

Patents, International Technology Transfer and Spanish Industrial Dependence (1759-1878)*

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Introduction

This article will attempt to reflect on the processes of international technology transfer at the beginning of European industrialization, concretely at the end of the 18th century and during the first 75 years of the 19th century. During this period, when the achievement and the spread of technical innovations were vital to the acceleration of economic growth, the more underdeveloped countries experienced an increase in technological dependency on the leading countries. In some of them, the transfer of foreign technical information was more important than that generated by the nation itself, which – in spite of the cost increase of implanting foreign innovations, given the scant integration of international equipment markets – supposed a reduction of the degree of uncertainty associated with all processes of technological changes. Hence, external technological transfer became an essential factor without which there would have been no push towards industrialization in certain underdeveloped countries, once the necessary institutional changes were made in their political systems in order to solidify the market economy and sustain the expansion based on demand.

The principal objective of the following pages is to analyse in detail the case of Spain, a country in obvious economic decline at the end of the 18th century and well below the average for Europe for most of the 19th century. This well-known delay translated into an external technological dependence in several economic sectors, which left its mark on the industrial protection system. Patent documents, therefore, become the main source for research. Technological information which contains applications will be taken as a valid indicator – although only partial – of the direction and structure of the pro-

* I want to thank the interesting comments from Christine Macleod which have greatly contributed to improve the paper. Any remaining errors in the text are my responsibility.

cesses of innovation in the Spanish economy. Upon careful study of the origin of patented inventions, it can be ascertained, among other things, the exact degree of dependence upon external technology; which countries played an essential role in the transfer of technology to Spain; and which economic sectors depended more on foreign technology.

The Spanish Patent System

Before continuing, certain general considerations must be mentioned as to the beginnings of the Spanish patent system. Like the rest of Europe, in Spain it was possible to document the existence of royal privileges of invention and introduction for the protection of new ideas since the 16th century. The earliest known document dates back to Felipe II in 1522. These monopolies were arbitrarily granted throughout the Modern Age¹. During the reign of Carlos III and Carlos IV (1759-1808) these concessions increased, not only as a method to reward and protect inventors or innovators of new techniques, but also clearly as an instrument of economic and industrial development policy. As in other countries, these privileges in the *Ancien Regime* coincided with other rewards (cash, positions, etc.) granted as compensation for the task of inventing. In any case, privileges and rewards were given without any norms or legislation on the subject. This did not occur in England or France, where, throughout the 17th and 18th centuries, rules were adopted which clearly distinguished between the privileges given to inventors and other royal grants, establishing basic application and concession laws which served as antecedents to the future industrial protection policies. In the United Kingdom, the first law, the Statute of Monopolies, was passed in 1624, and since then, until 1852, played an important role in British legislative tradition², while in the French case the first law, the *Déclaration du Roi concernant les privilèges en fait de commerce*, was passed in 1762³, and was replaced by the revolutionary Law the 7th of January, 1791⁴.

1. See N. García Tapia, *Patentes de invención españolas en el Siglo de Oro*, Madrid, 1990.

2. About the development of the English Patent System in the 17th and 18th centuries see C. Macleod, *Inventing the Industrial Revolution. The English Patent System, 1660-1800*, Cambridge, 1988. Also H. Dutton, *The Patent System and Inventive Activity during the Industrial Revolution*, Manchester, 1984.

3. About invention privileges in France see L. Hilaire-Pérez, "Invention and the State in 18th-Century France", *Technology and Culture*, n° 4, 1991, p. 911-931.

4. See F. Savignon, "La Révolution Française et les Brevets d'Invention", *La Propriété Industrielle*, n° 11, 1989, p. 415-424. Also Y. Plasseraud, F. Savignon, *L'État et l'invention : histoire des brevets*, Paris, 1986.

Precisely the liberal French revolutionary principles underlying the Law of 1791, supply the basis for the Spanish patent system. The French norm was the first written European code for the “sacred” rights of intellectual property, and Napoleon was in charge of exporting it to Spain. In fact, Jose I’s government of French sympathizers – under the presidency of Mariano Luis de Urquijo – promoted what came to be the first patent law, the Royal Decree of September 16, 1811. Just as they had adopted Napoleon’s civil and commercial codes, the Decree of 1811 copied the 1791 legislation in an attempt to promote invention activity and to organize its administration. Therefore, during the War of Independence and at the beginning of the Spanish Liberal Revolution – which went on to at least 1840 – this system was being developed. The 1811 Decree was in effect only a short time, given the political circumstances of the country, and when Fernando VII returned to power the French revolutionary norms were abolished. In general, the counter-revolutionary periods (1814, 1823) saw the return to the *Ancien Regime* and the arbitrary concession of privileges, just as the liberal return to power in 1820 marked the passing of a Spanish patent law, the 2nd of October Decree, controlling invention certification. Even at that, the French influence was evident in the Decree, which remained in effect until the entrance of the “100 000 children of Saint Louis” in 1823 to restore the absolute king to the throne.

On few occasions, however, political intentions change the course of history. Hence, on 27th of March, 1826, King Fernando VII himself supported the Royal Decree of industrial “privileges”, which, in practice, became a true patent law, with clearly liberal connotations in its 28 articles (in spite of the insistence that the king concedes monopolies, and in spite of the use of the term “privilege” instead of “certificate” or “patent”). The Decree remained in effect until the restoration of the Bourbon monarchy, guaranteeing the protection of any inventor who applied for it, and upon paying the corresponding fees. Later legislation, in 1878, 1902, 1929 and 1986, developed, complicated, adapted and updated the law according to the changing times, but since 1811 the spirit of the law has remained unchanged. Without interruption since 1826, therefore, the private property of new technologies had been guaranteed in Spain, clearly establishing the rules necessary for the development of capitalism and centralizing the administration and documentation of technological information in Madrid⁵.

5. All about Spanish patent laws and the signature of international agreements can be found in J. P. Sáiz González, *Propiedad industrial y revolución liberal. Historia del sistema español de patentes (1759-1929)*, Madrid, 1995. The body of laws in J. P. Sáiz González, *Legislación histórica sobre propiedad industrial. España 1759-1929*, Madrid, 1996.

Patents as Technological and Economic Indicators

One of the most serious problems any researcher interested in economic history based on patents can encounter is the evaluation of its importance as a technological indicator⁶. The different means of innovation in an economy are well-known : advances in productive processes can be invented and incorporated without being registered, just as they can be imported directly from another country – or foreign technicians can be brought in and used in their construction – without leaving a trace in the patent system ; at the same time, some advances simply cannot be protected (such as organizational changes or know-how, for example). Moreover, it cannot be affirmed that all patents – simple ownership contracts which contain technological information – are really innovations. Only those which are exploited, put into practice and are productive can be considered as such. The study of the patent system, therefore, is simply a sample of the complete process – indicative but difficult to evaluate and measure⁷. But from our point of view, patents are not only a partial technical indicator, but also, whether or not they are put into practice, they are an important economic indicator of investment tendencies in new technologies. In general, the decision to patent in a given country and moment is based on expected profits from the invention, the patent fees, and how complicated the process is. These expectations are demand-driven and will depend on the ex-

6. See, for example, Z. Griliches, "Patent Statistics as Economic Indicators : A Survey", *The Journal of Economic Literature*, vol. XXVIII, n° 4, p. 1661-1707. See also T. Griffiths, P. A. Hunt, P. K. O'Brien, "Inventive Activity in the British Textile Industry, 1700-1800", *The Journal of Economic History*, vol. 52, n° 4, p. 881-906. See, also, R. J. Sullivan, "Patents Counts and Textile Invention : A Comment on Griffiths, Hunt and O'Brien", *The Journal of Economic History*, vol. 55, n° 3, p. 666-670.

7. The real innovation rate in an economy would be given by adding non-registered but working inventions, plus implemented patents, plus non-technical changes (those of management), plus foreign technology imports, plus the development of qualified labour and know-how. Therefore, implemented patents are only a share of the innovation process. We might have sufficient, correct and well-distributed data of each of mentioned variables as well as an effective theoretical model, which would allow the homogenization and measurement of the participation of these variables in the innovation process, but to find out the real influence of each.

8. Hence, we start from Schmookler's thesis about the importance of demand forces on innovation and technical change processes, which we think strongly applies in the case of the patent system. See J. Schmookler, *Invention and Economic Growth*, Cambridge, Massachusetts, 1966. See also K. L. Sokoloff, "Inventive Activity in Early Industrial America : Evidence from Patent Records, 1790-1846", *The Journal of Economic History*, vol. XLVIII, n° 4, p. 813-850 ; and D. S. Landes, *The Unbound Prometheus : Technological Change and Industrial Development in Western Europe from 1750 to the Present*, Cambridge, 1969.

tension and the degree of market integration and the economic growth rate⁸. Added to this is the enormous advantage of patents as a source of study, as a consequence of the existence in all industrialized countries of complete series from a very early date ; it should not be surprising that they have been used as raw material for much historic research⁹. Here, as already mentioned, we propose that, based on the analysis of all 19th century Spanish patents, we can draw valid conclusions and extrapolate them to the process of economic renewal of the country -independently of the means- which permit an understanding of the nature and direction of technological changes and the weight and structure of the transfer of outside technology.

This study is based on two very clearly differentiated sources. The first is a sample of “privileged” inventions awarded between 1759 and 1826, that is, the period from the *Ancien Regime* and the Liberal Revolution until Fernando VII’s Decree (which regulated and centralized patent registration). For almost 70 years, very critical to the Spanish economy – especially after 1790 –, inventors received a wide variety of different rewards, without a centralized file and a rational organization system. This geographical and institutional dispersion, typical of absolutist and arbitrary administrations, increased the cost of access to information. Through the analysis of historical archives and publications, we managed to compile 79 invention and introduction privileges and 153 awards (cash, posts, etc.) granted by the central government and other organisms, which we assume are a fairly representative sample of inventions developed during that period¹⁰. The second source is much more reliable, since it is the general archive of the Spanish Patent and Trademark Office (OEPM)¹¹, which contains the complete files of applications from 1826 on. We have studied in detail, over a period of ten years, 5,134 patents applied for until 1878¹².

9. USA (Phillips, Schmookler, Sokoloff, Griliches...), UK (Dutton, Griffiths, Hunt, Macleod, O’Brien, Sullivan...), France (Hilaire-Pérez, Plasseraud, Savignon...), etc.

10. These 232 documented privileges and awards come from the Spanish National Archives (Archivo Histórico Nacional [AHN]: Sección de Estado, Subsección de Fomento; Sección de Mapas Planos y Dibujos) and from the analysis of the *Gaceta de Madrid* (GM) between 1759 and 1827. This periodical serves, from its beginnings, as the Spanish State’s official bulletin, in which invention privileges and monopoly grants were usually published. Of course, we know other privilege files existed in several central and regional archives, such the *Archivo General de Simancas* or *Sociedades Económicas de Amigos del País’* and *Juntas de Agricultura, Industria y Comercio’s* archives in the different Spanish provinces.

11. c/ Panamá nº 1, Madrid.

12. Further information about this documentation and its economic analysis in J. P. Sáiz González, *Invencción, patentes e innovación en la España contemporánea*, Madrid, 1999.

The International Transfer of Technological Information to Spain in the 19th Century

The first thing which stands out upon studying Spanish patents is how few applications were registered during the 19th century compared to other European countries. Although this is not the place to go into a detailed international comparison, it should be pointed out that, both in absolute terms and in patents per capita, Spain falls well below the European average¹³. In the first case, Spain comes after the most industrialized countries: the United Kingdom, France, the United States and Belgium, but also below Austria, Germany and Italy. Before 1880, Spanish patent series were similar to those of Central Europe or Scandinavia, with much smaller populations and markets (such as Holland, Sweden and Denmark), superior to the annual registrations in Norway, Finland, Russia and Portugal. If comparisons are made in terms of patents per capita, the results are similar. Spain was ahead of these last four countries before the second industrial revolution, closer to Austria-Hungary, Germany and Italy and well behind the rest¹⁴.

But, as we shall see, what makes Spain special is the strong presence of foreign technology within the system. The approximate proportion is based on the percentage of foreign patents plus Spanish introduction patents¹⁵. Since the system accepted applications from citizens of any nationality, a comparison of applications by both foreigners and Spaniards gives us an initial idea of the situation. But, since the Spanish system allows for two different types of registration – inventions based on original ideas and the introduction of techniques from other countries not practiced in Spain¹⁶ – all introduction patents applied for by Spaniards protected foreign technical information. Accordingly, combining these two points, we obtain a complete view of the degree of technology transfer which was produced within the system, as well as its source (Table 1).

As seen in Table 1, almost half of the privileges and patents registered in Spain between 1759 and 1878 were applied for by foreigners. The average varies over time, since before 1850 it was around 32 %, while between 1850 and 1878 – a sub period with most of the patents – foreign presence reached

13. An international comparison in the 19th century and in the first thirty years of the 20th century on *Idem, Ibid.*, cap. II.1.

14. See the graphs of international comparison in the Appendix of this article.

15. We mean the patentee's nationality, whether a Spanish or a foreign resident. Therefore, we also consider the inventions developed in Spain by foreign qualified labour as technology transfer.

16. These two patent types were established in 1826 and both of them existed during the *Ancien Régime* also.

almost 53 %¹⁷. In any case, most of the foreigners were either French or British. French patent owners deserve a special mention, since they made up 31 % of the total¹⁸. This shows that the role of France is basic to the transfer of technological information to Spain. First, because, for the most part of the 19th century, Spanish legislation was totally influenced by the French, as already explained, and second, because French entrepreneurs and inventors used the system to protect possible future profits in the Spanish market. This does not imply that the patented products were always French, but it does mean that through French investment (payment of patent registration) technical information arrived in Spain. The other nationality of note here, although their presence was felt less than that of the French, is the British, which made up 9 % of the applications, less than could be expected of the instigators of the Industrial Revolution, but still significant. Most British technology reached Spain by other means, either due to entrepreneurs from a third country, national introduction patents, or unregistered direct imports. With a lesser participation, we find the United States (2.2 %), Italy (1.7 %), Germany (1.6 %) and Belgium (1.2 %), and with a participation of less than 1 %, those countries listed in Table 1. France and the United Kingdom, therefore, are the countries which, theoretically, transferred the most technical information to Spain through patents. This agrees with existing knowledge of the participation of companies and technicians from these two countries in key sectors of early Spanish industrialization. Their participation in the construction of the railway system (with capital and technology) or in the exploitation of Spanish mines is already part of Spanish economic history. Doubtlessly, the expansion of investments towards lesser-known sectors also must have been significant throughout the 19th century (Table 2).

In Table 2 we see the distribution of privileges and patents according to the type applied for. The averages show a clear predominance of invention over introduction patents (77.5 % compared to 22.5 %). Introduction patents were much more common before 1850, making up about half (48 %) of those registered, but this figure declined to less than 18 % by 1878¹⁹. Invention patents protected new ideas, lasted longer (up to 15 years) and were cheaper²⁰. Introduction patents were three times as costly and lasted for 5 years, the advantage offered being that the authorship of the inventor did not have to be de-

17. For more details see J. P. Sáiz González, *op. cit.*, note 12, cap. II.3.1 y II.3.2.

18. This supposes about 64 % of foreign patents.

19. See J. P. Sáiz González, *op. cit.*, note 12, cap. II.2.2.

20. See footnote 30.

monstrated, as long as the technology had never been carried out in Spain²¹. In general, foreign patentees used the invention more often than the introduction patent, although the French used the second slightly more (Table 2). Spaniards applied for a greater number of introduction patents, since, in spite of being more costly, they reduced technological uncertainty, having been tried and proven successful in other countries. Introduction patents, therefore, always contain foreign technological information. Hence, by adding Spanish introduction patents to the total of foreign ones, we get a clear idea of foreign technological presence in the system. Consequently, it can be assumed that approximately 63 % of Spanish patents reflected foreign novelties, techniques or inventions, while the remaining 37 % represented Spanish developments²².

The study of introduction patents offers additional data on the origins of transferred technological information, since occasionally, the patentee mentions the inventor or the country the idea came from. This is not frequent, since not naming the inventor makes things more difficult for possible competitors, but there are more than enough of these to make them useful for analysis. In the case of Spanish introduction patents the origins of the technology is mentioned 48 % of the time, distributed as seen in Table 3. This distribution is similar to that of total (including foreign) introduction patents²³ and emphasizes France and the United Kingdom as the source of patented ideas. In more than 54 % of Spanish introduction patents, France as originator is mentioned, which points out the strong influence French scientists, inventors and entrepreneurs had on the Spanish productive classes. In 29 % of the patents, British machinery is mentioned, which, as can be predicted, increases the importance of British technology among those wanting to introduce innovations. Far behind France and the United Kingdom in number of introduction patents are the four countries appearing in Table 1: the United States (6,6 %), Germany (3,3 %), Belgium (2,1 %) and Italy (1,5 %); the other countries mentioned have a merely symbolic incidence.

21. In Spain, introduction patents protected technology production (never importation) without being the invention's owner. In this way, for example, the Bessemer's converter was introduced and implemented in Spain, registered by Ibarra Hermanos & Co. and Jose Vilallonga some time before Bessemer tried it (OEPM, Privilege n° 1.482). That also can be said about Bell's telephone (OEPM, Privilege n° 5.753).

22. This foreign technology dependence continued to be evident in the patent system between 1878 and 1936, such as can be evidenced in J. M. Ortíz-Villajos, *Tecnología y crecimiento económico en la historia contemporánea*, Madrid, 1999, cap. 5.2. The author works with a seven-year sample of the period studied. Using his data and adding foreign patents to Spanish introduction ones, the foreign presence of technological information would be over 60 % on average. This percentage would be greater still during the 1880's and 1890's.

23. See J. P. Sáiz González, *op. cit.*, note 12, cap. II.3.2.

Spanish Industrial Dependence during the 19th Century

As we have seen, most technological information protected by Spanish patents was transferred, either directly or indirectly from foreign sources. The total foreign plus Spanish introduction patents make up 63 % of all applications, revealing an extreme scientific and technical dependence. Moreover, the United Kingdom and France – the most industrialized countries before 1870 – were the most influential in this process, both in the participation of qualified workers, who invested to protect new technologies in Spain, and as the essential focuses of technological information for Spanish entrepreneurs. This corresponds, moreover, with the general impressions of historians of the influence that those two leading countries had in the actual transfer of technology towards productive activities in Spain and other parts of Europe. But once we recognize this dependence, we should also look into its implementation in the Spanish economic structure during the period studied, so that we can determine whether some sectors were more dependent than others and which ones they were (Table 4).

In Table 4 we see that 70 % of total patents in the period studied are polarized around seven activities: textile; machinery and equipment; food, beverage and tobacco; chemical; basic metals; services and construction. If we add mining, railway, and gas and lighting this increases to over 80 %. In these ten sectors foreign presence was studied with special interest, since most of the demand for innovation lies here, and, therefore, expectation of profit from new technologies²⁴. As already pointed out, upon adding, in these sectors, foreign patents and Spanish introduction patents, it can be appreciated that in the most complex and difficult activities, traditionally associated with the success of the first industrial revolution, foreign dependence is greater than in other areas where technological development allowed the relative success of Spanish invention. This is reflected in Table 4, where the important sectors can be grouped into three categories. The first is made up of the basic metals, railways, mining and gas and lighting industries, activities which involve an above-average foreign presence (71 % for mining to almost 83 % for railways). These are basic heavy industry sectors, with heavy investment requirements, high fixed costs, interesting potential externalities, and an important driving effect on the rest of economy. This also fully coincides with specialized historians' opi-

24. Patents are classified according to the sector in which the invention applies. For further details about the technological groups of each sector see *Id. Ibidem*, part III.

nion of Spanish technological dependency in the implementation of railway transport, in the expansion of mining (oriented towards export) or in the establishment of the first group of basic metals production in both southern and northern Spain²⁵. The second group includes textiles, machinery and equipment industries (tooling machines and engines) and chemical production. Foreign presence is quite high, reaching the average for patent applications, with a greater foreign influence in textile inventions (66,7 %)²⁶. These are lighter industries, with more moderate investment necessities and more consumer oriented -in the case of textiles and chemicals of that period (soap, candles, pharmaceuticals, cosmetics, matches...)- or towards basic multisectorial equipment (water pumps, steam engines, etc.). Finally, a third group would be patent applications related to construction; food, beverages and tobacco industries; and services. Foreign presence in these three activities is lower than the average, above all in the areas of basic services (housing, urbanization, furnishings, heating, medicine and hygiene, education, etc.) in which the transfer of foreign technology barely reached 50 %. Food processing, housing construction, and basic services are sectors of fairly inelastic demand, whose production needed to be speeded up, since they are directly related to the immediate improvement of living conditions of the population. Innovations also tend to be simpler, easy to finance, and in an area in which national inventiveness and commercial activity would meet with greater success. Upon analysing foreign patents in all of the above mentioned sectors, the French and British applications stand out; the French generally represent an above-average presence in services, construction, gas and lighting and textiles, while the British presence is concentrated, in a greater proportion, in heavy industry: basic metals, railways and mining.

25. About the railway technical dependence see, for example, F. Comín, P. Martín, M. Muñoz, J. Vidal, *150 años de historia de los ferrocarriles españoles*, Madrid, 1998, cap. III. Also see F. Cayón, E. Frax, M.ª J. Matilla, M. Muñoz, J. P. Sáiz, *Vías paralelas. Invención y ferrocarril en España (1826-1936)*, Madrid, 1998. About mining see S. Coll Martín, "Las empresas mineras del sudoeste español, 1850-1914", G. Anes, L. A. Rojo, P. Tedde eds., *Historia económica y pensamiento social. Estudios en homenaje a Diego Mateo del Peral*, Madrid, 1983. About metals see L. M. Bilbao Bilbao, "La primera etapa de la industrialización en el País Vasco, 1800-1880: cambio tecnológico y estructura de la industria siderúrgica", E. Fernández, J. L. Hernández eds., *La industrialización del Norte de España*, Barcelona, 1988. About the gas industry see C. Sudriá, "Notas sobre la implantación y el desarrollo de la industria del gas en España, 1840-1901", *Revista de Historia Económica*, vol. 1, nº 2, 1983, p. 93-118.

26. The technology transfer in textile patents was produced through introduction patent rather than by invention patents, more common in other sectors.

Qualified Labour Immigration in the Spanish Economy

In addition to the nationality of patent applicants, the study of remaining documents permits the analysis of their places of residence, which, in turns, helps us to complete our vision of the process of foreign technology transfer towards Spanish soil. For example, In Graph 1, we see that 14 % of the patents were applied for by foreign residents who lived, at one time in Spain, which constitutes approximately one-fourth of foreign patent applications. The total applications for residents in Spain, therefore, is 64,5 % (national plus foreign residents) compared to only 35,5 of non-resident applications.

From all this, we can deduce that an important part of the technological information supplied by foreigners available in Spain was generated through the immigration of qualified labour ; an input which we know was necessary for the technical development of several sectors, of which railways, mining, and basic metals was only an early exponent. Engineers, technicians or entrepreneurs residing in Spanish territory, and using the patent system to protect new technologies and to start new businesses, came, primarily from France (74,8 % of total foreign residents), confirming, once again, the important role this country had in the transfer, diffusion and implementation of innovations in Spain. In addition to French citizens, there were (Graph 1) also 14 % British, 4 % Italians, and a little over 2 % Germans with a relatively insignificant incidence of citizens of other nationalities. In any case, the participation of this qualified labour force in Spain is almost unknown and cannot be used to give a exact evaluation of it contribution to the industrialization and economic development of the country, and, undoubtedly, deserves more attention from researchers in the future. In the second half of the 18th century, the Spanish crown attracted, in as much as it was possible, foreign specialists to direct laboratories and other types of institutions, as well as to organize the manufacture of certain products²⁷. We also know that during the 19th century, many foreign technicians moved to Spain in order to direct certain specialized jobs, such as railway construction or basic metals production. But this tendency – which before industrialization was less pronounced, although common in

27. There were a lot of examples of foreign qualified workers in Spain ; some surnames are Balfre, Beauche, Bennet, Berry, Bredin, Calldwell, Douglas, Goebel, Gomond, Greatrey, Hill, Milne, Quilty, Rettilby, Valori, Wadle, Wood... See J. P. Sáiz González, *op. cit.*, note 12, cap. I.3.1.

most of Europe²⁸ – was generalized and extended to all activity sectors, until it became an important means of technical transfer, as well as a consequence of the progressive liberalization of the mobility of productive forces the establishment of international capitalism gave rise to. No doubt the foreign entrepreneurs and engineers who lived in Spain in the three-fourths of the 19th century – mainly French and British nationals, but also Belgians, Germans, Italians and Americans – were an essential cornerstone in the founding of communications networks, market integration, organization of mining expeditions, training qualified labourers or directing machinery and equipment, chemical, textile and basic metals factories. Their presence in the patent system is just another proof of their importance.

Effectiveness of Technical Transfer Through Patents

Spanish legislation on industrial ownership – since the earliest laws were passed – required the implementation of patented technologies within a year ; after that, the patent expired and the technical information became public knowledge. The need to follow these norms gave place to such documents as notarised testimonies and institutional reports related to the actual application of inventions. These documents permit an accurate study of which percentage of patents actually become technological innovations in some productive process, and which ones were the most influential variables in increasing systems effectiveness²⁹. Obviously, these are legal documents ; that is, they prove that some patents were implemented -although for a short period of time or with a minimal impact and diffusion- but there is no proof that those inventions which were not implemented within the time limit were not exploited economically at a later date (Table 5).

In Table 5 we see the distribution of patent applications in Spain between 1826 and 1878, according to the reasons for their expiration. In general, the average indicates that 25.6 % of the patents were actually put into practice and remained in effect for the allotted period (5, 10 or 15 years depending on the type of application). This means, therefore, that more than 74 % lost their rights within a year, either because they officially expired from not being implemented (44,7 %) or because they were abandoned after three months,

28. See, for example, the interesting work of J. R. Harris, *Industrial Espionage and Technology Transfer : Britain and France in the eighteenth century*, Aldershot, Hants, 1998.

29. A detailed analysis of patent implement process (administrative steps, documentation problems, information trustworthiness...) see J. P. Sáiz González, *op. cit.*, note 12, cap. II.5.

the time allowed between the application and the payment of fees or the correction of administrative errors. Since patents fees were quite high³⁰, many applicants decided not to pay if the expectation of profit was low or if they did not find partners will to supply the capital needed to implement the idea.

With the data concerning implemented technology, we were able to elaborate a simple index of effectiveness which reflects the deviation of different groups patents from the national average (Table 5). Accordingly, we can observe notable differences in the effectiveness of the innovation process, depending on which variable we manipulate. Hence, patents applied for by nationals were more effective (1.36), in general, than those applied for by foreigners (0.64), substantially varying, moreover, the reasons for terminating the patent from one group to another. In the Spanish group, there is a predominance of abandonment; that is, the fees generally were not paid when there was a doubt as to the implementation of the patented technology, while foreigners invested in the patent even though they lost it later by not implementing it. Foreign patentees, therefore, made more mistakes than Spanish inventors and entrepreneurs in calculating profit expectation. Several factors explain this: first, asymmetrical information which goes against foreigners (especially non-residents), since, theoretically, they are less familiar with the country and its industrial and market peculiarities; second, patent fees were cheaper for them than for nationals, since the United Kingdom and France had a greater per capita income and a much higher standard of living than Spain, which meant that they would patent an innovation with a lesser degree of profit expectation; and third, foreign companies could invest, even risking the loss of a short-term monopoly, following international protection strategies, which, at least momentarily, impeded other from copying them by the use of an introduction patent. In Table 5, we see a similar situation comparing (Spanish or foreign) residents to non-residents, since the former more effectively introduce innovations (33.1 %) than the latter (12.6 %). This indicates that when foreign reside in Spain, they have the same measure of success as nationals, while non-residents exhibit the lowest degree of effectiveness (0.49) and show the most expired patents because of non-implementation. Accordingly, introduction patents (both Spanish and foreign) were put into practice to a

30. Between 1826 and 1878, the patent fees were paid once at the grant, before the ownership title was issued. Invention patents could be applied for 5, 10 or 15 years and their cost was respectively 1,000, 3,000 and 6,000 reales. Introduction patents were extended only during 5 years and their cost was 3,000 reales. We must note that 6,000 reales was more than the annual wage of a qualified worker (mason, carpenter, photographer).

greater degree than invention patents, since, as already explained, the technology had already been tested, which increased the probability of success. The Spanish residence of qualified labour, and the protection of technology which was well known and already implemented, were the factors which increased the possibility of success in the transfer of technology to the production system.

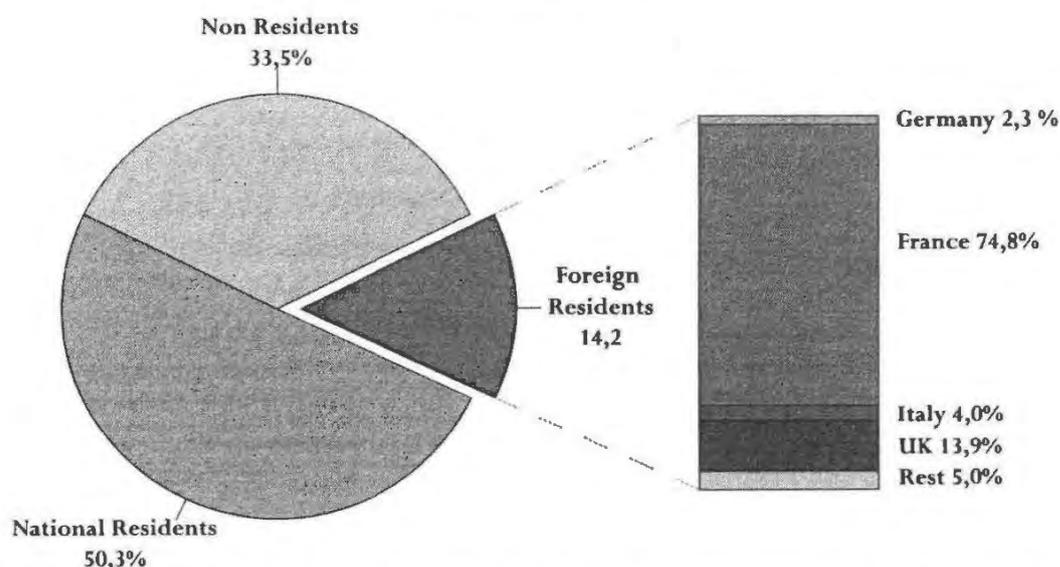
Conclusion

This article has attempted to use information gleaned from the analysis of the Spanish patent system to research the transfer of foreign technology to Spain. The study covers the period from 1759 to 1878, which formed the basis for the delayed economic situation in the 19th century and in which dependence upon foreign technology and industry increased. In order to carry out this task, we have relied on the study of patents to obtain valid data, which is partial but sufficiently representative of the general process of innovation in the Spanish economy and of the tendencies in technology investments. Researching the nationality of the patentees, as well as the patent type, we concluded that the presence of foreign technology could be determined by adding the foreign patent total to that of the Spanish introduction patents. This permits us to demonstrate a strong technical dependency in the area of technological information, since more than 60 % of the patents represent foreign inventions. If we add to this the well-known direct import of foreign machinery and equipment, one of the causes of the deficit in the trade balance of Spanish commerce during the period studied, a notable dependence on foreign input results. Through the study of patents based on foreign technology, we discovered the importance of French (and to a lesser degree British) technicians and entrepreneurs in the transfer of technology to Spain. France took a special interest in Spanish industrialization, making up 30 % of the patents registered in Madrid. Then influence was also felt in the legal organization of the system, which began under the leadership of Jose Bonaparte and was practically a translation of the French Revolutionary Law of 1791. France was also the source of inventions mentioned in Spanish introduction patents, though there was an important percentage from the United Kingdom also. When we researched the place of residence of foreign patentees, we found that almost 25 % of them resided in Spain when they applied for the patent, which indicates the necessity of in-depth analysis on the emigration of qualified labour at the beginning of the process of industrialization. Spanish historians recognize the participation of foreign entrepreneurs and engineers in the construction of

the railroad, in mining and in the basic metals industry, but this percentage of residents indicates the possibility of a major influence on other economic sectors. Most of the foreign residents (75 %) are French, which highlights their role in Spanish industrialization and economic growth during the 19th century. As to the economic structure of technical dependence the distribution of patents throughout different economic sectors demonstrates a concentration of foreign patents in the most complex and difficult activities, which also need a greater investment. Hence, the foreign presence in railways, mining, basic metals and gas and lighting is higher than average for the system, approximately between 71 % and 82 %. Finally, we studied the implementation of the patents, in order to measure the effectiveness of foreign technology transfer. There is a clear indication that when technology is protected by an introduction patent or the patentee resides in Spain the possibility of exploiting the invention is greatly increased.

All of the above can be seen from two perspectives. The negative one, which emphasizes scarcity of inventions, scientific and technical underdevelopment and a strong industrial dependency characteristic of modern Spanish economic growth; and the positive one, which assumes that without the foreign (and especially French) mobility of production factors, and their participation in the Spanish production system, the slow economic and industrial development of the country would not only have been delayed, but perhaps stopped altogether.

Graph 1. Patents according to nationality and place of residence of applicant.
Spain 1759-1878



* In "Rest" we included USA (1,3%), Belgium (1,1%), Portugal (1,1%), Switzerland (0,5%), Austria (0,3%), Chile (0,3%), Mexico (0,3%), and Dannemark (0,1%)
Source : see table 1

Table 1. Patent applications (including privileges and other awards) according to the patentee's nationality. Spain 1759-1878.

Country	Patents	Percentage
Spain*	2671	50,9
France	1646	31,4
UK*	481	9,2
USA	117	2,2
Italy*	87	1,7
Germany*	86	1,6
Belgium	61	1,2
Switzerland	23	0,4
Austria*	19	0,4
Portugal	16	0,3
Russia	11	0,2
Netherlands	10	0,2
Sweden*	8	0,2
Chile	4	0,1
Rest*	7	0,1
TOTAL	5247**	100,0

*Among the Spanish patents are included several from Cuba, Puerto Rico and the Philippines. In the case of Italy and Germany we included the different states existing before the unifications. In that of Austria we included two Hungarian and one Czech patent. In that of the UK we included five Irish patents ; in the case of Sweden we included a Norwegian patent and under the category "Rest" we included two Danish, one Mexican, one Canadian, one Panamanian and one Turkish patent.

**Distribution was carried out on 97.8 % of the patents, privileges and other awards. In the rest, no data is indicated.

Source : *AHN and GM for privileges and other awards previous to 1826 and the OEPM files after this date.*

Table 2. Patent types (including privileges) according to the patentee's nationality. Spain 1759-1878.

	% Invention	% Introduction	Patents
Spain	73,0	27,0	2567*
France	80,5	19,5	1624*
UK	85,8	14,2	473*
Rest	84,5	15,5	432*
SYSTEM AVERAGE	77,5	22,5	5096*

*Distribution was carried out on patents and privileges (other awards not included) in which both data is known : applicant type and patentee nationality. Therefore, approximately 95 % of records were used (5,096 out of 5,366).

Source : *AHN and GM for privileges and other awards previous to 1826 and the OEPM files after this date.*

Table 3. Origin of technological information included in Spanish introduction patents (1759-1878).

Origin	Patents	Percentage
France	182	54,3
UK	97	29,0
USA	22	6,6
Germany	11	3,3
Belgium	7	2,1
Italy	5	1,5
Rest*	11	3,3
Total	335	100,0
<i>Unknown</i>	359	—
TOTAL	694	—

*In "Rest" we included three records from Spanish colonies, and three Dutch, two Russian, one Australian, one Austrian and one Swiss patent.

Source : *AHN and GM for privileges and other awards previous to 1826 and the OEPM files after this date.*

Table 4. Patent applications. Sectorial structure and foreign technology presence. Spain (1759-1878).

Sectors	Patents	Sectorial Distribution	Percentage of foreign technology*	Index of foreign technology transfer*
Textile	702	13,1	66,7	1,06
Machinery and equipment	697	13,0	62,1	0,99
Food, beverages and tobacco	656	12,3	58,4	0,93
Chemical	486	9,1	62,0	0,99
Basic metals	461	8,6	73,4	1,17
Services	449	8,4	49,1	0,78
Construction	287	5,4	60,6	0,97
Mining and coal	216	4,0	71,2	1,14
Railway	209	3,9	82,7	1,32
Gas and lighting	199	3,7	76,9	1,23
Other sectors**	987	18,5	—	—
TOTAL SPAIN	5.349***	100,0	62,7	1,00

*The foreign technology percentage is derived from the sum of foreign patents plus Spanish introduction patents. The index of foreign technology transfer is the quotient of the percentage of foreign presence in each sector over the total percentage in the country and is expressed in relation to the national average : Spain = 1.

** In the rest of activities we included with lesser percentages and in the following order the arms industry (3.4 %), communications (3.0 %) the paper industry (2.8 %), sea transport (2.6 %), lumber industry (2.0), non-rail transport (1.9 %), agriculture (1.7 %), aeronautics (0.5 %), electricity (0.4 %) and canals (0.2 %).

***Distribution was carried out on 99.7 % of total patents. In 17 cases the patents were unclassifiable since there were no technical plans or descriptions of the inventions and they had generic titles such as "new procedure".

Source : *AHN and GM for privileges and other awards previous to 1826 and the OEPM files after this date.*

Table 5. Patents applications and implement percentage. Spain 1826-1878.

Category	I Implemented %	II Expired %	III Abandoned %	Non-implemented (II+III) %	Patents	Effectiveness Index**
Spanish patents	34.7	26.1	39.2	65.3	2,432*	1.36
Foreign patents	16.5	62.9	20.5	83.4	2,488*	0.64
Invention patents	23.3	49.3	27.4	76.7	3,868*	0.91
Introduction patents	33.4	28.8	37.9	66.7	1,136*	1.30
Resident patents	33.1	27.1	39.9	67.0	3,179*	1.29
Non-resident patents	12.6	75.4	12.0	87.4	1,818*	0.49
SPAIN AVERAGE	25.6	44.7	29.7	74.4	5,003*	1.00

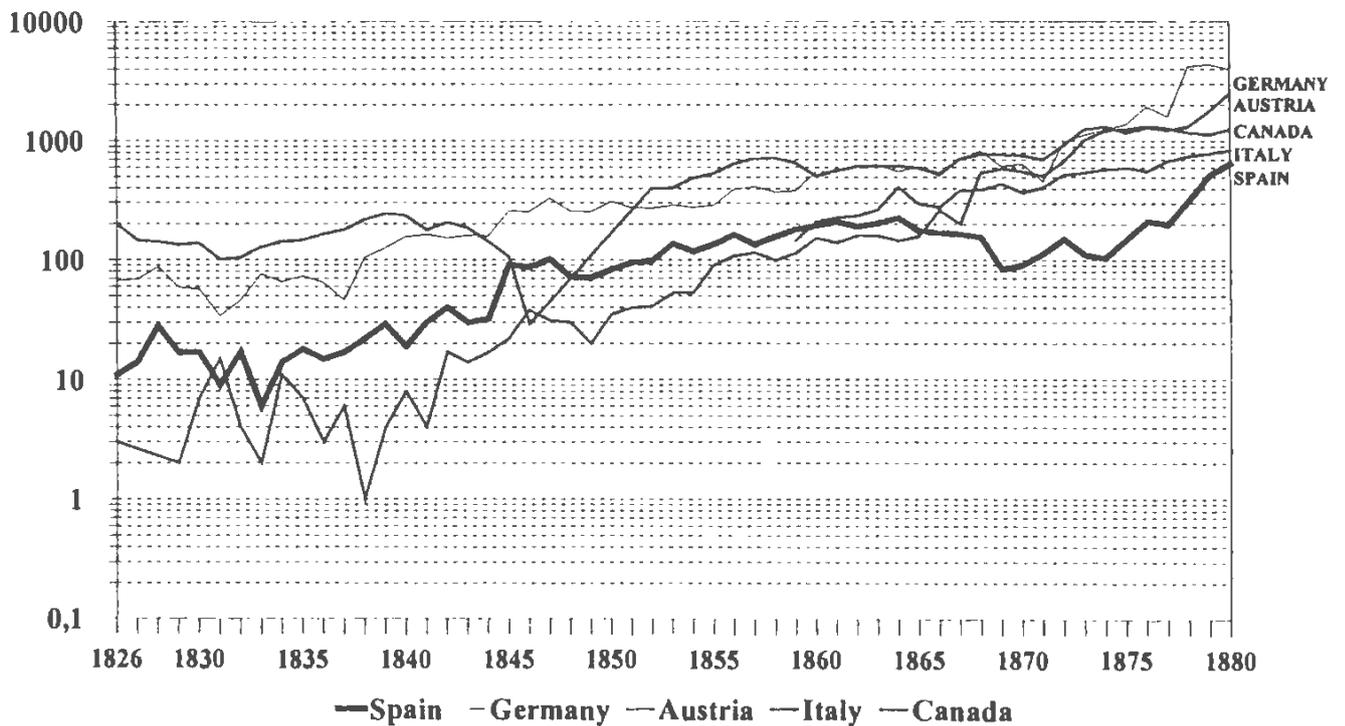
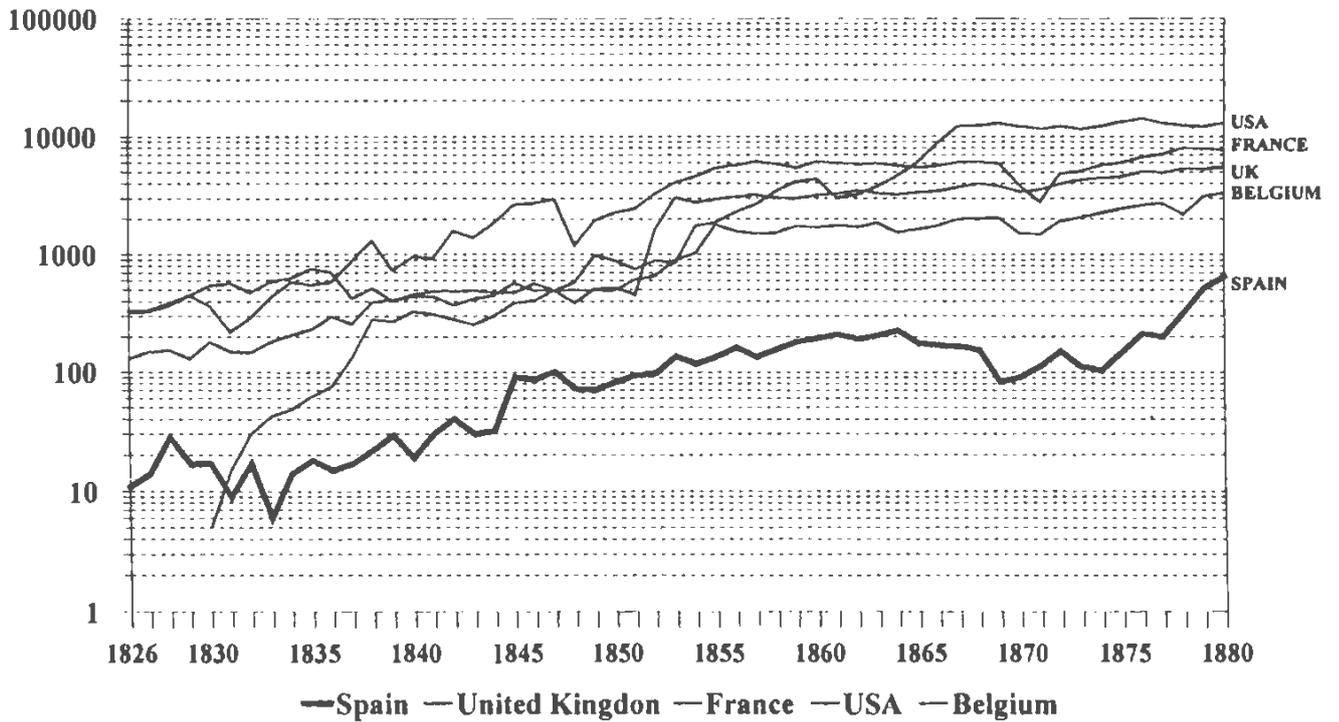
*Distribution carried out on patents (privileges and other awards not included) in which both data are known : category and reason for expiration. Therefore, 97 % of patent applications between 1826 and 1878 were used.

**The effectiveness index is the quotient of the percentage of implemented patents in each category over the total percentage of implemented patents and is expressed in relation to the national average : Spain = 1.

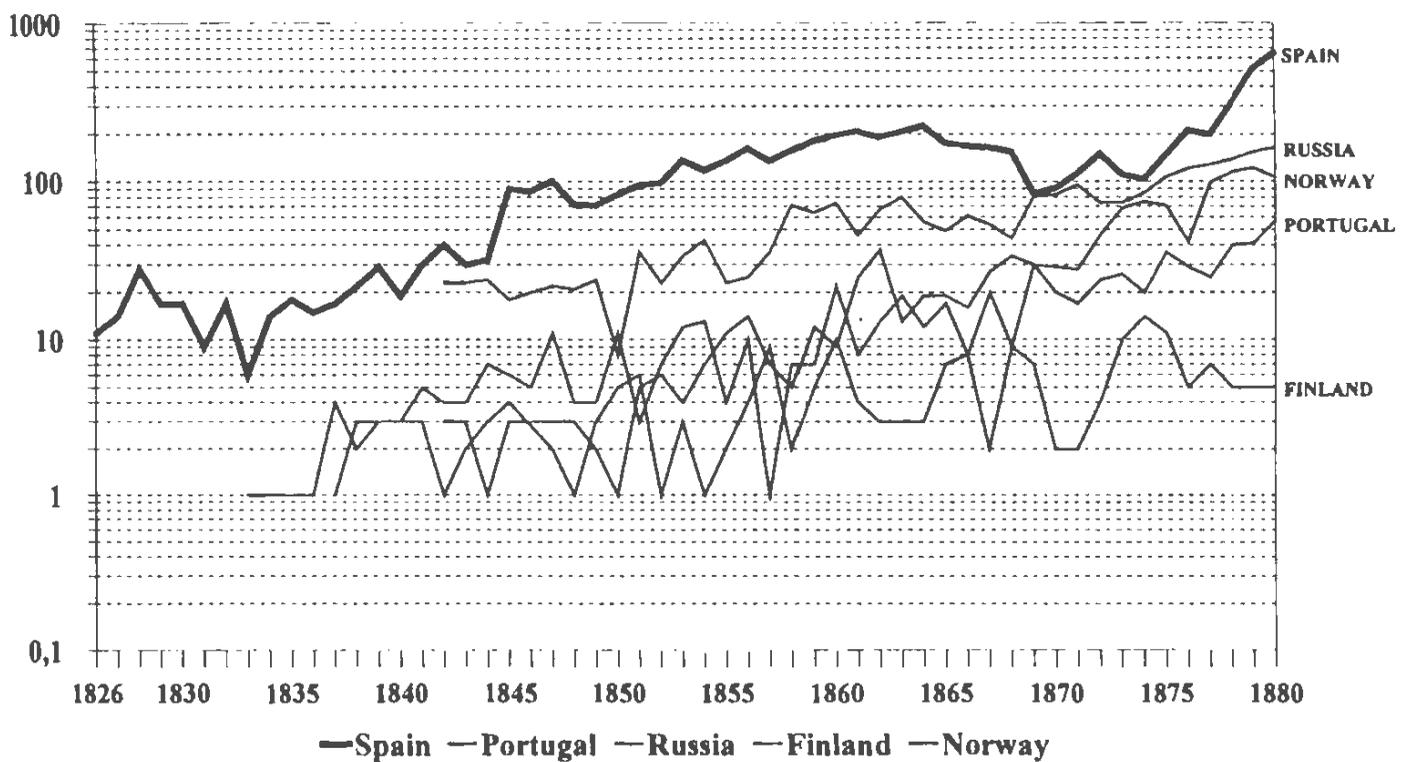
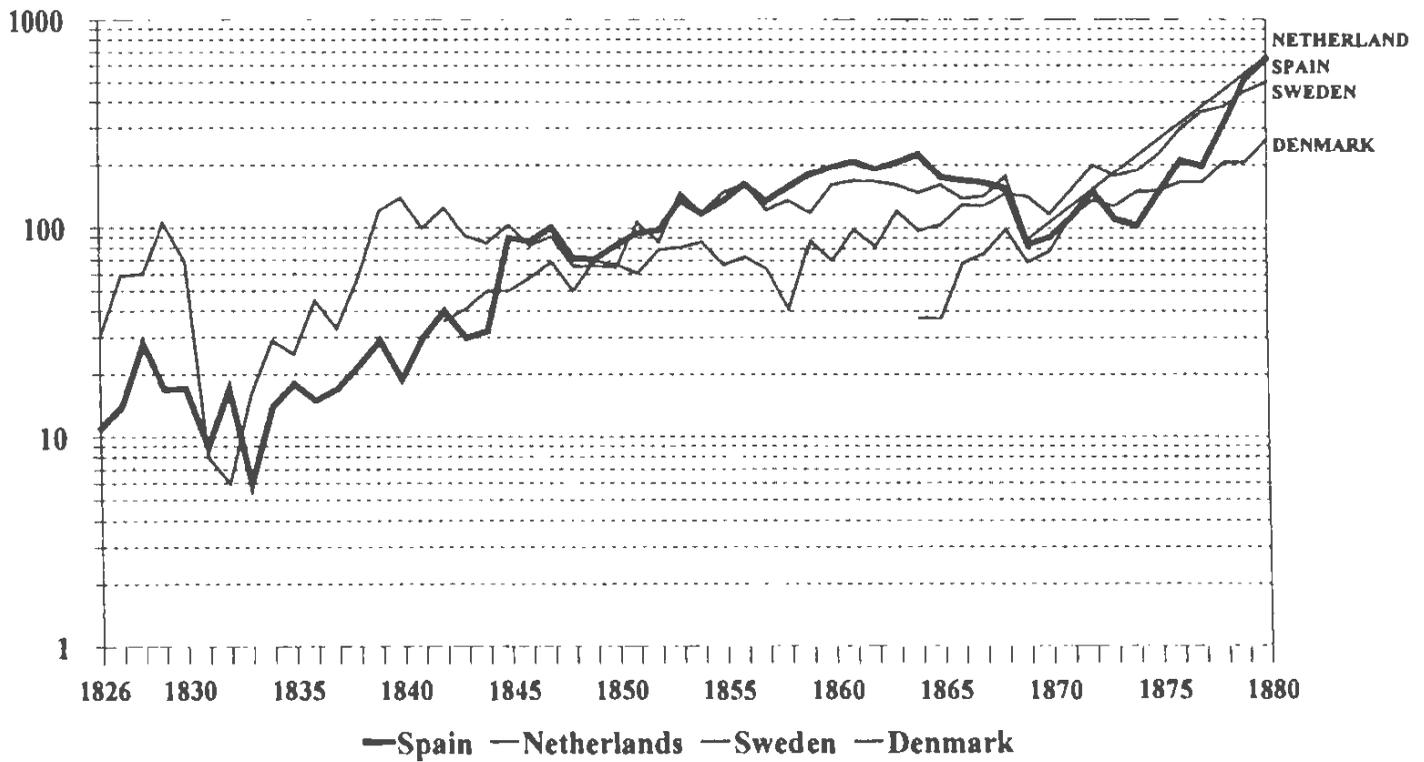
Source : *AHN and GM for privileges and other awards previous to 1826 and the OEPM files after this date.*

LES CHEMINS DE LA NOUVEAUTÉ

I. Patents applications in Austria, Belgium, Canada, Denmark, Finland, France, German, Italy, Netherland, Norway, Portugal, Russia, Spain, Sweden, Switzerland, UK and USA (1826-1878).

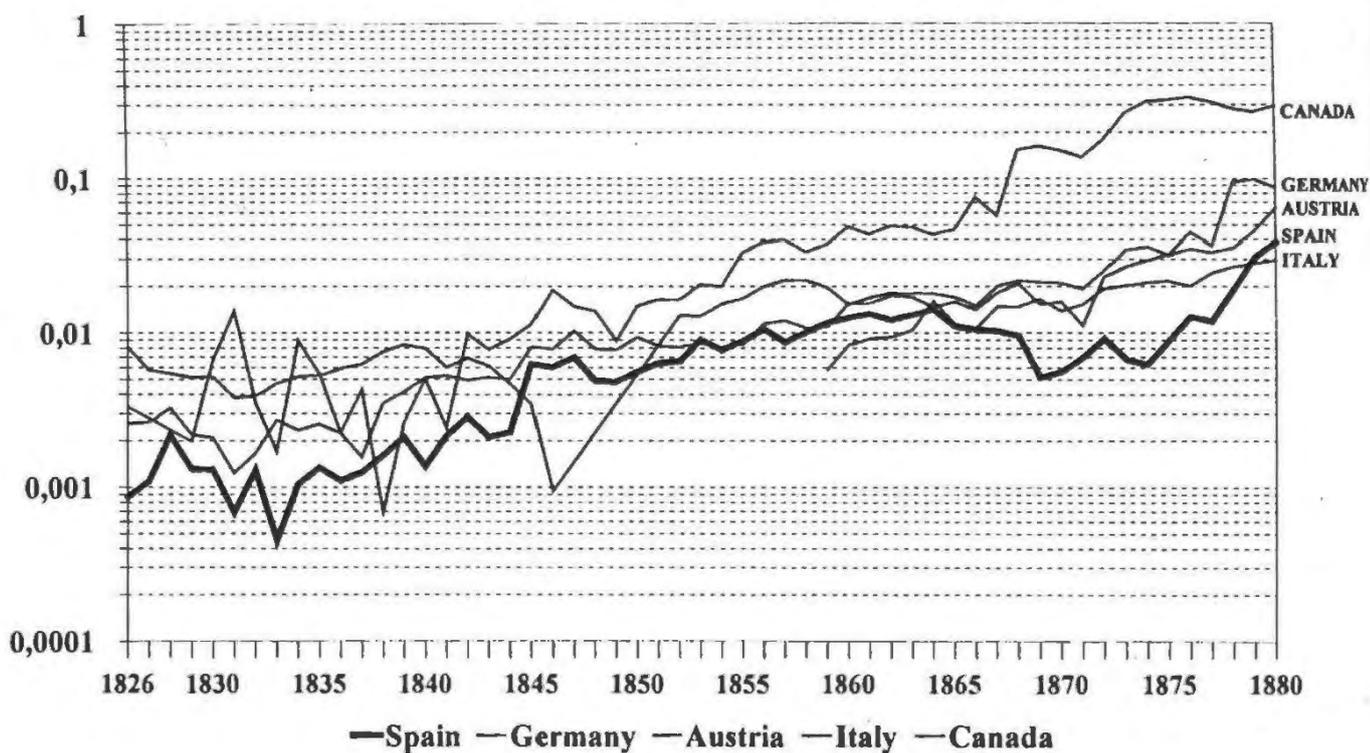
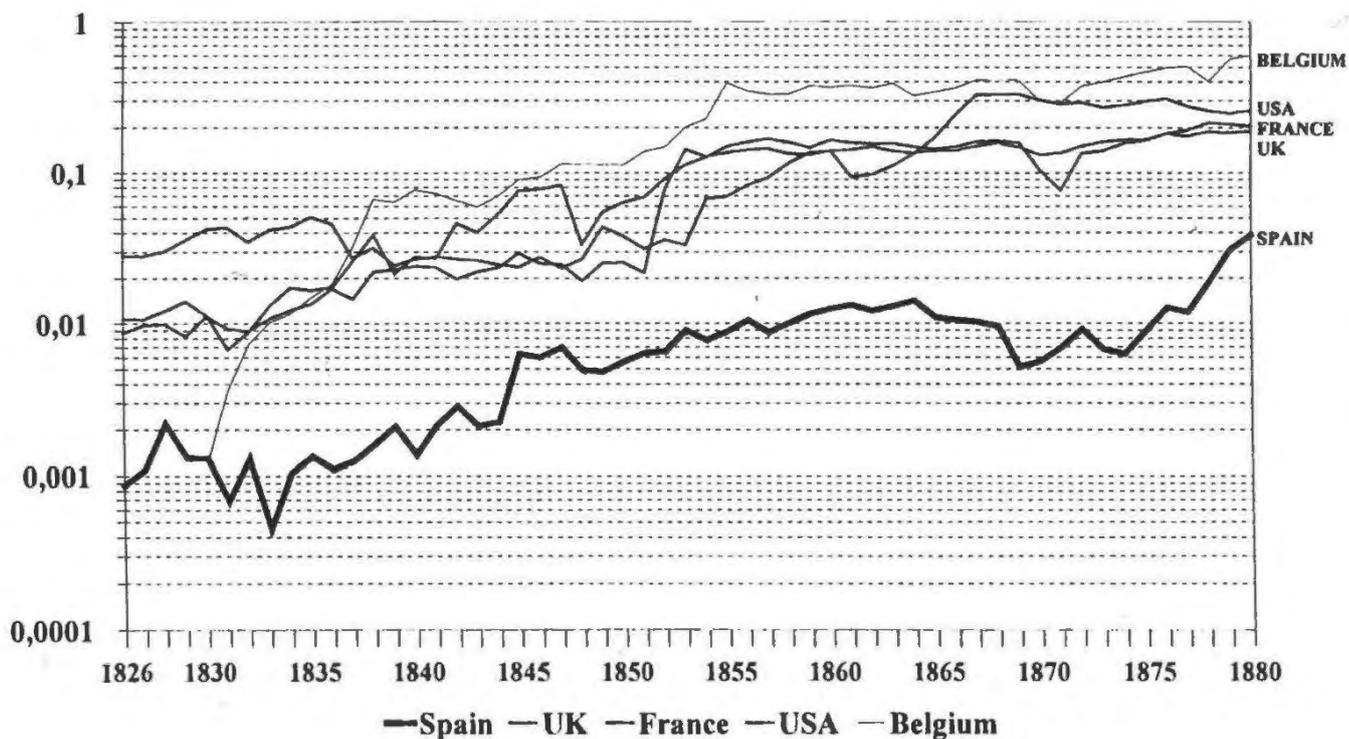


PATENTS, INTERNATIONAL TECHNOLOGY TRANSFER

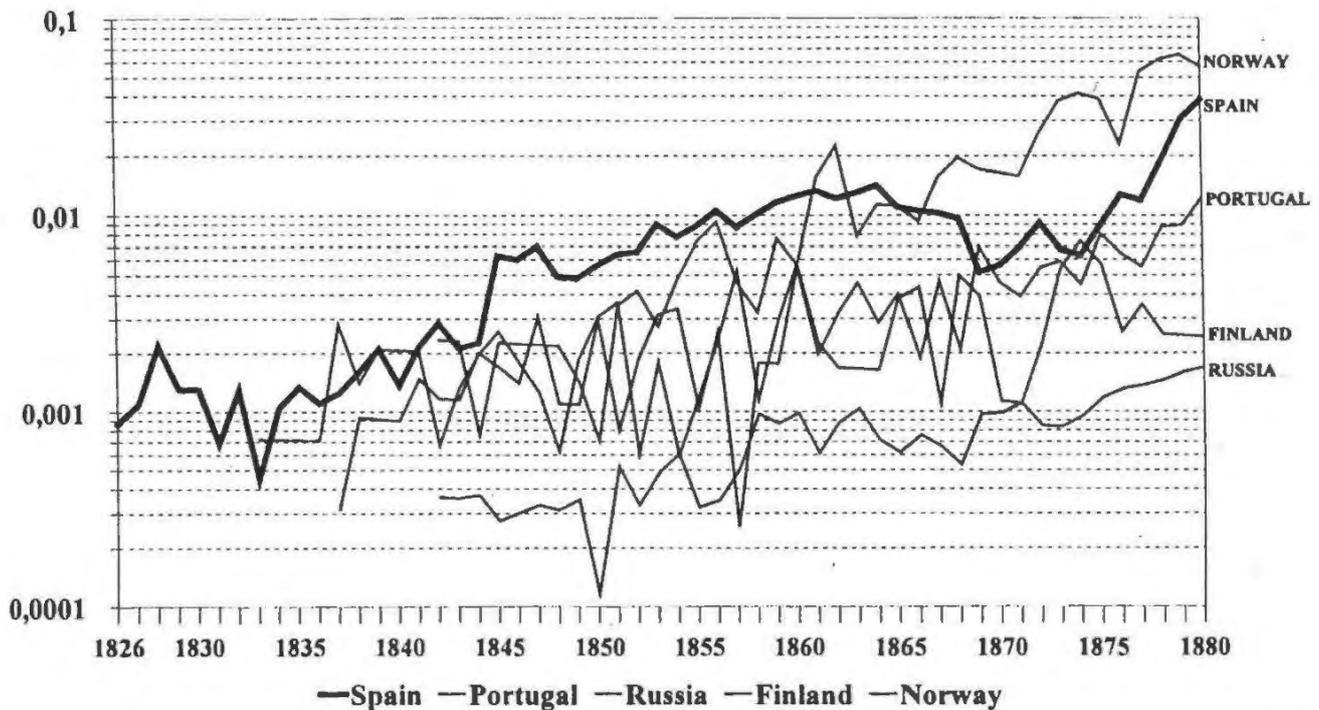
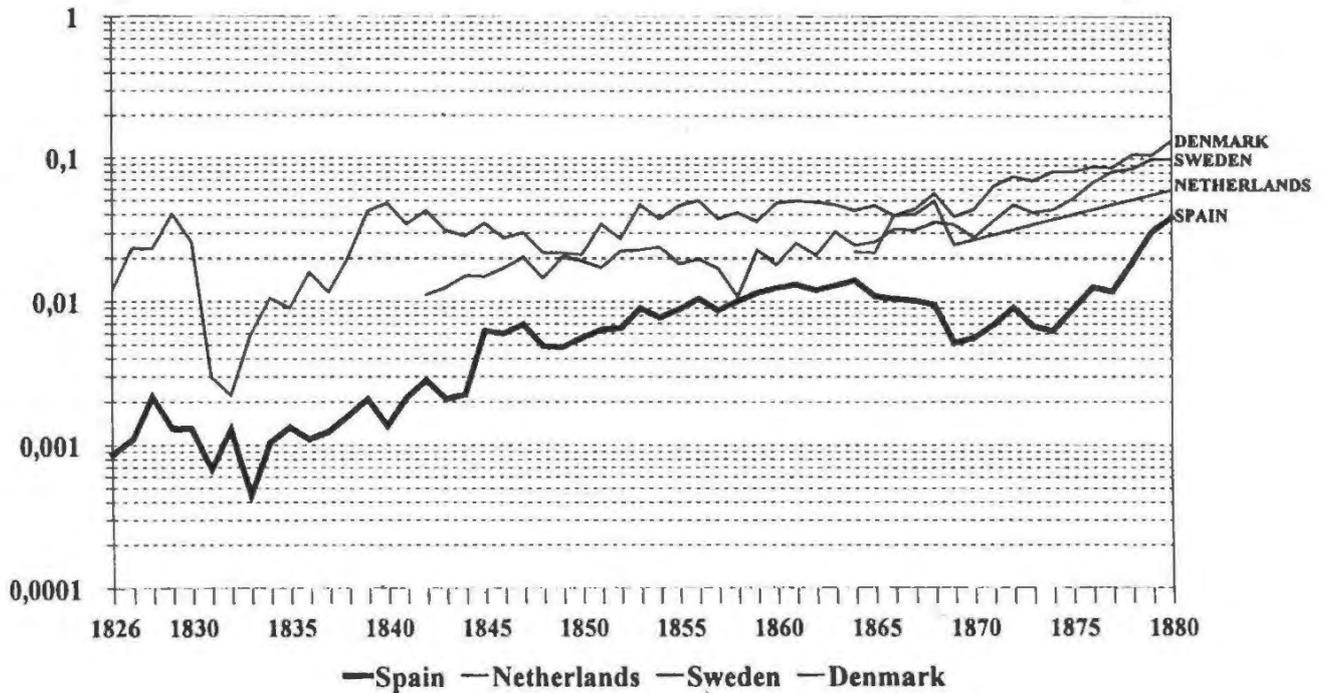


LES CHEMINS DE LA NOUVEAUTÉ

II. Patents applications per thousand habitants in Austria, Belgium, Canada, Denmark, Finland, France, German, Italy, Netherland, Norway, Portugal, Russia, Spain, Sweden, Switzerland, UK and USA (1826-1878).



PATENTS, INTERNATIONAL TECHNOLOGY TRANSFER



Source : OEPM files (Spain), Institute National de la propriété industrielle (France), The Patent Office (UK), Office de la propriété industrielle (belgium) and Instituto Nacional da Propriedade Industrial (Portugal) files and series, and data supplied in *100 years of industrial Property Statistics*, OMPI, Genova 1983 and FEDERICO, P. J., "Historical Patent Statistics" *Journal of the Patent Office Society*, vol.46 n°2, for Austria, Canada, Denmark, Finland, Germany, Italy, Netherland, Norway, Russi, Sweden, Switzerland and USA. Population series of each country had been elaborated throughout data interpolation of the Census supplied in MITCHEL, B. R. *European Historical Statistics, 1750-1970*, Abridged Ed., London, Macmillan, 1978 e *International Historical Statistics : the Americas and Australasia*, London, Macmillan, 1983