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AN INTERNATIONAL COMPARISON OF CONCENTRATION RATIOS

Frederic L. Pryor

I Introduction

UP to now empirical research on industrial monopoly utilizing comparative data for several countries has focused primarily on relative concentration levels in certain specified industries. The purpose of this article is to supplement these analyses by investigating from international data what we can learn about overall concentration as well as concentration in every manufacturing industry. This is accomplished by comparing the degree of industrial concentration in twelve nations on both an aggregate level and on the individual industry level. For the major industrial nations I show not only that the average levels of concentration in the manufacturing sector are the same, but also that concentration ratios are roughly the same in any specified four-digit industry.

After a short discussion of several important relationships, the empirical analysis is started with an examination of weighted averages of four-firm, four-digit concentration ratios for various nations. This is followed by a regression analysis of individual concentration ratios for specified industries for pairs of nations. An attempt is made to interpret these results in the following section and the study ends with a brief summary of the most important implications of the empirical results. Technical matters including the sources of data and their adjustment are in the appendix.

II Several Preliminary Remarks

An implicit or explicit assumption in many discussions about international aspects of the "monopoly problem" is that industrial concentration is lower in the United States than in other countries having smaller domestic mar-

kets.[1] Underlying this assumption are the arguments that a single minimum-efficient scale (MES) or optimal size enterprise may produce more than enough to supply the domestic market of a small nation, while in the United States, domestic consumption is equal in many cases to the production of many MES or optimal size firms; further, the minimum efficient or optimal scale of an enterprise is roughly the same in all developed nations; and finally, the relevant market facing the enterprise is related to the domestic GNP, and foreign trade is an irrelevant consideration.

These views have come under attack on several fronts. The minimum efficient or optimal scale (in terms of output) may depend on relative factor prices; or it may also depend on size of the domestic market.[2] Further, since many United States industries are regional, not national, the average degree of concentration in the United States is much higher than previously suspected when this phenomenon is properly taken into account;[3] and the European industrial concentration data do not look so out of line with the American results. Foreign trade considerations also seem too important to omit as many analysts have done. Although attempts have been recently made to construct coherent models taking all these various factors systematically into account, we have far to go to reach a satisfactory explanation.

[1] For instance, in an introduction to a presentation of French concentration ratios, Jacques Loup ("La concentration dans l'industrie française," *Études et conjoncture*, XXIV (Feb. 1969) expressly notes that the United States concentration ratios are lower but does not bother to carry out any actual empirical comparisons which would, in point of fact, show the reverse conclusion (see table 2).

[2] This point was emphasized to me in correspondence by Peter Pashigian; for a detailed analysis of certain other critical aspects of the relationships between market size and monopoly, see his "The Effect of Market Size on Concentration," Report 6710, Center for Mathematical Studies in Business and Economics, University of Chicago; or his "Market Concentration in the United States and Great Britain," *Journal of Law and Economics*, XI (1968), pp. 299–319.

[3] This is argued by William G. Shepherd, *Market Power and Economic Welfare* (New York: Random House, 1970).

[130]

In the industrial organization literature one finds scattered comments about the degree to which given industries in different nations have similar degrees of concentration. Although it seems likely that more concentrated industries in one nation might also be more concentrated in another, a satisfactory model of this phenomenon has not yet been presented either, and primary efforts have focused on explaining differences in industrial concentration between the United States and the United Kingdom.

Any type of complete theoretical statement on these matters must take into account the following empirical observations:

1) Average sizes of manufacturing establishments among nations are strongly correlated with indicators of market size of these nations.[4] Data illustrating this relationship are presented in table 1 for various types of measures of average establishment size for the manufacturing sector as a whole; similar relationships hold for narrowly defined industries as well.

2) The degree to which economies are characterized by multi-establishment enterprises is correlated also with indicators of the market size of nations.[5] This relationship holds not only for manufacturing as a whole but also for narrowly defined industries as well.

3) Given the above two empirical relationships, it should not be surprising that average size of industrial enterprises among nations is strongly correlated with indicators of market size. Data illustrating this relationship are also presented in table 1 for various types of measures of average enterprise size for the manufacturing sector; similar empirical results can be obtained for narrowly defined industries as well.

Since the purpose of this paper is to present the results of an empirical study of concentration, exploration of the theoretical factors

[4] This relationship is argued from theoretical considerations and is also found empirically to hold true in my article "The Size of Production Establishments in Manufacturing," *Economic Journal*, LXXXII (June, 1972). Other alleged determinants of establishment size such as the level of development of the economy were tested and did not seem to be correlated with establishment size, at least in my sample of 23 developed or semideveloped economies during the 1960's.

[5] Data and theoretical justifications for this relationship are presented in my book *Property and Industrial Organization in Communist and Capitalist Nations* (forthcoming).

underlying the above described relationships would lead us too far from the central focus.

TABLE 1. — AVERAGE EMPLOYMENT SIZES OF ESTABLISHMENTS AND ENTERPRISES IN MANUFACTURING [6]

	S	R^2
Establishments		
$\ln A = 2.805 + .166^* \ln Y + .093 \ln X$ $\quad\quad\quad (.035) \quad\quad\quad (.084)$	23	.36*
$\ln E = 1.070 + .273^* \ln Y + .241^* \ln X$ $\quad\quad\quad (.049) \quad\quad\quad (.117)$	23	.61*
$\ln N = 1.843 + .508^* \ln Y + .481^* \ln X$ $\quad\quad\quad (.082) \quad\quad\quad (.193)$	23	.67*
Enterprises		
$\ln A = 1.882 + .173^* \ln Y + .065 \ln X$ $\quad\quad\quad (.060) \quad\quad\quad (.138)$	10	.63*
$\ln E = -3.203 + .541^* \ln Y + .087 \ln X$ $\quad\quad\quad (.121) \quad\quad\quad (.279)$	10	.82*
$\ln N = -7.785 + .919^* \ln Y + .682^* \ln X$ $\quad\quad\quad (.105) \quad\quad\quad (.243)$	10	.93*

* = statistical significance at the 0.05 level.
A = arithmetic average employment size of production units in manufacturing. E = entropy index of employment sizes of production units in manufacturing. N = Niehans index of employment sizes of production units in manufacturing. Y = GNP calculated with dollar price weights in 1000 dollars. X = ratio of nonagricultural merchandise exports to value-added in manufacturing and mining. S = number of nations in sample. R^2 = coefficient of determination.

[6] The regressions come from the sources cited in footnotes 4 and 5. In the regressions two measures of "market size" are used: the total GNP (with the dollar value of the GNP calculated with purchasing power exchange rates) and the relative importance of nonagricultural exports. When the latter variable is omitted from the regressions, the other calculated regression coefficients remain roughly the same. The standard errors are shown in parentheses below the calculated coefficients.

For the employment size variables, only establishments or enterprises with labor forces of 20 or more are included in the calculations. The entropy and Niehans indices are weighted averages that are explained and analyzed by George Stigler, *The Organization of Industry* (Homewood, Ill.: Irwin, 1968), chapt. IV. The formula for the entropy index is $\log E = \log L - \Sigma s_i \log (1/s_i)$; and the formula for the Niehans index is $N = \Sigma s_i L_i$, where E = entropy index; N = Niehans index; s_i = share of labor force of a particular production unit in the total labor force; L = total labor force; and L_i = labor force in the production unit.

For the foreign trade variable I am assuming that the ratio of value added in nonagricultural export good production to total value added in manufacturing is roughly in the same proportion in all nations to the ratio of total value of nonagricultural exports to value added in manufacturing, an approximation for which some evidence exists.

Regressions such as those shown in the table have also been calculated for individual industries and, in most cases, show roughly similar results. Other regression experiments using the entire manufacturing sector but assuming a constant composition of output for all nations were also carried and the results were very similar to those presented in the above table.

In addition, consideration of alternative theories linking enterprise size and market size (e.g., theories that link product variety to enterprise size and size of domestic market to product variety) must also be left to others. Whatever the theoretical explanations underlying the results presented in table 1, the empirical relations shown must be noted carefully before the empirical comparisons of monopoly presented below can be correctly interpreted.

III The Average Degree of Monopoly

Our empirical knowledge about relative industrial concentration is small, especially since most international comparisons have been limited to the United States and the United Kingdom.[7] Using some newly released data, we can now extend such international comparisons.

The statistic used below to measure industrial concentration is the four-firm concentration ratio, i.e., the percentage of the value of shipments or production accounted for by the top four enterprises in a narrowly defined industry. In certain cases, which are designated below, the concentration ratios are based on the percentage of employment in a particular industry that is accounted for by the largest four enterprises in an industry. Although there are certain well-known objections to the use of concentration ratios as a measure of monopoly, they provide the only available data with which any comparisons can be made.[8] The concentration

ratios are calculated primarily for industries corresponding to the four-digit classification in the United States industrial statistics reporting system; in certain cases, however, concentration ratios for five-digit industries (i.e., industries defined more narrowly) are used after appropriate adjustments are made.

From pairs of concentration ratios for similarly defined industries of the United States and a given foreign country there were computed weighted averages of overall concentration for each. The results for all countries were then standardized by setting the weighted United States concentration ratios equal to 1.00 and recalculating the foreign weighted average so that the derived ratio was obtained. The number of such pairs of concentration ratios in the indices varied, ranging from 24 (the United States-Netherlands comparisons) to 107 (the United States-Sweden comparisons), and depended on the number of similarly defined industries for which no concentration data could be found.

The indices (or weighted averages) were actually calculated in a two-step procedure because of weighting difficulties.[9] Where concentration ratios based on value of shipments were available, value-added weights were used to consolidate the ratios of individual industries into weighted averages for classes corresponding to the International Standard Industrial Classification (ISIC) two-digit branches of manufacturing. These two-digit branch averages were then combined using value-added weights for the entire branch to calculate the aggregate measure for the entire manufacturing sector.[10] Where only concentration ratios from employment data are available, a similar two-step procedure was carried out using employment in individual industries and in the

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[7] Two recent international comparisons dealing with more than the United States and the United Kingdom deserve mention: Joe S. Bain, *International Differences in Industrial Structure* (New Haven: Yale University Press, 1966); and Morris A. Adelman, "Monopoly and Concentration: Comparisons in Time and Space," in Tullio Bagiotti (ed.), *Essays in Honor of Marco Fanno* (Padua: University of Padua, 1966). In neither study are global comparisons of industrial concentrations calculated.

[8] One objection to the use of four-firm concentration ratios is that the relative concentration in two industries might be reversed if a different cutoff point is used; empirical investigations using United States data show this objection of little consequence. Another criticism is that concentration ratios may understate concentration in regional industry since they are calculated on a national level; I try to make corrections in my analysis for this factor. Finally, many have argued that the four-digit classifications are too broad and that industries must be more narrowly defined. In many cases this is a quite valid objection but unfortunately this empirical investigation is limited by the data at hand.

[9] Weighted averages or indices of concentration have been analyzed and used by a number of economists. For a theoretical analysis of their construction see Leonard W. Weiss, "Average Concentration Ratios and Industrial Performance," *Journal of Industrial Economics*, XI (Mar., 1963), pp. 237–254.

[10] Greater details on the construction of the averages are given in the appendix. Value-added weights are used to aggregate concentration ratios within the two-digit branches in order to minimize differences in definition between weights that might occur because the degree of vertical integration of a particular industry is defined differently in the various national statistics.

two-digit industrial branches as weights instead. For France both types of concentration ratios were available and the results were roughly the same.

There is, of course, an index-number problem in the choice of the national weights in the individual comparisons between the United States and different foreign nations. And, moreover, problems of interpretation arise whatever weights are selected. In order to gauge quantitatively the magnitude of this problem, three different sets of indices were calculated for the two-country comparisons: one using United States value-added weights for the individual industries and two-digit branches; another using United States value-added weights for the individual industries but foreign value-added weights for the two-digit branches; and a third using foreign value-added weights for both individual industry and industrial branch weights. Much less data are available for the third comparison but, as shown below, the results for all three calculations are roughly the same, so that we can draw relatively unambiguous conclusions without worrying unduly about index-number effects.

A final problem arises in the treatment of regional industries and several choices of method are available. Rather than adjust the concentration ratios for each country to reflect whether regional industries are involved, I have chosen to omit from the indices those industries that can be classified as regional in the United States.[11] This procedure considerably reduces

TABLE 2. — WEIGHTED FOUR-FIRM, FOUR-DIGIT AGGREGATE AVERAGE CONCENTRATION RATIOS AS A RATIO OF WEIGHTED CONCENTRATION RATIOS IN THE UNITED STATES [12]

Country	Date	Type of Concentration Ratio	Size of "Basic Sample"	Sub-branch Weights / Branch Weights	U.S. v.a. or Employment / U.S. v.a. or Employment	U.S. v.a. or Employment / Other Nation v.a. or Employment	Other Nation v.a. or Employment / Other Nation v.a. or Employment
A) No Adjustments							
United States	1963	both			1.00	1.00	1.00
Belgium	1963	shipments	54		1.66	1.52	N.A.
Canada	1948	employment	48		1.38	1.35	1.34
France	1963	shipments	70		.93	.95	.92
West Germany	1963	shipments	89		.94	.92	N.A.
Italy	1961	employment	56		.89	.86	.83
Japan	1962	shipments	70		1.14	1.11	N.A.
Netherlands	1963	shipments	24		1.23	1.25	N.A.
Sweden	c.1965	shipments	107		1.54	1.55	1.41
Switzerland	1965	employment	61		1.63	1.68	1.71
United Kingdom	1951	shipments	101		1.20	1.13	1.14
Yugoslavia	1963	shipments	42		1.47	1.41	N.A.
B) Omitting U.S. "Regional Industries"							
United States	1963	both			1.00	1.00	1.00
Belgium	1963	shipments	37		1.54	1.35	N.A.
Canada	1948	employment	37		1.34	1.31	1.29
France	1963	shipments	47		.85	.87	.85
West Germany	1963	shipments	67		.91	.93	N.A.
Italy	1961	employment	38		.82	.76	.79
Japan	1962	shipments	46		1.02	1.02	N.A.
Netherlands	1963	shipments	16		1.10	1.10	N.A.
Sweden	c.1965	shipments	74		1.42	1.45	1.49
Switzerland	1965	employment	39		1.51	1.69	1.72
United Kingdom	1951	shipments	72		1.07	1.03	1.13
Yugoslavia	1963	shipments	29		1.33	1.28	N.A.

[11] I have followed the designation of these industries (with several minor modifications) that is made by Shepherd, op. cit., appendix table 8. It should be added that in the choice of comparable United States and United Kingdom industries, I also partly followed Shepherd's designation in his article "A Comparison of Industrial Concentration in the United States and Britain," this REVIEW, XVIII (Feb., 1961), pp. 70–75, but included industries with low concentration ratios as well.

[12] For the "type of concentration ratio" I have distinguished for simplicity only between those based on shipments and employment. In the former class I include those

the size of the samples and, in order to give some perspective on the effect of this measure, comparisons based on the raw data without such adjustments for regional industries are also presented.

The data in table 2 show that three nations, France, West Germany, and Italy, have weighted concentration ratios somewhat lower than the United States, while an additional three, Japan, the Netherlands, and the United Kingdom, have weighted concentration ratios only slightly higher than the United States. In only five nations are concentration ratios clearly higher, namely, Belgium, Canada, Sweden, Switzerland, and Yugoslavia. It is also noteworthy that concentration in Yugoslavia, a socialist nation which some have believed to be highly monopolized, has about the same degree of concentration as Sweden and Switzerland.

Unfortunately, no convenient tests of statistical significance can be performed on these doubly weighted averages in order to determine whether or not the differences are important. Nevertheless, the unweighted averages yield results quite similar in most cases to the weighted averages and for these we can perform significance tests. Some relevant data for the various nations excluding United States regional industries are presented in table 3; similar results are obtained when other samples are used.

TABLE 3. — UNWEIGHTED AVERAGES OF AGGREGATE FOUR-FIRM/FOUR-DIGIT CONCENTRATION RATIOS EXCLUDING UNITED STATES "REGIONAL INDUSTRIES" [13]

Country	Size of Sample	Ratio of Foreign Mean to U.S. Mean	Difference Between Absolute Levels of Mean Concentration Ratios, Stated as Percentages
Belgium	37	1.46	18.41*
Canada	37	1.52	20.94*
France	47	.90	− 5.26
West Germany	67	.98	− 0.84
Italy	38	.97	− 1.20
Japan	46	1.05	2.76
Netherlands	16	1.17	6.77
Sweden	74	1.58	27.63*
Switzerland	39	1.49	17.47*
United Kingdom	72	1.04	1.78
Yugoslavia	29	1.50	26.93*

* Designates statute significance at 0.05 level.

The data in table 3 show that there are no statistical differences at the 0.05 level in the average aggregate concentration ratios of the United States and France, West Germany, Italy, Japan, the Netherlands, and the United Kingdom. In the remaining five nations the overall levels of concentration are higher.

From table 2 it should be clear that the aggregate degree of concentration is related in some way to the overall market size, rather than level of economic development. The countries fall quite naturally into two groups: those with large dollar values of gross national production (United States, France, West Germany, Italy, Japan, and the United Kingdom); and those with small dollar values of gross national production (Belgium, Canada, the Netherlands, Sweden, Switzerland, and Yugoslavia). The countries in the first group have roughly the same concentration ratios; further, their overall levels of concentration are much lower than the nations in the second group (with the exception of the Netherlands). Dividing the groups of nations into those with relatively high and low per capita income admits of many more exceptions to any generalization. Using regression techniques to analyze the data yields the same conclusions.[14]

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based on production, sales, and shipments and defined in either value or quantity terms. The "basic sample" designates the number of comparable industries included in the comparison with the United States using United States weights for both sub-branch and branch weights. The number of comparable industries using foreign sub-branch weights is somewhat greater since a number of five-digit industries are included. N.A. means not available. To give some idea of the absolute values involved in the comparisons, the following data on United States weighted concentration ratios (using 427 four-digit industries) may be of interest (with weighted concentration ratios based on employment data in parentheses): no adjustments to the raw data, 0.39 (0.30); adjustments made by excluding United States regional and local industries, 0.44 (0.33). Shepherd, op. cit., makes different adjustments by including the regional and local industries, but increasing their concentration ratios and, in addition, adjusting the concentration ratios of certain industries to take into account the fact that they are too widely or narrowly defined. If we follow Shepherd's adjustments, the United States weighted concentration ratio rises to 0.58 (0.44); this procedure is not, however, followed in the text. Sources of data and methods of calculation are given in the appendix.

[13] Sources of data are the same as the previous table. The concentration ratios for each pair of comparisons are added without weighting one industry more than another.

[14] I calculated a number of such regressions, of which a typical one is: $\ln C = 1.712 − .218* \ln Y$; $R^2 = .71$; $S = 11$
(.047)

In interpreting these results one caveat must be emphasized: the data related only to structural characteristics and not to the functioning of the individual economies. Before we can generalize from such structural information to the state of competition, we must have information about other considerations such as the degree of cartelization (or collusion) and the role of foreign trade. Since foreign trade plays a more important role in most foreign nations than in the United States, imports may provide an additional competitive element in those economies vis-à-vis the United States (assuming that tariff barriers are roughly similar); on the other hand, cartelization may be more important in these foreign nations as well. Credible conclusions about the relative state of competition in various nations can only be drawn from highly detailed studies in which these various factors can be properly weighted.[15]

IV Concentration Within Particular Industries

The first step of the analysis is to rank the various two-digit manufacturing branches in each of the twelve nations of the sample according to their weighted average concentration. The average rankings of such weighted average concentration estimates are presented in table 4.

A very distinct pattern of relative concentration emerges and the concordance coefficient, which designates the degree to which the rank

orderings of the various nations are similar, is statistically significant at the 0.01 level. Concentration in all nations is highest among the

TABLE 4. — AVERAGE RANK ORDERINGS OF WEIGHTED CONCENTRATION RATIOS [16]

ISIC Number	Industry	
20	Food processing	13
21	Beverages	15
22	Tobacco products	1
23	Textiles	16
24	Clothing and shoes	18
25	Lumber products export furniture	19
26	Furniture and fixtures	20
27	Paper products	14
28	Printing and publishing	8
29	Leather products	17
30	Rubber products	6
31	Chemicals	5
32	Petroleum and coal products	4
33	Stone, glass, glass products	10
34	Primary metals	12
35	Metal products export machinery	11
36	Machinery export electric and transport	3
37	Electrical equipment	7
38	Transportation equipment	2
39	Miscellaneous	9
Concordance Coefficient		.51
Number of Nations in Sample		12

industries in the tobacco, transport equipment, machinery and petroleum and coal product branches and lowest in the furniture, lumber products (except furniture) and clothing branches.

A more detailed comparison can be made by examining the relationship between individual comparable concentration ratios for the United States and each of the foreign nations and the results of one set of such calculations is presented in table 5.

The calculations show that in all cases there is a statistically significant (0.05 level) relation-

(United States excluded) and where C = average aggregate concentration ratio, regional industries excluded, United States weights for both sub-branches and branches; and the rest of the symbols are the same as in table 1. Changing the form of such regressions or adding additional independent variables does not substantially change the results.

[15] Foreign trade considerations can be partly taken into account by calculating concentration ratios so as to include imports (see William G. Shepherd's forthcoming study using this approach) or by calculating international concentration ratios, so as to be able to take into account multinational enterprises (see Joseph Miller's forthcoming study using this approach). Nevertheless, we also used information concerning the degree to which tariffs protect domestic markets and the substitutability of foreign and domestic trade before the competitive effect of foreign trade can be fully judged. Quantitatively determining the effect of formal and informal collusion, cartelization, and other such devices dampening the forces of competition is even more difficult. Effects of both foreign trade and domestic market considerations are analyzed in one manner by Esposito and Esposito in this REVIEW LIII (Nov. 1971), 343–353.

[16] Weighted two-digit, four-firm concentration ratios were calculated for the twelve nations and then ranked; the average ranks for the manufacturing sector for the individual two-digit industries are presented in the table. The sources for the data are the same as the previous table.

The concordance coefficient, which ranges from 0.00 to 1.00, designates the degree to which the various rank orderings are similar; the coefficient presented in the table is significant at the 0.01 level, i.e., the rankings in the various nations comprising the sample are quite similar. This coefficient is defined and analyzed by Maurice G. Kendall, Rank Correlation Methods (New York: Hafner, 1962).

TABLE 5. — RELATIONSHIPS BETWEEN FOREIGN AND U.S. FOUR-FIRM, FOUR-DIGIT CONCENTRATION RATIOS (excluding U.S. "regional industries")[17]

Country			S	R^2
Belgium	$F =$	.283* + .752* U (.095) (.216)	37	.26*
Canada	$F =$	.220* + .973* U (.063) (.138)	37	.59*
France	$F =$	.009 + .918* U (.073) (.125)	47	.55*
West Germany	$F =$	.088 + .807* U (.053) (.095)	67	.53*
Italy	$F = $	−.019 + 1.017* U (.053) (.118)	38	.67*
Japan	$F =$	.162 + .754* U (.088) (.149)	46	.37*
Netherlands	$F =$	.195 + .674* U (.107) (.241)	16	.36*
Sweden	$F =$	.444* + .652* U (.044) (.083)	74	.46*
Switzerland	$F =$	.290* + .674* U (.061) (.145)	39	.37*
United Kingdom	$F =$	.227* + .541* U (.056) (.110)	72	.26*
Yugoslavia	$F =$	.557* + .469* U (.073) (.119)	29	.36*

F = foreign four-firm/four-digit concentration ratio. U = U.S. four-firm/four-digit concentration ratio. S = number of concentration ratios of different four-digit industries in sample. R^2 = coefficient of determination. Asterisks denote a statistical difference from zero at the 0.05 level.

ship between the four-firm, four-digit concentration ratios in the United States and the various foreign nations. The amount of variation of the foreign concentration ratios that is "explained" by variation in comparable United States ratios ranges from 26 to 67 per cent.

The most striking results occur for France, West Germany, Italy, Japan and the Netherlands; for these nations we cannot reject the hypothesis (at the 0.05 level of significance) that the concentration ratios in particular industries are numerically the same as in the United States, i.e., that the regression equation is: foreign concentration ratio for industry $X = 0.0 + 1.0 \times$ United States concentration ratio for industry X! Thus, for five out of the six nations that have similar overall levels of concentration as the United States, the results

[17] Standard errors are placed below the calculated regression coefficients; asterisks denote statistical significance at the 0.05 level. The source of data is the same as in previous tables.

appear because the concentration ratios for individual industries are similar as well. (The United Kingdom is the only exception.) These results are particularly impressive because there is a statistical bias in the regressions that leads to slopes less than unity, a positive constant coefficient, and an *underestimation* of the degree of equality between foreign and United States concentration ratios because concentration ratios are bounded between 0.00 and 1.00.[18] Investigation of the individual industries in which concentration ratios in the five nations differed significantly from those of the United States yielded no very interesting results.

For Belgium and Canada we cannot reject the hypothesis (at the 0.05 level) that the individual concentration ratios are equal to the individual United States ratios plus a constant; and, comparing tables 2 and 3, the constant in the regression is roughly equal to the difference between the overall levels of concentration in these nations and the United States. Thus, for seven out of the eleven nations under examination (Belgium and Canada plus the five nations discussed in the previous paragraph) the slope coefficient relating the United States and foreign concentration ratios for individual industries is not statistically different from unity.

For the remaining four nations (Sweden, Switzerland, the United Kingdom, and Yugoslavia), the pattern of relationship with United States concentration ratios is statistically significant but less easy to interpret, since, for a

[18] The nature of this bias can be seen most clearly by starting with the full form of the calculated regression: $F = a + bU + u$, where it is a random disturbance. If U is very small, u will tend to be positive since F cannot be less than 0.00; if U is very large, u will tend to be negative since F cannot be greater than 1.00. This will lead to a positive intercept and a slope less than unity, even when the true relation is $F = 0.00 + 1.00 \ U$. Certain complicated statistical techniques such as probit analysis can be employed to get around this difficulty but for the purposes at hand these did not seem necessary. Several experiments were made to test the strength of the bias, e.g., the regressions were recalculated, omitting from the sample all industries in which the concentration ratio of one or both nations is a prespecified distance from 0.00 and 1.00. These seemed in most cases to yield roughly the same results as those presented in table 5 above. The samples did not seem large enough to be able to be used to discriminate between different functional forms of the relationship between the concentration ratios of pairs of nations and, therefore, I chose the most simple relationship.

given industry, their concentration ratios are greater than those in the United States for industries with low concentration, and are lower than those in the United States in highly concentrated industries.[19]

The results show clearly that forces making for monopoly in a particular industry are similar in the twelve nations. A considerable amount of empirical work has been devoted to explaining the impact of forces such as barriers to entry on industrial concentration in the United States and much work needs to be done on other nations as well. The available international data do not permit adequate derivation of measures of barriers to entry that are independent of the concentration variable that we are trying to explain.[20] I did try to test a recently proposed hypothesis by L. G. Telser that the nature of the competitive process is such that concentration is related to the capital intensiveness of production by calculating a rank order correlation coefficient between relative concentration (table 5) and relative capital/labor ratios;[21] but the calculated coefficient was low and not statistically significant. A quantitative international study of forces encouraging monopoly in particular industries must be put on the agenda of future research if we wish

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[19] Pashigian, "Market Concentration in the United States and Great Britain," op. cit., argues that the differences in concentration ratios for individual industries in the two nations can be explained by the relative sizes of the individual markets for these two countries.

[20] I did find significant correlations between the rank order of concentration (table 4) and rank orders of fixed capital in average size enterprises in the two-digit industries, or of workers and employees in average size enterprises. Unfortunately, since absolute and relative enterprise size are highly correlated, such measures of barriers to entry are quite inadequate. From United States and Swiss industrial censuses, I found data on the ratio or research and development personnel to total personnel in the industry; and these data give some indication of the "degree of technical intensiveness" of an industry which, in turn, might reflect an important barrier to entry. Although such a rank ordering of industries is significantly correlated with the average rank ordering of concentration, the measure of this technological barrier is sufficiently imperfect to make interpretation of the results very uncertain.

[21] This proposition has been argued on the basis of an interesting model of business behavior by L. G. Telser, "Cutthroat Competition and the Long Purse," *Journal of Law and Economics*, IX (Oct. 1966), pp. 259–277. The capital/labor ratios come from a multi-national comparison contained in Pryor, *Property and Industrial Organization* . . . , op. cit.

to fully understand industrial organization from a world standpoint.

V Some Interpretative Remarks

For those who believe that the degree of industrial concentration is inversely related to market size, the results presented in this paper provide an interesting paradox. The following remarks are intended to provide assistance in unraveling this problem.

First, the empirical results of this study are consistent with the proposition presented in section B that average enterprise sizes (both in the manufacturing sector as a whole and also in individual industries) vary according to the market size in aggregate. If we look closely at the various indicators of enterprise size in the regressions reported in table 1, we note that the greater the weight placed on the largest enterprise (the Niehans index places greater weight on the largest sized enterprises than the entropy index; and the entropy index places greater weight on these large enterprises than the arithmetic average), the closer the calculated elasticity coefficient of average enterprise size to total GNP is to unity. It thus appears from the regressions in table 1 that the size of the largest enterprises vary in the same proportion as total GNP and this is quite consistent with the results that the average degrees of industrial concentration for many nations are roughly the same. The rise in industrial concentration in nations with small GNP's would, according to this interpretation, reveal a nonlinearity that is not reflected in the specification of the regressions in table 1. Although questions about the functional form and the numerical value of coefficients linking average enterprise size and GNP cannot be resolved with the small sample of nations with comparable data with which we have to work, the existence of a relationship between enterprise size and GNP seems crucial to interpret the empirical results presented in the last two sections of this study.

Second, the approach used in this essay focuses the search for an explanation of the similarity of four-firm, four-digit concentration ratios in the largest industrial nations on those factors underlying the positive correlation between enterprise size and total GNP, namely,

the positive relationships between total GNP and average establishment size and also the degree to which industries are characterized by multi-establishment enterprises in nations with different GNP's.

Third, alternative approaches toward an explanation that rely on the impact of differential tariffs or that start from Markov analyses of the growth of enterprises show little promise for helping us understand the results. Trying to explain the results of this study from the empirical analyses of concentration in a single country (that show an inverse relationship between market size and industrial concentration) with the addition of one or two more explanatory variables to take into account "international effects" does not seem very promising to me either. One explicitly acknowledged difficulty in all of these more intensive studies of market size and concentration is the difficulty in obtaining an adequate measure for market size.

Fourth, the results of this study of concentration may have one important implication on the analysis of production functions, namely, that the optimal or minimum efficient sizes of enterprises may not be invariant in all nations but may vary with size of the GNP. If the link between these results and production functions is denied, then some alternative explanation for the correlation between enterprise size and the GNP must be specified. One possible alternative explanation that resorts to differences in relative factor prices to explain the conclusions about concentration was casually examined by the author, but my empirical results to examine this hypothesis seemed sufficiently unpromising to encourage any greater efforts along these lines.

Fifth, the empirical results in this paper, especially those showing great similarity in the degree of concentration in the group of largest nations, are the cross-section analog to results reported by others showing that for individual nations, the degree of concentration has not changed greatly over long periods of time.[22]

This numerical similarity of concentration at several points in time has never been adequately explained but implies a distinct relationship between average enterprise and market size, a relation that seems crucial to the above reported results as well. It must be added that neither the time-series nor the cross-section comparisons of industrial concentration give insight into the exact nature of this relation between enterprise and market size, but merely demonstrate the existence of such a relation. But recognizing the existence of some force is an important step in trying to assess its nature.

Finally, the similarity of industrial concentration in the largest nations at one point in time and the similarity of industrial concentration in particular nations over time makes us wonder whether or not anti-trust legislation and enforcement, particularly in the United States, has been very effective.[23]

VI A Brief Summary

The data show that the average four-firm, four-digit concentration ratios among large industrial nations are roughly the same; and also that concentration in these nations is less than among smaller nations.

The data also show that the rank order of concentration ratios by specific industries are

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[22] Op. cit. For the United States the key study is by Morris A. Adelman, "The Measurement of Industrial Concentration," this REVIEW, XXXIII (Nov. 1951), pp. 269–296. [The relevant data are reprinted by U.S. Bureau of Census, *Historical Statistics of the United States, Colonial Times to*

1957 (Washington, D. C.: U.S. Government Printing Office, 1960), p. 573.] A study of the more recent period is by William G. Shepherd, "Trends of Concentration in American Manufacturing Industry, 1947–1958," this REVIEW, XLVI (May, 1968), pp. 200–212. For the United Kingdom, data on these matters are analyzed by R. Evely and I.M.D. Little, *Concentration in British Industry* (Cambridge: University Press, 1960). Studies of the more recent period include William G. Shepherd, "Changes in British Industrial Concentration, 1951–1958," *Oxford Economic Papers*, XVIII (Mar. 1966), pp. 126–133; and Kenneth D. George, "Changes in British Industrial Concentration, 1951–1958," *Journal of Industrial Economics*, XV (July, 1967), pp. 200–211. The Norwegian case is examined by Fröystein Wedervang, *Development of a Population of Industrial Firms* (Oslo: Universitetsforlaget, 1964), chap. VI.

In the short run the degree of industrial concentration has apparently changed considerably in some nations, e.g., in Yugoslavia over a nine-year period, average concentration markedly declined. (Such data are analyzed by Stephen R. Sacks, "Changes in Industrial Structure in Yugoslavia, 1959–1968," *Journal of Political Economy* (forthcoming).

[23] This question has also been raised in the context of a comparison between the United Kingdom and the United States concentration by George Stigler, "The Economic Effects of the Anti-trust Laws," *Journal of Law and Economics*, IX (Oct., 1966), pp. 225–258.

roughly the same in all nations. Indeed, for most of the larger industrial nations, such concentration ratios are roughly the same for individual four-digit industries. And for the rest of the nations, simple relationships between such individual four-firm, four-digit concentration ratios and those in the United States can be easily established.

Underlying the results is a previously determined empirical relationship showing that average enterprise size (both for manufacturing as a whole and for individual industries) and total market size appear to be highly correlated. And this correlation appears to be the result of the fact that establishment size and the degree to which industries are characterized by multi-establishment enterprises are correlated with GNP. Although the exact form and parameters of these various relationships have not been accurately determined because of the limited number of degrees of freedom of the samples on which they were derived, such relationships nevertheless appear to be the key to unlocking the meaning of the empirical results on industrial concentration in twelve nations that are presented in this paper.

APPENDIX

(A) Sources

United States: The concentration ratios come from Subcommittee on Antitrust and Monopoly of the Committee on the Judiciary, U.S. Senate, *Concentration Ratios in Manufacturing Industry, 1963* (Washington, D.C.: U.S. Government Printing Office, 1966); the branch weights in manufacturing come from U.S. Bureau of the Census, 1963 Census of Manufactures, vol. I (Washington, D.C.: U.S. Government Printing Office, 1966).

Belgium, West Germany, Netherlands: The Concentration ratios were calculated by the European Economic Community (E.E.C.) and presented by Jacques Houssiaux, "Annex I to Statement," in Subcommittee on Antitrust and Monopoly of the Committee on the Judiciary, U.S. Senate, *Economic Concentration*, Part 7A (Washington, D.C.: U.S. Government Printing Office, 1969). These data were supplemented in several cases by estimates made by Joseph Miller. The branch weights come from E.E.C., *Industrial Statistics*, J-A/1967.

Canada: The concentration ratios come from Gideon Rosenbluth, *Concentration in Canadian Manufacturing Industries* (Princeton: Princeton University Press for

National Bureau of Economic Research, 1957), p. 90 and Appendix A. Those ratios given for just three firms were adjusted in the following manner: three- and four-firm concentration ratios by individual industries that were given by Rosenbluth were compared and a curve was fitted. This relationship was then used to adjust those three-firm ratios for which four-firm ratios were not given. Branch weights were estimated from data from: United Nations, *The Growth of World Industry, 1938–1961* (New York: 1963) and Dominion Bureau of Statistics, *General Review of Manufacturing Industries of Canada 1954* (Ottawa: 1957).

France: The concentration ratios come from Houssiaux, op. cit. and Jacques Loup, "La concentration dans l'industrie francaise, d'après le recensement industriel de 1963: la structure des marchés," *Études et conjoncture*, XXIV (Febr. 1969), pp. 17–239. For the concentration ratios based on value of shipment, the two-digit averages were calculated with value of shipment weights, rather than value-added weights which were not available. The branch weights come from E.E.C., *Industrial Statistics*, J-A/1967. For the value-added weights enterprise rather than establishment data had to be used since the latter were not available.

Italy: The concentration ratios were calculated from employment data by size class following a technique described by Joe S. Bain, *International Differences in Industrial Structure* (New Haven: Yale University Press, 1966), pp. 27–29. The basic data come from Istituto centrale di statistica, *4° Censimento generale dell' industria e del commercio*, vol. III, Industria, Tomo 1, *Imprese* (Rome: 1966). The branch weights come from E.E.C., *Industrial Statistics*, J-A/1967.

Japan: The concentration ratios come from Tokihiki Iinkai, *Nihon no sangyo shucho* (Tokyo: 1964). The branch weights come from United Nations, *The Growth of World Industry*, 1967 edition, vol. 1 (New York: 1967).

Sweden: The concentration ratios come from Statens offentliga utredningar, Finansdepartementet, *Industrins struktur och konkurrensförhållanden, Koncentrationsutredningen*, III (Stockholm: 1968). The basic set of statistics are ratios by industrial branches, table 2, pp. 86–95; these were supplemented by ratios for products according to the Brussels classification, table 3, pp. 95–110. The former were based on value of shipment and had value-added weights supplied; the latter were based on physical shipments and had gross-sales information. The gross-sales data were converted into value-added weights by applying the United States ratios of these magnitudes. Certain estimates were also made in those cases where concentration ratios for more than four firms were presented. The branch weights come from Statistiska Centralbryan, *Industri 1965* (Stockholm: 1965).

Switzerland: The concentration ratios were calculated according to the Bain method from employment data by size group presented in Eidgenössisches Statistisches Amt, *Eidgenössische Betriebszählung September 1965*, Band 1, *Unternehmungen: Hauptergebnisse für die Schweiz*, Heft 409, Reihe Df-1 (Berne: 1967). The

data are not completely comparable with those of the other nations because of the Swiss practice of isolating those firms that produce products in a great many industries and placing them in a special category entitled "Verbindung," a procedure that may greatly affect the calculated concentration ratios in the machinery branches. The branch weights are from Band 2, Heft 410, Reihe Df-2 in the same series.

United Kingdom: The basic data on concentration ratios come from Richard Everly and I.M.D. Little, *Concentration in British Industry* (Cambridge: University Press, 1960), appendix B. Where three firm concentration ratios are given, estimates for four-firm ratios are made using the relationship found for Canada and described above; where five- and six-firm concentration ratios are presented, estimates of four-firm ratios were made using the Bain method. Branch weights were estimated from data from: United Nations, *The Growth of World Industry 1938–61*, op. cit., and Central Statistical Office, *The Index of Industrial Production* (London: HMSO, 1959).

Yugoslavia: The concentration ratios come from Joel Dirlam, "Tables to Accompany Statement," Subcommittee on Antitrust and Monopoly, *Economic Concentration*, part 7A, op. cit. Although the original source could not be located, a similar table is published by Izak Drutter, "Tržišni aspekti koncentracije," *Problemi privredne koncentracije* (Zagreb: Ekonomski institut, 1964), table 13. One misprint was corrected. Branch weights come from Savezni zavod za statistiku, "Jugoslovenska Industrija 1963," *Statistički biltin*, No. 421 (1966).

(B) A Detailed Description of the Calculation of the Weighted Averages

The basic data were comparable concentration ratios for a number of four- and five-digit industries for eleven foreign nations plus a complete set of four- and five-digit concentration ratios for the United States. In order to simplify discussion, the following symbols are used:

$UC5_i$ the concentration ratio in a five-digit industry i in the United States.

$FC5_i$ = the concentration ratio in the foreign country that is comparable to $US5_i$.

$UC4_i$ = the concentration ratio in a four-digit industry that includes industry i in the United States.

$FC4_i$ = the concentration ratio in the foreign country that is comparable to $US4_i$.

$UU2$ = weighted two-digit concentration ratio for the United States for the particular sample, using United States value-added weights.

$FU2$ = weighted two-digit concentration ratio for the foreign nation for the particular sample, using United States value-added weights.

$UUT2$ = weighted two-digit concentration ratio for the United States for all industries in that classification, using United States value-added weights (one set of these were calculated using all industries, another set excluding regional industries).

For each country the foreign five-digit ratios were first "converted" into four-digit ratios by using a simple method. For those industries in which only one pair (i.e., comparable United States and foreign ratios) of five-digit concentration ratios was available, the foreign ratio was adjusted by multiplying by $(UC4_i/UC5_i)$ and was then paired with $UC4_i$. Where several pairs of five-digit ratios were available, a weighted average (using value-of-shipment weights) was first calculated and then the foreign weighted average was adjusted by multiplying by $(UC4_i/\text{United States weighted five-digit average})$.

The calculated two-digit weighted averages give the desired relationship between the United States and foreign ratios, but they cannot be considered to reflect satisfactorily the absolute degree of concentration since the sample of industries is not necessarily representative. Therefore, both the $UU2$ and the $FU2$ data were adjusted by multiplying by $(UUT2/UU2)$. The results were then used to calculate the final weighted averages.

When the averages using the foreign weights were calculated, one additional problem arose since we had no complete set of foreign ratios with which to calculate an aggregate corresponding to $UUT2$. If we assume that the adjusted $FU2$ average (i.e., $FU2 \times UUT2/UU2$, which I designate by the letter X) reflects the *level* of concentration for the whole two-digit branch, then we can adjust both the foreign-weighted United States and foreign two-digit weighted averages by multiplying both by $X/\text{foreign-weighted}$ foreign two-digit weighted average. While this procedure is the best we can do with the available data, it does leave something to be desired if we are interested only in this result alone. However, the reason for the exercise is to gain some idea of possible index number effects by comparison with the United States weighted results and, therefore, the major purpose is served.