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Roberto Fontana
Alessandro Nuvolari
Hiroshi Shimizu
Andrea Vezzulli

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Hitotsubashi University

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Roberto Fontana
University of Pavia & KITeS – Bocconi University
Via Sarfatti 25, 20139, Milano, Italy
roberto.fontana@unibocconi.it

Alessandro Nuvolari
LEM – Sant'Anna School of Advanced Studies,
Piazza Martiri della Liberta' 33, 56172, Pisa, Italy
alessandro.nuvolari@sssup.it

Hiroshi Shimizu
Institute of Innovation Research Hitotsubashi University
2-1 Naka Kunitachi, Tokyo, Japan
shimizu@iir.hit-u.ac.jp

Andrea Vezzulli
Department of Management – University of Bologna
Via Capo di Lucca 34, 40126, Bologna, Italy
andrea.vezzulli@unibo.it

Abstract

This paper presents an exploratory study on the characteristics of inventive activities as captured on the basis of the analysis of a data-set of R&D awards. Our data source is the "R&D 100 Awards" competition organized by the journal *Research and Development*. Since 1963, the magazine (which at that time was called *Industrial Research*) has been awarding this prize to 100 most technologically significant new products available for sale or licensing in the year preceding the judgment. The jury is composed of university professors, industrial researchers and consultants with a certified level of competence in the specific areas they are called to asses. The main criteria for assessment are: i) technological significance (i.e., whether the product can be considered a major breakthrough), ii) competitive significance (i.e., how the product compares to rival solutions available on the market). Throughout the years, key breakthroughs inventions such as Polacolor film (1963), the flashcube (1965), the automated teller machine (1973), the halogen lamp (1974), the fax machine (1975), the liquid crystal display (1980), the printer (1986), the Kodak Photo CD (1991), the Nicoderm antismoking patch (1992), Taxol anticancer drug (1993), lab on a chip (1996), and HDTV (1998) have received the prize. We use these data to study the shifts in the distribution of innovative activities across countries, sectors and types of institutions and the changes in the sources of inventive activities over time. Our preliminary findings show: i) the emergence of a challenge to US technological leadership from other rival nations such as Japan and Germany, ii) the critical role of scientific instrumentation as a powerful source of technological breakthroughs, iii) a change in the institutional arrangements where innovative activities take place, from individual corporations, to partnerships increasingly involving public research organizations and universities, iv) a large chunk of inventive activities undertaken without patent protection.

JEL CODES O34, O31, O32, N80

1. Introduction

Innovation scholars have traditionally relied intensively on patents to investigate the sources, the nature and the effects of inventive activities. Inventive activities are inherently elusive phenomena which almost by definition are bound to defy systematic attempts of (quantitative) measurement. It is not surprising then that the existence of patents records has been regarded for long time, mostly by economists, but also by other scholars of innovation with different disciplinary backgrounds, as an almost unique source for providing insights into the nature of inventive activities. The main merits of patent records as a source for measuring innovation are easy to summarize: i) they are by definition related with inventive activities;[1] ii) they are readily available (allowing to economize efforts of data collection);[2] iii) they are available for relatively long periods of time (in the case of Western countries either from the eighteenth or from the nineteenth century); iv) they contain a significant depth of information (inventors' names and addresses, ownership of the invention, description of the invention and its relation with previous ones (as represented by patent citations). These factors have made patents the most adopted indicator for scholars interested especially in measuring the output of inventive activities. Although much progress has been obtained in this way, it is well known that indicators of innovation based on patents suffer from two main limitations. The first is that there exists a different propensity to patent across industries. This may lead to the overlooking of inventive efforts in sectors characterized by low patenting propensities. The second limitation is that patents differ greatly in their technological and economic significance.[3] Innovation scholars have attempted to deal with this problem by weighting patents using citations or other information such as claims, family size, etc. Still, it is recognized that these methods represent imperfect proxies of the quality of the invention underlying the patent in question.

Alternative approaches to the study of significant inventions exist in the literature. Jewkes *et. al.* (1969) have shown the potential of carrying out a number of in-depth case-studies of inventions using a common comparative research protocol. In this way, they have been able to show the resilience of individuals as a critical source of invention even in an historical phase where inventive activities increasingly took place in corporate research laboratories. A different approach, which has been recently explored, is to complement patents with other sources of information concerning the significance of inventions. For example, Moser (2005) has constructed a data-set of

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[1] In the words of Griliches (1990, p. 1169): "[A] patent represents a minimal quantum of invention that has passed both the scrutiny of the patent office as to its novelty and the test of the investment of effort and resources by the inventor and his organization into the development of this product or idea, indicating thereby the presence of a non-negligible expectation as to its ultimate utility and marketability"

[2] The "accessibility" of patent as a source has greatly increased over the last 20 years or so thanks to the creation of on line search engine such as ESPACENET and the efforts of construction of data-bases containing information gathered by patent records such as the NBER US patent data-set (Hall, Jaffe and Trajtenberg, 2001) and the OECD PATSTAT data-set.

[3] In the words of Kuznets (1962, p. 37): "[T]he main difficulty with patent statistics is, of course, the enormous range in the magnitude of the inventions covered…patented inventions do differ widely in their potential economic magnitude".

inventions on the basis of the Catalogues of industrial exhibitions (in her case she has used the Crystal Palace exhibition of 1851 and the Centennial exhibition in Philadelphia in 1876). Moser's findings have produced novel insights on the sources of invention across countries and sectors during the second half of the nineteenth century.

In this paper, we perform a similar exercise to that carried by Petra Moser for the period 1977-2004. Our source of data is the "R&D 100 Awards" competition organized by the journal *Research and Development.* It is worth noting that we are interested in exploring the potentialities of this source from a twofold perspective. The first is to check its general reliability for the construction of innovation indicators (to be used to integrate insights from the analysis of patent trends or in alternative to patents in contexts where the use of patents may be fraught by major shortcomings). The second is to use this source to examine the relationship between inventive activities and patents.

2. The "R&D 100 Awards"

As mentioned our source of data is the "R&D 100 Awards" competition organized by the magazine *Research and Development* (previously called *Industrial Research*). The magazine was founded in 1959 and it represents probably one of the most authoritative regular publications for R&D practitioners. Currently it has an estimated monthly readership of over 80,000. It is estimated that about 75% of the readers works in high-tech industries, whereas the remaining 25% works for government laboratories, universities, and similar organizations. Over 60% of the readers have managerial or executive type of jobs. [4] The "R&D 100 Awards" competition has been running since 1963. Each year the magazine awards with a prize the 100 most technologically significant products available for sale or licensing in the year preceding the judgment. Throughout the years, key breakthroughs inventions such as Polacolor film (1963), the flashcube (1965), the automated teller machine (1973), the halogen lamp (1974), the fax machine (1975), the liquid crystal display (1980), the printer (1986), the Kodak Photo CD (1991), the Nicoderm antismoking patch (1992), Taxol anticancer drug (1993), lab on a chip (1996), and HDTV (1998) have received the prize. In order to apply for the prize, the inventors or their companies must fill an application form providing a detailed description of the product in question. The application form for the year 2009 is reported in Appendix 1.[5] The prize is awarded only to those products whose applications have been regularly submitted. The prize consists of a plaque which is presented in a special ceremony. There is no sum of money involved.[6] The prize is awarded by a jury composed of university professors, industrial researchers and consultants with a certified level of competence in the specific areas they are called to asses. The members of the jury are selected by the

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[4] All information have been retrieved from the magazine website, www.rdmag.com, accessed 17 January 2008

[5] There is a small submission fee (250$ in 2009)

[6] The fact there is no sum of money involved is a positive feature for the use of the "R&D 100" awards as indicator of invention because it limits the possible effect of strategic behaviours.

editor of the magazine. The main criteria for assessment are two: i) technological significance (i.e., whether the product can be considered a major breakthrough from a technical point of view); ii) competitive significance (i.e., how the performance of the product compares to rival solutions available on the market).

The technological significance requirement is to be understood in fairly broad terms:

"products and processes that can change people's lives for the better, improve the standard of living for large numbers of people, save lives, promote good health, clean up the environment, etc….. A cure for cancer or AIDS. An engine that runs on water. A safe, cheap method for cleaning up toxic waste. A vehicle that can fly 800 passengers from New York to Tokyo in two hours. A device that would cut automotive accidents, or one that would reduce workplace injuries. A pollution-free herbicide that would increase crop production in Third World countries".[7]

Accordingly products with a wide potential of application are preferred to those catering to very specialized sets of user needs:

"Products or processes that solve very specialized or circumscribed problems could be judged less significant than those that meet larger, more broad-based needs. For example, a new scientific instrument that only benefits a few scientists in a narrow field of interest would have difficulty competing against a device with much broader application. It would depend on how significant the two fields of interest were and how much the technical improvements contributed to the success of each device."

Furthermore for attaining the prize there should be a proven link between the effect of the innovation and an improvement in technology:

"these improvements must be attributed to significant breakthroughs in technology. In general, this means your product should exhibit multiple levels of improvement - 53 times faster, 103 greater throughput, 503 times more accurate - or, preferably, orders of magnitude improvement over existing technology. Again, we're looking for 'leapfrog' gains in performance, not expected, incremental improvements."

Additionally the product should also represent a major improvement in comparison with alternative solutions already existing on the market. For this reason, the applicant is requested to provide a 'competitive matrix' illustrating how the product compares with rival solutions already available on the market:

"The competitive matrix should show how your product compares to existing products in terms of the crucial factors involved in the technology. This is your opportunity to give the judges a quick overview of how your product beats the competition….Include only factors crucial to the technology. Don't waste space (and the judges' time) throwing in every conceivable factor, just to pad your entry. However, you must list all factors that are indeed crucial to the technology, even if you don't 'win' hat particular point. For example, if you fail to include 'hardness' in an entry involving a new alloy, your entry may be looked upon with suspicion by the judges. Some typical factors you might want to include: signal-to-noise ratio, weight, speed, reliability, resolution, cost, accuracy, life expectancy, mean time between failures, sensitivity, reproducibility, strength, power consumption, production yield, environmental operating , intensity, efficiency, size, output rate, bandwidth, number of materials tested, stability".

The product must exist in marketable form at the moment of the submission of the application. This means that applicants are required to provide evidence of the

[7] All the citations concerning the rules and organization of the "R&D 100" awards have been retrieved by the website http://www.rdmag.com, accessed on December 28, 2008.

existence of the invention in marketable form. Applicants are not restricted to firms, but also governmental laboratories, universities, public research centres are allowed to compete. It is possible for organizations to submit a joint application for a specific product (in that case the application should include all the organizations that have given a significant contribution to the creation of the product). Finally an organization may submit as many products they wish at each yearly competition.

There are a number of characteristics of the R&D 100 awards that, at least *prima facie*, appear particularly promising for using these data source to measure inventive activities.

1) The R&D 100 awards competition seems to represent a good opportunity for companies, government laboratories, etc. to showcase the outcome of their inventive activities. Thus, we can expect that the awards will provide us with a fairly reliable sample of inventions attained by R&D performers;
2) R&D 100 awards are granted to inventions that, at least in principle, should embody a significant improvement of the state-of-the-art that is clearly documented. In other words awarded inventions should represent a breakthrough;
3) The selection of the awards is made by what appears a competent, authoritative jury of experts;
4) There seems to be limited space for strategic behaviours and attempts to conditioning the jury, because the nature of the prize is simply honorific.

All in all, these properties are reminiscent of those discussed by Moser (2005) for using nineteenth century exhibition data as indicators of innovation. A further advantage of the R&D 100 data awards in comparison to Moser's exhibition data is that they are available for an interrupted period of more than 40 years, where exhibition data were available only at two specific moments in time (1851 and 1876).

Given these properties, it is somewhat surprising that innovation scholars have so far paid just scant attention to this source. To the best of our knowledge the R&D 100 awards data have been used so far only used in two contributions: Carpenter *et al.* (1981) and Scherer (1989). Carpenter *et. al* (1981) used the 1969 and 1970 awards list and match these inventions with the corresponding US patents.[8] In this way, they obtain a set of 100 patents whose technological significance has been 'certified' by the granting of the award. They then compare the citations received by this group of patents with the citations received by a random sample of patents distributed with the same time cohort. The results show that the patents covering the R&D 100 awards receive a significantly higher number of citations than the control group. In the interpretation of the authors, the results provide an important corroboration for the use of citation received as indicator of patent quality. Scherer (1989) instead uses information on the mean and maximum R&D costs which was provided until the 1980s with the list of the winners. From our perspective, it seems reassuring that the two authoritative contributions in the field of innovation studies have made use of the data.

[8] For winning the award it is not necessary that the invention is patented.

3. Preliminary Analysis

We have constructed a data-set with all the R&D 100 awards granted from 1963 to 2005. In what follows we will explore the properties of this data-set and attempt to provide an interpretation of the trends in the data for the changing nature of innovative processes in this period.

Figure 1: Share of US awards

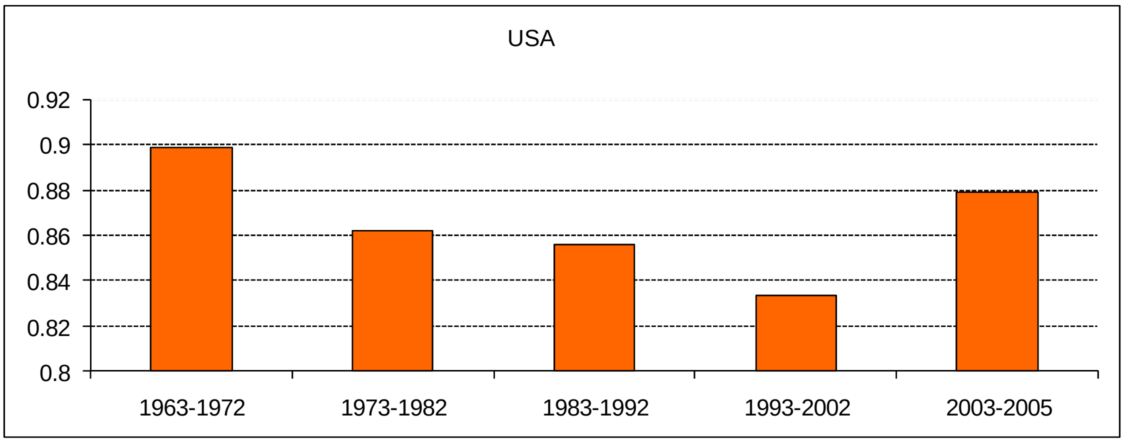


Figure 1 displays the share of awards granted to US applicants. The nationality of the applicants has been assigned using the organization, rather than by looking at the nationality of the inventors. The trend of the figure is quite clear. Over the period 1963-2002, the share of US awards is declining indicating that other countries are closing the gap with the US in terms of technological performance. Interestingly enough, the period 2003-2005 seems to be one where the US are regaining and edge in technological, but, of course, it is a too short span of time for detecting clear trends.

Figure 2a: Share of Awards by countries (subperiods)

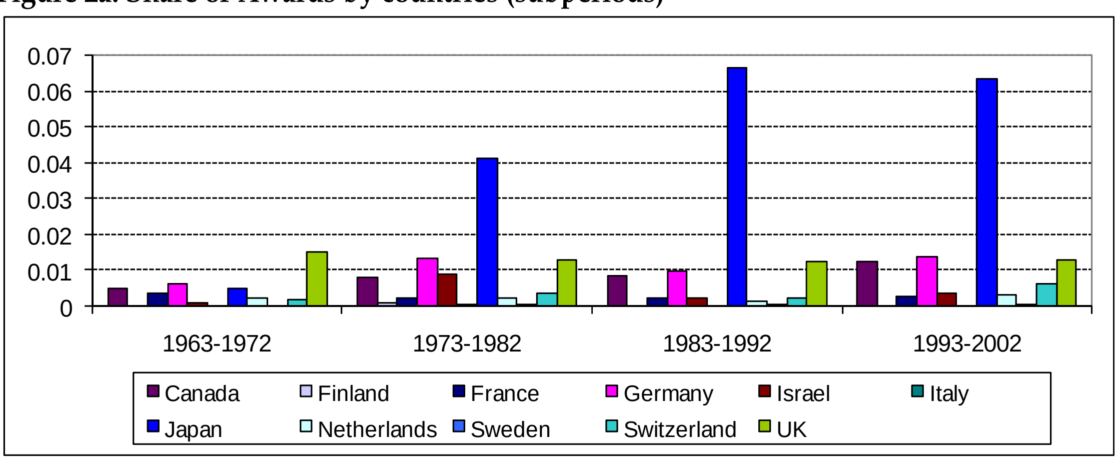


Figure 2b: Share of Awards by countries (total period)

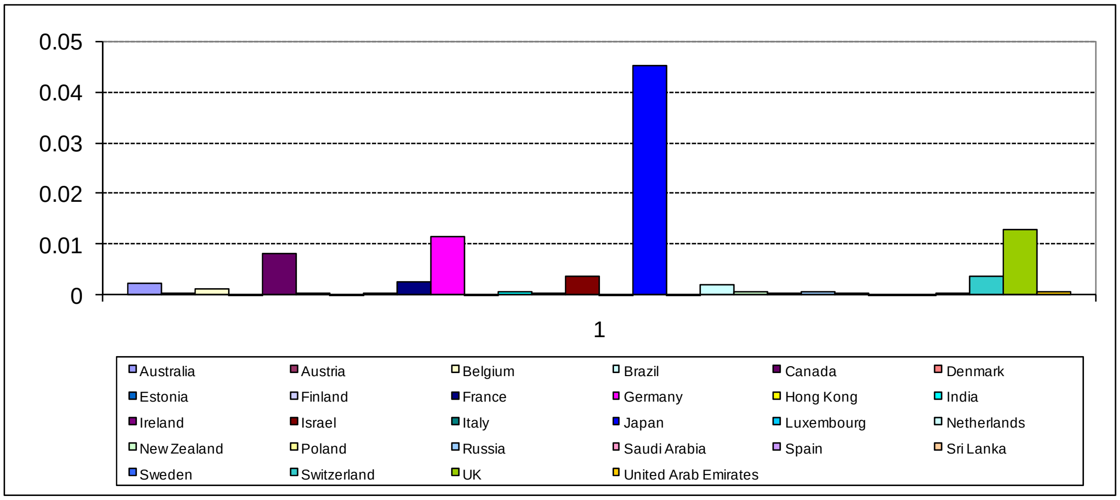


Figure 2a and 2b display the share of awards by countries excluding the US that, as one would have expected given the nature of the competition and the place of publication of the magazine, dominate the sample. Figure 2a shows the shares divided by sub-periods and Figure 2b shows the shares for the total sample from 1963 to 2005. The figures clearly indicate that Japan and Germany are the two most prominent followers of US technological leadership. Figure 2a shows how this effort of closing the gap evolved over time, with Japan and Germany progressively overtaking two older established players such as France and UK. It is interesting to note that the figure reveal a good performance of some small European countries such as Sweden, Finland and the Netherlands. On the other hand, countries with good level of economic performance but characterized by historically weak R&D systems such as Italy display a poor performance. However, the most noteworthy feature of Figure 2a and Figure 2b is the remarkable performance of Israel. This however is only relatively surprising since the dynamism of the national system of innovation of that country has been frequently pointed out in the innovation policy literature (Teubal, 1993). All in all, the picture emerging from these figures is fully in line with the account of global technological competition put forward in the national innovation system literature (Nelson, 1993). This suggests that R&D Awards may be a very useful for the assessment of technological performance at the country level. In particular, notice that in Figure 2a, Israel's technological performance was already visible in the 1970s. In this respect, one possible recommendation would be a further exploration of the source in terms of its potentialities for its use in benchmarking exercises such as the EU Innovation Scoreboard. On the other hand, the source seems to suffer from an obvious bias towards high-tech and formalized R&D labs type of inventive activities. Hence, the low visibility of countries like Italy that were capable of attaining good level of economic performance by means of less formalized and more low-tech inventive efforts. Therefore, we should recognize that the R&D 100 awards when used to measure the technological performance may severely underestimate this type of innovation processes. This suggest a more sophisticated use of this indicator, namely to employ this source explicitly as a measure of the 'formalized R&D' segment of the innovative performance of a country. Used in this way, this source may reveal the possible biases of other indicators such as patent counts that are typically used to assess the performance of aggregate inventive activities

Figure 3: Number of countries with at least 1 award

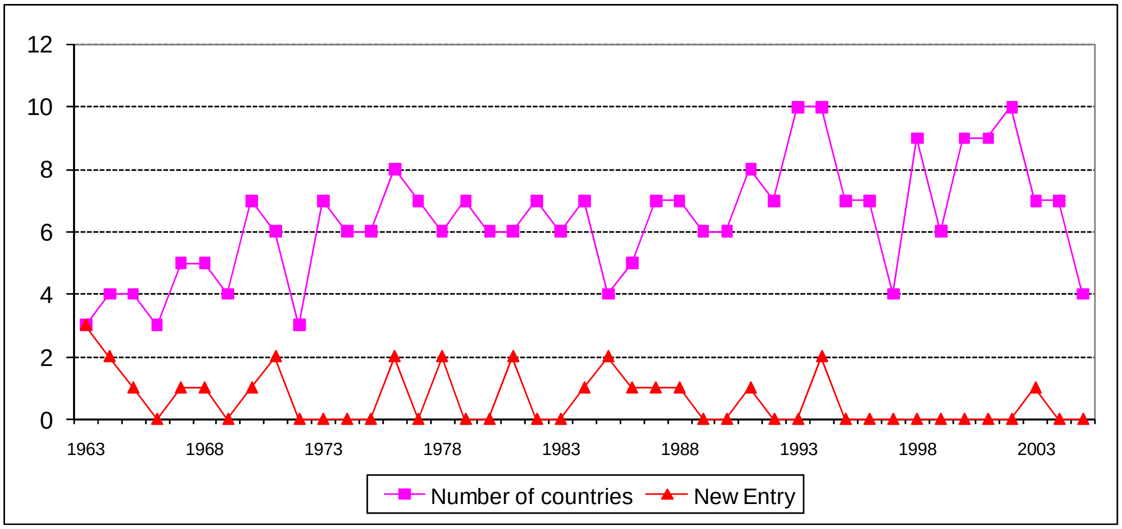


Figure 3 displays the number countries with at least one award in the early prizes. As we may notice, R&D 100 awards remain restricted to a very restricted number of players (never more than 10 countries). This may suggest a cautionary attitude towards the findings of the international business literature that has emphasized the increasing dispersion of R&D activities. Indeed, Figure 3, shows that major R&D efforts leading to major technological breakthroughs remain heavily concentrated in a handful of countries. The second time series in Figure 3 shows the number of countries winning the award for the first time. Again, the trend towards persistence is quite clear. It seems very difficult for outsiders to enter in the club of the winners. Furthermore, the data for the last 10 years seem to suggest further entry may have become increasingly more difficult.

Figure 4: Shares of Awards granted to different type of Institutions

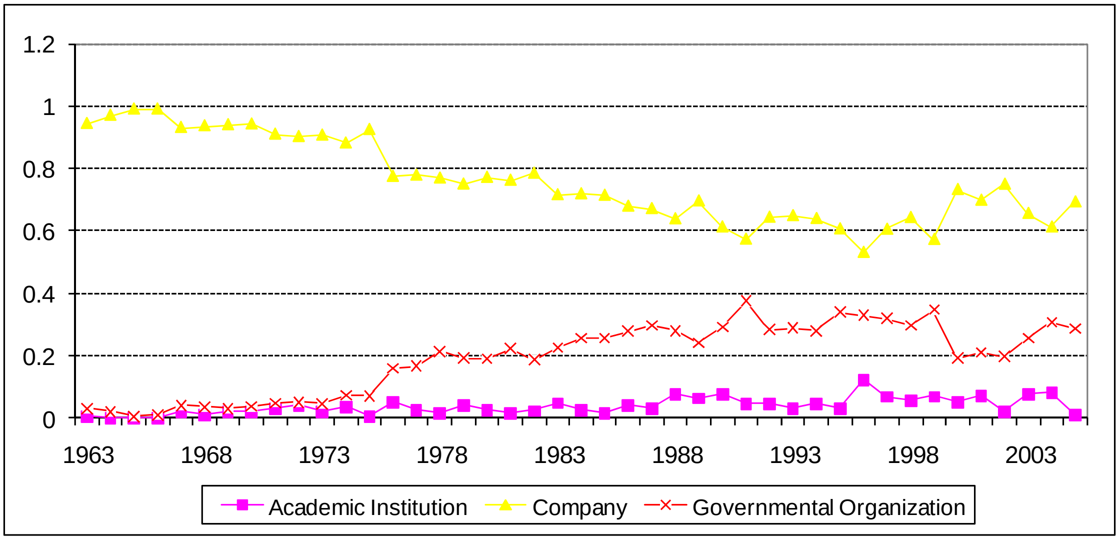


Figure 4 shows the shares of awards granted to different type of organizations. The trends in Figure 4 are in line with the literature that has recently pointed out the increasing involvement in inventive activities of a number of new actors such as government laboratories and universities (Freeman, 1994). Whereas in the early 1960s corporations were clearly the primary source of inventions, in the most recent years this is clearly not the case. The obvious public policy implication is that due to attention must be paid to supporting inventive activities also occurring in non-corporate type of contexts.

Figure 5: Number of Collaborative Inventions receiving an Award

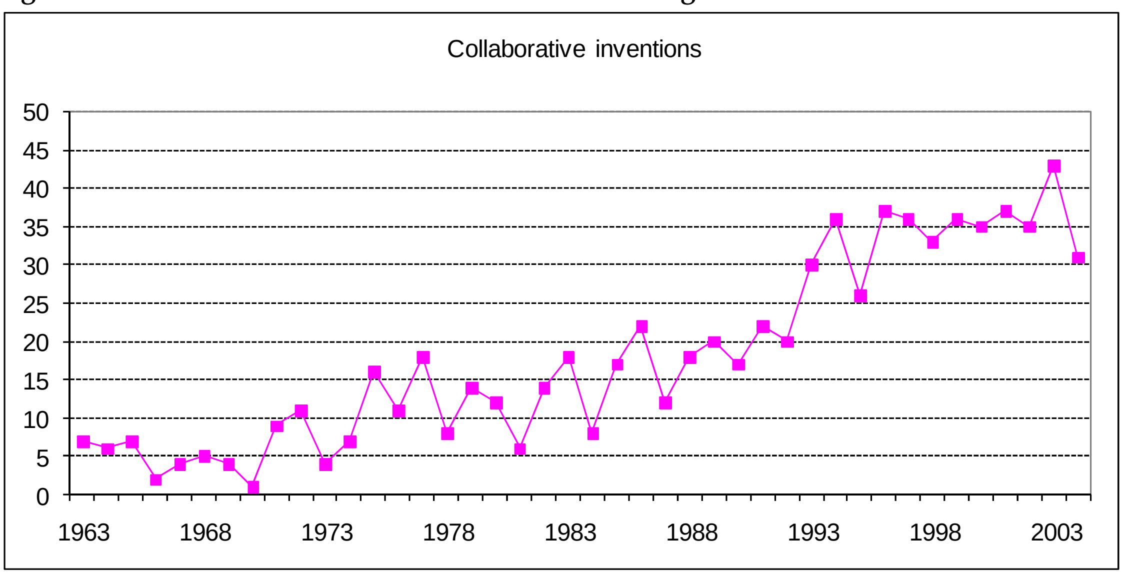
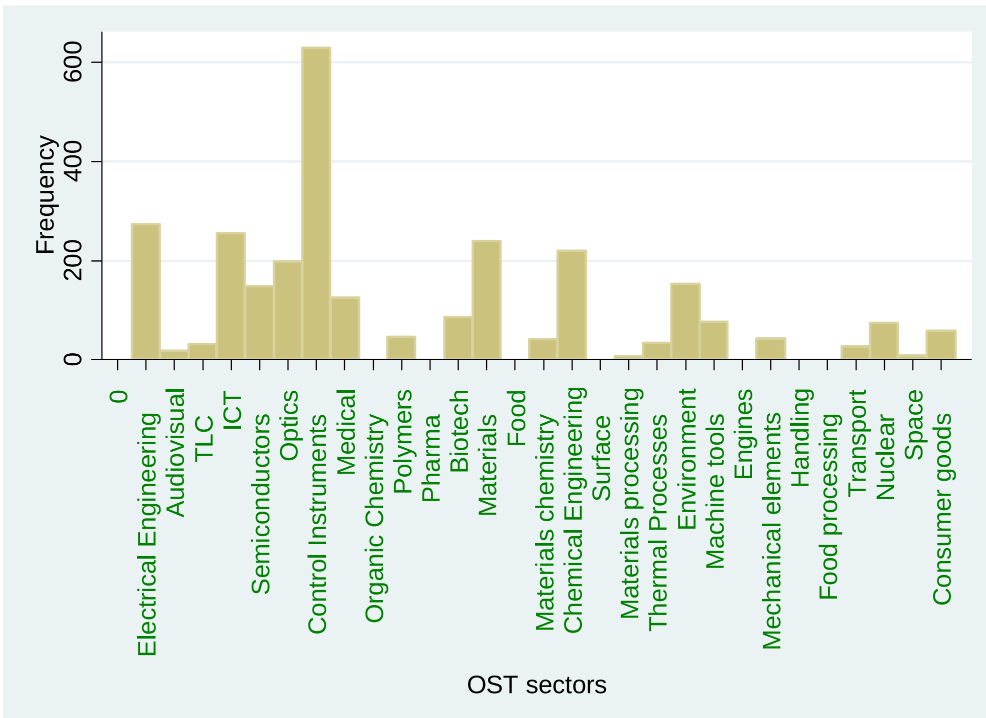


Figure 5 displays the number of inventions receiving an award that are the outcome of collaborative activities. The figure shows a clear increasing trend which is fully consistent with the emphasis that has been put on the growing role of cooperation and networking in the field of innovative activities (Freeman, 1991). Again, if one is tempted to draw policy prescriptions, Figure 5 provides some corroboration for public policy measures supporting the formation of partnership and networks.

Figure 6: Distribution of Awards across technology types, 1963-2005



R&D 100 awards are classified in a number of different product categories. Unfortunately the classification is not consistent over time. Further in some cases the inventions were not assigned to a specific category. Thus, in order to examine the distribution of awarded inventions across different technological fields, we have proceeded as follows. First we have reclassified each awarded invention according to a new technology-oriented classification of 30 different sectors based on the co-occurrence of the International Patent Classification (IPC) codes proposed by the *Observatoire des Sciences et des Techniques* (OST)[9]. In a few doubtful cases, we have not only the classification in product categories of the R&D100 awards but also looked at the invention description. It is important to note that we have assigned each awarded inventions to only one of the 30 OST sectors. These sectors have been further aggregated into 5 "macro" technological classes (called "OST5" henceforth) defined

[9] See Hinze, Reiss, Schmoch (1997).

according to the following ISI-INIPI-OST patent classification based on the EPO IPC technological classes, as shown in Table 1. [10]

Table 1 - Aggregation of the 30 ISI-INPI-OST sectors in 5 macro-classes

MacroISI-INIPI-OST	ISI-INIPI-OST	Technological Class
1	1,2,3,4,5	Electrical engineering
2	6,7,8,27	Instruments
3	9,10,11,12,14,15	Chemistry, Pharmaceuticals
4	13,16,17,18,20,24,25	Process engineering
5	19,21,22,23,26,28,29,30	Mechanical engineering

Figure 6 contains histograms showing the distribution of the awarded inventions across the 30 OST sectors. It is important to notice that there is no effort on the part of the jury to make sure that the yearly list of winners would cover a large spectrum of technologies. The only criteria adopted are those mentioned in the previous section, that is to say technological and competitive significance. For this reason figure 6 provide the best indication of the biases of the R&D awards in terms of representation of inventive activities. As one would have expected, there is a powerful distortion towards "high-tech" sectors such as instruments, biotechnology, information and communication technologies, optics (lasers), semiconductors, etc. The predominant technology is the field of instrumentation (control instruments). In part this may be clearly explained by the interests of the editors and the readership of the magazine (instrumentation plays a central role in the majority of modern R&D processes). An additional reason for this finding may be related to an advantage for entries in this category in demonstrating in a credible way that they are superior to the state of the art, by means of quantitative assessment of technological performance. What is worth remarking is that, even in a competition whose explicit aim is to reward technological invention in a broad sense ("change people's lives for the better"), it seems possible to reveal the existence of bias towards technological sophistication. More "mundane" technological classes such as food, food processing and consumer goods exhibit relatively few inventions.

All in all, these results confirm that the R&D 100 awards tend to cover, as one would have expected, a "high-tech", R&D intensive segment of the economy.

Table 2 displays the shares of awarded inventions that have been patented (patenting rates) subdivided across both 5 and 30 OST sectors. In order to construct table 2, we have tried to match each awarded invention with one or more USPTO patents (given the nature of our data source, the most obvious choice is to look for US patents) . In particular, we have searched USPTO patents granted in a time interval ranging from 3 years before to 3 years after the award. The other criteria for ascertaining a "positive" match were the name of the inventors, the company and the consistency between the description of the "R&D" 100 invention and the title and abstract of the patent. We should stress that these results are to be considered provisional and that the matching is inevitably subjected to errors. However, note that

[10] Technology-oriented classification system jointly elaborated by the German Fraunhofer Institute of Systems and Innovation Research (ISI), the French Patent Office (INIPI) and the Observatoire des Science and des Techniques (OST).

in uncertain cases the "benefit of the doubt" was given to a positive match (ie, we considered the awarded invention as covered by a patent).

Overall, we found that only 269 awarded inventions (slightly less than 10%) where patented according to our matching criteria. Intriguingly, this is quite in line with the findings of Petra Moser which reports total patenting rates between 11% and 14% for the inventions displayed at the Crystal Palace exhibition of 1851 (Moser, 2005, p. 1221). Of course, the preliminary nature of our results, means that we should not put an excessive weight on this finding. However, even if we consider possible errors that may have led us to underestimate patenting rates, the result is staggering. We should consider that here we are dealing with a competition that aims to capture the output of formalized R&D efforts, which is notoriously one of the contexts with the highest propensity to patent. Further, we are in principle dealing with major innovations. Thus, our findings seems again to reveal that patent protection, even in this context, may be a much less used instrument for protecting innovation than what is generally believed. In our judgment, our finding is actually a powerful corroboration of the findings of both Moser (2005) and with the results of the Yale and Carnegie Mellon survey (Levin et al., 1987; Cohen et al.,2000) indicating that only in a restricted number of contexts patents are considered as essential tools for protecting innovation by companies. The obvious policy implication is actually that in terms of attitudes towards intellectual property the recent developments (strengthening of IPR regimes) may be actually going in the wrong direction, as it would appear considering the predominant share of inventive activities which is actually carried out without resorting to patent protection. For a more elaborate discussion of this point see Boldrin and Levine (2008).

Table 2- Patenting Rates of "R&D" 100 inventions

OST5	OST30		N Inventions	Share Patented
	1	Electrical engineering & devices	274	0.1350
	2	Audiovisual technology	19	0.1053
	3	Telecommunications	32	0.1563
	4	Information Technologies	255	0.0824
	5	Semiconductors	148	0.1149
Electrical engineering			**728**	**0.1126**
	6	Optics	198	0.1111
	7	Control technology	629	0.0493
	8	Medical technology	125	0.1120
	27	Nuclear engineering	75	0.0400
Instruments			**1027**	**0.0682**
	9	Organic chemistry	0	-
	10	Polymers	47	0.1489
	11	Pharmaceutics	0	-
	12	Biotechnology	87	0.0690
	14	Food chemistry	0	-
	15	Basic materials chemistry	42	0.2857
Chemistry, Pharmaceuticals			**176**	**0.1420**
	13	Materials metallurgy	240	0.1458
	16	Chemical engineering	220	0.1091
	17	Surface technology	0	-
	18	Materials processing	8	0
	20	Environmental technology	154	0.0714
	24	Handling & printing	0	-
	25	Food processing	0	-
Process engineering			**622**	**0.1125**
	19	Thermal processes	34	0.0882
	21	Machine tools	77	0.1169
	22	Engines	0	-
	23	Mechanical elements	43	0.0465
	26	Transport	27	0.0370
	28	Space technology	9	0.1111
	29	Consumer goods	59	0.1017
	30	Civil engineering	0	-
Mechanical engineering			**249**	**0.0884**
Total			**2802**	**0.0960**

The share of patented inventions however change considerably across sectors as evidenced by Table 7. In terms of macro-sectors, the sector with highest propensity to patent is chemical/pharmaceuticals (this is also in line with the results of the Yale and Carnegie surveys on the effectiveness of patents for protecting inventions in these field). On the other side, the macro-sector with the lowest patenting rate is instruments. In this case we should not forget that many organizations active in this sector are non-corporate institution such as universities and public research centers and this may contribute the relatively low patenting rate.

4. Econometric analysis.

In this section we carry two econometric exercises: the first one is to inspect how different patterns of innovation regimes (as measured by patent indicators) affect the probability to observe an important/breakthrough invention (i.e. an awarded invention) in a given macro-sector; the second one is to analyze which determinants affect the propensity to patent an awarded invention in a given macro-sector and year.

4.1 Patterns of Inventive Activities and Technological Breakthroughs

For each of the five macro-classes mentioned above we have computed a set of time-varying indicators, aiming to proxy different patterns of innovative activities across classes and over time, using patent data from the NBER Patent Data Project[11], which collects a very comprehensive set of information on USPTO patents for the period 1976-2006 (e.g.: dates of application and grant, inventors and applicant's name, number of claims, technological classes, forward and backward citations, etc.)[12]. In particular, defining with j=1,..,5 each OST5 sector and with t=1976,…, 2006 the year of granting of each patent, following the contributions of Breschi, Malerba, and Orsenigo (2000), Hall, Jaffe and Trajtenberg (2001) and Corrocher, Malerba and Montobbio (2007), we computed the following indicators:

1) $PAT\_GROWTH_{jt} = \frac{PAT_{jt}-PAT_{jt-1}}{PAT_{jt-1}}$

Where PAT_{jt} is the total number of patent granted in OST5 class *j* in year *t*.

2) $ENTRY_{jt} = \frac{NEWPAT_{jt}}{PAT_{jt}}$

[11] See Hall et al. (2001) and https://sites.google.com/site/patentdataproject/Home for a comprehensive description of the database.

[12] The reclassification of all USPTO patents according to the 2008 IPC classification system is available on the NBER Patent Data Project website and it has been performed on the basis of the International Patent Classification Eighth Edition available at http://www.uspto.gov/go/classification/uspc002/us002toipc8.htm

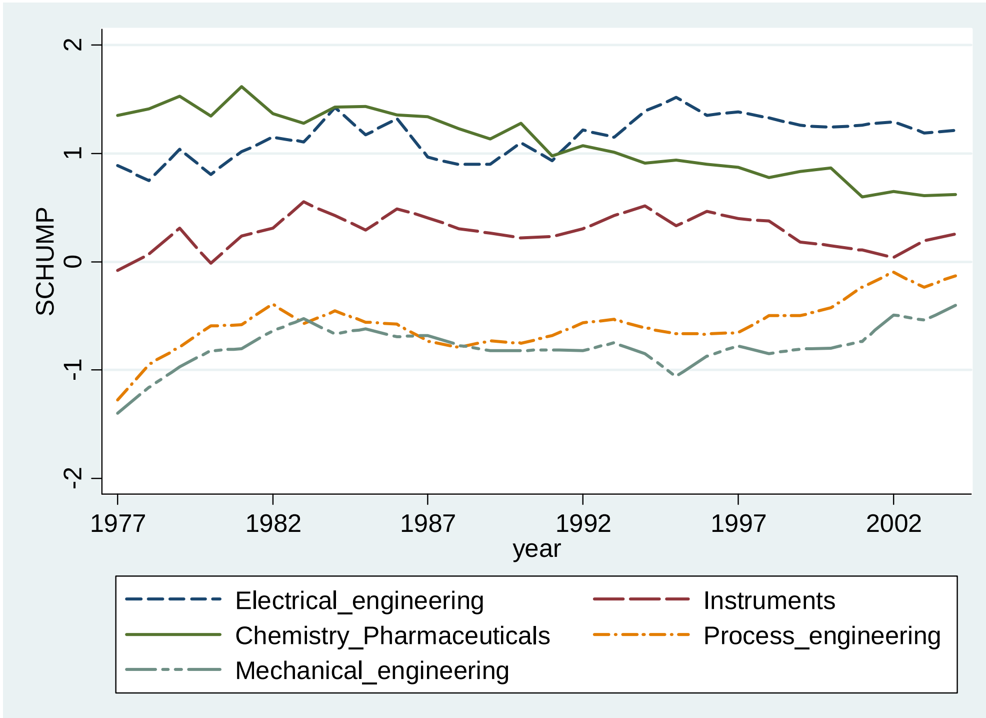
Where $NEWPAT_{jt}$ is the total number of patent granted in OST5 class j in year t by new innovators, i.e. by firms patenting for the first time in class j.

3) $C4_{jt}$ represents the concentration ratio, in term of number of patent granted in a given year t and class j of the top four patenting firms.

4) $STABILITY_{jt}$ is the Spearman rank correlation coefficient between hierarchies (in term of number of patent granted) of firms patenting in year t and firms patenting in year t-1 in class j.

The last three indicators (ENTRY, C4 and STABILITY) are then synthesized in a unique indicator called $SCHUMP_{jt}$ by means of principal component analysis. The computed scoring coefficients, i.e. the correlations between the principal component extracted (which accounts for about 70% of the total variance) and our three original indicators C4, ENTRY and STABILITY are, respectively 0.37, -0.67 and 0.64. We thus find (similarly with Breschi et al. 2000) that our indicator SCHUMP (which represents the prediction obtained using the scoring coefficients of the first component and the standardized values of the original variables) provide a synthetic indicator of the type of Schumpeterian pattern of innovation prevailing in a given class i in year t: high values of SCHUMP reflect an innovation pattern near to Mark II type regime (i.e. deepening pattern of innovative activities with a concentrated and stable population of innovators) , whereas low values of SCHUMP reflect an innovation pattern near to Mark I type regime (i.e. widening pattern with a large and turbulent population of innovators). Figure 7 depicts the different trend of SCHUMP across the OST5 macro sectors considering along our time window. We can see that two sectors (Electrical Engineering and Chemistry&Pharma) are consistently close to a Schumpeter Mark II type regime, two other sectors (Mechanical and Process Engineering) are close to a Schumpeter Mark I type regime and one sector (Instruments) displays an intermediate pattern between these two. Despite the Electrical Engineering sector (which tends to remain close to a Mark II regime along time),we can appreciate a converging trend of the other sectors toward an intermediate type Schumpeterian regime.

Figure 7 – Trends of SCHUMP along time for each OST5 macro sector.



5) $HERFSOURCES\_TECH_{jt}$, this is an index of the relative variety of knowledge sources across technological classes and it is calculated in a similar way as Hall et al. 2001, Trajtenberg et al. 2002 and Corrocher et al. 2007). Let $a_{jht} = c_{jht}/c_{jt}$ be the share of backward citations from patents granted in year t and belonging to OST5 class j to previous patents in IPC class h (defined at 4 digit level), where c_{jht} is the total number of patents belonging to IPC class h and cited by patents granted in year t and belonging to OST5 class j and $c_{jt} = \sum_h c_{jht}$, let then $v_{jht} = P_{jht}/P_{jt}$ be the share of patents (for each granting year t) in OST5 class j belonging to IPC class h. Let $HERF\_TECH_{jt}$ and $HERFCIT\_TECH_{jt}$ be the corrected Herfindahl indexes (Hall, 2000) calculated using respectively the shares a_{jht} and v_{jht} and indicating how much each OST5 class j and its knowledge sources are concentrated (in term of number of patents granted and number of backward citations made) across different IPC 4 digit sub-classes in a given year t. The resulting relative index of concentration of knowledge sources across IPC technological classes is given by the ratio of the previous two indexes: $HERFSOURCES\_TECH_{jt} = \frac{HERFCIT\_TECH_{jt}}{HERF\_TECH_{jt}}$.

6) $HERFSOURCES\_FIRM_{jt} = \frac{HERFCIT\_FIRM_{jt}}{HERF\_FIRM_{jt}}$, this is an index of the relative variety of knowledge sources across firms and it is calculated (for each granting year t) in a

similar way as $HERFSOURCES\_TECH_{jt}$. Here the Herfindahl index at the numerator is calculated using the shares of backward citations from patents in class *j* to patents applied by firm z: $b_{jzt} = d_{jzt}/d_{jt}$, where d_{jz} is the total number of cited patents from OST5 class *j* applied by firm *z* (excluding self citations) and $d_{jt} = \sum_z d_{jzt}$. The Herfindahl index at the denominator measures the degree of concentration across firms in a given class *j* calculated with respect to the number of patents granted in a given year *t*.

7) $SELFSOURCES_{jt} = \frac{sc_{jt}}{c_{jt}}$ is an index of intensity of internal knowledge sources and it is defined for each OST5 class *j* and granting year *t* as the ratio between the total number of self-citations (i.e. backward citations to patents applied by the same firm z) over the total number of backward citations.

Our first model aim to analyze which factors affect the probability of observing a breakthrough invention in each OST5 sector by considering both industry-level technological regimes and invention specific characteristics. The set of variables involved in the analysis is the following:

Table 3 – Variables description

DEPENDENT VARIABLE	DESCRIPTION	TYPE
OST5	Invention-type classification according to OST5 (see table 4.1)	5 categories: j=1,2,3,4,5.
INDEPENDENT VARIABLES		
Sector-level characteristics	**j=category of the invention (OST5); t=year of award**	
PAT_GROWTH_{jt}	Patent growth rate	continuous
$SCHUMP_{jt}$	Schumpeterian pattern of innovative activities index	continuous
$HERFSOURCES\_TECH_{jt}$	Variety of knowledge sources across technological classes index	continuous
$HERFSOURCES\_FIRM_{jt}$	Variety of knowledge sources across firms index	continuous
$SELFSOURCES_{jt}$	Intensity of internal knowledge sources index	continuous
Invention-level characteristics		
MAPPL	= 1 for multiple applicant organizations, = 0 otherwise	dummy
NINV	Number of inventors	count
USA	= 1 if at least one applicant is a U.S. organization, = 0 otherwise	dummy
GOV	= 1 if at least one applicant is a governmental organization, = 0 otherwise	dummy
ACAD	= 1 if at least one applicant is an academic organization, = 0 otherwise	dummy
Other controls		
dum1986_1995	= 1 the invention has been awarded in the 1986-1995 decade, = 0 otherwise	dummy
dum1996_2005	= 1 the invention has been awarded in the 1996-2005 decade, = 0 otherwise	dummy

Our final reference period of analysis ranges from 1977 to 2005[13] with a total of 2802 inventions awarded. The following tables report the main descriptive statistics of the variables involved in the analysis and the distribution of the awarded inventions across sectors and over time.

[13] We dropped the first (1976) and last (2005) year of reference to avoid possible inconsistencies when calculation our time-varying industry indexes based on patent data.

Table 4 – Main descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
OST5	2802	2.514	1.322	1	5
PAT_GROWTH_{jt}	2802	0.049	0.126	-0.290	0.478
$SCHUMP_{jt}$	2802	0.414	0.050	0.291	0.658
$HERFSOURCES\_TECH_{jt}$	2802	0.521	0.103	0.273	0.910
$HERFSOURCES\_FIRM_{jt}$	2802	0.841	0.156	0.565	1.382
$SELFSOURCES_{jt}$	2802	0.142	0.048	0.085	0.448
MAPPL	2802	0.256	0.437	0	1
NINV	2802	1.665	0.902	1	5
USA	2802	0.877	0.329	0	1
GOV	2802	0.320	0.467	0	1
ACAD	2802	0.074	0.262	0	1
dum1986_1995	2802	0	0	0	1
dum1996_2005	2802	0.322	0.467	0	1

Table 5 – Distribution of the awarded inventions across sectors.

Year	Electrical Eng.		Instruments		Chem. & Pharma		Process Eng.		Mechanical Eng.		All sectors	
1977	20	(20.2%)	38	(38.38%)	14	(14.14%)	18	(18.18%)	9	(9.09%)	99	(100%)
1978	24	(24.24%)	37	(37.37%)	17	(17.17%)	14	(14.14%)	7	(7.07%)	99	(100%)
1979	33	(32.35%)	32	(31.37%)	18	(17.65%)	12	(11.76%)	7	(6.86%)	102	(100%)
1980	35	(32.11%)	32	(29.36%)	8	(7.34%)	30	(27.52%)	4	(3.67%)	109	(100%)
1981	24	(24.74%)	47	(48.45%)	7	(7.22%)	13	(13.4%)	6	(6.19%)	97	(100%)
1982	25	(25.25%)	40	(40.4%)	7	(7.07%)	17	(17.17%)	10	(10.1%)	99	(100%)
1983	20	(20.2%)	38	(38.38%)	6	(6.06%)	19	(19.19%)	16	(16.16%)	99	(100%)
1984	24	(24.24%)	44	(44.44%)	0	(0%)	21	(21.21%)	10	(10.1%)	99	(100%)
1985	36	(36.36%)	39	(39.39%)	1	(1.01%)	19	(19.19%)	4	(4.04%)	99	(100%)
1986	34	(34.34%)	37	(37.37%)	0	(0%)	23	(23.23%)	5	(5.05%)	99	(100%)
1987	25	(25%)	50	(50%)	0	(0%)	20	(20%)	5	(5%)	100	(100%)
1988	15	(15%)	60	(60%)	0	(0%)	25	(25%)	0	(0%)	100	(100%)
1989	22	(22.22%)	49	(49.49%)	0	(0%)	21	(21.21%)	7	(7.07%)	99	(100%)
1990	23	(23%)	46	(46%)	0	(0%)	25	(25%)	6	(6%)	100	(100%)
1991	22	(22%)	35	(35%)	5	(5%)	30	(30%)	8	(8%)	100	(100%)
1992	21	(21%)	32	(32%)	8	(8%)	24	(24%)	15	(15%)	100	(100%)
1993	29	(29%)	29	(29%)	8	(8%)	22	(22%)	12	(12%)	100	(100%)
1994	26	(26%)	35	(35%)	5	(5%)	22	(22%)	12	(12%)	100	(100%)
1995	18	(17.82%)	29	(28.71%)	6	(5.94%)	27	(26.73%)	21	(20.79%)	101	(100%)
1996	31	(30.69%)	29	(28.71%)	8	(7.92%)	28	(27.72%)	5	(4.95%)	101	(100%)
1997	27	(27%)	26	(26%)	12	(12%)	23	(23%)	12	(12%)	100	(100%)
1998	26	(26%)	33	(33%)	1	(1%)	30	(30%)	10	(10%)	100	(100%)
1999	28	(28%)	32	(32%)	1	(1%)	26	(26%)	13	(13%)	100	(100%)
2000	26	(26%)	29	(29%)	7	(7%)	33	(33%)	5	(5%)	100	(100%)
2001	26	(26%)	35	(35%)	4	(4%)	24	(24%)	11	(11%)	100	(100%)
2002	32	(32%)	26	(26%)	11	(11%)	23	(23%)	8	(8%)	100	(100%)
2003	31	(31%)	40	(40%)	6	(6%)	12	(12%)	11	(11%)	100	(100%)
2004	25	(25%)	28	(28%)	16	(16%)	21	(21%)	10	(10%)	100	(100%)
Total	728	(25.98%)	1,027	(36.65%)	176	(6.28%)	622	(22.2%)	249	(8.89%)	2,802	(100%)

Generalizing the approach followed by Moser (2005) we assume that both individual (i.e. invention-level) and environmental (i.e. sector-level) characteristics affect the probability of observing a breakthrough invention. Even though in our setting this probability does not reflect directly an individual specific choice (amongst a fixed set of alternatives) which maximizes a latent random utility function (McFadden 1974), we can assume that the observed distribution of prizes across sectors (as resulting by the yearly decision of the R&DMag awarding board) would mimic quite closely how "nature" chooses in which sectors a breakthrough invention is more likely to occur.

We therefore rely on the estimation of a conditional logit model with both alternative-varying and individual-varying regressors. In this setting the probability of observing a breakthrough invention *i* in a given macro-sector *j* is defined as:

$$p_{ij} = \frac{\exp\,(\mathbf{x}'_{ij}\beta + \mathbf{z}'_{i}\gamma_{l})}{\sum_{l=1}^{m} \exp\,(\mathbf{x}'_{il}\beta + \mathbf{z}'_{i}\gamma_{l})} \qquad j = 1, \ldots, m$$

Where $\mathbf{x}_{ij}$ are a set of alternative-specific regressors and $\mathbf{z}_{i}$ are a set of case-specific regressors. Table 6 report the estimated coefficients of the model.

Table 6 – Multinomial logit regressions

VARIABLES	(1) All sectors	(2) Instruments	(3) Chemistry Pharma	(4) Process Eng.	(5) Mechanical Eng.
MAPPL		-0.237*	-0.349	0.0453	0.605***
		(0.130)	(0.242)	(0.138)	(0.174)
NINV		0.0682	0.185**	0.132**	0.0366
		(0.0583)	(0.0910)	(0.0627)	(0.0829)
USA		0.380***	0.918***	0.848***	0.254
		(0.145)	(0.294)	(0.186)	(0.215)
GOV		-0.124	-0.567***	-0.0606	-0.388**
		(0.113)	(0.212)	(0.124)	(0.172)
ACAD		0.486**	0.319	-0.455*	-0.846**
		(0.201)	(0.333)	(0.247)	(0.355)
dum1986_1995		-0.0995	-0.595**	0.196	-0.114
		(0.152)	(0.246)	(0.164)	(0.226)
dum1996_2005		-0.416***	0.340	-0.0359	-0.348
		(0.146)	(0.311)	(0.181)	(0.260)
PAT_GROWTH	0.603				
	(0.509)				
SCHUMP	-0.481***				
	(0.178)				
HERFSOURCES_TECH	-0.676				
	(1.084)				
HERFSOURCES_FIRM	-1.106***				
	(0.325)				
SELFSOURCES	7.326***				
	(2.311)				
Constant		-0.508**	-3.060***	-2.146***	-1.919***
		(0.234)	(0.481)	(0.435)	(0.433)
Observations	14010	14010	14010	14010	14010

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

The marginal effects for individual-specific regressors are computed according to the following formula:

$$\frac{\partial p_{ij}}{\partial \mathbf{z}_{\mathrm{i}}} = p_{ij}\left(\gamma_j - \overline{\gamma}_\iota\right)$$

where $\overline{\gamma_{\mathrm{i}}} = \sum_{\mathrm{l}} \mathrm{p}_{\mathrm{ij}}\, \gamma_{\mathrm{l}}$ for $l = 1, \ldots, m$ is a probability weighted average of the estimated coefficients, whereas the marginal effect for a given alternative-specific regressor x_{rik} (i.e. the value of the regressor x_r for individual *i* and alternative *k*) is computed as:

$$\frac{\partial p_{ij}}{\partial x_{rik}} = \begin{Bmatrix} p_{ij}(1 - p_{ij})\beta_r & \text{for} \;\; j = k \\ -p_{ij}p_{ik}\beta_r & \text{for} \;\; j \neq k \end{Bmatrix}$$

Thus the own-marginal effect (for *j*=*k*) has the same sign of the estimated coefficient, whereas the cross-marginal effect (for *j*≠*k*) has the opposite sign.

In the following table 7 only individual-specific and own alternative-specific marginal effects are reported, for each alternative they are computed at the average value of each regressor. Having a multiple applicant (MAPPL) decreases the probability of observing a breakthrough invention in the sector of Instruments (-0.073) whereas it increases the probability of observing a breakthrough invention in the sector of Mechanical Engineering (+0.087). Breakthrough inventions with at least one U.S applicant organization are more likely to occur in the Chemistry & Pharma and Process Engineering sectors, whereas are less likely to occur in the Electrical Engineering sector. Breakthrough inventions with at least one governmental applicant are less likely to occur in the Chemistry & Pharma and Mechanical Engineering sectors, whereas are more likely to occur in the Electrical Engineering sector. Finally a breakthrough invention with at least one academic applicant are less likely to occur in the Process Engineering and Mechanical Engineering sectors, whereas is more likely to occur in the Instruments sector. Focusing on alternative-specific regressors we can see that the variable SCHUMP has a negative marginal effect. This evidence would mean that breakthrough inventions are more likely to occur in an entrepreneurial environment (Mark I type regime) than in a Mark II type regime. Concerning the variety of knowledge source across firms indicator (HERFSOURCES_FIRM) we find that the more the amount of relevant knowledge in a sector is concentrated across firms, the less the probability of observing a breakthrough invention in that sector. At the same time, however, the degree of knowledge "cumulativeness" in a given sector as captured by the relative degree at which each firm exploit its internal source of knowledge (SELFSOURCES) increases with the probability of observing a breakthrough invention.

Table 7 – Marginal Effects.

VARIABLES	(1) Electrical Eng.	(2) Instruments	(3) Chemistry Pharma	(4) Process Eng.	(5) Mechanical Eng.
Pr(OST5=j | 1 selected)	0.264	0.372	0.056	0.221	0.087
MAPPL	0.008	-0.073***	-0.017	0.017	0.065***
	(0.021)	(0.023)	(0.010)	(0.020)	(0.016)
NINV	-0.018*	0.001	0.007	0.014	-0.003
	(0.010)	(0.011)	(0.004)	(0.009)	(0.006)
USA	-0.110***	0.006	0.025**	0.089***	-0.010
	(0.029)	(0.029)	(0.010)	(0.022)	(0.017)
GOV	0.033*	-0.001	-0.023**	0.014	-0.022*
	(0.020)	(0.022)	(0.009)	(0.018)	(0.011)
ACAD	-0.026	0.167***	0.013	-0.098***	-0.057***
	(0.034)	(0.039)	(0.019)	(0.024)	(0.012)
dum1986_1995	0.009	-0.025	-0.029***	0.052**	-0.007
	(0.026)	(0.027)	(0.010)	(0.022)	(0.017)
dum1996_2005	0.045	-0.089***	0.031*	0.029	-0.015
	(0.028)	(0.027)	(0.018)	(0.026)	(0.017)
PAT_GROWTH	0.117	0.141	0.032	0.104	0.048
	(0.099)	(0.119)	(0.027)	(0.088)	(0.041)
SCHUMP	-0.093***	-0.112***	-0.025***	-0.083***	-0.038***
	(0.035)	(0.042)	(0.010)	(0.031)	(0.014)
HERFSOURCES_TECH	-0.131	-0.158	-0.036	-0.116	-0.054
	(0.210)	(0.253)	(0.057)	(0.533)	(0.086)
HERFSOURCES_FIRM	-0.215***	-0.258***	-0.059***	-0.190***	-0.088***
	(0.063)	(0.076)	(0.001)	(0.056)	(0.026)
SELFSOURCES	1.423***	1.712***	0.388***	1.261***	0.582***
	(0.449)	(0.541)	(0.125)	(0.399)	(0.187)
Observations	14010	14010	14010	14010	14010

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

4.2 The determinants of patent propensity

In order to study in detail the propensity to patent we run a probit regression model by taking as dependent variable a dummy (PAT) which equals 1 if the invention was patented and 0 otherwise, the estimates are reported in Table 8. We ran two separated regressions: one controlling for differences across sectors by including a dummy variable for each of the 30 original OST sectors considered (columns 1 and 2, estimates of the sector dummies are not reported) and the second (columns 3 and 4) controlling for differences across sectors by including our previous time-varying sector-level regressors calculated by using a finest OST30 classification level.

Table 8 – Estimation results of the propensity to patent probit model

VARIABLES	(1) Coefficients	(2) Marginal effects	(3) Coefficients	(4) Marginal effects
MAPPL	-0.0891	-0.0122	-0.0719	-0.0103
	(0.0959)	(0.0127)	(0.0929)	(0.0129)
Ninv	0.128***	0.0181***	0.122***	0.0179***
	(0.0384)	(0.00539)	(0.0377)	(0.00548)
USA	-0.266***	-0.0434**	-0.260***	-0.0438**
	(0.101)	(0.0188)	(0.100)	(0.0193)
GOV	-0.715***	-0.0860***	-0.718***	-0.0897***
	(0.0973)	(0.00936)	(0.0946)	(0.00971)
ACAD	-0.185	-0.0233	-0.204	-0.0265
	(0.163)	(0.0184)	(0.160)	(0.0181)
dum1986_1995	-0.123	-0.0170	0.0183	0.00270
	(0.0823)	(0.0112)	(0.105)	(0.0155)
dum1996_2005	-0.134	-0.0184	0.0923	0.0139
	(0.0973)	(0.0129)	(0.126)	(0.0193)
pat_growth			0.257	0.0378
			(0.216)	(0.0317)
SCHUMP			-0.0222	-0.00326
			(0.0360)	(0.00528)
HERFSOURCEStechi			0.000207	0.0001
			(0.251)	(0.0368)
HERFSOURCESfirm			-0.00221	-0.000325
			(0.147)	(0.0216)
SELFSOURCESi			3.048***	0.448***
			(0.827)	(0.120)
Sectors Dummy	Yes		No	
Constant	-0.864***		-1.588***	
	(0.164)		(0.262)	
Observations	2794	2794	2802	2802
Log likelihood	-804.9124		-820.80015	
AIC	1665.825		1667.6	
BIC	1832.011		1744.795	

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

In general terms we find that the probability of patenting a given invention is lower if the organization in question is a government organization (as one would expect). It is also lower if the invention is produced by a non-US organization. Vice versa, the probability is higher when the inventions has a higher number of inventors.

Amongst the set of sector-level regressors only SELFSOURCESi is positive and statistically significant. However the contribution of this indicator seems to explain most of the variation of the propensity to patent across sectors when compared with the dummy variable models. In fact the two models seems to perform equally in term of the Akaike Information Index (AIC), whereas the second one is more parsimonious with a better performance in term of the Bayesian Information Index (BIC). Interestingly enough, the variable SCHUMP is not significant, which seems to indicate that there are no major differences in the propensity to patent between Schumpeter mark I and Schumpeter mark II regimes.

5. Conclusions

In this paper we have carried out a preliminary exploration of a source that we believe may have interesting applications in the innovation studies literature: the "R&D 100" awards. The source seems to have a good potential for constructing a number of indicators of technological performance that can usefully complement the use of patents.

To sum up, the main advantages of the source are:

1. It seems to contains inventions that at least in principle ought to represent sizable improvement of the state-of-the-art (ie, it seems less likely that frivolous type of invention will be included in the list)
2. The source is available continuously over the period 1963-2005. This is an advantage in comparison to other ad-hoc inventions data-set
3. The source captures the inventive activity of what seems to be a well defined segment of the economy (high tech sectors)

Our preliminary explorative analysis of the R&D100 has highlighted these trends:

1. the emergence of a challenge to US technological leadership from other rival nations such as Japan and Germany (although in the last 2-3 years the US seems to have recovered an edge)
2. a change in the organizational set-up where innovative activities take place, from individual corporations to public research organizations and universities.
3. an increasing importance of collaborative inventive activities
4. a critical role of scientific instrumentation as a supplier of technological breakthroughs.
5. a large share of inventions that are not protected by means of patents, casting serious doubts on the critical role of patents for generating technological breakthroughs.

We have also carried out two econometric exercises aimed at unravelling the connections between Schumpeterian patterns of innovation and the generation of innovative breakthroughs (as capturer by the R&D awards).

These are our main results:

1. Technological breakthroughs seems more likely to emergence in “turbulent”, Schumpeter mark I types of context, rather than in more stable Schumpeter mark II environments.
2. There appears to be no significant differences between Schumpeter mark I and Schumpeter mark II regimes in terms of propensities to patent breakthrough innovations.

Appendix 1: 2009 R&D 100 Awards entry form[14]

Instructions:

--Read "How To Win An R&D 100 Award". This is vital information, and is available at http://www.rdmag.com/RD100Win.html

--All 2009 Entries *must* be filed electronically. This file should be used to complete your 2009 R&D 100 Award entry. When you complete the entry, it must be uploaded at www.rdmag.com.

--The electronic entry submission form will be posted at www.rdmag.com by January 2009. PLEASE NOTE: Completed entries must be uploaded as a single file: a PDF, Word document, or zip file are all acceptable.

--Entries with incomplete information will not be accepted.

7. **Submitting Organization**

Organization
Name
Address
City
State
Zip/Postal Code
Country
Submitter's Name
Phone
Fax
Email

AFFIRMATION: I affirm that all information submitted as a part of, or supplemental to, this entry is a fair and accurate representation of this product. Submitter's signature

2. Joint entry with (company names)…
(if necessary, list additional companies on a separate sheet and check here:)
Organization Name
Address
City
State
Zip/Postal
Country
Contact Name
Phone
Fax
Email

7. **Product name**

7. **Briefly describe (25 words or less) what the entry is (e.g. balance, camera, nuclear assay, etc.)**

[14] The entry form has been retrieved from http://www.rdmag.com, accessed on January 29, 2009

When was this product first marketed or available for order? (Must have been first available in 2008.)

6. Inventor or Principal Developer (List all developers from all companies)
Developer Name
Position
Organization
Address
City
State
Zip/Postal
Country
Phone
Fax
Email

7. Product price

8. Do you hold any patents or patents pending on this product (yes or no)?

9. Describe your product's primary function as clearly as possible. What does it do? How does it do it? What theories, if any, are involved?

10.
A. List your product's competitors by manufacturer, brand name and model number.
B. Supply a matrix or table showing how the key features of your product compare to existing products or technologies. Include both numerical and descriptive comparisons.
C. Describe how your product improves upon competitive products or technologies.

11.
A. Describe the principal applications of this product.
B. List all other applications for which your product can now be used.

12. Summary. State in layman's terms why you feel your product should receive an R&D 100 Award. Why is it important to have this product? What benefits will it provide?

ORGANIZATION DATA
13. Contact person to handle all arrangements on exhibits, banquet, and publicity.
Name
Position
Organization
Address
City
State
Zip/Postal
Country

Phone
Fax
Email

ENTRY PROCEDURE

1. Any new technical product that was first available for purchase or licensing between Jan. 1, 2008, and Dec. 31, 2008, may be entered. Proof-of-concept models should not be entered until they reach a more advanced age. PHYSICAL EXISTENCE OF THE PRODUCT MUST BE SHOWN IN PHOTOGRAPHS.
2. Answer all questions as provided in this form.
3. Supporting information, such as scientific papers, patents, or articles may included in the upload.
4. The entry fee is $250. Payment can be made as part of the entry submission process at www.rdmag.com.
5. Winning products will be selected on the basis of their importance, uniqueness, and usefulness by a panel of technical experts.
6. All winners will be notified of the judges' decision by June 30, 2009. A complete report will be published in the September 2009 print and electronic issues of R&D Magazine.
7. For more information, please call 973-920-7063, fax: 973-920-7542

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