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THE STRUCTURE AND CAUSES OF INDUSTRIAL CONCENTRATION IN MEXICO

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INTRODUCTION

The purpose of this paper is to estimate, empirically, the degree of industrial concentration in Mexico between 1965 and 1970 and to verify some hypotheses concerning its causes. In particular, we study the effects that market size and the most efficient size of firm have on the degree of industrial concentration. In Section I we present the model used to test our main hypotheses and in Section II we discuss the results obtained. However, in order to center our discussion in a broader perspective and before we begin the analysis of the main topics of this paper, we review in this Introduction the literature that relates concentration to some relevant issues of welfare economics, emloyment, and income distribution. We should emphasize, however, that we do not make any empirical analysis of these important issues.

A. Welfare and Concentration

Firms exhibit different behavior with regard to pricing and output produced under different market structures (perfect competition, monopoly, oligopoly etc.); hence, the pattern of resource allocation and level of efficiency also varies according to the type of market structure. For example, in a monopolistic market structure (i.e. one with a high degree of concentration), as compared with one of perfect competition, price is set above marginal cost, output is lower, and "abnormal" profits result. A deviation from the marginal conditions that prevail in perfect competition causes disequilibrium in the marginal condition of efficiency (in the sense of Pareto) with the consequent loss of social welfare. The degree of social welfare due to monopoly has been studied using the notion of consumer surplus since the time of Dupuit and Marshall, and more recently by

Harberger (1954), who has quantified its effects.[1]

When there are economies of scale, the marginal conditions for efficiency in production and consumption necessary to attain a situation of Pareto optimality are not fulfilled. In this situation the economic policy dilemma is to know to what extent the disadvantages of a high level of concentration (monopoly markets with high prices, low output, consumer welfare loss and inefficient resource allocation) are offset by the advantages (low unitary costs, and probably a rapid rate of technological change) of the economies of scale of a concentrated market (Williamson 1968). From this perspective the central policy problem is not to determine if there are economies of scale, since they usually exist, but to know whether they can be obtained only with the scale of plant that accompanies very high degree of concentration. If the trade-off between the disadvantages of concentration and the advantages of the economies of scale favor the latter, it follows that large firms should be encouraged. On the contrary, if the advantages of the economies of scale associated with a high level of concentration are small, welfare can be increased by stimulating a more competitive economy of small firms. If it were possible to determine the advantages and disadvantages of concentration we could conceivably establish the most convenient level of concentration for the economy.

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[1] One of the few studies on the welfare cost of monopoly in a less developed country is the one by Alonzo (1969) for the Philippines.

B. Employment and Concentration

It is generally accepted that in most of the less developed countries capital is scarce and labor is abundant. Given this factor endowment, a high degree of efficiency is attained in the economy when the productivity of capital is high. The relevant question, from the point of view of concentration policies, is to determine whether small firms use less capital and other scarce resources than the large ones to produce a given level of output. Most of the available evidence suggests that small firms tend to use less capital per unit of output than large ones (Ranis 1962, Marsden 1969, Mehta 1969, Todd 1971, Berry 1972), although some contrary evidence also shows that the productivity of labor and of capital increases with the size of firm (Dhar and Lydall 1961, Boon 1964, Sanderasa 1966, 1969, Cardwell 1978). Moreover, since, in general, labor productivity (output-labor ratio) tends to be higher for large firms than for the small and medium size ones, and since an industry with few large firms is usually one with a high degree of concentration, it follows that labor productivity increases with concentration. If we accept the argument that small firms are more efficient in the intensive use of the scarce capital (low capital-output ratios), and also make extensive use of the abundant labor (low capital-labor ratio), then it is meaningful to reduce the level of concentration, i.e. to increase the number of small and medium size firms in the economy.

The point of view that small and medium size firms use more labor intensive techniques (low capital-labor ratio) than the large ones, is supported by most of the empirical evidence (Dhar and Lydall 1961, Ranis 1961, Shetty 1963, Marsden 1966, Berry 1972, Ditullio 1972). The reasons usually given to explain the use of labor-intensive techniques by small and medium size firms are as follows. Small and medium size firms face a more competitive environment than do large size firms and are thus forced to choose a technology more in accordance with the factor abundance in the economy. They are also stimulated to innovate in the direction of labor-intensive techniques. In other words, small firms are confronted with a set of relative factor prices closer to the real scarcity prices than the set faced by the large ones. Large firms, on the other hand, tend to be less labor intensive and to pay high wages due to the presence of powerful unions and because wage legislation is more effective in large firms than in small ones. It has been found by Garberino (1950), Weiss (1966) and Phlips (1971), that large firms in highly concentrated industries pay higher salaries than firms in less concentrated ones. The negative effect of high wages on employment has been documented by Reynolds and Gregory (1965). Another factor for the capital intensiveness of large firms is that subsidised credit and other capital subsidies such as preferential fiscal treatment, as well as facilities to import capital are mostly available to them.[1]

In accordance with the foregoing argument, wages tend to be low (high) and capital costs high (low) for small (large) size firms, and hence they tend to use labor (capital) intensive techniques. If it is true that small firms use labor-intensive techniques,not because they operate on a small

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[1]This is particularly important if it is true that the advantages of large scale production and growth of firms can be explained by the economies of scale that originate in the size of the capital stock (see Fei, J.C.H. 1977).

scale, but because they face a less distorted set of relative factor prices than the large ones, it can be argued that policies to increase employment should not encourage the creation of more small size firms (reduce concentration) but should work to eliminate the factor price distortions that give rise to dual factor markets. If these policies are successful, firms of all sizes will adopt more labor-intensive technologies.

C. Income Distribution and Concentration.

Firms of different sizes select different capital-labor ratios (technology) when the relative prices of capital and labor change; i.e. the elasticity of substitution varies with size of firm. Therefore, the elasticity of substitution in a highly concentrated industry with large firms will have a different value than a more competitive one with small firms. If the economy behaves according to neoclassical principles, we can establish a clear relationship between the value of the elasticity of substitution and the ratio of relative shares in output of capital and labor.

If, as the evidence suggests, both the elasticity of substitution in the manufacturing sector of less developed countries varies between industries (Daniels 1969, Katz 1969, Williamson 1971) and the degree of concentration also varies among these industries (Gollas 1975, Syrkin 1970, Balderas 1973), then a general increase, or decrease, in the price of one factor of production will change its relative share in total industrial output. Suppose that in the manufacturing sector there is an industry composed of large firms, with a high degree of concentration and an elasticity of substitution of less than one; and another industry of small firms, low degrees of concentration and an elasticity of substitution greater than one. Under these circumstances, as the wage rate increases we expect the share of the less concentrated industry (elasticity of substitution more than one) to decline and the one of the more concentrated (elasticity of substitution less than one) to increase. The final outcome would be to shift the distribution of industrial income from the less concentrated to the more concentrated industry.

One of the few formulations that relate concentration and income distribution is that of Kalecki (1951) which proposes a model of income distribution and shows that the labor share varies negatively with the "average" degree of monopoly in the economy.[1] The implications of the model are that the greater the degree of monopoly conditions in the economy the greater will be the share of monopoly profits and the smaller the share of labor in national output.

The relation between concentration and profits has been widely studied in the industrial nations (see Weiss 1974 for a recent review of the literature). Most of the empirical evidence shows that there exists a positive and significant effect of concentration on the rate of profits. Little is known in the developing countries about the mechanism by which the degree of concentration is related to the factors that

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[1]In Kalecki's formulation:

$$W = [1 - (1/\bar{\eta}\ ]$$

where W is the share of labor, and $\bar{\eta}$ the average degree of monopoly.

determine the rate of profit among different industries and how concentration affects income distribution.

When studying income distribution it is important to know the origin and the effects of price increases, since inflation redistributes income differently among people, regions and industries. Again, the evidence for the more industrialized nations supports the hypothesis that the largest increases in prices take place in the more concentrated industries (Blair 1974, Ross 1973, Phlips 1971). Little is known in less developed countries of the role that the more concentrated industries or the degree of concentration in the economy as a whole, have in determining the rate of inflation and its distributional effects.

I THE EFFECTS OF MARKET SIZE AND OF THE OPTIMUM FIRM SIZE ON INDUSTRIAL CONCENTRATION.

A. The Industrial Concentration in Mexico

The degree of industrial concentration may be described by the distribution of the firm size as measured by, for example, the value of output or the number of workers. Using the census data for 1965 and 1970, Figures 1 and 2 show the distribution of firms by size according to the number of workers. According to Figure 2, in 1970 the majority of firms in the industrial sector were small and only a few were large: almost 63% of the industrial firms had less than 6 workers and only about 1.7%

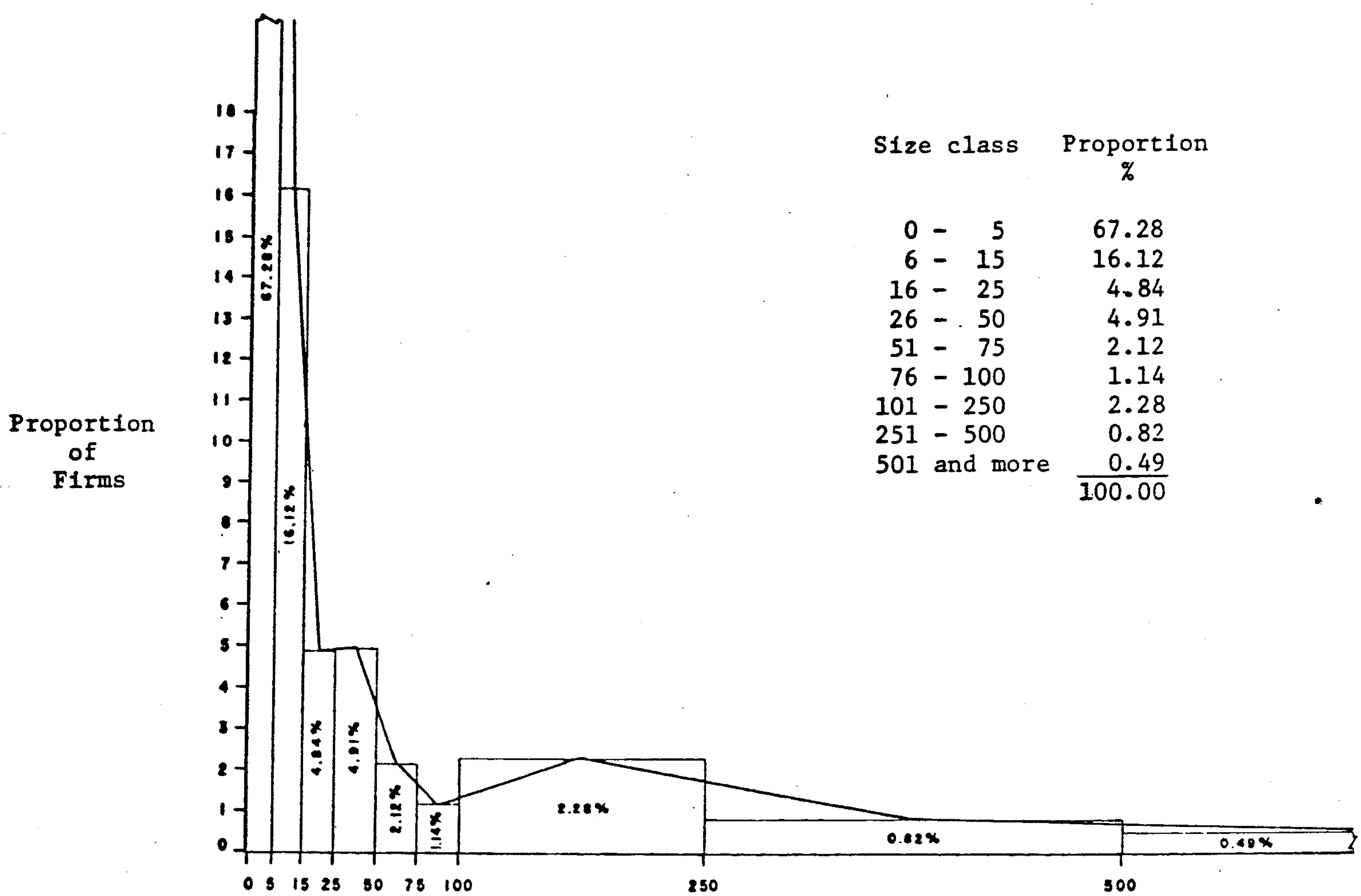
had more than 250 employees. Table 1 shows the distribution of output and employment by size of firm for 1970. The distribution of employment and output by firm size is highly concentrated: the small firms (less than 6 workers) which make up 63% of all firms produce only 2.4% of industrial production and give employment to only 7.2% of the labor force in the industrial sector. On the other hand, a small number of large firms (250 workers or more), only 1.7% of the total number of firms, produced almost 54$ of industrial output and gave employment to about 42% of the labor force in that sector.

Economists have devised several summary measures of industrial concentration. Industrial concentration, like income concentration among individuals, or land concentration among farmers, may be viewed as a measure of the inequality of a distribution by size. In the case of industrial concentration it is of interest to know the extent to which a small number of large firms controls a large proportion of the output or the employment in an industry. From this perspective it is important to know the degree of dispersion of the distribution of firms by size and not their absolute number. One can observe the same degree of dispersion (concentration) between two industries with wide differences in the number of firms each has. Some authors believe, however, that the study of industrial concentration should be focused not only on the analysis of the unequal distribution of firms by size but also on the absolute number of firms (Adelman 1951). Because of these different views, one finds in the literature both measures of concentration and measures of inequality, also

Figure 1

Mexico: Size Distribution of Firms According to Employment

1965



Size class	Proportion %
0 - 5	67.28
6 - 15	16.12
16 - 25	4.84
26 - 50	4.91
51 - 75	2.12
76 - 100	1.14
101 - 250	2.28
251 - 500	0.82
501 and more	0.49
	100.00

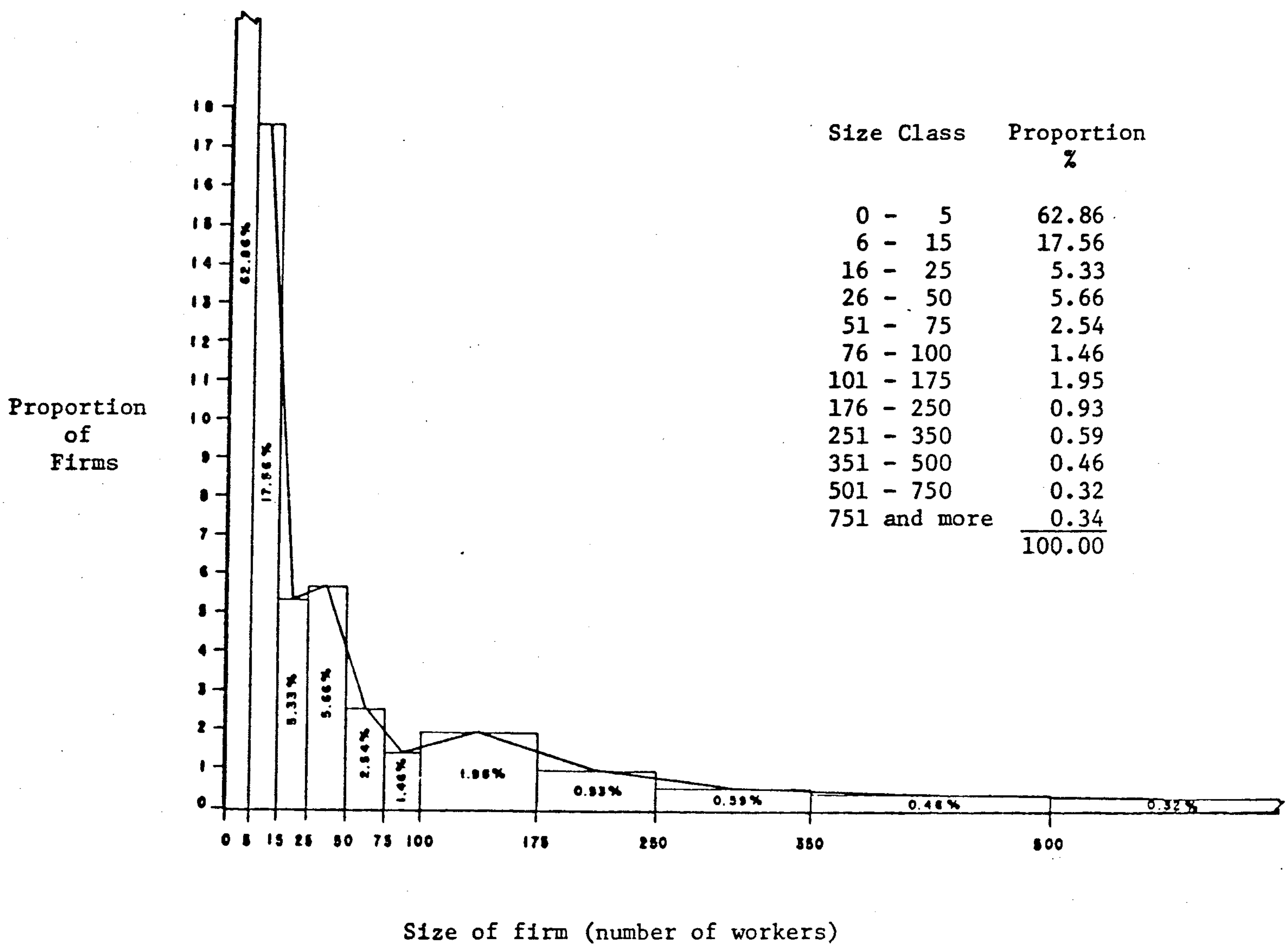
Size of firm (number of workers)

Source: Manuel Gollas, Loc. cit

Figure 2

Mexico: Size Distribution of Firms According to Employment

1970



Size Class	Proportion %
0 - 5	62.86
6 - 15	17.56
16 - 25	5.33
26 - 50	5.66
51 - 75	2.54
76 - 100	1.46
101 - 175	1.95
176 - 250	0.93
251 - 350	0.59
351 - 500	0.46
501 - 750	0.32
751 and more	0.34
	100.00

Source: Manuel Gollas, Loc. cit

Table 1

Mexico: Number, Employment and Value of Output of Industrial Firms by Size Class

1970

Size of Firm (Number of workers)		Proportion of Total Number of Firms %		Proportion of Total Employment %		Proportion of Total Output %
0 - 5		62.86		7.2		2.4
6 - 15		17.56		6.6		3.4
16 - 25		5.33		4.4		3.3
26 - 50		5.66		8.5		6.5
51 - 75		2.54		6.5		5.7
76 - 100		1.46		5.4		5.1
101 - 175		1.95		10.9		10.9
176 - 250		0.93		8.2		9.0
251 - 350	1.71	0.59	42.3	7.3	53.7	8.1
351 - 500		0.46		8.0		9.8
501 - 750		0.32		8.1		10.7
751 -		0.34		18.9		25.1
Total		100		100		100

Source: Manuel Gollas, "Reflexiones sobre la concentración económica y el crecimiento de las empresas", El Trimestre Económico, No. 166, Vol. XLII (2), Mexico, April-June, 1976, pp. 457-485.

referred to as measures of absolute and relative concentration, respectively. It has been shown, however, that in some cases measures of inequality can be transformed to measures of concentration and vice versa (Marfles 1971). An extended discussion of different measures of industrial concentration can be found in Hall and Tideman (1967), and in Hart (1971, 1975).

To measure the degree of industrial concentration in Mexico we used, among other indexes to be discussed later in the paper, the Gini coefficient and the Herfindahal index.[1] We estimate these indices at two and four-digit levels according to the industrial classification of the Mexican Industrial Census for 1965 and 1970. The Gini and the Herfindahal measures of employment concentration at the two-digit level are shown in Table 2. It can be seen from this table that the degree of concentration varies considerably among industries and that the concentration ranking (columns 4 and 8), according to the Gini coefficient, did not change in most industries between 1965 and 1970.

B. The Effects of the Extent of the Market and the Size of Firms on the Degree of Industrial Concentration

It is often argued that the degree of concentration in an industry and the size of its market are inversely related (Nelson 1963, Weiss 1963, Rosenblueth 1957, Pashigian 1969, Sawyer 1971). The argument runs as

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[1]See page 23 for a definition of the Herfindahal index. As with the Gini coefficient, the Herfindahal index approaches one when there is total inequality.

Table 2

Mexico: Indices of Industrial Concentration According to Employment

1965 - 1970

Industry	1965				1970			
	Herfindahl (1)	Gini (2)	Number of Firms (3)	Concentration Rank (4)	Herfindahl (5)	Gini (6)	Number of Firms	Concentration Rank
11 Coal and graphite	0.730	0.557	18	24	0.345	0.615	14	22
12 Metallic mines	0.306	0.757	333	8	0.322	0.734	323	8
14 Gravel and Sand mines	0.171	0.601	218	23	0.167	0.598	265	23
15 Non-metallic minerals	0.165	0.661	219	20	0.159	0.672	215	18
20 Food Products	0.145	0.709	22 187	13	0.144	0.720	23 764	10
21 Beverages	0.192	0.811	1 487	1	0.233	0.822	1 263	1
22 Tobacco	0.722	0.772	30	3	0.419	0.662	52	19
23 Textiles	0.170	0.685	2 721	16	0.171	0.692	2 579	17
24 Clothing and Shoes	0.126	0.694	6 234	15	0.125	0.718	6 743	11
25 Wood Products	0.198	0.782	749	2	0.210	0.758	490	6
26 Furniture	0.125	0.669	1 265	18	0.129	0.654	3 107	20
27 Paper	0.185	0.710	444	11	0.196	0.705	517	15
28 Printing	0.120	0.699	2 730	14	0.124	0.705	3 323	15
29 Leather	0.140	0.647	769	22	0.153	0.641	792	21
30 Rubber	0.140	0.770	1 036	6	0.156	0.768	1 403	4
31 Chemicals	0.157	0.709	2 175	12	0.171	0.712	2 511	13
32 Petro-Chemicals	0.332	0.682	49	17	0.180	0.708	80	14
33 Non-Metallic Products	0.148	0.758	3 912	7	0.163	0.763	4 704	5
34 Steel and Iron	0.455	0.665	187	19	0.470	0.726	322	9
35 Metal Products	0.140	0.774	4 337	5	0.145	0.773	5 021	3
36 Machinery and Tools	0.128	0.734	2 043	9	0.134	0.736	1 754	7
37 Electrical Products	0.225	0.728	777	10	0.220	0.704	949	16
38 Automobile and Transport	0.333	0.776	435	4	0.361	0.802	695	2
39 Various Manufacturing	0.139	0.661	1 801	21	0.133	0.714	1 410	12

Source: Manuel Gollas, "Reflexiones sobre la concentración económica y el crecimiento de las empresas", El Trimestre Económico, No. 166, Vol. XLII (2), Mexico, April-June, 1976, pp.457-485.

follows: Since empirically one typically finds a positive relationship between the market size and the number of firms, and a negative relationship between the number of firms and the degree of concentration, then it follows that the larger the size of the market the smaller the degree of concentration and vice versa.

As a first step, we empirically test whether the degree of concentration and the number of firms in the industrial sector of Mexico are inversely related. Another index of concentration, besides the Gini and Herfindahal, is the number of the largest firms that together produce 80% of the output of an industry.[1] We refer to this index as C_2 and it measures inversely the degree of concentration, i.e. the larger its value the smaller the degree of concentration and vice versa. Regressions 1 and 2 in Table 3 relate (in linear and in linear logarithmic form) the number of firms in an industry N, and the index of concentration in that industry, C_2. Regression 3 relates the rate of change of these variables between 1965 and 1970. The data used for these calculations is at the four-digit level. Our estimates, as expected and not surprisingly, support the assertion that the number of firms and the degree of concentration are inversely related. Because of the linear-log specification of the regressions, the estimated coefficients are elasticities. Thus, according to equation (2), for example, an

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[1]Another index commonly found in studies of industrial concentration is the proportion of output produced by the largest 4 or 8 firms in an industry. The equivalent index that we use is the number of firms needed to produce a certain percentage of the output of an industry, in our case 80%.

increase of 10% in the number of firms in the industrial sector of Mexico would have the effect of reducing by 7.8% the degree of industrial concentration. According to equation (3), an increase of 10% in the rate of change of the number of firms will decrease concentration by more than 6%.

We now turn to the main focus of this paper: What are the factors which determine the degree of industrial concentration in Mexico? We attempt to answer this question by studying the relationships between concentration and (1) the most efficient firm size needed in a given industry and (2) the market size of an industry. We will first discuss the arguments for (1).

1. Minimum Optimum Size of Firm and Concentration

The minimum optimum, or most efficient firm size in an industry is that size which has the minimum average cost of production (Stigler 1958, Saving 1961, Weiss 1964, Comanor and Wilson 1967, and Scherer 1973 among others). In most of the empirical work on industrial concentration where the concept of the minimum firm size is used, it is assumed that the long run average cost of production has an L shape as shown in Figure 3. The size of firm MOS is referred to as the minimum optimum size.

TABLE 3

Regressions Between Concentration and the Number of Firms in an Industry [a/]

1970

Independent Variable	Intercept	Number of Firms	R^2
(1) C_2	0.49	0.26 (0.010)	0.82
(2) $\ln C_2$	0.40	0.78 (0.043)	0.73
(3) $\ln \Delta C_2$	-0.16	0.63 (0.065)	0.33

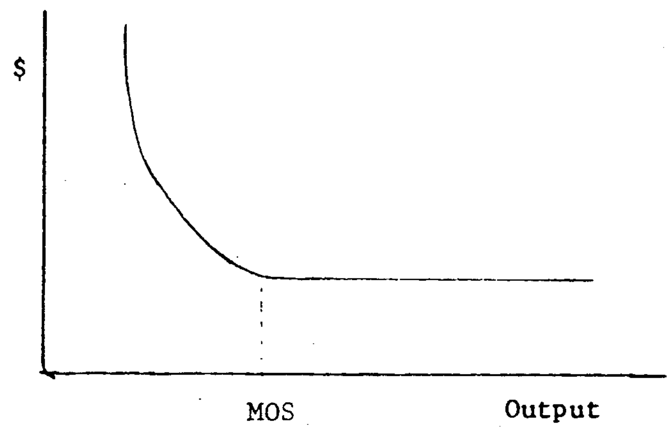
a/ The index of concentration C_2 refers to the number of firms which produce 80% of the industry output. The rate of change of concentration and of the number of firms is between 1965 and 1970.

Repression (1) is linear and regressions (2) and (3) linear in the logarithms.

The number of observations (industries) in regressions (1) and (2) is 123 and in regression (3) 195.

The standard errors are given in parenthesis.

Figure 3



The size of firm MOS is optimum because it has the lowest average cost; it is the minimum because firms smaller than MOS have higher average costs. This definition of the most efficient size implies that firms larger than the minimum are also efficient sizes. To the left of MOS, firms are subject to diseconomies of scale because of their small size (Stigler 1958, p. 58) or, seen from another perspective, firms in that segment of the long run average cost will experience increasing returns to scale if they increase their size. If the long run average cost curve slopes upward, firms in that size range also experience diseconomies of scale (Stigler 1958, p. 61). The minimum optimum size of firms has been used (Comanor and Wilson 1967, p. 428) as a <u>proxy</u> variable to estimate economies of scale in production. It should be pointed out that if the economic environment (access fo capital markets, technological options, etc.) is different for different sizes of firms, there will be more than a single optimum firm size. The optimum firm size may also change through time as factor prices and technology change.

Optimum firm size may determine concentration, since in some instances it may not be possible to attain an efficient scale of production without firms which are so large that concentration is inevitable (Bain 1959). Moreover, the minimum size may be so large that it becomes an important barrier to entry of new plants, thus reducing competition and increasing concentration (Bain 1956, Hall and Weiss 1967, Shepherd 1971).

Further on in this paper we will test the hypothesis that the larger the minimum optimum firm size in an industry the larger its expected degree of concentration. However, in the next section, we discuss the relation between different measures of market size and concentration.

2. The Absolute and Relative Extent of the Market and Concentration

It has long been held that an increase in market size reduces concentration. However, despite numberous empirical studies (Nelson 1963, Evely and Little 1960, and Rosenbluth 1957 among others), the evidence does not unambiguously support this hypothesis. The argument that large markets and concentration are inversely related rests on the empirical observation that (a) large markets have a large number of firms, and (b) a large number of firms implies a low degree of concentration (see p. 15 above for empirical evidence on Mexico).

Although the absolute market size may be an important factor in explaining the degree of concentration, a more relevant notion of the market is its relative size, that is, the absolute size of the market deflated by a measure of the optimum firm size (Pashigian 1969, Scherer 1973). This relative measure of market size takes into account the fact that a given firm size may, or may not, be optimum depending on the size of the markets in which it operates. That is, the effect of market size on concentration is effectively measured when the optimum size of the firm for that market is taken into consideration. Moreover, if it is true that increases in the absolute size of the market decreases concentration, and that increases in the minimum optimum firm size increases it, then it follows that increases in the value of both of these variables could leave concentration unchanged. In other words, the increase in market size, which decreases concentration, could be offset by an increase in the optimum size of the firm which increases concentration. We will empirically measure the effect that the relative market size has on the degree of concentration.

The steepness of the slope of the long run average cost curve for firms which are smaller than the minimum optimum size, may be important in explaining the degree of concentration of an industry (Weiss 1963, Pashigian 1969). The argument is as follows. If the slope of the long run average cost curve at suboptimal sizes is relatively horizontal, it is reasonable to suppose it will be relatively easy for new firms of less than optimum size to enter the industry, since the difference in average unit cost between optimum and less than optimum size is not large. In other words, the flatter the long run average cost curve for suboptimal firm sizes, the easier the entrance of new firms and, because of the inverse relationship observed between the number of firms and concentration, the smaller will be the degree of concentration. A similar but contrary reasoning can be made if the slope of the long run average cost curve at suboptimal levels is fairly steep.

An indirect measure (as opposed to directly estimating a cost function) of the slope of the average cost curve for firm size less than the optimum is to calculate the proportion of total output produced by all the firms of less than the optimum size. This is the output produced inefficiently by high cost, less than optimum size firms. If the proportion of output produced inefficiently is relatively large, then the difference in unitary cost between firms of less than optimum size and those of optimum size is not that large (the slope of the cost curve to the left of the optimum is not very steep). Under these circumstances it is relatively easy for new firms to enter the industry, thus reducing concentration. If the proportion of the industry's inefficiently produced output is small, the converse argument holds: the difference in average costs between firms less than optimum and those of optimum size is probably very large (the slope of the average cost curve in the relevant segment is very steep). It is then difficult for firms of less than the optimum size to enter the industry, thus increasing concentration. In other words, the proportion of an industry's total output which is produced inefficiently (the sum of the output produced by all the firms of size less than optimum) is a measure of the extent to which economies of scale may be realized if less than optimum size firms increase their size.

In the following sections we test the hypothesis that the larger the proportion of the industry output produced inefficiently, the smaller the degree of concentration and vice versa. Also in the following sections we test the hypothesis, from (1) above, that the larger the minimum optimum firm size, the larger its expected degree of concentration.

C. The Model and the Variables

1. The Model

The least-squares regression specification used in our analysis is of the multiplicative form:

$$C_r = AS_m^{\beta_1} M_{km}^{\beta_2} I_{km}^{\beta_3} \varepsilon_m$$

$$C_r = AR_{km}^{\alpha_1} I_{km}^{\alpha_2} \varepsilon_m$$

where

A = a constant

C_r = Index of concentration where r = 1, 2, 3, or 4 refer to different estimates of this index.

S_m = Absolute market size in terms of value of output, value added, or value of assets.

M_{km} = Minimum optimum size of firm in terms of value of output, value added, or value of asset, and where k=1, 2, 3, or 4 refer to different estimates of minimum optimum firm size.

I_{km} = Proportion of output, or value added produced inefficiently, and where k = 1, 2, 3, or 4 refer to the value of this variable using different estimates of minimum optimum firm size.

R_{km} = Relative market size $(\frac{S_m}{R_{km}})$ in terms of value of output, value added, or value of assets and according to different estimates of minimum optimum firm size.

2. The Variables

In our statistical analysis we used alternative definitions and measures of the main variables. The following is a detailed discussion of their most important properties and how they were calculated.

Indices of Concentration

C_1: Herfindahal.[1]

It is calculated by adding the square of the participation of each class of firm size in the total output of a given industry.

$$C_1 = \sum_{j=1}^{n} \frac{(a_j^2)}{A}$$

where a_j is the number of workers, the value of output, the value added or the value of assets of each class j,[2] and A the total employment or output or value added or value of assets in a given industry. In this index each class is weighted by its relative participation in employment, output, value added or assets of a given industry. Because of this the classes of smaller firms have less weight in the measure of concentration. The value of this index fluctuates from 1, when there is only one class size in the industry to 1/n when there are n number of classes and each has the same weight. The value of this index tends toward zero when the number of classes is very large. The Herfindahal index has the advantage of showing the degree of inequality of participation in employment, output, value added or assets of different classes of firm size; simultaneously, it is sensitive to the number of classes in the industry. It is because of this property that its value decreases when the number of classes increase.

C_2: The number of firms that together produce 80% of the output of an industry.

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[1]Several authors dispute the paternity of this index. According to Rosenbluth (1957), A. O. Hirschman first proposed this index in his book National Power and the Structure of Foreign Trade (1945).

[2]When data at the firm level is available, a_j refers to the number of workers, value of output, value added, or value of assets of each firm.

This index is calculated by first adding each class's (going from largest to smallest) share of the output until 80% is obtained. Then the number of firms that produced this output is estimated. In some cases this is done directly, in others, some interpolation within a class is needed.

Notice that there is an inverse relationship between the value of this index and the degree of concentration: the higher the value of C_2 the lower the degree of concentration and vice versa.

C_3: The number of firms that together give employment to 80% of the labor force of an industry.

This index is similar to the preceding one except that it measures concentration according to the degree of employment concentration. As in the above index, the higher the value of C_3 the lower the degree of concentration and vice versa.

C_4: Largest Size Class Participation

The proportion of an industry's total output which is produced by the largest size class (in terms of the number of workers) in that industry.

Minimum Optimum Sizes

M_1: The "survivor" minimum.

The estimation of an optimum firm size by determining the size that survives best in its total economic environment has been suggested since the time of Mill and Marshall. This approach has recently been revived thanks to Stigler (1958) and has been applied in numerous empirical studies (Savings 1961, Weiss 1964, Sheperd 1967).

Following this approach an optimum firm size is one which has the minimum average cost of production. The minimum optimum firm size must be determined relative to the factors and output market conditions the firm faces (supply and demand of factors of production, taxes, subsidies, and prices for its products). In Stigler's words (1958) an efficient firm size "is one that meets any and all problems the entrepreneur actually faces: strained labor relations, rapid innovation, government intervention, unstable foreign markets, and what not." What is that size of firm? The size of firm that survives best in the market. The criteria for evaluating how well a given firm size has survived is to estimate whether its class's share of the total output of an industry has increased or decreased. It is believed that the firm size with the minimum average cost will be the size which will best survive in the market. Accordingly, if there is a certain firm size whose class is increasing its share in the industry's output, we can say that the firm is within the optimum size range (see Figure 3). An optimum size that has decreased its share in the industry's output and "cannot survive rivalry with other sizes is a contradiction." (Stigler 1958, p. 56)

Since the survivor technique is nothing but a comparison of firm sizes participation rates in two or more periods of time, we computed the percentage of industry value of output, or value added for each class of every industry for the Census data of 1965 and 1970. First the rate of growth of participation was estimated for each class. Then the average firm size was calculated for the class that had the largest rate of growth of participation.

M_2: Average firm size of the class with the largest participation in the value of output or the value added of an industry in a given year.

This minimum optimum size of firm is estimated as follows:

$$M_{2m} = \frac{P_m}{N_m}$$

where

P_m = Value of output or value added (when m = 1 or 2 respectively) of the class with the greatest share in the total value of these variables in a given industry in a given year.

N_m = The number of firms in the class with the largest participation in the value of output or value added of an industry in a given year. The unit of measurement of M_2 is the Mexican monetary unit. The estimates of M_2 are for 1970.

M_3: Weighted average size of firm.

This measure (Pashigian 1969) is the sum of the average size of firm in each jth class weighted by that class's participation in the total value of output or value added for each industry.

$$M_{3m} = \sum_{j=1}^{n} \left(\frac{P_{jm}}{N_{jm}} \right) x \left(\frac{P_{jm}}{P_m} \right)$$

where

j = classes

P_{jm} = value of output or value added of the jth class m = 1 or 2, respectively.

P_m = total value of output or value added in a given industry and m = 1 or 2 respectively.

N_{jm} = number of firms in the jth class and m = 1 or 2 as above.

The unit of measurement of M_3 is the Mexican monetary unit; it was calculated for 1970,

Market Sizes

S_m: Absolute market size.

The absolute market size of an industry in a given year was measured by the total value of output (m=1) or the total value added (m=2) of that industry.

R_{km}: Relative market size.

This measure is the absolute market size in an industry divided by the relevant minimum optimum size for that industry.

$$R_{km} = \frac{S_m}{M_{km}}$$

where

S_m = Absolute market size as defined above.

M_{km} = Minimum optimum firm size, where k = 1, 2, or 3 refer to the different optimum firm sizes in terms of value of output (m = 1) or value added (m = 2).

I_m: Inefficient Production

The proportion of the value of output or the value added of all the firms of less than optimum size and where m = 1 or 2 refers to value of output or value added respectively.

The data used to estimate our variables and the model was obtained from the 1965 and 1970 Mexican Industrial Census at the four digit level.

II. REGRESSION ANALYSIS AND CONCLUSIONS

Tables 4, 5, and 6 summarize the main results of our empirical tests. Because of the multiplicative form of the regression specification, the regression coefficients can be interpreted as elasticities between the concentration variables and (a) absolute and relative market sizes,

(b) the output or value added produced inefficiently, and (c) the minimum optimum size of firms. The data used for all variables is from the 1970 Industrial Census, with the exception of M_1 (minimum optimum size of firm estimated by the survivor technique) which was calculated using data from the 1965 Industrial Census as well.

The estimated coefficients for all regressions have the expected sign and their standard errors are sufficiently low to make them statistically significant. The values of R^2 are relatively high with the exception of the regressions of Table 6. In Appendix I we include, as an example, four tables which show, for the regressions of Table 5, the average values and the standard deviations of the variables used in this regression.

The coefficients of the minimum optimum sizes and the absolute market sizes have the expected signs, and are statistically significant in all regressions (see Tables 4, 5, and 6). The signs of M_1, M_2, M_3 and M_4 are, as expected, positive for regressions with concentration measured by C_1 and C_4 and negative for regressions with concentration measured by C_2 and C_3 since the latter measure the degree of concentration inversely. On the other hand, the coefficients of the different versions of absolute market sizes have a negative sign in the regressions where concentration is measured according to C_1 and C_4 and positive for regressions with C_2 and C_3, since, as noted above, their values are inversely related to concentration.

TABLE 4

Multiple Regression Equations Explaining Concentration[a/]

1970

Independent Variables and Other Statistics	Regressions			
	C_2		C_4	
	M_2 (1)	M_3 (2)	M_2 (3)	M_3 (4)
Minimum Optimum Size (M)	-0.77 (0.038)	-1.09 (0.040)	0.06 (0.018)	0.13 (0.032)
Absolute Market Size (S)	0.80 (0.042)	1.08 (0.044)	-0.12 (0.025)	-0.20 (0.03)
Inefficient Production (I)	0.57 (0.053)	0.14 (0.051)	-0.21 (0.03)	-0.23 (0.034)
R^2	0.77	0.86	0.32	0.57
F	203	414	31	77
Number of Industries	179	201	201	180
Relative Market Size (R)	0.73 (0.032)	0.13 (0.051)	-0.062 (0.018)	-0.10 (0.027)
Inefficient Production (I)	0.38 (0.055)	1.09 (0.039)	-0.23 (0.039)	-0.22 (0.036)
R^2	0.76	0.86	0.28	0.37
F	314	624	38	58
Number of Industries	201	201	201	201

a/ C_2 is the index of concentration measured as the number of firms that produce 80% of the total output in an industry. C_4 is the index of concentration that measures the proportion of total output in an industry produced by the largest class of firms in that industry.

The definitions of absolute market sizes (S), relative market size (R), inefficient production (I) and minimum optimum sizes M_2 and M_3 are given in the text. All independent variables are measured in terms of the value of industry output.

The statistics in the lower panel refer to the results obtained when the absolute market size is deflated by the relevant minimum firm size. The standard errors are given in parenthesis.

TABLE 5

Multiple Regression Equations Explaining Concentration [a/]

1970

Independent Variables and other Statistics	Regressions			
	C_1		C_3	
	M_2 (1)	M_3 (2)	M_2 (3)	M_3 (4)
Minimum Optimum Size (M)	0.19 (0.018)	0.12 (0.033)	-0.76 (0.052)	-1.06 (0.071)
Absolute Market Size (S)	-0.24 (0.021)	-0.21 (0.032)	0.78 (0.058)	1.04 (0.070)
Inefficient Production (I)	-0.46 (0.026)	-0.34 (0.035)	0.59 (0.068)	0.20 (0.081)
R^2	0.73	0.66	0.66	0.76
F	167	113	112	173
Number of Industries	185	180	177	169
Relative Market Size (R)	-0.25 (0.021)	-0.09 (0.034)	0.77 (0.055)	1.04 (0.066)
Inefficient Production (I)	-0.52 (0.033)	-0.50 (0.054)	0.63 (0.081)	0.25 (0.093)
R^2	0.69	0.52	0.60	0.75
F	181	100	122	254
Number of Industries	167	184	164	177

[a/] The index of concentration C_1 refers to the Herfindahl index in terms of employment, and C_3 to the number of firms that give employment to 80% of the labor force in the industry.

The definitions of absolute market size (S), relative market size (R), inefficient production (I), and minimum optimum sizes M_2 and M_3 are given in the text. All independent variables are measured in terms of the value added in each industry.

The statistics in the lower panel refer to the results obtained when the absolute market size is deflated by the relevant minimum firm size. The standard errors are given in parehthesis.

TABLE 6

Multiple Regression Equations Explaining Concentration a/

1970

Independent Variables and other Statistics	Regression C_1 M_1 (1)	C_2 M_1 (2)	C_3 M_1 (3)
Minimum Optimum Size (M)	0.059 (0.037)	-0.28 (0.080)	-0.29 (0.080)
Absolute Market Size (S)	-0.24 (0.059)	0.46 (0.11)	0.53 (0.120)
Inefficient Production (I)	-0.076 (0.040)	0.25 (0.087)	0.36 (0.092)
R^2	0.29	0.24	0.30
F	6	9	12
Number of Industries b/	55	91	91
Relative Market Size (R)	* c/	0.32 (0.080)	0.34 (0.82)
Inefficient Production (I)	*	0.25 (0.088)	0.35 (0.094)
R^2	*	0.22	0.27
F	*	12	16
Number of Industries	*	91	91

a/ The C_1 index refers to concentration measured by the Herfindahl index in terms of employment; C_2 is concentration measured by the number of firms that produce 80% of output in an industry; C_3 is concentration measured by the number of firms that give employment to 80% of the labor force in an industry.

The definitions of absolute market size (S), relative market size (R), inefficient production (I), and minimum optimum size (M), are given in the text. All independent variables are measured in terms of industry output.

The statistics in the lower panel refer to the results obtained when the absolute market size is deflated by the relevant minimum optimum size of firm. The standard error of the coefficients are given in parenthesis.

b/ The number of industries for this regression refer to the manufacturing sector alone.

c/ The * indicates that the estimated coefficients were not statistically significant.

Our results, then, add evidence to support the hypothesis (a) that the larger the minimum optimum size of a firm in an industry the larger the degree of concentration; and (b) that a large absolute market size in an industry would reduce concentration. The converse also holds. Since the coefficients of the M's and the S's measure the elasticities of concentration with respect to the minimum optimum size and with respect to the absolute market size, respectively, we can say that, for example, an increase of 10% in the minimum optimum firm size would increase the degree of concentration by 7.7% and that a proportional increase of the same magnitude in the size of the market would decrease it by 8% (Table 4, regression 1). Similar interpretations can be made of the regressions in the other tables.

A proportional increase in the minimum optimum size and in the absolute market size would leave the degree of concentration unchanged if the value of their respective elasticities are equal. This is because of the contrary effect that an increase in the value of these two variables would have on concentration. A visual inspection--as opposed to a statistical test--of regressions in Tables 4 and 5 shows that the value of the coefficients (elasticities) of the M's and of the S's do not differ considerably. The relative stability of the degree of concentration in the industrial sector in Mexico (see Table 2) between 1965 and 1970 may have occurred because the effects of market increases on concentration were offset during this period, by the effects of increases in the minimum optimum sizes.

The coefficient of the variable that measures the proportion of output or value added produced inefficiently (the I's) has the expected sign in all regressions. The sign of this variable is positive in regressions where concentration is measured by C_2 and C_3 and negative when concentration is measured by C_1 and C_4, since the latter indices measure concentration inversely. Our empirical estimates suggest that the degree of concentration would be small if a large proportion of the total output of an industry is produced inefficiently and vice versa. Let us interpret our results in more detail.

The proportion of output or value added produced inefficiently is obtained, as explained above, by adding the output, or value added of all the firms of less than optimum size in an industry. This variable is thought of as a proxy variable to measure the steepness of the slope of the long run average cost curve or easiness of entry of new firms into the industry. If the value of this variable is large it means it is easy for firms to enter the industry and therefore the degree of concentration would be reduced. For example, a decrease of 10% in the value of I (i.e. a reduction of 10% in the difficulty of entry into the market, expressed as the unitary cost difference between firms of optimum and less than optimum size) would reduce concentration by 5.6% according to regression 1 of Table 4 or by 4.6% according to regression 1 of Table 5. Similar interpretations can be made for other regressions. If our analysis is correct, policies to reduce concentration in Mexico should be seen as policies to reduce the barriers of entry of new firms into an industry by decreasing the unitary cost difference of firms of different sizes. The magnitude of the proportion of output or value added produced inefficiently may be viewed as a measure of the extent to which economies of scale can be realized by increasing the size of firms which are less than the optimum.

Our empirical estimates, then, lend support to the supposition that there is a significant inverse association between the degree of concentration and the steepness of the slope of the long run average cost curve within the range of less than optimum size firms. Or, in other words, that the unitary cost differences between firms of optimum and less than optimum size represent significant barriers to entry which may lead to a decrease in the number of firms in the industry and to an increase in concentration.

Finally, the lower panels of Tables 4, 5, and 6 show the coefficients for the regressions that relate concentration with the relative market size (absolute market size divided by the relevant minimum optimum size.) In all regressions the coefficients (elasticities) of this variable have the expected sign: positive for regressions where concentration is measured by C_2 and C_3 and negative for regressions where concentration is measured by C_1 and C_4. The difference in the signs of the coefficients is explained as above. Our results support the notion that the degree of concentration and the extent of the market measured as the relative market size are inversely related. Notice that the depressing effect of the relative market size on concentration is smaller (the value of the elasticities are smaller) than the effect of the absolute market size and that both are statistically significant. Observe also that in most regressions the reducing effect of the absolute market size on concentration is larger than the opposite effect of the minimum optimum firm size. The sign and magnitude of the estimated coefficients for the regressions with absolute and relative market size underline the importance of Mexico's industrial sector's market expansion as a policy variable to reduce concentration.

To summarize our results:

1. Our empirical estimates support the view that there is a positive relationship between the degree of industrial concentration in Mexico and the minimum optimum firm size, and a negative relationship between Mexico's industrial concentration and the absolute size of the industry's market.

2. Our results support the hypothesis that there is an inverse relationship between the degree of concentration and the relative market size (absolute market size weighed by a minimum optimum firm size) of each industry.

3. The relative stability of industrial concentration in Mexico between 1965 and 1970 may be explained by considering that during this period the depressing effects of market growth on concentration were probably offset by the effects of increases in the minimum optimum firm sizes.

4. Our empirical estimates support the argument that there is a positive relationship between the degree of concentration and the barriers to entry as measured by the steepness of the slope of the long-run average cost curve within the range of less than optimum firm size. That is, large unitary cost differences between firms of optimum and less than optimum size represent significant barriers to entry which may lead to increases in industrial concentration.

APPENDIX

Table A1: Means and Standard Deviation of variables in Regression (1) of Table 5

Variable	Mean	Standard Deviation
C_1	0.34	0.19
M_2	$31,714	41,628
S	$398,746	478,775
I	42%	22

Table A2: Mean and Standard Deviation of the variables in Regression (2) of Table 5

Variable	Mean	Standard Deviation
C_1	0.336	0.19
M_3	\$16,503	17,040
S	\$352,691	421,784
I	45%	20

Table A3: Mean and Standard Deviation of the variables in Regression (3) of Table 5

Variable	Mean	Standard Deviation
C_3	47 firms	81
M_2	\$32,346	42,243
S	\$389,332	475,808
I	43%	21

Table A4: Means and Standard Deviation of the variables in Regression (4) Table 5

Variable	Mean	Standard Deviation
C_3	53 firms	94
M_3	\$16,421	16,584
S	\$343,170	417,416
I	45%	19

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