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Marshall's Dilemma: Intangible Assets and European Universities

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**Marshall's Dilemma and
Commercialization of European Research**

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**Marshall's Dilemma and
Commercialization of European Research**



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Abstract

Difficulty in extracting scientific and research findings from EU universities and placing such knowledge at the commercial disposal of innovation-dependent firms and industries is a cause for grave concern by the European Commission and many of its member states and regions. A review of evidence from the perspective of knowledge-generating universities and academics reveals only country or institution based studies about university commercialization, but nothing at the broader EU level. At the same time knowledge flows and “third-mission” commercialization activities are being promoted far more aggressively by the EC, universities are being totally restructured, harmonised in many respects and decentralized regarding governance and accountability. Together, these momentous events pose both opportunities and potentially divisive pressures within universities among their various faculties and individual members.

Results from a web-survey of EU university professors suggest several unusual findings of interest and importance. Considering first the decision of an academic to engage in commercialization, 30% did so between 2004 and 2009; among the important factors accompanying their decision is their parallel and uncompensated service on public and community boards, the second, highly complementary leg of “third-mission” activities. Of academics who did attempt to commercialize academic findings and skills for compensation, higher levels of relative income were realized by social or applied (not basic) scientists or those who provided research services to external clients. The solution to Marshall’s Dilemma implies greater future efforts and that likelihood is greater for academics with low teaching loads, those who publish scientifically from externally funded research or who see opportunity in selling IPR and technical assistance to commercial clients. Finally, a comparison of viewpoints with US academics shows stronger EU agreement with university policies that support university-based startups and spinoffs, although agreement differs across EU countries.

Introduction

One of the key challenges in capitalizing on the intellectual and scientific base of universities is the ability to convert knowledge into the *intangible innovative assets* that yield economic benefit. The inability to convert significant research knowledge has in recent years been referred to as the European paradox, but a similar dilemma was also observed much earlier in England by Alfred Marshall:

“[T]he small band of British scientific men have made revolutionary discoveries in science; but yet the chief fruits of their work have been reaped by businesses in Germany, where industry and science have been in close touch with one another (Marshall 1923, 101-2, fn 1, as quoted in Hughes, 2007).

At nearly the same moment, the economic advantages for the U.S. arising from scientific genius had been envisioned by Marshall’s contemporary, William James:

“The world, in fact, is only beginning to see that the wealth of a nation consists more than anything else in the number of superior men that it harbors...Geniuses are ferments; the whole population seems to share in the higher energy which they awaken. The effects are incalculable and often not easy to trace in detail, but they are pervasive and momentous.

(James 1911, p. 363, as quoted in Zucker and Darby, 2007)

While the U.S. has been able to nurture and extract considerable economic value from the intangible assets represented by its scientists, much attention continues to focus on the need to launch appropriate efforts that would *bring science and industry closer together in Europe*, particularly prospects for reaping the latent intangible assets seen to be locked away in university scientific systems and practices. This article intends to focus attention directly on the European situation.

“Bringing Them Together”: Multiple Concepts and Approaches

How exactly is university science and industry brought closely together? Some of this engagement can arise quite naturally as a consequence of an academic’s *classic missions to teach and to conduct research*, which accelerated during the industrial and professional revolutions of the 19th and 20th centuries. It is quite common for students’ research and dissertations to be co-supervised by colleagues from industry or practice, perhaps some of whom are graduates of the same university. Students may hold permanent employment in discipline-related organizations while continuing their studies or take positions in industry upon completing studies. In all such cases that involve teaching, knowledge flows quite spontaneously between the personnel of universities and industry in rich and varying mixes.

Nor can research activities of many fields always be partitioned exclusively into purely commercial research to be conducted exclusively by firms and non-commercial research conducted elsewhere. It is therefore common for research teams to consist of members from universities, research organizations and private R&D groups, whether operating with public or private funds. These same members consider themselves freely mobile between posts in these sectors for periods of limited or extended duration. Consequent co-authorships of reports and articles or co-presentations at conferences attended by the same mix of scientists and scholars become the norm. They read each others’ publications, attend joint seminars, and defend their own ideas and findings in widely attended conferences. Many referee the other’s blindly-submitted manuscripts or openly identified competitive research proposals, and knowledge passes quickly among these nodes of informally-organized networks¹. The bulk of this knowledge or public science moves among users as a “public good”, without explicit pecuniary consideration. Indeed, some argue that public science is that which is most highly valued by corporate R&D branches (Bergman,,).

The former are clearly important forms of routine engagement with industry and practice, but other forms that fall outside the traditional university mission activities are now called the “Third Mission”² and they have gained even greater attention, particularly among policymakers in government and universities. These are engagements that result in some form of *knowledge-dependent property*—entrepreneurial or intellectual (or both)—that enters the market and in which pecuniary consideration to the academic or university often plays a motivating role. The evidence of academic effort here is not the academic yield of publications, citations, star students, research grants or attendance at conference proceedings. Rather, activities are of the type closely monitored by a university’s TTO or commercialization office: 1. disclosures of novel findings and discoveries, 2. patent

¹ These complementary activities arise spontaneously and usually without epistemological intent. However, XXX draws our attention to an epistemological imperative that requires reductive scientific efforts to be more broadly contextualized in larger systems to make progress. This implies a specific organization of research that deliberately bridges universities and market or social institutions engaged in research.

² The “Third Mission” is also applied to the uncompensated contributions of academics to non-university organizations that benefit from their scholarly engagement. The significance of these efforts will be discussed at greater length in a subsequent section.

applications and awards, 3. spin-off firms, 4. attracting corporate research facilities or infrastructure to universities. The promotion of intellectual property is the most visible and institutionally-organized activity, but other forms operate somewhat below the TTO radar. These include a wider range of other extra-academic efforts that provide commercial services to firms, governments, and other organizations for pecuniary consideration. Consulting, personal services contracts (including external research), commercial publications or media performance, compensated board memberships, and the like are typical forms of engagement. While less visible and far less the object of university policy, they represent a substantial degree of extra-academic engagement and perhaps compensated services open to academics from a wide spectrum of disciplines. These are the additional activities that often escape attention, but which deserve to be included in the study of university commercialization.

Academic Commercialization in Europe: A Brief Literature Overview³

The literature reviewed here examines the empirical evidence concerning commercialisation efforts from the perspective of European institutes and departments in which academics hold academic posts or the views of individual academics. Most of the studies focus explicitly on the type of contact academics have with industry and try to understand the factors that influence the frequency or nature of such contacts. Four institute-level studies (Austria, Sweden, Switzerland and UK) were reviewed and three individual-level studies (UK and two Swedish) are reviewed.

Schartinger, et al. (2001) surveyed all departments of Austrian universities. Their university survey examined the factors responsible for the types of contact the full academic staff had with firms: joint supervision of theses/dissertations, researcher mobility, joint research and contract research. Since contact data refer to department totals, factors contributing to contact with firms were controlled by the size of department (number of researchers), which indicate improved chances for all types of contact as department size increases. Disciplinary variables showed uniformly higher (technical sciences department) or lower (humanities department) chances for every form of contact.

The special research characteristics of Austrian university departments showed further effects of interest. Departments with high numbers of public presentations and levels of public engagement were significantly *less* likely to have any type of contact with firms, which may reveal that non-commercial contacts could substitute for commercial contacts. Quite logically, departments that conducted contract research with business were significantly *more* likely to have multiple types of contact. Departments that engaged in contract research with public authorities or with higher numbers of international publications, or that engaged in natural science were also significantly more likely to collaborate with firms in joint research projects.

The second study of commercial activity by academic departments (Arvanitis, et al, 2005) summarized here was conducted by Arvanitis, et al, (2008) to understand how knowledge is both “pushed and pulled” into the economy from university institutes. Unlike the broader set of disciplines examined in Austrian study, the Swiss survey was sent only to academic and scientific institutes related to science and technology. Collaborative contacts were distinguished as: 1. informal (workshops, conferences), 2. infrastructure (technical facilities, laboratories), 3. education and training, 4. research activities, and 5. consultation services.

³ This overview borrows heavily from Bergman (forthcoming).

They were also combined as a composite indicator of knowledge and technology transfer (KTT). Overall, KTT measured for the 2002-04 period was more likely in the presence of research funds supplied by business, by larger numbers of PhD students, by higher ratios of applied to basic research, and in departments of engineering, natural sciences, economics/management, and medicine (p. 23). The percentage of time spent teaching imposed obstacles to research and thereby diminished chances of KTT.

The following specific commercial outputs of Swiss institutes were also tested: 1. patenting, 2. spin-offs, and 3. licensing (p. 29). Apart from size (over 100 employees) and a generally supportive environment, patenting activities appear not to be systematically stimulated by typical features of research institutions: a pattern of obstacles that limit business contacts also appears to have depressed patenting activities, but little else mattered. Spinoffs were depressed by the same pattern of obstacles that affected patenting, although spinoff chances improve with increasing institute size. Somewhat surprisingly, spinoffs were also more likely to arise in institutes with higher percentages of time spent teaching. Licensing activities are very nearly the exclusive province of Swiss federal research institutes, the dummy variable for which proved to be the sole positive factor. Every additional significant factor tested showed depressing effects on licensing in other academic or research environments: higher applied-to-basic research ratios, higher percentages of time spent teaching, the pattern of obstacles that limit business contacts, mid-size institutes or those that focus on economics or medicine. Academic and scientific units in this Swiss survey are the respondents and, like the Austrian study, remains subject to “principal agent” reporting limitations.

Braunerhjelm (2006) studied 4 Swedish universities—2 *traditional* (Lund and Uppsala) and 2 *recently founded* (Linköping and Umea)—to test for expected university-level differences in commercialization activities among researchers at universities of the two “vintages”. Unexpectedly, the two traditional universities *and* Linköping university all had rather comparable rates of researcher commercialization. Umea fell much behind, despite a working hypothesis that anticipated “...more recently established universities to be more engaged in commercialization activities...” (p. 10). This unexpected pattern may have resulted from higher response rates of Umea researchers that “commercialization is not possible” (p. 23) and from Umea’s far lower rates of privately-financed research (p. 24). Of those researchers who had successfully commercialized research results, about 80% uniformly said that their university’s TTO *does not* succeed in clarifying the support it offers or researchers lack information of what is offered. Braunerhjelm sees in Sweden what might be considered certain features of Marshall’s Dilemma, concluding “...there seems to be a quite large unexploited stock of research, or ongoing research, that has not been included in the commercialization process” (p. 14).

The influence of RAE quality ratings (and, indirectly, university rankings) plus other institutional factors on the frequency of university-firm partnerships was examined in a paper (D’Este and Immarino, 2010) that analyzed survey data from the same universe of academics examined in a previous study (see D’Este and Patel, 2007, below). The frequency with which 318 university departments engaged in such partnerships from 1999 to 2003 is analysed using negative binomial regression, which was shown to rise with higher RAE ratings, but diminish with the distance between partners. Segmenting the departments into Bohr-Pasteur groupings, higher RAE ratings of basic scientific departments show strong correlations with frequency of industry partnership. Ratings or rankings, then, appear to have their greatest effects on basic rather than applied science relations with industry.

Useful as the findings of these studies are, they are probably underestimate connections or relationships and their reasons, since data are reported for whole departments (or universities) with differences among individual researchers in a department averaged out. Institutional responses are generally less satisfactory than individual views when attempting to understand motives and enabling factors, which highlight the “principal agent” problem when evaluating the pursuit of commercialized applications by individual researchers.

In addition to the department-level studies discussed above, two individual-level studies of faculty-industry interactions have been completed recently in Sweden and one in the UK. The large-scale UK survey was conducted among individual researchers who were “principal investigators-of-record” in listings of the UK Engineering and Physical Sciences Research Council for 1995-2003, although the sample was restricted to those with grants between 1999 and 2003 (D’Este and Patel, 2007). Missing are disciplines related to biology and medicine. The questionnaire permitted the construction of five types of scientist-industry interaction: 1. meetings and conferences, 2. consultancy and contract research, 3. creating physical facilities, 4. training, and 5. joint research. The possible contacts were modelled in two “varieties”: 1. number of contact types (ordinal variable), and 2. absolute frequency of all contact types. Groups of independent variables were tested sequentially, starting first with university characteristics, then departmental characteristics, and finally individual characteristics. While several university and departmental characteristics proved significant when entered alone, their collective impact diminished markedly as the more powerfully significant individual characteristics of scientists were included in the final model results reported below.

Considering first the range of contact types for all UK respondents (p. 1307), the number of joint publications co-authored, EPSRC collaborative grant sums obtained and researcher status as professor were associated with a larger number of contact types, while older researchers had fewer types of contact. Departmental research income per staff and *low* RAE 2001 status also improved contact frequency. No characteristic of the respondent’s university and very few departmental level characteristics proved to be significant. The factors responsible for both range (variety 1) and frequency (variety 2) of interaction were remarkably similar, the only difference being that RAE 2001 status had no effect on interaction frequency (variety 2). Further division of respondents according to basic vs. applied research focus reveals that low RAE 2001 status is significant only for respondents associated with applied research foci. Also revealed is the fact that researchers in basic disciplines at former polytechnics interact over a broader range of contacts (p. 1308-09).

The results align generally with expectations, since industry interactions should be more common among previous principal investigators with a history of industry co-authorships, collaborative industry grants and industry research income. Somewhat surprising is the age penalty, which may reflect a purely chronological effect (reduced energy, openness, etc.) or perhaps a cohort indicator of better research training and analytic skills among younger academics better able to compete for funding. Surprisingly, high departmental RAE ratings for research excellence have nothing to do with industry-academic contacts.

A second study attempts to understand the commercialization issues associated with the Marshall dilemma/European paradox by studying Lund university inventors and patenting behaviour (Goktepe, 2006). The sample of university researchers was based on a Lund faculty name-matched list of EPO patent-holders, where at least one named patent-holder indicated a Swedish address. This matching resulted in the identification of 250 university holders of 458 total EPO patents, which increased steadily in numbers between 1990 and 2004. Technical fields (electronics, chemistry) dominated patenting (nearly 2/3), while

medical faculty accounted for 1/3, and the remaining few patents were held by natural scientists.

Lund professors accounted for about 40% of patent-holders, associate professors and PhD students each accounted for about 20%, with the balance among post-docs and part-time adjuncts. Patenting is highest between ages 45-50 for both men and women. Overall patent production at Lund is highly skewed, with 130 of 250 researchers holding one patent, 40 holding 5 or more (termed “serial inventors”), up to a maximum of 15 patents held by one person. The intellectual property rights regime in Swedish universities may also help shape the manner in which patents become commercialized in firms and industries. Patents are usually applied for by firms to which the patents will be assigned (377 patents), by TTOs (19 patents), or by inventors (98 patents). Of the 377 patents applied for by firms (mainly Swedish), large firms accounted for 210, SMEs for 87, and an additional 80 patents were instrumental in founding spin-off firms. The author sees evidence that commercial absorption of university-based inventions and patents is taking place, thereby casting at least some doubt on the seriousness of “Marshall’s Dilemma” in Sweden.

Another Swedish university study examined forms of academic entrepreneurship in Linköping university (Braunerhjelm, 2007), in which a sub-sample of university researchers at technology and medical institutes were extracted from a larger survey conducted by the Swedish National Audit Office. The questionnaire focused on attitudes and experiences with commercialization efforts by researchers. About 17% of Linköping researchers had some experience with commercialization, most of which concerned the researcher as sole proprietor or with proprietary interest. Another 44% believed their research had commercial potential but had not yet taken necessary steps. Researchers reported needing very little or quite simple support in cases where they had no proprietary interest, unlike those who pursued a proprietary path (spinoffs, equity stakes, etc.) to commercialization. Four out of five Linköping researchers who commercialized research were unaware of the support offered by their university. Those that have yet to commercialize research possibilities cite a lack of time to investigate or pursue next steps.

If we group the type of commercialization variables found in the literature into the categories

FIRST MISSION: TEACHING CONTACTS WITH INDUSTRY

Joint supervision of theses/dissertations (Schartinger, et al, 2001)

Education and training (Arvantis, et al; D’ Este and Patel, 2007)

SECOND MISSION: RESEARCH CONTACTS WITH INDUSTRY

Researcher mobility (Schartinger, et al, 2001)

Joint research (D’ Este & Immarino; Arvantis, et al; D’ Este and Patel, 2007)

Contract research (D’ Este & Immarino; Arvantis, et al; D’ Este and Patel, 2007)

Informal workshops (Arvantis, et al, Schartinger, et al, 2001)

Conferences (Arvantis, et al; D’ Este and Patel, 2007)

THIRD MISSION: PECUNIARY RELATIONS WITH INDUSTRY

Consultation services (Arvantis, et al; D’ Este and Patel, 2007)

Patenting (Arvantis, et al; Goktepe, 2006; Braunerheljm, 2007))

Spinoffs (Arvantis, et al.; Braunerheljm, 2007)

Licensing (Arvantis, et al.; Braunerheljm, 2007)

Infrastructure (Arvantis, et al plus D’ Este and Patel, 2007)

outlined above, we find all are represented. As can be seen, they tend to be mixed together rather opportunistically in studies reviewed, sometimes with equal weights in counts or frequencies, despite dramatic differences in the circumstances from which they may have arisen. This causes no problem if the main line of

inquiry is to document and account for *any type of possible contact* with industry or the market.

But if we want to distinguish which forms of contact result from market-driven appropriation incentives and the factors that dispose academics to shift their gaze increasingly toward Marshall and perhaps away from Merton, then we are invited to focus more heavily on the “Third Mission: Pecuniary” category. In fact, Breschi and Lissoni (2001) essentially argue that the flows of knowledge some studies consider to be “technological externalities” are in fact pecuniary in nature: “...knowledge spillovers seems therefore to have resulted from a specification error, i.e. the inability to control for the contract arrangements linking individual scientists to local firms”. They do not claim “technological externalities” are non-existent, but rather that they are likely to be overestimated when barely visible appropriation mechanisms are not properly accounted for. We intend to follow their advice and focus directly on knowledge flows and transfers mediated by pecuniary considerations, while at the same time also measuring incidental (“technological spillovers”) but consequential contacts as contributing factors. Finally, we also examine the range of contacts that extend beyond firms and industries to societal organizations, including measures of the academic contributions of non-compensated knowledge to them as a further element of universities’ “Third Mission”.

Hypotheses Variables and Survey Evidence

We define our principal dependent variable **Commerce** as *actions taken to pursue or commercialize the results of research findings or academic skills in ways that could potentially increase overall academic income*. This definition goes well beyond single property-based methods, e.g. “patenting”, although we subsequently inquire about it and other specific methods as well. It also includes activities that reflect intentions as well as outcomes *and* it stresses the criterion of income gain to distinguish it from uncompensated forms of third-mission activities.

A second dependent variable **Income** is *the commercial income received relative to a respondent’s base academic salary*. This Likert-scaled variable is heavily skewed to the right, which indicates low average ratios of commercial to academic income. A third dependent variable **Effort** is *the future level of commercialization effort planned*, relative to previous activity. It too is Likert-scaled and right-skewed, indicating less future than past effort. As we were unable to find studies or literature that had considered the latter two variables, the following discussion of hypotheses apply only to **Commerce**, although a common set of variables will be used in all modeling exercises.

The importance of an academic’s discipline, particularly technical sciences (basic and applied), was a significant factor in the Scharfetter, et al (2001) and Arvanitis, et al (2009) studies of academic collaboration with firms. So too was the ratio of applied to basic sciences within departments (Arvanitis, et al, 2009), which implies differential rates of potential collaboration. Following Stokes (), we collapse our original 6 sample stratifications into 3 distinct groups and code them accordingly as control variables: 1. “**Bohr**” or basic science (physics and biology), 2. “**Pasteur**” or applied science (chemical engineering and computer science), and 3. “**North**” or social science (history and economics).

Whether firms establish academic contacts with the most prestigious (or lesser) university departments was examined by D’Este and Patel () and D’Este and Immarino (2010), using RAE rankings and the UK Engineering, Physical and Social Science Research Council data, although each pursued different research designs. Their results are somewhat equivocal as well, with one study (sample survey of individual academics) showing academics from *lower*

RAE ranked departments having greater frequency of contact, while the other study (analysis of administrative records) shows that *higher* RAE ranked departments on average had greater frequency of contact. We proxy the RAE variable by adopting the **Shanghai** Top 500 ranking of EU universities, which tends to stress excellence in Bohr disciplines with unknown effects for the Pasteur and North equivalents. Since **Shanghai** ranking was used to stratify the original sample, it too will be considered a control variable.

A third control variable is indicated by 0/1 dummies that indicate: a. national university system (18 country acronyms), and b. language used to answer questionnaire (**English2, French, German, Italian or Spanish**).

The issue of whether commercialization activities reduce teaching or vice versa was examined by Arvantis, et al (2009), who found that higher teaching loads reduced the chances for collaborative contacts with industry but increased the chances of spinning-off firms. We test for the influence of teaching burden on EU academic commercialization by measuring the number of full-time courses taught in the previous 2 years (**ClassLoad**).

Hypothesis 1: the higher the class load, the less likely academics have pursued commercialization opportunities.

The importance of externally-funded research funding as a stimulant to commercialization was analyzed by Schartinger, et al (2001), Arvantis, et al, (2009), and D Éste and Patel (2007). We capture this effect with the variable **Collaborate**, which indicates whether the respondent has been personally involved in externally-funded industry research projects with collaborators in firms during the previous 5 years. Prior contacts are often precursors to further engagements, including commercialization efforts.

Hypothesis 2: previous participation in funded research projects with industry colleagues increases the probability of pursuing commercialization opportunities.

Whether an academic publishes in international journals (Schartinger, et al, 2001) or has co-authored numerous publications (D Éste and Patel, 2007) is also highly related to close ties with industry. We measure this potential influence with three variables: 1. the number of peer-reviewed articles published by the academic in the previous 2 years (**PeerRPubs**), and 2. whether externally-funded research projects led to publications recognized as scholarly (**SciPubs**) or privately-submitted reports (**PolPubs**).

Hypothesis 3: higher numbers of peer-reviewed publications and the conversion of funded research to scientific and policy publications increases the chances that respondents commercialize.

While commercialization is often categorized as an emerging “third mission” of universities, Schartinger, et al (2001) examined the effects of a second, *social definition of this mission* that includes activities that engage the public and society, which may be considered as a possible alternative to, or substitute for, commercialization activities. They found that industry contacts were systematically fewer in university departments with greater amounts of public engagement. This would indicate a trade-off between one type of “third mission” activity for the other. On the other hand, evidence from U.S. life-science faculty indicates simultaneously high levels of public service, publication and industry research (Blumenthal, et al. 1996), which may indicate that insights and exposures gained elsewhere help stimulate commercialization efforts. We measure the potential impact of public service (**PubSvs**) by evidence of substantial uncompensated service to non-commercial, community entities in the previous 5 years. This is augmented by a series of more detailed types of public service that

specify the type of social contact, one of which is membership on an advisory board of some social, non-commercial institution (**PubBdMem**).

No Hypothesis, although likely to be significant

Some personal attributes of academics also appear to affect some forms of contact with industry. For example, D'Este and Patel (2007) find that academics with professor status have more types of contact with industry, although older academics have fewer types. We proxy academic status with whether respondents hold a permanent or limited **Contract** and measure age by the number of years (**Vintage**) since the respondent's terminal degree was received. Other personal attributes of academics were also measured such as **Gender**, **Tenure** (at present post), **Commute** time from home to post, whether **Home** is located in the present region of residence, and the respondent's openness to a possible **Relocation**.

Hypothesis 4a: respondents who are male or hold permanent contracts are more likely to engage in commercialization.

Hypothesis 4b: respondents who have held few or no other university posts in their career or who are not open to relocation are more likely to commercialize.

Hypothesis 4c: respondents who hold older terminal degrees or have long tenures in post are less likely to engage in commercialization.

Hypothesis 4d: respondents whose home is in another region or who commute long distances are less likely to commercialize.

Governance variables/hypotheses

Entrepreneurial Uni variables/hypotheses

The survey includes a rich variety of data that permits the generation of many additional variables that one might logically expect to influence commercialization tendencies or that reflect current policy debates. In addition to the personal characteristics of respondents mentioned above, data were collected concerning mobility history since receiving the terminal degree, including mobility plans.

Considerable detail is also available concerning academic activities that correspond to traditional university mission (teaching, research, publication) and third mission (several commercialization and public service activities). Moreover, rather unique data have been collected that report the views of academics concerning their university's entrepreneurial and commercialization policies and the degrees to which those policies reflect the engagement of various stakeholders in university affairs. Finally, we control for the national university system in which the respondent is employed *and* which of the 5 EU languages was selected to answer the questionnaire.

Consequently, we have developed additional variables for use in models that estimate commercialization efforts, and also for additional models that estimate relative commercialization incomes and planned commercialization efforts. These will be defined in the discussion of specific models and their results.

What Leads EU Academics to Commercialize?

The above review of literature and logical effects of variables used in previous studies present us with a variety of likely explanations. To this list we also add some additional variables that reflect the respondent's collaboration with industry colleagues, view of the home university's commercialization policies, perceived stakeholder influence on those policies, and a willingness to consider mobility to another university.

The results from a logistic regression model below culminate as the final in a series of steps that tested groups of variables (e.g. all personal attributes or national university systems), thereby eliminating collinear variables within a group and retaining the most robust individual variables over several alternative specifications.

Logistic regression	Number of obs =	1198
LR chi2(11) = 246.28	Prob > chi2 =	0.0000
Log likelihood = -616.62834	Pseudo R2 =	0.1665

Commercialize Model

	Coeff.	P>/z/
Vintage	0.01	0.06
Gender	0.44	0.03
English2	0.42	0.01
PubSvs	0.45	0.01
PubBdMem	0.47	0.02
Collaborate	0.84	0.00
PeerRevKnow	0.19	0.01
UniEntrep	-0.07	0.00
BusVoice	0.30	0.06
OnlyEurope	0.71	0.02
SeekSalary	0.28	0.05
_cons	-26.77	0.06

When modelled with this much richer set of possible variables, relatively few of the effects identified in previous literature were retained, and the effects noted for two are sometimes reversed: for age (**Vintage** of terminal degree/respondent) and for **PubSvs**, both of which are now significantly positive. The **PubSvs** variable in this model was measured for each individual within the previous period, while the equivalent Scharinger, et al (2001) variable was instead calculated as the average for all members of a university department or institute. Industry-funded projects with industry **Collaborators** was significantly related to commercialization activities of EU academics.

New variables include the use of **English2** as spoken in other-language countries, which may reflect the greater external contacts and information regarding commercialization prospects or perhaps reflects some residual element of Anglo-Saxon business culture as well (NYT, 2007). The positive effect of the **PubSvs** variable is of particular interest, given the intense interest in the “third-mission” of universities. A second, more precise activity of serving as a board member of a public or social institution is also highly significant (**PubBdMem**). While much interest in “third-mission” issues has been directed to the main theme of this model—commercialization of knowledge and innovation—one can now allay any element of concern that focusing on commercialization may deprive EU society from the benefits of better university engagement with communities. This appears to be a wholly unfounded concern, as academics who engage society *also* engage the economy. Indeed, one might instead be led to conclude that voluntary social engagement secondarily creates exposures, contacts and

networks that benefit those with commercial prospects, and vice-versa⁴. This is another way of saying that the data do not permit inferences of causal direction, and this in turn implies that both “third-missions” are virtuously and simultaneously interacting.

One of the two most significant variables is **Collaborate**, which accounts for the kind of industry funding and collaboration from which academics clearly gain highly valuable contacts and reputation that could conceivably stimulate commercial possibilities, plus the incentives to capitalize upon them. While the first variable measures external contact with firms and industries, the second (**UniEntre**) is the academic’s internal view of the university’s entrepreneurial policies, particularly concerning commercialization by academic staff. It is measured as a composite of 12 separate Likert-scale questions which tap quite different dimensions and whose scale measures disapproval, hence the negative sign, of entrepreneurial policy and activity by universities. Consequently, the more entrepreneurial an academic sees the home university, the greater the chances that commercialization efforts arise. A second viewpoint by academics concerns the influence of business stakeholders (**BusVoice**) on the development of their university’s entrepreneurial culture and commercialization policies. Academic commercialization is likelier to occur at universities whose commercialization governance is influenced by business and industry stakeholders.

Two final variables test the effects of academics’ willingness to take their knowledge to another institution, i.e., academic mobility, and the effects of this move on the transfer of their knowledge to the market via commercialization activities. **OnlyEurope** indicates that an academic would accept a new post in another European country only, while **SeekSalary** indicates that one of the 3 conditions necessary to consider mobility anywhere would be higher salary. Both are positively significant.

What reasons do the academics who do not commercialize give? The single most important reason given by 25% of respondents indicated was a principled focus on advancing the core scholarship or science base of their discipline. This also tends to accompany a rejection of “third-mission” commercialization, a view echoed at several points in the questionnaire where respondents could offer personal views or opinions.

The additional factors given for not commercialization are: 1. research lacks commercial possibilities (18%), 2. university obligations do not permit time (8%), 3. lack knowledge of how to commercialize (5%), 4. lack opportunities in region (3%), and 5. university does not encourage/discourages (1%)⁵.

What Relative Incomes Do Academics Receive from Commercialization?

Of the 30% of EU academics who do attempt to commercialize, what incomes do they receive? This is measured with reference to their academic salary on a Likert-scale: 1=none and 2=much less, 3=somewhat less, 4=approximately equal, 5=somewhat more and 6=much more than academic salaries. The median salary score is approximately 2, with more than 40% receiving zero commercial income.

In the absence of literature regarding this issue, we explore the influence of each group of variables mentioned above, knowing in advance that many of the variables predicting

⁴ The PubSvs variable also proved very significant in a wholly different model unreported here that tested its effects on academic mobility: the activities associated with public service appear to stimulate awareness of possibility and provide contacts when considering alternatives to the academic status quo.

⁵ Other specific reason offered or missing responses=38%

commercialization are unlikely to have an effect in the relative income model. Based on the ordinal scaling of the dependent variable, we use ordinal logistic regression to estimate the effects of several additional variables.

Ordered logistic regression	Number of obs =	457
LR chi2(11) =	Prob > chi2 =	0.0000
Log likelihood = -412.49499	Pseudo R2 =	0.1336

Relative Income Model

	Coeff.	P> z
Vintage	-0.02	0.02
Italy	0.69	0.10
Pasteur	0.50	0.03
North	1.67	0.00
ResearchIncome	0.52	0.01
PeerRevPubs	0.23	0.01
UniFirmEquity	0.20	0.03
CommNoThreat	-0.30	0.00
PubBdMem	0.88	0.00
Collaborate	0.67	0.01
CommuteTime	-0.24	0.09

Two variables from the first model do repeat: **Vintage** shows older academics earn relatively *less* commercialization income, while **Collaborate** shows joint research with industry funding and colleagues earns relatively more income. Although one's discipline had no effect on decisions to commercialize in the previous model, discipline has a decided effect on income of those who do: social scientists (**North**) receive somewhat better incomes than applied scientists (**Pasteur**), and both earn more when compared with omitted **Bohr** variable. This is a bit surprising, since the usual stereotype is that of a core scientific discovery that is parlayed into valuable patents, licenses or startup firms. None of these methods proved significant⁶. Instead, we see that the *only* type of commercialization that matters for commercial income is personal research services (**ResearchIncome**), for which basic science would have few customers. Note also the absence of a **Gender** effect on income, which implies that income is gender-neutral; indeed, the three academics who scored highest were all women.

Incomes were also higher for academics who do not consider commercialization a threat to basic research (**CommNoThreat**), while incomes were lower for academics that disapproved of university investment in startup firms (**UniFirmEquity**). Serving as a member of a public or community body (**PubBdMem**) tended to boost relative incomes as did an academic's number of peer-reviewed publications (**PeerRevPubs**). Time spent commuting (**CommuteTime**) cut commercial income possibilities, suggesting there are significant consequences of time trade-offs. Finally, academics working in Italian universities (**Italy**) have higher (relative) commercial incomes, which may reflect the average Italian ratio of

⁶ Of the 11 categories of commercialization approaches listed for selection, only six were pursued by 20% or more academics. These are: 1. developing a book or media contract (21%), 2. seek to license some discovery or method (23%), 3. supplier of research services (25%), 4. applied for patent(s) (31%), 5. fee-based personal consultations with external clients (33%), and 6. consulted university TTO officials about technology transfer (33%).

university to private-sector compensation and consequently greater efforts by Italian academics to compensate for shortfalls, although the “professor’s privilege” may also account for some of this effect.

Given the relatively small income gains for the vast majority of academics who attempt commercialization, those who do receive the most are not in basic science, younger, publish more, sell research services, are involved more with industry and public affairs and can save valuable commuting time to devote to profitable commercial activities.

What are Academics’ Plans For Future Commercialization Efforts?

The same 30% of academics to commercialize supplied information about their future plans (2009-2012): would their efforts be *less than before, same as before, or more than before?* About 25% indicated less, 58% the same, and about 17% more. Ordinal logit regression can again be used with the scaling of this dependent variable to detect the possible influences, where the same testing procedures mentioned above were repeated.

Ordered logistic regression	Number of obs =	492
LR chi2(8) = 107.09	Prob > chi2 =	0.0000
Log likelihood = -419.70965	Pseudo R2 =	0.1131

Future Effort Model

	Coeff.	P>/z/
LicenseIncome	0.68	0.00
Vintage	0.06	0.00
Home	0.80	0.03
TeachLoad	-0.18	0.05
RegionVoice	0.67	0.00
SciPubs	0.70	0.02
TechAssist	-0.45	0.00
Consult>1	-0.26	0.00

Vintage of academic degree is significant for the 3rd time, indicating in this model a relatively greater effort in the next 3 years by older academics, perhaps due to the lower relative incomes they received in previous efforts. The ability to convert funded research findings into scientific publications (**SciPubs**) and having received license-based commercial income (**LicenseIncome**) both contribute to plans for greater future effort. The influence of regional government and officials on the university’s commercialization policies (**RegionVoice**) also helps stimulate future efforts, as does the fact that academics now reside in the region they identify as **Home**. For those with heavy instructional obligations (**Class Load**), less effort is planned in future. Finally, academic views of home university policies toward commercialization also tend to increase planned efforts, particularly approval of policies that permit more than 1 day per week consulting (**Consult>1**) with external clients or that provide incentives to academics who provide technical assistance (**TechAssist**) to regional businesses.

Intensified efforts are therefore much more likely among those academics who presently live in their home region or see businesses as potential clients, whether in the form of personal services or sale of intellectual property. Older academics and those with more publications appear to see more prospects than younger or less-well published colleagues.

These are mixed but not necessarily comforting findings to policymakers who are trying to maximize the “third-mission” impact of university research. On the one hand, well-published academics are becoming more engaged in commercialization as well as those who see commercialization policies at their university influenced by regional needs. These are both likely to be seen as valuable

But heavy teaching loads of academics reduce future commercialization efforts of any kind, while business consulting and the sale of intellectual property are the sole commercialization methods that appear to have appeal. These are surely useful activities, but consulting and other business organizations also provide these services; however, those who prefer to perform core research are mute concerning their future plans. Moreover, the contributions of academics who bring knowledge from other countries or regions do not plan more commercialization, while those already living in their declared home region will spend more effort in future. The benefits of mobile knowledge are therefore not available to the commercialization efforts of universities’ “third-mission”.

Are US and EU Academic Views Similar Regarding Commercialization?

We are in a position to offer some tentative findings concerning issues surrounding the public vs. private science orientation of EU faculty members. These orientations will be referenced to results from similar U.S. surveys (Goldstein, 2008; Lee, 1996). This section concentrates on results from a battery of possible university policy issues, some of which proved significant in previous models. These are scaled by rank-ordered Likert degrees of participant (dis)agreement or (dis)approval. They are organized in three principal situational groupings. The first attempts to assess respondent views of whether their universities should be more *externally engaged* in: 1) regional economic development, 2) assisting local firms with technical or managerial support, 3) promoting commercialization of university-based research, 4) providing start-up assistance to firms that grow out of university-based research, or 5) making equity investments in technology-based businesses that result from university-based research. Together, these cover a wide range of extra-mural opportunities now facing many EU universities.

A pair of questions inquires further about the soundness of two university *incentives for promoting* these extra-mural opportunities: 1) official credit or advantage for patented inventions be given to academics during their tenure and promotion processes, and 2) encouragement and reward to faculty members for engaging in proprietary research with industry funding. These obviously apply only to a subset of faculty, but they represent a restructuring of the basic university reward system more toward the sciences in general and toward “Bohr” and “Pasteur” quadrants in particular.

A final group of scenarios present possible *ethical dilemmas* or problematic situations that might emerge in universities that pursue more active entrepreneurial or commercialization strategies. Respondents are asked about the ethics of: 1) consulting for private industry more than one day per week, 2) accepting a 6-month delay in publication of research findings to protect industry funding-source investment, and 3) and serving as supervising advisor of PhD research funded by firm in which that advisor has a financial interest. All examine a single dimension of possible conflicts-of-interest between the classical ideals of university service and contemporary challenges presented by a more entrepreneurial, commercialized university.

While the individual findings for each component were useful in modeling, and are likely to arouse interest from specific quarters of the university community, it is the *overall pattern* of engagement, incentives and ethics associated with a more entrepreneurial university that comprise our main interest at this point. This multi-element ensemble proves sufficiently flexible to grasp the overall shape of sentiments now prevailing among EU faculty members, as well as those held by important sub-groups of universities, disciplines and faculty member cohorts. The following will compare the views of EU faculty on these several dimension with their U.S. counterparts, as well as between specific EU cohorts.

We first benchmark EU responses concerning the 12 policy issues surrounding entrepreneurship issues that were examined for the U.S. by Goldstein (2008). This comparison seems particularly apt, since US academics have lived longest and perhaps most intensely with these issues; moreover, Lisbon and similar objectives are typically posed using US success with commercialization as a relevant comparison. These issues were evaluated by respondents, using a 5-point Likert scale. We then summarize for groups of respondents their pseudo-medians (means of ranks) for each issue⁷. The resultant “medians” for each issue can be arrayed along lines from lowest (most approval) to highest (most disapproval) scores for each respondent group, as shown on the accompanying graph of the Academic Entrepreneurship Index.

In general, the average U.S. academic approved mildly of only two issues (peer-reviewed research is best for knowledge-generation, and that universities should play active roles in development of regional economies), while disapproving rather strongly of three conflict-of-interest issues (extra time for faculty consulting, delay in publication to protect business sponsor, and PhD research at firm where advisor has financial interests). Others oscillated closely around the mean indifference rank.

Adopting the U.S. responses as our comparative baseline, we then plot the median scores for the same issues using EU respondents and some striking differences arise, which occur mainly in areas where U.S. respondents expressed overall higher degrees of disapproval (i.e., medians ≥ 3.00). EU respondents approved more favorably regarding the actions of universities to assist with academic spinoff firms (bQ18), to reward faculty for proprietary research (dQ18), and to participate in ownership of academic startup firms (cQ18). The average EU respondent also saw less conflict of interest when PhD students conduct dissertation research with firms in which their advisors have a financial interest (cQ19) and disagreed more with the proposition that research commercialization threatens the integrity of basic, scholarly research (iQ18).

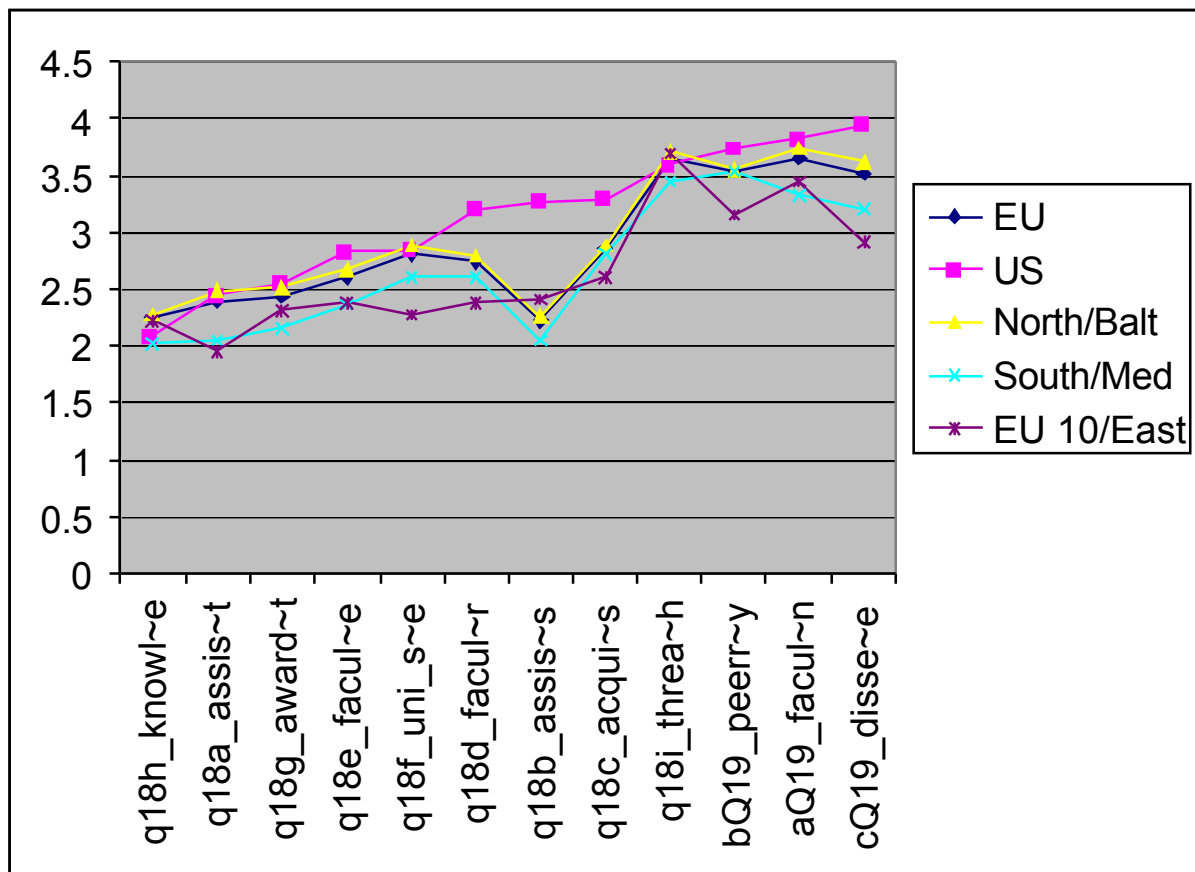
Our interpretation of this comparison must highlight first the overall consistency of academics on both continents, but it also identifies a very specialized departure by EU academics. While consistent with U.S. academics on many controversial issues surrounding commercialization, EU responses appear to identify a substantially stronger need for university-supported startups and equity investment in spin-off firms as commercialization strategies⁸, while also discounting heavily some apparent contradictions between scholarly and commercial issues to which U.S. academics objected strongly. Is it the case that academics in all EU regions are

⁷ The sum of 12 individual issue scores was used to calculate the value for the variable **UniEntrep**, which was used in the commercialization model tested above.

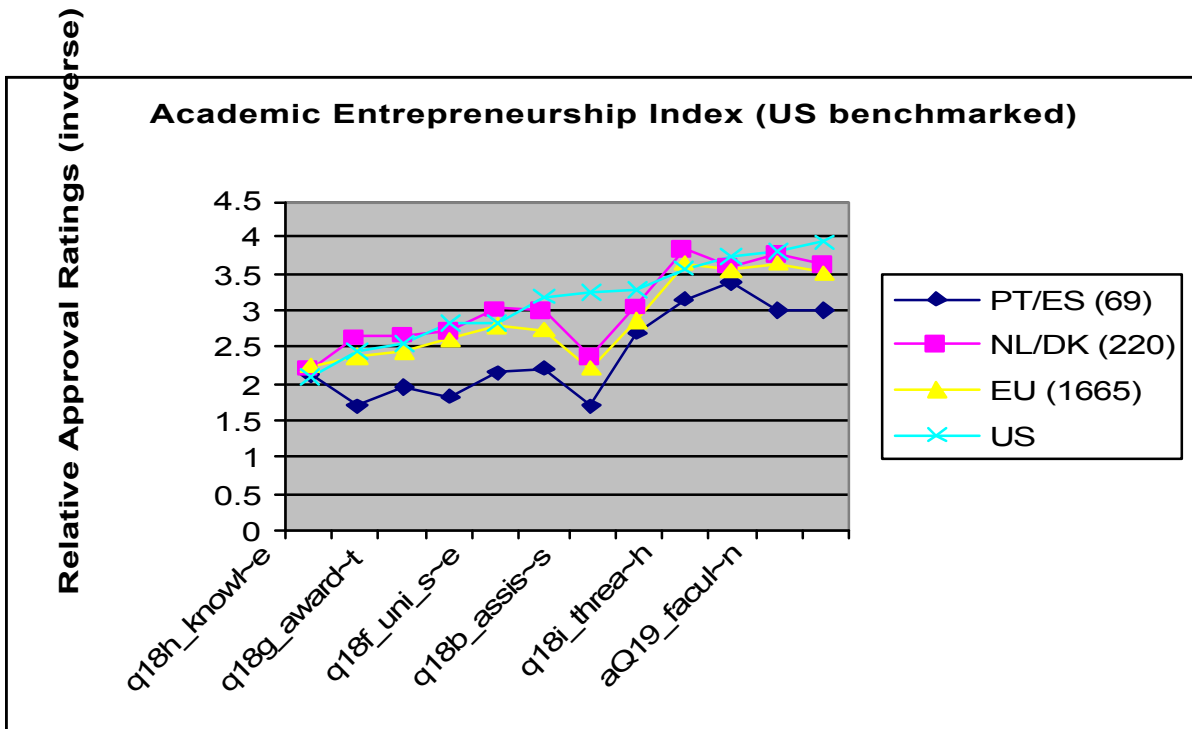
⁸ Lee (1996) shows very heavy early U.S. opposition to these strategies, opposition which Goldstein (2009) sees continuing a decade later, despite a more favourable 1990s view of intellectual property as equivalent to refereed publications than in 1980s. Commercial gain or pecuniary advantage obtained from university status appears more heavily ingrained in U.S. academics at the moment.

much more favorably inclined to individual entrepreneurial activity within Europe's best research universities?

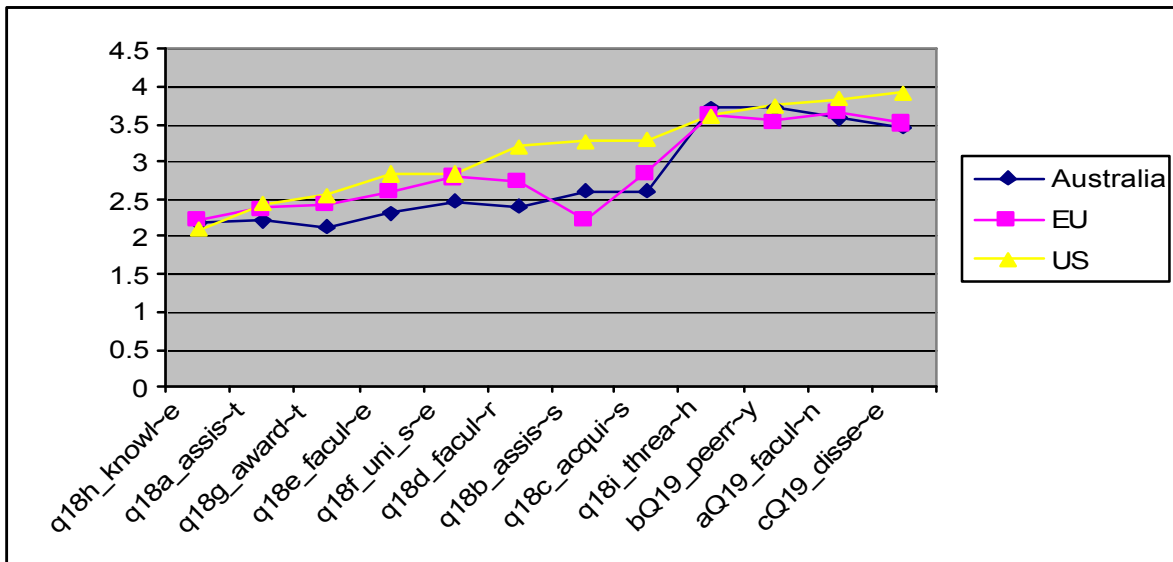
The following graph gives some further insight. It is an extension of the previous graph, where respondent countries have been regionalized: a. Mediterranean, b. EU 10, and the wealthy North/Baltic residual. Academics in Mediterranean and EU 10 countries generally approve of more entrepreneurial activities, while the North/Baltic countries approve fewer than others, much like the US on several issues.



Focusing on national outliers, the Dutch and Danish can be seen to differ nearly as much from the Spanish and Portuguese academics as the EU does from the US; indeed, the former are even more disapproving of 4 issues than US respondents. Since the EU survey was taken early in 2009 as the financial crisis worsened, one can expect that the relative fortunes of these four countries could influence how academics see entrepreneurial efforts within their universities.



Finally, we might ask if academics in other western countries view these issues more like the US or the EU? In short, which is the true outlier? If we compare available US, EU and Australian responses, it seems as though the US is the true outlier, since Australian and the EU approval rates are rather similar overall.



Considered together, these comparisons show the EU (and Australia) to favour more entrepreneurial activities within their university systems than do the US. As Goldstein (2009) suggests, US academics no longer take for granted the importance of commercialization as part of their “third-mission”. Perhaps a similar view will eventually prevail in the EU, once commercialization is more widely practiced. Indeed, the respondents of all three continents concur in their high and nearly identical discomfort with the possibility that commercialization interests threaten basic research (Q18i). However, premature moves to oppose commercialization efforts within universities might also delay further or forestall

entirely a satisfactory resolution of Marshall's Dilemma and compromise progress toward the original Lisbon—now the 2020—goals of the European Commission.

Conclusions

We have examined European academics' engagement in efforts to commercialize their intellectual capital, the relative pecuniary advantage realized from such engagements, and prospects for future engagement. A large sample of respondents was collected from six representative disciplines in all European universities listed in the Shanghai Top 500 universities.

The factors that account for each type of engagement are nearly unique in all three models, with only the **Vintage** of the respondent's degree being significant in all, although various attitudes toward one's home university's entrepreneurial policies also remained important throughout.

When modeling the likelihood that an academic had taken steps to **Commercialize** discoveries or skills, personal factors loomed relatively large: **Gender, Vintage and English²**. That likelihood was further enhanced by previous collaborative research contact with industry colleagues (**Collaborate**) and public service contributions (**PubSvs**). Both variables illustrate the value of having distinguished between types of industry contact (pecuniary vs. technological) and between 3rd Mission activities (social vs. market contributions), since they help clarify the complex relations in play.

Moreover, these two factors were also associated with higher relative commercialization incomes. Higher incomes were also possible for academics in the social (**North**) or applied (**Pasteur**) sciences as compared with basic (**Bohr**) science, which was the only model where disciplines were significant factors. Incomes also benefitted from working close to home (**Commute**) and from certain income sources (private research). Similar variables, i.e. working in one's **Home** region and seeking **LicenseIncome**, were further important factors in whether to maintain or intensify future commercialization efforts. Future efforts hinged as well on 1st and 2nd mission activities: less intensity as **TeachLoads** increase, more intensity as **SciPubs** rise. In combination, these three models provide a much richer and more nuanced sense of what European academics consider when encountering commercialization issues.

Their view of university policies and practices, while occasionally significant in the commercialization models, was also compared with the views of U.S. academics. For most issues, both groups of academics had rather similar views, although university activism concerning support and financing of university spin-offs and startups was more widely approved among European academics. If Europeans eventually adopt the U.S. stance on these commercialization-dependent matters, the chances of resolving Marshall's Dilemma could suffer.

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Variable Label	Definitions of Independent Variables	Mean Std Dev	Min. Max.	Observations
UniEndog	Present post at same university that granted terminal degree	0.38 0.49	0 1	1716
Contract	Unlimited employment contract	0.69 0.46	0 1	1716
Tenure	Number of years at present post	11.4 9.7	0 44	1799
Vintage	Number of years since Terminal degree received	35.0 10.7	0 51	1689
Voice	Influence of academic staff on university governance	0.32 0.47	0 1	1694
ProvostVoice	Influence of university administrators on university governance	0.74 0.44	0 1	1692
ExternalVoice	Influence of industry leaders on university governance	0.60 0.49	0 1	1684
ClassLoad	Class teaching load in last 2 years (1=0, 2=1-3, 3=4-5, 4=6-10, 5=>10)	2.86 1.16	1 5	1798
Gender	Male	0.81 0.39	0 1	1798
PeerRPubs	Peer-reviewed publications last 2 years (1=0, 2=1-3, 3=4-5, 4=6-10, 5=>10)	3.44 1.27	1 5	1798
PhdProg	Present post in academic department with PhD students	0.92 0.27	0 1	1732
PostDegMob	At least 6 months experience elsewhere between degree and present post	0.70 0.46	0 1	1724
PubSvs	Non-compensated service to external parties in previous 6 years	0.39 0.49	0 1	1710
SciPubs	Peer-reviewed publications generated from funded research	0.76 0.42	0 1	1798
Commerce	Taken actions to commercialise academic findings or skills	0.30 0.46	0 1	1730
NatEndog	Present post in same country as university granting terminal degree	0.74 0.44	0 1	1716
Policy	Client or policy reports generated from funded research	0.34 0.47	0 1	1798
CollabProj	Collaborative funded research with industry colleagues	0.46 0.50	0 1	1798
PeerRevKnow	Peer-reviewed publications best measure of university knowledge*	2.25 1.06	1 5	1715
BasicThreat	Basic science threatened by university research commercialisation*	3.66 1.07	1 5	1710
UNITED KINGDM	Respondent in a UK university	0.13 0.33	0 1	1799
SWITZERLAND	Respondent in a Swiss university	0.07 0.25	0 1	1799
SWEDEN	Respondent in a Swedish university	0.03 0.16	0 1	1799
SPAIN	Respondent in a Spanish university	0.03 0.18	0 1	1799
PORTUGAL	Respondent in a Portuguese university	0.01 0.09	0 1	1799
POLAND	Respondent in a Polish university	0.01 0.11	0 1	1799
NETHERLANDS	Respondent in a Dutch university	0.09 0.29	0 1	1799
ITALY	Respondent in a Italian university	0.07 0.25	0 1	1799
IRELAND	Respondent in a Irish university	0.01	0	1799

		0.12	1	
HUNGARY	Respondent in a Hungarian university	0.01	0	1799
		0.12	1	
GREECE	Respondent in a Greek university	0.01	0	1799
		0.09	1	
GERMANY	Respondent in a German university	0.29	0	1799
		0.45	1	
FRANCE	Respondent in a French university	0.08	0	1799
		0.26	1	
DENMARK	Respondent in a Danish university	0.04	0	1799
		0.19	1	
BELGIUM	Respondent in a Belgian university	0.03	0	1799
		0.17	1	
AUSTRIA	Respondent in a Austrian university	0.07	0	1799
		0.25	1	
Colleagues	Work with stronger colleagues	0.21	0	1379
		0.40	1	
Ropportunity	Better research opportunities	0.43	0	1379
		0.50	1	
Students	Work with stronger students	0.14	0	1379
		0.35	1	
Salary	Higher salary	0.38	0	1379
		0.49	1	
PubPress	Less publishing pressure	0.03	0	1379
		0.18	1	
TeachLess	Lower course load	0.12	0	1379
		0.33	1	
FirmOrg	Better contacts with firms, orgs.	0.06	0	1379
		0.24	1	
LessAdmin	Less Administration/Committees	0.18	0	1379
		0.39	1	
Benefits	Better Health/Pension benefits	0.05	0	1379
		0.22	1	
QOW	Quality of working conditions	0.18	0	1379
		0.38	1	
FamilyQOL	Quality of Life for self/family	0.33	0	1379
		0.47	1	
Language	Ability to work in preferred language	0.07	0	1379
		0.25	1	
Promotion	Promotion to a higher/permanent post	0.31	0	1379
		0.47	1	
Prestige	More Prestigious University	0.18	0	1379
		0.37	1	

The Survey Sample

The data analyzed in subsequent sections to investigate academic commercialization were taken from the European web-survey of university academicians⁹, as follows. The results are based upon 1798 responses, which represent approximately 20% of the original sample of university faculty members from university webpages. The universities included in the survey are found in 19 countries, 201 of which are Shanghai-ranked, with 14 additional universities from Austria and Switzerland that were added to help understand possible differences between the Shanghai-ranked and unranked groups.

Within the overall university sampling-frame, we further stratified the sample of academics by discipline, choosing six from each university's webpage: Physics, Biological Sciences, Chemical Engineering, Computer Science, Economics and History. Three respondents were drawn from each disciplinary unit present in all sampled universities' web-pages¹⁰, where the director or chair was included when identification was possible, plus two (or three) other randomly selected respondents. This yielded a total of 9,393 invitations to participate in the survey, which were sent as an e-mailed letter of invitation that introduced the survey's purpose and supplied a unique log-in code to secure the file from uninvited or multiple respondents.

Excluding all invalid e-mail addresses and respondents who contacted us to say that they don't want to participate we had a final number of 8826 valid contacts. Respondents could choose to answer survey questions in any of the 5 most widely-used European languages: English, French, German, Italian and Spanish. Of 8826 valid contacts, 1798 filled out the full questionnaire, yielding a 20% response rate. Response rates to other surveys of mobility among European academics range as low as 12-16%, and indeed UK and Spanish respondents fell within that bracket, although Polish and Italian academics responded at twice these rates (30-33%). Response rates differed little across disciplines¹¹ (2-3 percentage points around the mean), while proportionately more responses were received from high as compared with lower Shanghai-ranked universities.

<i>Austria</i>	7 (plus 7)
<i>Belgium</i>	7
<i>Czech</i>	1
<i>Denmark</i>	4
<i>Finland</i>	6
<i>France</i>	23
<i>Germany</i>	40

⁹ See Schneider and Bergman (2009).

¹⁰ French universities present a problem: they do not list their academic faculty members and researchers by discipline, nor do their web-pages supply e-mail addresses necessary to conduct a web-survey. As an alternative, we searched the ISI Web of Science to locate suitable academics and then select those at a given French university who had previously published in journals of a given discipline. Author data provided on the publications listed in the Web of Science sometimes included e-mail addresses or further information that permitted additional on-line search to obtain usable e-mail addresses.

¹¹ An imbalance in respondents by discipline results directly from sampling anomalies: Chemical Engineering is sparsely distributed in the overall sample and among respondents (4%), while Physics (28%) and Biological Sciences (25%) are profusely and diversely represented, sometimes in multiple academic units at the same university. On the other hand, academic units of Computer Science (18%), Economics (13%) and History (12%) are more evenly distributed across universities and among our respondents.

<i>Greece</i>	2
<i>Hungary</i>	2
<i>Ireland</i>	3
<i>Italy*</i>	22
<i>Netherlands</i>	12
<i>Poland</i>	2
<i>Portugal</i>	2
<i>Slovenia</i>	1
<i>Spain</i>	9
<i>Sweden</i>	11
<i>Switzerland</i>	8 (plus 4)
<i>United Kingdom</i>	42