

Patent length and the value of inventions in Brazil in the 19th Century

Luciano M.C. Póvoa

Federal Senate – Brazil

Andrea Cabello

Economics Department at University of Brasília, Brasília – Brazil

Draft version

Abstract

This paper presents a new set of historical patent data ranging between 1830 and 1882 in Brazil, during its first patent law. According to this law, each patent term had its length determined by the quality of the invention. We analyze the economic factors related to the social value assigned to inventions, measured in years of monopoly granted by the government. Furthermore, we explore the kind of inventions that arose and what were the most important ones in an agricultural nineteenth-century economy, based mainly on coffee exports. The results suggest that inventions related to transports, commodity-export trade, and foreign inventions were considered more important.

1. Introduction

Sometimes History gives us better data than the present time. This happens, for example, because of less litigious environments in the past (Goldin, 1995). Thus, we can study the effects of rules that could hardly be applied today. This is the case when it comes to patents.

Currently, most countries adopt a fixed term for the duration of the monopoly, which is usually 20 years from the filing date of the patent application. Hence, one of the major limitations of using patent data to study the rate and direction of inventive activity is that each patent has the same term and counts as one invention, no matter its importance or quality (Griliches, 1990). Therefore, there is a variability of economic significance of patents that is not captured by current patent data.

However, some countries have adopted different terms in the past according to each patent. For example, according to the US Patent Act of 1790, the Patent Board members could assign any length provided it did not exceed fourteen years. A similar provision was also included in the first Brazilian patent law, enacted in 1830, which lasted until 1882.

This paper presents a new set of historical patent data ranging between 1830 and 1882 from Brazil, a period that covered its first patent law. According to this law, each patent term would have its length determined by the quality of each invention, that is, its economic importance or social value. Our goal is to analyze the economic factors related to the length assigned to inventions, measured in years of monopoly granted by the government. Furthermore, we explore what kind of inventions arose and what were the most valued ones in a rural nineteenth-century economy, based mainly on coffee exports.

The economics literature on patents often analyzes two dimensions: the patent length and breadth. Models of optimal patent length try to determine the conditions that affect the choice of the optimal duration. According to Nordhaus (1969), the patent office has to choose the period of patent protection considering the effect on the inventors' effort on R&D. If the patent office sets out a small period of protection, inventors will devote less effort on R&D. On the other hand, a too long period will reduce the future benefits for consumers after the expiration of the patent. This kind of model considers the *ex ante* determination of the patent length. The problem investigated in this paper is the opposite. By the Brazilian law, all the inventors knew *ex ante* was the maximum duration possible for his invention the law could grant. The real duration was determined *ex post*, ranging from 5 to 20 years.

Two important studies arrive at opposite conclusion about the optimal combination between length and breadth. Gilbert and Shapiro (1990) argue that the optimal mix is narrow but infinite patents. So it would generate many substitutes' goods and processes. On the other side is the conclusion arrived by Klemperer (1990), that the best system is the one with broad and short-lived patents.

Gilbert and Shapiro (1990) discuss the tradeoff between the need to reward inventors and the welfare loss imposed on society by the market power created by intellectual propriety protection, and how this debate has been casted in terms of the

optimal lifetime for patents. The authors focus on the patent's breadth, which they define as "the flow rate of profit available to the patentee while the patent is in force" (Gilbert and Shapiro, 1990, p.106). Their analysis suggests that when patent policy is viewed broadly, that is, as choice both of length and breadth, the optimal length might be infinite – if patent breadth is increasingly costly in terms of deadweight loss. This longer length might call for licensing contracts on one hand but could not prevent strong protection from infringement, if rewards to inventors are not adequate.

They, however, alert that their conclusions have limitations, specially the predictability of the environment considered and the fact that it is stationary. They point out, for example, that an overly-long patent could retard innovation, by monopolizing a line of research in such a way that "the trade-off between deadweight loss and profits at the margin would no longer be constant as the patent lifetime increases. Rather, there might be increasing social costs in comparison to patentee profits as the patent grant is extended in time" Gilbert and Shapiro (1990, p.112). Also, they compare their result with Klemperer (1990), who they noticed reached a different conclusion regarding "the optimality of very short, very broad patents, if substitution to alternative products is the main source of deadweight loss rather than substitution out of the product altogether" Gilbert and Shapiro (1990, p.111).

Klemperer (1990) discusses the tradeoff between a patent's length and its width, defined as its scope of coverage, and how it affects the deadweight losses it imposes on society. He adopts a spatial model, in which consumers differ in demands and costs of substitution alternative varieties and that the patentee produces the variety all consumers prefer. The width in this case is the distance from the preferred point to the one in which the competition is allowed to operate.

In Klemperer (1990), welfare losses arise because of switches to least preferred varieties that cheaper than the patented one and consumers that give up the product type altogether. Wider patents cause two types of effects: while they reduce the freedom to switch to unpatented varieties (the first type of loss), they might increase the second type of switch (and loss). Klemperer (1990) notices that, at the extreme, with infinitely wide patents, only the second type of loss would be important. On the other hand, with extremely narrow ones, only the first type would matter.

The next section presents the economic aspects of the first Brazilian patent law. The data set is presented and analyzed in the third section. The fourth section presents regressions on the relation between economic sectors and patent length. The last section concludes.

2. Economic Aspects of the First Patent Law

A patent system was already in place in Venice in the fifteen century. Monopolies were granted to inventors all over Europe in the sixteenth and seventeenth centuries (Machlup and Penrose, 1950). However, Brazil stands out due to its economic structure and History. Brazil is one of the pioneers in the recognition of the social value of inventions, still in its colonial period. When the Portuguese Royal Family fled to Brazil due to the invasion of Napoleon's troops in 1807, Brazil became the administrative center of the Portuguese Empire. As a result, several measures were taken to develop the country. One of them was the Royal Charter of April 18, 1809, which established, among other things, the exclusive privilege to "inventors and introducers of new machine and new invention in the arts." However, this measure had no significant effects on the national manufactures, and Brazil continued to import manufactured products from England.

Brazil became independent from Portugal in 1822, and the first patent law was enacted in 1830, prior to Portugal, that enacted its own law only in 1837. The patent law of 1830 was also the one that lasted the longest, replaced only in 1882. The law was intended to "grant privilege to who discover, invent or improve a useful industry and a reward for introducing a foreign industry". So, the Law did not allow patents on imported inventions, and the novelty requirement was rigorous. Only inventions new to the world were granted patents. This strong provision for a country without any indigenous manufacture proved disastrous. According to Ministry Reports, there was never any budget to reward introducers of foreign inventions. The result was the fact that, for many years, it was not possible for foreigners to establish patents in Brazil. Furthermore, by preventing the copying of foreign inventions, the law imposed a technological barrier to Brazil, since that in the nineteenth century many countries granted patents without proof of originality (Chang, 2002).

For all applications, a preliminary examination was performed to demonstrate the novelty and utility of the invention, and patents were granted for free. Rodrigues

(1973), based on Ministry Reports, indicates disapproval of several patent applications that did not meet the requirements of novelty and utility, which suggests that examinations of the merits of the patent were carried out with some rigor.

According to the Law, the patent was given to the "first to invent". Also, the inventor would lose this privilege if he did not put into practice the invention within two years after the grant of the patent, or if he had already obtained a patent for the same invention abroad. In other words, the legislator intended to turn those inventions into benefits for the society, going beyond the mere protection of property rights. Unfortunately, there were no records of the effectiveness of this provision.

The focus of this article refers to the patent length established by law. Like the first US patent law, Brazil did not set a single term for the validity of the patents. According to the law, a patent could have the duration of 5 to 20 years, according to the quality of the invention. The original draft of the Bill did not mention quality, but the "importance and value of the invention". So, this paper uses the length assigned to the patent in years as a proxy for the social value of the invention.

This prohibition of registration of patents already granted abroad began to be challenged in the 1860s. In the words of a minister, "it is not fair to deny patent under the pretext of being already known outside the Empire" (Rodrigues, 1973, p. 656).

In the 1870s, there were significant changes in the interpretation of the law to exclude the previous examinations of patent applications and to start granting patents to foreigners, as Thomas A. Edison, for example (Rodrigues, 1973). The claim for suspension of these previous examinations was the recognition of the rights of inventors to the full secret of their discoveries¹.

The discontent with the patent law dragged on for two decades, culminating on the adoption of a new Patent Law in 1882. This new law was drafted during the first meetings that resulted in the Paris Convention for the Protection of Intellectual Property, which occurred in 1883, when Brazil was one of the signatories. The law incorporated the main principles of the Convention, like the *priority claim*² and equal

¹ For several years the Auxiliary Society of the National Industry carried out the examination. The inventors argued that employees of that society – an institution outside the public administration – would have access to the secrets of patents before its expedition, which would violate the right to confidentiality.

² Period of one year ensured to an inventor to apply for the same patent in another country.

treatment of patent applications and foreign nationals. It was also established a fixed term of 15 years for all patents.

Thus, all patents granted during the period from 1830 to 1882 can be analyzed according to its importance to the Brazilian economy and society. In order to evaluate this aspect, it is presented an original database in the next section.

3. The Database

3.1. General Description

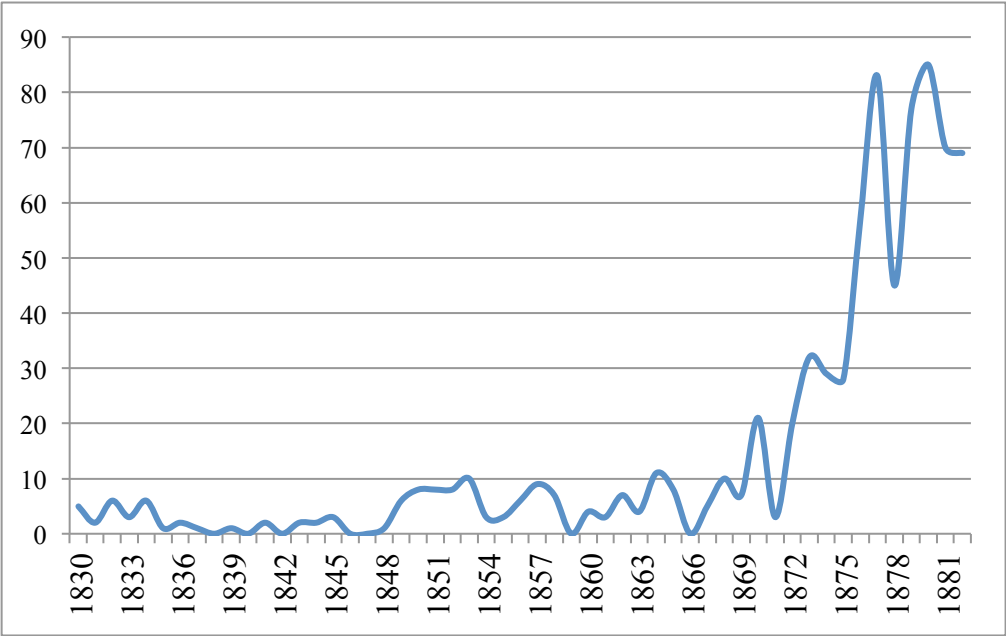
The first attempt to collect historical data on Brazilian patents was carried out by Rodrigues (1973), as it was published in its appendix. He was the first author to study the relevance of patents for the Brazilian economy. Despite the enormous effort, there were errors in his records, such as missing information, duplicates, misspelling, etc, that makes any deep analysis unreliable. We reconstructed the database from the start by accessing the original Ministry Decrees that granted each individual patent, available on the Brazilian Chamber of Deputy website, and added more information which Rodrigues (1973) had not compiled.

The information Rodrigues (1973) provided on the appendix of his book were year, name of the patentee and description of the patent. Compiling the decrees and Ministry Reports we were able to obtain the length of patent and to infer the type of patent (if it was an invention, an improvement or the introduction of a foreign invention).

A total of 783 patents were granted in Brazil between 1830 and 1882. Despite this small number of patents compared to developed countries, it is significant considering the fact that Brazil was an agricultural export-based economy with no relevant higher educational institutions, few cities and based on slavery. It is important to notice that the evolution of the patent activity was highly concentrated on the last two decades. Almost 80% of the patents were granted after 1870 (see Graph 1). At the same time Brazil started to have growing trade surplus on its balance trade after decades of deficit. Based on the exports and imports data, Furtado (1959) argues that the Brazilian economy was stagnated from the end of the eighteenth-century to the first half of the

nineteenth-century. During the second half of the nineteenth-century the per capita income grew at a rate of 1.5% per year.

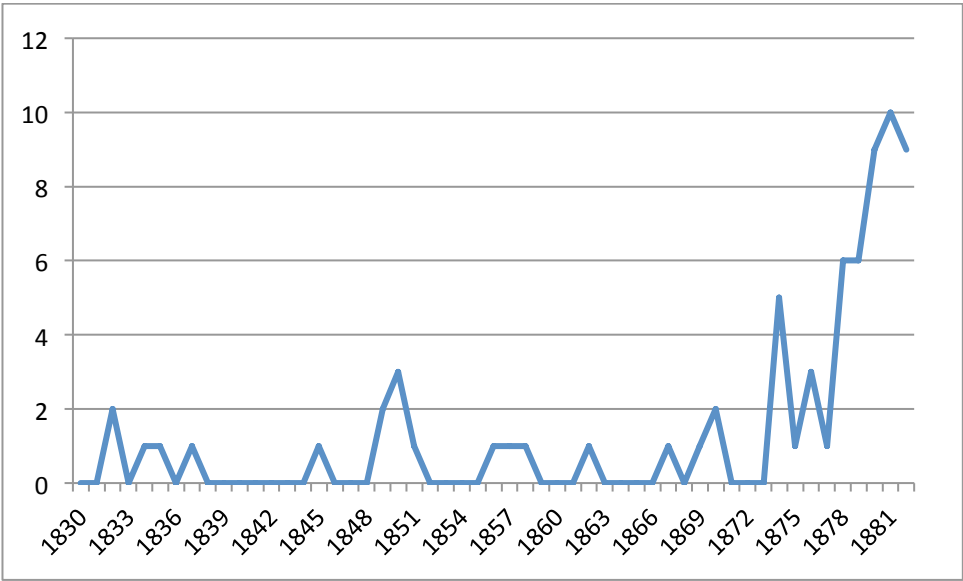
Graph 1 – Evolution of patents in Brazil (1830-1882)



Source: Compilation by the authors from Ministry Decrees available at the Brazilian Chamber of Deputy website.

Throughout the period, the number of foreign inventions that entered the Brazilian market also increased greatly, as graph 2 shows.

Graph 2 – Evolution of foreign patents in Brazil (1830 - 1882)



In order to analyze the relation between patent activity and the economic and the social transformation in the country all patents were classified. Griliches (1990) discusses problems involving the task of classifying patents among sectors or some other criteria applied to them. This task is challenging when dealing with century-old patents descriptions that are not always accurate and might be misleading as to what the product or process in question is really about. For example, an invention can be classified according to the industrial sector that is likely to produce it, or according to the sector that will use the final product resulting from it. It depends on the question that is addressed.

Since we are interested in studying the importance of inventions for the economy and society, we classified the patents according to the sector of use of the invention based on the invention description. For example, an invention described as “machine for pulping coffee beans” was classified as invention for the agriculture sector, for the coffee sub-sector, in the equipment group. Like every subjective classification, it is subject to inaccuracies. Table 1 shows the categories used.

Table 1 – Categories applied to the data set

Sector	1. Agriculture	2. Transportation	3. Consumption goods	4. Extrative	5. Others
Sub-Sector	11. Coffee	21. Cargo	31. Food		
	12. Sugar	22. Urban	32. Textile		
	13. Others	23. Others	33. Others		
Group	111. Equipment	211. Railroads			
	112. Farming	212. Small cars			

These categories were chosen due to Brazil’s economic structure in the mid- and late nineteenth-century, which explains the predominance of agricultural and transports patents. Also, we observed a large number of patents that dealt with consumption goods.

Table 2 presents the number of patents according to sector and sub-sector. Patents related to agriculture were prevalent, representing 29.9% of the total. Coffee stands out as the most important sub-sector. Of the 783 patents, 141 (or 18%) were clearly related to the coffee trade. It is not surprising since during the nineteenth-

century it became the main commodity in the Brazilian balance of trade. For example, in 1891 it represented 63% of the exports (Baer, 2001). The number of patents related to coffee production could be much higher as the “others” sub-category on agriculture was created mainly for patents in which descriptions either did not specify their application or are regarded to general inventions that could be applied to many crops. This category represents 57 patents (7.3% of the total). Patents related to sugar reached 4.6% of the total.

Table 2 – Patents classified according to sector and sub-sector

Sector	Sub-sector	Patents	(%)
Agriculture	Coffee	141	18.0
	Sugar	36	4.6
	Others	57	7.3
	Total	234	29.9
Transportation	Cargo	20	2.6
	Urban	15	1.9
	Communications	4	0.5
	General	83	10.6
	Total	122	15.6
Consumption goods	Food	46	5.9
	Textile	15	1.9
	Others	54	6.9
	Total	115	14.7
Extractive	Total	35	4.5
Others	Total	277	35.4
Total		783	100.0

A further division was done to distinguish among equipment and farming (not shown on the table), and applied to all the three aforementioned agriculture categories. We classified 210 patents, almost 27% of total patents, as equipment and 24 (3% of total patents), as farming.

Because of the relevance of coffee production for the Brazilian economy at that time, it is important to analyze its technological dynamics. First, 98.5% of the patents directly related to coffee were machines and equipments to be applied after harvesting the coffee cherries. Among them were devices to clean the beans, to remove the pulp, to

peel, to dry, and to polish it. There were also storage methods to maintain the beans before export.

Second, coffee production is a labor intensive activity. Pressured by England, Brazil prohibited the traffic of slaves on 1850. Nonetheless, the domestic slave market continued active until slavery was abolished in 1888. According to Versiani et al (2003), Brazil was the main importer of African slaves. From 1800 to 1850, it imported 340 thousand slaves per decade. In the 1860s the impacts of the supply shortage of slaves and, perhaps more important, the increasing demand, started to affect the prices in the coffee region. Prices raised an average of 10% per year in this decade (Versiani et al, 2003).

This institutional and structural change in the labor market had significant impacts on the adoption of technologies. According to the Habakkuk hypothesis, extended by a model presented in Acemoglu (2010), labor shortage can induce labor saving inventions. Indeed, the number of agricultural machines advertised in newspapers by importers, and news about indigenous inventions, increased remarkably during the 1860s (Canabrava, 2005). Our data seems to confirm this hypothesis since most of coffee patents were granted after de 1860s.

Another aspect of the patent activity related to coffee is the considerable number of very similar inventions (at least observed by the description). Dozens were designed to do the same basic stage of production. For example, 30 patents were granted to general processing machines, 23 patents to polishing machines, 21 to drying machines, and 11 to remove the peel. This fact suggests that, at least for the case of inventions related to the coffee production, the first Brazilian patent system was “thin”, in the sense that the monopoly protection was allowed only for very specific inventions. It was possible to invent similar devices without infringe another patent.

Because of the boom of coffee production in the second half of the century, the transport of the production became crucial. In our patent classification, the second most important sector is transportation (15.6% of the total). It was divided into four sub-sectors. The cargo category contains only patents that specifically described a cargo transportation method or device (2.6%). That does not mean that in the “general” category there are not vehicles of small cars that could be used for cargo transport – we just could infer that from the description given by the inventor. The urban category

(1.9%) includes public transportation such as trolley cars and ticket collection methods to prevent frauds. The “general” category includes inventions related to cars with no specific description, wheel axle and others (10.6%). We also included in this sector four inventions related to communications.

A sub-division was also applied here to analyze the impact of railroads in the inventive active and another to distinguish small cars such as carriages from trains and ships (not shown on the table). Of the transportation patents, 33 patents (4% of total patents) are clearly related to railroads. We could distinguish by the description given that 9% of the transportation patents are related to small cars.

The next sector we considered was the consumption goods (14.7%). We added this one as Brazil was an agro-exporting economy which imported a large variety of consumption goods. Exchange rate instability constituted an incentive to import substitution and industrial investments (Versiani, 1980). Therefore, the inventive activities would focus on the production activities but also on the consumption habits. The data does seem to support that idea, because of the considerable number of patents with this rationale.

At the same time, the internal trade market among the provinces of different regions became more relevant. Marcondes (2012) analyzes the importance of short sea shipping for internal commerce and consumption and the share of interprovincial commerce in the nineteenth-century. This is an interesting perspective as it shines light on the kind of domestic market of this economy and helps us explain the interest inventors had in some sectors. Not only sugar and coffee were important for their export status but they also played an important role in the domestic economy as well. From 1845-49 and 1869-73, sugar and its byproducts, meat, leather and tobacco made up 50.1% and 44.8% of the share of commodities in interprovincial commerce respectively.

We divided the consumption goods sector into three sub-sectors: food (5.9%), textile (1.9%) and others (6.9%). These categories represent goods most consumed by that type of society and were also the first sectors in which Brazil began to show industrial effort. Suzigan (2000) presents historical data on textile machinery imported from England to support the thesis that the Brazilian industrialization began in the 1870's. According to Cruz and Tavares (1986), the number of inventions related to textiles started to grow after 1877, and from 1877 to 1891 there were 61 patents related

to textile industry. Because our database covers the period only until 1882, it did not capture this important aspect of the Brazilian industrialization.

The extrative sector included mostly mining (gold and diamond) and fishing activities (4.5%). The last category, others, included inventions such as motors, glass, cement, rock cutting machines, methods to produce bricks, and others which the description was too vague.

We also proposed an alternative classification to analyze the value of inventions in section 4. It distinguished between patents focused on the domestic market and the commodity-export trade. The transports category was maintained. We also included a category for inventions related to social use, which comprised utility services such as water plumbing, energy and other urban infrastructure inventions (e. g. system for construction of bridges and sidewalks). Table 3 shows this classification

Table 3 – Alternative classification

Sector	Patents	(%)
Export-Oriented Patents	237	30,3
Domestic-Market Patents	351	44,8
Transportation Patents	108	13,8
Social Patents	87	11,1
Total	783	100,0

Summing up, at least one third of the inventive activity in Brazil during the 1830-1882 period was concentrated in the agro-export complex (agriculture and cargo transport). The characteristics of the inventions seem to validate the thesis of Cruz and Tavares (1986) that invention activity in Brazil during the nineteen-century can be explained by demand pull theory. There was no relevant scientific activity in Brazil and no development of general purpose technologies such as electricity to start a technology push movement. However, there was a growing population demanding simple consumer goods, an expanding export sector demanding new methods of transport, and technical railroad construction challenges to be solved in order to connect new and productive farms hundreds miles away from the main ports. There was also demand for new methods of processing and drying the coffee beans. This was important not only

because labor shortage, but also because it increased the value of the beans around 10% and made possible to use distant lands to produce coffee and transport to the ports without rot the beans (Silva, 1986).

3.2. Patent Duration

As Griliches (1990, p.292) points out, many patents “reflect minor improvements of little economic value. Some of them, however, prove extremely valuable. Unfortunately, we rarely know which are which and do not yet have a good procedure for ‘weighting’ them appropriately.” That is especially true here, as most of the invention’s descriptions are concise, not allowing us to grasp the economic reach of the product or process.

Nevertheless, our database has information that helps to overcome these problems. First, it was collected the duration of each patent in years. Second, based on the description of the invention, each patent was classified according to whether the patent in question was a new invention, an improvement, or the introduction of a foreign invention in the country, as they started to be allowed in the 1870s as discussed in the second section.

Table 4 presents the duration of patents by types of invention privilege. The average duration of the patents was 9.2 years. But there were relevant differences among them. New inventions (almost 80% of the total) were granted with the lowest average duration (9.0 years). Foreign inventions (12.1%) were granted with an average duration of 9.5 years, which is higher than indigenous inventions. The quality of foreign inventions was expected to be higher. Because of the difficulties of communications in the nineteen-century, foreign inventors were interested in protecting only relevant inventions in an agricultural export-based country.

Improvements accounted for 8.9% of total patents, but curiously had the higher average duration (9.8 years). Our hypothesis to explain this fact is that only inventions with real economic or social significance were objects of improvements. Compared to all other inventions (a diversified group), those inventions were evaluated as having a higher importance.

Table 4 – Average duration of patents according to types of invention privilege (1830-1882)

Type of privilege	Patents	(%)	Average duration in years	S.D.	Min	Max
Inventions	618	78.9	9.0	3.0	4	20
Improvements	70	8.9	9.8	3.5	4	24
Foreign inventions	95	12.1	9.5	3.0	5	20
Total	783	100	9.2	3.1	4	24

Given the importance attributed to improvements and foreign inventions, it is interesting to analyze the distribution of types of privileges by the sectors (Table 5). The first aspect to be highlighted is the prevalence of indigenous inventions (and improvements) in the agriculture sector. In other words, the dynamic sector provided inventive challenges, and Brazilians inventors coped with these challenges to solve problems as labor shortage and quality improvement of the processing of coffee beans. The proportion of foreign inventions was relevant in the transport (12.3%) and consumption goods (15.7%).

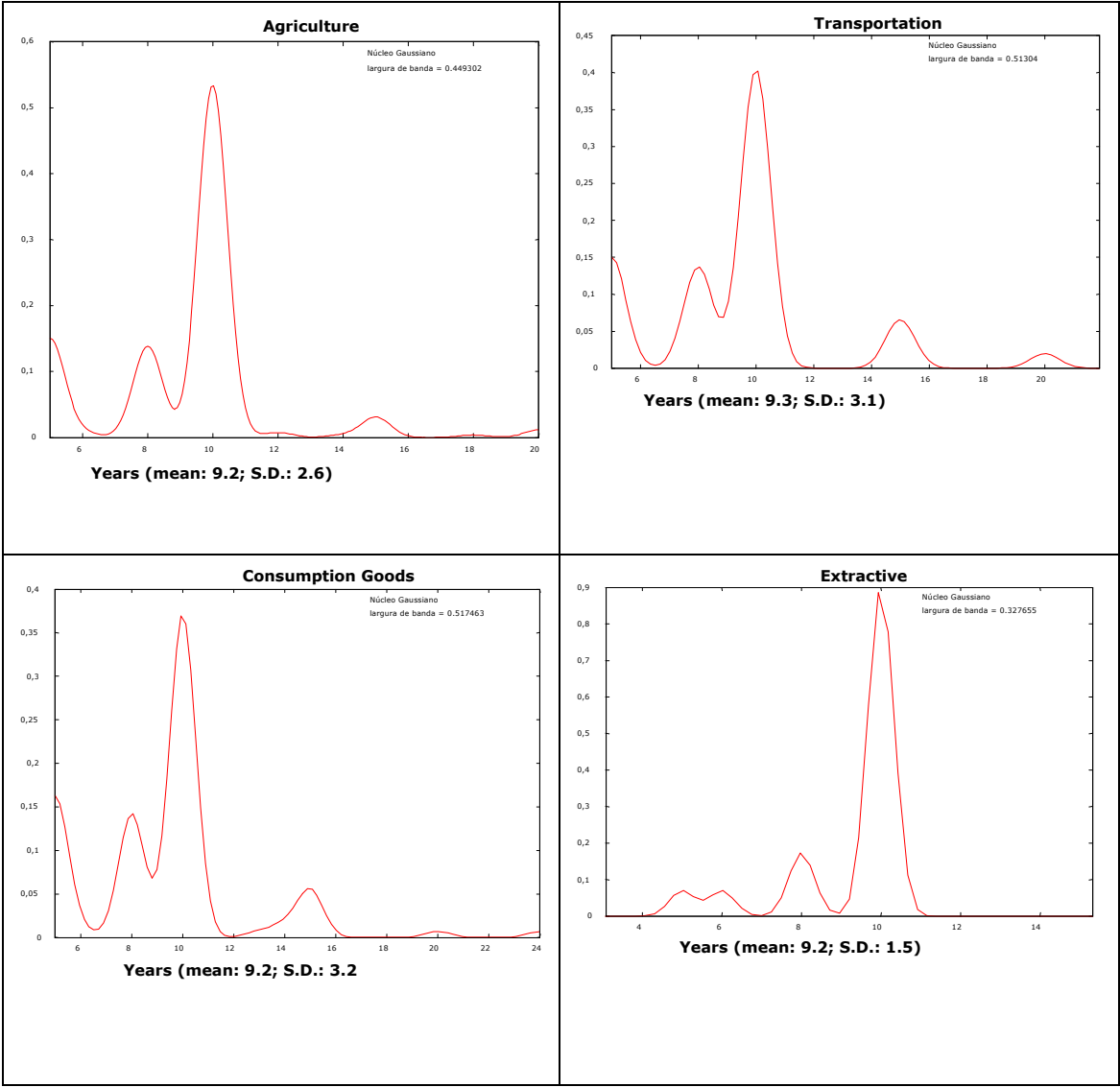
Table 5 – Patents sector and types of privileges (%)

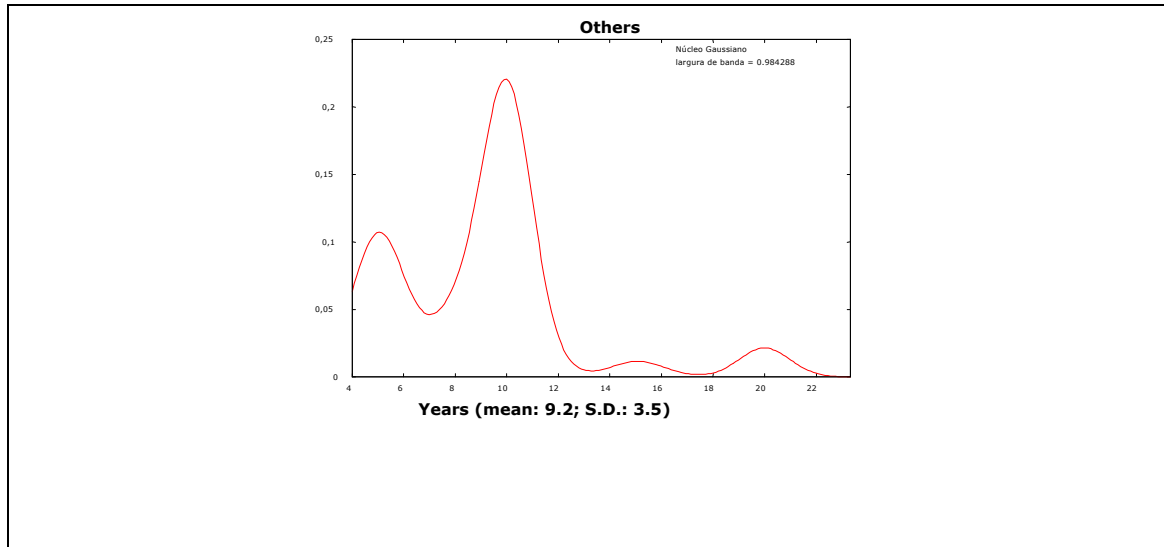
Sector	Inventions	Improvements	Foreign inventions	Total
Agriculture	82,5	13,2	4,3	100
Transport	82,0	5,7	12,3	100
Consumption goods	79,1	5,2	15,7	100
Extractive	74,3	17,1	8,6	100
Others	75,1	7,2	17,7	100
Total	78,9	8,9	12,1	100

The duration of the patents by sectors is very similar. Figure 2 provide the estimated density of duration according to the sectors. It shows that the distribution is almost the same for the agriculture, transportation and consumption goods. Only the extractive sector and the patents classified as “others” presents a different distribution. A common pattern is the concentration of patents granted with 10 years of duration, a total of 55.3%.

The next section analyzes in more detail the correlation among type of inventions, economic sectors and duration of patents.

Figure 1 – Estimated Density of Duration





4. Value of Inventions by Type and Economic sectors: Ordered Logistic Regressions

Our hypothesis is that inventions related to the dynamic sectors of the economy, agriculture and transportation, tend to be considered more important by the patent examiners.

The database consists in a pooled cross-section with a discrete dependent variable (years of monopoly). Because of the small variability (patents assigned with 5, 8 and 10 years account for 87.2% of the values), and considering that the duration mean of the dataset is 9.2 years, we created the ordered variable y_i (importance). It assumes the following values:

$y_i = 1$ (less important inventions), if duration of the patent is ≤ 5 years;

$y_i = 2$ (medium important inventions), if duration of the patent is > 5 and ≤ 9 years;

$y_i = 3$ (important inventions), if duration of the patent is > 9 and ≤ 14 years;

$y_i = 4$ (outstanding inventions) if duration of the patent is ≥ 15 years.

The ordered logistic model can be used when there are more than two categories with a sequential ordinal scale. It assumes that the distance between each category of

the dependent variable is proportional. We use the Brant test for the consequences of violating this assumption.

Table 6 reports ordered logistic regressions of importance of inventions y_i against a set of characteristics of each invention. The regressions are for equation

$$(1) y_i = \alpha_k T_{ki} + \beta_k S_{ki} + \gamma_k D_{ki} + \varepsilon_i$$

where T_i is the type of invention (invention, improvement of foreign invention), S_{ki} are the economic sectors (where S is a vector of the k sectors), D_i are dummies for decade of invention, α_k , β_k and γ_k are estimated coefficients for the equation and ε_i is a random error term.

Columns (1), (3), and (5) show results for the whole database (763 classified inventions). Columns (2), (4), and (6) show results for the sample data (605 classified inventions from 1870 to 1882). This restriction of period is relevant because it encompasses most of inventions and it is considered the beginning of the industrialization.

All regressions suggest that the economic sector of the invention is not a determinant for differences in the importance of the invention. Only Columns (5) and (6) presents regressions that are statistically significant. Both indicate that foreign inventions were considered more important and that this importance increased in the last two decades of the period, especially in the 1880s.

Column (5) presents the results for the whole period. It shows that the importance of inventions increased over the decades.

Table 6 – Ordered Logistic Regressions: Importance of inventions

	(1) importance Whole base	(2) importance Sample	(3) importance Whole base	(4) importance Sample	(5) importance Whole base	(6) importance Sample
Agriculture	1.17 (0.91)	1.81 (0.86)	1.20 (1.03)	1.25 (1.14)	1.18 (0.93)	1.33 (1.44)
Transport	1.18 (0.77)	1.44 (0.55)	1.22 (0.92)	1.17 (0.65)	1.17 (0.73)	1.27 (0.97)
Consumption	1.00 (0.00)	0.98 (-0.08)	1.02 (0.10)	1.00 (0.00)	0.98 (-0.07)	1.04 (0.17)
Extractive	1.43 (1.08)	1.64 (1.25)	1.40 (1.02)	1.66 (1.29)	1.18 (0.49)	1.72 (1.37)
Improvement			1.68 (2.02)**	1.41 (1.18)	1.57 (1.77)*	1.35 (1.01)
Foreign invention			1.56 (1.88)*	2.00 (2.56)**	1.81 (2.39)**	2.27 (2.94)**
dec_1840					0.93 (-3.34)**	
dec_1850					0.28 (-2.58)**	
dec_1860					0.20 (-3.20)**	
dec_1870					0.13 (-4.71)**	
dec_1880					0.17 (-4.05)**	1.39 (1.87)*
Cut 1	-1.28	-1.30	-1.19	-1.18	-3.05	-1.03
Cut 2	-0.47	-0.39	-0.37	-0.26	-2.23	-0.11
Cut 3	2.61	3.01	2.74	3.25	1.01	3.43
LR chi2	2.04	2.30	9.17	10.05	36.94**	13.56*
Observations	763	605	763	605	763	605

Notes: Only models (5) and (6) are statistically significant at 10%.

Absolute value of z statistics in parentheses

* significant at 10%; ** significant at 5%

We also tested our alternative classification that distinguished between patents focused on the domestic market and the commodity-export trade, a transports category and a category for inventions related to social use.

Table 7 presents ordered logistic regressions for the alternative classification. Except for model (1), all others are statistically significant at 10% level of confidence. The importance of inventions varied over the decades, but it is not possible to assert that it increased.

Table 7 – Ordered Logistic Regressions: Importance of inventions³

	(1) importance Whole base	(2) importance Sample	(3) importance Whole base	(4) importance Sample	(5) importance Whole base	(6) importance Sample
Exports	1.33 (1.19)	1.78 (2.12)**	1.40 (1.37)	1.98 (2.47)**	1.41 (1.40)	1.94 (2.39)**
Domestic	1.32 (1.21)	1.71 (2.06)**	1.38 (1.40)	1.85 (2.32)**	1.36 (1.32)	1.74 (2.07)**
Transport	1.90 (2.24)**	2.24 (2.43)**	2.01 (2.43)**	2.43 (2.66)**	1.83 (2.09)**	2.40 (2.63)**
Improvement			1.74 (2.16)**	1.43 (1.22)	1.62 (1.89)*	1.37 (1.07)
Foreign invention			1.59 (1.95)*	2.11 (2.75)**	1.82 (2.42)**	2.31 (3.02)**
dec_1840					0.09 (-3.36)**	
dec_1850					0.28 (-2.54)**	
dec_1860					0.21 (-3.09)**	
dec_1870					0.14 (-4.61)**	
dec_1880					0.17 (-4.05)**	0.76 (-1.52)
Cut 1	-1.08	-0.87	-0.95	-0.70	-2.79	-0.64
Cut 2	-0.27	0.04	-0.14	0.22	-1.96	0.28
Cut 3	2.82	3.53	2.99	3.76	1.28	3.83
LR chi2	5.14	6.55*	13.03**	15.41**	39.96**	17.74**
Observations	763	605	763	605	763	605

Notes: Only model 1 is not statistically significant at 10%.

Absolute value of z statistics in parentheses

* Significant at 10%; ** significant at 5%

The distinction between domestic market and the commodity-export trade patents was statistically significant only for models that considered only the most recent period, that is, 1870-1882. For this period the coefficients for the export sector are slightly higher, indicating that the odds of outstanding invention versus the combined categories of important, medium important and less important inventions are slightly higher for export-oriented versus non export-oriented inventions than for domestic-oriented versus non domestic-oriented inventions, holding all other variables constant.

Transport patents were significant in all models. For example, in model (6), for the transport category, the odds of outstanding invention versus the combined categories of important, medium important and less important inventions are 2.4 times higher than for non-transport patents, holding all other variables constant. Similarly, the odds of the

³ This variable was dropped from the model due to multicollinearity.

combined categories of outstanding, important and medium important inventions versus the less important ones is 2.4 times higher for the transport category compared to non-transport one, holding all other variables constant.

Patents regarding improvements were significant only for the whole database, and not for the restricted sample. Patents related to foreign inventions were significant in all models but had larger coefficients on the restricted sample ones, which indicates that in later years higher importance was placed on this type of patents.

Together, these results seem to indicate that the office of patents look for a sign that an invention had market value before granting a longer patent, which is consisted with the spirit of the law (as the inventor would lose this privilege if he did not put into practice the invention within two years after the grant of the patent). Throughout the period, these signs were the fact that the patent related to transportation sector and the fact that it was a foreign invention (and that it was likely already patented somewhere else). However, foreign inventions grew considerably in numbers in the later decades of the nineteenth-century, which might explain our improvement result. When foreign inventions were not common, the fact that a patent related to an improvement in a previous invention might have been used more frequently as a sign than in later years when foreign inventions became more present in Brazil and were possibly considered better indicators of market value. Only in later years the difference between export-oriented and domestic-oriented became significant, which is a consequence of the enhanced importance of coffee exports in the Brazilian economy in the late nineteenth-century.

Brant tests were performed and, in general, the proportional odds assumption holds. For example, in column (6) only for variable `dec_1880` (which is not statistically significant) the assumption is violated.

5 Conclusion

Our goal in this paper was to analyze the factors related to the importance, or social value, of patents in Brazil during its first patent law in the nineteenth-century. It is a peculiar scenery since it was an agro-export economy beginning its process of industrialization with a very advanced patent legislation.

We built a database from the original Ministry Decrees that granted each individual patent, available on the Brazilian Chamber of Deputy website, adding on and improving the work of Rodrigues (1973). We found that the number of patents granted increased greatly in the last two decades of the term of the law, that is, the 1870s and 1880s.

We tested the importance of the patents, measured in years of monopoly granted by the government, compared to the structure of the economy, in the sense they were related to the agriculture, transportation and consumption sectors. The results suggest that importance is not related to the economic sector of the patent.

On the other hand, the results suggest a preoccupation with market value of the invention when assigning patent duration. Patents related to the transportation sector were longer, as were patents of foreign inventions. Improvements on invention seemed to be important mostly on the early years of the law. When we restricted our sample to the last two decades of our period of analysis, the distinction between export-oriented and domestic market-oriented patents became statistically significant, with slighted higher coefficients for the first ones.

References

- ACEMOGLU, D. (2010) When does labor scarcity encourage Innovation? *Journal of Political Economy*, vol. 118, n. 6, December, pp. 1037-1078.
- CANABRAVA, A. (2005) História econômica: estudos e pesquisas. Editora UNESP.
- CHANG, H-J. (2002) Kicking Away the Ladder: Development Strategy in Historical Perspective. Anthem Press; 1st edition.
- CRUZ, H. N. e TAVARES, M. “As Patentes Brasileiras de 1830 a 1891”, *Estudos Econômicos*, v. 16, no. 2, pp. 205-225, maio/agosto 1986.
- BAER, W. (2001) The Brazilian Economy: Growth and Development. Praeger, Fifth edition.
- FURTADO, C. Formação Econômica do Brasil. S. Paulo: Cia. Editora Nacional, 1959.

- GILBERT, R.; SHAPIRO, C. (1990) "Patent Length and Breadth", *RAND Journal of Economics*, 21, no. 1, pp. 106-112.
- GOLDIN, C. (1995) "Cliometrics and the Nobel." *Journal of Economic Perspectives*, vol. 9 n. 2, pp. 191-208.
- GRILICHES, Z. (1990) "Patent statistics as economic indicators: a survey", *Journal of Economic Literature*, 28, pp. 1661-1797.
- KLEMPERER, P. (1990) "How broad should the scope of patent protection be?" *RAND Journal of Economics*, 21, no. 1, pp. 113-130.
- MACHLUP, F.; PENROSE, E. (1950) The Patent Controversy in the Nineteenth Century. *The Journal of Economic History*, vol. 10, n. 1.
- MARCONDES, R. (2012) "O Mercado Brasileiro no Século XIX: Uma Visão Por Meio do Comércio de Cabotagem", *Revista de Economia Política*, vol. 32, no. 1(126), pp. 142-166.
- NORDHAUS, W. (1969) *Invention, growth and welfare*, Cambridge, Mass., MIT Press.
- RODRIGUES, C. C. A (1973) *Inventiva Brasileira*, Brasília: Instituto Nacional do Livro.
- SILVA, S. (1986) *Expansão Cafeeira e Origens da Indústria no Brasil*. Ed. Alfa-Omega.
- SUZIGAN, W. (2000) *Indústria Brasileira; Origem e Desenvolvimento*. São Paulo, Hucitec.
- VERSIANI (1980) Industrial Investment in an 'Export' Economy: The Brazilian Experience Before 1914. *Journal of Development Economics*, v. 7, n.3, p. 307-329.
- VERSIANI, F.; TANNURI-PIANTO, M. E.; VERGOLINO, J. R. (2003) Demand Factors in the Nineteenth-Century Brazilian Slave Market. Proceedings of the 31th Brazilian Economics Meeting.