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Patenting the *Risorgimento*: Economic Integration and the Formation of the Italian Patent System (1855–1872)

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Abstract: In 1864, the patent law of the Kingdom of Sardinia was extended to the newly created Kingdom of Italy. In this paper, on the basis of a new dataset containing all Italian patents granted over the period 1855-1872, we examine the formative years of this crucial institutional change. Firstly, we map the characteristics of the inventors before and after the 1864 reform. In particular, we look at their nationality and geographical distribution within the country, the technological fields in which they were active, the intensity of use of the system (sporadic versus "systematic" patentees), and their investments in patent protection (measured in terms of the fees they were paying). We find that the reform of the patent system prompted a reconfiguration of the geographical structure of Italian inventive activity, producing an increasing participation of the inventors of the other pre-unitary states, and, at the same time, becoming more attractive for inventors on a large international scale. This can be interpreted as a sign of an effective integration policy, at least in this specific domain of government activity.

JEL-Codes: N 73, O 31, O 34

Keywords: patents, Risorgimento, innovation, Italy, Patente, Risorgimento, Innovation, Italien

1 Introduction

In a long-term historical perspective, the creation of "modern" patent systems during the 18th (England and USA) and 19th centuries (Western Europe and Japan) represents an important institutional milestone marking the emergence and

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consolidation of the process of modern economic growth. It is well-known that patent systems had their first early origins in the special grants and privileges granted by most European countries to artisans and skilled workers who imported technologies from abroad during the early Renaissance.[1] This practice very soon evolved to comprise also exclusive grants and privileges for the reward of indigenous innovations.[2] Furthermore, in some countries, patent systems were the subject of major legislation, such as the Venetian Patent Statute of 1474 or the English Statute of Monopolies in 1623.

From the second half of the 18th century, it is possible to discern a discontinuity in the history of patent systems of many Western countries. In some cases, such as in France or in US, the discontinuity is neatly marked by the enactment of specific laws. In other cases, like in England, it was the outcome of the accumulation of administrative reforms and of evolving jurisprudence.[3] At all events, it is during the second half of the 18th century and the first half of the 19th century, that patent systems began to assume their relatively modern shape consisting of the following features: *i*) patents granted to inventors on the basis of a formalized set of specific requirements; *ii*) patents granting an homogeneous set of exclusive rights to inventors (no case by case or *ad hoc* privileges); *iii*) emergence and consolidation of specialized bureaucracies entrusted with the procedures of examination and release of patents. It is revealing that in Meiji Japan the development of modern patent systems in Western countries was in fact perceived as a fundamental backbone of their process of economic modernization.[4]

At all events, the creation of modern patent systems was by no means a linear process. In almost all countries, the economic rationale of this institutional reform was heavily criticized, sometimes with compelling arguments.[5] As a matter of

1 *C. Belfanti*, Between Mercantilism and Market. Privileges for Invention in Early Modern Europe, in: Journal of Institutional Economics 2, 2006, pp. 319-338.

2 One of the early examples of this practice is the exclusive right granted for three years to Filippo Brunelleschi in 1421 for the special boat "Badalone", designed to transport marble stones on the Arno river for the construction of the Dome: *F. Praeger/G. Scaglia*, Brunelleschi. Studies of his Technology and Inventions, Cambridge (Mass.) 1970 and *M. Vasta*, Dal Badalone a Windows. La proprietà intellettuale e la tutela dell'innovazione, in: *R. Giannetti (Ed.)*, Nel mito di Prometeo. L'innovazione tecnologica dalla rivoluzione industriale ad oggi. Temi, inventori e protagonisti dall'ottocento al duemila, Florence 1996, pp. 260-278.

3 *C. MacLeod*, Inventing the Industrial Revolution. The English Patent System, 1660-1800, Cambridge 1988 and *S. Bottomley*, The British Patent System during the Industrial Revolution 1700-1852. From Privilege to Property, Cambridge 2014.

4 *O. Granstrand*, The Economics and Management of Intellectual Protection, Aldershot 1999, pp. 136-137.

5 *F. Machlup/E. Penrose*, The Patent Question in the Nineteenth Century, in: Journal of Economic History 10, 1950, pp. 1-29.

fact, the exact effect of patent systems on inventive activities remains a matter of contention even today for both economists and economic historians.[6]

In this paper, we focus on the formation of modern patent systems by considering them as a sort of special vantage point for examining the construction of state capacity and the promotion of economic integration. We study the case of Italy during the second half of the 19th century. In this period, the relatively small Kingdom of Sardinia, by virtue of skilful diplomatic manoeuvres and a series of fortunate military campaigns was able to take over the control of the whole of Italian peninsula.[7] The strategy adopted by the ruling elites for fostering the economic integration was the straightforward extension of Piedmontese laws and regulations (including the patent system) to the whole country. The underlying rationale for the adoption of this type of strategy, at least in the minds of the most acute policymakers of the time such as Cavour, was that the Kingdom of Sardinia had probably the most "advanced" pieces of legislation in most domains of government activities. In this respect, one can mention the case of primary education which was extended to the whole country with the Casati Law. In principle, this was an advanced law since it introduced compulsory primary education in a country whose population was still largely illiterate.[8] However, the implementation of the law, which was based on decentralization, did not take into account the specific context of the different regions of the country, resulting in a failure to substantially raise literacy rates in the South.[9]

The aim of this paper is too look at the early phases of the Italian patent system against the background of this broader process of economic integration. In this way, the paper is related to two streams of literature. First, it contributes to the ongoing literature on the strategies of economic development adopted by the Italian governments during the Liberal Age.[10] Second, it contributes to the stream of literature which has examined the effects of specific patent reforms.[11]

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6 *A. Nuvolari*, Collective Invention during the British Industrial Revolution. The Case of the Cornish Pumping Engine, in: Cambridge Journal of Economics 28, 2004, pp. 347-363; *M. Boldrin/D. Levine*, Against Intellectual Monopoly, Cambridge 2008; *P. Moser*, Patents and Innovation in Economic History, in: Annual Review of Economics 8, 2016, pp. 241-258.

7 *M. Dincecco/G. Federico/A. Vindigni*, Warfare, Taxation, and Political Change. Evidence from the Italian Risorgimento, in: Journal of Economic History 71, 2011, pp. 887-914.

8 At the time of the Unification (1861), the literacy rate in Italy was only 27 percent.

9 *G. Cappelli/M. Vasta*, Can School Centralization Foster Human Capital Accumulation? A Quasi-Experiment from Early-XX-Century Italy, in: Economic History Review, forthcoming.

10 *L. Cafagna*, Dualismo e Sviluppo nella Storia d'Italia, Venice 1989; *S. Fenoaltea*, The Reinterpretation of Italian Economic History. From Unification to the Great War, Cambridge 2011; *P.*

We make use of a new dataset containing all patents granted in the Kingdom of Sardinia over the period 1855-1863 and all Italian patents over the period 1864-1872. This allows us to have a comprehensive view of the evolution of the system: from the initial period in which it was basically the patent law of the Kingdom of Sardinia to 1872 when the law covered the entire territory of the Italian peninsula.[12] In this way, we cover the culminating phase of the Italian *Risorgimento*: from the Plombières Agreement of 1858, to the Second War of Independence of 1859, to the expedition of the thousand by Garibaldi to the Third War of Independence (1866) and the annexation of Rome in 1870.[13] The dataset allows an in-depth empirical analysis of the response of inventors to the creation of a unified patent system, which, since 1864, allowed the protection of an invention in the new larger context of a unified Italy. By examining the differences between the two periods – that is before and after the creation of a unified system – we try to understand how this major institutional change affected innovative activity in regard to the nationality of the inventors, their geographical distribution within Italy, the technological characteristics of their patents and the investments of inventors in patent protection.

The rest of the paper is organized as follows. In Section 2 we provide a compact outline of the historical evolution of patent laws in Italy from the Restoration to the 1864 reform that extend the Piedmontese patent law to the whole of Italy. Section 3 discusses the sources and the construction of our patent data base. Section 4 examines how inventors used the Italian patent systems during these early phases of its development. Section 5 concludes.

2 Building the Italian patent system: from the *ancien régime* to the 1864 Law

After the Congress of Vienna of the 1814-15, the Italian peninsula was divided in five major political units: The Kingdom of Sardinia – corresponding to broadly to today's regions of Piedmont, Liguria and Sardinia – ruled by the House of

Di Martino/M. Vasta, Happy 150th Anniversary, Italy? Institutions and Economic Performance since 1861, in: Enterprise & Society 16, 2015, pp. 291-312.

11 *T. Nicholas*, Cheaper Patents, in: Research Policy 40, 2011, pp. 325-339.

12 It should be noted that our dataset covers, also for the period 1855-1863, a large share of all patents granted on the Italian peninsula, since the patents registered in the other pre-unitary states were rather limited.

13 *G. Pécout*, Naissance de l'Italie contemporaine (1770-1922), Paris 1997.

Savoy; the Kingdom of Lombardy-Venetia, which was part of Austrian empire; the Grand Duchy of Tuscany ruled by the House of Habsburg-Lorraine, and in this way linked with the Austrian empire; the Papal States, corresponding broadly to the regions of Latium, Marches, Umbria and the South-East part of Emilia-Romagna, under the control of the Pope; the Kingdom of the Two Sicilies, which covered the Southern part of Italy under the rule of the House of Bourbons. In the Centre of Italy, there were also some smaller political units linked by means of dynastic connections to the Austrian empire: the Duchy of Parma, Piacenza and Guastalla, the Duchy of Modena and Reggio and the Duchy of Lucca.

Overall, the legislation on patents and on privileges was not a major concern for the pre-unitary states of the peninsula. During the Napoleonic period, at different moments in time, the French legislation of 1791 was extended to all the different areas of Italy. After the Restoration, somewhat paradoxically, most countries retained the main thrust of the French 'revolutionary' law, introducing only minor modifications, as shown by Table 1, which provides a synthetic summary of the main features of the patent legislations existing in Italy before the unification.

The major exception to this pattern was the Kingdom of Sardinia, which adopted a reform that re-established a fully *ancien regime* approach to privileges and patents. The Piedmont law prescribed a strict examination process tightly controlled by the *Accademia delle Scienze* of Turin for the applications of privileges: in this aspect following the example of the French system before the Revolution.[14] The other country that prescribed a formal examination procedure was, between 1820 and 1832, the Kingdom of Lombardy-Venetia. At the same time, in the Kingdom of the Two Sicilies, although the 1810 law did not explicitly prescribe an examination procedure for all patents, since the 1820s, the *Regio Istituto di Incoraggiamento* was entrusted with the assessment of all patents' application. In this way, even in the absence of a change in the legislation, an *ancien régime* approach towards patenting matters was *de facto* restored also in this country.[15]

14 *L. Hilaire-Perez*, L'Invention Technique au siècle des Lumieres, Paris 2000.

15 For the role of the *Regio Istituto di Incoraggiamento* in the monitoring process of patents' application, see *M. Lupo*, "L'Innovazione Tecnologica in un'Area Periferica. Primi Risultati di una Ricerca sul Mezzogiorno Preunitario (1810-1860)", in: Rivista dell'Istituto di Storia dell'Europa Mediterranea 4, 2010, pp. 461-481. It is also worth noting that the selection process was quite strict since out of about 1,200 applications for the period 1810-1860 only 364 patents were granted, see *Lupo*, Innovazione Tecnologica, p. 471. For a detailed overview of all the patents granted in the Kingdom of the Two Sicilies in the period 1810-1860, see *M. Lupo*, Il calzare di piombo. Materiali di ricerca sul mutamento tecnologico nel Regno delle Due Sicilie, Milano 2017.

Tab. 1: Main characteristics of patent legislations in pre-unitary States.

Pre-Unitary State	Year of main legislation	Notes	Examination	Restrictions	Working requirement	Duration in years
Duchy of Parma and Piacenza	1833	Before 1833 there was the French Law of 1791	no prior-art examination	No restrictions	Invention must be put in practice within 2 years	5, 10 or 15 years
Kingdom of Lombardy-Venetia	1820	Law modified in 1832 and 1852	From 1820 to 1832 examination by the Chamber of Commerce in Vienna; no examination after 1832		Invention must be put in practice within 1 year	From 1 to 15
Kingdom of the Two Sicilies	1810	Law modified in 1844	No prior-art examination; but examination for health and public safety		Invention must be put in practice within 1 year	5, 10 or 15
Kingdom of Sardinia	1826	Privilege law of 1826, modified in 1829 and 1832	Examination by the Accademia delle Scienze di Torino	No restrictions	Yes, but discretionary	At the discretion of the government (usually 6, 8 or 10 years)
Papal States	1833	Law introduced by Gregorio XVI without modifications until the Unification	No examination	No restrictions	Invention must be put in practice within 1 year	min 5 max 15 years

Continuation Tab. 1:

Pre-Unitary State	Year of main legislation	Notes	Examination	Restrictions	Working requirement	Duration in years
Duchy of Modena and Reggio Emilia	1848	Adoption of Piedmont Law also in 1854		No restrictions		
Grand Duchy of Tuscany		No specific patent or privilege law				
Duchy of Lucca	1807	Law modified 1819; from 1847 Lucca is absorbed in the Granducato di Toscana	Examination by an appointed committee	No restrictions	not specified	not specified

Source: own elaboration on *R. Urlig*, The Law of Patents in Foreign Countries, London 1845; *C. Loosey*, Collection of the Laws of Patent Privileges of all the Countries of Europe, the United States of North America and the Dutch West-Indies, London 1849; *A. Tolhausen*, A Synopsis of the Patent Laws in Various Countries, London 1857.

In Figure 1, we report patenting activity in the Kingdom of Sardinia and in the Kingdom of the Two Sicilies, the two major political units of pre-unitary Italy.[16] The figure suggests that there was a very limited patenting activity: in both cases there were less than 1 patent per million inhabitants per year. This confirms the impression that in the pre-unification Italian context, the issue of securing privileges or patents was not a major concern for potential inventors.[17] Figure 1 also shows that the examination processes of the *Accademia* was particularly rigorous: throughout the period considered, less than one third of the applications were granted.

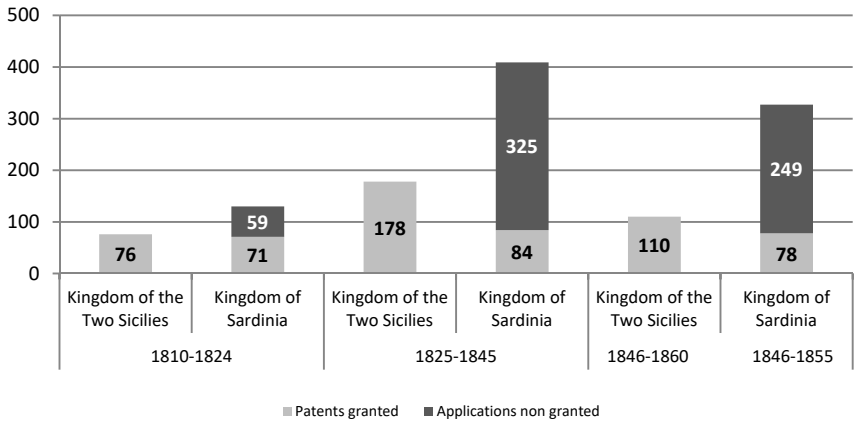

Fig. 1: Innovative activity in the Kingdom of the Two Sicilies and in the Kingdom of Sardinia (1810-1860). Source: own elaboration on *Marchis/Dolza/Vasta*, Privilegi Industriali and *Lupo*, Filosofia del Rotto.

Also in the other most important state of the peninsula, the Kingdom of Lombardy-Venetia, patent activity was sporadic. According to Carletti, between 1824

16 These two countries were the largest amongst those in the Italian peninsula. The population of the Kingdom of the Two Sicilies was about nine million inhabitants in 1861, while the population of the Kingdom of Sardinia was about four million.

17 For analyses of patent behaviour in Kingdom of the Two Sicilies and Kingdom of Sardinia, see respectively *M. Lupo*, La Filosofia del Rotto? Alcuni Risultati di uno Studio su Brevetti, Innovatori e Innovazione Tecnologica nel Mezzogiorno Preunitario (1810-1860), in: *G. Biorciand/P. Castagneto (Eds.)*, Crocevia Meditteranei. Società, Culture e Migrazioni nel Mediterraneo (secoli XIX-XX), Cagliari 2010 and *V. Marchis/L. Dolza/M. Vasta*, I Privilegi Industriali come Specchio dell'Innovazione nel Piemonte Preunitario, Turin 1992.

and 1845, there was an average of less than 30 applications per year.[18] He suggests that this was probably due to the preference of inventors for the various systems of prizes and awards that were conferred by local societies for the encouragement of sciences and practical arts that were exerting a sort of 'crowding-out' of the patent system.

Overall, these pre-unitary patent systems were not particularly attractive for foreign inventors. Lupo estimates that the patent share of foreign inventors in the Kingdom of the Two Sicilies was about 8.5 percent of the total, considering as "foreign" both inventors from other Italian pre-unitary state and from outside Italy.[19] According to Marchis, Dolza and Vasta, the share of foreign inventors in the applications for privileges in the Kingdom of Sardinia was modest until the 1850s.[20]

The scarce attractiveness of the systems was certainly due to the small dimension of the pre-unitary states of the peninsula, which could offer only limited market prospects for inventors. The relationship between the dimension of the states and the attractiveness of the different systems is confirmed looking at Table 2, in which the fees for the pre-unitary states are presented. Indeed, an important feature of a patent system is the cost of the fees for taking and maintaining a patent alive. The level of the fees does not only determines the attractiveness of the system for foreign inventors, but it also defines its degree of accessibility for domestic inventors, or using the definition by Khan its "democratization".[21] Remarkably, the Duchy of Tuscany did not have any specific legislation concerning patents or privileges for the protection of inventions.

Interestingly enough, the smaller states had cheaper fees, with the exception of the Kingdom of the Two Sicilies, which prescribed a low-priced access to the system, despite its large size. This low cost to register a patent can account for the relatively large number of patents granted in that country, as shown in Figure 1.

18 *C. Carletti*, Top-down Legislation versus Local Traditions. Entrepreneurship and Innovation Strategies in the Lombardo-Veneto Kingdom, in: Revue Economique 64, 2013, pp. 55-68.

19 *Lupo*, Filosofia del Rotto, p. 98.

20 *Marchis/Dolza/Vasta*, Privilegi Industriali.

21 *Z. Khan*, The Democratization of Invention. Patents and Copyrights in American Economic Development, 1790-1920, Cambridge 2005.

Tab. 2: Patent fees in pre-unitary States (1857-1863).

Pre-unitary State	Patent fees for max duration (1857) in British pounds	Patent fees (1863) in Italian lire	Patent fees (1863) in British pounds
Duchy of Parma and Piacenza	6	150	5.92
Kingdom of Lombardy-Venetia	70	1500	59.17
Kingdom of the Two Sicilies	costs uncertain	85	3.35
Kingdom of Sardinia	40	1500	59.17
Papal States	30	808	31.87
Duchy of Modena and Reggio Emilia	-	180	7.10
Grand Duchy of Tuscany	-	-	
Other countries			
USA	6 (for US citizens); 60 (European citizens); 100 (British citizens)		
France	62.5		
England	175		

Source: *A. Tolhausen*, Synopsis of Patent Laws and *Ministero di Agricoltura, Industria e Commercio [MAIC]*, Bollettino delle privative industriali del Regno d'Italia, Turin 1864. The 1863 data were converted from Italian lire to British pounds using data on exchange rates kindly provided by Giovanni Federico.

In 1855, a major reform was introduced in the Kingdom of Sardinia. This reform was prompted by Camillo Cavour (the prime minister of the Kingdom) and carried out by Antonio Scialoja, a "liberal" patriot coming from the Kingdom of the Two Sicilies and one of the most authoritative economists of the time.[22] In preparation of this new law, Scialoja undertook a major study of patent laws around the world. At the end, the model adopted was that of the French law of 1844.[23] In particular, the Piedmont law of 1855, later revised in 1859, followed the French model, adopting an application procedure based on registration and not on

22 For a detailed account of the 1855 patent reform and the role played by Antonio Scialoja, see *M.F. Gallifante*, Antonio Scialoja e le Riforme Legislative in Piemonte negli Anni Preunitari. La Legge sulle Privative Industriali, in: Il Risorgimento 55, 2003, pp. 367-404.

23 For an account of the French law of 1844, see *G. Galvez-Behar*, La Republique des Inventeurs. Propriete et Organisation de l'Innovation en France (1791-1922), Rennes 2008. For a useful comparative analysis of the English, French and US patent systems in the XVIII and XIX centuries, see *Khan*, Democratization of Invention, Chap. 2.

examination. The major change introduced by the 1855 reform was in the rationale underlying the patent law. It was firmly established the principle that patents were granted to reward inventors for their efforts. In this way, the patent system assumed its modern role of an institutional device that allowed a suitable balance between the incentive to innovative activities and the diffusion of knowledge. [24] In 1859, following the victory in the Second War of independence against the Austrian empire and the annexation of Lombardy, the patent law was extended also to this region.

The major breakthrough in the building process of the Italian patent system, which characterized the entire Liberal age up to the early 1920s, was the extension of the 1855 Piedmontese Law to the entire new Kingdom of Italy. This was done in 1864, three years after the Unification, with the Law no. 1657, January 31st 1864. Later on, following the process of unification of the country, the law was extended to the Venetia in 1866 and to Rome in 1870. It is worth noticing that, in comparative perspective the access to the system, following the 1855 law, was cheap and flexible.[25] An inventor could register a patent for a duration from one to 15 years according to his own choice. There was an initial fee that was proportional to the number of years for which the patent was requested (ten Italian lire for one year, 20 lire for two years, ..., 150 lire for 15 years). In addition, it was necessary to pay an annual renewal fee for keeping the patent alive. This fee increased over time: 40 lire for the first three years, 65 lire from the fourth to the sixth year, 90 lire for the seventh up to the ninth year, 115 lire for the tenth to the twelfth year and 140 lire for the last three years. Furthermore, the law gave also the possibility of "extending" the duration of a patent initially taken for a shorter period. For doing this, the inventor had to apply for an *attestato di prolungamento*. This cost 40 lire plus all the other fees required for a normal patent of the same duration. Hence, since *prolungamento* involved an extra cost of 40 lire, when the inventor was sure about the prospects of his invention, it was more convenient to take the patent for the desired duration immediately. However, when the prospects of the invention were uncertain, the possibility of taking *prolungamento* gave to the system a further degree of flexibility.

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24 For further discussion see *V. Grembi*, La Questione della Proprietà Intellettuale. Il Contributo degli Economisti Italiani al Dibattito, in: *M. Augello/M. Guidi (Eds.)*, La scienza economica in Parlamento, 1861-1922. Vol. 1., Milano 2002, pp. 267-294; *Gallifante*, Antonio Scialojia; *A. Nuvolari/M. Vasta*, The Italian Patent System(s) during the Long Nineteenth Century. From the Congress of Vienna to World War I, in: *G. Gooday/S. Wilf (Eds.)*, Fashioning Global Patent Cultures. Diversity and Harmonization in Historical Perspective, Cambridge 2018, forthcoming.

25 *A. Nuvolari/M. Vasta*, Independent Invention in Italy during the Liberal Age, 1861-1913, in: Economic History Review 68, 2015, pp. 858-886.

3 Sources and methods

To study the creation of the Italian patent system, we have constructed a new dataset comprising about five thousand patents granted along the period 1855-1872. For the sake of interpretation, this timespan can be disaggregated in two main sub-periods.

The first one, which we call the pre-reform period, refers to the period 1855-1863 for which the 1855 Law covered all patents registered in the Kingdom of Sardinia up to 1861 and thereafter, up to 1863, in the new Kingdom of Italy. The second one, the post-reform period, starts after the extension of the Law to the entire Italy in 1864 and covers all patents registered in Italy in the period 1864-1872.

The historical sources of these data are the official serial publications of *Ministero di Agricoltura, Industria e Commercio* (MAIC). The source used for the first sub-period is *Descrizione delle machine e procedimenti per cui vennero accordati attestati di privativa* (1855-1863),[26] while, for the second sub-period, is the *Bollettino industriale del Regno d'Italia* (1864-1872).[27] Overall, we have 4,739 patents; 1,640 for the pre-reform period (resulting in 182.2 patents per year) and 3,099 for the post-reform period (344.3 per year). In this way, we have the full coverage of the early years of the Italian patents system with two sub-periods of the same length. For each patent we have collected the following information:

1. The date in which the patent was granted (*data di rilascio*);
2. The official patent number;
3. The name(s) of the patentee(s): this may be an individual inventor or a firm;
4. The residence(s) of the patentee(s);[28]
5. The initial duration of the patent;
6. The number and duration of the extensions (*prolungamento*) of the patent;[29]
7. A short description of the invention;
8. If the invention was granted to a patentee who had registered another patent;
9. The technological category in which the patent was classified by the office;

26 *Ministero di Agricoltura, Industria e Commercio [MAIC]*, Descrizione delle machine e procedimenti per cui vennero accordati attestati di privativa, Turin 1855-1863.

27 *Ministero di Agricoltura, Industria e Commercio [MAIC]*, Bollettino delle privative industriali del Regno d'Italia, Turin 1864-1885.

28 We have classified the residence of the patentee according to both the 1855 borders before Italian Unification and to the 1870 borders after Italy had annexed Rome.

29 For each patent, we have thoroughly checked the possible existence of extensions (*prolungamento*) in the same publications of the following fifteen years.

10. Other information about the life of the patent (changes in the number and residence of patentees following a *prolungamento* or *completivo*, changes in the patent specification).

In addition, we have reclassified all patents from the original administrative technological classes to a new classification mainly inspired to the International Standard Industrial Classification (ISIC) categories. This new dataset represents an important integration to the previous Nuvolari and Vasta dataset of Italian patents during the Liberal age.[30]

4 Inventors in a changing context

In this section, we examine the effect of legislative evolution on the behaviour of the inventors during the early years of the Italian patent system. In particular, our focus is on the extension of the patent system to the entire new Kingdom established by the Law no. 1657 of January 31st 1864. As said, the law did not contain major changes with respect to the original law enacted in 1855 for the Kingdom of Sardinia. Hence, it is plausible to interpret variations in patent propensity as essentially a response to the wider coverage of patent protection after 1864, possibly coupled with a somewhat stronger enforcement against infringement related to the higher levels of state capacity of Piedmont, in comparison of some of the other pre-unitary states.

Figure 2 represents the number of patents granted by the Italian patent system over the period 1855-1872, distinguishing between patents filed by Italian and foreign inventors. In the figure, Italian inventors refers to residents in the Kingdom of Italy in its final configuration after the Risorgimento (1870 borders), whereas foreign refers to inventors with foreign residence, that is outside the 1870 borders of the Kingdom of Italy. Overall, there seems to be a structural break around 1860, with both Italian and foreign patents increasing after that moment. In 1864, the number of Italian patents reaches the level of 140, overtaking the previous historical maximum of 129 that was attained in 1856 (which was probably an effect of the introduction of a new law in the Kingdom of Sardinia stimulating the patenting of a backlog of inventions). In the second half of the 1860s and early 1870s there is a further increase of Italian patenting, whose

30 *Nuvolari/Vasta*, Independent Invention; *Idem*, The Geography of Innovation in Italy, 1861-1913. Evidence from Patent Data, in: European Review of Economic History 21, 2017, pp. 326-356.

number is always higher than foreign patents. In international comparative terms, we are dealing here with relatively low numbers, probably reflecting the embryonic nature of Italian patent institution in this period.

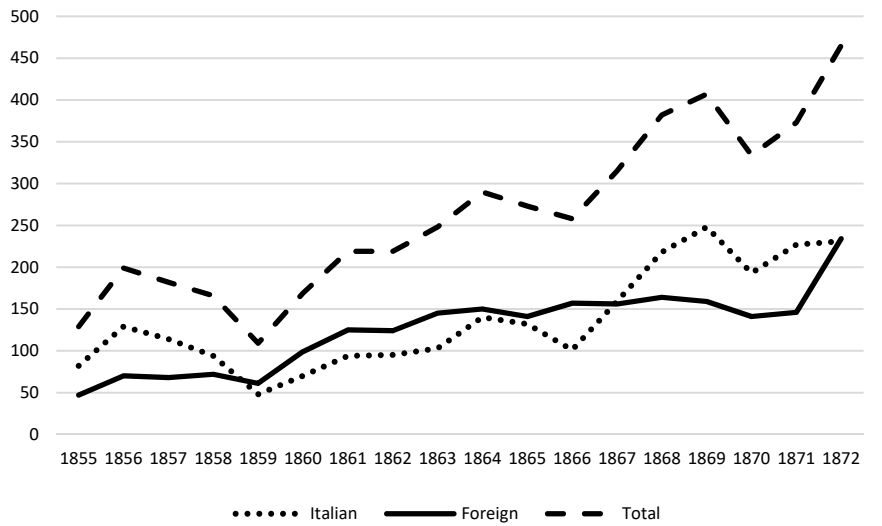

Fig. 2: Number of patents in the Italian patent system, 1855-1872.

Figure 3 presents histograms showing the share of the number of patents granted to Italian residents, considering their residence according to the border of pre-unitary states. As such, Figure 3 shows the evolution of the residence of the Italian inventors that were the users of the patent system in different phases. Indirectly, we believe that Figure 3 can possibly provide some fresh insights into the degrees of economic integration among the various regions of the country during the period.

The histograms for the period 1855-1863 show clearly that only inventors in the Kingdom of Lombardy-Venetia made systematic use of the patent system of the Kingdom of Sardinia. This might reflect stronger trade links between these states driven by geographical proximity.[31]

31 For the influence on the geographical distance of foreign patenting in Germany in the same period, see: *A. Donges/F. Selgert*, Technology Transfer via Foreign Patents in Germany, 1843-77, in: Economic History Review, forthc. 2018.

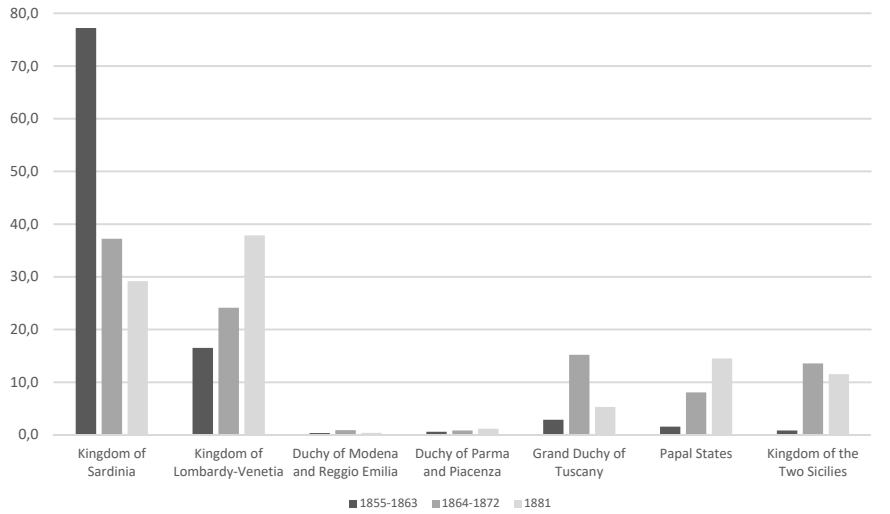

Fig. 3: Distribution of patents (percent) according to 1855 Italian pre-unitary State borders. Note: Shares are calculated considering only patentees with residence in Italy, that is excluding foreign patents.

However, it is worth noting that on October 30th 1859 the Piedmontese Law was extended to the annexed region of Lombardy.[32] Nevertheless, the inventors of Lombardy were already active in the Piedmontese system before 1859, representing the 7.3 percent of the shares of Italian inventors in the period 1855-1859. Even after 1863, inventors of the Kingdom of Lombardy-Venetia were those most ready to take further advantage of the Italian patent system. The Duchy of Modena and Reggio Emilia and the Duchy of Parma and Piacenza are characterized by very low shares. The result of the Grand Duchy of Tuscany is intriguing. As we have noted, this pre-unitary state did not have a specific patent legislation. Hence, the sharp rise after 1863 can be interpreted as inventors in this region getting patent protection for a backlog of inventions they had in store. A similar phenomenon has been noted by Schiff for the case of the re-enactment of patent law in the Netherlands in 1913.[33] However, one should also note that in this period (1865-1870), the capital of the Kingdom of Italy was moved from Turin to Florence, and this may have also exerted some effect. Finally, inventors in the

32 Venetia was annexed only in 1866 after the Third War of Independence.

33 *E. Schiff*, Industrialization without National Patents. The Netherlands, 1869-1912; Switzerland, 1850-1907, Princeton 1971.

largely populated countries of Papal States and Kingdom of the Two Sicilies seem to be characterized by slower rates of integration in the new patent system.

Table 3 shows the numbers of patents granted to inventors in different pre-unitary states, normalized by population. Even, when normalizing for population, inventors in the Kingdom of Lombardy-Venetia display a relative strong inclination to use the new patent system. Again, Grand Duchy of Tuscany displays what seems to be a short-term increase occurring in the moment in which patent law was extended. In 1881, there is a sharp increase in the number of patents per capita for residents in the areas of the former Papal States, which plausibly reflects the shift of the capital of the Kingdom from Florence to Rome in 1870.

Tab. 3: Patents per million inhabitants according to 1855 Italian pre-unitary State borders.

	1855-1863	1864-1872
Kingdom of Sardinia	17.2	15.6
Kingdom of Lombardy-Venetia	2.8	7.4
Duchy of Modena and Reggio Emilia	0.5	2.5
Duchy of Parma and Piacenza	1.2	3.2
Grand Duchy of Tuscany	1.5	14.1
Papal States	0.3	5.7
Kingdom of the Two Sicilies	0.2	2.6

Note: population retrieved from Italian national censuses for the years 1861 and 1871.

As noted in the previous section, the Italian patent system did not have an examination requirement and was characterized by relatively low renewal fees.[34] Furthermore, the system did not contemplate any discriminatory clauses towards foreign patentees. In principle, these features should have made this system particularly attractive for foreign inventors, in particular after 1861 when the system was covering a country of more than 20 million inhabitants. Figure 4 shows the degree of openness (measured as the share of patents granted to foreign inventors according to the 1870 borders) of the Italian patent system over the period 1855-1872. The degree of openness is remarkably high. In the period considered, the measure is characterized by large fluctuations which are an outcome of the relatively low numbers shown in Figure 2. The decline in the

34 *Nuvolari/Vasta*, Independent Invention.

degree of openness in the late 1860 and early 1870s can be related with a more intensive use of the system by Italians that were residents outside the Kingdom of Sardinia. After the 1870s, the degree of openness of the Italian system increases sharply reaching a level between 60 percent and 70 percent a remaining around that level until WWI.[35]

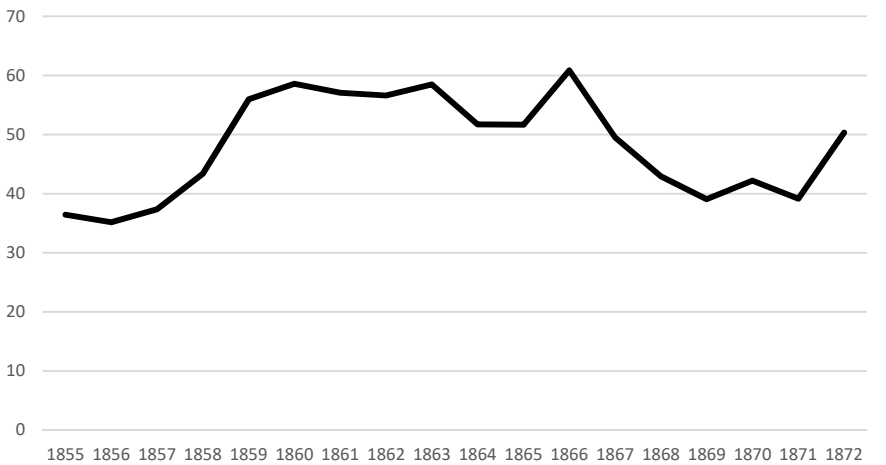

Fig. 4: Degree of openness (percent of foreign residents at 1871 borders on total patenting) of the Italian patent system, 1855-1872.

It is interesting to study who were the foreign inventors that were taking advantage of the patent protection granted by the Italian patent system. Figure 5 shows the share distribution of foreign inventors over the 1855-1872 period. France is clearly the dominant country, in particularly in the early phases. This is hardly surprising giving the economic, cultural and political connections linking the Kingdom of Sardinia and France.[36] As a matter of fact, many patent specifications in the early years both by French and Italian inventors are actually written only in French. Throughout the period considered, Figure 5 shows a remarkable increasing share of UK inventors and, in lesser degree, of German and US inventors. It is interesting to note that the share of Austrian inventors is

35 *Nuvolari/Vasta*, Italian Patent System(s).

36 French inventors were also very active in other neighbouring countries, such as Baden; see *Donges/Selgert*, Technology Transfer.

a minor one. In terms of technology flows, as captured by patenting, Italy appears to have been mostly connected with France and the UK.

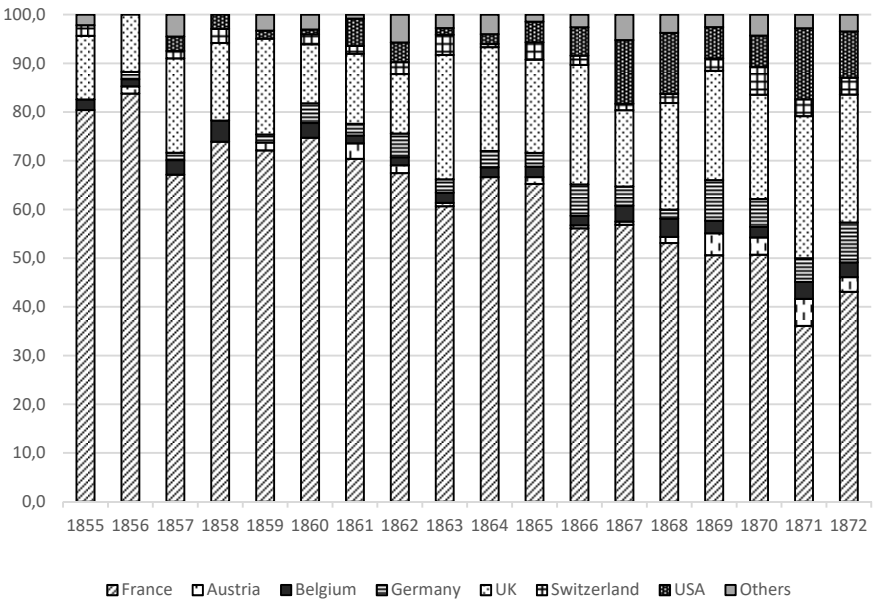

Fig. 5: Distribution of foreign patents (percent) in the Italian patent system, 1855-1872.

The Italian patent system was characterized by a very flexible renewal duration, which allowed patents to take patents for any given duration between one and 15 years, paying fees that increased over time. In this paper, we should interpret data on the "scheduled" patent duration not so much as an indicator of the intrinsic quality of the patent, but as an indicator of the propensity of different type of inventors to invest in the Italian patent system.[37]

37 In general, in the literature, renewal rates and patent durations are commonly used as indicators of the quality of the patented invention. As noted by *Nicholas*, Cheaper Patents, this approach is particularly warranted in a stable patent context; this is, for example, the case of *Nuvolari/Vasta*, Independent Invention. In the context of patent reform, renewal rates should instead be probably more cautiously interpreted as the investment in patent protection made by the inventors.

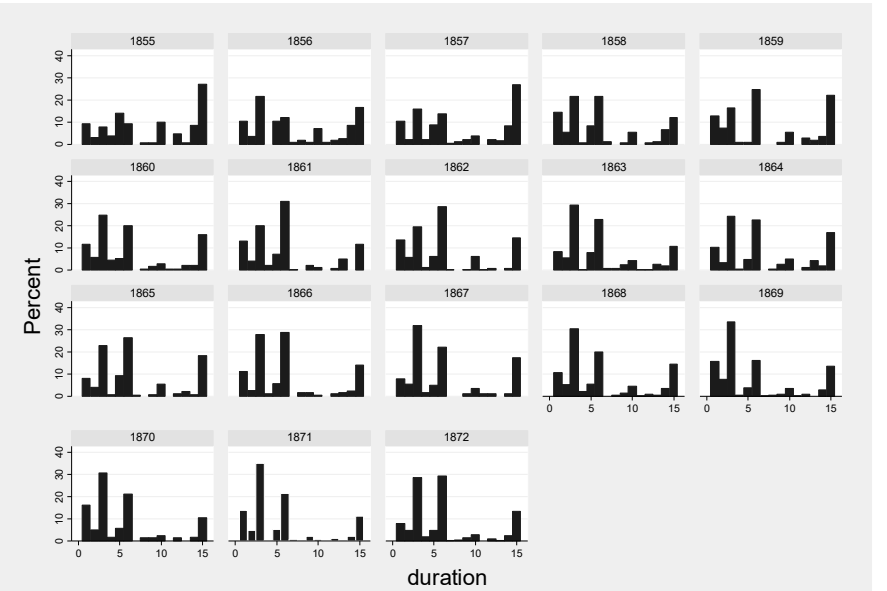

Fig. 6: Distribution of scheduled duration (percent) in the Italian patent system, 1855-1872.

Figure 6 shows the distributions of scheduled patent durations by year. The overall profile of duration is not left skewed as it is usually found in empirical data on the value of innovations.[38] Overall, the general profile of scheduled patent duration is similar to that reconstructed by Nuvolari and Vasta using a patent sample covering the period 1861-1913.[39] Also in that sample there are peaks at one, three, six and 15 years. The peaks at one and 15 years reflect clearly inventors with extreme low and high value patents. The peaks at three and six years can be plausibly accounted for by the structure of the fee, which increased from 40 to 65 lire in the fourth year of patent life and from 65 to 90 lire in the seventh year of the patent life. However, the peak at six years might be explained also by the "working requirement" clause of the system. For patents taken for a period of five years or less, inventors had one year for putting the patent into practice. Instead, for patents taken for a duration of more than five years, patentees had a

38 *G. Silverberg/B. Verspagen*, The Size Distribution of Innovations Revisited. An Application of Extreme Value Statistics to Citation and Value Measures of Patent Significance, in: Journal of Econometrics 139, 2007, pp. 318-339.

39 *Nuvolari/Vasta*, Independent Invention.

period of two years for putting the patent into practice.[40] Unfortunately, so far no specific research has been done on the effectiveness of this working clause for the enforcement and repeal of patents. However, the distribution of durations in Figure 6 suggests that it was something more than perfunctory.

Figure 7 compares the distribution of the scheduled patent duration of Italian and foreign patentees. The two profiles are very similar with peaks at one, three, six and 15 years. It is worth noting that the foreign patentees have a larger share of patents with the scheduled duration of more than twelve years and particularly of 14 and 15 years.

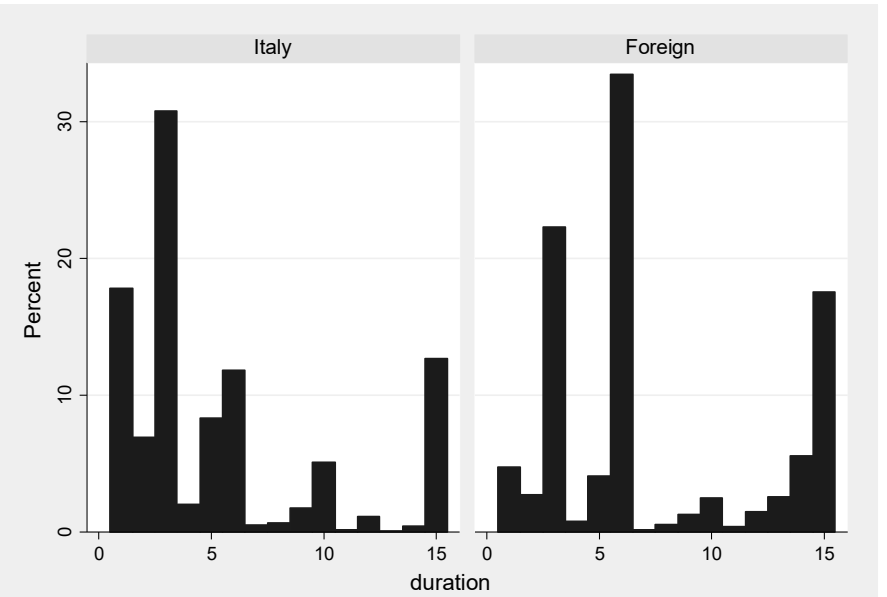

Fig. 7: Distribution of scheduled duration (percent) in the Italian patent system, 1855-1872 by nationality.

Tables 4a, 4b and 4c provide a number of descriptive statistics which illustrate the effect of the reform on different patent characteristics. We consider nine years before the reform (1855-1863) and nine years after the reform was introduced (1864-1872).

40 *Ibid.*, p. 875.

Table 4a shows the change in the location pattern of patentees after the reform. The most important effect is clearly the increase in the share of Italian inventors with residence outside the Kingdom of Sardinia. It is worth noting that the share of inventors with residence in the three provinces of the Industrial Triangle (Turin, Milan and Genoa) is declining, which suggests that the increasing spread of patenting following the reform was driven by the increasing participation of inventors outside these core areas. This increase in the share of Italian inventors, outside the former continental Kingdom of Sardinia, seems to be reflected also in the slight decline of the share of foreign inventors. These effects are evident looking at the maps of Figure 8, which report the geographical distribution of the patenting activity for the periods before and after the reform. It appears clear that, after the reform, there was a generalized increase in patenting activity along the entire peninsula, pointing to an evident economic integration process.

Tab. 4a: The effects of the 1864 reform: location.

	Pre-Reform (1855-1863)	**Post-Reform (1865-1872)**
Patents	1,640	3,099
Location (%)		
- Foreign	51.6	46.8
- Industrial Triangle	37.6	23.3
- Turin	21.0	10.7
- Genoa	9.9	5.1
- Milan	6.5	7.4
- Florence	1.0	5.9
- Italian pre-unitary states (not Kingdom of Sardinia)	11.1	33.1
- France	34.9	24.4
- Germany	1.0	2.0
- UK	8.1	10.5
- USA	1.2	3.9

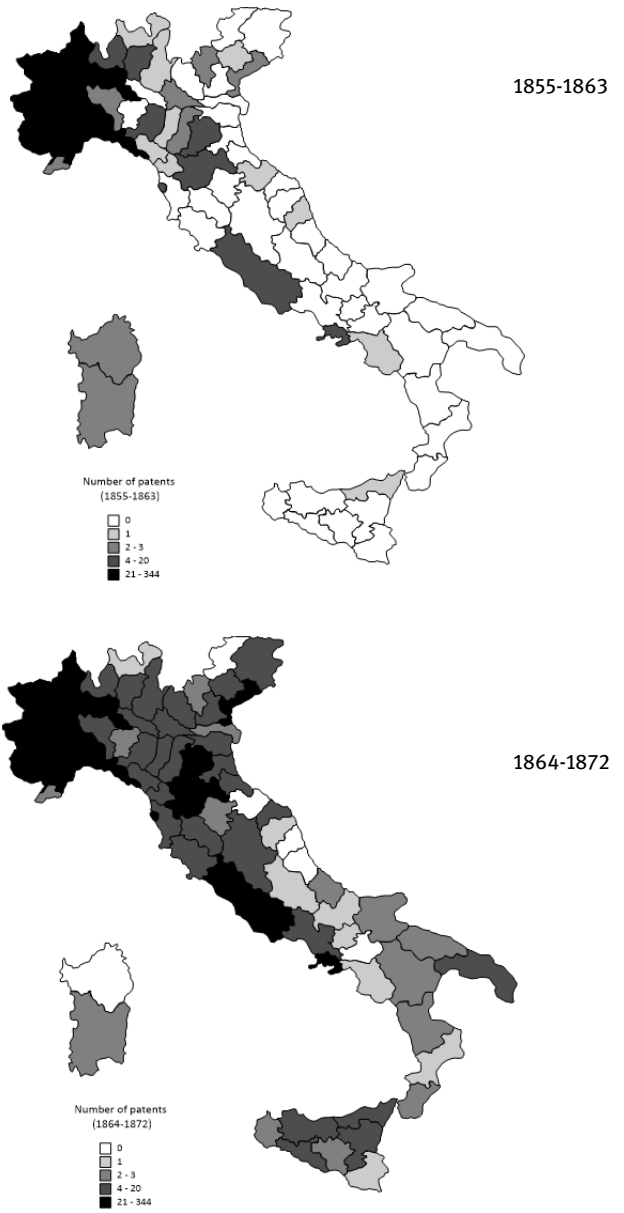

Fig. 8: Number of patents by provinces and pre-unitary States (1855-1872).

Tab. 4b:

	Pre-Reform (1855-1863)	Post-Reform (1865-1872)
Patents (number)	1,640	3,099
Low-tech (%)	**69.7**	**58.9**
Agriculture	6.2	8.3
Construction and construction materials	9.3	9.5
Food and beverages	3.8	5.3
Mining	1.2	2.0
Other manufactures	15.5	11.1
Paper and printing	2.4	3.7
Textiles, Apparel and Leather	12.8	9.6
Transport	17.4	9.4
Hi-tech (%)	**31.3**	**41.1**
Chemicals	13.1	8.7
Electricity	1.8	1.5
Machinery and metals	8.2	17.4
Scientific Instruments	3.2	3.4
Weapons	5.0	10.2

Table 4b shows the changes in the sectoral distribution of patents after the 1864 reform. We have identified a sub-set of "high-tech" patents. These are patents directly related to the main "macro-inventions" of this period comprising both the technological systems of the First Industrial Revolution (such as steam power and machine tools) and the embryonic new technologies of the Second Industrial Revolution (chemicals, steel and electricity). There is a sizable increase in the share of high tech patents (from 31 percent to 41 percent). It is remarkable the strong increase in the share of weapons (from 5 percent to 10 percent), which may be ascribed to stimulus to inventors provided by the military procurement of the new Kingdom. Other notable changes are the increase in the share of machinery and metals (from 8 percent to 17 percent) and the reduction in the share of transport (from 17 percent to 9 percent). A possible interpretation is that despite the investment in the development of the railway networks taking place in this period, the capabilities of Italian firms in the production of sophis-

ticated pieces of equipment such as locomotives in this historical phase were still limited.[41]

Table 4c documents changes in a number of other patent characteristics. First, it is worth noting that throughout the period considered, inventive activities were still dominated by independent inventors, considering that patents granted to firms are less than 5 percent of the total. Second, we consider two other characteristics of the patentees: the experience (that is if a patent is registered by a patentee who has taken more than one patent along the period considered) and the propensity to collaborate (that is whether a patent is taken by only one individual or by two or more).

Tab. 4c: The effect of patent reform: patent characteristics.

	Pre-Reform (1855-1863)	Post-Reform (1865-1872)
Patents	1,640	3,099
Organization (%)		
Granted to firms	3.9	4.8
Patentee experience (%)	31.3	32.0
Multiple patentees (%)	14.8	15.7
High value patents (%)	29.8	21.8
Foreign high value patents (%)	36.6	26.7
Italian high value patents (%)	22.4	17.7
Low value patents (%)	16.3	16.4
Foreign low value patents (%)	10.1	5.6
Italian low value patents (%)	23.1	25.8
Patent value		
Duration of patent (years)	6.8	6.0
Duration of Italian patent (years)	5.9	5.0
Duration of Italian patent not Kingdom of Sardinia (years)	5.4	5.0
Duration of foreign patent (years)	7.7	7.2

Note: high value patents (patents with scheduled duration >9 years); low value patents (patents with scheduled duration <3 years).

41 *C. Ciccarelli/A. Nuvolari*, Technical Change, Non-Tariff Barriers and the Development of the Italian Locomotive Industry, 1850-1913, in: Journal of Economic History 75, 2015, pp. 860-888.

We find that the shares of these two types of patents are remarkably similar in the two periods. This suggest that the reform did not affect these specific behaviours of inventors. Third, we examine the variation in the duration of patents by considering, following Streb, Baten and Yin, as high value patents, those with a duration of ten years or more.[42] On the other hand, we identify as low value patents those with a duration of less than three years. One can notice a sizable reduction of the share of high value patents, which moves from 29.8 percent to 21.8 percent. This decrease seems to characterize both Italian and foreign patentees. This outcome can perhaps be explained by the fact that the extension of the system to the entire territory of Italy stimulated inventors with somewhat less valuable inventions to search for patent protection. The share of low value patents is instead stable. Finally, the average scheduled duration remains rather stable throughout the period with foreign patentees, with foreign patents taking patents for longer durations.

In order to provide a more comprehensive assessment of the effect of the patent reform of 1864, we estimate an econometric model of the determinants of patent duration.[43] As dependent variable we consider the number of years for which each patent has been taken beyond its initial year. The most suitable econometric approach for estimating this kind of models is the use of a censored Poisson regression model with robust standard errors estimated with the pseudo-maximum likelihood method.[44]

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42 *J. Streb/J. Baten/S. Yin*, Technological and Geographical Spillover in the German Empire 1877-1919, in: Economic History Review 59, 2006, pp. 347-373.

43 *Nuvolari/Vasta*, Independent Invention, have estimated a similar model of patent duration for a different patent sample.

44 *C. Gourieroux/A. Monfort/A. Trognon,* Pseudo Maximum Likelihood Methods. Theory, in: Econometrica 52, 1984, pp. 681-700. Since the minimum patent life is 1, we can consider as indicator of patent duration either the complete patent life ranging from 1 to 15 or the number of years of renewal beyond the initial year ranging from 0 (when a patent is not renewed beyond its initial year) to 14 (when the patent is at its maximum duration and it is renewed for 14 years beyond the initial year). Considering the number of years of scheduled duration, beyond the initial year as a measure of patent duration, has the advantage of avoiding the use of zero-truncated models. At the same time, we consider patent 'scheduled' duration, our dependent variable, as right-censored, since the maximum observable value of 14 years means that a patentee was available to renew its patent for a period of *at least* 14 years. However, it is possible that the assessment of the value of the patent by the patentee would have justified renewing the patent even for a longer period if the law would have allowed him this option. We adopt what Hilbe calls the "econometric specification" of the Poisson censored model and we consider all the observations with a value of 14 as potentially right-censored. See: *J. Hilbe*, Negative Binomial Regressions, Cambridge 2001, pp. 387-406.

Accordingly, we estimate the following count regression model:

$$E\left[PATLENGHT|X\right] = \exp\left[\alpha + \beta TREND + \sum_c \gamma_c Z_c + \delta REFORM\right] \quad (1)$$

where PATLENGTH is the "scheduled" patent duration, TIME TREND is a time-trend variable that controls for possible time variation effects in our patent sample,[45] Z_c is a set of predictor variables, REFORM is a dummy variable taking a value of 0 if the patent was issued before the 1864 reform and 1 otherwise. As we have noted, given the increasing fee structure, each additional year of patent duration represented for an inventor an additional cost. In this way, the "scheduled" duration of a patent can be interpreted as an indicator of the total investment made by a patentee for the patent protection of a specific invention. In this framework, the REFORM variable will capture the effect of the variation in the investment in patent protection for all patents granted under the new law, after controlling for other confounding factors. In particular, we consider as predictor variables a set of variables related to the geographical characteristics of the patents (FOREIGN, KINGDOM OF SARDINIA, INDUSTRIAL TRIANGLE, MILAN and ITALY NOT KINGDOM OF SARDINIA). We also control for the technological characteristics of the patent by including in the regression a dummy variable constructed using hi-tech patent classes (HI_TECH). Finally, we control for the experience of the patentee (PAT_EXPERIENCE) and for his attitude to cooperate with other inventors (TEAM).

Table 5a presents the result of our baseline model which does not include the REFORM variable. The results suggest that foreign patents (FOREIGN) are systematically characterized by longer durations. Interestingly enough, all patents whose inventors have a residence in Italy, at 1870 borders, have negative coefficients even if INDUSTRIAL TRIANGLE and MILAN are the only significant ones. In contrast, with a patent sample covering mostly later years, Nuvolari and Vasta found a positive effect of Industrial Triangle on patent duration.[46] This can be accounted by the still embryonic nature of innovation capabilities in that area, in this period. Considered together with the previous evidence on the geographical distribution of patentees, the results of Table 5a suggest that, in this period, there was an increasing participation by Italian inventors in the system, without, however resulting in a higher amount of investments in average patent protection. The TIME TREND variable is negative and significant,

45 This variable is constructed such as that 1855 = 1, 1856 = 2, etc.

46 *Nuvolari/Vasta*, Independent Invention.

indicating that later patents were characterized by lower patent durations. Speculatively, one can perhaps interpret this finding as a sign of the increasing "democratization" of the system.[47] Finally, high-tech patents (HI-TECH) are not characterized by longer durations. However, high-tech patents granted to foreign patentees (FOREIGN-HI-TECH) are instead characterized by systematically longer durations, even if also this effect is not significant. Finally, we find that neither PAT_EXPERIENCE, which is a variable constructed as the number of patents that the patentees have taken before the patent in question, and TEAM, which is a dummy variable with 1 for a patent taken by more than 1 patentee, do not significantly affect patent duration. Perhaps, this result might suggest that many patents were covering relatively simple technologies which were not characterized by major learning and scale effects.

Table 5b contains the estimates of the model when the variable REFORM is included among the co-variates. The size and sign of the estimated coefficients are rather close to those estimated in Table 5a. At all events, the main result is that the coefficient of the variable REFORM is positive and statistically significant, being robust across all specifications. The size of the REFORM coefficients suggests that the increase in patent duration after reform, after controlling for all other factors, is about 26 percent. Our interpretation is that the reform of 1864 resulted in a rise of investment in average patent protection. This result is particularly remarkable considering that the time trend maintains a negative and significant effect also in these regression models (Table 5b).

Tab. 5a: Determinants of patent duration, 1855-1872.

	(1)	(2)	(3)	(4)
Foreign	0.373***	0.286***	0.343***	0.353***
	(0.0404)	(0.0413)	(0.0351)	(0.0396)
Kingdom of Sardinia	0.0153			
	(0.0422)			
Hi-tech	-0.0177	-0.0172	-0.0236	-0.0177
	(0.0456)	(0.0455)	(0.0455)	(0.0456)
Foreign hi-tech	0.0704	0.0719	0.0760	0.0699
	(0.0561)	(0.0559)	(0.0560)	(0.0561)

47 *Khan*, Democratization.

Continuation Tab. 5 a:

	(1)	(2)	(3)	(4)
Time trend	-0.0215***	-0.0240***	-0.0215***	-0.0213***
	(0.00275)	(0.00269)	(0.00262)	(0.00271)
Pat_experience	-0.0162	-0.0137	-0.0160	-0.0163
	(0.0124)	(0.0123)	(0.0123)	(0.0124)
Team	0.0367	0.0409	0.0368	0.0362
	(0.0367)	(0.0367)	(0.0367)	(0.0367)
Industrial triangle		-0.145***		
		(0.0436)		
Milan			-0.163**	
			(0.0666)	
Italy not Kingdom of Sardinia				-0.0279
				(0.0448)
Constant	41.54***	46.31***	41.58***	41.20***
	(5.126)	(5.014)	(4.881)	(5.044)
Observations	4,712	4,712	4,712	4,712

Censored Poisson regressions (dependent variable is patent duration in years), *, **,*** indicate significance levels of 10%, 5%, 1% respectively. Robust standard errors in parentheses.

Tab. 5b: Determinants of patent duration, 1855-1872, including the reform effect.

	(1)	(2)	(3)	(4)
Foreign	0.381***	0.298***	0.353***	0.361***
	(0.0404)	(0.0412)	(0.0351)	(0.0396)
Kingdom of Sardinia	0.0153			
	(0.0422)			
Hi-tech	-0.0240	-0.0235	-0.0290	-0.0241
	(0.0455)	(0.0454)	(0.0454)	(0.0455)
Foreign hi-tech	0.0667	0.0682	0.0717	0.0662
	(0.0560)	(0.0558)	(0.0559)	(0.0560)
Reform	0.233***	0.226***	0.226***	0.233***
	(0.0500)	(0.0501)	(0.0501)	(0.0500)
Time trend	-0.0407***	-0.0425***	-0.0401***	-0.0405***
	(0.00499)	(0.00495)	(0.00493)	(0.00497)

Continuation Tab. 5 b:

	(1)	(2)	(3)	(4)
Pat_experience	-0.0141	-0.0118	-0.0140	-0.0142
	(0.0123)	(0.0123)	(0.0123)	(0.0123)
Team	0.0353	0.0394	0.0355	0.0349
	(0.0366)	(0.0366)	(0.0366)	(0.0367)
Industrial triangle		-0.137***		
		(0.0435)		
Milan			-0.147**	
			(0.0668)	
Italy not Kingdom of Sardinia				-0.0265
				(0.0447)
Constant	77.18***	80.63***	76.09***	76.86***
	(9.286)	(9.205)	(9.163)	(9.239)
Observations	4,712	4,712	4,712	4,712

Censored Poisson regressions (dependent variable is patent duration in years), *, **,*** indicate significance levels of 10%, 5%, 1% respectively. Robust standard errors in parentheses.

5 Conclusions

The main conclusions of this paper can be summarized as follows: First, the changes of the patent system, following the process of political unification of the country, prompted a reconfiguration of the geographical structure of Italian inventive activity, producing an increasing participation of the inventors from the other pre-unitary states. This can be interpreted as a sign of an effective integration policy, at least in this specific domain of government activity. This is not a completely foregone outcome because of profound cultural and administrative differences between the pre-unitary states and the significantly higher costs of the new system.

Second, concerning the participation of foreign inventors, this period is, in general, characterized by a sizeable share of foreign patents, fluctuating between about 40 and 60 percent. Furthermore, the French dominance, which was characteristic of the 1850s, is progressively eroded by the entry of English and American inventors. In this sense, it seems that, after the unification, the Italian patent system was progressively becoming more attractive for inventors on a large international scale.

Third, the 1864 reform produced an increase of the investment in patent protection. This suggests that the unified system was perceived as more valuable by domestic inventors too because at the same costs it was possible to obtain a wider scope of protection and perhaps stronger enforcement.

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Bionotes

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