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The patenting regime in the Italian public research system. What motivates public inventors to patent

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Abstract. The paper deals with two aspects: the public ownership of intellectual property rights and the holding of the title (individuals vs institutions) for the public financed research.
A key problem in the past and still now in Europe has been the low transfer of results coming from public research to industrial users. Recently a new trend developed which favours the patenting of the scientific results of public actors. This change partly comes from the modification of the public funding mechanism of allocation and goes with changes in the regulation and regime related to the ownership of intellectual property rights.
The paper is built on a pilot study, which controlled if and how the modification in national regulation affected the actors' behaviour. It is based on a survey of public inventors, in two public institutions (Cnr and Roma 1 University) who disclosed their inventions to the institutions in the last three years; on interviews with the responsible persons of the patent offices in the two institutions and on some data from the Cnr 2005 patent portfolio.
This pilot study on public patenting in Italy seems to confirm the persistence of the academic incentives in the patenting activities of the public research institutions, even in presence of the 2001 patenting regime, aimed to assign IPR title to the public inventors.
Furthermore the results highlight the presence of a relation between public institutions and firms that are not completely captured by the patenting indicators. Patents are only the emerging part of a more large hidden area of relationships between public institutions and industrial firms.

Key words: Public patenting, Regulation on public patenting, Incentives for public inventors, Determinants of public patenting.

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Introduction

A relevant problem in the past was and still is the narrow transfer of research results to industrial users. Recently an orientation finalised to modifying some institutional aspects (regulation and internal organization within public research institutions) gained place for improving the on going situation. The trajectory followed by the various European countries was different. In Germany in 1998 a new regulation assigned the title of inventions produced within the research funded by the State to the public research organizations, but the privilege granted to professors was abolished only in 2001. The present legislation defines the professors' inventions as a service belonging to Universities. As an effect of the new regulation the public research institutions are reorganising themselves for sustaining the patenting of invention realised by their employees. In France Universities have enjoyed since a long time the title of the inventions realised by their professors. A recent Chart on Intellectual Property in Public Research Institutes and University nevertheless reinforced this opportunity, pointing out to these organizations the legal duty of protecting and exploiting inventions produced by their employees. In Italy the law 383/2001 established (art 7) a revising of the provisions related to the statute of civil employees of the State and established the recognition of the IPR title to the University's and to the public research institutions' employees for their own inventions.

This legislative innovation produced different reactions: apparently appreciation by industry (Cesaroni e Piccaluga, 2002), debate and criticism within the scientific environment. More recently (2005) Italian Government has introduced a new legislative act (D.L.30/2005 art 65), which leaves to the public researchers the IPR entitlement only in the case of research financed with core intra-institutional fund, while in all the other cases of contract fund the ownership is attributed to their public employer. In the meanwhile, between 2001 and 2005, public institutions have elaborated internal regulation, which leaves to their employee-researchers a large range of options

How much do these institutional changes impact on the propensity of professors and public researchers to patent? Which are the mechanisms favouring individual patenting? How much do they modify the incentives of the scientific system or how much do they represent a specific incentive to realise patentable inventions?

The economic literature dealt with these aspects without arriving to a convergent result. Studies on the effect of the new regulation in US, the 1980 Bayh-Dole Act, which assigned the IPR title to the Universities and public research institutions on inventions coming out the research activity financed by public funds and the Stevenson–Wydler Technology Innovation Act, in the same year, which explicitly attributed to the public laboratories the technology transfer mission, to be realised through the creation of dedicated technology transfer (TT) structures (Jaffe, 2000) have in some case put into evidence a direct relation between these institutional innovations and the increase in public patenting in US (Trajtenberg *et al.*, 1997). In other cases this increase was considered independent and due to other factors, such as the growth of new research fields, where higher is the link between basic and applied research (Mowery *et al.*, 1998). Some other studies considered that the quantitative growth of public patenting in US has not been always characterized by good quality (Henderson *et al.*, 1998); the public patenting increase could be attributed to the entry of newcomer universities in the patenting activity, with a resulting lower average quality of patent (Cesaroni and Piccaluga, 2002).

Europe represents a less studied and lightly different case: the regulation to which public research institutions could refer themselves for ruling the IP entitlement of the internally realised inventions is older than the US one and in some case very old (Italy, R.D. 1127, June 29, 1939). At the same time it had a low impact, in fact both in France and in Italy recent studies have put into evidence that, notwithstanding a low institutional public patenting, there is a more or less large (depending on scientific fields) phenomenon of public inventors, who realise patents in collaboration with firm and other partners (Balconi *et al.*, 2002; Azagra-Caro *et al.*, 2004). The change at institutional

level is more recent (end of 90's) and partly driven by the new patent regulation, partly due to changes in the attitude of the same institutions, under the pressing push of giving a justification of the public research funding in terms of direct contribution to the productivity and competitiveness of the economic system (Geuna, 2001).

This study can be considered a first step of a more complex programme of research, not only because at present it is limited in its extension, but also because at present it doesn't take into consideration in a more detailed way the specific local applications of the patent regulation change, which probably has a more direct effect on researchers behaviour. Our study is focused on individual researchers and at present has the aim of verifying the impact of the new regulation in relation to three aspects: the diffusion of information on the general patent regulation and on its "local" applications, within a sample of public inventors, verifying at the same time the relation between patenting and being informed on regulation; verifying the presence of a more entrepreneurial attitude among public inventors and the institutional and individual factors which characterise it; verifying the relation between the new incentive (IPR title to researchers) and scientific incentives. At present we consider only two public institutions (one University and a public research institution), both multidisciplinary: the University La Sapienza (Roma 1), with one of the larger Italian university patent assets and one of the first to have introduced a Patent Office (1999) and launched an internal policy of patenting promotion; the National Research Council, the Italian public institution with the richer patent portfolio (Cesaroni and Piccaluga, 2002). We take into consideration a three years period, 2001-2003, when the new 2001 patent regulation starts to be applied. Given the short time after the introduction of the new patent regulation, of course, our study doesn't take into consideration the public patenting trend for finding out a relation with the new regulation; moreover it doesn't study the impact of the State regulation on the behaviour of the public institutions through some cost function, neither the new patent regulation impact on the individuals' economic compensation.

The paper is organised as following: in the paragraph 1 we pay attention to the main aspects of the 2001 Italian patent law and to its application regime in the two institutions (University Roma 1 and Cnr); in paragraph 2 we consider the historical trend of the patent portfolio of both the public institutions; in the next paragraph we introduce research questions and empirical results from the socio-economic literature; in paragraph 4 we introduce the sample; the other two paragraphs deal with results: in the 5th descriptive statistics and in the 6th a factor and cluster analysis are presented; finally we give our conclusion and indicate future research lines.

1. The new regulation on public patent in Italy

In Italy the legal reference which ruled the intellectual property rights in public institutions until 2001 was the R.D. 1127/1939 (the Italian law on industrial patents) and in particular the art 34. This legislative article assigned the IP title of invention realised by public employees to their public research institutions; public inventors, besides the right to be recognised as moral author of their invention, had the right of benefiting of a prime ("equo premio") in case of patent commercialisation. The amount of this prime was established by the internal regulation of universities and public research institutions. A survey realised in the past on 155 research units, which had taken part into a finalised project[1] (Poti', Cesaroni, Cioppi, 1999) pointed out a diffused dissatisfaction with the patent regulation and its application by Cnr. Some researchers complained that Cnr institutes had scarce autonomy, in relation to the central administration, in managing patents, and the same for the researchers. It was complained the absence of practices of withdrawing by the public institution side, with the related possibility of access to the IPR title by public

[1] Finalised projects, managed by Cnr, have been an important source of public patents. They still exist, but have been strongly curtailed. They last on average 5 years, are organised in temporary research units, including university, public research institutions and industry, and deal with strategic research areas.

researchers. Moreover some researchers sustained the necessity of introducing more economic incentives for the inventor, higher than the existing "equo premio": the current incentive was considered too low. At that time following the CNR regulation the inventor received 20% of the gross economic return from the patent commercialisation. More largely it was complained the absence of investments dedicated by public research institutions to these activities, with a real support in the management and valorisation of the patent portfolio. It was said "patenting happens in a sort of empty space". Also other aspects of weakness was lamented: the fact that the research fund of the finalised projects or the institutes were charged by the cost of patenting, instead of the Cnr central administration. Finally it was lamented that publications could circulate only after the patent. In sum, it was sustained that in the absence of a specific management and economic support, and of a real incentive, the researcher, even if favourably oriented toward translating research results in a more directly transferable form, above all if he was young, preferred publishing and ignored patenting.

Italian law 383 (18/10/2001) innovates the pre-existent patent legal framework: in that one only a reference to Public administration was inserted, now a specific article is dedicated to patenting in public research institutions, differentiated from industrial research. Summarising, the new regulation provides that the exclusive title of the proprietary rights deriving from patented inventions, realised within university and public research institutions, goes to the researcher. The researcher's patrimonial rights are limited between 50% and 70% of the economic return from the commercial exploitation of the invention; the residual amount goes to university or public research institution, which, not enjoying any more IPR title, are relieved of the patent management cost. Inventor is charged of the expenditure and strategies dedicated to the patent exploitation. He has the duty of information toward his public employer. The law then refers to the public employer for the definition of all the other aspects about the relations with the researchers/inventors. Since the law referred the organization of the relations between public employer and researchers to a contractual definition, the offices of the public research institutions have formulated internal regulation to adapt their administrative action. Here we refer to the adaptation made by the two institutions considered in our study. Both provided to regulate the possibility of an IPR assignment by the inventor to the institution.

The University Roma 1 provided two hypotheses of IPR assignment, ex ante and ex post to the patent application, for inventions realised within the University. After the positive evaluation of the proposal by its Patent Office, the University goes on with formalising the IPR acquisition at the following conditions: the inventor is charged by the irreversibility of the proposal, the duty of confidentiality; the commitment to present the patent application within a predefined deadline and the collaboration in the definition of the patent protection and exploitation. University is charged by patent protection, expenditures, marketing and transfer. In case of assignment asked after a patent application, the inventor who enjoys the IPR title can choose if going on with it or keeping the title and agreeing with University upon a contract of exclusive licence. In all these three alternatives University recognises to the inventor the right to 50% of the economic return (equo premio) from the patent exploitation, deducted its expenditures.

If the researcher prefers to keep the IPR and to go on autonomously with the patent protection and exploitation, the University has the right to 40% of the economic return from the patent commercialisation. The new regulation, which introduces the purchase of a right from a private person, has produced a more cautious and selective behaviour on the Patent Office side, which in its turn has to justify more strictly its budget towards the University central administration. In the past the justification was first of all in terms of excellence (on the basis of sectoral studies) and lastly in terms of patent economic value; at present, with a structural lack of resources, the criteria of cost-benefit become more relevant. At the same time it becomes clear that patents are not a direct source of funds, but they have an economic value as property and a signal value, together with publications. Moreover they have an

indirect economic effect, since patents attracts new research contracts.

The new patent regime was applied by the University of Roma 1 since June 2002.

At Cnr, inventors, who are employees, have two options: applying directly for a patent, keeping the IPR title and the related expenditures or drawing out an IPR assignment contract. If the inventor keeps the IPR title, 30% of his economic return from patent exploitation goes to the institution. The inventor is asked to take informed his institution, but of course there is the possibility of opportunistic behaviour and moral hazard between employee and public employer. The institution puts a limit to this risk, when establishes that the assignment has to be contracted before applying for a patent (assignment of a dawning right). Another limit to the risk of moral hazard comes from the fact that Cnr suggests the practice of receiving directly from the firm, which acquires a licence on an inventor's patent, its quota on the firm's economic return, without passing through the researcher. Moreover even if there is not an obligation of communication on the inventor side, the institutions can prosecute the researcher who doesn't enforce the internal regulation. The new patent regime leaves then place to conflicts between institution and researcher and ask for trust commitment.

Since 1995 Cnr institutes have been charged of the patent expenditures for the first three years and have to assure the first selection of patents. Even if at present there isn't a quota from the patent's economic return going to the Cnr institutes, there is a form of indirect return for them, through the research contract that are stipulated with industry at the moment of a licence agreement.

The new regulation is adopted by Cnr since April 2003.

Summarising, the present changes go in the direction of giving a range of choices to the inventor and a proactive patent policy to institutions. But at the same time they introduce more constraints: duty of confidentiality, responsibility of information, selection of the IPR assignment to be accepted, and on the side of the economic incentive changes ask for an assessment of the alternatives, together with the patent value and the efficiency of the internal TTO.

A full assessment of the effects of the new regulation will be possible only in two-three years. At present our study takes into consideration only general aspects and specifically: the information of researchers on new regulation; a first assessment by the researchers; the more or less favourable propensity toward an entrepreneurial attitude.

2. The patent portfolios: characters and evolution

During the time Cnr have accumulated an important IPR portfolio and it to day collects around 298 patents (30/10/2004). As to a recent study (Abramo and Lucantoni, 2003) the 1982-2001 patent portfolio represented 59.1% of patents registered by the whole Italian public research system. From 1996 to 2003 the total Cnr IPR portfolio (including patents, copyrights and others) went down from 618 to 419; this was due to the fact that since 2001 the institution has controlled and verified the state of its IPR property and left the IPRs taken for obsolete or without interest for industry. Nonetheless also the yearly flow of new patent deposits has a tendency to go down. The uncertainty due to the change in regulation in the more recent period 2002-2003 could explain the strong decrease in annual patent production in these two years. But the reduction of the patent production seems to be an "historical" characteristics of the institution: in the study to which we refer (Abramo *et al.*, 2003) the authors make a comparison between the yearly average patent production in two periods and they find out that it slows down from 73 in 1989-1995 to 43 in the period 1996-2001. The reduction is particularly relevant in patents deriving from research activity organised by finalised projects (see footnote 1). One of the reason of the slowing down seems therefore to lay in the continuous reduction of State fund to Cnr for finalised projects. The research expenditure for finalised projects in the two periods went down of -19%, while the ordinary

research expenditure was reduced of -8%. But the slowing down of patent production was worse (-41%). Among the possible reasons, besides the two ones quoted above (slowing down of the State fund for finalised projects and of Cnr ordinary research expenditure), the authors refer to the new patent policy of the institution, which since 1995 decentralised the patent expenditure's burden from the central administration to the institutes and finalised projects. This new policy should have created a competition in the resources allocation between research and patenting expenditure within institutes and finalised projects with an effect of disincentive to patent. This Cnr policy have had the aim of giving more decentralised responsibility in the selection of patent to research informed people. At present the Cnr institutes have an indirect benefit for their disclosure activity: in case of license contracts, automatically research contracts are established between the industry and the institute. A worsening of the transfer activity from the institution didn't go with the historical slowing down of the yearly average patent production: the number of patent yearly transferred remained more or less the same. But this doesn't indicate automatically that the quality of patents is better than before, since it could also be present an opposite phenomenon of loosing good patent inventors, together with the recurrent phenomenon of researchers abandoning CNR for University. Moreover an orientation to patenting "elsewhere" (with industry or abroad with public institutions) resulted from a previous study on a CNR finalised project. (Poti' *et al.*, 1999). What can be happened is a higher attention dedicated to the technology transfer mission by the institution. Anyway this issue asks for a specific investigation.

An opposite phenomenon of patent growth or emersion characterised the University Roma 1. In 1999, when it was established, the patent office found the property of 34 patents. Until that moment no one patent had been transferred or commercially promoted. At the end of 2002 the IPR portfolio (it doesn't include copyrights) of Roma1 had 72 patents, which corresponds to a growth of 85% in the period (28% by year). In the same date patents in an on going transferring process were 21.

While the motivation of the public researchers to patent is still mainly based on scientific incentives, the motivations of the administrative structures are mainly economic. In both cases the extension of the patent application abroad can amplify the expected results: larger recognition for the researchers and higher opportunity of economic return for the public institutions, through contracts with industry or royalties by licensing.

Tab. 1 - Cnr IPR portfolio: flows and stock

	1996	1997	1998	1999	2000	2001	2002	2003
National patents*	39	29	46	42	39	63	20	21
International extension of patents	9	11	8	13	18	14	19	19
National IPR Portfolio	618	590	567	554	513	500	431	419
Portfolio of internationally extended IPRs	nd	nd	nd	nd	101	112	125	125
Yearly contracts	12	9	10	6	12	12	8	3
Expenditure for IPR management (x1000)	358	361	359	413	413	413	413	413
Revenue from IPR (x1000)	370	461	466	336	628	680	414	258

*Only institutionally owned patents are included

Source: Cnr/DAST

The patent international extension, nevertheless, didn't become cross border licensing with a similar to public patenting intensity. A recent analysis of the Italian public patent commercialisation, through direct patent sale and (temporary) licenses, (Abramo and Pugini, 2004), in 44 universities and at Cnr, showed that the geographical proximity and, linked with that, the characteristics of the local environment, are predominant in the Public research system's technology transfer. The (1999-2003) technology transfer was concentrated in the North of Italy regions. Neither the South of the country nor the international market and MNEs were the final buyers/licensees of the public patents. Other two interesting empirical results (even if on a more restricted number of examined cases) are that the main users of the technology transfer are national incumbent firms of medium-large size and that exclusive licenses predominate.

3. Institutional changes and motivation of public inventors

3.1 Institutional factors

Empirical study on the determinants of patenting in the public research system devoted attention to institutional factors that can affect the propensity to patent in the public research institutions:

- the disciplinary field
- the institutional diversity (institution more or less research oriented)
- TTO strategy
- institution's patent history
- the source of funding (contract funding and within it the industrial contract funding)

Patent activity is related to the field of specialization: in life science and engineering it is more frequent to apply for intellectual property right protection. Meyer Krahmer and Schmoch (1998) find out that some technological areas give higher opportunities to patent and innovate.

The TTO is the administrative service created to manage and support the university inventions. The presence and role of a technology transfer office is fundamental, given the low awareness of patenting among public researchers. The effect can be different: it can encourage the disclosure of invention and the patent activity, but also, if highly selective in accepting inventions or conservative in contracting licenses, have a counter productive effect (Siegel *et al.*, 1999). Some authors find that the size of the TTO matters positively (Folz *et al.*, 2000). Carlsson and Fridh (2002) explore the role of TTO in patenting and licensing in 12 US universities. They find that inventions depend on the year of creation of TTO and the number of staff, along with the total research expenditure.

The institution's experience in patenting has an effect on aggregated and individual higher propensity to patent (Stephan *et al.*, 2004).

Azagra-Caro, Carayol and Llerena (2003) have studied the effect of contractual funding by source on public patents (university owned and university invented but owned by industry) in a large University (Louis Pasteur) at laboratory level. Relation with industry and research funded by industry can support patent activities in the public research system. The authors find that contractual funding (public and private) has a positive influence on the generation of institutional patent, even after controlling by laboratory differences (size, discipline, institutional type). But when distinguishing contract fund by public and industrial source, university owned patent is less responsive to industrial fund, than university invented patent (owned by industry).

3.2 Individual factors

The analysis on patenting in public institutions in the socio-economic literature is mainly focused on institutional aspects, while the relation with individual researcher characteristics or the interplay between personal and institutional factors has been less explored. It has been studied mainly in relation to scientific publications. A different path has been

followed by Stephan, Gurmu, Summel and Black (2004). The authors start from the hypothesis that patent can be a "logical outcome of research activity, that is designed first and foremost with an eye to publication". Three factors can mostly encourage patenting:

- a more applied oriented scientific environment: working in engineering faculty or technical university or in biomedical research can give research results both patented and published. In this case the patent can be viewed as a by product of publication, given the low marginal cost of producing a communication for the technology transfer office;
- the interaction with industry, that can increase the interest and the opportunity to patent of public scientists;
- the economic reward accompanying the patent protection of research findings through the technology transfer, even if economic returns from patenting is highly skewed.

Other less prominent factors can also play a positive role in patenting orientation:

- the academic visibility: patents confirm the novelty of the scientific results and attract industrial firms collaborations;
- other return from the industry, such as the access to equipment.

The disclosure of invention to their public institution and TTO by the scientists is constrained mainly by opportunity cost consideration (Thursby and Thursby, 2003) such as time to take away from research for being involved in licensing and development, because the researcher involvement is asked also for institution owned patents. Some of these constraints are due to "learning costs" and experience can help future disclosures.

Given these pros and cons factors, some personal character can influence the propensity to patent of public scientists: age and cohort effect, career stage, scientific productivity.

The hypothesis made by Stephan *et al*. (2003) are that incentive to do patentable research is not different from incentive to do publishable research, therefore the rate of patenting should decline with the age, following a trend similar to the age-publishing profile. At the same time this trend can be alleged by the career stage consideration: at the beginning of career there is the necessity of concentrating time on research activity, while late in career the scientist can allocate more time to activity that could produce additional revenue. Another factor that can alleged the life cycle effect on patenting come from the cohort effect: younger institutions could be more patent oriented, given an important recent change in academic culture.

The results from a multivariate cross section analysis (patent equation in Stephan *et al*., 2003), including institutional and individual factor variables, are not completely congruent with these hypothesis: there is little evidence of life cycle effects on the number of patents applications that a scientist makes. A strong results is instead the positive and significant relation between patents and publications.

In another study which examined patenting activity at individual level in a Department of MIT, the authors (Agrawal and Henderson, 2002) found out that disclosures are negatively related to age and positively to career stage; but the cohort effect is opposite to the hypothesis of a "cultural change" in University, since new cohort were less oriented to invention disclosure to their institutions

Another study (Wallmark, 1997) describes the inventors profiles (age, gender, individual patent productivity) at a Sweden University of Technology. It is found out that the individual patent productivity is unevenly distributed: 75% of researchers contribute to 25% of patents while the top 10% contribute to 75% of the results. The presence of very productive individuals should influence the distribution of patents among the different schools at the technical University: in fact, instead of the different size of schools and the different patent frequency among industry branches, the patenting are evenly distributed among schools. Wallmark finds also that the patent production curve over the life cycle seems to be the same obtained for publication production: an inverse U shape over the life cycle.

3.3 Scientific incentive versus economic incentive

Does patent production follows the same incentives of scientific production, i.e. reputation based reward, associated with recognition by peers, new position in better locations and wage increase?

Carayol (2004) considers that patents follow a slightly different incentive regime, since the research leading to high performance in publication can be different from the one leading to patents (therefore patents are not often a by product of publications); and the reputational reward of patent may not be evaluated in the same way by scientific community and not produce the same effect in terms of career.

The question therefore is if and how publishing affects patenting. Following Agrawal and Henderson (2002), patenting is not affected by publishing activity. Carayol (2004) explores the non neutrality of publishing, on the basis of two different hypothesis: that one may expect a positive effect of publication (best researchers can exhibit both the best patenting and publishing profile) and on the other hand that some researchers specialize in patenting.

His conclusion is that the academic reward system doesn't provide incentives for patenting. The reputational reward of patent seems low and this is a disincentive for young researcher to patent, while older researchers are more sensitive to value the application of their research and its pay off. In sum, patenting should ask for a specific strategy, often in collaboration with industry.

Calderini, Franzoni and Pezzulli (2004) also studied the effect of quantity and quality of scientific publications over the decision to patent, controlling for the effect of personal, institutional and environmental characteristics by a sample of 1323 Italian public researchers. They find that the probability of patenting with private company increases with quantity and quality of publications, the expertise of TTO and the presence of firms in the area of scientist location; the probability to patenting depends on reputation accumulated along the career, but the probability of patenting for a top scientists is very low. This can be probably due to the fact that top scientists "do not engage in contract research because their time is fully financed". In sum the effect of scientific productivity is higher than scientific quality on the probability of patenting with industry.

3.4 The role of regulatory framework

As to the patent regulatory framework (patent laws and related administrative regulations), some authors (Meyer Kramher and Schomch, 1998) see it as one important factor explaining the different national patterns in university patenting. Nevertheless there is a lack of in - depth study on the national patent laws impact on public patenting. An interesting track can be found in Harhoff and Hoisl (2004) work on the German Employees' Invention Act and particularly on the monetary compensation for inventors, that in Germany is regulated by law and not (as in other countries, included Italy) by negotiations between employer and employee inventor. Their study is based on a survey collected within the scope of a European project (PatVal) started in 2002 and even if it is not specifically dedicated to public inventors, it gives a good insight into the functioning of a patent's economic compensation scheme and its capacity of creating incentive to patent for employee inventors.

Policies on ownership of patent at public research organisation are changing within Oecd countries and encouraging the ownership of invention by the institution where the research have been performed. A way for realising these change in Europe passed through modifying the employment laws, so that university professors are not exempted from legislation that gives employers the ownership of the intellectual right generated by employees.

In Italy, as presented above, two kinds of change, with different rationale, happened in a short time:

- in 2001 (L 383, art 7) the IP title was recognised to the individual researcher employed by a university or a public research organization; as a consequence the

public institutions introduced new rules for filling the space left by the law to parties' agreement and in particular the possibility for the employee researcher of asking the employer institution (ex ante or ex post the individual patent application) for an assignment contract. The new legislation and its application gave therefore to the individual researcher a large space for alternative solutions;

– in 2005 a new law passed, modifying substantially the previous one: it recognises the IP ownership to the employer- institution in all cases of research contract financed by external (private or public) funds. Only in case of research activity funded by core fund the inventor employee can take the IP title or choose the IP assignment contract to its institution. In this way Italy backed out and followed the general European concern of giving greater legal certainty to firms interested in exploiting research results. The justification of this tendency is that the IP ownership to institutions, as opposed to title to individual researchers, should low transaction costs for industrial partners and encourage more formal channels for technology transfer (Oecd). This more recent regulatory change is not taken into consideration in our survey.

An Oecd study (2002) puts into evidence some problem leaved a part from innovation in regulation: firstly information on IP policies is not well disseminated within the public system of research and often institutes or single researcher have a very approximate idea of the legal framework. Moreover some rules on ownership are still lacking or are unclear: the case of student or other non faculty members inventing at University.

And, secondly: patent reform are mainly based on ownership change, while incentives remain more or less the same for public research organization. As to researchers, why disclosing the invention to the institution instead of directly contracting with industry? And why public organisations should become more active in disclosing, protecting and commercialising patent? The incentive side of the institutional change in public patenting asks for better control.

4. Data

The purpose of our analysis was to understand if the change in patent regulation for public research organizations, and specifically the IP title to individual researchers, had found a positive acceptance within public researchers. Since the new regulation passed in 2001, time was too short for finding evidence (increase or decrease in yearly patent applications) from official patent data. Moreover the new legislative regulation has been accompanied by new specific administrative regulation, allowing researchers a choice among different strategies of entitlement and reward, that could not be detected from official data.

We studied the public patenting behaviour at individual level through a qualitative survey addressed to all the inventors who patented in two large public research organizations, the University La Sapienza (Roma1) and the National Research Council (CNR) in three years (2001, 2002, 2003). The 2001 new regulation has been adopted later in these institutions: in June 2002 by the University Roma1 and in April 2003 by CNR. In the meanwhile the institutions have used the old legislation, taken into account that it could be used for inventions done before the law.

The interviews, made by telephone, were addressed to the 163 researchers present in the patent list of the two institutions, for the period 2001-2003, some of them with more than one patent. The list of patents of the University Roma 1 for 2003 was not complete[2]. The dataset has been built on 125 questionnaire filled by 102 researchers: the same one answered to more than one questionnaire when he filed more than one patent, both because he co-patented or because he had more than one patent in the period.

The distribution of patent by institution and date of deposit is in the following table.

[2] Data for 2003 are not complete since information on patent application couldn't be circulated before 18 monthes by University Roma1

	University Roma 1	CNR	Total
2001	43	31	74
2002	13	21	34
2003	2*	15	17
Total	58	67	125

(*) Information on patent application couldn't be circulated before 18 months by the University Roma 1

Some University researchers has patented with CNR within the CNR finalised projects. Given this situation and the too recent intra-institutional regulation we didn't compare different institutional patent regime and in this preliminary study we only explore the level of information of public researchers on regulation.

The questionnaire and the dataset contains mainly qualitative information on three kinds of questions: the individual characteristics of researchers with institutional patents and their motivation to patent; their level of information on the new regulation and their evaluation; the orientation towards a more entrepreneurial behaviour in patenting.

5. Results: Descriptive statistics

The patenting activity has mainly being realised following the old patent regime (title to the institution), 74.4%; for the 23.2% patents following the new patent regime researchers have adopted the assignment contract to institution (18.4%) and only 4.8% have chosen the individual patent entitlement.

The public inventors informed on the 2001 patent regulation are 56.8% and on its application to the institution are 53.8%.

The international geographical extension, that can be considered an indicator of quality for patents, concern 41.9% of all patents.

The predominant behaviour is co-patenting (91.2%), mainly within the same institution (59.6%); co-patenting with industry in the period represents 7%.

Around half of researchers has a past experience in patenting (59.2%); 40.8% are newcomers in patenting.

Around one third (27.2%) of researchers has co-patented or developed a patent with industry in the past, mainly at CNR.

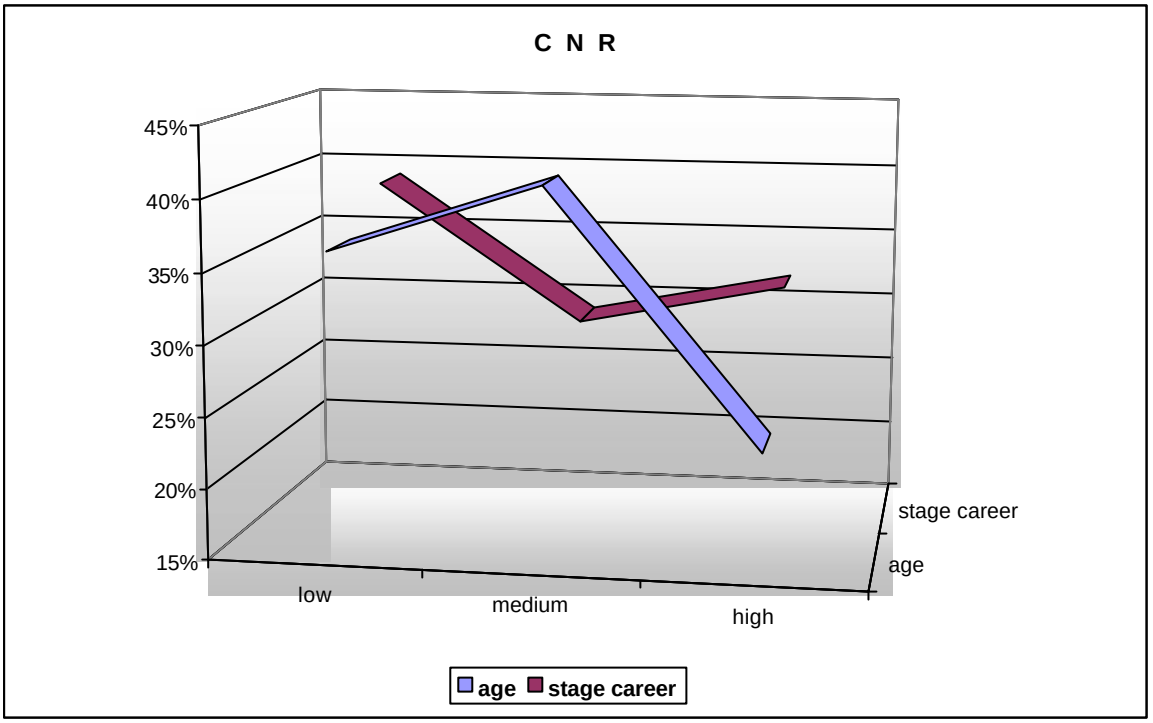
A larger number has professional linkages with industry (56%) and in this case there are no significant differences between University and Cnr.

Even if the applied type of research prevails as the main research activity (54%), also basic research as main research activity is largely represented (38.4%) and without significant differences among the two institutions; development (7.2%) has a larger presence as main activity at CNR.

Age and career stage effects

The cross sectional distribution of patenting by age shows a grow with the age of individuals and a decline after a peak at 46-55 years, probably later than in an age-publishing profile. The career stage effect alleges the age patenting profile, since at University the tendency is a growth in patenting when going from the low to the high career positions. Patenting late in career can suggest that reputational reward of patent is low and this is a disincentive for young researchers.

Cnr represents an anomalous case, where, for the absence of a policy of human resources valorisation, researchers are for the great majority concentrated at the lowest level.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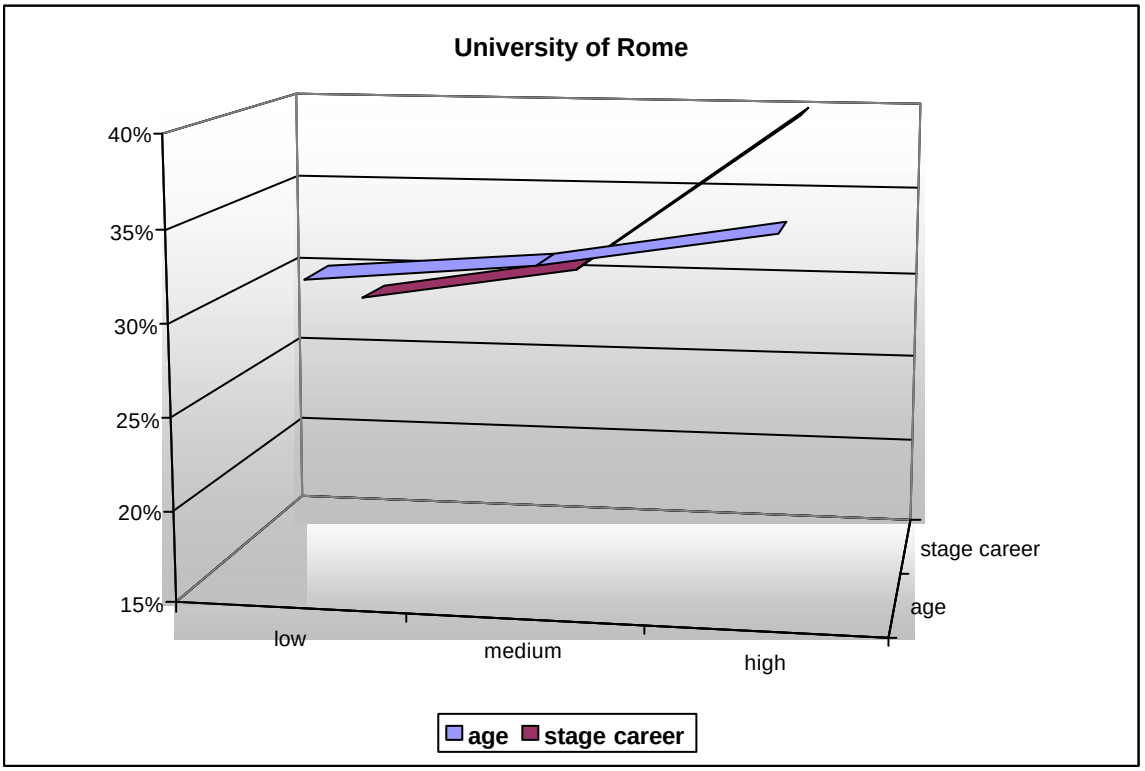
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Publishing and patenting

For almost all the researchers, patenting goes with publishing (90.2%), it is a product linked to publishing. The large presence of engineering science and biomedical sciences as scientific environment of inventors can allow both patented and published results. Patents are concentrated in disciplines where there is a low marginal cost of producing a patent communication. Individuals in these scientific environments are, nevertheless, largely oriented to give preference to publications. Patents in our sample of public inventors look effectively like "logical outcome of research activity, that is designed first and foremost with an eye to publication" (Stephan *et al.*, 2004).

Tab. 2 - Main orientation of public inventors

	N Observations	Publishing	Patenting	No one/Both	Total
University Roma 1	44	50.0%	13.6%	36.4%	100.0
CNR	42	57.1%	21.4%	21.4%	100.0
Total	86	53.5%	17.4%	29.1%	100.0

Individual motivation to patent

The strictly individual motivations (career advantage and economic return) have a low relevance: they receive mainly low scores; but scientific visibility is considered a high motivation (2+3 score) by 65% of the inventor-researchers, confirming our previous result.

Around the same percentage of inventors (62.5%) give a high score to the motivation of diversifying scientific production. In sum it looks like there is a complementary relation between publishing and patenting in our sample (CNR + University Roma 1 last three years patents): researchers who patent are scientists, but in the disciplinary environment where more patents occur, patenting is not considered as crowding out the scientific visibility of researchers.

Motivations related to attracting more external resources to research activity receive the larger percentage of high score: resources arrive through more contracts and collaborations with industry (Tab. 3).

Tab. 3 - Motivation for patenting: score

	N of Obs	0	1	2	3
No motivation					
Scientific visibility	121	7.4%	27.3%	35.5%	29.8%
Career advantage	121	38.8%	28.9%	24.8%	7.4%
Individual economic return	123	47.2%	31.7%	11.4%	9.8%
Attracting more resources	123	4.1%	9.8%	31.7%	54.5%
Incrementing collaboration with firms	122	11.5%	13.9%	37.7%	36.9%
Diversification of output	120	15.0%	22.5%	43.3%	19.2%

Tab. 4 - Relevance of institutional factors for patenting decision: frequencies and subjective judgement (score)

	N Obs	Yes	0	1	2	3
The national Patent regulation	125	54.5%				
TTO role	125		35.0%	23.3%	29.2%	12.5%
Public funding	125		19.0%	25.6%	34.7%	20.7%
Non academic institutions	125	53.6%				

Tab. 5 - Type of research activity by discipline

Factors	Medicine	Physic sciences	Chemistry sciences	Engineering sciences	Biological sciences	Environmental sciences	Agricolture sciences	Materials	**Total**
N. observations	*11*	*18*	*36*	*44*	*26*	*6*	*2*	*7*	***150****
Basic research	27.3%	44.4%	58.3%	15.9%	57.7%	16.7%	100%	0%	**37.9%**
	3	*8*	*21*	*7*	*15*	*1*	*2*	*0*	***47***
Applied research	72.7%	44.4%	36.1%	75%	34.6%	83.3%	0%	85.7%	**54.8%**
	8	*8*	*13*	*33*	*9*	*5*	*0*	*6*	***68***
Development research	0%	11.2%	5.6%	9.1%	7.7%	0%	0%	14.3%	**7.3%**
	0	*2*	*2*	*4*	*2*	*0*	*0*	*1*	***9***
Total	100%	100%	100%	100%	100%	100%	100%	100%	**100%**

* the inventors could choose two disciplinary areas

Institutional factors

Among the institutional factors that can affect the propensity to patent in the public research institutions we took into consideration:

- the regulation
- the disciplinary field of patents

We dedicate below a specific attention to regulation, controlling for disciplinary differences:

- the institutional diversity (institution more or less research oriented)
- the TTO role
- the public funding supporting collaborative research and spin off

All the institutional factors show a not very high relevance: they concern around the half of our inventor sample or they register a high score (2+3) only by around the half of the same sample (Tab. 4).

The role of disciplines: differences among them

The inventions in our 2001-2003 list occurred mainly in engineering (44), chemistry (36) and biological (26) sciences.

The distribution of research activity by type is in table 5.

Basic research is over the average in chemistry, biological sciences and physics. Applied research is mainly concentrated in materials, engineering and environmental sciences.

Past experience in patenting is over the average in physic (almost all the inventors in the list) and chemistry sciences (63.9%).

Past and present collaboration with industry in patenting is over the average in physic (38.9% of the inventor in the discipline), engineering (34.1%) and environmental sciences (50%).

1

Differences among discipline look like being important, partly reflecting disciplinary characteristics and partly the institutional (but it can be extended to national) scientific history. In physic and chemistry, where basic research is relevant, there is also an important patent heritage (tab. 6).

Professional linkages with industry is more diffused (56% of the sample) than patenting with industry (27.2%) and it is over the average in engineering (77.3%), environmental (66.7%) and chemistry sciences (58.3%).

Regulation: how many public inventors know the regulation

There is no relation among attributing relevance to the role of a national patent regulation and being informed, while there is a relation between information on the new patent law and its institutional application (tab. 7).

Only around one half of inventors are informed about the new patent regulation and on its institutional application.

There are differences in information among disciplines: the more up to date are physic scientists in our sample: 94.4% know the new norm and 83% the institutional application. Well informed on the 2001 law are also scientists in material sciences, but they know less the institutional application (tab. 8).

The relevance of a patent regulation for patenting activity is specially recognised in materials, environmental, biological and chemistry sciences, but only scientists in materials, chemistry and physic sciences attribute an over the average (55.4%) positive role to regulation in reducing uncertainty and attributing value to public patenting.

Tab. 6 - Patenting behaviour by discipline

Factors	Medicine	Physic sciences	Chemistry sciences	Engineering sciences	Biological sciences	Environmental sciences	Agricolture sciences	Materials	**Total**
N. observations	*11*	*18*	*36*	*44*	*26*	*6*	*2*	*7*	***150****
Past experience in patenting	36.4%	94.4%	63.9%	56.8%	38.5%	33.3%	0	100%	**59,2%** ***74***
Patent with firms	18.2%	38.9%	27.8%	34.1%	19.2%	50%	0	28.6%	**27.2%** ***34***
Links with industries	18.2%	44.4%	58.3%	77.3%	30.8%	66.7%	0	100%	**56%** ***69***

*the inventors could choose two disciplinary areas

Tab. 7 - Attribution of a relevant role to regulation and level of information
Test of statistical significance (Pearson Chi -Square)

	Value	df	Asymp. Sig.
Relevant role for regulation and information on the new patent law	4.649	2	0.98
Relevant role for regulation and information on the new institutional application	1.676	2	0.433
Information on the new patent law and on the new institutional application	89.714*	1	0.000

*statistically significant relationship among the variables.

Tab. 8 - Role of patent regulation and level information by discipline

Factors	Medicine	Physic sciences	Chemistry sciences	Engineering sciences	Biological sciences	Environmental sciences	Agricolture sciences	Materials	**Total**
N observations	*11*	*18*	*36*	*44*	*26*	*6*	*2*	*7*	***150****
Relevant role of the patent regulation	3.3%	50%	71.4%	27.3%	80.8%	83.3%	100%	85.7%	**54.5%** ***67***
National patent regulation reduces uncertainty	3%	61.5%	70.8%	35.7%	42.9%	40%	0	100%	**55.4%** ***41***
Informed on new patent law	45.5%	94.4%	58.3%	47.7%	57.7%	50%	100%	71.4%	**56.8%** ***71***
Informed on the new patent law application in the institution	40%	83.3%	55.9%	52.5%	57.7%	33.3%	100%	57.1%	**53.8%** **64**

* the inventors could choose two disciplinary area

Economic incentives: what does encourage scientists to patent?

We explore the propensity of public inventors towards a higher but more uncertain economic return. The patent regulation recognises a prime for patenting to the inventors when the IP title is to the institutions, while when the title is to inventors there is no more prime and the inventor/owner must transfer to the institution a quota of its return from the IP commercialisation. In both the cases the economic return depends on the market success of the invention, and in both the case a collaboration between researcher and institution can be present, but in the case of title to inventor he has larger responsibility together with larger return. There is room for exploring the scientists interest to change towards larger but more risky return in patenting.

Scientists in our sample show a prevailing "conservative" attitude: 51.8% is in favour of the "equo premio" regime. Nonetheless a good 38.4% is in favour of a more high and risky economic return and this attitude is slightly more present among university scientists (tab. 9).

We explored which factor can have an impact on this different attitude.

Only age, career stage and type of research have a statistically significant relation with the preference for more high and risky economic return: nor the collaboration with industry in patenting, neither the main orientation toward patenting instead of publishing, neither the non academic institution (Cnr), or the experience in past patenting (tab. 10).

It seems to emerge a profile of young researcher, at the beginning of his career and working in more applied oriented research, who should be more oriented towards a more risky behaviour. We will explore better the composition of our sample by homogeneous groups and their relative weight below by a cluster analysis.

Tab. 9 - Attitude towards the economic return to inventors

	University	*Cnr*	*Total*
Low and established economic return	*22* 44.4%	*34* 58.6%	*58* 51.8%
High and risky economic return	*23* 42.6%	*20* 34.5%	*43* 38.4%
Doesn't know	*7* 13%	*4* 6.9%	*11* 9.8%
Total	*54* 100%	*58* 100%	*112* 100%

Tab. 10 - Individual and institutional factors influencing the attitude towards a high and risky return to inventor

Factors	*Mode*	*Value*	*df*	*Asymp. Sig.*
Age	36-45	10.146*	3	0.017
Career stage	low/starting (researcher)	6.115*	2	0.047
Institution	University	0.778	1	0.378
Academic attitude (preference for publication)	No academic	3.438	1	0.064
Patent with firms	No	0.966	1	0.326
Kind of research	applied research	9.940*	1	0.007
Informed on the new patent regulation	Yes (56.8%)	0.099	1	0.753
Past experience in patenting	Yes (51%)	1.019	1	0.313

Evaluation of the new patent regime

The main advantage attributed to the new patent regime (title to individual inventor) by informed researchers is the opportunity of an economic exploitation of patent, but the average score given to the scientific visibility is not so far: the attribution of title to the individuals is considered to produce higher visibility. Moreover this answer reinforces what we wrote above: in the scientific environment where patenting is more diffused, scientific visibility goes with patenting (tab. 11).

The main disadvantage is considered the higher constraints imposed by institutions in the application of the new regime. As we underlined above, the new patent regime introduced/ reinforced a problem of moral hazard in the relation between inventor and institutions and a selective attitude by Patent Office towards the IP assignment on inventions. At the second place is the cost –opportunity disadvantage in terms of time to be dedicated to marketing patents.

Asking more directly why choosing the individual IPR title, we collected a very low number of answers, even if higher than the number of inventors who chose it, and "autonomy" in patent managing received the highest score (tab. 12).

Asking directly why going for an IPR assignment contract to the institution, we received a number of answer lightly higher than the number of inventors who did it and the lack of expertise was the reason with the highest score (tab. 13).

Patenting with firms: what does firm trust more, individuals or institutions?

One of the justification for giving the IPR title to institutions is that firms trust more to treat with institution when contracting patent licenses; on the other side there is the justification of the reduction of risk of firms opportunistic behaviour towards single inventors. Our sample of inventors answered differently to the question "On your experience, do firms prefer to establish the relation with the researcher or with the institution" distinguishing by (research and service) contract and (research) project and by the old regime (title to institution) and the new one (title to inventor).

The distinction allowed us to separate the important phenomenon of individual consultancies from research projects. We got a limited number of answers, around the number of the event of patenting with industry, but very convergent: even if slightly lower for research projects, the large majority indicates the direct relation with researchers as the preferred one by firms. Of course this result leaves open the possibility of firm opportunistic behaviour toward individuals (tab. 14).

Tab. 11 - Advantages and disadvantages of the new patent regime

ADVANTAGES	*N Obs.*	*Min*	*Max*	*Mean*	*St. Deviation*
Economic return	72	0	3	1.57	0.81
Autonomy of patent management	72	0	3	1.46	0.71
Opportunity of economic exploitation	72	0	3	1.72	0.74
Scientific visibility	71	0	3	1.61	0.62
DISADVANTAGES					
Economic costs	72	0	3	1.25	0.52
Excessive time for managing patents	72	0	3	1.61	0.74
Lack of expertises	71	0	3	1.28	0.48
Higher constraints imposed by the institution	70	0	3	1.90	0.76

Note: the inventors were asked to give a score from 0 to 3 (0 min, 3 max) for each advantage and disadvantage

Tab. 12 - Motivation for choosing the IPR individual entitlement

Factors	*N Obs*	*Min*	*Max*	*Mean*	*St. Deviation*
Economic return	16	0	3	2.25	0.86
Autonomy of patent management	16	0	3	2.44	0.96
Opportunity of economic exploitation	16	0	3	1.69	0.95

Tab. 13 - Motivation for doing an assignment contract to institution

Factors	*N Obs*	*Min*	*Max*	*Mean*	*St. Deviation*
Economic costs	31	0	3	2.03	1.02
Excessive time for managing patents	31	0	3	2.16	0.82
Lack of expertises	31	0	3	2.23	0.88

Tab. 14 - A direct relation with researchers or with institution: what do firms prefer better, by type of link and type of patent regime

	N of Observations	*Individuals*	*Institutions*
Old Regime: contracts	39	87.2%	12.8%
Old Regime: projects	40	72.5%	27.5%
New regime: contracts	30	86.7%	13.3%
New Regime: projects	32	68.8%	31.3%

6. Multivariate analysis

In order to understand how our sample of inventors should adapt to the patent regime change, we reduced the 125 cases into three internally homogeneous groups.

First of all we reduced the variables into principal factors. Dealing with categories, we chose a multiple correspondence analysis (ACM) for the application of factorial method. The ACM allows to synthesize several variables into few factors that represent some combinations among variables and are able to explain the maximum of variance and to minimize the loss of information. See methodological annex.

The first two factorial axes explain 74% of the total variance (49% the first axis and 25% the second axis).

Variables which contribute more to the formation of the axis 1 (see also the methodological annex) are information on new patent regime and on its application, and experience (patent in the past and patent with firms).

Variables which contribute more to the formation of the axis 2 are professional linkages with industry and role attributed to patent regulation (Axis 1).

The interpretation of the Axis 1 can be summarised as "Information with patent experience-Lack of information and new comer in patenting" and analysing the relative contribution of the illustrative variables, the best represented ones are in Axis 1(1).

The interpretation of Axis 2 can be summarised as "Direct relation with industry and low role attributed to patent regulation-No relation with industry and high role attributed to patent regulation". The best represented illustrative variables are in Axis 2.

Axis 1

	Negative semi axis	**Positive semi axis**
Information on new regulation	Informed -8.05	Not informed 8.65
Information on new regulation applied in institution	Informed -7.67	Not informed 8.46
Patents in the past	Yes -6.72	No 7.10
Patents with industry	Yes -5.99	No 6.44
Axis 2		
Relevant role of patent regulation	Relevant -6.57	Not Relevant 8.08
Professional linkages with industry	No Linkages –5.12	Linkages 6.0

Axis 1(1)

Informed and with experience in patenting	age 46-55	working at CNR		
Not informed and new comer in patenting	age under 35	working at University	biological sciences	gender: female

Axis 2

Direct relation with industry and low role attributed to patent regulation	age 46-55	high career stage	engineering sciences
No relation with industry and high role attributed to patent regulation	age 36-45	low career stage	

7. Cluster analysis

We reduced the 125 cases into clusters with the lowest internal heterogeneity, positioned in the space defined by the two factorial axes, through a hierarchical cluster analysis (See methodological annex).

The sample can be reorganized in three groups. The first cluster explains 41% of the cases; the second cluster, coming from a division of the first one, explains 18% and the third one explains 41% of the sample. The categories better defining the clusters, compared with their percent value in the sample, and the weight of each cluster by these categories, allow the following interpretation:

Cluster 1 regroups inventors with a good information, both on the new patent regime and on its application (around 70% of these categories is in this group); they attribute a relevant role to regulation for patenting and specifically to its contribution in reducing uncertainty and giving recognition to public patent (70.7% of this category is reproduced in cluster 1). These inventors haven't linkages with industry and co-patent with other public institutions (70.8% of this category in this cluster). 87.5% of inventors in physic science is in this cluster.

Cluster 2, which is a component of the cluster 1, regroups inventors informed on the new patent regime, who nonetheless don't attribute a high role to regulation; they have experience in patenting and linkages with industry; and are mainly involved in applied research activity; 42.5% of inventors in engineering science is in this cluster. The orientation toward the economic return to patent contribute (78%) to define this group profile, who has a "conservative" attitude, being in favour of a low and established return

Cluster 3 regroups inventors who have not information on the new patent regime, new comers in patenting, working at University (53.4% of the category is in the cluster) and involved in basic research (56.2 of this category is represented by this cluster).

The three groups in our sample are different type of inventors: a large group that represents the core of public inventors, who have a tradition of patenting and where publishing and patenting go together, even in absence of relation with industry. The core of this core group is the community of Physic science researchers, who traditionally represent the excellence group of scientist in Italy and whose attitude is to look at patent regulation as a useful and known instrument, which they draw for co-patenting with other public scientists.

Within this large group of informed individuals, there is a subgroup with a different attitude: they have experience in patenting, but don't attribute an incentive role to the patent regulation, even in the new innovative version, which attributes title to inventors. In fact the average attitude towards the economic benefit for the inventors is largely "conservative". These inventors prefer the traditional prime (equo premio), without developing new entrepreneurial behaviour. The core of this inventors is represented by the engineering scientific community, who has good linkages with industry: they co-patent with firms and mostly have professional linkages with industry.

There is then a large group of new comer inventors, without past experience and without information on the patent regulation; they are not characterised by age or discipline, neither have a common attitude towards the economic return to inventors. What is their common character, present in this group more then on the average (sample) is doing basic research at university.

8. Conclusion

Our exploratory work is based on an empirical approach, mainly qualitative at present, whose aim was to look at the patent production of public research institution from the side of individual inventors. The starting idea was to understand if there was ground for the new 2001 national patent regime, which for the first time in our country gave autonomy and responsibility to public inventors. Italy, differently from Germany, has not experience of title to inventors, but, as France, registers an interesting phenomenon of scientist inventing out of the public institutions. Our investigation is of course

biased, since we only took into consideration inventors who patented within their institution. We wondered if in this specific environment there were signal of a new orientation, more individually based, to patent. It was also the occasion for controlling the relation between the traditional scientific incentive and the patenting behaviour.

The limit of our analysis is certainly the size of the sample, reduced in terms of years and institutions. Nonetheless we obtained some interesting results. First of all, working on multidisciplinary institutions and using a cluster analysis, we learnt that disciplines count very much and that reasoning at aggregate and average level can drive to unclear results. In our sample the attitude of physic scientists towards regulation is different from that of engineering, even if both patent within the public institutions. The aggregate result can depend on the size of the different scientific communities within a national public research system. Following the same line of thought, it is not correct to generalise the relevance of the relation with industry for public patenting. What is a strong result of our analysis is the complementary relation of patenting and publishing. In this case different scientific communities arrive to a convergent attitude, through different paths and it is not necessary to extend one path to all the other scientific environments. Engineering scientists have a tradition of relation with industry and this is the base for patenting, they have more opportunities to patent coming from these relations, but physic scientists consider patent as another way for getting scientific visibility, which doesn't crowd out their reputation. What probably is relevant, but it needs more control, is the cost opportunity of patenting. Patents are probably more concentrated in those communities where there are more opportunities, but also where this cost is low, where patent communication and publication are not too far. A strong motivation for patenting indicated by researchers is the attractiveness of market resources to research activity which come with patenting. This is also a subject which should need more control and it could be done also at individual researcher level.

Looking at the question of scientific versus economic incentive, a not marginal part of our sample should be oriented towards a more entrepreneurial attitude and toward higher and risky return from patenting: they are new comers to patenting, young researchers, at early stage in career. Therefore they represent a not stabilized group, whose motivation can be mainly influenced by the still weak position in the institutions. For the remaining sample, scientists, in all disciplines, are very much institutionally oriented: the majority preferred to assign the title to the institution and are "conservative" in terms of economic return. This is an interesting result for many reasons. When we looked at single institutional factor having an impact on the sample of public inventors, we found out that nor the role of TTO, neither the public funding for collaborative research and spin off, nor the institution (more or less academic) had relevance. But individual scientist behaviour is an outcome deriving also from his institutional environment and this is why, if we look, as we did, at a sample of public scientist patenting within their institution, we easily find a common term in their behaviour. In our case it is the generalised distance from a more risky attitude towards marketing their invention.

Given that, the research policy question could be: what kind of regime or factor could increase the present favourable attitude toward patenting in patenting scientific communities and how to promote new entries from other scientific fields? Our analysis at present doesn't allow an answer, that should be searched looking at the relation between patent productivity and individual/institutional factors. What our analysis allow us to say is that legal regulation and its application doesn't seem very relevant in relation to the practice of patenting. Half of the patenting scientists of our sample had a practice of patenting separated from the awareness of their duty and right. Most of them, the not informed scientists, are patenting for the first time and interestingly they are mostly at university, which is really a new comer institution in patenting. But probably the attitude of the old patenting scientists, such as engineering scientists, who are informed about the new legislation, but don't attribute relevance to it, depends on the long history of public patenting in Italy and specifically in the public

research institutions, with a very poor patent legislation.

The 2001 patent regulation innovated more than it can appear, since, arriving in a time of attention to the technology transfer service by public institutions, produced a rich body of internal regulations. These applied regulations, which need a specific attention, opened the road to a range of autonomous patent strategy for researchers. They created also room for developing more trust relation between institution and its researchers along with risk of opportunistic behaviour. But this story, which was just beginning and which was not easy to forecast, since asked for totally new behaviour from individual researchers (autonomy and responsibility in market activity), will not be written. In fact in 2005 the rules have changed again. The new patent regulation gives the title of all the invention coming from externally funded research, and developed within a public institute, to the institution, leaving to the researcher the possibility of a title only for research funded by the intra-institution source. In this way the possibility of differentiation of behaviour within researchers is strongly reduced, in favour of a more controlled relation with external actors, who are relevant source of fund for the public institutions.

In the future, together with the extension of our sample, for better controlling the role of different institutions, we intend to explore more in depth the impact of specific internal patent regulation on public scientist patenting behaviour, the relation between scientific results and patenting and finally we should develop a cost-benefit analysis of the public patenting policy.

Methodological Annex

ACM analysis

The ACM has been realized distinguishing the variables as follows:

Active variables (directly contributing to define the factors)

1. previous patents (yes/no)
2. patent with firms (yes/no)
3. links with industries (yes/no)
4. type of research (basic/applied)
5. academic/non academic orientation
6. economic return to inventors (certain/uncertain)
7. relevant role of national patent regulation (yes/no)
8. patent regulation reduces uncertainty and give recognition to public patent (yes/no)
9. information on the new patent regime (yes/no)
10. information on the new patent regime application in the institution (yes/no)

Illustrative variables (they don't contribute to factors' formation, but help to their interpretation)

1. age
2. gender
3. stage career
4. institution
5. type of co-patenting
6. discipline

At first it also other variables have been taken into consideration, but then they have been rejected, because they got over the value test. In particular, the active variables have been chosen with a *contribution* of 4.8 (100/21 variables) and the illustrative ones with a *value test* of 2%, for each factor.

We examined the first two factors that both explain the 36% of variance. This percent could seem low, but the ACM transforms the factors' categories into single variables and it involves a proliferation of the number of variables and therefore a several number of extractable factors.

With Benzecrì's formula, the variance explained from the first factors has been re-valued so that the first two explain the 74% of variance (the first factor explains 49% and the second 25%).

Benzecrì, to whom it is attributed the paternity of the ACM, proposes an "optimistic" formula that considers only the eigenvalues above the ratio1/p (where p is the number of variables), to revalue the explained variance.

In this work the 1/p ratio is 0.045 (1/22), and it includes the first ten factors. Now, following Benzecrì, we weigh the relevant eigenvalues (the first 10) raising to square the differences between the originals eigenvalues and the constant 1/p; we compute again the percent of variance explained summarizing the relevant eigenvalues and referring each eigenvalue to this new total.

Table of eigenvalues

Trace of the matrix: 1.26736 0.0944

N	*Eigenvalues*	*Percent*	*Cumulative Percent*	*Eigenvalues Re-valued*	*Percent*
1	0.2588	20.42	20.42	0.0457	48.4
2	0.1982	15.64	36.06	0.0235	24.9
3	0.1452	11.46	47.52	0.0100	10.6
4	0.1257	9.92	57.44	0.0065	6.9
5	0.1110	8.76	66.20	0.0043	4.5
6	0.0918	7.25	73.44	0.0022	2.3
7	0.0905	7.14	80.58	0.0021	2.2
8	0.0719	5.67	86.25	0.0001	0.2
9	0.0580	4.57	90.83	0.0000	0.00
10	0.0465	3.67	94.50	0.0000	0.00
11	0.0403	3.18	97.68	0.0000	0.00
12	0.0170	1.35	99.02	0.0000	0.00
13	0.0065	0.52	99.54	0.0000	0.00
14	0.0039	0.31	99.85	0.0000	0.00
15	0.0019	0.15	100.00	0.0000	0.00
16	0.0000	0.00	100.00	0.0000	0.00
17	0.0000	0.00	100.00	0.0000	0.00
18	0.0000	0.00	100.00	0.0000	0.00
19	0.0000	0.00	100.00	0.0000	0.00
20	0.0000	0.00	100.00	0.0000	0.00
21	0.0000	0.00	100.00	0.0000	0.00
22	0.0000	0.00	100.00	0.0000	0.00

Finally, the variables have been placed on positive and negative semi-axes following the sign (+, -) of their coordinates.

Description of axis 1

ACTIVE VARIABLES

Variable's label	*Category's label*	*Value-Test*	*Loads*
Negative semi-axis			
information on new regulation	knows new regulation	-8.05	71.000
information on new regulation applied in institution	knows new regulation applied in institution	-7.67	64.000
previous patents	yes previous patents	-6.72	74.000
patent with firms	yes patent with firms	-5.99	34.000
type of research activity	applied research	-5.02	68.000
links with industries	yes links with industries	-5.01	70.000
CENTRAL AREA			
Positive semi-axis			
type of research activity	basic research	5.02	48.000
links with industries	no links with industries	5.44	55.000
patent with firms	no patent with firms	6.44	91.000
previous patents	no previous patents	7.10	51.000
information on new regulation applied in institution	not knows new regulation applied in institution	8.46	55.000
information on new regulation	not knows new regulation	8.65	54.000

ILLUSTRATIVE VARIABLES

Variable's label	*Category's label*	*Valeu-Test*	*Loads*
Negative semi-axis			
age	from 46 to 55	-3.02	51.000
institution	Cnr	-2.08	67.000
CENTRAL AREA			
Positive semi-axis			
discipline 1	medicine	2.02	9.000
gender	female	2.04	20.000
type of co-patenting	University- Cnr	2.14	15.000
institution	university	2.52	58.000
age	until 35	2.56	13.000
discipline 1	biological sciences	2.93	21.000

Description of axis 2

ACTIVE VARIABLES

Variable's label	*Category's label*	*Value-Test*	*Loads*
Negative semi-axis			
role of patent regulation	relevant	-6.57	67.000
regulation reduce uncertainty public patent	yes	-5.65	41.000
links with industries	no links with industries	-5.12	55.000
information new patent regulation	knows new regulation	-4.83	71.000
Information regulation applied in institution	knows regulation in institution	-4.68	64.000
economic treatment for inventors	higher economic return	-3.90	43.000
patent with firms	no patent with firms	-3.44	91.000
CENTRAL AREA			
Positive semi-axis			
economic treatment's inventors	limited and certain return	4.10	58.000
information new regulation in institution	not knows regulation in institution	4.41	55.000
patent with firms	yes patent with firms	4.43	34.000
Information new patent regulation	not knows new patent regulation	5.84	54.000
links with industries	yes links with industries	6.00	70.000
role of patent regulation	not relevant role	8.08	38.000

ILLUSTRATIVE VARIABLES

Variable's label	*Category's label*	*Value-Test*	*Loads*
Negative semi-axis			
age	da 36 a 45	-4.18	32.000
stage career	low-researcher	-3.78	47.000
discipline 1	physic sciences	-3.16	14.000
discipline 1	biological sciences	-3.06	21.000
kind of co-patenting	other public institutions	-2.80	24.000
CENTRAL AREA			
Positive semi-axis			
kind of collaboration	privates	2.72	7.000
age	from 46 to 55	3.27	51.000
gender	male	3.31	105.000
discipline 1	engineering sciences	5.43	40.000
stage career	High: professor or research director	5.55	39.000

Cluster analysis

After reducing the variables in principal factors by ACM, we did a cluster analysis, or the reduction of the cases in groups, placed in the space delimitated by the factorial axes.. The aim of the cluster analysis is to minimize heterogeneity between individuals within groups and to maximize the heterogeneity between the groups.

The analysis has been realized using the software Spad 5 applied to the previous ACM. It has been used the Hierarchical Cluster.

For defining the clusters we need to consider several values together. First of all we need to observe how each categories contribute to define the cluster by its percent in the cluster (column a); than we need to compare this value with the percent in the survey (column b); finally, we need to observe how the cluster reproduces the category and so how the category divides itself among the clusters (column c).

Cutting the dendogram in different points, the best division was the one with three groups, mainly characterized by their position on the first factor.

The first cluster explains 41% of the cases and it is placed on the third quadrant, so it is on the negative semi-axis of the first factor and on the negative semi-axis of the second factor.

Cluster 1 / 3 (cases: 51 - Percent: 40.80) **a** **b** **c**

Variable's label	*Category's label*	*% category in the cluster*	*% category in the sample*	*% cluster in category*	*Value-Test*	*Probability*	*Poids*
information new patent regulation	knows new regulation	98.04	56.80	70.42	8.26	0.000	71
new regulation in institution	knows new regulation in institution	92.16	51.20	73.44	7.86	0.000	64
role of patent regulation	high	80.39	53.60	61.19	4.92	0.000	67
patent regulation reduce uncertainty	yes	56.86	32.80	70.73	4.58	0.000	41
discipline 1	physics sciences	23.53	11.20	85.71	3.37	0.000	14
kind of co patenting	with other public institutions	33.33	19.20	70.83	3.09	0.001	24
links with industries	no links with industries	60.78	44.00	56.36	2.96	0.002	55
links with industries	yes links with industries	39.22	56.00	28.57	-2.96	0.002	70
stage career	professor or research director	15.69	31.20	20.51	-2.98	0.001	39
discipline 1	engineering sciences	11.76	32.00	15.00	-3.98	0.000	40
role of patent regulation	low	5.88	30.40	7.89	-5.06	0.000	38
information new regulation in institution	no information	7.84	44.00	7.27	-6.96	0.000	55
information on new patent regulation	not knows new regulation	1.96	43.20	1.85	-8.26	0.000	54
institution	other	0.00	0.00	0.00	-99.99	0.000	0

The second cluster explains the 18% of the cases and it is placed into the second quadrant, so it is on the negative semi-axis of the first factor and on the positive semi-axis of the second factor.

Cluster: 2 / 3 (cases: 23 - Percent: 18.40) **a** **b** **c**

Variable's label	*Category's label*	*% category in the cluster*	*% category in sample*	*% cluster in category*	*Value-Test*	*Probability*	*Poids*
patent with firms	yes patent with firms	82.61	27.20	55.88	6.06	0.000	34
role of patent regulation	low	78.26	30.40	47.37	5.09	0.000	38
links with industries	yes links with industries	100.00	56.00	32.86	5.04	0.000	70
previous patents	yes previous patents	100.00	59.20	31.08	4.74	0.000	74
discipline 1	engineering sciences	73.91	32.00	42.50	4.39	0.000	40
research activity	applied research	91.30	54.40	30.88	3.93	0.000	68
economic treatment for inventors	limited and certain return	78.26	46.40	31.03	3.20	0.001	58
information on new legal system	knows new legal system	86.96	56.80	28.17	3.14	0.001	71
age	from 46 to 55	69.57	40.80	31.37	2.86	0.002	51
discipline 1	biological sciences	0.00	16.80	0.00	-2.36	0.009	21
information on new legal system	not knows new legal system	13.04	43.20	5.56	-3.14	0.001	54
research activity	basic research	8.70	38.40	4.17	-3.21	0.001	48
new regulation in institution	not known	13.04	44.00	5.45	-3.22	0.001	55
patent regulation reduce uncertainty	yes	4.35	32.80	2.44	-3.27	0.001	41
economic treatment of inventors	higher economic return	4.35	34.40	2.33	-3.43	0.000	43
role of patent regulation	high	13.04	53.60	4.48	-4.21	0.000	67
previous patents	no previous patents	0.00	40.80	0.00	-4.74	0.000	51
links with industries	no links with industries	0.00	44.00	0.00	-5.04	0.000	55
patent with firms	no patent with firms	17.39	72.80	4.40	-6.06	0.000	91
institution	other	0.00	0.00	0.00	-99.99	0.000	0

The third cluster explains the 41% of the cases and it is placed on the first quadrant, so it is on both positive semi-axis of factors.

Cluster: 3 / 3 (cases: 51 - Percent: 40.80) **a** **b** **c**

Variable's label	*Category's label*	*% category in the cluster*	*% category in sample*	*% cluster in category*	*Value-Test*	*Probability*	*Poids*
information on new regulation	not informed	98.04	43.20	92.59	11.10	0.000	54
information on new regulation in institution	not informed	94.12	44.00	87.27	9.86	0.000	55
previous patents	no previous patents	62.75	40.80	62.75	3.98	0.000	51
patent with firms	no patent with firms	86.27	72.80	48.35	2.67	0.004	91
research activity	basic research	52.94	38.40	56.25	2.58	0.005	48
institution	university	60.78	46.40	53.45	2.50	0.006	58
institution	Cnr	39.22	53.60	29.85	-2.50	0.006	67
discipline 1	physic sciences	1.96	11.20	7.14	-2.60	0.005	14
patent with firms	yes patent with firms	13.73	27.20	20.59	-2.67	0.004	34
previous patents	yes previous patents	37.25	59.20	25.68	-3.98	0.000	74
new legal system in institution	informed	0.00	51.20	0.00	-10.34	0.000	64
information on new legal system	informed	1.96	56.80	1.41	-11.10	0.000	71
institution	other	0.00	0.00	0.00	-99.99	0.000	0

The third group collect inventors from university, who develop based research activities, they are not informed on the new patent regime, haven't previous patents and haven't co-patented with firms.

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