Are Patent Subsidies for SMEs Effective?

Empirical evidence from Italy

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Abstract

Over the last decade, public patent subsidies have played an important role in several countries in enhancing international filings by domestic companies, expecially SMEs. In this paper, we first analyze the policy actions based on patent subsidies implemented in Italy from year 2002 to year 2011. We then use data from a sample of 222 subsidized and control patents, in order to assess the impact on patent value of the first and the largest of such programs. We conclude by discussing policy recommendations for the optimal design of patent subsidy schemes.

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1. Introduction

Over the last decade, patent subsidies have played an important role in several countries in enhancing international filings by domestic companies, expecially SMEs. Patent subsidies refer to a series of policies, undertaken at the national or local level, aimed at financing the costs of firms' patent applications, examination and maintenance. They are intended to stimulate firms' patenting activities (in particular those undertaken at the international level), by lowering the financial burden which tend to be particularly relevant for SMEs. Significant policy actions centered on public subsidies for SMEs have been launched over the last decade in a wide variety of countries (i.e. Italy, Spain, Belgium, Japan, China, India, United Kingdom), with the aim to foster the innovation capabilities of domestic inventors. However, in spite of a rich literature addressing the rationale and effectiveness of R&D subsidies programs (Klette et al., 2000; Blanes, 2004; Gonzalez and Pazo, 2008; Colombo et al., 2011), no attention has been devoted yet to the mapping and assessment of patent subsidies policies. To our knowledge, no specific attention has been devoted on how to optimally design this type of schemes in order to encourage innovation and competition, and no empirical exercise has been undertaken in order to evaluate their impact.

As to this latter point, a critical issue surrounding this type of policy measure relates to patent quality. A debate involving both government insiders, legal experts and academic scholars (Jiachun et al., 2008; Zhou and Stembridge, 2010), and reflected in the financial press (Financial Times, 2008; The Economist, 2010), has raised concerns about the possibility that subsidization by public bodies leads to an increase in the number of patents with low quality. According to more critical views, in fact, by reducing or eliminating initial fees and costs to be paid by the applicants, such measures could lead to an inflation of patent filings that do not meet the statutory requirements (and whose legal validity can therefore be challenged) and that are characterized by a limited economic value for the applicants.

Building on such debate, our study intends therefore to fill a gap in the literature, by analyzing the policy actions based on patent subsidies implemented in Italy from year 2002 to year 2011, and assessing the impact on patent value of the first and the largest of such programs, the one promoted by the Chamber of Commerce of Milan, the Province of Milan and the Region Lombardia in Northern Italy. The case of Italy is particularly interesting given that numerous and diversified schemes centred on patent subsidies and specifically oriented to SMEs have been established over the last decade, promoted by both local, regional or national authorities. In particular, the measure promoted in the province of Milan in Northern Italy has funded,

since its inception in year 2002, hundreds of SMEs by covering part of the expenses related to their international patent filings. Based on this empirical evidence, the paper addresses the following two research questions: *1) How are patent subsidies programs designed? 2) Which is the impact of such programs on the value of subsidized patents (as compared to a control group of non-subsidized ones)?*

The objective of the first part of the study is therefore that to investigate the characteristics of all the policy measure established in Italy at various levels (national, regional and local) in order to promote patent filings by domestic firms. In this stage, we first identify and map all 34 patent subsidies measures implemented in Italy since 2002 and analyze them along the following dimensions, which are relevant for the program design: main objectives, promoting institutions, geographical scope of the measure, eligible expenses, eligible companies, amount of funding, ex-ante and ex-post evaluation.

The second part of the study is aimed at assessing the impact of such policy actions on patent value, by analyzing, in a regression framework, differences in patent value between two groups of patents: a group of 111 patents that were subsidized over the period 2002-2007 in the province of Milan, and a control group of 111 non-subsidized patents. The control group was created using a matched-paired research design, identifying, for each subsidized patents, a corresponding patent, with the same priority year and filed by a SME located in the province of Milan. In order to measure patent value, we adopted measures based on patent-information, identified and validated in the literature, resorting in particular to the number of forward citations and the legal status of the patents (Munari and Sobrero, 2011; Reitzig, 2003, 2004).

We therefore aim to contribute to the empirical literature that evaluates the effects of public support to R&D and innovation activities (Klette et al., 2000; Blanes, 2004; Gonzalez and Pazo, 2008), by focusing for the first time on the design and impact of patent subsidies program, a topic that, despite its increasing relevance for policy-making, has not been directly addressed until now. We adopt in this specific case a research approach, focused on the analysis of patent value, that has been previously applied in other settings, for instance in the evaluation of the impact on academic patenting of the Bay-Dole Act in the United States (Henderson et al., 1998; Mowery and Ziedonis, 2002). In terms of policy implications, our study intends to shed light on the role of public intervention to foster SMEs patenting, in order to stimulate innovation, promote markets for new ideas and products, and enhance the economic development. Ultimately, we intend to provide policy guidelines for the design and implementation of effective patent policies for SMEs.

The rest of the paper is organized as follows. In the first section, we review the relevant literature and provide an overview of the different actions centred on patent subsidies implemented around the world. We then focus on the Italian experience, by mapping and analyzing the different actions realized at the national, regional and provincial level. We then describe in more detail our sample and variables, related to a group of patents by SMEs in the province of Milan. We finally report the results of our regression analyses and conclude by discussing policy implications

2. Literature Review

2.1. Patenting by SMEs: is there a market failure?

Endogenous-growth theory claims that technological change is a major factor driving economic growth and that governments can therefore enhance economic growth by influencing the pace of technological change through subsidizing firms' R&D expenditures (Grossman and Helpman, 1994; Davison and Segerstrom, 1998). Moreover, the growing body of literature on the importance of spillovers in R&D and innovative activities (Klette, Møen and Griliches, 2000), has recognized the existence of market failures as one of the main justifications for policy measures subsidizing R&D and innovation programs. Subsidies are thus intended to adjust market failures and to augment the supply of socially rewarding technologies. Such market failures tend to be particularly pronounced for small and medium-sized enterprises (SMEs), due to the limited financial resources to support R&D, patent and innovation expenditures (Gabriel and Florence, 1993) and to the absence of scale and scope economies in R&D (Ortega-Argilés et al.,2009). As a consequence, extensive innovation support programs across the European Union (and in other regions of the world) have been explicitly targeted towards SMEs over the last decades (Hoffman, Bessant and Perren, 1998).

For what concerns patent activity, the patent system itself is viewed as a policy instrument originally aimed at encouraging innovation generation and diffusion. Similarly with issues explored in the R&D subsidies literature, issues related to the design of appropriate patent systems and to the assessment of their impact on innovation activities, are some of the main concerns addressed in recent research on patent policies (Guellec and Van Pottelsberghe, 2007). Encaoua et al. (2006), in an overview of the economics of patents and patent policy, suggest that economic research should focus more on how to design effective policies in the patents field, in order to lever the innovation process.

In particular, SMEs represent a very important and specific target for patent policies, since it is well documented that they present a low propensity to file for and use patents, due to several reasons (Blind et al., 2006; Munari et al., 2011). A first explanation deals with the high costs involved in patent filings and maintenance, which can represent a significant financial burden for small enterprises. In addition to that, one should also calculate the honorary of the IP consultants who are generally involved in the registration process, given that such kind of companies typically do not maintain in-house IP professionals. Moreover, IP rights are costly to enforce. Consider for instance the type of costs that an innovator has to undertake in case of infringement disputes. On the one hand, there are direct legal costs. In addition to that, there are business costs of litigation that can take several forms, going from the time devoted by managers and researchers to prepare documents and depositions in the court, to the blockage of cooperative relations with suppliers and customers, to the shut-down of production and sales activities during the litigation period. SMEs may not have the financial resources to fund such dispute resolution procedures and face the related risks, therefore preferring to recur to informal protection mechanisms (such as trade secrets). Finally, an important organization resource to fully exploit IP strategies is represented by the availability of firm-level expertise in the area of IP law and IP management. Given the

financial and resource constraints which typically characterize SMEs, it is very difficult that they retain in-house the necessary expertise, either in formalized IP department, or in single IP professional.
Existing empirical evidence supports the view that firm's size is an important driving force of patenting and that SMEs tend to be disadvantaged in comparison to large companies (Blind et al.,2006). For all such reasons, it is likely that a specific market failure characterizes patent activity by SMEs. To address such issue, over the last decades, in several countries policy actions centred on patent subsidies have been established in many countries around the world.

2.2. Patent Subsidies for SMEs: international experiences

Over the last decade, an increasing number of countries and regions around the world have been establishing subsidies or funds to support R&D/innovation activities for national enterprises, research institutes and universities. Among such measures, the use of patent subsidies, in particular in favour of SMEs, has recently gained an increased attention by policy-makers. Table 1 summarizes some international experiences of patent subsidies over the past decade, identified through existing literature and Internet sources. Typically, such measures take the form of direct support to finance part of the expenses related to national and, more often, international patent filings. Generally such schemes are intended to cover part of the filing costs, with a few of them also subsidizing maintenance fees or enforcement expenses, as in the experience of the Chinese government and the region of Chongqing.
Such measures can be funded by the national government, through a ministry or a central bureau, as in the case of Italy, Spain and China, or through a specialised agency, as illustrated in cases of Canada and Ireland. Patent subsidies could also be awarded by regional authorities, through a department (as for measures activated in Lombardia, Scotland or Wallonia), or through a specialized institute (as in the case of Hongkong, Chongqing and Gujarat).
Domestic SMEs constitute the primary target of patent subsidies measures, even though other beneficiaries can be found, such as large enterprises, research institutes and universities.
Although the amount of patent subsidies conferred to beneficiary firms largely varies across countries, they are mostly executed through the reimbursement of a certain proportion of the costs incurred (typically with an upper limit), or through a fixed amount for each subsidized patents.

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2.3. How to design and assess the effectiveness of patent subsidies? Insights from the literature on R&D subsidies

Despite the growing diffusion and relevance of patent subsidies measures around the world, that we have partially documented so far, to our knowledge no attempts have been made in the literature to assess their characteristics, optimal design and effectiveness. We therefore rely on the established literature on R&D subsidies to infer some useful indications for the appropriate design, implementation and assessment of patent subsidies measures.

Several efforts have been dedicated to evaluate the effects of R&D subsidies on firms' R&D behavior and growth. A key indication relates to the balance between public and private R&D, in terms of complementarity or substitution. On one hand, the positive impact of R&D subsidies on firms' R&D expenditures was suggested by works such as Leyden and Link(1991), Busom(2000), Almus and Czarnitzki(2003), Koga(2005), Hussinger (2008), Aerts and Schmidt(2008), Bérubé and Mohnen(2009), among others. On the other hand, the substitutive effect of public R&D crowding out private R&D was instead observed by studies of Lichtenberg (1984,1987,1988), Mamuneas and Nadiri(1999) and Wallsten(2000).

For what concern the design and implementation of the programs, previous studies have analyzed the allocation process of R&D subsidies. Blanes and Busom (2004), for instance, reveal the heterogeneity of projects and firms selection rules across different agencies and industries. They suggest that national and regional programs end-up supporting different types of firms and that each agency may use R&D subsidies with different policy goals in each industry. Giebe et al. (2006) identify two sources of inefficiency in the application rules for allocating R&D subsidies and propose an improved mechanism designed to correct the allocation inefficiency, which includes the form of auction whereby applicants bid for subsidies. A recent study of Colombo et al. (2011), based on a sample of new technology based firms in Italy, compare the effects of different types of subsidization schemes distinguishing between ''automatic'' and ''selective'' subsidies, where the latter provide financial support only to selected applicants. Their results suggest that the receipt of selective R&D subsidies tend to have a higher impact on firm's performance as compared to automatic subsidies, thus resulting more beneficiary for the success of target firms.

On a different level, Scherer and Harhoff (2000) suggest that technological policy should allocate government subsidies in order to support a sizeable array of projects with the emphasis placed on a relatively number of big successes, as a consequence of the highly skewed distribution of the value of innovations (i.e. the fact that a small minority of innovations yield the lion's share of all innovations' total economic value). This observation is particularly important in the case of the assessment of the effectiveness of patent subsidies, due to the high heterogeneity in the value of patents, which have been well documented in the literature (Gambardella et al., 2008).

To sum up, the rich literature on R&D subsidies provides several important indications on how to assess the effectiveness of patent subsidies for SMEs. First, as mentioned by Encaoua et al.(2006), more empirical testing of the economic effects of patent policies is required. Second, the debate on the additionality or crowding-out effects of R&D subsidies provides important methodological guidelines for the assessment of patent subsidies measures, in particular for what concern the application a matching estimations method (Berube and Mohnen, 2009). Third, the review highlights the necessity to assess the impact of policy measures not only in terms of number of additional patent filings undertaken by SMEs, but also in terms of value of subsidized patents.

This latter point appears of particular interest in the light of the recent debate involving both government insiders, legal experts and academic scholars (Jiachun et al., 2008; Zhou and Stembridge, 2010), and reflected in the financial press (Financial Times, 2008; The Economist, 2010), about the possibility that patent subsidization by public authorities leads to an increase in the number of patents with low quality. More critical voices have advanced that,

by reducing or eliminating initial fees and costs to be paid by the applicants, such measures may lead to an inflation of weak patents, whose legal validity can be ultimately challenged or that can generate little or not economic value for their owners. Such debate has been particularly centred on the experience of China, whose impressive growth in the number patent filings over the last decade has been in part encouraged by a relevant program of patent subsidies administered by central, provincial and city governments (Zhou and Stembridge, 2010). The fact that most Chinese patents over the period 2001-2008 were related to new design appearances or new models, thus not requiring great technical innovation, has been interpreted as a signal that public subsidies to cover patent application costs can become a factor that artificially inflates the number of filings (Financial Times, 2008; The Economist, 2010).

The economic literature has convincingly questioned the assumption that "more patents is better", arguing that a surge in the number of low-value patents can have, on the contrary, a detrimental effect on innovation and competition (Guellec and Van Pottelsberghe, 2007). On the one hand, a more practical concern is related to the difficulties of patent offices to cope with an inflated workload, ultimately inducing a significant backlog that can raise delays in the procedures (Encaoua et al., 2006). On the other hand, and more importantly, an inflation in the volume of patents with low quality or even illegitimate patents (i.e. not novel or not sufficiently inventive) can rise the uncertainties about the enforceability of property rights and induce situations of overlapping patents (patent thickets), ultimately increasing patent disputes and discouraging innovation (Lemley and Shapiro, 2005; Bessen and Maurer, 2008).

As to this point, Encaoua et al. (2007) highlight that patent application and renewal fees can act as "self-selection mechanisms" to encourage high valuable inventions to be patented and discourage the least valuable ones.

Based on such arguments, it becomes therefore important to assess whether the provision of public subsidies to SMEs impacts or not the value of patents. In the empirical part of our work, we address such research question, by mapping first the characteristics of patent subsidy measures adopted in Italy, and assessing then their effectiveness in terms of patent value, by comparing a sample of subsidized and control patents. The analyses we perform are primarily oriented to derive lessons for policy makers that can be usefully applied in the design of patent policy measures, as discussed in the final part of our work.

3. Research design

We focus our analysis on the policy actions implemented in Italy to foster patenting by SMESs. The case of Italy is of particular interest for several reasons. First, the Italian economic system is characterized by a strong diffusion of SMEs, which account for the lion's share of persons employed and value added generated in the country, with value considerably above EU-average levels. As far as innovation is concerned, according to the European Innovation Scoreboard (2009), Italy lies behind its main European partners in many indicators of technology and innovation – and in particular in those indicators concerning EPO and USPTO patent applications – also as a consequence of the predominance of small and medium-sized enterprises affecting R&D expenditure, innovation enhancement and protection. For such reasons, several policy actions have been implemented over the last decade in Italy

at different levels (national, regional and local) in order to promote patent applications by domestic firms, in particular by SMEs. For all such reasons, Italy represents an ideal context to address our research interests.

We performed our data collection and analyses in two steps. We were first interested in identifying the main characteristics in the design of patent subsidies measures implemented in Italy. Therefore, we initially conducted a detailed mapping of all such measures realized in Italy by national, regional or provincial authorities. We then focused our attention on the experience of the Chamber of Commerce of Milan, in the region Lombardia in Northern Italy, in order to assess the impact of subsidies on patent value. We analyzed the different measures established by the Chamber of Commerce of Milan, the Province of Milan and the Region Lombardia, in Northern Italy, in order to support European and International Patent filings by SMEs located in the province of Milan. Such measures started in year 2002, with a total available funding of 2 millions Euro for that year. The subsidy was assigned automatically, based on chronological order of the applications (after a check of formal requirements). It covered up to 50% of expenses incurred by an SME for an international patent filing (including drafting expenses), up to a maximum amount of 15.000 Euro). The measure has been repeated up to 2011 (with the exception of year 2004), funding hundreds of companies. Up to August 2011, it has been by far, the most important measure of this kind in Italy, in terms of amount of funding and number of companies involved[1].

In this section we first present the sources we used to collect the data, and describe than in more detail the sample and variables we adopted in our analyses focused on how subsidies affect patent value.

3.1. Data sources

In order to identify all the patent subsidies measures promoted in Italy over the last decade, we first analyzed the web-pages of all the Chambers of Commerce in Italy, since they responsible, through local competent offices, for patent filings registrations, in collaboration with the Italian Patent and Trademark Office (UIBM)[2]. In addition to this role, local Chamber of Commerce are typically responsible for a series of several activities aimed at promoting the diffusion of a patent culture. We then complemented this initial search, by performing a more general web search using key-words related to patent subsidies[3]. In order to complement such initial search, we then performed five further interviews, respectively with: representatives of the Patent Office of two major Italian Chambers of Commerce (Milan and Bologna); consultants of two leading IP consulting firms in Italy; a consultant of a major Italian consulting firm specialized in enterprise and public funding. The interviews were intended first to complete our knowledge and understanding of the main measures implemented in Italy to promote patenting, clarify their design and logics, and have a first feedback on their impact

[1] In August 2011 the Italian Ministry of Economic Development has launched an ambitious subsidy scheme with the objective to boost the number of patent filings by SMEs and their economic exploitation, allocating a budget of 40 milion Euro to such measure. This measure is however too recent to be included in our assessment exercise.

[2] Patent applications for industrial inventions in Italy can be filed with the Chamber of Commerce or directly to the Italian patent and trademark office. In the first case, the Chamber sends the documents received to the central office.

[3] We used the following keywords to perform the web search: “Brevetti” (Patents) + “Sussidio” (Subsidy), or “Incentivi” (Incentives), or “Contributo” (Aid), or “Bando” (Call).

and effectiveness.
Based on such effort of data collection, we were able to identify 34 patent subsidy actions implemented in Italy over the period 2002-2011: 25 actions have been promoted by local Chamber of Commerce, 3 by provincial authorities, 3 by regional authorities, and 2 at the national level by the Ministry of Economic Development (Ministero per lo Sviluppo Economico).
We then focused on the patent subsidy measures established, from year 2002, by the Chamber of Commerce of Milan, the Province of Milan and the Region Lombardia, in Northern Italy.

3.2. Sample

In our study on the different measures established by the Chamber of Commerce of Milan, the Province of Milan and the Region Lombardia, in Northern Italy, we decided to focus on the calls published in years 2002, 2003, 2005 and 2006 (in 2004 the measure was not implemented), in order to have a time period sufficient to assess the final outcome (i.e. grant) of the patent application process. We were able to identify all patents and companies receiving the subsidies in such years (as well as those companies which applied for a subsidy, but were not selected), using information from the website of the Chamber of Commerce of Milan.
Our data gathering was structured in three phases. In the first phase, we identified all SMEs, and their related patents, which obtained a subsidy over the year 2002, 2003, 2005 and 2006. This initial sample consisted of 146 SMEs in province of Milan operating in several industries, ranging from biotechnologies and healthcare, to electronics and ICT, as well as mechanics and materials.
In the second phase, we collected information on such patent applications, using Espacenet as data source. We retained from the initial sample only those SMEs for which information on the subsidized patents were available in the patent database. After whittling down the initial sample following these criteria, we were left with a sample of 136 SMEs, and 191 subsidized patents.
In the third and final phase of our data collection, we constructed a matched sample of SMEs (and related patents) located in the province of Milan which did not receive a patent subsidy over the period of analysis. In order to construct such a control group, for each subsidized patent, we identified a corresponding patent satisfying the following three conditions: 1) having a SME as applicant; 2) having Milan as the applicant's address; 3) having the same priority date of the subsidized patent. We applied the SME definition of the European Commission in order to filter the patents in the control group. We therefore checked whether the applicant's turnover (in the priority year of the subsidized patent) fell within the limits posed the the EC definition of SMEs, matching companies included in the same category of micro, small and medium-sized enterprises.[1] More precisely, a subsidized patent of micro enterprise was matched by a corresponding patent, with the closest priority date, filed by a micro enterprise located in the province of Milan. Following the same logic, we identified the control patents for small and medium-sized companies included in our sample. Information

[1] We use Recommendation 2003/361/EC adopted by European Commission as a criteria in this aspect, categorizing micro enterprise with a turnover not greater than 2 million euro, small enterprise not greater than 10 million euro, and medium-sized enterprise not greater than 50 million euro.

on firm's turnover and address for the initial and matched samples came from the commercial database AIDA, including accounting information on public and privately-held companies in Italy.
In this process, we were not able to find a corresponding match for some of the subsidized patents, since accounting information were not available on AIDA either for beneficiary or for target companies. For such reasons, we were left with the final sample of 111 subsidized patents - including 60 EP patents and 51 PCT patents - applied by SMEs in the province of Milan with the priority years ranging from 2000 to 2007. Such patents were matched to a corresponding group of 111 control patents (including 60 EPO patents and 51 PCT patents) which did not receive a subsidy, identified with the procedure described above.

3.3. Methods and variables

We employed two main regression models in order to evaluate the effects of subsidies on patent value. We first used as dependent variable the number of forward citations received by each patent, since it represents the most frequently used proxy for the value of patents in the literature (for a review of this literature see Munari and Sobrero, 2011 and Omland, 2011). As dependent variable in the second model, we used a dummy variable to capture whether the patent was granted or not up to May 2011. Because of the non-negative, discrete and highly skewed nature of the first dependent variable ("Number of forward citations"), we adopted a Poisson regression model in the first equation. In the second equation, we used a logit specification to analyse the impact of patent subsidies on the likelihood of grant.

Dependent variables. As a measure of *patent value* we used the number of forward citations received by each patent from patents subsequently issued. Forward citations were identified and collected through Espacenet. Citations from later patents to the patent under examination (forward citations) represent a significant indicator of value, which has been analyzed, validated and used in numerous scientific studies since several decades (Carpenter et al., 1981; Albert et al., 1991; Harhoff et al., 1999; Reitzig, 2003 and 2004; Trajtenberg, 1990). Several theoretical arguments explain this empirical fact (Omland, 2011). First, the existence of citations from later patents indicates that patents on similar technology have been applied for later, meaning that subsequent investments building on such invention have been made and that the technology is perceived as attractive. Second, it suggests that the cited patent contained a technical aspect that is used in later technology, thus revealing that the original invention contained a useful aspect. Third, citations indicate that the claims of the later patent may have been limited by what was already described in the earlier patents. This suggests that the newer invention might integrate aspects already protected by earlier patents. Hence, the 'old' patent claims appear to be still relevant in the newer technology space.
It is probably the most commonly used proxy in the literature for the value of patents, (Sapsalis et al.,2006). As an additional variable of patent quality, we used the legal status of the patent, constructing a dummy variable *Patent granted* which takes the value 1 if the patent has been granted as of May 2011. It serves as another empirical indicator widely used in the literature to approximate the value of a patent by indicating the probability of getting a patent granted (Guellec and van Pottelsberghe de la Potterie, 2000, 2002).

Independent variable. In our regression models, we included a dummy variable *Patent subsidies* taking the value 1 to indicate the beneficiary status for the subsidized patent in our sample, and 0 otherwise (for patents in the control group). We use this dummy of patent subsidies as a key explanatory variable in order to evaluate the effectiveness of the patent policy measures on patent value.

Control variables. The *number of inventors* for each patent was counted and collected as a potential determinant of patent value. It is established as an indicator of the number of researchers involved in the research project and a proxy reflecting the importance of the research for the company and the potential profits expected (Sapsalis et al., 2006). Another variable used to determine the value of a patent in our study is the number of *co-assignees*, which indicates the level of collaboration with other knowledge-generating institutions or individuals (Sapsalis et al., 2006). We then built a *patent scope* variable, counting the number of IPC classes to which the patents is assigned. As IPC classes encode and classify the technical content of patent documents which is positively correlated with the patent value (Lerner 1994, Harhoff and Reitzig 2004). We also counted the *number of backward citations* for each patent as another determinant of patent value. This measure could indicate the extent to which a patent is based on previous science or technological knowledge and it is theorized to operationalize the technical novelty of a patent (Sapsalis et al., 2006; Reitzig, 2004). Utility is a dummy variable taking the value 1 for the patent of a unility model when there is a kind code of U after the publication number, and 0 for all the other cases of invention patents. We also included a dummy variable *PCT* to separate PCT patents from others. The choice of the application route has been proposed as a potential value indicator (van Zeebroeck et al., 2008). The observed choice of the applicant to use the PCT system has been tested as a value indicator by Harhoff et al. (2004; 2007). We also constructed a dummy *Utility patent* to distinguish utility models from patents for technical inventions. The time effect of patents being cited or granted is taken into account through a set of time dummies (Sapsalis et al., 2006), corresponding to the priority year of each patent from 2000 to 2007. A variable *Firm's turnover* was adopted in order to capture size effects which might impact on the quality of the patent. For each firm, turnover levels were measured in the priority year of the patent, according to AIDA.

4. Analyses and results

4.1. The design of patent subsidies measures in Italy

In the first step of our research we have identified all patent subsidies measures established in Italy from 2002, for a total of 34 actions that we were able to map and analyze. Table 2 briefly analyze such different measures along a series of dimensions which are relevant in the design of the scheme: 1) promoting institutions and geographic coverage; 2) rationale and objectives; 3) target beneficiaries of the measure; 4) eligible costs; 5) maximum amount of funding; 6) overall budget; 7) selection and evaluation criteria.

--- Include Table 2 around here ---

From the analysis of Table 2, it is immediate to notice some critical issues which have characterized the design of patent subsidy schemes in Italy. First, it emerges a strong fragmentation of the different programs, due to the activation of several schemes which are often geographically bounded to single provinces, benefit of a limited available budget (in many cases inferior to Euro 50.000) and award to beneficiary firms only a small amount of funding to cover a minimum part of patent expenses. Therefore, such measures are often established with a mere signaling role, but it is unlikely that they can have a real impact as an incentive for SMEs to file additional patents, due to the limited funding available. Moreover, the emerging picture is that of a limited coordination between the different institutional actors involved in the process (Chambers of Commerce, Provinces, Regions, Foundations), which hinders the possibility to establish sizeable programs with the critical mass to provide a real contribution.

A second critical point relates to the definition of the objectives of the measures. The vast majority of the schemes have a strong focus on supporting an increase in the number of patents filed by SMEs, as a way to strengthen innovation and internationalization process. In other words, the measures are centred on augmenting the number of patents filed, with limited or no attention on improving the quality of patents filed or fostering the economic valorization of such intellectual property rights. However, it is well documented in the literature that the value of patents is extremely skewed, and the large majority of patents are of limited, if any, value for the applicants, since they are not subsequently exploited in downstream product developments or licensing agreements (Munari and Sobrero, 2011). The twin challenges of patent quantity and quality should therefore be encouraged by policy makers, also in the light of the explosion in both the number and the volume of patent filings for all patent offices in the last two decades (Guellec and Van Pottelsberghe, 2007). Despite that, no measure in our sample has been established with the declared objective to enhance the number of "high-quality" patents. Moreover, in only a limited number of cases the objective of favouring the economic exploitation of patents is mentioned.

A third critical issue, which directly stems from the previous one, is the lack of pre-defined criteria to guide the evaluation and selection of the patents to be subsidized. In the vast majority of the schemes under analysis, no ex-ante evaluation of the submitted patent was made, with the exception of a formal check on the satisfaction of eligibility criteria. Typically, the subsidies were automatically awarded based on the chronological order of the submission, up to the consumption of overall budget. In only four cases out of 32 the programs were managed as selective schemes providing financial support only to selected applicants. In such cases, a committee of experts was formed to perform a selection based on pre-defined criteria (including the geographic and technological scope of the patent; the degree of innovativeness; potential market size and scope; competences of the applicant; collaborations with universities and public research centres). As to this point, previous research on the impact of public R&D subsidies have highlighted that selective schemes, when competition among applicants is tough and the support program is administered by a reputable governmental, are likely to be more beneficial than automatic ones to foster SMEs value creation (Colombo et al., 2011). Moreover, as suggested by Lerner (1999), selective schemes may provide a

certification of the quality of beneficiary firm (and the underlying patent) to uninformed third parties, such as external investors or potential licensees.
A direct consequence of such shortcomings in the design of policy measure is the risk of subsidizing patents characterized by low quality and limited exploitation potential, thus limiting the effectiveness of the measure. This is essentially what we wanted to test in our next analyses, based on data from patent subsidized in the province on Milan.

4.2. The impact of subsidies on patent value: descriptive analyses

In the following sections, we report the results of our analyses to test whether the receipt of subsidies impacts patent value, based on data related to patent subsidy schemes implemented in the province of Milan. Table 3 reports descriptive statistics on our sample of 222 patents of SMEs located in the province of Milan, including 111 subsidized and 111 control patents with priority years ranging from 2000 to 2007.

--- Include Table 3 around here ---

Table 3 shows that the average patent in the sample receives less than 1 forward citations by subsequent patents (0.91), with a maximum number of 10 citations per patent. About 40% patents in our sample were granted by May 2011, with the majority of applications still pending at that deadline as a consequence of the lengthy examination process of EPO and PCT procedures. The average breadth of patents, as measured by the number of four-digit IPC classes, is around 3. The average number of inventors and of applicants nearly reach to 2 per sample patent, with maximum levels of 8 and 9 respectively. The number of backward citations on average arrives at nearly 5. Such descriptive statistics related to different measures of patent quality - such as the number of forward citations, the likelihood of grant, the number of IPC classes, the number of inventors, the number of applicants, the number of backward citations – suggest a high skewness in the value distributions, which are consistent with findings of previous studies demonstrating a high heterogeneity in the value of patents (Munari and Sobrero, 2011).
The SMEs responsible for these international fillings have, on average, an annual turnover of 6 million Euro, corresponding to the EU definition of small enterprises. It is noteworthy that, as a consequence of the matching procedure we adopted in the construction of the control group of patents, average turnover levels are similar between beneficiary firms and control firms.
We then used a corrected t-test to compare the mean values of different indicators of patent quality between the two samples of subsidized patents and control (i.e. non-subsidized) patents. Table 4 reports the results of this comparison, showing in general terms that no statistically significant differences in patent quality seem to emerge between the two samples.

--- Include Table 4 around here ---

The number of forward citations received by subsidized patents is indeed slightly higher than the matched sample, with average values of 0.94 citations as compared to 0.87 citations, even

though the difference is not statistically significant at conventional levels. Similarly, subsidized patents have a slightly higher likelihood to receive a final grant as compared to control patents (more precisely, 42% of them are granted as to May 2011, as compared to 34% of control patents), but the difference is not statistically significant either. Moreover, the number of backward citations in the sample of patents with subsidies is greater than in the matched sample, with the average value of 5.1351 compared to 4.7838, but the difference is not significant. On the other hand, the breadth, the number of inventors and the number of applicants are smaller for subsidized patents than the matched sample, but only in the case of the number of investors such difference is statistically significant at the 10% level[1].

4.3. The impact of subsidies on patent value: regression analyses

We then performed regression analyses in order to control for other factors which might influence patent value, in addition to the receipt of a subsidy. Table 5 first reports the correlation matrix for our main variables in the full sample. It shows that traditional patent value determinants, such as the patent breadth, the number of inventors, the number of applicants, the number of backward citations tend to be correlated with each other. However, no significant evidence of multi-collinearity seems to emerge from the data.

--- Include Table 5 around here ---

Turning to the regression models reported in Table 6, Model 1 adopts the total number of forward citations received by each patent as dependent variable. It includes the dummy *Patent Subsidy* as independent variable, and other value determinants as control variables. The subsequent Model 2 adopts the dummy *Patent grant* as dependent variable and the same explanatory variables than the previous model.

--- Include Table 6 around here ---

The results of running the regression models are in accordance with the t-test analysis. The evidence presented in both Model 1 and Model 2 shows that the fact of obtaining a patent subsidy does not have a significant effect on patent value, either in terms of subsequent forward citations, or the probability of getting the patent granted. In both cases, in fact, the coefficient of the dummy *Patent Subsidy* is positive, but not statistically significant at conventional levels[2]. We therefore do find support for the concerns that patent subsidy

[1] As a further robustness check, we replicated our analyses first in the sub-sample of EPO patents (including 60 subsidized and 60 control patents), and then in the sub-sample of PCT patents (including 51 subsidized and 51 control patents). Results were largely confirmed, both in terms of signs and magnitude of the differences. The only notable exception is represented by the likelihood of grant in the sub-sample of EPO patents, which is still higher in the case of subsidized patents (50% vs. 33%), with the difference now significant at the 5% level.

[2] This result is confirmed also when we replicate our regression analyses in the two different

measures may provide incentives for low-quality patents.
When examining the effect of traditional other value determinants, in Model 1 we notice that the coefficient of the number of IPC classes on the number of forward citations is positive and significant at 1% level, signaling that patent with a larger scope are more likely to be subsequently cited. Besides, the number of inventors has a positive and significant impact (at the 1% level) on patent value. Indeed, the size of the research team and the resource allocated to the research project can be linked to quality of the underlying invention and its expected profit. Therefore a larger inventors' team would suggest a better patent quality with a higher expected value. On the other hand, the number of applicants has a negative and significant influence on the number of forward citations (at the 5% level). These results might be explained that the number of co-assignees tends to raise the opportunistic behaviors, risks or other difficulties particularly for SMEs when collaborating with individuals or other institutions which in turn would have a negative effect on the quality of the patent. Furthermore, there seems a mixed impact of backward citations on patent value. On the one hand, the effect of the number of backward citations on the number of forward citations is positive and significant at 1% level, suggesting that the broad state of art upon which the patent is based is reflected in citations coming from later patents. On the other hand, the larger number of backward citation does not necessarily lead to a higher probability to get the patent granted, as evidenced by the negative and significant coefficient (at 10% level) shown in Model 2. Not surprisingly, the coefficient of the time dummies in both models suggest that more recent patents have a lower likelihood to receive subsequent citations and obtain a final grant, as compared to older ones. Finally, our results do not suggest a significant effect of firm's size on patent value or patent grant as well.

5. Conclusions and policy implications

This paper has investigated a series of issues related to the design and assessment of patent subsidies schemes to foster patent activities by SMEs. Such measures have gained increasing importance over the last years in a wide variety of countries as a way to address the market failures connected to innovation and patenting activities by small and medium enterprises. To our knowledge, this is the first attempt in the literature to empirically investigate the optimal design of such schemes and to evaluate their effectiveness. We were particularly interested in assessing the impact of public subsidies on the value of patents, inspired by a series of concerns related to a potential inflation of low quality patents following the adoption of this kind of measures (Jiachun et al., 2008; Financial Times, 2008; The Economist, 2010).
From an empirical standpoint, we first mapped and analyzed a series of 34 policy programs centred on patent subsidy schemes activated in Italy by local, regional or national authorities starting from 2002. We than studied a sample of 222 patents, including 111 subsidized and 111 control patents, from the province in Milan, in Northern Italy, to test whether the receipt of a subsidy was associated with low patent value.
Our results reflect some flaws which seem to characterize the majority of this type of schemes activated in Italy: a strong fragmentation of the measures, resulting often in a limited budget

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sub-samples of EPO patents and PCT patents.

and a small amount of funding provided to beneficiary firms; a lack of coordination between actions undertaken at different levels (local, regional, national); a prioritary focus on increasing the number of international patent fillings, but not on increasing the quality of patents; the predominant automatic assignment of the subsidies, and the consequent absence of ex-ante evaluation on the quality and economic potential of submitted patents. All such shortcomings may have negative consequences, such as providing inadequate incentives for SMEs, or funding patents with limited economic potential, thus generating inefficiencies in the distribution of public financial resources.

For what concerns the impact of patent quality, results from our regression analyses on a sample of subsidized and control patents, do not support the concerns that the receipt of a subsidy is associated to lower patent value (measured in our case in terms of both the number of forward citations and the probability of getting the patent granted). However, they do not support either the existence of a higher value of subsidized patents, given that no statistically significant differences emerge in these dimension with respect to the control sample of non-subsidized patents. This evidence can be a direct consequence of the design of the specific measure we have analyzed, based on the award of automatic subsidies to applicants, following a mere check of the formal requirements.

Our study, therefore, suggests some important lessons and implications that can be applied by policy-makers to design and implement effective patent policies for SMEs based on subsidies. A first issue concerns the size of the programs. Rather than fragmenting the financial resources in narrowly designed schemes (often with rigid geographical limits), with limited budgets available and providing small amount of money to beneficiary firms, the implementation of sizeable programs should be encouraged (Scherer and Haroff, 2000). A second issue relates to the importance of jointly boosting the quantity *and* the quality of patents filed. It is doubtful that the establishment of patent subsidy schemes assigned with an automatic procedure is able to reach this goal, as suggested by our results. Selective schemes providing financial support only to selected. applicants, based on an ex-ante evaluation of the quality of the patent and the economic potential of the invention, could be more appropriate to reach this goal. Our review of the measures implemented in Italy has suggested a series of criteria that can be used to perform this kind of selection by a committee of experts, including the geographic and technological scope of the patent; the degree of innovativeness; potential market size and scope; competences of the applicant; collaborations with universities and public research centres. Finally, and as a direct consequence of the previous point, from a policy perspective, it appears important to encourage not only domestic and international patent filings by SMEs, but also their actual use to generate economic value. There is ample evidence that often patents generate no or very little value for their owners, since they remain unexploited (Giuri et al., 2007; Munari and Sobrero, 2011). SMEs in particular can take advantage from their patents in a wide variety of ways, including the protection from imitation and of the freedom to operate, but also outward licensing, access to external financing and reputation building (de Rassenfosse, 2011). An ideal extension of patent subsidy measures, therefore, would be that to encourage also the economic exploitation of patents, by covering not only expenses related to patent drafting and filings, but also to services related to their use and commercialization (for instance, costs for services related to patent evaluation and due diligence, technology marketing, license drafting, feasibility studies

and proof of concepts). In this sense, a recent and interesting initiative that we observed in our study is the scheme launched in August 2011 by the Italian Ministry for Economic Development, devoting a budget of 40 Euro million to two different calls oriented to SMEs. The first call aims to foster domestic and international patent applications, by covering part of the drafting and filing expenses (up to a maximum of 6000 Euro per patent). The second call aims to foster the economic valorization of patents, by covering expenses (up to a maximum of 70000 Euro) related to prototyping and engineering studies, feasibility studies, market analyses, technological due diligence, license agreements drafting.

In conclusions, the evidence we presented provides several implications which are worth some reflection by policy makers, due to the increasing diffusion of public patent subsidies measure around the world.

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Tables and Figures

Table 1 - An overview of international experiences of patent subsidies schemes over the past decade

County/ Region	Funding Scheme	Eligible Costs Relate to Patenting	Agency Responsible	Target Company	Amount
Spain	The Foreign Promotion Initiation Plan	Registration of patents and trademarks abroad, including the professional fees of an Industrial Property Agent.	The Spanish Institute for Foreign Trade, and the Higher Council of Chambers of Commerce	Spanish SMEs	The subsidy of up to 80% of the expenses, up to a maximum of €46,000
China	A Special Financial Subsidy Program for International Patent Filings	The official fees of out-going pantent applications and three years after the patent granted.	The Ministry of Finance, and the State Intellectual Property Office	Chinese SMEs	The amount of subsidy for each country/region (maxium 5 countries or regions per earch patent) not more than 10 million RMB, except for a significant innovation.
Canada	The Atlantic Innovation Fund	Patent searches and filing fees	The Atlantic Canada Opportunities Agency, a federal government agency in Canada	Private sector firms	Actual cost
Ireland	R&D Fund	Costs of research, development and innovation projects in preceding the granting of the patent or other industrial property rights in Ireland and aboard.	The government agency of Enterprise Ireland, coordinated by Department of Enterprise, Trade and Employment.	Irish based companies, particularly SMEs	The maxium R&D grant of a company is €450,000, with the Patent costs no more than 20% of the overall project cost.
Milan, Italy	Measure to Support European and International Patenting	Expenses incurred for an international patent filing.	The Chamber of Commerce of Milan	SMEs in Milan	Up to 50% of expenses incurred with a maximum amount of 15.000 Euro.

	Processes of SMEs of the Province of Milan				
Scotland, U.K.	The SMART, SPUR or SPUR ^{PLUS} Grants	Essential project costs such as: labour, overheads, materials, sub-contracting, consultancy and intellectual property.	Scottish Executive Enterprise,Transport and Lifelong Learning Department of the Scottish Government	SMEs based in Scotland	75%,35%,35% of eligible costs, with maximum grant of €35,000, €52,000, €351,000 for SMART, SPUR and SPRUR ^{PLUS}.
Wallonia, Belgium	Subsidy for Patent Registration and Extension	Patent application to national or European patent office with a search for previous patents; additional formalities and the extension to other territories.	The Directorate General Operational for Economy, Employment and Research (DGO6) of the Ministry of the Walloon Region.	Local SMEs	35% and 70% of the costs incurred of patenting an innovation and all cost incured for national validation.
Hong kong	Patent Application Grant	Patent application and the administration fee charged by HKPC	Innovation and Technology Commision, and Hong kong Productivity Council	Local companies	90%(maximum HK$150,000) of the sum of the total direct cost.
Chongqing, China	Special Patent Fund	Patent fling fees, substantive examination fees, and maintenance fees and the first annuity due in the year after the patent granted	The Chongqing Scientific and Technological Committee of the Municipal Government of Chongqing	Enterprises in Chongqing	A grant of RMB 1 million
Gujarat, India	Patent Registration Assistance	Patent registration in india and abroad.	Industries and Mines Department of the Government of Gujarat	Local small, medium and large company	50% (maximum Rs. 5.00 Lakhs) of necessary expenditure incurred for obtaining the patent.

Source: WIPO ducument at http://www.wipo.int/sme/en/documents/managing_patent_costs.htm#P108_27414, and own summarization.

Table 2 - The design of patent subsidies measures in Italy

(Data are related to 34 measures promoted by local Chambers of Commerce, Provincial, Regional or National Authorities in Italy over the period 2002-2010)

Promoting institutions and geographic coverage	The vast majority of patent subsidy measures (25 cases) have been promoted and managed by local Chambers of Commerce, often with the financial support of provincial or regional authorities (11 cases our of 25). In three cases (Venezia, Puglia, Lazio), the measure was promoted, funded and managed directly by a regional authority, in three cases by a provincial authority (Roma, Trento and Parma), and in one case by a foundation (Fondazione Cassa di Risparmio di Imola in the case of Imola). Two recent measures have been established at the national level in August 2011 by the Ministry for Economic Development. For measures promoted by Chamber of Commerce and Provincial Authorities, the scheme is oriented only to companies located in the relevant province. For measures managed by Regional Authorities, the action is oriented to companies localized within the region.
Rationale and objectives	All the calls we have analyzed present similar objectives oriented to encourage firms to protect their IPRs at an international level, so to foster innovation and internationalization activities, particularly by SMEs. Only three calls report the objective to promote the exploitation of patents (Italian Ministry for Economic Development, Regione Lazio, Provincia di Trento), and not only their grant.
Target beneficiaries	In most of the cases, the target beneficiaries of the measures are small and medium enterprises (typically defined according to the EU classification). In all of the cases, only companies satisfying the requirements of the "de minimis aid" rule are admitted in the calls, in order to comply with the state aid regulations of the European Community[1]. Submission presented by individual inventors are typically not admitted (with the exception of one measure). In some cases, also patents from universities and public research centres are admitted (the call of the Region Puglia is specifically reserved to such institutions).
Eligible costs	Typically subsidies for invention patents and utility patents are provided[2]. Coherently with this aim, the subsidies (awarded in the form of grant) cover all the costs incurred for submitting an application to the national office or the European Patent Office (including filing fees, costs for patent attorneys, costs for patentability search), and the costs for extensions of the patent in other territories[3].

[1] According to the "de minimis rule", an aid of no more than EUR 200 000 granted over a period of three years is not regarded as state aid within the meaning of Article 87(1). The Regulation does not apply to aid for fisheries and aquaculture, the primary production of agricultural products, export-related activities, the coal sector, the acquisition of road freight transport vehicles or firms in difficulty, or to aid tied to the use of domestic over imported goods. It applies to aid granted to firms in all other sectors, including transport and, on certain conditions, for the processing and marketing of agricultural products.

[2] In a few cases such subsidies address also registered designs, whereas in only one case (Chamber of Commerce of Mantova) also layout designs for integrated circuit and plan variety rights are included. Generally, registered trademarks are not considered in such measures, with the exception of the measure implemented by the Chamber of Commerce of Avellino.

[3] Generally, maintenance fees of the patent are excluded from eligible costs in such actions. In two cases (Chambers of Commerce of Gorizia and Udine), the aids are also intended to cover legal expenses incurred for litigations of the patent.

Amount of funding awarded	The maximum amount of funding awarded significantly varies across measures, ranging from a minimum amount of 500 euro per applicant (Campobasso) up to 70.000 euro (Italian Ministry of Economic Development).
Overall available budget	There is high variation in the overall budget available for the measures, ranging from a minimum of Euro 5000 Euro of budget (Chamber of Commerce Campobasso) to a maximum of Euro 1.200.000 for provincial measures (Milano), Euro 3.000.000 for regional measures (Lombardia), Euro 40.000.000 for national measures (Italian Ministry of Economic Development).
Selection and evaluation criteria	In the vast majority of cases, no ex-ante evaluation of the submitted patent is made (except for a formal check of the satisfaction of eligibility criteria), but the subsidies are automatically awarded on chronological order of the submission, up to the consumption of overall budget. In only five cases out of 32 (Ravenna, Imola, Venezia, Roma and Region Lazio, Italian Ministry for Economic Development) the selection is made by a Selection Committee based on pre-defined criteria (including degree of innovativeness; potential market size and scope; competences of the applicant; collaborations with universities and public research centres).

Table 3 - Descriptive statistics of patent applications by SMEs in the province of Milan

Variable	*N*	*Mean*	*Std.*	*Min*	*Max*
Number of Forward Citations	222	0.91	1.59	0.00	10.00
Dummy Grant	222	0.38	0.49	0.00	1.00
Dummy of subsidies	222	0.50	0.50	0.00	1.00
Number of IPC class	222	3.07	3.34	1.00	39.00
Number of Inventors	222	1.72	1.20	1.00	8.00
Number of Applicants	222	1.97	1.49	1.00	9.00
Number of Backward Citations	222	4.96	2.82	0.00	20.00
Dummy PCT	222	0.46	0.50	0.00	1.00
Dummy Utility	222	0.06	0.24	0.00	1.00
Turnover (in million Euro)	222	6,0099	8,3133	0,001	35,564589

Source: AIDA database, Espacenet.

Table 4 - Comparison of patent value indicators between the sample of patents with subsidies and the control group

	Patents with subsidies (mean value)	*Control patents (mean value)*	*T-value*	*Sig. (2-tailed)*
Number of Forward Citations	0.9369	0.8739	0.319	0.750
Dummy of Grant	0.4234	0.3423	1.347	0.181
Number of IPC class	3.0360	3.1081	-0.171	0.865
Number of Inventors	1.5856	1.8468	-1.740	0.085
Number of Applicants	1.9640	1.9820	-0.129	0.898
Number of Backward Citations	5.1351	4.7838	0.890	0.375

Data refer to 111 patents with subsidies and 111 control patents.

Table 5 - Correlation matrix among main variables in the full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)Forward citations	1.00							
(2)Dummy Grant	0.53	1.00						
(3)Dummy Subsidies	0.02	0.08	1.00					
(4)IPC class	0.30***	0.06	-0.11	1.00				
(5)Inventors	0.09	-0.12*	-0.11	0.14**	1.00			
(6)Applicants	0.05	-0.11*	-0.01	0.20***	0.76***	1.00		
(7)Backward citations	0.09	-0.05	0.06	0.21***	0.09	0.14**	1.00	
(8)Dummy PCT	0.03	-0.08	0.00	0.19***	0.24***	0.68***	0.07	1.00

*p<10%, **p<5%, ***p<1%

Table 6. Regression models on the impact of patent subsidies for SMEs on patent value (full sample)

	(1) Poisson regression model	(2) Logit regression model
	Dependent variable: Number of forward citations	Dependent variable: Dummy of granted patent
Dummy of patent subsidies	0.1268(0.1510)	0.4408 (0.3253)
Number of IPC class	0.0381 (0.0125)***	0.0195 (0.0527)
Number of inventors	0.3865 (0.1069)***	-0.1281(0.2706)
Number of applicants	-0.2446 (0.1118)**	0.0031 (0.2895)
Number of backward citation	0.0205(0.0258)	-0.1131(0.0638)*
Dummy of PCT	0.2781(0.2538)	-0.2218 (0.5636)
Log Turnover	-0.0320 (0.0386)	-0.0335 (0.0863)
Dummy utility patent	0.1485(0.2738)	-0.9814 (0.6657)
Dummy priority year		
2000	Reference case	Reference case
2001	-0.7727(0.3568)**	-0.2715(0.8744)
2002	-0.2618(0.2657)	-0.9517(0.7415)
2003	-0.7918(0.2768)***	-1.5386(0.7315)**
2004	-1.0023 (0.3496)***	-1.6489(0.8355)**
2005	-1.4873(0.3420)***	-3.6734(0.9251)***
2006	-1.9932(0.4340)***	-2.9055(0.8850)***
2007	-13.8314(526.4201)	(omitted)
Constant	0.4681 (0.7277)	2.2113 (1.6748)
Log likelihood	-298.0555	-120.2082
LR Chi^2	91.01	51.18
Prob>Chi^2	0.0000	0.0000
Number of observations	222	220

*p<10%, **p<5%, ***p<1%; standard errors are in parentheses.