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HIGH-TECH/LOW-TECH INDUSTRIES AND THE STRUCTURE-PERFORMANCE RELATIONSHIP WITHIN MEXICAN MANUFACTURES

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RESUMEN

La literatura reciente sobre industria en México ha hecho énfasis en el desarrollo desigual de empresas y sectores industriales: algunos sectores han sido exitosos en su desempeño, mientras que el resto se mantiene bastante rezagado. A partir de esta preocupación, el presente artículo propone una división inédita para la industria mexicana, en sectores High-Tech y sectores Low-Tech. Dicha división se basa en la generación de capacidades tecnológicas para una muestra reciente de sectores y su robustez es verificada por la técnica del análisis discriminatorio. Posteriormente, la división propuesta se utiliza para estimar un modelo empírico de estructura-desempeño en la industria mexicana. Los resultados de la estimación revelan un comportamiento asimétrico de los sectores High-Tech y Low-Tech.

Clasificación JEL: L1, L6, O3

Palabras clave: Sectores High-Tech, sectores Low-Tech, capacidades tecnológicas, estructura y desempeño industrial

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ABSTRACT

Recent literature on Mexican industry has emphasized its uneven sectorial development: some sectors have been successful, while the rest remain well behind. Given these circumstances, the present paper proposes a particular division for Mexican industry in High-Tech and Low-Tech sectors. This division is based on technological capabilities for a particular sample of industries during the nineties and verified for statistical robustness using the discriminant analysis technique. Finally, the division is used for an empirical application in terms of profitability and market structure. The empirical results reveal a diverse behaviour of the High-Tech and Low-Tech groups.

JEL classification: L1, L6, O3
Keywords: High-Tech sectors, Low-Tech sectors, technological capabilities, industrial structure & performance

1. INTRODUCTION

Recent empirical studies on Mexico have emphasized the existing heterogeneity in manufacturing: some sectors seem to be more *successful* than others. However, the definition of *success* has been rather ambiguous. The second section resumes previous studies that attempt to categorize Mexican manufactures in successful and unsuccessful sectors. Subsequently, a particular categorization, that considers technology (defined by a group of variables later on) as an aspect correlated with success, is proposed for Mexico.

Following the literature on technological change in developing countries (and, in particular, studies that focus on the concept of technological knowledge), we argue that in Mexico only one type of sector has been able to accumulate knowledge and participate in the process of incorporating new technology into the production function: the High-Tech sector, while the rest of sectors (Low-Tech) have been rather poor in terms of technological experience.

In order to formally identify these sectors, a group of variables (proposed by empirical studies on technological knowledge) is used to split a survey of

Mexican manufactures, 1994-2000, into High-Tech and Low-Tech sectors. This categorization is presented in the third section and tested for statistical robustness (how precise the separation is and how relevant the discriminant variables are) via the discriminant analysis technique, in a fourth section.

Once the two types of sectors are formally identified, we analyze their performance in recent years. This performance can be interpreted as a measure of success. More precisely, in fifth section a classical structure-performance framework is used to analyze the determinants of profitability (our measure of success) in the whole of manufacturing industry and within High-Tech and Low-Tech sectors.

The hypothesis for this empirical analysis is that higher degrees of market concentration are related to higher margins of profits (following Bain, 1951). This hypothesis is tested for the whole manufacturing industry and for each group of sectors. The results reveal that there exists a solid structure-performance relationship in Mexican manufactures (as stressed by previous studies), but that this relationship is true for the Low-Tech sectors only. These results suggest the application of discretionary industrial policy for each one of the groups proposed in the third section. In particular, we argue that, to some extent, restrictive competition policies could be associated with higher profit margins in the Low-Tech group of sectors.

2. HETEROGENITY WITHIN MEXICAN INDUSTRY

Since the 1980s, the Mexican government has redirected the country's development strategy. The import substitution strategy ended during the 1982-1988 period, when the first steps towards the liberalization of the economy were made.[1]

[1] Some of the main policies implemented during the eighties and nineties were: (1) the unilateral elimination of trade tariffs, in order to enter the GATT in 1986; (2) the signing of economic agreements between the government, the private sector and worker unions (*pacto económico*) with emphasis on the privatization of state firms in December 1987; (3) the amendments to the Law of Foreign Investment to facilitate its entrance and lower its control in 1989; (4) the signing of several free trade agreements, specially the NAFTA with the US and Canada in December 1993 (Dussel, 1996).

Although the whole effect of those changes is yet to be seen, two decades after the first measures, one of the sectors that may reflect more clearly the impact of the mentioned reforms is manufacturing. Since the opening of the economy, Mexican firms have suddenly found themselves in a completely new situation, as a high number of multinationals entered the country. Those firms have clearly dominated their sectors, due to their advanced technology and modern administrative and management strategies (Unger, 1994).

On the other hand, domestic firms, which usually operate with older technology, have been competing against the multinationals in disadvantageous conditions. In this sense, the study of Unger & Oloriz (2000), that analyzes the differences between foreign and domestic firms, finds the formers' advantages in terms of technology composition, R&D investment and patenting efforts have placed them in a predominant position.

In this context, many authors have argued that within the unbalanced development of Mexican manufactures, two types of sectors have emerged: the *successful* and *unsuccessful* ones (Arjona & Unger, 1996; Brown & Domínguez, 1999; Cimoli, 2000).[2] However, it is still not clear what being *successful* means. Many attempts to define this expression have been made in recent years. There are several studies that propose a specific distinction between successful and unsuccessful sectors. Some of the authors label these sectors "winners" and "losers" (Casar, 1993), while others consider them the "benefited" and "damaged" ones by the new development policies (Dussel, 1994). Some of these studies are described here.

Despite these efforts, the proposed distinctions are highly heterogeneous (mainly, due to the specific purpose of each study) and even contradictory to each other. The truth is that the concept of *success*, as well as the possible variables that determine it, has not been completely defined. This situation has opened space for new studies to be carried out.

The literature that analyses Mexican manufactures since the 1980s is extensive, in terms of volume and particular aspects and time periods considered.

[2] For instance, Cimoli points out that Mexican manufactures have been developed in a very unbalanced structure, as the industry specializes in just a few sectors.

However, only some of these studies propose a formal categorization for successful and unsuccessful sectors. For the purposes of this paper, only these studies are relevant and described in detail. Through their description, it is possible to understand why the heterogeneity of the existing results and the lack of emphasis on technological aspects have left an open space for new and more rigorous studies to explain the success of some sectors in Mexico.

The first study that proposes a formal division for the Mexican manufacturing industry is Casar *et al.* (1990). The authors focus on the market structure of manufactures during the 1980s. For this purpose, a separation that combines market concentration and product differentiation, proposed by Steindl (1952), is used to divide the industry in five groups: competitive markets, competitive oligopolies, competitive & differentiated oligopolies, concentrated oligopolies and concentrated & differentiated oligopolies. The authors combine this split with the type of leadership of each sector (multinational, private domestic or shared) for an empirical analysis that evaluates the impact of market structure and barriers to entry on revenues of distinct groups of Mexican sectors.

In the same line of analysis, Brown & Domínguez (2002) use Steindl's distinction (competitive markets, competitive oligopolies, competitive & differentiated oligopolies, concentrated oligopolies and concentrated & differentiated oligopolies) for data on Mexican manufactures during the 1990s. The authors consider some factors that have characterized the market structure in Mexico (market concentration, economies of scale and product differentiation). The division is used to describe structural characteristics, competition patterns and market structure in manufactures during the 1980s / 1990s.

Dutrenit (1991) represents the first attempt to propose a new categorization for Mexican manufacturing industry. Her study is based on export performance and structural changes during the 1980s. The aim of the study is to verify the success of the export orientation policy and the possibility that such a re-orientation become permanent. The author proposes a particular categorization of Mexican manufactures based on their export behavior. Here, two types of distinctions are made: one for traditional exporting sectors (1978-1983) and another for those re-oriented towards exports (1983-1987).

In the first of the studies, Dussel (1994) analyses the behavior of different incentives to production for each group of sectors. The author constructs an empirical model for the period 1970-1991, where the GDP is included as the dependent variable, while three potential incentives (the 1982-1991 relative prices, the profit rate and the rate of returns) are included as the explanatory variables. The results of the estimations reveal that the manufactures, and particularly group I, reflect a larger effect of economic incentives.

For the second study, Dussel (1996) applies his categorization to describe the dynamics of the created groups. In terms of trade, the five sectors within the group IA presented the highest AAGR in exports since liberalization, and all sectors in sub-groups of type A accounted for the highest AAGR in exports. In addition to this heterogeneity, the author finds an increasing concentration in exports, since two sectors (automobiles and auto-parts, both in group I) contributed 41% of the growth in total manufactures' exports during 1988-92. Similarly to exports, the author points out an increase in imports for the same period (an AAGR of 22.4%), where sectors in sub-groups of type B registered the highest growth. As well as for exports, only two sectors (non-electrical machinery and auto-parts) accounted for 34.2% of imports. The author concludes that despite the increasing productivity and GDP of the manufactures, the main features of the structural change of the industry are its heterogeneity and its high levels of concentration.

More recently, Brown & Domínguez (1999) use a statistical and econometric approach to find out the determinants of productivity in Mexican manufacturing industry for the 1984-1994 period. Since the beginning of the analysis, the authors describe the existing heterogeneity in Mexican manufactures in terms of productivity. In this case, two types of sectors are considered: those that have had an increase in their productivity during the period, and those that have experienced a decrease in productivity. The descriptive statistics presented in the study show that within the first group it is possible to find mainly large firms, while the smaller ones are usually located in the second group.

should, be tested for statistical robustness. One way of doing so is through the discriminant analysis technique to see how well statistically separated, and explained by the variables included, are the groups proposed. This technique is explained and applied to our categorization in section 4.

3. HIGH-TECH/LOW-TECH INDUSTRIES IN MEXICO

Given the heterogeneity in Mexican manufactures stressed by several authors (Arjona & Unger, 1996; Brown & Domínguez, 1999; Cimoli, 2000), it seems natural that the literature has become concerned with determining the successful and unsuccessful sectors in the industry and the reasons behind that *success*. As presented in the previous section, many attempts to do so have been made from different perspectives and following different objectives. However, the discussion cannot be considered as exhaustive. Mexican manufacturing industry is very dynamic and some technological aspects, discussed in this section, have not been included so far.

The heterogeneous or uneven development of Mexican manufactures, stressed by recent literature on the topic, is indeed predicted by the new literature on technological change for the developing countries that emerged in the 1980s (Fransman, 1985; Cohen & Levinthal, 1990; Lall, 1992). According to this literature, such heterogeneity is a natural element within an industry, as there is an unbalanced creation of technological capabilities, based on individual experiences (Lall, 1992; Cimoli, 2000). Our analysis takes this argument as a point of departure to identify a group of variables for a new categorization for Mexican manufactures. Therefore, the literature on technological change for the developing countries is presented in detail in what follows.

Since the 1980s there has been a major shift in the study of technology in the developing countries. Previous (neoclassical) studies used to focus more on problems associated with the transfer of technology from developed countries. The management of advanced technology in those countries was assumed to be rather poor and the general belief of the literature was that they have not developed technological skills or knowledge, as they only import advanced technology from abroad (Fransman, 1985; Lall, 1992).

Based on the evolutionary theories of Nelson & Winter (1982), a new perspective for technology in the developing countries emerged during the 1980s. This perspective challenged the assumption about poor experience in the management of advanced technologies and focused its attention on the analysis of technological processes and change in developing countries. For the first time, importance was given to the mastering and adaptation of advanced technology as creators of experience. This new literature departs from the idea that firms generate technological capabilities,[7] which are accumulated in time, and that firms compete against each other on the basis of their capabilities (Fransman, 1985; Lall, 1992; Arias, 2003).

The literature presented above defines technological change as a different way of transforming inputs into outputs (it is not the 'black box' idea of technological progress proposed by the neoclassical literature anymore). During this process, learning is essential, as the existing experience will improve the management of advanced technology. In this sense, technological learning is related to the dynamic process of acquisition of technological capabilities (Fransman, 1985; Teece, 1994; Arias, 2003).[8] According to this literature, the definition of success is the generation of technological knowledge that allows the firm to operate with advanced technology.

In other words, there are two novel elements in this literature: (a) it has been argued that while using advanced technology and adapting it to local conditions, the developing countries' firms generate technological knowledge, which is accumulated over time, and allows a better management of advanced

[7] A technological capability is defined as the ability to make an effective use of technological knowledge (Arias, 2003). Other authors, such as Cohen & Levinthal (1990), use the expression 'absorptive capacity' instead, but refer to the same firm's ability.

[8] Dosi, *et al.* (1988) resume the process of technological learning: "Technology is not a free good, but involves specific, often idiosyncratic, partly appropriable knowledge which is accumulated over time through equally specific learning processes, whose directions partly depend on firm-specific knowledge and other technological already in use" (p. 16).

technology in the future[9] (this process is embodied in the concept of technological capability) and (b) a crucial characteristic of these capabilities, stressed by the literature, is the asymmetric allocation of knowledge among firms and sectors. Technological knowledge is not shared equally and some sectors have developed higher capabilities (Lall, 1992; Hernández & Sánchez, 2003).

This uneven development of technological capabilities suggests the existence of certain activities inside the firm that can foment learning and generate knowledge. There have been many empirical studies that have recommended particular activities destined to increase firm's ability to generate technological knowledge (Fransman, 1985; Dosi, 1988; Cohen & Levinthal, 1990; Lall, 1992; Teece, *et al.*, 1994; Hernández & Sánchez, 2003). However, there are many similarities among these studies, which can be presented here. The activities related to the creation of technological capabilities, suggested by the literature, can be summarized in three groups:

- *Mastering of technology* (search of available alternative technology; selection of the most appropriate technology; adaptation of the technology to suit specific production conditions; assimilation of process technology; licensing new technology; technical assistance in managing new technology; learning by using).
- *Further development of technology* (own R&D activities; basic research; quality improvement).
- *Personnel training* (training and recruitment of skilled personnel; advanced technical training; personnel rotation; courses for personnel; production manuals).

Given the predicted possibility of asymmetric ability to accumulate knowledge within an economy, we argue that Mexican manufactures are characterized by two types of sectors: one that has experience in managing advanced technology and, as a result, has developed an ability to accumulate technological knowledge (hence

[9] Therefore, technological change can be understood as a cumulative activity (Dosi, *et al.*, 1988).

a High-Tech sector), and another with an ability to incorporate new technological processes into production that is poor and which has not accumulated technological knowledge (hence a Low-Tech sector). In this sense, one contribution of this section is the proposal of a methodology to formally identify High-Tech and Low-Tech sectors, based on variables related to the generation of technological knowledge, represented by the activities described above.

In order to characterize the High-Tech and Low-Tech types of sectors empirically, a group of variables is considered, based on the experiences described in the previous section. The study conducted here is based on the Annual Industrial Survey, 1994-2000 (Survey) that considers 7,200 manufacturing firms and contains information on expenditure in R&D and technology, non-existent in more aggregated samples.

A group of variables is proposed for the analysis. According to the literature on technological change in developing countries, there are at least three types of activities related to the creation of technological capabilities: mastering of technology, further development of technology and personnel training. The first of these will be "proxied" here by the expenditure in technology (TECH), which includes licensing, technical assistance and know-how. The second of these is measured by R&D expenditure (RD), while the last one is measured by labor productivity (PROD).[10]

The variables are summarized in table 2. Each sector is classified into one of the two groups proposed, High-Tech or Low-Tech, according to its value for each variable. The criteria applied for the categorization is as follows: if a sector has a higher value for a particular variable than the average of all the sample, an H is assigned to that sector for that variable; if, on the other hand, its value is below the average, an L is assigned instead. The averages for each variable are also reported in table 2.

[10] Other variables that could be included in the analysis are the number of patents obtained or labor skill (measured as the proportion of white-collar/blue-collar workers). However, our data set does not consider any of these variables. Also, it has to be mentioned that labor productivity could not be the best proxy for personnel training, as it can be high already (before training) from large capital investment and, under these circumstances, there is no sense to train workers too much.

Then, according to the number of Hs or Ls, a sector can be either H* (H in all variables), H2 (H in two variables), L2 (only one H) or L* (L in all three variables). Later on, the proposed groups are created: the High-Tech group includes sectors of type H* and H2, while the Low-Tech group includes the rest of the sectors (L* and L2). In other words, a sector is considered as High-Tech if it has a higher value than the average for at least two variables. Table 3 presents the results of the High-Tech/Low-Tech categorization.

TABLE 2
Technological capabilities variables considered

VARIABLE	FORMULA	CRITERIA
PRODUCTIVITY	Added Value / Workers	H if higher than 272,000
TECHNOLOGY EXPENDITURE	Tech. Expenditure / Value of Production	H if higher than 5.7 %
R&D EXPENDITURE	R&D Expenditure / Value of Production	H if higher than 0.14 %

Source: Annual industrial Survey, INEGI.

As a result of the method applied, 55 sectors are in the High-Tech group and 150 are in the Low-Tech group out of the total 205 sectors included in the Annual Industrial Survey. Therefore, the proportion of High-Tech sectors is 26.8%. However, the High-Tech accounts for 46% of the added value and 56% of total exports of the sample, with only 26% of employment.

4. THE DISCRIMINANT ANALYSIS TECHNIQUE

Once the High-Tech and Low-Tech groups have been found, it is important to test the categorization for statistical robustness. First, as it was mentioned

Table 3
High-Tech/Low-Tech categorization

TYPE	NUMBER OF SECTORS	%
H*	15	7
H2	40	20
HIGH - TECH	**55**	**27**
L*	84	41
L2	66	32
LOW - TECH	**150**	**73**
TOTAL	*205*	*100*

Source: Own elaboration from the Annual Industrial Survey 1994-2000, INEGI.

before, there are no antecedents for such testing in the literature on Mexico, which means that this analysis represents a novel procedure. Second, it is important to define what is meant by statistical robustness. As we proposed a particular categorization for manufactures in the previous section, statistical robustness will be referred to how well separated the two groups created are. This will be done through a discriminant analysis, which is presented here.

Discriminant analysis is one of many multivariate analysis techniques in statistics. In general, a multivariate procedure analyses several random variables related to each other and equally important for the analysis, simultaneously.[11] The multivariate analysis has been used for several disciplines such as sociology, biology and anthropology. In economics the use of these techniques is not alien either. Discriminant analysis has been used extensively in banking, financial or macroeconomic areas, among others, in economics. One of its main advantages, acknowledged in the literature, is the capacity of discrimination among

[11] For a more complete description of multivariate analysis techniques see Manly (1985) or Sharma (1996).

independent variables that explain the differences between two (or more) types of sectors, households or events. In other words, the discriminant analysis technique is useful to advice the researcher about the relevance of each variable considered for the split of the sample in two (or more) groups.

Two-group discriminant analysis is a technique that allows the researcher to divide the sample of observations in exactly two groups and to test for the precision of the categorization.[12] The use of this technique has several aims: to identify the variables that discriminate best between the proposed two groups; to create a linear combination of the existing variables to compute a new function that represents the differences between the groups; and to use the derived function to classify future observations according to the group in which they fit the best. Discriminant analysis will result in the maximum possible separation between the groups if two conditions are satisfied: the averages of each group, for each variable considered, must be as separated as possible and the values of each observation, for each variable, must be as close as possible to the respective group averages. In our case, this technique is the most appropriate one, given our interest of determining whether the two groups of sectors (High-Tech/Low-Tech) are well separated statistically and if our variables (proxies from the literature of technological change) are significant.

The procedure for discriminant analysis begins with the calculation of averages and standard deviations for each group. Then, the difference between the groups, in terms of averages, is tested statistically to see whether that difference is significant so that, effectively, the groups are independent. This can be seen through a t-statistic (the null hypothesis in this case is that the groups are not independent in terms of the variables proposed for the distinction). If the groups test as independent (the null hypothesis is rejected), the variables proposed are statistically significant as discriminants for the sample and will then be used to compute the discriminant function. This function is a linear combination of the variables proposed and allows determining the specific weight of each variable for the categorization.

[12] For the description of the discriminant analysis, we follow Sharma (1996).

Once the discriminant function is computed, it is possible to calculate a discriminant value that divides the sample in two groups (through the centroids of each group). Combining those centroids (the average of the observations evaluated in the discriminant function) a cut-off value is obtained. This value is a limit for any observation, after which it will switch to a different group. In this sense, one of the most interesting results from discriminant analysis is the percentage of group adjustment (number of correctly assigned observations with respect to the total of cases). Each observation of the sample is evaluated in terms of the initial (proposed) group that it belongs to and the cut-off value to belong to any of the groups. Therefore, it is possible to determine the percentage of cases correctly assigned in each group and observe the cases for which the initial (proposed) group was wrongly assigned.

In terms of the variables proposed, two aspects can be observed in the results. First, it is possible to determine the percentage of variance between the groups that is explained by the variables proposed. This is calculated by the canonical correlation (the squared value of which is equivalent to an R^2). Additionally, the discriminant analysis tests for the significance of each one of the proposed variables for the division through stepwise analysis. This technique follows an inclusion/exclusion procedure in several steps. In each step, the variable that is the most significant for the analysis (according to the Wilks lambda test, which is equivalent to an F-statistic) is considered for the discrimination and the significance of the partial discriminant function is obtained. For the rest of the variables that have not been included for the discrimination, a similar test of significance is conducted in order to determine if one of these variables should be included in the discriminant function for the next step. This is repeated until only those variables that are not significant for the discrimination are left out of the discriminant function.

Therefore, the advantage of using the discriminant analysis technique to test for statistical robustness of the proposed division lies in the fact that it allows us to determine if the division is correctly made. In practical terms, the results obtained from this technique can be used to observe the precision of the created division (in terms of the correctly assigned observations) and the statistical significance of each one of the variables proposed for such division. Moreover, it is possible to know whether a particular observation belongs to the initially assigned group or whether it must be switched to the other one. This allows for a correction of groups, in order to work with a more precise division than the one initially set up.

In section 3, a particular categorization for Mexican manufactures, based on the Annual Industrial Survey, was proposed. In the present section, this categorization is tested for statistical robustness through the discriminant analysis technique, described previously. The aims of this process are to determine how well the groups are separated, to determine the significance of each variable used for the categorization and to determine the correct group in which each sector must be included.

The discriminant analysis was used for our categorization for the Survey, in which case, as a result of the method applied, 55 sectors were High-Tech, while the other 150 sectors were classified as Low-Tech. The results of discriminant analysis show that the group averages are statistically different for each variable proposed and, therefore, the groups are statistically independent. The null hypothesis of inter-dependence of the groups is rejected, through the F-statistic applied to the individual average of each variable: PROD [60.0], TT [87.2] and RD [48.6].

Through the canonical correlation (0.722) it is possible to determine that the proposed variables (altogether) explain 50.9% of the differences between the groups (this percentage is equivalent to an R^2 for a regression type of analysis). Via the Wilk's Lambda test (which is equivalent to a chi-squared test), with a value of 0.478 (a chi-squared value of 148.6) it is possible to reject the null hypothesis of group inter-dependence in terms of joint averages of all three variables.

The discriminant function obtained for this sample is:

$$Z = -1.69 + 0.02\ PROD + 0.95\ TT + 3.34\ RD$$

The coefficients of the discriminant function reveal the importance of each proposed variable for its construction (and the subsequent split in two groups of sectors). Although all variables are significant (as determined by the stepwise analysis, which is presented later on), the highest importance for the split in the two groups lies in the R&D expenditure (then in expenditure in technology and, finally, in productivity).[13] This could be due to the measurement of R&D itself (i.e. the intuition of this result could come from a statistical point of view): there are large differences in R&D expenditures among sectors and many of them account for small percentages of this expenditure.

The centroids (averages of observations evaluated in the discriminant function) for each group are: 1.716 for the first group (High-Tech) and -0.629 for the second (Low-Tech). Through these values, it is possible to obtain the cut-off value (1.087) that separates both groups. In terms of the precision of the proposed categorization, the results show 91% precision (78% of High-Tech sectors are, effectively High-Tech and 96% of Low-Tech sectors belong to the Low-Tech group). That is, only 9% of the sectors (12 for the High-Tech group and 6 for the Low-Tech one) are wrongly assigned initially and, therefore, belong to a different group than the one proposed.

Finally, via the stepwise analysis, it is possible to determine that all the three variables proposed for the categorization are statistically significant and, therefore, must be considered for the (High-Tech/Low-Tech) distinction proposed. All three coefficients are significant as the critical value of the partial F-test to remove one of them from the analysis is 2.71, while the F-test to remove those variables, at each step, was: expenditure in technology, first variable entered (87.2); expenditure in R&D, second variable entered (48.02); and productivity, last variable entered (36.5). The main results of the discriminant analysis are summarized in the tables 4 and 5.

To conclude, according to the discriminant analysis, the proposed categorization is quite accurate in terms of adjustment, if we consider that a margin of error of 9% is acceptable for this type of analysis. In other words,

[13] The coefficients of the discriminant function can establish the order of importance of the independent variables, but not the magnitude of their impact. In this sense we cannot conclude that the expenditure in R&D (coefficient of 3.34) is three times more important than the expenditure in technology (0.95).

TABLE 4

Main results of the discriminant analysis (1)

Categorization	% Correct	Stepwise	Canon. Correl.	Λ Wilks / X^2	Centroids
Survey	91.2	All	0.722	.478 / 149	1.72 / -0.63

Source: Own elaboration from the Annual Industrial Survey 1994-2000 of INEGI.

TABLE 5

Main results of the discriminant analysis (2)

	SURVEY		
HIGH-TECH (RIGHT / WRONG)	43		12
LOW-TECH (RIGHT / WRONG)	144		6
% CORRECT		91.3	

Source: Own elaboration from the Annual Industrial Survey 1994-2000 of INEGI.

the initial categorization is very close to the final assignment that results from discriminant analysis. Moreover, all the variables proposed are statistically significant and, therefore, are correctly included for the distinction.

Perhaps one of the shortcomings of the analysis is that these variables account for only 51% of the differences between the groups. This can be seen in the value of the canonical correlation, as well as in the case of the R^2 for the regression type of analysis. However, if we consider that there are other variables that impact firms' technological knowledge, this result is not as bad as one initially may think, as many variables could have been left out. In fact, the following section represents an attempt to include two more variables in the categorization for the Survey, in order to see if the discriminant analysis is improved.

5. THE STRUCTURE-PERFORMANCE RELATIONSHIP

In the previous section we argued that, using a group of variables proposed by the literature on technological change in developing countries, it is possible to create a formal categorization for Mexican manufactures and identify the High-Tech/Low-Tech sectors. Our categorization was then tested for statistical robustness. However, it is still not clear if our High-Tech definition corresponds to the concept of success. In other words, does being High-Tech mean necessarily being successful? This relationship is yet to be tested. The answer to the question formulated above is the main aim of the present section.

Following a classical IO framework (that links structure and performance) we estimate the determinants of profitability,[14] as a proxy for success, for the High-Tech and Low-Tech types of sectors in Mexico. Profitability is chosen among other proxies of success for Mexican manufactures (productivity, annual growth rate, competitiveness) due to its novelty in the literature on Mexico and due to its relevance in the industrial organization field: Mexican *successful* sectors are said to be profitable (Casar *et al.* 1990) but the profit factor has not been considered a crucial object of study in the last decade.

The margin of profits has been a common proxy for firm and industry performance since the first empirical studies in industrial organization (Bain, 1951; Unger, 1985). Therefore, the use of this margin as the performance variable allows us to determine whether the High-Tech sectors tend to have higher profits than the Low-Tech ones and, if this is the case, what variables help to determine this better performance.

Our methodology is, therefore, as follows: we propose a proxy for success (profitability) and test the determinants of this success within Mexican manufactures as a whole and within High-Tech and Low-Tech sectors separately. The empirical model constructed for the estimations is based on

[14] For the purposes of the present section, profitability is equivalent to the price-cost margin, even though it can be measured in different ways. The particular variable used for the analysis is presented later on.

the standard structure-performance framework proposed by the industrial organization literature (higher concentration is positively related to higher profits). It has to be said that our main interest is not the empirical verification of the structure-performance relationship, but of this relationship (and the relevance of several variables as determinants of profitability) for the High-Tech/Low-Tech sectors.

The structure-performance framework is based on the hypothesis that highly concentrated industries tend to have higher profits, as suggested by the IO literature since Bain (1951). Apart from the concentration index, the empirical model proposed here considers several barriers to entry (technology, R&D or advertising expenditures) that could also have a positive impact on profits. As argued before, our estimation is conducted at two levels: for the whole Mexican manufacturing industry and for the High-Tech/Low-Tech categorization proposed in the third section.

We believe that the High-Tech/Low-Tech categorization is relevant for the structure-performance analysis on Mexico. In particular, we intend to verify the hypothesis that the High-Tech sectors are more profitable and that the relationship market concentration-profit margin is affected by the inclusion of a group variable (that considers the proposed division). Moreover, it could be the case that the relationship suggested in the literature is presented in only one of these groups, and that the determinants of profitability vary from group to group. In other words, our initial hypothesis is that the relationship concentration-profits is not necessarily true for both, High-Tech and Low-Tech, types of sectors and that different variables are responsible for higher profits in each case.

The determinants of profitability can be explored in different ways. However, the most common way of doing this within the industrial organization literature has been through the structure-performance framework, for which a relationship between market structure and profits has been established. The first author that argued for such a relationship was Bain (1951), who hypothesized that profitability could be determined by market structure. The theoretical hypothesis, stressed by Bain is rather simple: there exists a positive relationship between market structure and profitability given that firms with higher market power will tend to fix higher prices in order to have higher profits. In this sense, he argued that industries with oligopolistic structures tend to have higher profits.

Apart from the market structure itself, Bain (1956) recognizes that there exist other variables that have an impact on profitability. In particular, Bain points out that one should focus also on the existing barriers of entry, and other structural variables, within the industry. The author mentions several barriers of entry such as product differentiation or the presence of economies of scale.

In recent literature on industrial organization there are several studies that test empirically the hypothesis presented above. For the Mexican case, there have been at least five influential studies on the concentration-profits relationship during the last 25 years. However, only the two recent ones are discussed here: Unger (1985) and Casar *et al.* (1990). In both of them, the structure-performance framework is adapted for Mexican manufactures, underlying crucial aspects as the foreign firms' presence. In both studies, the empirical modeling follows a standard OLS procedure and does not include concentration as an endogenous variable. This represents their main shortcoming and gives relevance to our analysis.

Unger (1985) is interested in testing the determinants of the price-cost margins in Mexican manufactures during the mid-1970s based on two samples: the 1975 manufacturing census (123 sectors) and a survey of 119 firms for 1978. Additionally, the samples are divided in domestic and foreign firms for separate estimation. This division is based on the hypothesis that foreign firms tend to have higher profits within Mexican manufactures, proved by several studies cited by the author.

The empirical model considers a price-cost margin as the dependent variable determined by the concentration ratio (CR4 and individual participation in total sales, for the survey), product differentiation (R&D investment and licensing), a foreign-domestic firm dummy, technology expenditure, market size and export ratio. The estimation results reveal that concentration has no significant effect either for the survey or for the census. Also, in both cases, foreign firms tend to have higher profits, which justifies the division into domestic/foreign firms for separate estimation, although the results are similar for both sub-samples. Additionally, market size and expenditure in technology have a negative and significant impact on profits (for both samples), as well as the R&D investment (only considered for the survey sample). Unger concludes that these particular characteristics of Mexican manufactures should be considered for the formulation of industrial policies.

Casar *et al.* (1990) study is similar to the previous one, but only includes an aggregate sample of 183 sectors, based on the 1980 census. The empirical model considers the profits as the dependent variable (measured by the price-cost margin, the revenues margin over fixed capital and the revenues margin over total capital). Among the independent variables, the CR4 concentration index (adjusted by exports), the advertising expenditure (product differentiation), the presence of foreign firms and several barriers to entry (minimum efficient scale, market size and cost-advantage ratio) are included.

The estimation results reveal that market concentration and product differentiation have a positive a significant impact on any of the three measures for profits considered. With respect to other variables considered, the presence of foreign firms has a positive and significant impact, similar to previous studies on Mexico, while the minimum efficient scale is never significant. The authors conclude, therefore, that the theoretical hypothesis is proved for the Mexican case.

The turning point in the literature is the recognition of a possible endogeneity problem of the concentration variable. Some recent studies (Jacquemin *et al.*, 1980; de Melo & Urata, 1986; Sleuwaegen & Yamawaki, 1988) have proposed a two-equation empirical model where not only profits, but also the concentration ratio was included as an endogenous variable. This means that the variables that are explaining the price-cost margin can be explaining the concentration ratio as well or, in other words, that concentration can be itself a variable determined by structural variables.

Despite the apparent exhaustion of the concentration-profits analysis in the literature, the results for Mexico are less clear. The two recent studies that consider this problem, Unger (1985) and Casar *et al.* (1990) use data for the 1970s (prior to huge changes in the development strategy during the 1980s-

90s) and obtain contradictory results: while Unger's study does not find any relationship between concentration and profits, Casar's study finds a rather strong relationship. Most importantly, neither of these studies corrects the empirical model for the endogeneity of market concentration, as suggested in the literature.

The apparent contradiction of their results, the need for analysis with more recent data and the weakness of their econometric techniques are the main motivations for our analysis. Nowadays, it is not clear if the structure-performance relationship holds in the Mexican manufacturing industry, especially after the radical changes in the development strategy initiated during the 1980s. Therefore, it is interesting to test the theoretical hypothesis presented in this section with recent data on Mexican manufactures, making a particular emphasis on our High-Tech/Low-Tech categorization.

The aim of our analysis is to test for Mexico the theoretical structure-performance relationship hypothesis presented in the industrial organization literature. According to such hypothesis, the more concentrated is a sector, the higher are its profits. Also, the importance of the barriers of entry is acknowledged: the higher are such barriers, the higher will be the industry's profits. Our empirical model is based on the initial Bain model. We follow closely the studies of Unger (1985) and Casar *et al.* (1990), mainly due to the availability of Mexican data (i.e. our variables are similar to those that they use in their estimations). However, the main difference of our analysis with respect to previous works is the inclusion of market concentration as an endogenous variable in our model.

As explained before, an additional aspect is included in the present analysis. In the second section, a categorization of Mexican manufactures in High-Tech/Low-Tech types of sectors was proposed and these sectors were empirically identified. Here, this categorization will be applied to the estimation to observe the particular determinants of profitability for each type of sectors, in order to discuss specific policies later on. The virtue of such detailed estimation is that it makes possible the description of a structure-performance relationship in more homogeneous sub-samples of firms.

The empirical model proposed here is based on the theoretical hypothesis described above: an industry's profits are determined by the market structure, barriers of entry, some structural and other variables. In particular, the dependent variable is the price-cost margin (PCM), measured as the net value of output minus the wages/salaries divided by the sales revenue. The same measure has been used recently by Symeonidis (2000) and by both Unger (1985) and Casar *et al.* (1990).

Among the independent variables included in the estimation, there are of three types: a market structure variable, proxies for barriers to entry and other structural variables. The market structure variable considered is the CR4 concentration index,[15] which represents the percentage of sales of the largest four firms in each industry. This variable is expected to have a positive effect on the price-cost margin, according to the theory.

Among the barriers to entry, several variables are included: a product differentiation variable (advertising expenditure divided by the sales revenue), ADV, which is expected to have a positive impact on the price-cost margin, as those sectors that invest more in product differentiation are believed to generate a higher barrier to entry for new firms. Also, a foreign-capital variable (FDI) is included as a possible barrier to entry, in order to test the argument presented by previous studies on Mexico that sectors with stronger foreign presence tend to have higher profits.[16] This variable is measured as the foreign direct investment inflows to each sector divided by the sales revenue and is expected to have a positive sign, as revealed in Unger (1985) and Casar *et al.* (1990).

Finally, two technological variables are included in the model as potential barriers to entry: R&D expenditures (RD) and technology expenditures (TECH), which include patents, licensing, know-how and technical assistance. Both

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[15] The CR4 is the only available concentration variable as we work with aggregate data for each sector. We do not have data on individual firms' sales, so a Herfindhal concentration index cannot be constructed.

[16] The FDI can be consider as an entry barrier, due to the fact that those sectors that receive higher amounts of foreign investment tend to produce with more advanced technology, which gives the existing firms a huge advantage over potential entrants (Blomstrom, 1986).

expenditures are divided by the sales revenue and are expected to have a positive impact on profits. According to the definition of process innovation, firms that invest in technology tend to produce with lower costs and, therefore, have higher price-cost margins (Tirole, 1988).

We also include the proportion of feminine labor force (WOMEN) as an instrument to control for potential endogeneity of R&D expenditure: R&D intensive industries might have low proportions of women and that proportion might itself not be very correlated with profitability. The variable WOMEN is measured as total feminine workers divided by the total workers of the industry and has not been considered in previous empirical studies on structure-performance relationship.

Another structural variables are included in the model: EXP (export share) is the proportion of sales abroad divided by the sales revenue. The sign of its impact on profits is initially unknown because of the results presented by previous studies: while Jacquemin *et al.* (1980) does not find a significant impact of the exports share on profits, de Melo & Urata (1988) find a negative and significant effect of exports share.

Two more structural variables are included: the industry's capital intensity (K) which is the capital/labor ratio, expected to have a positive impact on profits, as proved by Symeonidis (2000) and the investment ratio (INV), which is measured as the creation of capital/existing capital ratio, and is expected to have a positive impact on profits.

Therefore, the empirical model to be estimated can be expressed as:

$$PCM = f(CR4, ADV, TECH, RD, FDI, EXP, K, INV) \quad (1)$$

Where

$$CR4 = f(CR4_{-1}) \quad (2)$$

As it can be seen in equation (1), we do not entirely replicate previous studies on Mexico, but include new variables that are not considered there (as TECH or R&D). This represents an advantage, as the datasets used for previous analyses does not contain technological information. Apart from that, (1) is similar to Casar *et al.* (1990) model.

Equation (2) reflects the inclusion of concentration as an endogenous variable in our model expressed by (1). As it was described in the previous section, some studies (Jacquemin, *et al.*, 1980; de Melo & Urata, 1986; Sleuwaegen & Yamawaki, 1988) have proposed a two-equation empirical model where not only profits, but also the concentration ratio was included as an endogenous variable. This means that the variables that are explaining the price-cost margin can be explaining the concentration ratio as well or, in other words, that concentration can be itself a variable determined by structural variables.

To deal with this potential endogeneity problem, an additional variable (used as an instrument for the concentration ratio) should be proposed. However, it is very difficult, if not impossible, to find a variable that affects only concentration but does not affect profits, as these variables are so related. Here, one variable is proposed: the lagged CR4 ratio ($CR4_{-1}$), which is measured by an average of the previous three concentration indexes for each year (1980, 1985 and 1988 for 1994; 1985, 1988 and 1995 for 1998). The lagged concentration ratio seems to be a good instrument, as it is highly correlated with concentration (0.77), but almost no correlated with PCM (0.12).

In sum, we estimate a two-equation model, where concentration is determined by the lagged concentration ratio (as the instrument) and the rest of the exogenous variables. Later on, the estimated CR4 is included among the explanatory variable in the profits equation. We report two types of results: (a) the results of equation (1), without considering the endogeneity problem of CR4 and (b) the results for the two-stages estimation, which solves this problem. This is because our results show how biased are the results without correcting the model for endogeneity, as done in previous works for Mexico.

The data used for the estimation is based on the Annual Industrial Survey (Survey) 1994-2000. However, due to the lack of data in such survey, many variables had to be taken from the 1994 and the 1998 manufacturing censuses.

The Survey includes information on 7 200 (mainly large) firms that are divided into 205 sectors and is provided by the Mexican Statistical Institute (INEGI).

According to this institute the Survey contains information on firms that represents almost 80% of the total value of the manufacturing industry. Most of the variables for the estimation are taken from this survey: PCM, ADV, TECH, RD and EXP. However, the main shortcoming is that it has not any concentration ratio, as it does not include sales of each firm (from which is possible to construct a Herfindhal concentration index, as explained before).

There could be many ways of dealing with the lack of data presented before. For the purposes of the present study, the most reliable way of dealing with such problem seems to be the inclusion of only two years: 1994 and 1998, for which is possible to obtain extra information from the manufacturing censuses. Therefore, it was possible to obtain CR4, K, WOMEN and INV from the 1994 and 1998 censuses.

Despite the fact that the Census includes information on all existing (344,000) firms in the manufacturing industry, the information for those variables could be a good proxy, as the Survey is said to include information on firms that represents almost 80% of the total value. One last variable, FDI was obtained from the Ministry of Economy and represents the total foreign investment inflows, which again is only a proxy for the FDI that arrived to those firms included in the Survey in 1994 and 1998. However, according to the theory on foreign capitals, the FDI arrives mainly into the largest firms (most of them multinationals). Table 6 presents some statistics of the variables included.

The estimation is conducted using a panel of 205 sectors for two years, 1994 and 1998, leading to 410 observations for each variable. A panel contains two types of information: cross-sectional information (changes between subjects) and time-series information (changes within subjects). While the random-effects model (RE) uses both types of information, the fixed-effects model (FE) uses only the time-series information.

TABLE 6

Statistics of the considered variables

VARIABLE	MEAN	STD. DEV.	MIN	MAX
PCM	27.51	10.18	0.79	70.02
CR4	47.13	25.23	4.13	100.00
ADV	1.12	2.44	0.00	23.82
TECH	0.71	1.06	0.00	10.10
RD	0.24	0.59	0.00	7.89
FDI	1.68	8.86	0.00	151.06
EXP	16.02	17.61	0.00	88.57
K	212.77	383.19	4.97	4268.88
INV	9.71	6.88	0.00	65.59

Source: Annual Industrial Survey, 1994-2000; Manufacturing Census 1994, 1998; INEGI, Mexico.

The results are presented for three types of estimations: an OLS type of relationship among the sectors, a random-effects model (RE) and a fixed-effects model (FE). As explained before, for each one of these estimations, we present the model without considering concentration as an endogenous variable in the model (regressions A) and the model with the instrumental variable that corrects the endogeneity problem (regressions B).

Table 7 presents the first group of results for an OLS type of estimation (this is, pooling all sample, without considering the panel). A direct comparison is made between the OLS regression without (A) and with (B) the instrumental variable for concentration. The first and third columns show the model with concentration as the only explanatory variable, while the second and fourth show the results for the complete model. The same logic applies to the following tables of results.

TABLE 7

OLS results

	[A]		[B]	
	[Incomplete]	[Complete]	[Incomplete]	[Complete]
CONST	23.45***	20.58***	24.59***	21.77***
CR4	0.09***	0.03	0.06**	- 0.01
ADV	-	1.36***	-	1.45***
TECH	-	2.58***	-	2.65***
RD	-	0.21	-	0.28
FDI	-	0.10	-	0.09
EXP	-	- 0.013	-	- 0.003
K	-	0.01***	-	0.01***
INV	-	0.13	-	0.14*
R^2	0.05	0.30	0.04	0.29
N	410	410	410	410

Notes: The dependent variable is PCM. *** = 99% Significance; ** = 95% Signif.; * = 90% Signif.

Source: Annual Industrial Survey, 1994-2000; Manufacturing Census 1994, 1998; INEGI, Mexico.

The results of table 7 show that if we ignore the endogeneity of concentration (as done in previous works on Mexico) the results could be biased. Although the incomplete model (with concentration as the only explanatory variable, columns 1 and 3) shows a positive relationship between concentration and profits, when we include the rest of the explanatory variables in the model (complete model, columns 2 and 4), the coefficient of concentration is no longer significant.

Therefore, if we acknowledge that concentration is an endogenous variable, as suggested in the literature, the concentration index does not have a positive relationship with profits (as suggested by the theory), when controlling for barriers to entry and structural variables. Also, it can be seen that correcting for endogeneity leads to slightly smaller coefficients for CR4 as the previous bias is reduced.

Finally, advertising, expenditure in technology, capital intensity and investment have a positive and significant impact on profits in Mexican manufactures, when pooling the data via OLS estimation.[17] It has to be said that, even when an R^2 of 0.3 seems to be low, previous studies on Mexico obtain similar levels of adjustment.

Table 8 presents the results of the random effects regressions (considering both cross section and time series information in our panel of sectors). The endogeneity aspect is even more evident with random effects: with both, the incomplete and the complete models, the coefficient of concentration loses significance when using the instrumental variable to correct the endogeneity problem. It can be said, therefore, that with random effects we cannot prove the existence of a positive relationship between market concentration and profits for Mexican manufactures.

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[17] As it can be seen from table 7, the coefficient of R&D expenditure is not significant. The use of WOMEN as an instrument to control for potential endogeneity of R&D expenditure reports the same signs and significance for the rest of variables, and an insignificant coefficient for RD itself. The same result is obtained for random-effects and fixed-effects estimations. Despite the fact that these results reveal that the proportion of feminine labor can be a good instrument for the R&D expenditure and that R&D expenditure does not seem to have problems of endogeneity, it is not relevant for this chapter to report both results: with and without WOMEN as an instrument for R&D, so we just present the second case.

TABLE 8

Random effects results

	[A]		[B]	
	[Incomplete]	[Complete]	[Incomplete]	[Complete]
CONST	22.47***	20.41***	29.18***	24.61***
CR4	0.11***	0.06***	- 0.04	- 0.07
ADV	-	0.90***	-	1.13***
TECH	-	1.28***	-	1.59***
RD	-	- 0.49	-	- 0.57
FDI	-	- 0.003	-	- 0.04
EXP	-	0.03	-	0.08**
K	-	0.002**	-	0.004***
INV	-	0.14***	-	0.19***
R^2	0.05	0.24	0.05	0.19
N	410	410	410	410

Notes: The dependent variable is PCM. *** = 99% Significance; ** = 95% Signif.; * = 90% Signif.

Source: Annual Industrial Survey, 1994-2000; Manufacturing Census 1994, 1998; INEGI, Mexico.

With respect to the rest of the variables included, it can be observed that there are two barriers to entry that have a positive and significant impact on profits: expenditure in advertising and expenditure in technology. Additionally, three structural variables, exports, capital intensity and investment, have also a positive impact on the profit margin. According to the RE estimation, it seems that sectors that have a higher export share, are more capital intensive and invest more tend to have higher profits.

A surprising result, however, is the non-significance of FDI, which was expected to be positive, in order to prove the presence of higher profits for sectors that receive more foreign capitals, as it was revealed by previous studies on Mexican manufactures (as in Unger, 1985 and Casar *et al.,* 1990). This can be due to the use of two different sources of information (recall that FDI inflows are not included in the Survey).

Table 9 contains the results of the fixed effects regressions, which only consider time series information in the sample.

An interesting result of the FE estimations is that, contrary to the OLS and RE regressions, our evidence supports the main hypothesis suggested by the IO literature and presented before (that higher concentration is related to higher profits). This is true for both types of regressions, with and without the instrumental variable for concentration and for both the model with concentration as the only explanatory variable and for the complete model (controlling for barriers to entry and other structural variables). This means that, when considering the time series effect in the panel of Mexican sectors, we find evidence of a positive correlation between concentration and profit margin.

Additionally, our results show a positive and significant impact of exports on profits. However, expenditure in technology loses its significance with respect to the random effects estimation, while the expenditure in advertising has a negative and significant coefficient now.[18] This could mean that these two potential barriers to entry have a positive impact on profits that does not hold on time.

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[18] The negative coefficient of ADV with fixed effects (following a positive coefficient with random effects) is something natural, as these estimations consider different information from the data set (time-series or cross section). In fact, this change in sign makes the Hausman test significant, as discussed later.

TABLE 9

Fixed effects results

	[A]		[B]	
	[Incomplete]	[Complete]	[Incomplete]	[Complete]
CONST	21.72***	22.33***	17.66***	19.66***
CR4	0.12***	0.06**	0.21***	0.14**
ADV	-	- 1.09**	-	- 1.02**
TECH	-	- 0.19	-	- 0.37
RD	-	-0.65	-	-0.51
FDI	-	-0.04	-	-0.01
EXP	-	0.16***	-	0.12**
K	-	0.001	-	0.001
INV	-	0.11**	-	0.08
R^2	0.05	0.27	0.05	0.23
N	410	410	410	410

Notes: The dependent variable is PCM. *** = 99% Significance; ** = 95% Signif.; * = 90% Signif.

Source: Annual Industrial Survey, 1994-2000; Manufacturing Census 1994, 1998; INEGI, Mexico.

After the estimation of our panel of sectors with random and fixed effects, the main question remains apparently unanswered: should we believe the random effects regressions that suggest that market concentration is not associated with higher profits in Mexico? or should we believe the fixed effects result that suggests a positive correlation between concentration and profits? The answer to this apparent contradiction can be obtained from the Hausman test. This test is used to see whether the coefficients provided by the random effects regressions are equivalent to those provided by the fixed effects ones. The null hypothesis is that the difference in the coefficients is not systematic.[19]

In our case, the H_0 has to be rejected with 99% confidence (the test has a chi-squared of 44.48), which means that the coefficients are indeed statistically different. Commonly, if the test reveals statistically different coefficients, authors reject the random-effect estimations and work only with the fixed-effects model (see Symeonidis, 2000, as an example). In our case, we present both results in this section.

However, if we follow the common procedure in the literature, we should forget about the random effects regression and concentrate in the fixed effects one. If this is the case, we can provide evidence for a positive correlation between concentration and profit margins (as suggested in the classical IO literature) for the whole sample of Mexican manufactures. But this is not our main goal. Instead, we focus our analysis on the estimation of the model for the separate High-Tech and Low-Tech groups of sectors.

Once it has been seen that there is a positive correlation between concentration and profits in the whole sample of Mexican manufactures (with fixed effects), it is interesting to observe this structure-performance relationship for the categorization proposed in the section 3. In order to do so, the empirical model described by equation (1) is repeated with an additional variable: GROUP.

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[19] The Hausman test measures the statistical similarity between the random-effects and the fixed-effects coefficients. This test allows us to determine whether the time component (considered in the fixed-effect estimations) is the only relevant component for the analysis or not. In other words, the null hypothesis is that random effects coefficients are consistent and efficient (Baltagi, 2001).

This variable is a dummy with a value of 1 when the sector is High-Tech and 0 if it is Low-Tech, as in section 3. We run here two types of regressions: an aggregate one, for all 205 sectors including GROUP, and a separate one for the 55 High-Tech sectors and another for the 150 Low-Tech ones.[20]

The inclusion of a constructed dummy into the analysis could represent a bias of the standard errors. However, the GROUP dummy was constructed using an average of 7 years (1994-2000), while here only two years are included in the estimation (1994, 1998). Also, not all the variables used to create GROUP are included among the regressors.[21]

Table 10 presents the results when including GROUP in the estimation. As this variable is equal to 1 when the sector is High-Tech, the positive sign of GROUP that results for both the OLS and RE estimations implies that in our sample High-Tech sectors tend to have higher profits. This coefficient is positive and significant in both cases. The augmented model could not been tested with fixed-effects, because as GROUP remains the same for both years included in the panel (i.e. does not contain any time series information), the variable is dropped from the FE estimation.

The rest of the variables maintain the same sign and significance as in previous estimations (without GROUP). This suggests that there is no multicolinearity problem due to the inclusion of GROUP. The main result still holds, as we do not have evidence that higher concentration is related to higher profits with OLS or RE (as before).

As the coefficient for GROUP resulted positive with both OLS and RE techniques, the separation of the sample in High-Tech/Low-Tech types of sectors

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[20] It has to be said that in the regressions with GROUP and in the separate regressions for High-Tech and Low-Tech groups we always consider concentration as an endogenous variable. This variable is, therefore, instrumented with the lagged concentration ratio, given that our results proved to be sensible to the endogeneity problem. This means that all regressions presented in this section are of type [B].

[21] Additionally, it has to be said that the inclusion of expenditure in R&D (which was also used to classify High-Tech/Low-Tech sectors in the previous chapter) on the RHS of our empirical model (equation 1) reduces the "variations" that we may have in this variables, making it more difficult to obtain significant coefficients in our analysis.

TABLE 10

OLS & RE results when including group

	OLS	RE
CONST	21.96***	24.73***
GROUP	3.57***	6.12***
CR4	- 0.01	- 0.09*
ADV	1.35***	0.99***
TECH	1.95***	1.02**
RD	- 0.08	- 0.77
FDI	0.09	- 0.04
EXP	- 0.01	0.09**
K	0.005***	0.003**
INV	0.14*	0.19***
R^2	0.31	0.22
N	410	410

Notes: The dependent variable is PCM. *** = 99% Significance; ** = 95% Signif.; * = 90% Signif.
Source: Annual Industrial Survey, 1994-2000; Manufacturing Census 1994, 1998; INEGI, Mexico.

for individual estimations is justified. Table 11 presents the results of the model applied to the High-Tech group of sectors (55), while the results for the Low-Tech group (150) are included in table 12.

Considering botht tables 11 and 12, the first aspect that strikes the reader is that the results of the model applied to the Low-Tech group are similar to the full sample of sectors. This includes the verification of the main theoretical hypothesis: concentration has a positive correlation with the price-cost margin with fixed effects (concentration is again non significant with OLS or random effects) for this group of sectors. The same is true for other variables such as advertising, exports, capital intensity or investment. This similarity of the Low-

Table 11
The model applied to the H-T group

	OLS	RE	FE
CONST	31.21***	38.63***	32.27***
CR4	- 0.08	- 0.19	0.04
ADV	1.12***	0.63	- 1.14**
TECH	2.58***	0.96	- 0.21
RD	- 0.25	- 0.64	- 1.08
FDI	0.52**	0.03	0.12
EXP	- 0.08	0.09	0.19**
K	0.006***	0.003*	0.001
INV	- 0.08	0.04	- 0.07
R^2	0.34	0.12	0.18
N	110	110	110

Notes: The dependent variable is PCM. *** = 99% Significance; ** = 95% Signif.; * = 90% Signif.
Source: Annual Industrial Survey, 1994-2000; Manufacturing Census 1994, 1998; INEGI, Mexico.

Table 12
The model applied to the L-T group

	OLS	RE	FE
CONST	18.94***	21.29***	15.57***
CR4	0.03	- 0.04	0.17***
ADV	2.12***	1.58***	- 1.03
TECH	1.09	0.87	- 0.38
RD	0.23	- 0.41	0.29
FDI	0.06	- 0.03	- 0.01
EXP	0.02	0.08**	0.09*
K	0.003**	0.004**	0.002
INV	0.23**	0.25***	0.14***
R^2	0.19	0.10	0.27
N	300	300	300

Notes: The dependent variable is PCM. *** = 99% Significance; ** = 95% Signif.; * = 90% Signif.
Source: Annual Industrial Survey, 1994-2000; Manufacturing Census 1994, 1998; INEGI, Mexico.

Tech results with the full sample can be, however, due to the higher number of observations with respect to the High-Tech group (300 vs 110, respectively).

In any case, it can be concluded that within the High-Tech group, the most profitable sectors are those that invest in advertising and technology, receive high amounts of foreign capitals and are capital-intensive. Also, it is not possible to determine whether more concentrated sectors are associated with higher profits or not in this group. On the other hand, the results suggest that within the Low-Tech group the main hypothesis discussed here holds: the more concentrated is a sector in this group; the higher are its profits. Also, a profitable Low-Tech sector seems to be highly investing, especially in advertising and capital-intensive.

In other words, while higher profits are associated with certain barriers to entry (advertising for High-Tech and Low-Tech; expenditure in technology and FDI for High-Tech) for both groups of sectors, it is not possible to determine if higher concentration is positively associated with higher profits for the High-Tech group. For the Low-Tech group of sectors, concentration and profits are positively correlated (as for the whole sample of manufactures), when considering the time series information of the sample (provided by the fixed effects model). This result is unprecedented, not only for the literature on Mexican manufactures, but for the general IO literature, as no previous study has proposed a High-Tech/Low-Tech categorization for the manufacturing industry and tested the structure-performance hypothesis on this categorization, as we do here.

6. FINAL REMARKS

The purpose of the last section was to analyze the determinants of profitability in Mexican manufacturing industry during the 1990s. The framework chosen for this analysis was the traditional hypothesis of a structure-performance relationship, which states that the more concentrated the industry, the higher its profits, due to the possibility of fixing higher prices by an oligopoly. Using a price-cost margin as a measure of profitability and including the CR4 concentration index and several barriers to entry among the independent variables, the mentioned hypothesis has been tested for a panel of 205 Mexican sectors, based on the Annual Industrial Survey for 1994 and 1998.

The empirical estimations have been conducted at several levels. Initially, we present a comparison between the model without concentration as an endogenous variable (as in previous studies on Mexico) and the model with an instrumental variable (lagged concentration) to correct this endogeneity problem. These regressions were run with the standard OLS technique and with a panel one (random-effects and fixed-effects models).

Our baseline model results reveal that there exists a positive structure-performance relationship in Mexican manufactures, at least for the fixed effects model (chosen as the right one by the Hausman test), as shown already by previous studies, such as Casar *et al.* (1990). Concentration, as well as several barriers to entry, such as expenditure in advertising and technology, has a positive correlation with the price-cost margin for the sample considered. An unexpected result, however, is the non-significance of foreign presence within the manufactures, which had been correlated with higher profits in previous studies. This could be due to data imperfections, as the FDI inflows included in our model come from a different source than the database used.

Finally, our model is augmented by including a GROUP dummy, which considers the High-Tech/Low-Tech categorization proposed in section 3. As GROUP coefficient results positive and significant, it seems that a High-Tech sector tends to be more profitable in Mexico, which lends support to the argument presented in the previous chapter. Also, the positive sign of GROUP justifies the estimation of the model separately for each group.

Although the results of the sub-samples seem to be rather poor, especially in the case of High-Tech sectors, perhaps due to the lack of data, some light can been thrown on the situation within Mexican manufactures. In particular, it can be said that the structure-performance relationship depends on the type of sector considered. For the Low-Tech type of sectors the hypothesis presented above is verified: highly concentrated Low-Tech sectors are associated to higher profits (in the fixed effects regression). An intuition for this result could be that these sectors, non-familiar with advanced technology, have other type of (non technological) advantages that can be exploited when the competition is low.

On the other hand, the same hypothesis cannot be held for the High-Tech group. Although itself a High-Tech sector represents higher profits, within the group there is no apparent difference between concentrated and competitive sectors in terms of profits. This could be due to the fact that competition is not relevant anymore for sectors that use advanced technology, but also because our sample size could be low (only 55 sectors are High-Tech). With respect to the rest of the variables included in the model, some of them are significant in both sub-samples, such as expenditure in advertising or capital intensity, while others have a positive effect on profits only in one group, as FDI for the High-Tech group or the export share for the Low-Tech group.

Our estimations provide novel information to understand the dynamics within the High-Tech/Low-Tech sectors in Mexico. In this sense, a crucial lesson has to do with policy orientation. In general, Mexican government has promoted, if not helped directly through a group of offices, the acquisition of advanced technologies by domestic firms and an export orientation. However, as it can be seen in the present analysis, not every type of sector has gains due to investment in technology or exports, at least in terms of profits. For instance, expenditure in technology has no apparent positive impact on profits within Low-Tech sectors, while exports could have a negative impact on the price-cost margin for the High-Tech ones. Therefore, a more specific formulation of policies, considering the differences between the High-Tech and Low-Tech sectors, is needed.

Further research should be conducted to understand the dynamics of the High-Tech/Low-Tech types of sectors, in order to formulate concrete policy recommendations for each group of sectors, which, as we have shown in this paper, not necessarily have parallel structures.

One should be careful with endogeneity issues in this type of empirical analysis. As it was discussed in section 5, previous studies on structure-performance have emphasized in the importance of including an instrument for the concentration variable (that, according to the standard IO theory has a positive impact on profits). We have dealt with this by including a lagged concentration index as an instrument, to control for endogeneity. Additionally, we have include the proportion of feminine labor in the RHS of the empirical model, in order to control for potential endogeneity of R&D and advertising expenditures, as argued earlier in the paper.

Finally, there are some shortcomings to the present study and future research in this direction is needed. The use of a sample of firms/sectors from a survey represents many advantages with respect to data from censuses of manufactures: the information is presented in detail. Unfortunately, for the present study, only two years could be used for the construction of the panel, due to the lack of data. If a more extended survey becomes available for the Mexican manufacturing industry, it would be very interesting to repeat (or even extend) our analysis to obtain more valuable long-run information.

Also, the question of causality between High-Tech sectors and successful sectors seems to be left rather open in this chapter. The main reason for this is the availability of data: we cannot say anything about how the investments in technology and advertising are funded from the information we deal with in this paper. If this type of information becomes available in the future it would be easier to explain (High-Tech/Low-Tech) firm decisions to invest in R&D and advertising in order to become successful.

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