INSTITUTIONAL REFORMS AND THE GROWTH OF OWNERSHIP OF ACADEMIC PATENTING IN ITALY (1976-2007)

di Bianca Potì

Abstract

The article examines the ownership patterns of Italian University-invented patents before and after the introduction of the 'professors' privilege' in 2001 and explore how Universities react to the IP reform and how the resulting implementation affected the patenting activities. The article is built on data and results from a five years ESF project (Academic Patents in Europe). Results for Italy show a decreasing role of academic patents on the whole of resident patents and a shift from individually-owned and firm-owned patents to University-owned patents. The top Universities, where 50% of academic patents is concentrated, are probably the most affected by this change.

Key words: University patenting, technology transfer, professors' privilege, academic patents

INTRODUCTION

Academic patenting is an old but until recently scarcely understood and explored aspect[1]of the knowledge transfer from University to society, which can originate from publicly funded more fundamental research or from public-private collaboration. It is an instrument for the realization of the third mission of University, which is part of the current University transformation pursued by governments in various European countries. Academic patent can be defined as a property right on a research result in which it is possible to identify almost one University employee among the inventors. In this paper I refer and elaborate upon a work developed with Francesco Lissoni, Michele Pezzoni and Sandra Romagnosi within the ESF/APE project[2], which had the main aim of producing a freely available database on "academic patenting in Europe", containing reliable and comparable information on the contribution of European academic scientists to technology transfer via patenting. Academic patenting is (probably) not the more frequent way of academic knowledge transfer, in comparison with consultancy or research contracts and collaborations[3], but it is easier to identify and since its occurrence within the economic and managerial literature, it has attracted a lot of attention. One of the most studied subject was the impact of IPRs reforms on the property regime distribution: precisely if the introduction in Europe of new IPR legislation, shifting the control on the IP from the academic inventor to the academic institution, has risen the institutional ownership of academic patents.

The subject can be articulated into three research questions:

1. did the academic patenting of a country, measured as the quota of country's resident patents with almost one academic inventor, register an increase during the considered period? This was a less explored aspect for lack of longitudinal data, but it is relevant since it can explain if there was only a change in the IPR ownership distribution or also an expansion of the academic outcome transferred to society (through patents);

[1] These types of linkages can include or not patentable results.
[2] The studies by Meyer (2003) for Finland, and Balconi et al. (2004) for Italy have been the first ones to deal with this issue.
[3] The project "Academic Patenting in Europe (APE-INV)", is a five year European Science Foundation Research Networking Programme, lasting from 2009 to 2013.

2. how did the distribution of academic patents change among the possible owners: individual scientists, Universities, public research organizations, industrial companies or a combination of some of those actors. And in particular, since the academic patents in the past has been under the control of industrial companies for a very high percentage, is the growth in the University ownership accompanied by a decrease in the industrial companies' one? If changes go in this direction, the net effect of knowledge transfer is a little bit questionable;
3. did the recent IPRs reforms, coeteris paribus, impact the changes under the points 1 and 2 above? In particular did the 2000's European countries' change from laws supporting the so called "professor privilege"[1] to laws supporting the ownership of the academic institutions produce an effective increase in University owned academic patents? For the Italian case the question have to be reformulated in this way: did the introduction of the "professor privilege" in 2001 produce an increase in University owned academic patents? It could be translated into: did the IPR reform result in a stronger incentive for scientists to disclose their inventions, did it succeed in changing the behavior of "expert" inventors, with past experience in patenting and collaboration with industry and/or did it bring on the scene new academic inventors?

A certain complexity of aspects behind these questions is evident. First of all the IPR reform happened in parallel with or during the period of other reforms devoted to change University's governance and accountability and to improve the University autonomy and congruity to society needs. So one can imagine there was an interaction between the two kinds of reform and this certainly happened in Italy, where, in opposite trend to the other European countries (except Sweden, Finland and a few others), the "professor privilege" was introduced, giving a full control on the IPR to the academic inventors, at least in the legislator aim. This Italian reform went in an opposite direction also to the introduction of a stream of laws giving to the Italian University more control on their staff, on their funds and on their identity. The reaction of Italian Universities, writing their statutes during the same period, transformed the content of that reform. IPR reform in Italy wasn't well received by firm associations, nor by University managers neither by the same scientists, who had experienced in the past that it was possible to leave the IPR ownership to companies, receiving some economic reward and without incurring in University punishment. In sum, what happened in Italy was a compromise: very early University statutes gave a large possibilities of transferring IPRs from the scientific inventor to the academic institution and a later revision of the IPR law (in 2005) recognized the professor privilege only in the case of research activity fully internally funded by the Department/University. Of course this solution maintains some uncertainty and do not help University-industry collaboration. Moreover there are many other aspects, at disciplinary, regional, technological and University level that can have impacted on the academic patent trends and, anyway, University knowledge transfer needs a fertile context to be developed.

[1] The patent ownership attributed to academic inventors is an exception to the rule attributing the ownership of the employee invention to the employer.

In the following I will report firstly the background literature, to which we referred for our analytical frame and for identifying the variables of our analysis; then some main aspect of the University reform, of the IPR reform in Italy and of their relation; successively I present very shortly the methodology for identifying the academic inventors and for building the dataset followed by Italian team in the project APE, then some descriptive statistics showing the main characters of the Italian academic IPR trends, finally the econometric models, the results and a short conclusion.

1.THE BACKGROUND LITERATURE

Did the national University reforms influence the size of the knowledge transfer through academic patents or (only) the distribution of the control rights on academic inventions? One of the main scope of the work (Lissoni et al., 2013) was to check if the legislative and administrative changes had an impact on the production of academic patents, i.e. on a component of the University performance. Baldini et al. (2006, 2007), adopting a neo-institutional perspective, modeled the inter temporal organizational responses to IPR reform looking at the evolution of University internal regulation on "University" patenting[1], i.e. they worked on the academic patents "owned by Universities" (a more restricted outcome) between 1993 and 2009. These scholars observed that in Italy during '90s there was a shift in the University system from a strong centralization to more autonomy, where establishing internal regulation (statutes) meant the University's possibility of giving rules to its own activities. Statutes modified the 2001 IPR reform; then in 2005 a modification of the IPR law was introduced. It gave legitimation to the local solutions found by the University institutions and was reinforced also by the emergence of a community of practice (NETVAL[2]) (Baldini et al. 2006, 2007).

Besides considering the introduction of new legislation as source of behavior change, the neo-institutional and organizational literature tried to translate the University reform into specific indicators and to analyze their impact: various scholars tried to find out a relation between the new governance and the performance of Universities. OECD (2007) developed a series of indicators, on the basis of surveys of its member countries, measuring autonomy (financial autonomy, staff policy autonomy through hiring/firing and wages, student selection and course content) and accountability (evaluation mechanisms and funding rules). Van der Ploeg and Veugelers (2008) made an overview of statistical evidence, showing a high variance in University governance across countries. They found out also a lot of differences in various dimensions of governance across countries, that shows a multifaceted nature of governance, where different dimensions of autonomy and accountability resulted not necessarily correlated. As a consequence, each system can be characterized as a relatively unique bundle of governance characteristics. Aghion et al. (2009 a, b), using survey information collected from European Universities that belong to the top 500 of the Shanghai Ranking, found a high variance in University governance, also among those countries which performed well in terms of research. Universities' autonomy can be identified as the capacity of managing own financial and human resources with the lowest possible direct control by government. Aghion et al. (2009 a, b) considered two main indicators: whether a University's budget needs to be approved by the State and the percentage of the University's budget associated to competing grants.

[1] For University patents it is intended academic patents filed by Universities. The definition for academic patent is the following: " We define *academic patents* all those patents that cover inventions to which academic research has contributed to some degree. Empirically we call *academic patents* those patents that have at least a University scientist among the inventors" Lissoni et al (2010, p.3).

[2] The Network for the Valorisation of Universities' Research- NetVal- was created in 2002- (www.netval.it)

These scholars report some findings on the relationship between their set of proxies for governance and the research performance, measured by the Shanghai Ranking of their set of surveyed Universities or by their institutional owned patents.

The results indicate that to find out a positive and significant relation it is important to correct for other determining factors, besides governance: size, age and "budget per student" all affect positively research performance. Once these factors are included, the only governance indicator that turns out to be significant is budget autonomy. The scholar's conclusion is that the positive effects of having large "budgets per student" are higher if Universities enjoy a higher degree of budget autonomy and this suggests that policy should tackle simultaneously funding and governance. Italy is included among the continental weak performers (France, Germany, Spain and Italy) and, notwithstanding a large dispersion in governance characteristics among these countries, the resulting "common" aspects were the low levels of autonomy, accompanied by relatively high levels of accountability. This seems consistent with the complaint of overregulation in these systems.

Van der Ploeg and Veugelers (2008) wrote that combined under-funding and system rigidities are so acute in some European countries that they impede the reform process at Universities, who are consequently trapped in a vicious circle. Notwithstanding this, it is possible, also in Italy, to find an improved capacity of organization by Universities, which could have impacted on the management of academic patenting activities and on the implementation of the recent IPRs reform.

Looking for specific University characterization of the recent change, an aspect indicated as relevant by the literature is the structure of the Universities' funding. Many governments have shifted to a mix of funding schemes in which a larger share is allocated through competitive funding (Geuna 2001; Lepori et al. 2007) as opposed to the traditional institutional funding, largely determined on a per-capita basis (Lepori et al. 2005, Schmoch and Schubert 2009; Auranen and Nieminen 2010). From this it can be derived the hypothesis that academic institutions attracting more competitive research funds are also institutions of better quality, which attract better researchers, resulting in better University performance, also in terms of academic patents. Another relevant aspect deal with the difference between public and private university funding sources: van der Ploeg and Veugelers (2008) assert that the private funding gap is relevant at European level. This gap could influence the academic patenting result. Unfortunately CNSVU (a ministerial observatory) financial data don't allow to distinguish between private and public sources. We planned the introduction of data on university funding sources in our model as co-variables and collected data from CNSVU source, but these data (as showed later in the paper) didn't work well.

Another aspect related to the university funding structure deals with the size of Universities and the attraction of competitive funds, which could produce an increasing concentration of funds and of performance, also in terms of academic patents. Lepori et al. (2005) looked at the change in the funding patterns within a sample of European Universities: the authors didn't find a correlation between the change in Universities' revenue in the last half of '90s and the first half of 2000s, which shows that the composition of funding changed fundamentally. But these scholars didn't find an evident correlation between HEI's size and the share of competitive funds (grants and contracts), so they commented that an empirical evidence that large institutions were able of attracting more third party funds is lacking. As to the relation between the quality of University research and likelihood of interaction with external partners, it remains unclear in the literature. While some authors find a positive relationship between academic excellence and participation in technology transfer (Cohen et al. 2002; Bruno and Orsenigo 2003;

Renault 2006) other find a negative relationship (Ponomariov 2008).

In sum, it is conceptually relevant to introduce some proxies for University autonomy and in particular some variables on funding structure, when looking at the impact of University reforms on performance (academic patents and the sub group of academic owned patents), even if empirical evidence within the literature is still weak.

An aspect of the University reform is the relevance of the so called third mission, i.e. the contribution to the economic growth and competitiveness through direct knowledge transfer. This aspect can be better explored looking at the characters of the regions where Universities are located. If there were a growth in the demand of knowledge transfer activities, this could impact also on academic patenting, even if the technology transfer is an heterogeneous bundle of activities, which can complement or substitute each other. A large literature on regional economics shows that several activities in knowledge transfer take place within geographic distances internal to regions: a significant portion of knowledge spillovers from Universities take place within a regional system. Anselin et al. (1997) found a significantly positive impact of University research on innovative activity of high-tech firms within a range of 50 miles, while Varga (2000) identified effects up to 75 miles.

The characters of regions where Universities are located were important co-variables to be introduced in our model.

Of course knowledge transfer, and in general the third mission, touch also upon individual motivational factors and social norms in the scientific community, for instance in the decision to patent the research results (Owen-Smith and Powell 2001; Baldini et al. 2007). Individual scientists are affiliated to University departments, which reflect their disciplinary orientation and influence their research practice. The disciplinary mix characterizing an University could not be considered in our frame, which should imply we assume that differences between basic and applied research are not so strong in relation to academic patenting. This is sustained within the literature by the empirically tested positive relation between publications and patents at University level. In our frame we test if and what characters of the patent (in particular its scientific content) explain the probability of being an "academic" one.

The evolution of the sector composition of patent applications and the appearance of new research fields in which basic and applied research are more interconnected has been shown as relevant explicative factors by scholars studying the determinants of the growth of academic patents: Mowery et al. (2001) for U.S., Goektepe (2007) for Sweden. This last scholar considered new technological opportunities and higher scientific content of industrial research the explicative factors of academic patent growth in absence of a legislative reform (the professor privilege has been maintained). We controlled for the technological classes of patents and their relevance to the academic patenting.

If we refer more strictly to the University ownership of academic patent, we find that there isn't convergence on many aspects within the literature.

There isn't a full convergence on the more commonly recognized trend, i.e. the rise of the University ownership of academic patents. Some author sustains that it is entering a decreasing trend (Leydesdorff and Meyer, 2010) since, within the largest third mission, components can substitute and not complement each other.

There isn't convergence on the "net" effect of the academic patenting reforms on the ownership allocation. Some authors find out (like us) that there is an effect of substitution between University and industrial firms ownership (von Ledebur et al. 2009), others found a net additional effect (van Loy et al., 2009). There isn't convergence on the fact that the University ownership is a preferable model of academic patent ownership. Supporters advocate that a stronger control of Universities on patent use/applications offer more certainty of quality or consistency with ethical aspects and higher rewards for academic institutions. Other scholars

(Kenney and Patton, 2009) sustain that it is difficult to realize an alignment between academic inventors and academic administrations and between these last ones and the transfer offices on incentives, motivations and information and therefore a coming back to the "professor privilege" rule would be preferable.

A normative analysis of the regime of University ownership of academic patent was not our scope; we limited our work to explore what was on-going (trends) within this component of the academic knowledge transfer in a country (Italy) which followed an IPR policy reform opposite to that of most of the European countries.

2. MAIN ASPECTS OF IPR REFORM, UNIVERSITY REFORM AND THEIR RELATION

We look here at University reform mainly in terms of its interaction with IPR reform and of links with the academic patenting implementation.

Until '90s the University personnel didn't have the position of Universities employees, but that of civil servants, paid directly by the State, which also regulated their careers and teaching duties,. The first law introducing a structural change in the relation between State and University in Italy (L.168/1989) was not immediately effective for the absence of specific operating regulation. That law established (art. 6), among other aspects, that Universities adopt an autonomous set of rules through the internal Statutes, settled by elected internal bodies; the Statutes would have received a supervision by the central Administration, but they represented a fundamental expression of the University autonomy. In 1993 the L.168/1989 was implemented by the provision of new rules (L. 537/1993), which, among other aspects, introduced a general fund (FFO), which amounted to about 90% of the resources transferred by the State to the Universities; it marked a change from a line-item budgeting to a lump sum budgeting, giving more room to University decisions. The fund covered the operating expenditures, the institutional activities (teaching and research) and the revenues of the University personnel, while in the past these last resources were transferred separately after the State authorization. Then the 1996 financial law established and allowed the responsibility of Universities for the allocation of the resources transferred by the State. Since then it became possible, for instance, to allocate resources to a technology transfer function. Notwithstanding a large range of powers was retained by the State (i.e. rules on recruitment and salary amount of professors, thresholds for tax on students and for the expenditures on personnel, basic rules for HEI 's government bodies), which circumscribed the autonomy of the higher education institutions, the Universities acquired the possibility of building their plan, establishing their priorities, managing their staff.

In Europe since 2000 there was a wave of IPR reforms: the abolition of "professor privilege" in German-speaking and Scandinavian countries, justified as a remedy against what was considered an inefficient legal institution in the way of commercialization of academic research results. Within this kind of environment, in 2001 the Italian government reformed the academic patenting regulation, introducing the "professor privilege" (L. 283/2001, art. 7) without consultation with Universities. It was the product of a new government, who judged necessary to overcome the bureaucratic inertia of Universities (and public research organizations) towards the commercial use of their research results. It was an exogenous event, which clashed against the general trend of granting to Universities more control over their staff's activities, contrasting a possible movement of emersion of academic patenting, when University started looking for autonomous policies of resources valorization.

The Italian IP reform cannot be ascribed to a Bayh-Dole Act legislation diffusion and its impact was marked by an implementation, due to the interested actors, non really conformed to the same IP reform.

Before L. 283/2001 the ownership of an invention realized within the Italian

Universities was entitled to the public institution. In Italy, in fact, since 1939 an IP law recognized to the Universities the ownership of the patentable research results obtained by their employees. Notwithstanding it, the number of academic patents owned by Universities before '90s was low. Some scholars (Baldini et al., 2006, 2010, 2012) attribute this behavior to the strong dependence of Universities from the State within a line-sum regime, i.e. an externally determined allocation of funds. Together with this explanation, there was probably also a lower sensitivity to a societal role of Universities. The "professor privilege" arrived at a time when Universities as institutions were granted with responsibility and autonomy and were asked to change towards more social responsiveness and more market oriented behavior. Baldini et al. (2006, 2010, 2012) have looked attentively at how Universities behaved and reacted to this change through the analysis of the presence and content of an internal regulation devoted to academic inventions. The L. 283/2001 remitted to Universities the regulation of specific aspects of the relation between the inventor-employee and the academic institution. One or two years after 2001, only a small part of the Universities complied with the content of the law 283, while other Universities proposed alternative interpretations, by attributing the ownership of inventions, obtained under specific contingencies, to the academic institution. Many Universities waited.

The law presented many drawbacks: it didn't regulate the case in which non-employee personnel participate in the invention activity; it didn't give a solution to the cases in which different institutions, public and private, following different norms of ownership, were involved in the invention (the case of public-private research partnership typical of public funded research programs); it left the inventor charged of the cost of patenting and of the bargaining with industry, without giving any incentive to the public institutions for managing the inventions found in their laboratories. Universities in fact were entitled "any way" to receive between 30% and 50% of the net revenues coming from the commercial exploitation of the patented inventions.

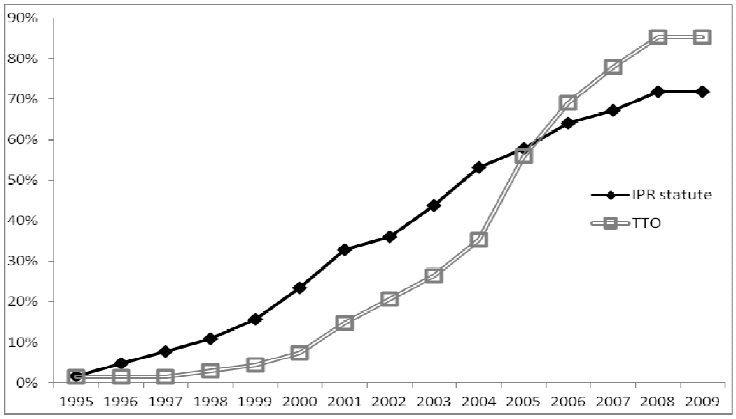
In short, some early pioneer Universities had introduced an IP regulation between 1996 and 2001 innovating in respect to the previous passive practice. After 2001 the University interest for their employees' inventions grew more diffusely: internal regulations of academic inventions, when present, allowed assignment contracts between the academic inventor and the public institution ,i.e. a sort of declaration of interest of Universities towards the commercialization of research results of their employees. After pioneering Universities introduced IP regulation, a mimetic behavior followed, i.e. a search of legitimation in presence of high uncertainty, by the imitation of the strong models. The first imitations were close to those models, so resisting to the 2001 legislation; later, more differences appeared among Universities, sometimes allowing also case by case internal decisions.

Meanwhile there was an important evolutionary process of transformation of the technology transfer from a simple function in the hand of the Rector to a specific team (TTO) with a specific budget, mainly funded by the University internal resources (Baldini et al., 2008). In 2002 was created the Association of technology transfer organizations, NETVAL, a professional network strengthening the diffusion of organizational norms.

Internal regulation on academic patents (statutes) and TTOs represent the organizational change through which Universities mediated the impact of the new IPR law on society, allowing a managerial discretionality to themselves. We refer to these two types of interrelation between University reform and IPR reform as determining factors which accompanied the legislative change on academic patenting and the related University ownership.

Of course a central aspect for getting a positive impact on the University ownership concerns the acceptance of the individual scientists of disclosing the inventions to their academic institution, while in the past they

had the possibility of a discretional behavior. In fact, given the expectation of low commitment from Universities in the commercialization of research results, scientific inventors behavior in the past resulted very often in attributing the ownership of the invention to industrial companies, against the recognition of the inventorship and an economic return. So a behavioral change in favor of the academic institution, in particular from inventors with good relations with industry, given also the absence of enforcement measures, cannot be taken for granted. Looking at the distribution of academic patent by ownership it will be possible to get an idea of the IPR reform's effects on the individual disclosure and on the industrial companies ownership.



Sources: Lissoni et al. (2013) elaborations on NETVAL survey and CNSVU

Fig.1 Diffusion of technology transfer offices (TTOs) and IP statutes, all Italy (1995-2009)

Our analysis stops at 2007 (after that year our data were not affordable, because not complete) and the last years events related to academic patents would offer a low empirical evidence within our frame, anyway further changes followed. Probably thanks to the diffused critical voices, the 2001 law was included in the IPR Code (DL 30/2005) with a relevant innovation: the art. 65, V comma, establishes that IP ownership is not recognised to the inventor when the research is funded by an external to the University, private or public, source of funding. So since 2005 the "professor privilege" would concern cases in which there isn't a possible contradictory treatment of public and private inventors. An administrative circular (471/July 2005) explained that the legislator with the change introduced in the IP Code (art 65, V comma) wanted to ease the technological transfer and to channel possible private and external public funds towards the academic research. But a double regime survives and it could be a source of uncertainty. At the end of 2000s the Parliament delegated the Government to exercise the legislative function on academic patenting (together with other issues related to public employment). A draft for the amendment to the new IP code (D. Lgs. n. 131/2010) meant to totally abolish the professor's privilege. This new rule, however, disappeared from the version of the law that was finally approved in 2010 (D.lgs the 13th August/2010).

3. METHODOLOGY FOR DATA COLLECTION[1]

The main database used in this paper consists of patent applications filed at EPO, the European Patent Office, with priority dates comprised between 1996 and 2007 and at least one inventor with an Italian address.

Academic inventors and their patents are identified by means of a 3-step procedure.

STEP 1: Disambiguation of inventors' names.

[1] This paragraph is largely taken from the paper Lissoni et al. (2013, paragraph 4) forthcoming in *Industry and innovation* .

STEP 2: Name matching between disambiguated inventors and academic personnel, the latter's names made available in 2000, 2005 and 2009 by the Italian Ministry of University and Research. This step produced 10118 "professor-patent" pairs obtained by attributing to each professor the patents signed by the matched inventors.

STEP 3: Validation of "professor-patent" pairs, on the basis of automatic criteria, manual checking, telephone and email surveys, and two regression exercises.

After completing these three steps, we had:

- a dataset of Italian patents and inventors, containing all patents by inventors with an Italian address in the period of interest (42784 inventors for 51054 patents);
- three datasets of Italian academic patents, containing respectively a "lower bound", an "intermediate", and an "upper bound" estimate of the phenomenon of interest.

Full details of step 1 are provided by Pezzoni et al. (2013). In what follows there is a short illustration of the differences between "lower bound", "intermediate", and "upper bound" datasets. Lower bound dataset: this estimates the number of academic patents in Italy for the period considered based on the assumption that all non-reachable and non-response cases are equivalent to negative responses. However, this estimate is subject to time-related bias. In fact, to the extent that non-reachable cases include a high proportion of patents from the 1990s, it is possible to observe a bias with respect to the time distribution of academic patents, namely a negative bias for early years and a positive bias of any estimated time trend. Surveying professors who are present only in early cohorts (say, 2001 or 2005) was difficult: having they retired or left the academy, there may be no way to reach them. At that point data from former research projects turned out to be useful, as they included information from surveys run at a time when most professors from these cohorts could still be reached (in particular, the survey conducted in 2002 by Balconi et al., 2004; and the 2006 KEINS survey by the KEINS project[1]). Based on such information, we run two probit regression exercises, whose estimated coefficients allow us to predict whether the professor-patent pairs corresponding to unreachable or non-respondent cases can be validated as academic or not.

The choice of running separate regressions for unreachable and non-respondent cases is due to differences between the two groups. The unreachable group is by and large composed of professors from the early data cohorts, now retired, who were active at a time when the legal, cultural, and economic circumstances differed from those in which the younger colleagues (more numerous among non-respondents) act nowadays. We apply the estimated coefficients and the selected threshold values from the probit regression exercises to the overall samples of unreachable and non respondent cases in order to predict how many patents from each group can be validated as academic.

Intermediate dataset: in this dataset predicted academic patents out of non-reachable cases were added to academic patents in the "lower bound" academic patent dataset.

Upper bound dataset: here predicted academic patents out of non-responses are further added. This dataset contains probability estimates of both no-responses and unreachable as academic.

4. ACADEMIC PATENTING TRENDS

The academic patenting in Italy between 1996 and 2007[2] grew whatever dataset we consider.

[1] Information on KEINS database are at:
http://portale.unibocconi.it/wps/wcm/connect/Centro_KITES/Home/Research+Networks/KEINS/

[2] Data for 2007 are not complete.

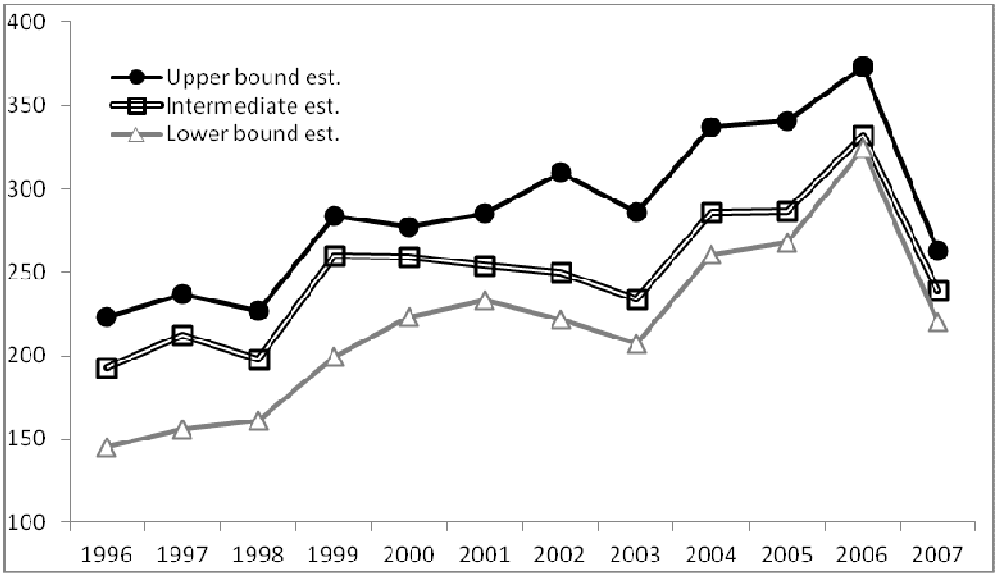


Fig.2. Nr of academic patents, 1996-2007; upper, intermediate & lower bound

But if we report the same data as percentage of the total number of Italian inventors' patents, with estimated time trends in the form of simple linear regressions (based on years 1996-2006, i.e. excluding observations for 2007) the academic trend results negative even if statistically not significant. Only for the lower bound estimation, which is negatively biased for early academic patents, there is a positive time related bias. According to the type of estimation considered, the 1996-2006 average share of academic patents is between 4.5% and 7%. The econometric analysis will help to better understand the sign of the time trend together controlling for other relevant factors.

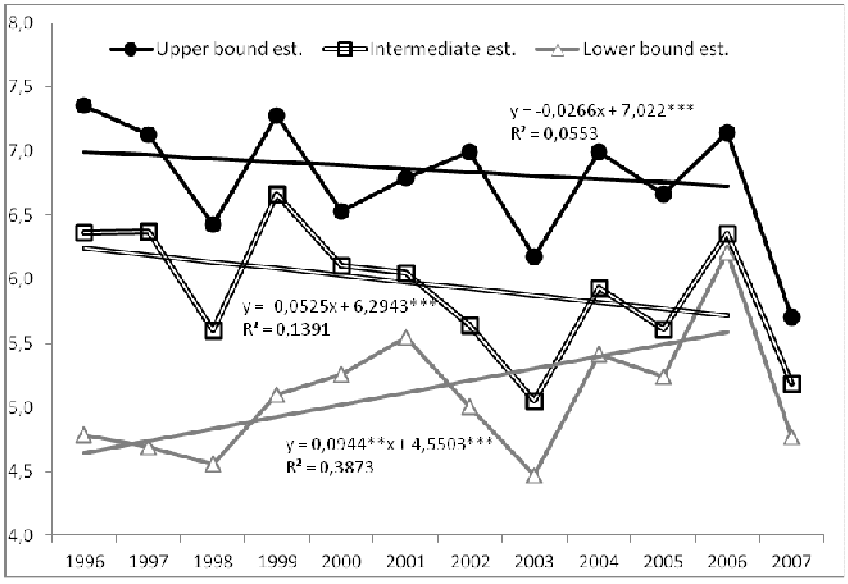


Fig 3. Share of academic patents over all patents by Italian inventors, 1996-2006; upper, intermediate and lower bound estimates (% values)

The trend of academic patents is different if we consider specific ownership: the University control on IP grew during the ten years considered, while industry ownership decreased (Fig.4). A decrease is visible already before 2000 in public research institutions' ownership of academic patents; the academic patents' ownership by individual scientists reduces slowly, mainly after 2004.

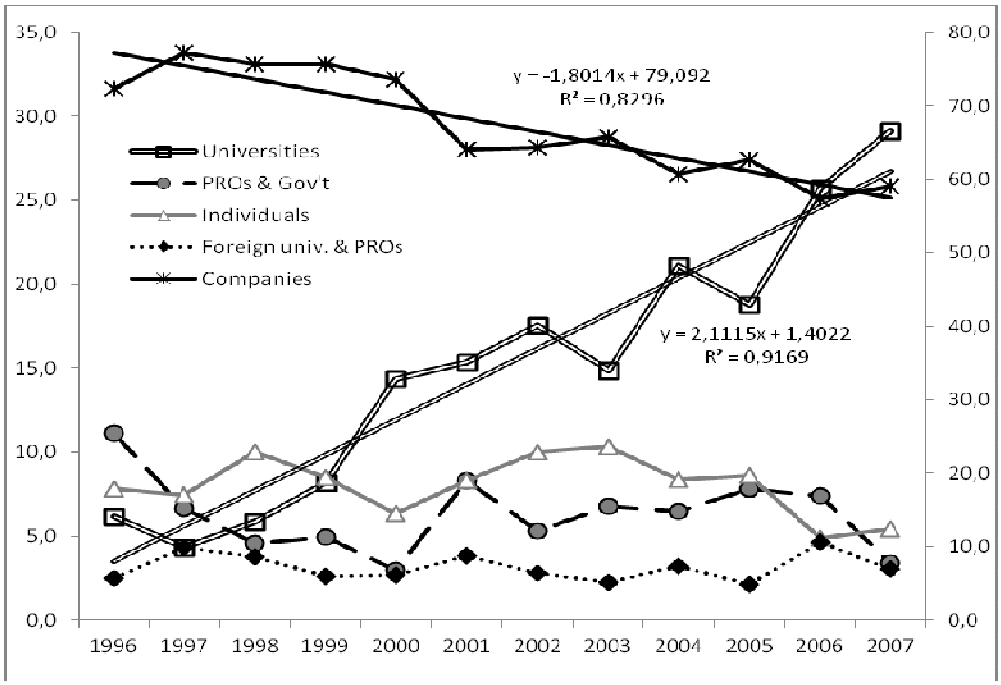


Fig. 4. Ownership[1] 10 of academic patents 1996-2007; upper bound estimates

[1] Ownership information dates back not to the filing or priority date of the patent, but to information contained in the 2010 edition of PatStat. This suggests that some change of property may have occurred, (Sterzi, 2012). Consultation of alternative sources suggests them to be around 5%.

Table1. shows that academic patents are concentrated (in the top ten Universities) and that the percentage of individual inventors is stronger in the group of weak patenting Universities, where also the role of industrial companies as patent owners is weaker.

			Ownership (% share by type of owner)				
	nr patents	% patents	University	Company	Individual	Gov't & PROs	Foreign univ & PROs
Milano	331	7.7	14.6	72.8	4.3	5.2	3.2
Politecnico Milano	290	6.7	25.9	67.5	3.4	2.2	0.9
Bologna	288	6.7	17.0	66.4	7.5	5.0	4.1
Roma "Sapienza"	241	5.6	27.0	58.9	4.8	7.0	2.2
Firenze	169	3.9	18.4	61.1	12.4	5.4	2.7
Napoli "Federico II"	169	3.9	11.8	64.7	11.2	4.3	8.0
Padova	168	3.9	10.1	70.4	10.1	6.7	2.8
Pisa	164	3.8	11.0	72.7	10.5	3.5	2.3
Catania	158	3.7	7.8	83.1	3.0	5.4	0.6
Torino	156	3.6	15.2	69.0	9.9	2.9	2.9
Total top 10 Universities	2134	49.4	18.4	74.1	7.7	5.2	3.2
Other Universities with ≥50 patents [(1)]	1488	34.4	22.0	71.2	7.9	8.1	3.0
Other Universities with >1 patent	699	16.2	13.4	52.6	10.4	11.0	4.4

[(1)] Ferrara, Pavia, Modena & Reggio, Roma "Tor Vergata", Politecnico Torino, Genova, Parma, Perugia, Milano-Bicocca, Siena, Palermo, Bari, Udine, Trieste, Brescia, Salerno, Cagliari

Table 1. Distribution and ownership of academic patents by University (top ten vs. others), 1996-2007; upper bound estimates

5. THE ANALYTICAL FRAME AND THE ECONOMETRIC MODEL

The characterization of a resident patent as academic is studied in relation to a set of regressors linked to time, which are useful to capture the (2001) introduction of IPR reform and the reaction of University through the introduction of an internal IP regulation (statute) and of a technology transfer office (TTO). This core regression is accompanied by a set of characters for patents, regions and Universities. We don't introduce data for the individual inventors. Firstly there is a regression of time dummies on the probability that a resident's patent be an academic one, i.e. that almost one academic inventor be identified; then other variables for patents, regions and Universities are introduced, controlling also for sectoral dummies; the last model include funding University variables, i.e. the general fund level (FFO) and the research competitive funding, from public and private sources, which are available for a more restricted period of time.

The core regressors are similar for studying the total academic patents trends and that of sub groups of academic patent with specific ownership (University owned, industry or individual owned), but in the first case (total academic patents) we cannot introduce data at single University level, since our dependent variable are all Italian resident patents. We have therefore aggregated data, dealing with University introduction of a statute or TTO and University funding, at regional level; if the academic patent has more than one academic inventor working in different academic institutions, we have considered a multi-region aggregation. This approach results giving more importance to the local environment in which the inventors work.

Financial data have been made available online by CNSVU since 1999. The quality of these data varies greatly from year to year and across Universities, so that visual inspection and reclassification are necessary. As these task were performed by the Aquameth project for years until 2004, we relied on Aquameth data for 1999-2004, and integrated them with our own elaborations for successive years. We built two variables (FFO_RATIO and SCIENCE_RATIO) that respectively measure, for each University, the weight of block grants (FFO) and of research project fund on total revenues.

Data on the adoption of IPR regulation come from a survey run by Baldini et al. (2010), which covered 65 Universities out of 83 ones now active in Italy[1]. We record the year of adoption, for each University, of the first statute (over the years, several Universities replaced the original statutes with new ones). On this basis we build a dummy variable (FIRST_STATUTE) that takes value 1 on the adoption year and the following ones.

Data on technology transfer offices come from different sources (several CNSVU surveys, and a survey run by NETVAL, the association of Italian TTOs); since they are quite contradictory, it required us to take some rather arbitrary decisions. As a consequence, we opted for assigning to each University a few alternative "TTO opening dates", and select for our analysis the lowest one (for example, for the University of Florence we have three dates - 2003, 2004, and 2007 – and we selected 2003). On this basis, we created a TTO dummy that takes value 1 on the adoption year and the following ones.

All the University-level variables were also used to build regional-level variables, namely:

- FFO_RATIO_REGION: total amount of block grants (FFO) received by Universities in a region, as % of total revenues collected by the same Universities, for each year 1999-2006;
- SCIENCE_RATIO_REGION: total amount of scientific project funding received by Universities in a region, as % of total revenues collected by the same Universities, 1999-2006;
- FIRST_STATUTE_REGION: share of Universities in the region having adopted an IP statute, 1996-2006;
- TTO_REGION: share of Universities in the region having already opened a TTO, for each year 1996-2006;
- NR_UNIVERSITIES_REGION: the number of respondents to the CNSVU survey, for each year 1996-2006 (it proxies for the number of Universities active in each year).

[1] None of the Universities not covered by Baldini et al.'s survey, host academic inventors, as in most cases they have no medical, engineering, or scientific faculty.

Additional variables at the regional level come from ISTAT (the Italian National Institute of Statistics), namely:

- BERD/GDP: business R&D over GDP in each region, for each year 1996-2006;
- RD_SHARE_PAUNI: share of R&D expenses by the Public Administration and the Universities in each region, for each year 1996-2006.

The variables by group are the following:

- time (year dummies): professor's privilege effect - 2001 is the reference year;
- patent characteristics (number of inventors; backward citations from non patent literature -NPL; IPC class) = the first two variables are proxies for quality and science intensity of the patent; the third one deal with differences by technological classes: as several patents fall in more than one technological field, we keep all dummies in the regression with no reference case;
- regional innovation system (in the inventor's region): Business R&D (BERD[1])/GDP region; Universities' and PRO[2]s' share of R&D (RD_SHARE_PAUNI);
- regional University system (in the inventor's region): diffusion of University IP statutes and TTO (shares); average weight of FFO over total revenues ; average scientific project funding over total revenues. In order to control for the number of Universities in the region, we consider the number of Universities locally active in each year, as reported by CNSVU;
- regional dummies: they control for heterogeneity across regions besides the R&D structure and the diffusion of IP statutes and TTO.

All regional variables are inserted with a 1 year lags following classic findings on RD-patent lag structure (Hall et al.,1986; Griliches, 1990).

The econometric model is a two step Heckman probit model; in STEP 1 we analysed the probability of an Italian patent to be academic between 1996-2006; in STEP2 we estimated the probability of an academic patent to be owned or co-owned by the inventor's University: the dependent variable takes value 1 if the patent assignee is a University or, in case of multiple assignees, if at least one of them is a University.

Table 2 gives the complete descriptive statistics for the STEP1 regression's dependent variable (with values for the dependent variables for both lower bound, intermediate, and upper bound estimates) and regressors.

Table 3 reports the complete descriptive statistics for the STEP2 regression, only for upper bound estimate data.

[1] Business Enterprise Research and Development
[2] Public Research Organizations

	Obs	Mean	Std. Dev.	Min	Max
Dependent variable (Academic patent):					
upper_bound	51054	0.067	0.251	0	1
Intermediate	51054	0.059	0.235	0	1
lower_bound	51054	0.051	0.221	0	1
Regressors:					
Year 1996	51054	0.059	0.236	0	1
Year 1997	51054	0.065	0.247	0	1
Year 1998	51054	0.069	0.254	0	1
Year 1999	51054	0.076	0.266	0	1
Year 2000	51054	0.083	0.276	0	1
Year 2002	51054	0.087	0.282	0	1
Year 2003	51054	0.091	0.287	0	1
Year 2004	51054	0.094	0.292	0	1
Year 2005	51054	0.100	0.300	0	1
Year 2006	51054	0.102	0.303	0	1
Year 2007	51054	0.090	0.287	0	1
1.Electrical eng.; Electronics	51054	0.172	0.378	0	1
2.Instruments	51054	0.150	0.357	0	1
3.Chemicals; Materials	51054	0.136	0.342	0	1
4.Pharmaceuticals; Biotech.	51054	0.099	0.299	0	1
5.Industrial processes	51054	0.253	0.435	0	1
6.Mechanical eng.; Machines; Transport	51054	0.243	0.429	0	1
7.Consumer goods; Civil eng.	51054	0.186	0.389	0	1
N_INV	51054	2.097	1.587	1	49
SHARE_NPL	51054	0.368	0.418	0	1
TOT_CIT	51054	4.010	6.859	0	217
TTO_REGION	50931	0.517	0.332	0	1
STATUTE_REGION	50875	0.395	0.323	0	1
NR_UNIVERSITIES_REGION	50931	7.077	4.024	1	12
BERD/GDP	50930	0.665	0.339	0	1.48
RD_SHARE_PAUNI	50927	0.424	0.181	0.033	1
FFO_RATIO_REGION	32395	0.44	0.1	0.12	0.87
SCIENCE_RATIO_REGION	32395	0.12	0.04	0.02	0.28

Regional dummies (obs=51054):					
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Abruzzo	0.019	0.137	Piemonte	0.140	0.347
Basilicata	0.003	0.054	Puglia	0.013	0.113
Calabria	0.004	0.062	Sardegna	0.005	0.068
Campania	0.020	0.141	Sicily	0.019	0.135
Emilia-Romagna	0.175	0.380	Toscana	0.065	0.246
Friuli VG	0.036	0.186	Trentino AA	0.015	0.123
Lazio	0.059	0.236	Umbria	0.011	0.105
Liguria	0.028	0.164	Val d'Aosta	0.002	0.042
Lombardia	0.354	0.478	Veneto	0.134	0.340
Marche	0.024	0.153	Unknown region	0.219	0.414
Molise	0.001	0.029			

Table 2 - STEP1 regression: descriptive statistics

	Obs	Mean	Std. Dev.	Min	Max
Dependent variables (Patent ownership):					
University	3443	0.177	0.382	0	1
Individual	3443	0.087	0.282	0	1
Company	3443	0.731	0.443	0	1
Regressors:					
Year 1996	3443	0.065	0.246	0	1
Year 1997	3443	0.069	0.253	0	1
Year 1998	3443	0.066	0.248	0	1
Year 1999	3443	0.082	0.275	0	1
Year 2000	3443	0.080	0.272	0	1
Year 2002	3443	0.090	0.286	0	1
Year 2003	3443	0.083	0.276	0	1
Year 2004	3443	0.098	0.297	0	1
Year 2005	3443	0.099	0.299	0	1
Year 2006	3443	0.108	0.311	0	1
Year 2007	3443	0.076	0.266	0	1
1.Electrical eng.; Electronics	3443	0.207	0.405	0	1
2.Instruments	3443	0.256	0.437	0	1
3.Chemicals; Materials	3443	0.275	0.446	0	1
4.Pharmaceuticals; Biotech.	3443	0.380	0.486	0	1
5.Industrial processes	3443	0.110	0.313	0	1
6.Mechanical eng.; Machines; Transport	3443	0.069	0.253	0	1
7.Consumer goods; Civil eng.	3443	0.036	0.186	0	1
N_INV	3443	3.680	2.331	1	49
SHARE_NPL	3443	0.600	0.396	0	1
TOT_CIT	3443	7.255	10.570	0	200
BERD/GDP	3438	0.602	0.309	0	1.48
RD_SHARE_PAUNI	3438	0.484	0.203	0.145	1
STATUTE	3443	0.643	0.479	0	1
TTO	3361	0.476	0.499	0	1
FFO_RATIO	1954	0.467	0.123	0.009	0.9
SCIENCE_RATIO	1954	0.132	0.063	0.0002	0.43

University dummies (obs=3343):					
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Bari-Politecnico	0.017	0.131	Palermo	0.025	0.155
Bologna	0.092	0.290	Parma	0.035	0.184
Catania	0.047	0.212	Pavia	0.048	0.214
Ferrara	0.040	0.195	Perugia	0.028	0.165
Firenze	0.056	0.230	Pisa	0.054	0.227
Genova	0.032	0.176	Roma"La Sapienza"	0.078	0.267
Milano-Bicocca	0.026	0.160	Roma "Tor Vergata"	0.037	0.189
Milano	0.105	0.307	Siena	0.029	0.169
Milano-Politecnico	0.085	0.279	Torino	0.048	0.213
Modena	0.039	0.193	Torino-Poilitecnico	0.034	0.181
Napoli "Federico II"	0.049	0.215	Udine	0.017	0.128
Padova	0.055	0.229			

Table 3 - STEP2 regression: descriptive statistics (for upper bound estimate of academic patenting)

6. RESULTS

The academic patents trend, conditional on its (changing) environment -regional innovation systems, sectoral composition of resident patents, characters of patents- shows a positive sign for the years before 2001 and has a negative sign after 2001.

Notwithstanding the growth of TTO and of University IPR statutes and the growth of patents in biotechnology and pharmaceutical sectors, the number of academic patents grew less than the Italian resident patents on average. None of the variables related to Universities characteristics seems to matter: neither the regional diffusion rates of IP regulations and TTOs, nor the share of revenues due to block grants or due to competitive funds for research: regional aggregation probably cut meaningful University differences.

Moreover as to the funding variables, the FFO at regional level is not positively related to the economic wealth of the region and the competitive research funding (by public and private sources) decreased on average as share of the total University revenue, probably since other and more heterogeneous sources of fund developed during the last years, for compensating the general fund (FFO) reduction.

A positive effect on the academic patent is registered at regional level by both BERD/GDP (the industrial demand side) and the Universities' share of R&D (the supply side).

	(1)	(2)	(3)
Year 1996	0.0	0.16*	
	(0.0	(0.05	
Year 1997	0.0	0.12*	
	(0.0	(0.05	
Year 1998	-	0.024	
	(0.0	(0.05	
Year 1999	0.0	0.11*	
	(0.0	(0.05	
Year 2000	-	-	
	(0.0	(0.04	
Year 2002	0.0	-	0.04
	(0.0	(0.05	(0.0
Year 2003	-	-	-
	(0.0	(0.05	(0.0
Year 2004	0.0	-	-
	(0.0	(0.05	(0.0
Year 2005	-	-	-
	(0.0	(0.06	(0.0
Year 2006	0.0	-	-
	(0.0	(0.07	(0.0
Year 2007	-	-	-
	(0.0	(0.08	(0.1
Electrical Eng.; Electronics		0.046	-
		(0.03	(0.0
Scientific instruments; Measurement		0.31*	0.34
		(0.02	(0.0
Chemicals; Materials		0.095	0.08
		(0.02	(0.0
Pharmaceuticals; Biotechnology		0.57*	0.53
		(0.03	(0.0
Industrial Processes		-	-
		(0.03	(0.0
Mechanical Eng.; Machines; Transport		-	-

		(0.03	(0.0
Consumer goods; Civil Eng.		-	-
		(0.04	(0.0
N_INV (nr of inventors)		0.15*	0.15
		(0.00	(0.0
SHARE_NPL (% of citations to non-patent literature)		0.41*	0.45
		(0.02	(0.0
TOT_CIT (tot nr of backward citations)		0.009	0.01
		(0.00	(0.0
TTO_REGION (regional diffusion TTOs)		-	0.06
		(0.08	(0.1
STATUTE_REGION (regional diffusion IP statutes)		0.10	0.14
		(0.06	(0.0
NR_UNIVERSITIES_REGION		0.016	0.01
		(0.01	(0.0
BERD/GDP (regional BERD/GDP)		0.41*	0.22
		(0.17	(0.2
RD_SHARE_PAUNI (% of R&D by public administration & Universities, in region)		1.09*	0.92
		(0.29	(0.4
FFO_RATIO_REGION (block grant as % of univ.'s revenues, regional avg)			0.23
			(0.2
SCIENCE_RATIO_REGION (public research funds % of univ.'s revenues, regional avg)			0.63
			(0.5
Constant	-	-	-
	(0.0	(0.24	(0.3
Regional dummies	N	Y	Y
Observations	51,	50,87	32,3
Pseudo R2	0.0	0.24	0.26

Standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1

STEP1 probit regression (dep. variable: probability of a patent to be academic; upper bound data)

STEP2: we estimated the probability of an academic patent to be owned by the inventor's University, 1996-2006 as a function of:

- time (year dummies): ownership trend;
- patent characteristics and regional innovation system;
- University's characteristics:
    - fixed effects (University dummies, but only for Universities with at least 50 patents);
    - time-variant:
    - adoption of IP statute
    - TTO opening;
    - amount of scientific project funding (SCIENCE_RATIO) ;
    - weight of FFO over total revenues (FFO_RATIO).

As in STEP1, in case of multiple inventors from different Universities for the same patent, we consider the cross-region averages, for all regions listed on the patent, and multiple dummies.

We cannot consider the dependent variable in STEP2 as indicating Universities' exclusive control of the patents. For this reason we decided to opt for three different probit regressions, each with a different type of ownership as the dependent variable, instead of a multinomial logit, which would

have been more suitable in case of mutually exclusive types of ownership.

Econometric analysis shows:

- a positive time trend, even if several post 2001 coefficients are non significant;
- as for patent characteristics, the share of citations to non patent literature exhibits a significant and positive sign: a high share of non-patent literature citations indicates that the research underlying the academic University owned patent is more of a fundamental type and probably therefore more easily appropriable by the University;
- a positive determinant of University ownership is the adoption of an IP regulation. We inserted in the regression some University dummies controlling for fixed effects, so our result can be interpreted (in a causal way) as indicative of a change in the University strategic attitude towards patenting, made possible by the newly gained autonomy.

Other results are:

- No effect of the FFO_RATIO at University level;
- No effect of TTO opening;
- No effect of the R&D structure of the region.

	University ownership		**Individual ownership**		**Firm ownership**	
	(1)	(2)	(3)	(4)	(5)	(6)
Year 1996	-0.20		-0.034		-0.019	
	(0.17)		(0.18)		(0.14)	
Year 1997	-0.48***		-0.18		0.29**	
	(0.18)		(0.17)		(0.13)	
Year 1998	-0.41**		0.034		0.23*	
	(0.17)		(0.16)		(0.13)	
Year 1999	-0.29**		-0.13		0.30**	
	(0.15)		(0.16)		(0.12)	
Year 2000	-0.011		-0.14		0.28**	
	(0.13)		(0.16)		(0.12)	
Year 2002	0.16	0.13	0.24	0.14	0.095	-0.093
	(0.13)	(0.14)	(0.15)	(0.19)	(0.12)	(0.15)
Year 2003	-0.048	-0.024	0.21	0.034	0.063	-0.076
	(0.14)	(0.15)	(0.15)	(0.20)	(0.12)	(0.15)
Year 2004	0.087	0.16	-0.00094	-0.30	0.066	-0.17
	(0.13)	(0.15)	(0.16)	(0.22)	(0.12)	(0.16)
Year 2005	-0.047	0.071	0.047	-0.15	0.12	-0.13
	(0.14)	(0.16)	(0.16)	(0.22)	(0.12)	(0.17)
Year 2006	0.28**	0.35**	-0.23	-0.42*	0.033	-0.24
	(0.14)	(0.16)	(0.18)	(0.24)	(0.12)	(0.17)
Year 2007	0.36**	0.39**	-0.20	-0.31	0.056	-0.28
	(0.15)	(0.18)	(0.19)	(0.26)	(0.13)	(0.19)
Electrical Eng.; Electronics	-0.17*	-0.0032	-0.61***	-0.28*	0.45***	0.23**
	(0.093)	(0.10)	(0.12)	(0.16)	(0.084)	(0.11)
Scientific instruments; Measurement	0.29***	0.45***	-0.074	-0.071	-0.17**	-0.30***
	(0.078)	(0.082)	(0.095)	(0.13)	(0.071)	(0.10)
Chemicals; Materials	-0.038	-0.029	-0.43***	-0.34***	0.25***	0.22**
	(0.072)	(0.082)	(0.090)	(0.12)	(0.065)	(0.089)
Pharmaceuticals; Biotechnology	0.13	0.40***	-0.20*	-0.096	-0.052	-0.24**
	(0.094)	(0.093)	(0.11)	(0.15)	(0.088)	(0.12)
Industrial Processes	0.25**	0.17	0.14	0.19	-0.036	-0.18
	(0.099)	(0.12)	(0.12)	(0.15)	(0.092)	(0.13)
Mechanical Eng.; Machines;	-0.090	-0.19	0.091	0.22	0.24**	0.12

Transport						
	(0.14)	(0.15)	(0.15)	(0.21)	(0.12)	(0.17)
Consumer goods; Civil Eng.	-0.017	-0.0070	0.41***	0.42	0.018	0.031
	(0.17)	(0.21)	(0.16)	(0.26)	(0.15)	(0.23)
N_INV (nr of inventors)	0.0089	0.075***	-0.19***	-0.19***	0.050**	0.072**
	(0.018)	(0.024)	(0.028)	(0.032)	(0.023)	(0.036)
SHARE_NPL (% of citations to non-patent literature)	0.62***	0.84***	0.12	0.12	-0.54***	-0.68***
	(0.091)	(0.089)	(0.11)	(0.16)	(0.079)	(0.11)
TOT_CIT (tot nr of backward citations)	-0.00081	0.0062	-0.00023	-0.0057	0.00036	0.0015
	(0.0033)	(0.0040)	(0.0035)	(0.0062)	(0.0028)	(0.0047)
BERD/GDP (regional BERD/GDP)	-0.079	-0.31	-0.58*	-0.13	0.22	-0.087
	(0.26)	(0.30)	(0.30)	(0.43)	(0.23)	(0.32)
RD_SHARE_PAUNI (% of R&D by public administration & Universities, in region)	0.42	0.035	0.023	0.79	-0.98***	-1.25**
	(0.40)	(0.46)	(0.47)	(0.67)	(0.35)	(0.49)
FIRST_STATUTE (IP regulation in place)	0.35***	0.23**	-0.058	-0.14	-0.22***	-0.22**
	(0.083)	(0.100)	(0.094)	(0.13)	(0.072)	(0.10)
TTO (TTO in place)	-0.087	-0.14	0.032	0.13	0.0080	0.027
	(0.085)	(0.094)	(0.097)	(0.13)	(0.075)	(0.099)
FFO_RATIO (block grant as % of revenues)		0.014		-1.03*		-0.48
		(0.37)		(0.53)		(0.40)
SCIENCE_RATIO (research as % revenues)		-0.42		-0.61		-0.19
		(0.59)		(0.86)		(0.63)
Constant	-1.90***	-2.77***	0.32	0.56	1.29**	2.27***
	(0.52)	(0.60)	(0.68)	(0.97)	(0.51)	(0.82)
University dummies(§)	Y	Y	Y	Y	Y	Y
Observations	50,793	32,041	50,793	32,041	50,793	32,041
Rho	0.065	0.62**	-0.31*	-0.46**	-0.17	-0.17
Censored observations	47437	30187	47437	30187	47437	30187
Pseudo R2	0.16	0.17	0.13	0.14	0.09	0.11

Standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1

(§) Only for Universities with >50 patents (all other Universities as reference case)

(#)The nr. of observations is slightly less than that reported in section 5.1, due to missing values

Table 3. Heckman probit regressions (STEP1, unreported; STEP2: prob. of an academic patent to be owned by University/individual/company) – upper bound estimate data

Summing up

1. Academic patents

The absolute number of academic patents has increased, but

(i) their weight on total patenting by domestic inventors has not .

The probability to observe an academic patent depends on:

- the technology considered

- the science-intensity of research,

- and the characteristics of the local innovation system,

After controlling for these determinants:

(ii) the conditional probability to observe an academic patent upon resident patents has declined over time.

2. University owned academic patents

(iii) the share of University-owned academic patents has increased.

The rise of University ownership is explained, among others, by:

(iv) the increased autonomy of Italian Universities through introduction of explicit IP regulations.

The introduction of the professor privilege in 2001 had no impact at all on either (1 and 2) trends

7. CONCLUSION

Despite European legislators tried to imitate the US ones (Mowery and Sampat, 2004), European Universities were less able or more reluctant than their US counterparts to manage directly the IPRs over their scientists' inventions. Still, most patents over inventions from European academic scientists are in the hands of business companies, and many are owned by individuals and not-for-profit or governmental organizations (Lissoni et al., 2008 and 2009).

Italian case is a different one, since the legislator introduced the "professor privilege" and this reform was contrasted by the now more autonomous Universities, which produced a regulation allowing the transfer of the ownership from inventors to their academic institution.

Academic patents didn't increase in Italy, notwithstanding the University reform, which stressed the academic institution's third mission and the responsibility of raising external funds, probably due to the heterogeneous range of third mission activities, not always complementing each other, and the emerging heterogeneous range

of funding sources, not always devoted to research activities, all together with a reduction of resources transferred by the State (TTO) and probably a less easy collaboration between Universities and industry. As underlined by Valentin and Jensen (2006), University patenting, to be intended as the effort by Universities to retain the IP over their scientists' inventions, could interfere with established patterns of company-scientist or company-University cooperation, with no much gain in terms of technology transfer. Following these scholars, the IPR reform substitutes to bilateral agreements between inventors and industrial companies, trilateral agreements where Universities want or enjoy the right of control on IPs. The same authors write that Universities can renounce in favour of industrial companies, but there is a relevant element of uncertainty due to the possible delay in the decision of TTO or University administration. Moreover there can be unexpected results from research activity, whose property right now go to Universities, making less attractive the explorative public-private joint ventures.

What result from our work is that there has not been a net increase of academic patents, but a redistribution of their ownership, with a decrease in industry, public research institutions and individual inventor's ownership. The adoption of internal IP regulations by Universities, together with other conditions, neutralized the "professor privilege". This happened mainly in the top Universities (where 50% of academic patents is concentrated.) The question, open to other contributions, is if the substitution of University ownership to the other ones produce effectively a knowledge transfer more efficient, in terms of level, quality and use, and if this is valid for all disciplines.

The increased University-ownership occurred also with Universities reclaiming co-ownership with companies or governmental organizations , as in France (see Lissoni et al., 2010), but while there the role of companies as academic patent holders seemed safe, in Italy a reduction of companies' role looks like to prevail. The question, which needs more research activity, is why and how in Italy funding patterns and relationships between industry and (top) academic scientists were more influenced by the IPR reform (as implemented by Universities), resulting less long standing.

References

Aghion, P., L. Boustan, C. Hoxby, and J. Vandenbussche (2005). Exploiting States' Mistakes to Identify the Causal Impact of Higher Education on Growth, NBER conference paper, http://www.nber.org/confer/2005/

Aghion, P, M. Dewatripont, C. Hoxby, A. Mas-Colell, and A. Sapir (2007). "Why Reform European Universities", Bruegel Policy Brief., September 2007/04, Brussels.

Aghion P., Dewatripont M., Hoxby C., Mas-Colell A., & Sapir A., (2009a), The Governance and Performance of Research, Universities: Evidence from Europe and the U.S., December 2008, CEPR, Brussels, 24-25 April.

Aghion P., Dewatripont M., Hoxby C., Mas-Colell A., & Sapir A., (2009b), The Governance and Performance of Research, Universities: Evidence from Europe and the U.S., NBER Working Paper No. 14851, Issued in April. http://www.nber.org/papers/w14851

Aghion , L'excellence universitaire: leçons des expériences internationales, (2010), Rapport d'étape de la mission Aghion à Mme Valérie Pécresse Ministre de l'enseignement supérieur et de recherche, Le 26 Janvier.

Anselin, L., Varga, A. and Acs, Z. (1997). "Local Geographic Spillovers between University Research and High Technology Innovations," Journal of Urban Economics, 42.

Auranen, O., & Nieminen, M. (2010).” University research funding and publication performance. An international comparison”. Research Policy, 39, pp.822–834.

Balconi M., Breschi S., Lissoni F. (2004), "Networks of inventors and the role of academia: an exploration of Italian patent data" , Research Policy 33, pp. 127-145.

Baldini, N., Grimaldi, R., & Sobrero, M. (2007).” To patent or not to patent? A survey of Italian inventors on
motivations, incentives, and obstacles to University patenting”. Scientometrics, 70(2), pp.333–354.

Baldini, N., Fini, R. & Grimaldi, R. (2012). The Transition Towards Entrepreneurial Universities: An Assessment of
Academic Entrepreneurship in Italy. http://ssrn.com/abstract=1979450 or http://dx.doi.org/10.2139/ssrn.1979450.

Baldini, N., Fini, R., Grimaldi, R. & Sobrero, M. (2010). “The Institutionalisation of University Patenting Activity in Italy: Diffusion and Evolution of Organisational Practices”, SSRN eLibrary.

Baldini, N., Grimaldi, R. & Sobrero, M. 2006. Institutional changes and the commercialization of academic knowledge: A study of Italian Universities’ patenting activities between 1965 and 2002. Research Policy, 35, pp.518-532.

Bonaccorsi A. & Daraio, C. (eds.) 2007. Universities And Strategic Knowledge Creation. Specialization and Performance in Europe, Edward Elgar.

Bonaccorsi A., Secondi L., Setteducati E., Ancaiani A., 2012, Participation and commitment in third-party research funding: evidence from Italian Universities, published on line 15 Nov.

Breschi S., Lissoni F., Montobbio F. (2007), The scientific productivity of academic inventors: new evidence from Italian data, Economics of Innovation and New Technology, 16(2), pp.101-118.

Bruno, G., & Orsenigo, L. (2003). “Determinanti dei finanziamenti industriali alla ricerca universitaria in Italia”. In A. Bonaccorsi (Ed.), Il sistema della ricerca pubblica in Italia, Milano, Franco Angeli.

von Ledebur S., Buenstorf G. and Hummel M., 2009, University Patenting in Germany before and after 2002: What Role Did the Professors´ Privilege Play?, Jena Economic Research Papers, 2009 - 068

Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2002). Links and impacts: The influence of public research on industrial R&D. Management Science, 48(1), pp.1-23.

Della Malva A., Lissoni F., Llerena P. (2010), “Institutional Change and Academic Patenting: French Universities and the Innovation Act of 1999”, KITES Working Paper 29, Università Bocconi, Milano

Geuna A., Nesta L. (2006), "University patenting and its effects on academic research. The emerging European evidence" Research Policy, 35(6), pp.790-807.

Geuna, A. (2001). The changing rationale for European University research funding: Are there negative unintended consequences?, Journal of Economic Issues, 35, pp.607–632.

Geuna, A. & Rossi, F. (2011), "Changes to University IPR regulations in Europe and the impact on academic patenting". Research Policy, 40, pp.1068-1076.

Göktepe D., 2007, University Inventors and University Patenting Patterns at Lund University: Conceptual- Methodological & Empirical Insights, CIRCLE, Sweden, 2007-08-20

Griliches, Z. (1990). "Patent Statistics as Economic Indicators: A Survey", Journal of Economic Literature, 28, 37.

Hall, B. H., Griliches, Z. & Hausman, J. A. (1986). Patents and R&D: Is There A Lag? National Bureau of Economic Research Working Paper Series, N. 1454.

Kenney, M. & Patton, D. (2011). "Does inventor ownership encourage University research-derived entrepreneurship? A six University comparison", Research Policy, 40, pp.1100-1112.

Jaffe A.B., Trajtenberg M., Henderson R. (1993), "Geographic localization of knowledge spillovers as evidenced by patent citations", Quarterly Journal of Economics, 108, pp. 577-598

Lepori B., Benninghoff M., Jongbloed B., Salerno C., Slipersaeter S., (2005), "Changing patterns of higher education funding: evidence from CHINC countries", An interim report for the project Changes in University Incomes: Their Impact on University-Based Research and Innovation (CHINC) November

Lepori, B., Benninghoff, M., Jongbloed, B., Salerno, C., Slipersaeter, S., (2007) "Changing models and patterns of higher education funding: some empirical evidence". In: Bonaccorsi, A., Daraio, C. (Eds.), Universities and Strategic Knowledge Creation. Specialization and Performance in Europe. Edward Elgar, Cheltenham, pp. 85–111.

Lepori, B., van den Besselaar, P., Dinges, M., Potı`, B., Reale, E., Slipersaeter, S., et al., (2007), "Convergence versus national specificities in research policies. An empirical study on public project funding", Research Evaluation, 27(2), pp.83–93.

Leydesdorff L. and Meyer M., (2010), "The decline of University patenting and the end of the Bayh–Dole effect", Scientometrics, 83, pp.355–362

Lissoni F., Llerena P., McKelvey M., Sanditov B. (2008), Academic patenting in Europe: new evidence from the KEINS Database, Research Evaluation 16(2), pp. 87-102

Lissoni F., Lotz P., Schovsbo J., Treccani A. (2009), "Academic Patenting and the Professor's Privilege:
Evidence on Denmark from the KEINS database", Science and Public Policy 36/8, pp. 595-607

Lissoni F., Pezzoni M., Potì B., Romagnosi S., 2012, "University autonomy, IP legislation and academic patenting: Italy, 1996-2007", Cahiers du GREThA, n° 2012-26 (http://cahiersdugretha.u-bordeaux4.fr/2012/2012-26.pdf

Lissoni, F. (2013), "Academic Patenting in Europe: Recent Research and New Perspectives", Industrial Dynamics, Innovation Policy, and Economic Growth through Technological Advancements. IGI Global.

Lissoni F., Pezzoni M., Potì B., Romagnosi S., (2013), "University autonomy, IP legislation and academic patenting: Italy, 1996-2007", Industry and Innovation, forthcoming

Lissoni F, Maurino A, Pezzoni M, Tarasconi G (2010), APE-INV's "name game" algorithm challenge: a guideline for benchmark data analysis & reporting http://www.esf-ape-inv.eu/download/Benchmark_document.pdf.

Lissoni F, ,Montobbio F., Seri R., (2010), Ownership and impact of European University patents, presented at EAEPE Conference, Universitè Bordeaux IV, October 28-30, 2010

Meyer M., "Academic patents as an indicator of useful research? A new approach to measure academic Inventiveness", Research Evaluation, vol. 12, n. 1, April 2003, pp. 17–27.

Mowery D.C., Nelson R.R., Sampat B.N., Ziedonis A.A., (2001), "The Growth of Patenting and Licensing by US Universities: an Assessment of the Effect of the Bayh-Dole Act of 1980", Research Policy, 30, pp. 99-119

Mowery, D. C., & Sampat, B. N. (2004). The Bayh-Dole Act of 1980 and University–industry technology transfer: A model for other OECD governments? The Journal of Technology Transfer, 30(1), 115–127.

OECD, (2007), Tertiary education for the knowledge society: volume 1: special features: governance.

Owen-Smith, J., & Powell, W. W. (2001). "To patent or not: Faculty decisions and institutional success at technology transfer", Journal of Technology Transfer, 26(1), pp.99–114.

Ponomariov, B. L. (2008). "Effects of University characteristics on scientists' interactions with the private sector: An exploratory assessment", Journal of Technology Transfer, 33(5), pp.485–503.

Potì B. and Reale E., (2005), "The patenting regime in the Italian public research system: what motivates public

inventors to patent", Fifth Triple Helix Conference, The capitalisation of knowledge: cognitive, economic, social & cultural aspects, Turin 18-21 May

Potì B. and Reale E. (2005), "Changing Patterns in Public Allocation for R&D: Composition and Evolution of Government Project Funding in Italy", paper presented at the Workshop on S&T indicators production, Lisbon 22-23 September 2005.

Potì B. and Romagnosi S., (2010), "Effectiveness of the new tools for University research valorisation: TTOs characterization in IP management and their performance", International Technologic Transfer Workshop on Organizational Models of Technology Transfer Offices and the technology transfer manager profession, NetVal, Alghero, September 10.

Reale E. and Potì B. (2009), "Italy. Local policy legacy and moving to an "in-between" configuration" , in Paradeise C, Reale E, Bleiklie I and Ferlie E., University Governance: Western European Comparative Perspectives, Dordrecht, Springer, 77-102

Renault, C. (2006). "Academic capitalism and University incentives for faculty entrepreneurship". Journal of Technology Transfer, 31(2), pp.227–239.

Schmoch, U., & Schubert, T. (2009). Sustainability of incentives for excellent research. Fraunhofer Institute for Systems and Innovation Research Discussion Paper, Karlsruhe.

Sterzi, V., (2013), Patent quality and ownership: An analysis of UK faculty patenting. Research Policy, 42-2 pp.564-576

Valentin F., Jensen R.L. (2007); "Effects on academia-industry collaboration of extending University property rights". Journal of Technology Transfer, 32, pp.251-276.

van der Ploeg F., and Veugelers R., (2008), "Towards Evidence-based Reform of European Universities", CESifo Economic Studies, Vol. 54, 2/2008, pp.99–120,

Van Looy B., Du Plessis M., Meyer M., Debackere K., (2009), The impact of legislative framework conditions on the entrepreneurial activities of Universities: an (empirical) assessment at the level of EU-15, presented at the EPO conference, Wien, Sept.

Varga, A (2000). University Research and Regional Innovation, Boston, Kluwer Academic Publishers

Veugelers, R. and F. van der Ploeg (2008), ''Reforming European Universities: Scope for an Evidence-Based Process'', in M. Dewatripont and F. Thys-Clement, eds., Governance of European Universities, Editions de l'Université de Bruxelles, Brussels.

BIANCA POTI'

CERIS-CNR, sede di Roma. She has a long experience in international /European funded research collaborations. Her scientific interests and academic experience are on industrial and innovation economics and policy.

Contatti:

CNR/CERIS Via dei Taurini, 19 00185 Roma (Italy)
Tel.: +39(0)649937847 E-mail: b.poti@ceris.cnr.it