Paper to be presented at

DRUID15, Rome, June 15-17, 2015

(Coorganized with LUISS)

Distinguishing between breadth and depth of Knowledge Transfer Activities: the predominance of Third mission motives for Italian scientists

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Abstract

The debate on the entrepreneurial university has raised questions about what motivates academics to engage with industry as well as what forms these knowledge transfer activities (KTT) can take. This paper distinguishes between the capacity to extend the number of channels for KTT and the frequency with which each channel of KTT are used by scientists in the analysis of their motivation. Whereas the literature has shown that academics are essentially motivated by the possibility to raise funds as well as access to knowledge in their KTT activities, an interesting result of this paper is that building networks appears to be essentially determined by a ?mission? type of motivation, namely the extent to which the scientist feels invested by the necessity of the university of complete its third mission. The specificities of the chosen case, namely a representative sample of Italian scientists, are discussed in light of this result.

Jelcodes:O31,O33

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Keywords: Knowledge and technology transfer activities, individual motivations, university third mission, depth and breadth of relationships

JEL codes: O31, O33, L26

1. Introduction

A central theme in industrial and technological policy discussions in recent years has been the exploitation of knowledge created at universities to spur the development of old and new sectors and therefore economic growth (for instance European Commission, 1995, 2007; OECD 2002a, 2002b). Governments at regional, national and international levels consider that the 'entrepreneurial university' has an important role to play in the economic development of their territory via knowledge transfer to the industrial sector (Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2003).

This has stimulated debates among scholars and the literature on this topic of university-industry relationship is now wide (see Perkmann et al., 2013, for a review).

This paper analyses the relationship between different forms of motivations, namely "mission" (following the entrepreneurial mission of the university), "learning" (access to wider knowledge base for research enhancement) and "funding" (obtaining financial resources), and the depth and breadth of knowledge transfer activities, measured by the combination of various formal and informal activities and the frequency of interactions.

Regarding the type of Knowledge and Technology Transfer activities (henceforth KTT), while there is consensus on the fact that the forms and types of such activities are numerous (Perkmann et al., 2013; D'Este and Patel, 2007; Siegel et al., 2007), most studies of academic motivations for KTT have been concerned with commercialisation activities, sometimes referred to as formal knowledge technology transfer (KTT) activities (patenting, licensing and spinoffs) (Rothaermel at al., 2007). However, other forms of collaborations, such as collaboration and research contracts, student placements in industry, teaching, consulting, and so on) are also important (Landry et al., 2007, 2010; D'Este and Perkmann, 2011, Perkmann et al., 2013).

In this paper, we consider KTT activities as a set of activities carried out by academic scientists in order to build networks of relationships and knowledge exchange. To our knowledge, this view as networks has not been adopted in the literature, although the complementarities between different types of KTT activities has been stressed. Hence we consider not only the variety of KTT activities, namely formal and informal, related to teaching, research and/or consultancy activities, but also the breadth and depth of the relationships each scientist develops with industry.

Regarding motivation, generally the literature finds that academic engagement is determined by individual characteristics (gender, age, seniority, academic success) and organisational and institutional characteristics (size of the department, university policy towards academic engagement). The discipline has a strong influence on the propensity to engage in industry, science and engineering disciplines being more inclined to university – industry (U-I) collaboration, but the discipline also influences the type of academic engagement preferred (Bekkers and Bodas Freitas, 2008). In addition, motivations related to the necessity to raise funds as well as to the opportunity to access to knowledge or test the application of knowledge created at university is found to be an important motivation (D'Este and Perkmann, 20011, Lam, 2011).

In this paper the analysis of motivations for KTT activities on the basis of an in-depth survey of academics in Italy. In a country where industry is characterised by the prevalence of low-tech, traditional sectors and lower firm dimensions (SMEs), the motivations for KTT as well as the forms KTT activities take may differ relative to other countries such as the UK and the USA. While pecuniary objectives ('gold' in the sense of Lam, 2011) and objectives related to the recognition of the scientist among peers ('ribbon' in the sense of Lam) are likely to be similar, the intrinsic motivations ('puzzle') may differ. Lam (2011) identifies these intrinsic motivations mainly as the satisfaction derived from solving the puzzle, doing something for its inherent pleasure and satisfaction, following the discussion by Stephan (2007).

However, another type of motivation may be added, related to the mission the scientist may feel to be invested in. The "Third Mission" of universities has been stressed in the last decades and has been strongly promoted by governments as a mean to favour territorial development and growth.

Especially in countries where innovation and high tech industries lack dynamism scientists in universities might come to be motivated by this "mission" in setting up their KTT activities.

This motivation in fact come out of the empirical analysis of this paper. Using a number of survey answers regarding different aspects of motivation, three types of motivations are identified by statistical (factor) analysis. In this way three main motivations appear for the scientists, namely "mission", "funding" and "learning", meaning respectively the willingness to pursue the university's mission in transferring knowledge to the territory and promoting its development, access to finance, and the enhancement of knowledge and research by knowledge sharing with industry.

We use an original database derived from a survey aimed at collecting information on the KTT activities of Italian scientists with industry on a representative sample of academic researchers. The sample used in this paper has 133 academics in the fields of Life Sciences, Chemistry, Mathematics and Physics, Technological Sciences and Medical Sciences.

The questionnaire included detailed questions on the type of KTT activities as well as on motivation. The period referred to is 2004 to 2008. The questionnaire also included questions on the frequency of collaboration with industry, so that we are also able to build indicators of the breadth and depth of the network relationships scientists build with industry. The breadth is defined as the number of channels or KTT activities used by the researcher, while depth is defined by the extent to which the researcher draws deeply from the different knowledge sources. We hypothesize that different motivations determine different types of network relationships, namely the depth and breadth of the scientist's collaboration with industry.

The paper is structured as follows. Section 2 provides literature review and hypotheses, while section 3 presents data and methodology. Section 4 discusses the results, while section 5 concludes.

2. Literature Review and Hypotheses

2.1. Knowledge and Technology Transfer (KTT) activities

There are different forms of interactions between academics and industry. Commercialisation of academic innovations has been a primary channel considered in the literature (D'Este and Perkmann, 2011). Commercialisation takes the form of patents, licensing and spinoff, and has a direct impact on industry. Commercialisation has been analysed in the literature using patent data (Azoulay et al., 2009; Bonaccorsi and Thoma, 2007; Hall and Ziedonis, 2001; Henderson et al. 1998; Mowery et al., 2002), citations data (Spencer, 2001), licensing (Thursby and Thursby, 2002, Dechenaux et al., 2011) or spinoff (Shane and Stuart, 2002; Rothermael et al., 2007; Larsen, 2011).

Many universities have created facilities dedicated to easing such commercialisation, including science parks, technology transfer offices and incubators. Governments have also helped this form of university-industry interaction by financing facilities and providing grants to industry-university collaborative research projects.

University – industry interactions however also include other channels, including university-industry contracts (which in turn can take the form of consultancy, academic research or joint research), and informal channels such as participation into conferences, joint supervision of Ph.D or graduate theses, students' training periods in firms, etc.

Link et al. (2007) provide one of the first systemic empirical evidence on the propensity of academics to engage in informal technology transfer. They define formal technology transfer as activity involving a formal instrument such as a patent, a license or royalty agreement. Informal technology transfer is a mechanism facilitating the flow of technological knowledge through informal communication processes, such as technical assistance, consulting and collaborative research. They consider three modes of informal technology transfer: transfer of commercial technology, joint publications with industry scientists and industrial consulting. Based on a survey of US scientists and engineers, they find that male, tenured and research-grant active academics are more likely to engage in all three forms of informal technology transfer. However, they only have dichotomous measures of informal technology transfer and are unable to relate knowledge transfer activities through time. Compared to their study, we have measures of the extent of such activities and a much richer set of data to measure informal knowledge transfer. They also find that star scientists, namely scientists with more publications and more research grants obtained in the past, are more likely to engage in informal knowledge transfer.

The literature has also stressed that there might be complementarities between the different knowledge transfer activities. Complementarities arise when "doing more of one thing increases the returns to doing more of another" (Milgrom and Roberts, 1995, p. 181). Complementarities have been found between publishing and patenting (Azoulay et al., 2009; Fabrizio and Di Minin, 2008), teaching, research and consulting (Mitchell and Rebne, 1995), commercial and non-commercial activities (Siegel et al., 2003; Link et al., 2007). Landry et al. (2010) analyse complementarities between the whole range of knowledge transfer activities, namely publishing, teaching, informal knowledge transfer, patenting, spinoff creation and consulting. Using a survey a Canadian scientists and engineers, they find that the six knowledge transfer activities are interdependent and reinforce each other, except for publishing and teaching which appear substitute.

Landry et al. (2007) consider not only commercialisation but also other forms of KTT activities. They classify the determinants of knowledge transfer into attributes of knowledge (publications, research fields, research projects that focus on users' needs, novelty of research findings), financial assets (private, government or internal funding), organisational assets (university size, research unit size, teaching requirements), relational assets (linkages with potential non-academic users), personal assets (experience) and control variables such as gender and seniority. Commercial KTT include patenting, engaging in spin-off creation and consulting services, while non commercial KTT include publications, teaching and informal knowledge transfer. They find that researchers transfer knowledge much more actively in non commercial KTT channels.

2.2. Motivation in KTT activities

Interestingly, the literature on academics' motivations to engage in knowledge transfer activities is essentially empirical, with conceptual discussions of motivations then checked empirically rather than discussions of theoretical models to be checked. One exception is Link et al. (2007) who mention the principal-agent model of Jensen et al. (2003) of the process of university disclosure and university licensing through technological transfer offices.

Specific motivations to do KTT activities should be coherent with the general motivations university scientists have in their in their job. Regarding the latter, Bruneel et al. (2010) stress that academics accept lower wages to work at universities rather than private firms or research centres and therefore are likely to be motivated by intrinsic goals and the social objectives of the university (see also Stern, 2004). According to Dasgupta and David (1994) university scientific research explicitly rejects the monopolization of new ideas and secrecy and favours knowledge disclosure, which stands in contrast to profit-maximising businesses. Indeed, in their view academics' motivations are determined by different factors. A primary motivation is the recognition in the academic community, which is a requirement for promotion and tenure. Recognition in the academic community depends on publications, especially on scientific journals with impact factor, presentations at conferences and workshops, grants and research funds from public or private organisations. Financial gains, obtained by knowledge transfer activity, is useful less for personal benefits then to secure acquisition of human and physical capital for their research, which may increase their reputation.

Bruneel et al. (2010) highlight that the university system is rooted in Mertonian norms of science that include communalism, universalism, disinterestedness and organised scepticism; the knowledge transfer activities are not in conflict with this view, as the creation of new and high quality knowledge that can be diffused to the economy and the society and contribute to the cultural, civil and economic development of the territory is to a certain extent the most important mission of the university, which academics are aware of and which determines their motivation and choices in performing their job. While Stephan (1996) suggests that scientists might be interested in earning money, Lam (2011) finds that financial rewards play a small role in motivating academics to commercialise knowledge; she classifies motivations for commercialisation in three categories: ‘gold’, meaning financial rewards, ‘ribbon’, meaning reputational and career rewards and ‘puzzle’ meaning intrinsic satisfaction in resolving the puzzle of research. According to Bammer (2008), academics participate in research collaboration for different reasons, including access to complementary expertise, access to additional equipment and resources, acquisition of prestige, visibility and recognition.

Regarding KTT activities, the main motivations considered in the literature appear to be access to financing, research enhancement as well as the intrinsic motivation related to solving the research puzzle. D’Este and Perkmann (2011) in their study of UK engineering and physical scientists consider commercialisation and research-related motivations (possibility of learning linked to knowledge exchange with industry). Lam (2011) also focuses on the UK and shows that intrinsic motivations, which she indicates as ‘puzzle’, are also important in motivating academic scientists. Besides financial rewards (‘gold’) and learning (‘ribbon’). An earlier study (Lee, 2000) found that science and engineering faculty in US research universities engage with industry mainly for reasons of financing and research enhancement.

Overall, the literature on academics’ motivations for KTT activities has mainly focused on surveys of academics carried out in Anglo-Saxon countries (in UK: D’Este and Patel, 2007; D’Este and Perkmann, 2011; Abreu and Grinevich, 2013; in the USA: Link et al., 2007; in the USA and Canada, analysis of specific knowledge transfer activities: Landry et al., 2007, 2010). One exception is Arvanitis et al. (2008), who study knowledge transfer activities in Swiss universities. While the university system in Anglo-Saxon countries has a longer tradition of links with industry, other countries in the world have stressed the importance of these links and started policies to favour them.

The specificities of U-I relationships in Italy have been highlighted in previous studies. Thus for instance Rizzo (2014) and Rizzo and Ramaciotti (2014) stress that the context, namely the characteristics of the labour market for academics and Ph.D. students, as well as the degree of innovation of the regional innovation system and the regional policies for innovation are important determinants of the propensity respectively to create spinoff and to patent. Individual characteristics are also important but relatively less than in what has been emphasised in other national contexts.

Muscio and Pozzali (2013) have shown that U-I relationships have developed in Italy despite cognitive distance between the two institutions: this barrier does not appear to have hindered the extent of U-I relationships developed but has hindered the frequency of interactions. Our analysis extends these considerations to a wide variety of KTT activities.

3. Data and methodology

The sample used in this paper was extracted from an original database developed in 2009 following the research project TRACKs financed by the Autonomous Province of Trento. The project contained a survey intended to collect information on the KTT interactions of Italian scientists with industry by administering a structured questionnaire to a representative sample of academic researchers. The questions concerned information on individual characteristics, motivations and obstacles to carry out KTT activities and a full set of detailed mechanisms through which the scientists interact with external agents.

The data refer to the 2004–2008 period. The design of the survey and the construction of the database underwent a careful preparation phase.

At the beginning of 2009, in-depth face-to-face interviews were conducted with the directors of three Knowledge and Technology Transfer Offices of three different Italian Universities. All of the informants were interviewed once and were asked about the main themes that the research group intended to include in the questionnaire. The interviews lasted for 45–60 minutes and were conducted by two people, with one researcher posing the questions and the other taking notes. The main purpose of these interviews has been to: (i) collect preliminary information on KTT activities in the Italian Higher Education System; (ii) build a classification of the different channels of KTT though which Italian academics interact with industry and (iii) provide a distinction between formal and informal channels for KTT. The results of this preliminary analysis were used to design the questionnaire.

The research group intended to administer the questionnaire to a representative sample of academic inventors working in Italian Public Universities in a selected number of fields of science (Life Sciences, Chemistry, Mathematics and Physics, Technological Sciences and Medical Sciences).[1]

For this purpose, on September 2008 a list containing the national population of academic scientists was downloaded from the institutional website of the Italian ministry of university and research (MIUR) and subsequently matched to a database containing information on the full list of Italian

1 The choice to rely on Italian academic inventors, defined broadly as those researchers affiliated to Italian universities that appear as inventors in at least one patent filed at the European Patent Office, comes from the necessity to balance to contrasting features. On the one hand, we wanted to have a sample as much representative as possible of the overall population of Italian academics. On the other hand, we wished to maximize the changes of surveying academics with an active portfolio of knowledge and technology transfer activities.

academic inventors, namely CESPRI-PATSTAT.[2] The resulting population included 31332 academic scientists.

Next, a subset of 380 target academics was extracted. This subset was stratified according to the official categorization of the field of science provided by the Italian Ministry of University and Education3 (Life Sciences, Chemistry, Mathematics and Physics, Technological Sciences and Medical Sciences) and academic position (assistant professor, associate professor and full professor). Between March and June 2009, the academics were contacted and asked to fill the online questionnaire described earlier, and 189 did so (response rate: 49.74%). In this study we used records for which we were able to collect full information on the variables of interest. Therefore, the sample used in this paper includes 133 academics.

Table 1 provides the distribution of academics contained in our sample for a full set of different typologies of interaction with industry for different fields of science. Interestingly, Table 1 shows that contractual-based and informal means of knowledge and technology transfer (e.g. use of non-academic literature, research contracts, secondments to industry, etc.) are a frequent KTT activity among university academics analyzed in this paper. Indeed, as Table 1 shows, these arrangements are more frequently used than more formal (and widely studied) KTT channels, such as licenses and spin-offs. It is also interesting to note that there are significant differences by scientific discipline: scientists in engineering-related fields have a much higher propensity to engage in the full set of activities – e.g. above 70% of scientists in Engineering engage in academic consulting or contract research over the five-year period analyzed, compared to less than 60% for the cases of scientists who belong to the others scientific disciplines analyzed.

Table 2 provides the correlation matrix of the different channels through which academic scientists in our sample interact with industry. Quite interestingly, the correlation among different channels is reasonably low meaning that the extent of overlap among different typologies of involvement with industry is negligible.

[Insert Table 1 and 2 about here]

Econometric model

Dependent Variable and Methods

As discussed in the Introduction, we are interested in examining the relationship between the motivations to carry out KTT activity and the different forms through which this interaction can be realized (KTT breadth) as well as the intensity with which KTT activity is carried out (KTT depth).

2 As the year of reference for CESPRI-PATSTAT is 2004, the list was updated using information from the MIUR website (affiliation, position, if retired or moved abroad, change of scientific field).

3 This classification closely resembles the UNESCO international standard nomenclature for fields of science and technology (UNESCO, 1974).

To collect data for the construction of our dependent variables, we use information coming from a set of questions contained in our questionnaire and focusing on a large set of KTT mechanisms. The respondents to our questionnaire were asked to rate the frequency of interaction with industry through a number of different mechanisms during the period 2004-2008.[4] The two main dependent variables are then created following Laursen and Salter (2006) in their construction of knowledge breadth and depth variables.

On the one side, KTT breadth is constructed as a combination of the 13 mechanisms listed in footnote 7. As a starting point, each of the 13 mechanisms are coded as a binary variable, 0 being no use and 1 being use of the given mechanism. Subsequently, the 13 mechanisms are simply added up so that each scientist gets a 0 when no mechanisms are used, while the scientist gets the value of 13, when all mechanisms are used. Although our variable is a relatively simple construct, it has a reasonable degree of internal consistency (Cronbach's alpha coefficient = 0.73).

On the other side, KTT depth is defined as the extent to which scientists draw intensively from different mechanisms for knowledge and technology transfer activity. Accordingly, this is constructed using the same 13 mechanisms as those used in constructing KTT breadth. In this case each of the 13 mechanisms are coded with 1 when the scientist in question reports that he/she uses the mechanism to a high degree (i.e. 3 or more times in the period 2004-2008) and in the case of no, low (1 time), or medium (2 times) use of the given mechanism. As in the former case, the 13 mechanisms are subsequently added up, so that each scientist gets a score of 0 when no mechanisms are frequently used, while the scientist gets the value of 13 when all KTT mechanisms are used to a high degree (Cronbach's alpha coefficient = 0.6).

The two dependent variables are of a count type. Accordingly, we implement count models to take this into consideration. The two models that are estimated can be written as:

$$KTTBreadth_i = \alpha_1 + \beta_1 Mission_i + \beta_2 Learning_i + \beta_3 Funding_i + \delta_s^T Z_i + \varepsilon_{1,i}$$

$$KTTDepth_i = \alpha_2 + \beta_4 Mission_i + \beta_5 Learning_i + \beta_6 Funding_i + \delta_r^T Z_i + \varepsilon_{2,i}$$

where $KTTBreadth_i$ and $KTTDepth_i$ indicate the two variables just described. Mission, Learning and Funding are the key explanatory variables; Z_i is a vector of scientist-specific control variables; and $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ are the error terms. Our preferred specification if a Poisson specification estimated via quasi-maximum likelihood as, contrary to negative binomial models, it has been shown to provide consistent estimates of the coefficients of interest even when the underlying distribution of the

4 The different means of interactions were: consulting contracts, research contracts; joint research projects; patent licenses; patents co-invented with industry; participation in the creation of spin-offs; supervision of post-doctoral students carrying out research activity in private companies; use of technical infrastructure from industry; teaching activity carried out in companies; use of non-academic literature in own research; co-supervision of post-graduate theses with industry and other more informal activities of knowledge transfer (such as phone calls made with industry practitioners to solve specific research problems, etc.).

dependent variable is not Poisson (Gourieroux, et al., 1984). Further robustness checks have been implemented and refer to two separate issues. First, we controlled whether the estimated coefficients are biased due to a problem of overdispersion (conditional expected value of KTT breadth and depth are relatively far away from its conditional variance). To control for that, we run negative binomial regression. Second, to account for the relative high number of zeros characterizing KTT depth, we estimate a zero inflated Poisson model (Cameron & Trivedi, 1998).[5]

Independent and control variables

Our three main independent variables refer to academics' motivations for engaging with industry: (i) acquisition of new knowledge for future research (Learning); (ii) broadening of University mission (Mission) and (iii) funding new research activity (Funding). The three variables were built from responses to the following question contained in the survey: "Please rank the following motivations to engage with industry according to their level of importance". Respondents were asked to rank the importance of each item on a four-point Likert scale, ranging from "not important" to "highly important". We run factor analysis on the 16 different items contained in this question in order to synthesize the information in underlying common factors driving decisions to carry out KTT activities.[6] The three resulting predicted factors are used as main explanatory variables in the econometric model outlined above. Results of the factor analysis are presented in Table 3. Note that different methods of factor extraction – principal components, iterated principal factors and maximum likelihood – yield consistent results. Previous literature assists the interpretation of these three constructs (D'Este & Perkmann, 2011; Lam, 2011). The first factor includes items that involve learning opportunities in the engagement with industry. Accordingly, this is labeled Learning. The second group, Mission, contains a range of items that relate to the overall perceived usefulness of research for society at large. It is worth stressing how this motivation has not been detected in previous empirical works and it therefore constitutes a novel contribution to the extant literature in itself. The third groups relates to funding possibilities coming from the interaction with industry. The corresponding group is labeled Funding.

The other explanatory variables, which act mainly as controls, are Age which controls for age effects on the frequency of engagement with industry; Gender is a dummy variable taking value 1 whether scientist i is a male and 0 if she is a woman. We also control for the amount of research

5 All different specifications provide similar results to the ones presented below. They are available from the authors upon request.

6 The 16 items relating to motivation for the involvement in interactions with industry contained in the question were: 1) obtaining public research funding; 2) obtaining additional resources for basic research; 3) obtaining further resources for the research team; 4) access to complementary competences; 5) strong predisposition to research; 6) exchange of ideas and experiences with industrial researchers; 7) on-site experience for institute staff and/or students; 8) gaining additional research insights in own area of research; 9)gaining experience on practical problems; 10) opportunity to test own research findings in practice; 11) securing good job prospects for students and/or institute staff in the business sector; 12) extending university mission; 13) promoting the diffusion of a particular technology; 14) diffusing key research findings amongst the public; 15) promoting local development; 16) improving the reputation of science.

funding the academic scientist is able to attract, as previous literature showed that this can be an important determinant of the intensity of engagement with industry at the scientist level (Gulbrandsen & Smeby, 2005; Landry et al., 2010). Public Funding is equal to the share of public funding for research obtained over the total amount of funding the same scientific field during the 2004-2008 period.[7] Variable Research Quality controls for the quality of scientific production of scientist i, as more productive scientists are more attractive for firms willing to collaborate with industry and, thus, are more likely to present a higher degree of interaction with industry. To build the variable, we make use of the Journal Citation Reports, published yearly by the Institute for Scientific Information. ISI ranks journals by impact factor (JIF) in different scientific fields. We weight each article published by the academics in our sample by the corresponding journal's impact factor, sum these weights for all the published output in the period 2004-2008 and divide by the publication count in the given period. The resulting variable is taken to be a measure of quality for the average article published by one of our scientists in the given period (Azoulay et al., 2009).

To capture the role played by star scientists in the KTT process we use a dummy (Star) that equals 1 in case the scientist is in the top quartile (i.e. top 25%) of the distribution of Research Quality.

We control also for environment, status and field in which the scientist operates. In particular: we control for geographical location of the University the scientist is affiliated with (Geographical);[8] To control for a status effect, we include a number of dummy variables relating to the academic position of the scientists contained in our sample (Status); finally, we control for the specific effects of the scientific field using a series of field-specific dummies (Scientific Fields).[9] We also include a complete set of cohort dummies (Cohort) to control for effects stemming from different individuals that were born in different periods in time.

We also included in the analysis the quadratic terms of Learning, Mission and Funding, in order to test if their effect on KTT breadth and depth is linear or not and the interaction among the three motivations, in order to verify if there are some substitution effects among the motivations or, on the contrary, they are reciprocally reinforcing.

Finally, in line with the arguments put forward in the theoretical section, we included some interaction effects in order to test the moderating effect of scientific productivity and academic position on the relationship between motivations and KTT breadth and depth.

7 Public research funding refers to the funding obtained under the public Italian competitive program "Research Projects of National Interest (PRIN)" and financed by the Italian Ministry for University and Research (MIUR). During the period of reference PRIN was one of the most important sources of funding for public research.

8 Geographical areas refer to the following categories: (i) North; (ii) Center and (iii) South and islands.

9 Following the classification provided by the Italian Ministry of University and Research, we considered the following scientific fields: Life Sciences, Chemistry, Mathematics and Physics, Technological Sciences and Medical Sciences.

In Table 4 we provide descriptive statistics of the variables used in this study while Table 5 reports the correlation matrix for the covariates. In general, the correlation across the independent variables is low, thus suggesting the absence of any relevant problems of multicollinearity.

[Insert Table 3, 4 and 5 about here]

4. Results

We estimated five different regression models; results are reported in Tables from 6 to 9.

All the models are estimated twice, having both KTTBreadth and KTTDepth as dependent variable. The first model is the basic one, including the academic motivations and all the control variables; the second model adds to such variables the quadratic terms of academic motivations; the results of the estimation of these models are presented in Table 6[10]. The third model adds to the baseline model the interactions between the three motivations among them (the product of each motivation for one of the two others and the product of the three motivations) but excludes the control dummy variables for status, geographic, scientific fields and cohort; the results are presented in Table 7. The fourth model adds to the baseline model the quadratic terms of academic motivations and the interactions between the academic motivations and the variable indicating the scientific productivity (Star), excluding the control dummy variables; the results are presented in Table 8. The fifth model adds to the baseline model the quadratic terms of academic motivations and the interactions between the academic motivations and the variables indicating the academic position (Full Professor and Academic Professor), excluding all the control variables[11]; the results are shown in Table 9.

We report now the significant results of our estimations, where we consider significant the coefficients above the 90% level.

All the academic motivations always have a positive sign, but Mission is significant in all but one (model 4.2 for KTTDepth) of the estimated models, Funding is significant in many cases (Models 1 and 2 both for KTTBreadth and KTTDepth; model 3 for KTTBreadth; model 4.2 for KTTBreadth and all models 4 for KTTDepth; model 5.2 and 5.3 for KTTDepth) and Learning is significant only in a few cases (Models 1, 2, 4.1, 4.2 and 5.3, always for KTTDepth only).

10 In the tables the models are identified with a number (1 for model 1, 2 for model 2, etc.) and a letter: a when KTT Breadth is the dependent variable, b when KTT Depth is the dependent variable.

11 The interactions between the academic motivations and the variable Star are not included together in the same estimation, but three different regressions are estimated, each of them including the interaction between one motivation with Star. Therefore we may say that the fourth model is, more precisely, a group of three models (in the tables we identify them as 4.1, 4.2 and 4.3). The same holds for the interactions between academic motivations and the variables indicating the academic status: even in this case we may say that the fifth model is more precisely a group of models (in the tables we identify them as 5.1, 5.2 and 5.3).

Let us consider now the quadratic term of academic motivations and their interaction terms. The quadratic term of Mission is always negative; it is significant for KTTBreadth in almost all models, (it is not significant for models 4.2 and 4.3) and never significant for KTTDepth; this indicates a decreasing effect of the Mission motivation on the variety of forms of KTT activities. The quadratic term of Funding is always negative and significant in all models but one (model 4.3 for KTTDepth), indicating a decreasing effect of the Funding motivation on the variety of forms of KTT activities and on the intensity of involvement in KTT activities. The quadratic term of Learning is always positive but never significant.

Model 3 includes the interaction among the motivation variables: only the interaction between Mission and Funding has a significant coefficient for KTTDepth; as the sign is positive, we may conclude that the greater is the Funding motivation, the larger is the effect of the Mission motivation on the intensity of involvement in KTT activities (and vice versa: when Mission motivation is stronger, the effect of Funding motivation on KTTDepth is larger).

Among the control variables, Gender has a positive and significant effect on KTTBreadth and on KTTDepth (only in Model 3 for KTTDepth the coefficient is not significant), meaning that males are involved in more intense and diversified KTT activities. The variety of KTT activities decreases with the age (younger professors are involved in more diversified KTT activities), as the negative and significant effect of Age on KTTBreadth in all the models implies, while the effect on KTTDepth is never significant. Cohort 1961-1970 results to have less KTTBreadth if compared with cohort 1930-1940.

As regards geographic localization, the dummy variable for Centre has a positive and significant effect on KTTBreadth , meaning that teachers in the Centre of Italy are ceteris paribus involved in more varied KTT activities than teachers located in the South and Islands. The dummy variable for North has also a positive sign, but it is not significant. Both variables for Centre and North are positive also for KTTDepth, but not significantly.

Among scientific sectors, engineering shows an higher breadth and depth of KKT activities if compared with biological sciences, while the other sectors do not significantly differ from the benchmark category.

Public Funding has a positive and significant effect both on KTTBreadth and KTTDepth (only in model 5 for KTT Depth the coefficient is not significant), meaning that those professors who obtain an higher percentage of public funds are also more involved in KTT activities.

Research Quality and the academic status have no significant direct effect on KTTBreadth and KTTDepth. Nevertheless, these variables have some significant effect on KTTBreadth and KTTDepth if we consider their interaction with the academic motivation for technology transfer. In fact the interaction between Funding and Star is negative and significant for KTTDepth; this result means that the effect of Funding motivation on the intensity of involvement with industry is weaker for star-scientists. The interactions between Mission and the dummy variables for academic status (Full Professor and Associate Professor) are negative and significant both for KTTBreadth and KTTDepth); these results mean that the effect of Mission motivation on the intensity and variety of involvement with industry is weaker for professors at the top of the academic career than at its beginning; the interaction between Learning and the variables for academic status are negative and significant for KTTDepth, meaning that the effect of Mission motivation on the intensity of technology transfer activity is greater for professors at the beginning at their career.

<u>Synthesis of results</u>

Expanding the mission of the university unequivocally appears as a motivation to increase, in terms of variety and intensity, the involvement in KTT activities. The possibility to raise funds is another important motivation, as it results from many of our estimations; the effect of this motivations is not linear, as it pushes the involvement in KTT activities at a decreasing rate. The possibility to expand their own knowledge has, on the contrary, a statistically uncertain (even though always positive in our sample) effect on the professors involvement in KTT activities. These motivations are not alternative, on the contrary they are reciprocally reinforcing: this result is statistically significant for mission and funding motivations.. The analysis lets to sketch a portrait of the scientist more involved in KTT activities: he is an engineer, male, young and able to obtain many public funds with research projects; ceteris paribus, scientists in central regions of Italy are more involved in more diversified KTT activities. There is no significant relationship between the academic level and the quality of publications on one side and the involvement in KTT activities on the other side, but for professors at the beginning of their career the importance of mission and learning motivation (their effect on involvement in KTT activities) is larger than for their colleagues with an higher academic status; besides, for better (in terms of publications quality) scientists the importance of funding motivation is smaller than for their colleagues.

5. Conclusion

This paper has analysed Italian scientists' motivation for KTT activities, based on a survey of a representative sample of Italian academics asking about the type, number and frequency of KTT as well as different questions regarding the motivations for these activities.

Three broad categories of motivations have emerged from a factor analysis on the variables derived from the survey answers: 'funding' (search for additional funding for research) and 'learning' (in the sense of the possibility to access complementary knowledge and competencies) as has been found in other studies of this kind, but also a type of motivation that appears specific to Italian scientists which is called ‘mission’. The latter regards the willingness of extending the university third mission, namely knowledge transfer to industry to promote industrial and economic development. Therefore in contrast to other studies such as Lam (2011) who stresses the ‘puzzle’, namely the satisfaction in resolving research issues and extending knowledge in the discipline, Italian academics appear to be particularly motivated by their possibility to actively contribute to economic growth via technological transfer.

In a country resulting as a ‘moderate innovator’ (European Innovation Scoreboard, 2014), with different industrial structural problems, and where governments, at both national and regional levels, have stressed the importance of U-I relationships and technology transfer to help industry upgrading and development, scientists appear to be particularly invested by this Third Mission motive.

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Table 1. Proportion of active researchers who engage in different knowledge and technology transfer activities over the period 2004-2008, by field of science (%):

	Life Sciences n=22	Chemistry n=54	Mathematics and Physics n=6	Technological Sciences n=39	Medical Sciences n=12
Joint supervision of PGs	36.36	48.15	33.33	74.36	33.33
Secondments to industry	54.55	64.81	66.67	71.79	66.67
Informal activities	95.45	96.30	100.00	100.00	91.67
Use of non-academic literature	81.82	96.30	83.33	79.49	83.33
External teaching	31.82	38.89	50.00	58.97	16.67
Use of Technical Infrastructure	40.91	35.19	33.33	71.79	25.00
Post-doctoral students	31.82	42.59	33.33	61.54	25.00
Spin-offs	31.82	7.41	16.67	28.21	8.33
Patents	100	100	100	100	100
Licensing	13.64	38.89	16.67	20.51	16.67
Joint research projects	31.82	38.89	50.00	66.67	33.33
Research contracts	40.91	61.11	83.33	87.18	58.33
Consulting contracts	31.82	38.89	83.33	76.92	50.00

Table 2: Correlation coefficients for different knowledge and technology transfer activities over the period 2004-2008

		1	2	3	4	5	6	7	8	9	10	11
1	Consulting contracts	1										
2	Research contracts	0.27	1									
3	Joint research projects	0.31	0.24	1								
4	Licensing	0.06	0.17	0.07	1							
5	Spin-off	0.10	0.17	0.35	0.07	1						
6	Post-doctoral students	0.16	0.16	0.33	0.15	0.29	1					
7	Use of Technical Infrastructure	0.16	0.31	0.36	0.14	0.31	0.39	1				
8	External teaching	0.39	0.22	0.28	0.18	0.08	0.19	0.35	1			
9	Use of non-academic literature	-0.05	-0.13	0.04	-0.03	0.06	0.07	0.13	0.10	1		
10	Informal activities	0.18	0.15	0.16	0.11	0.08	0.07	0.07	0.15	-0.07	1	
11	Secondments to industry	0.25	0.11	0.19	0.18	0.05	0.11	0.19	0.33	0.20	0.24	1
12	Joint supervision of PGs	0.25	0.33	0.34	0.23	0.26	0.38	0.31	0.39	0.13	0.18	0.34

Beyond 0.17 the correlation coefficients are significant at standard levels (5%).

Table 3: Factor Analysis

		Iterated Principal Factors			Maximum Likelihood			Principal Components		
		Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Learning	Access to complementary competences	**0.6539**	0.0027	0.1313	**0.6488**	0.0006	0.1474	**0.6206**	0.02	0.1266
	Strong predisposition to research	**0.4219**	0.2256	0.0118	**0.4086**	0.2253	0.0583	**0.4466**	0.237	-0.0289
	Exchange of ideas and experiences	**0.5257**	0.1167	0.1014	**0.5389**	0.1226	0.1017	**0.5451**	0.0942	0.1159
	On-site experience for staff and/or students	**0.7045**	0.2179	0.0738	**0.6961**	0.2151	0.091	**0.6881**	0.2129	0.0902
	Additional research insights	**0.5732**	0.1997	0.0799	**0.5794**	0.2057	0.0536	**0.5674**	0.1909	0.1007
	Experience on practical problems	**0.4358**	0.4035	0.0179	**0.4276**	0.4043	0.031	**0.4432**	0.3868	0.0447
	Testing own research findings in practice	**0.4014**	0.3676	0.0888	**0.401**	0.3637	0.0605	**0.4089**	0.3683	0.0961
	Job prospects for students/staff	**0.4959**	0.2822	0.151	**0.5082**	0.2937	0.0787	**0.4927**	0.2599	0.1972
Mission	Extending university mission	0.1625	**0.5394**	0.2188	0.1701	**0.5482**	0.1815	0.1627	**0.5106**	0.2673
	Diffusion of a particular technology	0.2021	**0.4963**	0.0859	0.2224	**0.4751**	0.0611	0.1843	**0.5486**	0.0775
	Diffusing key research findings	0.2435	**0.5411**	0.144	0.2403	**0.5177**	0.1764	0.2369	**0.5784**	0.1244
	Promoting local development	0.1487	**0.5285**	0.1101	0.1493	**0.5646**	0.071	0.1441	**0.5179**	0.1764
	Improving the reputation of science	0.0946	**0.6956**	0.1281	0.0803	**0.7009**	0.1635	0.1173	**0.646**	0.1529
Funding	Funding of public research	0.1059	0.2073	**0.2813**	0.1233	0.199	**0.2545**	0.0931	0.1918	**0.3386**
	Additional resources for basic research	-0.0016	0.0975	**0.8331**	-0.0153	0.0776	**0.9969**	0.0205	0.105	**0.6572**
	Further resources for the research team	0.2081	0.1849	**0.6134**	0.2136	0.208	**0.519**	0.2014	0.1566	**0.6291**
	Cumulative % of variance explained	0.4352	0.5635	0.6657	0.2078	0.3813	0.5272	0.2967	0.3988	0.482

Rotation method: Varimax with Kaiser normalization
Note: loading in bold indicate to which factor the item was assigned

Table 4: Descriptive Statistics (n=133)

Variable	Mean	Median	Std.Dev.	Min	Max
Dependent Variables					
KTT Breadth	7.421	8	2.783	2	13
KTT Depth	1.098	1	1.397	0	6
Independent Variables					
Learning	0	-0.120	1.180	-3.094	2.738
Mission	0	0.114	1.153	-3.880	2.434
Funding	0	0.162	1.021	-2.283	1.544
Control Variables					
Gender	0.827	1	0.380	0	1
Age	57.526	58	8.561	40	78
Research Quality	2.503	2.58	1.325	0	6.94
Public Funding	0.020	0	0.058	0	0.368
Assistant Prof.	0.060	0	0.239	0	1
Associate Prof.	0.308	0	0.464	0	1
Full Prof.	0.632	1	0.484	0	1
South	0.180	0	0.386	0	1
North	0.602	1	0.491	0	1
Center	0.218	0	0.414	0	1
Biological Sciences	0.165	0	0.373	0	1
Chemical Sciences	0.406	0	0.493	0	1
Mathematics & Physics	0.045	0	0.208	0	1
Engineering	0.293	0	0.457	0	1
Medical Sciences	0.090	0	0.288	0	1
1941-1950 Cohort	0.361	0	0.482	0	1
1951-1960 Cohort	0.353	0	0.480	0	1
1961-1970 Cohort	0.143	0	0.351	0	1

Table 5: Correlation Matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Learning																				
2	Mission	-0.15																			
3	Funding	-0.03	0.02																		
4	Gender	-0.02	-0.07	-0.15																	
5	Age	0.07	-0.11	0.00	0.36																
6	Research Quality	-0.02	-0.03	0.15	-0.27	-0.05															
7	Public Funding	0.12	0.03	0.01	0.08	0.21	0.01														
8	Assistant Prof.	0.13	-0.02	-0.14	-0.22	-0.29	-0.07	-0.09													
9	Associate Prof.	-0.14	0.08	0.07	-0.30	-0.37	0.16	-0.15	-0.17												
10	Full Prof.	0.07	-0.07	0.01	0.39	0.49	-0.12	0.18	-0.33	-0.87											
11	South	0.02	0.07	0.21	-0.04	-0.08	0.09	-0.09	-0.12	-0.02	0.07										
12	North	-0.13	0.03	-0.23	0.16	0.00	-0.16	-0.12	0.21	0.01	-0.11	-0.58									
13	Center	0.14	-0.10	0.08	-0.14	0.08	0.10	0.23	-0.13	0.00	0.06	-0.25	-0.65								
14	Biological Sciences	-0.08	-0.04	-0.05	-0.01	0.06	0.23	-0.02	-0.03	0.05	-0.04	-0.05	-0.01	0.06							
15	Chemical Sciences	-0.03	0.05	0.14	-0.19	0.00	0.27	0.19	-0.08	0.14	-0.10	-0.03	-0.02	0.05	-0.37						
16	Mathematics & Physics	0.02	-0.15	-0.05	0.10	0.00	-0.01	-0.08	-0.06	0.01	0.02	0.09	-0.05	-0.03	-0.10	-0.18					
17	Engineering	0.08	0.12	-0.17	0.25	-0.11	-0.59	-0.09	0.11	-0.18	0.12	-0.09	0.15	-0.10	-0.29	-0.53	-0.14				
18	Medical Sciences	0.02	-0.11	0.14	-0.13	0.10	0.19	-0.10	0.03	-0.04	0.02	0.19	-0.17	0.02	-0.14	-0.26	-0.07	-0.20			
19	1941-1950 Cohort	0.12	-0.06	0.07	0.22	0.41	-0.12	0.06	-0.12	-0.26	0.31	0.01	0.00	-0.02	0.00	-0.08	-0.01	0.07	0.04		
20	1951-1960 Cohort	-0.13	0.05	-0.07	-0.20	-0.41	0.13	-0.17	0.01	0.15	-0.15	0.10	-0.11	0.03	-0.03	0.03	0.14	-0.10	0.04	-0.56	
21	1961-1970 Cohort	-0.06	0.09	0.01	-0.21	-0.62	-0.05	-0.04	0.26	0.29	-0.40	-0.02	0.11	-0.11	-0.01	-0.03	-0.09	0.16	-0.13	-0.31	-0.30

Beyond 0.1 the correlation coefficients are significant at standard levels (5%).

Table 6: Determinants of Knowledge and Technology Transfer (KTT) breadth and depth: baseline results (Models 1 and 2)

	KTT Breadth (1a)	KTT Depth (1b)	KTT Breadth (2a)	KTT Depth (2b)
Learning	0.0282	0.1796*	0.0256	0.1605*
	[0.024]	[0.093]	[0.024]	[0.094]
Mission	0.1039***	0.2868***	0.0934***	0.2908***
	[0.025]	[0.102]	[0.025]	[0.112]
Funding	0.0671**	0.2927***	0.0526*	0.2607**
	[0.029]	[0.109]	[0.032]	[0.125]
$Learning^2$			0.0134	0.0357
			[0.012]	[0.051]
$Mission^2$			-0.0211*	-0.0729
			[0.013]	[0.068]
$Funding^2$			-0.0550**	-0.2773*
			[0.027]	[0.159]
Gender	0.2918***	0.6522*	0.3077***	0.6604*
	[0.101]	[0.344]	[0.103]	[0.364]
Age	-0.0213**	-0.0144	-0.0251***	-0.0366
	[0.009]	[0.034]	[0.010]	[0.035]
Research Quality	0	0.0542	-0.0043	0.0371
	[0.023]	[0.078]	[0.025]	[0.099]
Public Funding	0.7638**	2.6633**	0.6441*	2.0984*
	[0.360]	[1.317]	[0.340]	[1.237]
Status dummies (Ref. Cat.: Assistant Prof.)				
Associate Prof.	-0.0071	0.0602	-0.0378	-0.0834
	[0.151]	[0.482]	[0.161]	[0.488]
Full Prof.	0.1127	0.429	0.076	0.2344
	[0.160]	[0.526]	[0.173]	[0.548]
Geographical dummies (Ref. Cat.: South & Islands)				
North	0.1461	0.3592	0.1472	0.3103
	[0.095]	[0.297]	[0.095]	[0.287]
Centre	0.2106**	0.4025	0.1816*	0.2134
	[0.098]	[0.301]	[0.099]	[0.315]
Scientific Field dummies (Ref. Cat.: Biological sciences)				
Chemical Sciences	0.0873	0.15	0.1123	0.2256
	[0.101]	[0.354]	[0.099]	[0.321]
Mathematics & Physics	0.2442	0.2015	0.2956	0.3765
	[0.183]	[0.745]	[0.183]	[0.692]
Engineering	0.2864***	0.8695**	0.2826**	0.8614**
	[0.110]	[0.370]	[0.111]	[0.343]
Medical Sciences	0.0518	-0.0506	0.0494	-0.0342
	[0.146]	[0.494]	[0.144]	[0.450]
Cohort dummies (Ref. Cat.: 1930-1940 cohort)				
1941-1950 Cohort	-0.1144	0.1413	-0.1678	-0.1458
	[0.101]	[0.418]	[0.109]	[0.416]
1951-1960 Cohort	-0.2514	-0.0578	-0.3142	-0.4527
	[0.182]	[0.731]	[0.196]	[0.739]
1961-1970 Cohort	-0.5152**	0.2736	-0.6450**	-0.5059

	[0.259]	[0.964]	[0.281]	[1.002]
Constant	2.8069***	-1.05	3.1764***	1.1151
	[0.686]	[2.659]	[0.760]	[2.730]
Observations	133	133	133	133
Log-likelihood	-296.5207	-172.118	-294.4954	-167.8399
Wald χ^2	104.797(18)***	69.7802(18)***	138.1441(21)***	67.5499(21)***
Mc Fadden's Pseudo R^2	0.0887	0.1716	0.0949	0.1922

Notes: Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Degrees of freedom of the Wald $\chi2$ test are reported in parenthesis.

Table 7: Determinants of Knowledge and Technology Transfer (KTT) breadth and depth: Interaction among motivations (Model 3)

	KTT Breadth (3a)	KTT Depth (3b)
Learning	0.0257	0.134
	[0.027]	[0.103]
Mission	0.1007***	0.2367**
	[0.025]	[0.107]
Funding	0.0594**	0.1738
	[0.029]	[0.114]
Learning*Mission	0.0144	0.0101
	[0.020]	[0.074]
Learning*Funding	-0.0065	0.1393
	[0.020]	[0.094]
Mission*Funding	0.0137	0.2453**
	[0.024]	[0.107]
Learning*Mission*Funding	-0.018	-0.1026
	[0.019]	[0.079]
Gender	0.3007***	0.5778
	[0.102]	[0.360]
Age	-0.0209**	-0.0275
	[0.009]	[0.037]
Research Quality	0.0008	0.0866
	[0.023]	[0.085]
Public Funding	0.7175**	2.9765**
	[0.362]	[1.323]
Constant	2.7616***	-0.2982
	[0.715]	[2.859]
Observations	133	133
Log-likelihood	-296.0032	-168.2051
Wald χ^2	111.4533(22)***	89.6722(22)***
McFadden's Pseudo R^2	0.0903	0.1904

Notes: Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Degrees of freedom of the Wald $\chi2$ test are reported in parenthesis. Cohort, scientific fields, geographical and status controls have been included but are not reported for space reasons.

Table 8: Determinants of Knowledge and Technology Transfer (KTT) breadth and depth: Moderation effect of scientific productivity (Model 4)

	KTT Breadth (4.1a)	KTT Breadth (4.2a)	KTT Breadth (4.3a)	KTT Depth (4.1b)	KTT Depth (4.2b)	KTT Depth (4.3b))
Learning	0.025	0.0246	0.0423	0.1737*	0.1708*	0.0357
	[0.023]	[0.026]	[0.032]	[0.090]	[0.096]	[0.118]
Mission	0.0915***	0.0754*	0.0978***	0.2843***	0.1212	0.3031***
	[0.024]	[0.040]	[0.028]	[0.106]	[0.185]	[0.113]
Funding	0.0705	0.0540*	0.0506	0.4950***	0.2568**	0.2505**
	[0.050]	[0.031]	[0.031]	[0.179]	[0.127]	[0.123]
$Learning^2$	0.0148	0.0139	0.0142	0.0575	0.0453	0.0094
	[0.012]	[0.012]	[0.013]	[0.049]	[0.056]	[0.060]
$Mission^2$	-0.0240*	-0.0188	-0.019	-0.1146	-0.0689	-0.0507
	[0.013]	[0.014]	[0.013]	[0.077]	[0.080]	[0.072]
$Funding^2$	-0.0476*	-0.0533**	-0.0577**	-0.2437*	-0.2803*	-0.2728
	[0.028]	[0.027]	[0.028]	[0.144]	[0.154]	[0.169]
Star*Learning			-0.0545			0.1838
			[0.045]			[0.291]
Star*Mission		0.0596			0.3192	
		[0.049]			[0.262]	
Star*Funding	-0.0833			-1.0515***		
	[0.075]			[0.405]		
Gender	0.3218***	0.3173***	0.3074***	0.9200**	0.7004*	0.6494*
	[0.108]	[0.104]	[0.102]	[0.378]	[0.372]	[0.362]
Age	-0.0247**	-0.0248**	-0.0257***	-0.0328	-0.0289	-0.0368
	[0.010]	[0.010]	[0.010]	[0.036]	[0.037]	[0.036]
Research Quality	-0.0012	-0.0069	-0.0061	0.0384	0.0052	0.0248
	[0.024]	[0.025]	[0.026]	[0.102]	[0.107]	[0.104]
Public Funding	0.6257*	0.7790**	0.6043*	1.9804	2.1216	1.7434
	[0.344]	[0.386]	[0.350]	[1.291]	[1.424]	[1.270]
Constant	3.1101***	3.1297***	3.2344***	0.4027	0.5392	1.159
	[0.760]	[0.790]	[0.752]	[2.913]	[2.850]	[2.730]
Observations	133	133	133	133	133	133

Log-likelihood	-294.00	-293.97	-294.11	-161.51	-166.98	-167.06
Wald χ^2	166.17(24)***	166.90(24)***	144.25(24)***	101.14(24)***	68.44(24)***	67.33(24)***
McFadden's Pseudo R^2	0.10	0.10	0.10	0.22	0.20	0.20

Notes: Robust standard errors are in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Degrees of freedom of the Wald $\chi2$ test are reported in parenthesis. Cohort, scientific fields, geographical and status controls have been included but are not reported for space reasons

Table 9: Determinants of Knowledge and Technology Transfer (KTT) breadth and depth: Moderation effect of status (Model 5)

	KTT Breadth (5.1a)	KTT Breadth (5.2a)	KTT Breadth (5.3a)	KTT Depth (5.1b)	KTT Depth (5.2b)	KTT Depth (5.3b)
Learning	0.0247	0.0214	0.0785	0.1498	0.1331	1.4710***
	[0.024]	[0.024]	[0.184]	[0.095]	[0.094]	[0.525]
Mission	0.0921***	0.3181***	0.0927***	0.2883***	2.1099***	0.2725**
	[0.025]	[0.098]	[0.025]	[0.111]	[0.659]	[0.111]
Funding	0.0595	0.0473	0.0511	0.5259	0.2499**	0.2222*
	[0.084]	[0.031]	[0.032]	[0.426]	[0.125]	[0.125]
$Learning^2$	0.0135	0.0125	0.0124	0.0392	0.0308	0.0224
	[0.012]	[0.012]	[0.012]	[0.052]	[0.055]	[0.057]
$Mission^2$	-0.0218*	-0.0242*	-0.0217*	-0.0675	-0.1096	-0.086
	[0.013]	[0.014]	[0.013]	[0.067]	[0.093]	[0.069]
$Funding^2$	-0.0568**	-0.0550**	-0.0559**	-0.2983*	-0.2930*	-0.2904*
	[0.029]	[0.027]	[0.027]	[0.161]	[0.160]	[0.159]
Learning*Associate Prof.			-0.0554			-1.4438***
			[0.186]			[0.558]
Learning*Full Prof.			-0.0548			-1.2777**
			[0.187]			[0.551]
Mission*Associate Prof.		-0.2153*			-1.6423**	
		[0.120]			[0.736]	
Mission*Full Prof.		-0.2431**			-1.9400***	
		[0.100]			[0.684]	
Funding*Associate Prof.	0.0106			-0.0278		
	[0.096]			[0.519]		
Funding*Full Prof.	-0.0191			-0.4198		
	[0.086]			[0.456]		
Constant	3.2607***	3.1841***	3.1655***	2.1355	0.1661	0.1005
	[0.783]	[0.745]	[0.770]	[2.907]	[2.586]	[2.700]
Observations	133	133	133	133	133	133
Log-likelihood	-294.421	-293.299	-294.448	-166.448	-163.342	-164.999
Wald χ^2	140.6584(23)***	156.5128(23)***	153.2274(23)***	69.1314(23)***	105.3054(23)***	80.554(23)***

McFadden's Pseudo R^2	0.0951	0.0986	0.0951	0.1989	0.2138	0.2059

Notes: Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Degrees of freedom of the Wald $\chi 2$ test are reported in parenthesis. All controls have been included but are not reported for space reasons.