Intellectual Property and Productivity: Evidence for Mexican industry

Submitted to the World Intellectual Property Organization

by

Flor Brown and Lilia Domínguez,

April 28,2009

1. Introduction

In the last twenty years, the generation of knowledge and the application of technological knowledge in innovation are viewed together in the literature as one of the determining factors of productivity increase. Analysis of technological knowledge is identified as a learning process, endogenous in the economy, resulting from the technological effort made by firms and the complex interaction of these firms with various (business, academic and governmental) institutions. Therefore, when considering the determining factors of productivity, it is necessary to ask ourselves of the impact from the various activities and instruments of technological effort on productivity. In particular, those derived from industrial property (IP) are very important.

Patents have captured plenty attention by researchers, but trade marks have been considered only minimally in economic theory, and the focus of analysis has been restricted to a strategy used by firms to differentiate between products, requiring actions and expenses linked to erecting barriers to entry and monopoly power Nevertheless, a number of authors have recently suggested the pertinence of trade mark registration as a proxy for product innovation effort . Firms use different strategies for innovating and developing new products which involve expenditures in R&D, engineering and marketing but also actions to protect these innovations and to signal for product differentiation. Nevertheless, not all trade mark registrations are linked to innovative products. Since the data on trade marks do not contain information on inputs, products or impacts, trade mark registration should be considered in conjunction with other indicators because The objective of this paper is to examine the impact of the use of trade marks and patents registered by industrial firms on the productivity of Mexico's manufacturing industry. Trade mark registration in Mexico has increased considerably since 1993, the year the Mexican Industrial Property Institute (*Instituto Mexicano de Propiedad Industrial*—IMPI) was established, and the number of trade marks is significantly higher than the number of patents and franchises.

There is a vast number of studies on productivity determinants in the case of Mexico, and at different levels of analysis: case studies at the firm level , statistical analysis at the establishment level, and the four digit level . Some of these studies examined the role of technological capabilities, technology access and research and development , and capital ownership . The impact of industrial property activity has not been analyzed in relation to productivity. Greenhalgh and Rogers analyzed the relationship between trade marking and productivity using a production function, with panel data for the manufacturing industry, for the years 2003 to 2006.

There are a number of reasons for focusing analysis on the manufacturing industry. First of all, it is the sector with the most industrial property activity. Secondly, the concepts of technology and innovation are more relevant for manufacturing than for other sectors. Lastly, manufacturing is the sector with the greatest accumulation of knowledge.

Ideally, the information for a study of this type should come from the same source. Nevertheless, the IMPI does not have a database with information on the characteristics of the firms that have registered a trade mark or a patent. Its information is limited to the name of the firm with the characteristics of the trade mark, and is not available to the public. For this reason we turned to other sources of information such as a database created from newly available information from the Mexican Economic Census and in addition the National Survey on Employment, Wages, Technology and

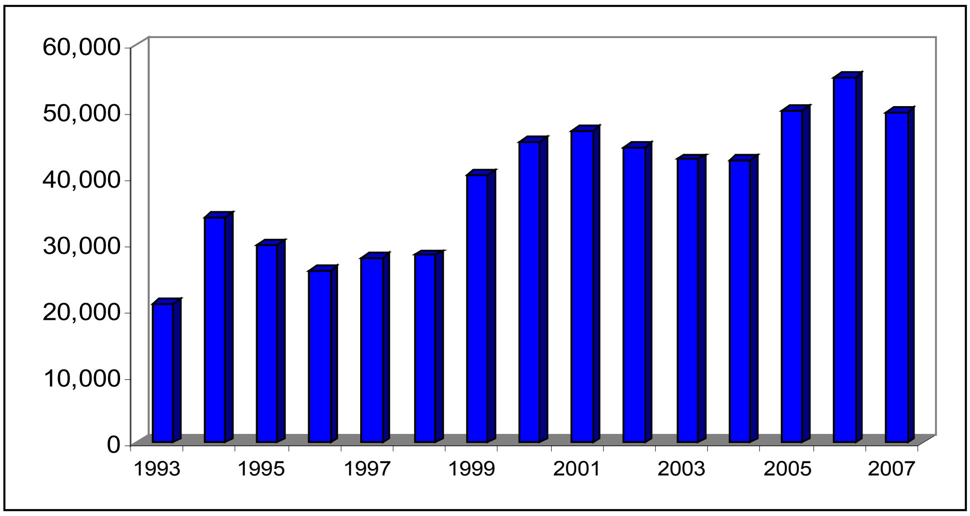
Training (*Encuesta Nacional de Empleo, Salaries, Technología y Capacitación*—ENESTYC) and the Annual Industrial Survey (*Encuesta Industrial Annual*—EIA).

We will begin by giving a panorama of industrial property in Mexico, first based on statistical information from the IMPI which is the official agency for the matter in the country and secondly we will present the information coming from the Census. In Section 3 we will outline the production function framework within which we are working and the measurement issues of our variables. Then, in Section 4 we will present our results, and the last section is dedicated to presenting our conclusions.

2. Panorama of industrial property in Mexico

Trade mark registration in Mexico has increased considerably since 1993, when the IMPI was established, and the number of trade marks is significantly higher than the number of patents and franchises. According to the IMPI, the number of trade marks registered increased from 20,893 in 1993 to 49,746 in 2007 (Graph 1). We can observe a procyclic tendency, since the number of trade marks diminished in 1995 and in 2002 and 2003, which correspond to recession years.

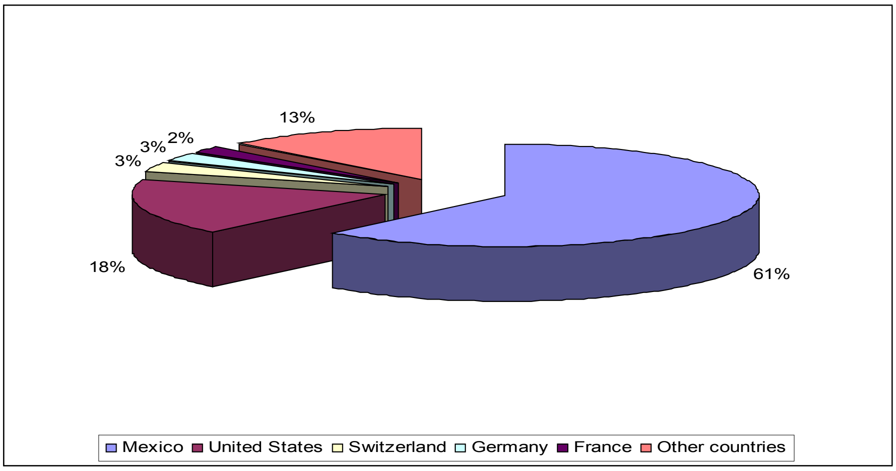
Graph 1
Trade marks registered in Mexico



Source: Mexican Industrial Property Institute (*Instituto Mexicano de Propiedad Industrial*—IMPI).

In relation to the composition of trade marks by country of holder, most of the trade marks, or approximately two thirds, are registered by Mexican owned firms, IMPI does not provide information whether they are majority owned. US firms registered 18% in 2006, the rest of the trade marks are distributed among a number of different countries with none of them having more than 3%, as illustrated in the graph 2.

Graph 2
Nationalities of registered trade mark holders: 2006



Source: Mexican Industrial Property Institute (*Instituto Mexicano de Propiedad Industrial*—IMPI).

While the number of patents registered is much lower than the number of trade marks registered, growth in patent registration has accelerated, from 3,944 patents in 1997 to 9,632 in 2006. Among the group of eight selected countries in table 1, Mexico has the sixth rank in trade marks granted by office and the fifth in patents. Korea`s relation of patents to trade marks is ten times that of Mexico`s and USA`s is six times. México is slightly below China and above, Brazil and Chile.

Table 1
Trade marks and patents granted by office: 2006

Country	Trade mark	Patents	Patents/trade marks

	s		
Brazil	32,673	2,465	0.075
Chile	34,345	406	0.012
China	267,007	57,786	0.216
Mexico	55,406	9,632	0.174
Korea	69,359	120,790	1.742
United Status	154,812	173,770	1.122
Spain	55,412	2,165	0.039
Germany	58,059	21,034	0.362

Source: WIPO Statistics Database, December 2008

The number of trade marks and patents granted is not enough to give a full idea of the IP activity of a country since a great percentage of holders may be foreign. This is especially true for the case of patents in Mexico where not only Mexican holders` share has traditionally been very low but it has declined in the last 10 years from 2.8% to only 1.4%, in contrast to 61% of the trade marks. Patents registered by US holders have the greatest share, although it has gone down from 72% to 54% in the same period. In 2006 German holders had 9.1% and Swiss holders 5.2%. (Table 2).

Table 2
Patents Granted, by Nationality of Holder / Main Countries / 1997-2006

Year	Total	Mexico	United States	Germany	Switzerland	Other countries
1997	3944	112	2873	227	112	620
1998	3219	141	2060	215	101	702
1999	3899	120	2324	351	152	952
2000	5519	118	3158	525	228	1490
2001	5479	118	3237	480	181	1463
2002	6611	139	3706	736	246	1784
2003	6008	121	3368	610	241	1668
2004	6838	162	3552	726	315	2083
2005	8098	131	4338	806	386	2437
2006	9632	132	5180	877	506	2937

Source: Mexican Industrial Property Institute (*Instituto Mexicano de Propiedad Industrial*—IMPI).

Next we present the characteristics of firms with IP activity, but first it is necessary to present the nature and coverage of the information form our sources of data.

The coverage offered by the Economic Censuses (*Censos Económicos*) is complete, including approximately four million establishments in the manufacturing, commerce and services industries. These censuses are conducted every five years. The ENESTYC is an official survey carried out by the National Institute of Statistics, Geography and Informatics (INEGI). It is conducted approximately every three years, and the 2005 survey included 8,000 establishments. It contains nationally representative information on the characteristics of manufacture's productive organization and R&D activities, the amount and type of employment generated, occupational structure, pay and training. The survey contains 115 questions with about 570 reply options. The Annual Industrial Survey (*Encuesta Industrial Anual*—EIA) includes approximately 7,000 establishments and inquires as to the economic activities of establishments, their income and expenditures, personnel employed and investment in fixed assets. There are some common variables among them, however others appear in only one source. For example, information on patents and trade marks are only found in the 2003 Census, in which for the first time firms were asked whether they operated with registered trade marks, patents, franchises or concessions. Our objective was to construct a data base that captured the best information from each of the three sources, and our work was carried out with the cooperation of authorities with the Census and with the other surveys at INEGI.

In the Economic Census (*Censo Económico*) for 2003, there is a question asking for the form under which establishments operate, specifically they must select from the following possibilities: a franchise, a registered trade mark, patents, concessions or other. On our opinion this question is not very specific enough, since it does not provide information whether a firm uses its own patents or those of others, each with a distinct implication. The same can be said of the other forms of industrial property. Nevertheless, by using other variables linked to firms' technological effort in our model, we hope to eliminate part of the bias originating from the ambiguousness of the question.

Following the Census: 16,126 establishments operate through franchises; 5,618 with commercial trade marks; 1,130 with patents; and 10,130 indicating "other," while the majority did not specify any particular form. Most franchises correspond to services (59.4%) and commerce (37.8%). Also, 91% of the establishments with commercial trade marks, and 62.8% of patents are in the manufacturing industry (table 3).

Table 3.
Establishments with intellectual property
2003 Census

Modality of Operation	Establishments	%	Sector	%
Total	3005157	100		
Franchise	16126	0.5		**100**
			Manufacturing	2.8
			Commerce	37.8
			Services	59.4
Commercial Trade mark	5618	0.2		**100**
			Manufacturing	91
			Commerce	3.3
			Services	5.7
Patent	1130	0		**100**
			Manufacturing	62.8
			Commerce	34.1
			Services	3.1
Others	10316	0.3		
None	2 971 967	98.9		

Source: Economic Censuses (*Censos Económicos*), 2003, INEGI.

Both the Economic Census and the EIA collect information by establishment. Thus the analysis will be done at the establishment level. This brings some biases since trade marks and patents are granted to firms which may have more than one establishment (especially larger ones). Also research and development activity (R&D) is usually carried out by the corporation and it is not necessarily distributed in all establishments. Neither we know the criterion of the firm to assign IP and research activity between its various establishments. The fact is that one establishment may report the IP activity of all firm as well as the R&D and other establishments reporting none which would probably imply an underestimation of the extent of this activity among firms having more than one establishment.

Since the information provided by small-sized establishments is frequently not reliable, and since our interest was the manufacturing industry, which is characterized by an average size greater than other economic activities, we opted for examining patent and trade mark registration among establishments with 50 or more employees, in response to a suggestion made by Census authorities. The of establishments with more than 50 employees in the 2003 Economic Census reduced to only 25,176, of which 2,311 establishments (9%) registered a trade mark; 1,381 establishments (5%), a franchise; 321 establishments (1%), a patent; and 85% report having none of the mentioned concepts. Since franchises are associated with a trade mark, they are presented under the same heading.

In terms of capital ownership, 82% of the establishments operating under commercial trade marks have a share of foreign capital (more than 25%)[1]. A similar proportion (71% versus 29%) is found in the case of patents. In this sample of

[1] The difference with information from IMPI (graph 2) can be explained by the fact that small establishments are not included here.

establishments with 50 or more employees, 65% of registered trade marks and all patents are found in the manufacturing industry (Table 4).

Table 4

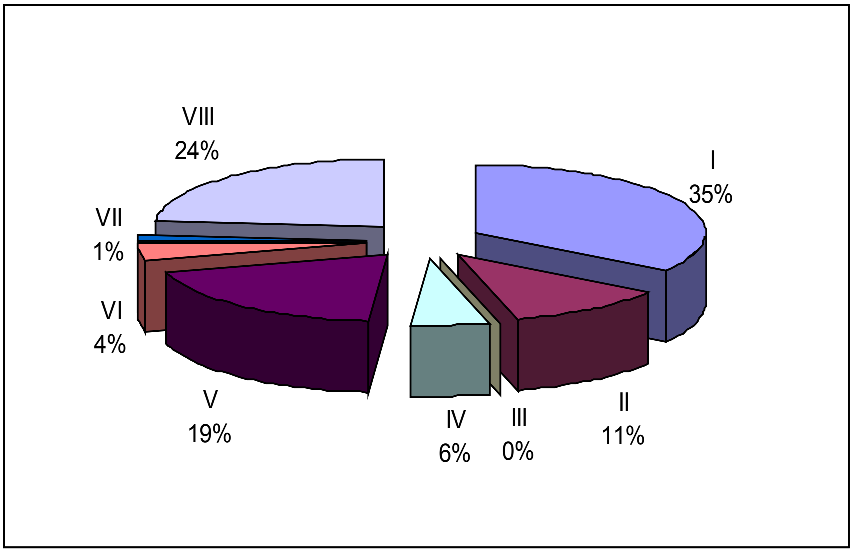
Establishments with industrial property in the sample of economic units with 50 or more employees: 2003

	Foreign		National		Total	
	Trade mark	Patent	Trade mark	Patent	Trade mark	Patent
Manufacturing	1829	228	559	93	2388	321
Commerce	252		15		267	
Services	909		81		990	
Total	2990	228	655	93	3645	321

Source: Sample elaborated from the 2003 Economic Census by INEGI.

The distribution of manufacturing establishments that have a registered trade mark by industry is illustrated in Graph 3. The three manufacturing industries with the highest number of establishments in this category are: food, beverages and tobacco, with 35%; metal products, machinery and transportation equipment, with 24%; and the chemical industry, with 19%. The same three industries top the list for patents, however in a different order: metal products, machinery and transportation equipment (47%), chemical industry (24.8%), and food, beverages and tobacco (16.3%).

Graph 3. Trade marks by two digit industry classification in manufacturing industry



Where:

I Food, beverages and tobacco; II Textiles, garments and leather; III Wood industry;
IV Paper industry; V Chemical industry; VI Non-metallic minerals; VII Basic metals;
VIII Metal products, machinery and transportation equipment; IX Other manufacturing industries
Source: Sample elaborated from the 2003 Economic Census by INEGI.

Table 5 illustrates not only that the practice of trade marking is concentrated in only a few sectors, but also that economic units operating with trade marks account for a significant amount of added value. Specifically, establishments in the manufacturing industry with a registered trade mark correspond to 37.7% of total value added. Establishments with registered trade marks in the food, beverages and tobacco sector account for 62.3% of the value added in that sector; in non-metallic minerals, 43.2%; in metal products, machinery and transportation equipment, 36.5%; and in the chemical industry, 25.9%. In contrast, the percentage of establishments with patents is very low: they account for only 5.4% of total value added in manufacturing. Only two industries have a greater share of value added: the chemical industry (8.1%) and metal products, machinery and transportation equipment (6.2%).

Considering the number of establishments with IP activity per employee as a measure of intensity, this is rather low in average and the ranking shows little differences. Food, beverages and tobacco have the highest trade mark intensity per employee (0.16%), followed by the chemical industry (0.11%) and the paper and non metallic industries, both with 0.10%. Regarding patent intensities, which are very small as can be observed, the highest intensity goes for the chemical industry (0.025%), non-metallic minerals has 0.017% and metal products, machinery and transportation equipment 0.016%.

Table 5

Share in total value added and patent and trade mark per employee

	Trade mark (%)	Patent (%)	trade mark/employee (%)	Patent / employee (%)
Manufacturing industry	37.7	5.4	0.09	0.01
Food, beverages and tobacco	62.3	4.7	0.16	0.01
Textiles, garments and leather	22.8	0.8	0.04	0.002
Wood industry	4.6	0		0.001
Paper industry	19.9	3.5	0.10	0.01
Chemical industry	25.9	8.1	0.11	0.025
Non-metallic minerals	43.2	1.1	0.10	0.017
Basic metals	25.3	0.7	0.05	0.01
Metal products, machinery and transportation equipment	36.5	6.2	0.05	0.016
Other manufacturing industries	28.7	2.1	0.07	0.00

Source: Sample elaborated from the 2003 Economic Census by INEGI.

The Census also reports payment of, or income from, royalties, and this can be an indicator for assessing the characteristics of IP in these establishments. On the one hand, as can be gathered from the first two columns of table 6, firms generate little activity in terms of licensing trade marks or patents to other firms that would bring income in for them, thus income is very low in comparison to what they pay out. On the other hand, nearly all (89%) of royalty payments comes from the establishments with commercial trade marks, 10% from those with patents, and less than 1% from those with franchises.

In terms of size of establishment, Table 6 indicates that both payment for and income from royalties are correlated with the size of establishments in the census. Specifically, 67% of royalty payments and 86% of income from royalties come from those with more than 500 employees in the case of trade marks, and in the case of patents, 66% of royalty payments and 99% of income from royalties come from this same size group. The relation of income from royalties to payments is above average (4%) among the first and the last size strata of establishments in the case of trade marks (7.0% and 5.1% correspondingly). This relation is far above average (5.2%) only among the largest size of establishments (7.7%).

Table 6

Royalty payments and income

Trade marks				
	Payments	Income	%	
TOTAL	7081188	282160		
51 A 100	143812	10075	2.0	3.6
101 A 250	592041	14728	8.4	5.2
251 A 500	1610927	13557	22.7	4.8
500 or more	4734408	243800	66.9	86.4
Patents				
	Payments	Income	%	
TOTAL	759215	39509		
51 A 100	13394	0	1.8	0.0
101 A 250	87084	0	11.5	0.0
251 A 500	150202	271	19.8	0.7
500 or more	508535	39238	67.0	99.3

. Source: Sample elaborated from the 2003 Economic Census by INEGI

Firms without foreign capital pay the majority of these royalties (59%), although as seen previously, less than 30% of trade marks and patents are found in these establishments (Table 7).

Table 7
Royalties by nationality of capital in economic units

	Commercial trade mark	Patent	Total
Payments			
With foreign capital	43	19	41
Mexican	57	81	59
Income			
With foreign capital	66	14	60
Mexican	34	86	40

Source: Sample elaborated from the 2003 Economic Census by INEGI.

In summary industrial property is highly concentrated in the manufacturing industry and in certain industrial branches. In contrast to IMPI´s statistics, foreign firms dominate national firms in the use of industrial property, and while trade mark and patent registration is distributed at all levels, most of the payments for and income from royalties correspond to large firms. In the following section, we will present the model and details on the construction of the sample for analyzing the relationship between industrial property and manufacturing productivity.

3. Productivity and industrial property

Following Greenhalgh and Rogers` methodology, we will analyze the productivity determinants on the basis of an econometric estimation of a $Y=AL^{\alpha} K^{\beta}$ type Cobb-Douglas production function.

Where *Y* is value added, *L* is personnel employed, *K* is capital *A* reflects increases in product quality and innovation in new products, production processes and forms of organization, that allow firms to increase sales, reduce costs, better use their installed capacity and consequently increase productivity. Thus, *A* depends on a set of activities defined within technological effort, including R&D in its various modalities, plus hiring of highly qualified personnel, acquisition of technological information, interaction with other firms and activity linked to industrial property.

Given the characteristics of the information we used, it was not possible to access the necessary data for including all these variables in the specification of production function. We focused on indicators linked to industrial property, complemented by information from the ENSTYC on the use of R&D in the establishment of or in activities linked to technology acquisition and transfer. Therefore, the specification of the model estimated is:

$$\log Yit = \beta_0 + \beta_1 \log L_{it} + \beta_2 \log K_{it} + \beta_3 Pat_{it} + \beta_4 Tm_{it} + \beta_5 R\&D_{it} + \beta_6 Ind_{it} + u_{it}$$

Where[2]:

Pat: Establishments with patents
Tm: Establishments with trade marks
R&D: Establishments with R&D activities
Ind: industry
i represents the establishment and t represents time (2003 to 2006)

The description of variables is explained in the next methodological section.

3.1. Construction of sample and variables

INEGI obtained a sample that crosses information between the Census, EIA and ENESTYC on establishments with over 50 employees. The number of establishments was 3,609 of which 538 registered a trade mark and 84 registered a patent. The information obtained from the EIA included value added, employment, capital assets. The information from the ENESTYC was capital ownership and whether or not research and development and technological transfer were carried out. From the Census, information was obtained on firms operating under different forms of industrial property, as already mentioned.

The added value corresponding to each establishment at 2003 prices was used as a measure of the product (Y). Using value added avoids the problem of double accounting that is generated when intermediate inputs are included in the measuring of the product. The inputs used are labor and capital. The personnel employed by each establishment was used for work. As indicated by Hernández Laos (2008). Lastly, this

2

does not correct for changes in the average number of hours worked, or the increased education and training of employees during 2003-2006. Both effects are likely to cause biases in our estimations, but the biases might partly offset each other, finally capital was calculated using the method of perpetual inventories (see methodology in Annex). Table 8 describes the methodology for the rest of the variables and its source.

Table 8

Variables and sources of information

Variable	Description	Source
value added (Y)	Gross production minus inputs	EIA;2003-2006
Employment (L)	Number of employees	EIA;2003-2006
Capital (K)	Capital assets	EIA; 2003-2006
trade marks (Tm)	1 when the establishment reports a trade mark and 0 otherwise	2004 Industrial Census
Patents (Pat)	1 when the establishment reports a patent and 0 otherwise	2004 Industrial Census
R&D and Technological transfer	1 when firm carries out these activities and 0 otherwise	2005 ENESTYC
Industry (Ind)	1 for industries with higher trade mark intensity and 0 otherwise	2004 Industrial Census
Foreign capital (Fcapital)	1 when company's foreign capital is 25% of total capital or more and 0 otherwise	2005, ENESTYC

As in many such studies, an immediate implication of the decisions we made regarding the sample, is that our database cannot be seen as a random sample. We believe, however, that our remaining sample is large enough to generate results that offer some insight into the relationships we are investigating.

In our specification, trade mark activity can be viewed as an element in the process of innovation , and the same is true for patent activity.

We divided the sample into two groups: one with establishments reporting R&D or technology transfer and the other with establishments that do not conduct these activities. The purpose of this division was to distinguish between establishments that conduct activities indicating technological effort, which can lead to innovation, and those without these activities. We expected to find differences between the two samples in their industrial property coefficients. Below we will present the statistical differences found between the two samples. The description of the construction of each variable will also be presented below.

3.2. Descriptive statistics of sample

Table 9 illustrates the differences between the establishments that conduct R&D activities or technological transfer, and the others. In the first case, the average size is 25% greater, and 63% of the establishments have registered trade marks and 69% have registered patents. The establishments in this group contribute 42% of value added and 53% of exports. In this case, therefore, it appears there is an association between industrial property activity and our proxies of innovation

Table 9
Economic variables in each sample

	With R&D	Without R&D	Total
Average size (employees)	404	292	329
% establishments with trade marks	63	37	538
% establishments with patents	69	31	84
% of added value	42	58	100
% exports	53	47	100

Source: Subsample form EIA

Illustrated in table 10 are the characteristics of the two samples, according to the firms' size structure and the origin of their capital. In both cases, with and without R&D, there are firms of all sizes and both national and foreign firms. Those with national capital dominate.

Table 10
Characteristics of the samples

	Number of establishments	% of added value	Trade marks	Patents
WITH R&D				
50-100	122	0.01021	13	6
100-250	509	0.12115	147	19
250-500	302	0.19599	102	18
Over 500	254	0.67265	81	15
	1187		343	58
National capital	973	0.65041	258	40
Foreign capital	214	0.34959	85	18
	1187		343	58
WITHOUT R&D				
50-100	789	0.05032	9	2
100-250	874	0.14214	93	9
250-500	454	0.21323	52	10
over 500	305	0.59431	40	5
	2422		194	26
National capital	2298	0.89983	132	17
Foreign capital	124	0.10017	62	9
	2422		194	26

Source: Subsample form EIA

3.3. Results from estimations

To avoid the problem of the potential endogeneity that may present itself with this type of estimations and to control the effects that are not observable, some authors suggest estimating the model in a grouped form, with first differences . Nevertheless, as pointed out by Wooldridge , this procedure is not the best to use when samples have short time periods, as in our case. Therefore we estimated our model with the method of panel corrected standard errors. This method is used when the model has contemporaneous correlation, panel heteroskedasticity or serial correlation. This approach estimates the same number of parameters as the FGLS method and it has better small sample properties[3].

We estimated three regressions. The first was estimated with the entire sample (table 1 annex). The results of this regression were not satisfactory. Variables for trade marks and patents and the variable related to R&D were not significant. This can be explained by the extremely high degree of heterogeneity in Mexican manufacturing establishments .

The other estimations correspond to the two subsamples: with R&D and no R&D. The results are shown in table 10. In the first regression for establishments without R&D or technological transfer activities, the coefficients for trade marks and patents were not significant. This was to be expected since, as pointed out in the beginning, the act of registering a trade mark does not always translate into product innovation. In order for trade mark registration to be associated with innovation, the indicator needs to be complemented by others.

In contrast, the results of the equation for the group of establishments with R&D were very satisfactory. The variable for trade marks was statistically significant. This was not the case for patents. The latter can be explained by the very low number of establishments in the sample that have registered patents. Since trade marks is a dummy variable, this result indicates that when the establishment becomes a trade marker, value added increases by 10%. It must be noted that the capital and labor coefficients sum more than one, which suggests the presence of returns to scale, which does not occur in the estimations for other samples. On our opinion this is coherent with

[3] This method is similar to White's heteroskedasticity-consistent standard errors for cross-sectional estimators, but is better because it take advantage of the information provided by the panel structure of the data Beck and Katz Nathaniel and Jonathan N. Katz Beck, "Nuisance Vs. Substance: Specifying and Estimating Time-Series-Cross-Section Models," *Political Analysis* 6 (1996).. Through Monte Carlo studies, these authors demonstrate that PCSEs produce more reliable standard errors than FGLS methods.

the fact that this subsample concentrates the most innovative establishments. The specific effects of industry were also significant.

Since the evidence from various studies (Domínguez and Brown 2004) indicate that foreign firms have greater productivity than national firms, we introduced a dummy variable to distinguish foreign firms from national firms. By controlling the origin of capital, the coefficient for trade marks decreased to 0.06, however it continues to be significant, or in other words, the increase in productivity with this same assumption would be 7% (Table 11).

Table 11
Results from estimations
Dependent variable value added

	No R&D	R&D	R&D
Labor	0.39	0.99	0.98
	(0.10)***	(0.02)***	(0.02)***
Capital	0.36	0.25	0.24
	(0.04)***	(0.01)***	(0.01)***
Patent	0.05	-0.02	-0.06
	(0.21)	(0.08)	(0.08)
Trade mark	-0.15	0.10	0.07
	(0.16)	(0.03)***	(0.03)**
Industry	-0.10	0.17	0.21
	(0.18)	(0.03)***	(0.03)***
Foreign capital			0.37
			(0.04)***
Constant	3.82	1.40	1.54
	(0.46)***	(0.11)***	(0.11)***
R2	0.80	0.57	0.57
Wald Chi^2 test	210	6396	7109
Probability	0.00	0	0.00
N[4]	9664	4676	4676

Note: Numbers in parentheses are standard errors: ***p < 0.01; **p < 0.05; *p < 0.10
*with foreign capital ownership

The results of the three estimations (establishments with R&D and with no R&D) are statistically satisfactory (table 10): their R^2s are above 57% and the Wald Chi^2 test

[4] 24 establishments were eliminated because of incomplete information

indicates the overall statistically significance of coefficients. The estimations did not present autocorrelation, according to the Wooldridge test for panel estimations. An estimation with OLS with clustered standard errors gave similar results (table 2 annex).

4. Conclusions

A number of conclusions can be derived from this study: one with respect to the general state of industrial property in Mexico's economy; a second regarding the relationship between industrial property and productivity; and a third regarding the quality of information.

1. An analysis of industrial property statistics from various sources suggests that industrial property registration has increased, however it is far from becoming a generalized practice, and more trade marks are registered than patents. From the information collected from the Economic Census sample, we can see that the manufacturing industry is the sector with the greatest number of establishments having trade marks and patents, and we can begin to see some characteristics of firms that register trade marks and patents. Specifically, if we look at the origin of capital ownership, we find that more than two-thirds of the trade marks and patents reported in the Census are registered by firms with foreign capital. If we look at size, we find that patents and trade marks are distributed among the various strata of establishments. Nevertheless, if we compare the payment of royalties, we find in both cases that 67% of the total amount is paid by firms with over 500 employees. In terms of income from royalties, we find that 86.4%, in the case of trade marks, and 99.3%, in the case of patents, of the total amount is spent or perceived by establishments belonging to the same stratum according to size. The available information does not allow for

quantifying the number of trade marks by establishment, and this indicates that the large firms may have more than one trade mark, or may have trade marks with a relatively higher value on the market.

2. Regarding the relationship between industrial property and productivity, a positive, significant association was only found between trade marks and value added in the sample of establishments that conduct research and development or activities related to the purchase and transfer of technology. The fact that results are selective is meaningful, in our opinion. Since trade marks are not necessarily linked to innovation, we find that only when trade marks are accompanied by activities related to technological effort is there a positive association with productivity, and they are an indicator of innovation. This confirms what has been pointed out by Rogers (2007) regarding their link with product innovation.

Results from patents were not satisfactory in any of the cases. Patents often have a delayed effect on productivity, since in order to carry out an innovation, the patent requires investments in machinery and marketing that cannot always be made immediately (Bloom and Reenen, 2000). However, in our case, we believe the explanation is that the establishments in our sample that operate on the basis of a patent are very few.

2. The ideal information for an analysis such as the one we have engaged in here would have been information that would have made it possible to count the number of patents and trade marks for each firm, with their economic and institutional characteristics, as well as the amount of research and development carried out. Since the information from the IMPI did not allow for this, our information was based on responses by firms to a question in the Census that sought to identify the establishments that have or use some

form of industrial property. In addition, since we did not have information on amounts of research and development, it was not possible to obtain a quantitative measurement between R&D and productivity.

Despite the above, our data base allowed for a higher degree of reliability from a sample that brought together a set of variables of different types, making it possible to achieve consistent results. We can say, therefore, that this study is an initial step in providing some of the keys for understanding the great diversity of firms that use industrial property instruments. And the latter is not always linked to innovative behavior.

On our opinion, it is of the up most importance that IMPI improves the data base on the characteristics of firms undertaking IP activity because more research will be needed in the future to construct appropriate indicators of innovation.

References

Beck, Nathaniel and Jonathan N. Katz. "Nuisance Vs. Substance: Specifying and Estimating Time-Series-Cross-Section Models." *Political Analysis* 6 (1996): 1-36.

Blomström, M. "Foreign Investment and Productive Efficiency: The Case of Mexico." *The Journal of Industrial Economics* 35, no. 1 (1986): 97-110.

Blomström, M. y H. Pearsson y E. N. Wolff. "Multinational Corporations and Productivity Convergence in Mexico " In *Convergence in Productivity: Cross-National Studies and Historical Evidence*, edited by J. Baumol, Nelson, R. y E. Wolff. Oxford: Oxford University Press, 1994.

Brown, F., L. Domínguez "Productividad En Grandes Y Pequeños Establecimientos Con Distintas Intensidades En La Utilización De Insumos." *Economía Mexicana* VII, no. 1 (1998).

Brown, Flor and Lilia, Domínguez "The Dynamics of Productivity Performance in Mexican Manufacturing." *The Developing Economics* XXXII, no. 3 (1994).

Brown, Flor, Lilia Domínguez "Productividad En Grandes Y Pequeños Establecimientos Con Distintas Intensidades En La Utilización De Insumos." *Economía Mexicana* VII, no. 1 (1998): 79-96.

Calderon-Madrid, A. and A. Voicu. "Multifactorial Productivity Growth and Job Turnover in Mexican Manufacturing Plants in the 1990s." 46: Institute for the Study of Labour Working, 2004.

Domínguez, Lilia y Flor, Brown "Capacidades Tecnológicas: Propuesta De Medición Y Agrupamientos Para La Industria Mexicana." *Revista de la CEPAL* (2004): 135-51.

Dosi, G, Nelson, R., S., Winter. *The Nature and Dynamics of Organizational Capabilities*. Oxford: Oxford University Press, 2002.

Greenhalgh, Christine and Mark, Rogers. "Trade Marks and Performance in Uk Firms: Evidence of Schumpeterian Competition through Innovation." 38: Oxford Intellectual Property Research Centre and Harris Manchester College, 2007.

Grether, J.-M. "Trade Liberalization, Market Structure and Performance in Mexican Manufacturing, 1985-1990 " In *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity and Market Structure*, edited by M. J. y J. R. Tybout Roberts, 260- 84. New York.: Oxford University Press, 1996.

Grether, Jean-Marie "Determinants of Technological Diffusion in Mexican Manufacturing: A Plant-Level Analysis." *World Development* 27, no. 7 (1999): 1287-98.

Hernández Laos, E. " Evolución De La Productividad Total De Los Factores En La Economía Mexicana (1970-1989)." México: Secretaría del Trabajo y Previsión Social, 1993.

Hernández Laos, Enrique. *La Productividad Y El Desarrollo Industrial De México*. México: Fondo de Cultura Económica, 1985.

Kokko, Ari. . "Productivity Spillovers from Competition between Local Firms and Foreign Affiliates." *Journal of International Development* 8 (1996): 517-30.

Lundvall, Bengt-Ake. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning* Londres: Pinter Publishers, 1992.

Mendonc¸a Sandro, Pereirac Santos Piago, Manuel Mira Godinhod. "Trademarks as an Indicator of Innovation and Industrial Change." *Research Policy* 33 (2004): 1385–404.

Salgado Banda, Héctor and Lorenzo E., Bernal Verdugo. "Multifactor Productivity and Its Determinants: An Empirical Analysis for Mexican Manufacturing." 1-48: Banco de M´exico, 2007.

Shaked, A., and J., Sutton. "Relaxing Price Competition through Product Differentiation." *Review of Economic Studies* 49 (1982): 3-13.

Tybout, J., and D., Westbrook. "Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries." *Journal of International Economics* 29, no. 1 (1995): 53-78.

Wooldridge, Jeffrey. *Introductory Econometrics a Modern Approach*. Mason: South Western, 2008.

Annex

Table 1

Dependent variable value added

	PCSE	Cluster
Labor	0.39	0.39
	(0.10)***	(0.00003)***
Capital	0.35	0.35
	(0.03)***	(0.001)***
Patent	0.02	0.02
	(0.12)	(0.34)
Trade mark	0.01	0.01
	(0.10)*	(0.07)
Industry	-0.003	-0.003
	(0.13)	(0.002)
Constant	3.84	3.84
	(0.41)***	(0.004)***
R2	0.80	0.8
Wald Chi^2 test	415.00	
Probability	0.00	
N	14384	14384

Table 2

Dependent variable value added

OLS estimates with clustered standard errors

	No R&D	R&D	R&D
Labor	0.39	0.99	0.98
	(0.00001)***	(0.05)***	(0.04)***
Capital	0.36	0.25	0.24
	(0.002)***	(0.01)***	(0.01)***
Patent	0.05	-0.02	-0.06
	(0.57)	(0.16)	(0.15)
Trade mark	-0.15	0.10	0.07
	-0.01	(0.02)	(0.02)*
Industry	-0.10	0.17	0.21
	(0.001)***	(0.01)***	(0.01)***
Foreign capital			0.37
			(0.03)**
Constant	3.82	1.40	1.54
	(0.01)***	(0.34)	(0.29)*
R2	0.8	0.57	0.57

N	9664	4676	4676

The annual industrial survey does not provide a final estimation for the value of net capital assets but it includes most of the necessary data to build this variable: a) facilities and installations, b) machinery and equipment, c) transportation equipment and d) office equipment.

1) One initial problem refers to the initial value of capital assets. Some authors estimate this value from the information of the Economic Census making an allowance for the contribution of the annual industrial survey to total value added (around 75%). However, this is applied on a three digit level, and therefore since the share of each establishment or industry in the total varies, there are biases in the information. Other possibility is taking the initial annual gross investment reported by each establishment, which was our choice. The disadvantage is that it underestimates the level of the initial value of capital assets. But, since this bias tends to disappear through the years, we think that it is a better solution. In order to diminish this bias, following the suggestion of an anonymous referee, we capitalized the initial value of investment by the sum of the growth rates of investment and depreciation.

2) The estimation for the next years is the following: assets purchase (AF), plus assets produced by the enterprise for there own benefit (AP), plus retrofitting expenditures (AM), less sales of fixed assets (AV) deflating each asset by their corresponding GDP index implicit.

$FB_t = AF_t + AP_t + AM_t - AV_t$

3) Due the lack of information of the useful life of each asset, we took the depreciation reported by the annual survey.

$IN_t = IB_t (1\text{-}d)$

4) The last estimation was done with the net assets (AN) with the previous annual net asset plus the net formation of the current year.