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Julia Olmos Peñuela, Paul Benneworth, Elena Castro-Martínez

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Explaining researchers' readiness to incorporate external stimuli in their research agendas

Julia Olmos Peñuela^a, Paul Benneworth^b, Elena Castro-Martínez^a

^a INGENIO (CSIC-UPV), Valencia (Spain)

^b Center for Higher Education Policy Studies, University of Twente, the Netherlands.

Abstract: This paper seeks to provide a better understanding of how researchers incorporate external (non-academic) influences in their research process. Firstly we advance the notion of 'openness' as a researcher characteristic that describes researchers' readiness to let external stimuli modify the different stages of the research cycle and we identify the kind of behavioural changes expected from 'open' researchers. Secondly, we look at the factors explaining researchers' openness. We empirically analyse researchers' openness drawing upon a database containing 1583 researchers from the Spanish Council for Scientific Research (CSIC). We found that researchers open in any stage of the research process tend to be also open through the rest of the stages. We also found that personal factors related to researchers' identity and past experiences are key aspects that determine researchers' openness. Policy implications are derived regarding suggestions to foster researchers' openness.

Keywords: research cycle, valorisation, research agenda determination, researchers' societal engagement.

JEL Codes: I23, O31, O32

1 Introduction

There is an increasing imperative within policy and academic communities to understand how research benefits society. The last thirty years have seen the emergence of a social knowledge economy where the critical determinant of growth and wellbeing is societal capacity to create and generate new knowledge (Rutten and Boekema, 2012). Indeed, academic literature has increasingly focused on understanding these processes of how academic knowledge creates societal value (Donovan, 2007). Set against a perception in some (often policy) communities that academics may out of internal preferences choose not to engage with business and community users, one of the most pressing scientific questions requiring addressing is the issue of why academics choose to engage or not (D'Este and Perkmann, 2011).

An academic debate is emerging considering academic behaviours and intentions towards engagement as part of better understanding the relationship between societal engagement and academic research. Part of the problem is that issue of engagement is not value-neutral to academic communities. Some have suggested that engagement works against the interests of objective knowledge production, thus researchers having to reconcile conflicting interests (Sauermann and Stephan, 2013). Others have been more positive, and have noted that there is a relationship between being a 'star scientist' and being engaged with non-academic audiences (see in Perkmann et al., 2013 for a review).

This is part of a wider ambiguity regarding the effects of engagement activities on academics, which undermines policy-makers and academics making concrete statements on what drives engagement by academics. This in turn hinders developing effective interventions and instruments to stimulating academic research being more useful for users, and hence better contributing to growth, welfare and solving the grand societal challenges of the 21st century.

We seek to contribute to this debate by exploring one under-researched dimension of academic behaviour: openness to external (non-academic) influences on the research agenda. With engaging with non-academic partners bringing many pressures, a number of studies have explored what motivates people to engage with third parties (Baldini et al., 2007; D'Este and Perkmann, 2011; Lam, 2011; Lee, 2000) and hence address these tensions – balancing the need for scientific excellence with practical user needs. The

idea of ‘motivation’ has emerged as a promising new area of inquiry to which increasing attention is being devoted.

Yet at the same time we concur with Perkmann et al. (2013) that these debates around ‘motivation’ run the risk of being poorly grounded in theory, failing to explore the constraints of perception-based data and default to instrumentally arguing that academics engage because of its benefits. In parallel with practical problems in rigorously measuring motivation (highlighted by Perkmann et al., 2013) there remains a pressing need to understand the factors which influence whether academics engage with external partners, and whether they are prepared to make efforts to make their research useful for society. We argue ‘motivation’ to date remains akin to McNeill (2006)’s idea of a quasi-concept or a chaotic concept uncritically mixing ideas from different fields.

Our starting point is to simplify the issue around research impact by focusing on a single area, academics’ openness to having their research questions influenced by external stakeholders. Progressing beyond a motivation approach, we argue that the reasons underlying researchers’ societal engagement are driven by a more complex set of factors beyond immediate benefits. Our proposed approach focuses on a core element of the scientific process: setting research questions (Gläser, 2012). We contend that the more open academics are to external influences in setting research questions, then the more useful their research will be.

In this paper, we propose to explore academics’ willingness to let research questions and agendas (research trajectory) to be shaped with involvement of third parties. We called this researcher characteristic ‘openness’. We indirectly analyse these changes in the research trajectory by exploring the stages of the research cycle, and whether they are somehow influenced by non-academic inputs. On the basis of an existing Spanish survey (IMPACTO) we operationalise openness at the different scenarios (the different research stages) and undertake a multivariate analysis to identify which factors are the most salient in determining the academics’ propensity to set their research cycle (and ultimately the research agenda and trajectory) in ways that involve their users. We note that in contrast to the existing literature, two elements, namely academic identity and past experience, appear to be salient in terms of determining a willingness to allow external actors to co-determine the research agenda.

2 The research cycle

The increasing interest in the engagement of researchers has come at the same time as a realisation that the way that knowledge is created is changing, and need be reframed away from a linear model separating knowledge creation and exploitation. There is an increasing realisation that the interactivity and interdependency of innovation processes means that the conditions of the production of knowledge have implications for its successful use. This recognition in turn has important consequences for the governance of science, highlighting that for academic knowledge to be useful, it should be produced through interaction and interdependence with its users. The ‘Mode 2’ of knowledge production (Gibbons et al., 1994), ‘system of innovation’ (Edquist, 1997), the ‘Triple Helix’ (Etzkowitz and Leydesdorff, 2000) or ‘post-academic science’ (Ziman, 2000) are some of the examples of the diversity of diagnoses describing and characterising these recent science system trends.

A common feature of all these approaches has been the relevance they assign to the choice of the research agenda and to the academic external relationships as central topics in the academic transformation process (Hessels and Van Lente, 2008). These changes in the research agenda have often accommodated external pressures, responding to diverse factors related with shifts in policy research priorities (Gläser, 2012; Leisyte et al., 2008), changes in funding patterns (Gulbrandsen and Smeby, 2005), variations in the emphasis of prevailing research modes (Gibbons et al., 1994), and increasing promotion of direct academic interactions with societal agents (Martin, 2003).

These changes suggest value in reorienting research agendas towards other (non-academic) goals, including addressing socio-economic problems and political research priorities. However, despite these external pressures, the final decision about setting research questions and determining research agendas remain reserved to the individual researcher (Gläser, 2012). We contend that the more open academics are to external influences along the research cycle, then the more amenable their research will be to eventually being taken up in one of the processes that constitute ‘productive interactions’ with societal partners, via a direct contact, embedded in an artefact or transmitted at a distance (Spaapen and van Drooge, 2011).

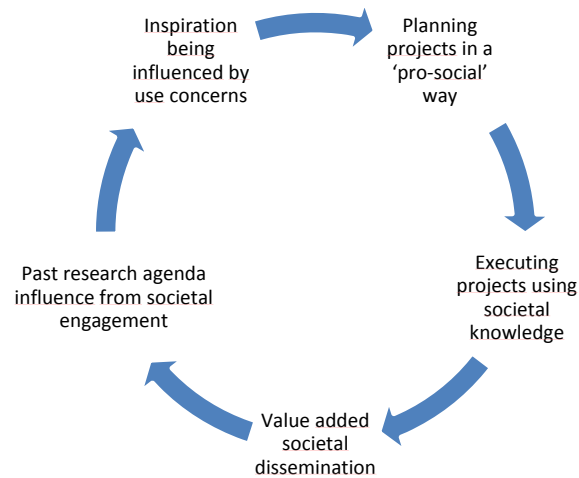
Therefore, we approach this characteristic of openness to co-determine the research agenda by decomposing the research cycle into different stages, and we identify for each

stage elements showing researchers' readiness to let external partners shape somehow their research process (i.e. through the provision of knowledge, the identification of societal needs for setting research questions, etc.). To look at the external influences on the research cycle (and ultimately on the research agenda) provides a means to sort out the messy motivation concepts – and tease out the underlying factors at play – than the benefit-focused approaches hitherto adopted in science policy studies.

We content that identifying the potential changes occurring at each of the stages of the research cycle – as a consequence of non-academic inputs – is critical to understand the overall changes in the research trajectory and research agendas because of third parties influences. We distinguish five stages in which the research cycle can be decompose and were 'openness' can be demonstrated (1) *reframing stage*: the past research agenda is the starting point for the researcher to conduct her ongoing research – where societal engagement could have influenced her past research agenda; (2) *the inspiration stage*: the researcher could be inspired by users or societal issue that might want to address through the development of a research project; (3) *the planning stage*: the researcher could design and produce a research project proposal in which user knowledge, user interests and user needs are included as part of the research process; (4) *the execution stage*: the researcher could undertake her research by actually using user (non-academic) knowledge, making her research project dependent on unique knowledge held by societal partners; (5) *the societal dissemination stage*: the researcher could participate in value-added societal dissemination that brings him back new insight or knowledge to continue or reorient the research.

These five stages represent the ideal-type 'stylised stages' of the research process cycle: the reframing (starting point), thinking (inspiration), planning, researching (executing), and disseminating (see Figure 1). We content that, at each of these stages, there is a change in the overall research trajectory that might make the research more usable by societal partners. So over the course of the cycle, the consideration of users inputs makes the research more amenable to 'productive interactions', and so potentially more 'usable'. More detail on these five stages – which constitute our dependent variables for the empirical study – is provided below.

Figure 1: Conceptual framework of the research cycle incorporating non-academic inputs



2.1 Reframing stage

Researchers commonly built their research from the state of the art of the literature of their field and on the bases of their knowledge background and previous research outputs. Then, past research conducted in collaboration with third parties is sensible to lead to knowledge somehow shaped by external influences that might modify the research trajectory. Indeed, the research agenda skewness as a consequence of external influences has been a matter of concern in the literature on university-industry relationships (Lee, 1996; Nelson, 2001; Verspagen, 2006). Thus, it is reasonable to argue that research conducted in collaboration with non-academic partners might have influences in the future research agenda since past research outputs can be identified as the starting point upon which new research projects are implemented.

2.2 Inspiration stage

At the inspiration stage can be identified the researchers' orientation of their scientific research. According to the Stokes' quadrants (Stokes, 1997), researchers may develop their research to contribute to fundamental understanding (Böhr Quadrant), to seek considerations of use (Edison Quadrant) or to pursue both knowledge and utility purposes (Pasteur Quadrant). Conducting research as "Edison" or "Pasteur" implies that the content of the research agenda is somewhat influenced by considerations of use, then by socio-economic aspects that may shape the research questions' construction and the whole research process. According to this 'utility' attitude, the researcher is prone to

directing scientific research to solve practical problems, letting non-academics needs to influence the core research, thus opening-up the pathway for creating usable knowledge for society.

2.3 Planning stage

Once researchers know how they aim to orientate their research (to fulfil fundamental understanding or/and consideration of use), the next step is to develop the research proposal. The research proposal is crucial to determine the societal impact of the research, since the sensitivity to the impact of the research, and then to the societal usefulness of the results, is a process built from the start of the research configuration (Hessels and Van Lente, 2008: 742). In this case, the elaboration of a research project that consider the societal impact of its outputs requires from an explicit reflection on the potential use of the results, and a proper identification of the intermediaries and users of the research outputs; in short, it requires from a pro-social behaviour/approach (D'Este et al., 2013). This pro-social behaviour can be an indicator of researchers propensity to let external parties influence their research, since the research objectives might be shaped by the identification of these three components (usefulness, intermediaries and end users), determining the final research project and the possibility of observing the research cycle being shaped by non-academic interests.

2.4 Execution stage

Once the research project is planned, the researchers operationalize it and execute it. At this stage, accessing the resources necessary to carry out research is critical. The control of the resources is one of the most common channels for influencing the research content (Glasër, 2012: 9). In much of the literature, this has referred to all the resources that are involved in research, including financial. However, from the perspective of determining a research agenda, the most germane resource is that of knowledge, and in particular to what extent are researchers willing to undertake their research where they are dependent at least partly on knowledge held by a third party. Previous studies on engagement motivations identified knowledge resources as salient motivations for non-academic engagement (Abreu et al., 2009; Baldini et al., 2007; D'Este and Perkmann, 2011; Lam, 2011; Lee, 2000). Unlike other kinds of research, knowledge – particularly advanced scientific knowledge – is not easily or readily fungible or replaceable by other knowledge

providers, particularly for knowledge outside the academy which may be legally protected, shrouded in secrecy or even difficult to determine precisely who has that knowledge. Therefore we argue that those researchers who, during the execution of the research project, make their own knowledge creation processes dependent on the knowledge resources of third parties, are more prone to generate useful knowledge because of the direct inclusion of knowledge input from potential users.

2.5 Dissemination stage

The last stage of the research cycle is the dissemination of the results. The dissemination can be conducted within the academic environment (e.g. publications in scientific journals) or outside academic (e.g. patenting, dissemination in the media, generation of clinical guidelines, etc.). Focusing on the influence of non-academic parties on the research cycle, one can argue that some activities of the dissemination process (those that offer the possibility of a two-way interaction), might favour situations in which researchers receive insights and new ideas from the non-academic audience to be implemented in future research proposal, changing then their future research agenda. Then, we could expect that someone who is willing to let their research agendas to be influenced by external parties will participate in added-value societal dissemination activities.

Overall, we argue that researchers' openness can be observed through how they include users' inputs throughout the different stages of the research cycle. Then, the diverse changes in the way the research is implemented in the different stages of the research process can contribute to a significant ultimate change of the research agenda. Those, analysing external influences on the research agenda through the exploration of the different intermediary changes allow having a comprehensive perspective to better understand researchers' propensity to co-determine their research allowing third non-academic parties to modify their research questions and agendas. A next step to advance the research is to explore the factors affecting the different stages of the research cycle.

3 Why do researchers might let external agents to influence their research cycle and ultimately their research agenda?

The main hypothesis of this paper is that there are many factors that can affect researchers' openness to modify their research agenda – thorough the research cycle– due to the influence of third non-academic parties. Given that academic research is characterized by its decision-impregnatedness – future decisions are structured by past decisions Knorr-Cetina (1981) –, the individual researcher takes the decision about the project to develop, the methods to apply and the collaborations to establish – with academic and non-academic agents – in tackling the research agenda (Aghion et al., 2008). Put it simply, the individual researchers are an “obligatory point of passage” (Latour 1988: 43-44) in setting the research agenda since they are autonomous and the decisions about how the research is conducted are all made by the researchers themselves (Gläser, 2012). Thus, the researcher is free to establish the research questions and research lines, however, this decision is made on the basis of opportunities or pure curiosity driven (Tartari and Breschi, 2012).

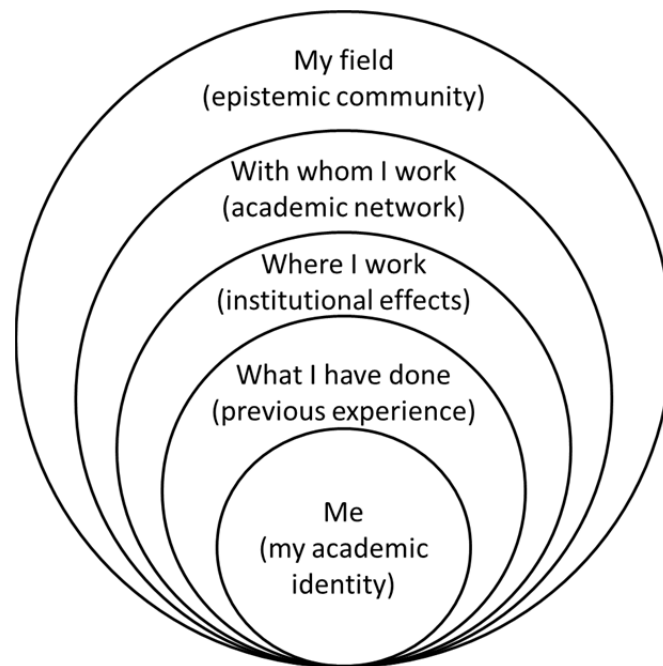
Nevertheless, even that the scientific question-setting process is a final decision of the individual, researchers adapt their decision to the different situations they confront (Gläser, 2012). Central to this idea of the paper is the notion of the ‘academic agent’ – that the autonomous agent in the process of science is an academic who takes decisions about setting research questions that ultimately combine to create ‘fields’ and advance scientific paradigms. The rise of the motivation literature stems from a desire to understand what shapes the decisions that these academic agents take.

Our analysis is that to date this literature has assumed that individuals have simple motivations related to first order desires and beliefs, of what they want to achieve and how they believe the world should be. Our contribution to the debate comes in situating the academic agent in the wider structures of the academy and arguing that these structures also influence agents' decisions, even though academic agents do enjoy significant apparent autonomy (Bourdieu, 1988). We argue that agents are embedded in structures – in terms of socialised institutional systems – at a variety of degrees of remove from the individual (from the personal to the epistemic). Therefore the factors

shaping ‘openness’ – our independent variables - can be understood in terms of dimensions at these various degrees of remove.

For the purposes of this paper, we distinguish between a set of levels germane within which academic agent or decision-maker is embedded that may affect decisions pertaining to the determination of research questions, on the basis of the degree of externality. The purely autonomous agent makes decisions on the basis of their academic identity, formed during the education and training process (the Ph.D.). The choice of questions is also affected by the activities that an individual has previously undertaken. Behaviour is also affected by external factors, and we here distinguish three levels, from the immediate operational environment of the work-floor, to the wider extended network of personal contacts and connections to the level of the academic discipline as an epistemic community. These five layers form the basis for our analysis by which we gain insights into openness, and are represented in the diagram below (Figure 1).

Figure 2 The embeddedness of the academic agent setting research questions in wider social structures.



Source: authors' own design.

3.1 Personal effects

The first level we distinguish in our model is the academic agent. The way that academics set their research questions – and their willingness to involve non-academic interests in that process – is shaped by their personal academic identity, orientation and

role identity (Jain et al., 2009; Lam, 2011). For this purpose, we consider scientist identity as being mappable along a continuum ranging from pure traditional scientist to a pure entrepreneur. The pure scientist can be understood as largely adhering to Mertonian ideals (Merton, 1973) which emphasize, among other, the search for fundamental understanding directed through scientists' own decisions.

Conversely, a “pure” entrepreneur is heavily involved in commercial and collaborative activities with external agents in which those external agents' interests are a material consideration in scientific governance. The identity of the researcher can be positioned in this continuum of identities reflecting who their self-identifying community is – the extent to which they are part of a hermetically-sealed scientific community (following the Mertonian perspective) or part of a knowledge creation effort involving non-scholarly – and potentially private interests. We contend that *researchers' with an identity closer to the entrepreneurial ideal type are more open (Hypothesis 1)*.

The second level in our model is that of the researchers' immediate experiences and achievements, following Knorr-Cetina (1981)'s observation that individuals' past answers shape future questions, what she refers to a “decision-impregnatedness”: if one generates answers to questions that have been set in collaboration with external agents, then that influences an academic agent's future starting point for determining questions. This argument is corroborated by literature; scholars without previous collaborations with non-academic agents have, in the absence of effective experiences, difficulties in assessing the potential cost or benefits from these collaborations (Audretsch et al., 2010). Conversely, as showed in literature on academic entrepreneurship, researchers with personal previous entrepreneurial experiences acquire knowledge and skills that contribute to their aspiration and ability to participate in entrepreneurial activities (Hoye and Pries, 2009).

As noted by Ajzen (2001) prior experiences may explain actual intention and behaviour to perform an activity. For instance, academic entrepreneurial intentions are predicted by academics' previous experience engaging in entrepreneurial activities (Goethner et al., 2012). Indeed, having past experiences in engagement with non-academic agents may shape researchers' sense of feasibility of these collaborations, since they are already well-positioned to understand the trade-offs and compromises involved in societal engagement. If researchers have positively evaluated their past engagement practices, *ceteris paribus*, this would suggest that they might be less sceptical toward this type of

practice and thus willing to get involved again in similar collaborations. On this basis, we expect that *researchers with a positive evaluation on their past collaborative experience are more willing to be open than researchers with negative or not past experiences. (Hypothesis 2).*

3.2 Institutional and environmental effects

A second set of levels are those that are largely exogenous to the academic agent, but represent the networks and environments whose rules are germane to the agent. Academic activities are structured according to different kinds of units, and academics likewise organise their own units and structures to facilitate the prosecution of research. These units (e.g. universities, public research organizations) have their own institutional logic that is not necessarily shared by those of the researchers' activities, which opens the possibility of institutional norms pressuring them to act in particular ways (Pinheiro et al., 2012).

Our three external levels highlight three distinctive kinds of unit or research milieu within which researchers are embedded in carrying out their research activities. The first kind of unit is the academic work environment of the researcher, the laboratory, research group, department or institute. The social or institutional contexts are material microlevel influences for researchers' practices (Bandura, 1977; DiMaggio and Powell, 1983; Schein, 1985). The presence of these external pressures from the academic organisation might not always guarantee researchers' compliance with the institutional norms. The study conducted by Bercovitz and Feldman (2008) show the relevance of institutional norms, with academic entrepreneurs conforming to local norms (from their academic institutions) rather to their imprinted norms; this indicating the significant influence of the institutional context in researchers' decision to participate in entrepreneurial activities.

We argue that local norms can be reflected on the institutional practices and support measures received by researchers from their academic institutions. Thus, researchers' willingness to establishing collaborations with non-academic agents might be affected by the support and facilities provided by their institute to initiate or maintain these relational activities. Institutional support might imply researchers' belief of a higher feasibility for establishing non-academic collaboration and an increasing openness. In sum, we

therefore suggest that *researchers with a positive perception about institutional support for engaging with non-academic agents are more open (Hypothesis 3)*.

The second external level we highlight is the academic networks within which academics find themselves embedded. As research is a socially situated process, the norms and practices of an academic agent's immediate professional network is a context within which behavioural norms including openness to outside influences are set (Fromhold-Eisebith et al., 2014; Kronenberg and Caniëls, 2014).

A key issue here is the extent to which an academic agent's research is capable of participating in a collective knowledge pool, that is to say the characteristics of the kinds of knowledge with which it can usefully connect. We highlight two kinds of characteristics suggestive of kinds of knowledge that has the capacity of travelling outside the immediate scholarly domain. Firstly are those academic agents who work with other academics other institutes, sectors or countries, who lack institutional and organisational proximity. Secondly, there are also those academic agents who are active in research networks where there are other academic agents but in other disciplines. Each of these external agents have their own norms, values and meaning structure whose knowledge has to be translated into the scholar's research agenda – Bercovitz and Feldman (2008) cite Venkataraman (1997) and Shane (2000) in arguing that there is a correlation with multi-disciplinarity and academic entrepreneurship. In sum, we therefore suggest that:

Academic agents who are active in an immediate research network that is more connected to external academic agents are more open (Hypothesis 4a).

Academic agents who are active in an immediate research network that is more connected to academic agents in other disciplines are more open (Hypothesis 4b).

The final level that we distinguish in this research is the imagined community of the field within which the academic agent is active, Bordieu's academic habitus (Becher and Trowler, 2001). An academic discipline is a means of co-ordinating a scientific search effort by regulating a process which defines which questions are worthy of studying and which are not. Disciplines are communities at a distance, and can be cast as straddling between epistemic and imagined communities (Adler and Haas, 1992; Anderson, 1991). The discipline is also enacted in a range of formal and informal institutions and

organisations – such as conferences, journals, learned societies, departmental and faculty structures.

Nevertheless, individuals have to make judgements about how to relate to the discipline and it is the co-ordinating effects of that calculative behaviour that create the habitus averred to by Bordieu. Therefore it is not unreasonable to suppose that an individual academic agent's openness will be influenced by the extent to which it is a common norm within one's habitus (Deem and Lucas, 2007; Jacobson et al., 2004). On the basis of the review we therefore suggest that *academic agents in disciplines where external agents are seen as being legitimate contributors towards the creation of valid knowledge are more open (Hypothesis 5)*.

3.3 Other factors

Alongside these situational factors, we highlight a set of other factors which may also play a role in researchers' openness. Previous studies support the idea that researchers trained in the age of the "Ivory tower", largely adhering the 'academic logic' (Sauermaann and Stephan, 2013) could have been imprinted by the Mertonian norms and values that do not primarily encourage interactions with third non-academic parties (Bercovitz and Feldman, 2008; Tartari and Breschi, 2012). Thus we consider the inclusion of researchers' academic *position* in the lifecycle to control for researchers' correspondence to the generation of the "Ivory tower" which might influence their openness.

Another aspect that might be controlled is the type of resources secured related with researchers' openness other than those knowledge resources strictly necessary to prosecute a research agenda. Academics may choose to modify their research agendas for more pragmatic reasons, such as the ease of access to these resources, the compromise alluded to by (Gulbrandsen and Smeby, 2005). Collaborating with non-academic agents might lead to a modification of the research agenda but also to the provision of benefits in the form of access to financial or in-kind resources and prestige (Baldini et al., 2007; D'Este and Perkmann, 2011; Lam, 2011). We contend that these benefits, not directly related to knowledge exchange, might also be included to control for researchers' openness.

A last consideration regards the type of non-academic agents with whom the researchers engage. The rise of the discourse of entrepreneurial science might see 'firms' being seen

as more legitimate shapers of research questions than other kinds of societal partners (Berman, 2011). Policy research provides an interesting field laboratory, then engaged with policy-makers may be more ‘open’ (Krueger and Gibbs, 2010). Finally, it might be expected that those who work with community groups and non-profit organisations do so out of a normative motivation towards praxis and an affinity with their goals (Tinker and Gray, 2003), from which might be deduced that working with NPO partners might be associated with openness. Thus, the type of non-academic agents collaborating is also a control factor to be considered in relation to openness. Finally, as different openness patterns might exist across fields, it is also important to control across field.

Our argument is that these personal and external levels might affect researchers’ openness at the different research cycle stages (reframing, inspiration, planning, execution and dissemination). The hypotheses are tested using a database of researchers working at the CSIC. In order to better frame the testing process, we now provide an explanation of the dataset, the construction of the variables and the analytical plan.

4 Data and methodology

4.1 Data

The empirical study is focused on the Spanish Council for Scientific Research (CSIC), the largest public research organisation in Spain. We use a database developed within the framework of the IMPACTO project containing the results of a questionnaire distributed to contracted and tenured researchers working at CSIC. The questionnaire¹ was constructed included a range of question about researchers’ profile (position, field), their research characteristics (research orientation, operationalising research projects, researchers’ task relevance), or their external engagement (motivations, frequency, type of non-academic entities, results of the collaboration).

Data was collected in 2011 through a multi-method process combining online questionnaires with telephone follow-up to ensure a final sample proportionally distributed by fields and scientific categories. Our population of study are the 4240 contracted and tenured researchers working at CSIC in 2011. They were distributed in 126 research institutes organised along eight main scientific fields. Our final sample of

¹ See Olmos-Peñuela et al. (2013) for more details about the questionnaire structure and data collection.

study is 1,583 researchers, which accounts for 37% of total population. A summary of the population distribution is presented in Table 1.

Table 1 Population and sample distribution by scientific field of knowledge

	Population (N)	Population (%)	Sample (N)	Sample (%)	% Differences χ^2 test (*)
Biology and Biomedicine	771	18.2%	244	15.4%	-2.8%
Food Science and Technology	285	6.7%	128	8.1%	1.4%
Materials Science and Technology	562	13.3%	201	12.7%	-0.6%
Physical Science and Technology	569	13.4%	204	12.9%	-0.5%
Chemical Science and Technology	480	11.3%	209	13.2%	1.9%
Agricultural Sciences	412	9.7%	203	12.8%	3.1%*
Natural Resources	759	17.9%	277	17.5%	-0.4%
Social Sciences and Humanities	402	9.5%	117	7.4%	-2.1%
TOTAL	4,240	100	1,583	100	

Source: Olmos-Peñuela et al., 2013

Note: χ^2 test has been used to assess whether there are differences between the population and the sample distribution for each area of knowledge.

* indicates statistical differences at 5%. Agricultural sciences are statistically overrepresented in the sample.

4.1.1 Dependent variables

The definitions and descriptives statistics of the dependent variables used in our empirical analysis are presented in Table 2. We consider five dependent variables to capture openness at the different stages of the research cycle highlighted in the theoretical framework.

Openness at the *reframing* stage is measured using a binary variable that takes the value ‘1’ if researcher experienced changes or substantial changes in past research agenda as result of relationships with external entities (27.8%), and ‘0’ otherwise.

Openness at the *inspiration* stage is measured using a binary variable that takes the value ‘1’ if the researcher reported that the scientific activity was inspired or significantly inspired by considerations of use (71.4%), and ‘0’ otherwise.

Openness at the *planning* stage is measured as a continuous variable constructed from three items (Cronbach $\alpha= 0.789$) capturing researchers’ pro-social attitude (i.e. identifying the potential use of the results, users and intermediaries). This variable ranges from 1 to 4 and the average researcher scored 2.52.

Openness at the *executing* stage is measured as a continuous variable constructed from four items (Cronbach $\alpha = 0.713$) that measure researchers' dependence on external knowledge (i.e. to keep abreast of the areas of interest of these non-academic entities, to test the feasibility and practical application of the research, to obtain information or materials necessary for the development of the current lines of research and to explore new lines of research). This variable ranges from 1 to 4 and the average researcher scores 3.11.

In both variables regarding openness at the planning and execution stages, we test that these multi-scale variables satisfy unidimensional criterion. Additionally, Cronbach α indicate that the items forming each index are reliable, and the Q–Q plots procedures show that both variables match a normal distribution.

Openness at the *dissemination* stage is measured as a binary variable that takes the value '1' if researchers reported as important or very important the value-added activities resulting from external collaboration (28.5%), and '0' otherwise.

Table 2 Operational definitions and descriptive statistics of the dependent variables²

Dependent variables (continuous)	Measure	Sub-items	Method and descriptive statistics
Openness at the Planning stage	Measured as an index on a Likert scale of frequency ranging from 1 (never) to 4 (regularly) regarding frequency with which the researcher engages in each of the following activities when conducting a research project. The scores of the respondents, which initially ranged from 3 to 12, were weighted in order to take into account “does not apply” answers. Thus, for each respondent, the sum of the score was divided by the number of applicable item(s). Even though the initial index has integer values from 1 to 4, once weighted, it can take on non-integer values.	<ul style="list-style-type: none"> Identify the potential results of your research that can benefit users Identify the potential users who can apply the results of your research Identify intermediaries in order to transfer the results of your results 	Sum of the three items divided by the number of applicable items Range: 1-4 Mean: 2.52 S.D: 0.73 Cronbach's α:0.789
Openness at the Execution stage	Measured as an index on a Likert scale of frequency ranging from 1 (not important) to 4 (very important) regarding the degree of importance the researcher attaches to each of the following items, as reason for interacting with external entities (firms, public administration agencies, non-profit organisations). The scores of the respondents, which initially ranged from 4 to 16, were weighted in order to take into account “does not apply” answers. Thus, for each respondent, the sum of the score was divided by the number of applicable item(s). Even though the initial index has integer values from 1 to 4, once weighted, it can take on non-integer values.	<ul style="list-style-type: none"> To keep abreast of about the areas of interest of these non-academic entities To test the feasibility and practical application of your research To obtain information or materials necessary for the development of your current lines of research To explore new lines of research 	Sum of the four items divided by the number of applicable items Range: 1-4 Mean: 3.11 S.D: 0.55 Cronbach's α:0.713
Dependent variables (categorical)	Description		Descriptives % of '1'
Openness at the Reframing stage	Dichotomous variable: - coded '1' if the researcher has experienced changes or substantial changes in the past research agenda as a result of the relationships with non-academic entities, and 0 otherwise.		27.8%
Openness at the Inspiration stage	Dichotomous variable: - coded '1' if the researcher scientific activity was inspired or substantially inspired by the practical use and/or application of knowledge outside the academic environment, and 0 otherwise.		71.4%
Openness at the Dissemination stage	Dichotomous variable: - coded '1' if the researcher, as a result of collaborating with with non-academic entities, reported as important or very important the following three results identified as value-added dissemination activities they got: 1) obtaining patents or other intellectual property right; 2) developing exhibitions and/or exhibition catalogues; generating clinical guidelines, standards, and 3) codes of practices), and 0 otherwise.		28.5%

4.1.2 Independent and control variables

As indicated in the literature review, the explanatory variables are regrouped in the following six categories: (1) academic identity; (2) previous experience; (3) local

² This paper adopts the convention that all material reproduced from the questionnaire appears translated into English by the authors, and represents a faithful rendering of the Spanish original.

environment; (4) academic network; (5) epistemic community; and (6) control variables. For succinctness the operational definitions and descriptive statistics of these variables are broadly presented in Table 3.

The academic identity category is captured through the binary variable *entrepreneurial ideal*, measured as a binary variable that takes the value ‘1’ if the researcher reported to attach *importance* or *significant importance* to contributing to the resolution of socioeconomic problems (64%), and ‘0’ otherwise. Previous experience of the research regarding the influence of external knowledge for the research agenda is captured using the binary variable *knowledge accessed* that takes the value ‘1’ if the researcher reported that, as a direct consequence of working with non-academic entities, she/he obtained *some* or *very* important information or material for the development of the research lines (58.5%), and ‘0’ otherwise. Local environment is captured using two binary variables namely institute moral support and institute administrative support. *Institute moral support* takes the value ‘1’ if the researcher reported that the supportive attitude of the research institute *positively* affects the current relationships with non-academic entities (28.7%), and ‘0’ otherwise. Likewise, *institute administrative support* takes the value ‘1’ if the researcher reported that the administrative and managerial capacity of the research institute to conduct collaborative activities *positively* affects the current relationships with non-academic entities (25.6%), and ‘0’ otherwise. Personal academic network is captured using two variables namely personal network and multidisciplinary network. *Personal network* is a continuous variable ranging from 1 to 6 that measures the extent to which researchers are distant from the academics with whom they conduct the research activities. The average researcher scores 3.46, higher scores meaning higher distances. The normality of the continuous variable was verified using the Q-Q plot procedure which indicates that the distribution of the variable external network matches a normal distribution. *Multidisciplinary network* is a binary variable that takes the value ‘1’ if the researcher reported to *usually* conduct research with researchers from other scientific disciplines (28.8%), and ‘0’ otherwise. The epistemic community category is captured using the binary variable *lack of scientific merit*, which measures whether the lack of scientific merit attached to external collaborations are an obstacle for establishing relationships with non-academic entities. 29.7% of the sample reported that the lack of scientific merit – associated to external collaborations – was *a major obstacle or an obstacle* (coded as ‘1’) for establishing relationships with non-academic entities.

The control variables for our analysis are related to researchers' position, the type of agent with whom they collaborate, the field to which they belong and they resources they secure (not linked to knowledge) when they collaborate with non-academic entities. Our sample is composed of *Post-Doc* contracted researchers (18.1%), and permanent researchers categorised according the CSIC structure as *Tenured researchers* (36.4%), *Scientific researchers* (27.2%) and *Research professors* (18.3%). According to the CSIC scientific areas organisation, the sample is made up of 8 fields being *Natural resources* (17.5%) the largest field of the sample followed by *Biology and biomedicine* (15.4%); *Chemical science and technology* (13.2%); *Physical science and technology* (12.9%); *Agricultural sciences* (12.8%) and *Materials science and technology* (12.7%). Among the smallest field of the sample we found *Food science and technology* (8.1%) and *Social sciences and humanities* (7.4%). The last control variable used is a continuous variable labelled *resources secured* measured as an index of 5 items (Cronbach $\alpha = 0.668$) related to the degree of relevance that the researcher attach to a set of personal motivations (related with the obtaining not-knowledge resources) to establish interactions with non-academic entities. The variable ranges from 1 to 4 and the average researcher scores 2.86. We test that these multi-scale variable satisfies unidimensional criterion. Moreover, the Cronbach α indicates that the 5 items forming the index are reliable, and according to the Q-Q plot procedure, the variable matches with a normal distribution.

Table 3 Operational definitions and descriptive statistics of the independent and control variables³

<i>Independent variables (continuous)</i>	Measure	Sub-items	Method and descriptive statistics
Personal (academic) network	<p>Researchers were asked to indicate the two most frequent type of people with whom they usually conduct their research activities. The type of people is an ordinal variable ranked according to researchers' distance from other academics, and ranges as follows:</p> <ol style="list-style-type: none"> 1. Alone or with people from firms and non-academic entities 2. With people from your own research group. 3. With people from your own research institute. 4. With people from other CSIC research institute 5. With people from universities and research centres in Spain 6. With people from universities and research centres in other countries <p>Personal (academic) network is measured as the index capturing researchers' distance from the type of people with whom they usually conduct their research activities. The scores of the respondent are computed as the average of the two most frequent options and were weighted in order to take into account "does not apply" answers. Thus, for each respondent, the sum of the score was divided by the number of applicable item(s). Then, the final scores can take non-integer value from 1 to 6, where 1 indicates that researchers do not usually work with other academics, and 6 indicates the highest researchers' distance from the academics with whom they usually work.</p>		<p>Sum of the two most frequent options divided by the number of applicable items.</p> <p>Range: 1-6 Mean: 3.42 S.D: 0.84 Cronbach's α: N.A</p>
Resources secured	<p>Measured as an index on a Likert scale of frequency ranging from 1 (not important) to 4 (very important) regarding the degree of importance the researcher attaches to each of the following items, as personal motivations to establish interactions with non-academic entities (firms, public administration agencies, non-profit organisations). The scores of the respondents, which initially ranged from 5 to 20, were weighted in order to take into account "does not apply" answers. Thus, for each respondent, the sum of the score was divided by the number of applicable item(s). Even though the initial index has integer values from 1 to 4, once weighted, it can take on non-integer values</p>	<ul style="list-style-type: none"> • To obtain additional funds for your research • To be part of a professional network or expand your professional network • To have access to the experience of non-academic professionals • To have access to equipment and infrastructure necessary for your lines of research • To obtain grants and job opportunities for your students 	<p>Sum of the six items divided by the number of applicable items</p> <p>Range: 1-4 Mean: 3.05 S.D: 0.53 Cronbach's α: 0.668</p>
Independent variables (categorical)	Description		Descriptives % of '1'
Entrepreneurial ideal	<p>Dichotomous variable: - coded '1' if the researcher, thinking on his/her job, attaches a <i>importance</i> or <i>significant importance</i> to contributing to the resolution of socioeconomic problems, and '0' otherwise.</p>		64%
Knowledge accessed (previous experience)	<p>Dichotomous variable: - coded '1' if the researcher, as a direct consequence of working with non-academic entities, has obtained <i>some</i> or <i>very important</i> information or material for the development of the research lines, and '0' otherwise.</p>		58.5%
Institute moral support	<p>Dichotomous variable: - coded '1' if the researcher reports that the support provided by the research institute to initiate collaborative activities <i>positively</i> affects the current relationships with other non-academic entities, and '0' otherwise.</p>		28.7%

³ This paper adopts the convention that all material reproduced from the questionnaire appears translated into English by the authors, and represents a faithful rendering of the Spanish original.

Institute administrative support	Dichotomous variable: coded '1' if the researcher reports that he administrative and managerial capacity of the research institute to conduct collaborative activities <i>positively</i> affects the current relationships with non-academic entities, and '0' otherwise.	25.6%
Multidisciplinarity network	Dichotomous variable: - coded '1' if the researcher reports to <i>usually</i> conducting research with researchers from other scientific disciplines, and '0' otherwise.	28.8%
Lack of scientific merit (epistemic community)	Dichotomous variable: - coded '1' if the researcher reports that the lack of scientific merit is a <i>major obstacle</i> or an <i>obstacle</i> in the establishment of relationships with non-academic entities, and '0' otherwise.	29.7%
Position	The level of academic position was measured as follows: post-doc [POST] researcher is a binary variable coded '1' if the researcher is a post-doctoral contracted scientist, and '0' otherwise; tenured scientist [TEN] is a binary variable coded '1' if the researcher is a tenured scientist, and '0' otherwise; scientific researcher [SCIEN] is a binary variable coded '1' if the researcher is a scientific researcher, and '0' otherwise; finally, professor researcher [PROF] is a binary variable coded '1' if the researcher is a professor researcher, and '0' otherwise. This first category was used as the reference category in the econometric models. These mutually exclusive categories are based on the CSIC categorisation of research staff.	POST: 18.1% TEN: 36.4% SCIEN: 27.2% PROF: 18.3%
Firm	Dichotomous variable: - coded '1' if the researcher has collaborated at least once over the last three years with firms located in Spain, and '0' otherwise.	76.2%
Government agencies	Dichotomous variable: - coded '1' if the researcher has collaborated at least once over the last three years with <u>government agencies</u> , and '0' otherwise.	78.3%
Non-profit organizations	Dichotomous variable: - coded '1' if the researcher has collaborated at least once over the last three years with <u>non-profit organisations</u> , and '0' otherwise.	48.6%
Research fields	Research fields were measured with a series of dichotomous variables defined as follows: Biology and biomedicine [BIO] is a binary variable coded '1' if the respondent is a researcher in biology and medicine, and '0' otherwise; Food science and technology [FOOD] is a binary variable coded '1' if the respondent is a researcher in food science and technology, and '0' otherwise; Materials science and technology [MAT] , is a binary variable coded '1' if the respondent is a researcher in materials science and technology, and '0' otherwise; Physical science and technology [PHY] is a binary variable coded '1' if the respondent is a researcher in physical science and technology, and '0' otherwise; Chemical science and technology [CHE] is a binary variable coded '1' if the respondent is a researcher in chemical science and technology, and '0' otherwise; Agricultural sciences [AGR] is a binary variable coded '1' if the respondent is a researcher in agricultural sciences, and '0' otherwise; Natural resources [NAT] is a binary variable coded '1' if the respondent is a researcher in natural resources, and '0' otherwise; and finally Social science and humanities [SSH] is a binary variable coded '1' if the respondent is a researcher in social science and humanities, and '0' otherwise. This last category of researchers was used as the reference category in the econometric models. These mutually exclusive categories are based on the CSIC scientific areas organisation.	BIO: 15.4% FOOD: 8.1% MAT: 12.7% PHY: 12.9% CHE: 13.2% AGR: 12.8% NAT: 17.5% SSH: 7.4%

4.1.3 Analytical plan

The analytical plan contains two stages. First, by using *Mplus 3* – a structural equation package (see Muthén and Muthén, 1998-2004) – we simultaneously estimated five regression equations to explore the correlated of 'openness' at the five stages of the research cycle (reframing, inspiration, planning, executing and dissemination), and the factors affecting 'openness'. This first model corresponds to the saturated multivariate path model.

As suggested in previous studies (Landry et al., 2010; Ouimet et al., 2007), we used weighted least squares mean and variance adjusted estimators (WLSMV) due to our different types of regression equation: binary probit for the reframing, inspiration and dissemination stages variables; and ordinary least squares for the stages of planning and execution (see Muthén 1998-2004:17-20 for technical details).

The path model is similar to five separate regression models – three binary probit and two ordinary least squares – except that it applies to five simultaneously estimated equations with free error-term covariance. These error-term covariances also serve as proxies of the interdependence between openness at the different stages, and therefore the extent to which the openness is demonstrated throughout the research process. The use of standards models when using separate regressions might lead to inefficient estimators if some equations disturbances are correlated (Belderbos et al., 2004). Therefore, this multivariate path model allows to jointly estimate the five equations while controlling for the existence of mutual covariances between the equation's disturbance.

A second stage consist in estimating the same model, but fixing insignificant coefficient ($p\text{-value} > 10\%$, two-tail) at 0. Unlike the first model, this second model – unsaturated multivariate path model – can be assessed for model fit since its degree of freedom is different from 0 (since we fixed the insignificant parameters found in the first model).

5 Results

The saturated path model estimated (step 1) could not be assessed for model fit as it typically has 0 degree of freedom. Thus, for succinctness; the results of the saturated path model are not presented. Table 4 presents the fit of the unsaturated model (step 2), which only takes into account the significant coefficients by excluding the insignificant parameters found in the saturated model in step 1.

The results of the comparison of the constrained saturated path model and the unsaturated path model with free error-terms are reported in the lower part of Table 4. The unsaturated path model has 36 degree of freedom and an insignificant χ^2 statistic of 38.25 ($p\text{-value}=0.368$), which indicates that the final unsaturated path model has a very good fit. The R^2 estimates are presented on the lower part of Table 4 and indicated that openness at the execution stage the most effectively explained. We also estimated the same unsaturated path model, but with the covariance between the equation error-terms

fixed at 0. The computed value of the χ^2 for this path model is significant ($\chi^2 = 257.66$; 44 degree of freedom; p-value=0.000), indicating a poor model fit. This suggests that the use of separate regression models is not appropriate to estimate the factors affecting openness given that the path model with error-term covariances better reflects the data than a path model with error-term covariances fixed at 0.

The results of the error-term covariances of openness between the five stages are listed at the bottom of Table 4, indicating highly significant and positive covariances between openness at the five stages. This suggests that researchers demonstrating openness at one stage do it consistently throughout the research process. More specifically, the covariances range from 0.354 to 0.029, being the highest relationship between reframing and inspiration stages. Regarding the extent to which our independent variables are related to openness at the various stages, we focus on those relationships exhibiting significance above the 5% level⁴ to test whether our hypotheses are verified.

Results show that the academic identity and the previous experience are salient variables associated to openness. More specifically, the *entrepreneurial ideal* and *knowledge accessed* are significantly and positively associated with openness at the *reframing*, *inspiration*, *planning* and *executing* stages, and in the case of *knowledge accessed*, also openness at the *dissemination* stage. These results overall confirm our Hypothesis 1 than researchers with an identity closer to the entrepreneurial ideal are more open; and also our Hypothesis 2 than researchers with a positive evaluation on their past collaborative experience are more open.

Regarding our Hypothesis 3, our results do not overall support it since the institute moral support and institute administrative support are not variables significantly related to openness at any of the five stages considered, with the exception of the positive relationship between *institute informal support* and openness at the *dissemination* stage (at 5%).

Hypothesis 4a is not supported by our empirically results since personal network is not significantly related to openness at any of the stages (at least at a 5% of significance). However, the hypothesis 4b is partially verified since *multidisciplinary network* emerges

⁴ The relationship between multidisciplinary network and the experiential dimension; and between lack of scientific merit and the attitudinal dimensions are not discussed despite reporting significant at the 10% level following the convention of Noymer (2008) - it may make sense to choose '0.1' for alpha in a smaller data set - they are not regarded as being useful correlations.

as significant and positively associated to openness at the *inspiration*, *planning* and *dissemination* stages. Thus, following hypothesis 4b, our results support that researchers who are usually connected with other academic agents in other disciplinary areas are more willing to demonstrate openness when thinking on the problematic to address, planning the project and disseminating it.

Finally, regarding our last hypothesis (Hypothesis 4), we only found counter-intuitive evidence that the lack of scientific merit is positively related to researchers' openness at the inspiration stage. Nevertheless, overall the results do not support the hypothesis that researchers in disciplines where external agents are seen as being more legitimate contributors towards the creation of valid knowledge are more open.

For the control variables, we found that the researchers' position is not a significant variable to explain researchers' openness. However, to collaborate with *firms* is positively associated with openness at all the stages. Finally, to attach a higher degree of importance to get non-knowledge resources from non-academic collaborations is positively related with openness at the *planning* and *execution* stages.

Table 4 Unsaturated multivariate path model results explaining openness through the research cycle stages (1st iteration)

Dependent variables	Openness at the Reframing Stage		Openness at the Inspiration Stage		Openness at the Planning Stage		Openness at the Execution Stage		Openness at the Dissemination Stage	
	Coeff. (β)	t value	Coeff. (β)	t value	Coeff. (β)	t value	Coeff. (β)	t value	Coeff. (β)	t value
Independent variables										
<i>Intercept</i>					1.536***	9.757	1.129***	11.970		
<i>Threshold 1</i>	1.023***	3.019	0.286	0.691					1.752***	4.920
Academic identity										
• Entrepreneurial ideal	0.309***	3.130	1.026***	10.246	0.360***	8.545	0.095***	3.553	0.167*	1.689
Previous Experience										
• Knowledge accessed	0.356***	3.888	0.313***	3.106	0.171***	4.128	0.119***	4.780	0.640***	6.665
Local environment										
• Institute informal support									0.244**	2.594
• Institute administrative support										
Academic network										
• Personal network							-0.027*	-1.782		
• Multidisciplinary network			0.292**	2.643	0.162***	3.913			0.194**	2.176
Epistemic community										
• Lack of scientific merit			0.274**	2.554						
Control variables										
• Firm	0.449***	3.276	0.329**	2.695	0.248***	4.548	0.101***	3.191	0.563***	4.088
• Government Agency					0.142**	2.668				
• Non-profit organisation					0.171***	4.317			0.228**	2.575
• Resources secured	-0.148*	-1.750			0.079**	2.052	0.589***	25.857		
• Tenured scientist ^a										
• Scientific researcher ^a							-0.065**	-2.506		
• Professor researcher ^a										
• Biology & Biomedicine ^b										
• Food science & technology ^b					0.240***	3.064	0.106**	2.143		
• Materials science & technology ^b			0.761***	4.328						
• Physical science & technology ^b					0.251***	4.069	0.144***	3.762		
• Chemical science & technology ^b										
• Agricultural sciences ^b	-0.342***	-2.390					0.098**	2.407	-0.342**	-2.390
• Natural resources ^b	-0.298***	-2.202	-0.491***	-3.530					-0.298**	-2.202

Covariance between disturbances	ε_1	ε_2	ε_3	ε_4	
ε_2	0.354***				
ε_3	0.127***	0.209***			
ε_4	0.062***	0.072***	0.034***		
ε_5	0.287***	0.235***	0.116***	0.029*	
Number of cases	1064				
R ²	0.112	0.325	0.219	0.437	0.202
Unsaturated path model with free error terms		$\chi^2 (36) = 38.25, p\text{-value} = 0.368$			
Constrained unsaturated path model with free error terms fixed at zero:		$\chi^2 (44) = 257.66, p\text{-value} = 0.000$			

Notes: *, ** and *** indicate that the variable is significant at the 10%, 5% and 1% level, respectively

a The reference category is Post-Doc

b The reference category is social sciences and humanities

6 Discussion and conclusion

In this paper, we have proposed ‘openness’ to describe researchers’ willingness to having their research questions and agendas influenced by non-academic agents since changes through their research process (at the different stages of the research process). Our research seeks to extend literatures addressing motivations for researchers’ societal engagement. We concur with D’Este and Perkmann (2013) that understanding why researchers’ decide or not to engage with third parties is a pressing question that needs further fundamental consideration. To date motivational studies have focus on the gold, puzzle and ribbons (Lam, 2011), emphasising direct benefits that societal engagement provides; our argument is that these studies demonstrate that motivation is important, but these instrumental benefits are one of a wider set of factors that might underlie engagement decisions.

Our approach begins with the core element of the research (i.e. the research setting) by addressing researchers’ openness which allows societal engagement (or external influences) to change the research process and ultimately their research questions and agendas. Our analysis sought to improve our understanding on the ambivalent ideas (optimistic and pessimistic views) regarding external engagement and research activities (Gulbransen and Smeby, 2005).

Thus, we disentangle the how changes in the research process happen by analysing researchers’ behaviour at the different stages of the research cycle (reframing, inspiration, planning, execution, and dissemination). We find that openness at the five stages are positively correlated, those indicating that researchers demonstrating openness tend to behaving in an open way throughout all the research process. We contend that the researchers’ openness might be influenced by different factors, related to different levels (personal and external) of the social academic structures in which researchers are embedded. Our results indicate that the most salient factors that explain openness are related to the personal characteristics of the researchers – i.e. their academic identity and their past experiences. These findings contrast with previous studies suggesting that institutional norms are more salient than imprinted norms (Bercovitz and Feldman, 2008).

Given that our findings seem slightly at odds with some existing studies, and our own research is admittedly exploratory, clearly more research is needed. Clearly our study does validate interest in motivation, and underscores the need for further insights into the relevance of the personal characteristics in researchers' openness to complement the work of Lam et al. (2011). But rather than externally imposing instrumentalist norms and rationales regarding engagement practices, our results suggest that researchers' identity and previous experiences are determinants for researchers' openness and hence societal involvement.

Finally, our message to policy makers (including universities themselves) is that they should not fall for the simplistic messages that altering incentive structures are enough to change behaviour: propensity to engage is formed over the course of an academic career – beginning with the Ph.D. and followed with experiences in engagement to date. An ongoing focus on benefits and incentives imposed from outside (from managers and policy makers) do not seem appropriate to promote researchers involvement with third parties, as they are at best tangentially related to the 'imprinted characteristics' of the researchers.

Thus, we suggest that policy-makers should not play to promote researchers' societal engagement through short-run measures linked to particular incentives and benefits. Fostering researchers' openness is anchored to a more long-term process related academic formation stage (when academic identity is shaped) and the opportunities to engage with third parties (previous engagement practices). Therefore, ensuring positive opportunities for engagement, and seeing engagement as a valid activity are more important to stimulating universities and scholars to better contribute to external knowledge processes, and maximise their contributions to society.

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References

- Abreu, M., Grinevich, V., Hughes, A., Kitson, M., 2009. Knowledge exchange between academics and the business, public and third sectors. Centre for Business Research and UK-IRC, Cambridge.
- Adler, E., Haas, P.M., 1992. Conclusion: epistemic communities, world order, and the creation of a reflective research program. *International organization* 46, 367-390.
- Aghion, P., Dewatripont, M., Stein, J.C., 2008. Academic freedom, private-sector focus, and the process of innovation. *RAND Journal of Economics* 39, 617–635.
- Ajzen, I., 2001. Nature and operation of attitudes. *Annual review of psychology* 52, 27-58.
- Anderson, B., 1991. *Imagined communities: Reflections on the origin and spread of nationalism* Verso, London.
- Audretsch, D.B., Bönte, W., Krabel, S., 2010. Why do scientists in public research institutions cooperate with private firms. DRUID (Danish Research Unit for Industrial Dynamics) Working Paper.
- Baldini, N., Grimaldi, R., Sobrero, M., 2007. To patent or not to patent? A survey of Italian inventors on motivations, incentives, and obstacles to university patenting. *Scientometrics* 70, 333-354.
- Bandura, A., 1977. *Social Learning Theory*. Prentice-Hall, Englewood Cliffs, NJ.
- Becher, T., Trowler, P., 2001. *Academic tribes and territories: Intellectual enquiry and the culture of disciplines*. McGraw-Hill International.
- Belderbos, R., Carree, M., Diederer, B., Lokshin, B., Veugelers, R., 2004. Heterogeneity in R&D cooperation strategies. *International Journal of Industrial Organization* 22, 1237-1263.

- Bercovitz, J., Feldman, M., 2008. Academic entrepreneurs: Organizational change at the individual level. *Organization Science* 19, 69-89.
- Berman, E.P., 2011. *Creating the market university: How academic science became an economic engine*. Princeton University Press.
- Bourdieu, P., 1988. *Homo academicus*. Polity Press, Cambridge.
- D'Este, P., Llopis, O., Yegros, A., 2013. Conducting pro-social research: Cognitive diversity, research excellence and awareness about the social impact of research. *INGENIO (CSIC-UPV) Working Paper Series*.
- D'Este, P., Perkmann, M., 2011. Why do academics engage with industry? The entrepreneurial university and individual motivations. *Journal of Technology Transfer* 36, 316-339.
- Deem, R., Lucas, L., 2007. Research and teaching cultures in two contrasting UK policy contexts: Academic life in education departments in five English and Scottish universities. *Higher Education* 54, 115-133.
- DiMaggio, P.J., Powell, W.W., 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American sociological review*, 147-160.
- Donovan, C., 2007. The qualitative future of research evaluation. *Science and Public Policy* 34, 585-597.
- Edquist, C., 1997. System of innovation approaches: their emergence and characteristics, in: Edquist, C. (Ed.), *Systems of Innovation: Technologies, Institutions and Organizations*. Pinter, London, pp. 1-35.
- Etzkowitz, H., Leydesdorff, L., 2000. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. *Research policy* 29, 109-123.
- Fromhold-Eisebith, M., Werker, C., Vojnic, M., 2014. Tracing the social dimension in innovation networks – from conceptualization to empirical testing, in: Rutten, R., Benneworth, P., Boekema, F., Irawati, D. (Eds.), *The social dynamics of innovation networks*. Routledge (in press), London.
- Gibbons, M., Limoges, C., Nowotny, H., Schartzman, S., Trow, M., Scott, P., 1994. *The new production of knowledge: the dynamics of science and research in contemporary societies*. Sage London.
- Gläser, J., 2012. How does Governance change research content? On the possibility of a sociological middle-range theory linking science policy studies to the sociology of scientific knowledge. Technical University Berlin. *Technology Studies Working Papers*, TUTS-WP-1-2012,(downloaded on 1 April 2012 from: <http://www.ts.tu-berlin.de/fileadmin/fg226/TUTS/TUTS-WP-1-2012.pdf>).
- Goethner, M., Obschonka, M., Silbereisen, R.K., Cantner, U., 2012. Scientists' transition to academic entrepreneurship: Economic and psychological determinants. *Journal of Economic Psychology* 33, 628-641.
- Gulbrandsen, M., Smeby, J.-C., 2005. Industry funding and university professors' research performance. *Research policy* 34, 932-950.
- Hessels, L.K., Van Lente, H., 2008. Re-thinking new knowledge production: A literature review and a research agenda. *Research policy* 37, 740-760.

- Hoye, K., Pries, F., 2009. 'Repeat commercializers,'the 'habitual entrepreneurs' of university–industry technology transfer. *Technovation* 29, 682-689.
- Jacobson, N., Butterill, D., Goering, P., 2004. Organizational factors that influence university-based researchers' engagement in knowledge transfer activities. *Science Communication* 25, 246-259.
- Jain, S., George, G., Maltarich, M., 2009. Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Research policy* 38, 922-935.
- Knorr-Cetina, K., 1981. *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*. Pergamon Press., Oxford.
- Kronenberg, K., Caniëls, M., 2014. Professional proximity in research collaborations, in: Rutten, R., Benneworth, P., Boekema, F., Irawati, D. (Eds.), *The social dynamics of innovation networks*. Routledge (in press), London.
- Krueger, R., Gibbs, D., 2010. Competitive global city regions and sustainable development: an interpretive institutionalist account in the South East of England. *Environment and planning A* 42, 821-837.
- Lam, A., 2011. What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle'? *Research policy* 40, 1354-1368.
- Landry, R., Saihi, M., Amara, N., Ouimet, M., 2010. Evidence on how academics manage their portfolio of knowledge transfer activities. *Research policy* 39, 1387-1403.
- Latour, B., 1988. *The pasteurization of France*. Harvard University Press.
- Lee, Y.S., 1996. 'Technology transfer'and the research university: a search for the boundaries of university-industry collaboration. *Research policy* 25, 843-863.
- Lee, Y.S., 2000. The sustainability of university-industry research collaboration: An empirical assessment. *The journal of Technology transfer* 25, 111-133.
- Leisyte, L., Enders, J., De Boer, H., 2008. The Freedom to Set Research Agendas— Illusion and Reality of the Research Units in the Dutch Universities. *Higher Education Policy* 21, 377-391.
- Martin, B., 2003. The changing social contract for science and the evolution of the university, in: Geuna, A., Salter, A.J., Steinmueller, W.E. (Eds.), *Science and Innovation: Rethinking the rationales for funding and governance*. Edward Elgar, Cheltenham, UK, pp. 7-29.
- McNeill, D., 2006. The diffusion of ideas in development theory and policy. *Global Social Policy* 6, 334-354.
- Merton, R.K., 1973. *The sociology of science: Theoretical and empirical investigations*. University of Chicago press, Chicago.
- Muthén, B.O., 1998–2004. *Mplus Technical Appendices*. Muthén & Muthén. Los Angeles, CA., Retrieved from URL: <http://www.statmodel.com/download/techappen.pdf>.
- Nelson, R.R., 2001. Observations on the post-Bayh-Dole rise of patenting at American universities. *The journal of Technology transfer* 26, 13-19.

- Noymer, A., 2008. Alpha significance level of test, in: Lavrakas, P.J. (Ed.), *Encyclopedia of Survey Research Methods*. SAGE Publications Inc., <http://dx.doi.org/10.4135/9781412963947>.
- Olmos-Peñuela, J., Benneworth, P., Castro-Martínez, E., 2013. Are 'STEM from Mars and SSH from Venus?': Challenging disciplinary stereotypes of research's social value. *Science and Public Policy*, sct071.
- Ouimet, M., Amara, N., Landry, R., Lavis, J., 2007. Direct interactions medical school faculty members have with professionals and managers working in public and private sector organizations: A cross-sectional study. *Scientometrics* 72, 307-323.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., 2013. Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research policy* 42, 423-442.
- Pinheiro, R., Benneworth, P., Jones, G.A., 2012. University ambiguity and institutionalisation: a tale of three regions, in: Pinheiro, R., Benneworth, P., Jones, G.A. (Eds.), *Universities and Regional Development. A Critical Assessment of Tensions and Contradictions*. Routledge, New York, pp. 11-32.
- Rutten, R., Boekema, F., 2012. From learning region to learning in a socio-spatial context. *Regional Studies* 46, 981-992.
- Sauermann, H., Stephan, P., 2013. Conflicting logics? A multidimensional view of industrial and academic science. *Organization Science* 24, 889-909.
- Schein, E.H., 1985. *Organizational Culture and Leadership: A Dynamic View*. Jossey-Bass, San Francisco, CA.
- Shane, S., 2000. Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science* 11, 448-469.
- Stokes, D.E., 1997. *Pasteur's quadrant: Basic science and technological innovation*. Brookings Institution Press.
- Tartari, V., Breschi, S., 2012. Set them free: scientists' evaluations of the benefits and costs of university-industry research collaboration. *Industrial and Corporate Change* 21, 1117-1147.
- Tinker, T., Gray, R., 2003. Beyond a critique of pure reason: from policy to politics to praxis in environmental and social research. *Accounting, Auditing & Accountability Journal* 16, 727-761.
- Venkataraman, S., 1997. The distinctive domain of entrepreneurship research: An editor's perspective, in: Katz, J., Brockhaus, R. (Eds.), *Advances in entrepreneurship, firm emergence, and growth*. JAI Press Greenwich, CT, pp. 119-138.
- Verspagen, B., 2006. University research, intellectual property rights and European innovation systems. *Journal of Economic Surveys* 20, 607-632.
- Ziman, J., 2000. *Real Science: What it is, and What it Means*. Cambridge University Press, Cambridge.