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Does academic consulting require any research?

Examining the relationship between research funding and academic consulting

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Abstract

This paper investigates the relationship between the sources of funding for research activities and the engagement of scientists in one specific type of knowledge transfer: academic consulting. By relying on a sample of 2603 individual faculty, from five Spanish universities, who have been recipients of publicly funded grants or have been principal investigators in activities contracted by external agents over the period 1999-2004, we find a positive effect of research funding on the amount of consulting contracts obtained by academic scientists. We also find that both networking and signalling effects are present and contribute to explain the amount of consulting activity acquired by academic scientists. By offering evidence of a positive correlation between the volume of academic consulting and different types of extramural research funding, our paper shows that: a) consulting is largely a function of strong involvement in research, knowledge-generation activities; b) the positive connection is particularly strong for the social sciences, where the type of knowledge transferred is more likely to be conceptual and symbolic than instrumental.

Keywords: academic consulting; technology policy; knowledge and technology train

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1 Introduction

Academic researchers are becoming increasingly accountable, from public funded agencies, to provide evidence of excellence in their research activities and demonstrate economic and social relevance of their research findings. This balance between excellence and utility of academic research is not always easy to achieve. While it is generally acknowledged that generation of knowledge is critical to produce any valuable knowledge to be eventually transferred, it is not always easy to strike a balance between the efforts oriented to knowledge creation and those required for effective knowledge transfer to potential users. Indeed, there is mixed evidence about whether these two activities - 'doing research' and 'conducting knowledge transfer' - are actually in conflict or they rather complement one another.

We examine this issue by investigating the relationship between the sources of funding for research activities and the engagement of scientists in one specific type of knowledge transfer: academic consulting. On the one hand, we focus on the sources of funding for research. Undertaking research requires access to funding, which is instrumental to recruit qualified researchers, have access to specialised equipment and materials, and to setting up the conditions for potential knowledge creation activities and scientific discoveries. Research funding is normally obtained through research grants, research contracts, or a combination of the two.

On the other hand, while acknowledging that knowledge transfer can take a wider variety of forms, we focus on academic consulting as this is a relevant and strategic vehicle for knowledge transfer. The rationale for this choice is based on the following arguments. First, academic consulting implies a direct, personal interaction between scientists and users, and a purposeful effort (often a bi-directional one) to agree on expected goals and to deliver actionable knowledge and expertise. Second, academic consulting is a widespread phenomenon compared to other contractual (i.e. licensing) or relational (joint research) channels of interactions with non-academic organisations. Despite this, consulting has been largely under-examined in the literature, to some extent as a consequence of the difficulty to systematically trace consulting activities due to its often informal character.

In examining the relationship between the amount of extramural research budget obtained by the scientist and the amount of engagement in consulting activities, we theorize two main channels through which scientists can attract consulting contracts: networking and signalling. On the one hand, a researcher might gain a reputation as a "trustful" partner among those who have interacted with him and who serve as informants to their second-tier connections (network effect). On the other hand, a researcher able to attract external budget for research through competitive grants might be reputed as a critical contributor to a relevant body of knowledge and as a highly qualified and excellent scientist (signalling effect). We also propose a rationale to explain why external funding may detract researchers from consulting: research-orientation. Researchers who are mainly oriented to curiosity-driven research and wish autonomy in deciding their research agendas, are less likely to dedicate deliberate efforts to knowledge transfer or compromise their own research targets to external sponsors' goals.

To test our hypotheses we rely on a sample of 2603 individual faculty, from five Spanish universities, who have been recipients of publicly funded grants or have been principal investigators in activities contracted by external agents (mainly government agencies or companies) over the period 1999-2004. We exploit the longitudinal nature of our data and estimate several linear and non-linear panel data models, in this way controlling for unobserved heterogeneity, reverse causality and censoring in the data.

We find, on the whole, a positive effect of research funding on the amount of consulting contracts obtained by academic scientists in our sample. Moreover, we find that both networking and signalling effects are present and contribute to explain the amount of consulting activity acquired by academic scientists. More specifically, we find that doubling the amount of research budget financed by a client yields a 4% increase in the amount of consulting value and that doubling the amount of competitive research grants increases the amount of consulting value of 2%. However, if we look at each of the scientific disciplines separately, the above mentioned effects are found to hold mainly in the field of 'social sciences' and to a weaker extent in hard sciences and life sciences.

Our results are also of interest to policymakers aiming to stimulate technological and economic development from university research. University-industry collaborations have been attracting the attention of policymakers for years. However, to date, policy measures have largely been directed to support collaboration through patents and spin-offs. By offering evidence of a positive correlation between the volume of academic consulting and different types of extramural research funding, we argue that: a) consulting is largely a function of strong involvement in research, knowledge-generation activities – little valuable (i.e. paid) consulting emerges as a substitution for publicly funded research; b) the positive connection is particularly strong for the social sciences, where the type of knowledge transferred is more likely to be conceptual and symbolic than instrumental.

The paper is structured as follows. In the next section, we propose the theoretical background of the paper. In Section 5, we illustrate the data set and describe the sample used in the empirical analysis. Section 6 specifies the econometric models and describes the variables included in the models. Section 7 summarizes the results of the econometric estimates. The last section synthesizes the main findings, acknowledges the limitations of the study, and indicates directions for further research.

2 Theoretical background

2.1 Defining academic consulting

Many authors have argued that consulting can be a strategic vehicle for transferring knowledge between academic scientists and decision-makers in companies and government agencies, as consulting can be particularly effective at promoting an interactive and problem-solving oriented mode of knowledge use [13]. The problem, however, has been placed on whether consulting distracts academics from *doing research* or whether both activities go hand in hand [18]. Before moving on to address this issue, it is first important to agree on a definition for academic consulting.

Following Perkmann and Walsh [18: 1885], we define academic consulting as “the provision of a service by academics to external organizations on commercial terms. This may involve providing advice, resolving problems as well as generating or testing new ideas”.[1] As pointed out by Bozeman and Gaughan [4: 695]: “consulting agreements (…) are not generally viewed as ‘university funding’ since they typically provide no institutional funds for the university and are made on a bilateral basis with the individual. The only university role in individual consulting is to set policies about the acceptable amount of time devoted to consulting and about conflicts of interest and use of university resources in consulting”.

Perkmann and Walsh [18] go further into the characterisation of different types of academic consulting, suggesting three forms of consulting according to the motivations of the researcher: opportunity driven, commercialisation-driven and research-driven. Research-driven consulting is expected to be consubstantial with academic research, as this type of consulting is directly related to academics’ research projects; while opportunity driven consulting is expected to be

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[1] Other definitions of consulting are also in line, such as Jacobson et al. [13], who define consulting as: “Consulting is broadly defined as a process of transferring expertise, knowledge, and/or skills from one party (the consultant) to another (the client) with the aim of providing help or solving problems” (13: 302).

negatively associated with research, as the main motivation from academics is to respond to personal income opportunities. Commercialisation-driven is not expected to have any impact on research productivity, as it is linked to the scientists' efforts to commercialise their own technologies.

While we fully concur with the above characterisation of academic consulting, which constitutes the starting point of our conceptual framework, we think it is important to bring to the foreground the potential differences in the consulting-modes across different fields of science, particularly due to the distinct demands from the contracting partners in consulting activities. This is important since, as we argue below, 'to whom' knowledge is dominantly transferred may fundamentally affect 'what' type of knowledge is transferred.

External organisations that act as clients hiring academics for consulting purposes, can be of very different types: companies, government agencies, private associations, not-for-profit organisations or particulars, to cite a few. It is critical to pay attention to this as the needs for academic consulting may differ substantially by type of client. Different clients may look for very distinct forms of expertise. Companies might differ substantially from government agencies, for instance, in the roles they expect from consultants. Whether organisations search for a technician, an adviser, a fact finder, an applied theoretician or a bridge builder, among other consultant roles pointed out by Gallessich [9], might depend on the type of contracting partner.

Accordingly, it is likely to expect that companies are more often in search of technical expertise and managerial advice from consultants, compared to government agencies, which may be more likely to look for reputed experts capable of shedding new light on alternatives for strategic action available to policy-makers. Indeed, the type of knowledge transferred through consulting depends on the use that clients want to make of university research findings and on the type of expertise embodied by the academic researcher [16].

As Amara et al. [2] have argued, university research can be useful for different purposes: instrumental, conceptual and symbolic. Instrumental use is defined as acting on research in specific and direct ways, such as to solve a particular problem at hand [16]. Conceptual use involves using research to inform debate by providing concepts and theoretical perspectives that contribute to enlightening the decision making process [22]. Symbolic use involves using research knowledge to justify, support or legitimate pre-determined positions or actions taken by the client [2,16].

Instrumental use is likely to be dominant in the context of consulting activities contracted by organisations interested in getting access to scientific expertise and specialised facilities to solve well-defined technical problems. Companies are clear candidates to demand this type of consulting, which is likely to entail personal income opportunities for the academic scientists (i.e. "opportunity-driven" consulting). However, companies are also frequent clients of consulting services driven by the pursuit of enlightenment for strategic decision-making, which is likely to require more substantive contribution from the scientists and might be more compatible with research activities. Consulting activities contracted by companies, therefore, could be compatible with the different types of scientists' motivations to engage in consulting, suggested by Perkmann and Walsh [18]: opportunity-driven, commercialisation-driven and research-driven.

On the contrary, conceptual and symbolic use might be dominant in the case of government agencies as contractors, who are more interested in searching for factual evidence and conceptual frameworks to inform strategic decision-making. In this sense, we could expect that when scientists engage in consulting patterns dominated by government agencies as contractors, these consulting activities could be more complementary with research activities, and thus akin to the type characterised as research-driven consulting.

In short, we argue that considering explicitly the different nature of the partners involved as consultant contractors (e.g. whether companies or government agencies) can provide further insights into the distinction made by Perkmann and Walsh [18], about the different types of academic consulting. More particularly, if the dominant type of partner in consulting contracts differs across scientific fields of science, the explicit consideration of the type of consultant contractor can help us improve our understanding about the circumstances under which the degree of conflict between 'doing research' and 'doing consulting' could be particularly acute, or conversely whether there is an easy compromise between the two. The following section addresses the relationship between doing research and doing consulting in further detail.

2.2 Relationship between doing research and doing consulting

2.2.1 Financial resources for research and engagement in consulting activities

Conducting research activities requires funding; often, lots of funding. Those academics who have large amounts of funding available for research, or have numerous funding opportunities due to an extraordinary research track, may enjoy a particularly unique position to decide the direction of their research, and follow their own will in setting research goals. This makes them less susceptible to be bound to funding agencies' goals in pursuit for funding.

To the extent that one of the determinants to engage in consulting is associated to resource-scarcity [15] and to personal income motivations [18], scientists who are successful fund raisers should be particularly less prone to engage in consulting activities as compared to researchers who have few opportunities to obtain funding for research. Drawing on this argument, we will contend that scientists with large volumes of funding available for conducting research activities, should exhibit a lower likelihood to engage in consulting activities.

However, the relationship between research funding and engagement in consulting may not be that simple. Abundance of resources to conduct research may actually spur knowledge transfer activities to non-academic organisations. Indeed, resource-abundance may provide the appropriate conditions to mobilise research capabilities and scientific expertise to provide advice and services to companies and government agencies [15]. These affluent researchers may become particularly well-endowed to engage in consulting, not only because of the financial, human and technical resources available to them, but also due to the opportunities to divert efforts away from the production of academically valuable results, towards the demonstration of the utility, applicability and socio-economic impact of their research findings.

Drawing on the above discussion, we put forward the following two competing hypotheses:

> *H1a. Academic scientists who have larger volumes of funding available for research will exhibit a greater degree of involvement in consulting activities.*

> *H1b. Academic scientists who have larger volumes of funding available for research will exhibit a lower degree of involvement in consulting activities.*

2.2.2 Multiple sources of funding and engagement in consulting activities

Research funding comes from various types of sponsors - i.e. public or private - and research funding can be mission-oriented or target-free. As Goldfarb [12] has put it: "research is a sponsored activity". However, who sponsors research and how research funding is channelled to the academic researcher, can have a great influence in shaping the balance between excellence and utility in research activities. There are two main fundamental mechanisms to channel funding for conducting research activities: competitive and contract funding [4, 11, 12]. For the purpose of our narrative, it is important to discuss them in some detail.

3 Competitive funding

Competitive funding refers to public funding allocated through research grants. That is, funding is provided to universities by the National Science Ministries, Research Councils or international institutions[2]. These government agencies allocate funds through research grants, which are awarded after a peer review decision process has examined the scientific merits of proposals and applicants. While a variable proportion of competitive funding might be a response to specific government targets, this system is characterised largely by being a bottom-up process where applicants (typically, university researchers) propose lines of research they feel most attracted to. Competitive grants are oriented to support scientific production of high impact and provide, to the awarded researchers, the extraordinary opportunity to follow a curiosity-driven research agenda. In short, and to put it bluntly: within the context of competitive grants, government funding agencies would prioritise the claim and demonstration of scientific excellence as mandatory; while utility and use as largely recommendable.

When it comes to the relationship between competitive funding and academic consulting, two conflicting logics seem to be at work. On the one hand, a 'research orientation' effect: if grant holders are dominantly oriented towards curiosity-driven research and to conforming with the norms of science in terms of first priority and scientific impact, they are likely to be less concerned about raising the attention of potential users or even identifying them. This logic would support the argument of a substitution effect, as researchers with large amounts of funding from competitive grants would be less likely to engage in consulting activities.

On the other hand, there is a 'signalling' effect. Academics that excel in raising competitive funding for research are either contrasted outstanding scientists with a long-standing track of highly cited work or scientists with a promising research agenda, who are likely candidates to make an impression among potential users of university research. Non-academic organisations

[2] For instance, the Framework Programmes of the Commission of the European Union.

may particularly direct their focus to this type of scientists, as they are particularly visible and well-known experts in the field [4]. This logic would support the argument of a complementary effect, as researchers with large amounts of funding from competitive grants would be more likely to engage in consulting services.

As before, following the preceding discussion, we formulate the above logics as two competing hypotheses:

> *H2a. Academic scientists who have larger volumes of 'competitive' funding available for research will exhibit a greater degree of involvement in consulting activities.*

> *H2b. Academic scientists who have larger volumes of 'competitive' funding available for research will exhibit a greater degree of involvement in consulting activities.*

4 Contract funding

Contract funding is characterised by being a more demand-driven process where the sponsoring agency, be this a public or a private organisation, allocates money for research either through a tender to invite applications or directly connecting with a university research team. Research contracts generally involve well-specified goals and are more mission-targeted than competitive grants. Contract funding also tends to be short or medium term, and generally involves more applied research than fundamental or basic research. As Geuna [11] and Goldfarb [12] have argued, the importance of this vehicle to channel research funding has increased in importance, in part as a response to pressure from policy makers to make scientific research more relevant and more oriented towards socially useful goals. Even though contract funding involves knowledge creation and scientific production, the main goal is to satisfy the targets defined by the research sponsor, and it may not necessarily involve reaching the higher standards of scientific excellence. In short, and to put it bluntly again: within the context of contract funding, research sponsoring agencies would prioritise the production of useful results, according to the initially agreed goals, as mandatory; while the contribution to scientific excellence as largely recommendable.

The relationship between contract funding and academic consulting is likely to be less compounded than in the case of competitive funding; however, it is still likely to be multifaceted. There are two main logics to support a positive relationship between contract funding and academic consulting. On the one hand, the 'embedded' logic. Consulting activities can be directly linked to the sponsored research activities in which researchers are involved. In this sense, co-production of knowledge between the contracting agent and the academic scientist might require consulting activities as an integral part of the research project [18]. In less idyllic terms, Goldfarb [12] points out the risk of a path-dependent process in which scientists who dominantly engage in sponsored, contract research could experience a limitation in the likelihood of generating important insights and discoveries, and restrict themselves to a narrower range of funding opportunities; mainly to funding channels oriented to satisfy sponsors and to consulting activities.

On the other hand, there is a 'network' logic that supports the argument for a positive relationship between contract funding and consulting. This logic builds on the idea that involvement in research projects sponsored by industry or government agencies improves the scientists understanding of the context of application of their research, and helps advance the scientists' skills to increase reliability in reaching agreed targets, delivering useful results and overcoming conflicts of interest and cultural barriers associated to the exchange of codified and tacit knowledge [5]. The reinforcement of these collaboration-related skills, due engagement in sponsored research projects, helps creating trustful relationships with non-academic organisations, and building strong and weak ties with external organisations. In short, being considered as a trusted academic partner and having a wide network of potential sponsors, is likely to increases the opportunities for deepening the engagement in consulting activities. Indeed, some empirical evidence has already shown that the involvement of academics in industry-sponsored research increases the probability that scientists engage in consulting activities [7, 15].

Drawing on the preceding discussion, we put forward the following hypothesis:

> *H3. Academic scientists who have larger volumes of 'contract' funding available for research, will exhibit a greater degree of involvement in consulting activities.*

Differences by field of science

Finally, the strength and direction of the relationship between sources of funding for research and the degree of engagement in consulting activities may be contingent on the scientific discipline of scientists. As argued above, certain types of consulting activities are more likely to be consubstantial with conducting research, due to the type of knowledge transferred: whether instrumental, conceptual or symbolic. Scientists in certain disciplines might be more frequently engaged in consulting activities that involve an instrumental use of knowledge as compared to a conceptual or a symbolic use of knowledge.

There is a vast literature on how social science research may affect decision making in both government agencies and companies. Weiss [22] and Beyer and Trice [3] argue that instrumental use of research findings is relatively infrequent in the field of social science, because of the difficulty to produce general and immediately applicable results and prescriptions for organizations that exhibit idiosyncratic routines and distinct repertoires of behaviour. On the contrary, they sustain that conceptual use of research, such as using basic concepts, general principles or theory-related ideas for enlightening decision-making, is a more frequent form of use. Conceptual use is not so constrained by the distinct repertories of behaviours in organisations, as it gives users the autonomy to “selecting, redefining, altering, combining and generally reinterpreting research results to fit a wide variety of circumstances”[3: 600].

In consulting activities where substantive work includes tasks like conducting literature reviews and syntheses of best practices, collecting qualitative and/or quantitative data, analyzing data and developing recommendations, consulting can be complementary to the scientists’ research activities. This range of tasks can be common to consulting activities in many fields of science. However, it is likely that consulting in engineering and biomedical sciences, in particular, includes also a significant proportion of commercial and standardised services based on the provision of tests and technical analysis – using specialised equipment facilities and expertise available at universities. This type of consulting activities can be characterized as the provision of a commodity service product, susceptible for a direct application among a wider client-base of potential contracting organizations. In this sense, this latter type of consulting is more akin to the opportunity-driven type, and thus, less closely linked to knowledge-generation oriented research activities.

Drawing on the preceding discussion, we put forward the following hypothesis:

H4. In fields of science where knowledge transfer via consulting is more often conceptual and symbolic (rather than instrumental), we would expect a stronger complementarity between research activities and consulting activities.

5 Data sources and descriptive statistics

5.1 Data

The main source of information used in this investigation was provided by the technology and transfer offices of the five public universities of the Valencian Higher Education system: University of Alicante (UA), Miguel Hernández University (UMH), Jaume I University (UJI), University of Valencia (UV) and the Polytechnic University of Valencia (UPV). Except for the University of Valencia, all other universities have been created in the last 40 years. The data are analysed at the individual faculty level. Our sample consists of 2603 research active faculty – that is, academics who have been recipients of publicly funded grants or principal investigators in R&D contracts over the period 1999-2004.

Our faculty sample is distributed across the five universities considered in this study, as follows: 37% at UV; 28% UPV; 12% UA; 13% UJI; and 10% UMH (a distribution that is largely identical to that corresponding to the entire faculty population across the five universities). One of the value added features of this data is that it provides detailed time varying information on the specific type of research projects and contracts in which academic researchers have been involved over the period 1999-2004. This includes project level information for both publicly funded research projects and contractual arrangements with third-parties, either industry or public administration. One of the contractual arrangements for which this data provides detail information is academic consulting, including the precise number of consulting contracts in which researchers are engaged as well as the amount of funding obtained through this source.

5.2 Academic consulting

In order to fully understand the nature of our data on academic consulting, it is important to provide a brief overview on the regulation that governs the contractual arrangements that university researchers are allowed to establish with non-academic agents.

In the Spanish context, university-industry linkages are regulated by the Organic Law of Universities (LOU-2001, and specifically, Article 83). This regulation authorizes academic researchers to sign agreements with public or private organisations for the development of work of a scientific, technical or artistic nature, as well as for the development of specialisation courses or specific activities associated with training. In this sense, academics have the capacity to establish contractual arrangements with companies, and perform advisory and consulting agreements for them, provided that such contracts are established through the university – that is, through the organisational structures available at universities that have the mission to channelling knowledge and technology transfer activities.

Under this University Act, each university is autonomous in establishing procedures for authorisation of the work and monitoring consulting agreements, and to set the criteria to determine the destination of the assets and resources obtained through these agreements. In the case of the Polytechnic University of Valencia (UPV), for example, this university retains 10% of the total amount of funding from external agents in concept of overheads, while the rest of the stream of income from the contract covers the material costs involved in the development of the planned tasks and the remuneration of the academic scientist responsible for the implementation of the activities agreed in the consulting contract. With regards to the remuneration of faculty involved in consulting activities, the income received must not exceed 1.5 times the annual salary that corresponds to the highest category of academic faculty – i.e. the category of full-time professor[3].

Considering this legal framework as our point of reference, consulting activities are identified on the basis of well-defined activities developed through contractual agreements. More specifically, the purpose of these contractual arrangements is generally an activity aimed at solving specific problems and provide qualitative advice: it is not supposed to generate new scientific or technological knowledge, but can promote or facilitate technical and/or organisational innovation. In this type of contracts we find technical and professional work, including design and technological support to industry. Consulting work also includes other type of tasks such as technical services (e.g. data analysis, testing) that are normally provided by universities through specialised equipment and skilled personnel available at research centres.

Drawing on the above characterisation of academic consulting, **Table 1** shows that academic consulting is a frequent contractual arrangement among academics in the universities analysed in this paper. Indeed, as **Table 1** shows, 46% of our sample of academic researchers has been involved at least once in academic consulting over the period 1999-2004. The proportion of scientists involved in academic consulting is systematically higher than the proportion of scientists involved in R&D contracts, regardless of the field of science. It is also interesting to note, however, that there are significant differences by scientific discipline, with regards to the degree of engagement in consulting activities. Scientists in engineering-related fields have a much higher propensity to engage in academic consulting – above 70% of scientists in Engineering engage in academic consulting over the six-year period analysed, compared to 46% for the case of scientists in Social Sciences or 32% for scientists in Mathematics and Physics.

[Tables 1, 2 and 3 in here]

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[3] UPV's Management Regulations for Research, Technology Transfer and Continuing Education, BOUPV 43, http://www.upv.es/entidades/SG/infoweb/sg/info/U0537298.pdf.

It is worth noting that the volume of funding is substantially different per mode of contract type. As **Table 2** shows, consulting agreements (column 1) involve, on average, a much lower volume of funding compared to contract R&D (column 2) and competitive R&D (columns 3 and 4). The average volume of funding increases as we move from consulting to contract R&D and to competitive R&D, which is largely a consequence of the fact that consulting agreements are generally much shorter term contracts, and involve lower amounts of time committed by PIs, compared to contract R&D and competitive R&D. We distinguish two types of competitive R&D funding (i.e. National and International R&D) because national standard grants might substantially differ from international grants in terms of the volume of resources mobilised and the reviewing processes involved in the assessments leading to the final award decisions.

Finally, **Table 3** shows that there are notable differences, by field of science, with regards to the type of contracting organisations that pay for consulting services. Companies are the most important client for academic consulting in several fields of science, accounting for approximately 50% of the total volume of funding committed to consulting services in the cases of Engineering and Biomedical Sciences. Conversely, in Humanities and Social Sciences, government agencies represent the single most important contractor of consulting services, accounting for about 40% of the total volume of paid consultancy.

6 Econometric model

6.1 Dependent variables and methods

As discussed in Section 2.2, we are interested in examining the relationship between doing research and doing consulting.

The model can be written as:

$$VConsulting_{it} = \alpha + x_{i,t-1}^{T}\beta + \delta^{T}Z_{i} + \mu_{i} + \varepsilon_{it}$$

where $VConsulting_{it}$ is the dependent variable and is measured as the natural logarithm of the total amount of consulting obtained by scientist i in year t (plus one); $x_{i,t-1}$ denotes the set of time-varying covariates measured at the time $t-1$ to partially control for reverse causality issues (see Section 6.2); Z_i indicates a series of individual-specific control variables (see again Section 6.2), μ_i the unobserved individual-specific effect, and ε_{it} is the error term.

We measure the extent of engagement in consulting by using the information available in our dataset. In particular, we use the total monetary income from the consulting contract obtained by the scientists contained in the sample. We spread the contract value over the whole award period, i.e., if the contract lasts 2 years we split it equally across those 2 years. This is done in order to account for the on-going benefits and implications of a contract and to mitigate against the effect of focusing all the funds at the beginning of the period.

To study the relationship between scientists' sources of funding and the extent of engagement in consulting activities we investigate which, among the multiple sources of funding available to the researcher, influence the amount of consulting obtained. We employ different specifications of our panel data model: a pooled cross-sectional approach, a random effects estimator, a censored random effects estimator and fixed effects estimators.

We estimate different versions of this model. First, we assume that $\mu_i = 0$, and thus the model can be estimated as a simple pooled cross-sectional model, where we adjust the standard errors for firm clusters to account for the panel structure of the data. Thus, we allow the error terms to be correlated within individual observations. Although useful as starting point, the pooled model has the disadvantage of not controlling for unobserved time-invariant factors such as scientist ability that are relevant in estimating consistently the coefficients of the regression model. In the second version of the model, we apply a random-effects panel estimator so that μ_i is different from zero. However, this requires the assumption that the unobserved heterogeneity term to be distributed with mean equal to the average of the individual effect. In the third version of the model, we apply a random-effects tobit panel data estimator to deal with the censoring of the data (i.e. $VConsulting_{it}$ takes value 0 in 54% of cases). Finally, in our fourth and preferred model we apply alternative fixed-effects panel data estimators that get rid of the unobserved heterogeneity term and thus fully control for his influence on our estimates. In particular, we apply a within estimator that eliminates all time-invariant regressors and is able to provide consistent estimators for the time-variant ones. Unfortunately, by definition time-invariant regressors are not estimated because not identified. As a second fixed effects estimator we provide the Hausman-Taylor estimator that is an instrumental variable estimator that additionally enables the coefficients of time-invariant covariates to be estimated.

6.2 Independent and control variables

Our main independent variables, as discussed in Section 2.2, are variables pertaining to the different sources of funding available to the individual scientist: the overall volume of funding for conducting research, the volume of competitive funding and the volume of contract funding. These variables were defined as stocks (rather than flows) because we expect scientist's rate of engagement in consulting to be affected by the cumulated stocks of funding and not only by current or lagged flows. Moreover, using variables in stocks overcomes a potential endogeneity problem that can arise if flows are used instead. In this framework, the stock variables were computed using the perpetual inventory method based on the following formulas:

$$Stock_{X_t} = Stock_{X_{t-1}}(1-\delta) + Flow_{X_t}$$

$$Stock_{X_{t_0}} = \frac{Flow_{X_{t_0}}}{(g + \delta)}$$

As far as the pre-sample growth rate g for *Xs* are concerned, we assume them to be equal to the average growth rate of *X* in our sample over the period 1999-2004. As far as the depreciation rate (δ) for *Xs* is concerned, we assume a constant value of 0.15 as is common in the cited literature.

The stock variables are as follows. First, $VContract_{i,t-1}$ is the natural logarithm of the stock of funding (plus one) to support research activity provided by external agents (firms, public administrations, other individuals, etc.) to scientist *i* in year *t-1*. Second, $VCompetNat_{i,t-1}$ is the natural logarithm of the stock of funding (plus one) to support research activity obtained via competitive funding at the regional and national level (e.g. National Plan Standard Grants[4]) by scientist *i* in year *t-1*. Third, $VCompetInt_{i,t-1}$ is the natural logarithm of the stock of funding (plus one) to support research activity obtained via competitive funding at the international level (e.g. EU funded projects) by scientist *i* in year *t-1*. Finally, $VFunding_{i,t-1}$ is the natural logarithm of the stock of funding (plus one) to support research activity obtained via the three means defined above by scientist *i* in year *t-1*.

The other explanatory variables, which act mainly as controls, are as follows. Exp_i is a proxy for work experience and is measured as the number of quinquenios[5] obtained by the scientist. In order to control for the presence of a curvilinear effect in the level of experience we also include the squared value of the last variable: Exp_i^2. We also control for the status, the environment and the field in which the scientist operates. In particular, we control for the effects stemming from the academic position of the scientist ($DAcademicPosition_i$), University affiliation ($DUniversity_i$)

[4] The National Plan standard grants represent the most important vehicle for competitive grants at the National level for Spanish academic researchers (see the following link for further details www.idi.mineco.gob.es).

[5] In Spain, the *quinquenio* (literally a five-year period) is a form of recognition granted to academic scientists based on their experience and affects their salaries. *Quinquenios* are granted every five years, following an evaluation process. Thus, a professor who has been in a university for 20 years could possess up to 4 *quinquenios*. We use *Quinquenios* as a proxy for academic experience.

and year effects (*DYear*$_i$) by including a series of specific dummies. Finally, we control for specific effects due to the scientific field by including a series of field-specific dummies.[6]

shows the correlation matrix for all the time variant variables included in our analysis (*VConsutling*, *VContract*, *VCompetNat*, *VCompetInt*) and for the variable accounting for experience at the individual level: Exp. As **Table 4** shows, variables are weakly correlated to each other, suggesting there should be no multicollinearity problems with our data.

[**Table 4** in here]

7 Results

The empirical analysis focuses on the relationship between multiple sources of research funding and the amount of consulting activities obtained by the individual scientist and is mainly based on panel data model estimation to control for unobserved heterogeneity.

The estimation is presented in two steps. First, we present different panel data estimators of the econometric model presented in the previous section on the overall sample comprising 2603 individuals (**Table 5**). At this stage, the main aim is to find support for the hypotheses 1 to 3 developed in the theoretical section of the paper. Second, among the different estimation strategies we choose the most reliable one and applied it on different sub-samples composed by individuals working in different fields of science (**Table 6**). At this stage, we aim to find support for hypothesis 4.

The regression results of the first step of estimates are reported in **Table 5**. The first two columns contains pooled cross-sectional estimates, the second and third are random-effects panel data estimator (linear and censored respectively) that account for unobserved scientist-specific

[6] We considered the following five scientific fields: (i) Agricultural, Biological and Medical Sciences; (ii) Social Sicences; (iii) Humanities; (iv) Mathematics and Physics; and (v) Engineering and Technology.

heterogeneity by assuming that its expected value is equal to zero. The estimates in columns 4, 5 and 6 relax this assumption by estimating fixed effects.

Overall, **Table 5** shows the following results. Across all the different specifications, the volume of contract funding for research - variable *VContract* - has a positive impact on the extent of engagement in consulting activities. This result supports hypothesis 3. According to the fixed effects model, that is the one estimating in the most reliable way the coefficient of interest, doubling the amount of contract funding for research increases by 4% the amount of consulting contracts obtained. A similar result, supporting hypothesis 1a, is found for the volume of funding available for conducting research (variable *VResearch*). Column 4 of **Table 5** shows that doubling the amount of research funding increases of 3% the amount of consulting contracts obtained.

The amount of competitive funding obtained at the national level – variable *VCompetNat* - has a negative and significant effect according to the specifications contained in columns 1 and 3. The sign of the coefficient changes to positive in the fixed effects specification. This clearly shows the relevance of controlling for fixed effects such as scientist innate ability. The negative effect of *VCompetNat* on Consulting can be actually driven by a negative correlation between unobserved heterogeneity at the scientist level that is not controlled properly in the other specifications. The positive sign supports hypothesis H2b.

A similar behaviour is apparent from the amount of competitive funding obtained at the international level – variable *VCompetInt* – that from positive in column 1 changes to negative in the fixed effects specifications in columns 5 and 6. By the same reasoning applied above, the apparent positive relationship between *VCompetInt* and *VConsulting* is driven by the strong positive correlation between the latter and the unobserved heterogeneity term that, once controlled for, changes the sign of the relationship. This result is consistent with hypothesis H2a.

Regarding the control variables, the coefficient of *Exp* is positive and significant at conventional confidence levels in all of the specifications. Reasonably enough, experience plays a positive role in obtaining consulting contracts. Interestingly, all of the remaining controls are significant at a joint level (Position dummies, Time dummies, University Dummies and Field Dummies). In **Table 5** we also provide the results of scientific field dummies because they are informative about the role played by different scientific areas in the extent of consulting activity. As expected from **Table 1**, both *Humanities* and *Mathematics & Physics* exhibits a significant and negative coefficient meaning that by working in this field a scientist should be expected to collect less consulting contracts compared to *Agricultural, Biological & Medical Sciences* (the reference category). Always in line with expectations, *Engineering & Technology* field exhibits a positive and significant coefficient.

[**Table 5** in here]

Table 6 shows results of the within estimator (our preferred specification) across the different scientific fields. The table shows a non-negligible heterogeneity at the field level with some of the results presented above holding for some scientific areas while losing their significance in others. Nevertheless, a clear pattern is present in the *Social sciences* where the coefficients of both *VContract* and *VCompetNat* are positive and significant. We interpret this result as supporting hypothesis 4. In particular, we expect knowledge transfer in social sciences to be more conceptual and symbolic (rather than instrumental) and, in line with that, a higher complementarity between funding for research and the amount of consulting activities is found. In this case, we can talk of a genuine *social science effect*.

[**Table 6** in here]

8 Conclusion

In this paper, we analyze the relationship between the sources of funding for research activities and the engagement of scientists in one specific type of knowledge transfer: academic consulting.

By using a unique data set comprising project-level funding information for 2603 individual faculty, from five Spanish universities over the period 1999-2004, and through the application of a panel data econometric approach, we find a positive effect of research funding on the amount of consulting contracts obtained by academic scientists. Moreover, we find that both networking and signalling effects are present and contribute to explain the amount of consulting activity acquired by academic scientists. However, if we look at each of the scientific disciplines separately, the above mentioned effects are found to hold mainly in the field of 'social sciences' and to a weaker extent in hard sciences and life sciences.

The paper, in the spirit of the present special issue, contributes to the relevant literature in two main respects. First, it adds to the extensive academic debate on university-industry interactions, by moving beyond technology transfer and studying softer, less easily traceable channels of interaction [21]. As several authors have noted, technology transfer channels (i.e. patents or licensing IPRs) are not representative of the patterns of knowledge generation and transfer from public research organisations [1, 6]. However, the prevalence of other forms of collaboration between University and Industry as well as their internal functioning are issues still poorly explored [17].

In this sense, our work adds to the stream of the literature that specifically analyzes knowledge and technology transfer in university-industry linkages [10]. The engagement of scientists in knowledge and technology transfer activities is a topic that has attracted an increasing amount of interest in the last years, both among scholars and policy makers. Governments worldwide have been calling for greater interaction between universities and industry, under the rationale that this interaction is instrumental to foster technological development and economic achievements [8] and to strengthen the co-evolution between scientific and commercial opportunities [20]. At the same time, sceptics have raised concerns about a possible negative impact that universities' involvement in technology transfer can have on the production and advancement of scientific knowledge/production [14]. Conversely, in general, no conclusive evidence has been provided about whether these two activities - 'doing research' and 'conducting knowledge transfer' - are actually in conflict or they rather complement one another. By documenting the existence of a positive association between the amount of research funding and the amount of consulting contracts obtained by academic scientists in our sample, this paper suggests that an indirect way to support knowledge is through the financial support of knowledge-generation, research activities.

Second, our paper has relevant practical implications. On the one hand, we show that financing research has a positive effect on a specific kind of knowledge transfer such as academic consulting. Our findings suggest that to secure informal knowledge transfer, policy makers should try to guarantee a continuous and non-negligible amount of funding for research (being it on a contractual or competitive basis). The idea that, to favour knowledge and technology transfer one should directly intervene on the incentives to transfer knowledge themselves, is not fully supported from our findings. Conversely, we show that consulting is a prevalent mode of university-industry interaction, across all fields of science, and, thus it might not require directed policy intervention measures to foster consulting activities, but rather policies oriented to secure that valuable knowledge generation activities are in place.

On the other hand, we find a mixed result for the role played by competitive funding for academic consulting. In particular, a positive relationship of regional and national competitive funding with the amount of academic consulting is found, while a negative relationship is present in the case of international competitive funding. This result may be of interest to policymakers because it suggests that signalling effect has to be nuanced to the different source of funding while networking effect has a clear and consistent effect on knowledge and technology transfer. In particular, the signalling effect can be counterbalanced and eventually reversed by a research-orientation effect thus providing the mixed effect cited above.

Finally, we show that the main effects discussed above are idiosyncratic to the scientific field considered. Although a large proportion of scientists working in engineering and technology fields are involved in consulting, it looks like that this particular type of knowledge transfer activity is weakly connected with research funding (at least with competitive funding). In the same vein, we reveal the peculiar case of social sciences that is found to be particularly conducive to academic consulting. This specificity is explained referring to the type of knowledge characterising the field under consideration that is more symbolic and conceptual compared to a more instrumental type characterising other scientific fields. Given that social sciences are so conducive to academic consulting, one possible vehicle to spur this knowledge transfer channel could be to foster contamination of other fields of science with social sciences - e.g. in the form of advanced specialised training [19]. In this light, the recent creation of a sub-field such as Engineering Management could be seen as a well-headed initiative in this direction. Overall, a more general implication of the result refers to the role played by inter-disciplinarity in activating positive loops between research funding and knowledge and technology transfer in the form of consulting activity.

References

1. Agrawal, A. & Henderson, R. (2002), 'Putting Patents in Context: Exploring Knowledge Transfer from MIT', *Management Science* 48(1), 44--60.

2. Amara, N., M. Ouimet and R. Landry (2004). “New evidence on instrumental, conceptual, and symbolic utilization of university research in Government Agencies”. *Science*

Communication 26 (1): 75-106.

3. Beyer, J.M. and H.M. Trice (1982). "The utilization process: a conceptual framework and synthesis of empirical findings". *Administrative Science Quarterly* 27: 591-622.

4. Bozeman, B. and M. Gaughan (2007). "Impacts of grants and contracts on academic researcher's interactions with industry". *Research Policy* 36: 694-707.

5. Bruneel, J., P. D'Este and A. Salter (2010). "Investigating the factors that diminish the barriers to university-industry collaboration". *Research Policy* 39 (7): 858-868.

6. D'Este, P. & Patel, P. (2007), 'University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry?', *Research Policy* 36(9), 1295-1313.

7. D'Este, P. and M. Perkmann (2011). "Why do academics engage with industry? The entrepreneurial university and individual motivations". *Journal of Technology Transfer* 36(3): 316-339.

8. Dutrenit, G. & Arza, V. (2010), 'Channels and benefits of interactions between public research organisations and industry: comparing four Latin American countries', *Science and Public Policy* 37 (7), 541-553.

9. Gallessich, J. (1985). "Toward a meta-theory of consultation". *The Counseling Psychologist* 13 (3): 336-354.

10. Gander, J. (1986), 'The economics of university-industry research linkages', *Technological Forecasting and Social Change* 29(1), 33-49.

11. Geuna, A. (2001). "The changing rationale for European university research funding: Are there negative unintended consequences?". *Journal of Economic Issues* 35 (3): 607-632.

12. Goldfarb, B. (2008). “The effect of government contracting on academic research: Does the source of funding affect scientific output?”. *Research Policy* 37: 41-58.

13. Jacobson, N., D. Butterill and P. Goering (2005). “Consulting as a strategy for knowledge transfer”. *The Milbank Quarterly* 82 (2): 299-321.

14. Krimsky, K. (2003). Science in the private interest: has the lure of profits corrupted the virtue of biomedical research? Rowman & Littlefield, Lanham.

15. Landry, R., M.Saïhi, N. Amara and M. Ouimet (2010). “Evidence of how academics manage their portfolio of knowledge transfer activities”. *Research Policy* 39(10): 1387–1403

16. Lavis, J.N., D. Robertson, J.M. Woodside, C.B.McLeod and J. Abelson (2003). “How can research organizations more effectively transfer research knowledge to decision makers?”. *The Milbank Quarterly* 81 (2): 221-248.

17. Perkmann, M. & Walsh, K. (2007), 'University–industry relationships and open innovation: Towards a research agenda', *International Journal of Management Reviews* 9(4), 259--280.

18. Perkmann, M. and K. Walsh (2008). “Engaging the scholar: Three types of academic consulting and their impact on universities and industry”. *Research Policy* 37: 1884-1891.

19. Phillips, F. (1998), 'University-industry partnerships in management research', *Technological Forecasting and Social Change* 57(3), 257--260.

20. Rosenberg, N. and Nelson, R.R. (1994), ‘American universities and technical advance in industry’, *Research Policy* 23, 323-348.

21. Vedovello, C. (1998), 'Firms’ R&D activity and intensity and the university–enterprise

partnerships', *Technological forecasting and social change* 58(3), 215--226.

22. Weiss, C.H. (1979). "The many meanings of research utilization". *Public Administration Review* 39 (5): 426-431.

Table 1: Proportion of active researchers who obtained extramural budget over the period 1999-2004 by field of science

	Consultancy	Contract R&D	National Public R&D	International Public R&D	N
	%	*%*	*%*	*%*	
Agricultural, Biological and Medical Sciences	44.76	33.14	73.17	9.00	697
Social Sciences	45.98	38.84	52.00	5.60	448
Humanities	35.12	18.84	65.58	3.25	430
Mathematics and Physics	32.24	24.28	71.84	7.75	490
Engineering and Technology	70.26	33.64	48.14	7.62	538
Total	46.29	30.19	62.85	6.90	2603

Table 2: Amount of funding per contract by field of science

	Consultancy €	Contract R&D €	National Public R&D €	International Public R&D €
Agricultural, Biological and Medical Sciences	6170	21659	34764	106186
Social Sciences	7878	12889	16286	60392
Humanities	6591	21281	14199	65670
Mathematics and Physics	5576	23699	33374	82076
Engineering and Technology	6965	22016	32898	147173
Total	6686	20070	27993	100950

Table 3: Distribution of volume of consulting by type of contractor and field of science (% relative to the total volume of paid-consultancy, in million €, for the period 1999-2004)

	Agricult. Bio. & Medical Sc.	Social Sciences	Humanities	Physics & Mathematics	Engineering & Technology
Government Agencies	34.6	41.4	38.2	31.6	30.3
Companies	45.9	33.6	32.7	40.7	48.0
*Others**	19.6	25.0	29.1	27.7	21.7
Total (%)	100%	100%	100%	100%	100%
Total volume	13.1 M€	9.2 M€	5.7 M€	7.5 M€	36.1 M€

*The category *Others* include: Non-profit organisations, Associations, Public and Private Resarch Institutes, individuals, etc ...

Table 4: Correlation matrix

	VConsulting	*VContract*	*VCompetNat*	*VCompetInt*
VConsulting	1			
VContract	0.15	1		
VCompetNat	0.02	0.18	1	
VCompetInt	0.05	0.18	0.2	1
Exp	0.04	0.13	0.23	0.09

Table 5: Results of the econometric estimates of the relationship between multiple sources of research funding and the amount of consulting activities

	(1)	(2)	(3)	(4)	(5)	(6)
		Random Effects		Fixed Effects		
	Pooled Cross-Section	Random Effects	Tobit Random Effects	Within Estimator	Within Estimator	Hausman-Taylor Fixed Effects
VResearch	-	-	-	0.03***	-	-
				(0.01)		
VContract	0.10***	0.08***	0.43***		0.04***	0.03**
	(0.01)	(0.01)	(0.05)		(0.01)	(0.01)
VCompetNat	-0.02***	-0.01	-0.12**		0.02**	-0.01
	(0.01)	(0.01)	(0.05)		(0.01)	(0.01)
VCompetInt	0.03*	-0.00	-0.03		-0.03*	-0.04**
	(0.02)	(0.02)	(0.09)		(0.02)	(0.02)
Exp	0.19***	0.20**	1.35*			0.22**
	(0.07)	(0.10)	(0.70)			(0.11)
Exp^2	-0.01	-0.01	-0.10			-0.01
	(0.01)	(0.01)	(0.09)			(0.01)
Field Dummies (Reference category: Agricultural, Biological and Medical Science)						
Social Sciences	0.09	0.11	0.84			0.13
	(0.09)	(0.13)	(0.86)			(0.13)
Humanities	-0.20***	-0.23*	-2.40***			-0.29**
	(0.08)	(0.12)	(0.91)			(0.13)
Mathematics and	-0.36***	-0.37***	-3.89***			-0.39***

Physics						
	(0.07)	(0.12)	(0.90)			(0.13)
Engineering and technology	0.34***	0.37**	2.16**			0.41***
	(0.10)	(0.14)	(0.91)			(0.14)
Year Dummies	Inc.	Inc.	Inc.			Inc.
Position Dummies	Inc.	Inc.	Inc.			Inc.
Constant	0.78***	0.78***	-15.85***	1.05***	1.06***	0.75***
	(0.14)	(0.19)	(1.45)	(0.04)	(0.04)	(0.21)
Joint significance of Position Dummies						11.11(2)**
Joint significance of University Dummies						45.83(4)***
Joint significance of Year Dummies						25.33(4)***
Joint significance of Field Dummies						42.35(4)***
F-test	23.95***			17.07***	7.51***	
Wald χ^2		182.75(19)***	225.28(19)***			167.77(19)***
No of observations	13015	13015	13015	13015	13015	13015
No of groups	2603	2603	2603	2603	2603	2603

* p<0.10, ** p<0.05, *** p<0.01; Robust standard errors and degrees of freedom are in parentheses.

Table 6: Results of the econometric estimates of the relationship between multiple sources of research funding and the amount of consulting activities by scientific field.

	Agricultural, biological and medical sciences	Social sciences	Humanities	Mathematics and Physics	Engineering and Technology
VContract	0.02	0.11***	0.02	0.01	0.05*
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)
VCompetNat	0.03**	0.07***	0.00	-0.01	-0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
VCompetInt	0.03	-0.12*	-0.08	0.08**	-0.15***
	(0.03)	(0.06)	(0.06)	(0.03)	(0.04)
Constant	1.08***	0.93***	0.93***	0.78***	1.47***
	(0.08)	(0.11)	(0.08)	(0.07)	(0.10)
F-test	2.52*	9.32***	0.82	2.19*	5.09***
No of observations	3485	2240	2150	2450	2690
No of groups	697	448	430	490	538

* p<0.10, ** p<0.05, *** p<0.01; Only panel data fixed effects estimates are reported. Robust standard errors and degrees of freedom are in parentheses.