STEM researchers work users that are relatively homogenous in terms of the kinds of things they are after - process inputs creating economic growth – whilst SSH researchers work with users who have a much more diverse range of uses for the knowledge. Alongside this, SSH researchers are much more likely to work with symbolic users who embed their knowledge in eventual products, rather than firms who are instrumental users.

Returning to our opening question, these results provide a clear answer. The question we originally posed was

> "Is social science, humanities and arts research different to science, technology, engineering and mathematics research in ways that make it systematically less useful to society?"

Our answer is that our findings suggest that social science and humanities research is different to STEM research, but not in ways that make it systematically less useful to society, thus corroborating Nightingale and Scott's (2007) contention. This likewise contradicts Van Langenhove's perception that social sciences and humanities scholars idealise themselves as living in ivory towers: whilst scholars may themselves say that that is what they think they do, this question was not asked in the survey. When we look concretely to what researchers reported doing, SSH researchers surveyed were not behaving less usefully than STEM researchers: there were users for SSH research just as there were users for STEM research. The existence of users in turn suggests a public group in Spain that find SSH research useful.

More research is needed to replicate the work in other national contexts. An important issue to address here is the importance of differing demand and environmental conditions between SSH and STEM research. It is not clear that conceptualising the way public value of SSH arises within an innovation system framework makes sense. The fragmented, diffuse and indirect relationships between actors and the relatively limited roles that individual knowledge producers play in the eventual incorporation of SSH knowledge appear to shape practices in a deep-seated way allowing relatively comparable usability of the emerging knowledge.

Likewise, our findings suggest that SSH research does differ from STEM research in the way that it creates benefits, so not directly by working with businesses but less visibly, creating content for the media, and working with government and NPOs to contribute to improving quality of life. These findings are not surprising, because they are suggested in the literature but our research contributes by substantiating these points with the finding that the fact that their pathways are less visible is not accompanied by a lower orientation towards utility. Literature provides good explanations of why these differences might exist, and but fact that they exists suggest that new and better ways need to be found to understand the way that SSH research creates public value.

This finding raises the interesting question of why this discursive distortion fallacy has emerged in the policy discourse, and there are a number of potential explanations that warrant further investigation. The first is that there has been a change, and SSH used to be less useful than STEM, but has changed and the policy discourse will over time itself evolve to reflect this change. The second is that it is a result of differential availability of statistics, and a general stronger trust and acceptance in economic statistics as proving this situation. The third is that it is an irrational belief that has become embedded in discourses and is sufficiently attractive to persist despite the contradictions that it raises. We therefore see that research is also needed into policy-makers behaviour to understand if they are adapting to this message, and how these new and better ways of understanding value can become implemented in policy-making and science instruments.

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Notes

1. According to the quadrants proposed by Stokes (1997): Bohr´s Quadrant (pure basic research) represents research concerned solely with the pursuit of fundamental understanding; Edison´s Quadrant represents research solely interested in considerations of use (pure applied research) and Pasteur´s Quadrant represents the combination of both fundamental understanding and considerations of use (user-inspired basic research).

2. The research institutes from CSIC involved in the IMPACTO project were INGENIO (Institute for Innovation and Knowledge Management) and IESA (Institute for Advanced Social Studies).

3. It should be noted that "Escuela Española de Historia y Arqueología" is located in Rome.

4. CSIC is divided into eight scientific areas namely Humanities and Social Sciences; Biology and Biomedicine; Food Science and Technology; Materials Science and Technology; Physical Science and Technology; Chemical Science and Technology; Agricultural Sciences; Natural Resources. These last seven scientific areas belong to STEM.

5. Following CSIC's organisational level, scientific civil servants can hold the categories of tenured scientist, scientific researcher and research professor. Teachers

and professors from universities which are attached to CSIC have been included in the category of tenured scientist and research professor, respectively.

6. It should be noted that contracted researchers are slightly under-represented in the data base.

7. These results correspond to data from CSIC, where all disciplines are not equally represented due to historical and institutional reasons. The test presented have also been run with an evenly distribution of the scientific areas (by weighting data) to extrapolate the results and conclusions to other context, as our objective is to compare SSHA and STEM communities broadly (regardless of the context). By this procedure, we obtain different results for one test run corresponding to the variable [Stokes Quadrant] in which we find the following significant differences: $(\text{Unnamed})_{SSH} < (\text{Unnamed})_{STEM}$; $(\text{Borh})_{SSH} > (\text{Borh})_{STEM}$; $(\text{Edison})_{SSH} < (\text{Edison})_{STEM}$.

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Table 1: Population and sample distribution

	Population (N)	Population (%)	Sample (N)	Sample (%)
STEM	3,838	91	1,466	93
SSH	402	9	117	7
TOTAL	4,240	100	1,583	100

Source: adapted from the IMPACTO project

Table 2: Definitions of Variables

Variables	Measure	Method (Range)
Continuous variables		
National Orientation	• The number of different types of national entities divided by the number of different types of international entities with whom the researcher has collaborated over the last 3 years. This variable is constructed following three-step procedure. Firstly, we codified in binary variables 5 assertions regarding the researcher's collaborations with different national entities and international entities. Therefore, we coded '1' each variable if the researcher indicated that he has collaborated with at least one of the following entities: firms located in Spain; government agencies; non profit organisation; firms located outside of Spain; and international organisation, over the last 3 years; and '0' otherwise. Secondly, three of these binary variables are used to construct a three-item variety index ranging between 0 and 3 (national entities) regarding whether or not a researcher has collaborated over the last 3 years with the following national entities: 1) firms located in Spain; 2) government organisation; 3) non profit organisation. The two remaining entities named firms located outside of Spain and international organisation are used to construct a two-item variety index ranging between 0 and 2 (international entities) regarding whether or not a researcher has collaborated over the last 3 years with these two international entities. Thirdly, the variable [National Orientation] is then constructed as a percentage by using the following formula: [National Orientation]= (national entities) / (international entities) * 100	Ratio
Formality	• The percentage of the formal pathways used by a researcher to collaborate with non academics related to the total pathways used over the last three years. This variable is constructed following three-step procedure. Firstly, we codified in binary variables 14 assertions regarding the researcher's collaborations activities with different entities. Therefore, we coded '1' each variable if the researcher indicated that he has collaborated with at least one of the following entities: firms, government agencies, international organisations or non profit organisations, over the last 3 years; and '0' otherwise. Secondly, eight of these binary variables are used to construct an eight-item variety index ranging between 0 and 8 (formal pathways) regarding whether or not a researcher has developed the following collaborative activities with firms, government agencies, international organisations or non profit organisations over the last 3 years: ➔ Contract research *(original research project totally commissioned by the contracting entity)* ➔ Research framed in a Spanish public program *(research project within the National Plan or regional plans, projects CENIT, CONSOLIDER and similar)* ➔ Research framed in international programs *(Framework Programme or similar)* ➔ Courses and specialized training activities taught by the CSIC ➔ Use of CSIC´ infrastructures or equipment by this entity ➔ License of patents *(or other types of Intellectual Protection)* ➔ Creation of a new firm in partnership ➔ Participation in the creation of a new centre or joint unit of R&D The six remaining binary variables are used to construct a six-item variety index ranging between 0 and 6 (informal pathways) regarding whether or not a researcher has developed the following collaborative activities with firms, government agencies, international organisations or non profit organisations over the last 3 years: ➔ Occasionally contacts or consultations *(not formalized through a contract or an agreement)* ➔ Technical services, technical reports or technological support ➔ Temporal stay of a person of your team in this entity ➔ Training of postgraduates on this entity *(including PhD Thesis)* ➔ Consultancy through committees and expert meetings ➔ Participation in diffusion activities in professional environment *(congress or professional conferences, trade fairs)* Thirdly, the variable [Formality] is then constructed as a percentage by using the following formula: [Formality]= (formal pathways) / (formal pathways + informal pathways) * 100	Ratio
Popularisation	• Measured as the percentage of time spent by the researcher on popularisation activities (e.g. publications of articles in newspapers or in textbooks, participation in radio or television programs, in "science weeks, etc.).	Ratio
Government Agencies	• Measured as the frequency of collaborations with government agencies divided by the frequency of collaborations with firms located in Spain over the last 3 years. The frequency of these collaborations are both measured using a 4-point Likert scale ranging from '1'= *Zero times* to '4'= *Seven or more times.*	Ratio

NPO	•	Measured as the frequency of collaborations with non profit organisations divided by the frequency of collaborations with firms located in Spain over the last 3 years. The frequency of these collaborations are both measured using a 4-point Likert scale ranging from '1'= *Zero times* to '4'= *Seven or more times.*	Ratio
Instrumental Users & Symbolic Users	•	Measured using a fourteen-item variety index regarding whether or not the researcher has developed collaborative activities with firms ('instrumental' users) or government agencies ('symbolic' users) over the last 3 years. The activities are: ➔ Contract research *(original research project totally commissioned by the contracting entity)* ➔ Research framed in a Spanish public program *(research project within the National Plan or regional plans, projects CENIT, CONSOLIDER and similar)* ➔ Research framed in international programs *(Framework Programme or similar)* ➔ Courses and specialized training activities taught by the CSIC ➔ Use of CSIC´ infrastructures or equipment by this entity ➔ License of patents *(or other types of Intellectual Protection)* ➔ Creation of a new firm in partnership ➔ Participation in the creation of a new centre or joint unit of R&D ➔ Occasionally contacts or consultations (not formalized through a contract or an agreement) ➔ Technical services, technical reports or technological support ➔ Temporal stay of a person of your team in this entity ➔ Training of postgraduates on this entity *(including PhD Thesis)* ➔ Consultancy through committees and expert meetings ➔ Participation in diffusion activities in professional environment	Sum (0-14)
Categorical Variables			
User Demand	•	Measured using a 4-point Likert scale ranging from '1'= *Not at all* to '4'= *Often* to indicate the answer of the researcher to the following question: 'To what extent the little interest of other entities about your research is an obstacle to establish relationships with other entities?'	Ordinal (the scale ranges between 1 and 4)
Check Validity	•	Measured using a 4-point Likert scale ranging from '1'= *Not important* to '4'= *Very important* to indicate the degree of importance for the researchers of the following assertion: 'the motivation to establish relationships with other entities is to check the validity or practical application of the research developed.'	Ordinal (the scale ranges between 1 and 4)
Stokes Quadrant	•	Categorical variable coded '1' if the researcher's research is classified in the Unnamed Quadrant; '2' in the Edison´s Quadrant; '3' in the Bohr´s Quadrant and '4' in the Pasteur´s Quadrant (more details in Appendix 2, Q.1). The variable [Stokes Quadrant] is operationalized by using two variables: 1). the extent to which scientific activity is inspired by making contributions to fundamental understanding; and 2). the extent to which researcher activity is inspired by considerations of use. The construction of the categorical variable [Stokes Quadrant] used in this paper is based on these two variables and was derived in a two-step process. First, we codified both variables ('fundamental understanding' and 'considerations of use') into 'high' if the researcher has answered 'a lot' and '0' otherwise. Second, the four configurations of scientific research orientation were characterized by combining the two variables in the following manner: ➔ *Unnamed Quadrant*: low fundamental understanding and low consideration of use ➔ *Edison Quadrant*: low fundamental understanding and high consideration of use ➔ *Bohr Quadrant*: high fundamental understanding and low consideration of use ➔ *Pasteur Quadrant*: high fundamental understanding and high consideration of use	Nominal
Firms	•	Measured using a 4-point Likert scale ranging from '1'= *Zero times* to '4'= *Seven or more times* to indicate the frequency with which a researcher has collaborated with firms located in Spain over the last 3 years.	Ordinal (the scale ranges between 1 and 4)
Area	Dichotomous variable: •	coded '1' if the researcher belongs to the SSH area and '0' if the researcher belongs to the STEM area. STEM area encompass the following sub-areas: 1) Biology and Biomedicine; 2) Food Science and Technology; 3) Materials Science and Technology; 4) Physical Science and Technology; 5) Chemical Science and Technology; 6) Agricultural Sciences; 7) Natural Resources.	Binary

Table 3: Descriptive Statistics

Continuous Variables	Type of variables	Mean	Standard deviation
National Orientation	Continuous: number	72.11	21.918
Formality	Continuous: number	43.31	17.944
Popularisation	Continuous: number	4.04	6.635
Government Agencies	Continuous: number	1.21	0.731
NPO	Continuous: number	0.86	0.533
Instrumental Users	Index: 14 items	2.60	2.519
Symbolic Users	Index: 14 items	4.15	3.024
Categorical Variables		**Distribution**	**Median**
User Demand	*Not at all*	*14.4%*	
	A little	*31.3 %*	
	Quite	*35.3 %*	*Quite*
	A lot	*19.0 %*	
Check Validity	*Not important*	*2.7 %*	
	Some important	*15.7%*	
	Important	*48.8 %*	*Important*
	Very important	*32.8 %*	
Stokes Quadrant	*Unnamed*	*10.0 %*	
	Edison	*9.7 %*	
	Bohr	*58.1 %*	
	Pasteur	*22.2 %*	
Firms	*0 times*	*23.8 %*	
	1-3 times	*42.4 %*	*1-3 times*
	4-6 times	*18.9 %*	
	7 or more times	*14.9 %*	
Area	*SSH*	*7.4%*	
	STEM	*92.6%*	

NOTE: these descriptive statistics are referred to the whole sample: SSH and STEM together.

Table 4: Results of statistical tests (χ^2 and U)

	Null Hypotheses tested	*Differences between SSH and STEM*	*Mean[a] SSH*	*Mean[a] STEM*
H1	[National Orientation]$_{SSH}$ = [National Orientation]$_{STEM}$	SSH > STEM***	0.77	0.72
H2	[User Demand]$_{SSH}$ = [User Demand]$_{STEM}$	SSH = STEM	2.50	2.60
H3	[Check Validity]$_{SSH}$ = [Check Validity]$_{STEM}$	SSH = STEM	3.09	3.12
H4[b]	[Stokes Quadrant]$_{SSH}$ and [Stokes Quadrant]$_{STEM}$	SSH = STEM	–	–
H5	[Formality]$_{SSH}$ = [Formality]$_{STEM}$	SSH < STEM***	0.38	0.44
H6	[Popularisation]$_{SSH}$= [Popularisation]$_{STEM}$	SSH > STEM***	6.88	3.83
H7	[Firms]$_{SSH}$ = [Firms]$_{STEM}$	SSH < STEM***	1.96	2.27
H8	[Government Agencies]$_{SSH}$ = [Government Agencies]$_{STEM}$	SSH > STEM***	1.71	1.17
	[NPO]$_{SSH}$ = [NPO]$_{STEM}$	SSH > STEM***	1.38	0.81
H9	[Instrumental Users]$_{SSH}$ = [Instrumental Users]$_{STEM}$	SSH < STEM***	1.50	2.69
	[Symbolic Users]$_{SSH}$ = [Symbolic Users]$_{STEM}$	SSH > STEM***	4.90	4.09

, and * indicate that the coefficient is significant, respectively at the 5%, 1% thresholds.

[a] Means are provided for ordinal variables for practical purposes. They indicate the direction of the differences between STEM and SSH.

[b] H1 has been tested with a χ^2 test.

Appendix 1

Summary of the hypotheses	
STEM is more useful than SSH	H1. The rate of involvement with national users compared to international users is higher for SSH researchers than for STEM researchers. H2. SSH researchers experience a lower demand for their research than is correspondingly the case for STEM research. H3. SSH researchers have less interest in checking the validity and applicability of their research than STEM researchers. H4. SSH researchers are more concerned with the pursuit of fundamental understanding whereas STEM researchers are more focused on considerations of use.
STEM is differently useful to SSH	H5. SSH researchers use a lower proportion of formal pathways to interact with non academic actors compared to STEM researchers. H6. SSH researchers spend more time in popularisation activities than STEM researchers. H7. SSH researchers collaborate less with firms than STEM researchers. H8. The frequency of collaborations with non economic agents compared to private sector is higher for SSH researchers than for STEM researchers. H9. SSH researchers use fewer pathways working with 'instrumental' users on their research (firms) than STEM researchers and more pathways working with 'symbolic' users of their research (government agencies).

Appendix 2

Selected questions from the questionnaire:

Q1. To what extent your scientific activity is inspired by...?

	Not at all	A little	Some	A lot
To make scientific contributions to the understanding of phenomena and facts	1	2	3	4
Practical use and/or application of knowledge outside the scientific or academic environment	1	2	3	4

Q2. Indicate whether you have developed the following activities with firms, government agencies, international organisations or non profit organisations over the last 3 years.

		With Firms	With Government Agencies	With International Organisations	With NPO
I	**Occasionally contacts or consultations** (not formalized through a contract or an agreement)	O	O	O	O
I	**Technical services, technical reports or technological support.**	O	O	O	O
F	**Contract research** *(original research project totally commissioned by the contracting entity)*	O	O	O	O
F	**Research framed in a Spanish public program** *(research project within the National Plan or regional plans, projects CENIT, CONSOLIDER and similar)*	O	O	O	O
F	**Research framed in international programs** *(Framework Programme or similar)*	O	O	O	O
I	**Temporal stay of a person of your team in this entity**	O	O	O	O
F	**Courses and specialized training activities taught by the CSIC**	O	O	O	O
I	**Training of postgraduates on this entity** (including PhD Thesis)	O	O	O	O
F	**Use of CSIC´infrastructures or equipment by this entity**	O	O	O	O
F	**License of patents** (or other types of Intellectual Protection)	O	O	O	O
F	**Creation of a new firm in partnership**	O	O	O	O
I	**Consultancy through committees and expert meetings**	O	O	O	O
I	**Participation in diffusion activities in professional environment** (congress or professional conferences, trade fairs)	O	O	O	O
F	**Participation in the creation of a new centre or joint unit of R&D**	O	O	O	O

Note : F= Formal activities; I= Informal activities

Q3. Indicate the number of times that you have contacted the following type of entities over the last 3 years.

	0	1-3	4-6	7 or more
Firms located in Spain	1	2	3	4
Firms located in other countries	1	2	3	4
Government Agencies	1	2	3	4
International Organisations (UNESCO; FAO; World Bank, European commission, etc.)	1	2	3	4
NPO (NGOs, associations, foundations, technological centres)	1	2	3	4

Q4. To what extent the following aspect has been an obstacle to establish relationships with other entities?

	Not at all	A little	Some	A lot
Little interest of other entities about your research	1	2	3	4

Q5. From the following personal motivations to establish relationships with other entities (firms, government agencies, international organisations and/or NPO), indicate the degree of importance for you:

	Not important	Some important	Important	Very important
To check the validity and/or the practical application of the research developed	1	2	3	4

Q6. Indicate which is the approximate percentage of time spent on each of these activities in a normal working week.

Type of activities	*% Time*
Research (do not include research conducted in collaboration with other non academic entities)	%
Management	%
Teaching	%
Relationships with other entities (firms, government agencies, other)	%
Social diffusion of research results (popularisation activities)	%
TOTAL	**100%**