Harvey Goldstein and Edward M. Bergman and Gunther Maier

University mission creep? Comparing EU and US faculty views of university involvement in regional economic development and commercialization.

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Regional Engagement or Knowledge Commercialization?
A Comparison of University Faculty Norms in the U.S. and Europe

Harvey Goldstein, Edward Bergman*, and Gunther Maier***

Abstract

The expansion of universities' missions to include the support of regional economic development has led to conflicts between traditional norms of open science and the norms of entrepreneurialism, as well as placing university faculty in situations of potential conflict of interest. We posit that there are important differences between *how* universities support regional economic development in terms of leading to normative and ethical conflicts. Using data from two independent samples of U.S. and European faculty, we explore and compare faculty attitudes towards regional engagement and knowledge commercialization using factor analysis. The results show that U.S. faculty make a clear distinction between the appropriateness of university regional engagement, on the one hand, and knowledge commercialization, on the other. European faculty view regional engagement and knowledge commercialization along the same spectrum in terms of appropriateness. At the same time, attitudes of faculty in the U.S. and in Europe reveal independent commitment to the norms of open science and avoidance of situations of conflicts of interest.

Keywords: universities, academic entrepreneurship, knowledge commercialization, engagement, open science, conflicts of interest

JEL Classification: O31, O32, O38, O17

** MODUL University-Vienna
* Vienna University of Economics and Business

1. Introduction

The 'entrepreneurial turn' of universities has a number of faces. Universities are now widely perceived, and expected, to be important assets and actors in helping regions become and remain competitive in the globalized, knowledge-based economy. Indeed, the well-known, traditional tripartite mission of public U.S. research universities, of teaching, research, and public service, has now become a four-part mission with the addition of economic development. While state legislatures may use a subtle set of sticks and carrots for universities to become engaged in activities to promote economic development, there is also a sense of social responsibility by university officials and research faculty to be engaged in economic development, in exchange for the privileges and benefits they receive as both organizations and as individual researchers. At the same time, almost all research universities in the US, both public and private, have been motivated to become more involved in the commercialization of knowledge in order to diversify research funding sources, to more generally improve their revenue picture and endowments, and to retain and attract entrepreneurially inclined faculty and graduate students (Goldstein, Bergman, Maier 2012).

In Europe, until quite recently, the principal mission of universities was teaching, while knowledge transfer functions and responsibility for basic science were shared between academies of science and national research institutions. Hence most universities remained quite distant from both deliberate applications of knowledge, including knowledge commercialization, and a commitment to assist in the economic development of their respective regions. A number of factors have changed that since the 1990s, including: greater autonomy and flexibility given to state-supported universities from national ministries; a more open and competitive environment among European universities for recruiting academic talent, securing external research funding,

and prestige; and increased awareness of the need for the EU to play 'catch-up' by leveraging all of its knowledge assets in order to more successfully compete in the global, knowledge-based economy.

With new missions added to universities' responsibilities, however, it should not be unexpected that there will be tensions and conflicts in how universities adapt to the additional roles in terms of resource allocations, rules and regulations, and norms of academic behavior. This should be the case in universities on both continents, though the nature of these tensions and role conflicts would be different between the U.S. and Europe because of the different histories and traditions of their respective higher education systems. Many policy officials view university engagement in assisting economic development, on the one hand, and universities' commercialization of knowledge as a continuum of highly overlapping activities. We hypothesize that these activities are quite distinct in terms of the institutional and individual norms that guide attitudes and behavior within universities, and their perceived appropriateness. Yet we also posit that these norms will differ between faculty in the U.S. and faculty in Europe, for the reasons sketched above, and hence faculty attitudes in Europe towards the appropriate role of universities will differ from faculty attitudes in the U.S.

We hypothesize that U.S. faculty are less likely than European faculty to perceive regional engagement and knowledge commercialization as two roles on the same spectrum. More specifically, we expect U.S. faculty to view knowledge commercialization as a threat to the violation of the Mertonian norms of open science (Merton 1973) and to pose greater possibility of serious conflicts of interest, but that regional engagement is not perceived as posing such threats and is nearly consensually approved. In Europe, because both of the new roles of universities' regional engagement and knowledge commercialization were added at the same

time, faculty are less likely to perceive them as different in terms of appropriateness and less likely to see either as a threat to the (arguably, less strongly embedded) norms of open science or posing serious ethical conflicts of interest.

Using web-based attitudinal surveys of university faculty in the US and in the EU countries, we explore the structure of attitudes towards these two faces of academic entrepreneurship. The results will shed light on the prospects of universities being able to act entrepreneurially and *at the same time* preserve a set of norms that are valuable, if not necessary, for universities to be able to continue their important fiduciary role given to them by society, seeking truth.

The next section provides a brief review of the relevant literature. In section three we describe the study population, data collection procedures, measures and the analytic techniques used. Section four presents the separate results of our empirical analysis and hypothesis tests for the U.S and European data. We compare and contrast the results in section 5 and in section 6 we conclude the paper with the key findings and a discussion of some of their implications for universities continuing on the entrepreneurial path after making the 'turn'.

2. Literature review

There is by now a large extant literature on academic entrepreneurship. A comprehensive literature review is found in Rothaermel, Agung and Jiang (2007). This literature spans both positive and normative dimensions of universities engaging in patenting and other forms of commercialization, including the opportunities and threats posed by the 'entrepreneurial turn' (e.g., Etzkowitz, Webster and Terra, 2000; Bok 2003), the impacts of intellectual property laws and regulations on university technology transfer activities (e.g., Mowery et al. 2001; Murray

2006; Litan, Mitchell, and Reedy 2007), the productivity and effectiveness of university technology transfer offices (Thursby and Kemp 2002; Siegel et al. 2004), and motivations for, and explanations of, entrepreneurial behaviour within the academy (e.g, Owen-Smith and Powell 2001; Stuart and Ding 2006).

There is also a fairly large literature on the emergence and growth of an entrepreneurial culture within universities, with implications for norms that govern or guide behaviour as well as institutional policies and priorities. Etzkowitz et al. (2000) have argued that the traditional norms governing or guiding behaviour within universities will (and should) change to adapt to the entrepreneurial turn. Clark (1998, 2003) and Davies (2001) use a broader concept of academic entrepreneurship and suggest the behaviour of some universities to adapt and adjust to an altered set of external demands and even to take advantage of new opportunities such as greater autonomy does not necessarily imply erosion of the hallmark of institutions of higher education as places of open and free inquiry. Yet one of the most oft-discussed potential impacts of the entrepreneurial turn is whether it has lead to an erosion of the norms of open science. Analyzing survey data of about 700 natural scientists in Japan, Shibayama (2012) concluded that the norm of making 'practical' contributions, and the norms of open science are determined independently. In other words, they are not perceived to be inherently conflictual, leaving open the possibility that academic entrepreneurship can be promoted by universities without compromising the norms of open science. Ambos et al. (2008) consider the institutional, organizational, and individual attributes that allow university researchers to reconcile the conflicting demands (and norms) of academic research and commercialization and thus behave 'ambidextrously'.

While the attitudes of faculty and other university-based researchers actively involved in knowledge commercialization have been studied (e.g., Blumenthal et al.1996; Louis et al. 2001), there have been relatively few attempts to systematically gauge the attitudes of a broad range of university faculty towards the university's 'entrepreneurial turn', whether they are actually engaged in commercialization activities or not, with the exception of Lee (1996).

Lee surveyed faculty in 115 research universities in the US from nine different disciplinary groupings in the natural sciences, engineering, and the social sciences. They were asked questions about whether they approved of changes in evaluative standards of faculty performance with respect to weighing user-oriented research and patentable inventions, and whether they were in agreement with a variety of university roles involving industry collaboration. The results of Lee's study were that: (1) a large majority of faculty respondents were in favour of changes in the criteria for evaluating faculty performance by giving weight to 'user-oriented research' and patentable inventions and this represented an increase from the 1980s; (2) a majority of respondents said they agreed with their universities actively participating in local and regional development, facilitating commercialization of university-based research, and encouraging faculty to engage in consulting for private firms; but (3) a majority did not support their universities providing start-up assistance or make equity investments in private firms. Lee's 1996 study suggests that while there is broad (and growing) acceptance of some aspects of the 'entrepreneurial turn', there are other activities or roles – that pose the greatest perceived threats to the 'core values of the research university' (Lee 1996, p. 860) – that are opposed by a significant portion of faculty members.

In part as an alternative response to some of the same pressures that have driven universities to become actively involved in knowledge commercialization, many universities in

the US have rededicated themselves to the ideal of 'public engagement'. With a long tradition rooted in the land-grant colleges and universities activity of cooperative extension, perhaps best exemplified in the 'Wisconsin idea' (Ward 1992), the engaged university represents:

> " . . . the partnership of university knowledge and resources with those of the public and private sectors to enrich scholarship, research, and creative activity; enhance curriculum, teaching, and learning; prepare educated, engaged citizens; strengthen democratic values and civic responsibility; address critical societal issues; and contribute to the public good." (CIC Committee on Engagement 2005)

Even within the domain of university-industry collaboration, there are activities that fall within the sphere of engagement rather than commercialization. These include consulting, joint research, and training, in contrast to patenting and licensing and spin-off activities (D'Este and Patel 2007).

University engagement has had a different history and focus in Europe. Recent expansions of the EU call for much greater standardization of study programs, recognition of equivalent degrees, mobility of faculty and students, and uniform practices that have benefitted the US higher education system for many decades.[i] At the same time, major changes in governance were underway, with national university systems granting greater autonomy, budgetary discretion, and a general shift from regulation- to performance-based management practices (CHEPS 2006; Estermann and Nokkala, 2009). Aghion et al. (2007, pp. 6, 7) have argued that sufficient funds should be supplied to a subset of Europe's research universities, along with greater budgetary and administrative autonomy, to leverage such funding effectively; attention to greater academic mobility and less endogamy should also be given. Aghion, et al.

(2009) argue further that the structural changes most capable of stimulating the academic output of all public European universities in the Shanghai Top 500 are autonomy (institution-level budgeting, purchasing, hiring, salary scales) and competition (research funds, faculty, students), including the administrative procedures to implement these reforms. They argue both are needed simultaneously and have their greatest effects in countries whose university systems operate close to knowledge and innovation frontiers.

The decentralization of authority and policymaking has steadily shifted oversight generally from ministerial and parliamentary to external bodies (e.g., EU-wide accreditation groups) and greater stakeholder oversight, including local governments, civil society and the economy. Europe's steady 'endogenization of universities' into the fabric of its social and economic life may be expected to increase simultaneously the number and variety of stakeholders and the demands placed upon university academics. New stakeholders expect academics to be responsive to needs that lie beyond the classic education and research functions of universities. Accordingly, so-called third-tier, third-stream or 'public service or engagement' obligations are growing in importance in the EU, such that academic units and faculties are expected to contribute to societal problem-solving by extending their missions beyond the confines of classical university concerns.

This extension of the European university's mission implies engagement in areas that were once the responsibility of other institutions. Traditional divisions of labor relegated exclusively to the university faculties their principal teaching and knowledge transfer functions, plus sharing with academies of science and national research bodies a responsibility for basic research. Most universities remained quite apart from the deliberate application of knowledge,

which was conducted within ministries and departments or by business, although individual faculties might exercise their 'professor's privilege' in transferring their specific research findings to the market. University faculties are now being drawn into all these functions at different rates and mixtures, often to permit joint and more cost-effective progress toward economic and social objectives, but also in response to commercial opportunities (Bergman 2009).

As university involvement in academic entrepreneurship has clearly increased over the last twenty years, so have the attitudes, for and against, changed. These attitudes, we suspect are more complex, because there are a number of different impacts generated by academic entrepreneurship, and whose valuations vary among actors. For example, many faculty may believe that technology-based start-ups by university staff are appropriate because they can enhance the innovativeness and hence the competitiveness of the regional economy. On the other hand, faculty may perceive that the same activities can also lead to thorny conflicts of interest or dilute the quality of more basic, scholarly research (Goldstein 2010).

3. Study Populations, Data Collection, Measures, and Analytic Techniques

The study population for the U.S. data set consists of faculty from six selected disciplines from all research universities. A random sample of 71 universities stratified by public land-grant, public non-land grant, and private, was drawn from the population of research universities in the US in the 'Very high' and 'High' research intensive categories.[ii] The resulting sample is shown in Table 1.

[Table 1 about here]

The six disciplines are biological sciences, physics, computer science, chemical engineering, economics, and history. These disciplines were selected based upon their: ubiquity among research universities, variation in the approaches to inquiry and knowledge production using the Stokes (1997) typology as adapted by Bergman (2009), and variation in the likelihood of opportunities for faculty to produce research that has potential for commercialization.[iii] Within each of the six academic departments in the 71 research universities, one tenured or tenure-track faculty member was randomly selected from each academic rank: assistant, associate, and full professor, plus the department chairperson. The web page of each department was used to provide the full listing of tenured and tenure-track faculty from which the particular faculty members were drawn for the final sample. A total of 1,611 faculty members were sent web-based questionnaires in January 2007, of which 84 were returned as undeliverable. After several follow-ups to non-respondents, we ended up with 369 usable responses for an effective response rate of 24.1 percent.

A set of fourteen attitudinal questions was included in the survey questionnaire. Faculty were asked to indicate on a five point Likert-scale if they: strongly agree (coded 5), agree (4), neither agree nor disagree (3), disagree (2), or strongly disagree (1) with each statement.

The questions are intended to either directly reveal attitudes towards at least two different faces of academic entrepreneurship – university engagement and knowledge commercialization -- or to reveal underlying beliefs that are considered to affect attitudes. The beliefs include the degree of commitment to the norms of open science, and the degree of commitment to the separation of personal financial interest from the roles of faculty members as researchers and teachers. We briefly discuss each of the fourteen questions in terms of how we interpret the

responses in relationship to the concepts of regional engagement, knowledge commercialization, norms of open science, and conflicts of interest.

Q1-RED. *My university, in addition to its basic functions of teaching and research, should be actively and directly involved in assisting state and regional economic development.* This provides a direct way to measure acceptance of the idea that universities have a larger societal obligation beyond the traditional missions of teaching and advancement of knowledge, and specifically to help improve regional economic conditions by bringing to bear knowledge and expertise. This role *does not necessarily exclude* knowledge commercialization as a means to improve regional economic development, but it is broader and implies an institutional commitment to social responsibility in return for receiving public resources.

Q2_TA. *My university should encourage and reward faculty for providing technical and/or managerial assistance to existing business organizations located in the region or state*. Providing technical or managerial assistance to existing regional businesses is a more specific means of universities assisting regional economic development, but compared to the broader role in question 1, the 'public good' dimension of this role is given up since the beneficiaries are individual businesses.

Q3_Comm. *My university should be actively involved in the commercialization of university-based academic research*. This question very directly probes the respondent's views that there is a legitimate mission of the modern research university is to pro-actively assist and encourage university researchers to commercialize their research when there is a potential market.

Q4_Startup. *My university should provide start-up assistance for technology-oriented firms that grow out of university-based research*. Providing assistance to start-ups that grew out

of university research is a direct form of knowledge commercialization and with the university *possibly* having a financial interest in helping such start-ups.

Q5_Equity. *My university should make equity investments in technology-oriented start-up businesses that grow out of university-based research.* This activity explicitly includes a university financial interest in the generation of technology-based start-up businesses as a form of knowledge commercialization. It places the university in the role of a venture capitalist typically where the university's investments are high risks.

Q6_ProprR. *My university should encourage and reward faculty to engage in user-oriented, proprietary research with industry funding.* This university policy is aimed at increasing research funding from private industry sources. Seeking new and under-exploited sources of research funding helps universities move up in the National Science Foundation rankings and to incidentally enhance their prestige. The policy described focuses on conducting *applied research*, which can be construed as a form of engagement, but it is also proprietary, which can mean restrictions on the dissemination of research results. .

Q7_Patent. *My university should reward faculty who produce a patentable invention at least the same amount of credit as a peer-reviewed article when making tenure and promotion decisions.* This is another policy aimed at giving 'weight' to a form of knowledge commercialization – patentable inventions – as part of the reward structure for faculty performance and productivity. The policy enlarges the scope of what has been understood to be scholarly achievement in most research universities, so as to create incentives for junior faculty to engage in commercialization.

Q8_PeerR. *Knowledge creation is best measured by scholarly, peer-review publications.* This statement is intended to indicate the respondents' views on one of the norms of open

science, peer review. It also identifies distinctions in views about the concept of knowledge: restricted to traditional, basic, scholarly knowledge, on the one hand, or inclusive of user-oriented knowledge.

Q9_FreeEx. *Unfettered inquiry and the free exchange of ideas is important in my work.* This statement also focuses on the degree of commitment to the central norms of open science. It counterposes any restrictions being placed on *what* is researched and on the dissemination of results.

Q10_Threat. *The increasing emphasis within many universities for commercializing university research threatens the quality of basic, scholarly research.* This expresses a perception that one of the major harms of commercialization within universities is a substitution of effort and resources from basic, 'scientific' research, to user-oriented research, and leading to a long-term loss in the production of cutting-edge scholarship.

Q11_Consult. *A full-time faculty member on average spends more than one day per week consulting.* This scenario poses a situation where the respondent may feel there is a conflict-of interest introduced between personal financial interest – expressed as spending more than the 'customary' time for consulting -- and meeting the teaching, research, service, and other obligations of a faculty member and university employee.

Q12_Delay. *It is legitimate for scholarly findings are delayed for circulation and peer review for six months in order to benefit the private industry funding source.* This statement is specifically about restrictions on dissemination of research results, and generally about the respondent's degree of commitment to the norms of open science.

Q13_SCoI. *A faculty member supervises a graduate student's dissertation research when the research is funded by a private company and the faculty member has a financial*

interest in that company. The scenario poses another possible conflict-of-interest situation, between the financial interest of the faculty member and the role of mentor and supervisor for the training of future scholars.

Q14_FCoI. *A faculty member has a research contract with a company in which the faculty member has a financial interest.* This is a variant of the scenario in Q13. Since it does not involve the role of supervising graduate students, however, it focuses just on the potential harm of the faculty member slanting, and/or restricting dissemination, of his/her own research results when there is a financial interest involved.

The faculty sample for the EU data set is drawn from all universities in the top 500 Shanghai rankings for 19 EU countries (except in Austria and Switzerland where all universities were included). Because European universities tend not be not structured with the same professorial ranks found in the U.S., the sampling procedure within the respective departments/institutes was also slightly different from that used in the U.S. Here the director of the department/institute was selected for the sample along with two additional faculty listed on the webpage. The responses to the questionnaire also allowed us to know whether the respondent had a permanent contract (equivalent to full or associate professor in U.S. universities) or a time-specified contract (equivalent to an assistant professor). Questionnaires were sent in winter of 2009. There were 1,798 valid responses representing an 18 percent response rate. Response rates did not vary significantly by discipline, by they did vary by country, from lows of 12 to 14 percent (Czech, Spain, UK) to highs of 27-30 percent (Finland, Slovenia, Italy). The number and distribution of EU faculty respondents by country is shown in Table 2.

(Table 2 about here)

The questions soliciting attitudes about university regional engagement, knowledge commercialization, the norms of open science, and the threat of conflicts of interest from academic entrepreneurship were the same as on the questionnaire administered to the U.S. faculty sample, with the exception that two of the questions were not included in the questionnaire administered to EU faculty.[iv]

Descriptive statistics for the results of both the U.S. and EU responses have been reported in Goldstein, Bergman, and Maier (2012), as have the results of estimated ordered logit models to explain the variation in attitudes towards university activities of regional engagement and knowledge commercialization. In this paper we employ and report on the application of factor analysis to explore the underlying relationships of attitudes among the different faces of academic entrepreneurship and how these attitudes are related to belief in the norms of open science and perception that academic entrepreneurship poses conflicts of interest for university faculty. Factor analyses with a varimax rotation are performed separately on the U.S and EU attitudinal variables described above. For factors with eigenvalues 1.0 or greater, we then estimate average factor scores on categories of faculty respondents by academic discipline, by ranking of university, and by regional economic condition.

4. Factor analysis of attitudes towards the multiple faces of academic entrepreneurship

To examine the relationships among attitudes towards the different dimensions of academic entrepreneurship we employ factor analysis. Factor analysis allows us to view the underlying multivariate *structure of correlations* among the variables by conveying the variation from the original set of variables into a more parsimonious set of new variables, or factors. The original variables entered in the analysis are the responses to the fourteen questions listed above

(twelve questions in the case of the EU data). We specifically are interested in what the relationship is between faculty attitudes towards university engagement, on the one hand, and knowledge commercialization on the other. But we also are able to investigate to what extent the norms of open science and perception of ethical conflicts of interest are associated with commercialization.

The questions that reveal attitudes towards university engagement are Q1_RED and Q2_TA; questions that reveal attitudes towards knowledge commercialization are Q3_Comm, Q4_Startup, Q5_Equity, Q7_Patent and Q10_Threat; questions that reveal attitudes towards the norms of open science are Q6_Propr, Q8_PeerR, Q9_FreeEx and Q12_Delay; and questions that reveal attitudes towards potential conflicts of interest are Q11_Consult, Q13_SCoI, and Q14_FCoI. Our working hypotheses are that (i) attitudes towards university engagement and knowledge commercialization are largely independent; (ii) adherence to the norms of open science will be inconsistent with positive attitudes towards knowledge commercialization; (iii) negative attitudes towards knowledge commercialization are associated with disapproval of behaviour that potentially poses conflicts of interest among roles for faculty members.

After using a varimax rotation, the factor loadings for the U.S. data are shown in Table 3 and for the EU data in Table 4 (the full correlation matrices are shown in Appendix Tables 1 and 2).[v]

(Tables 3 and 4 about here)

The results for the U.S. show there are five distinct factors that have eigenvalues above the threshold of 1.0, collectively explaining 67.1 percent of the total variation in the data. The interpretation of the factors based upon the loadings are the following:

- Factor 1, with high positive loadings on Q3_Comm, Q4_Startup, and Q5_Equity (and somewhat less on Q6_Propr) and a negative loading on Q10_Threat, establishes broad agreement concerning the appropriateness of *knowledge commercialization*.
- Factor 2, with high positive loadings on Q1_RED, Q2_TA, Q7_Patent, and (somewhat less) Q6_Propr, finds university engagement, broadly understood, to be appropriate. It combines approval of faculty who conduct user-oriented proprietary research and receive reward and credit from their university for the development of inventions (patenting) with efforts of the university to assist regional economic development and provide technical or managerial assistance to regional firms.
- Factor 3, combining Q13_SCoI and Q14FCoI, reveals disapproval of situations in which private research funding *might* have a corrupting influence on a faculty member's obligations to mentoring students and to conduct and produce 'objective' research.
- Factor 4, with high positive loadings on Q8_PeerR and Q9_FreeEx, indicates agreement with the norms of open science.
- Factor 5, loading positively on Q11_Consult and Q12_Delay, indicates the recognition that conflicts of interest may arise between, on the one hand, being a university employee and a member of a wider scholarly community, and on the other, acting legitimately as a private entrepreneur.

The results of the analysis for the EU data show three factors with eigenvalues at or above the threshold of 1.0, collectively taking into account 55.5 percent of the total variation.

- Factor 1 is interpreted as agreement of the appropriateness of *both* university regional engagement (Q1_RED and Q2_TA) *and* knowledge commercialization (Q3_Comm,

Q4_Startup, Q5_Equity, Q10_Threat) along with applied research (Q6_PropR and Q7_Patent).

- Factor 2, with positive loadings on Q11_Consult, Q12_Delay, and Q13_StdCoI, indicates attitudes about the appropriateness of situations in which there are actual or potential conflicts of interest between faculty members responsibilities to their universities and their wider scholarly communities, and their personal financial and entrepreneurial interests.
- Factor 3 is a singular factor (Q8_PeerR) that focuses on positive attitudes towards one of the norms of open science, of the importance of increasing the validity of research results by subjecting them to peer review.

Factor scores are the normalized values for the new variables (factors) for each observation.[vi] The mean factor scores for specific categories of faculty respondents are shown in Tables 5-7 (U.S. data) and Tables 8-11 (EU data). The factor scores allow us to identify which categories of respondents are likely to hold maximal approval or disapproval views on each of the respective factors.

For the U.S. faculty, there are clear and statistically significant differences in mean scores among the disciplines on all of the five factors, among categories of university rankings on factor 2 (only), and among categories of regional economic condition only on factor 3.

- Faculty in computer science are much more likely to approve of knowledge commercialization, and faculty in history are much more likely to disapprove, compared to the other disciplines;
- Differences in attitudes towards universities being involved in regional engagement, across disciplines are less significant than for other factors, in the sense it is closer to

being accepted consensually; it is interesting to point out that economists -- who potentially could contribute the most -- also disapprove of regional engagement the most, by far, among the six disciplines;

- Conflicts of interest situations are least likely, by far, to be accepted by faculty in history, while such conflicts tend to be most acceptable to faculty in engineering and to a lesser extent in physics and computer science;
- Commitment to the norms of open science is strongest in history and biology, and weakest in economics and computer science;
- Conflicts of interest between faculty as university employees and entrepreneurs (factor 5) are most acceptable to those in biology and physics, and least acceptable to faculty in economics and history.
- There are significant differences only on factor 2 (university regional engagement) across categories of university rankings
- There is no significant variation in faculty attitudes towards either knowledge commercialization or regional engagement across types of regional economic conditions;
- Attitudes towards conflict-of-interest situations involving company-funded research from companies in which the faculty member has a financial interest (factor 3) are significantly different across regional economic conditions; such situations are approved much less by faculty in universities located in low UE regions compared to other regions;
- Though the overall differences across categories are not significant, the strength of commitment to the norms of open science is highest in regions of lowest

unemployment, while acceptance of being in situations of conflicts of interest between a faculty member's obligations to his/her university and scholarly community, and his/her private entrepreneurial interest is significantly lower in regions with the lowest UE rates.

[Tables 5, 6, and 7 about here]

For EU faculty, there is significant variation in the scores for all three factors across academic disciplines and for factors 1 and 2 across university ranking categories. What is most clear, though, is the absence of variation in scores on *any* of the factors by regional economic condition. Specifically,

- Faculty in engineering and computer science, predictably, have the highest approval for knowledge commercialization with regional engagement (factor 1) while faculty in history have the lowest;
- Faculty in engineering and economics have the highest acceptance of being in situations of conflicts of interest involving academic entrepreneurship (factor 2) while faculty from history have the lowest;
- Faculty from chemical engineering and biology have the greatest commitment to the norm of peer review as a dimension of open science (factor 3) while faculty from history have the lowest; at first the result for historians might seem counterintuitive, but it is consistent with a tradition of many European historians not regarding their discipline as a scientific one, and hence the importance of peer review is not as embedded in disciplinary practice.
- The higher the university ranking, the less approving are faculty of knowledge commercialization/regional engagement;

- The higher the university ranking, the lower the approval of situations of conflict of interest.

[Tables 8, 9, and 10 about here]

5. Comparing U.S. and EU Results

The results show a number of expected similarities in the structure of attitudes towards academic entrepreneurship, but also some rather important differences. First, and perhaps most salient of all, the appropriateness of knowledge commercialization and regional engagement are viewed as distinctly different by U.S. respondents, but EU faculty do not differentiate these activities in terms of their approval (or not). Rather, EU faculty view them as activities on the same spectrum, with a certain amount of blending. This differentiation between the U.S. and EU respondents is understandable from the point of view that in the U.S. there has been a history and tradition of university engagement in regional development that easily predates knowledge commercialization, whereas in the EU these two activities were adopted at about the same time and for many of the same reasons.

Second, attitudes towards situations that pose potential conflict-of-interest and the violation of norms of open science are differentiated from attitudes towards knowledge commercialization in both U.S. and EU results. The implication here is that faculty can simultaneously have both positive attitudes towards knowledge commercialization *and* regard situations that can potentially occur with commercialization as inappropriate as well as maintain commitment to the norms of open science. We interpret this as a feeling that, "Yes these (bad) things (from knowledge commercialization) could potentially happen, but I (or my colleagues) would not allow those to occur."

There are differences here, however, between the U.S. and EU results. For EU respondents, concerns with potential conflicts-of-interest are resolved in one factor. For U.S. respondents, however, attitudes towards conflict-of-interest are more subtly differentiated: one factor is focused focus on the potential threat of research results and student advising being tainted (corrupted) by a faculty member having financial ties to private research sources, while another involves the potential conflict between acting entrepreneurially and obligations to one's employer and to one's community of scholars.

Third, the 'scores' on all of the factors vary significantly across academic discipline, in both the U.S. and EU cases. Generally speaking, faculty for both the U.S. and the EU in the Pasteur disciplines – computer science and engineering – were more approving of knowledge commercialization, while faculty in the humanities (history) were the least approving. Whether that stemmed from ideology or from less opportunity personally to engage in commercialization cannot be discerned from the results.

Fourth, regional economic conditions do not matter much in accounting for variations in attitudes towards academic entrepreneurship on either side of the ocean. We would expect, other things equal, that faculty in universities located in regions with greater levels of economic distress would be more inclined to especially accept university regional engagement, but also knowledge commercialization along with greater tolerance for situations posing conflicts-of-interest and violations of the norms of open science. But only in the U.S. on factor 3 – conflict of interest situations involving receiving research funding from a company in which the faculty member had a personal financial interest – are there significant differences among types of regions by economic well-being.

Fifth, in setting out to compare faculty attitudes in the U.S. with those in EU research universities, we have implicitly treated the EU as relatively homogeneous in terms of national systems of higher education, Yet we are aware that within the EU bloc there are important differences in the historical and institutional roles of universities across countries, Accordingly, we have examined whether factor scores on the three significant factors vary among different groups of relatively homogeneous countries of the EU.

Using four macro-regions (Nordic countries, countries bordering the Mediterranean, the ten countries of the former Communist bloc (the EU-10), and the remaining EU 'core') analysis of variance tests show significance differences in the mean factor scores among the four macro-regions on all three factors (see Table 11). Faculty in universities located in the countries bordering the Mediterranean and to a lesser extent the former Communist bloc countries were more approving of knowledge commercialization *cum* engagement and less concerned by potential conflicts of interest involving commercialization compared to faculty in the Nordic countries or in the EU core. This pattern correlates with the widely acknowledged North-South and West-East divides in terms of socioeconomic development within Europe and suggests that the imperatives of 'catch-up' at the national level outweigh traditional views of the priorities among university missions. That faculty in the Nordic and Mediterranean countries have significantly stronger agreement with the importance of peer review as a norm of open science, compared to faculty in the EU-10 (the EU core mean is close to zero), suggests to us that the degree of adherence to the norms of open science may be more related to variation in recent national investments and upgrading of the quality of research universities than to the overall level of national economic development. This is only speculative, however, and deserves further empirical investigation[vii]. As we had suspected, an analysis of variance test for differences in

the factor scores across the four Census regions of the U.S. showed no significant differences on any of the five factors, indicating a high degree of national integration of systems of higher education within the U.S., despite that a majority of universities are funded and regulated by the individual 50 states.

[Table 11 about here]

6. So What (Does it Mean)?

We have analyzed the relationships among attitudes towards multiple dimensions of academic entrepreneurship held by faculty in US and European universities. Both knowledge commercialization and 'engagement are 'on the rise'; they each represent ways that universities can demonstrate their responsiveness to external demands, as well as ways that the institutions can enhance their revenue (in the case of commercialization) and their attractiveness to entrepreneurially-minded faculty and graduate students who seek non-academic outlets for their scholarly and professional work. But still there are important differences. While university engagement has a long and generally noble tradition in the U.S., going back to the Morrill Act of 1865 that initiated the establishment of land-grant universities, knowledge commercialization is relatively new and poses (to many) a putative threat to the widely-held norms of open science and involves situations rife with conflicts of interest. In EU universities, regional engagement has not been a traditional activity of universities, and this helps to explain why faculty respondents do not separate or make a clear distinction between engagement and commercialization.

Somewhat surprising to us is that the attitude towards university engagement appears *not* to be motivated primarily as commitment to work for the common or public good, but rather to engage for engagement's sake, to extend the beneficiaries of their knowledge transmission and

expertise beyond the ivory tower. In the case of the U.S., the evidence for this comes from the high loading of favourable attitudes towards conducting user-oriented, proprietary research and with patenting on factor 2, the regional engagement factor. In the EU case, it is the combining of regional engagement with commercialization along with patenting.

The results shed some new light on *why* faculty may approve or disapprove of different dimensions of academic entrepreneurship. Attitudes towards knowledge commercialization are bound up with one's degree of commitment to the norms of open science and to the risks one perceives of conflicts of interest, but the evidence suggests that these risks are not considered likely by those who have favourable views towards commercialization. Otherwise it is difficult to explain how one can approve of commercialization and strongly adhere to the norms of open science, and disapprove of situations posing conflicts of interest.

Overall, the results reinforce the importance of universities in both the U.S. and in Europe, as they proceed further down the path of entrepreneurialism, of being able to safeguard long-cherished norms of open science and taking steps to enforce conflict of interest policies, not relaxing them.

References

Aghion P, Dewatripont M, Hoxby C, Mas-Colell A, Sapir A (2007), 'Why reform Europe's universities?' *Bruegelpolicybrief* **4**, 1–8

Aghion P, Dewatripont M, Hoxby C, Mas-Colell A, Sapir A (2009) The governance and performance of research universities: Evidence from Europe and the US. Working paper 14851, National Bureau of Economic Research, Cambridge, MA

Ambos, T.C., K.Makela, J. Birkinshaw, and P. D'Este (2008), 'When does university research get commercialized? Creating ambidexterity in research institutions, *Journal of Management Studies* **45**, 1424-1447.

Bergman, E.M. (2009), 'Marshall's dilemma: intangible assets and European universities', IAREG Working Paper 1.3.e, p. 29.

Bergman, E.M. (2010). "Knowledge links between European universities and firms: A review", *Papers in Regional Science* **89** (2), 311-333.

Blumenthal, D., E.G. Campbell, N. Causino, and K.S. Louis (1996), 'Participation of life-science faculty in research relationships with industry,' *New England Journal of Medicine* **335**, 1734-1739.

Bok, D. (2003), *Universities in the Marketplace: The Commercialization of Higher Education*. Princeton, US: Princeton University Press.

Carnegie Foundation for the Advancement of Teaching (2006) www.carnegiefoundation.org/classification

CHEPS (2006), 'The extent and impact of higher education governance reform across Europe: Part four, governance reform survey results,' Center for Higher Education Policy Studies, University of Twente.

CIC Committee on Engagement (2005). *Resource Guide and Recommendations for Defining and Benchmarking Engagement*. Champaign, US: Committee on Institutional Cooperation.

Clark, B. (1998), 'The entrepreneurial university: demand and response," *Tertiary Education and Management* **4** (1), 5-16.

Clark, B. (2001), 'The entrepreneurial university: new foundations for collegiality, autonomy, and achievement," *Higher Education Management* **13** (2), 9-24.

Davies, J.L. (2001), 'The emergence of entrepreneurial cultures in European universities,' *Higher Education Management* **13**(2), 25-43.

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

Estermann T, Nokkala T (2009) *University autonomy in Europe I: Exploratory study*. Brussels European University Association, Brussels

Etzkowitz, H., A. Webster, C. Gebhardt and B.R.C. Terra (2000), 'The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm,' *Research Policy* **29**, 313-330.

Goldstein, H.A. (2010), 'The 'entrepreneurial turn' and regional economic development mission of universities,' *Annals of Regional Science* **43**(1), 83-109.

Goldstein, H.A., E. Bergman, and G. Maier (2012), 'University mission creep? Comparing EU and US faculty views of university involvement in regional economic development and commercialization', *Annals of Regional Science* (available on-line).

Lee, Y.S. (1996), 'Technology transfer and the research university: a search for the boundaries of university-industry collaboration,' *Research Policy* **25**, 843-863.

Litan, R.E., L. Mitchell, and E.J. Reedy (2007), 'Commercializing university innovations: a better way', NBER Working Paper (April), Cambridge, US: National Bureau of Economic Research.

Louis, K.S., L.M. Jones, M.S. Anderson, D. Blumenthal, and E.G. Campbell (2001), 'Entrepreneurship, secrecy, and productivity: a comparison of clinical and non-clinical life sciences faculty', *Journal of Technology Transfer* **26**, 233-245.

Merton, R.K. (1973). The Sociology of Science. Chicago, US: University of Chicago Press.

Mowery, D., R. Nelson, B. Sampat, and A. Ziedonis (2001), 'The growth of patenting and licensing by U.S. universities: an assessment of the effects of the Bayh-Dole Act of 1980', *Research Policy* **30**, 99-119.

Murray, F. (2006), 'The oncomouse that roared: resistance and accommodation to patenting in academic science', Unpublished manuscript, MIT Sloan School of Management, February.

Owen-Smith, J. and W.W. Powell (2001), 'Careers and contradictions: faculty responses to the transformation of knowledge and its uses in the life sciences', *Research in the Sociology of Work* **10**, 109-140.

Rothaermel, F.T., S.D. Agung and L. Jiang (2007), 'University entrepreneurship: a taxonomy of the literature', *Industrial and Corporate Change* **16** (4), 691-791.

Shibayama, S. (2012), 'Conflict between entrepreneurship and open science, and the transition of scientific norms', *Journal of Technology Transfer* **37** (4), 508-531.

Siegel, D. S., D.A. Waldman, L.E. Atwater and A.N. Link (2004), 'Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies', *Journal of Engineering & Technology Management* **21** (1-2), 115-142.

Stokes, D.E. (1997), *Pasteur's Quadrant: Basic Science and Technological Innovation*. Washington, DC: Brookings Institution Press.

Stuart, T. and W.W. Ding (2006), 'When do scientists become entrepreneurs? The social structural antecedents of commercial activity in the academic life sciences', *American Journal of Sociology* **112** (1), 97-144.

Thursby, J.G. and S. Kemp (2002), 'Growth and productive efficiency of university intellectual property licensing', *Research Policy* **31**, 109-124.

Ward D. (1992), 'Serving the State: the Wisconsin idea revisited', *Educational Record* (Spring): 12-17.

Table 1: Sample of Research Universities: U.S.

Research Intensity*	Public Land-Grant	Public Non Land Grant	Private	Total
Very high	13	13	16	42
High	7	14	8	29
Total	20	27	24	71

*Based upon Carnegie Foundation for the Advancement of Teaching (2006), Classification of Institutions of Higher Education

Table 2: Distribution of EU Faculty Respondents by Country

Country	Frequency (%)	Country	Frequency (%)
Austria *	118 (6.6)	Hungary	26 (1.5)
Belgium	56 (3.1)	Ireland	26 (1.5)
Switzerland*	125 (7.0)	Italy	117 (6.5)
Czech Republic	12 (0.7)	Netherlands	161 (9.0)
Germany	514 (28.6)	Poland	21 (1.2)
Spain	62 (3.5)	Portugal	16 (0.9)
Finland	33 (1.8)	Sweden	49 (2.7)
France	138 (7.7)	Slovenia	8 (0.4)
Greece	16 (0.9)	U.K.	229 (12.7)

*Oversampled to include all universities

Table 5: Factor Scores by Academic Discipline
U.S. Data

Discipline		Factor Score 1***	Factor Score 2*	Factor Score 3***	Factor Score 4***	Factor Score 5***
Biology N = 66	Mean (Std dev)	.181 (0.964)	.778 (0.977)	-.092 (1.028)	.195 (0.847)	-.352 (0.859)
Comp Sci N = 57	Mean (Std dev)	.526 (1.15)	.140 (.988)	.163 (1.06)	-.216 (1.028)	.077 (1.04)
Economics N = 62	Mean (Std dev)	-.052 (.818)	-.317 (1.18)	.103 (.924)	-.354 (1.18)	.195 (1.07)
Engineering N = 51	Mean (Std dev)	.084 (1.04)	.035 (.959)	.400 (1.10)	.016 (.958)	.118 (.977)
History N = 76	Mean (Std dev)	-.611 (.750)	-.062 (.886)	-.539 (.798)	.210 (.896)	.194 (.867)
Physics N = 57	Mean (Std dev)	.060 (.936)	.164 (.959)	.192 (.864)	.082 (.983)	-.245 (1.10)

***Significant @0.01
*Significant @0.10

Table 6: Factor Scores by University Ranking
U.S. Data

University Shanghai Ranking		Factor Score 1	Factor Score 2***	Factor Score 3	Factor Score 4	Factor Score 5
1-50 N = 102	Mean (Std dev)	.098 (1.02)	-.512 (1.02)	-.070 (.947)	-.040 (1.11)	-.079 (.995)
51-200 N = 89	Mean (Std dev)	.000 (1.00)	.142 (.901)	-.037 (1.04)	.126 (.906)	-.010 (1.06)
201-400 N = 95	Mean (Std dev)	-.169 (.970)	.160 (.942)	.108 (.980)	.028 (1.03)	-.006 (.941)
401 + N = 83	Mean (Std dev)	.072 (1.00)	.294 (.918)	.002 (1.04)	-.117 (.910)	.114 (1.01)

*** Significant @ 0.01

Table 7: Factor Scores by Regional UE Rate
U.S. Data

Regional UE Rate Category		Factor Score 1	Factor Score 2	Factor Score 3*	Factor Score 4	Factor Score 5
Very low N = 70	Mean (Std dev)	.018 (.953)	.181 (.908)	-.266 (.976)	.115 (.909)	-.105 (1.01)
Low N = 124	Mean (Std dev)	.010 (1.07)	-.088 (1.12)	.113 (1.02)	-.134 (1.16)	.017 (.997)
High N = 113	Mean (Std dev)	.022 (1.01)	-.059 (.931)	-.014 (.959)	.068 (.933)	-.035 (.953)
Very high N = 62	Mean (Std dev)	-.081 (.903)	.080 (.962)	.099 (1.03)	.013 (.849)	.148 (1.08)

*Significant @ 0.10

Table 3: Rotated Component Matrix

U.S. Data

	Component				
	1	2	3	4	5
Q1_RED	.192	.750	.162	.151	-.015
Q2_TA	,291	,775	,131	,044	,095
Q3_Comm	.707	.310	.253	-.029	-.076
Q4_Startup	.848	.201	.113	.013	.119
Q5_Equity	.845	.130	-.013	-.002	.152
Q6_ProprR	.435	.540	.164	-.138	.047
Q7_Patent	.077	.700	-.029	-.284	.086
Q8_PeerR	.058	-.253	.068	.798	-.062
Q9_FreeEx	-.125	.182	-.214	.729	-.101
Q10_Threat	-.525	-.200	-.341	.344	.271
Q11_Consult	.064	.091	-.001	-.099	.858
Q12_Delay	.077	.062	.437	-.059	.540
Q13_StdCol	.086	.147	.867	-.056	.047
Q14_FCol	.185	.087	.803	-.057	.087

Extraction method: principal component analysis

Rotation method: Varimax with Kaiser normalization

Table 4: Rotated Component Matrix

EU Data

Variable	Component		
	1	2	3
Q1_RED	.697	.211	-.024
Q4_Startup	.756	.035	.069
Q5_Equity	.653	-.013	,215
Q6_ProprR	.740	.289	-.093
Q2_TA	.742	.252	-.129
Q3_Comm	.735	.176	.090
Q7_Patent	.591	.127	-.291
Q8_PeerR	-.010	-.030	.938
Q10_Threat	-.584	-.213	.177
Q11_Consult	.091	.733	-.083
Q12_Delay	.203	.642	-.038
Q13_StdCOI	.149	.674	.045

Extraction method: Principal component analysis

Rotation method: Varimax with Kaiser Normalization

Table 8: Factor Scores by Academic Discipline

EU Data

Discipline		Factor Score 1***	Factor Score 2***	Factor Score 3***
Biology	Mean	-.030	-.009	.159
N = 413	(Std dev)	(.989)	(.954)	(.916)
Comp Science	Mean	.185	.076	.029
N = 302	(Std dev)	(1.00)	(1.01)	(1.01)
Economics	Mean	-.072	.184	.100
N = 213	(Std dev)	(.984)	(.97)	(1.07)
Chem Engr	Mean	.253	.461	.227
N = 59	(Std dev)	(.991)	(1.09)	(.957)
History	Mean	-.269	-.322	-.503
N = 192	(Std dev)	(.988)	(.957)	(1.11)
Physics	Mean	.017	-.049	.061
N = 474	(Std dev)	(.994)	(1.01)	(.920)

***Significant @ 0.01

Table 9: Factor Scores by Shanghai Rankings
EU Data

University Shanghai Ranking Category		Factor Score 1***	Factor Score 2***	Factor Score 3
1-50 N = 154	Mean (Std dev)	-.130 (1.06)	-.127 (1.03)	.126 (.928)
51-200 N = 651	Mean (Std dev)	-.089 (.984)	-.087 (.995)	-.039 (1.05)
201-400 N = 540	Mean (Std dev)	.071 (1.02)	.086 (.997)	-.020 (.998)
401 + N = 307	Mean (Std dev)	.129 (.942)	.097 (.981)	.054 (.927)

***Significant @ 0.01

Table 10: Factor Scores by Regional UE Rate Category
EU Data

Regional UE Category		Factor Score 1	Factor Score 2	Factor Score 3
Very Low UE N = 51	Mean (Std dev)	.067 (.862)	-.005 (1.02)	.077 (1.16)
Low UE N = 972	Mean (Std dev)	.021 (.991)	.001 (.987)	.042 (.978)
High UE N = 405	Mean (Std dev)	-.079 (1.06)	-.008 (1.01)	-.083 (1.04)
Very High UE N = 224	Mean (Std dev)	.038 (.956)	.011 (1.03)	-.050 (.970)

Table 11: Factor Scores by EU Macro-Region

EU Macro-Region		Factor Score 1***	Factor Score 2***	Factor Score 3***
EU Core N = 1129	Mean (Std dev)	-0.059 (0.994)	-0.083 (0.985)	0.044 (1.03)
Mediterranean N = 323	Mean (Std dev)	0.223 (1.02)	0.269 (1.03)	0.126 (0.888)
Nordic N = 145	Mean (Std dev)	-0.081 (0.949)	-0.100 (0.973)	0.136 (0.928)
EU-10 N = 55	Mean (Std dev)	0.106 (0.940)	0.380 (0.869)	-0.191 (0.991)

*** Significant @ 0.01

Appendix Table 1: Bivariate Correlations, U.S. Data

	Q1 RED	Q2 TA	Q3 Com	Q4 Start	Q5 Equity	Q6 ProprR	Q7 Patent	Q8 PeerR	Q9 FreeEx	Q10 Threat	Q11Consult	Q12 Delay	Q13 StCOI	Q14 FacCOI
Q1 RED	1.000													
Pr														
Q2 TA	.616	1.000												
Pr	0.00													
Q3 Comm	.385	.424	1.000											
Pr	0.00	0.00												
Q4 Startup	.374	.467	.599	1.000										
Pr	0.00	0.00	0.00											
Q5 Equity	.288	.370	.520	.677	1.000									
Pr	0.00	0.00	0.00	0.00										
Q6 ProprR	.358	.511	.500	.412	.422	1.000								
Pr	0.00	0.00	0.00	0.00	0.00									
Q7 Patent	.290	.376	.292	.234	.241	.357	1.000							
Pr	0.00	0.00	0.00	0.00	0.00	0.00								
Q8 PeerR	-0.04	-.099	0.044	0.025	-0.011	-.086	-.212	1.000						
Pr	0.348	0.021	0.302	0.566	0.806	0.044	0.00							
Q9 Free Ex	0.031	-0.06	-.140	-.148	-.091	-.145	-.085	.229	1.000					
Pr	0.48	0.17	0.001	0.001	0.04	0.001	0.05	0.00						
Q10 Threat	-.281	-.313	-.539	-.413	-.384	-.419	-.225	.137	.230	1.000				
Pr	0.00	0.00	0.00	0.00	.00	0.00	0.00	0.001	0.00					
Q11 Consult	0.074	.166	0.066	.121	.160	.128	.104	-.173	-0.054	-0.027	1.000			
Pr	0.09	0.00	0.13	0.005	0.00	0.003	0.02	0.00	0.22	0.53				
Q12 Delay	.194	.206	.254	.231	.151	.285	.127	-0.04	-.220	-.191	.221	1.000		
Pr	0.00	0.00	0.00	0.00	0.001	0.00	0.004	0.36	0.00	0.00	0.00			
Q13 StdCOI	.189	.233	.310	.221	.180	.295	.108	-0.039	-.193	-.328	.113	.352	1.000	
Pr	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.38	0.00	0.00	0.009	0.00		
Q14 FacCOI	.215	.242	.320	.294	.271	.274	.124	-0.033	-.163	-.348	.129	.282	.636	1.000
Pr	0.00	0.00	0.00	0.00	0.00	0.00	0.004	0.45	0.00	0.00	0.003	0.00	0.00	

Appendix Table 2: Bivariate Correlations, EU Data

	Q1 RED	Q2 TA	Q3 Comm	Q4 Startup	Q5 Equity	Q6 ProprR	Q7 Patent	Q8 PeerR		Q10 Threat	Q11 Consult	Q12 Delay	Q13 StCOI	
Q1 RED	1.000													
Pr														
Q2 TA	.539	1.000												
Pr	0.00													
Q3 Comm	.441	.514	1.000											
Pr	0.00	0.00												
Q4 Startup	.490	.496	.479	1.000										
Pr	0.00	0.00	0.00											
Q5 Equity	.389	.349	.403	.438	1.000									
Pr	0.00	0.00	0.00	0.00										
Q6 ProprR	.489	.690	.527	.495	.399	1.000								
Pr	0.00	0.00	0.00	0.00	0.00									
Q7 Patent	.375	.434	.377	.355	.302	.423	1.000							
Pr	0.00	0.00	0.00	0.00	0.00	0.00								
Q8 PeerR	-.036	-.072	.036	-.012	.052	-.069	-.137	1.000						
Pr	0.14	0.03	0.143	0.63	0.03	0.00	0.00							
Q10 Threat	-.404	-.414	-.484	-.340	-.239	-.453	-.314	-.082		1.000				
Pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001						
Q11 Consult	.226	.282	.195	.120	.102	.265	.170	-.078		-.184	1.000			
Pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001		0.00				
Q12 Delay	.273	.255	.253	.196	.168	.277	.252	-.069		-.224	.269	1.000		
Pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.004		0.00	0.00			
Q13 StdCOI	.192	.221	.216	.194	.135	.288	.160	-.052		-.201	.252	.249	1.000	
Pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.032		0.00	0.00	0.00		

NOTES

[i] The following discussion of EU faculty engagement draws upon Bergman (2010).

[ii] Public, land-grant universities are a subset of public universities originally created by legislation of the U.S. Congress *(*Morill Acts of 1862 and 1890). They historically had the special mission of teaching the 'practical subjects of agriculture, applied science, and engineering, and specializing in research related to the needs of the states' agricultural and industrial sectors. In general there is designated one land grant university per state.

The Carnegie Foundation for the Advancement of Teaching has a widely used classification system of all institutions of higher education in the U.S. Their latest classification has three categories of doctoral-granting universities. Doctoral-granting are those that awarded a minimum of 20 doctorate degrees in 2003-04. Within 'Doctoral granting' are three sub-categories: Research university/Very high intensity (RU/VH); Research university/High intensity (RU/H); and doctoral granting (DRU). Assignment of an institution to one of these sub-categories is based upon a set of multiple indicators of the amount of research activity that occurs within the institution. Based upon the Carnegie classification in 2006, there were 96 RU/VH institutions, 103 RU/H institutions, and 87 DRU institutions.

[iii] Biology and physics fit within Stokes' 'Bohr disciplines', and computer science and chemical engineering are 'Pasteur disciplines'. Extending Stokes' typology, economics and political science can be considered 'North disciplines', as they provide the theoretical and conceptual backing for institutional arrangements (Bergman 2009). English and history are not considered scientific disciplines.

[iv] The two questions not included on the EU faculty instrument were: "Do you agree or disagree with the following statement, unfettered inquiry and the free exchange if ideas is important in my work", and "To what extent do you agree or disagree that the following is appropriate: a faculty member has a research contract with a company in which the faculty member has a financial interest."

[v] We conducted factor analyses using equamax, and quartimax rotations to test the robustness of the results to the choice of rotation algorithms. The differences in results were negligible. We also conducted the analysis with data from only the Pasteur and Bohr disciplines, and the results were substantially different.

[vi] Because factors are linear combinations of original variables with different scales, factor scores are normalized with means = 0.0 and the standard deviations = 1.0

[vii] As evidence of the relative gains in research university quality in the Mediterranean macro-region, over the 2003-2012 period there was a net gain of eight universities from France, Italy and Spain (combined) in the Shanghai Top 500 University rankings list, while over the same period there was a net loss of nine universities in the Shanghai Top 500 rankings from Germany, the Netherlands, Switzerland, and the U.K. (combined).