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Is the US Outperforming Europe in University Technology Licensing? A New Perspective on the European Paradox

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Abstract:
Europe is perceived to be lagging behind the US in converting its academic results into economic outcomes. Using new survey data on European and US Technology Transfer Offices (TTOs), we find that differences in academic research, TTO staff and experience explain to a great extent the gap between the US and Europe in terms of the number of license agreements concluded. However, these factors account for only part of the difference in license income. We relate the difference in licensing income to differences in the organization and staffing of TTOs. Our analysis reveals that US TTOs do not attach more importance to generating revenue as an objective than their European counterparts. However, they employ more staff with experience in industry which explains some of the remaining differential in license income performance.

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1 Introduction

"Compared to North America, the average university in Europe, generates far fewer inventions and patents. This is largely due to a less systematic and professional management of knowledge and intellectual property by European universities."

(European Commission, 2007)

"Contrary to the "paradox"conjecture, European weaknesses reside both in its system of scientific research and in a relatively weak industry."

(Dosi, Llerena, Sylos-Labini, 2006)

The European Commission (EC) has on several occasions[1] stressed that Europe has been less successful than the US in converting its academic results into economic outcomes. In a number of documents it has advocated the importance of improving knowledge transfer between public research institutions and third parties, including civil society and industry partners.

The argument behind the EC's concerns is that while European research institutions are good at producing academic research outputs, they are not as good at transferring these outputs to the economy. This argument is known as the "European Paradox".

A number of economic studies have contested the validity of the claim that European academic institutions are good at producing scientific knowledge (of quality). Controlling for the relative size of Europe and the US, Dosi *et al.* (2005) show that European countries lag significantly behind the US with regard to a number of indicators for academic quality, including the volume of publications and article citations. Bauwens *et al.* (2008) point to the "massive" dominance of American universities in the total sample of ISI Highly Cited Scientists. They highlight the fact that the gap in research productivity between Europe and the US is due, in part, to a lack of financial resources made available for universities and research in Europe, but also to inefficiencies in the way these resources are managed. Aghion *et al.* (2009) argue that institutional autonomy and competition account for the better academic research output of US universities when compared to the output of their European counterparts.

Other studies have investigated whether it is true that the main weakness of European academic institutions lies in translating scientific knowledge into innovations. Crespi *et al.* (2008) show that while Europe lags behind the US in terms of university-owned patents, the gap becomes smaller

[1] See, for example, the Green Paper on Innovation (EC, 1995), the Third Report on Science and Technology Indicators (EC, 2003) or the communication entitled "Improving knowledge transfer between research institutions and industry across Europe - embracing open innovation - Implementing the Lisbon Agenda"(EC, 2007).

when university-invented patents are taken into consideration. They analyzed the situation in six major European countries and showed that two thirds of the patents with at least one university inventor are not owned by universities. Similar results are found by Lissoni *et al.* (2008), who show that in France, Italy, and Sweden most academic patents are not university-owned. These studies all focus on patents as a measure of technology transfer. This was partly due to a lack of quality data on licensing outcomes in Europe.

This study contributes to the understanding of whether a "European Paradox" actually exists and, if so, what its causes could be. We tackle a specific aspect of university technology transfer - the licensing activity of university technology transfer offices (TTOs) - to determine whether US TTOs conclude more license agreements and earn more license revenue than their European counterparts.

For this purpose, we complement public information available on US and European universities with new survey data on university technology transfer offices in Europe and in the US. The survey distributed to European TTOs included questions on quantitative outcomes (i.e. number of licenses executed and license income) as well as other questions on objectives, metrics of success, staffing levels and composition. The target population was TTOs of universities located in Western Europe whose researchers published more than 200 scientific articles between 2004-2006. The response rate was 59.4%, with 211 answers coming from 15 countries. The survey distributed to US TTOs was aimed at integrating the information available from the 2008 AUTM survey with questions on objectives, metrics of success, and TTOs staffing composition. The target population for the US survey was selected according to the same publication parameters as was used for the European survey, though we added as an additional condition having answered to the 2007 AUTM survey; the response rate was 58%, with 89 answers.

In the first part of the analysis, we found that, having controlled for measures of academic scientific production and quality, academic orientation, demand for technology, national policies on university intellectual property rights (professor's privilege), and TTO staffing levels and experience, European TTOs did not execute fewer licenses than their US counterparts. However, they earn significantly less revenue from licenses. These results were robust to different specifications of the econometric model.

In the second part of the analysis, we explored the differences between Europe and the US that might explain why European TTOs earn less income than their US colleagues. We focused on two main hypotheses: 1) US TTOs place a greater emphasis on "generating revenue" as an objective;

2) US TTOs employ more staff who have experience in the industry sector and who might be more skilled at negotiating the financial clauses of licensing contracts.

Contrary to our expectations, US TTOs did not attach more importance than their European counterparts to generating revenue when compared to other objectives such as local development and faculty service. However, our proxies for TTO business experience had a positive and statistically significant impact on the license revenue earned by TTOs, and their inclusion in our regressions led to a decline in the license revenue differential between the US and Europe.

In accordance with other studies investigating the "European Paradox", we considered Europe as a homogeneous entity. However, we showed that there are significant differences among European countries. Specifically, Italy and Finland underperform the rest of Europe in terms of the number of licenses, while Austria and Norway underperform the rest of Europe in terms of license income earned. At the other end of the spectrum, countries like Switzerland and Belgium do significantly better than the European average.

Our findings led to a reinterpretation of the European Paradox. Contrary to the EU Commission's assertions, but consistent with what was found by Dosi *et al.* (2005), our data suggested that there is a gap in academic scientific production between Europe and the US. Our analysis revealed that, having controlled for this gap and other factors, Europe is lagging behind the US in terms of license income earned but not in terms of the number of license agreements concluded. While we do not think that revenue generation should be the ultimate goal of TTOs, we note that US and EU TTOs place equal emphasis on revenue generation.

The remainder of the paper is organized as follows. Section 2 reviews the determinants of TTO productivity. Section 3 presents the empirical analysis. Section 4 describes differences in TTO organization and staffing that might explain why European TTOs earn less license income than their US counterparts. Section 5 concludes.

2 A review of the determinants of TTO productivity

University technology transfer offices are often seen as institutional bridges between universities and industry (Siegel *et al.* 2003). Their role is to facilitate the transmission of university knowledge to the economy.

Several studies have attempted to discern the factors affecting the productivity of TTOs, measured mainly in terms of number of licenses and license revenue (Thursby and Kemp, 2000; Siegel *et al.*, 2003; Thursby *et al.*, 2001; Jensen and Thursby, 2001; Friedman and Silberman, 2003; Lach and Schankerman, 2003; Chapple *et al.*, 2005; Belenzon and Schankerman, 2007; Macho-Stadler *et al.*, forthcoming). The majority of these studies have analyzed the functioning of TTOs in the US. The interest in US university technology transfer is mainly driven by the "dramatic rise" in university licensing since the passing of the Bayh-Dole Act in 1980. In recent years, university technology transfer has also gained momentum among policy-makers and economists in Europe. As mentioned earlier, the European Commission in its communication "Improving knowledge transfer between research institutions and industry across Europe: embracing open innovation – Implementing the Lisbon Agenda" (2007), notes that Europe has been less successful than the US in commercializing academic research results. An increasing number of studies have started investigating the phenomenon of university technology transfer in Europe, mainly with analyses at the country (Chapple *et al.*, 2005) or academic institution level (Macho-Stadler *et al.*, forthcoming). Inter-country comparisons are still lacking due to lack of data. A notable exception is represented by Siegel *et al.* (2008) who compare the relative performance of the UK TTOs relative to the US ones, considering a multiplicity of output measures.

When examining the licensing activities of TTOs, economic literature has made a distinction between TTO outputs and inputs. In the majority of cases, the number of licenses and license revenue represent the outputs. The inputs are usually classified into four main categories.

The first category includes the technology that is produced by an academic institution. As mentioned above, TTOs are expected to work with university inventions and ensure that these are disseminated in the economy. Measuring university technology is not an easy task, however, due to different requirements in the US and EU, respectively. For example, some economists suggest using the number of invention disclosures to measure university technology. This proxy seems to work well in studies on US university technology transfer. In fact, in the US - at least in principle - faculty members are required to disclose inventions to their TTOs. But this is not true in Europe, where, in many cases, there are no formal requirements for academic scientists to disclose inventions. Other economists suggest using the number of patents, but this measure has serious drawbacks for a number of reasons. First, it is not clear whether patents are an input for licenses or vice-versa. In fact, in many cases, patents are filed only after a license is negotiated between an academic institution and the industry counterpart. Moreover, as we realized by discussing the matter with technology transfer professionals in Europe, TTOs often consider patents outputs *per se*. Furthermore, licenses are not always backed by patents, as in the case of software technology. Finally, in Europe, the drawback of using invention disclosures also applies here. Since academic researchers are not usually required to disclose their inventions to academic TTOs, the latter do not always have a record of the patents filed by the researchers at their institution. Chapple *et al.* (2005) have suggested using total research income as a proxy for the stock of university technology when analyzing the factors affecting TTO productivity in the UK.

The second category includes the characteristics of the academic institution in which a TTO operates, namely the quality of the institution and its research orientation. The impact of quality on university technology transfer is twofold. On the one hand, it affects the quality of the technology that is being produced and, on the other hand, it impacts a company's "perception" of the quality of university technology. As for the research orientation, Thursby and Kemp (2000) show that institutions with a strong focus on engineering and life science tend to produce output that is more easily transferred to the industry sector, either because of its applied nature or because industry is interested in absorbing this output. However, life science inventions tend to represent a greater share of the technology portfolio of TTOs relative to engineering inventions (Jensen and Thursby, 2001).

The third category encompasses the demand for technology in the academic institution's geographical area. The logic is that TTOs will find it easier to conclude licensing agreements if there is a local demand for them. Moreover, the presence of high-tech companies in the proximity of an academic institution may have an influence on the institution's output. This influence, as noted by Anselin *et al.* (1997) and Audretsch and Feldman (1996), is greater as the geographical proximity of the academic institution and the high-tech companies increases.

The last category comprises the characteristics specific to a TTO, namely the number of staff and their experience, the latter of which is measured by number of years since the foundation. It is commonly believed that the relationship between TTO size and output is characterized by diminishing returns to scale. Thus, adding one staff positively affects the number of licenses and license revenue, although the impact decreases with the number of staff added. Also, TTO experience is usually found to have a positive effect on the output of a TTO, with a notable exception being provided by Chapple *et al.* (2005).

There are, however, other factors that affect university technology transfer that have started to be investigated only recently. These factors include TTO objectives, incentives, and staff skill composition. TTO objectives are important in shaping the activities performed by these offices. Their definition is often the result of the interplay between a number of institutions, including national and local authorities, the academic administration, and the TTO itself. Belenzon and Schankerman (2007) found that TTOs with strong local development objectives earn less revenue from licenses and tend to conclude more license agreements with local startup companies. Belenzon and Shankerman (2007) have analyzed the role of incentive pay in TTO licensing activities and have found that the adoption of incentive pay positively affects income earned from licenses. Finally, staff skills are of crucial importance when analyzing TTO licensing activities. Interviews conducted by Siegel *et al.* (2003) suggested that staff with experience in the industry sector might better understand the needs and values of private companies. Conti *et al.* (2007) found evidence that personnel with a PhD in science play an important role in facilitating communication between academics and the TTO.

3 Empirical Analysis

3.1 The data

European data. This paper is based on a new survey of university technology transfer offices in Europe conducted in summer 2008.

The pre-existing European data on university technology licensing are very limited. Most surveys are national-based and thus limited in scope. There are two surveys from professional associations covering several European countries. The survey from the Association of Science and Technology professionals includes only 75 answers from universities in its 2007 edition. The Proton survey includes more answers but presents severe problems concerning representativity, consistency, and sample selection. Finally, none of these surveys has made their results publicly available at a disaggregated level[2], as is the case in the US.

The target population of our survey was TTOs of universities located in Western European countries whose researchers published more than 200 scientific articles during the period 2004-2006. Although there are a number of universities below that threshold, we expected that their technology transfer output would be rather limited and that many of them may not have a technology transfer office anyway. A total of 351 universities met our eligibility requirements.

The contact persons for technology transfer were identified from university websites. The directors of the technology transfer offices were then contacted by telephone and invited to answer an online questionnaire. In a small number of cases no contact person for technology transfer could be identified; we suspected these cases to be universities that do not provide technology transfer services to faculty.

The questionnaire included questions on objectives, metrics, organization, staffing levels and composition, and licensing outcomes[3]. To increase the response rate, we did not ask for the license

[2]The ASTP has made the anonymized results of its survey available to some researchers on request.
[3]The survey questions we used for this study are reported in Appendix A1.

income directly but asked respondents into which category their license income fell[4]. Moreover, we asked for the number of licenses, *including* the assignment contracts that regulate allocation of intellectual property rights to industry partners. In fact, many of the TTOs in our population associate assignment contracts with licenses and do not report them separately.

The response rate was 59.4% with 211 answers. We received answers from 15 countries with four or more answers for each country. Figure 1 clearly shows that response rates are higher than average for small countries such as Switzerland, Denmark, Belgium, Norway, Finland, Portugal and Ireland. The lowest response rates are for Germany with 27 answers out of 61 universities in the target population (44.2%) and Italy with 23 out of 51 (46%).

In the first part of the paper, we use information from those 163 respondents who had answered the questions on the number of licenses, license income, total number of staff, and year of foundation of a TTO. In the second part of the paper, where we explore the role of staff with experience in industry, we reduce the sample to 157 respondents, excluding those who had not answered the questions on the composition of the staff.

⟨ Insert figure 1 about here ⟩

US data. Data on university technology licensing in the US is readily available from the Association University Technology Managers (AUTM) survey. We use the data from the publicly available 2008 AUTM survey, which includes answers from 141 US universities. The AUTM survey coverage is excellent as it includes answers from 80% of US universities that have more than 200 scientific publications in Science and Engineering. The AUTM survey focuses on the licensing activity of technology transfer offices based mainly in the US. It includes questions on the number of licenses, license revenue, number of the licensing staff, and the year of foundation of the TTOs.

The AUTM survey did not include some of the questions we were interested in. Thus we contacted the respondents of the AUTM survey and asked them to answer a small number of additional questions from our European survey. We sent the survey to the 154 TTOs who had answered the 2007 AUTM survey. We received 89 answers out of the target population of 154

[4]Prior testing had shown that, despite our promise of confidentiality, some respondents were unwilling to indicate their exact license income, particularly if the latter was either very large or very small . The intervals were: less than 30,000 euros, between 30,000 and 100,000 euros, between 100,000 and 300,000 euros, between 300,000 and 1 million euros and more than 1 million euros.

respondents, i.e. a response rate of 58%. Of these answers, we used those 82 that provided information on the composition of the staff.

In the first part of the paper we use the full AUTM sample (i.e. all AUTM survey respondents), and in the second part we use the results of our survey on US TTOs.

3.2 Descriptive statistics on licensing outcomes

It is interesting to first consider the differences in raw numbers between the US and Europe. Figure 2 shows a box plot of the number of licenses concluded by US and European universities in 2007. The mean number of licenses for European universities is only 7.8 compared to 26.4 for the US. This difference is not due to just a small number of strong performers in the United States. In fact, the median number of licenses for European universities is only 4 compared to 13 for US universities.

⟨ Insert figure 2 about here ⟩

Our measure for license income earned by US and in European TTOs in 2007 is represented by license revenue gross of licensing costs[5] The differences in license income are equally striking. Figure 3 shows the number of universities that earn license revenues in the relevant categories[6]. Only 18 European universities have license revenues exceeding one million euros, whereas this is the case for 75 US universities. At the other end of the distribution, 81 European universities have license revenues below 30,000 euros, whereas this is the case for only 7 US universities.

⟨ Insert figure 3 about here ⟩

These raw numbers suggest a superior licensing performance by US universities, although the explanation may be that US universities produce more knowledge or devote more effort to technology licensing.

[5]The license income question that we posed to European TTOs is the same as that posed by the AUTM to US TTOs.

[6]For US universities we knew the exact license income figures but we converted them into intervals to make them comparable with European data. We used the 2007 yearly average exchange rate to convert the dollar amounts into euros.

3.3 Econometric specifications

While we adopted a standard linear regression model for the number of licenses, we performed an interval regression analysis for the license income earned to take into account the fact that we did not observe the exact value of license income but only the interval into which it falls. This methodology allows also for the possibility that the observations are right-censored. In fact, as mentioned earlier, we observed only that license income is greater or lower than the threshold value, 1.000.000 euros, but we did not know what the upper bound was. Interval regression assumes that the data come from a normal distribution. In our case, license income was not distributed normally, although we can assume that its log follows a normal distribution. Therefore, if license income falls within our survey categories, its log should fall within the logs of these categories.

Interval regression is a generalization of the censored regression model, where the latent variable, y_i^*, is expressed as a function of x_i explanatory variables:

$$y_i^* = x_i'\beta + u_i \qquad \text{with } u_i \sim N(0, \sigma^2)$$

What we observe is $y_i = y_i^*$ if $y_{iL} \leq y_i^* \leq y_{iR}$ and $y_{iR} = y_i^*$ if $y_{iR} \leq y_i^*$.

All regressions are run with robust standard errors.

3.4 Determinants of licensing outcomes

Publication volume. As proxy for the pool of technologies available at an academic institution, we used the number of articles in Science and Engineering. This measure also obviously controls for the quality of the academic institution. For each university in our sample we collected the total number of articles published in Science and Engineering during the period 2004-2006 by researchers of the university, as reported in the ISI Web of Science.

Quality of the academic institution. We experimented with different measures of the quality of the academic institutions[7]. In our preferred specification, we took the number of highly cited scientists affiliated with the university, as reported in the Shanghai world ranking of universities. For those universities not listed in the ranking, we assumed that the number of highly cited scientists is zero.

Orientation of the academic research. We controlled for biotechnology orientation of an academic institution with the ratio of the number of top ten journal publications in the fields of medicine,

[7] As a robustness check, we used the total score in the Shanghai world ranking of universities or specific components of that score other than that used in our preferred specification (publications in *Nature* and *Science*, number of staff who have received the Nobel Prize or the Fields medal). All the different specifications delivered similar results.

biology, and chemistry to the number of top ten journal publications in the field of engineering. We selected the journals according to the total number of citations they had received, as reported by the ISI Web of Science. Finally, we also controlled for whether the university has a medical school or is a technology institute.

Age of TTO. For European universities we did not know the exact year in which the TTO was created because in the survey we only asked for intervals (between 2003 and 2007, between 1997 and 2002, etc.). Thus, we created a discrete variable that takes increasing values for earlier years of foundation[8]. The age variable is defined in such a way that the coefficient of this variable in a regression can be interpreted as the effect of one additional year of experience.

Professor's privilege. Several European countries used to have a law (commonly referred to as "professor's privilege") according to which the intellectual property generated from university inventions belonged to the researcher rather than to the university. The professor's privilege was abolished in Germany (2001), in Norway (2002), in Denmark (2004) and in Finland (2007). However, it is still applicable in Sweden and was introduced in Italy in 2005. One implication of this regime is that university researchers are under no obligation to even report licensing activities to the technology transfer office. To take this into account we constructed a dummy that assumes the value one if the university is located in Sweden, Italy, or Finland. We included Finland in the definition of the countries with professor's privilege since it abolished the privilege only very recently. However, our results are robust to not including Finland in the definition of countries with professor's privilege.

Demand for technology. We followed the economics of innovation practice of using patent indicators to capture aspects of the innovative performance. We used the OECD regio database to obtain the number of patent applications (EPO patent applications for European regions, USPTO patent applications for US regions) at the regional level. The regional level is that of the "TL2" which corresponds to a state in the US, a Land in Germany, etc. To ensure the comparability of the regional patent counts between the US and Europe we adjusted the regional patent counts by each country's propensity to patent (number of triadic patent families divided by the number of national applications).

Staffing level. For the US we knew how many licensing staff (full-time equivalents) were employed by the TTO. For Europe, we knew the total staff in the TTO and the percentage of time they spend on licensing, and by multiplying the two we obtained a measure equivalent to the US variable.

[8]The variable takes the value 3 if the TTO was created between 2003 and 2007, the value 8 if created between 1998 and 2002, 13 if created between 1993 and 1997, 18 if created between 1988 and 1992 and 23 if created earlier than 1988.

3.5 Descriptive statistics on the independent variables

Table 1 gives descriptive statistics for the control variables, distinguishing between European and US universities. Large differences are apparent. The average US university in our sample produces almost twice as many publications as the average European university in our sample. US universities also have a greater orientation towards biotechnology, our index being twice as large for the US than for Europe. Furthermore, the TTOs of US universities are older and tend to employ more staff devoted to licensing than their European counterparts.

⟨ Insert table 1 about here ⟩

3.6 Sample representativity

In this section we investigated the representativity of our sample relative to its target population, by comparing the characteristics of the sample with those of the corresponding target population. Specifically, we built a probit model where the dependent variable was one if a TTO was selected in the sample from the target population. We then related the probability that a TTO was selected in the sample to a number of characteristics of the university to which the TTO was affiliated. The characteristics we considered include the number of scientific articles in the period 2004-2006, the number of highly cited scientists (provided by the Shanghai world ranking of universities), whether the university is a Technology institute, and whether it has a medical school.

We present the results separately for European and US TTOs. As already specified, the target population comprised TTOs of universities whose researchers published more than 200 scientific articles during the period 2004-2006. Moreover, the sample of European TTOs encompassed those 163 survey respondents who had provided an answer to the questions on license outcomes, staff, and year of establishment of a TTO. Finally, the sample of US TTOs included the respondents to the 2008 AUTM survey, whose university had satisfied the criterion of 200 scientific articles during the period 2004-2006.

Table 2 shows that the characteristics of the European sample did not significantly differ from those of the corresponding target population. In fact, none of the characteristics we included in the regression below were statistically significant. On the contrary, our sample of US TTOs over-represented high quality universities, the coefficient for the Shanghai score on highly cited scientists being positive and statistically significant. This result needs not to be a source of concern, however; in our regressions, as shown in the next tables, we always controlled for the quality of the academic institutions.

⟨ Insert table 2 about here ⟩

3.7 Results

The results of the regression on the number of licenses are given in Table 3. Without controls (column I), the coefficient of *US* was large and significant.

Once we control for the quantity, quality and composition of the research as well as demand for technology (column II), the coefficient of *US* drops from 1.124 to 0.567 but remains significant at the 1% confidence level. This suggests that factors external to the TTO account for around half of the observed difference in the number of licenses, which is consistent with the observation that US universities produce more publications and employ more stars than European universities. The controls for quality and composition of the research *Publications, Bio orientation, Shanghai score on hici* are all positive and significant at the 1% level. Location in a technology institute has a positive impact and significant on the number of licenses concluded by a TTO. Having a medical school increases the number of licenses but not significantly so. Regional demand for technology is not significant.

Once we controlled for the quantity, quality, and composition of the research, as well as demand for technology (column II), the coefficient of US dropped from 1.124 to 0.567 but remained significant at the 1% confidence level. This suggests that factors external to the TTO account for around half of the observed difference in the number of licenses, which is consistent with the observation that US universities produce more publications and employ more stars than European universities. The controls for quality and composition of the research *Publications, Bio orientation, Shanghai score on hici* were all positive and significant at the 1% level. Location in a technology institute had a positive and significant impact on the number of licenses concluded by a TTO. Having a medical school increased the number of licenses but not significantly so. Regional demand for technology was not significant.

⟨ Insert table 3 about here ⟩

In column III, we controlled for countries that either apply the professor's privilege (Italy and Sweden) or that have recently abolished it (Finland). The impact of *Professor's privilege* was negative and statistically significant. Taking it into account reduced the coefficient of *US* further.

In column IV we included the age of the TTO and the number of staff employed in licensing. This specification constitutes our preferred, or baseline, regression. As expected, the effect of *Staff* (expressed in log) and *Age* on the number of licenses concluded by a TTO was positive and highly significant. As a result of adding these controls, the coefficient of *US* became small and no longer significant. Thus, the remaining difference between US and European universities was explained by the fact that US universities have more experience in technology transfer and more personnel devoted to licensing activities.

In the last column, we introduced an interaction effect between *US* and *Staff* to allow for the possibility that US TTO employees are more productive than their European counterparts, which did not appear to be the case.

The regression results lead us to conclude that there is no great difference between US and European university TTOs when we consider the number of licenses and control for the relevant inputs. Almost all of the observed difference in the number of licenses executed could be explained by differences in inputs to the technology transfer process. We now turn to licensing income and repeat the same exercise.

⟨ Insert table 4 about here ⟩

In column I, we only regressed license income on the US dummy and found a very large and significant effect. In column II, we include our proxies for the quantity, quality, and composition of the research and the demand for technology. Having added these controls, the coefficient of *US* dropped from 3.366 to 2.037 but remained large and highly significant. As expected, the coefficients of *Publications* and *Shanghai score on hici* were statistically significant at the 1% level. *Medical school* and *Bio orientation* did not appear to have an effect on license income. Highly cited biologists are a very important fraction of highly cited scientists. Thus the life science effect may go through *Shanghai score on hici* especially if leading edge biomedical research is more important for license income performance. The coefficient on regional patents was positive and significant in the specification of column II and in some of the subsequent specifications, which contrasts with what we found when analyzing the number of licenses.

In column III we included the dummy *Professor's privilege* whose coefficient, as before, was negative and statistically significant. Once again, the coefficient of *US* decreased but remained significant.

Column IV presents the regressions results when the variables *Staff* (expressed in log) and *Age* are added to the model. Their coefficients were positive and significant at the 1% level. Having added these controls caused the coefficient of *US* to fall from 1.9 to 1.3 without, however, affecting its statistical significance.

As before, we included the interaction terms between *US* and *Staff* in column V. The interaction term was significant at the 10% confidence level; the effect of staff on license income thus seemsed to be larger in US universities. An interesting potential explanation for this result is that US universities may employ staff with higher levels of human capital. We pursue this hypothesis in section 4 by considering business experience of TTO employees.

Finally, as a robustness check, we conducted a thought experiment whereby we compare the observed number of licenses for European with the counterfactual created by applying US coefficients to European Universities. Unfortunately, we could not apply the same method to licensing income due to the limitations of our license income data [9]. The experiment consisted of running the regressions on US universities only and then make out-of-sample predictions for European universities. This technique has been employed in labor economics to analyze male-female wage differentials (Malkiel & Malkiel 1973).

⟨ Insert table 5 about here ⟩

The first two rows of table 5 display the number of licenses in logs for EU universities ($\bar{L}_{EU} = 1.839$) and US universities ($\bar{L}_{US} = 2.744$), leading to an observed mean difference of ($\bar{L}_{US} - \bar{L}_{EU} = 0.905$). The next two rows show the number of licenses predicted by applying US coefficients to US universities. In one case we ran the US regressions only with factors external to the TTO ($\tilde{L}_{EU} = 2.218$) and in another we ran the US regressions with both external factors, staff and age ($\hat{L}_{EU} = 1.922$). We could then use these predictions to decompose the observed mean difference into separate components. 58% of the observed mean difference between the US and Europe could be attributed to factors external to the TTO and 90.8% to external factors, age and staff. The result of the application of this method was thus completely consistent with our earlier finding that observable TTO inputs account for almost the entire US-EU differential in the number of licenses.

3.8 Heterogeneity within Europe

In our analysis, we implicitly assumed that Europe was an homogeneous group. Even though we took into account the professor's privilege, cross-national differences may go beyond regulations concerning intellectual property ownership. While we did not have sufficient data to analyze cross-national differences within Europe in detail, introducing country-fixed effects in our regressions may provide some clues.

[9] We did not know the exact license income earned and for the top performers we only know that their license income was above one million euros.

Table 6 presents the regressions for the number of licenses (Column I) and license income (Column II), having introduced country-fixed effects. Switzerland and Belgium appeared to outperform the rest of the European countries in terms of both the number of licenses executed and license income earned. Their coefficients were positive and statistically significant in the regression for the number of licenses, indicating that Belgian and Swiss TTOs performed better than their US counterparts relative to the number of licenses executed. At the other end of the distribution, Finland, Italy and Sweden executed fewer licenses than the other European countries and the US, while Sweden, Norway and Austria earned the least in terms of license income.

⟨ Insert table 6 about here ⟩

4 Exploring the source of the license income differential between the US and Europe

As we have shown in the previous section, European TTOs earn less income from licenses than their US counterparts, having controlled for academic quality and research orientation, demand for technology and TTOs characteristics.

In this section we present evidence on differences between the organization of European and US TTOs that might explain why European TTOs earn less license income. We conjecture the following two hypotheses: 1) US TTOs might be more oriented towards generating revenue than their European counterparts; 2) US might employ more staff with experience in the industry sector than their European counterparts. These hypotheses were formulated after discussions we had with technology transfer representatives in Europe and in conforming to the literature on objectives and incentives at US TTOs. The rationale for the two hypotheses is the following. If generating revenue is a TTO's primary objective, then it will focus on negotiating those licenses that ensure higher revenue rather than maximizing the number of licenses negotiated. Moreover, staff with experience in the industry sector may be more apt at negotiating licenses with private companies and, especially, financial clauses.

In this analysis we made use of 157 answers by European TTOs and 82 by US TTOs.

To test the first hypothesis we provided qualitative evidence based on the answers furnished by the TTO respondents in the US and in Europe. The rationale for the qualitative analysis stands in the acknowledgment that introducing any variable capturing the importance of generating revenue as an objective in the regression for license income entails serious problems of endogeneity. Of course, a TTO that does not earn a large license revenue would be tempted to say that generating revenue is not an important objective. On the contrary, to test the second hypothesis, we used a quantitative approach and included in our regression for license income our proxy for a TTO industry experience.

4.1 Objectives and metrics of success

US and European TTOs were asked to evaluate the following objectives: 1) promote diffusion of scientific knowledge and technology; 2) generate revenues; 3) promote local economic development; 4) promote national economic development; 5) attract and retain faculty through quality of technology transfer services. We used a 5-point Likert scale ranging from “not important” to “extremely important”. Our prior was that US TTOs tend to focus more on “generating revenue” than their European counterparts.

The results of the survey showed that, in absolute terms, US TTOs tended to place a greater value on the objective of “generating revenue” than their European counterparts. In fact, the percentage of US TTOs indicating that “generating revenue” is either important, very important or extremely important was 80.7%, while the same percentage in Europe was 72.9%[10].

However, relative to their European counterparts, US TTOs did not place more importance on generating revenue than they did on “promoting local development” and “attracting and retaining faculty”. In fact, table 4 shows that the percentage of TTOs that indicated that “generating revenue” is more important than “promoting local development” was very similar for US and Europe. However, the percentage of respondents estimating that “generating revenue” was less important than “promoting local development” was greater in the US than in Europe. Similar results were obtained, when comparing the objective of “generating revenue” with that of “attracting and retaining faculty”.

⟨ Insert table 7 about here ⟩

We also asked TTOs to evaluate the following metrics of success: 1) license income; 2) number of licenses/options executed; 3) number of patents awarded; 4) number of startups established.

In absolute terms, US respondents attached more importance to license income than did their European counterparts. In fact, 86.4% of the US respondents declared that license income was either important, very important or extremely important, while in Europe this percentage was

[10]The percentage of total respondents who indicated that “generating revenue” was either very important or extremely important was 42.1% for US TTOs and 33.8% or European TTOs.

71.4%[11]. These results were in line with what we found for the importance of "generating revenue" as an objective, which seems to be more relevant, in absolute terms, to US TTOs than to European ones.

In relative terms, US TTOs attached less importance than their European counterparts to license income when compared to the number of licenses negotiated and the number of startups created. However, US TTOs attached more importance than their European colleagues to license income relative to the number of patents filed.

⟨ Insert table 8 about here ⟩

4.2 Staff with experience in the industry sector

Our second hypothesis was that US technology transfer professionals are more experienced at negotiating the financial clauses of licensing contracts. Very often in discussions with academic researchers and firms in Europe, we heard anecdotes about TTO personnel lacking adequate experience to negotiate with companies because of their insufficient comprehension of industry logic and goals

To verify whether US technology transfer professionals are more experienced at negotiating licenses, we decided to include in our survey two questions asking whether the head of a TTO had at least five years of experience in industry and how many licensing staff members had at least five years of experience in industry. The logic behind these questions was that TTO staff members with experience in industry would be more acquainted with the goals and the *modus operandi* of private companies than would staff members with no such experience. Moreover, the question relative to the head of a TTO was motivated on the basis that the goals and the activities a TTO pursues can be influenced, at least in part, by the convictions of their head.

The results of our survey revealed clearly that the TTO staff (including the director) in the US had more experience in industry than did the TTO staff (including the director) in Europe. 77% of the US respondents declared that the head of their TTO had at least five years experience, while in Europe this percentage was 43%. Moreover, the US respondents had an average of 2.6 licensing staff with experience in industry, while Europe had an average of only 0.8.

In table 9, column II, we added to the regression on license income a dummy equal to one if the head of a TTO had at least five years of experience in industry. As expected, the coefficient

[11] The percentage of respondents who indicated that license income was either very important or extremely important, was higher in the US (50%) than in Europe (40%).

for *business director* was positive and significant at the 5% significance level. Taking into account the industry experience of a TTO director reduced the coefficient of the US dummy by 14%. In column III, we used the number of staff with at least five years of experience in industry as a proxy for TTO industry experience. Again, the coefficient of *business staff* was positive and significant and the coefficient of the US dummy declined by 21% to 0.90[12].

⟨ Insert table 9 about here ⟩

The econometric results seemed to confirm our hypothesis that TTO experience in industry is important when negotiating license contracts, especially financial clauses. As we have shown, including our proxies for industry experience entailed a decline in the US dummy coefficient. However, the latter remained positive and statistically significant. Surely, the proxies we adopted control only imperfectly for the TTO staff experience in industry. The effect of business experience would be larger if we had been able to take into account the different types of experience TTO staff had acquired in industry. An examination the CVs (available on line) of TTO directors in the US revealed that some TTO directors had launched their own companies prior to joining the TTO, while others were licensing executives for major companies[13].

5 Concluding Remarks

Combining new survey data on university technology transfer offices in Europe together with public information available on both US and European universities, we investigated whether US technology transfer offices conclude more licenses and earn more license revenue than their European counterparts.

Our first result showed that, having controlled for the quality of the academic institutions, their research orientation, the number of publications, the local demand for technology and TTO staff, and age, we could not conclude that US TTOs make more license agreements than their European counterparts. In fact, the coefficient of the US dummy was small and insignificant.

[12]As a robustness check, we included the variables *business staff* and *business director* in the regression for the number of licenses. None of these variables was statistically significant, confirming our prior suspicion that the role of industry is especially important for the negotiation of the financial clauses of a license.

[13]The head of the TTO of MIT spent 20 years in industry, primarily in the fields of membrane separations, medical devices, and biotechnology at such companies as Amicon, Millipore and Applied Biotechnology. The head of the TTO of Emory University, served as in-house patent counsel for an international pharmaceutical corporation for seven years. The head of the TTO of the University of Vermont had ten year of experience in the Science and Medical Products Divisions of Corning Glass works. The head of the TTO of Boston University had co-founded two companies: Kytogenics Inc. and Genmap Inc.

Our second result showed that, having controlled for the same factors as for the number of licenses, US technology transfer offices earned more revenue from licenses than their European counterparts. The coefficient of our US dummy was positive and highly significant. Our controls explained two thirds of the difference in license income earned between the US and Europe.

The situation in Europe did not prove to be homogeneous. Switzerland and Belgium outperformed the other European countries, whereas Italy and Finland underperformed the rest of Europe in terms of the number of licenses, and Austria and Norway in terms of license income earned. An in-depth investigation of the origins of cross-country differences was beyond the scope of this paper but is an important avenue for future research.

We conjectured that US TTOs have more staff with experience in industry, which makes them both better at understanding the *modus operandi* of firms and more skilled at negotiating the financial clauses of licensing contracts. Our proxies for TTO business experience had a positive and statistically significant impact on license revenue earned by TTO and entailed a decline in the US dummy coefficient. Moreover, we speculated that US TTOs tend to place more importance on the objective of "generating revenue" than their European counterparts and, therefore, have more incentive to negotiate licenses that potentially generate high revenue. Here, the evidence was mixed. In absolute terms, US TTOs tended to place more importance on generating revenue than European TTOs. However, they did not place more importance than European TTOs on revenue generation relative to other objectives, such as local development and faculty service.

We believe our analysis helps to clarify the debate on the "European Paradox". To the best of our knowledge, we are the first to employ micro-level evidence to analyze transatlantic differences in licensing performance. Our findings highlight the importance of university inputs, such as publications, and of TTO size and experience as factors explaining the gap between the US and Europe in terms of number of licenses concluded. As for license revenue, these factors are still very important but leave part of the difference between the US and Europe unexplained.

The different performance in terms of license income need not in itself be a source of concern. There is nothing in economic theory to suggest that TTOs should maximize license revenue. Social welfare might be better served by TTOs facilitating local economic development or helping to translate academic research into products. However, to the extent that revenue generation is an objective (and many TTOs say it is), policy changes are advisable to close the gap between the US and Europe. Preliminary evidence points to the usefulness of industry experience in negotiating licenses, especially financial clauses. The optimal composition of a TTO and the nature of organizational practices that TTOs should employ remain a subject for further research.

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A Description of the Variables

⟨ Insert tableA1 about here ⟩

B Survey Questions

Questions asked to EU TTOs only

1. When was your office established originally (CHOOSE ONE OF THE OPTIONS BELOW)?

   - In the last 5 years (2002 -2007)
   - Between 5 and 10 years ago (1997-2001)
   - Between 10 and 15 years ago (1992-1996)
   - Between 15 and 20 years ago (1987-1991)
   - More than 20 years ago

2. How many licenses/options did your OFFICE execute last year (include exclusive AND non-exclusive licenses/options, assignments and software licenses)?

3. What was the total amount of license income earned from university intellectual property (EUR)?

   - 0 - 29,000
   - 30,000 - 99,000
   - 100,000 - 299,000
   - 300,000 - More than 1,000, 000

Questions asked to EU AND US TTOs

1. At present, approximately how many employees (full time equivalents) are in your office?

2. Among employees (full time equivalents) how many have an experience in the industry sector of AT LEAST FIVE years?

3. Please indicate the percentage of time your OFFICE spends approximately on the activities below. (THE TOTAL HAS TO SUM TO 100%)

   - Assessing the patentability of inventions, applying for patents and negotiating and managing licenses
   - Negotiating and managing research contracts and/or grants (regional, national, EU)
   - Supporting start-up companies (excluding activities in A and including for example assessing the opportunity for a technology to be commercialized with a start-up, providing contacts with venture capitalists, support in the design of the business plan...)
   - Increasing awareness among academic researchers and industry of technology transfer opportunities (organization of courses, workshops, participation in workshops...)
   - Others (managing data flows, designing technology transfer policies...)

4. In your opinion, what are the main objectives your OFFICE pursues when engaging in technology transfer activities? Please indicate the degree of importance attached to the objectives below.

   ⟨ Insert tableA2_1 about here ⟩

5. We are interested in how you measure the success of your TTO. How important to you are the following measures of success? Please indicate the degree of importance attached to the measures of success below.

⟨ Insert tableA2_2 about here ⟩

C Correlation Table

⟨ Insert tableA3 about here ⟩

Tables

Table 1: Descriptive Statistics

	Europe (n=163)				US (n=141)			
Variable:	**Mean**	**St.Dev.**	**Min**	**Max**	**Mean**	**St.Dev.**	**Min**	**Max**
Publications (thousands)	2.354	1.910	0	8893	4.478	4.098	0.117	26.366
Shanghai score on hici	6.768	8.810	0	40.6	20.713	18.519	0	100
Bio orientation	0.060	0.1861	0	0.963	0.130	0.252	0	0.992
Technology institute	0.080	0.272	0	1	0.057	0.232	0	1
Medical School	0.031	0.173	0	1	0.106	0.309	0	1
Professor's Privilege	0.215	0.412	0	1	0	-	0	0
Regional patents	154.091	264.612	0 163	1633.229	480.468	614.335	11.461	4052.206
Staff	2.237	2.642	0	24	5.184	5.104	0	37
Age	9.932	6.195	3	23	17.539	6.003	3	23

Table 2a: likelihood of inclusion in the sample

	(1) US	(2) EU
# of universities with more than 200 scientific publications between 2004 and 2006	185	358
# of useable answers	141	163
Useable answer as %	76.63%	45.53%

Table 2b: Probit estimation of the likelihood of inclusion in the sample

	(1) US	(2) EU
	D=1 if we have a useable answer	
Publications	-0.008	0.038
	[0.006]	[0.023]
Technology institute	0.039	-0.069
	[0.129]	[0.090]
Medical school	0.126	-0.076
	[0.078]	[0.139]
Shanghai score on hici	0.008***	-0.004
	[0.002]	[0.005]
Observations	184	358

Marginal effects reported.
*** p<0.01, ** p<0.05, * p<0.1
Robust standard errors in brackets

Table 3: Results on the number of licenses

	(1) licenses (in logs)	(2) licenses (in logs)	(3) licenses (in logs)	(4) licenses (in logs)	(5) licenses (in logs)
US	1.124***	0.567***	0.375***	0.076	-0.066
	[0.132]	[0.123]	[0.125]	[0.114]	[0.232]
Publications		0.115***	0.135***	0.066**	0.063**
		[0.038]	[0.038]	[0.031]	[0.031]
Technology institute		0.579***	0.591***	0.459***	0.475***
		[0.216]	[0.201]	[0.173]	[0.177]
Medical school		0.080	0.129	0.132	0.133
		[0.174]	[0.162]	[0.158]	[0.158]
Regional patents		0.000	-0.000	-0.000	-0.000
		[0.000]	[0.000]	[0.000]	[0.000]
Bio orientation		0.003***	0.002**	0.002**	0.002**
		[0.001]	[0.001]	[0.001]	[0.001]
Shanghai score on hici		0.021***	0.018***	0.012**	0.012**
		[0.007]	[0.006]	[0.005]	[0.005]
Professor's privilege			-0.945***	-0.596***	-0.610***
			[0.156]	[0.153]	[0.154]
Age				0.031***	0.030***
				[0.008]	[0.008]
Staff (in logs)				0.598***	0.547***
				[0.110]	[0.129]
Staff (in logs) interacted with US					0.120
					[0.161]
Constant	1.658***	1.142***	1.332***	0.561***	0.631***
	[0.085]	[0.104]	[0.106]	[0.126]	[0.165]
Observations	304	304	304	304	304
R^2	0.196	0.482	0.531	0.614	0.615

*** p<0.01, ** p<0.05, * p<0.1
Robust standard errors in brackets

Table 4: Results on license income

	(1) license income (intervals, in logs)	(2) license income (intervals, in logs)	(3) license income (intervals, in logs)	(4) license income (intervals, in logs)	(5) license income (intervals, in logs)
US	3.366***	2.037***	1.736***	1.287***	0.388
	[0.325]	[0.284]	[0.279]	[0.282]	[0.651]
Publications		0.227**	0.290***	0.158	0.156
		[0.095]	[0.095]	[0.096]	[0.097]
Technology institute		0.431	0.426	0.239	0.308
		[0.487]	[0.483]	[0.438]	[0.448]
Medical school		-0.143	-0.018	0.011	0.018
		[0.436]	[0.427]	[0.428]	[0.430]
Regional patents		0.001**	0.001	0.001*	0.001
		[0.000]	[0.000]	[0.000]	[0.000]
Bio orientation		0.004	0.002	0.003	0.002
		[0.004]	[0.004]	[0.003]	[0.003]
Shanghai score on hici		0.065***	0.057***	0.048***	0.044**
		[0.018]	[0.017]	[0.017]	[0.017]
Professor's privilege			-1.554***	-0.950**	-1.032**
			[0.449]	[0.447]	[0.439]
Age				0.059***	0.054**
				[0.021]	[0.021]
Staff (in logs)				0.764**	0.517
				[0.298]	[0.339]
Staff (in logs) interacted with US					0.779*
					[0.480]
Constant	10.710***	9.602***	9.910***	8.797***	9.171***
	[0.209]	[0.275]	[0.274]	[0.376]	[0.451]
Observations	304	304	304	304	304
McFadden R^2	0.125	0.237	0.252	0.377	0.278

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Using US coefficients to predict EU licensing outcomes

Observed # of licenses in logs- EU universities	$\bar{L}_{EU}$	1.839
Observed # of licenses in logs- US universities	$\bar{L}_{US}$	2.744
Predicted # of licenses in logs for EU universities with US coefficients, regressions with factors external to the TTO	$\tilde{L}_{EU}$	2.218
Predicted # of licenses in logs for EU universities with US coefficients regressions with factors external to the TTO, age and staff	$\hat{L}_{EU}$	1.922
Observed mean difference	$\bar{L}_{US} - \bar{L}_{EU}$	0.905
Percentage of the observed mean difference explained by factors external to the TTO	$(\bar{L}_{US} - \tilde{L}_{EU})/(\bar{L}_{US} - \bar{L}_{EU})$	58.1%
Percentage of the observed mean difference explained by factors external to the TTO, age and staff	$(\bar{L}_{US} - \hat{L}_{EU})/(\bar{L}_{US} - \bar{L}_{EU})$	90.8%

Note: To ensure consistency with the rest of the analysis, universities from EU countries with professor's privilege (Sweden, Norway and Finland) were excluded from the comparison because the coefficient for professor's privilege cannot be estimated from US data alone.

Table 6: exploring heterogeneity within Europe

	licenses (in logs)	license income (intervals, in logs)
Publications	0.054*	0.151*
	[0.030]	[0.085]
Technology institute	0.358**	0.321
	[0.176]	[0.399]
Medical school	0.180	0.272
	[0.154]	[0.419]
Regional patents	-0.000	0.001
	[0.000]	[0.000]
Bio orientation	0.002**	0.002
	[0.001]	[0.003]
Shanghai score on hici	0.011**	0.025
	[0.006]	[0.016]
Age	0.033***	0.092***
	[0.009]	[0.022]
Staff (in logs)	0.660***	0.654**
	[0.104]	[0.282]
Austria	-0.478	-5.390***
	[0.644]	[0.402]
Belgium	0.610*	0.262
	[0.315]	[0.942]
Switzerland	0.881***	0.874
	[0.269]	[0.614]
Germany	0.135	-1.507***
	[0.182]	[0.497]
Denmark	0.146	0.663
	[0.427]	[0.496]
Spain	-0.334	-2.700***
	[0.213]	[0.464]
Finland	-0.639**	-2.084***
	[0.320]	[0.587]
France	-0.343**	-1.229*
	[0.173]	[0.649]
Netherlands	0.183	-0.423
	[0.252]	[0.658]
Ireland	-0.227	-0.953
	[0.370]	[0.999]
Italy	-0.650***	-1.433***
	[0.196]	[0.533]
Norway	-0.563***	-6.230***
	[0.185]	[0.391]
Portugal	-0.132	-2.913***
	[0.411]	[0.637]
Sweden	-0.636*	-4.151***
	[0.362]	[0.906]
United Kingdom	-0.203	-0.732*
	[0.181]	[0.385]
Constant (Omitted group: US)	0.605***	9.985***
	[0.167]	[0.462]
Observations	304	304
R^2	0.642	0.336

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Relative importance of objectives

	EU	**US**
Generating revenue is more important than promoting local development	20.5%	21.3%
Generating revenue is equally important than promoting local development	34.8%	27.0%
Generating revenue is less important than promoting local development	44.7%	51.7%
Generating revenue is more important than attract and retain faculty	24.8%	24.7%
Generating revenue is equally important than attract and retain faculty	31.4%	28.1%
Generating revenue is less important than attract and retain faculty	43.8%	47.2%

Table 8: Relative importance of metrics of success

	EU	**US**
License income is more important than # licenses	27.5%	19.5%
License income is equally important than # licenses	51.4%	47.2%
License income is less important than # licenses	29.1%	41.6%
License income is more important than # startups	26.2%	22.5%
License income is equally important than # startups	31.4%	39.3%
License income is less important than # startups	42.4%	38.2%
License income is more important than # patents	32.4%	48.3%
License income is equally important than # patents	36.7%	38.2%
License income is less important than # patents	30.9%	13.5%

Table 9: Licensing income and business experience of TTO directors and staff

	(1) license income (intervals, in logs)	(2) license income (intervals, in logs)	(3) license income (intervals, in logs)
US	1.136***	0.978***	0.902***
	[0.326]	[0.335]	[0.349]
Publications	0.215**	0.235**	0.226**
	[0.108]	[0.107]	[0.105]
Technology institute	0.147	0.239	0.170
	[0.496]	[0.500]	[0.496]
Medical school	0.062	0.043	0.001
	[0.512]	[0.462]	[0.485]
Regional patents	0.001*	0.001*	0.001*
	[0.000]	[0.000]	[0.000]
Bio orientation	0.001	0.002	0.002
	[0.004]	[0.004]	[0.004]
Shanghai score on hici	0.049**	0.043**	0.043**
	[0.019]	[0.019]	[0.019]
Professor's privilege	-1.325***	-1.295***	-1.302***
	[0.479]	[0.494]	[0.481]
Age	0.043*	0.050**	0.040*
	[0.023]	[0.023]	[0.023]
Staff (in logs)	0.820**	0.731**	0.641**
	[0.332]	[0.329]	[0.326]
Business staff			0.217*
			[0.121]
Business director		0.608**	
		[0.277]	
Constant	8.817***	8.515***	8.903***
	[0.437]	[0.454]	[0.439]
Observations	239	239	239
McFadden R^2	0.229	0.235	0.232

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in brackets

Table A1: Variable Definition

US	dummy equal to 1 if a TTO is located in the US
Publications	regional # of patents * (triadic patent filings / national patent filings)
Shanghai score on hici	# of publications in thousands (pbs.)
Bio orientation	# of pbs. in top 10 biology, chemistry and medicine journals / # of pbs. in top 10 engineering journals
Technology institute	dummy equal to 1 if a TTO is located in a Technology institute
Medical School	dummy equal to 1 if an academic institution has a medical school
Regional Patents	regional # of patents * (triadic patent filings / national patent filings)
Age	years since the foundation of a TTO
Professor privilege	dummy equal to 1 if a TTO is located in either Sweden or Finland or Italy
Staff (in log)	log of the number of licensing staff
Business director	dummy equal to 1 if a TTO director has at least 5 yrs. experience in industry
Business staff	# of licensing staff with at least 5 yrs. experience in industry

Table A2.1: TTO Objectives					
	Extremely important	Very important	Impor tant	Somewhat important	Not important
Promote diffusion of scientific knowledge and technology					
Generate revenues					
Promote local economic development					
Promote national economic development					
Attract and retain faculty through quality of tech transfer services					
Others (please specify)					

Table A2.2: TTO Metrics of Success					
	Extremely important	Very important	Impor tant	Somewhat important	Not important
License Income					
Research contracts/grants income					
# of licenses/options executed					
# of research contracts/grants executed					
# of patents awarded					
# of start-ups established					
Others (please specify)					

Table A1: Correlation table

Variables	# of licenses	log license income	Publi- cations	Technology institute	Medical school	Regional patents	Bio orien- tation	Shanghai score on hici	Privi- lege	Age	Staff (in logs)
# of licenses	1.000										
log_license_income	0.600	1.000									
Publications	0.635	0.566	1.000								
Technology institute	0.089	0.039	0.031	1.000							
Medical school	-0.008	0.112	-0.024	-0.020	1.000						
Regional patents	0.270	0.305	0.307	0.100	0.112	1.000					
Bio orientation	0.118	0.216	0.128	-0.114	0.316	0.062	1.000				
Shanghai score on HiCi	0.643	0.623	0.868	0.085	0.009	0.448	0.145	1.000			
Privilege	-0.211	-0.237	-0.039	0.024	-0.054	-0.168	-0.123	-0.132	1.000		
Age	0.471	0.577	0.452	-0.017	0.048	0.273	0.185	0.498	-0.346	1.000	
Staff (in logs)	0.610	0.632	0.626	0.102	0.029	0.268	0.072	0.625	-0.254	0.537	1.000

Figures

Figure 1: Respondents by country

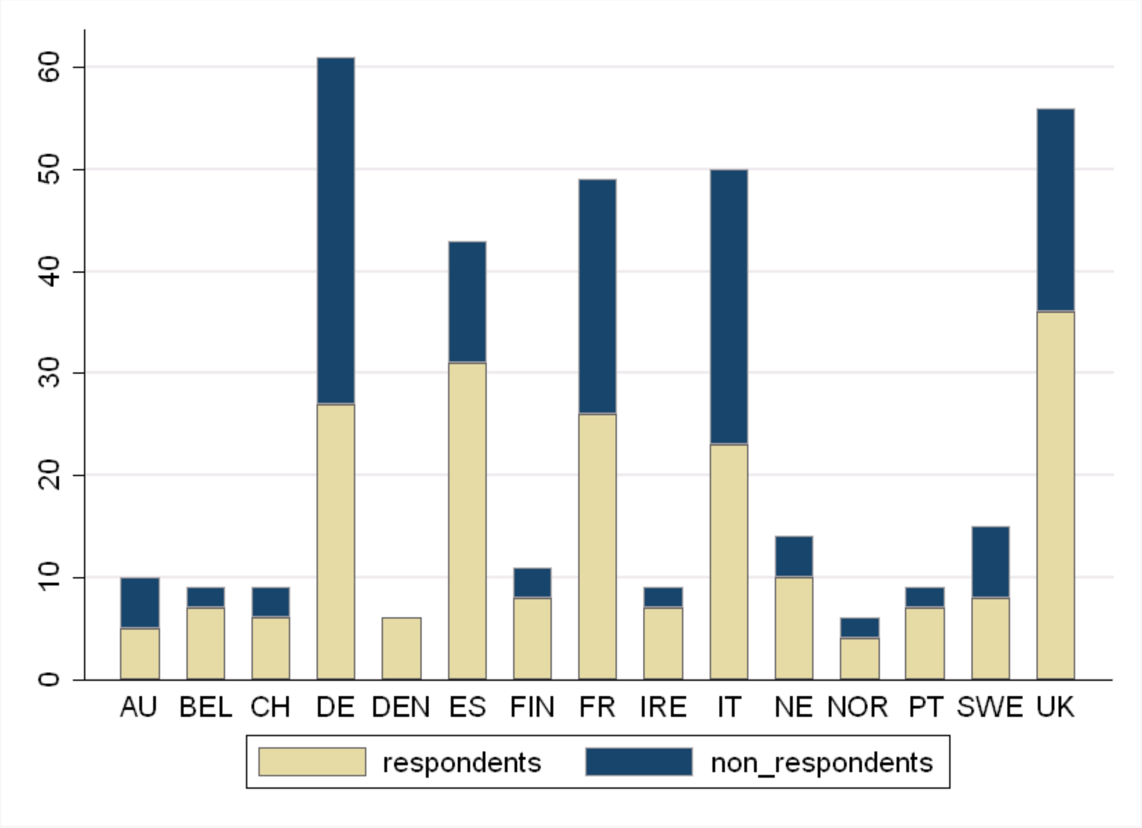

Figure 2: Distribution of the number of licenses

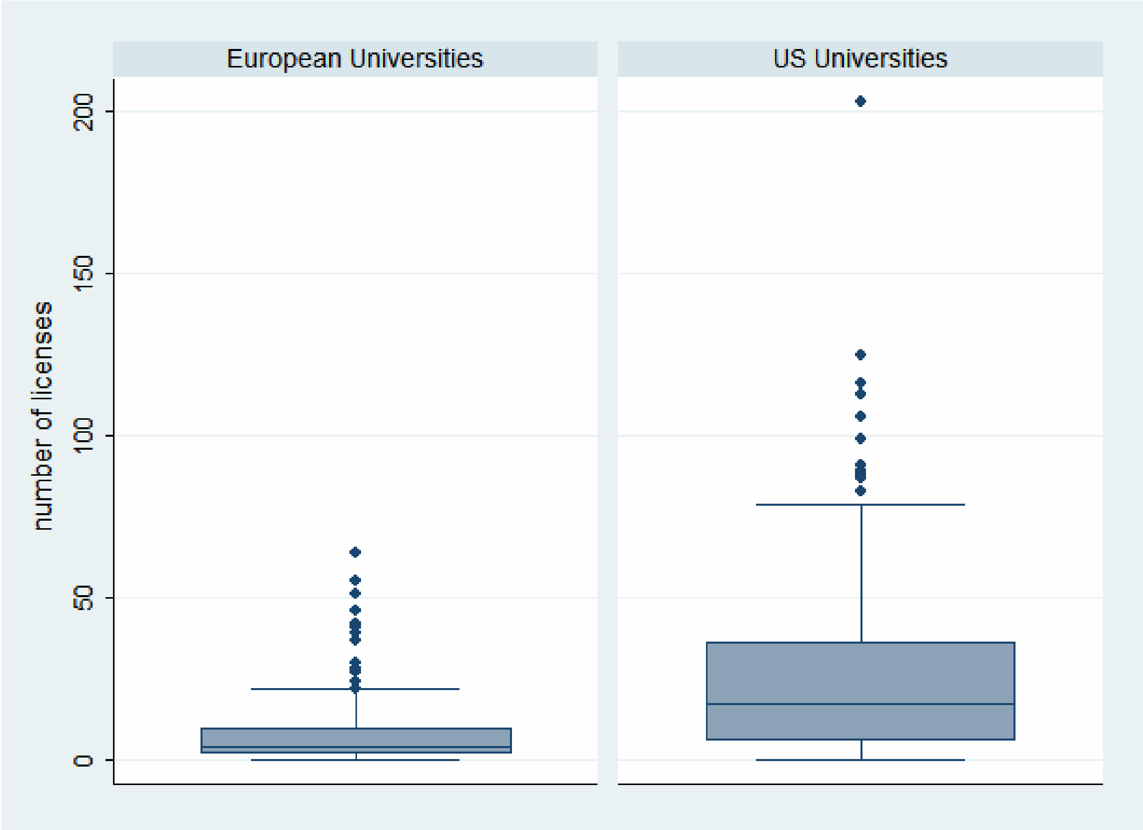

Figure 3: Distribution of license income