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Exhibitions, patents, and innovation in the early twentieth century: evidence from the Turin 1911 International Exhibition

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This paper investigates the relevance for innovation of international exhibitions. While the first of these events, i.e., London's 1851 Great Exhibition, was an "exhibition of innovations," many of the subsequent ones, following the model of industrial exhibitions developed in France, did not select exhibits based on novelty. In fact, they displayed a large spectrum of products, ranging from machines to primary products. Therefore, the suitability of data from their catalogs for proxying innovation, and their relationship to the traditional patent measure, should be better qualified. To do so, this paper performs an in-depth analysis of the Turin 1911 international exhibition, a medium-sized representative "French-model" exhibition. It matches a new database, built from the catalog of this event, with patents granted in Italy, revealing substantial differences. Furthermore, it evaluates how inventors could use the exhibition to promote their ideas, establish their reputation, and develop their career.

1. Introduction

Since at least the seminal work of Schumpeter (1942), innovation is considered a central driver of economic growth. Its quantification is therefore a highly relevant matter, and a number of measures have been identified and designed for this task. Arguably, this is of special importance in economic history; but in this field, special issues are also encountered, due to the scarcity of available proxies. Indeed, when dealing with the pre-Second World War era, little is left, apart from patents. These 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 long ago in time.

Patents, however, suffer from well-known shortcomings (Griliches 1990; Nagaoka *et al.* 2010). First, a patent strictly speaking represents an invention, rather than an innovation, that is the commercial application of an invention. It can be treated as an innovation, in as much as it indicates "the presence of a non-negligible expectation as to its ultimate utility and marketability" (Griliches 1990, p. 1669). Moreover, not all inventions are patented, as revealed by industrial surveys (Levin *et al.* 1987; Arundel *et al.* 1995; Cohen *et al.* 2000).

In a historical context, evidence that patents fall short of representing a comprehensive measure of innovation is provided by the works by Moser (2005, 2011, 2012), using data

from the catalog of London's 1851 Great Exhibition (also known as the "Crystal Palace" exhibition). Moser presents London's exhibits as an alternative proxy for historical innovation, including both patented and non-patented items, as they were selected for their "novelty and usefulness" (Moser 2005, p. 1218); and, matching exhibition data to patent data, she finds that as much as 89 percent of the British exhibits at the 1851 exhibition were not patented.

This effectively demonstrates that a huge part of innovative activity occurred outside the patent system in the nineteenth-century.[1] However, it would be misleading to interpret Moser's results as general evidence about the relation between innovation and the long stream of international exhibitions that followed London's 1851 Great Exhibition (see table 1). This can be understood, paying attention to the very origins and evolution of these events.

Although the roots of industrial exhibitions can be traced back to the display, since 1761, of machines that were awarded invention prizes by the British *Society of Arts* (Luckhurst 1951, p. 63), the "modern exhibition movement" properly started with a series of 11 *expositions publiques des produits de l'industrie française*, held between 1798 and 1849 in Paris. Devised in the aftermath of the Revolution with the purpose of reviving French industry, these exhibitions were "of a more general character than those of the Society of Arts … and particularly of the *products* of industry rather than merely of its tools" (*ibidem*, p. 70). This model was subsequently extended on an international scale. In fact, it was Britain that organized the first international exhibition, i.e., the Crystal Palace; which, in line with the tradition from the Society of Arts' exhibitions, was conceived as an "exhibition of innovations" (Moser 2005, p. 1218; 2012, pp. 49–50). But France soon responded by organizing an international exhibition in Paris in 1855, and since then confirmed its leadership in the field by organizing the largest number of these events, and the most attended ones, in the second half of the nineteenth-century; while geographically and culturally close Belgium became the most active organizer around the turn of the twentieth-century (see table 1). Therefore, after the Crystal Palace, the "modern exhibition movement" mainly evolved along the lines of the French model.

In particular, this implied that exhibited items were not necessarily innovative. In fact, Moser argues that novelty was a requirement for admission at the Crystal Palace exhibition; which allows her to use that exhibition's data as a representative sample of innovation.[2] This, however, does not apply to many of the following international exhibitions. Four years later, at the Paris 1855 exhibition, no selection was made, based on novelty: this approach was maintained at the successive expos organized by France and, because of that country's leading role in the field, extended to other countries' exhibitions.[3]

[1] Notice that a similar study, carried out by Thomson (2009) on data from the 1853 New York "Crystal Palace" exhibition, finds a much larger correspondence between exhibition and patent data, as "[t]ree-fifths of Americans exhibited patented products" (p. 204).

[2] Actually, Moser (2005, 2011, 2012) also employs data from three later exhibitions, held in the United States of America, namely Philadelphia 1876, Chicago 1893, and San Francisco 1915. However, her main focus is on the Crystal Palace, and from the other exhibitions she mainly considers the technological-frontier sectors of chemicals and manufacturing machinery.

[3] At Paris 1855, art. 13 of the *Règlement général* stated as admissible "all products of agriculture, manufactures, and art," except for selected categories, like dangerous materials (Paris 1855 Expo, 1855, p. vii). The Imperial Commission only had the right of excluding "such French objects as may appear to it injurious or incompatible with the object of the Exhibition" (art. 15; *ibidem*). The principle was identical at the last of the five Parisian expos of the nineteenth-century (i.e., that of 1900; see Paris 1900 Expo, 1896, artt. 29–30). The same applies to the rules of the Turin 1911 exhibition, studied here (see the next section).

Table 1. *Comparative data about international exhibitions, 1851–1915*

Year	City	Visitors (millions)	Surface (Ha)	Participating countries	Total exhibits (from the host country)	Openness
1851	London	6.0	10	25	14,000 (6,861)	51.0
1853	New York	1.2	2	20	4,400 (2,200)	50.0
1855	Paris	5.2	15	27	23,954 (11,986)	50.0
1862	London	6.1	11	39	29,765 (9,140)	69.3
1867	Paris	15.0	69	42	52,200 (15,969)	69.4
1873	Vienna	7.3	233	35	53,000 (9,104)	82.8
1876	Philadelphia	10.0	115	35	30,864 (8,175)	73.5
1878	Paris	16.2	75	35	52,835 (25,872)	51.0
1880	Melbourne	1.3	25	33	12,791 (2,130)	83.3
1885	Antwerp	3.5	22	24	14,473 (3,411)	76.4
1888	Barcelona	2.3	47	30	12,900 (8,600)	33.3
1889	Paris	32.3	96	35	61,722 (33,937)	45.0
1893	Chicago	27.5	290	19	70,000 (25,000)	64.3
1894	Antwerp	3.0	27	27	12,239 (4,398)	64.1
1897	Brussels	6.0	36	27	13,263 (5,521)	58.4
1900	Paris	50.9	120	40	83,047 (38,253)	53.9
1904	Saint Louis	20.0	500	60	(15,009)	
1905	Liège	7.0	70	35	17,000 (4,000)	76.5
1906	Milan	7.5	100	40	27,000 (3,995)	85.2
1910	Brussels	13.0	90	26	29,000 (6,500)	77.6
1911	Turin	7.4	25	37	22,271 (6,774)	69.6
1913	Ghent	9.5	130	24	18,932 (5,000)	73.6
1915	San Francisco	18.9	254	24	30,000	

Note: Openness is defined as the ratio between foreign and total exhibits.
Sources: Antwerp 1885 Expo (1886); Antwerp 1894 Expo (1894); Turin 1911 Expo (1915); for New York 1853, Thomson (2009); for all other exhibitions, Schroeder-Gudehus and Rasmussen (1992).

International exhibitions were also known as "universal exhibitions": this alternative expression refers to the fact that they covered all the fields touched by human work and ingenuity.[4] Indeed, they displayed a large spectrum of products, ranging from machines and other items characterized by high technological and innovative content, to traditional consumer goods, e.g., textiles and furniture, produced with well-established and mature technologies; as well as to primary products, like minerals and crops (Khan 2015, pp. 653–4; Thomson 2009, pp. 207–8). They also featured displays having "social" or "educational" character. In general, they aimed at providing a representative picture of the products and activities of the participating countries.

A third phrasing by which these events are known, namely "world's fairs" (popular in the United States of America), stresses their nature as big marketplaces, providing visibility on a worldwide scale: this made them particularly attractive for firms that operated in the wide national and international markets, and aimed at advertising their products and strengthening

[4] In fact, non-universal (i.e., specialized) international exhibitions also existed, as well as country-level universal ones. The major exhibitions as per table 1, however, were both international and universal.

their reputation (Khan 2013, pp. 107–8; 2015, p. 658; Richardson 2009, p. 411; Schroeder-Gudehus and Rasmussen 1992, p. 6; Thomson 2009, pp. 205–8).

While their scope was larger than just displaying innovations, the relevance of international exhibitions for innovation should not be understated or overlooked. In fact, in an era of breakthrough technological changes, when the technological paradigms associated to the Second Industrial Revolution emerged, these events celebrated "the splendors of progress" (Schroeder-Gudehus and Rasmussen 1992), and played an important function in the diffusion of new technologies (Ahlström 1996; Roca Rosell 2015). Exhibitions were great opportunities for inventors and producers of innovative products to advertise their ideas and products to an audience that was particularly keen on the newest advances of science and technology. To ensure participation by inventors, exhibition rules typically made specific provisions for the temporary protection of exhibited inventions.[5] Many famous inventions were displayed at international exhibitions, like Colt's revolver and Goodyear's vulcanized rubber at London 1851, the saxophone and the Singer sewing machine at Paris 1855, the Remington typewriter and Bell's telephone at Philadelphia 1876, the Lumière brothers' cinema at Paris 1900. Notice that most of these had been invented, and patented, several years before their display at exhibitions;[6] still, the latter were opportunities for them to reach a large audience.

The present paper investigates the relevance for innovation of the international exhibitions that followed the Crystal Palace exhibition. While the latter can be characterized as an "exhibition of innovations," this section has argued that such a characterization does not apply to many subsequent exhibitions. The sheer number of these events, as well as the bulk of information that each of them generated (catalogs, reports, acts of congresses, etc.) and that can be exploited by economic historians, calls for a careful assessment of their function, and in particular of the role they played for innovation. In this regard, the suitability of data from their catalogs for proxying innovation *à la* Moser, and their relationship to the "traditional" patent measure, should be better qualified. To do so, this paper makes an in-depth analysis of a medium-sized exhibition of the early twentieth-century, namely the Turin 1911 international exhibition; and matches a new database, built from the catalog of this event, with data about patents granted in Italy. Furthermore, it evaluates how inventors could use the exhibition to promote their ideas, establish their reputation, and develop their career.

Section 2 introduces the Turin 1911 international exhibition and the Italian patent system in the contemporary international context, and motivates the study of the Italian case. In Section 3, the new database about the manufactured products displayed at the Turin 1911 exhibition is matched to patent data, and the relationship between them is evaluated; moreover, econometric techniques are used to delve deeper into the determinants of exhibiting

[5] In the occasion of the Crystal Palace exhibition, the British Parliament passed the Protection of Inventions Act, granting temporary patent protection to exhibitors who made request for it (Purbrick 1997). Likewise, such a system was devised by artt. 53–57 of the *Règlement général* of the Paris 1855 exhibition (see Paris 1855 Expo, 1855, p. x). By the contrary, the inadequate protection of inventions at the Vienna 1873 international exhibition generated widespread concerns, which led to the passing of special legislation for exhibited items, as well as to a series of international talks (in Vienna in the same year, and in Paris in 1878), culminating in the signing, in 1883, of the Paris Convention on the protection of industrial property. This was a milestone, wide-range agreement, establishing rules for the international protection of intellectual rights. In particular, art. 11 of that text envisaged the temporary protection of patentable inventions displayed at international exhibitions. Special legal provisions for the patenting of exhibited inventions also applied to the Turin 1911 exhibition, as explained in Section 3.

[6] The mentioned inventions were first patented in 1836, 1844, 1846, 1851, 1868, 1876, and 1895, respectively.

and patenting. Section 4 studies how inventors and innovators used the exhibition to promote their ideas and products, as well as to boost their reputation and career. Finally, Section 5 makes conclusive remarks on the findings of the paper.

2. Exhibitions and Patents in Early Twentieth-Century Italy: an Overview

The analysis conducted in this paper is based on data from an international exhibition held in Italy in 1911 and from the Italian patent system. This requires some motivation, since Italy was at that time a peripheral developing country; which might raise concerns about its representativeness. As this section demonstrates, pre-First World War Italy is actually a good case for investigating the relevance of exhibitions as "markets for products" and as "markets for technologies," precisely because it was an emerging country, characterized by a developing economy, an expanding market, and increasing innovative activity and technological transfer; because of the openness of the 1911 exhibition and of the Italian patent system; and because of the availability of good-quality data.

The studied exhibition, the *Esposizione internazionale delle industrie e del lavoro* (International exhibition of industries and labor), took place in Turin from 29 April to 19 November 1911, and was officially joined by 22 foreign countries from Europe, Asia and the Americas (but exhibitors came from even more countries). It was based in the *Parco del Valentino* of the cosmopolitan former capital of the Kingdom of Italy, both geographically and culturally close to France and the rest of continental Europe, and was visited by 7.4 million people. As table 1 reveals, while considerably smaller than the exhibitions hosted by France and the United States of America, the size of Turin's exhibition was of the same order as that of exhibitions held in other countries, notably Belgium (Antwerp 1885 and 1894, Brussels 1897 and 1910, Liège 1905, Ghent 1913) and Italy itself (Milan 1906). These smaller exhibitions were characterized by a large degree of openness, defined as the ratio of foreign participants over total participants. In the case of Belgian ones, however, openness was inflated by the large participation from France, even surpassing that from the host country. The Italian exhibitions of Milan 1906 and Turin 1911 hence emerge to be the most "genuinely" open ones: remarkably, Milan's exhibition shows a record openness of 85 percent. However, the Turin 1911 exhibition is preferred, to be the object of the present analysis, because complete digitalized information is available about Italian patents granted in 1911.[7] This makes data from Turin's exhibition particularly suitable for being matched and compared to patent data, which is one of the main tasks of this paper.

The Turin exhibition, following the "French exhibition model" presented in the introduction, aimed at displaying all sorts of human work, with no specific requirement of novelty.[8] It was held in the occasion of the fiftieth anniversary of Italy's Unification, and was seen by the organizers as a great opportunity to show the world that "the intelligence of the country does not only apply to painting and making music, speaking or writing, but also acts on markets" (Turin 1911 Expo 1915, p. 1). Indeed, it took place towards the end of the country's first important phase of economic development, when the growth rate of the Italian economy more than doubled, with respect to the previous decades, and aligned to that of the most advanced economies (Toniolo 2013; Felice and Vecchi 2015). All the more

[7] Nuvolari and Vasta (2015a) digitalized information from Italian patents in 5 benchmark years over the Italian "Liberal age" (1861–1913), including 1911. I am grateful to them for disclosing their data.

[8] The purpose of the exhibition, as per art. 3 of the *Regolamento generale* (Turin 1911 Expo 1911a, p. 2), was to gather "all products of agricultural and industrial work, and generally all expressions of economic and civil life".

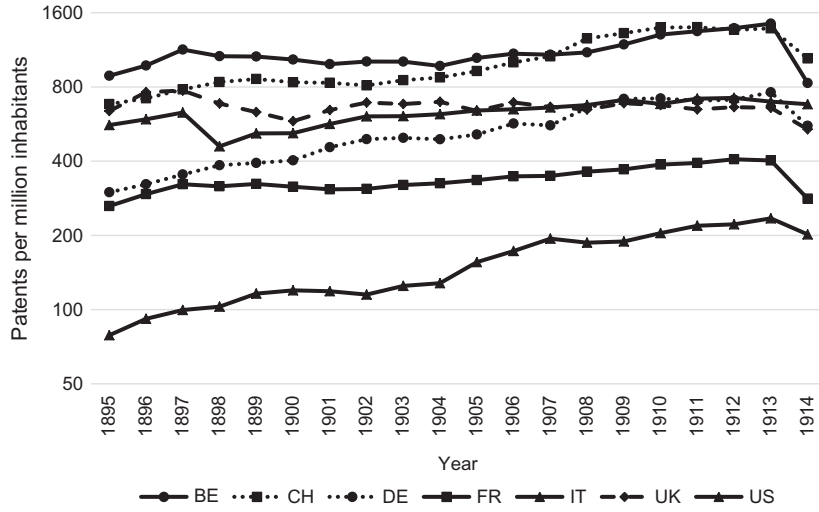

Figure 1. *Patent applications per million inhabitants in selected European countries (logarithmic scale), 1895–1914.*
Sources*: Own elaboration on WIPO's historical patent data (http://www.wipo.int/ipstats/en/) and population data from the Maddison Project 2018 version (Bolt* et al. *2018).*

so, the city of Turin was one the main centers of Italy's industrialization, as the country's expanding industrial sector (and related inventive activity) concentrated in those decades in the "industrial triangle," i.e., the North-Western cities of Genoa, Milan, and Turin itself (Ciccarelli and Fenoaltea 2013; Nuvolari and Vasta 2017). The developing Italian economy was an attractive destination for foreign capital, the presence of which was considerable (involving more than one-eighth of the largest Italian joint-stock companies, and almost one-fifth of their share capital) and pervasive across sectors, though stronger in technology- and capital-intensive ones (Colli 2010, pp. 89–93).

In line with these general economic trends, the Italian patent system was expanding. Figure 1 shows that the population-adjusted number of patent applications in Italy grew throughout the years 1895–1913, until a generalized fall in patenting activity was brought about by the war, and converged towards those of the major industrial countries. This expansion reflects an increase of patents taken out by both Italians and foreigners at the same rate, as the openness of the Italian patent system (defined as the share of patents accounted for by foreigners) was broadly stable, between 60 and 70 percent. Such a degree of openness was considerably higher than that featured by more economically developed countries, with the exception of small open economies like Belgium and Switzerland (Nuvolari and Vasta 2015b, table 3). Patenting in Italy was appealing for foreigners because of the country's system being flexible and cheap, by international standards, and not discriminating against foreign inventors. Moreover, it was "easy," since the Italian system, following the French model, did not entail any examination regarding the invention's novelty, but only checked formal requirements (Nuvolari and Vasta 2015a, pp. 862–6; 2015b, pp. 275–80). Finally, the technological backwardness and size of the Italian market created opportunities for the commercial exploitation of foreign technologies: indeed, the highly open Italian patent system was an important channel by which cutting-edge foreign technology was transferred to Italy (*ibidem*). Based on these characteristics, this paper assumes that any inventor with some interest in the Italian

Table 2. *Selected countries' shares in Turin exhibits, Italian patents, FDI in Italy, and Italian imports in 1911*

	Italy	Belgium	France	Germany	Switzerland	United Kingdom	United States of America
Exhibits							
% on official	30.4	1.8	28.1	3.9	0.3	3.4	0.5
% on database	35.6	2.8	20.2	11.2	1.1	7.2	1.2
Patents							
% on total	34.9	1.8	9.8	23.2	8.1	4.3	8.2
% on database	44.2	1.7	8.2	19.9	2.7	6.4	8.3
FDI							
% of firms	-	25.0	18.9	16.5	20.1	4.2	8.5
% of capital	-	28.0	16.0	21.0	4.6	19.0	7.0
Imports							
% of imports	-	2.4	9.7	16.2	2.3	15.0	12.5

Note: For patents, "total" includes *rivendicazioni*, while "database" excludes them (see fn. 13 and 17).
Sources: For exhibits, tables A1 and A2 (in Appendix A); for patents, own elaboration on data by Nuvolari and Vasta (2015a); for FDI, Colli (2010, table 4.2); for imports, Federico *et al.* (2011, table 1.10).

market could and would get Italian patent protection. Notice that this was facilitated by international agreements regarding intellectual property protection, first established at the Paris Convention of 1883: notably, when applying for protection in a second country, an inventor would enjoy a (limited) "priority right," by which the date of the new patent would correspond to that of the first patent application. Another relevant point to notice is that Italian patents could be taken out by firms as well as by individual inventors.

Table 2, displaying the shares of selected countries in Turin 1911 exhibits, Italian patents, foreign direct investment (FDI) in Italy, and Italian imports, provides quantitative evidence about the openness of the Italian economy, and reveals some connections between the mentioned aspects, about which more will be said below. It confirms that the Turin 1911 exhibition was an important opportunity for Italian producers and innovators to demonstrate their achievements on an international scale, and for their foreign equivalents to promote their items in the expanding Italian market.

3. Matching Exhibition and Patent Data

The exhibition data employed in this paper come from a new database, based on the partial digitalization of the *Catalogo generale ufficiale* of the Turin 1911 International Exhibition (Turin 1911 Expo 1911b). Official statistics, available in Appendix A, indicate that more than 22 thousand exhibits were presented at that event, classified into 26 groups, further divided into 167 classes. A very large amount of the products on display, however, consisted of primary commodities (e.g., agricultural and mining products), which are insignificant for this paper's analysis of the relevance of the exhibition for innovation. Therefore, the database does not list every single item that was displayed in Turin; rather, it provides an account of the manufactured products on display.[9] In total, 7,671 exhibits are included:[10]

[9] Following a widely diffused practice, those products falling under divisions 0–4 of the *Standard International Trade Classification* (SITC) are considered as primary, the others as manufactured.
[10] Each observation of the database corresponds to a single entry from the catalog.

Table 3. *Exhibitors and patentees: descriptive statistics and matching results*

	1911 exhibitors matched to 1906–1913 patentees			1911 patentees matched to 1911 exhibitors		
	Total	Italy	Foreign	Total	Italy	Foreign
(A) Descriptive statistics						
Total observations	4,732	2,269	2,463	3,555	1,698	1,857
Type (% in total)						
Firm	69.3	59.1	78.6	17.3	10.4	23.7
Individual	30.7	40.9	21.4	82.7	89.6	76.3
Product class (% in total)						
Non-mechanical	69.4	72.1	66.9	40.3	40.6	40.0
Mechanical	30.6	27.9	33.1	59.7	59.4	60.0
(B) Matching results						
Matched observations	787	469	318	261	172	89
% in total	16.6	20.7	12.9	7.3	10.1	4.8
% in firm	18.1	22.1	15.3	20.6	36.9	14.1
% in individual	13.4	18.7	4.0	4.6	7.0	1.9
% in non-mechanical	10.3	12.9	7.7	6.2	9.0	3.5
% in mechanical	31.1	40.8	23.5	8.2	10.9	5.7
Type (% in matched)						
Firm	75.3	63.1	93.4	48.7	37.8	69.7
- Other type: Firm	50.8	37.9	69.8	48.7	37.8	69.7
- Other type: Individual	24.5	25.2	23.6	0.0	0.0	0.0
Individual	24.7	36.9	6.6	51.3	62.2	30.3
- Other type: Firm	0.0	0.0	0.0	27.2	29.1	23.6
- Other type: Individual	24.7	36.9	6.6	24.1	33.1	6.7
Product class (% in matched)						
Non-mechanical	42.8	45.0	39.6	33.5	35.7	29.2
Mechanical	57.2	55.0	60.4	66.5	64.3	70.8
(C) Quality observations						
% of quality in sample	39.2	18.3	55.4	9.4	4.5	13.9
% of matched in quality	37.5	64.7	30.5	10.6	15.6	9.0

Sources: For Turin 1911 exhibition data, own database; for Italian patent data, own elaboration on data from Nuvolari and Vasta (2015a) and MAIC (1906-1913).

Notes: (i) Mechanical classes are Electricity, Machine tools, Scientific instruments, Steam engines, Transport, and Weapons; (ii) the shares of quality observations are computed in mechanical exhibitors and total patentees (see Section 4.2).

these amount to 34 percent of the official total, which demonstrates that non-manufactured products were preponderant among the items on display at the exhibition. Furthermore, among manufactured products, more than half fall in the classes referring to textiles and apparel, construction (including glass and ceramics), furniture, and chemicals, among which low-technological content products, like fertilizers and perfumes, prevailed.[11]

The fact that a large fraction of the exhibits of the Turin 1911 exhibition was constituted by primary products and low-technology manufactured goods shows that innovative

[11] Exhibit-level descriptive statistics about the Turin 1911 database are available in Appendix A.

products were a minority among them.[12] This section matches the Turin 1911 exhibition database with patent data, traditionally employed as a proxy for historical innovation, and points out the differences between the two.

The exercise conducted here is similar, but not equivalent, to the matching of patent data to exhibition data, carried out by Moser in her works (2005, 2011, 2012). She computes the share of exhibits that find a correspondence among patents; which, based on the assumption that the Crystal Palace exhibits represent a relatively unbiased sample of innovations, provides an estimate of innovators' propensity to patent. In the case of the Turin exhibition, as well as of many other international exhibitions, exhibits did not only include novel items. Hence, exhibits should not be seen as a more comprehensive proxy for innovation than patents, of which the latter represent a subset. In fact, exhibits and patents might rather be largely disjoint sets, having a small intersection: in other words, they might be mostly made of different elements, representing different phenomena. Therefore, in order to clearly picture the extent to which they share common elements, not only the share of exhibits that found a correspondence among patents should be evaluated, *à la* Moser, but also the share of patented inventions that were exhibited. In this spirit, this section first presents a matching from exhibition data to patent data, then an opposite-direction matching, from patent data to exhibition data.

The first of these two exercises is performed by searching the names of Turin 1911 exhibitors in the indices of patentees, published at the end of each annual issue of the *Bollettino della Proprietà Intellettuale* (MAIC 1906-1913), between 1906 and the first semester of 1913.[13] These lists are only available since 1906—hence the lower bound of the matching time interval. As for the upper bound (the first semester of 1913), it takes into account the special provisions for the patenting of items displayed at international exhibitions, originally devised by the Paris Convention[14] and regulated, in the case of the Turin exhibition, by the law n. 423, 16 July 1905, and the *regio decreto* n. 692, 17 September, 1910. According to the latter, exhibitors had a 1-year time window, since the opening of the exhibition, to apply for patent protection of an exhibited item; and if they did so, the patent's priority date would be set to one month before the start of the exhibition. Considering that the lag between the application and the grant of a patent in 1911 was less than 1 year for 95 percent of granted patents,[15] this issue can be practically fully accounted for by setting the upper boundary of the exhibitors-to-patentees matching time interval to 2 years after the opening of the Turin exhibition, i.e., mid-1913.

The structure of the employed patent data source causes the matching to be performed at the level of the individual (i.e., exhibitor-patentee), rather than at the level of the item (i.e., exhibit-patent). This approach also presents some advantages of its own: first, it is looser and more conservative in establishing matches.[16] Second, it provides better ground

[12] This was not a peculiarity of the studied exhibition, as reviewed in the introduction.

[13] These alphabetical indices display the pages of the *Bollettino* at which each patentee's patent records can be found, plus synthetic information about each patent's class and type. Regarding the latter, this matching exercise considers patents originally applied for in Italy and those extended from abroad via the Paris Convention (*rivendicazioni di priorità* and *importazioni*), whereas it disregards extensions (*attestati di prolungamento*) and variations in scope (*attestati completivi* and *attestati di riduzione*), due to their accessory character.

[14] See fn. 5.

[15] Own calculation based on data by Nuvolari and Vasta (2015a).

[16] Notice that Moser herself adopts a conservative approach, when matching exhibits and patents: "To capture as many patents as possible, patents are counted as a match as long as they are related to the exhibit" (Moser 2012, p. 50).

for the econometric exercise performed below, a discrete-choice model that investigates the determinants of decisions to exhibit and to patent.

The second matching exercise verifies whether firms and individuals, granted an Italian patent in the year 1911, find a correspondence in the Turin 1911 database. The list of patentees is obtained from the Nuvolari and Vasta (2015a) database for 1911. Notice that this exercise is similar, but not exactly specular to the previous one, due to the set of patentees being different in the two cases (1906–1913 in the first, 1911 only in the second).[17]

Not all data from the Turin 1911 database are employed for these exercises. The exhibitor types[18] other than individual and firm are excluded, because they did not take out patents, apart from rare exceptions.[19] At the country level, Italy and the major foreign industrial economies are considered (Belgium, France, Germany, Switzerland, the United Kingdom, and the United States of America), which jointly account for almost 80 percent of 1911 exhibits and for more than 90 percent of patents (cf. table 2).

Table 3 displays basic statistics about exhibitors and patentees (panel A), and the results of both matching exercises (panel B).[20] Both samples are almost equally split into Italians (48 percent) and foreigners. Instead, sharp contrasts between exhibitors and patentees emerge, when looking at the breakdowns by type and (aggregate) product class.[21] Notably, almost 70 percent of the former are firms, while more than 80 percent of the latter are individuals.[22] These large shares make no surprise: on one side, as pointed out above, exhibitions were important means of advertisement and reputation-building for firms; on the other, the relevance of the contribution to patenting by individual inventors, in the decades between the nineteenth and the twentieth-century, is well known in the literature (Hughes 1989; Lamoreaux and Sokoloff 1999; Nicholas 2010, 2011; Nuvolari and Vasta 2015a). Furthermore, the cost of exhibiting could represent a barrier for participation in the exhibition by individuals, whereas patenting was more accessible: indeed, an estimate of the costs of exhibiting and patenting, the details of which are presented in Appendix B, reveals that the former was two or three times more expensive than the latter. In addition to the cost difference, it should be considered that patents were assets that remained in the inventors' portfolios, and were important to make inventions safely marketable; whereas the exhibition was a temporary event, the benefits from which might be uncertain.[23] In the case of both exhibitors and patentees, individuals represent a larger share in Italians than in foreigners. This cannot be explained by the lower costs faced by Italians to exhibit in Turin: in fact, as shown in Appendix B, exhibiting was even more expensive for Italians in real terms, as a consequence of their lower income. The reason should rather be sought for in the absence of non-monetary barriers, e.g., linguistic ones, and by the fact that this domestically-hosted exhibition was a more direct reference for Italians than for foreigners.

[17] Furthermore, the Nuvolari and Vasta (2015a) data does not include *rivendicazioni*, which are instead considered in the exhibitors-to-patentees matching (cf. fn. 14).

[18] Exhibitor type is not directly indicated by the source, but inferred by the author based on the exhibitors' names and other information indicated in the sources. For details, see fn. 4 in Appendix A.

[19] Only one patent was granted in Italy in 1911 to such a type of exhibitor.

[20] Panel C is analysed in Subsection 3.2.

[21] Exhibition data has been re-classified into the categories of the simplified version of the Italian patent classification by Nuvolari and Vasta (2015a).

[22] This was not an Italian peculiarity: in fact, the share of patents accounted for by individuals was similar (between 70% and 80%, in 1911) in the patent systems of technologically leading countries (Nuvolari and Vasta 2015a, Figure 5).

[23] Section 4 focuses on exhibition participation by individual inventors.

A striking difference between exhibitors and patentees can also be noticed, regarding the industries they operate in: 60 percent of patentees are in mechanical classes, whereas 30 percent of exhibitors are. Also, this contrast can easily be explained: indeed, it is known that patenting is most intense in industries where knowledge can easily be codified and the effectiveness of alternative means of appropriation is low—a point particularly stressed by Moser (2005). On the other side, the relatively low relevance of mechanical classes in data from international exhibitions confirms the latter's universal character.

Given these differences, it is expected that the matching rates, indicated in panel B of the table, are not high. Overall, 17 percent of the selected exhibitors can be found in the patent records of years 1906–1913, a figure quite in accordance with that found by Moser (2005). This share is larger for Italians than for foreigners, marginally larger for firms than for individuals; and most remarkably, it is more than three times as large in mechanical classes than in non-mechanical ones. Again, the latter result is in accordance with Moser's, and is connected to the better representativeness of patents in mechanical classes. On the other side, 7 percent of the individuals and firms granted a patent in Italy in 1911 can be observed in the Turin exhibition database. Like the exhibitors-to-patentees, the patentees-to-exhibitors matching rate is higher for Italians than for foreigners, for firms than for individuals, and in mechanical classes. In this case, however, the difference by type is particularly substantial: the patentees-to-exhibitors matching rate is 21 percent for firms, *vis-à-vis* 4 percent for individual patentees.

The lower part of panel B provides more detailed information on matched observations, as they distinguish the types 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.[24] One-half of matches are firm-firm. 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 that exploited commercially their patents (what would today be labeled as "start-ups"), and regarded the exhibition as a market for their innovative products. By the contrary, this function of the exhibition was not relevant for individuals who both patented and exhibited as such, constituting the remaining fourth of matched observations, since they were not producers. Rather, their presence suggests that the exhibition, besides being a "market for products" (innovative as well as non-innovative), could also work as a "market for technologies" (Lamoreaux and Sokoloff 1999; Arora *et al.* 2001; Arora and Gambardella 2010).[25] Notice that these shares are very different between Italians and foreigners: less than 40 percent of Italian matches are firm-firm, *vis-à-vis* around 70 percent of foreign; individual-individual account for more than one Italian match in three, but only 7 percent of foreign; while the share of "inventor-entrepreneurs" is similar. Overall, notice that firms account for a larger share in matched than in total exhibitors and, especially, patentees. The same is true of mechanical classes, which represent 60 percent (and more) of matched observations—in the case of exhibitors, a share almost twice as large as that in total observations.

[24] The other combination, corresponding to observations that exhibited as individuals, but patented as firms, is never observed.

[25] A deeper investigation of the latter point will be made in Section 4.2.

3.1 Econometric Analysis

The insights from the descriptive statistics presented above can be verified and deepened, by making use of regression analysis. This allows jointly accounting for all the above-mentioned dimensions, and quantifying their relationship with exhibiting and patenting. Table 4 displays the results of probit regressions, investigating the determinants of exhibitors' and patentees' decisions, respectively, to patent and to exhibit. In both cases, the following baseline specification is considered:

$$Y = \propto + \beta_1 Firm + \beta_2 Class + \beta_2 Location + \varepsilon \quad (1)$$

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

$$Y = \propto + \beta_1 Firm + \beta_2 Class + \beta_3 Transport + \varepsilon \quad (2)$$

The dependent variable denotes whether Turin 1911 exhibitors were granted at least one patent in Italy over the period 1906–1913 (Columns 1–3), or whether the patentees of year 1911 participated in Turin's exhibition (Columns 4–6). As for the independent variables, *Firm* is a dummy, denoting the exhibitor/patentee type (firm or individual). *Class* is a categorical variable, taking the values of the Italian patent classification. *Location* is also a categorical variable, which denotes the geographical origin of exhibitors/patentees, and is constructed as follows: each foreign country is attributed a category, while Italy is divided into its three macro-areas (North-West, North-East and Centre, South and Islands). Besides reflecting distance from Turin, this division accounts for Italy's regional economic divide (Felice 2011). For the same reason, Italy's main economic centers, i.e., the cities of the "industrial triangle" (Genoa, Milan, and Turin) and the capital Rome, are dedicated separate categories. Finally, *Transport* is a continuous variable, indicating transport costs to Turin, which do not just depend on distance, but also on the availability of different means of transportation and their different fares in various countries, as described in Appendix B.[26]

Let us start from column 1, investigating whether the exhibitors of Turin 1911 were granted patents in Italy over the period 1906–1913. The coefficients reported in the table are marginal effects, which, for a categorical regressor, indicate, for each value it takes, the effect on the dependent variable resulting from the regressor taking that value, rather than its baseline value. Therefore, the coefficient on dummy *Firm* implies that firm exhibitors were on average 5 percent more likely to patent than individuals were, in line with evidence shown above.

The coefficients about the *Class* variable indicate that exhibitors in the classes *Electricity*, *Steam engines*, and *Transport*, patented significantly more than those belonging to the class *Scientific instruments*, which is chosen as the baseline, because of its matching rates being close to the average. This does not surprise, since, in those mechanical classes, the propensity to patent was high, and reverse-engineering was relatively easy (Moser 2012, p. 65), which rendered exhibiting without being protected by a patent very risky. By the contrary, significant negative coefficients are attached to the classes *Chemicals*, *Other manufactures*

[26] Significance levels in table 4 are based on heteroskedasticity-robust standard errors. Results employing clustered standard errors (by geographical category, product class, or both), available upon request from the author, lead to fully consistent conclusions.

Table 4. *Probit regression results (marginal effects)*

	Do exhibitors patent?			Do patentees exhibit?		
	(1)	(2)	(3)	(4)	(5)	(6)
Firm	0.048***	0.065**	0.018	0.197***	0.185***	0.192***
Product class						
Agriculture	0.061*			0.045	0.049	0.046
Chemicals	−0.077***			0.018	0.016	0.015
Construction and construction materials	−0.029			0.000	0.001	0.000
Electricity	0.223***	0.234***	0.234***	0.020	0.021	0.020
Food and beverages	0.023			−0.054**	−0.051**	−0.053**
Machine tools, machinery, components, and metalworking	0.054	0.066*	0.076**	0.005	0.004	0.006
Mining	0.009			−0.034	−0.026	−0.034
Other manufactures	−0.101***			−0.042**	−0.041**	−0.042**
Paper and printing	−0.044*			−0.007	−0.004	−0.007
Steam engines	0.250***	0.254***	0.233***	0.013	0.014	0.013
Textiles, apparel, and leather	−0.107***			−0.035*	−0.036*	−0.034*
Transport	0.196***	0.196***	0.200***	0.002	0.006	0.003
Weapons	0.019	0.021	0.004	−0.050**	−0.045*	−0.049**
Location						
Italy, Genoa	−0.007	0.038	0.014	−0.148***		−0.152***
Italy, Milan	0.078***	0.084	0.050	−0.109***		−0.111***
Italy, Rome	0.168***	0.262**	0.211*	−0.171***		−0.173***
Italy, Rest of North-West	0.007	0.018	0.015	−0.090**		−0.090**
Italy, North-East and Centre	−0.008	0.005	0.015	−0.151***		−0.153***
Italy, South and Islands	−0.074**	−0.128	−0.119	−0.170***		−0.171***
Belgium	−0.103***	−0.185**	−0.258***	−0.125***		−0.129***
France	−0.092***	−0.197***	−0.268***	−0.161***		−0.166***
Germany	−0.039*	−0.129***	−0.199***	−0.200***		−0.204***
Switzerland	0.047	−0.035	−0.062	−0.157***		−0.160***
United Kingdom	−0.100***	−0.154***	−0.206***	−0.205***		−0.209***

(*Continued*)

Table 4. *Continued*

	Do exhibitors patent?			Do patentees exhibit?		
	(1)	(2)	(3)	(4)	(5)	(6)
United States of America	−0.132***	−0.245***	−0.264***	−0.233***		−0.236***
Transport					−0.004***	
Quality			0.183***			0.023*
Number of observations	4732	1448	1448	3555	3555	3555
Pseudo R^2	0.144	0.090	0.116	0.195	0.168	0.196

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 *Italy*, *Turin* for the categorical variable *Location*, and *Scientific instruments* for the categorical variable *Class*.

(i.e., furniture), and *Textiles*, where most exhibits were traditional consumer goods with no innovative features.[27]

As for the 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, i.e., the "industrial" and the "administrative" capitals of Italy. The rest of Italy's North and Centre displays non-significant coefficients; whereas the South features a significantly negative one, reflecting the backwardness of that part of the country (in line with the geographical distribution of patenting activity in Italy, illustrated by Nuvolari and Vasta 2017). The significant negative coefficients attached to most foreign countries, by the contrary, may be attributed to (industrial property protection in) the Italian market not being as important for foreigners as it was for Italians. Notable exceptions are Germany and Switzerland, respectively, featuring a small negative and a positive (though not significant) coefficient; which, in the light of figures displayed in table 2, may be explained by the former country's particularly intense patenting activity, and to the latter's disproportionate relevance in FDI in Italy, making it important to secure protection in the Italian market.

Column 4 investigates whether the individuals and firms that were granted patents in Italy in 1911 participated in Turin's International Exhibition. The coefficient on the dummy *Firm* is again positive and significant, but much larger than previously observed (19 percent): in other words, firms are generally more likely to perform both activities than individuals are, which may be motivated with their larger financial resources; but it is more likely for patenting firms to exhibit, than for exhibiting firms to patent, which highlights the particular relevance of the exhibition for businesses.

The coefficients attached to product categories are generally smaller than in Column 1, and only few (negative) coefficients attached to traditional sectors are significant. Therefore, the likelihood of exhibiting varies less across sectors than that of patenting does, in accordance with the "universal" character of the exhibition. By contrast, from the results concerning the variable *Location*, it clearly emerges that all patentees outside Turin were significantly less likely to exhibit than those based in the exhibition's host city. The coefficients broadly decrease, denoting a lower likelihood to exhibit, as distance increases: indeed, they are smallest (in absolute value) for Milan and the *Rest of North-West*, and

[27] The coefficients attached to *Agriculture* and *Paper and printing* are barely significant (their *P*-value is 0.10).

largest for the United States of America. Most interestingly, the coefficients attached to foreign countries follow the same ranking as the shares in FDI in Italy, displayed in table 2 and proxying the degree of involvement in the Italian economy: notably, they are highest for the largest investor, Belgium, in spite of it not sharing a border with Italy. This is an important piece of evidence, which, together with the prevalence of firms, demonstrates that commercial motivations were at the heart of the decision of participating in an exhibition.

The alternative specification (Column 5), replacing the categorical variable *Location* with the continuous cost variable *Transport*, fully confirms the points just made: propensity to exhibit decreases in the cost per unit of weight, which depends on distance, but also on national railway fares and access to the sea.

To sum up the results from the matching and the related econometric exercises, a substantial mismatch emerges, between exhibitors and patentees, reflecting a difference in the motivations behind exhibiting and patenting. On the one hand, the main function of the exhibition appears to be that of a means of commercial promotion. On the other hand, patents were mostly taken out by individual inventors, the majority of whom were not interested in that function, since they never engaged in production and sale. In fact, historical evidence from patent systems involving renewal fees shows that most patentees would soon realize that their patents had little or no market value, and would stop paying for keeping them "alive," which is particularly true of Italy (Nicholas 2011, pp. 1009–11; Nuvolari and Vasta 2015a, pp. 872–6; Streb *et al.* 2006, pp. 350–7).

3.2 Accounting for Quality

The analysis carried out in this section implies that exhibition data and patent data suffer from specular drawbacks, as proxies for innovation: indeed, exhibits represent not-necessarily-new commercialized products, while patents represent not-necessarily-commercialized inventions. Hence, they both include innovative as well as non-innovative products. It can be hypothesized that, if innovations could be identified and isolated in each set, then the correspondence between (innovative) exhibitors and patentees would increase.

Doing this, however, is not straightforward, nor unproblematic. A possible way to identify innovative exhibits could be to resort to information about the prizes awarded at exhibitions. As already mentioned, these were a major feature of those events, as awards were used as reputation-boosting means. Moser (2005, pp. 1218–9; 2012, p. 51) uses prizes awarded at the Crystal Palace exhibition for "exceptional novelty and usefulness" as a proxy for exhibit quality and innovativeness. However, the reliability of prizes at most other exhibitions as quality signals is questionable, as pointed out by Khan (2011, 2015, pp. 655–6), due to the awarding procedures being often opaque and inconsistent, and based on criteria other than novelty. As for patents, the number of citations received, or the number of renewals, depending on the specific patent system, are employed in the literature as proxies for patent quality, following the seminal works by Schankerman and Pakes (1986) and Trajtenberg (1990), respectively. Controlling for quality is particularly important in the case of the Italian patent system, as the lack of an examination about "novelty and usefulness" implies that ideas characterized by an insufficient inventive step could get patent protection, possibly introducing a downward bias in average patent quality.

At the Turin 1911 exhibition, a large array of prizes was awarded, and most items on display were in fact attributed some form of acknowledgement. Furthermore, the jury reports reveal that in most groups novelty was not a criterion for awarding (Turin 1911 Expo 1915).

To deal with these two issues, two restrictions are adopted here in the use of prizes as a proxy for quality and innovativeness. First, only the two most important acknowledgements are considered, namely the *gran premio* and being declared "out of competition": the latter occurred when the excellence and experience of an exhibitor was manifest and well-known, and he was called to be a jury member. Second, only mechanical classes are considered, as in those, unlike in most others, novelty was often cited in the jury reports as an awarding criterion.

On the side of Italian patents, the number of renewals can be used as a proxy for quality (Nuvolari and Vasta 2015a). In particular, patents requested for the maximum length (15 years), accounting for the top 10 percent of total patents, are considered as high-quality. In this case, no class restriction is necessary.

Based on panel C of table 3, quality exhibitors, defined as explained above, overall represent 39 percent of mechanical exhibitors, although a striking difference can be observed between Italians, only 18 percent of which can be labeled as quality exhibitors, and foreigners, for which the same share is 55 percent. The quality exhibitors-to-patentees matching rate is 38 percent, which is higher than the average 31 percent for mechanical exhibitors: in particular, a staggering 65 percent of Italian quality mechanical exhibitors took out a patent between 1906 and 1913. Similar statements apply to quality patentees (which represent 9 percent of total 1911 patentees), although the improvement in the patentees-to-exhibitors matching rate is much less spectacular than that of the exhibitors-to-patentees matching rate.

Columns 2, 3, and 6 in table 4 display the result of probit estimations of a specification as per Equation 1, to which a dummy denoting quality exhibitors/patentees is added. In fact, Column 2 runs the baseline specification as per Equation 1 (without dummy *Quality*) on the restricted sample of mechanical classes, to check whether the above-mentioned general results specifically hold for them. They are indeed confirmed, as few coefficients change their significance level (e.g., *Machine tools*), though not their sign. Most interestingly, however, after adding *Quality* to the specification in Column 3, firms' patenting premium decreases and becomes not significant. In other words, it is completely accounted for by the fact that they display higher-quality items. On average, quality (mechanical) exhibitors are 18.3 percent more likely to patent than others. A different picture emerges for the exhibiting premium of quality patentees (Column 6): indeed, the addition of the dummy *Quality* leaves the coefficient estimates as per column 4 substantially unaltered. The "quality premium" itself is low, compared to Column 3, and only significant at the 10 percent level.

4. Inventors at the Exhibition

The claim, made in the previous sections, that most items displayed at exhibitions were not innovative, does not imply that those events were irrelevant for innovation. A corollary of the above-made claim that exhibition data and patent data suffer from specular drawbacks, as the former represent not-necessarily-new commercialized products, while the latter represent not-necessarily-commercialized inventions, is that their intersection can be identified as a core of "inventions brought to the market," corresponding to the strictest definition of innovation. The breakdown by type of exhibitor-patentee matches, made in

table 4, revealed that various kinds of innovators participated in the exhibition, namely established businesses, new businesses made by inventors-entrepreneurs, and individual inventors.[28]

The latter case is particularly interesting, as it suggests that promotion might involve "ideas," that is disembodied technologies, as well as products. In other words, not only (innovative as well as non-innovative) producers could advertise their products at the exhibition; but inventors who were not producers could use it as a market for technologies (Lamoreaux and Sokoloff 1999; Arora *et al.* 2001; Arora and Gambardella 2010), among the visitors (and fellow exhibitors) of which they could find potential buyers or licensees for their patents, as well as partners or investors, allowing them to set up new businesses (Thomson 2009, p. 207). Furthermore, exhibitions might be effective in establishing inventors' reputation, in the same way as they did for businesses.

In this section, the relevance of the exhibition for individual inventors is investigated. It first (in Subsection 4.1) investigates whether it had a positive effect on the commercialization of patent rights. Then (in Section 4.2) it speculates about alternative motivations for exhibiting by individual patentees, by reviewing some famous cases.

4.1 Exhibiting Activity and Patent Assignments

A first reason why patentees might decide to exhibit is to promote their patents and improve their chances to commercialize their patent rights. In accordance with this, we might expect that patentees who exhibited were afterwards more successful in assigning their patents, i.e., transferring the rights deriving from them. To investigate this hypothesis, I have compiled a list of all (1,411) patent assignments made in Italy between 1911 and 1916.[29] Based on this, it can be observed whether, among the patentees of year 1911, those who participated in Turin's exhibition were more likely than others to assign their patent rights in the following 5 years. Out of 3,555 patentees (cf. table 3), 121 transferred their patent rights in the years 1911–1916, corresponding to 3.4 percent. In particular, eight of the 261 patentees that exhibited in Turin assigned their patents, corresponding to a marginally lower share (3.1 percent), which is not significantly different from that for non-exhibitors.[30] Furthermore, half of those eight cases are firm-firm matches, one is an "inventor entrepreneur," and two are individual-individual matches, which however can be connected to a firm.[31] This does not support the hypothesis that the exhibition worked as a market for technologies, where individual inventors could effectively commercialize their patent rights. A possible explanation for this is that the services of patent agents (Lamoreaux and Sokoloff 1999; Nicholas 2010, 2011; Lamoreaux *et al.* 2013; Andersson and Tell 2016) could represent a more efficient means to achieve that purpose than direct efforts by patentees.

[28] Notice that the expression "individual inventors" is related, but not equivalent, to "independent inventors": in fact, it is more general than the latter, as it also encompasses exhibitors/patentees having some kind of relation with a firm, of which instances are provided in this section.

[29] The employed source is the *Gazzetta Ufficiale*, where a list of patent assignments was published at regular time intervals.

[30] Based on the results from a t-test of the hypothesis of mean equality ($t = 0.31$).

[31] The latter are Felice Bosco and Gino Donadelli, from Terni, who exhibited together at Turin 1911. Bosco was the son of Antonio, an inventor-entrepreneur, founder of the Terni-based *Società anonima officine meccaniche e fonderie Antonio Bosco*.

Still, some relationship between exhibiting and transferring activity can be traced, by matching the identities of assignors and assignees to Turin 1911 exhibitors. In year 1911, a total of 209 distinct assignors transferred the rights of 230 patents to 175 distinct assignees. Only 2.9 percent of the assignors were exhibitors, *vis-à-vis* 14.3 percent of the assignees. This reveals that exhibitors were much more frequent on the side of those who bought patent rights, than on the side of those who sold them. As assignees were often firms that could produce the innovative products protected by the assigned patent rights, this provides evidence of the importance of the exhibition as a market for innovative products.

4.2 Exhibiting and Inventors' Career Development

Final evidence about the motivations for exhibiting by inventors who were not involved in production and promoted their "ideas," as well as for the exhibition's general relevance for innovation, can be obtained by reviewing the stories of some inventors who individually participated in the Turin exhibition.

An excellent case in point is Riccardo Arnò, a Piedmontese electrical engineer, who both made an extensive use of the patent system (he patented a large number of inventions, not only in Italy but also in many other countries, including Austria, Canada, France, Germany, Switzerland, the United Kingdom, and the United States of America) and had a long and successful record of participation in national and international exhibitions.[32] At the Turin 1898 General Italian Exhibition he was awarded the *diploma d'onore*, as well as the golden medal of the *Società Ingegneri ed Architetti di Torino* to the best invention; at the International Electricity Exhibition of 1899 in Como he received another *diploma d'onore*; and most remarkably, he obtained the *grand prix* at the great universal exhibition of Paris 1900. After this important acknowledgement, he participated out of competition in the two international exhibitions organized in Italy, i.e., Milan 1906 and Turin 1911—a sign of the renown and authoritativeness he had achieved (Turin 1911 Expo 1911b, p. 114).[33] Arnò did not personally exploit his discoveries from a commercial point of view; in fact, he pursued an academic career. Therefore, his participation in the exhibition was not aimed at commercial promotion; yet he appears to have benefited from that in professional terms, as he became full professor at the Polytechnic University of Milan in 1902, 2 years after his success in Paris. Finally, among his reasons for participating cannot be excluded the sheer desire of disseminating scientific knowledge and obtaining personal gratification, which are suggested by his involvement in designing and directing the "Gallery of electrical experiences" at the Turin 1911 exhibition.

Very similar is the case of Gino Campos. He also was an Italian electrical engineer with patents in the highly competitive American patent system, and was not an entrepreneur, personally exploiting his inventions: in fact, he worked for the Italian electrical-engineering firm CGS, founded by Camillo Olivetti. Campos exhibited at the Milan 1906 international exhibition and at the Brescia 1909 electricity exhibition, in both of which he was awarded a

[32] The Turin 1911 exhibition catalog reports, under the name and product of each exhibitor, the awards obtained at previous exhibitions (to be disclosed in the exhibition application form; see Turin 1911 Expo 1911a, art. 14).

[33] He was a member of the jury for class 30, "Electric lighting" (Turin 1911 Expo 1915, p. 209).

golden medal (Turin 1911 Expo 1911b, p. 100); then he participated out of competition at the Turin 1911 exhibition.

A final case, deserving to be reviewed for the important role exhibitions played at all stages of his career, is that of François Hennebique, one of the main developers of reinforced-concrete construction. A self-made man from the north of France, starting as a bricklayer, Hennebique drew inspiration for his reinforced-concrete construction technique from the previous developments by Joseph Monier, patented in 1867, which he (then 25-year-old) saw at that year's universal exhibition in Paris. In the same year, he moved to Brussels, where he founded a contracting company. His business strategy changed when he founded his *bureau d'études* in 1892, the same year when he obtained his main patent: "Hennebique no longer presented himself as a contractor, but as an independent agent, providing expertise and know-how" (Van de Voorde 2009, p. 1454). International exhibitions were important moments for promoting reinforced-concrete construction to potential licensees: most effectively, Hennebique could provide actual demonstrations of his system. He built the Belgian pavilion's façade of the Paris 1878 exhibition; furthermore, the Mativa bridge in Liège, built in the occasion of the universal exhibition held in that city in 1905, and the Risorgimento bridge in Rome, inaugurated in the occasion of the 1911 exhibition,[34] were built according to the "Hennebique system" (*ibidem*, p. 1453–7).[35]

The cases reviewed in this subsection show that participation in the exhibition by individual inventors might be aimed at, and indeed played an important role in establishing inventors' reputations and fostering their careers. Interestingly, this parallels the "heterodox" use of the patent system, by some English patentees of the eighteenth-century, to establish scientific reputation, pointed out by MacLeod (1988, pp. 78 ff.).

5. Conclusions

The present paper investigates the relevance for innovation of international exhibitions. In doing so, it builds on and complements the seminal works by Moser (2005, 2011, 2012), using data from the Crystal Palace exhibition as a proxy for innovation. While that event can be characterized as an "exhibition of innovations," this study argues that such a characterization does not apply to many subsequent exhibitions, where a wide range of not necessarily novel products was exhibited. This is confirmed by an in-depth analysis of one representative exhibition, namely Turin 1911.

Of particular interest is the comparison between exhibition data and patent data, which are typically used as a proxy for innovation, especially in historical studies. Comparing Turin 1911 data to Italian patent data reveals a substantial mismatch, deriving from the fact that these data representing two different phenomena, attracting different types of economic agents. On the one hand, the exhibition mainly worked as a means of commercial promotion of products, both new and pre-existing, as the preponderance of firms among exhibitors indicates; on the other hand, in the "age of the independent inventor," patents were mostly taken out by individuals, the majority of whom were not interested in commercial promotion, since they were not producers. Yet, if exhibitors and patentees characterized by particular quality are focused on, the extent of matching increases.

[34] In 1911, Rome hosted a historical and artistic exhibition, which was conceived as a complement's to Turin's industrial exhibition (Turin 1911 Expo 1915, pp. 7–18).

[35] The latter bridge was constructed by the exhibiting company *Porcheddu*, which was the exclusive licensee of the Hennebique system in Italy.

Data from international exhibitions after the Crystal Palace appear therefore to be characterized, as a proxy for innovation, by an opposite drawback to that commonly attributed to patent data: while the latter represent inventions, which might fail to reach the market, the former indicate commercialized products, which might have no innovative content. Both measures therefore capture both innovative and non-innovative products. A corollary of this is that the intersection between exhibition data and patent data can be identified as a core of "inventions brought to the market," corresponding to the strictest definition of innovation. The joint use of these two sources, therefore, represents an important instrument for studying historical innovation, and should be encouraged, when possible.

The fact that most exhibits were not innovations does not imply that exhibitions were irrelevant for innovation. In fact, this study provides evidence that exhibiting activity was a particularly important means for the promotion and diffusion of innovative products, as well as for the establishment of inventors' reputations and the development of their careers.

This work opens avenues for further research on the use of exhibition data in economic history. Regarding the study of historical innovation, while research has so far focused on the nexus between exhibiting and patenting activity, evidence from this paper implies that the former might be more related to less-formalized innovative activities and "lighter" intellectual property rights, like industrial designs and trademarks, which are characterized by a lower inventive step, but are more applied and instrumental for product commercialization. The relationship between exhibiting and these "pettier" innovative activities should therefore be explored. Moreover, and more importantly, the potential of exhibition data beyond the study of innovation should be exploited. Once acknowledged that exhibited items were not only innovative, but reflected a wide and various spectrum of products, and that the main motivations behind exhibiting were commercial, exhibition data could be employed for studying the activities by which participant firms and countries promoted their products on international markets.

Supplementary material

Supplementary material is available at *European Review of Economic History* online.

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None declared.

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