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## Independent invention in Italy during the liberal age, 1861-1913

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## WORKING PAPER SERIES

### **Independent Invention in Italy during the Liberal Age, 1861-1913**

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# INDEPENDENT INVENTION IN ITALY DURING THE LIBERAL AGE, 1861-1913

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**ABSTRACT:** In this paper we examine the phenomenon of independent invention in Italy during the liberal age (1861-1913). We make use of a new dataset comprising all patents granted in Italy in five benchmark years: 1864-65, 1881, 1891, 1902 and 1911. We carry out the following exercises. First we examine the relative shares of independent, corporate and foreign inventions and their evolution over time and across industries. Second, by exploiting the peculiarities of Italian patent legislation which established a maximum patent length of fifteen years and a flexible renewal scheme which allowed inventors to maintain a patent “alive” for almost any specific duration, we assess the relative quality of independent and corporate patents. Our results indicate that in Italy independent inventors provided an important contribution to technological change but the quality of their patents was significantly lower than that of firms and of foreign patentees.

JEL codes: N73, O31

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## 1. Introduction

Following an original cue of Schumpeter (1942), it has been frequently suggested that during the Second Industrial Revolution there was a significant shift in the location of invention from individuals to the research laboratories of large firms.<sup>1</sup> This shift was determined by the complexities and the high research costs involved by the newly emerging technological systems of the Second Industrial Revolution such as chemicals, electricity and steel (Freeman and Louçã 2001). The search for innovations in these fields required the access to bodies of new scientific knowledge, the integration of different technological skills, the utilization of expensive pieces of equipment and long development times. All this, clearly amounted to a major increase in the scale and scope of the resources underpinning inventive activities and determined a major organizational transformation with large firms and corporations establishing dedicated in-house research laboratories employing specialized teams of scientists and engineers (Von Tunzelmann 1995: 161-165; Freeman and Soete 1997: 80-84; Mowery and Rosenberg 1998).

Lamoreaux and Sokoloff (2012) have shown that the empirical evidence of the US patent records provides support to this “Schumpeterian” account.. The patent data studied by Lamoreaux and Sokoloff (2012) shows that, over the period 1870-1911, a growing share of patents were assigned at issue to large-firms and other companies. In their view, this piece of evidence indicates that inventors were increasingly carrying out inventive activities either as firms’ employees or by being involved in relationships of long-term collaboration with firms. In a related paper, Lamoreaux, Sokoloff and Sutthiphisal (2009) provide a more “nuanced” picture by noting the co-existence of two alternative patterns of organization of invention. One structured around the R&D laboratories of large firms was typical of the Middle Atlantic region and is fully consistent with the narrative outlined above. However, alongside this model it is possible to identify a second patterns of innovative activities characterized by smaller entrepreneurial dynamic firms mostly located in New England.

This “Schumpeterian” tale of the rise of organized research resulted undoubtedly appealing since it was broadly consistent with narratives of business historians and historians of technology describing the rise of the corporate economy in countries such as the USA,

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<sup>1</sup> Schumpeter’s thesis on the demise of individual inventors was actually anticipated in Schumpeter (1928: 370, italics in the text): “[I]n ‘trustified’ capitalism...[i]nnovation...is not any more embodied typically in new firms, but goes on, within the big units now existing, largely independently of individual persons”.

Germany and Britain (Chandler 1990; Hounshell 1996). However, it did not command a universal consensus. The most famous dissenting voice is probably the classic study by Jewkes, Sawers and Stillerman (1958). On the basis of detailed case studies evidence, they claimed that the most important breakthrough innovations of the twentieth century, were actually the outcome of the efforts of individual inventors. In their view, the bureaucratization of corporate laboratories produces a conformist approach to research which ultimately prevents the discovery of genuine radical innovations.<sup>2</sup> As a result, there was no major shift in the “sources of invention” from the nineteenth to the twentieth century and independent inventors have continued to provide the most important contribution to technological progress.

Assessing the historical plausibility of the account by Jewkes, Sawers and Stillerman (1958) is by no means straightforward. Their work is based on detailed historical descriptions of a selection of nineteenth and twentieth century macro-inventions in different countries. Accordingly, it is hard to ascertain whether their sample of inventions may indeed be regarded as truly representative of historical trends in innovation both worldwide and in specific countries.

In two recent papers, Tom Nicholas (2010; 2011a) has attempted to shed new light on this issue by providing a systematic assessment of contribution of independent inventors to technological progress using evidence from the patent records.<sup>3</sup> Nicholas shows that in the US, Britain and Japan independent inventors continued to account for a very significant volume of inventive activities and, more importantly, for the generation of several high-quality innovations until the late 1930s, playing a vital role for the advancement of the technological frontier. In all these countries, despite the differences in patent legislation, independent inventors could make use of relatively functioning “market for technologies” for reaping economic returns from their inventions, and they could specialize in inventive activities without becoming directly involved in commercialization and production.<sup>4</sup>

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<sup>2</sup> For an insightful discussion of the role played by individual inventors in the generation of major technological breakthrough, see O’Brien (1997).

<sup>3</sup> Other papers have recently examined the role played by independent inventors using patents: Saiz (2012) for the Spanish context in the period 1820-1939 and Basberg (2012) for Norway in the second half of the nineteenth century.

<sup>4</sup> For a thorough appraisal of the functioning of “markets for technologies”, see Arora, Fosfuri and Gambardella (2001). For historical evidence on the consolidation of “markets of technologies” in the United States in the period we are considering here, see Lamoreaux and Sokoloff (2002).

In this paper we expand on this line of research by looking at the role played by independent inventors in Italy during the liberal age (1861-1913). We make use of new dataset of all Italian patents granted in five benchmark years. These data allow us to examine closely the inventive output of individual inventors and firms both domestic and foreign.

The Italian case seems particularly promising for further tackling this research question for at least two reasons. First, although Italy, in the period in question, was a “latecomer industrializer”, it was able to generate endogenously a number of significant breakthrough inventions (radio, electric dynamo, nitroglycerin). This is probably explained by a long term cultural heritage that allowed the country to remain connected with the shifts of the world technological frontier despite its relative economic backwardness (Giannetti 1998). Second, the Italian case is also interesting in terms of the characteristics of its patent system. In particular, in terms of the costs of patenting, Italy was an intermediate case between the “very expensive” British and German and the “very cheap” Japanese and American patent systems. Since the cost of patents is probably an important factor shaping the incentives of independent invention, the Italian evidence seems to have the potential to shed some further light on this issue.

We proceed as follows. In section 2 we provide a sketch of the Italian patent system in comparative perspective. Section 3 contains a description of the historical sources used and of the methods adopted for the construction of the dataset. In section 4 we present a statistical overview of the data examining the relative shares of independent, corporate, domestic and foreign inventions and their evolution over time, across industries and different locations. Using renewal data as a proxy for the value of patents, section 5 provides a systematic comparison of the relative quality of independent and corporate patents. Section 6 concludes.

Overall, we find that the quality of the patents taken by independent inventors in Italy was lower than that of corporate patents. Our interpretation of this result is that the phenomenon of independent invention in Italy was rather different from the cases of UK and US studied by Nicholas. In these countries, independent inventors were relatively skilled individuals able to generate high quality inventions, perhaps also with a view at their commercialization using market for technologies. On the contrary, in the Italian case, independent inventors could provide an important contribution to technological change but, it is important to acknowledge

that the quality of their patents was significantly lower than that of firms and of foreign patentees.

## **2. The Italian patent system in comparative perspective**

After the political unification, the patent system of the Kingdom of Piedmont was extended to the entire country (Law n. 1657, 31<sup>st</sup> January 1864). The original version of this law (inspired by the French and Belgian examples of 1844 and 1854) was introduced in Piedmont in 1855. The Italian patent system was a registration system and, accordingly, there was no examination of the actual novelty of the invention patented. In practice, this meant that controversies on the novelty of patents were to be settled by means of court cases. In the Italian system, patents could be registered either in the name of individual inventors or in the name of firms.<sup>5</sup> This peculiarity of the Italian patent Law allow us to have an immediate direct assessment of whether a patent is to be ascribed to an independent inventor or to a firm.

One of the main features of a patent system is the cost of taking and maintaining a patent alive. These costs affect the choice of an inventor on whether and how long protecting his/her invention. If a patent system is very expensive, fewer inventors will resort to patent protection and, at the same time, it is likely that patent protection will be used mostly by firms or independent inventors with sufficient financial resources. Furthermore, in an expensive system, it is unlikely that inventions that are expected to generate limited economic returns will be patented (this because the profits of the invention may not cover the full costs of patent protection).

In Italy the system was extremely flexible: an inventor could take a patent for a duration from 1 to 15 years according to his own choice. There was an initial fee that was proportional to the number of years for which the patent was requested (10 lire for one year, 20 lire for two years... 150 lire for 15 years). In addition, it was necessary to pay an annual renewal fee for keeping the patent alive. This fee was increasing over time: 40 lire for the first three years, 65 lire from the fourth to the sixth year, 90 lire for the seventh up to the ninth year, 115 lire for the tenth to the twelfth year and 140 lire for the last three years. The *Gazzetta Ufficiale del Regno d'Italia* regularly published the entire list of patents expired due to non-payment of the renewal fees. Furthermore, the Law gave also the possibility of “extending” the duration of a

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<sup>5</sup> The article 27 of Regolamento of the 1864 Law stated explicitly that the application for a patent could be submitted both by individuals and by corporations or other organizations.

patent initially taken for a shorter period. For doing this, the inventor had to apply for an *attestato di prolungamento*. This cost 40 lire plus all the other fees required for a normal patent of the same duration. Hence, since *prolungamento* involved an extra cost of lire 40, when the inventor was sure about the prospects of his invention, it was more convenient to take immediately the patent for the desired duration. However, when the prospects of the invention were uncertain, the possibility of taking *prolungamento* gave to the system a further degree of flexibility. Finally, it was also possible to extend the scope of a patent, for example by adding improvements and other features to an original patent application. This was done by applying for an *attestato complessivo* that cost a fixed fee of lire 20.

Unfortunately, it is difficult to compare precisely the costs of patenting in different countries. This because of subtle differences in the structure of patent fees and in the actual enforcement of patent protection in different legislations. To these difficulties, we should add the need of converting patent fees in a common currency, taking properly into account variations in the price level and properly discounting the patent fees that must be paid at different moments. So far, there are two seminal contributions that have provided estimates of the costs of maintaining a patent alive for its full legal duration in different systems: Lerner (2000) and Khan and Sokoloff (2006). These estimates are presented in table 1. Khan and Sokoloff formulate their cost assessment using a discrete scale (1-4) based on the conversion of fees in current US\$, whereas Lerner attempts to provide precise estimates in 1998 US\$. Overall the estimates are in broad agreement. According to table 1, the most expensive systems of the time were the British and the German. On the other side, in comparative perspective, the American system was cheap and affordable. Interestingly enough, the Italian system has an intermediate position between these two models.

[Table 1 about here]

In figure 1 we compare the structure of renewal fees in Italy, UK and Germany. The renewal fee structure for Britain is discussed in Nicholas (2011b) and that of Germany in Streb, Baten and Yin (2006). The yearly fees have all been converted in US\$ using contemporary exchange rates and they refer to a patent taken in 1883 with a duration of 15 years.<sup>6</sup> Overall, the figure shows that (except for the initial year) the costs for keeping a patent alive is systematically lower in Italy than in Germany and UK. The last histogram on the right reports the total amount of the fees paid throughout the patent life (without discounting). Again, Italy

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<sup>6</sup> We are grateful to Giovanni Federico for providing the exchange rates series.



appears to offer considerably cheaper fees in comparative perspective. Sokoloff and Khan (1990) and Khan (2005) have argued that the US system by being relatively cheap and accessible provided a large share of the population with the opportunity of exploiting their inventive activities by means of patent protection (“democratization of invention”). Figure 1 prompts the consideration that also the Italian system is probably to be regarded as relatively affordable to individuals (even to those with limited financial resources). For example, according to Bosio (1891) an authoritative legal scholar of the time, the idea of making the system accessible also to inventors with financial constraints, was an explicit rationale accounting for the peculiar renewal fee structure of the Italian system.

[Figure 1 about here]

After having presented the Italian patent legislation focusing in particular on the renewal fee structure, it is worth examining trends in patenting behavior across countries. Figure 2 shows the number of patents per million inhabitants in different systems during the period considered. The critical effect of legislations (and in particular of patent fees) on patenting behavior is illustrated by the sharp discontinuity of the British series in 1883 (when the cost of patenting was drastically reduced). Even if Italy at the time was a latecomer country, its volume of patent activity is not distant from that of a leading country of the Second Industrial Revolution such as Germany. Of course, in drawing this comparison, it is important to keep in mind the significant lower costs of the Italian system presented in figure 1.

[Figure 2 about here]

The trends presented in figure 2 should not be regarded as a proxy for the innovation performances of different countries. Technology gaps across countries are instead better captured by the time series presented in figure 3 which shows the number of patents granted in the US to foreign residents normalized by population. This indeed is a proxy for national technological performance which is frequently used in the economics of innovation literature (see for instance, Freeman and Soete 1997). In figure 3, Germany and UK are clearly the two leading countries, Italy is at a significantly lower level, although there is some “catching up” during the period, whereas Japan is consistently at the bottom.

[Figure 3 about here]

Table 2 shows the share of foreign patents in different countries. This may be regarded as a proxy for the “openness” of national patent systems. The table shows that the system with the lowest share of foreign patents is the American. On the other hand, the Italian system is definitively the most open from the very outset. This is remarkable because, as noted by Bilir, Moser and Talis (2011), before the Paris Convention of 1883, in most countries patenting abroad was severely constrained by procedural difficulties and discriminatory clauses. Overall, the large share of foreign patents in Italy is probably to be ascribed to the combined effect of the low costs of patenting, the technological backwardness of the country and its size in terms of population, which made Italy an appealing market.

[Table 2 about here]

### 3. Sources and Data

We have built a new dataset comprising all the 10,123 patents granted in Italy in five benchmark years: 1864-65 (519 patents), 1881 (941 patents), 1891 (1,618 patents), 1902 (2,987 patents) and 1911 (4,058 patents).<sup>7</sup> The choice of these benchmarks has been dictated by our concern of ensuring an even coverage of the entire liberal age period. Furthermore, we have also added to our data a 20% random sample for patents granted in 1922 (288 patents), which allows us to provide a glimpse of the post-WWI situation. The historical sources of these data are the Italian official serial publications of Ministero di Agricoltura, Industria e Commercio (MAIC 1864-1885, 1886-1893, 1894-1901, 1902-1916, 1917-1923). For each patent we have collected the following information:

1. The date in which the patent was applied (data di deposito);
2. The date in which the patent was granted (data di rilascio);
3. The official patent number;
4. The name(s) of the patentee(s): this may be an individual inventor or a firm;<sup>8</sup>
5. The residence(s) of the patentee(s);
6. The initial duration of the patent;

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<sup>7</sup> Given the small number of patents registered in the early years after the unification, we have decided to have an initial benchmark of two years, 1864 and 1865.

<sup>8</sup> By following patents over their lifespans, we have identified 106 patents that were initially granted to independent inventors and some years later, when prolonged, were attributed to firms. In this case, we have decided to classify these patents as corporate. Interesting enough, 12 of these patents were granted to Thomas A. Edison and prolonged few years later in the name of Compagnie Continentale Edison societ  anonyme.

7. The number and duration of the extensions (prolungamento) of the patent;<sup>9</sup>
8. A short description of the invention;
9. The technological category in which the patent was classified by the office;
10. Other information about the life of the patent (changes in the number and residence of patentees following a prolungamento or completo, changes in the patent specification);
11. For benchmark years 1881, 1891 and 1902 we also have information about the date in which the patent expired because the patentee did not pay the renewal fees. This allows us to determine the “real” duration of the patent.<sup>10</sup> The information about the expiration of patents due to missing payment of renewal fees was collected by examining the complete series of the *Gazzetta Ufficiale del Regno d'Italia* for fifteen years after each benchmark year.

In addition, we have reclassified all patents from the original administrative technological classes to a new classification mainly inspired to the ISIC (International Standard Industrial Classification) categories.

#### **4. Independent invention in Italy**

In figure 4 we compare the evolution of independent invention in Italy with that of other major industrializing countries (US, Britain and Japan) using the data compiled by Nicholas (2011a).<sup>11</sup> We have also added data from Spain taken from Saiz (2012). Figure 4 shows that the share of independent invention on total patents over the period 1864-1922 is characterized by a decreasing and concomitant trend in all countries. The observation for 1922 for Italy shows an apparently anomalous “resurgence” for the share of independent inventors’ patents which is in contrast with the overall trend. On close inspection, this is an effect of the fall of the share of German and Austrian patents in Italy during and following WW I. Most of these foreign patents were indeed registered in the name of companies. Interestingly enough, also the levels of the shares appear to be remarkably similar for US, Britain, Spain and Italy,

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<sup>9</sup> For each cohort, we have thoroughly checked the possible existence of extensions (prolungamento) in the official publications of the following fifteen years.

<sup>10</sup> It was not possible to retrieve such information for 1864-65 cohort because the *Gazzetta Ufficiale del Regno d'Italia* provided the full list of expiring patents only starting from the last trimester of 1867. At the same time, it was not possible to have information for 1911 cohort because from 1915 the *Gazzetta* did not publish anymore the list of expired patents.

<sup>11</sup> We would like to thank Tom Nicholas for providing us with the detailed data on independent inventions in US, UK and Japan used in figure 4.

exhibiting a decline from a share of about 90-95% around 1880 to a share of about 85% in 1900 and, finally declining to about 70-75% during the 1910s. Japan is also characterized by a decreasing trend, but the major decline in the share of independent occurs at a later period: from 1900 to 1920.

Overall, figure 4 suggests that a significant shift towards the growth of corporate patent is actually taking place across all countries. On reflection, this is remarkable since we are considering countries characterized by different patent laws and at different stages of development (two first comers, UK and US; and three latecomers, Italy, Japan and Spain). However, it is worth noting that in the 1910s in all countries considered, the share of independent inventors is still almost three quarters of the total. These trends are fully consistent with the “Schumpeterian” tale of the rise of corporate invention previously discussed in the introduction.

[Figure 4 about here]

Before proceeding further, a word of caution is in order: we should take into account that, as noted by Schmookler (1966: 25-7) determining whether a patent is to be ascribed to a firm or an individual is not straightforward. It is possible that some of the patents assigned to corporations are actually covering inventions due to the efforts of individuals (when, for example, companies have entered in agreements with individuals before the granting of the patent). In the historical context we are considering, this is not very likely with the exception of the US. On the other hand, it is also possible that patents formally granted to individuals are actually covering the formalized inventive activities taking place inside companies. This is probably a more serious source of error for the period we are considering. For this reason, as argued already by Nicholas (2011a), the data presented in figure 4 are to be regarded more as approximations rather than exact figures.

Table 3 contains descriptive statistics of the new patent dataset we have constructed. The first panel of the table contains the share of independent inventors and the number of patents. It is interesting to note that while the share of independent inventors’ patents is decreasing, their actual number is increasing (from 498 in 1864-65 to 3,079 in 1911). The first panel shows the relative share of foreign vis a vis domestic patents. Consistently with what we have already noticed on the degree of openness of the Italian system, we find that in all benchmark years the majority of patents were granted to foreign inventors, reaching a share of 70% in 1891.

[Table 3 about here]

The second panel of table 3 shows that about half of the patents granted to Italian residents were taken by inventors located in the provinces of the “Industrial Triangle” (Genova, Milano and Torino). In particular, for the patents assigned to firms, the share of residents in the “Industrial Triangle” is roughly two-thirds of the total.

The third panel of table 3 examines the average ‘planned’ length of patents, which takes also into account the extensions (prolungamento) granted to each single patent. There are two rather clear patterns: i) the average length of patents granted to firms is systematically higher than that of individuals; ii) the average length of foreign patents is considerably higher than the Italian ones. The last panel of table 3 considers the behavior of patentees with respect to the extension of the patent using attestato di prolungamento. The shares of patent extended ranges between one-tenth in 1864-65 and one-fourth in 1911. The two categories of patentees that make most intensive use of extensions are firms and, at a somewhat lower level, foreign inventors.

In order to study the sectoral distribution of patents we have classified all patents according to 14 industry classes. We have also tried to single out a sub-set of patents directly related to the main “macro-inventions” of this period comprising both the technological systems of the First Industrial Revolution (such as steam power and machine tools) and the emerging new technologies of the Second Industrial Revolution (chemicals, steel and electricity). These categories are indicated in table 4 with an \*. We consider this particular set of patents as covering inventions with a significant degree of technological “sophistication” and, accordingly, we label this category as “high tech” patents. We have decided to consider as “high tech” patents also those related with the technologies of the First Industrial Revolution to take into account the status of Italy as a latecomer country.<sup>12</sup> Overall, the share of these “high tech patents” is about 40% and is rather stable throughout the period. It is worth noting that independent inventors seems to be rather active in these technological fields.

[Table 4 about here]

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<sup>12</sup> Fenoaltea (2011: 233-235) considers the industrial expansion of the liberal age in Italy as based on a peculiar combination of the technological trajectories of the First and of the Second Industrial Revolution. Vasta (2006) and Giannetti and Vasta (2010) point that even the top 200 Italian joint stock companies by assets were mostly active in the sectors of the First Industrial Revolution up to the 1920s.

## 5. The determinants of patent length

In the previous section, we have shown that the contribution of independent inventors to patenting remained considerable throughout the period. Moreover, Nicholas (2010, 2011a) has argued that in the US and Britain independent inventors were also responsible for “high-quality” innovations providing significant contributions to the advance of the technological frontier. What about Italy?

In his contributions, Nicholas adopts the number of citations in US patents as the main indicator of the “quality” of the patent. In the economics of innovation literature, both citations and renewal data have been extensively used as proxies for the quality of patents (Schankerman and Pakes 1986; Griliches 1990; Trajtenberg 1990; Moser, Ohmstedt and Rhode 2013). Each proxies has both advantages and disadvantages. In our case, it is unlikely that an Italian patent would be cited in US patent applications because very few US inventors or patent examiners were probably able to read patent specifications written in Italian. For this reason we cannot use US patent citations to Italian patents. On the other hand, the Italian Law did not prescribe the use of citations for describing prior art. Therefore, in this period, Italian patent citations simply did not exist. Hence, the only approach available in the Italian case is to use, as proxy measure of patent value, the renewal behavior of the patentee. The use of renewal behavior to estimate the quality of patents has been adopted as a reasonable working procedure also in other recent historical studies such as Streb, Baten and Yin (2006) and Saiz (2012).<sup>13</sup>

Our dataset allows us to construct two different indicators of patent value. The first is what we label the “planned” duration of the patent (measured in years). This is computed by adding to the initial duration all the years for which the patent was prolonged. The intuition is straightforward: patents taken or prolonged for longer durations are probably seen, in the eyes, of the patentees as covering more important inventions.

The second proxy of patent value that we construct is what we label the “real” duration of each single patent. This second proxy is measured by looking at the full period for which the fees of the patents were regularly paid by the patentee. To sum up, the first proxy – the “planned” duration – may be interpreted as representing an ex ante assessment of the value of

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<sup>13</sup> Bessen (2008), on the basis of a detailed empirical study of a large sample of US patents granted in the 1990s, has recently argued that patent citations can be used as a (noisy) indicator of the relative technological significance of a patent, but that renewals are definitely to be preferred as indicators of the economic value of the inventions.

the patent, with some possible revisions due to the extensions. Instead, the second proxy – the “real” duration – reflects an ex post assessment of the quality of the patent.

Figure 5 presents the distribution of the “planned” patent length by type of inventor. Both for firms and independent inventors the distribution of “planned” patent length is concentrated on the range between 1 and 6 years. There is a peak at 6 years because the Italian Law prescribed that a patent taken for a period up to five years had to be put into practice within one year from the granting date.<sup>14</sup> This working requirement was more flexible for patents taken for longer periods of time that instead had to be put into practice within two years of the granting date. Interestingly enough, for firms and, to a minor degree, also for independent inventors, the distribution is characterized by a peak at 15 years, the maximum length of the patent.

[Figure 5 about here]

Table 5 presents the data on the renewing behaviour of the patentees. The first panel of the table contains the share of patents that expired before their “planned” duration. Overall the share of expired patents is around two-thirds of the total and it is similar for independent inventors and firms. In the second panel of the table we examine the average “real” duration in terms of years. Also in this case we find that the average duration is higher for firms and foreign inventors. Finally, in the third panel we show the share of patents which expired within the first year of life: this might perhaps be regarded as a sort of “infant mortality rates” of patents. The mortality rate of about 30 per cent seems quite remarkable, but more importantly there is a significant difference between independent inventors and firms, the former being characterized by a much higher share of patents not surviving the first year of life.

[Table 5 about here]

Figure 6 contains histograms of the joint distribution of the two proxy measures of patent value. It is interesting to note that the distribution it is not spread evenly on the underlying support and it is concentrated on the range of values 1-6 years with a series of additional peaks for value 15 years.

[Figure 6 about here]

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<sup>14</sup> Art. 58, Law of 30<sup>th</sup> October 1859 and art. 84 of Regolamento.

Figure 7 shows the distribution of “real” patent length by type of inventor. In this case the total distribution is left skewed with a high concentration of low quality patents, which is a pattern fully in line with similar evidence emerging from recent dataset of patent value (Silverberg and Verspagen 2007). The distribution of independent inventors and firms seems to be quite similar even if firms data present a higher peak for patents of 15 years duration.

[Figure 7 about here]

In order to assess the effects of multiple sources of variation on the quality of the patents , we estimate two models of the determinants of patent length. Since our dependent variable ranges from 1 to 15 and the data appear to be characterized by “over dispersion”, we estimate a zero truncated negative binomial regression model.<sup>15</sup>

The results for “planned” patent duration are reported in table 6. Our variable of interest is INDEPENDENT (a dummy variable coded as 0 in the case of firm and as 1 in the case of independent inventors). We examine also the effects of other covariates such as FOREIGN (a dummy variable indicating a foreign inventor), INDUSTRIAL TRIANGLE (a dummy variable indicating residence of the patentee in one of the three provinces of the Italian industrial triangle), URBAN – NOT TRIANGLE (a dummy variable indicating the residence of the patentee in one of the major Italian cities, excluding Milano, Torino and Genova, so that is Venezia, Bologna, Firenze, Roma, Napoli and Palermo), HIGH TECH (a dummy indicating a patent belonging to the high tech classes specified in table 4). In the model we control for industry and time effects (the baseline categories being “textiles, apparel and leather” and “1902”).

[Table 6 around here]

Overall, we find that INDEPENDENT has a significant and negative effect on patent duration across all the specifications, which indicates that patents taken by independent inventors were of lower quality than those taken by firms. The estimated coefficients imply that the class of independent inventors took patents with a “planned” duration that was

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<sup>15</sup> As an additional check, we have also estimated a set of ordered logit models corresponding to the specifications reported in tables 6 and 7 obtaining fully consistent results.



between 31.8% and 41.3% shorter than that of other patentees (the percentage change is computed as  $[\exp(\text{coefficient})-1] \times 100$ ). These results are robust across all the specifications.<sup>16</sup> Moreover, we find also a positive and significant effect of the variable FOREIGN, amounting to a higher patent duration of 45.9% to 74.2% (again the percentage change is computed as  $[\exp(\text{coefficient})-1] \times 100$ ). It is interesting to observe from columns 2-5 that independent foreign inventors (INDEPENDENT x FOREIGN) generate patents of higher quality. Therefore our findings suggest the existence of an important difference in the technological contribution of independent inventors, with “Italian” independent mostly producing patents of reduced quality and “foreign” independent making instead valuable innovations.

An important stream of literature has suggested that urban areas constitute environments that can foster innovation and inventive activities (Mokyr 1995). In this respect, table 6 shows also that these positive urban effects are significant only in the provinces of the “industrial triangle” which played a pivotal role in the early phase of Italian industrialization and not in other major Italian cities (columns 3-5). Finally, concerning the technological content of the patents, we find that high tech patents were also correlated with a longer patent life.

Table 7 reports the results for regressions similar to those of table 6, but using as dependent variable the “real” patent length. These regressions cover only the three benchmark years (1881, 1891 and 1902) for which we could calculate the “real” patent length using renewal data. Overall, the results are fully consistent with those obtained in table 6, even if for the “real” patent length the negative impact of independent inventors is even higher than in the previous case. The impact of the other covariates is also similar to that of table 6.<sup>17</sup>

[Table 7 around here]

## 6. Conclusions

Independent inventors remained an important source of innovation during the Second Industrial Revolution, alongside corporate R&D laboratories. This is true for the case of the

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<sup>16</sup> It is worth noting that the negative size of the coefficient of INDEPENDENT is not likely to be affected by some possible misattributions of corporate patents to independent inventors. Since the average quality of corporate patents is higher than that of independent, biases in the direction just mentioned will in general tend to increase the average value of independent inventors’ patents.

<sup>17</sup> We have run the same regressions of table 7 using “planned” patent duration as dependent variable only for the three benchmark years (1881, 1891 and 1902) obtaining results similar to those of table 6 in terms of the size of the coefficient.

United States, where independent inventors were incentivized by a “democratic” and reliable patent system. However, also in the case of Britain, Nicholas (2011a) shows that independent inventors provided an important contribution to technical progress (measured in terms of “valuable” inventions), notwithstanding the high costs of patent protection.

The Italian case, documented in this paper, sheds further light on these issues. During the Liberal age, Italy was characterized by a relatively cheap and flexible patent system which, at least in principle, seems to provide very favorable conditions for the activities of independent inventors. Accordingly, the evidence examined in this paper shows that independent inventors (both domestic and foreign) made an intensive use of the Italian patent system. However, comparing the Italian with the British case, one may note an important difference. In Britain, a significant share of the innovations patented by independent inventors were of relatively high quality, whereas in Italy independent inventors’ patents were clustered on the low quality segment of the innovation quality distribution. Interestingly enough, these findings are in agreement with the innovation patterns in the silk industry described by Federico (1994). The silk industry was one of the few sectors in which, during the period in question, Italy was the universally acknowledged technological leader. According to Federico, in the industry the most valuable innovations were introduced by firms that were specialized suppliers of machines and other pieces of equipment. These firms did not resort to patent protection, but they make use of alternative appropriability strategies based on reputation, customers’ service, etc. As a result, the large share of patents in this sector were taken by independent inventors. According to Federico’s detailed appraisal, most of these independent inventors’ patents were of limited economic and technological significance and very few of them were actually put into practice (Federico 1994: 163-165).

Of course, this evidence raises the question of why Italian inventors, despite operating in a seemingly favorable context, failed to act as “a dynamic source of new technology formation” (Nicholas 2011a: 1022) as their British counterparts.

We would suggest that two main factors are probably responsible for the relative low quality of the innovations patented by Italian independent inventors. The first is the structural weakness of the Italian innovation system (especially in terms of human capital formation) throughout this period which, in general, did not provide a favorable context for the generation and development of technological breakthroughs (Nuvolari and Vasta 2012). The second explanation revolves more closely around the activities of independent inventors and the context in which they worked. A recent stream of literature has highlighted the critical role played by institutional arrangements that are complementary to the functioning of the

patent system such as patent agents and other intermediaries that allows the functioning of “markets for technologies”. These institutions promote the successful commercial implementation of the innovations generated by independent inventors either by facilitating transactions on the “markets for technologies” (licensing or sales of the invention) or by helping to raise the capital for the creation of new companies.

Although the activities of patent agents and other intermediaries in Italy have not been yet studied systematically, it is possible to point to some pieces of qualitative evidence suggesting that the institutional quality of these structures was largely inadequate, at least by international standards.<sup>18</sup> In this respect, a revealing example is the case of Guglielmo Marconi (1874-1937) and the invention of the radio. Marconi made the invention in Italy, but he was able to successfully commercialize its invention only after having moved to England. Guagnini (2002) has documented the key-role played by Carpmael & Co. (Marconi’s patent agents in London) in ensuring both the international appropriability of the invention and the successful gathering of the financial resources necessary for the entrepreneurial exploitation of the invention by means of the creation of a new company.

Another instructive case is that of Alessandro Cruto (1847-1908). He invented a highly efficient electric light bulb that in a systematic experiment in 1883 clearly outperformed Edison’s (Coriasso, n.d.) After the experiment, Cruto tried to exploit the invention by taking a patent and creating a new company. However, the commercial success of the firm, also because of its inability of exploiting the patents on international markets, was short-lived and the firm, after several vicissitudes, was finally bought by Philips in 1927.

To sum up, our findings may be seen as adding an important qualification to those obtained by Nicholas. Independent inventors could were a critical source of invention also during the Second Industrial Revolution period, but it is likely that they could play such a role only when they were supported by an appropriate institutional framework.

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<sup>18</sup> The relative low quality of the patents of independent inventors and the limited role played by markets for technologies are also pointed out by Saiz (2012) in the Spanish case. Interestingly enough, according to Nicholas and Shimizu (2013), markets for technologies and related institutions were instead relatively well functioning in the case of Japan, another late-comer country.

## References

- Arora, A., Fosfuri, A. and Gambardella, A. (2001), *Markets for Technology: The Economics of Innovation and Corporate Strategy*, Cambridge, MA, MIT press.
- Basberg, B. (2012), 'Amateur or professional? a new look at 19th century patentees in Norway', *Norwegian School of Economics Discussion paper*, 12.2012.
- Bessen, J. (2008), 'The value of US patents by owner and patent characteristics', *Research Policy*, vol. 37, 932-945.
- Bilir, L., Moser, P. and Talis, I. (2011), 'Do treaties encourage technology transfer ? Evidence from the Paris convention', *Working Paper*, Stanford University.
- Bosio, E. (1891), *Le Privative Industriali nel Diritto Italiano*, Torino.
- Coriasso, R. (n.d.), 'Alessandro Cruto', in Amatori, F. (ed.), *Dizionario Biografico degli Imprenditori Italiani*, mimeo.
- Chandler, A. D. (1990), *Scale and Scope. The Dynamics of Industrial Capitalism*, Cambridge, Belknap Press of Harvard University Press.
- Federico, G. (1994), *Il filo d'oro. L'industriale mondiale della seta dalla restaurazione alla grande crisi*, Venezia, Marsilio.
- Fenoaltea, S. (2011), *The Reinterpretation of Italian Economic History. From the Unification to the Great War*, Cambridge, Cambridge University Press.
- Freeman, C. and Louçã, F. (2001), *As Time Goes by: From the Industrial Revolution to the Information Revolution*, Oxford, Oxford University Press.
- Freeman, C. and Soete, L. (1997), *The Economics of Industrial Innovation*, London, Continuum.
- Giannetti, R. (1998), *Tecnologia e sviluppo economico italiano*, Bologna, Il Mulino.
- Giannetti, R. and Vasta, M. (2010), 'Big business (1913-2001)' in A. Colli and M. Vasta, (eds.), *Forms of Enterprise in 20<sup>th</sup> Century Italy. Boundaries, Structures and Strategies*, Cheltenham: Edward Elgar, 25-51.
- Griliches, Z. (1990), 'Patent statistics as economic indicators: a survey', *Journal of Economic Literature*, vol. 28, 1661-1707.
- Guagnini, A. (2002), 'Patent agents, legal advisers and Guglielmo Marconi's breakthrough in wireless telegraphy', *History of Technology*, vol. 24, 171-201.
- Hounshell, D. (1996), 'The evolution of industrial research in the United States', in Rosebloom, R. and Spencer, W. (eds.) in *Engines of Innovation: US Industrial Research at the End of an Era*, Boston: Harvard Business School Press, 13-69.
- Jewkes J, Sawers D, Stillerman R (1958), *The sources of invention*, London, MacMillan (rev. edn. 1969).
- Khan, Z. (2005), *The Democratization of Invention: Patents and Copyrights in American Economic Development, 1790-1920*, Cambridge, Cambridge University Press.
- Khan, Z. (2008), 'An Economic History of Patent Institutions', *EH.Net Encyclopedia*, R. Whaples (ed.), March 16, 2008, <http://eh.net/encyclopedia/article/khan.patents>
- Khan, Z. and Sokoloff, K. (2006), 'Institutions and Technological Innovation During Early Economic Growth: Evidence from the Great Inventors of the United States, 1790-1930', in T.

Eicher and C. Garcia-Penalosa (eds.), *Institutions and Economic Growth*, Boston, MIT Press, 123-158

Maddison, A. (2009), *Historical Statistics of the World Economy: 1-2008 AD*, <http://www.ggdc.net/MADDISON/oriindex.htm>

Lamoreaux, N. and Sokoloff, K. (2002), 'Intermediaries in the US Market for Technology, 1870–1920', NBER Working Paper n. 9017.

Lamoreaux, N. and Sokoloff, K. (2012), 'The decline of the independent inventor: a Schumpeterian story ?' in F. Scott Kieff and T. A. Paredes (eds.), *Perspectives on Commercializing Innovation*, Cambridge, Cambridge University Press.

Lamoreaux, N., Sokoloff, K and Sutthiphisal, D. (2009), 'The reorganization of inventive activity in the United States during the early twentieth century', NBER Working Paper n. 15440.

Lerner, J. (2000), '150 years of patent protection', NBER Working paper n. 7478

Ministero di Agricoltura, Industria e Commercio [MAIC] (1864-1885), *Bollettino delle privative industriali del Regno d'Italia*, Torino

Ministero di Agricoltura, Industria e Commercio [MAIC] (1886-1893), *Bollettino delle privative industriali del Regno d'Italia*, Roma.

Ministero di Agricoltura, Industria e Commercio [MAIC] (1894-1901), *Elenco degli attestati di privativa industriale, di prolungamento, completivi, di importazione e di riduzione*, Roma. .

Ministero di Agricoltura, Industria e Commercio [MAIC] (1902-1916), *Bollettino della proprietà intellettuale*, Roma.

Ministero per l'Industria , il Commercio e il Lavoro [MAIC] (1917-1923), *Bollettino della proprietà intellettuale*, Roma.

Mokyr, J. (1995), 'Urbanization, technological progress, and economic history', in H. Giersch (ed.) *Urban Agglomeration and Economic Growth*, Berlin, Springer-Verlag.

Moser P., Ohmstedt J. and Rhode, P.W (2013), 'Patent Citations and the Size of Patented Inventions - Evidence from Hybrid Corn', Working paper, Stanford University.

Mowery, D. and Rosenberg, N. (1998), *Paths of Innovation. Technological Change in Twentieth Century America*, Cambridge, Cambridge University Press.

Nicholas, T. (2010), 'The role of independent invention in US technological development, 1880-1930', *Journal of Economic History*, vol. 70, 57-82.

Nicholas, T. (2011a), 'Independent invention during the rise of the corporate economy in Britain and Japan', *Economic History Review*, vol. 64, 995-1023.

Nicholas, T. (2011b), 'Cheaper patents', *Research Policy*, vol. 40, 325-339.

Nicholas, T. and Shimizu, H. (2013), 'Intermediary functions and the market for innovation in Meiji and Taisho Japan', *Business History Review*, vol. 87, 121-149.

Nuvolari, A. and Vasta, M. (2012), 'The ghost in the attic? The Italian national innovation system in historical perspective, 1861-2011', Working Paper n. 665, Department of Economics and Statistics, University of Siena.

O'Brien, P.K. (1997), 'The Micro Foundations of Macro Invention: the Case of Reverend Edmund Cartwright', *Textile History*, vol. 28, 201–233.

- Saiz, P. (2012), 'Social networks of innovation in the European periphery: exploring independent versus corporate patents in Spain circa 1820-1939', *Historical Social Research*, vol. 37, 348-369.
- Schankerman, M. and Pakes, A. (1986), 'Estimates of the value of patent rights in European countries during the post-1950 period', *Economic Journal*, vol. 96, 1052-1076.
- Schumpeter, J. A. (1928), 'The instability of capitalism', *Economic Journal*, vol. 8, 361-386.
- Schumpeter, J. A. (1942), *Capitalism, Socialism and Democracy*, New York, Harper.
- Silverberg, G. and Verspagen B., (2007), 'The size distribution of inventions revisited: an application of extreme value statistics to citations and value measure of patent significance', *Journal of Econometrics*, vol. 139, 318-339.
- Sokoloff, K. and Khan, Z. (1990), 'The democratization of invention during early industrialization: evidence from the United States, 1790-1846', *Journal of Economic History*, vol. 50, 363-378.
- Streb, J., Baten, J. and Yin, S. (2006), 'Technological and geographical knowledge spillover in the German empire, 1877-1918', *Economic History Review*, vol. 59, 347-373.
- Trajtenberg, M. (1990), 'A penny for your quotes: patent citations and the value of innovations', *RAND Journal of Economics*, vol. 21, 172-187.
- Vasta, M. (2006), 'The largest 200 manufacturing firms (1913-2001)' in Giannetti, R. and Vasta, M. (eds.), *Evolution of Italian Enterprises in the 20<sup>th</sup> Century*, Heidelberg: Physica-Verlag, 87-110.
- Von Tunzelmann, G. N. (1995), *Technology and Industrial Progress*, Cheltenham, Edward Elgar.

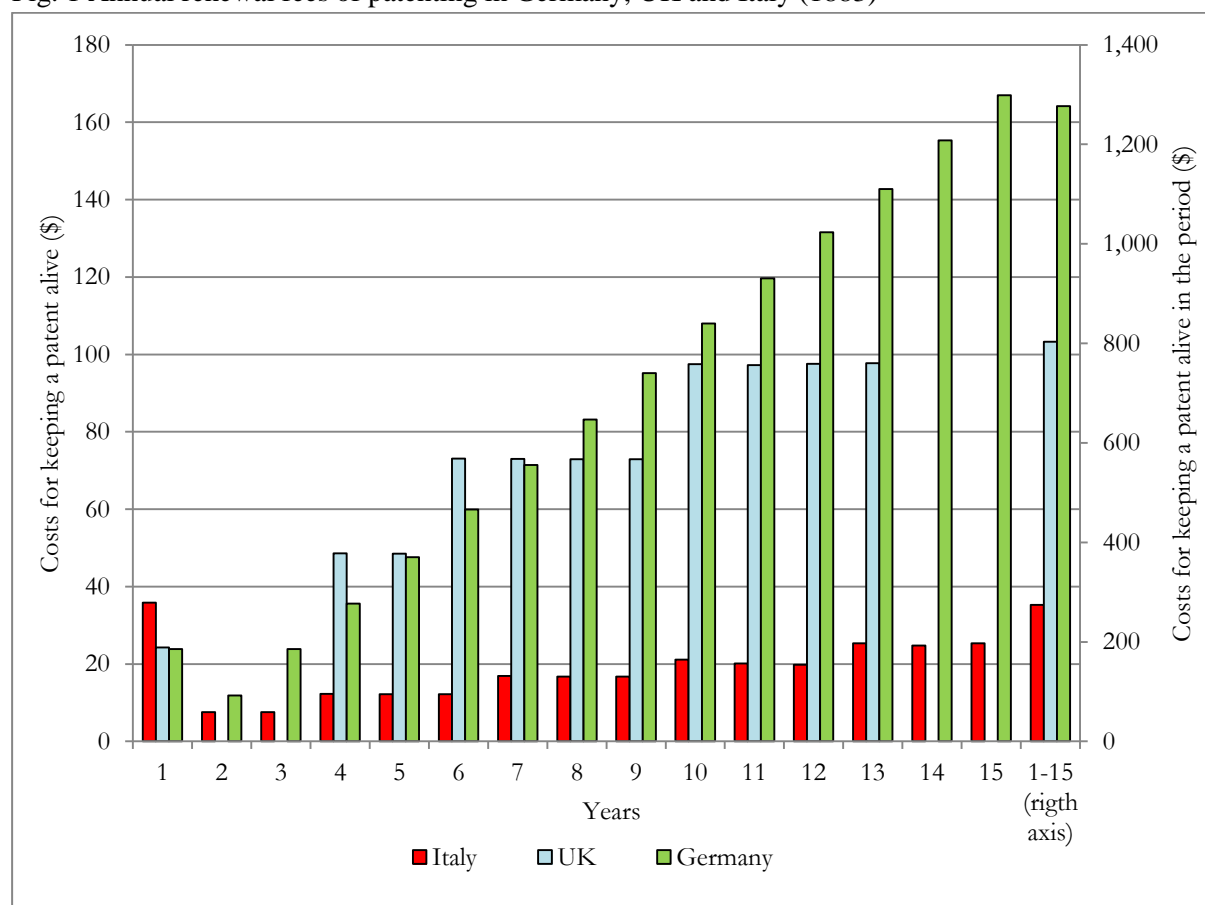
Tab. 1 Cost of patenting (to keep a patent alive for full legal term) in different countries

Countries	1871/1875		1891	1899/1900	
	a	b	a	A	b
Germany		19	\$\$\$\$	\$\$\$\$	22,694
Italy	\$	2,665	\$\$\$	\$\$\$	4,341
Japan				\$	2,356
United Kingdom	\$\$\$\$	10,195		\$\$\$\$	6,612
United States		546		\$	720

Source: a: Khan and Sokoloff (2006, tab. 5.6); b: Lerner (2000, tab. 3).

Note: a: \$ (\$ 0-100), \$ (\$ 100-250), \$\$\$ (\$ 250-500), \$\$\$\$ > \$ 500 in current US\$; b: in 1998 US\$.

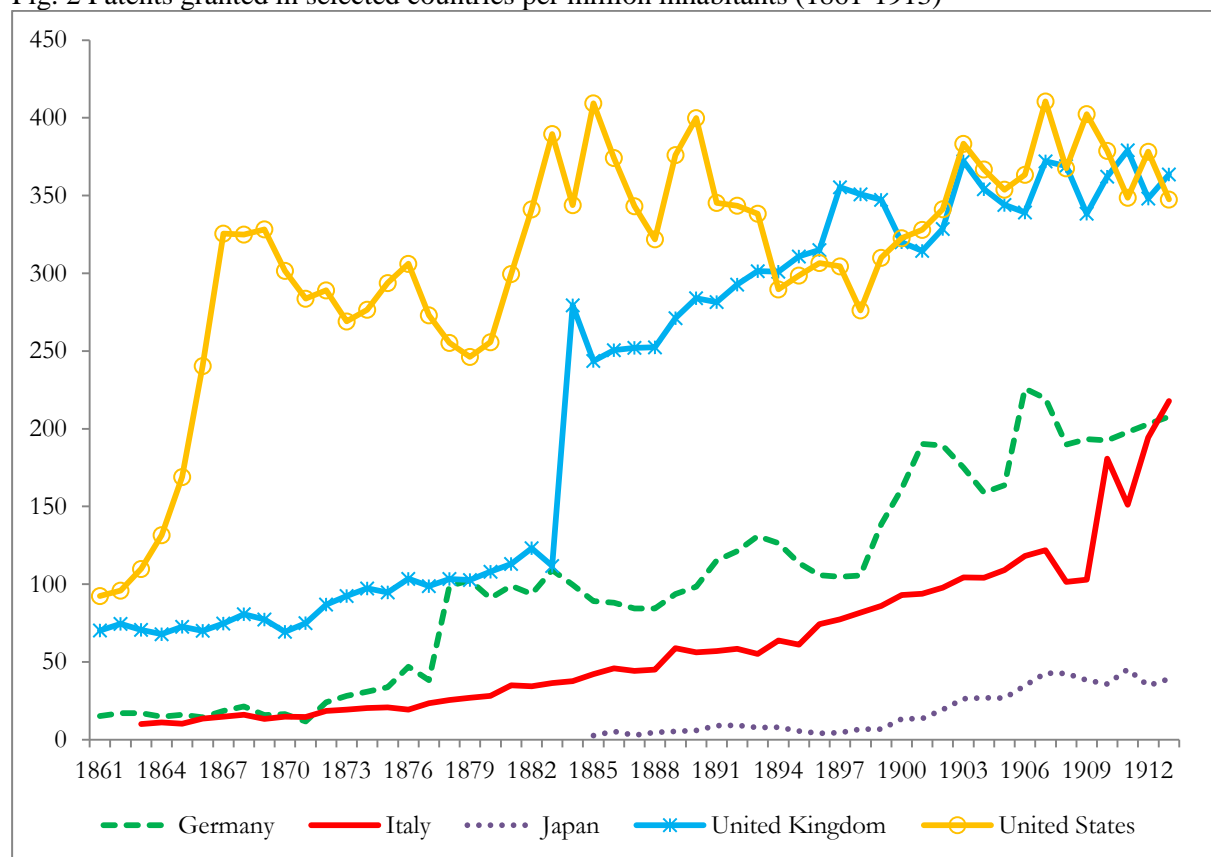
Fig. 1 Annual renewal fees of patenting in Germany, UK and Italy (1883)



Source: own elaboration based on: UK, Nicholas (2011b), Germany, Streb, Baten and Yin (2006) and Italy Italian Law nr. 1657, 31<sup>st</sup> January 1864. Exchange rates kindly provided by Giovanni Federico.

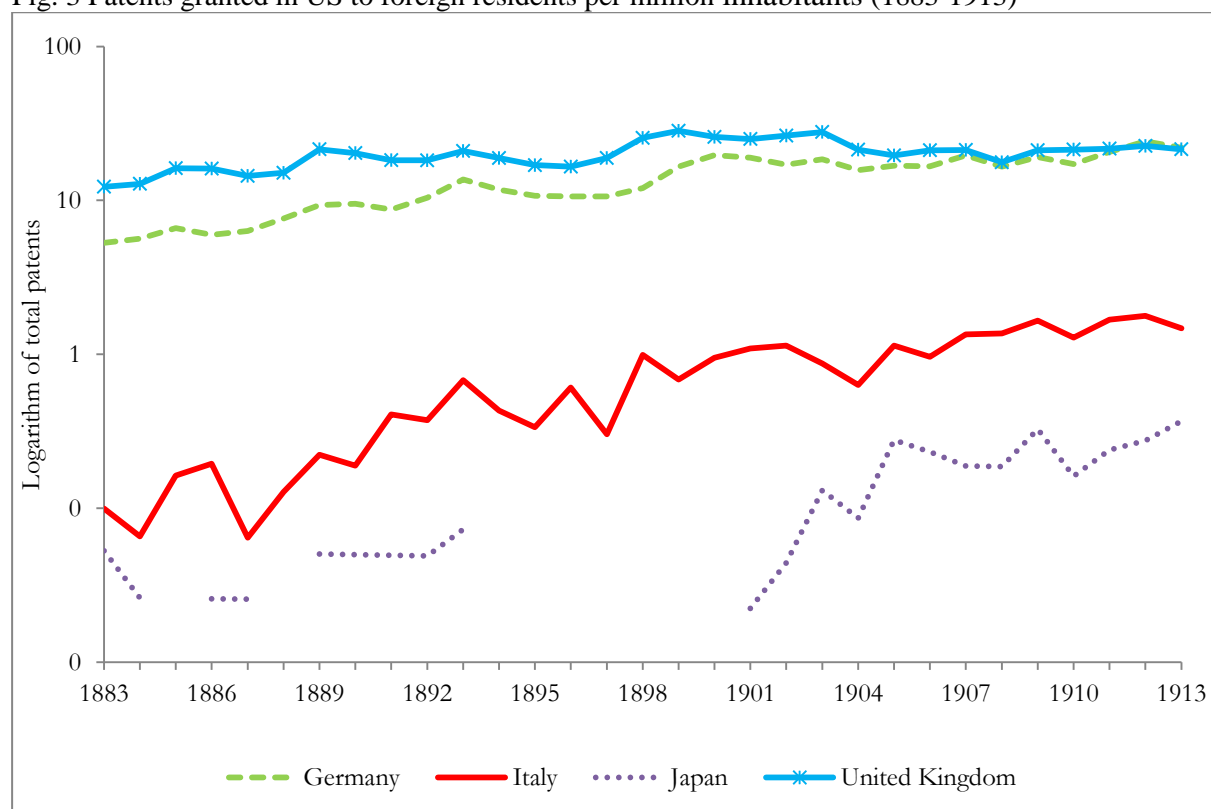
Note: years from 1 to 15 in the left axis; total period 1-15 in the right axis.

Fig. 2 Patents granted in selected countries per million inhabitants (1861-1913)



Source: own elaboration on 1883-1922: WIPO Statistics Database, December 2011; 1861-1882: Khan (2008); data for Italy from MAIC (various years).

Fig. 3 Patents granted in US to foreign residents per million inhabitants (1883-1913)



Sources: own elaboration on Maddison (2009) and on USPTO TAF Mar. 1977.



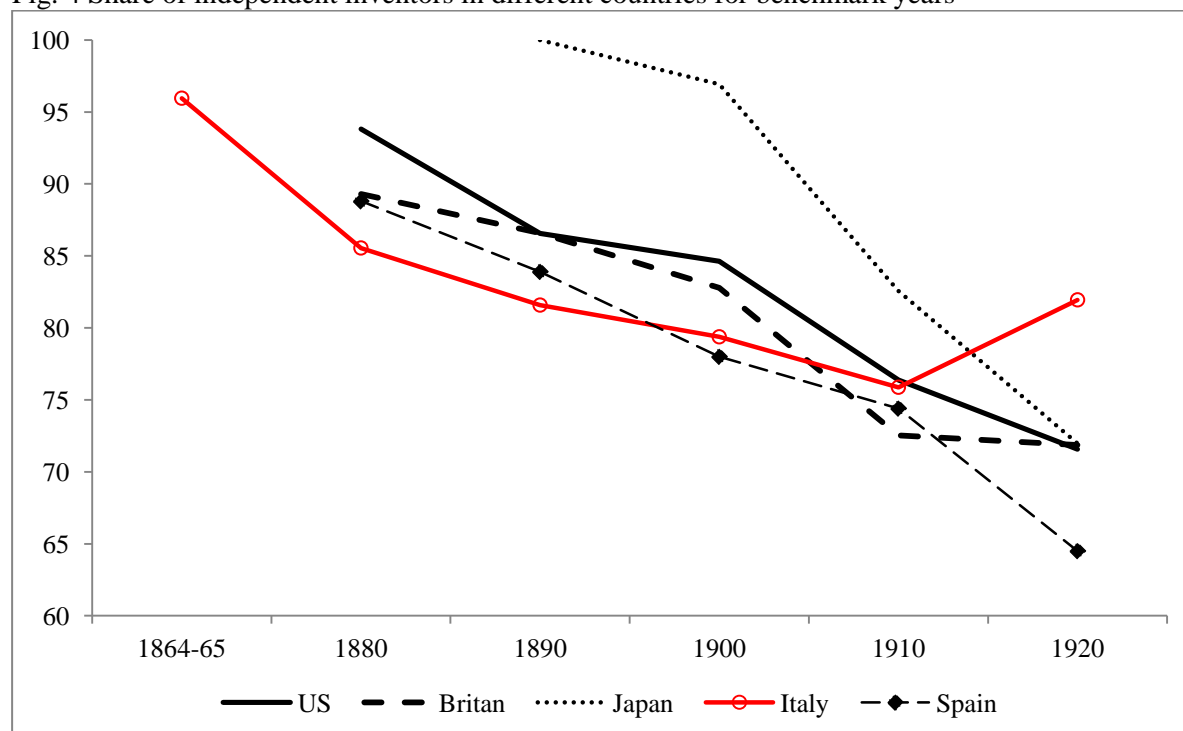
Tab. 2 Degree of Openness (% of non-residents on total) of patent systems (1871-1922)

Countries	1864/65	1880	1901	1914	1922
Germany		31.1	37.1	30.1	25.5
Italy	50.7	64.9	64.9	61.5	56.0
Japan					30.8
United Kingdom			53.2		44.2
United States			13.3	11.5	11.6

Source: own elaboration on WIPO Statistics Database, December 2011; data for Italy from MAIC (various years).

Note: for Germany 1883 instead of 1880; for Japan 1923 instead of 1922; for United Kingdom 1921 instead of 1922.

Fig. 4 Share of independent inventors in different countries for benchmark years



Sources: own elaboration on data kindly provided by Nicholas (2011: Figure 3) for US, Britain and Japan and for Spain on Saiz (2012, table 1); for Italy our own elaborations.

Note: for Italy the benchmark years are: 1881, 1891, 1902, 1911, 1922; for Spain data corresponds to 10 years average centred on 1884, 1894, 1904, 1914 and 1924.

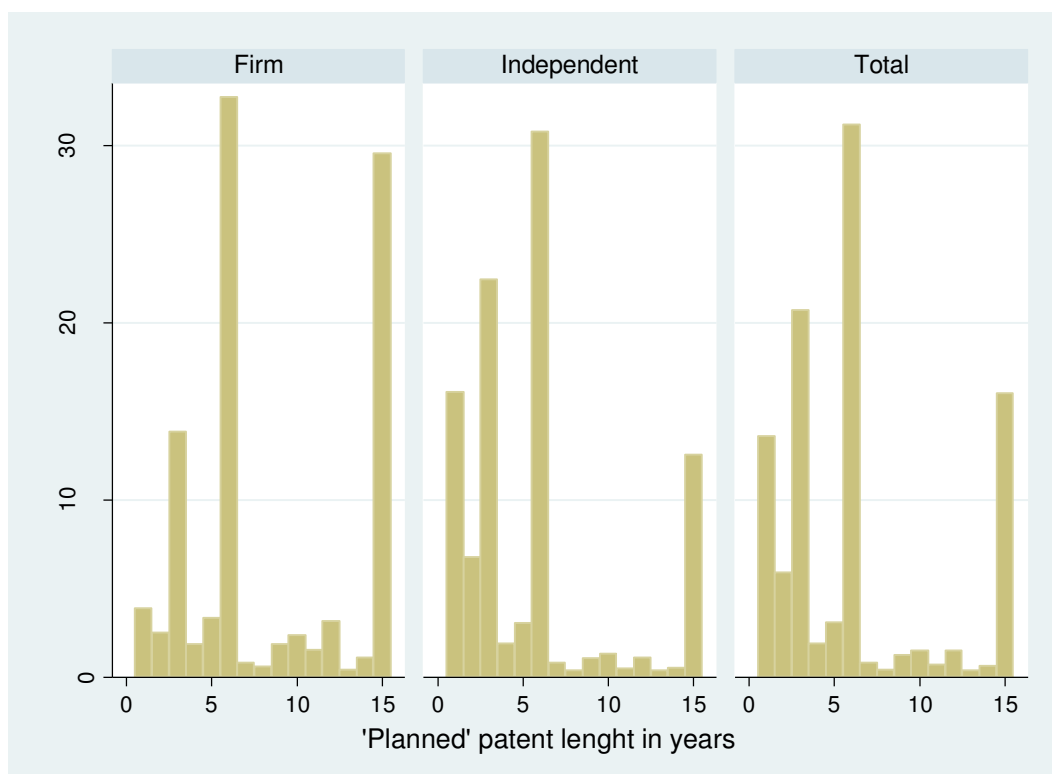
Tab. 3 Italian patent sample (descriptive statistics)

	1864-65	1881	1891	1902	1911
<b>Number of patents</b>					
Total	519	941	1,618	2,987	4,058
Firm (%)	4.0	14.5	18.4	20.6	24.1
Independent (%)	96.0	85.5	81.6	79.4	75.9
Foreign (%)	50.7	64.1	70.0	65.8	55.8
Italy (%)	49.3	35.9	30.0	34.2	44.2
<b>Industrial triangle cities (Genoa, Milan, Turin) (%)</b>					
Total	58.6	52.1	47.9	49.0	55.2
Firm	69.2	73.3	69.4	64.5	69.9
Independent	58.0	48.8	43.4	47.1	52.7
<b>Average ‘planned’ length (years)</b>					
Total	6.8	6.2	7.3	6.3	5.6
Firm	7.5	8.3	9.0	8.7	8.1
Independent	6.8	5.8	6.8	5.6	4.7
Foreign	7.7	7.1	8.4	7.6	6.7
Italy	5.9	4.5	4.6	3.8	4.1
<b>% of patents prolonged (excluding patents with original length = 15)</b>					
Total	10.7	17.9	17.5	23.8	24.1
Firm	22.2	39.7	27.6	36.2	38.1
Independent	10.2	14.4	15.5	21.0	20.0
Foreign	11.9	19.8	15.3	27.1	25.2
Italy	9.5	14.7	21.4	18.3	22.7

Tab. 4 Distribution of patents across industries

	1864-65	1881	1891	1902	1911
<b>Distribution of patents across industries</b>					
Agriculture	4.8	6.6	5.6	3.3	2.9
Chemicals *	9.8	6.8	5.5	5.8	4.7
Construction and construction materials	7.1	3.9	5.7	6.3	7.7
Electricity *	6.7	13.5	14.9	19.3	14.8
Food and beverages	9.6	7.7	3.6	3.7	1.8
Machine tools, other machinery and components *	1.5	2.8	3.2	4.2	4.2
Mining & Metallurgy *	8.9	3.8	3.5	2.5	1.6
Other manufactures	13.9	15.3	14.1	7.2	9.2
Paper and printing	3.5	3.5	3.2	4.2	3.8
Scientific instruments	2.5	7.7	4.3	6.2	6.4
Steam engines *	7.3	8.0	10.1	11.0	14.2
Textiles, apparel & leather	7.3	8.2	9.8	10.5	8.2
Transport	11.2	8.9	10.9	12.3	18.0
Weapons *	5.8	3.4	5.8	3.6	2.5
Total	100.0	100.0	100.0	100.0	100.0
<b>% of high-tech patents *</b>					
Firm	19.0	44.1	49.3	52.9	51.9
Independent	39.0	37.3	37.2	41.6	36.7

Fig. 5 Distribution of “planned” patent length by type of inventor (1864/65-1911)



Tab. 5 Patents expired before “planned” length (1881-1902)

	1881	1891	1902
<b>Total</b>			
Total number of patents	941	1,618	2,987
Expired	627	1,144	1,909
%	66.6	70.7	63.9
<b>Firm</b>			
Total number of patents	136	298	616
Expired	84	213	402
%	61.8	71.5	65.3
<b>Independent</b>			
Total number of patents	805	1320	2371
Expired	543	931	1507
%	67.5	70.5	63.6
<b>Average “real” length (years)</b>			
Total	3.5	3.4	3.7
Firm	5.4	4.9	5.7
Independent	3.2	3.1	3.2
Foreign	4.0	3.6	4.4
Italy	2.7	2.8	2.5
<b>% expired in the first year (with “planned” length &gt;1 year)</b>			
Total	30.3	32.1	29.7
Firm	19.3	22.7	15.1
Independent	32.3	34.5	34.2

Fig. 6 Distribution of “planned” patent length vs. “real” patent length (1881-1902)

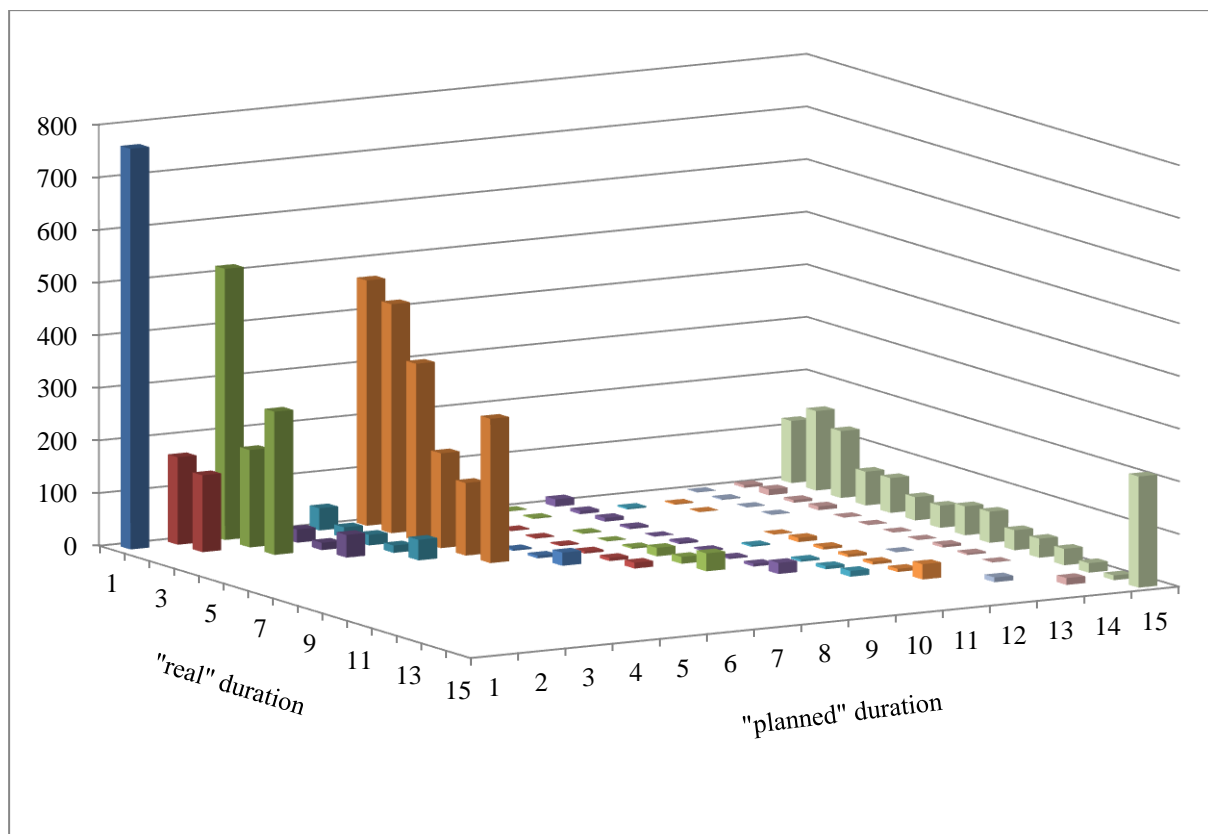
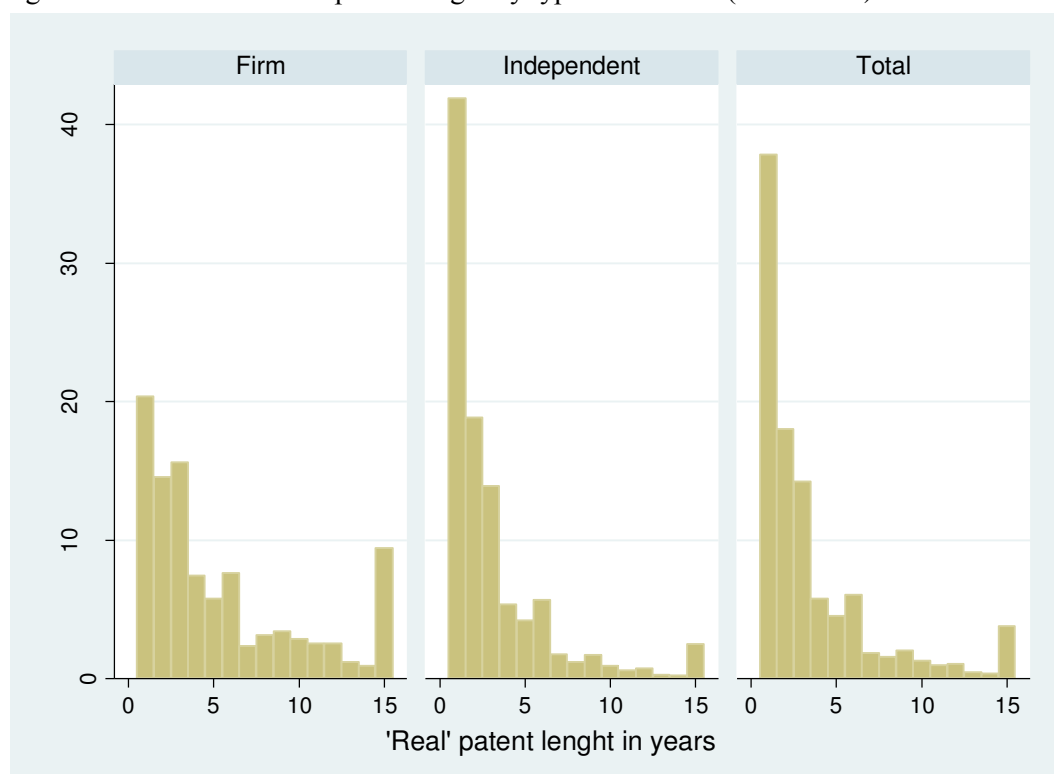


Fig. 7 Distribution of “real” patent length by type of inventor (1881-1902)



Tab. 6 Determinants of “planned” patent length (1864-1911)

Variables	(1)	(2)	(3)	(4)	(5)
Independent	-0.382*** (0.0172)	-0.532*** (0.0407)	-0.512*** (0.0412)	-0.524*** (0.0408)	-0.522*** (0.0414)
Foreign	0.555*** (0.0184)	0.391*** (0.0391)	0.470*** (0.0455)	0.378*** (0.0395)	0.467*** (0.0457)
Independent X Foreign		0.203*** (0.0442)	0.182*** (0.0447)	0.194*** (0.0444)	0.177*** (0.0449)
Industrial Triangle			0.113*** (0.0328)		0.0984*** (0.0329)
Urban - not triangle				-0.0980** (0.0413)	
High Tech Sectors					0.152*** (0.0155)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	No
Constant	1.576*** (0.0343)	1.701*** (0.0454)	1.621*** (0.0510)	1.711*** (0.0457)	1.654*** (0.0460)
Observations	10,100	10,100	10,100	10,100	10,100

Note: zero truncated negative binomial regressions (dependent variable is “planned” patent length in years), robust standard errors in parentheses (\*\*\* p<0.01; \*\* p<0.05; \* p<0.1). Baseline reference is 1902 for year and textiles, apparel & leather for industry.

Tab. 7 Determinants of “real” patent length (1881-1902)

Variables	(1)	(2)	(3)	(4)	(5)
Independent	-0.712*** (0.0443)	-0.914*** (0.106)	-0.872*** (0.108)	-0.881*** (0.106)	-0.892*** (0.107)
Foreign	0.621*** (0.0507)	0.396*** (0.0998)	0.576*** (0.119)	0.359*** (0.100)	0.561*** (0.119)
Independent X Foreign		0.273** (0.116)	0.230* (0.118)	0.241** (0.116)	0.244** (0.117)
Industrial Triangle			0.269*** (0.0931)		0.229** (0.0935)
Urban - not triangle				-0.323*** (0.106)	
High Tech Sectors					0.190*** (0.0410)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	No
Constant	0.612*** (0.0994)	0.780*** (0.124)	0.598*** (0.141)	0.810*** (0.124)	0.635*** (0.126)
Observations	5,546	5,546	5,546	5,546	5,546

Note: zero truncated negative binomial regressions (dependent variable is “real” patent length in years), robust standard errors in parentheses (\*\*\* p<0.01; \*\* p<0.05; \* p<0.1). Baseline reference is 1902 for year and textiles, apparel & leather for industry.