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Patents, exhibitions and markets for innovation in the early twentieth century: Evidence from Turin 1911 International Exhibition

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Giacomo Domini*

Abstract. This work contributes to the recent literature on international exhibitions, and on the use of data from these events as a proxy for innovation in economic history. In particular, it investigates the nature of international exhibitions, the role they played in the early twentieth century, the reasons why economic agents attended them, the relationship between exhibition data and patent data, and their suitability for measuring innovation. To do so, it makes an in-depth analysis of the International Exhibition held in Turin in 1911, and it matches a new database, built from the catalogue of this event, with data about patents granted in Italy. It is found that exhibiting and patenting did mostly occur separately, as exhibitions mainly worked as markets for products, which attracted firms, while patents were primarily taken out by individuals, most of whom might not be interested in that function. Yet, the presence is observed of a qualified niche of independent inventors, using the exhibition as a market for ideas, i.e. to advertise their findings to a selected public of potential investors, buyers or licensees.

Keywords: patents; international exhibitions; markets for innovation; Italy

JEL classification codes: N74, O31, O33

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1. Introduction

Patents occupy a primary position among the measures of innovation. Their popularity is motivated by a solid tradition in the literature on the economics of innovation (the first, pioneering studies making use of them date back to the 1950s and 1960s, notably Scherer 1965, and Schmookler 1957, 1966), and by their large availability for most countries and since very long ago in time. They are particularly important when pre-Second World War years are considered, due to other proxies for innovation, such as R&D expenditure, not being available for that period.

Patents, however, represent only a part of the universe of innovation. Industrial surveys over the last three decades (Arundel et al., 1995; Cohen et al., 2000; Levin et al., 1987) have revealed that firms typically protect their innovations by a variety of different means, of which patents are not deemed the most effective, but in few industries such as chemicals and pharmaceuticals. As the perceived effectiveness of these mechanisms varies across industries, the propensity to patent and the reasons why patents are taken out also vary. Indeed many patents are not exploited economically, but just used for strategic purposes.[1]

It may be argued that the results of these surveys cannot be extended too back into history, as they focus on the model of the big innovative corporation, which has become dominating only well into the twentieth century. In fact, in the decades between the nineteenth and twentieth century, a relevant contribution in both quantitative and qualitative terms was still coming from individual inventors, who were increasingly specialised and behaved entrepreneurially in the market for ideas, wherever this was endowed with adequate institutional arrangements (Hughes, 1989; Lamoreaux and Sokoloff, 1999; Nicholas, 2010, 2011; Nuvolari and Vasta, 2015a). In such a context, patents were an important requirement to make inventions safely marketable assets.

Yet evidence that patents fall short of representing a comprehensive measure of innovation also in a historical context has come from recent research, in particular from the works published by Moser (2005, 2011, 2012), using data from international exhibitions. These events were among the most important and characteristic of the second half of the nineteenth century and of the early twentieth century: in an era of breakthrough technological changes, they celebrated 'the splendours of progress' (Schroeder-Gudehus and Rasmussen 1992), and played an important function in the diffusion of new technologies (Roca Rosell, 2015). Their size, frequency, geographical coverage, and popularity, grew ever larger since their inception with London's 1851 Great Exhibition, and only entered decline after the First World War. Moser has presented data from the exhibitions' catalogues as an alternative proxy for historical innovation, including both patented and non-patented items; and, matching exhibition data to patent data, she has found that as much as 89% of British exhibits at the 1851 exhibition were not patented.[2]

While effective in conveying the idea that much innovation occurred outside the patent system,[3] the finding of a small correspondence between exhibition data and

[1] For a thorough account of the advantages and disadvantages of patents as a proxy for innovation, see Griliches (1990) and Nagaoka et al. (2010).

[2] A similar conclusion is reached, for a more recent time period, by Fontana et al. (2013), showing that 91% of innovations awarded the 'R&D 100 Award' by magazine *Research and Development* between 1977 and 2004 were not patented.

[3] A further reason why this was the case, pointed out by Moser, is that at that time some countries lacked patent laws, or excluded specific industries from patent protection. Also, it was not infrequent that

patent data does not imply *per se* that the former is a more comprehensive proxy for innovation, of which the latter represent a subset: rather, the sets of patents and exhibits might be largely disjoint, i.e. having a small intersection. To assess the real relationship between exhibits and patents, one should not only check how many of the former were patented, but also what proportion of the latter was exhibited.

Even before this issue, however, comes the question whether exhibits do represent innovations. This is certainly the case for a part of them, but not for all – which feeds back into the above-mentioned point of the sets of exhibits and patents being largely disjoint.[4] A central assumption behind the use of exhibition data as a proxy for innovation is that exhibits are characterised by novelty, which, as pointed out by Moser (2005, p. 1218), was a requirement for admission at the first international exhibition, namely London 1851. However, already at the second such event, namely the *Exposition Universelle* of Paris 1855, no selection was made, based on novelty; and this approach was maintained at the successive *expos* organised by France, which, being the leading country in that field,[5] strongly influenced those held in other countries.[6] A reason for the disappearance of novelty as an admission criterion might be the success and the profusion of those events themselves: indeed, the preface to the *Relazione della Giuria* (Jury Report) of Turin 1911 International Exhibition acknowledged that 'too many and recent exhibitions quickly followed each other, for true, highly-interesting novelties to be observed here' (p. 2).

Furthermore, the multifarious nature of international exhibitions resulted in a variety of different kinds of exhibitors taking part to these events. Exhibitions were great opportunities for innovators to advertise their products to a selected public, particularly keen on the newest advances of science and technology; but not only innovators took part in exhibitions. In fact, an alternative phrasing by which international exhibitions are known, namely *world's fairs*, stresses their nature of big marketplaces, providing visibility on a worldwide scale: this made them particularly attractive for firms – not necessarily innovative – that operated in the wide national and

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innovation was let freely accessible: for example, Allen (1983) and Nuvolari (2004) have shown that 'collective invention', involving the 'free exchange of information about new techniques and plant designs among firms in an industry' (Allen, 1983, p. 2), represented a major source of invention in the nineteenth century.

[4] In the words of (Khan, 2015, p. 32), 'numerous items on display were not patentable or even innovations; many comprised agricultural produce, interesting specimens of minerals and taxidermy, embroidery, and final goods that illustrated good workmanship or attractive design elements rather than innovation'.

[5] Although London's 1851 Great Exhibition was the first such event on an international scale, it was France that developed the modern industrial exhibition 'format', organizing 11 *expositions publiques des produits de l'industrie française* between 1798 and 1849; and it was still France that organized the largest number of *expositions universelles* in the second half of the 19th century (Paris 1855, 1867, 1878, 1889, and 1900).

[6] At Paris 1855, art. 13 of the *Règlement general* stated as admissible (my translation) 'all products of agriculture, industry and art', except for selected categories, like dangerous materials. The Imperial Commission only had the right of excluding French products that would be 'detrimental or incompatible with the aim of the Exhibition' (art. 15). The principle was identical at the last of the five Parisian expos of the nineteenth century (i.e. that of 1900), where 'all industrial or agricultural products, and in general all the objects that fall into the attached classification' could be admitted (art. 29), with the exception of 'dangerous materials, notably explosives' (art. 30). At Turin 1911, the purpose of the organisers was to gather 'all products of agricultural and industrial work, and generally all expressions of economic and civil life' (art. 3). Art. 16 of the *Regolamento generale* stated that the Executive Commission had to 'reject those [objects] having no industrial value': this vague formulation, however, does not appear to imply novelty as a requirement.

international markets, and aimed at advertising their products and strengthening their reputation (Khan 2013, 2015; Schroeder-Gudehus and Rasmussen 1992).

The present paper aims at shedding further light on the nature of international exhibitions, on the role they played in the early twentieth century, on the reasons why economic agents attended them, on the relationship between patent data and exhibition data, and on the suitability of the latter as a proxy for innovation. To do so, it makes an in-depth analysis of the International Exhibition held in Turin in 1911, and it matches a new database, built from the catalogue of this event, with data about patents granted in Italy. Section 2 introduces and describes Turin 1911 database. In Section 3, this data is matched to patent data, and the intersection between these two sets is evaluated. This also involves speculating about the function(s) played by the exhibition. Section 4 investigates by econometric means the drivers leading to economic agents' choices to exhibit and patent. One of this factors, i.e. cost, is dedicated a detailed analysis in Section 5. Finally, Section 6 makes conclusive remarks on the findings of the paper.

2. Turin 1911 database: presentation and descriptive statistics

The exhibition data employed in this paper come from a new database, based on the *Catalogo Generale Ufficiale* of Turin 1911 International Exhibition. The choice of this event is motivated by its representativeness: the *Esposizione internazionale delle industrie e del lavoro* (International Exhibition of Industries and Labour), taking place from the 29th of April to the 19th of November 1911, was officially joined by 22 foreign countries from Europe, Asia and the Americas, but exhibitors came from even more countries (*Relazione della Giuria*, pp. 78-79). It was based in the *Parco del Valentino* of the cosmopolitan former capital of the Kingdom of Italy, both geographically and culturally close to continental Europe, and it was visited by 7.4 million people. While considerably smaller than the exhibitions hosted by France and the United States, the size of Turin's exhibition was of the same order as that of similar events in other countries in the same period, such as Belgium (Antwerp 1885 and 1894; Bruxelles 1897 and 1910, Liège 1905, Ghent 1913), Spain (Barcelona 1888) and Italy itself (Milan 1906). The exhibition has a particular historical relevance for Italy, as it took place at the end of its first important phase of economic development (Toniolo, 2013), and was seen by the organisers as a unique opportunity to show the progress of the country to the world, in the occasion of the 50th anniversary of its Unification.[7]

Official sources indicate that a total of 22,271 exhibits were presented at Turin's International Exhibition, classified into 26 groups, further divided into 167 classes.[8] A very large amount of the products on display, however, consisted of primary commodities (e.g. agricultural and mining products), having nil technological content. To tackle this issue, the database does not list every single item that was displayed in Turin. Rather, it provides an account of the *manufactured* products on display. Following a widely diffused practice, those products (theoretically) falling into divisions 0 to 4 of the *Standard International Trade Classification* (SITC), are considered as primary, the others as manufactured.[9] As a consequence, entire groups

[7] In the preface to the *Relazione della Giuria*, Turin's Exhibition is rhetorically claimed to demonstrate that 'the intelligence of the country does not only apply to painting and making music, speaking or writing, but also acts on markets' (p. 1, my translation).

[8] Official data are available in Table A1 of the Appendix.

[9] An exception to this criterion is made for SITC sub-group 6511 (raw silk), which is treated as primary, based on the finding, by Federico (1997), that around 80% of raw silk's value was coming from the agricultural raw material, i.e. silk cocoons.

and classes, only containing primary products, are kept out of the database; while in some other classes a selection is performed. The adopted criterion does not ensure that all included observations are innovative – which cannot be done without introducing arbitrary and prone-to-error definitions –,[10] but it excludes items that obviously had no technological content.[11] Also excluded from the database are some groups (*Teaching*, *Social economy*, and *Colonisation and migration*) which mainly had illustrative purposes, as items largely consisted of paternalistic displays of the work of schools and third-sector organisations – not to cite class 164, dedicated to the 'Work of Italians abroad', which 'highly interested, as well as moved, the Italian visitors of the Exhibition' (*Relazione della Giuria*, p. 147, my translation).

Table 1 provides some descriptive statistics about Turin 1911 database. A total of 7,671 exhibits is included:[12] this figure is what is left, after performing the selection described above, and amounts to 34% of the official total, showing that non-manufactured products were preponderant, among the items on display at the exhibition. Indeed, 7,740 of total official exhibits were in the groups of *Agriculture* and *Foodstuffs*, where displayed items were mostly primary;[13] while 3,758 were in the three 'illustrative' groups mentioned above.

Italian exhibitors account for more than one-third of total entries in the database. France is the most represented foreign country (20%), followed by Germany (11%) and Great Britain (7%). All other European countries together (including Russia and Turkey) sum up to less than 10%; American ones to slightly more than that; Asian ones to 6%.[14]

[10] Unfortunately, there is no easy way to distinguish innovative exhibits from non-innovative ones. The exhibitions' classifications did not do so, and any distinction based on the exhibits' wordings in the catalogues would imply too high a degree of arbitrariness and a considerable margin of error. A possible solution could be to use prizes conferred at exhibitions, but awarding procedures look quite opaque: while theoretically based on technical merit, they were in fact influenced by a number of different motivations, as pointed out by various studies (reviewed by Khan, 2015, pp. 29-39). In the case of Turin's International Exhibition, art. 14 of the *Regolamento della Giuria Internazionale* stated that awards were based on the exhibitors' 'industrial and scientific merit', but not novelty.

[11] It should be noticed that still, among the manufactured products that have been included into the database, many appear to be fashionable goods, works of art, traditional artisanal products, or consumer goods, whose technological content is dubious. These are particularly serious issues in the groups of *Furniture* and *Jewellery and accessories*, but also in *Apparel* and *Leather*. However, a further selection of these products would imply too high a degree of arbitrariness.

[12] Each observation of the database corresponds to a single entry from the catalogue (i.e. an exhibit by a certain exhibitor, in a certain class). However, in some cases, the same item can be observed in several classes, under the same writing or a similar one; plus, some entries correspond to more than one single item. Many of these 'multiple' entries, however, do not precisely list the number of items on display. This makes it impossible to refine the database, in such a way that each observation corresponds to a single displayed item. In the rest of this work, the term 'exhibit' will therefore be used to mean a catalogue entry in a certain class.

[13] An additional reason for filtering primary products out is to improve the comparability between exhibition data and patent data in the next sections' empirical analysis. In the sector of agriculture, primary commodities dominate among the former; whereas all patents granted in 1911 refer to agricultural equipment. Likewise, in the sector of foodstuffs, simple foods and beverages prevail among exhibits; whereas a patent about a 'gluten-rich bread' appears to be the only, introducing a somewhat new alimentary product – all the others being about industrial material and processes.

[14] It is worth noting that the actual presence of Latin American countries at Turin's Exhibition was much larger, than it emerges from the database: official statistics (displayed in Table A1 in the Appendix), show that they exhibited 5,365 items, corresponding to almost one-fourth of total items on display. The filtering process, upon which the database is constructed, considerably downsizes these countries, as a large share of their exhibits consisted of primary products.

Table 1. Turin 1911 database: descriptive statistics.

	Total	Italy	Belgium	France	Germany	Great Britain	Switzerland	United States	Rest of Europe	Latin America	Asia
Total	7,671	2,734	218	1,552	861	554	86	95	426	708	437
Country %		35.6	2.8	20.2	11.2	7.2	1.1	1.2	5.6	9.2	5.7
Type of exhibitor											
Firm %	65.8	59.2	74.3	69.9	89.7	96.2	88.4	90.5	69.2	38.6	33.2
Individual %	28.2	35.8	21.1	26.7	9.1	3.2	11.6	4.2	22.5	42.8	49.0
Other types %	*6.0*	*5.0*	*4.6*	*3.4*	*1.3*	*0.5*	*0.0*	*5.3*	*8.2*	*18.6*	*17.8*
Average exhibits per exhibitor	1.2	1.1	1.2	1.1	1.9	1.8	1.4	1.0	1.1	1.2	1.1
Product class											
Agriculture	277	123	2	56	25	11	5	12	21	18	4
Chemicals	794	268	16	163	34	91	0	3	42	152	25
Construction and construction materials	913	343	44	241	60	40	5	3	45	80	52
Electricity	461	154	3	100	100	22	18	4	26	33	1
Food and beverages	225	133	7	10	25	24	6	1	6	13	0
Machine tools, machinery, components and metalworking	281	84	2	33	85	12	13	30	18	3	1
Mining	125	45	3	26	12	7	2	3	3	21	3
Other manufactures	785	291	5	156	77	27	1	2	66	59	101
Paper and printing	527	179	18	106	65	45	2	9	29	57	17
Scientific instruments	500	181	4	71	101	83	7	7	15	27	4
Steam engines	274	93	3	24	73	38	19	8	7	9	0
Textiles, apparel & leather	1,739	555	65	413	64	80	5	7	135	195	220
Transport	629	250	33	121	117	59	3	6	9	23	8
Weapons	141	35	13	32	23	15	0	0	4	18	1

The dominant exhibitor type is by far the firm, accounting on average for two-thirds of the displayed items.[15] Individuals account for 28%, while the remainder is accounted for by exhibitors of other types, namely third-sector associations (e.g. charities and clubs), governmental bodies (ministries, municipalities, etc.), and educational and research institutions (schools, universities, scientific institutes). Two non-mutually exclusive reasons can be advanced for the prevalence of firms among exhibitors: on the one hand, exhibiting involved costs, which could be negligible for

[15] It should be noticed that the source is not providing clear information about the type of some exhibitors. Particularly ambiguous are the cases when only a name and a family name are shown: all such cases have been treated as individuals, although they might in fact be firms, having the names of their founders/owners. Therefore, the share of firms presented above might be an underestimation of the actual one.

firms, but could represent a substantial barrier for individuals, as will be illustrated in Section 5. On the other hand, while firms could expect a return from joining the exhibition, given by advertisement and reputation-building,[16] expected benefits might be uncertain for individuals; hence, even in the case costs did not represent a significant barrier, the net present value from participating in the exhibition might be negative for many individuals.

Italy features a larger share of individuals than average, which can be justified by the lower costs of transport and travel that Italians had to face; as well as by the absence of cultural barriers, and by the fact that this domestically-hosted exhibition was a more direct reference for Italians than for foreigners. By the contrary, for Germany, Switzerland, and the United States, firms account for around 90%, and even more than that for Great Britain. The values for Belgium, France and the 'rest of Europe' are broadly around the general average. Extra-European countries (except for the United States) present a very different distribution, characterised by a low share of firms (below 40%), and a high weight of other types of exhibitors than individuals and firms (18%).

Britain, Germany, and Switzerland also feature a higher-than-average number of items per exhibitor, respectively 1.8, 1.9, and 1.4, *vis-à-vis* an average 1.2. The same fact can be seen from Figure 1, showing the distribution of exhibitors by country and number of exhibits: the above-mentioned countries feature thick tails of exhibitors with a large number of items. A close inspection reveals that these 'great' exhibitors correspond to firms, such as the German *Passburg Emil Maschinenfabrik* (21 entries in the database), *Deutsche Waffen- und Munitionsfabriken* (17), and *Heintze & Blanckertz* (16), and the British *Boake A., Roberts & Co.* (20), *Aerators* (18), and *The Swift Manufacturing Co.* (16).[17] By the contrary, cross-country differences in the number of exhibits by individuals are marginal. The 'greatest' individual exhibitors were Italian, namely Ercole Gardini, presenting seven different inventions in seven classes belonging to six distinct groups, and Giuseppe Pascoli (the eclectic brother of the famous Italian poet Giovanni), who presented four inventions in four different groups.

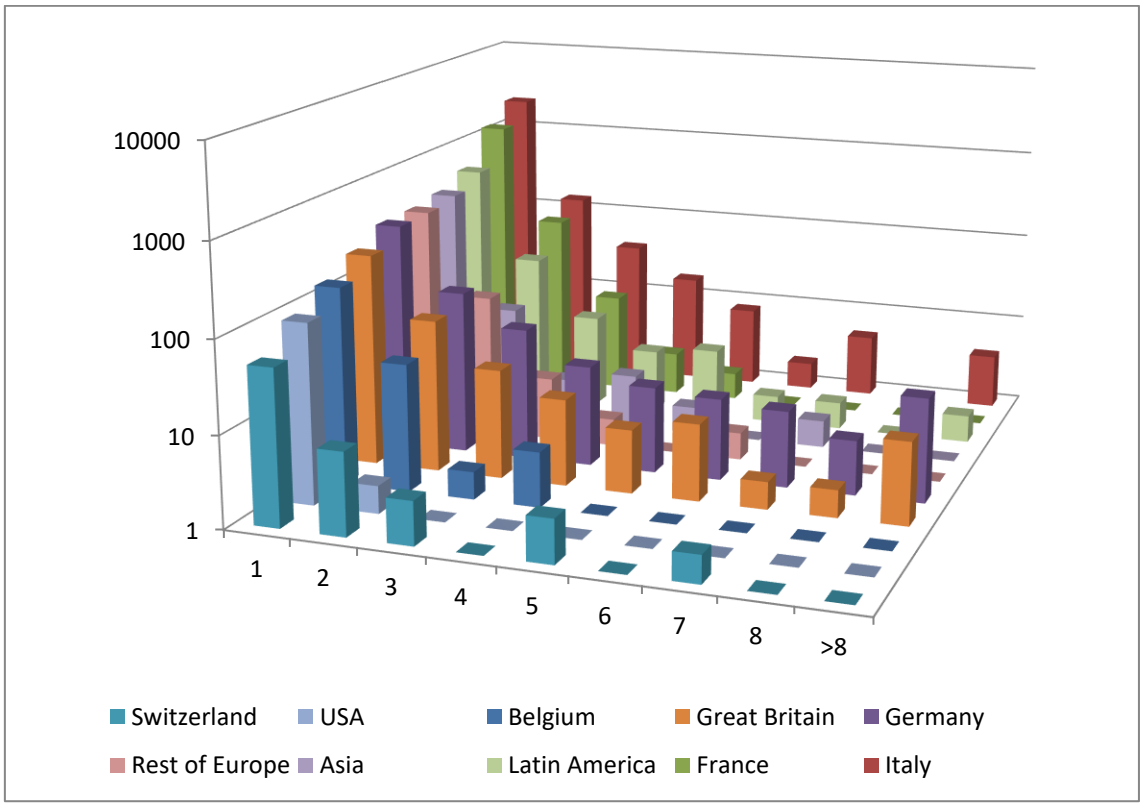
The breakdown by product class, shown in the bottom part of the table, does not follow the original classification of the exhibition: in fact, observations have been re-classified into the simplified 14-industries version of the Italian patent classification, introduced by Nuvolari and Vasta (2015a). The reason for this is that groups and classes in the original scheme were highly heterogeneous, as they mixed products of different nature, for instance the group *Sports* included clothing alongside cars. Furthermore, the adoption of the Italian patent classification ensures full comparability with patent data. The largest product class is *Textiles, apparel and leather* (henceforth referred to simply as *'Textiles'*), accounting for 23% of total exhibits included in the database. This is followed by *Construction and construction materials* (including glass and ceramics; henceforth *'Construction'*), *Chemicals*, and *Other manufactures* (a residual category, mainly consisting of furniture). However, large country differences can be noticed: while Italy, Belgium, and France follow quite closely the average pattern (to determining which they largely contribute), Germany, Great Britain, Switzerland and the United States are characterised by larger shares of sectors with high engineering content, like electricity, instruments, machines, and transport. By the contrary, countries from the rest of Europe, and from outside the continent (except for the United States)

[16] Direct sale in the exhibition's premises was forbidden without an authorisation by the Executive Commission (art. 34 of the *Regolamento Generale*).

[17] Among Italians, the 'greatest' exhibitors were *Ferrovie dello Stato* (20), *Ansaldo* (14), and *FIAT* (12). Figure 1 also shows one 'great' exhibitor from Latin America, corresponding to the Peruvian Organising Committee.

feature a disproportionate amount of items in the class of textiles (e.g. carpets from Persia, and silk fabrics from China and Japan).

Figure 1. Distribution of exhibitors in Turin 1911 database, by country and number of exhibits, logarithmic scale.



Note: all original values have been added one before taking the logarithm, to ensure that the transform of original values equal to unity is different from zero.

3. Exhibitors and patentees in Italy in 1911

This section provides an evaluation of the extent to which exhibition data and patent data overlap. To do so, it matches the names of exhibitors in Turin 1911 database with those of economic agents granted a patent in Italy in the same period. Not all data from Turin 1911 database is employed for this task, though. The exhibitor types other than individual and firm are excluded because such types did not take out patents, apart from very rare exceptions.[18] Furthermore, unlike firms and individuals, those agents might join the exhibition because of non-economic reasons. In other words, while it seems reasonable to think that individuals, and especially firms, joined the fair by rationally evaluating the net present value from participating, this might not be the case for other exhibitor types. For example, governmental bodies might want to join for national prestige; third-sector organisations for informing the public about their missions and achievements; educational and research institutions for diffusing their most recent findings. Therefore, including these 'other' exhibitors alongside firms and individuals would undermine the consistency of the following analysis. Also a selection by country is performed: besides Italy, Belgium, France, Germany, Great Britain, Switzerland, and the United States are included, because of their being the main

[18] In 1911, the only patent granted in Italy to such a type of exhibitor was an 'improvement in artillery spyglasses', by the Artillery Precision Laboratory of the Italian Ministry of War.

industrial economies, as well as the most active ones in exhibiting and patenting. Indeed the host country plus the above-listed foreign countries account for 80% of all observations included in Turin 1911 database, and for 93% of patents granted in Italy in 1911. In either case, the above-mentioned foreign countries jointly account for a larger share than Italy's (the latter equalling 36% of total exhibits, and 44% of total patents).[19]

Table 2 displays the results of the matching of exhibition data and patent data. In the left-hand block, it is verified whether each exhibitor from Turin 1911 database, belonging to the selected types and countries, was granted a patent in Italy in the years 1908-12.[20] In the right-hand block, the names of agents granted a patent in year 1911 are matched to those of exhibitors in Turin 1911 database.[21] A look at the first rows reveals a sharp contrast in the distribution by type, between exhibitors and patentees: almost 70% of the former are firms, while more than 80% of the latter are individuals.[22] In both cases, individuals represent a larger share for Italy, thanks to the 'home-court advantage', allowing a larger share of individuals to overcome cost- and non-cost related barriers.

Overall, 17% of the considered exhibitors can be found in the patent records of years 1908-1912. This share is larger for firms than for individuals, although the difference is not very large. It is also larger for Italy than for foreign countries, with two exceptions, namely Germany and Switzerland: the former country's patenting rate is slightly higher than Italy's, the latter's is more than twice as large. The particularly high patenting rates of these countries are driven by firms; in fact, for German and Swiss individuals, exhibitor-patentee matches are broadly as frequent as for other foreign individuals, and much less frequent than for Italians.

On the other side, 7% of agents granted a patent in Italy in 1911 can be observed in Turin 1911 database. As in the case of exhibitors, firm patentees feature a higher matching rate than individual ones; but in this case the difference is very large (21% for firms, *vis-à-vis* 4% for individual patentees). This is in accordance with the arguments made above, that costs and non-cost barriers might be relevant for individuals; and that the latter might expect a limited, or even negative, net present value from participating in the exhibition.

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[19] As Nuvolari and Vasta (2015a, pp. 865-6) point out, patenting in Italy was appealing for foreigners because of the country's system being very cheap by international standards and not discriminating foreign inventors, as well as because of the technological backwardness and size of the Italian market. Moreover, taking out a patent in Italy was 'easy', since the Italian system did not entail any examination regarding the invention's novelty, but only checked formal requirements.

[20] It should be noticed that a large deal of patent granted in 1912 were applied for in 1911: for patents granted in the latter year, the average time between the application for a patent and its grant was around six months.

[21] In the right-hand block of Table 2, 1911 is taken as a representative year for the period 1908-1912. Notice that this causes the number of total matches to be different in the two blocks of Table 2 (782 to the left, *vis-à-vis* 254 to the right): in fact, it would be the same on either block, if all patentees in the period 1908-1912 were considered also on the right-hand one. The use of 1911 as a representative year is justified by the matching rate in that year being similar to the average rate for the period 1908-1912: indeed, the share of patents granted to matched agents over total patents granted in 1911 is 9.8, *vis-à-vis* 8.5 over the period 1908-1912. (If anything, therefore, the figures displayed in the right-hand block of Table 2 are a slight overestimation of the matching rate over the period 1908-1912.) Complete information about patents granted in 1911 is available from the database by Nuvolari and Vasta (2015a), fully digitalising patent data for five benchmark years over the Italian 'Liberal age' (1861-1913). I am grateful to these authors for disclosing their data.

[22] Such a large share was not an Italian peculiarity: in fact, Nuvolari and Vasta (2015a, Figure 5) show that the share of patents accounted for by individuals was similar (between 70% and 80%, in 1911) in the patent systems of Italy and of other countries, including technological leaders such as Great Britain and the United States.

Table 2. Results from exhibitor-patentee matching.

	Exhibitors 1911 matched to patentees 1908-1912								Patentees 1911 matched to exhibitors 1911							
	Italy	Belgium	France	Germany	Great Britain	Switzer-land	United States	Total	Italy	Belgium	France	Germany	Great Britain	Switzer-land	United States	Total
Total observations	2,271	174	1,376	455	307	61	89	4,733	1,693	60	342	728	316	102	311	3,552
Firm	1,342	132	981	382	292	51	85	3,265	177	13	70	205	57	20	78	620
Individual	929	42	395	73	15	10	4	1,468	1,516	47	272	523	259	82	233	2,932
Total matched %	20.9	7.5	44.3	22.0	9.4	11.4	8.0	16.7	9.8	11.7	8.5	4.8	2.8	7.8	0.3	7.2
Firm matched %	22.4	9.1	11.3	25.4	11.6	51.0	8.2	18.0	37.3	30.8	25.7	13.2	14.0	25.0	1.3	20.8
Individual matched %	18.4	2.4	4.6	4.1	6.7	10.0	0.0	13.3	6.6	6.4	4.0	1.5	0.4	3.7	0.0	4.3
Total matched	472	13	129	100	35	27	7	783	166	7	29	35	9	8	1	255
Firm exhibitor - Firm patentee	178	8	75	87	23	17	6	394	66	4	18	27	8	5	1	129
Firm exhibitor - Individual patentee	123	4	36	10	11	9	1	194	43	2	6	7	1	2	0	61
Individual exhibitor - Individual patentee	171	1	18	3	1	1	0	195	57	1	5	1	0	1	0	65

Unsurprisingly, Italian patentees have a higher propensity to exhibit than average. More interestingly, this is also the case for the two small economies considered, namely Belgium and Switzerland, featuring larger exhibiting rates than Italy's (again, more than double in the case of Switzerland). The reason for this is the large industrial and technological involvement in the Italian economy of these two countries, which ranked top, among the countries-of-origin of Foreign Direct Investments in Italy before the First World War (Colli, 2010, Table 4.2).[1] Shifting attention to larger foreign economies, Germany and France feature the largest propensities to exhibit, which are lower for farther-away Great Britain and the United States.

The bottom rows of Table 2 provide more detailed information on matched observations, as they distinguish the types (i.e. firm/individual) by which matches appear in exhibition data and in patent data. These need not be the same: in fact, besides 'firm-firm' and 'individual-individual' matches, also the mixed case is observed, corresponding to observations that patented as individuals, but exhibited as firms.[2] One-half of matches are firm-firm; let us call them 'pure firms'. One-fourth is represented by individual patentees, who exhibited as firms: these can be interpreted as 'inventors-entrepreneurs', who had managed to set up innovative firms, exploiting commercially their patents, and regarded the exhibition as a *market for products*, in the same manner as pure firms did. This function of the exhibition was not relevant for individuals who both patented and exhibited as such, constituting the remaining fourth of matched exhibitors, since they were not producers. As a matter of fact, these appear to be independent inventors, using the exhibition as a *market for ideas*, i.e. to advertise their patents to potential investors, who could allow them setting up new businesses, or to existing firms, willing to buy or license the patents. Foreigners represent one-half of pure firms, around one-third of inventors-entrepreneurs, and just one-eighth of independent inventors. This comes as no surprise, as most of the latter probably did not have sufficient means to operate at an international scale.

Therefore, a substantial mismatch emerges, between exhibition data and patent data, which can be interpreted as a consequence of the reasons for exhibiting and for patenting being different. On the one hand, the main function of the exhibition appears to be that of a market for products; on the other hand, patents were mostly taken out by individual inventors, the majority of whom might never engage in production and sale, either because of the quality of their inventions being low,[3] or because of financial constraints, that even good-quality independent inventors might face. As a consequence, most patentees were not interested in participating in the exhibition, as a market for products. Yet the presence of some patentees who joined the exhibition as individuals reveals a second function of the exhibition, as a market for ideas, the relevance of which is minor but not negligible, as those observations (corresponding to 'individual-individual' matches) represent 4.2% of exhibitors from all countries considered, and 7.6% of Italian ones.

[1] Colli's study is based on the IMITA.db database, including Italy's largest joint-stock companies in various benchmark years, among which 1913. In that year, Belgium ranked first, based on the number of Italian firms characterized by the presence of that country's capital (41), on its share of total foreign-controlled capital (28%), and on its share of total foreign-controlled assets (31%). Based on the same measures, Switzerland ranked, respectively, second (33), third (19%), and fourth (16%).

[2] The other combination, corresponding to observations that exhibit as individuals, but patent as firms, is never observed.

[3] This was particularly likely to be the case for Italians: Nuvolari and Vasta (2015a) show that Italian independent inventors, unlike their American, British and Japanese counterparts (Nicholas, 2010, 2011), patented lower-than-average-quality inventions.

4. Econometric analysis

The insights from the descriptive statistics presented above can be verified, and new ones can be added, by making use of econometric techniques. Table 3 displays regressions, investigating the determinants of exhibitors' and patentees' decisions, respectively, to patent and to exhibit. In either case, the following 'baseline' specification is considered:

$$Y = \propto + \beta_1 Firm + \beta_2 Product\_class + \beta_2 Location + \varepsilon \qquad (1)$$

In addition to this, when analysing patentees' choice to exhibit, the following alternative specification is added:

$$Y = \propto + \beta_1 Firm + \beta_2 Product\_class + \beta_3 Transport\_cost + \varepsilon \qquad (2)$$

Each equation is estimated by two different econometric models, namely probit and negative binomial, the difference between which lies in the dependent variable being, respectively, a dummy variable or a 'count' variable (taking non-negative integer values). More precisely, in the probit, the dependent variable denotes whether Turin 1911 exhibitors were granted at least one patent in Italy over the period 1908-1912, or whether agents, who were granted at least one patent in Italy in 1911, exhibited at Turin's expo, irrespective of the number of patents they took out, or exhibits they displayed. By the contrary, the negative binomial's dependent variable indicates the number of patents or exhibits.

Three types of independent variables are inserted on the right-hand side of the equations, denoting exhibitors/patentees' type, geographical origin, and product class. In particular, *Firm* is a dummy variable, equalling unity for firms, and zero for individuals; and *Product class* is a categorical variable, taking the values of the 14-industries reduced version of Italian patent classification. The difference between the two specifications presented above lies in the employed geographical-origin variable, respectively *Location* and *Transport cost*. The first is a categorical variable, constructed as follows: each foreign country is attributed a category; Italy is divided into several 'tiers', based on distance from Turin (*Rest of North-West*, *North-East and Tuscany*, *Centre and South*, *Extreme South and Islands*);[4] finally, Italy's main economic centres, i.e. the cities of the 'Industrial Triangle' (Genoa, Milan, and Turin) and the capital Rome, are dedicated separate categories. *Transport cost* is a continuous variable, indicating the cost (per unit of weight) of shipping to Turin from each patentee's place, which does not only depend on geographical distance, but also on national railway fares, and on the availability of alternative modes of transport (railway, sea).[5]

Let us start from the first column of Table 3, investigating whether the exhibitors of Turin 1911 were granted patents in Italy over the period 1908-1912, by means of a probit model. The coefficients reported in Table 3 are marginal effects, which, since the regressors (with the exception of *Transport cost*) are categorical, indicate, for each value taken by a regressor, the effect on the dependent variable resulting from the regressor taking that value, rather than its selected baseline value. Therefore, the (highly

[4] Italian regions are distributed as follows: Liguria, Lombardy, and Piedmont (including present-day Aosta Valley) in *Rest of North-West*; Emilia-Romagna, Tuscany, and Venetia (including present-day Friuli) in *North-East and Tuscany*; Abruzzi (including present-day Molise), Campania, Latium, Marches, and Umbria in *Centre and South*; Apulia, Basilicata, Calabria, Sardinia, and Sicily in *Extreme South and Islands*.

[5] In fact, a set of most representative nodes has been selected and employed. Each node's land and sea distance, and cost-minimising mode of transport, are provided in Table A2 in the appendix.

significant) coefficient on dummy *Firm* implies that firm patentees are 5% more likely to exhibit than individuals, which is in line with evidence from the previous section.

Table 3. Probit and negative binomial regression results.

	Do exhibitors patent?		Do patentees exhibit?			
Specification:	(1)	(1)	(1)	(1)	(2)	(2)
Model:	probit	nbreg	probit	nbreg	probit	nbreg
Firm	0.046***	0.250***	0.195***	0.476***	0.185***	0.481***
Product class						
Agriculture	-0.001	-0.145	0.065*	0.036	0.054	-0.021
Chemicals	-0.098*	-0.389*	0.045	-0.035	0.036	-0.073
Construction and construction materials	-0.068	-0.314	0.021	-0.002	0.010	-0.048
Electricity	0.174***	0.769**	0.024	-0.033	0.020	-0.065
Food and beverages	-0.038	-0.251	0.029	-0.039	0.026	-0.069
Machine tools, machinery, components and metalworking	0.033	-0.015	0.033	0.008	0.021	-0.034
Mining	-0.003	-0.164	0.004	-0.088	0.005	-0.122
Other manufactures	-0.141***	-0.445**	-0.040	-0.142*	-0.046	-0.178*
Paper and printing	-0.098*	-0.353	0.033	-0.047	0.027	-0.084
Scientific instruments	-0.056	-0.278	0.002	-0.077	-0.005	-0.113
Steam engines	0.217***	1.424***	0.002	0.031	-0.005	0.002
Textiles, apparel & leather	-0.141***	-0.448**	-0.015	-0.096	-0.026	-0.133
Transport	0.134**	0.489**	0.027	-0.032	0.023	-0.070
Location						
Belgium	-0.122***	-0.312***	-0.141***	-0.427***		
Center and South	-0.012	-0.107	-0.149***	-0.422***		
Extreme South and Islands	-0.124***	-0.394***	-0.191***	-0.490***		
France	-0.103***	-0.331***	-0.172***	-0.448***		
Genoa	-0.010	0.158	-0.172***	-0.393***		
Germany	-0.036	0.064	-0.211***	-0.468***		
Great Britain	-0.122***	-0.397***	-0.219***	-0.521***		
Milan	0.079***	0.443**	-0.118***	-0.349***		
North-East and Tuscany	-0.026	-0.211**	-0.189***	-0.490***		
Rest of North-West	0.008	-0.037	-0.121***	-0.354***		
Rome	0.170***	0.003	-0.192***	-0.499***		
Switzerland	0.082	0.522	-0.167***	-0.413***		
United States	-0.156***	-0.452***	-0.244***	-0.559***		
Transport cost					-0.004***	-0.007***
Number of observations	4733	4733	3552	3552	3552	3552

*Notes: (i) *, ** and *** denote p < 0.1, p < 0.05 and p < 0.01, respectively (based on heteroscedasticity-robust standard errors); (ii) (omitted) baseline categories are* Turin *for the categorical variable* Location*, and* Weapons *for the categorical variable* Product class*.*

The coefficients about the *Product class* variable indicate that exhibitors in the classes of *Electricity*, *Steam engines*, and *Transport* are significantly more likely to patent than those belonging to the class of *Weapons*, which has been chosen as a baseline, because of its exhibitor-patentee matching rate being close to the average. This does not surprise, since in these engineering-related classes items typically constitute patentable matter, and patenting activity is particularly high. As a further explanation, it can be advanced that reverse-engineering was relatively easy in mechanical industries (Moser, 2012, p. 65), which rendered very risky to exhibit without being protected by a patent. By the contrary, significant negative coefficients are attached to the classes of *Other manufactures* (i.e. furniture) and *Textiles* (-14% in both cases), where most exhibits are traditional low-tech consumer goods, produced with well-established and mature technologies. Also negative, but lower in absolute value (-10%) and only significant at the 10% level, are the coefficients attached to classes *Chemicals* and *Paper and printing*. The puzzling negative coefficient of the first of these – a science-based sector, linked to the technological trajectories of the Second Industrial Revolution – is explained by the prevalence, at the exhibition, of chemical products characterised by low technological content, like fertilizers and perfumes.

As for variable *Location*, the only geographical areas, the exhibitors from which turn out to be significantly more likely to patent than those from Turin (the baseline category), are Milan and Rome.[6] All other Italian geographical categories display non-significant coefficients, except for the extreme South, displaying significantly negative ones, the magnitude of which (-12%) is comparable to that of foreign countries – a symptom of the low inventive activity in the most remote Italian regions (cf. Nuvolari and Vasta, 2015b). Indeed, most foreign countries present significant negative coefficients, since the Italian market was not as important for foreigners, as it was for Italians, resulting in a lower co-occurrence of exhibiting and patenting; but exceptions can be observed, namely Germany and Switzerland, displaying non-significant coefficients. These exceptions can be motivated by those countries' particular degree of involvement and interest in the Italian market; as well as by the concentration of their exhibits in the product classes related to mechanics, where the propensity to patent is particularly high.

Results from the negative binomial model, shown in the second column, are very similar. The main difference is constituted by the size of the coefficients, being larger than in the probit (for example, the coefficient on dummy *Firm* is 25%, meaning that the number of patents taken out by firms is one-fourth larger than that of individuals, *vis-à-vis* 5% in the probit): the reason for this is that, while in the latter model the dependent variable is limited between zero and one, in the negative binomial it can take larger values. Furthermore, the significance of a few coefficients also changes: notably, the negative coefficient on the geographical category *North-East and Tuscany* gains significance, while *Rome* loses it. In other words, economic agents from Italy's capital were more likely than those in Turin to patent, but the average number of patents they were taking out was not larger. By the contrary, agents from Milan were both more likely to patent, and taking out a larger number of patents, on average, confirming that city's status as the actual economic and technological 'capital' of Italy.

[6] It might appear surprising that Turin's performance is not significantly better than that of most areas of the country, in the light of its being one of the vertices of the so-called 'Industrial Triangle' (Genoa-Milan-Turin), the centre of Italian industrial and technological activity. This can be seen as a consequence of Turin's status of host city, encouraging the participation of relatively low-quality agents.

The remaining columns of Table 3 investigate whether agents granted patents in Italy in 1911 did participate in Turin's International Exhibition. The coefficient on the dummy *Firm* is again positive and highly significant, but much larger than previously observed (19% in the probit, and 48% in the negative binomial). This means that firms were less likely than individuals to be involved in exhibiting only or patenting only, than to perform both activities; but patenting only was especially unlikely.

The coefficients attached to product categories are generally not significant: in fact, that of category *Agriculture* is significant in the probit, and that of *Other manufactures* in the negative binomial, but only at the 10% level, and without consistence over the two models. Therefore, unlike propensity to patent, propensity to exhibit emerges not to vary significantly across sectors.

Instead, from the results concerning the variable *Location*, it clearly emerges that all patentees outside Turin (the baseline category) were significantly less likely to exhibit than those based in the exhibition's host city, as coefficients are all negative and significant at the 1% level. The magnitude of coefficients broadly increases in distance, but a strict monotonicity cannot be observed: indeed, they are lowest for Milan and the *Rest of North-West*, and highest for Great Britain and the United States; but they are higher for the *North-East and Tuscany* than for the *Centre and South*, despite the latter being father away from Turin than the former. To solve this puzzle, it should be considered that a marked divide existed, in patenting activity, between the North plus, in the centre, Tuscany and Rome, on one side, and the rest of the Centre, the South, and the islands, on the other.[7] The relatively few patentees from the latter regions, however, might be particularly motivated to present their items at a distant and internationally relevant venue like Turin's exhibition, and in so doing they were helped by a capillary organisational network.[8] Among foreigners, Belgium, France, and Switzerland display the smallest coefficient (in absolute value), meaning the highest likelihood to exhibit. The latter two countries were geographically close to the exhibition's host city; while Belgium, as observed above, was the largest foreign investor in Italy at that time, as well as the most frequent organiser of international exhibitions in the early twentieth century.

The alternative specification, replacing the categorical variable *Location* with continuous *Transport cost*, fully confirms the points just made: propensity to exhibit (unsurprisingly) decreases in the cost per unit of weight, which depends on distance, but also on national railway fares and access to the sea. Results about the other variables are congruent to those from the baseline specification.

[7] This divide is apparent from the maps in Nuvolari and Vasta (2015b), showing the geographical distribution (at the provincial level) of patents per million inhabitants in five benchmark years over the Liberal age (1861-1913). In the sample used in this analysis, 766 patentees were coming from the 'Industrial Triangle' cities (Genoa, Milan, Turin), 298 from the *Rest of North-West*, 277 from the *North-East and Tuscany*, 187 from Rome, and only 165 from the rest of the country.

[8] Art. 6 of the *Regolamento generale* invited the Chambers of Commerce to establish local committees that would act as intermediate bodies between the Exhibition's organisers and the general public. These were charged not only with promotional and communicating tasks, but also with real decision-making competencies, like the pre-selection of items to be sent to the Executive Commission for admission to the Exhibition. The establishment of such committees was also promoted abroad (art. 7) by foreign Chambers of Commerce, consulates, institutes and associations.

5. Considerations about the cost of exhibiting and patenting

With the exception of transport costs, the econometric analysis from the previous section has not kept into account the cost of patenting and exhibiting, which could in fact be a crucial factor, determining the choice of performing those activities. In the absence of individual-level data about all expenses actually made by the economic agents considered, the best alternative is to construct 'synthetic' costs, based on pieces of information from official sources about the type and amount of costs incurred by exhibitors and patentees. Two caveats are in order: first, most sources report unitary costs (e.g. the cost per occupied square metre at the exhibition, and transport fares per kilometre per tonne), which must be multiplied by some imputed values (e.g. occupied surface, and the weight of exhibits) to obtain costs in monetary units. Though some information exists that could 'guide' the quantification of those values, a high degree of arbitrariness cannot be avoided; moreover, values cannot realistically be imputed per single economic agent, but only per homogeneous groups, e.g. by product class or geographical origin. This generates a second issue: synthetic costs depend on the variables used in the econometric model above. The approximation and arbitrariness of the costs thus obtained, their limited variability, and the potential for collinearity, suggest not to attempt including them in an econometric model. Rather, this section provides a description of the costs faced by exhibitors and patentees, tries to quantify them, and speculates on how they could influence participation in the exhibition and in the Italian patent system.[9]

The costs that exhibitors had to bear are well specified in the *Regolamento Generale* of Turin's International Exhibition. Enrolment itself involved the following disbursements: i) a fixed fee of 20 lire; ii) a surface occupation fee that was proportional to the occupied area, and depended on location quality;[10] iii) the cost of 'technical services' (if required), i.e. the supply of water, steam, gas, and electricity. If the total did not exceed 100 lire, it had to be paid outright (art. 17). Furthermore, exhibitors had to bear all the costs related to the transport to and from the exhibition's venue, delivery and pick-up, opening and repacking, storage of boxes and tools, as well as for exhibiting material (tables, etc.) and maintenance (art. 18). As a facilitation for foreigners, exhibits could be temporarily imported in Italy duty-free (art. 27).[11]

Occupied surface can be estimated by matching data about the size of the exhibition's pavilions (from the exhibition guide edited by the *Touring-Club Italiano*), to data about the distribution of exhibitors across them (from the catalogue). Substantial regularities emerge: most exhibitors occupied an average surface of 12 square metres, determining a cost of 200 lire (inside galleries). For those presenting mechanical items, however, occupied average surface and cost doubled. Some of the latter exhibitors displayed their machinery at work in the *Galleria delle machine in azione*: in this case, average occupied surface would rise to 40 square metres, and cost to 625 lire. On top of this, technical services were probably another relevant cost component, although no hint can be obtained in this regard from any official source.

[9] Costs are expressed in 1911 lire. In that year, one lira exchanged for 0.19 United States dollars, 0.81 German marks, 0.99 French francs, and 0.04 British pounds (Ciocca and Ulizzi, 1990, Tab. 1).

[10] The surface occupation fee was 15 lire/m^2 (20 for the first square metre) inside galleries; 10 lire/m^2 under porticoes and in open galleries; 5 lire/m^2 (10 for the first square metre) outdoor. In all galleries and porticoes, fees were increased by 30% if areas could be accessed by two sides; by 60% if they could be accessed by three sides; and by 100% if they were isolated.

[11] Art. 27 of the *Regolamento* also envisaged that special transport fees would be arranged for exhibitors. No source could be retrieved, however, reporting such benefits.

Table 4. Unit transport cost from selected nodes to Turin.

Geographical area	*Node*	*Port (if different from node)*	*Land distance*	*Distance from port*	*Sea distance*	*Mode*	*Unit cost*
			km	km	nm		lire per tonne
Italy (TC=1.2618 lire per km per tonne; VC=0.0515 lire per tonne)							
Abruzzi	Pescara		710	0	1,209	Sea	22.57
Apulia	Bari		1,000	0	948	Sea	22.04
Basilicata	Potenza	Napoli	1,005	160	341	Sea	29.05
Calabria	Catanzaro	Gioia Tauro	1,260	110	590	Sea	26.98
Campania	Naples		870	0	341	Sea	20.81
Emilia-Romagna	Bologna		335	-		Railway	18.51
Latium	Rome	Civitavecchia	682	70	220	Sea	24.16
Liguria	Genoa		170	-		Railway	10.02
Lombardy	Milan		140	-		Railway	8.47
Marches	Ancona		560	0	1,234	Sea	22.63
Piedmont	Turin		0	-		Railway	0.00
Sardinia	Cagliari		-	0	387	Sea	20.90
Sicily	Catania		1,500	0	664	Sea	21.46
Tuscany	Florence	Livorno	400	90	53	Railway	21.86
Umbria	Terni	Civitavecchia	625	120	220	Sea	26.74
Venetia	Venice		405	0	1,325	Sea	22.12
Belgium (TC=5.1039 lire per km per tonne; VC=0.0232 lire per tonne)							
Whole country	Bruxelles	Antwerp	1050	50	2,529	Railway	27.51
France (TC=5.7289 lire per km per tonne; VC=0.0145 lire per tonne)							
South-East	Lyon	Marseille	350	250	190	Railway	8.57
Rest of the country	Paris	Le Havre	800	200	2,364	Railway	15.10
Germany (TC=4.8956 lire per km per tonne; VC=0.0250 lire per tonne)							
South	Munich	Hamburg	650	800	2,897	Railway	19.36
North Rhine-Westphalia	Cologne	Hamburg	900	430	2,897	Railway	25.63
North	Berlin	Hamburg	1,200	315	2,897	Railway	33.14
Great Britain (TC=1.8749 lire per km per tonne; VC=0.0412 lire per tonne)							
South	London		884	0	2,505	Sea	25.82
North	Birmingham		1,049	160	2,453	Sea	32.31
Switzerland (TC=5.1039 lire per km per tonne; VC=0.0232 lire per tonne)							
Whole country	Zurich		420	-	-	Railway	12.91
United States (TC=2.5520 lire per km per tonne; VC=0.0116 lire per tonne)							
North-East	New York		6,428	0	4,483	Sea	30.53
Rest of the country	Chicago	New York	7,285	1,300	4,483	Sea	45.59

Source: based on railway and shipping rates from Missiaia (2016) (for Italy, Ferrovie dello Stato 1912; cf. fn. 35). Notes: (i) railway fares' terminal and variable components (variable cost per km, and fixed cost, denoted by TC and VC, respectively) are shown in brackets close to each country's name; shipping fares' terminal and variable components (constant across countries) are 7.29 and 0.00112, respectively; (ii) Land distance *is between* Node *and Turin,* Sea distance *between* Port *and Genoa; (iii)* Unit cost *refer to the cost-minimising mode of transport (displayed in column* Mode*), between 'Railway' (denoting fully railway-based shipment) and 'Sea' (denoting shipment from* Node *to* Port*, then by sea to Genoa, then again by railway to Turin).*

Transport costs can be estimated, based on the railway and shipping rates (in lire per km per tonne) provided by Missiaia (2016, Tables 2 to 4).[12] In this case, two parameters must be imputed, namely distance and weight. While the former can be straightforwardly calculated, based on each exhibitor's location of origin, for the latter only few helpful elements can be obtained from official sources, which are specific to single observations and not suitable for being generalised.[13] Therefore, total transport costs can only be estimated, at the price of discretionary assumptions on weight. Let us rather pay attention to the unitary transport cost from various locations, displayed in Table 4. For shipping an item weighing one tonne, an Italian from Milan (the second largest location of origin of Italian exhibitors, after Turin) and a French from Paris (the most frequent location of origin, over all countries joining the exhibition) would spend, respectively, 17 lire and 30 lire. Even in the 'extreme' case of an exhibitor from Chicago, return transport costs would be less than 100 lire. Transport costs, therefore, appear to constitute a minor fraction of the total cost of exhibiting.

As for patenting, the cost scheme of the Italian patent system is described by Nuvolari and Vasta (2015a, p. 862), who point out that it was a very flexible and cheap system, by international standards. It involved an initial fee that was proportional to the requested number of years (10 lire per year), and a series of annual renewal fees that had to be paid to keep the patent 'alive', which increased over time (from 40 lire to 150 lire). It was possible to extend the duration of the patent, initially applied for, by an extra cost of 40 lire. Patenting can be treated as not involving other costs: in fact, the cost of displacement for presenting patent applications was negligible, as a very capillary network was in place.[14] 'Synthetic' patenting costs can therefore be computed by making assumptions on patent lengths and extensions. For either parameter, the actual values for 1911 can be imputed: in that year, individual patentees applied for an average initial duration of 3.76 years, and extended that duration by 1.05 years; for firms, the respective values were 6.04 and 1.96. Rounding these values to the closest integer, a cost of 340 lire is obtained for individuals, and of 615 for firms.

Although the computations made in the present section are general and rough approximations, they can still provide useful insights. Indeed, comparing these costs with the average daily wage of an Italian worker in 1911, equalling 2.67 lire (peaking at

[12] A caveat is in order: the fares indicated by Missiaia refer to coal and grain, as representative goods. Fares for other staples might actually be higher. To tackle this issue, in the case of Italy, the fare reported in Missiaia's work is substituted with the general fare for shipping 'merchandise', provided by the source she employed (Ferrovie dello Stato, 1912). This fare was structured into eight classes: the lowest (i.e. the cheapest) one is considered. For other countries, Missiaia's fares are maintained, since they do not appear to introduce a significant bias: in the case of France, the main foreign participating country, the source employed by Missiaia (Bureau of Railway Economics, 1915) reveals that the fare for shipping fabricated iron goods was close to the average of those for coal and grain (in fact, even marginally lower than that).

[13] In a few cases, mostly belonging to mechanical classes, data about the weight of exhibits is provided by the jury reports. The following examples give a taste of the heterogeneity of the various item's weight, even within the same product class. The rotating part of the tree-phase electrical generator exhibited by the *Officine di Savigliano* weighted 19 tonnes; the dynamo of the same company weighted 9 tonnes, and that presented by the firm *Ganz* 7.2 tonnes (*Relazione della Giuria*, pp. 410-411). A locomotive presented by *A.E.G.* weighted 3.5 tonnes (p. 419). The airplane engine displayed by the car-maker *Itala* weighted 150 kg (p. 522), that of Roberto Rebaudi 65 kg (pp. 522-523). *Alti Forni Terni* was displaying a massive armor-plate of 62.5 tonnes (p. 679). A security machine for textile industry, by the *Société Anonyme Verviétoise pour la construction de machines - Ancienne Maison Houget & Teston*, weighted only 25 kg (p. 727-728).

[14] Art. 24 the *Regio decreto* no. 1674 of 1864, regulating the patent system, stated that patent applications could be presented at each *prefettura* (corresponding to the administrative level of the *provincia*) or *sotto-prefettura* (an even more decentralised level).

3.88 lire in the metal-engineering sector; Scholliers and Zamagni, 1995, Table A.6), reveals that they represented a large fraction of an individual's yearly earnings. This goes well along with the finding that most exhibitors were firms, as it shows that costs represented a significant barrier for individuals to exhibit. Yet, individuals constituted the majority of patentees, in spite of the cost of patenting having a similar magnitude as that of exhibiting. To explain this difference, it should be considered that patents were assets, which remained in the inventors' portfolios, whereas the exhibition was a temporary event, whose benefits might be uncertain. This could discourage independent inventors from exhibiting: rather, if their intention was to promote their patents, the services of patent agents might prove much more an effective instrument than participating in an exhibition (Nicholas 2010, 2011; Andersson and Tell, 2016).

Evidence in favour of the latter argument comes from the fact that the few individuals that have been observed to both patent and exhibit in Section 3, seem to be particularly qualified independent inventors, whose experience and reputation allowed them to move independently in the market for ideas. Many had their profession or title specified, in the exhibition's catalogue, e.g. 'engineer' or 'professor', arguably in order to signal their quality. Moreover, some of them, for instance Riccardo Arnò, Alessandro Artom, and Gino Campos, did not only patent their findings in Italy, but also in the United States, which is an indicator of a particularly high quality.[15] It appears therefore that prominent skills, experience, and renown were a requisite for inventors to exploit the exhibition as a market for ideas. In fact, this might not be a viable option for the majority of independent inventors.

6. Conclusions

This work contributes to the recent literature on international exhibitions, and on the use of data from these events as a proxy for innovation in economic history. It provides an in-depth analysis of one representative exhibition, namely Turin 1911, and compares data from this event to Italian patent data. A substantial mismatch emerges, between these two types of data, which appear to be largely disjoint sets. It is argued that the main reason, behind the difference between exhibition data and patent data, lies in the reasons for exhibiting and for patenting being different: on the one hand, the main function of the exhibition appears to be that of a market for products, as the preponderance of firms among exhibitors clearly reveals; on the other hand, patents were mostly taken out by individuals, the majority of whom might not be interested in that function. As a matter of fact, the presence has been observed of a secondary function of the exhibition, as a market for ideas, which could however only be profited from by particularly skilled independent inventors.

The degree of overlapping, between exhibition data and patent data is not homogeneous; in fact, it is much larger for firms than for individuals. Furthermore, exhibitors have a significantly higher propensity to patent in engineering-related product classes than in other ones, because of the risk of reverse-engineering being particularly high. By the contrary, the propensity to exhibit of patentees does not emerge to be significantly affected by product class; while it is largely determined by the location of economic agents.

[15] Between 1899 and 1919, seven patents were granted in the United States to Arnò, ten to Artom, and five to Campos. All three were electrical engineers. Arnò and Artom were also academics: the former was a professor of electrical engineering at the Polytechnic University of Milan, the latter was a professor of radiotelegraphy at the University of Turin. Campos worked for CGS, one of the leading Italian firms in the field of electrical engineering, founded by Camillo Olivetti.

The limited overlap between exhibition data and patent data can be interpreted as due to the former being characterised, as a proxy for innovation, by an opposite drawback to that attributed to the latter. As it is widely acknowledged, patents strictly speaking represent *invention*, rather than innovation. They can be used to measure innovation in as much as they indicate 'the presence of a non-negligible expectation as to its ultimate utility and marketability' (Griliches, 1990, p. 1669). Many patents, however, fail to reach the market, thus becoming innovations. Exhibits suffer from an opposite drawback: they do represent goods brought to the market, but not necessarily innovative ones. In fact, many are primary products, and a large fraction of manufactured ones is constituted by traditional low-tech consumer goods, produced with well-established and mature technologies, e.g. textiles and furniture.

This calls for a reconsideration of the use of exhibition data as a proxy for innovation. First, it should be adequately stressed that this data is mostly informative about the activity of firms. This is important, because exhibition data can provide a valuable overview on these economic agents during the 'age of the independent inventor', and therefore be a very useful complement to patent data, which by the contrary is dominated by individuals. Second, while exhibition data has so far been considered on a par with patent data, it can actually be more representative of 'pettier' innovative activities. Future works should explore the relationship of exhibition data with designs and trade-marks, which might prove closer than that to patent data. Furthermore, most present-day analyses follow the guidelines for collecting and interpreting innovation data, set out by the OECD (2005) in the 'Oslo manual', according to which any new product or service brought to the market is an innovation – a much looser criterion than those required for patentability, which fits exhibition data quite well. Therefore, research on exhibitions can not only add new insights to research on innovation in a historical perspective, but can also ensure an improved comparability to the most up-to-date non-historical works.

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Appendix

Table A1. Official distribution of exhibits, by country and group.

	Total	Italy	Belgium	France	Germany	Great Britain	Switzerland	United States	Rest of Europe	Latin America	Asia
Total	22,271	6,774	409	6,261	868	755	71	120	878	5,365	770
% country		30.4	1.8	28.1	3.9	3.4	0.3	0.5	3.9	24.1	3.5
1. Teaching	768	376	1	231	4	4	0	8	32	83	29
2. Instruments	310	108	0	78	48	41	4	6	10	15	0
3. Photography	334	125	3	71	39	43	0	1	8	38	6
4. Mechanics	487	168	6	75	119	43	20	35	9	12	0
5. Electricity	285	110	2	87	41	20	15	0	5	5	0
6. Construction	195	63	8	74	11	10	2	1	3	22	1
7. Land transport	316	112	15	74	53	29	3	1	6	19	4
8. Navigation	141	38	11	37	16	14	0	2	5	14	4
9. Aviation	64	14	3	25	18	3	0	0	0	1	0
10. Post services	13	7	0	0	1	1	0	0	0	3	1
11. Sports	350	123	15	113	26	62	0	3	0	5	3
12. The modern city	277	106	10	101	14	6	0	0	4	36	0
13. Furniture	1,207	373	8	396	61	53	3	7	64	106	136
14. Music and shows	169	69	3	19	43	4	0	5	6	17	3
15. Forestry	707	49	0	108	7	15	0	0	95	422	11
16. Agriculture	2,687	334	6	506	22	66	7	15	127	1,572	32
17. Foodstuffs	5,053	1,312	118	1,795	58	43	7	3	150	1,482	85
18. Mining and chemicals	1,901	516	35	334	88	113	2	15	118	621	59
19. Textiles	929	205	24	153	12	47	4	0	68	205	211
20. Apparel	709	185	15	257	22	14	1	5	39	76	95
21. Jewelry and accessories	390	93	8	121	47	5	0	2	34	16	64
22. Leather	514	154	21	94	20	35	0	2	31	149	8
23. Printing	1,294	264	27	614	64	73	3	9	35	189	16
24. Social economy	1,743	559	65	878	22	4	0	0	22	191	2
25. Colonisation and migration	1,247	1,165	5	20	0	0	0	0	0	57	0
26. National defence	181	146	0	0	12	7	0	0	7	9	0

Source: Relazione della Giuria, pp. 286-97.

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