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## Did patents of introduction encourage technology transfer? Long-term evidence from the Spanish innovation system

Patricio Sáiz

**Abstract** In this article, we reflect on how patents of introduction or importation, which compose an institutional policy related to weak IPR systems, could influence long-term international technology transfer. Both theoretically and empirically, the consequences of strengthening IPRs in lagging economies for technology transfer and innovation remain unclear. Although the mainstream literature tends to link stronger patent enforcement with better invention and innovation markets now and in the past, new theoretical and historical evidence supports extreme complexity in the relationship between IPR extension and scope and technological diffusion. For the first time, in this study, we analyze a large series of patents of introduction, which were a common feature of the early stages of almost all patent systems designed to favor technology transfer and innovation above original inventor property rights. Though typically used by pioneers, followers, and latecomers, we know little of how they functioned and their consequences. In this study, we analyze the use of patents of introduction throughout the nineteenth and twentieth centuries in Spain, which was a lagging country on the European periphery. The results demonstrate that this institutional policy could facilitate technology transfer, innovation, and advancement at earlier stages of industrialization. As additional research has demonstrated, such evidence may have serious implications for IPR treatment in both developing and underdeveloped economies.

**Keywords** IPR institutions Patents of introduction Technology transfer  
European periphery

**JEL Classification** N43 N44 N73 N74 O31 O34 O38

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## 1 Introduction

The impact of distinct IPR institutions on the scope and extent of technology transfer is a key issue in many economic and business fields. Relevant work and discussions have occurred in the areas of economic theory and business management as well as applied economics and economic history. Nevertheless, deep empirical analyses from long-term perspectives are rare even though they could shed light on the effects of patent institutions and agents on technology transfer. Did strong patent laws truly encourage long-term technical diffusion and efficient markets for new ideas, or did weak patent institutional policies favor technology transfer instead? Accurate answers to these questions would require more thorough inquiries and insights into each case, context, area, and period analyzed. Likely, the findings may differ depending on whether the focus is on technological diffusion in a single country or among several, their position as leaders or latecomers, their relative market size and scientific capabilities, the means of transferring (licensing, direct investment, skilled labor migrations, or machinery imports), or the historical phase studied.

From a current perspective, theoretical models and empirical results indicate that strongly enforced IPRs and patents in receiving countries promote both innovation (Gilbert and Shapiro 1990; Waterson 1990) and international technology transfer from technological leaders. This finding is especially true for increasing licensors' revenues (Yang and Maskus 2001; Smith 2001) and facilitating tacit knowledge transfer (Arora 1995) and has been widely confirmed for US multinational corporations and affiliates in 16 countries, which demonstrates that technology transfer increases where IPR institutions are strong (Branstetter et al. 2006). Foreign direct investment is also affected by patent systems in the recipient country because weaker IPRs can decrease the quality and scope of the transferred technology (Lee and Mansfield 1996). Although in certain cases weaker patents also enlarge direct investments from abroad, they may not be efficient enough (Nagoaka 2009).

In contrast, certain theoreticians suggest that strong patent rights may generate significantly less innovation compared with no patent protection when dynamics of sequential invention activity and entrepreneurial competitiveness are considered (Bessen and Maskin 2009). Considering the profitability of imitation and that open technical diffusion stimulates domestic capabilities, economic growth, and technical convergence (Goodfriend and McDermott 1998; Kelly 2009), strong IPRs in receiving countries might also reduce technology transfer and increase foreign technology costs (Nagoaka 2009). Robust patent protection will primarily profit northern countries with larger markets, skilled human capital, and greater R&D capabilities, while less innovative southern countries may benefit from weaker IPR institutions (Chin and Grossman 1990; Helpman 1993; Grossman and Lai 2004). Furthermore, based on their data and theoretical proof, Boldrin and Levine (2008, 2009) strongly supported the notion that IPR protection should be widely reduced throughout the globe to promote social good (technology transfer included), especially when the innovation market size increases.<sup>1</sup>

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<sup>1</sup> Best estimates show that the length of an optimal copyright term should not extend beyond 2 years, and patents should extend no greater than 10 years.

Economic historians have also contributed to this area, principally by analyzing long-term data on IPRs in pioneering countries and certain North Atlantic economies. The mainstream literature supports the notion of and offers historical evidence for positive consequences from patent enforcement and strengthening (through introducing examination systems or abolishing compulsory working clauses and patents of importation) on invention and innovation market development and consequently inventors' revenues and technology transfer in the United States as well as abroad (Lamoreaux and Sokoloff 2001; Khan and Sokoloff 2004; Khan 2005). In a recent paper, Khan (2012) claims that early and strong development of IPRs in the United States throughout the nineteenth and twentieth centuries contributed a well-organized technology market. This market supported invention specialization and extension of innovation commercialization throughout the nation, which crossed international boundaries and facilitated a 'global convergence in technology, productivity, and economic growth.' Additional research (Nicholas 2010, 2011) on the significant role of independent invention in the United States, Britain, and Japan during past centuries further demonstrates that the development and consolidation of technology markets (primarily through patent law enforcement) were vitally important for fostering private inventors.

Notwithstanding these predominant views, other scholars have recently presented strong new historical evidence that qualifies the previous findings. Certain scholars suggest that the strength of patent protection produced few positive effects in patent applications (Lerner 2002).<sup>2</sup> Additional scholars have suggested that IPR restriction, relaxation, or abolition could have significantly boosted technology transfer, imitation, and innovation in developing countries in the past or at least critically influenced the direction of inventive activity and technological change. Moser (2005) demonstrated the latter in her original work on innovations exhibited in two World Fairs by several North Atlantic countries with and without patent laws in the nineteenth century. Considering her results, strong and weak (or no) IPR regimes clearly determined in opposing directions the incentives to invent across industries. However, in the long term, both strategies could lead to technological leadership in distinct sectors, such as machinery manufacturing in the United States to scientific instruments, food processing, and dye-stuff in certain patentless North European economies (the Netherlands, Switzerland, and Denmark). Another recent example is the relevant work by Richter and Streb (2011), who demonstrated that Germany, which has recently accused China of patent right violations, has historically used the same methods to imitate and transfer American technology especially between 1870 and 1930. The German administration supported this strategy by using patent laws against foreign patent holders.

Thus, despite the predominant view and political feelings that currently favor strong IPR enforcement for the global economy, it is clear that the debate has not been settled. Theoretical questions persist, and historical evidence suggests that in certain cases weak IPRs could facilitate innovation, technology transfer, convergence, and economic growth. Much of the previous research includes direct

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<sup>2</sup> In this paper, Lerner examines 177 policy changes related to patent strengthening throughout 60 countries over 150 years.

reference to current developing countries and thus the political economy of IPRs. The TRIPs agreement (Trade Related Intellectual Property Rights) mandates stronger patent and copyright protection for latecomers, which is a harmonization that might 'benefit the North but possibly harm the South' (Grossman and Lai 2004). Other scholars have warned of possible conflicting effects on recipient countries (Nagoaka 2009), which might 'slow rather than accelerate economic growth' (Moser 2005) or 'slow down the speed of technological and economic progress in their domestic industry' (Richter and Streb 2011).

Nevertheless, given the significant body of research available, researchers have not conducted in-depth analyses on IPR management and long-term IPR effects for technology transfer in latecomers and technologically lagging countries. Thus, the principal aim of this paper is to offer for the first time results from an extensive in-depth study on IPR institutions in Spain and their effects on innovation and technology transfer. Spain is one of the most representative countries of the European periphery, as it consistently maintained weak patent institutions such as patents of introduction during the nineteenth and twentieth centuries. Throughout the greater part of both centuries, Spain lagged scientifically, technologically, and industrially, which impeded the development of a domestic research and development infrastructure capable of generating competitive inventive activity. However, we assert that the 'national system of innovation' (Freeman 1987; Lundvall 1988) was politically designed from the eighteenth century on to favor transfer of technology and human capital from abroad, and thus, it established the foundation for modern economic growth and industrialization. Such characteristics remained throughout the nineteenth and twentieth centuries, apparently sustained by institutional and socio-cultural weaknesses in education, scientific research, and technological development. The R&D incapacity of the Spanish economy was derived, first, from the seventeenth-century crisis and self-exclusion from the European scientific revolution. Second, the economy was incapacitated by the long and difficult transition from the Ancient Regime to the liberal society, which lasted almost the entire first half of the nineteenth century and impeded any development of a modern innovation system. Finally, Spanish R&D during this time was also weakened by the terrible consequences of the Civil War and the first 20 years of Francoism (1936–1959), which was devastating for the aforementioned aspects and endured through the end of the dictatorship (1975).

Therefore, our primary hypothesis is that the patent system was necessarily designed initially as a hybrid to conform to basic standards and protect invention activity but that it was sufficiently weak to encourage technical diffusion, imitation, domestic industrialization, and technology transfer over the rights of original inventors. The compulsory working clauses, patents of introduction, or lack of prior technical examinations were key institutions for the second purpose. Although this initial weakness was palpable in many countries, pioneers included, when industrialization began, such patent systems were progressively strengthened throughout the nineteenth and twentieth centuries as they enhanced their scientific and technological capabilities as well as international competitiveness. However, weak patent institutions persisted in Spain until recently, as is clearly demonstrated

by the long-term study on the evolution of 60 patent systems by Lerner (2000, Tables 4 and 5, 2005, Table 4).<sup>3</sup>

Specifically, we will characterize and study one such weak feature in the Spanish patent system, the patent of introduction, to understand its role and function. The patent of introduction permits anyone to protect foreign third-person technologies for local implementation, provided that the technology was not previously established in Spain. Although it is a clear declaration of intention for technology transfer and notwithstanding its presence in other patent systems, scholars have given little or no attention to the subject.<sup>4</sup> Therefore, it is unclear how these patents functioned, who used them, and what their consequences on innovation, industrialization, and technology transfer were, especially in scientifically and technologically underdeveloped countries such as Spain, which maintained patents of introduction until joining the European Union in 1986.

Section 2 examines the origins underlying patents of introduction or importation throughout the globe as well as the design and evolution of the Spanish patent system. Section 3 provides data on the long-term use and effectiveness of patents of introduction for technology transfer in Spain during the nineteenth and twentieth centuries, focusing on certain sectors. Section 4 provides evidence for their widespread use by foreign and domestic firms as well as entrepreneurs to introduce technology without respect for original IPRs. After reflecting on the determinants underlying patents of introduction and examining relevant case studies, Sect. 5 concludes by discussing historically how this institution may have positively influenced technology transfer in lagging economies.

## 2 Between protection and imitation: privileges, patents of introduction, utility models, and patents of exploitation

From the end of the seventeenth century on, and especially in the second half of the eighteenth century, which coincided with Charles III's reign, Spain, along with France and other European absolutist monarchies, experienced a proliferation of privileges of 'invention,' 'introduction,' or 'manufacture' that show increasing political interest in developing novel methods for industrial production. Although these privileges could be granted to protect national inventive activity, the enlightened mercantile spirit that guided such policies rewarded the introduction of new technologies and manufactures from abroad whether by nationals or by foreign technicians tempted by the prospect of monopolies to move into the country

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<sup>3</sup> In these tables, the evolution of compulsory working clauses, discrimination against foreigners, and the nature of prior examinations are analyzed. Compared with Germany, the United States, the UK, or France for instance, Spain was the only country that maintained together for over 160 years obligatory implementation, foreign discrimination (principally through patents of introduction), and grants without prior technical examinations.

<sup>4</sup> There are only indirect references to patents of introduction or importation for undeveloped countries in Penrose (1973, 782) and recently in Khan and Sokoloff (2008). Suggestions as to its negative effect in the UK by Khan and Sokoloff (1998, 312, Note 25). See also preliminary work on patents of introduction in Spain and Mexico in Beatty and Sáiz (2007).

(Macleod 1988; Hilaire-Perez 1991). The impact of the seventeenth-century recession on the Spanish productive economy must be considered as well as attitude reinforcement among the nobility, which devalued craftsmanship and industrial labor and found an outlet, during the eighteenth century, in substituting imports and attracting foreign skilled workers, the leading method for transferring technology and industrial arts (Epstein 2004). Accordingly, the differences between privileges of invention and introduction as well as manufacture grants were few and confusing during this period, wherein preference was invariably provided to establish monopolies on productions that were new to Spain.

However, several liberalization processes that led to the elimination of economic privileges in the Ancient Regime and establishment of private property rights for inventions did not prevent most countries from maintaining the potential for acquiring monopolies on new technology introduction. This potential was codified in the Statute of Monopolies of England in 1624, wherein privileges granted to the primary inventor or 'primary introducer' of new technologies were distinguished from additional economic privileges (Macleod 1988, 16–17). This potential was also codified in the revolutionary French Law of 1791, which referred to the acquisition of 'patents of importation' (Plasseraud and Savignon 1986, 186–187). This procedure was also common in the great majority of follower countries that adopted the patent system during the nineteenth century, such as Austria, Belgium, Italy, Portugal, Spain, Russia, and Sweden, as well as in South and Central America (Khan and Sokoloff 2008, Table 10.1). The conditions in Europe at the end of the eighteenth century and during most of the nineteenth century must be considered, as they included intense economic and technological competition among nations; thus, this type of patent was granted over and above the 'sacred' rights of the inventor to stimulate new production. However, patents of importation were progressively abolished in national legislation in the last quarter of the nineteenth century and the first part of the twentieth century as international treaties on industrial property signed from 1883 on established priority rights to facilitate international protection (Penrose 1951). For instance, by 1900 the UK, France, Germany, Austria, Belgium, Norway, and Sweden, which had previously employed patents of introduction, no longer allowed such protections (Khan and Sokoloff 2008, Table 10.1).

One of the few exceptions to introductions was the US Law of 1790, which only recognized invention patents (Lubar 1991, 934–935). Moreover, the United States quickly shifted to a system with prior technical examinations for novelty and abolished compulsory working clauses. However, initial US IPRs also had significant weaknesses. While the United States did not nominally allow 'patents of importation' as in certain countries, in practice, US businessmen and firms had 'super introduction rights,' as the law discriminated against foreigners (as in Japan until 1899) (Diebolt and Pellier 2011, 9–13). Patents were restricted to US citizens or residents attempting to become citizens (as affirmed and re-affirmed in the statutes of 1793, 1800, or 1832); when non-citizens were permitted to hold patents after 1836, discriminatory patent fees were imposed. Foreigners obtained the same rights as citizens only after 1861 (Khan 2012). Hence, foreigners could not extend IPRs to the US market, which allowed residents to import, establish, and commercialize new inventions from abroad without considering original and

‘sacred’ private property rights. This was the same strategy the United States used for copyright issues from Great Britain and additional countries, wherein the United States only recognized US writers’ rights, which generated bitter complaints from British authors against American publishers, such as from Dickens, who crossed the Atlantic to fight American piracy (Kaplan 1988, 124–125).

In Spain, where the first IPR laws were enacted during the heat of the liberal revolution and resembled the French Law of 1791, patents of introduction were initially specified; unlike other advanced economies, they remained until Spain joined the European Union (EU) in 1986 when new norms governing patents were decreed, which standardized European and international policy. Further evidence supporting the notion that the patent system was designed to stimulate industrial development and technology transfer more than to protect original inventive activity is the absence (until 1986) of a prior technical or novelty examination. In addition to the problems related to quality of protected ideas (Khan and Sokoloff 2004), such policies implied transferring to the market the administration of oppositions and configured a system that, in addition to judicial weakness in prosecuting fraud, favored copying and patenting foreign technology by residents. Although this weakness was initially common to many patent systems, difficult technical examinations were progressively established in the most developed economies during the nineteenth century. Germany and the United States were the first to establish such examinations before 1850, and by 1900, Austria, Norway, and Sweden had also required them. The UK had added similar restrictions by 1925. France delayed inclusion of such examinations until the second half of the twentieth century (Lerner 2005, Table 4).

Another essential aspect of Spanish legislation was compulsory working clauses, which requires the protected party to implement the patented technology within the national territory, which was difficult to enforce in various periods but clearly indicated an intention to implement real innovation processes by otherwise declaring an expiration date when that technology would pass into the public domain.<sup>5</sup> Theoretically, as with patents of introduction and the lack of technical examinations, compulsory working clauses did not aid original inventors in reinforcing IPRs, which would have created incentives and favored efficient technology markets. However, except for the United States, which has never had compulsory working clauses, such clauses remained in force everywhere during the nineteenth and twentieth centuries through today (Khan and Sokoloff 2008, Table 10.1; Lerner 2000, Table 4). Nevertheless, in our global economy, patents are currently considered in practice if the product, machine, or process patented is appropriately distributed throughout the domestic market even though it has been produced in another member country of the World Trade Organization (WTO). Thus, how these requirements functioned and evolved in different countries in the past is neither clear nor sufficiently studied. In Spain, such requirements, which necessitated domestic manufacture of a patented object within national borders, remained active from initial implementation in 1826 until Spain joined the EU in 1986.

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<sup>5</sup> The first laws (1811 and 1820) established a two-year period to implement the patent, which was reduced to one in 1826, returned to two in 1878, and set at three from 1902 on.

As shown in Table 1, the legislation contemplated applications for and acquisition of patents of introduction by persons of any condition and nationality who proposes to establish or establishes machinery, apparatus, instruments, processes, or mechanical or chemical operations which are wholly or in part new, or which are not established in the same mode or fashion in these Realms (Article 1, Royal Decree of the 27th of March, 1826); ...for 5, 10, or 15 years, decided by the interested parties, for objects of his own invention and for 5 years only if the application is for introduction from other countries; understanding that the privilege granted for these will be called 'introduction' and that the objects must be executed and implemented in these Realms, but not brought in completely from abroad (Article 3). The definition for this type of patent was similar in 1826, 1878, 1902, and 1929 and always stipulated that they cannot prevent importations.

In general, the cost was similar to invention patents (except from 1826 to 1878 when the cost tripled for the same time extension), but introductions were granted for only 5 years (10 years after 1929). These patents were subject to the same proceedings as invention patents as far as the administration and implementation within the country and were useful in copying and 'monopolizing' third-party inventions if they were not already registered and implemented in Spain. This was

Table 1 Patent type in Spanish legislation (1811–2011)

LAW	Patents of invention			Patents of introduction		
	Duration (years)	Cost (current prices)	Priority rights to foreign patents	Duration (years)	Cost (current prices)	Importation prevention
1811	15	Unknown	No	5	Unknown	Unknown
1820	10	3 €	No	5	1.5 €	No
1826	5, 10 or 15	1.5; 4.5 or 9 €	No	5	4.5 €	No
1878	20	First year: 0.06 € 20 years: 12.62 €	2 Years but limiting the patent to 10 years until 1884	5	First year: 0.06 € 5 years: 0.9 €	No
1902	20	First year: 0.06 € 20 years: 12.62 €	1 Year according to international agreements	5	First year: 0.06 € 5 years: 0.9 €	No
1929	20	Since 1924 First year: 0.06 € 20 years: 23.29 €	1 Year according to international agreements	10	Since 1924 First year: 0.06 € 10 years: 4.66 €	No
1986	20	First 2 years 562 € 20 years: 4,747.09 €	1 Year according to international agreements	–	–	–

To confirm patents of introduction in other countries during the nineteenth century, see Khan and Sokoloff (2008, Table 10.1). See also Lerner (2000, Table 5) for other discriminatory measures against foreigners

Source: Sáiz 2002, Table 1

especially effective before the recognition of priority rights for an original inventor under the Law of 1878 and before Spain's 1884 entry in the International Union for the Protection of Industrial Property. In any case, beyond the priority deadline, the patent of introduction could still be used to appropriate third-party technologies with no apparent problems.

In fact, the emphasis on innovation and industrialization over the rights of the original inventor increased during the most nationalistic and protectionist periods especially after WW I during the Primo de Rivera dictatorship, when the industrial sector experienced tremendous growth and accompanying technological changes. The Law of 1929, which was the culmination of this process, also penalized the duration of such grants by increasing yearly quotas and control over obligatory implementation (from 1924 on); increasing the protection period for patents of introduction to 10 years; recognizing 'utility models' (minor patents for 20 years covering incremental innovations that do not require international novelty but do require that the registered invention is manufactured in Spain)<sup>6</sup>; and allowing registration for patents of exploitation.

The latter produced a surprising legal procedure reminiscent of ancient 'manufacture privileges' because, in theory, they allowed monopolies on an entire industrial activity if it was previously absent from the country or the patent holder innovated or modernized an existing activity, as follows: Whoever has established, is establishing or proposes to establish an industry which is unique in Spain, or if others exist, but are rudimentary, imperfect in the means used or limited in production, does not prevent the national market from the necessity of supplying from foreign countries preferably or mostly, may obtain an exclusive patent, heretofore called 'patent of exploitation' (Article 73 of the Royal Decree-Law of the 26th of July, 1929). As with patents of introduction, this type of patent was granted for 10 years without impeding importations, but it was outside the International Union for the Protection of Industrial Property Agreement; thus, priority and patent rights for foreigners were not recognized. Obviously, such a system seriously infringed on international agreements, and this type of patent disappeared in 1930 (Royal Decree-Law of the 15th of March). However, we believe that it perfectly summarizes the spirit and characteristics of a hybrid patent system, which always gave precedence to domestic industrial activity even though it guaranteed ownership rights to national and foreign inventors.

In reality, we contend that the Spanish system is not exceptional because of its institutional environment favoring introductions, copies, and innovation over foreign IPRs, which was initially common elsewhere, but because such characteristics persisted over time. Almost all countries employed similar strategies that favored domestic industrialization to developing competency and comparative advantages in specific technological and economic areas, which allowed them to

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<sup>6</sup> According to Lerner (2005, Table 2), utility models were also used in many developing countries and even advanced economies such as Belgium, Germany, or Japan throughout the twentieth century. Others did not allow such protections (the United States, the UK, the Netherlands, Sweden, Norway, and France). Nevertheless, we lack a deep analysis on how they were administrated in each country (e.g., if they required prior technical examinations and international novelty). In Spain, they were closed to patents of introduction as they protected very simple ideas not implemented in the national market.

compete internationally. We have seen that certain countries, such as the United States, Japan, and Germany, have discriminated against foreigners during certain periods. Other countries, such as Switzerland, Denmark, and Holland, took advantage of absent or abolished patent laws<sup>7</sup> to acquire competency in leading technologies for specific sectors. However, despite such strategies, North Atlantic economies clearly converged on IPR protection as well as scientific and technological competency throughout the twentieth century.

However, during the greater part of the nineteenth and twentieth centuries, Spain did not achieve competitive capabilities worthy of mention in a technological sector even though it produced noteworthy scientists and technicians, especially in the first third of the twentieth century, whose work became a footnote in the long-term history of national technology. These innovators frequently worked abroad, which is also true today. The Spanish innovation system has historically been focused on transfer of foreign technology and has not significantly promoted domestic invention activity. Notwithstanding, Spain became part of the developed world although the weaknesses of such a model are especially obvious during economic crises. As in additional scientific and knowledge-based fields, the patent issue remains unresolved.

### 3 Patents of introduction and technology transfer during the nineteenth and twentieth centuries

How were patents of introduction used, and what was their true role in transferring foreign technology? First, it is necessary to note that exhaustive and reliable data are only available from 1770 to the Civil War (1936–1939). Accurate data on patents of introduction after 1936 are unavailable even though they were granted until 1986. Second, we must note that the Spanish patent system has generally had a strong presence of foreign inventive activity (an average of 65 %), which is measured both by patents of invention or introduction registered by foreigners and by patents of introduction under Spanish names (Sáiz 2002, Table 2). However, as previously discussed, applications for patents of introduction have specific technical transfer characteristics beyond original inventor rights (i.e., without respecting IPRs), which is a relevant subject for analysis under the aims of this work.

As shown in Fig. 1, before modern patent laws were established, grants for ‘privileges of introduction’ were given on a case-by-case basis. After researching several archives and sources from 1750 to 1820, we found and studied an interesting sample of 51 privileges, which were granted after 1770, and only four were ‘of introduction’ (i.e., given to Spanish nationals attempting to implement foreign products). For the same period, we also found 232 different award applications or grants for new technologies, which shows that privilege grants were more difficult to acquire than other awards (money, political, or administrative posts) and that inventions and introductions were not very distinctive (including manufacture

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<sup>7</sup> Switzerland did not pass a patent law until 1888, Holland rescinded theirs between 1869 and 1912, and Denmark had essentially no protection before 1876 and weak protection thereafter.

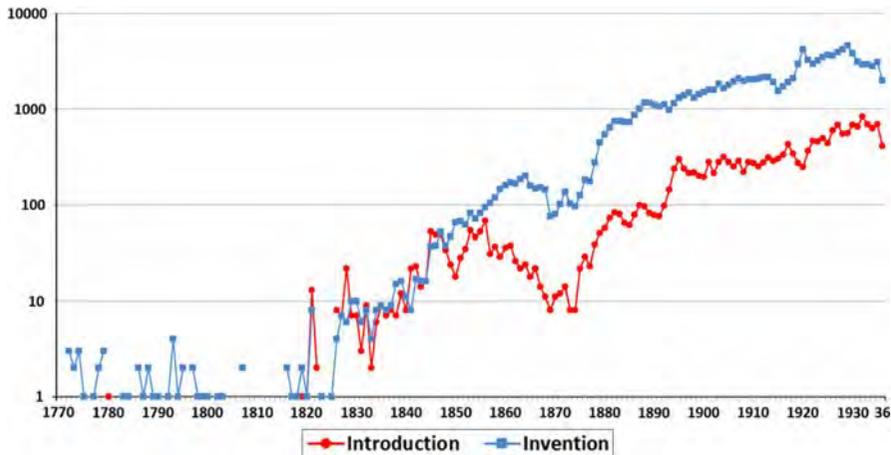


Fig. 1 Patents of invention and patents of introduction applications; Spain 1770–1936. Source: Archivo Histórico Nacional y Gaceta de Madrid for privileges from 1770 to 1826. Between 1826 and 1936: original patent files at the Oficina Española de Patentes y Marcas (OEPM). We do not include ‘additions’ available in Spanish legislation from 1878

privileges). As previously mentioned, such grants were a response to the same absolutist logic: monopolies to stimulate national production within a political system wherein private property rights do not exist.

More interesting is what transpired after consolidation of the liberal industrial property laws (1820 and 1826), wherein patents of introduction were regulated and became operative. As shown in Fig. 1, until 1856, the number of applications for patents of invention and introduction was equal when the system began to function and coincided with a period of industrial lag and socio-political problems under the long Spanish liberal revolution. With a few exceptions in Barcelona and Madrid as well as certain areas of Andalusia (the three regions with the greatest number of patent applications at the time), this period was characterized by a high level of economic divergence between Spain and the major European powers, wherein the first industrialization processes were consolidated. Therefore, patents of introduction may have played an interesting role in transferring efficient technologies already tested abroad during this phase, which was commercially protectionist. However, between 1856 and the Bourbon Restoration in 1874, the number of patents of introduction fell sharply before a general system collapse after the 1864 financial and institutional crisis, which affected the entire economy. The period between 1854 and 1864 included growth and convergence as well as construction for the railway system; the banking system was established; several industrial activities commenced; and in certain cases, technology imports were facilitated, such as the customs franchise for the railway system. Though somewhat protectionist, the tariff of 1849 had decreased prohibitions, and in the context of a gradual price increase, it aided in reducing protectionism from 1850 to 1860 and culminated in the 1868 free-trade tariff of Figuerola. Perhaps, a greater influence on the decrease in introduction applications was the restrictions that began in 1838 (and

Table 2 Annual growth rates for applications in Spain by patent type

	Invention	Introduction	
	1820–1930	6.33	4.44
	1820–1856	8.42	6.73
	1857–1874	0.33	–8.51
Bold highlights that the data in the row are for the whole period studied instead of distinct sub-periods below	1874–1883	23.41	25.21
	1874–1920	7.76	7.63
	1874–1930	6.53	7.69
Calculated from tri-annual averages	1891–1930	3.29	5.32
	1920–1930	1.04	7.97

Source: see Fig. 1

continued from 1849 on) and required implementation of registered objects and not simply importation from abroad. However, the growth rate for patents of introduction was greater than for patents of invention in the following decade (1874–1883) and from 1891 until the end of the period studied herein, with special emphasis on the 1920s in the framework of moderate beginnings followed by a general development of nationalist and protectionist changes in policy by Spain as well as internationally toward the end of the 1870s.

The annual growth rates for the periods in Table 2 confirm the general notions we have discussed. In addition, more applications for patents of invention were filed than for patents of introduction, and the growth rate for the former was greater than the latter for the entire period (1820–1930). Nevertheless, as we have already mentioned, the growth rates for patents of introduction increased during periods of protectionism especially in the 1920s, which was the peak of nationalism and protectionism for national industries. During this decade, the growth rate for patents of introduction was seven times greater than for patents of invention (in addition to extension of the protection period to 10 years). Utility models (and patents of exploitation) were passed and compulsory working clauses were reinforced. Such measures were a clear indication of an attempt to substitute industrial imports and stimulate imitation, technology transfer, and domestic invention activity.<sup>8</sup> During this period, heavy industry increased and the economic structure changed. For the first time, the secondary sector contribution to the GNP was greater than agriculture, which was later reversed during the Civil War and Franco dictatorship.

With the limiting tariff of 1875 and despite the patent legislation of 1878, which recognized priority rights of foreign inventors, the patents of introduction growth rates were almost always greater than for patents of invention regardless of the period examined. Recall that the tariffs of 1891, 1906, and 1922 were clearly protectionist as well as the additional legislation (in 1907, 1909, 1917, 1918, and

<sup>8</sup> Between 1880 and 1930, the Spanish system of innovation began to expand. Internationally relevant inventors, such as Isaac Peral, Leonardo Torres Quevedo, and Juan de la Cierva, emerged through a network of changes in scientific and technological education as well as innovative business activity. The only Nobel Prize in Science in Spanish history was awarded during this period (to Ramón y Cajal in 1906). Severo Ochoa, who was awarded the Nobel Prize in Physiology in 1959 after migrating and researching in the United States for 20 years, was an advanced student during the 1920s; he received his MD degree in Madrid in 1929.

1922) supporting national industry and favoring production in the country. Therefore, an innovation system based on the transfer of foreign technology, as in the case of Spain, had two options that could be combined: (1) acquire new technology by importing it (in a free-trade context) and improve rights for foreign inventors and enterprises and (2) use protectionist barriers and a legal framework, such as patents of introduction, to stimulate national industrialization, ‘learning by doing,’ and domestic invention activity. The efficacy of protectionism and, in this case, the factors that permit imitation and technology transfer has been hotly debated in economic theory and history, but its success in supporting the development of a country depends on numerous factors, such as the period in which it is used, the international context, its extension over time, the capability of developing later competitive technologies and skills, as well as the socio-cultural environment. In any case, one possible scenario is that protection and imitation are beneficial in the early stages of industrialization for acquiring comparative economic and technological advantages, as demonstrated in many countries where the economic policy of substitution of imports was initially essential.

However, to understand the use of patents of introduction at various times, besides observing growth rates, we will examine the effectiveness of grants. Through the large body of work generated over many years at the Spanish Patent and Trademark Office for each file,<sup>9</sup> we extracted and analyzed a vital feature in Spanish patent administration, that is, obligatory implementation. As previously indicated, within 1–3 years, the recipient was required to demonstrate that the patented object was implemented within the national territory. This requirement was enforced to varying degrees depending on the period; enforcement was especially efficient from 1849 to 1878 when notarized independent reports were required. Enforcement was similarly efficient after 1924 (and again in 1929) when a new regulation<sup>10</sup> clarified the Law of 1902, reinforced compulsory practice clauses, and required implementation under penalty of forced compulsory license for a patent to any applicant at first and then through an expiration date. From the beginning of the protection system through 1838, patent implementation was not strongly controlled; however, a radical change introduced by a Royal Decree in 1838 and 1849<sup>11</sup> included immediate expiration due to non-implementation (Fig. 2). This change drastically influenced the number of applications for patents of introduction in the 1850s as demonstrated in Fig. 1. The non-implementation provision and a decrease in protectionism were the primary basis for a reduction in applications for patents of introduction preceding the crisis of 1864. The registration of such patents was too costly and of short duration such that there was a risk of expiration due to non-implementation even where the protected object was easily imported. In fact, during

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<sup>9</sup> We indexed and studied (from the original files) approximately 150,000 patents between 1826 and 1939. Approximately 70 people were involved in this enormous project (see <http://historico.oepm.es> for further details).

<sup>10</sup> Regulation of the 15th of January, 1924 (Colección Legislativa de España, NS, T. LXXXIII).

<sup>11</sup> Royal Order of the 26th of March, 1838 (Colección de las leyes, decretos y declaraciones de las Cortes, y de los Reales Decretos, Ordenes, Resoluciones y Reglamentos generales expedidos por las Secretarías del Despacho, T. XXIII); and Royal Order of the 11th of January, 1849 (Colección Legislativa de España, T. XLVI).

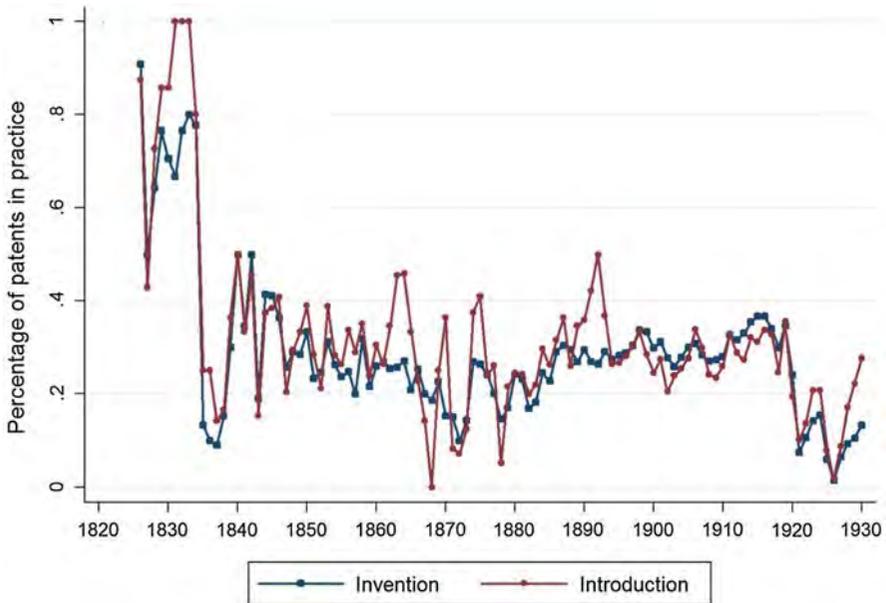


Fig. 2 Percentage of patents implemented within the legal time frame; Spain 1820–1930. Source: see Fig. 1

periods without harsh controls for implementation, many patents of introduction could be used just to monopolize technology importation. Between 1878 and 1924, the implementation procedure was relaxed; in certain cases, a report by an engineer was sufficient if it certified that the necessary means to produce an object were available at a particular factory.

Nevertheless, these data invite us to consider the efficacy of such monopolies, which was generally limited, as demonstrated in Fig. 2 and Table 3. Considering the entire system between 1820 and 1930, only 23 % of the patents were actually implemented; thus, three-quarters of the patents were null and void and became public. Although there is little literature on this topic, apparently the same was true for all systems and most applications were not real ‘innovations’ to the economy. Moreover, a portion of this implementation percentage may not be realistic and did not produce significant technical changes. However, the documentation of such patents should be researched in detail and further studied because such applications often contain specific data on the establishments, firms, and technicians involved in technology implementation.

Additionally, we can verify interesting differences between patents of invention and introduction; the latter is easier to demonstrate in practice because we assume that they were for implementing innovations already successfully tested abroad. Until 1874, the implementation percentage and effectiveness index shown in Table 3 were substantially greater for introductions than for inventions (37.2 % compared with 29.1 % before 1856 and 28.5 % compared with 21.7 % between 1856 and 1874). Between 1875 and 1920, the implementation percentage for patents

Table 3 Patents of invention and introduction effectiveness index; Spain (1820–1930)

	Patents of invention			Patents of introduction			Total introductions
	Implemented %	Non-implemented %	Effectiveness index <sup>t</sup>	Implemented %	Non-implemented %	Effectiveness index <sup>t</sup>	
1820–1930	22.6	77.4	0.98	24.9	75.1	1.08	14,446 <sup>tt</sup>
1820–1856	29.1	70.9	1.26	37.2	62.8	1.62	694
1857–1874	21.7	78.3	0.94	28.5	71.5	1.24	361
1875–1920	29.5	70.5	1.28	28.7	71.3	1.25	8,639
1921–1930	8.7	91.3	0.38	15.9	84.1	0.69	4,752
Two-sample K–S test [p value]				0.0229 [0.000]			

**Bold highlights that the data in the row are for the whole period studied instead of distinct sub-periods below**

We have estimated probit regressions using a dummy on patent implementation as a dependent variable (1 for patents that passed compulsory working clauses and 0 for patents that failed). As independent variables, we have tested the type of patent and the distinct periods shown in Table 3. The results are extremely consistent; with an intercept value at  $-1.31$  (0.01)<sup>\*\*\*</sup>, the likelihood of implementation was greater among patents of introduction [0.09 (0.01)<sup>\*\*\*</sup>] compared with patents of invention; the analysis is similar for patent applications between 1820 and 1856 [0.81 (0.03)<sup>\*\*\*</sup>], 1875 and 1920 [0.76 (0.01)<sup>\*\*\*</sup>], and 1857 and 1874 [0.55 (0.03)<sup>\*\*\*</sup>] compared with 1921 and 1930. We have tested other variables (e.g., country of residence and sectors) not included herein although estimation results are available from the author upon request

<sup>t</sup> The effectiveness index is the quotient for the percentage of patents implemented during each period and patent type over the national average for the entire patent system and periods (which is 2.3 %); therefore, the average is equal to 1

<sup>tt</sup> The values were calculated based on 95.4 % of patents. The remainder had no implementation data

<sup>ttt</sup> The Kolmogorov–Smirnov statistic follows a chi-square distribution. Based on the p value, the null hypothesis of equal distributions is rejected

Source: see Fig. 1

of introduction was almost 29 %, and the implementation percentage for patents of invention was slightly higher, which coincided with the long period of extremely lax enforcement for such requirements. However, as shown in greater detail in Fig. 2, in certain years between 1860 and 1895 the percentage of patents of introduction in practice significantly exceeded patents of invention. Finally, when enforcement increased dramatically during the 1920s, the implementation rate fell drastically for all types of patents, although patents of introduction were twice as successful as patents of invention.

Thus, there were three periods wherein patents of introduction were more relevant in implanting foreign technologies without respecting ownership rights of the original inventors or firms (Fig. 2). The first period was at the beginning of the patent system through the mid-1830s when there was little control over implementation requirements; the second included 1848 through the beginning of the 1890s; and the third was during the 1920s. The last two periods included convergence with European industrialization (especially between the 1850s and 1865, the 1880s and the early 1890s, as well as between 1915 and 1929); the latter was also a period of domestic increase in scientific and inventive activity.

If we focus on sectorial distribution of patents of invention and introduction throughout the period analyzed, several differences are clear. Such patents were classified following the typical approach for grouping inventions according to sector wherein new technology may produce an impact (Schmookler 1966, 20–23). Multisectorial inventions that clearly affect many industries (such as a generic advance in steam engines or boilers) were assigned to the group machinery and equipment except where the patent claims a specific use (e.g., steam engines for navigation or railways). Under this classification system, we have also considered whether the inventions related a new process or product.<sup>12</sup> The patent was classified directly from the patent drawings and descriptions. In doing so, we combined the sectorial approach with the technical criteria used in the International Patent Classification published by WIPO.<sup>13</sup>

Although patents of introduction composed only 12.6 % of the total patents granted, their distribution across industries (Table 4) reveals that they were more concentrated than patents of invention in light sectors related to consumption especially textiles (19 % for patents of introduction compared with 10 % for patents of invention) as well as the food, beverages, tobacco, paper, lumber, and services industries.<sup>14</sup> The sectors in which domestic productive activities and business thrived before 1930 comprised proven foreign technologies and products easier to implement by domestic technicians and entrepreneurs compared with complex innovations, and this finding is consistent with the aforementioned

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<sup>12</sup> For further consideration of problems with patent classification, see Griliches (1990).

<sup>13</sup> A task that was carried out throughout a decade of careful patent cataloguing and study. More information on the classification system and numerous examples can be found in Sáiz (2002).

<sup>14</sup> Novelties of different types for housing reorganization, furniture, private and domestic objects, urbanism, medicines, hygiene, heating, music, sport and plays, shows, teaching, fine arts, optics, and photography, among others.

Table 4 Sectorial distribution for introduction and invention patents; Spain 1820–1930

	Introduction %	Invention %
Machinery and equipment	15.6	21.9
Services	15.5	15.0
Textile	18.9	9.8
Food, beverages, and tobacco	9.2	8.2
Chemical	7.9	6.5
Electricity	3.8	6.0
Basic metals	5.8	4.2
Construction	4.1	4.1
Non-rail transport	3.3	4.0
Paper and graphic arts	4.4	3.3
Arms industry	2.2	3.3
Railway	1.7	2.8
Gas and lighting	1.8	2.3
Agriculture and cattle farming	1.1	2.0
Sea transports and ports	0.9	1.7
Communications	0.7	1.7
Mining and coal	1.4	1.5
Lumber industry	1.3	0.9
Aeronautics	0.4	0.8
Invention unknown	0.1	0.2
Total patents	15,053	104,796
*Two-sample K–S test [p value]	0.0632 [0.000]	

\* The Kolmogorov–Smirnov statistic follows a chi-square distribution. Based on the p value, the null hypothesis of equal distributions is rejected

Source: see Fig. 1

effectiveness for patents of introduction. This modality was also clear in basic metal production and the chemical industry; both sectors were critical for initiating domestic industrialization, and the latter was closely linked to goods of generic consumption before 1900.<sup>15</sup> In contrast, despite their larger numbers in every sector, patents of invention were proportionally more centered on heavy industries with greater technological complexity and based on scientific progress (especially after 1880). Such industries required high investment often from abroad for research and implementation, such as for technologies involved in energy production, transport, communications, armament, as well as machinery and mechanical construction. Even mining and agriculture, which were behind their ‘technological frontiers,’ shared this pattern.

<sup>15</sup> Advances in processing and manipulation of fats, oil, candles, soaps, cosmetics, glass, matches, medicines, fertilizers, lubricants, paints, and varnishes, among similar compounds.

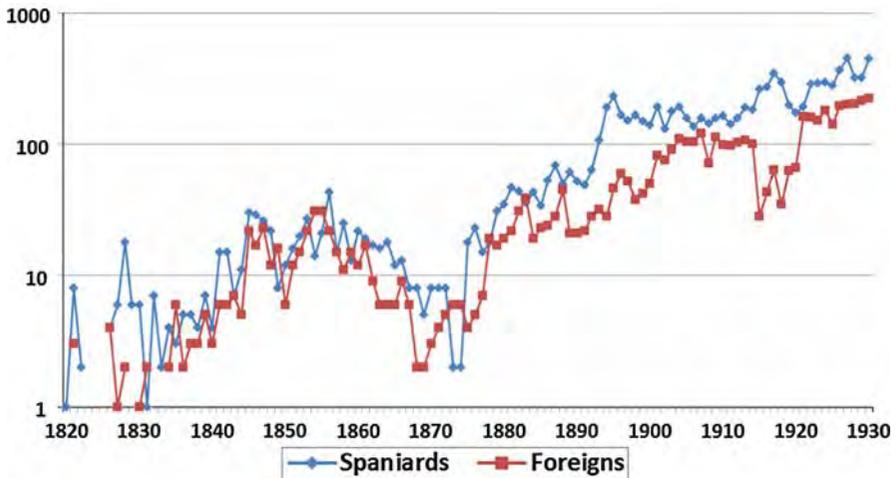


Fig. 3 Patents of introduction by applicant nationality; Spain 1820–1930. We do not include 560 patents of introduction in which the applicant’s nationality is unknown, although the surnames suggest they were likely foreigners. Source: see Fig. 1

#### 4 A peripheral anomaly? Who used patents of introduction and for what purpose?

Thus, if patents of introduction, which are a paradoxical means to establish property rights on others’ inventive activity, were commonly used in Spain throughout the period studied and if we consider that they were more effective than patents of invention despite having a shorter duration and higher costs, it would be convenient to address whether the use of such patents was biased toward certain socio-professional groups, which would be expected. In contrast to patents of invention during this period,<sup>16</sup> it is more likely that more Spaniards than foreigners used ‘introductions’ to import functional technology from abroad (given the lack of domestic inventive activity). These domestic patent holders were likely connected to the productive economy and incipient industrialization with a greater interest in introducing and monopolizing techniques widely tested in more advanced countries primarily in predominantly light sectors (e.g., textiles, food, or beverage), as we demonstrated above. As shown in Fig. 3, Spaniards applied for more patents of introduction than foreigners, although the ratio between such applicants was similar before 1855–1860. This trend continued from 1860 to 1890 (although domestic users began to slightly dominate), but it clearly changed to favor Spaniards from the 1890s to 1930 during the nationalist and protectionist events.

Hence, it seems that although patents of introduction were more generally used by Spaniards, this type of application was a common practice both for nationals and for foreigners before 1880–1890 (i.e., before the international agreements on industrial property and priority rights, when many other patent regimes also used ‘introductions’ to favor national industrialization, at least in the first half of the

<sup>16</sup> Foreign patents superseded domestic patents especially from 1870 to 1930 (Sáiz 2002, Fig. 1).

Table 5 Foreign patents of introduction by applicant nationality; Spain 1820–1930

	France %	Germany %	UK %	USA %	Rest %	Patents of introduction
1820–1930	28.2	22.3	17.4	9.8	22.3	4,690
1820–1856	73.4	1.0	15.2	1.7	8.6	290
1857–1874	67.1	2.9	12.1	5.7	12.1	140
1875–1920	26.0	25.7	19.0	8.2	21.1	2,423
1921–1930	21.0	22.8	16.0	13.5	26.8	1,837

**Bold highlights that the data in the row are for the whole period studied instead of distinct sub-periods below**

Source: see Figs. 1, 3

nineteenth century, or did not guarantee property rights to inventions, e.g., in Switzerland). Further, an international patent system was developed when pioneer and follower countries generated innovative and technological capabilities as well as became competitive internationally but maintained only patents of invention in their systems. Thereafter, Spain kept patents of introduction active for a long duration to promote innovative attitudes among national or resident entrepreneurs as well as industrialists and businessmen, who extensively used such patents to implement new technologies from abroad.

Nevertheless, although Spaniards dominated the scene after 1890, many foreigners also used this legal procedure to protect others' technologies in Spain thereafter. Table 5 shows the nationalities of foreign patentees that applied for introduction patents in Spain during the periods studied. There were two distinct phases. The first phase included 1820 to 1875 in which French applicants monopolized approximately 70 % of introduction patents followed by the British (12–15 %). The second phase included 1875–1930 in which the French ratio was reduced to a quarter or lower in the 1920s; however, North Americans and citizens from other countries, particularly Germans, increased their share (22–25 %), and the British maintained and slightly increased their share to between 16 and 19 %.

Thus, geographical proximity is relevant, which is clear for the French during the first three-quarters of the nineteenth century and after. Before 1878, France had a strong influence on Spanish laws and was the most important country from acquiring both patents of invention and introduction in Spain before that date. In addition, because the origins of the technology the patentee wanted to establish were cited for approximately half of the patents of introduction, we found that in such patents registered by Spaniards, France was the country most often mentioned (54.3 %). This French presence in the patent system was consistent with general investments in Spain by this country before 1914, as measured in total capital or number of enterprises with economic interests in Spain (Tortella 2000, Tables 1 and 5); this observation was also true for the remaining countries in Table 5. After 1875–1880, the arrival of German patentees completely changed the landscape. As we mentioned, the proportion of French patents of introduction decreased, and German technology and industry expanded, which generated inventions and patents throughout Europe during the second industrial revolution. The German expansion

also increased applications for patents of introduction in Spain by German engineers, businessmen, and corporations. The application increase was simultaneous with German penetration of other economies and investments outside their borders during the protectionist and nationalist battles, which were characteristic of the last decades of the nineteenth century and the beginning of the twentieth century. During this period and especially in the 1920s, other European countries and the United States increased their presence, investments, and patents in other nations, which is also reflected in the Spanish patent of introduction statistics.

Certain holders of foreign patents of introduction were residents in Spain at the time they applied, which was especially relevant before 1880 (i.e., before the international extension of patent agreements and the technological expansion of the second industrial revolution mentioned). The post-1880 changes in the international framework lead patentees (increasingly, corporations) and their agents to systematically register inventions in possible markets for the most interesting countries. By studying each file using the original documentation, we differentiated nationality and residence in many cases. If we analyze the entire patent system, the portion of foreign residents was more than half of the foreign applicants before 1850; almost one-quarter between 1851 and 1878; and less than 4 % between 1878 and the first decades of the twentieth century.<sup>17</sup> Figure 4 and Table 6 show the relationship between resident and non-resident foreigners for patents of introduction.

As shown in the figure, the results demonstrate first that when foreigners were granted patents of introduction, they were more likely to live in Spain than for patents of invention, especially before 1875–1880, when the ratio of residence was approximately 60 %. Thus, the mobility of human capital was essential for technology transfer during the greater part of the nineteenth century as with previous centuries, and as we have already suggested, this legal procedure was more widely used by people closely connected to the productive sectors and interested in importing sufficiently tested technology. Similar to domestic patentees, foreign residents had economic networks and knowledge of Spanish market and institutions with the advantage of the intangible assets from their original countries. Proper connections to technological enclaves in Europe as well as their business and technical knowledge allowed them to effectively attempt transfer of certain technologies that may have been useful to their economic interests in Spain. Alone or associated with Spaniards, many resident foreigners especially the French during this period as demonstrated in Table 6 as well as the British and other foreign applicants patented machines and processes they did not invent. Such foreign applicants invested in many sectors of the Spanish economy that held business opportunities at that time. The presence of French, British, Belgian, Swiss, and German engineers, mechanics, entrepreneurs, and technicians, among others, in railway, mining, chemical, and other industries in the nineteenth century is well documented in historiography. However, the true role of mobility for such human capital in technology transfer and Spanish modernization for certain sectors or regions is not well understood.

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<sup>17</sup> (Sáiz 2002, Table 3).

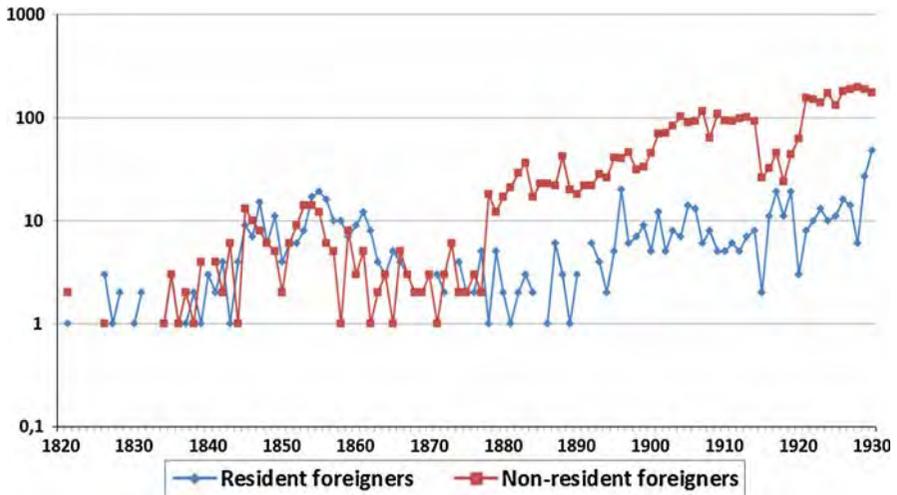


Fig. 4 Foreign patents of introduction by applicant place of residence; Spain 1820–1930. Source: see Figs. 1, 3

Table 6 Foreign patents of introduction by applicant place of residence and nationality of resident foreigners in Spain (1820–1930)

	Non-residents %	Residents %	France %	Germany %	UK %	USA %	Rest %	Patents of introduction
1820–1930	85.5	14.5	6.3	2.4	1.6	0.3	3.9	4,690
1820–1856	45.9	54.1	42.8	0.3	7.9	0.7	2.4	290
1857–1874	40.0	60.0	44.3	0.7	5.7	3.6	5.7	140
1875–1920	88.6	11.4	3.4	2.9	1.1	0.2	3.8	2,423
1921–1930	91.1	8.9	1.4	2.2	0.9	0.1	4.3	1,837

Bold highlights that the data in the row are for the whole period studied instead of distinct sub-periods below

Source: see Figs. 1, 3

In addition, Fig. 4 and Table 6 also show radical changes in the statistics surrounding 1880, which indicates a massive arrival of foreign applications ‘from abroad’ that also affected patents of introduction patterns. These observations also indicate institutional and economic changes, such as those from the Law of 1878 (including diminished costs, among other changes; see Table 1); the internationalization of the patent system guaranteeing priority rights; acceleration of innovations that characterized the period; as well as a growing number of corporations using patents and applying for intangible properties outside their countries of origin. In this context, wherein applications for patents of introduction slowed in total numbers compared with patents of invention (see Fig. 1), mobility was less important over time, although approximately 10 % of patentees were in Spain when they applied for the introduction patent (French, 3.4–1.4 %; Germans, 2.2–2.9 %; and citizens of

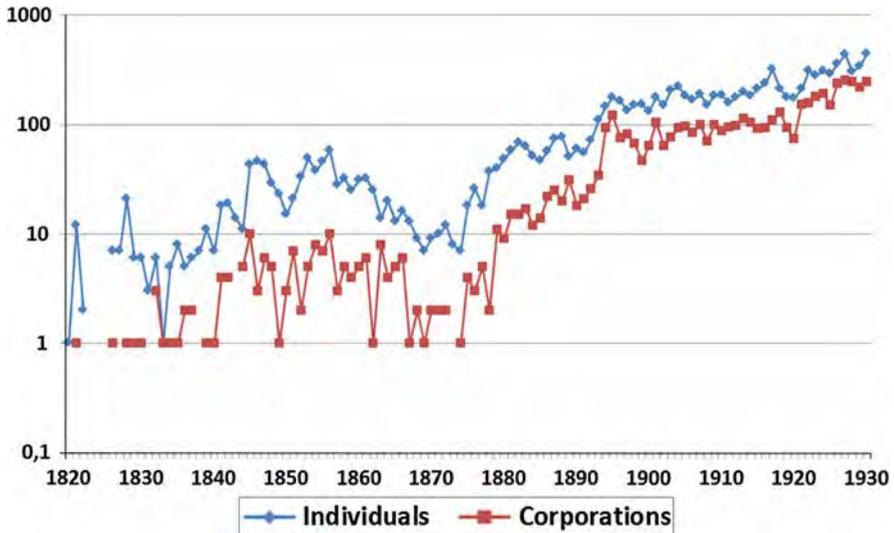


Fig. 5 Patents of introduction by applicant legal status; Spain 1820–1930. Source: see Fig. 1

Table 7 Patents of introduction by applicant legal status; Spain 1820–1930

	Corporations	Independents	Patents of introduction
1820–1930	32.6	67.4	15,053
1820–1856	13.4	86.6	724
1857–1874	15.7	84.3	369
1875–1920	31.5	68.5	8,659
1921–1930	38.3	61.7	5,301
*Two-sample K–S test [p value]		0.0434 [0.000]	

Bold highlights that the data in the row are for the whole period studied instead of distinct sub-periods below

\* The Kolmogorov–Smirnov statistic follows a chi-square distribution. Based on the p value, the null hypothesis of equal distributions is rejected

Source: see Fig. 1

other countries). German direct interest and investments in Spain had increased since 1880, especially in the 1920s, as important German corporations established factories or participated in joint ventures with Spaniards or other foreign investors in several sectors (e.g., chemical, electricity, and machinery and equipment, among others) (Puig and Loscertales 2001; Loscertales 2002). This process can also be followed through other countries’ investments, which generally occurred at the end of the nineteenth century and during the twentieth century. Hence, apart from patents of invention but to a lesser degree, patents of introduction were still used by foreign individuals and corporations to appropriate others’ inventions and to acquire monopolies in Spain during this period to the extent possible under national legislation to encourage technology transfer and industrialization.

Table 8 Independent patents of introduction by applicant socio-professional status; Spain 1820–1930

	Civil servants	Liberal professionals, qualified technicians	Manufacturers, salesmen, craftsmen, etc.	Others	Patents of introduction <sup>a</sup>
1820–1930	4.2	30.4	60.1	5.3	3,152
1820–1856	9.8	17.0	72.0	1.2	418
1857–1874	4.3	18.8	75.0	2.0	256
1875–1920	3.3	34.1	57.7	4.9	1,756
1921–1930	3.2	33.1	53.9	9.8	722

**Bold highlights that the data in the row are for the whole period studied instead of distinct sub-periods below**

<sup>a</sup> Profession was recorded for an average of 31.1 % of individual patents of introduction between 1820 and 1930. We have expressly excluded corporate patents

Source: see Fig. 1

Focusing on the legal status and socio-professional activities of patent of introduction applicants, Fig. 5 and Table 7 demonstrate that both domestic and foreign independent patentees predominated in the periods studied and that the corporations, especially foreign corporations, increased their presence after 1880 in Spain (as with other systems). Nevertheless, the ratio of corporations that used patents of introduction was higher than the ratio generated by analysis of the entire patent system (approximately 8.5 % from 1820 to 1875 and 26.7 % from 1876 to 1930), which clearly supports our hypothesis that the introduction patents were more widely used by people connected to productive activities, which may not have included the inventors but, rather, entrepreneurs and innovators attempting to implement new technologies. In the final analysis, enterprises and corporations are productive joint ventures that may develop their own inventive activity or use others' technologies by paying for licenses, copying without respect for property rights, using legal tools such as the patent of introduction when it is possible, or both systems simultaneously depending on the firm, R&D competence, technological and innovative capabilities, business, sector, period, or country.

The same issue emerges from analysis of independent party occupations, which reinforces our hypothesis on how patents of introduction were used. Except for corporations, one-third of patentees recorded their profession, position, or status, which allowed us to determine who applied for protection to establish inventions or technologies from abroad in Spain for a large sample. We have compiled and divided the patentees' data into four major categories according to different socio-professional characteristics, as shown in Table 8: (1) civil servants, which includes low-level clerks, high-level appointments, lawyers, military officers, university professors, or technicians working in an administrative position; (2) liberal professionals and qualified technicians, such as mechanics, engineers, architects, doctors, pharmacists, physicists, chemists, directors, designers, professors, or lawyers, whether self-employed or not, that emphasize their academic title or knowledge; (3) entrepreneurs, manufacturers, industrialists, businessmen, master craftsmen, craftsmen, skilled workers, and salesmen; and (4) others, which includes

a heterogeneous group with unskilled and semi-qualified laborers, nobility, or students. The third group formed by productive classes directly in charge of business activities is distinctive.

Considering the entire patent system, the average proportion of manufacturers, industrialists, and salesmen was approximately 59 % before 1875 and 41 % from 1875 to 1930. Compared with the percentages shown in Table 8 (72–75 % before 1875 and 54–58 % thereafter), these data clearly show a striking difference (15 %) for each period when we focus on patents of introduction. Thus, as with enterprises, individuals directly attached to productive activities were also the essential users for patents of introduction, which is consistent with their theoretical interest in seeking, establishing, and acquiring short-term monopolies on new technologies for workshops, factories, industries, and businesses. Table 8 also corroborates the differences between two periods. This first period included the first three-quarters of nineteenth century, when the presence of manufacturers is higher. The second period was from 1875 to 1930, when engineers and qualified technicians that were increasingly connected to scientific knowledge and academic training increased their presence until becoming the principal group of patent applicants (44 %), although not for patents of introduction, as previously discussed.

## 5 Concluding remarks

Things are not always what they seem. The establishment of patent systems throughout Europe, the United States, and several other countries in the nineteenth century and throughout world during the twentieth century has been usually considered a result of extending IPR observance and of increasing in international agreements signed with respect to intangible assets, such as assets from invention activity. Patent systems have also been studied as a logical consequence of expanding industrial development, technological training, and scientific knowledge, which has been linked to capitalist expansion, and to guarantee appropriation of intangibles to stimulate inventions and progress, which also favor technology transfer and economic growth.

Nevertheless, patent systems were established initially in the UK, France, Austria, Belgium, Germany, Sweden, Italy, Spain, Japan, and the United States, among others, not only to protect invention activity and intangible properties but also as a political strategy to promote innovation and advancement processes with or without respect for others' property. This was the predominant position until at least 1870 and later under nationalism and 'technological mercantilism' policies. Such policies were implemented during a period when technology transfer and human capital movements were important and copying, establishing, or commercializing new technologies, ideas, or productions from other countries was favored by all governments and nations. Currently, such policies are considered to endorse 'piracy,' especially by undeveloped or developing countries; however, for the first time in decades, certain theoretical economists have begun to openly speak out 'against intellectual monopolies' (Boldrin and Levine 2008).

Thus, historical evidence suggests that weak IPRs were the norm in burgeoning IPR systems everywhere for pioneers, followers, or latecomers. The consequences of such a weakness for invention activity, innovation, or technology transfer are unclear. As discussed in the introduction, certain theoretical and historical arguments support the notion that more strongly enforced IPRs and patent systems encourage inventive activity, markets for innovation, technology transfer, and economic growth. In contrast, other scholars suggest that certain weak IPRs, especially in lagging countries, might also promote technology transfer and innovation through imitation, which could accelerate rather than inhibit the acquisition of technological and inventive capabilities in the long run. In this study, for the first time, we have analyzed a common component of a weak patent system: patents of introduction or importation. As expected, not only undeveloped economies but also early pioneers and followers have used patents of introduction (or other constraints to foreigners) to facilitate innovations and transfer foreign technologies within national borders, leaving original property rights aside. The same policies have been observed on the periphery for latecomers, such as Spain, for which encouraging industrialization was one of the most important justifications for the patent system; further, Switzerland and Holland had no patents or abolished patents for a long period of time.

After transferring or copying from abroad, the majority of these follower countries eventually found technological niches for innovation in which they developed original invention activity at an internationally competitive level. Spain is an extraordinary case because the national system of innovation never achieved scientific or inventive capacities in a sector as a net complex system, but rather was based more on the individual genius of a handful of scientists and inventors that were honorable exceptions and typically worked abroad. We contend that there were three principal events that facilitated this process: the Spanish crisis of the seventeenth century, the long and difficult transition from the Ancient Regime to the liberal society in the nineteenth century, and the 40 harsh years of the Franco dictatorship in the twentieth century. These were three scientific and technological blows, especially under Franco, that led the innovation system to underdevelopment. Thus, we must seek there the basis for maintaining this status in the IPR system through patents of introduction, utility models, grants without technical examinations, compulsory working clauses within national borders, and other weak points until Spain joined the European Community in 1986. The Spanish innovation system depended on technology transfer and foreign scientific and inventive activity to achieve economic development, which demonstrates that such development is possible even without domestic scientific or technological competence.

In this article, we analyzed the means for protecting foreign inventions in Spain without the original inventor through patents of introduction, which despite a shorter duration, higher cost, same implementation requirements, and ineffectiveness for blocking importations compared with invention patents were continuously used from 1820 to 1986. They were applied as much as invention patents until 1855 and to a lesser degree after that year, although they always followed an ever-increasing trend until 1930. They were typically more effective than invention patents for compulsory implementation and were more concentrated in light industries. They

were more heavily used by Spaniards and to a certain extent by resident foreigners especially the French until 1875 and Germans from the end of the nineteenth century until 1930. They were also profusely used by corporations and individuals who were identified as industrialists, manufacturers, craftsmen, salesmen, or other professions or status linked to direct productive activities. Such observations suggest a special role for patents of introduction in promoting innovation among domestic and resident entrepreneurs or foreigners with a special interest in and knowledge of the national market.

In summary, Table 9 demonstrates through a very simple econometric exercise determinants for patents of introduction during the period studied. Through a binary probit model, we estimated two regressions, the first for all patents and the second for patents for independents who recorded their profession; thus, this variable could also be evaluated to a certain extent. The results clearly demonstrate first that distinct groups of variables are significant when tested as a whole. Second, the likelihood of holding a patent of introduction increased among Spanish or foreign residents compared with non-residents, and for the latter, the probability increased if the applicant resided in the UK or France but not in the United States (with respect to the rest of the countries). Likewise, statistically significant users for patents of introduction included corporations, independents linked to manufacturing and industrial jobs, and qualified professionals (second among the remaining professions). Third, the likely distribution among economic sectors is consistent with our findings in the previous sections. The likelihood of applying for patents of introduction increased in light sectors, such as textiles, lumber industry, paper, food, beverage, and tobacco, as well as in critical sectors during the first industrialization, such as basic metals, chemicals for consumption, and construction; the heaviest sectors, such as railway and machinery and equipment, among others (Table 9), were least likely to use patents of introduction (although statistical significance is a problem in certain categories). Finally, if we test the distinct periods analyzed, the results confirm that patents of introduction were more likely at the beginning of IPR recognition (1820–1856) and between 1920 and 1930. Both were periods of protectionism, and the latter included economic nationalism and domestic industrialization.

There is much unresolved work in progress researching case studies, which will facilitate a deeper analysis of micro-history samples and generate more information on the role for patents of introduction in promoting innovation. Currently, we can only contribute certain noteworthy clues pertaining to this topic. When the first smelting furnace was established in Marbella and Málaga (approximately 1830), most of the technologies were patented as introductions from the UK by the Andalusian entrepreneur and factory owner Manuel Heredia.<sup>18</sup> Before 1850, half of the Spanish iron was produced there. In 1856, after the public release of the Bessemer converter technology in London, certain Spanish iron entrepreneurs from the North registered the patent of introduction in Spain and implemented one of the

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<sup>18</sup> Between 1830 and 1841, the Sociedad Anónima de las Ferrerías de Marbella y Málaga applied for several patents of introduction related to the iron industry and implemented many in Manuel Heredia's iron factories, which effectively transferred British technologies to Spain. See OEPM, Historical Archive, privileges of introduction 98, 144, 177, and 178. Heredia's family also used introductions in other sectors during the nineteenth century.

Table 9 Determinants for patent type; Spain 1820–1930

Probit estimates dependent variable: 1 for patents of introduction, 0 for patents of invention

	(1)	(2)
Intercept	−1.96 (0.07)***	−1.99 (0.14)***
Resident	0.75 (0.02)***	0.48 (0.04)***
UK resident	0.14 (0.03)***	0.18 (0.07)***
French resident	0.06 (0.02)***	0.04 (0.05)
German resident US	0.00 (0.02)	0.05 (0.06)
resident Corporation	−0.10 (0.03)***	−0.30 (0.10)***
Manufacturer	0.41 (0.01)***	–
Qualified professional	–	0.31 (0.05)***
Civil servant	–	0.05 (0.05)
Textile	–	−0.26 (0.06)***
Basic metals	0.50 (0.07)***	0.55 (0.13)***
Lumber industry	0.49 (0.07)***	0.65 (0.14)***
Chemical	0.43 (0.08)***	0.40 (0.16)**
Paper and graphic arts	0.37 (0.07)***	0.50 (0.14)***
Mining and coal	0.36 (0.08)***	0.37 (0.14)***
Food, beverages, and tobacco	0.27 (0.08)***	0.42 (0.15)***
Construction	0.26 (0.07)***	0.31 (0.14)**
Non-rail transport	0.23 (0.08)***	0.23 (0.14)*
Services	0.22 (0.08)***	0.25 (0.14)*
Railway	0.22 (0.07)***	0.23 (0.13)*
Gas and lighting	0.18 (0.08)**	0.25 (0.15)*
Machinery and equipment	0.16 (0.08)**	0.29 (0.15)**
	0.16 (0.07)**	0.19 (0.13)
Arms industry	0.10 (0.08)	0.14 (0.15)
Electricity	0.09 (0.08)	0.31 (0.14)**
Sea transport and ports	0.03 (0.09)	0.20 (0.16)
Communications	−0.08 (0.09)	0.20 (0.17)
Agriculture and cattle farming	−0.11 (0.08)	0.00 (0.16)
1820–1856	0.85 (0.03)***	0.79 (0.05)***
1857–1874	−0.01 (0.03)	−0.04 (0.04)
1875–1920	−0.01 (0.01)	−0.06 (0.03)**
N	119,516	25,650
McFadden's R2	0.091	0.083
McFadden's Adj. R2	0.090	0.080
Significance test for groups of variables (p value reported)		
Country of residence	0.0000	0.0004
Profession	–	0.0000

Table 9 continued

Probit estimates dependent variable: 1 for patents of introduction, 0 for patents of invention

	(1)	(2)
Economic sectors	0.0000	0.0000
Periods	0.0000	0.0000

'Resident' reflects whether the patent application was signed by a Spanish resident. The dummy variables for the distinct countries of residence reflect the origins of non-resident applicants. 'Corporation' reflects whether the patent was taken by a firm. The dummy variables for 'Civil servant,' 'Qualified professional,' and 'Manufacturer' reflect independent's professions. The dummy variables for the distinct economic sectors reflect the industry of final use for patented inventions, as the distinct year intervals reflect the period in which patents were applied for. We have dropped 'Nationality' as an independent variable because of correlation problems with country of residence. The reference categories have been 'Rest of countries' for countries of residence; 'Other professions' for independent's professions; 'Aeronautics' for economic sectors; and '1921–1930' for periods. Robust standard errors in parenthesis. \*, \*\*, and \*\*\* represent significance at 10, 5, and 1 %, respectively

first European converters near the Somorrostro iron mines, which was enriched in the ideal mineral for the converter. Bessemer signed an agreement with these domestic businessmen to later acquire a patent of invention, but the first step was a patent of introduction.<sup>19</sup> A. G. Bell patented the telephone in the United States, using information from A. Meucci, who was later designated the real inventor by the US Congress.<sup>20</sup> A Catalanian optician, José Dalmau, used a patent of introduction to acquire a monopoly in Spain for Bell's phone and implement the first apparatus and communication technologies in several places in Barcelona.<sup>21</sup> Finally, previous research on the industrial impact of innovation and patents in Spain has demonstrated that patents of introduction were extensive and effectively used in the cotton textile industry in Catalonia. This was the most advanced industrial area in Spain during the nineteenth century, and such patents introduced known and tested looms, spinning machines, as well as other textile technology from abroad (Sáiz 1999, Figs. 59, 62, and 66). Catalanian textile industrialists could soon modify and invent new drives as well as machines, and a market for inventions and innovations emerged. The region was the leading user of the Spanish patent system by 1930, and currently, it is a focal point for Spanish technological and scientific research.

<sup>19</sup> The first patent of introduction was acquired in September 1856 by Jose Vilallonga and Ibarra Hermanos (OEPM, Historical Archive, privilege 1482), who were dealing with Bessemer to introduce the converter. They installed one in Guriezo (Cantabria) in north Spain. Days later, Bessemer registered a patent of invention (OEPM, Historical Archive, privilege 1510) and implemented the converter in the same place.

<sup>20</sup> The 15th of July, 2002, the US Congress passed a resolution declaring that Meucci was the true inventor of the phone (107th Congress; 1st Session; H. Res. 269).

<sup>21</sup> Jose Dalmau applied for the patent of introduction in September 1877 (OEPM, Historical Archive, privilege 5753) and implemented Bell's invention in Catalanian factories and between the Civil and Military Government. A month later, Bell applied for an invention patent for improvements on his phone (OEPM, Historical Archive, privilege 5766), which lasted no more than a year because he did not pass the compulsory working clause, which was another characteristic of a 'weak' patent system for impeding intellectual monopolies.

Hence, patents of introduction were useful and facilitated innovation at least in certain cases or early stages and achieved the goals established within the institutional framework. As with protectionism as a commercial policy, forcing processes of innovation without respecting original inventor rights in addition to frequent use by all countries in the early stages of advancement, when they tried to catch up pioneering economies, may also have positive consequences for technology transfer and industrialization. Thus, patents of introduction and other similar imitation strategies promoted technology transfer and innovation and eventually allowed many countries to develop technological capabilities and original invention activity in certain sectors. However, such strategies did not fully produce such consequences for Spain because of political and institutional problems in the nineteenth century and especially in the twentieth century. Questions that immediately emerge are related to current international patent protection and copyright policies and their role in the most underdeveloped economies, which will find it difficult under current policies to emulate the attitudes and behaviors of past lagging and pioneer countries.

**Acknowledgments** I would like to acknowledge research funding from the following sources: the Collaboration agreement between the Oficina Española de Patentes y Marcas and the Universidad Autónoma de Madrid for cataloguing and studying the historical documentation of patents and trademarks (1999–2012) as well as The British Academy International Networks (2003–2008) ‘Patents in history: Studies in the patterns and institutions of technological change and transfer.’ I would also like to acknowledge very useful comments from anonymous referees, Jose Luis Zofío-Prieto, Inmaculada Álvarez-Ayuso, and very especially Rocío Sánchez-Mangas, whose selfless help significantly contributed to improving the original draft.

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