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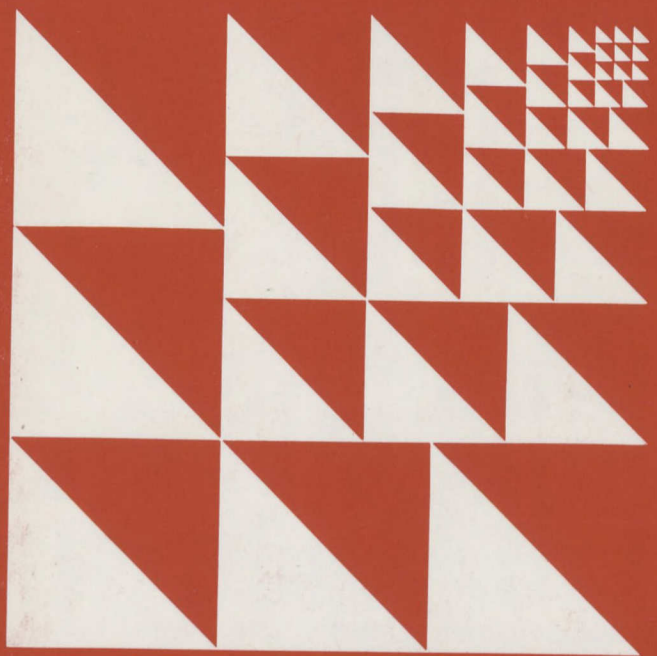
Concentration in the Manufacturing Industries of Canada:

Analysis of Post-War Changes

R.S. Khemani



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SUMMARY

Concentration in the Manufacturing Industries of Canada: Analysis of Post-War Changes

by

Dr. R.S. Khemani

Research Branch
Bureau of Competition Policy

Industrial concentration refers to the extent to which a small number of firms account for a large proportion of the economic activity in a given industry.

Economists in the field of industrial organization and competition policy generally hold the view that the degree of concentration affects industry conduct and performance. Economic theory and actual experience suggest that, other things being equal, the smaller the number of firms accounting for a large proportion of an industry's output, the more likely it is for monopolistic practices to prevail. In highly concentrated industries, firms tend to have considerable latitude in their decisions regarding price, output and other related matters because the presence of only a few rivals enables them to act inter-dependently. In contrast, when industry concentration is low, the existence of many rivals will force firms to behave independently with the result that they will have less discretionary power. In the latter case, industry price and output levels are likely to be determined by market forces rather than by the decisions of leading firms.

Changes over time in industry concentration levels are of interest because often they reflect changes in other structural factors which affect the discretionary market power of leading firms. From the point of view of administering competition policy and scientific case selection, it is important to identify the relative significance of these different factors contributing to changes in industry concentration levels. For example, in industries where leading firms have not exploited all the available economies of scale, increases in industry concentration are not likely to conflict with the basic objectives of competition policy. However, when increases in concentration are likely to result from horizontal mergers designed to limit competition, the Director of Investigation and Research, Combines Investigation Act, may use the legislative powers pertaining to mergers.

...2

In Canada, analysis of changes in industry concentration levels has been hampered by the paucity of relevant data. These data gaps have recently been bridged by a joint Bureau of Competition Policy and Statistics Canada project. Drawing on a unique data base, the present study analyzes levels, trends and selected determinants of change in concentration in Canadian manufacturing industries over the post-war period, 1948-72. This long period is selected because industry concentration levels tend to change only gradually over time.

The analysis in this study is based on a sample of 57 manufacturing industries, accounting for approximately half of total manufacturing shipments and employment. Data problems constrained the choice of the measure of concentration used in the main body of the study. The measure of concentration chosen is the four-firm employment concentration ratio, that is, the percentage of total industry employment accounted for by the four largest firms. While employment corresponds less closely to the concept and dimensions of a market than shipments, the two are highly correlated. Tests conducted in the study also indicate a high correlation between the four-firm concentration ratio and other types of measures of concentration.

Ideally, statistics on which industry concentration ratios are based should be adjusted to take into account factors such as geographic market segmentation and the influence of foreign trade. Concentration ratios computed on a national basis are likely to understate the actual levels of concentration prevailing in regional markets. Similarly, the degree of concentration may be overstated if the bulk of industry output is exported or if imports have not been explicitly taken into account. Tests in this study, conducted on a limited sample of industries, indicate that concentration ratios adjusted for these factors are highly correlated with those which are not. Thus, the shortcomings of the data on which this study is based are not likely to alter the general results and conclusions of the analysis.

The principal empirical results of the study are:

a) Canadian manufacturing industries have varying but generally high levels of concentration. In 1972, approximately half of the total number of census manufacturing industries had four-firm concentration ratios of 50 percent or more.

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b) Concentration levels on average have increased over the post-war period. The average four-firm concentration ratio in 1948 was 44.4 percent; in 1972 it was 48.3 percent.[1] The four-percentage point increase is significant given that generally concentration levels in countries such as the United States have remained relatively stable over the post-war period.

c) Concentration in industries with initial high levels has tended to decrease, but these industries still remain highly concentrated.

d) Econometric analysis indicates that the significant concentration-increasing factors are firm multi-plant operations, horizontal mergers and firm exits. The significant concentration-decreasing factors are market growth and entry of new firms.

e) The concentration-increasing effect of change in plant size is statistically insignificant. In other words, observed higher levels of industry concentration in 1972 do not result mainly from larger plant sizes. This result suggests that firms have probably exhausted the available economies of scale at the single-plant level.

f) In contrast, the significant concentration-increasing effect of firm multi-plant operations suggests that the firm level economies of operating two or more plants were not initially exhausted. The increases in firm multi-plant operations appear to stem in part from market growth.

g) Growth in market size, aside from possibly facilitating the growth of medium- and small-sized firms, also appears to have had the effect of reducing barriers to entry. Entry of new firms, which is found to be a significant deconcentration factor, is highly correlated with market growth.

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1. Since the completion of this study, Statistics Canada has provided concentration data for three additional years. The average four-firm employment concentration ratios for the sample of industries analyzed in this study for 1974, 1976 and 1978 are 49.2, 48.9 and 49.4 percent respectively. This additional information indicates that the trend towards higher levels of industry concentration has not been abated.

...4

h) The exit of firms possibly reflects rationalization of industry production. The relative effect of exit tends to be slightly greater in industries subject to the additional pressures of import competition.

i) The significant concentration-increasing effect of horizontal mergers suggests that the leading firms are the more active acquisitors of other firms in the sample of industries analyzed.

j) The effects of advertising and tariffs on concentration change are found to be insignificant.

The results cast doubt on theories which suggest that the tariff-protected small size of Canadian markets inhibits firms from pursuing potential plant economies of scale. If such economies were realized, industry concentration levels would be even higher. Increases in plant sizes were generally found to be statistically insignificant in explaining the post-war increases in industrial concentration levels. But the fact that increases in firm multi-plant operations have a significant concentration-increasing influence lends support to the conclusion of the Royal Commission on Corporate Concentration that the lack of adequate firm level economies was a major disadvantage confronted by Canadian firms.

The significant role that horizontal mergers have played in increasing concentration levels further buttresses the concerns of the Bureau of Competition Policy relating to mergers. The specific merger provisions of the Combines Investigation Act have been rendered ineffective by past legal interpretation. Without revisions to these provisions, the trend towards higher industry concentration levels will remain unchallenged.

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Ideally, statistics on which industry concentration ratios are based should be adjusted to take into account factors such as geographic market segmentation and the influence of foreign trade. Concentration ratios computed on a national basis are likely to understate the actual levels of concentration prevailing in regional markets. Similarly, the degree of concentration may be overstated if the bulk of industry output is exported or if imports have not been explicitly taken into account. Tests in this study, conducted on a limited sample of industries, indicate that concentration ratios adjusted for these factors are highly correlated with those which are not. Thus, the shortcomings of the data on which this study is based are not likely to alter the general results and conclusions of the analysis.

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CONCENTRATION IN THE MANUFACTURING INDUSTRIES OF CANADA: ANALYSIS OF POST-WAR CHANGES

BY

R.S. KHEMANI

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The analysis and conclusions of these studies are those of the authors themselves and do not necessarily reflect the views of the Department.

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I, of course, am solely responsible for any errors contained in this study.

The views expressed in the study should not be construed as necessarily being those of the Bureau of Competition Policy.

R.S. Khemani

FOREWORD

Occasionally, studies undertaken in the Research Branch provide the twofold opportunity to present fresh data of general interest in the area of competition policy and industrial organization and to produce analysis relevant for public policy. This study achieves both purposes.

With the cooperation of Statistics Canada personnel and innovative use of various statistical information collected by that agency, the author, Dr. R.S. Khemani, has bridged important data gaps on the structure of Canadian manufacturing industries. Drawing on this enriched data base, he has explored with new rigour the relative influence factors such as plant and multi-plant economies of scale, market growth and mergers have on determining changes in industrial concentration. The analysis reveals that industrial concentration has been increasing in Canada over the post-war period. Among the factors examined, the merger activity of leading firms is shown to have had an important influence on levels of industrial concentration.

These and other related findings of the study take on additional interest, arriving as they do at a time when important public policy issues relating to proposals for revision in the structural aspects of competition policy law are under active discussion in Canada. Because the study was presented earlier in the form of a doctoral dissertation for the London School of Economics, the present version of the study has benefited from the comments of several internationally acknowledged experts in the field.

D.F. McKinley
Director
Research Branch
Bureau of Competition
Policy

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CHAPTER I

INTRODUCTION AND SUMMARY

1.1: Introduction

A fundamental structural characteristic of Canadian manufacturing industries is the varying but generally high degree of concentration.[1] Recent Statistics Canada data relating to the year 1972, indicate that in approximately half of the total number of census manufacturing industries, the leading four or fewer firms[2] account for 50 percent or more of the total value of shipments. And only 29 of the total of 171 industries have four-firm

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1. The term "concentration" is used here for those genre of measures reflecting the extent to which a small number of firms account for a large proportion of an industry's output or some other unit of economic activity, e.g., employment. Economists in the field of industrial organization and competition policy generally regard the degree of concentration as bearing importantly on the market behaviour and performance of firms. Further details on the rationale(s) for measuring and studying industry concentration can be found in Bain (1968), National Bureau of Economic Research (1955) and Scherer (1971).

2. The term "firm" as used here is equivalent to the 'unconsolidated enterprise' defined by Statistics Canada (1977, page 8). The unconsolidated enterprise is the grouping of all establishments (plants) in a single census industry which belong to companies under common control. Companies with 50 percent or more of common voting stock owned by the same business entity, directly or indirectly, are defined as being under common control. The unconsolidated enterprise or firm is intended to approximate the economic decision-making unit with regard to prices, output and related matters.

concentration ratios of less than 25 percent.[3] Earlier studies also have noted the high degree of concentration in Canadian manufacturing.[4] In addition, concentration levels in Canada are generally recognized as being higher than those in identical or similar industries in the United States.[5]

Previous research has primarily focused attention on degrees of industry concentration prevailing in a given year. While limited attempts have been made to examine trends, these at best provide a general impression of the direction in which industry concentration levels have been changing. Moreover, the picture becomes blurred by changing industry definitions, differences in sample size, non-availability of concentration statistics for interim years and selected measures of concentration utilized in the various studies. This is especially the case when the

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3. Ibid., Table C, pages 22-23. Because of its general availability and the ease with which it can be computed, the "four-firm concentration ratio" (CR_4) is one of the widely used measures of concentration. It is simply the share of the largest four firms of total industry value of shipments (or some other measure of economic activity, e.g., employment). Similarly eight-, twelve-, etc., firm concentration ratios are computed. As a census convention, multiples of 'four' firms are selected in order to avoid disclosing the identity of individual firms. See Chapter III (and references cited therein) for discussion on the measurement of industry concentration.

4. See Rosenbluth (1957); Stewart (1970); Department of Consumer and Corporate Affairs (1971).

5. Rosenbluth (1957, Chapter IV); Department of Consumer and Corporate Affairs (1971, Chapter VI).

6. For example, the Standard Industrial Classification System was comprehensively revised in 1960 and 1970. No historical links with 1948 industry definitions were provided. Until the present study, concentration statistics for the years between 1948 and 1965 were not available. The measure employed was the number of firms required to account for 80 percent of industry employment (inverse index) in 1948, whereas later data consisted principally of the four-firm concentration ratio (CR_4) computed on a variety of bases including employment. See Chapter III.

analyses relate to post-war periods up to 1965. However, analyses based on the more exhaustive post-1965 data in turn are limited by the short time period of seven or less years for which concentration statistics are available. Industry concentration level and most of its structural determinants tend to change very slowly over time. In addition, trends analyzed over short periods such as seven or less years may be subject to one of the important criticisms frequently levied against cross-section studies, namely, that the results may reflect divergences between the observed levels of industry concentration and the equilibrium levels that would emerge if all the underlying forces were allowed to work themselves out.

This is explicitly recognized in the study by Caves[7] for the Royal Commission on Corporate Concentration. Part of the study analyzes the determinants of change in industry concentration levels over the very short period 1965-68. While the study makes an important contribution in the area of research methodology and design,[8] the empirical results must be regarded as being highly tentative.

Notwithstanding the improved concentration data available for the late 1960s, conflicting conclusions still obscure the picture. Caves states that there has been a slight tendency for concentration to increase over both the 1965-68 and 1965-70 periods.[9] Another study prepared for the same Royal Commission by Marfels[10] concludes that concentration levels between 1965 and 1972 have declined. It is unlikely that these contradictory statements arise because of different end years. The sample in the latter study includes industries which ought to have been excluded due to their heterogeneous product composition. Concentration indexes computed for such industries are meaningless. If such cases are excluded, on average, concentration levels in terms of the four-firm concentration ratio appear to have increased over the same period.[11]

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7. Caves, Porter, Spence et al. (1978).

8. See Chapter II of the present study for further details.

9. Caves et al. (1978, page 169).

10. Marfels (1978, page 139).

11. Khemani (1976, pages 22-24).

Thus, while concentration statistics - admittedly computed on varying bases - are available for as early as 1948, it is not known whether concentration in Canadian manufacturing industries has been increasing, stable or decreasing over the post-war period, nor what are the likely causal factors underlying the phenomenon of concentration change.

In contrast, there are a number of studies on post-war concentration trends in U.K. and U.S. manufacturing industries,[12] but research on causal factors is still in its formative stages. Caves has observed:

> Competition policies in most industrial countries now attempt to combat increases in concentration or at least curb some of its effects, if not actively to reduce it; and some measures seem designed to lower entry barriers. Yet we face a paradox in nominating these elements of market structure as objects for policy action: we feel we know their effects, but we know little about why they take the (sometimes noxious) values they do, or how tightly they are determined by behavioural forces.[13]

1.2: Focus of the Present Study

This study analyzes levels, trends and selected determinants of change in concentration in Canadian manufacturing industries over the post-war period, 1948-72. Aside from bridging the empirical gaps noted above, it is hoped that the results of the analysis will contribute to a better understanding of the process of industry concentration itself.

It is often asserted that industry concentration levels at any point in time reveal little about the various

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12. For U.K. see: George (1967, 1972); Gribbin (1976); Sawyer (1971).

    For U.S.A. see: Kamerschen (1972); Mueller and Hamm (1974); Nelson (1963); Shepherd (1964) and Weiss (1963).

13. Caves (1976, pages 3-4). Similar sentiments have been expressed by: Robinson (1953); Penrose (1956, 1968) and Sylos-Labini (1969).

structural and related conditions affecting competition.[14] However, changes that occur with the passage of time do convey information. Changes in industry concentration are:

> uniquely significant because often they reflect, at least partially, changes in other structural variables as well. For example, if entry barriers are declining because of growing markets or whatever, this tends to become reflected in lower concentration .... Hence, change in ... concentration may also reflect what is happening to other structural variables affecting the discretionary power of sellers.[15]

From this standpoint, industry concentration can be perceived as an index number.[16] Viewed as such, a systematic and detailed analysis of concentration change takes on added importance, particularly in connection with framing and implementing competition policy in the context of selected traits of Canada's secondary manufacturing sector.

An explanation frequently espoused in the literature for the prevailing high levels of industry concentration in Canada, relates to the small size of the domestic market in relation to "efficient" scale of production dictated by given technology.[17] In fact, studies on individual Canadian industries suggest that the observed levels of concentration would perhaps be higher if firms were able to exploit fully all the potential economies of scale. Interdependence among firms in a relatively small domestic market, it is argued, has inhibited installation of

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14. The issues and divergent viewpoints are perhaps best synthesized in: Goldschmid, Mann and Weston (1974) and Scherer (1971).

15. Mueller and Hamm (1974, page 511).

16. Adelman (1965, page 729).

17. The Canadian Bank of Commerce and Royal Commission on Canada's Economic Prospects (1956); Rosenbluth (1963, pages 18-23); Gorecki (1976a). This is also implicit in: Economic Council of Canada (1969, Chapter 5).

plants of efficient capacity, wherever efficient capacity was large in terms of the domestic market. Consequently, Canadian industries tend to be 'overcrowded' with plants of sub-optimal size, short production runs, duplicate product lines/output, and excess costs of production. It is argued further that these conditions are facilitated by protective tariffs which not only segregate the domestic Canadian market from the larger North American or international market, but also allow Canadian firms to incur excess costs of production and charge higher prices up to the amount of the tariff without stimulating import competition.[18]

Since this paradigm was first put forward, general population and economic growth, GATT and Kennedy Round tariff reductions have extended the market size confronting Canadian manufacturing firms. Depending on the degree to which this has occurred, it should have facilitated the pursuit of economies of scale, and may have reduced the interdependent behaviour among firms with respect to price and output policies and generated competitive pressures which in turn may have resulted in structural rationalization. Other things being equal, this suggests increases in industry concentration levels.

As in other countries, analyses of industry concentration levels and trends are an important element in the calculus of the Canadian Bureau of Competition Policy's investigation of actual or potential anti-competitive situations.[19] However, the prime objective of Canadian

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18. Eastman and Stykolt (1960, 1967); English (1964).

    The economies of scale issue as discussed in Canada has been both, in terms of plant and product specific economies. In the present context, since product data are not available, the focus is on the former type of economies. However, the argument analogously applies to product specific economies as well. Domestic Canadian markets are most likely too small for all existing plants in individual manufacturing industries to specialize in any one product. See Daly et al. (1968). See Scherer et al. (1975) for discussion on product and plant specific economies.

19. See for example the Annual Report of the Director of Investigation and Research, Combines Investigation Act, (Department of Consumer and Corporate Affairs, 1966), which sets out the criteria used (including market share information) to evaluate mergers.

    The role of market share information in implementing competition policy in other countries is described in: Subcommittee on Antitrust and Monopoly, Committee of the Judiciary, U.S. Senate (1968, Parts 7 and 7A).

competition policy is not to promote competition for its own sake, but as a vehicle to promote efficiency in the allocation and use of resources. Recognizing that the structural traits of the Canadian economy are a constraint against adopting a *per se* approach to industry concentration, Canadian competition policy does not prohibit increasing industry concentration where it does not damage competition or where efficiency or other considerations indicate a net benefit to the public.[20] The extent to which these structural traits are reflected in prevailing or increasing levels of industry concentration impinge importantly on strategic choices related to the instruments of competition policy.

For example, in industries where leading firms have not exploited all the available economies of scale, increases in industry concentration are not likely to conflict with the basic objectives of competition policy. Nevertheless, in such situations, to reduce the probability of collusive behaviour among firms and to ensure that benefits of economies of scale are translated at least in part into public gains, the Director of the Bureau of Competition Policy may seek tariff reductions to stimulate import competition. Similarly, when increasing levels of concentration result from horizontal mergers designed to gain control of and to monopolize markets, the Director may use the powers pertaining to mergers. In other cases, stable levels of industry concentration, or low rates of entry of new firms, may indicate structural rigidities and barriers to entry which need to be investigated.[21]

Therefore, from the point of view of administering competition policy and scientific case selection, it is important to identify the relative significance of the different factors contributing to change in industry concentration levels.

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20. Bertrand (1977).

21. Consumer and Corporate Affairs Canada (1977) describes the present (and proposed) powers of the Director (Competition Policy Advocate).

1.3: Selected Features of the Present Study

The analysis in this study is restricted to samples of definitionally comparable industries across the broad spectrum of the manufacturing sector and is based on published and unpublished data derived from Statistics Canada's Census of Manufactures. Excluded are industries deemed to be too heterogeneous in their product coverage for meaningful analysis. The total sample of industries analyzed accounts for approximately half of 1972 manufacturing employment and value of shipments.

Incorporated are selected measures of industry concentration previously not available and compiled in a joint Bureau of Competition Policy-Statistics Canada project undertaken specifically for the purposes of this study.[22] These measures are the four- and eight-firm concentration ratios (CR_4, CR_8) and the Herfindahl-Hirschman (H-H) index for the years 1954 and 1958.[23] Also included are revised computations of these measures for the year 1948 previously published on a different basis.[24] The measure used in the analysis is the four-firm concentration ratio (CR_4). This stems from the extensive use of this measure in previous

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22. The methodology used for compiling these statistics was developed by the author in consultation with Mr. H. Potter, Manufacturing and Primary Industries Division, Statistics Canada, Ottawa, Canada. Full details can be obtained by writing to the author c/o Research Branch, Bureau of Competition Policy, Consumer and Corporate Affairs, Ottawa-Hull, K1A OC9, Canada.

23. The H-H index is defined as the sum of squares of all the individual firm shares of industry employment or some other unit of economic activity.

    Algebraically, $H\text{-}H = \sum_{i=1}^{n} x_i 2$ where n = total number of firms and x_i is the share of industry employment of the ith firm. If the industry has only one firm (monopoly) the H-H index is equal to one, which is the maximum value of this measure of concentration.

24. These are based on unpublished tabulations kindly provided by Professor Gideon Rosenbluth, University of British Columbia, Vancouver, Canada.

studies and the prominent role assigned to it in the administration of competition policy generally. The measure is computed using industry employment. While employment corresponds less closely to the concept and dimensions of a market than shipments, the two are highly correlated. High correlations also exist for levels as well as change in this concentration measure computed on these two bases.

Concentration measures in the main body of research could not be adjusted to take into account changes in the identity or rank of the leading four-firms and the relative influence of factors such as geographic market segmentation and external trade.

Several new measures of factors influencing concentration, which have not been analyzed in earlier related research are presented in this study. These include measures of multi-plant operations of firms and entry, exit and horizontal merger of firms.

1.4: Summary of Principal Findings

Analysis of concentration levels and change based on national census of manufactures data, should incorporate adjustments for geographic market segmentation and external trade, factors that are significant determinants in certain industries. In absence of such adjustments, concentration in the former case is likely to be understated whereas in the latter it can be overstated. Lack of sufficient data precludes detailed analysis of the extent to which this occurs in the present study.

Available data suggest that the importance of geographically segmented markets can be overstated. For sub-samples of industries with regional markets, 61 percent of the plants, 70 percent of value of shipments and 63 percent of employment, on average, were located in the provinces of Ontario and Quebec in 1972. In addition, the largest plants and firms are located in these two provinces. It is this preponderant geographic region on which the structure and behaviour of most manufacturing industries is likely to be determined.

For sub-samples of industries, limited data on imports are available. Statistical analysis indicates that a high correlation exists between adjusted and unadjusted concentration ratios, and suggests, for purposes of inter-industry comparisons, that unadjusted concentration ratios used in the main body of the study are not likely to pose serious limitations on the analytical results. Export data could not be included in the analysis of concentration ratios.

A correlation analysis is conducted between the two measures of concentration used in this study, viz., the four-firm concentration ratio (CR_4) and the Herfindahl-Hirschman (H-H) index. High correlation coefficients computed for the total sample of industries confirm results reported in other studies, though less so for change in concentration than for levels. The correlation coefficients, however, tend to be lower when computed for sub-samples of industries ranked above a given level of concentration, or for a given magnitude of change, in one or the other concentration measure. These low correlation coefficients indicate choice between the two measures can be critical for analyzing industries with high concentration levels or large magnitudes of concentration change.

Descriptive statistical analysis suggests that over the 1948-72 period, on average, concentration in terms of CR_4 has tended to increase. In addition, concentration in industries with high initial levels has tended to decline whereas industries with low initial levels have become more concentrated. Similar trends are also observed in sub-samples of producer and consumer goods industries.

An econometric model of the determinants of change in industry concentration levels is specified and tested in the later chapters of this study. Among other factors, concentration change is described as being dependent on change in absolute plant size or in relative minimum efficient plant size, change in firm multi-plant operations, market growth, entry, exit and horizontal merger of firms.

The results of a regression analysis indicate that the concentration increasing effect of change in plant size is either statistically insignificant or it explains less of the inter-industry variation in the change in the four-firm concentration ratio than other factors. These results would be consistent with the conjecture that economies of scale at the single plant level have been exhausted. Various alternative measures of changes in plant size and proxies for minimum efficient plant size are used in the analysis.

In contrast, firm multi-plant operations (which have tended to increase) are found to explain significantly the increase in levels of concentration. This appears to stem in part from market growth, suggesting firm level economies of multi-plant operations may not initially have been exhausted. Further analysis indicates that the increased incidence of firm multi-plant operations does not arise solely from the inclusion of industries with regionally segmented (product or raw material) markets. In

industries with national markets, both change in plant size and change in firm multi-plant operations are found to be significant. Change in plant size is, however, less significant and contributes less to the inter-industry variation in concentration change than change in multi-plant operations. This suggests that the limit imposed by market size on plant size is, as would be expected, more likely to occur in regional industries, where economies of scale at the plant level are less fully exploited.

The deconcentration effect of market growth is found to be significant. Aside from possibly facilitating the growth of medium-and small-sized firms, it also appears to have had the effect of reducing barriers to entry. Entry of new firms is not only a significant deconcentration factor, but in part stems from market growth. These results lend additional support to the interpretation that plant economies of scale likely have been exhausted. Otherwise, the excess capacity among the leading firms would enable them to keep pace with the rate of market growth and would also pose a deterrent to entry of new firms.

The analysis also indicates that exit of firms, possibly reflecting rationalization of industry production, is a significant concentration increasing factor. The relative effect of exit tends to be slightly greater in industries subject to the additional pressures of import competition.

The increases in concentration levels in Canadian manufacturing industries are significantly related to horizontal mergers among firms. Extensions of the analysis suggest that this is of greater incidence in industries with regional markets.

Additional results reveal that tariffs and product differentiation do not appear to affect significantly change in industry concentration levels.

These results have a number of implications for policy. At a minimum they suggest that the 'tariff-protected small domestic market size limiting economies of scale' paradigm, which has been used in framing basic industrial and commercial policies in Canada needs to be re-evaluated insofar as it relates to plant level economies of scale. If such a paradigm were to apply, the growth in market size that has occurred during the post-war period should have facilitated economies of plant scale and the plant size variables used in the analysis should therefore exert a significant concentration-increasing influence.

In specific reference to competition policy, the results raise the question of whether or not there are significant gains in allocative efficiency from firm multi-plant operations and horizontal merger activity. If such gains are not to be found or are inadequate and if the pursuit of economies of scale as reflected in change in plant size indeed is not a dominant concentration-increasing factor, then it would remove an otherwise important constraint in the application of structural remedies to reduce industry concentration levels. In addition, the significant concentration-increasing effect of horizontal mergers lends support to the long-standing but to date unsuccessful initiatives to strengthen the merger and monopolization provisions of the Combines Investigation Act. The results also point to the fact that policies designed to lower barriers to trade can be used effectively to promote structural rationalization which may result in Canadian firms becoming more competitive internationally.

However, before such policies are framed, the results of this study would benefit from further research. Inter-industry analysis of inter-temporal change in concentration levels and its determinants is only a starting point. Differences noted among sub-samples of industries with different market or structural characteristics point to the need for renewed emphasis on industry-specific research, particularly of a kind conducted in a dynamic framework.

CHAPTER II

SYNOPTIC REVIEW OF METHODOLOGY AND EMPIRICAL RESULTS OF STUDIES ON FACTORS INFLUENCING INDUSTRY CONCENTRATION CHANGE

2.1: Methodological Problems

Empirical investigation into the determinants of levels and changes in industry concentration is a complex task.[1] In part this stems from the fact that measures of concentration essentially summarize the primary dimensions of the number and size distribution of firms in a given market or industry, and partly because concentration is determined by other elements of market structure which can also be linked to these primary dimensions. In addition, the static nature of industrial organization theory and the interdependency that exists between various determinants poses a number of difficulties for analysis of concentration change.

It is worth elaborating on the methodological and related problems connected with some of these points. Rosenbluth showed that measures of industry concentration can be partitioned into the number and inequality of firms or average firm size, inequality of firms and industry (or market) size.[2] Concentration rises with an increase in average firm size or in inequality of firm size and with a decrease in industry size. These conditions, however, do not cause the change in concentration levels. This is so because the relationship between concentration and these elements is defined by an identity. In order to explain causes of concentration, one has to identify factors which affect the inequality among firm sizes, average firm size and number of firms in an industry.

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1. The ensuing discussion relies heavily on: Caves (1976); Caves et al. (1978, Chapter 7); Ornstein et al. (1973) and Rosenbluth (1957).

2. Rosenbluth (1957, pages 29-32) measured concentration by the number of firms required to account for 80 percent of industry employment. Inequality was defined as the proportion of firms required to account for 80 percent of industry employment. Industry size was defined as total industry employment. Other measures of concentration, e.g., the four-firm concentration ratio (CR_4), can be similarly partitioned. See Section 2.2.

One factor which industrial organization theory does identify as causing concentration is minimum efficient firm size, viz., the smallest scale of output at which economies of scale are realized, assuming given technology and factor input prices. For a given minimum efficient firm size, ceteris paribus, the larger (smaller) the market size, the greater (fewer) will be the number of firms of efficient size and concentration will tend to be low (high). Similarly, for a given market size, ceteris paribus, the larger (smaller) the minimum efficient firm size, the fewer (greater) will be the number of such firms and concentration will tend to be high (low). This suggests that the inverse relationship between concentration and market size and the direct relationship between concentration and minimum efficient firm size operates through the number of firms. Given these interdependent relationships, it may not be possible to gauge the independent effect of these factors on concentration.

This is more so in the case of market size and number of firms since, generally, minimum efficient firm size is, at any given point in time, largely a technologically determined datum. Thus, it may be theoretically inappropriate to specify both market size and number of firms as separate factors "explaining" concentration. Moreover, while the scale required to exploit available firm economies may be primarily determined by technological factors, the actual scale of a firm's output (whether efficient or otherwise) is influenced by the size of market it serves. Market size, as well as minimum efficient firm size (among other factors), probably determines the average size of firms. Models of concentration which include average size of firms (as a proxy for minimum efficient firm size) along with market size and number of firms as other explanatory variables, may essentially specify an identity.[3]

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3. See Ornstein et al. (1973) for a review of studies where some of these problems have occurred. The review relates to analyses of inter-industry concentration levels for a given year. The identity-related problems are particularly acute when the concentration models specified have both structural and behavioural explanatory variables, and the former are based, not on separate information, but on information used to construct measures of industry concentration - the phenomenon one is seeking to explain. The identity relationships that emerge are not only between concentration and the explanatory variables but also between sub-sets of explanatory variables. In the example cited here, average firm size multiplied by the number of firms is equal to market size. Conversely, market size divided by number of firms is equal to market size. Caution is required when sets of variables specified in a model are

The extent of this will depend, in this example, on the role of the excluded term of the indentity, viz., firm size inequality.

Over and above these methodological difficulties are those created by the static nature of industrial organization theory and the wide range of possible hypotheses that can be formulated in connection with analyzing concentration change. For example, whether pursuit of economies of scale by firms over time results in higher concentrion levels depends importantly on assumptions relating to initial conditions prevalent in the industry under question, and the degree and nature of the inter-dependence between economies of scale and other factors. If, for a given market size, leading firms in an industry have already exploited available economies of scale and there is no change in the minimum efficient firm size, pursuit of economies of scale by other firms in the industry can result in the decrease in firm size inequality and the number firms. Whether concentration will change or not will depend on the relative importance of changes in firm size inequality vs. changes in the number of firms. Similarly, if markets grow, pursuit of economies of scale may be facilitated, but whether firm size inequality will change and/or whether changes in the number of firms will take place will depend, among other factors, on the assumptions regarding the size and number of firms that may enter the industry as a result of market growth. In light of such considerations, Bain observes that, generally, the exact level of industry concentration that will emerge at any given point in time

> ... cannot be predicted a priori unless we acquire more information than we now possess concerning the relative strength and detailed nature of the various forces.
> As to changes in concentration, the relative force of various concentration-increasing or concentration-deterring forces may alter significantly through time. Scale economies may become more or less important because of technological changes. Entry barriers based on patent or resource control may wither away, or new ones may emerge. Product developments may undercut old product differentiation barriers to entry. Legal restriction on concentration may be tightened or slackened. Markets may grow more or less

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jointly equivalent to one or more of the other variables also included in the model. Further discussion related to this problem is contained in Chapter VI where the model used in this study is presented.

> rapidly. The future course of changes in concentration cannot be foreseen until changes in all these dimensions can be predicted, and their probable consequences appraised.
>
> In our present state of knowledge, therefore, we cannot fully explain or rationalize the evolution of concentration in the past or accurately predict its future course.[4]

2.2: A Framework for Analysis and Results of Previous Studies on Canada

The analytical framework adopted in this study and considered most suitable has been formulated by Rosenbluth (1957) and Caves (1976, 1978). Caves' generalized description of the methodology is as follows[5]:

> First, we examine the identity-type factors underlying concentration, to discover how much of inter-industry differences in concentration are due to the differences in these various underlying primary structural characteristics.
>
> Defining concentration as C, and the dimensions of industry structure that can be related to it via a close identity as C_i, then we estimate the functional relations:
>
> $$C = f_1 (C_1, \ldots\ldots, C_i, \ldots\ldots, C_n). \qquad (1)$$
>
> Second, with this evidence in hand, we proceed to the behavioural determinants of concentration, S_i, and estimate relations that take the form:
>
> $$C = f_2 (S_1, \ldots\ldots, S_i, \ldots\ldots, S_n). \qquad (2)$$
>
> Finally, we examine the significant relations that have appeared between C and the S_i. The influence of the significant S_i on C should operate through theoretically identifiable subsets of the C_i, which we regress on the appropriate S_i to check inference:
>
> $$C_i = f_3 (S_i). \qquad (3)$$

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4. Bain (1968, pages 213-214).

5. See Caves *et al*. (1978, page 157).

The identity-type factors underlying the four-firm concentration ratio (CR_4) can be expressed as[6]:

$$CR_4 \equiv (S_4/S) \equiv (LFI) \cdot (4/N) \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\equiv (LPI) \cdot (LMP) \cdot (4/N) \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Where:

LFI = leading four firm size inequality = $(S_4/4)/(S/N)$.

LPI = leading four firm's plant size inequality = $(S_4/NP_4)/(S/NP)$

LMP = relative extent of multiplant operations of the leading four firms = $(NP_4/4)/(NP/N)$.

S= industry size, e.g., total shipments or employment.

S_4 = size of the four largest firms measured in the same units as S.

N= total number of firms in the industry.

NP= total number of plants in the industry.

NP_4 = number of plants among the leading four firms.

In his study for the Royal Commission on Corporate Concentration Caves analyzes the identity relationship expressed in equation (4) and finds that inter-industry differences in CR_4 levels in Canadian manufacturing are chiefly associated with inter-industry differences in the number of firms.[7] With this evidence in hand, Caves then

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6. See Caves et al. (1978, page 158). Other forms are given in: Evely and Little (1960, pages 100-114) and Nelson (1963, pages 66-77). Rosenbluth (1957, pages 29-37) presents similar identity relationships using the 80 percent inverse concentration index.

7. The analysis relates to the year 1968. Since the relationship specified in equation (4) is an identity, use of regression analysis is inappropriate. Analysis of variance or correlation analysis is generally employed. Caves employs correlation analysis and uses the term N instead of the term 4/N.

specifies a regression model to explain concentration that includes, among others, factors which economic theory postulates are related to the number of firms, viz., minimum efficient plant size, market size and regional market segmentation.[8] In the third step of his analysis, Caves replaces the dependent variable CR_4 (and CR_8) by their definitional elements LPI, LMP and N. The results obtained confirm that the set of variables used to explain concentration also account for a high percentage ($R^2 = 0.63$) of the inter-industry variation in the number of firms.

The essence of these results is that inter-industry differences in CR_4 levels in Canada are largely a function of the number of firms in each industry, and the number of firms in each industry is a function of the size of its markets.

These results were also obtained by Rosenbluth in his analysis relating to the year 1948. Rosenbluth found that inter-industry variation in concentration, using the 80 percent inverse concentration index, was definitionally related primarily to the variation in the number of firms. Further analysis by Rosenbluth indicated that the variation in average firm size was an important factor influencing the variation in the number of firms. And the variation in average size accounted for 64 percent of the variation in concentration. Thus, in order to explain concentration,

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8. Caves notes that the behavioural determinants of concentration fall logically into two categories. The first category consists of industry-specific factors, e.g., technology which is likely to vary little across countries. The second category consists of country-specific factors, e.g., market size and tariff protection. These latter factors are likely to vary greatly across countries. In order to control for the first set of factors, Caves includes in his model U.S. concentration levels. According to Caves, U.S. concentration levels are likely to reflect industry-specific factors which are insensitive to national differences on the grounds that the United States is the largest industrial country and on balance the one in which new products and technologies have been most fully diffused. Caves' model also has several innovative features. The minimum efficient plant size and market size variables are sub-divided to take into account different industry characteristics. For example, the market size variable is sub-divided so that its regression slope takes on different values, depending upon the extent to which industries in the sample analyzed differ in their exposure to international trade.

Rosenbluth specified a regression model where the explanatory variables could be related to average firm size, (and the number of firms), namely capital intensity, market size and regional market segmentation.[9] Inter-industry differences in inequality among firm size accounted for little of the variation in concentration levels. Therefore, Rosenbluth's model did not include variables directly related to firm size inequality.

The analyses presented by both Caves and Rosenbluth avoid the identity-related problems which have plagued many studies on concentration by focusing only on those factors which are related to the definitional element(s) accounting for a major part of the inter-industry differences in concentration. In addition to this procedure of eliminating certain variables, the procedure of re-specifying selected variables such that closed identity relationships do not exist can be fruitfully pursued in analyzing the phenomenon of industry concentration.[10] Also, analysis of changes in concentration levels over time as compared to analysis of concentration levels for a given year provides some leverage against identity-related problems if the time period selected for analysis is sufficiently long for structural change to have taken place. However, as mentioned at the outset of this study, there has been little research on changes in industry concentration levels in Canada. Data problems seem to have precluded both Rosenbluth and Caves from conducting detailed analyses of concentration change.

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9. Op. cit., Chapter II. Rosenbluth used a proxy for capital intensity (horsepower capacity of prime movers per employee) to capture plant economies of scale effects. The high correlation between average firm size and average plant size (0.978) and between firm and plant concentration levels (0.947) led Rosenbluth to infer that multi-plant operations play a negligible role in the determination of firm size as well as concentration. This, however, is not the case when changes in firm size and changes in concentration levels are analyzed. See Chapters V and VII in the present study.

10. Rosenbluth's use of horsepower per employee and Caves' use of average size of largest plants accounting for 50 percent of total industry shipments (as proxies for plant economies of scale) are examples of such "re-specifications".

Rosenbluth[11] examined plant concentration trends in 16 manufacturing industries over the period 1936-48. He found that there was a trend towards declining concentration. There was, however, a trend towards increasing plant size and an increasing degree of mechanization within industries.[12] That these two factors did not result in higher concentration levels, as economic theory suggests, was attributed by Rosenbluth to the concentration-reducing influence of growth in market size and increase in the total number of plants.

It should be noted that no information on firm concentration levels is available for years prior to 1948. Thus, firm concentration levels may have significantly increased over the period analyzed by Rosenbluth due to such factors as increase in multi-plant operations.

Some indication that firm and plant concentration trends can differ is provided in a study by the Department of Consumer and Corporate Affairs.[13] In a sample of 40 industries there was a clear increase in enterprise (firm) concentration levels over the period 1948-65. In contrast, over the same period, increases in establishment (plant) concentration levels appeared to have been approximately offset by decreases. The median number of large enterprises (firms) required to account for 80 percent of industry employment in 1948 was 13: in 1965 it was 11. This concentration measure in terms of number of plants for the same two years was 17 and 19 respectively.[14]

Caves,[15] in his study, notes that firm concentration levels have increased over both the 1965-68 and 1965-70 periods. In order to explain these changes in industry concentration levels, he specifies and tests a regression

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11. (1957, see pages 98-108).

12. As in the case of his analysis of 1948 concentration levels, (changes in) the index of horsepower per employee was used as a rough index of the substitution of capital for labor.

13. (1971, pages 43-46).

14. The higher the number of firms or plants required to account for 80 percent of industry employment, the lower is the degree of concentration.

15. Caves et al. (1978, page 169).

model consisting primarily of other structural variables, e.g., change in average plant size, market growth, relative cost disadvantages of small plant size and industry advertising intensity.[16] The statistically 'best' results Caves obtains account for only 24 percent of the inter-industry variation in concentration change. Changes in average plant size and market growth are found to be the principal explanatory factors.

Caves cautions readers about the tentative nature of his findings. The period over which the analysis is conducted is very short (1965-68) and collinearity between changes in average plant size and market growth is such that when the former variable is excluded from the model, the regression coefficient for market growth became statistically insignificant. In addition, Caves states that the significance of changes in the average plant size variable probably reflects the part identity relationship it has with concentration.

It is of some interest to note that while Caves finds concentration levels between 1965-68 and 1965-70 to have on average increased, another study prepared for the Royal Commission on Corporate Concentration reaches different conclusions. Marfels[17] concludes that concentration levels between 1965 and 1972 have declined. These differences arise because Marfels' sample includes industries which ought to have been excluded due to their heterogeneous product composition. If this is done then concentration levels on average appear to have indeed increased over the 1965-72 period.[18] Marfels' study is descriptive and does not attempt to explain the observed changes in industry concentration levels.

This is the present state of knowledge about the direction of and different factors underlying concentration trends in Canada.

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16. The model also includes concentration levels in counterpart U.S. industries on the hypothesis that they may reflect the "equilibrium levels" the concentration levels in Canadian industries are tending towards. Another variable is included to measure the effect of entry of already established and diversified firms. See ibid., pages 169-74.

17. Marfels (1978, page 139).

18. See Khemani (1976, pages 22-24).

2.3: Results Relating to Other Countries[19]

2.3.1: United Kingdom

Studies relating to concentration change in U.K. manufacturing industries have been primarily descriptive. For the most part, the analyses are based on two-way classification of concentration change and selected variable(s). Such tabulations, at best, provide a general impression of whether or not a systematic relationship exists between change in industry concentration levels and the selected variable(s), but do not enable one to quantify the observed relationship(s) or the relative influence of different factors on concentration change.

Generally, the studies reviewed conclude that concentration levels between 1951-58,[20] 1958-63[21] and 1964-70[22] have tended to increase in U.K. manufacturing industries. In addition, an inverse relationship is found between change in and initial levels of concentration.[23]

Disagreement exists on the relationship between concentration change and market growth. Shepherd,[24] for instance, concludes that over the 1951-58 period, the generally postulated inverse relationship between these two variables is not supported. There is in fact a weak positive relationship. Market growth is measured in terms of percentage change in industry employment by Shepherd. While employment statistics correspond less to the dimensions of a "market" than shipments, the two measures tend to be highly correlated. George[25] argues that Shepherd's analysis (based only on cases where there have been large magnitudes of change in concentration and/or industry employment) is very restrictive. He concludes that when the total sample is analyzed, growth does tend to offset the tendency towards higher concentration. A similar conclusion is reached by Gribbin for the 1963-70 period.

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19. This review is restricted to studies analyzing concentration change in U.K. and U.S. manufacturing industries since the Second World War.

20. Armstrong and Silberston (1965); George (1967).

21. George (1972); Sawyer (1971, Section 4).

22. Gribbin (1976).

23. See Prais (1958); Wallis and Roberts (1965).

24. Shepherd (1966).

25. George (1967).

In contrast to the preceding set of studies, Sawyer (1971) supplements his descriptive analysis with an attempt to quantify the relationship between concentration change and individual factors such as initial concentration level (CR_8), change in number of firms (DF), growth in industry employment (GE) and growth in industry output (GO). Growth in industry output is undeflated for price changes. The empirical results suggest concentration change is related inversely with each of these factors though the regression coefficient for GE is statistically insignificant.[26] If, however, GE and DF are regressed together against concentration change, the coefficient for GE becomes significant and positive. Sawyer reasons this result is compatible with the premise that larger firms which generally operate across different industries are able to grow at a faster rate than smaller independent "single-industry" (i.e., undiversified) firms. This occurs because they may be able to transfer resources 'internally' more rapidly than capital and labour markets can facilitate for the independent firm.

Use of the change in the number of firms (DF) variable to explain concentration change by Sawyer is highly questionable. This variable is definitionally related to concentration change and also tends to be highly correlated with GE.[27] In addition it reflects the combined effects of entry, exit and horizontal merger of firms - each of which warrants separate analysis.

2.3.2: United States

Early empirical studies in the United States have focused on the hypothesis that market growth leads to decreased concentration levels.[28] The influence of other factors (except for net changes in the number of firms) has not been included in the analyses until recently. Nelson tests the inverse market growth-concentration change relationship for the period 1947-54, Shepherd, for 1947-58 and Kamerschen, for 1947-63. Shepherd and Kamerschen, in addition to the four- and eight-firm concentration ratio, also employ the 20-firm concentration ratio. Market growth

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26. Single variable regression equations are estimated.

27. Shepherd (1972b).

28. Nelson (1960); Shepherd (1964); Kamerschen (1968a).

is measured in terms of the percentage change in value of shipments (undeflated for price changes) or industry employment.

The results of these studies suggest that market growth by itself accounts for little of the inter-industry variation in concentration change.[29] These results are obtained from analyses conducted over the total sample of industries as well as sub-samples of industries having initial concentration levels in excess of 50 percent or market growth of greater than 15 percent.

These studies also find that change in the net numbers of firms is significantly inversely related to concentration change, and that this variable tends to dominate the relationship when included in the regression equation along with the market growth variable. In addition, Kamerschen's analysis indicates that the inverse market growth-concentration change relationship tends to be less significant over shorter estimation periods.

The overall conclusion one can draw from these results is that the concentration-reducing effect of market growth tends to be generally weak in U.S. manufacturing. There appear to be other offsetting factors which enable leading firms to keep abreast with the pace at which markets tend to grow.

A more recent study[30] investigates the market growth-concentration change hypothesis covering the period 1963-67. Once again market growth is measured in terms of undeflated industry value of shipments. Changes in the number of firms as well as a binary dummy variable for producer goods and consumer goods industries are specified in the regression equation. The analysis is conducted for all industries and for sub-samples of industries with initial concentration (CR_4) levels of less than or greater than 50 percent.

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29. For example, Shepherd's (1964) analysis indicates that growth accounts for at most 11 percent of the inter-industry variation in concentration change in U.S. manufacturing.

30. Farris (1973).

The results indicate that the relationship between market growth and change in CR_4 tends to be positive in relatively unconcentrated industries whereas it tends to be negative in industries with high initial concentration levels. However, market growth does not explain much of the inter-industry variation in concentration change in either of these two groups of industries, and tends to be significant only when the relationship is tested for all industries.

It is concluded as well that consumer goods industries are more likely to become increasingly concentrated or to resist concentration-deterring forces than producer goods industries. This conclusion implies that market growth is less significant in its impact in consumer goods than in producer goods industries. Change in the number of firms is found to be associated with declining concentration, but the relationship is not close in the case of more highly concentrated industries, probably because barriers to entry are likely to be prevalent in such industries.

Similar results are obtained when the analysis is extended to cover earlier periods. However, longer time periods tend to yield slightly better statistical results. Depending on the sample size and time period estimated, the R^2 values range between 0.082 and 0.136. These results suggest the important causes of concentration change lie elsewhere - possibly in unique conditions peculiar to individual industries.[31]

That conditions peculiar to individual industries in part may account for differences in concentration change has been explored earlier by Weiss (1963). This study postulates that "competition in product design will be both more severe and less predictable in its effects on particular firms than other types of competition, at least in markets with some degree of recognized inter-dependence among firms" (page 71). From this it is derived that the variance in firm growth rates will tend to increase, and as a result "concentration is most likely to increase or least likely to decrease, other things being equal, in those industries where the prevailing form of competition is style or model change - that is, in the industries which produce differentiated durable or semi-durable goods" (page 71).

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31. Ibid., page 302.

To test his hypothesis, Weiss draws a sample of 87 four-digit S.I.C. industries for the period 1947-54. Analysis of variance indicates significant differences (at one percent level) in concentration change between "differentiated durable" and "semi-durable" goods industries and all other industries. The former show increases while the latter show decreases in concentration levels.

Weiss recognizes that several other factors may contribute to these changes. He reports that initial concentration levels, the local, regional or national character of markets, and single-value estimates for barriers to entry[32] are all found to be insignificant.

He also explores the influence of change in minimum optimum plant size relative to market size (MOS) on concentration change. A statistical proxy ('mid-point plant') for minimum optimum plant size is computed for 1947 and 1954 and deflated by industry size corresponding to these years.[33] Concentration change is measured as the ratio of 1954 CR_4 to 1947 CR_4 values. This method of measuring concentration change tends to give less weight to a given percentage point change in CR_4 in industries which have higher initial levels of concentration.

The empirical results indicate that change in minimum optimum plant size as measured here "explains" only about 25 percent of the inter-industry variation in concentration change. It does, however, have a significant positive impact on concentration levels and supports a priori predictions put forward in industrial organization theory.

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32. This he derives from Bain (1956).

33. Weiss states: "The mid-point plant size was estimated as follows: Cumulative totals of value added by employment size classes were computed to find the class containing the mid-point plant, and the employment size of that plant was estimated by interpolation. Its value added was then estimated by the value added per employee in its size class" (1963, page 74). This measure avoids both extremes of a plant size array and is less arbitrary than the mean or the median since a change in the number of small plants cannot alter it if industry output is not appreciably affected.

More recent studies of U.S. manufacturing industries have attempted to gauge the relative influence of other factors affecting concentration change. Dalton and Rhoades specify concentration change as a function of market growth, product differentiation, capital-output ratio and initial concentration levels. Mueller and Hamm (1974), in addition to these variables (except the capital-output ratio), include size of industry and change in the number of firms. Also, the influence of low, moderate and high degrees of product differentiation are examined.

The first of these two studies concludes that the changes in concentration and market growth (in terms of undeflated value of shipments) are inversely related over the long run, and directly (though weakly) related over the short run. Also, concentration is more likely to increase in industries with differentiated as opposed to homogeneous products.

The capital-output ratio (measured as gross book value of assets divided by shipments) is included in the analysis in an attempt to account for possible differences in long-run time periods among industries, particularly as it relates to the time required to make adjustments in capacity in relation to changing conditions of demand and supply. However, it is generally found to be statistically insignificant.

Initial concentration level is found to be significantly inversely related to concentration change. Statistically best results yield an R^2 of 0.1531 covering the period 1947-67. Much of the inter-industry variation in concentration change therefore remains "unexplained".

In terms of R^2 values, Mueller and Hamm obtain much better results. The values range between 0.20 and 0.36 depending on the regression form and tend to be higher for the 1947-70 as against the 1947-58 or 1958-70 estimation periods. As in other studies, initial concentration level is found to be significantly inversely related to concentration change. So is market growth (measured as change in undeflated value added) for the longer period. However, in sub-periods market growth tends to be insignificantly related to changes in industry concentration levels. In one case a positive relationship, which is statistically significant (at the five percent level), is found.

Change in the number of firms is found to be inversely related to concentration change. However, Mueller and Hamm recognize the questionable nature of the interpretation that can be attached to this variable and therefore exclude it from most of their analysis.

Generally, high and moderate product differentiation (using dummy variables) is found to be positively related to concentration change. The regression coefficient of low product differentiation tends to vary both in sign and significance in different sub-periods. For the 1947-58 period it is negative and significant while for 1958-70 it is positive and significant.

A variable not previously employed in other studies is industry size (measured as dollar value added in 1970). The authors postulate that the larger the absolute size of an industry, the lower are its entry barriers. Therefore, a priori industry size is expected to be inversely related to concentration change. The empirical results bear this out, though the estimated regression coefficients are not always significant.

2.3.3: Summary

This brief review of previous empirical studies reveals that much of the inter-industry variation in changes in concentration remains unexplained. In addition, several studies conduct only a partial analysis of concentration change in the sense that an attempt is made to gauge the influence of specific factors, e.g., market growth. Few studies examine the effect of changes in the number of firms with which concentration is definitionally related.

What becomes evident is that a multi-variate approach using a more complete specification of different factors influencing concentration change is required. Some recent studies, particularly relating to Canada and the U.S., have ventured in this direction. The best results (in terms of R^2 values) explain less than 37 percent of inter-industry variation in changes in concentration (Mueller and Hamm, 1974). The relative influence of factors such as change in plant size, extent of firm multi-plant operations, entry, exit and horizontal merger of firms have remained unexplored.

CHAPTER III

THE STATISTICAL BACKGROUND TO THE STUDY

3.1: Introduction

In compiling industry concentration measures in Canada, dependence is placed largely on Statistics Canada's Census of Manufactures data. From the viewpoint of this study this poses a number of analytical problems. One of these centres on the extent to which a census industry approximates, in a micro-economic sense, the concept of a market or industry. However, another problem relates to choice of a particular measure of industry concentration. Guidelines governing the public disclosure of data collected by Statistics Canada affect the precision with which industry concentration can be measured, and necessitate the construction of partial or summary measures.

This chapter reviews briefly some of these problems in the context of the selected sample of Canadian manufacturing industries used in the subsequent analysis, and reports on preliminary statistical testing of how these problems may affect measuring levels and changes in industry concentration.

3.2: Census Industry and Market Concepts

One practical difficulty in compiling industry concentration measures as a structural determinant of competition, is the classification of industries so that each approximates a group of competing firms in a given market. In a broad sense, all sellers compete with one another for a buyer's dollar. However, competition in the more direct and relevant sense occurs when firms offer to a common group of buyers products which are close substitutes for one another.

Substitution on the production or supply side can also be important in delineating groups of competing firms. Generally, the concept of an industry implies a group of firms engaged in the manufacture of similar commodities. These firms are often alike in their methods of manufacture. In reality similar methods of manufacture can be used to produce different products, and vice versa. Groups of firms producing non-competitive products may, nevertheless, be an

important source of potential competition if they employ essentially similar skills and machinery, and if there are no barriers preventing these firms from entering the others' product lines should it be profitable to do so.

Thus, the concept of both an industry and market is amorphous and impossible to demarcate sharply at the edges. In view of the unavoidable element of arbitrariness and the difficulties relating to statistics compiled to serve several different uses, it is hardly surprising that for present purposes census industry definitions and coverage fall considerably short of the ideal.

A Statistics Canada census manufacturing industry is "composed of establishments engaged in the same or a similar line of economic activity".[1] The line of economic activity is defined in terms of the commodities produced and the criteria include end use and/or chief component materials of the commodities.[2] The establishment is defined as "the smallest unit that is a separate entity capable of reporting all elements of basic industrial statistics".[3] In the case of manufacturing industries, the establishment is usually a factory, plant or mill. For purposes of computing concentration statistics, establishments are grouped into enterprises according to intercorporate ownership links.[4] Within an industry, the enterprise corresponds closely to the concept of a firm as an economic decision-making unit. Aggregated or industry data are primarily based on domestic production which includes exports by establishments but excludes imports of similar commodities.

These census practices or conventions have familiar implications for economic research that need not be reported here.[5] For example, entire establishment (and hence, enterprise, as defined above) production, based on a

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1. Statistics Canada (1970, page 7).

2. Ibid.

3. Ibid., page 9.

4. See footnote 2, Chapter I of this study, and Department of Consumer and Corporate Affairs (1971, Appendix C).

5. Further discussion of these problems is contained in Statistics Canada (1977), and in Conklin and Goldstein (1955).

criteria of "primary" commodities produced, is classified to a single census industry. But most establishments manufacture several products and some of them may not be close substitutes. It follows that establishments classified to different industries may nevertheless manufacture products which are substitutable.

3.3: Characteristics of the Selected Sample of Industries

S.I.C. three and four-digit[6] census of manufacturing industries as defined by Statistics Canada for the most part have been used for analysis in this study. Three principal criteria are used in the selection of the sample:

(i) measures of industry concentration must be readily available;

(ii) since the analytical focus is on change in industry concentration levels, industry definitions must be historically comparable; and

(iii) industry definitions must reflect fairly closely the micro-economic concept of an industry.

Although paucity of relevant product, regional, import and export statistics constrains selection of industries for inclusion in the sample, some of the necessary data could be extracted from varied but comparable Statistics Canada publications. Tabulations and statistical tests based on this data provide some indication of the extent to which individual industries included in the selected sample are likely to consist of groups of competing firms in given markets. The results of these tests tend to be sufficiently encouraging to warrant the analyses conducted in the subsequent chapters of this study.

Rosenbluth's study, the first comprehensive analysis of industry concentration in Canada, presents

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6. Statistics Canada (1977). This is the greatest level of industry detail for which concentration data are currently available.

concentration measures for 96 industries for 1948.[7] Special tabulations generated for the present study present, for the first time, concentration measures for 64 industries for the years 1954 and 1958.[8] Recently, Statistics Canada published concentration measures for 171 industries.[9] However, there are only 57 industries which are both historically comparable and for which selected enterprise concentration measures are available for each of the above-mentioned years.[10] More specifically, the concentration measures found to be most extensively available over the 1948-72 period are the CR_4 and H-H index calculated in terms of employment. Value of shipments as an indicator of economic activity would have been preferable, since it

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7. Rosenbluth (1957), Appendix A., Table A.1. The concentration measures used in this study are: the number of firms required to account for 80 percent of industry employment (80% inverse index), the top three firm employment concentration ratio (CR_3) and the Herfindahl-Hirschman, i.e., H-H (employment and shipment) indexes.

8. These measures were compiled using methodology developed jointly by the author and Mr. H. Potter of the Manufacturing and Primary Industries Division, Statistics Canada. These are CR_4, CR_8, and the H-H indexes based on employment and value of shipments; otherwise there was a complete gap in concentration statistics in Canada between 1948 and 1965. See Appendix B.

9. Statistics Canada (1977, Part II, Tables 1 and 3) presents a comprehensive set of CR and H-H measures on different bases.

10. Statistics for these industries are also available for 1965, 1968 and 1970. The sample of industries varies further, between 49 to 63, depending on the choice of industry concentration measure, time period selected for analysis, and the availability of related data. In order to conduct the present analysis, the author had to: (a) re-compute industry concentration measures for 1948 (see Appendix B) as Rosenbluth's measures differed from those published in later years, and (b) generate a list of census industries that remained historically comparable over 1948-72. Statistics Canada has no official list of these industries. Some industries had to be combined in different years for purposes of comparisons. The above samples exclude industries which are historically comparable but have "miscellaneous" and "not otherwise specified" in their titles. These are considered to be too heterogeneous in their product coverage for meaningful analysis. See also Appendix C.

TABLE 3-1

SIMPLE CORRELATION COEFFICIENTS (r) BETWEEN INDUSTRY VALUE OF SHIPMENTS (V.S.) AND EMPLOYMENT (EMPL.) AND BETWEEN SELECTED CONCENTRATION MEASURES COMPUTED ON THESE BASES

Variables	Correlation Coefficient (r)	Year(s)	Number of Observations
(V.S.) and (Empl.)	0.77	1948	57
(V.S.) and (Empl.)	0.79	1972	57
D(V.S.) and D(Empl.)[a]	0.83	1948-1972	57
CR_4 (V.S.) and CR_4 (Empl.)	0.98	1954[b]	57
CR_4 (V.S.) and CR_4 (Empl.)	0.98	1972	51
DCR_4 (V.S.) and DCR_4 (Empl.)[c]	0.86	1954- 1972[b]	51
H-H (V.S.) and H-H (Empl.)	0.98	1954[b]	55
H-H (V.S.) and H-H (Empl.)	0.96	1972	57
DH-H (V.S.) and DH-H (Empl.)[d]	0.91	1954-1972[b]	51

Notes:

a. Change measured as percentage growth.

b. 1948 data for CR_4(V.S.) and H-H (V.S.) not available.

c. Change measured as percentage point difference in CR_4 measures.

d. Change measured as difference in H-H measures.

TABLE 3-2

DISTRIBUTION OF ALL 171 AND SAMPLE OF 57 CANADIAN THREE- AND FOUR-DIGIT S.I.C. CENSUS MANUFACTURING INDUSTRIES ACCORDING TO CR_4 (EMPLOYMENT), 1972

CR_4 (Employment)	All Industries No.	All Industries %	Sample Industries No.	Sample Industries %
Under 9.9	3	1.75	2	3.51
10.0 - 19.9	22	12.86	8	14.04
20.0 - 29.9	19	11.11	4	7.01
30.0 - 39.9	33	19.29	9	15.78
40.0 - 49.9	22	12.86	10	17.54
50.0 - 59.9	20	11.69	4	7.01
60.0 - 69.9	18	10.52	7	12.28
70.0 - 79.9	17	9.94	4	7.01
80.0 - 89.9	9	5.26	6	10.52
90.0 - 99.9	8	4.67	3	5.26
	171	100.00	57	100.00
Mean		46.90		48.27
Coefficient of variation		0.50		0.52
Variance		543.36		635.85

Source: Special Tabulation, Statistics Canada and Appendix A, Table A-1.

Note: Percentages may not add up to 100 due to rounding.

provides a better approximation to the concept of the size of market.[11] Nonetheless, a high correlation (see Table 3-1) exists between total industry value of shipments (V.S.) and employment (empl.) as well as between levels and changes in CR_4 and H-H concentration measures computed on these bases.

The selected sample of industries accounts for 52.8 percent of the value of shipments and 48.3 percent of employment of the total manufacturing sector in 1972. Table 3-2 indicates that the distribution of these industries in terms of CR_4 (empl.)[12] is similar to that of all (171) industries. There are no statistically significant differences in the means and variances of these two groups of industries. This suggests that results of the analysis based on the sample are likely to be representative of all manufacturing industries.[13]

Table 3-3 presents the distribution of the selected sample of industries according to CR_4 (empl.) levels and major (S.I.C. two digit) industry groups. Due either to non-comparable industry definitions and/or non-availability of concentration statistics, the sample does not include industries in the Rubber, Printing and Publishing, and Electrical Product groups. Otherwise the CR_4 levels and the percentage of value of shipments of the major groups and of all industries vary considerably across the sample.

Parenthetically, it is worth noting that some economists reason that the very fact a sample of industries remains historically comparable shows that it consists of old, well-established industries rather than new 'dynamic' ones. Studies based on such samples are likely to exclude industries affected by dynamic elements of the competitive process such as the introduction of new products which often form the basis of changing census industry definitions. The extent to which this bias may be present in a sample of historically comparable industries should not be ignored. To establish the extent of such bias would involve detailed analysis of industry classification systems, and this falls outside the scope of the present study.

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11. Stigler (1968, page 30). The relative merits of other bases are discussed in Adelman (1951).

12. The distribution is also similar in terms of the H-H index.

13. Assuming a similar CR_4 distribution pattern exists between the sample and all industries in other years as well. This could not be empirically verified due to non-availability of data.

TABLE 3-3

Sample of 57 Canadian Manufacturing Industries, Classified by Major Industry and by CR_4 (Employment), 1972

Major Group \ CR_4 Employment	90.1 — 100		80.1 — 90		70.1 — 80		60.1 — 70		50.1 — 60		40.1 — 50		30.1 — 40		20.1 — 30		10.1 — 20		0 — 10		Total Sample		
	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industrues	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Shipments as % of Total Sample of Major Group	Nbr. of Industries	Value of Factory Shipments	
																						$ million	% of All Industries
Food & Beverages	1	4.72			2	5.53					4	32.37	3	15.45							10	5,955.37	58.09
Tobacco Products	1	70.68																			1	421.42	70.68
Rubber Industries	--		--		--		--		--		--		--		--		--		--		0	--	--
Leather Industries					1	18.32	1	4.23							1	56.43					3	353.20	78.99
Textile Industries	1	16.13	2	2.05			1	1.49			4	47.94	2	8.61							10	1,463.22	76.23
Knitting Mills															1	19.30					1	90.75	19.30
Clothing Industries									1	3.52							4	48.74	1	36.90	6	1,466.98	89.17
Wood Industries							1	0.87			2	13.34					2	70.79			5	2,622.80	85.01
Furniture & Fixtures																	1	100.00			1	958.36	100.00
Paper & Allied													2	88.31							2	3,898.42	88.31
Printing & Publishing	--		--		--		--		--		--		--		--		--		--		0	--	--
Primary Metal					1	45.32							1	13.68							2	2,474.70	59.01
Metal Fabricating																			1	5.73	1	219.37	5.73
Machinery									1	14.85											1	317.16	14.85
Transportation Equipment			1	52.06			2	10.56									1	0.85			4	4,918.56	63.48
Electrical Products	--		--		--		--		--		--		--		--		--		--		0	--	--
Non-Metallic Minerals			2	17.62											1	38.99					3	943.08	56.62
Petroleum & Coal			1	98.83																	1	2,412.58	98.83
Chemical							1	9.29					1	9.55	1	15.72					3	1,017.47	34.57
Miscellaneous							1	2.99	2	2.58											3	70.80	5.58

Source: See Appendix A, Table A-1 and Statistics Canada, (1977).

3.3.1: Primary Product Specialization (PPSI) and Coverage (CI) Indexes

Two ratios, viz., PPSI and CI assist in evaluating the extent to which the selected sample of industries consists of establishments (enterprises) manufacturing similar products.[14]

The PPSI measures the extent to which establishments (enterprises) classified in an industry specialize in manufacturing products regarded as primary to that industry. Value of shipments of products primary to an industry are expressed as a ratio of the total value of shipments of all products manufactured by establishments classified to that industry. Thus, low values of the PPSI would indicate that a large part of the range of products manufactured by establishments (enterprises) classified to a given industry fall outside of the industry in question.

The CI measures the extent to which products primary to an industry are manufactured by establishments (enterprises) classified to that industry. It is the value of shipments of products primary to a given industry manufactured by establishments (enterprises) which are classified to that industry expressed as a ratio of total shipments of those products manufactured by all establishments (enterprises) classified to industries in the manufacturing sector. Thus, low values of CI would indicate that a large part of the products which are primary to a given industry are manufactured by "competing" establishments (enterprises) classified to other industries.

For 41 of the 57 industries in the sample, PPSI and CI indexes are available for 1965. All had indexes of over 70 percent and most in fact were over 90 percent (see Table 3-4). Therefore they can be taken as sufficiently reliable in the two relevant respects for inclusion in the sample. The indexes for the remaining 16 industries were not published because of the possibility of disclosure of the details of particular establishments (enterprises). There is no reason to suppose that they would have differed from those of the 41 industries.

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14. These ratios are contained in Department of Consumer and Corporate Affairs (1971).

TABLE 3-4

DISTRIBUTION OF THE SAMPLE OF 57 CANADIAN MANUFACTURING INDUSTRIES ACCORDING TO PRIMARY PRODUCT SPECIALIZATION (PPSI) AND COVERAGE (CI) INDEXES, 1965

Percent - Deciles	Number of Industries PPSI	CI
90.1 - 100.0	26	33
80.1 - 90.0	9	7
70.1 - 80.0	6	1
Not Available	16	16
T o t a l	57	57

Source: Department of Consumer and Corporate Affairs (1971, Appendix A, Table A-1).

3.3.2: Industries with Regional Markets

In a geographically large country such as Canada, with widely dispersed population and related economic activity centres, regionally segmented markets are likely to be important in some industries. However, this importance can be easily overstated. A high proportion of goods in Canada are produced and consumed in the provinces of Ontario and Quebec. In addition, establishments (enterprises) in these two provinces tend to be relatively larger than those in the rest of the country. It is in this single dominating geographic region that the structure and behaviour of most industries are determined,[15] and industry concentration measures computed on a national basis tend to reflect the economic characteristics of these two provinces.

For the industries in the sample depicted as having regional markets,[16] 60.9 percent of establishments, 70.4 percent of the value of shipments and 63.3 percent of employment were located in the provinces of Ontario and Quebec in 1972. The corresponding averages among industries depicted as having national markets[17] are 85.7, 93.2, 90.2 percent respectively. Moreover, destination of shipment statistics for 1967 indicate that on average, in the former group of (regional) industries, 72.8 percent of Ontario pro-

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15. See, for example, Eastman and Stykolt (1967, page 59). The industrial belt, stretching approximately 600 miles from Southern Ontario to greater Montreal (Que.), is for the most practical purposes a single market.

16. These designations are based on Department of Consumer and Corporate Affairs (1971, pages 37-40). However, it needs to be noted that even within provinces there can be sub-markets, e.g., in the Soft-Drink Bottling industry. The breakdowns provided in this study were basically judgmental as "it proved impossible to obtain statistics covering regions with any precision to the actual regional market boundaries" (page 37). In the present study, 18 of the sample of 57 industries are considered as having regional markets. These are indicated in Appendix A, Table A-1.

17. Ibid.

duction (in terms of value shipments) is consumed in that province whereas 9.4 percent is shipped to Quebec. Similarly, on average, 69.5 percent of Quebec production is consumed in that province and 13.8 percent is shipped to Ontario.[18]

3.3.3: Imports and Exports[19]

The fact that census industry value of shipments (V.S.) does not include imports (M) and does not exclude exports (X) also does not appear to be as serious a limitation as might be expected. Generally high simple correlation coefficients are found to exist between (V.S.) and (V.S. + M) or (V.S. + M - X) among the industries included in the sample (see Table 3-5). High correlation coefficients are also found between CR_4 (V.S.) and CR_4 (V.S. + M). Similar correlations between CR_4 (V.S.) and CR_4 (V.S. + M - X) could not be computed as data on the proportion of the leading four enterprise production that is exported are not available.

It may be noted that the preceding set of high correlations between CR_4 measures, adjusted and unadjusted for imports, are only useful insofar as one wants to gauge for purposes of inter-industry comparisons, the sensitivity of the ranking of industries by CR_4 measures to the inclusion/exclusion of this factor. In individual industries imports may nevertheless significantly alter the CR_4 measure. Also, the high correlations should not be interpreted as implying that the competitive conditions prevailing in these industries are not importantly influenced by imports.

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18. These averages were computed from Statistics Canada (1971). Preliminary statistics for 1974 suggest there have been no dramatic changes in these types of statistics computed across all manufacturing. See Statistics Canada Daily, Wednesday, April 13, 1977.

19. Data are obtained from varied sources described in Appendix B.

TABLE 3-5

SIMPLE CORRELATION COEFFICIENTS (r) BETWEEN INDUSTRY VALUE OF SHIPMENTS (V.S.), ADJUSTED AND UNADJUSTED FOR IMPORTS (M) AND EXPORTS (X) AND BETWEEN CR_4 (V.S.) AND CR_4 (V.S. + M)

Variables	Correlation Coefficient (r)	Year(s)	Number of Observations[a]
(V.S.) and (V.S. + M)	0.97	1948	24
(V.S.) and (V.S. + M - X)	0.70	1948	24
(V.S.) and (V.S. + M)	0.98	1972	42
(V.S.) and (V.S. + M - X)	0.94	1972	42
D(V.S.) and D(V.S. + M)	0.95	1948-1972[b]	15
D(V.S.) and D(V.S. + M - X)	0.82	1948-1972[b]	15
CR_4(V.S.) and CR_4(V.S. + M)	0.97	1954[c]	42
CR_4(V.S.) and CR_4(V.S. + M)	0.77	1970[d]	42
DCR_4(V.S.) and DCR_4(V.S. + M)	0.71	1954-1970[e]	18

Notes:

a. Sample sizes vary due to non-availability of data.

b. Change measured as percentage growth.

c. 1948 CR_4 (V.S.) not available.

d. 1972 imports (M) not available.

e. Change measured as percentage point difference in CR_4 measures.

3.4: Choice of Industry Concentration Measures

A rich menu of alternative industry concentration measures, including those presented in this study, viz., CR_4 and H-H index, have been put forward in the literature. However, principal concentration measures for a given year generally tend to display similar patterns. For 15 two-way comparisons between six different measures of industry concentration computed for 1965, the average value of the rank correlation coefficient is 0.9394 and the lowest of these is 0.8273.[20] The simple correlation coefficients between the two concentration measures presented in this study for 1948 and 1972 (see Table 3-6) are of a similar magnitude.[21]

Correlation coefficients tend to be lower between alternative concentration measures for sub-samples of industries with high levels of concentration and between changes in these measures over time. For example, Hause (1977) finds that the simple correlation coefficient between CR_4 and H-H index for a sub-sample of industries where values of the latter index exceed 0.16, is 0.614, whereas for the total sample of 45 Swedish manufacturing industries, it is 0.831.[23] The simple correlation coefficient between changes in these indexes (measured in terms of differences, i.e., DCR_4 and DH-H) across the total sample is 0.417.

---

20. Department of Consumer and Corporate Affairs (1971, Appendix D., Table D-4). The measures used are CR_4 (V.S.), 80% inverse index (V.S. and empl.), and H-H (value added, V.S. and empl.) index.

21. Studies relating to the U.S. report similar correlations. See: Nelson (1963); Hall and Tideman (1967); Bailey and Boyle (1971).

22. The concentration measures are based on employment. Similar results are also obtained by Hause (1977) using Japanese data.

TABLE 3-6

SIMPLE CORRELATION COEFFICIENTS (r) BETWEEN CR_4 (empl.) AND H-H (empl.) INDEXES: LEVELS AND CHANGES

Variables	Correlation Coefficient (r)	Year(s)	Number of Observations	Remarks
CR_4 and H-H	0.89	1948	57	Total sample
CR_4 and H-H	0.93	1972	57	" "
DCR_4 and DH-H	0.62	1948-1972[a]	57	" "
CR_4 and H-H	0.72	1948	15	Sub-sample of cases where H-H $\geq$ 0.16
CR_4 and H-H	0.71	1972	14	"
CR_4 and H-H	0.69	1948	11	Sub-sample of cases where H-H $\geq$ 0.20
CR_4 and H-H	0.61	1972	10	"
CR_4 and H-H	0.62	1948	8	Sub-sample of cases where CR_4 $\geq$ 75%
CR_4 and H-H	0.66	1972	11	"
DCR_4 and DH-H	0.27	1948-1972[a]	15	Sub-sample of cases where DH-H $\geq$ 0.015
DCR_4 and DH-H	0.52	1948-1972[a]	18	Sub-sample of cases where DCR $\geq$ 10 points

Note: a. Change is measured as a difference in the relevant concentration measure between the two years. See text for further details.

Replicating these correlations using data for the sample of industries analyzed in this study, the results obtained (see Table 3-6) generally tend to support Hause's findings. Magnitudes of the correlation coefficients tend to be somewhat higher. In addition to using values of the H-H index greater than 0.16 and 0.20, CR_4 of greater than 75 percent is used to delineate sub-samples of highly concentrated industries. The analysis is extended further by delineating sub-samples of industries with "large" increases in concentration, i.e., where DCR is greater than 10 percentage points and, alternatively, DH-H is greater than 0.015. The simple correlation coefficients between DCR and DH-H using these two criteria are found to differ dramatically from each other (viz., 0.52 vs. 0.27).

The low correlation coefficients, sensitive to different criteria for selecting sub-samples of industries, arise from the different properties embodied in the CR_4 and H-H indexes. The choice of a particular index may thus be critical to a study of highly concentrated industries and/or change in industry concentration levels. The different properties of the CR_4 and H-H concentration measures have been discussed and debated extensively in the literature and will not be repeated here.[23] While the literature provides support for these two measures as well as several other measures of industry concentration, there is consensus for the view that no single index is ideal. However, a particular drawback of nearly all measures of concentration (including the CR_4 and H-H measures) should be borne in mind. Namely, these measures do not indicate changes over time in the identity or the ranks of leading firms. This is especially relevant in the context of the present study as changes in the relative market position of the leading firms would indicate healthy competitive conditions prevailing in that industry. The analysis in this study is conducted extensively in terms of the CR_4. This derives from the prominent role played by this measure in the administration and enforcement of competition policy in Canada and abroad. It also facilitates the comparison between the results of this study with those obtained elsewhere.

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23. In addition to the references cited in footnotes 4, 5, 7, 11, 21 and 22, see also The Conference Board (1957, 1974).

APPENDIX TO CHAPTER III

The 57 Industries for which CR_4 and H-H measures are available for each of the years for which data are presented in this study during the 1948-72 period are (in terms of 1960 S.I.C. No.s):

1010 Slaughtering Meat Processors

1110 Fish Products

1120 Fruit and Vegetable Canners

1280 Biscuit Manufacturers

1290 Bakeries

1310 Confectionery Manufacturers

1430 Distilleries

1450 Breweries

1470 Wineries

1530 Tobacco Products

1720 Leather Tanneries

1740 Shoe Factories

1792 Boot and Shoe Manufacturers

1830 Cotton Yarn

1950 Wool, Yarn and Cloth Mills

2010 Synthetic Textiles

2120 Thread Mills

2130 Cordage and Twine

2140 Narrow Fabric Mills

2160 Carpet and Rug Industry

2180 Textile Dyeing

2210 Canvas Products

2230 Cotton and Jute Bag

2310 Hosiery Mills

2431 Total Men's Clothing

2432 Men's Clothing

2441 Women's Clothing Factories

2442 Women's Clothing Contractors

2460 Fur Goods

2480 Foundation Garments

2513 Saw Mills

2520 Veneer and Plywood

2541 Sash and other Millwork Plants

2542 Hardwood Flooring

2580 Coffin and Casket Industry

2610/40/60/80 Household/Office Furniture

2710 Pulp and Paper Mills

2731/2/3 Folding-Corrugated Boxes

2910 Iron and Steel Mills

The 57 Industries for which CR_4 and H-H measures are available for each of the years for which data are presented in this study during the 1948-72 period are (in terms of 1960 S.I.C. No.s):

2920/40	Iron Foundries
3080	Machine Shops
3110	Agricultural Implements
3210	Aircraft and Parts
3230	Motor Vehicles
3270	Shipbuilding and Repair
3280	Boatbuilding and Repair
3410	Cement
3470/80	Concrete Products
3570	Abrasives Manufacturers
3650	Petroleum Refining
3740	Pharmaceuticals and Medicines
3750	Paint and Varnish Manufacturers
3760	Soap and Cleaning Compounds
3950	Fur Dressing and Dyeing Industry
3981	Button Fastener Industry
3989	Pen and Pencil Manufacturers

CHAPTER IV

CONCENTRATION LEVELS AND TRENDS IN CANADIAN MANUFACTURING INDUSTRIES: 1948-72

4.1: Introduction

This chapter provides an overview of concentration levels and concentration trends for a sample (and sub-samples) of 57 Canadian manufacturing industries for the post-war period 1948-72. The descriptive analysis presented below enables one to gauge the magnitude, direction and pattern of concentration change that has occurred among these industries, and provides a backdrop for subsequent analyses into the underlying factors explaining the observed trends.

4.2: Inter-temporal Changes in the Distribution of Industries by CR_4 Class Intervals

Using 1948 as a reference year, Chart 4-1 presents a two-way classification of the number, percentage value of shipments and employment of the total sample and of sub-samples (of producer and consumer goods manufacturing industries, respectively[1]) distributed according to CR_4 (employment) class intervals for the years 1948, 1958, 1968 and 1972.

Focusing first on the total sample of 57 industries, the chart indicates that there is a fair degree of variation between different CR_4 class intervals in the number of industries, and corresponding percentage value of shipments and employment in each of the years. However, a tendency towards an increased number of industries and increased percentage value of shipments and employment in the higher CR_4 class intervals can be discerned. Over the period 1948-72, the number of industries in the CR_4 interval of 60-100 percent has increased from 16 to 20. The percentage value of shipments and employment emanating from these increased from 33.28 percent and 19.94 percent to 39.79 percent and 26.48 percent, respectively. The converse is found for the CR_4 class interval of 0-20 percent, while in the class intervals of 20-40 and 40-60 percent, the number of industries and corresponding percentage value of shipments and employment remained relatively stable.

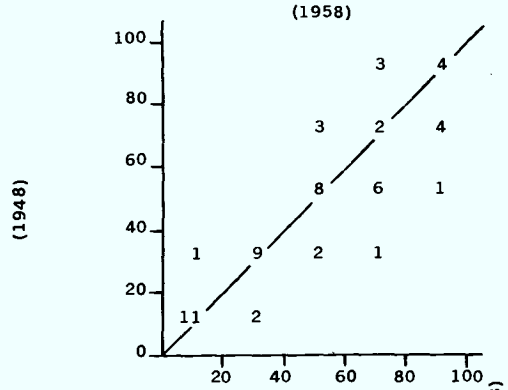
---

1. The classification of industries into these sub-samples is in terms of economic use of the products manufactured and is based on Statistics Canada (1972, Table 6).

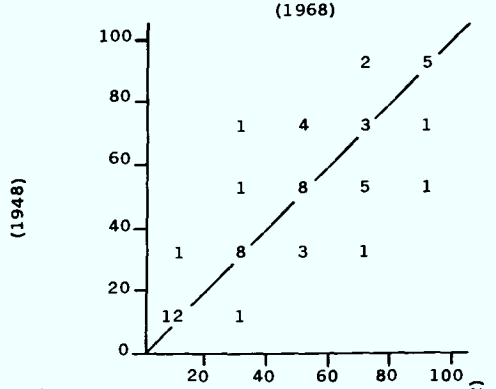
CHART 4-1

NUMBER OF INDUSTRIES AND PERCENTAGE SHARE OF SAMPLE VALUE OF SHIPMENTS AND EMPLOYMENT BY CR_4 EMPLOYMENT CONCENTRATION RATIO CLASS FOR THE TOTAL SAMPLE AND SUB-SAMPLES OF PRODUCER AND CONSUMER GOODS INDUSTRIES. 1948-72

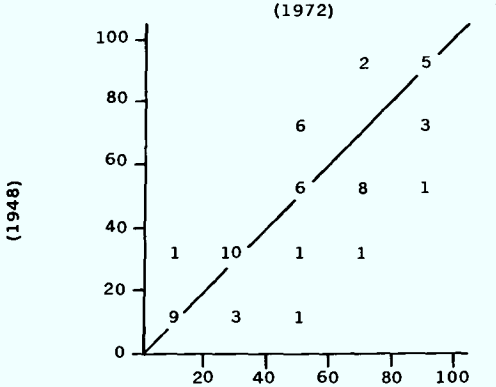
TOTAL SAMPLE



Totals (1958)						
No. of Industries	12	11	13	12	9	
Shipments (%)	17.81	26.21	13.70	26.55	14.86	
Employment (%)	30.99	27.38	10.08	19.71	11.85	



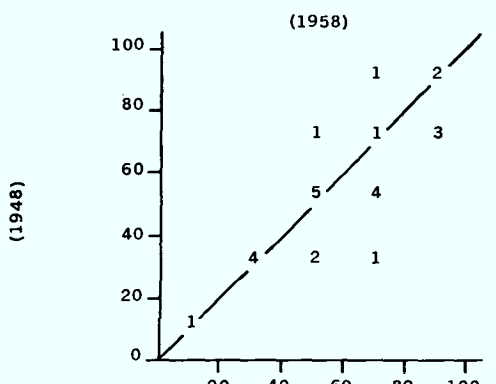
Totals (1968)						
No. of Industries	13	11	15	11	7	
Shipments (%)	18.71	24.68	15.50	14.48	26.63	
Employment (%)	31.04	27.27	13.97	16.67	11.06	



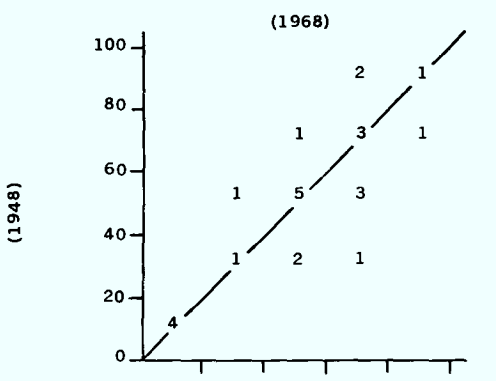
Totals (1972)						
No. of Industries	10	13	14	11	9	
Shipments (%)	16.15	26.84	17.06	12.82	26.97	
Employment (%)	26.83	31.34	15.37	14.30	12.18	

Totals (1948)	No. of Industries	Shipments (%)	Employment (%)
	7	16.03	8.53
	9	17.25	11.41
	15	14.26	15.82
	13	28.08	27.08
	13	24.37	37.17

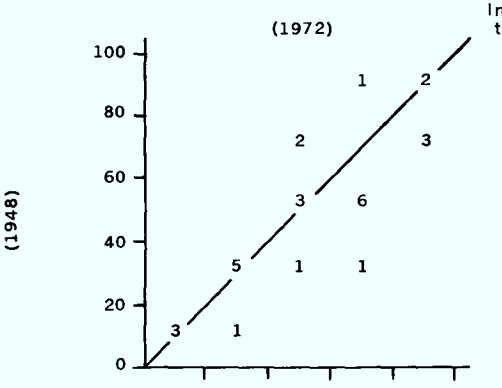
SUB-SAMPLE OF PRODUCER GOODS INDUSTRIES



Totals (1958)						
No. of Industries	4	4	8	7	5	
Shipments (%)	18.77	36.97	6.81	26.57	8.95	
Employment (%)	26.12	32.49	8.03	32.95	11.45	



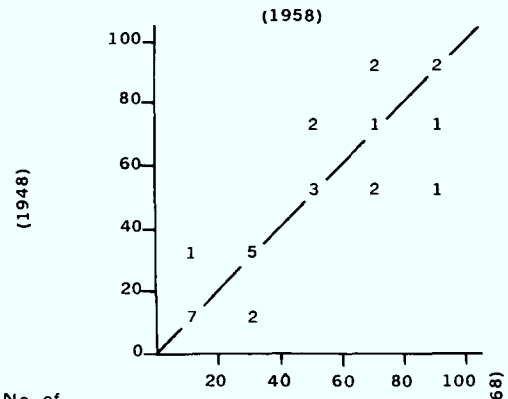
Totals (1968)						
No. of Industries	4	2	8	9	2	
Shipments (%)	20.92	35.07	9.97	28.62	3.15	
Employment (%)	23.24	28.72	14.30	29.86	3.38	



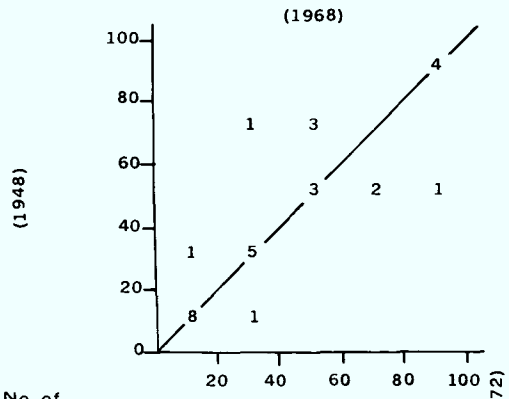
Totals (1972)						
No. of Industries	3	6	6	8	5	
Shipments (%)	18.26	42.91	10.86	22.60	4.99	
Employment (%)	19.84	37.96	13.06	28.81	5.35	

Totals (1948)	No. of Industries	Shipments (%)	Employment (%)
	3	2.83	3.24
	5	13.74	15.03
	9	18.99	22.04
	7	44.94	34.50
	4	19.50	25.19

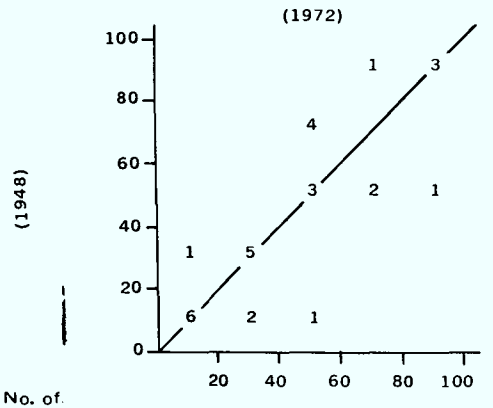
SUB-SAMPLE OF CONSUMER GOODS INDUSTRIES



Totals (1958)						
No. of Industries	8	7	5	5	4	
Shipments (%)	17.01	17.23	19.45	26.53	19.78	
Employment (%)	35.28	22.87	11.89	8.02	12.20	



Totals (1968)						
No. of Industries	9	7	6	2	5	
Shipments (%)	16.91	16.21	18.16	2.96	45.76	
Employment (%)	38.99	25.78	13.63	3.22	18.38	



Totals (1972)						
No. of Industries	7	7	8	3	4	
Shipments (%)	14.52	14.48	21.84	5.28	43.87	
Employment (%)	33.78	24.75	17.68	4.79	19.00	

Totals (1948)		
No. of Industries	Shipments (%)	Employment (%)
4	27.08	13.83
4	20.19	7.79
6	10.30	9.59
6	13.98	19.63
9	28.45	49.16

Note: See Text for further details.
Source: Appendix A, Table A-1.

Underlying these observations are the shifts in the number of industries between CR_4 class intervals in different sub-periods. For example, the two-way classification of the chart indicates that of the seven industries[2] with CR_4 levels between 80 and 100 percent in 1948, three[3] declined to CR_4 levels between 60 and 80 percent by the year 1958 and two by the years 1968 and 1972.[4] Of these seven industries, five are included in the nine industries[5] with CR_4 levels between 80 and 100 percent in 1972. Of these nine industries, four had CR_4 levels of less than 80 percent in 1948.[6]

The chart also indicates that across the total sample, a large number of industries remained within their respective CR_4 class intervals. Adding the number of industries along the diagonal, these range between 31 and 36 in the different periods. However, the number of industries with increases in concentration levels was greater than those with decreases. This can be seen by comparing the number of industries to the "right" as against the "left" of the diagonal. In the different periods, the number of industries with increases in concentration levels ranges between 12 and 18 while those with decreases range between seven and nine.[7]

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2. These industries are Distilleries, Tobacco Products, Thread Mills, Aircraft and Parts, Motor Vehicles, Cement, and Petroleum Refining.

3. These industries are Distilleries, Aircraft and Parts, and Petroleum Refining.

4. The two industries are not the same in 1968 and 1972. In 1968 these are Distilleries, and Aircraft and Parts, while in 1972 these are Cement, and Aircraft and Parts.

5. The additional four industries are Breweries, Cotton Yarn and Cloth Mills, Cordage and Twine, and Abrasives.

6. Ibid.

7. Since the CR_4 class intervals used are fairly broad, the number of industries with increases or decreases in concentration levels may tend to be understated. In actual fact, over the period 1948-72, 40 industries had increases, while only 17 industries had decreases in concentration levels. See Table 4-1.

In sub-sample(s) of producer and consumer goods manufacturing industries, a tendency towards an increased number of industries and an increased percentage value of shipments and employment in the higher CR_4 class intervals can be discerned. This, however, is more pronounced in the case of the former than the latter. In 1948 there were eight producer goods industries with CR_4 levels greater than 60 percent, whereas in 1972 there were 13 such industries. Over this period, the percentage value of shipments and employment emanating from these industries increased from 16.57 percent and 18.27 percent to 27.59 percent and 34.14 percent, respectively. The number of industries with increases in concentration levels (12) greatly exceeds the number of industries with decreases in concentration levels (3).[8]

In consumer goods industries, over the period 1948-72, the number of industries in the CR_4 class interval of 80-100 percent remained the same, viz., four. However, there was a dramatic increase in the percentage value of shipments accounted for by these industries. This increased from 27.08 percent in 1948 to 43.87 percent in 1972.[9] While the chart indicates that the number of industries with increases as compared with decreases in concentration levels was also the same, viz., six, there was a tendency for shift in the number of industries from lower to higher CR_4 class intervals. This is evident by the greater distribution of the six industries to the right as compared to the left of the diagonal.[10]

Table 4-1 presents the total sample and sub-samples of producer and consumer goods manufacturing

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8. The number of producer goods manufacturing industries with increases in concentration levels is actually 20, whereas those with decreases are eight. See Table 4-1.

9. This has primarily been due to the increased relative importance of the Petroleum Refining industry where the value of shipments (in current dollars) increased from $387.14 (million) to $2413.58 (million).

10. And by the fact that the number of consumer goods manufacturing industries with increases in concentration levels are actually 20, whereas those with decreases are only nine. See Table 4-1.

TABLE 4-1

DISTRIBUTION OF PERCENTAGE POINT CHANGE IN CR_4 (EMPL.) IN 57 CANADIAN MANUFACTURING INDUSTRIES, 1948 - 1972

Percentage Point Change in CR_4 (Empl.) 1948-1972	NUMBER AND PERCENTAGE OF INDUSTRIES					
	Total Sample		Producer Goods		Consumer Goods	
	No.	%	No.	%	No.	%
20.01 <	8[a]	14.03	5	17.85	3	10.34
10.01 to 19.9	10[b]	17.54	5	17.85	5	17.24
5.01 to 10	9	15.78	6	21.42	3	10.34
0.01 to 5	13	22.80	4	14.28	9	31.03
0	0	0	0	0	0	0
-0.01 to -5	3	5.26	2	7.14	1	3.44
-5.01 to -10	2	3.50	1	3.57	1	3.44
-10.01 to -20	9[c]	15.78	4	14.28	5	17.24
-20.01 <	3[d]	5.26	1	3.57	2	6.98
T O T A L S	57	100.00	28	100.00	29	100.00

Notes:

(a) Fish Products* (21.0 points), Biscuits* (22.3), Breweries* (38.3), Leather Tanneries (43.2), Cotton Yarn and Cloth Mills (24.7), Cotton and Jute Bags (24.6), Hardwood Floors (22.0), Shipbuilding and Repair (22.9).

(b) Shoe Factories* (13.7 points), Wool Yarn and Cloth (11.8), Canvas Products* (12.9), Fur Goods* (11.3), Foundation Garments* (14.2), Iron and Steel Mills (13.7), Iron Foundries/Steel Pipe and Tube Mills (11.0), Concrete Products/Ready-Mix (14.7), Abrasives (17.4), Soap and Cleaning Compounds* (15.5).

(c) Slaughtering and Meat Processors and Sausages and Casings* (12.3 points), Distilleries* (12.8), Wineries* (13.4), Synthetic Textiles (13.0), Narrow Fabric Mills (11.3), Women's Clothing Contractors* (15.3), Agricultural Implements (15.6), Motor Vehicles* (10.1), Cement (15.5).

(d) Carpet, Mat and Rug* (33.3 points), Aircraft and Parts (24.2), Fountain Pens and Pencils* (20.8).

*Consumer goods manufacturing industries.

Percentages may not add to 100.0 due to rounding.

distributed according to differing magnitudes of percentage point change in CR_4 levels over 1948-72. This table confirms that the number of industries with increases in concentration levels are greater than those with decreases. In the majority of cases, these increases are five or more percentage points in CR_4 levels. Comparisons suggest that this tends to have taken place in a relatively greater number (and percentage) of producer goods than consumer goods industries.

4.3: Trends in Average CR_4

Part I of Chart 4-2 presents, for different post-war years, the simple and weighted[11] average CR_4 levels for the total sample and for the two sub-samples of industries portrayed in Chart 4-1. Also presented are the averages[12] for these samples of industries distributed into different CR_4 class intervals according to their initial (1948) level of concentration. A visual interpretation of the average CR_4 trends in these class intervals is presented in Parts II and III.

Examining first the simple and weighted average CR_4 levels for the total sample, this table indicates that while there is some variation during the 1948-72 period, there was a consistent trend towards increased industry concentration. The simple average CR_4 level increased from 44.4 percent in 1948 to 48.3 percent in 1972. In terms of the weighted average the corresponding increase was from 44.3 percent to 51.1 percent. Marked increases in average CR_4 levels have occurred between 1948-54 and 1968-72 whereas average CR_4 levels decreased somewhat between 1965 and 1968.

A trend towards increased concentration levels is evident also in the sub-samples of producer and consumer goods industries. It is worth noting, that while over the post-war period the increase in the simple average CR_4 level was greater in producer goods than in consumer goods industries, the same is not the case in terms of the weighted average.

---

11. Industry value of shipments are used as weights.

12. Unless specified otherwise, the term "average" in the ensuing discussion will relate to both simple and weighted average CR_4 levels.

CHART 4-2
AVERAGE CONCENTRATION LEVELS AND TRENDS IN 57 CANADIAN MANUFACTURING INDUSTRIES: 1948-72
(DISTRIBUTED ACCORDING TO 1948 VALUES OF CR_4 EMPLOYMENT INDEX)

I

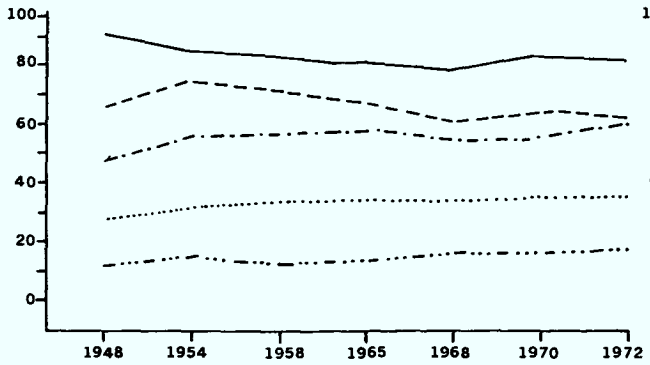
Simple and (Weighted*) Averages

CR_4 (Employment) Levels	1948	1954	1958	1965	1968	1970	1972
80-100	91.1 (89.3)	87.5 (83.3)	84.4 (81.7)	52.5 (86.9)	79.8 (83.6)	84.1 (86.5)	81.9 (82.5)
60-79	68.7 (65.2)	74.2 (68.4)	71.4 (61.1)	68.6 (62.6)	60.3 (57.1)	64.5 (56.2)	62.7 (54.4)
40-59	48.8 (51.8)	55.9 (63.8)	57.7 (67.9)	58.0 (67.2)	56.6 (65.8)	56.5 (66.0)	60.4 (67.3)
20-39	29.4 (31.5)	(32.2) (31.7)	33.5 (33.2)	34.2 (35.6)	35.7 (34.3)	36.4 (36.2)	36.4 (34.9)
0-19	11.3 1 (10.0)	13.6 (12.3)	13.1 (11.9)	14.4 (13.4)	15.1 (14.4)	17.3 (16.1)	18.1 (17.1)
TOTAL SAMPLE	44.4 (44.3)	47.6 (48.7)	47.5 (50.2)	47.3 (53.9)	45.8 (51.1)	47.6 (52.9)	48.3 (51.1)

II

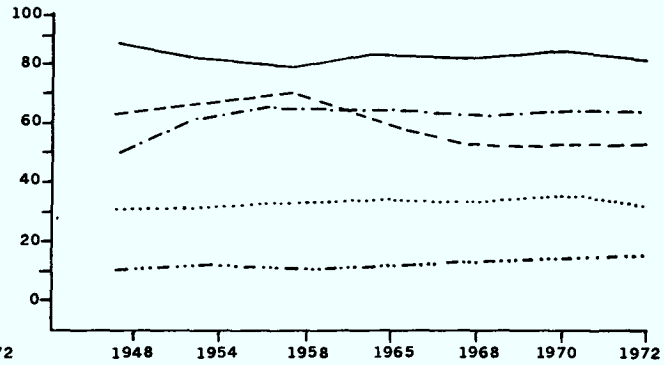
Simple Average Trends

TOTAL SAMPLE



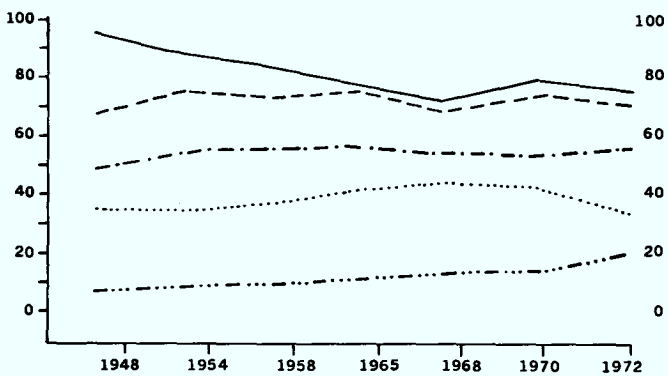
III

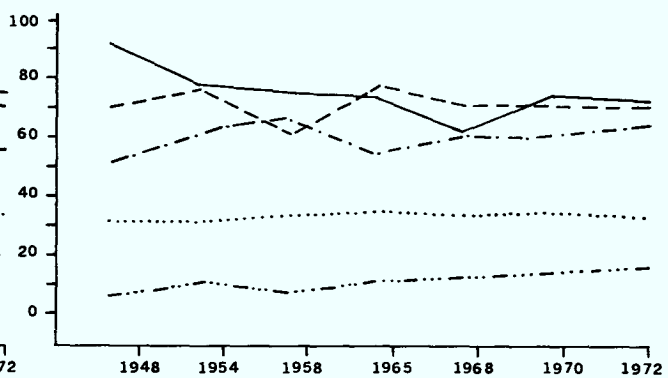
Weighted* Average Trends



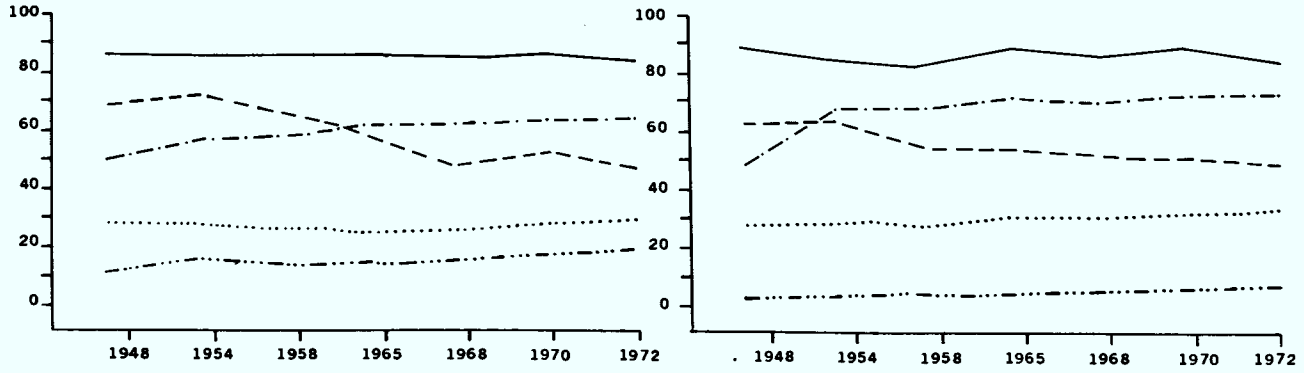
Sub-sample of Producer Goods Industries

CR_4 (Employment) Levels	1948	1954	1958	1965	1968	1970	1972
80-100	95.5 (93.8)	88.7 (79.7)	83.2 (77.7)	78.1 (75.2)	72.1 (64.7)	78.8 (72.3)	79.0 (71.5)
60-79	68.3 (70.5)	76.4 (79.1)	74.7 (64.0)	76.2 (79.6)	69.2 (72.0)	75.0 (78.4)	73.2 (75.2)
40-59	49.3 (53.5)	54.9 (63.5)	56.7 (68.1)	56.2 (57.3)	53.9 (64.4)	52.9 (63.8)	59.0 (65.4)
20-39	35.5 (32.3)	35.5 (32.5)	38.5 (34.8)	41.2 (37.2)	44.5 (36.0)	43.9 (37.9)	42.1 (35.0)
0-19	09.2 (08.3)	09.2 (11.5)	09.5 (09.5)	10.4 (12.2)	11.7 (14.0)	13.8 (16.0)	15.9 (17.6)
Producer Goods Industries	47.2 (39.3)	51.0 (41.3)	51.5 (43.4)	51.8 (47.8)	48.5 (42.5)	51.8 (44.2)	53.3 (42.7)





	1948	1954	1958	1965	1968	1970	1972
80-100	87.8 (89.0)	86.6 (84.1)	85.3 (82.6)	85.9 (88.5)	85.5 (86.5)	88.0 (88.4)	84.0 (83.6)
60-79	69.1 (62.2)	71.4 (63.8)	67.3 (56.2)	59.1 (54.9)	49.2 (51.9)	51.3 (50.2)	49.6 (49.0)
40-59	47.9 (49.1)	57.3 (64.4)	59.3 (67.6)	60.8 (71.3)	60.6 (69.1)	62.0 (71.1)	62.4 (72.0)
20-39	28.3 (29.5)	28.5 (29.6)	28.2 (29.2)	26.1 (30.6)	25.3 (30.0)	27.5 (31.8)	29.8 (32.5)
0-19	12.2 (11.0)	15.6 (13.0)	14.7 (13.8)	16.1 (14.0)	16.7 (14.8)	18.9 (16.2)	19.1 (16.6)
Consumer Goods Industries							
	41.2 (49.0)	44.4 (55.4)	43.6 (55.8)	41.6 (58.0)	41.5 (58.0)	43.6 (58.4)	43.4 (57.6)



Note: *Weighted by Value of Shipments.
See Text for further details.

Source: Appendix A, Table A-1.

4.4: Trends in Average CR_4: Relationships to Initial Levels

Within the total sample and sub-samples of producer and consumer goods manufacturing industries presented in Chart 4-2, the trend in average CR_4 levels varies across different CR_4 class intervals, and the data point towards a a possible systematic (inverse) relationship between initial levels and average CR_4 trends.

Focusing on the total sample, the table indicates that industries with high or moderately high initial (1948) levels of concentration (i.e., CR_4 levels between 60 and 100 percent) on average decreased while industries with medium and lower initial concentration levels increased in concentration. In particular, rapid increases in concentration occurred in the CR_4 class interval of 40-59 percent where between 1948 and 1972, the simple average CR_4 level increased from 48.8 percent to 60.4 percent and the weighted average CR_4 level increased from 51.8 percent to 67.3 percent.

Generally speaking, the inverse relationship between initial levels and average CR_4 trends is also observed in the sub-samples of producer and consumer goods industries. The fact that these trends tend to become accentuated in terms of the weighted average CR_4 is attributable to the differences in the magnitude of changes in value of shipments between producer and consumer goods industries.[13]

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13. The simple average value of shipments in 1948 and 1972 for these two sub-samples of manufacturing distributed according to (1948) CR_4 class intervals are:

CR_4 Class Interval	Producer Goods Industries		Consumer Goods Industries	
	1948	1972	1948	1972
	$(mil)		$(mil)	
80 - 100	28.4	244.3	243.4	1827.7
60 - 79	82.6	150.9	181.5	719.8
40 - 59	63.5	332.6	61.8	210.2
20 - 39	193.1	765.4	83.8	355.9
0 - 19	146.6	763.2	113.7	352.2
Total Sub-sample Average	108.4	460.4	124.0	577.8

TABLE 4-2

COEFFICIENT OF VARIATION OF CR_4 LEVELS FOR DIFFERENT YEARS

Years			
1948	1958	1968	1972
	Total Sample of Industries		
60.6	56.9	54.2	52.2
	Producer Goods Industries		
54.8	48.8	44.1	44.6
	Consumer Goods Industries		
67.2	65.5	64.6	59.9

Note: See text for further details.

TABLE 4-3

SPEARMAN RANK CORRELATION COEFFICIENTS: CR_4 LEVELS

Years		
1948-1958	1948-1968	1948-1972
	Total Sample of Industries	
0.942	0.872	0.870
	Producer Goods Industries	
0.928	0.825	0.829
	Consumer Goods Industries	
0.951	0.893	0.886

Note: See text for further details.

The trends in average CR_4 across and within different CR_4 class intervals in the total sample and sub-samples of producer and consumer goods manufacturing industries suggest that differences in CR_4 levels have tended to decrease over time. This is further evident from the decline over time in the coefficients of variation of four-firm contration ratios presented in Table 4-3.

The fact that some industries are decreasing and others increasing in concentration also suggests that there have been changes in the ranking (in terms of CR_4 levels) of industries. This "turnover" which was observed in part in Chart 4-1 is further implicit in the declining values of the Spearman rank correlation coefficients between industry CR_4 levels in the initial (1948) and subsequent years (1958, 1968 and 1972) presented in Table 4-3. Given the high correlation coefficients, the tendency for changes in the ranking of these industries must be characterized as gradual. Thus, while industries with high initial CR_4 levels tended to decrease in concentration, they remained relatively more concentrated than other manufacturing industries in the sample.

CHAPTER V

DEFINITIONAL ELEMENTS AND RELATIONSHIPS IMPLICIT IN THE CONCEPT OF INDUSTRY CONCENTRATION

5.1: Introduction

This chapter presents a statistical analysis of selected definitional relationships implicit in the CR_4 measure of industry concentration. It was mentioned in Chapter II that analysis of the extent to which inter-industry variation in concentration is systematically associated with each of these definitional elements (and their interaction) can be usefully employed to specify a model to explain concentration.

5.2: CR_4: Implicit Definitional Relationships

The definitional elements implicit in the CR_4 measure of industry concentration were presented and discussed in Chapter II, Section 2.2 and were expressed as follows:[1]

$$CR_4 \equiv S_4/S \equiv (LFI) \cdot (4/N) \quad \ldots\ldots\ldots (1)$$

$$CR_4 \equiv S_4/S \equiv (LMP) \cdot (LMP) \cdot (4/N) \quad \ldots\ldots\ldots (2)$$

where:

$LFI \equiv (S_4/4)/(S/N)$.

$LPI \equiv (S_4/NP_4)/(S/NP)$.

$LMP \equiv (NP_4/4)(NP/N)$.

S = industry size, e.g., total shipments or employment etc.

S_4 = size of the four largest firms measured in the same units as S.

N = number of firms in the industry.

NP = number of plants in the industry.

NP_4 = number of plants among the four largest firms.

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1. See Caves et al. (1978, Chapter 7). Other forms are given in: Evely and Little (1960, pages 100-114), Nelson (1963, pages 66-77)and Rosenbluth (1957, pages 29-37).

The terms LFI and LPI can be viewed as measures of firm and plant size inequality and LMP as a measure of the relative extent of multi-plant operations of the four largest firms. The term 4/N is the measure of the four largest firms' proportion of the total number of firms in the industry. However, since the numerator 4 is a constant (in the case of CR_4) this term reflects the total number of firms in the the industry.

These definitional relationships which pertain to levels can also be simply modified to partition changes in industry concentration levels between years t-n and t as follows:

$$(CR_4)_t \div (CR_4)_{t-n} \equiv [(LFI).(4/N)]_t \div [(LFI.(4/N)]t-n \quad \ldots\ldots(3)$$

$$\equiv [(LPI).(LMP).(4/N)]_t \div [(LPI).(LMP).(4/N)]_{t-n} \quad \ldots\ldots(4)$$

The additive form of equations (1) to (4) can be obtained by taking logarithms of the terms. Thus:

$$\log(CR_4) \equiv \log(LFI) + \log(4/N) \quad \ldots\ldots(1a)$$

$$\log(CR_4) \equiv \log(LPI) + \log(LMP) + \log(4/N) \quad \ldots\ldots(2a)$$

$$\log(CR_4)_t - \log(CR_4)_{t-n} \equiv \log(LFI)_t - \log(LFI)t-n + \log(4/N)_t - \log(4/N)_{t-n} \quad \ldots\ldots(3a)$$

$$\log(CR_4)_t - \log(CR_4)_{t-n} \equiv \log(LPI)_t - \log(LPI)_{t-n} + \log(LMP)_t - \log(LMP)_{t-n} + \log(4/N)_t - \log(4/N)_{t-n} \quad \ldots\ldots(4a)$$

According to the theory of linear transformations, where such definitional relationships exist, the observed inter-industry variations in levels and changes in concentration can be entirely attributed to its partitioned terms as they exit in the form of a linear combination.[2] Thus, from the general relationship:

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2. Ibid.; Wonnacott and Wonnacott (1969, pages 93-96).

$$\text{Var.}(X) = \text{Var.}x_1 + \text{Var.}x_2 \ \ldots \ \text{Var.}x_n + 2\text{cov.}(x_1x_2) + 2\text{cov.}(X_1x_2) + 2\text{cov.}(x_2x_n) + \ldots \ 2\text{cov.}(x_{n-1}\,x_n)$$

where $X = x_1 + x_2 + x_3 + \ldots \ x_n$ and its application to equations (1a) to (4a), one might observe which of the terms, LFI, LPI, LMP and 4/N contribute more to the inter-industry variation in concentration (CR_4).

5.3: The Statistical Results

Computation of equations (1a) to (4a) for directly comparable samples of industries are presented in Table 5-1. CR_4 is in terms of employment.

Examining equation (1a) for the years 1948 and 1972, one finds that the variation in 4/N exceeds that of LFI, both of which exceed the variation in CR_4. Though inter-industry variation in concentration levels in 1948 and 1972 appears to be primarily associated with the variation in the number of firms,[3] its contribution to the variation in concentration levels is not obvious due to the large (negative) value of the covariance term between LFI and 4/N. Comparing 1972 with 1948, the results suggest that there is less firm size inequality than before. There is also less inter-industry variation in concentration levels probably reflecting the inverse relationship between initial concentration levels and trends in average concentration noted in Chapter IV.

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3. Since the number of firms is measured inversely, the positive association still supports the proposition that increases in the number of firms results in lower concentration levels. Using a similar relationship based on the 80 percent inverse (empl.) concentration index, Rosenbluth (1957, page 33) found that inter-industry variation in concentration levels in 1948 was primarily associated with the variation in the number of firms. However, the magnitude of its covariance with firm size inequality is very different from that presented in Table 5-1 above. This is probably due to the different properties of the CR_4 and 80 percent measures of industry concentration (and or different sample sizes).

TABLE 5-1

VARIATION BETWEEN INDUSTRY CONCENTRATION AND ITS DEFINITIONAL ELEMENTS, LEVELS AND CHANGES (COMPUTED IN LOGARITHMS)

Var. CR_4	Var. LFI	Var. LPI	Var. LMP	Var. 4/N	[2. Cov.(LFI.4/N)]	[2. Cov.(LPI.LMP)]	[2. Cov.(LPI.4/N)]	[2. Cov.(LMP.4/N)]	Year/time Period	Type of Eqn Computed*
0.613	0.671			1.946	-2.004				1948	(1a)
0.501	0.622			1.646	-1.767				1972	(1a)
0.613		0.403	0.310	1.946		-0.042	-1.382	-0.622	1948	(2a)
0.502		0.481	0.286	1.646		-0.145	-1.298	-0.468	1972	(2a)
0.126	0.313			0.537	-0.724				1948-1972	(3a)
0.126		0.297	0.213	0.537		-0.197	-0.509	-0.216	1948-1972	(4a)

Notes: Sample Size = 57

Summation of terms may not add up to values for CR_4 due to rounding.

*See text for further details.

Insight into the variation in changes in these definitional elements can be gathered by examining equation (3a). The relative order of the magnitudes of variation in LFI, 4/N and their covariance remains the same. That is, in each of the equations (1a) and (3a), the covariance between LFI and 4/N is greater than the variation in 4/N, which is greater than the variation in LFI. However, inter-industry variation in each of these elements is less in terms of changes than for levels, suggesting that there are no dramatic forces at work which affect these elements so as to change the rank order of inter-industry concentration levels. It will be recalled that the value of the rank correlation coefficient between industry concentration levels in 1948 and 1972 is 0.870.

The negative covariance between LFI and 4/N in equation (1a) and (3a) indicates that decreases (increases) in the number of firms (reflected in 4/N) also result in lower (greater) firm size inequality. Decreases in the number of firms and lower firm size inequality would arise if relatively small firms were leaving the industry. Although information on the size of firms leaving the various industries in the sample is not available, further analysis of the data does indicate that (a) the average number of firms per industry decreased from 170 to 137 and (b) the average size of firms excluding the four largest firms has increased while the dispersion in their sizes has decreased between 1948 and 1972. The same is the case for the average size of the four largest firms, but to a lesser extent.

The extent to which inter-industry variation in CR_4 is due to the effect that the four largest firms operate larger than average plants (LPI) and/or a larger than average number of plants (LMP) in the industry is examined in equations (2a) and (4a) suggested by Caves et al. (1978).

Examining equation (2a) for 1948 and 1972, one finds that the variation in 4/N exceeds the variation of LPI and the variation of LMP suggesting that inter-industry differences in concentration levels are probably primarily associated with differences in the number of firms. However, as in the case of LFI, the large covariance between 4/N and LPI indicates that the separate contribution of 4/N to the variation of CR_4 is not obvious. The negative sign

of the covariance term suggests that there is a tendency for lower (greater) plant size inequality as the number of firms decreases (increases).[4]

The variation in LPI is greater than that of LMP. The smaller variation of LMP suggests that while there is some degree of multi-plant operations among leading firms, this probably exerts less influence on inter-industry variation in concentration levels than LPI.

The negative covariance between LPI and LMP tentatively suggests that if there is an increase in multi-plant operations among leading firms, the size of these plants is likely to differ less from the size of other (single plant) firms in the industry. This would be expected given the small size of Canada's domestic markets where firms face greater pressures, first, to exhaust economies of scale at the single plant level and then to exploit economies of multi-plant operations.[5] Further support for this proposition is lent by the negative covariance between LPI and 4/N. A decrease in LPI would take place if small (generally single plant) firms leave the industry and/or if production is increasingly concentrated among plants of more equal size.

If the existing size of markets is relatively small, growth in market size over time would lead to greater opportunities for exploiting economies of both plant level and multi-plant operations. These may correspondingly be reflected in the variation in LPI and LMP. Some differences can be noted by comparing equation (2a) for 1948 and 1972. However, it is more appropriate to measure changes in the variation of CR_4, LPI, LMP and 4/N as is the case in equation (4a).

Examining equation (4a) and comparing the results with equation (2a) for 1948 and 1972, suggest slightly different results. Although the relative order of the magnitudes of the variations in LPI, LMP and 4/N remains the same, differences among their variation are less marked. The relative variation in LMP is greater for changes than

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4. Caves arrives at a similar conclusion based on a correlation analysis between LPI and N for a larger sample of industries using CR_4 (shipments) for 1958. Caves et al. (1978).

5. This interpretation is also consistent with the negative though low value of the simple correlation coefficient between LPI and LMP, viz., -0.059 for 1948 and -0.195 for 1972.

for levels of CR_4 indicating that over time firm multi-plant operations are of increasing importance. Further analysis indicates that the mean of LMP in 1972 is greater than the mean in 1948 and is significantly different at the 5% level. There are also differences between the means of changes in LFI and LPI at the 5 percent level.[6] The latter differences can only arise due to firm multi-plant operations.

In order to examine further the relative importance of firm multi-plant operations, additional identities can be specified. In terms of logarithms these are:

$$\log(AFS_4) \equiv \log(APS_4) + \log(AMP_4) \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$\log(AFS_4)_t - \log(AFS_4)_{t-n} \equiv \log(APS_4)_t - \log(APS_4)_{t-n} + \log(AMP_4)_t - \log(AMP_4)_{t-n} \quad \ldots\ldots (6)$$

$$\log(AFS) \equiv \log(APS) + \log(AMP) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$\log(AFS)_t - \log(AFS)_{t-n} \equiv \log(APS)_t - \log(APS)_{t-n} + \log(AMP)_t - \log(AMP)_{t-n} \quad \ldots\ldots (8)$$

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6. In terms of logarithms these are:

	Mean	Std. Dev.
LMP_{1948}	0.462	0.556
LMP_{1972}	0.674	0.535
$LFI_{1948-1972}$	0.048	0.560
$LPI_{1948-1972}$	-0.164	0.545

Number of observations = 57

There are no statistically significant differences in the variance of these definitional elements.

where:

$AFS_4 \equiv S4/4$ = average size of the four largest firms,

$APS_4 \equiv S4/NP_4$ = average size of the plants among the four largest firms,

$AMP_4 \equiv NP_4/4$ = average number of plants among the four largest firms,

$AFS \equiv S/N$ = average size of the firms in the industry,

$APS \equiv S/NP$ = average size of the plants in the industry,

$AMP \equiv NP/N$ = average number of plants among firms in the industry

and t, t-n relate to the year.

Computation of the variation in levels and of changes in each of these definitional elements in equations (5) to (8) is presented in Table 5-2.

The results suggest that inter-industry variation in the average size of the four largest firms (AFS_4) in 1948 and 1972 is primarily associated with the variation in the average size of plants (APS_4) they operate. A similar finding emerges when the variation in the average size of firms and plants in the industry is examined (AFS, APS). However, the relative importance of average number of plants per firm among the four largest firms (AMP_4) does appear to be greater when compared with the industry as a whole (AMP). This indicates that multi-plant operations are a contributing factor to the large size of the leading firms in the industry, and most probably reflect the effects of diseconomies of scale that impose a limit on increases in individual plant size. Industrial organization theory would suggest that these limits are more likely to be encountered by firms that operate already large plants as compared to the other firms operating small plants in the industry.

Variation in the changes in the average size of the four largest firms implies an increasing and important role for multi-plant operations. The variation of AMP_4 is almost equal to that of APS_4. However, the large (negative) covariance between APS_4 and AMP_4 indicates that the individual contribution of these elements to the variation in changes in the average size of the four largest firms is difficult to identify. In contrast, variation in changes in

TABLE 5-2

VARIATION BETWEEN AVERAGE FIRM SIZE AND ITS DEFINITIONAL ELEMENTS: LEVELS AND CHANGES (COMPUTED IN LOGARITHMS)

Var.AFS_4	Var.APS_4	Var.AMP_4	Average of Four Largest Firms [2.Cov.(APS_4.AMP_4)]	Year/Time Period	Type of Equation Computed*
1.362	1.137	0.401	-0.178	1948	(5)
1.391	0.898	0.431	0.062	1972	(5)
0.255	0.277	0.244	-0.266	1948-1972	(6)
Var.AFS	**Var.APS**	**Var.AMP**	**Average of All Firms [2.Cov.(APS.AMP)]**	**Year/Time Period**	**Equation Number**
1.656	1.466	0.040	0.150	1948	(7)
1.664	1.183	0.118	0.364	1972	(7)
0.410	0.335	0.049	0.026	1948-1972	(8)

Notes: Sample Size = 57

Summation of terms may not add up to values for AFS_4, AFS due to rounding.

*See text for further details.

the average firm size (AFS) in the industry as a whole is primarily associated with the variation in average plant size (APS). The variation in the average number of plants operated by these firms (AMP) is relatively unimportant.

5.4: Summary and Conclusions

The preceding analysis focused on some of the definitional elements and relationships implicit in the four-mix concentration ratio (CR_4). Either in terms of levels or of changes, inter-industry variation in CR_4, by definition, can be related to the inter-industry variation in firm size inequality (LFI) and the total number of firms (4/N) or, plant size inequality (LPI), extent of firm multi-plant operations (LMP) and the total number of firms (4/N). However, statistical analysis of these relationships reveals that in several instances, the combined variation in LFI and 4/N, LPI and 4/N or LMP and 4/N is larger than the separate variation in these definitional elements or the variation in CR_4 itself. So much so, it is difficult to gauge the contribution made by the variation of these individual definitional elements to the variation in CR_4. While caution is required in interpreting the statistical results, it is ventured that inter-industry variation in concentration, particularly in terms of levels as against changes, may be ascribed (in order of relative importance) to the variation in 4/N, in LFI, in LPI and in LMP.

The variation in firm size inequality (LFI) which is greater than that of plant size inequality (LPI) appears in part attributable to the increasing importance of firm multi-plant operations. This is brought into bold relief by comparative analysis of the definitional elements and relationships implicit in the average size of the four largest (AFS_4) and all firms (AFS) in an industry. Inter-industry variation in the average number of plants per four largest firms (AMP_4) tends to be more important in relation to the variation in the average size of these firms (AFS_4) compared with the variation in the average number of plants per all firms (AMP) in relation to the variation in the average size of all firms (AFS).

CHAPTER VI

SPECIFICATION OF THE MODEL

6.1: Introduction

This chapter specifies a model of the determinants of changes in industry concentration levels. In addition to describing briefly the theoretical justification for the construction of the model and inclusion of the several variables, the results of selected tests conducted on these variables are reported. The Appendix to this chapter presents the algebraic relationships between the dependent and independent variables, and between sub-sets of independent variables. It demonstrates that identity relationships that would otherwise confound the analysis are not present in the model.

6.2: The Model

The model which is empirically tested in the next two chapters is:

DCR = f(CPS or CMES or CCI, CMPO, MG, EN, EX, HM, OMS, TP, PD)

where briefly:

DCR	is change in industry concentration level,
CPS	is change in absolute plant size,
CMES	is change in relative minimum efficient plant size,
CCI	is change in capital intensity,
CMPO	is change in firm multi-plant operations,
MG	is market growth,
EN	is the relative extent of entry of firms,
EX	is the relative extent of exit of firms,
HM	is the relative extent of horizontal mergers,
OMS	is initial concentration level in industries with oligopolistic market structures,
TP	is tariff protection, and
PD	is product differentiation

For reasons set out in the next section, the specified model is estimated with and without selected variables.

6.2.1: The Measurement of the Variables

All variables are computed for individual industries at the three- and four-digit S.I.C. level(s).

DCR: Change in Industry Concentration Levels

The measure of industry concentration change used as the dependent variable in the model is:

$$DCR = (CR_4)_t - (CR_4)_{t-n}$$

where CR_4 is the four-firm employment concentration ratio and t and t-n refer to the year for which this measure is computed.

The difference measure of concentration change is preferred to that of the ratio or percentage change in concentration because the latter has the effect of giving less weight to the same absolute amount of concentration change in an industry with an initially high concentration level than in one with a low concentration level.

CPS: Change in Absolute Plant Size

Theoretical considerations suggest that economies of scale in production exist partly at the plant level. Ongoing adjustments in plant size, which reflect the pursuit of these economies, should influence industry concentration levels. A priori, a positive relationship between changes in plant size and concentration change can be expected since pursuit of economies of scale generally result in larger plants.

In the present context, the measure of absolute change in plant size is preferred as it is more likely to reflect the actual adjustments made in the size of plants operated by firms in the industry. Some information on whether or not this is the case is lost if the plant size measure is deflated by industry or market size since over time market growth may have taken place while plant sizes may have remained unchanged.

Two separate measures of change in absolute plant size are used in the model:

$$CPS_1 = (PS_1)_t/(PS_1)_{t-n} = \left(\sum_{i=1}^{NP} e_i^2/E\right)_t \div \left(\sum_{i=1}^{NP} e_i^2/E\right)_{t-n}$$

$$CPS_2 = (PS_2)_t/(PS_2)_{t-n} = \left(\sum_{i=1}^{NP} s_i^2/S\right)_t \div \left(\sum_{i=1}^{NP} s_i^2/S\right)_{t-n}$$

where:

PS_1	is the Niehans' index[1] of plant size in terms of employment,
PS_2	is the Niehans' index of plant size in terms of shipments,
e_i	is the employment in the i^{th} plant,
s_i	is the shipments of the i^{th} plant,
E	is total industry employment,
S	is total industry shipments,
NP	is the total number of plants in the industry, and
t, t-n	refer to the year for which these data are computed.

The Niehans' index is used because it is sensitive to the relative number and importance of different plant sizes at a given time or over time. For example, if over time, there is an increase in the number of large plants, or if large plants are increasing in size at a rate faster than medium or small plants in an industry, the Niehans' index will increase. Such changes in the industry plant size distribution are not necessarily reflected by the simple average plant size measure used in some of the studies reviewed in Chapter II. In fact, the simple correlation coefficient between changes in the Niehans' index (CPS_1) and changes in average plant size (computed in terms of employment over 1948-72) is low, viz., 0.56. In terms of shipments, the correlation coefficient between these two measures is 0.57.

Since the Niehans' index assigns a greater weight to large plants, it may be in part definitionally related to concentration change. A detailed examination of the pattern of change in CPS_1 and in DCR was, therefore, conducted. No systematic relationship was evident. The simple correlation coefficient (computed over 1948-72) between CPS_1 and DCR is 0.170.

CMES: Change in Relative Minimum Efficient Plant Size

The minimum efficient or optimum plant size, in relation to the size of market, is generally recognized as one of the important factors determining concentration. However, while it is largely a technologically determined datum, it is not an unchanging one. Technological change, shifts in factor costs, transportation costs, etc., continually change the optimal scale of a new industrial plant. Changes in industry concentration levels may thus arise from changes in the minimum scale of output which is required to minimize plant costs of production. These will, to some extent, be reflected in the CPS_{1-2} measures presented above.

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1. Niehans (1958).

However, in any given period, small plants may exist. These may have been built in an earlier period, before demand had expanded or a technology which required large scale had been developed, or they may result from the entry of small firms. It is, therefore, important to select a measure which is insensitive to such factors.

Since independent information on changes in minimum efficient plant size is not available for large samples of industries, a statistical proxy is derived from individual industry size distribution of plants.[2] The measure is:

$$CMES = (MES)_t \div (MES)_{t-n} = (AE50/E)_t \div (AE50/E)_{t-n}$$

where MES stands for minimum efficient plant size, AE50 is the average employment in the largest plants accounting for 50 percent of total industry employment, E is total industry employment and t, t-n refer to the year for which these data are computed.

One drawback of the CMES measure is that it is based on the size of the largest plants which generally tend to be operated by the largest firms. Therefore, it may by definition be related to concentration change. However, the simple correlation (computed over 1948-72) between DCR and CMES is 0.25.

Caves argues that the minimum efficient plant scale should affect concentration only if the cost disadvantages of sub-optimal scale are substantial.[3] In other cases, the minimum efficient plant size is of no theoretical significance. To allow for these possible differences, Caves suggests a measure to capture the extent of cost disadvantages associated with sub-optimal plants, viz., the ratio of the value added per employee in the smaller plants accounting for 50 percent of industry employment to the value added per employee in the remaining (larger) plants in the industry.[4] This measure (CDRC) is constrained to have

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2. See Comanor and Wilson (1967) who first suggested this proxy (in terms of shipments) for a given year. For changes over time, this measure or its variant has been used by Caves et al. (1978) and Duetsch (1977).

3. Caves et al. (1975, 1978).

4. Caves' cost disadvantage ratio (CDRC) measure uses 50 percent of industry shipments. See Caves et al. (1978).

a maximum value of 1.00, i.e., cases where there are no cost disadvantages of having small plants. It is used to partition the relative minimum efficient plant size (MES) variable as follows:

> MES8 = MES in industries where CDRC $\leq$ 0.8 in the initial year (t-n). In such cases MES takes on its own value. In industries where CDRC > 0.8, MES takes on zero values.

MES8 is used instead of the CPS_{1-2} and CMES variables in selected forms of the specified model. Use of this measure assumes there has been no change in the relative minimum efficient plant size in industries where CDRC > 0.8 during the period t-n to t.

CCI: Changes in Capital Intensity

Given that the CPS_{1-2} and CMES measures are in terms of employment or shipments, they may not adequately reflect different or changing technological conditions and production processes which affect capital-labour ratios in plants across industries in a given year or over time. This drawback may be important since a number of studies suggest that the size of plant is related to the ratio of capital to labour. Where fixed capital is important relative to other factors, a larger number of operations are generally performed mechanically than is likely to be the case in industries where fixed capital is less important. The costs of production are lowest when machines are used in such proportions that each can be operated at full capacity. The minimum scale of production required to minimize costs therefore tends to be larger the greater the variety or amount of machinery used.[5] A priori then, changes in capital intensity can be expected to be positively related to concentration change through its effect on changes in minimum efficient scale. Appropriate measures of capital (and hence capital intensity) are not available. Two statistical proxies are therefore used (each separately) in this study, viz.,

$$CCI_1 = (CI_1)_t \div (CI_1)_{t-n} = (FE/E)_t \div (FE/E)_{t-n} \text{ and}$$

$$CCI_1 = (CI_2)_t \div (CI_2)_{t-n} = (FE/S)_t \div (FE/S)_{t-n}$$

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5. See Rosenbluth (1957, pages 37-39) for further discussion related to these points.

where CI stands for capital intensity, FE is the current dollar value of fuel and electricity consumed by plants, E is total industry employment, S is total shipments and t, t-n refer to the year for which these data are computed.[6]

Fuel and electricity consumption is chosen as it is likely to be related to various types of machinery used in the production processes. It also constitutes a part of an index of mechanization based on horsepower rating of mechanical equipment computed by Rosenbluth,[7] but which unfortunately cannot be measured for other years. However, the simple correlation coefficient (for 1948) between Rosenbluth's index and CI_1 and CI_2 is 0.953 and 0.912 respectively.

While the CCI_{1-2} measures are not directly reflective of change in plant size variables CPS_{1-2} and CMES, they are each used separately in the model.

CMPO: Change in Firm Multi-Plant Operations

A firm may be large because it operates large plants or multiple plants or both. While the CPS_{1-2}, CMES and CCI variables likely reflect economies of scale at the plant level, CMPO may reflect the firm level economies derived from having multi-plant operations. A priori, CMPO is probably positively related to concentration change since it results in larger firms.

The measure used in the analysis is:

$$CMPO = [(MPO)_t - (MPO)_{t-n}] \div (MPO)_{t-n}$$

where MPO is the average number of plants in firms operating two or more plants in the industry in the years t and t-n. If MPO can only be computed for one of these two years, the value of one (i.e., all firms operate one plant each) is assigned to the MPO measure relating to the other year. In industries where there were no multi-plant firms in both years, CMPO takes on a zero value.

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6. One obvious drawback of using current dollar value of fuel and electricity over time is that it includes the effects of price changes. Unfortunately, no easy adjustment procedure is available. The extent to which this also affects value of shipments used in the computation of CCI_2 is discussed below in connection with MG.

7. Rosenbluth (1957, pages 42-43).

While this measure is a more accurate and direct measure of firm multi-plant operations than has been previously computed and used in the literature,[8] one particular drawback needs to be borne in mind. This is that the measure does not reflect the different sizes of plants operated by multi-plant firms. Data relating to the size of individual plants operated by multi-plant firms are not available.

Since changes in multi-plant operations in a given industry may come about by the establishment of new plants or by horizontal merger, two other measures of multi-plant operations which allow for the separate analysis of these factors are included (instead of CMPO) in the model:

$$CMPO_1 = (NMPO)_{t-(t-n)} \div MPO_{(t-n)}$$

$$CMPO_2 = (AMPO)_{t-(t-n)} \div MPO_{(t-n)}$$

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8. A noted exception is the path-breaking study of Scherer et al. (1975) for the 12 industries analyzed in detail. However, for the larger sample of 101 to 155 industries, the Scherer study uses either the average number of plants per firm in the four and eight largest firms or derives a measure of multi-plant operations from plant and firm size distributions. In the case of the former, the measure may be biased downwards if not all four or eight firms have multi-plant operations. In the latter case, the measure is an estimate and does not take into account the fact that large firms may operate large and small plants (see ibid., Chapter 5). A detailed examination of the data contained in this study (see Table A-2, Appendix A) suggests there are several cases where firms other than the leading four or eight have multi-plant operations. Moreover, the average number of plants per leading four firms is often less than the average number of plants per the remaining multi-plant firms in the industry. The simple correlation coefficient between CMPO and changes in the multi-plant operations of the leading four (CMPO4) and leading eight (CMPO8) firms is 0.23 and 0.22, respectively. Rosenbluth (1957, pages 62-74) uses the simple and weighted average of plants per firm in the industry. The industry's percentage of employment in each firm-size class is used as weights to compute the latter measure. Both of these averages gauge the relative extent of firm multi-plant operations in the industry as a whole and are downward biased as they are sensitive to the total number of firms in the industry. Over time they would also be sensitive to the entry and exit of (most likely single-plant) firms. The simple correlation coefficient between CMPO and changes in the average number of plants per firm in the industry is 0.18.

where NPMO is the number of new plants established by firms and AMPO is the number of plants acquired by firms during the time period t-n to t. MPO is defined as before.

Further details on the computation of CMPO, $CMPO_1$ and $CMPO_2$ measures are contained in Appendix B.

MG: Market Growth

Market growth may encourage the entry of firms into industries since scale-related barriers tend to be less significant in an expanding market. In addition, if leading firms have exhausted available plant and multi-plant economies, market growth may facilitate the growth of medium and small size firms which result in the redistribution of market shares and lower degrees of firm size inequality. These propositions suggest that an inverse relationship between market growth and concentration change can be expected.

Market growth in the model is measured as:

$$MG = (S)_t \div (S)_{t-n)}$$

where S is the total industry value of shipments in current dollars and t, t-n refer to the year for which these data are computed.

Current dollar value of shipments are not likely to distort inter-industry variations in market growth in real terms since there is a high correlation ($r = 0.87$) between deflated and undeflated MG.[9]

The extent of the inverse relationship between market growth and concentration change may be partly related to the rate at which markets grow. If the rate of market growth is low, existing firms in the industry may be able to adjust their scales accordingly and entry of firms or redistribution of market shares may not take place. However, if the rate of market growth is high, the entry of firms is more likely to take place and leading firms will probably encounter difficulties in maintaining their relative market

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9. This was computed across a sample of 35 industries over the longest period for which comparable data were available viz., 1958-72. The industry selling price index was used to deflate MG. See Statistics Canada (cat. no. 62-528, various years) for further details on this index.

positions. In order to examine the effect of difference in market growth rates on concentration change, MG is partitioned as follows:

$MG_1 = MG \geq 600$ percent. Zero otherwise.
$MG_2 = 300 \leq MG < 600$ percent. Zero otherwise.
$MG_3 = MG < 300$ percent. Zero otherwise.

MG_{1-3} take on their actual industry values and are specified as separate explanatory variables (instead of MG) in the model.[10]

Entry (EN), Exit (EX) and Horizontal Merger (HM) of Firms

In the present study it was possible using census of manufacturers' mailing lists to derive data on the number of firms that have entered an industry (NNF), the number of firms that have exited from that industry (ENF), and the number of firms that have horizontally merged (NMF) in that industry during a given period. Details on the methodology used to derive these measures are presented in Appendix B.

Since information on the size of individual firms is not available, the entry (EN), exit (EX) and horizontal merger (HM) variables specified in the model are:

$$EN = (NNF)_{t-(t-n)} \div (NF)_{(t-n)}$$
$$EX = (ENF)_{t-(t-n)} \div (NF)_{(t-n)}$$
$$HM = (NMF)_{t-(t-n)} \div (NF)_{(t-n)}$$

where NNF, ENF and NMF are as described above, t-(t-n) refers to the period over which these data are computed and $(NF)_{t-n}$ is the total number of firms in the industry in the initial year t-n. Thus for given NNF, ENF and NMF, the relative values of the EN, EX and HM measures will be greater, the fewer the initial number of firms in an industry.

This approach, which takes into account the separate effects of each of these factors on concentration change, rather than using a single measure of the net changes in the number of firms employed as in previous studies, is analytically more appropriate. Net changes in the number of firms is a mis-specification since the effects of entry, exit and horizontal mergers on changes in industry concentration levels may be expected to differ. Theoretical considerations suggest that generally, EN has an inverse relationship while EX and HM have a direct relationship with concentration change.

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10. This procedure is based on Johnston (1972, pages 194-207); Rao and Miller (1971, pages 88-93).

Bain defines entry as "the establishment of an independent legal entity, new to the industry ... and the concurrent building or introduction by new firms of physical production in the industry prior to the establishment of the new firms".[11] Since the data used to construct the EN variable are derived from census mailing lists, which only provide the names and addresses of firms, it is possible that some of the firms identified as having entered an industry may not have actually started manufacturing activity. Moreover, some economists view establishment of new capacity by existing firms as constituting entry. This latter factor, while being partly reflected by the CMPO variable, will not be picked up by the EN variable. Finally, adjustments for other factors, such as differentiating types of entering firms (i.e., whether foreign or domestic, or new or established firms), could not be readily incorporated in the analysis. Such factors may be important in gauging the effects of EN on concentration change.

A point worth noting in connection with EX is that not all firms which exit from an industry reflect the closure or bankruptcy of firms. In some cases firms may have diversified and been classified to another industry. In such cases, EX of firms in one industry may be EN in another industry. In addition, EX will not cover firms acquired by another firm by horizontal merger in a given industry which have subsequently been closed down by the acquiring firm.

OMS: Initial Concentration Levels in Industries with Oligopolistic Market Structures

Stigler (1952) predicts declining concentration levels in highly concentrated oligopolies because it may be more profitable for firms to set higher prices and gradually yield part of the industry to new rivals. It is argued that if oligopolistic firms jointly price output along the long-run industry demand curve as against their own demand curve, then even if profits tend to decline from one period to another with the entry of new firms, the present value of these profit streams may exceed those that would otherwise be obtained.

A similar prediction is implied in the analysis of Worcester (1957). He argues that the market position of dominant firms is inherently unstable, and except in cases

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11. Bain (1956, page 5).

where there may be increasing returns to scale, the industry will disintegrate into competition or some form of consciously inter-acting oligopoly with or without a competitive fringe.

In contrast, in Bain's entry forestalling (limit) price model, industry structure becomes "irreversible"[12] once this price is established. Sylos-Labini (1969) puts forward a similar argument. Both theories predict stable concentration levels. A similar prediction is also made by Eastman and Stykolt (1967) in the perspective of Canada's industrial environment.

In order to test for these different propositions, the OMS variable specified in the model is the initial concentration level (i.e., in year t-n) in industries where $CR_4 \geq 75$ percent and/or in industries which can be designated as having oligopolistic market structures. The latter criteria are based on the list of industries commonly described as 'oligopolies' in the United States.[13] For each of these industries, the OMS variable takes on its own value. Zero values are assigned to other industries. Given the ambiguous nature of the theoretical predictions, no attempt is made to postulate a priori, the direction of the relationship between OMS and concentration change.

TP: Tariff Protection

Domestic tariffs on imports insulate industries from foreign competition. It is possible that this can result in increased concentration levels since leading firms will tend to be less fettered in their market behaviour.[14] On the other hand, industries may become less concentrated. A motive for a high tariff policy is to encourage domestic production. According to Eastman and Stykolt (1967), tariffs have facilitated the "over crowding" of Canadian industries by high cost sub-optimal plants and encouraged the entry of foreign firms, resulting in branch plant operations.

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12. Bain (1972, page 65).

13. See Kamerschen (1968b) and Shepherd (1964).

14. In Canada, during the post-war period, there have been 11 cases referred to by the Director of Investigation and Research, Combines Investigation Act and the Restrictive Trade Practices Commission, where tariffs have facilitated a particular anti-competitive market behaviour by a group of firms.

Several measures of tariff production are used (each separately) in the model. These are:

NTP = nominal tariff rate.

HNTP = high nominal tariff rate, i.e., industries where NTP $\geq$ 20 percent. For such industries the HNTP variable takes on its own value while for other industries it is assigned a zero value.

ETP = effective tariff rate.

HETP = high effective tariff rate, i.e., industries where HETP $\geq$ 20 percent. As in the case of HNTP, HETP takes on its own value in industries where it is applicable; otherwise it is equal to zero.

The NTP, ETP variables are partitioned as the relationship between tariff protection and concentration change may depend on some critical level of tariffs. The 20 percent criteria are chosen arbitrarily.

Data on nominal and effective tariff rates by industry are only recently available and do not extend back to the period over which the model is estimated. The NTP, HNTP, ETP and HETP variables are therefore measured for a single year,[15] viz., 1963. Thus the proposition that changes in the extent of tariff protection over time may also be systematically related to changes in industry concentration levels cannot be tested.

PD: Product Differentiation

The measurement of the degree of product differentiation as well as its relationship to concentration change has been the subject of intense and continuing debate.[16] In addition, the complexities are compounded in Canada, given the geographic proximity of Canadian markets to the United States and the spill-over effects of advertising and related marketing activities from that country. In view of the difficulties of devising or deriving more "sophisticated" measures (e.g., those based on cross-elasticities of demand between products), this study relies on the now traditional proxy variable for product differentiation, viz., the ratio of advertising expenditures to industry shipments (A/S).

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15. These are contained in Melvin and Wilkinson (1968).

16. See Ferguson (1976) for a synoptic review of the various issues. Also Ornstein (1977).

TABLE 6-1

MEAN AND COEFFICIENT OF VARIATION OF THE SPECIFIED VARIABLES AND THEIR ALTERNATIVE FORMS, 1948 - 1972

VARIABLE*		MEAN	COEFFICIENT VARIATION
Concentration Change	DCR	4.297	3.468
Change in Absolute Plant Size	CPS_1	1.693	0.765
	CPS_2	5.448	0.717
Change in Minimum Efficient Plant Size	CMES	1.526	1.073
Change in Capital Intensity	CCI_1	2.869	0.429
	CCI_2	0.361	1.299
Change in Multi-Plant Operations	CMPO	1.276	0.448
	$CMPO_1$	1.101	0.546
	$CMPO_2$	0.556	0.495
Market Growth	MG	5.034	0.807
	MG_1	3.040	1.666
	MG_2	1.352	1.486
	MG_3	0.643	1.538
Entry	EN	1.509	1.286
Exit	EX	1.172	0.687
Horizontal Merger	HM	0.088	1.509
Oligopoly	OMS	79.116[a]	0.231[a]
Tariffs	NTP	15.913[b]	0.529[b]
	HNTP	24.100[c]	0.152[c]
	ETP	26.495[b]	0.749[b]
	HETP	36.152[d]	0.446[d]
Product Differentiation	PD	1.746	1.463
	HPD	5.206[e]	0.531[e]
	MPD	1.258[f]	0.127
	LPD	0.243[d]	1.195[d]

Notes:
Source Appendix A and related references cited in the text.
*See text for detailed description of these variables.
Sample Size:
a = 11
b = 40
c = 15
d = 27
e = 13
f = 9
in all other cases it is equal to 49.

The data for calculating this measure are available for a single year only, 1965.[17]

In order to gauge whether concentration change also depends on the different levels of product differentiation the following variables are also included in the analysis (instead of PD):

HPD = high product differentiation, i.e., industries where A/S $\geq$ two percent.

MPD = moderate product differentiation, i.e., industries where one percent $\leq$ A/S $<$ two percent.

LPD = low product differentiation, i.e., industries where A/S $<$ one percent.

These variables take on their own values in the industries to which they are applicable and zero value otherwise.

The means and coefficient of variation of the different forms of the variables used in the specified model for the time period 1948-72 are presented in Table 6-1. Detailed statistics on individual industries for different years during this time period are presented in Appendix A.

6.3: Some Inter-relationships Between Variables Specified in the Model and Identity Related Factors Affecting Concentration Change

On theoretical grounds it can be postulated that the effect of entry of firms (EN) on concentration change may partly be attributed to the effect of market growth (MG) on EN. However, while MG may result in EN, it also may facilitate the pursuit of economies of scale leading to changes in plant size (CPS_{1-2}) and/or in firm multi-plant operations (CMPO). In order to gain further insight into such inter-actions, the specified model is estimated with and without selected variables.

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17. Statistics Canada (1968).

In addition, the forms:

DCR = f (CPS or CMES or CCI, CMPO, MG),
and
DCR = f (EN, EX, HM)

are estimated. This is because (as pointed out in Chapter II) it may be theoretically inappropriate to specify change in the number of firms (i.e., EN, EX, HM) in models of concentration change which also include market growth (MG) and plant or firm size related variables (e.g., CPS or CMES and CMPO). The latter set of variables along with MG may themselves be surrogates for the number of firms.[18] The effects of EN, EX and HM on concentration change may, thus, primarily reflect the impact of economic forces either unspecified or already included in the model. If the latter is the case, the introduction of these three variables may bias the results relating to the other variables if the model is complete and correctly specified. If, however, the former is the case, it is still of interest to gauge the effects of these three variables on concentration change after allowing for the effects of the other variables in the model. After all, entry of firms in a particular industry may take place with or without market growth and there are numerous other reasons for the exit of firms or horizontal mergers which are not necessarily related to changes in plant size or in firm multi-plant operations. To specify separately other factors which may affect concentration change via variables such as EN, EX and HM, requires more data than are presently available.

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18. Ornstein et al. (1973). See also footnote 3 in Chapter II. The argument is more applicable to analysis of differential concentration levels than to changes in concentration levels over time. As was pointed out in Chapter II, over time changes in plant size (CPS), number of firms (NF), etc., may or may not necessarily arise from concomitant changes in market size (i.e., S or in case of changes, MG). In the Appendix to this chapter it is shown that: $NF \neq (PS.MPO.S)$ or $NF_t/NF_{t-n} \neq (CPS.CMPO.MG)$. In addition, regression analysis of these relationships yield R^2 values of less than 0.43, and the estimated regression coefficients differ from 1.00, indicating clearly that an identity relationship does not exist between these variables. Finally, the specified model is primarily tested over the long period, 1948-72. It is extremely doubtful if structural change has not occurred over this period in the sample of industries analyzed in this study.

In Chapter V, concentration change was partitioned into change in firm size inequality (LFI or LPI, LMP) and in number of firms (4/N). The EN, EX and HM variables in the specified model, in effect, represent the change in the number of firms. The other variables in the model can be considered as (some of) the factors which influence change in firm size inequality.

The statistical analysis contained in Chapter V indicated that the covariance between LFI and 4/N exceeded the variance in each of these two terms and in concentration change itself. The large covariance term probably reflects the complex inter-actions or inter-relationships between factors which affect both LFI and 4/N. For example, while on theoretical grounds there may exist inter-actions between MG and EN, the effects of both of these variables on concentration change may be via LFI and/or 4/N. The entry of firms (EN) is likely to change the size inequality of existing firms in the industry. It, of course, leads to the increase in the total number of firms in the industry, ceteris paribus. Similarly, market growth (MG) may affect LFI since it facilitates pursuit of economies of scale. Thus the effect of CPS_{1-2} and/or CMPO on concentration change may be via its effect on LFI. In order to gauge these relationships, the model is also estimated by substituting in place of the dependent variable DCR, the elements LFI or LPI or LMP.

APPENDIX TO CHAPTER VI

Algebraic Relationships Between the Dependent and Independent Variables and Between Sub-sets of Independent Variables Specified in the Model

6.A.1: Definitions

For a given industry:

$$CR_4 = \left(\sum_{i=1}^{4} F_i / \sum_{i=1}^{NF} F_i\right) \quad \ldots\ldots (1)$$

$$= \left(\sum_{i=1}^{4} F_i / \sum_{i=1}^{NP} P_i\right) \quad \ldots\ldots (2)$$

where CR_4 is the four-firm concentration ratio. $F_1 > F_2 > F_3 \ldots$ Each F_i is the absolute size of the firm. Similarly, P_i is absolute size of the plant, NF is the total number of firms in the industry, NP is the total number of plants in that industry.

$$S = \sum_{i}^{NF} F_i = \sum_{i}^{NP} P_i \quad \ldots\ldots (3)$$

where S stands for market size.

$$NF \neq NP \quad \ldots\ldots (4)$$

except for cases where all firms in the industry operate only one plant.

$$PS = \left(\sum_{i=1}^{NP} P_i^2 / \sum_{i=1}^{NP} P_i\right) \quad \ldots\ldots (5)$$

where PS stands for plant size (i.e., Niehans' index).

$$MPO = NP^*/NF^* \quad \ldots\ldots (6)$$

where MPO stands for firm multi-plant operations, NP* number of plants among firms operating two or more plants and NF* is the number of such firms.

$$EN = (NNF)_{t-(t-n)} \div NF_{t-n} \quad \ldots\ldots (7)$$

$$EX = (ENF)_{t-(t-n)} \div NF_{t-n} \quad \ldots\ldots (8)$$

$$HM = (NMF)_{t-(t-n)} \div NF_{t-n} \quad \ldots\ldots (9)$$

where NNF, ENF and NMF are the absolute number of firms that have entered, exited and horizontally merged in a given industry over the period t-n to t.

$$NF_t - NF_{t-n} \equiv NNF_{t-(t-n)} - ENF_{t-(t-n)} - NMF_{t-(t-n)} \quad \ldots\ldots (10)$$

6.A.2: The Relationships in the Model

For any given year it is obvious that

$$CR_4 \neq PS.MPO.S. \quad \ldots\ldots (11)$$

$$\neq PS \pm MPO \pm S \quad \ldots\ldots (12)$$

Substituting the forms defined above in equation (11)

$$\left(\sum_{i=1}^{4} F_i / \sum_{i=1}^{NP} P_i\right) \neq \left(\sum_{i=1}^{NP} P_i^2 / \sum_{i=1}^{NP} P_i\right) \cdot (NP^*/NF^*) \cdot \left(\sum_{i=1}^{NP} P_i\right)$$

$$\neq \left(\sum_{i=1}^{NP} P_i^2\right) \cdot (NP^*/NF^*) \quad \ldots\ldots (11a)$$

Similarly for equation 12

$$\left(\sum_{i=1}^{4} F_i / \sum_{i=1}^{NP} P_i\right) \neq \left(\sum_{i=1}^{NP} P_i^2 / \sum_{i=1}^{NP} P_i\right) \pm (NP^*/NF^*) \pm \left(\sum_{i=1}^{NP} P_i\right) \quad \ldots\ldots (12a)$$

These unequal (or non-identity) relationships hold over time as well. Moreover, the variables EN, EX, and HM which are only relevant in analysis of concentration change over time, and the fact that the dependent variable DCR is specified in terms of differences whereas the independent variables are specified in terms of ratios, eliminates completely any possibility of an identity relationship between the right hand and the left hand side of the specified model. While this too can be shown algebraically, a numerical example is more convenient. Thus for the Breweries Industry (1960 S.I.C. No. 1450), change in concentration over 1948-72

in terms of the four-firm concentration ratio (DCR) is 38.4 points. The change in the values of the independent variables specified in the model[1] are presented in Table 6.A-1. The "multiplicative" and "additive" values of these variables are obviously not equal to the values of the DCR.[2]

Table 6.A-1

Variable	Value	Cumulative Multiplicative Relationship	Cumulative Additive Relationship
CPS_1	3.0	3.0	3.0
CMPO	1.9	5.7	4.9
MG	3.8	21.7	3.7
EN	0.2	4.3	8.9
EX	0.3	1.3	9.2
HM	0.7	0.9	9.9

Algebraically (and numerically) it can also be shown that:

$$NF \neq (PS \cdot MPO \cdot S) \text{ or}$$

$$\neq (PS \pm MPO \pm S) \text{ and}$$

$$(NF)_t/(NF)_{t-n} \neq (CPS \cdot CMPO \cdot MG) \quad \ldots\ldots\ldots\ldots (13)$$

$$\neq (CPS \pm CMPO \pm MG)$$

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1. These can be derived from Tables A-1 to A-4 presented in the Appendix.

2. The combination of "additive" and "subtractive" relationships based on a priori predictions on the effects of various variables on concentration mentioned in this chapter results in the value 1.9.

CHAPTER VII

THE DETERMINANTS OF CHANGE IN INDUSTRY CONCENTRATION LEVELS IN CANADA: THE EMPIRICAL RESULTS

7.1: Introduction

This chapter tests empirically, for a total sample of 49 industries,[1] the model specified in Chapter VI. In addition, the independent variables specified in the model are tested against the definitional elements of concentration change analyzed in Chapter V. Extensions and empirical tests of the model for sub-samples of industries with different market characteristics are contained in Chapter VIII.

7.2: Notes on the Econometric Procedures Adopted

In order to gain further insight into the phenomenon of change in industry concentration levels, it would have been desirable if the model had been estimated in terms of differential concentration levels for two (or more) years. Comparisons between the effects of various factors on concentration in terms of their levels at two different points in time would have assisted in establishing the extent to which structural change has taken place in the industries in the sample. However, this could not be done in the present study since selected variables specified in the model (e.g., EN, EX and HM) are either theoretically relevant in terms of changes only and/or can only be computed over time. Nevertheless, tests were conducted for equality between the means and variances of the other variables specified in the model in terms of their 1948 and 1972 values. The results of these tests, presented in the Appendix to this chapter, indicate significant differences between the means and/or variances of plant size (PS_1), market size (S), number of firms (NF) and number of plants (NP) in these two years.

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1. The analysis could not be conducted for the total sample of 57 industries described in Chapters III and IV due to non-availability of data on selected variables specified in the model. The eight industries that had to be excluded in terms of their 1960 S.I.C. No.s are: 1110, 1290, 2513, 2580, 2620, 2710, 3475, 3989. The mean and variance of CR_4 in the remaining 49 industries (in 1972 is 50.7 and 665.2, respectively. These do not statistically differ from that of the total sample of 57 industries.

Since an objective of this study is to compare the relative effect of different factors on change in industry concentration levels, all variables have been standardized to have unit variance and zero mean. As a result of this procedure, the constant (intercept) term in the estimated regression equations is always equal to zero and is therefore omitted.[2] However, it is important to report that in the original unstandardized estimates of these regression equations, the value of the constant term is found to be statistically insignificant. The standardized regression coefficients presented indicate the relative effect of the variables specified in the model and can be interpreted accordingly.

While industrial organization theory suggests, a priori, the probable direction of effect changes in selected factors have on changes in industry concentration levels, it provides little guidance on the specific form of these relationships. In this study, variants of the model are estimated in the additive form (i.e., $y = a + bx_1 + cx_2 + \ldots$) using ordinary least squares (OLSQ) techniques. The model in the double logarithmic form (i.e., $\ln (y) = A + B \ln x_1 + C \ln x_2 + \ldots$) explains less of the inter-industry variation in concentration levels. The estimates of the model in this latter form are presented in the Appendix to this chapter (see Table 7.A-2).[3]

Also appended to this chapter are estimates of the model for different sub-periods during 1948-72. The longer the time period over which the model is estimated, the higher are the $\bar{R}^2$ values. This can be expected, since structural characteristics of industries (e.g., concentration) generally change gradually over time. One exception is the comparison between the 1948-72 and the 1954-72 estimates, of which the latter has a higher $\bar{R}^2$ value. However, the model using alternative forms of the independent variables could be tested more extensively over the longer of the two periods. For this reason, and because differences in the $\bar{R}^2$ values are fairly small, selected estimates of the speci-

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2. See Nie et al. (1975, page 325).

3. It needs to be noted that the estimated regression coefficients in the double logarithmic form indicate "rates of change of change" in the variables. Theory is even more ambiguous on the effects on concentration of this latter type of change in selected factors than it is in terms of rates of change in these factors.

fied model and its variants for the period 1948-72 are presented and discussed in the main body of this chapter. Unless noted otherwise, the results of these equations are consistent with those not reported using alternative forms of selected variables.

The highest magnitudes of the simple correlation coefficients (r) between the independent variables used in alternative specifications of the model are:[4]

Variable	r
change in firm multi-plant operations (CMPO) and market growth (MG)	0.668
change in firm multi-plant operations (CMPO) and high market growth (MG_1)	0.628
establishment of new plants by firms ($CMPO_1$) and market growth (MG)	0.671
establishment of new plants by firms ($CMPO_1$) and high market growth (MG_1)	0.611
establishment of new plants by firms ($CMPO_1$) and acquisition of existing plants by firms ($CMPO_2$)	0.636
entry of new firms (EN) and exit of firms (EX)	0.877

In all other cases the simple correlation coefficients are less than 0.50 with the highest being 0.47. With the exception of the correlation coefficient between EN and EX (which *a priori* needs to be discounted as these variables reflect different economic phenomena),[5] the square of the correlation coefficient for any pair of these variables does not exceed the $\bar{R}^2$ value of the estimated regression equation(s) in which these variables are included. This simple

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4. Excluding simple correlations between alternative forms of the same variable. The correlation matrix is given in the Appendix to this chapter.

5. See subsequent discussion in Section 7.3.

test suggests that the degree of multi-collinearity among these variables is not likely to pose a serious problem in interpreting their effect on change in industry concentration levels.[6] Moreover, the results of the analysis reported in the next section and a priori theoretical considerations indicate that causal inter-relationships exist among these variables and that they interact with each other to determine jointly concentration change.

The Spearman rank correlation test[7] suggests that the problem of heteroscedasticity is not serious. The highest values of the rank correlation coefficient between the absolute values of the regression residuals and the independent variables used in the specification(s) of the model are found to be -0.413 and -0.432 in the case of MG and CMPO, respectively.

7.3: Estimates of the Model

Tables 7-1 and 7-2 present estimates of various specifications of the model using the percentage point change in the four-firm employment concentration ratio (DCR) as the dependent variable. These specifications of the model and its variants generally explain between 34 and 56 percent of inter-industry variation in DCR. In all the equations, the $\bar{R}^2$ values are higher than those reported by studies reviewed in Chapter II. (The two lowest $\bar{R}^2$ values found in this study are for partially specified models.) Also, the F statistic in all of these equations rejects the null hypothesis (i.e., that the multiple correlation between the dependent and independent variables is zero) at the 99.5 percent level of confidence, indicating that the various specifications of the model significantly explain DCR.

CPS_{1-2}: Change in Absolute Plant Size

In the complete specification of the model, the estimated regression coefficient for CPS_1, while having the predicted effect on concentration change, is consistently statistically insignificant (see Table 7-1). The degree of significance of this variable or the direction of its effect

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6. This test is suggested to avoid serious multi-collinearity by Farrar and Glauber (1967).

7. Johnston (1972, page 219).

on DCR does not change when one or more of the following variables are excluded from the model: CMPO, MG, HM, OMS, NTP, ETP, HETP, PD, (see Table 7-1, eqns. 6, 7, 10, 11, 13). However, when EN, EX and HM, or when EN or EX is excluded (see Table 7-1, eqns. 8, 14, 15), the regression coefficient for CPS_1 becomes statistically significant at the five percent level. This is probably due to the influence of entry (EN) and exit (EX) of small single-plant firms on the computation of the CPS_1 measure. It will be recalled that the CPS_{1-2} measures are based on the total industry size distribution of plants. Support for this proposition is provided by the fact that the CMES measure, which is based on the larger plants in the industry, does not become significant when EN, EX and HM are excluded from that specification of the model (compare eqns. 2 and 3, Table 7-2). Thus it can be concluded that if the effects of EN and EX are taken into account, ongoing adjustments in plant size (CPS_1), which probably reflect the fuller exploitation or increased extent of economies of scale, do not significantly affect concentration change. This conclusion is not altered when change in plant size is measured in terms of shipments, namely, CPS_2 (see Table 7-2, eqn. 1).

CMES, CCI_{1-2}: Change in Relative Minimum Efficient Plant Size and in Capital Intensity

The results presented in Table 7-2 suggest that change in relative minimum efficient plant size (CMES) and change in capital intensity (CCI_{1-2}) are also statistically insignificant in their effect on DCR. Moreover, the regression coefficients for CMES and CCI_1 (in Table 7-2, eqns. 2 and 6, respectively) have a sign contrary to *a priori* predictions.

MES8: Industries Where Cost Disadvantages of Operating Below Relative Minimum Efficient Size Exceeds 20 Percent

The proposition that the relative minimum efficient plant size may result in higher concentration levels if the cost-disadvantages of operating at sub-optimal levels are substantial (since in such cases sub-optimal plants will experience greater pressures to leave the industry) is not lent empirical support (see Table 7-2, eqns. 4 and 8). The estimated regression coefficients for MES8 are statistically insignificant and in one case (eqn. 4) the sign is contrary to *a priori* predictions.

CMPO, $CMPO_{1-2}$: Change in Firm Multi-Plant Operations

The regression coefficient for change in firm multi-plant operations (CMPO) is, as predicted *a priori*,

TABLE 7-1

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN CANADIAN MANUFACTURING INDUSTRIES, 1948 - 1972

CPS_1	CMPO	$CMPO_1$	$CMPO_2$	MG	MG_1	MG_2	MG_3	EN
0.156 (1.357)	0.292^b (2.114)			-0.600^a (4.168)				-0.786^b (2.302)
0.156 (1.390)	0.318^b (2.305)			-0.607^a (4.169)				-1.047^a (3.837)
0.159 (1.418)	0.324^b (2.325)			-0.612^a (4.168)				-1.031^a (3.695)
0.160 (1.387)	0.318^b (2.308)			-0.607^a (4.185)				-1.038^a (3.172)
0.139 (1.191)	0.368^a (2.615)				-0.945^a (4.360)	-0.480^a (2.790)	-0.414^b (2.381)	-1.067^a (3.824)
0.123 (1.205)	0.337^a (2.543)			-0.621^a (4.483)				-1.005^a (3.965)
0.107 (1.035)	0.389^a (2.845)				-0.965^a (4.549)	-0.497^a (2.950)	-0.407^b (2.390)	-1.007^a (3.989)
				Inter-Action Analysis				
Dependent Variable DCR								
0.241^b (2.114)	0.372^a (2.429)			-0.825^a (5.408)				
								-1.338^a (4.833)
0.189 (1.519)	0.384^a (2.615)			-0.690^a (4.494)				-0.592^b (2.367)
0.130 (1.076)				-0.391^a (3.355)				-1.137^a (3.916)
0.197 (1.439)		0.225 (1.215)	-0.032 (0.200)	-0.567^a (3.424)				-0.603^b (2.244)
0.077 (0.573)	-0.054 (0.432)							-1.425^a (4.562)
0.266^b (2.081)	0.397^a (2.545)			-0.785^a (5.010)				
0.228^b (1.873)	0.389^a (2.653)			-0.693^a (4.523)				-0.327^a (2.569)

Notes: Sample Size = 49
t-values are given in parentheses
a and b refer to 1% and 5% levels of significance (one-tail test) respectively.
*F-values significant at 99.5% level.

EX	HM	OMS	NTP	ETP	HETP	PD	$\bar{R}^2$	F	Eqn. No.
0.527[b] (1.739)	0.341[a] (2.823)	-0.169 (1.270)			0.037 (0.339)	-0.057 (0.489)	0.551	7.536*	(1)
0.738[a] (2.888)	0.344[a] (2.822)		0.024 (0.217)			-0.094 (0.796)	0.544	8.145*	(2)
0.726[a] (2.801)	0.339[a] (2.751)			0.037 (0.344)		-0.087 (0.767)	0.544	8.169*	(3)
0.729[a] (2.804)	0.345[a] (2.834)				0.028 (0.257)	-0.092 (0.796)	0.544	8.151*	(4)
0.751[a] (2.893)	0.310[a] (2.524)				0.005 (0.045)	-0.105 (0.901)	0.549	6.838*	(5)
0.701[a] (2.852)	0.326[a] (2.794)						0.558	11.116*	(6)
0.703[a] (2.874)	0.290[a] (2.437)						0.562	8.704*	(7)
				Inter-Action Analysis					
							0.395	11.436*	(8)
0.884[a] (3.181)	0.416[a] (3.102)						0.388	11.161*	(9)
0.307 (1.330)					0.043 (0.363)	-0.025 (0.205)	0.466	6.973*	(10)
0.838[a] (3.119)	0.392[a] (3.112)				0.014 (0.126)	-0.142 (1.196)	0.496	7.738*	(11)
0.311 (1.243)					0.061 (0.467)	-0.075 (0.551)	0.396	4.773*	(12)
0.959[a] (3.186)	0.448[a] (3.179)				-0.042 (0.330)	-0.167 (1.242)	0.360	4.857*	(13)
-0.146 (1.167)	0.091 (0.787)				0.148 (1.239)	-0.004 (0.032)	0.402	5.601*	(14)
	0.149 (1.385)				0.086 (0.739)	-0.035 (0.285)	0.467	7.017*	(15)

TABLE 7-2

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN CANADIAN MANUFACTURING INDUSTRIES, 1948 - 1972: USING ALTERNATIVE FORMS OF SELECTED INDEPENDENT VARIABLES

Dependent Variable DCR

CPS_2	CMES	MES_8	CCI_1	CCI_2	CMPO	MG	EN	EX	HM	$\bar{R}^2$	F	Eqn. No.
0.146 (1.253)					0.336[a] (2.541)	-0.669[a] (4.444)	-0.927[a] (3.353)	0.625[b] (2.352)	0.317[a] (2.684)	0.560	11.164*	(1)
	-0.004 (0.358)				0.307[b] (2.249)	-0.586[a] (4.257)	-1.097[a] (4.035)	0.780[a] (2.913)	0.350[a] (2.918)	0.543	10.511*	(2)
	0.158 (1.290)				0.355[b] (2.249)	-0.760[a] (4.873)				0.358	9.939*	(3)
		-0.070 (0.708)			0.296[b] (2.224)	-0.572[a] (4.128)	-1.077[a] (4.368)	0.757[a] (3.133)	0.348[a] (2.991)	0.548	10.719*	(4)
		0.093 (0.785)			0.336[b] (2.145)	-0.791[a] (5.008)				0.344	9.380*	(5)
			-0.043 (0.436)		0.306[b] (2.315)	-0.579[a] (4.175)	-1.113[a] (4.436)	0.790[a] (3.268)	0.351[a] (2.999)	0.545	10.589*	(6)
				0.020 (0.196)	0.309[b] (2.330)	-0.586[a] (4.257)	-1.088[a] (4.388)	0.775[a] (3.206)	0.344[a] (2.880)	0.543	10.526*	(7)

Notes:

Sample Size = 49

t-values are given in parentheses.

a and b refer to 1% and 5% levels of significance (one-tail test) respectively.

*F-values significant at 99.5% level

positively related to concentration change and is statistically significant in all equations except when market growth (MG) is excluded from the model (see Table 7-1, eqn. 13). This interaction between MG and CMPO may be expected if opportunities for exploiting firm-level economies are limited by diseconomies encountered at the individual plant level and by the size of the market. In such cases, market growth would result in increased firm multi-plant operations and partly explain the high positive correlation coefficient between CMPO and MG (0.668). The negative, though weak, correlation coefficient between CMPO and CPS_1 (-0.095) is compatible with the proposition that economies at the single plant level likely have been exhausted in Canadian manufacturing industries. These results suggest that economies derived from multi-plant operations are probably a significant concentration increasing factor.

Change in multi-plant operations arising from the establishment of new plants ($CMPO_1$) and those arising from acquisition of existing plants ($CMPO_2$) do not appear to affect DCR separately (see Table 7.1, eqn. 12). The reasons for these results may be more complex than can be established in this analysis. They may be attributable in part to firms engaging in both strategies to pursue advantages of multi-plant operations. The quest for one does not preclude pursuit of the other. This proposition is supported by the simple correlation coefficient between $CMPO_1$ and $CMPO_2$ of 0.636.[8] The distinction made in this study between these two sources of multi-plant operations in the analysis may not be appropriate. Moreover, this specification of the model explains less of the inter-industry variation in change in concentration levels than if CMPO (the aggregation of $CMPO_1$ and $CMPO_2$) is included.

MG, MG_{1-3}: Market Growth

The deconcentration effect of MG is statistically significant in all equations. In addition, higher rates of market growth can be expected to have a larger deconcentration effect than lower rates since the estimated regression coefficient for MG_1 is greater than that for MG_2, which in in turn is greater than that for MG_3 (see Table 7-1, eqns. 5, 7).

The exclusion of MG from the model (Table 7-1, eqn. 13), aside from its effect on CMPO discussed above, tends to

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8. Exclusion of either $CMPO_1$ or $CMPO_2$ does not alter (significantly) their respective regression coefficient and t-values.

increase the regression coefficient and t-value for EN. Similarly, the regression coefficient and t-value for MG increases if EN is excluded from the model (Table 7-1, eqn. 14). Since the simple correlation coefficient between these two variables is 0.428, this more likely reflects the causal relationship of market growth stimulating entry of firms than any significant degree of multi-collinearity. That the degree of multi-collinearity, if any, is not serious is further supported by the fact that when both MG and EN are included in the specified model, they remain highly statistically significant.

EN: Entry of Firms

The deconcentration effect of EN is consistently statistically significant. That this is so, even when MG with which it is correlated is included in the model, suggests that there are factors other than market growth which determine the entry rate of firms in an industry.[9]

The effect of excluding EN from the model on the regression coefficient and t-value of CPS_1 was discussed earlier. It was suggested that entry of small single-plant firms may have affected the computation of CPS_1. This proposition is lent some further support by the negative correlation between EN and CPS_1, viz., -0.117. The small magnitude of this correlation coefficient rules out any significant degree of multi-collinearity between these two variables, whereas its negative sign confirms the reducing impact of the entry of small single-plant firms on average plant size (i.e., Niehans' index) in the industry. However, another reason for the negative sign of this correlation coefficient may be that change in plant size resulting from the presence of economies of scale, is likely to pose as a barrier to entry for new firms. If entry nevertheless takes place, other things being equal, competition for market shares becomes more intensive and existing firms may not be able to expand plant production easily.

The exclusion of EN also affects the regression coefficients and t-values of EX and HM (Table 7-1, eqn. 14). The exclusion of EX or HM, while it affects the regression coefficients and t-values of each other, does not significantly affect the regression coefficient and t-value of EN. A variety of economic factors (e.g., changes in the business cycle, structural rationalization, technological development, etc.) may be reflected in the measurement of, and interaction between, these variables. For example, it

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9. See Orr (1974); Gorecki (1976b).

was previously noted that the simple correlation coefficient between EN and EX is 0.877. This most likely reflects more fundamental causal factors relating to these two different economic phenomena. One such explanation may be that due to technological change old firms/plants are being closed down while new ones are being established in their place; and EN and EX reflect varying rates of generational turnover of firms from industry to industry. Alternatively, industries with easy entry may have easy exit, and thus a high turnover of firms.[10] The limited context of the present study precludes a more detailed examination of what may be a complex set of interactions between these variables.

EX: Exit of Firms
HM: Horizontal Mergers

Both EX and HM have the postulated effect of increasing industry concentration levels and are consistently statistically significant except in Table 7.1, equations 10, 12, 14 and 15. These exceptions probably reflect the complex set of interactions between the EN, EX and HM variables mentioned above.[11]

OMS: Oligopoly Market Structures
TP: Tariff Protection
PD: Product Differentiation

The OMS, NTP, HXTP, ETP, HETP and PD variables are all statistically insignificant (see Table 7-1) and add little to the explanatory power of the model. It is worth noting that the negative sign of the OMS variable is consistent with the Stigler-Worcester theories of oligopoly which predict that leading firm market shares will decline over time. The negative sign of the PD variable contradicts theories which postulate product differentiation as being a concentration-increasing factor.[12]

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10. See Caves and Porter (1976, page 56).

11. The simple correlation coefficient between HM and EX is -0.146 and HM and EN is 0.122. These coefficients as well as the decrease in the t-values of these variables when one or the other is excluded do not indicate multi-collinearity.

12. The results relating to PD do not alter when replaced by "high", "moderate" and "low" product differentiation variables (i.e., HPD, MPD and LPD) in the model.

Comparisons between equations (6) and (8)-(9) in Table 7-1 suggest that the inclusion of EN, EX and HM along with CPS_1, CMPO and MG in the model significantly improves its explanatory power. This improvement also occurs when instead of CPS_1, CPS_2 or CMES or MES8 or CCI_{1-2} is specified in the model. These results lend further support to the analysis contained in the Appendix to the preceding chapter, viz., that the latter set of 'plant size' related variables along with MG are not surrogates for changes in the number of firms.

Results presented in Tables 7-1 and 7-2 tend to support the conventional hypotheses of industrial organization theory. The interaction analysis, while providing additional insights into probable economic phenomena underlying certain variables, suggests caution is required in interpreting the effect of these variables on concentration change as being independent of conditions prevailing in industries generally.

The results, however, do not support the thesis that the small size of the domestic market in Canada is insufficient for firms to exploit plant economies of scale, complete exploitation of which would necessitate yet higher industry concentration levels. If this was indeed the case, measures of change in plant size, in addition to being significantly related to change in industry concentration levels, also would be more strongly correlated with market growth than would change in firm multi-plant operations. Actually, the converse is found to be the case: the simple correlation coefficient between CPS_1 and MG is 0.043, that between CMPO and MG is, as noted earlier, 0.668.[13]

These results also do not lend support to Scherer's conclusion for the United States, namely:

> systematic associations involving concentration are more apt to be found in the realm of observed plant sizes ... than in the extent of multi-plant operations.[14]

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13. Stepwise regression analysis also indicates that CPS_1 explains less of the inter-industry variation in DCR than does CMPO, even in equations where it is statistically significant.

14. Scherer et al. (1975, page 204).

Admittedly, this conclusion was inferred from a cross-section analysis of industries in a given year, and may not be applicable to the relationship between changes in industry concentration levels and changes in firm multi-plant operations. However, insofar as the above results are indicative of trends, they point to the increased importance of firm multi-plant operations in Canada.

A number of explanations may be offered for the differences between the results of this study and those reported in previous (related) research.

For example, the greater importance of firm multi-plant operations relative to plant size, may reflect the small size of domestic markets in Canada being accentuated by factors such as geographically dispersed population centres and high transportation costs. These simultaneously may preclude opportunities for firms to exploit plant economies of scale in individual segmented markets while they provide an impetus for multi-plant operations across different geographic markets. The extent to which multi-plant operations occur may further depend on regional differences in market growth and incentive programs, e.g., tax benefits, grants, etc. Selected aspects of firm plant size and multi-plant operations in regional industries included in the sample of industries are analyzed separately in Chapter VIII. The results indicate that multi-plant operations remain a significant concentration-increasing factor, not only in industries with regional markets, but also in industries with national (i.e., non-segmented) markets.

It is also conceivable that the estimated regression coefficients for CPS_1 and CMPO reflect greater plant product specialization. Firm product lines may be specialized within plants without necessarily changing plant size, as measured in this analysis, and the manufacture of each of the products may be distributed to different but specialized plants. In other words, although firms have multi-plant operations, the plants may differ from each other, with each specializing in the manufacture of a particular product. Given the wide range of products generally included within a census industry, this possibility cannot be ruled out completely.

Prevailing views based on previous research on economies of plant scale in Canada usually have been formulated in a "static" framework.[15] The relationship

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15. Eastman and Stykolt (1967); Gorecki (1976a).

between costs and scale of output of plants is defined in terms of an "optimal" adjustment to a combination of a given set of factors at a unique point in time. With the passage of time, this relationship may change, as under dynamic conditions, the technological production function, supply conditions for factor inputs and demand conditions for products all may change. In addition, uncertainty as to future levels of demand and market fluctuations may lead to different combinations of factor proportions and products and dampen firms' incentives to take advantage of the 'static' economies of scale. Greater operational flexibility may lead to a smaller size of plant than otherwise.[16] The desire to spread risk in turn may lead to multi-plant operations.

The sifting of these considerations, relative to their effect on changes in plant size and firm multi-plant operations, requires examination that lies outside the scope of this study.

The significant effects of entry (EN) and exit (EX) of firms on concentration change (DCR) do not lend support to particular propositions relating to the structure of Canadian manufacturing industries. For example, Eastman and Stykolt argue that there is persistent excess capacity in plants and a lack of competitive pressures among firms in Canadian manufacturing industries.[17] If the former proposition held, EN would tend to be less significant or insignificant since excess capacity may deter entry of new firms.[18] The lack of competitive pressures in turn suggests that the effect of EX on DCR is less significant as well. It is worth noting that EX is significant whether or not market growth (MG) is included in the model (see Table 7-1, eqn. 13), although rapid market growth has the effect of dampening the pressures on firms to leave an industry.

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16. Schwartzman (1963).

17. Eastman and Stykolt (1967, Chapter I).

18. See, for example, Wenders (1971); Pashigian (1968a).

7.4: Determinants of Concentration Change and the Definitional Elements of DCR

It was mentioned in Chapter V that the four-firm concentration ratio includes, among other definitional elements, firm size inequality (LFI). The LFI term can be decomposed further into plant size inequality (LPI) and relative extent of multi-plant operations (LMP) in the four largest firms. In addition, it was suggested that some of the factors specified in the model in Chapter VI affect concentration via these definitional elements. The extent to which this is the case can be gauged by examining the results presented in Table 7.3. The terms LFI, LPI and LMP are each substituted for DCR. Change in LFI, LPI and LMP is measured in terms of the difference in their 1948 and 1972 values.

Examining equation (1), the statistically significant regression coefficient for EN has a positive relationship with LFI, implying entry of firms tends to increase the inequality in firm size. This would be the case if entering firms are of relatively small size. This interpretation is compatible with the one offered for the negative correlation coefficient between EN and CPS_1 reported in Section 7.3.

Other things being equal, increased firm size inequality results in higher degrees of concentration at some level. The fact that EN has the significant deconcentration effect reported earlier reflects its influence through increases in the total number of firms in the industry. The effects of other factors on LFI are statistically insignificant.

In equation (2) the significant positive effect of EN on LPI is similar to its effect on LFI. In this equation, change in plant size (CPS_1) and effective tariff protection (ETP) are also significantly positively related to LPI. The effect of ETP would support the Eastman-Stykolt hypothesis that tariff protection facilitates the survival of plants of relatively small scale. However, the effect of this variable is also compatible with the proposition that leading firms can increase their market share in tariff-protected markets since they are insulated from import competition. A similar "two-way" interpretation could be attached to the effect of CPS_1.

TABLE 7-3

DETERMINANTS OF THE DEFINITIONAL ELEMENTS IMPLICIT IN CHANGE IN THE FOUR-FIRM CONCENTRATION RATIO, 1948-72

Dependent Variables: Change in	CPS_1	$CMPO_1$	MG	EN	EX	HM	ETP	HETP	PD	R^2	F	EQN. NO.
LFI	0.203 (1.408)	0.024 (0.141)	-0.059 (0.324)	0.766[b] (2.194)	-0.355 (1.093)	-0.100 (0.660)		-0.037 (0.274)	-0.189 (1.316)	0.289	3.444*	(1)
LPI	0.249[b] (1.914)	-0.047 (0.289)	-0.139 (0.817)	1.029[a] (3.185)	-0.329 (1.100)	-0.043 (0.303)	0.271[b] (2.195)		-0.217 (1.648)	0.390	4.829*	(2)
LMP	-0.578[a] (3.920)	0.138 (0.782)	0.033 (0.176)	0.232 (0.650)	-0.278 (0.840)	-0.124 (0.800)		0.073 (0.522)	0.107 (0.731)	0.256	3.067*	(3)

Notes:

Sample Size = 49

t-values are given in parentheses.
a, b refer to 1% and 5% levels of significance (one-tail test) respectively.
*F-values statistically significant at 99% level.

In equation (3) only CPS_1 has a significant effect on LMP. The inverse relationship between these two variables supports the proposition that the larger the size of plants in operation in the particular industry, the less likely are leading firms to have multi-plant operations.

7.5: Conclusion

Using different combinations of the independent variables specified, the estimated model (OLS technique) tends to explain between 34 and 56 percent of the inter-industry variation in change in the four-firm concentration ratio (DCR). This is considerably higher than the explained variation reported in previous studies relating to either Canada or other countries. Although the relative significant levels of selected regression coefficients vary, the results tend to generally support the hypotheses put forward in industrial organization theory.

Thus, changes in plant size (CPS_{1-2}), in minimum efficient plant size (CMES) and in capital intensity (CCI_{1-2}) generally are related positively to DCR. However, they are not statistically significant in their effect. In a few cases where CPS_1 is significant, it makes a marginal contribution to the R^2 value of the estimated equation. Changes in firm multi-plant operations (CMPO) tend to be positively and significantly related to DCR only. In contrast, market growth (MG) and entry (EN), exit (EX) and horizontal merger (HM) of firms tend to be statistically significant in the majority of the relationships estimated. The MG and EN variables have the expected concentration-decreasing effect. The oligopoly, tariff protection and product differentiation variables (OMS, NTP, HNTP, ETP, HETP, PD) are statistically insignificant in all equations and do not add to the explanatory power of the model.

These results tend to cast doubt on the thesis put forward in Canada that the tariff-protected small domestic market and inter-dependence among firms inhibits the exploitation of economies of plant scale.

APPENDIX TO CHAPTER VII

TABLES 7.A-1 TO 7.A-5

TABLE 7.A-1

TESTS FOR EQUALITY OF MEANS AND VARIANCE BETWEEN SELECTED VARIABLES IN 1948 AND 1972

Variable	1948		1972		t-value	F-statistic
	Mean	Var.	Mean	Var.		
PS_1	431.1	710143.3	668.9	2364521.3	1.3	3.3*
S	99.1	15991.1	448.8	563403.4	4.5[a]	35.2*
MPO	2.7	2.3	2.9	1.7	1.0	1.3
NF	169.6	74111.4	136.9	37701.2	1.0	2.0*
NP	173.2	67528.8	150.5	39458.2	0.7	1.7*
CI_1	272.5	433262.8	555.1	1130989.7	2.2[b]	2.6*

Sample Size = 49

* F-value statistically significant at the 99% level.

a, b indicate t-values are statistically significant at the 99% and 95% levels, respectively.

TABLE 7.A-2

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN CANADIAN MANUFACTURING INDUSTRIES, 1948 - 1972. ESTIMATES IN DOUBLE LOGARITHMIC FORM

Dependent Variable LOG(DCR)

CPS_1	CMPO	MG	MG_1	MG_2	MG_3	EN	EX	HM
0.378^a (2.896)	0.131 (0.975)	-0.474^a (2.893)				-0.469^b (2.295)	0.105 (0.648)	0.173 (1.331)
0.347^a (2.878)	0.139 (1.142)	-0.496^a (3.278)				-0.423^b (2.304)	0.158 (1.092)	0.164 (1.393)
0.363^a (2.962)	0.129 (1.042)	-0.477^a (3.105)				-0.431^b (2.275)	0.147 (1.001)	0.150 (1.220)
0.380^a (2.975)	0.135 (1.071)	-0.473^a (3.011)				-0.475^a (2.429)	0.110 (0.715)	0.172 (1.346)
0.357^a (2.871)	0.179 (1.438)		-0.710^a (3.357)	-0.229 (1.310)	-0.282^b (1.876)	-0.485^a (2.562)	0.156 (1.034)	0.181 (1.439)
0.320^a (2.476)	0.165 (1.268)	-0.508^a (3.137)				-0.455^a (2.456)	0.151 (0.967)	0.192 (1.536)
0.298^b (2.311)	0.207 (1.569)		-0.761^a (3.397)	-0.325^b (1.786)	-0.327^b (2.059)	-0.445^a (2.420)	0.184 (1.163)	0.188 (1.472)

Notes: Sample Size = 49
t-values are given in parentheses.
a, b refer to 1% and 5% levels of significance (one-tail test) respectively.
All variables are in natural log forms
*F-values significant at 99.5% level.

OMS	NTP	ETP	HETP	PD	$\bar{R}^2$	F	Eqn. No.
-0.012 (0.100)			0.106 (0.870)	-0.258[b] (2.149)	0.438	5.163*	(1)
	0.251[b] (2.061)			-0.279[a] (2.446)	0.495	6.882*	(2)
		0.205 (1.656)		-0.254[b] (2.203)	0.477	6.478*	(3)
			0.107 (0.891)	-0.259[b] (2.191)	0.452	5.955*	(4)
			0.099 (0.846)	-0.305[a] (2.607)	0.485	5.532*	(5)
					0.407	6.493*	(6)
					0.416	5.285*	(7)

TABLE 7.A-3

SIMPLE CORRELATION COEFFICIENTS BETWEEN PRINCIPAL VARIABLES SPECIFIED IN THE MODEL

	DCR	CPS_1	MES_8	CCI	CMPO	$CMPO_1$	$CMPO_2$	MG	MG_1	MG_2	MG_3
DCR	1.000	0.170	0.053	-0.003	-0.202	-0.331	-0.266	-0.566	-0.528	0.107	0.161
CPS_1		1.000	0.123	-0.147	-0.095	-0.137	-0.133	0.043	-0.002	0.203	-0.227
MES_8			1.000	-0.056	-0.046	0.035	0.019	0.085	-0.019	0.273	-0.105
CCI_1				1.000	0.023	-0.019	-0.008	0.071	0.030	0.074	-0.012
CMPO					1.000	0.906	0.662	0.668	0.628	-0.160	-0.147
$CMPO_1$						1.000	0.636	0.671	0.611	-0.152	-0.067
$CMPO_2$							1.000	0.476	0.473	-0.203	-0.053
MG								1.000	0.946	-0.128	-0.473
MG_1									1.000	-0.412	-0.398
MG_2										1.000	-0.446
MG_3											1.000
EN											
EX											
HM											
OMS											
NTP[a]											
HNTP											
ETP[a]											
HETP											
PD											
HPD											
MPD											
LPD											

Notes: Sample Size N = 49
a. correlation coefficients for these variables computed over 40 observations.

EN	EX	HM	OMS	NTP[a]	HNTP	ETP[a]	HETP	PD	HPD	MPD	LPD
-0.512	-0.351	0.124	-0.410	-0.048	-0.031	0.011	0.123	0.088	0.108	-0.252	0.100
-0.117	-0.014	-0.005	-0.092	-0.123	-0.161	-0.196	-0.166	0.422	0.390	-0.067	-0.294
-0.019	-0.049	-0.045	0.178	0.291	0.202	0.283	0.286	0.241	0.113	0.249	-0.294
-0.118	-0.041	-0.068	-0.098	0.380	0.438	0.315	0.351	-0.051	-0.055	0.040	0.018
0.352	0.323	0.047	-0.023	0.087	-0.104	-0.035	-0.101	-0.174	-0.283	0.298	0.020
0.431	0.412	-0.080	0.044	0.131	-0.114	0.002	-0.165	-0.145	-0.295	0.339	-0.002
0.342	0.323	-0.261	-0.023	0.124	-0.195	0.049	-0.025	-0.304	-0.376	0.232	0.153
0.428	0.369	-0.013	0.131	0.197	-0.010	0.095	-0.045	-0.011	-0.137	0.323	-0.129
0.429	0.368	-0.002	0.109	0.083	-0.046	0.097	-0.042	-0.057	-0.191	0.293	-0.059
-0.143	-0.142	0.071	0.029	0.234	0.084	-0.060	0.019	0.282	0.324	-0.074	-0.230
-0.150	-0.076	-0.186	-0.081	-0.159	0.025	0.031	-0.010	-0.245	-0.247	-0.023	0.237
1.000	0.877	0.122	0.353	-0.358	-0.187	-0.301	-0.293	-0.201	-0.241	-0.022	0.231
	1.000	-0.146	0.054	0.106	-0.133	0.109	-0.152	-0.102	-0.161	-0.005	0.146
		1.000	0.336	-0.190	0.042	-0.134	-0.124	0.068	0.130	-0.081	-0.052
			1.000	-0.078	-0.027	-0.123	-0.121	0.045	-0.019	0.114	-0.072
				1.000	0.753	0.780	0.800	0.268	0.338	0.025	-0.319
					1.000	0.630	0.511	0.121	0.227	0.064	-0.252
						1.000	0.788	0.049	0.068	0.081	-0.124
							1.000	0.110	0.018	0.119	-0.109
								1.000	0.823	-0.092	-0.659
									1.000	-0.285	-0.666
										1.000	-0.525
											1.000

TABLE 7.A-4

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN CANADIAN MANUFACTURING INDUSTRIES, 1948 - 1972. ESTIMATES USING DIFFERENT INITIAL YEAR(s)

Dependent Variable DCR

CCI_1	CCI_2	CMPO	MG	EN	EX	HM	$\bar{R}^2$	F	Eqn. No.
				1948-1972					
-0.043		0.306^b	-0.579^a	-1.113^a	0.790^a	0.351^a	0.545	10.589*	(1)
(0.436)		(2.315)	(4.175)	(4.436)	(3.268)	(2.999)			
	0.020	0.309^b	-0.586^a	-1.088^a	0.775^a	0.344^a	0.543	10.526*	(2)
	(0.196)	(2.330)	(4.257)	(4.388)	(3.206)	(2.880)			
				1954-1972					
-0.103		0.248^b	-0.476^a	-0.862^a	0.496^a	0.110	0.629	14.571*	(3)
(1.109)		(2.126)	(4.344)	(6.633)	(3.383)	(0.961)			
	-0.084	0.236^b	-0.471^a	-0.855^a	0.476^a	0.116	0.625	14.379*	(4)
	(0.919)	(2.024)	(4.289)	(6.574)	(3.272)	(1.013)			
				1958-1972					
0.117		0.145	-0.002	-0.878^a	0.394^a	0.018	0.569	11.600*	(5)
(1.219)		(1.484)	(0.031)	(7.546)	(3.051)	(0.170)			
	0.023	0.129	-0.001	-0.875	0.403^a	0.024	0.555	10.988*	(6)
	(0.236)	(1.307)	(0.000)	(7.345)	(3.076)	(0.219)			
				1965-1972					
0.119		-0.002	-0.042	-0.529^a	0.279^b	0.095	0.280	4.116*	(7)
(0.923)		(0.000)	(0.334)	(4.014)	(1.935)	(0.625)			
	0.017	-0.037	-0.032	-0.547^a	0.279^b	0.091	0.266	3.900*	(8)
	(0.141)	(0.293)	(0.252)	(4.155)	(1.905)	(0.593)			

Notes: Sample Size = 49
t-values are given in parentheses
a, b refer to 1% and 5% levels of significance (one-tail test) respectively
*F-values significant at 99.5% level

TABLE 7.A-5

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN CANADIAN MANUFACTURING INDUSTRIES, 1948 - 1972. ESTIMATES USING DIFFERENT TERMINAL YEAR(s)

Dependent Variable DCR

CCI_1	CCI_2	CMPO	MG	EN	EX	HM	$\bar{R}^2$	F	Eqn. No.
				1948-1954					
-0.206 (1.538)		0.012 (0.100)	0.164 (0.716)	-0.440[b] (1.757)	0.344[b] (1.963)	0.196 (1.504)	0.308	4.573*	(1)
	0.287[b] (2.337)	-0.001 (0.000)	0.107 (0.479)	-0.409 (1.684)	0.198 (1.145)	0.232[b] (1.921)	0.353	5.380*	(2)
				1948-1958					
-0.161 (1.242)		0.206 (1.438)	0.066 (0.497)	-0.623[a] (4.517)	0.239 (1.638)	0.289[b] (1.965)	0.262	3.850*	(3)
	0.072 (0.573)	0.181 (1.240)	0.065 (0.483)	-0.599[a] (4.294)	0.213 (1.456)	0.316[b] (2.137)	0.241	3.547*	(4)
				1948-1965					
-0.059 (0.488)		0.049 (0.360)	0.048 (0.378)	-0.894[a] (4.386)	0.380[b] (1.884)	0.413[a] (3.309)	0.373	5.761*	(5)
	0.065 (0.565)	0.035 (0.254)	0.047 (0.370)	-0.865[a] (4.366)	0.358[b] (1.822)	0.427[a] (3.513)	0.374	5.786*	(6)

Notes: Sample Size = 49
t-values are given in parentheses
a, b refer to 1% and 5% levels of significance (one-tail test) respectively
*F-values significant at 99.5% level

CHAPTER VIII

THE DETERMINANTS OF CHANGE IN INDUSTRY CONCENTRATION LEVELS IN CANADA: FURTHER EXTENSIONS AND EMPIRICAL TESTS

8.1: Introduction

In the preceding chapter, no analytical distinction was made between sub-samples of industries displaying different product market or structural characteristics. The relative effect of selected determinants of industry concentration, however, may differ for different sub-samples, e.g., industries serving regional or national markets, or industries with oligopolistic market structures. This chapter extends the previous analysis to take into account the effects of such characteristics. Due to restrictions imposed by sample size, separate regression equations for different sub-samples of industries could not be estimated and extensive use of the dummy variable technique is made.[1]

8.2: Industries with National and Regional Markets

Of the sample of 49 industries analyzed in the preceding chapter, 35 industries are characterized as having national markets and 14 as having regional markets.[2] Statistical tests (see Table 8-1) suggest that between "national" (indicated by letter N) and "regional" (indicated by letter R) industries there are some differences in the means and/or the variances in change in absolute plant size ($NCPS_1$, $RCPS_1$), change in relative minimum efficient size (NCMES, RCMES) and horizontal mergers (NHM, EHM), but not in the case of change in firm multi-plant operations (NCMPO, RCMPO).[3] Differences are also evident when change

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1. See Johnston (1972, pages 194-207); Rao and Miller (1971, pages 88-93).

2. These are indicated in Table A.1, Appendix A and are based on Department of Consumer and Corporate Affairs (1971).

3. The statistical tests using the Student's t and F distributions are detailed in Kmenta (1971, pages 142-8).

TABLE 8-1

TESTS FOR EQUALITY OF MEANS (t-value) AND VARIANCE (F-ratio) BETWEEN SELECTED VARIABLES IN NATIONAL AND REGIONAL PRODUCT MARKET INDUSTRIES

Variable	Mean	Variance	t-Value	F-Ratio
$NCPS_1$	1.455	0.744	2.333^b	4.981^a
RCPS	2.354	3.706		
NCMES	0.871	0.594	0.649	5.470^a
RCMES	0.655	3.249		
NCMPO	1.255	0.366	0.403	0.672
RCMPO	1.330	0.246		
NHM	0.079	0.011	0.757	3.182^a
RHM	0.111	0.035		

Notes:

Sample size regional (R) = 14 and national (N) = 35 industries.

a and b refer to the difference being statistically significant at the 1% and 5% levels respectively.

in industry concentration level (DCR) is regressed against these variables (see Table 8-2).[4]

The estimated regression coefficients suggest that the effect of change in plant size or in minimum efficient plant size on DCR is greater in industries with national ($NCPS_1$ or NCMES) than in industries with regional ($RCPS_1$ or RCMES) markets.[5] The regression coefficients for $RCPS_1$ or RCMES are statistically significant at the one percent level (in eqn. 5, NCMES is significant at the ten percent level). These results suggest that the pursuit of economies of scale at the plant level are more apt to be limited in industries with regional than with national markets.

Change in firm multi-plant operations is statistically significant in industries with national (NCMPO) as well as in industries with regional (RCMPO) markets. In addition, the regression coefficient for the latter type of industries tends to be larger.[6]

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4. In computing "national" regression coefficients, observed values are used and zero values are assigned to regional industries. Similarly, in computing "regional" regression coefficients, observed values are used and zero values are assigned to national industries. This is following the dummy variable technique referred to in footnote 1. In interpreting either the national or regional regression coefficients, the underlying assumptions are that (a) there are no inter-industry effects between the two industry categories and (b) there are zero changes in plant size, firm multi-plant operations and horizontal mergers in national industries (or regional industries as the case may be). In reality these assumptions are stringent. While the model can sensibly be estimated separately for national industries, this is not the case for regional industries due to the limited sample size. The above procedure enables one to make comparisons between these two types of industries.

5. Using the unstandardized regression coefficients (as is appropriate) the differences between $NCPS_1$ and $RCPS_1$ or NCMES and RCMES are statistically significant at the 5 percent level.

6. The differences between the unstandardized NCMPO and RCMPO regression coefficients are, however, not statistically significant.

TABLE 8-2

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN CANADIAN MANUFACTURING INDUSTRIES WITH NATIONAL AND REGIONAL PRODUCT MARKETS, 1948-1972

Dependent Variable DCR

$NCPS_1$	$RCPS_1$	NCMES	RCMES	NCMPO	RCMPO	MG	EN
0.387^a	0.037			0.374^b	0.583^a	-0.628^a	-0.989^a
(2.843)	(0.266)			(2.024)	(2.893)	(4.505)	(3.388)
0.328^a	-0.001			0.423^b	0.620^a	-0.657^a	-0.926^a
(2.606)	(0.007)			(2.359)	(3.129)	(4.857)	(3.382)
0.443^a	0.067			0.424^b	0.763^a	-0.836^a	
(3.198)	(0.470)			(2.111)	(3.681)	(5.755)	
							-1.334^a
							(4.312)
		0.277	0.023	0.417^b	0.586^a	-0.545^a	-0.882^a
		(1.635)	(0.175)	(2.204)	(2.722)	(3.910)	(2.761)
		0.494^a	0.141	0.436^b	0.794^a		
		(3.052)	(1.107)	(2.151)	(3.795)		

Notes: Sample Size = 49
N and R refer to industries with National and Regional product markets respectively.
See text for further details.
a and be refer to 1% and 5% levels of significance (one-tail test) respectively.
*F-values significant at 99.5% level.

EX	NHM	RHM	HETP	PD	$\bar{R}^2$	F	Eqn. No.
0.702[a] (2.658)	0.194 (1.468)	0.285[a] (2.421)	-0.008 (0.077)	0.138 (1.221)	0.581	7.053*	(1)
0.655[a] (2.566)	0.194 (1.483)	0.247[b] (2.184)			0.586	8.548*	(2)
					0.462	9.247*	(3)
0.880[a] (2.921)	0.300[b] (2.002)	0.343[a] (2.817)			0.374	8.185*	(4)
0.603[b] (2.015)	0.226 (1.651)	0.250[b] (2.095)			0.547	7.434*	(5)
					0.453	8.942*	(6)

Except in equation (4), the effect of horizontal mergers on concentration change tends to be statistically significant only in industries with regional markets (RHM).[7] This result is in line with the proposition that firms merge in order to extend production and sales into geographically segmented markets. For example, Reuber and Roseman in a survey of 1,800 mergers in Canada between 1945 and 1961, found that the "geographic market extension" reason ranked seventh (in terms of frequency) among the 23 reasons identified for mergers in the questionnaire replies.[8]

8.3: Export- and Import-Oriented Industries

The total sample of industries contained in this analysis can be divided into sub-samples of 26 "domestic", 5 "export"- and 18 "import-oriented" industries.[9] The means and variances of change in plant size (CPS_1), change in minimum efficient size (CMES), exit of firms (EX) and horizontal mergers (HM) variables in these three industry categories (indicated by letters D, E and M respectively) are presented in Table 8-3. Tests for equality of means and

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7. The differences between the unstandardized NHM and RHM regression coefficients are, however, not statistically significant.

8. Reuber and Roseman (1969, Table 5-1, pages 78-79).

9. These categories are based on the 1972 ratio of exports (E) or imports (M) as the case may be, to total industry shipments (S) minus exports (E) plus imports (M) in dollar terms. Export-oriented industries are cases where $E/S-E+M \geq 20$ percent; import-oriented industries are cases where $M/S-E+M \geq 20$ percent; and domestic industries are cases when both $E/S-E+M$ and $M/S-E+M < 20$ percent. In cases where both of the export and import ratios are > 20 percent, the industry was grouped into the category where one of the ratios was greater. No adjustments can be made for cases where imports are subsequently exported. Non-availablity of a comprehensive set of data over time on Canada's external trade by industry precludes a more intensive analysis.

TABLE 8-3

TESTS FOR EQUALITY OF MEANS (t-value) AND VARIANCES (F-ratio) OF SELECTED VARIABLES BETWEEN DOMESTIC AND EXPORT AND BETWEEN DOMESTIC AND IMPORT ORIENTED INDUSTRIES, 1948-72

Variable	Mean	Variance	Differences Between D ⟷ E Oriented Industries		Differences Between D ⟷ M Oriented Industries	
			t-Value	F-Ratio	t-Value	F-Ratio
$ECPS_1$	0.132	0.179				
$DCPS_1$	0.929	1.211	1.545[c]	6.765[b]	0.774	1.572
$MCPS_1$	0.632	1.904				
ECMES	0.100	0.066				
DCMES	0.699	0.668	1.393	10.121[a]	0.295	4.816[b]
MCMES	0.801	3.217				
EEX	0.115	0.148				
DEX	0.611	0.483	1.498[c]	3.264[c]	0.664	1.702
MEX	0.447	0.822				
EHM	0.013	0.003				
DHM	0.045	0.014	0.571	4.667[b]	0.469	2.801
MHM	0.030	0.005				

Note:

Sample Size: Domestic (D) = 26, Export (E) = 5, and Import (M) = 18 oriented industries. a, b, c refer to the differences being statistically significant at the 1%, 5% and 10% levels, respectively.

TABLE 8-4

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN CANADIAN DOMESTIC, IMPORT AND EXPORT ORIENTED MANUFACTURING INDUSTRIES, 1948 - 1972

CPS_1	$DCPS_1$	$MCPS_1$	$ECPS_1$	DCMES	MCMES	ECMES	CMPO	MG	EN	EX
	0.180 (1.460)	0.095 (0.864)	-0.060 (0.548)				0.319[b] (2.418)	-0.622[a] (4.284)	-0.926[a] (3.542)	0.638[a] (2.574)
	0.365[a] (2.809)	0.142 (1.153)	-0.058 (0.492)				0.358[b] (2.415)	-0.836[a] (5.650)		
				0.168 (1.223)	0.032 (0.255)	0.054 (0.476)	0.290[b] (2.092)	-0.572[a] (4.027)	-0.949[a] (3.156)	0.653 (2.301)
				0.379[a] (2.902)	0.155 (1.228)	-0.008 (0.063)	0.313[b] (2.074)	-0.714[a] (4.765)		
0.126 (1.156)							0.293[b] (2.062)	-0.623[a] (3.988)	-0.810[a] (2.995)	
									-1.684[a] (5.621)	
0.108 (1.057)							0.310[b] (2.163)	-0.582[a] (4.101)	-0.066[a] (3.209)	0.733[a] (2.571)
									-1.162[a] (3.402)	0.756[b] (2.313)

Notes: Sample Size = 49
D, E and M refer to domestic, export and import oriented industry variables. See text for further details.
t-values are given in parentheses.
a and b refer to 1% and 5% levels of significance (one-tail test) respectively.
*F-values significant at 99.5% level.

DEX	MEX	EEX	HM	DHM	MHM	EHM	$\bar{R}^2$	F	Eqn. No.
			0.315[a] (2.614)				0.560	8.645*	(1)
							0.437	8.467*	(2)
			0.277[b] (2.108)				0.540	8.043*	(3)
							0.438	8.481*	(4)
0.464[b] (2.239)	0.571[b] (1.947)	0.084 (0.617)	0.276[b] (2.384)				0.522	7.548*	(5)
0.680[a] (3.461)	0.853[a] (3.434)	0.579[b] (2.385)	0.358[a] (2.905)				0.446	8.724*	(6)
				0.326[a] (2.979)	0.236 (1.509)	0.026 (0.243)	0.558	8.579*	(7)
				0.402[a] (3.239)	0.150 (0.805)	-0.011 (0.077)	0.376	6.788*	(8)

variances between domestic and export-, and between domestic and import-oriented industries, suggest that statistically significant differences exist primarily between the former pair of industries. The extent to which there may also be differences in the effect of these variables on change in concentration levels (DCR) in these industries can be gauged by examining the estimated regression coefficients[10] presented in Table 8-4.

The results indicate that change in plant size or minimum efficient plant size in export-oriented industries ($ECPS_1$ or ECMES) and in import-oriented industries ($MCPS_1$ or MCMES) does not significantly affect concentration change (DCR). In addition, in equations (1), (2) and (4), the regression coefficient for $ECPS_1$ or ECMES (as the case may be) has a negative sign. In equations (2) and (4), however, the regression coefficient for change in plant size or for change in minimum efficient size in domestic industries (i.e., $DCPS_1$ or DCMES) is positively and significantly related to DCR.

In equations (5) and (6) the exit of firms is significantly related to DCR in both domestic and import-oriented industries (DEX, MEX). The regression coefficient for exit of firms in export-oriented industries (EX) is also found to be significant in equation (b). The fact that the MEX regression coefficient is larger than either DEX or EEX lends marginal support to the hypothesis that rationalization of industry production is more likely to take place in industries subject to additional competitive pressures of imports.[11]

In equations (7) and (8) the horizontal merger variable in domestic industries (DHM) is both statistically significant and positively related to DCR. For import- (MHM) and export- (EHM) oriented industries, this variable is statistically insignificant. In equation (8) the negative sign of the EHM coefficient is contrary to a priori expectations. One reason for the significant effect of DHM may be that less uncertainty is generally attached to potential gains from horizontal mergers among firms in industries not subject to changing patterns of international trade.

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10. Using the dummy variable technique referred to in footnote 1.

11. The differences between the unstandardized DEX and MEX and between the unstandardized MEX and EEX regression coefficients are, however, not statistically significant.

8.4: Producer and Consumer Goods Industries

The sample of industries includes 25 "producer" and 24 "consumer" goods manufacturing industries.[12]

The means and variances of selected variables for these two industry categories are presented in Table 8-5. It is worth noting the highly statistically significant difference in both the mean and variance of the product differentiation (PD) variable between producer goods and consumer goods industries. As may be expected *a priori*, the mean of PD is higher in the latter type of industries.

Table 8-6 presents the estimated regression coefficients for otherwise identically specified equations for producer goods and consumer goods industries. Given the fact that some product differentiation is also undertaken in producer goods industries, the PD variable is included in the analysis of these industries as well.[13]

Application of the Chow test for equality between sets of estimated regression coefficients in equations (1) and (7), (2) and (8), (3) and (9), etc., confirms the null hypothesis, i.e., the relationship between change in concentration levels and the set of independent variables specified does not differ significantly between producer and consumer goods industries.[14] In addition, there are no

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12. This classification is based on economic use of the products manufactured. See Statistics Canada (cat. no. 31-001, various years).

13. See Statistics Canada (1968). It is worth noting that in a joint submission by 13 large Canadian corporations, 10 of which are listed in Fortune Magazines' 500 largest industrial corporations outside the U.S.A., concern was expressed that the extent of the proposed amendments to the misleading advertising provisions of the Combines Investigation Act did not encompass "such complex articles as aircraft, computers and rolling mills" (see Abitibi Paper Co. *et al.*, 1975, page 12). Similar concerns were also voiced in other submissions.

14. See Johnston (1972, pages 206-207). The null hypothesis is accepted at both one percent and ten percent levels of significance.

TABLE 8-5

TESTS FOR EQUALITY OF MEANS (t-value) AND VARIANCES (F-ratio) BETWEEN SELECTED INDEPENDENT VARIABLES IN PRODUCER AND CONSUMER GOODS INDUSTRIES, 1948-72

Variable	Consumer Mean	Consumer Variance	Producer Mean	Producer Variance	t-value	F-ratio
CPS_1	2.127	2.521	1.276	0.565	2.363[b]	4.462[a]
CMES	1.633	1.899	1.423	3.515	1.326	1.851
CMPO	1.337	0.451	1.218	0.215	0.709	2.098[b]
MG	5.906	24.602	4.198	7.965	1.458	3.089[a]
EN	1.173	1.084	1.831	6.270	1.168	5.784[a]
EX	1.127	0.312	1.215	0.994	0.371	3.186[a]
HM	0.079	0.024	0.096	0.012	0.436	2.000
HETP	0.542	0.259	0.560	0.257	0.121	1.008
PD	3.155	9.010	0.394	0.520	4.325[a]	17.327[a]

Notes:

a and b refer to the differences being statistically significant at the 1% and 5% levels, respectively.

Sample size: Consumer = 24, Producer = 25 goods industries.

TABLE 8-6

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN PRODUCER AND CONSUMER GOODS INDUSTRIES, 1948 - 1972

Dependent Variable DCR

CPS_1	CMES	CMPO	MG	EN	EX	HM	HETP	PD	$\bar{R}^2$	F	Eqn. No.
					Producer Goods Industries						
0.288 (1.624)		0.187 (1.126)	-0.402[b] (1.866)	-1.146[b] (2.169)	0.691 (1.560)	0.256 (1.312)	0.028 (0.170)	-0.149 (1.002)	0.527	4.343*	(1)
0.322[b] (1.944)		0.232 (1.503)	-0.437[b] (2.129)	-1.163[b] (2.471)	0.697 (1.695)	0.258 (1.430)			0.553	5.944*	(2)
0.516[a] (3.118)		0.241 (1.404)	-0.785[a] (4.280)						0.433	7.099*	(3)
				-1.756[a] (4.165)	1.134[a] (2.866)	0.370[b] (2.005)			0.481	8.431*	(4)
	-0.040 (0.213)	0.174 (0.948)	-0.246 (1.243)	-1.629[a] (3.236)	1.080[b] (2.325)	0.372[b] (1.957)			0.460	4.410*	(5)
	0.124 (0.622)	0.223 (1.036)	-0.563[a] (2.739)						0.185	2.816	(6)
					Consumer Goods Industries						
0.045 (0.255)		0.563[b] (2.348)	-0.790[b] (2.075)	-0.758[b] (1.887)	0.645[b] (1.863)	0.324 (1.683)	-0.075 (0.406)	0.169 (0.973)	0.569	4.798*	(7)
0.117 (0.833)		0.529[b] (2.351)	-0.778[a] (3.500)	-0.817[b] (2.511)	0.723[b] (2.361)	0.393[b] (2.256)			0.595	6.628*	(8)
0.201 (1.299)		0.510[b] (2.151)	-1.005[a] (4.292)						0.473	7.884*	(9)
				-1.155[a] (3.668)	0.935[a] (2.607)	0.514[b] (2.493)			0.400	6.116*	(10)
	0.027 (0.173)	0.512[b] (2.242)	-0.753[a] (3.313)	-0.867[b] (2.531)	0.751[b] (2.314)	0.392[b] (2.166)			0.579	6.272*	(11)
	0.185 (1.115)	0.466[b] (1.973)	-0.929[a] (3.809)						0.462	7.586*	(12)

Notes: Sample Size Producer = 25, Consumer = 24.
t-values are given in parentheses.
a and b refer to 1% and 5% levels of significance (one-tail test) respectively.
*F-values significant at 99.5% level.

statistically significant differences in the magnitudes of the individual regression coefficients between these two types of industries.[15] However, as is indicated by the t-values, the significance of the relative effect some of these variables have on change in concentration levels does differ between producer and consumer goods industries. Since there is little or no a priori basis for expecting these differences, the reasons postulated below must be viewed as being tentative.

The concentration-increasing effect of change in plant size (CPS_1) is statistically significant in the case of producer goods only (see eqns. 2 and 3; in eqn. 1, the CPS_1 regression coefficient is significant at the ten percent level). This probably reflects greater pressures on firms in such industries to operate at minimum cost scales. In addition, the significant impact of change in firm multi-plant operations (CMPO) in consumer goods industries may arise from economies in product differentiation and product and regional diversification.

The change in minimum efficient size (CMES) variable is insignificant in both producer as well as consumer goods industries.

Market growth has a significant deconcentration effect in both types of industries in 11 of the 12 equations estimated.

Entry (EN) of firms has a significant deconcentration effect in both producer and consumer goods industries. The concentration increasing effect of EX, however, tends to be more consistently significant in the latter type of industry only. This may reflect partly the effects of greater price and non-price competition that tend to prevail in consumer goods industries.[16]

The effect of horizontal mergers (HM) on concentration change also tends to be more consistently significant in consumer goods industries. This is primarily due to the merger activity in the Brewing industry and rationalization in the Textile group of industries that has taken place during the post-war period.

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15. Using the unstandardized regression coefficients.

16. Weiss (1963). And it may also reflect greater risk.

The high effective tariff rate (HETP) and product differentiation (PD) variables are statistically insignificant in both types of industries. However, it is worth noting that the otherwise consistently negative PD variable found in this study takes on a positive (though insignificant) value for consumer goods industries.

8.5: Industries with Oligopolistic Market Structures

Included in the sample are 11 industries designated as having oligopolistic market structures.[17] The average CR_4 levels prevailing in these industries in 1948 and 1972 are 79.1 percent and 73.3 percent, respectively. The average decrease of approximately six percentage points is, however, relatively small considering the initial levels of concentration. In fact, the means and variances of the CR_4 levels in these industries do not differ significantly between the two years.[18] This may reflect the stability of market structures attributable to the non-competitive behaviour generally postulated to exist in such industries,[19] and the probability that various barriers to entry insulate leading firms in these industries from competitive pressures that may otherwise be generated by potential entrants.

However, there is no consensus that oligopoly will necessarily produce market share stability. Scherer states that "heterogeneity of products and distribution channels, the inter-action of high overhead costs with adverse business conditions, lumpiness and infrequency of product purchases, opportunities for secret price-cutting, and weakness in an industry's informal social structure"[20] are some of the factors which may act as disincentives for oligopolistic co-ordination of price and output decisions.

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17. See Chapter VI for a description of the criteria used.

18. The variance in CR_4 levels in 1948 and 1972 is 332.6 and 245.9 respectively.

19. See, for example, Scherer (1971, Chapter 6).

20. Ibid., page 183.

TABLE 8-7

TESTS FOR EQUALITY OF MEANS AND VARIANCES BETWEEN SPECIFIC INDEPENDENT VARIABLES AMONG INDUSTRIES WITH (indicated by letter O) AND WITHOUT (indicated by letter C*) OLIGOPOLY MARKET STRUCTURES, 1948-72

Variables	Mean	Variance	t-Value	F-Ratio
$OCPS_1$	1.634	1.755	0.164	1.035
C^*CPS_1	1.709	1.695		
$OCMPO_1$	1.216	0.331	0.382	1.00
C^*CMPO_1	1.293	0.331		
OMG	5.866	7.524	0.755	2.541[c]
C*MG	4.793	19.123		
OEN	2.611	13.118	2.138[b]	15.112[a]
C*EN	1.189	0.868		
OEX	1.242	2.295	0.314	10.527[a]
C*EX	1.151	0.218		
OHM	0.166	0.020	0.228	1.428
C*HM	0.065	0.014		
OPD	2.303	11.015	0.799	2.055[c]
C*PD	1.584	5.359		

Notes:

a, b and c refer to differences being statistically significant at the 1%, 5% and 10% levels, respectively.

Sample Size: 0 = 11, C* = 38.

TABLE 8-8

DETERMINANTS OF CHANGE IN FOUR-FIRM EMPLOYMENT CONCENTRATION LEVELS IN INDUSTRIES WITH AND WITHOUT OLIGOPOLISTIC MARKET STRUCTURES, 1948-1972

Dependent Variable
DCR

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
CPS_1		0.182 (1.583)	0.168 (1.429)	0.178 (1.472)	0.172 (1.456)	0.166 (1.456)
$OCPS_1$	0.062 (0.537)					
$C*CPS_1$	0.143 (1.186)					
$CMPO_1$	0.326[b] (2.334)		0.307[b] (2.182)	0.318[b] (2.288)	0.316[b] (2.274)	0.239 (1.600)
$OCMPO_1$		-0.184 (1.411)	-0.170 (1.293)			
$C*CMPO_1$		0.342[a] (2.493)	0.347[a] (2.456)			
MG	-0.610[a] (4.170)	0.640[a] (4.411)		-0.645[a] (3.970)	-0.635 (4.089)	-0.548[a] (3.634)
OMG			-0.066 (0.465)			
C*MG			-0.601[a] (4.089)			
EN	-0.085[a] (3.671)	-0.744[b] (2.152)	-0.940[a] (2.682)		-0.908[a] (2.483)	-0.875[a] (2.873)
OEN				-0.156 (0.550)		
C*EN				-0.813 (1.642)		
EX	0.762[a] (2.828)	0.512[b] (1.765)	0.662[b] (2.222)	0.661[b] (2.284)		0.610[b] (2.232)
OEX					-0.116 (0.553)	
C*EX					0.717[a] (2.726)	
HM	0.341[a] (2.780)	0.326[a] (2.698)	0.349[a] (2.834)	0.340[a] (2.845)	0.351[a] (2.852)	
OHM						-0.193 (1.292)
C*HM						0.424[a] (3.132)
HETP	0.022 (0.200)	0.056 (0.509)	0.039 (0.350)	0.051 (0.439)	0.049 (0.424)	0.029 (0.272)
PD	-0.106 (0.890)	-0.066 (0.581)	-0.084 (0.723)	-0.080 (0.685)	-0.074 (0.618)	-0.106 (0.926)
$\bar{R}^2$	0.535	0.554	0.534	0.535	0.535	0.551
F	7.149*	7.647*	7.128*	7.153*	7.154*	7.55*

Notes: Sample Size = 49
t-values are in parentheses.
a, b refer to 1% and 5% levels of significance (one-tail test) respectively.
O and C* relate to industries with and without oligopoly market structures. See text for further details.
*F-values significant at 99.5% level.

Table 8-7 presents the means and variances of selected explanatory variables for sub-samples of industries with (indicated by letter O) and without (indicated by letter C*) oligopoly market structures. The cases where statistically significant differences exist between pairs of these variables are noted accordingly.

When regressed against DCR, the estimated regression coefficients for the preceding set of variables tend to differ significantly between the two sub-samples of industries (see Table 8-8). In all cases the estimated regression coefficients are statistically insignificant in oligopolistic industries.[21] Further detailed research into particular industries is required to determine whether this phenomenon is the result of the oligopolistic co-ordination of prices, output and related matters by firms in highly concentrated industries.

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21. The PD and HETP regression coefficients similarly delineated are statistically insignificant in both sub-samples of industries. While OPD is statistically insignificant, it has a positive value.

CHAPTER IX

IMPLICATIONS FOR POLICY

9.1: Introduction

The approach - indeed, the nature of this study itself - is not one that leads directly to specific recommendations for policy. The results of this analysis provide additional dimensions of understanding of the phenomenon under review (viz., changes in industry concentration levels) and create a platform of perspective from which existing or proposed policy can be examined. In this context, it is important to bear in mind in interpreting the results and extending their implications to the policy arena, that, at best, factors considered explicitly in this study account for only about 60 percent of observed inter-industry variation in concentration change. Also, because of data problems, the effects of a number of factors, such as transportation costs, foreign ownership and government policy in the fields of taxation and industrial development, could not be incorporated in the analysis.

In addition, specific shortcomings of the data used in this study need to be borne in mind. Concentration change, measured by inter-temporal differences in the four firm concentration ratio, does not take into account the identity or the turnover in the ranks of the leading four firms. Thus, in particular industries, the leading four firms in 1948 may not be the same leading four firms in 1972, or they may differ in their ranks. Such information, if it was available, would indicate healthy competitive conditions in industries with high stable or increasing levels of concentration. These and other shortcomings, including the concentration ratio being computed on a national basis without adjustments for regional market segmentation and external trade, and the entry, exit and horizontal merger variables being measured in terms of number of firms, were discussed in Chapters III and VI.

9.2: Summary of Findings

To recapitulate, analysis of four-firm employment concentration ratios indicate that:

- There is considerable inter-industry variation in concentration levels.

- The inter-industry variation in concentration levels tends to decrease over time. Although concentration in industries with high initial levels has tended to decline, industries with low initial concentration levels have recorded marked increases in concentration.

- Concentration levels on average have increased. The average four-firm employment concentration ratio in 1948 was 44.4 percent; in 1972 it was 48.3 percent.

- Similar concentration trends are also observed in sub-samples of producer and consumer goods manufacturing industries.

- The results of an econometric analysis conducted over the total sample of industries indicate that the significant concentration decreasing factors (in order of their relative effects) are entry by firms and market growth (see Table 9-1).

- The significant concentration increasing factors (in order of their relative effects) are exit by firms, change in firm multi-plant operations and horizontal mergers (see Table 9-1).

- The following factors are generally statistically insignificant: change in absolute plant size, change in minimum efficient plant size, change in capital intensity, the cost-disadvantages associated with sub-optimal plant size, oligopoly market structure, nominal tariff rates, effective tariff rates and product differentiation (i.e., advertising to sales ratio).

The significance of these variables does, however, vary in sub-samples of industries with different market characteristics. For example, the influence of change in absolute plant size or relative minimum efficient plant size on change in concentration is statistically insignificant in industries with regionally segmented markets whereas it is significant in industries with national markets. Such findings also emerge with respect to other variables between producer and consumer goods manufacturing industries and between industries characterized as being "domestic" or export/import oriented (see Table 9-1). These results suggest caution needs to be exercised when generalizing about the role different factors play in explaining changes in industry concentration.

TABLE 9-1

DETERMINANTS OF CHANGE IN INDUSTRY CONCENTRATION LEVELS
SUMMARY OF PRINCIPAL STATISTICAL RESULTS

Explanatory Variables	Expected Effect	Rank Import-ance**	Total Sample	Sub-Sample Analyses							
				National Product Markets	Regional Product Markets	Consumer Goods	Producer Goods	Domestic Industries	Export Oriented Industries	Industries Subject to Import Competition	Oligopoly Markets
Entry	-	1	S			S	S				NS
Exit	+	2	S			S	S*	S	S*	S	NS-
Market Growth	-	3	S			S	S				NS
Multi-Plant Operations	+	4	S	S	S	S	NS				NS-
Horizontal Merger	+	5	S	S*	S	S	S*	S	NS	NS	NS-
Absolute Plant Size	+		NS	S	NS	NS	S	S*	NS-	NS	NS
Minimum Efficient Plant Size	+		NS-	S*	NS	NS	NS	S*	NS	NS	
Capital Intensity	+		NS-								
Sub-optimal Cost Disadvantages	+		NS-								
Nominal Tariffs	?		NS+								
Effective Tariffs	?		NS+			NS-	NS+				
Product Differentiation	?		NS-			NS+	NS-				
Oligopoly Market Structure	-		NS-								

Notes: See Chapters VII and VIII for detailed results.
S = Statistically significant at 1% or 5% levels (one-tail test) respectively.
S* = Significant in selected specifications of the model.
NS = Not significant.
** = In terms of the relative magnitudes of the statistically significant (standardized) regression coefficients presented in Table 7-1, equation 6.

Theory suggests market growth will facilitate entry of new firms. The analysis contained in this study suggests that while such a link between market growth and entry exists, entry is a significant concentration-decreasing factor when the effect of market growth is held constant and vice versa. In other words, it would appear that firms are likely to overcome entry barriers in particular industries even when there is little or no market growth.

The significant concentration-increasing effect of change in firm multi-plant operations suggests plant level economies of scale may have been exhausted. This interpretation is supported by the high positive correlation between market growth and change in firm multi-plant operations, a low positive correlation between market growth and change in absolute plant size, and a negative correlation between change in firm multi-plant operations and change in absolute plant size. If plant level economies of scale were not exhausted, a high positive correlation between market growth and change in absolute plant size would be expected.

9.3: Policy Implications

These results have several implications for competition and industrial policies in Canada.

At a minimum, the results suggest that the traditional "tariff-protected small domestic market size limiting economies of scale" paradigm which, from time to time, has served as a backdrop in framing Canadian industrial and commercial policies, is not generally applicable in the context of plant level economies of scale. This result is consistent with the conclusion of the Royal Commission on Corporate Concentration, namely, that plant level economies of scale generally do not impose major cost disadvantages on Canadian firms in serving the Canadian market.[1] It was the Commission's view that plant level economies of scale are of little relevance in evaluating firm size vis-à-vis product specific economies, multi-plant

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1. Royal Commission on Corporate Concentration, Report (1978, pages 67-68). The Commission held that despite the fact that the Canadian market is roughly one-tenth of the U.S. market for most products, when the low end of the plant size distribution is excluded, Canadian plants are not much smaller than U.S. plants.

economies and economies of firm size.[2] Research on these types of economies takes on added importance in the context of this study's finding that a systematic relationship exists between increases in concentration and increases in firm multi-plant operations. If further research reveals that economies of multi-plant operations (as well as those derived from horizontal mergers) are not significant, it would remove an otherwise important constraint in the application of structural remedies to reduce industry concentration.

Horizontal mergers also are found to be a significant concentration-increasing factor. This is a specific matter on which the instruments of competition policy can be brought to bear. Since provisions relating to mergers in the Combines Investigation Act have been rendered ineffective by legal interpretation,[3] the need for an effective policy covering mergers that result in higher levels of industry concentration and are contrary to the public interest becomes more evident.

Differences in the significance and relative effect of selected determinants of concentration change in sub-samples of industries with different market characteristics point toward the danger of generalizing or prescribing a per se approach to the question of industry concentration. These results support the case-by-case approach adopted by the Director of Investigation and Research, Combines Investigation Act, in administering competition policy.

Generally, Canadian industries have a large number of sub-optimal plants (firms) which, it is argued, survive because of the oligopolistic inter-dependence among firms operating in small tariff protected markets.[4] The result that exit rates of firms are found to be more significant in industries subject to additional competition from imports, points to the fact that policies designed to lower barriers to trade can be used effectively to promote structural rationalization and result in Canadian firms becoming more competitive internationally.

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2. The extent to which such economies among large Canadian firms "justify" their relative size, however, was not documented by the Commission.

3. See Economic Council of Canada (1969); R. v. Canadian Breweries Ltd. (1960) 33 CRI; R. v. B.C. Sugar Refining Co. Ltd. et al. (1960) 32 W.W.R. (N.S.) 577.

4. Eastman and Stykolt (1967).

The finding that market growth and entry of firms lowers industry concentration levels simply buttresses the widely held awareness of the need for macro-economic policies which stimulate growth, and for application of those provisions of competition and related industrial policies which lessen barriers to entry.

Certain results presented in this study would benefit from further research. The inter-industry analysis of inter-temporal change in concentration levels and its determinants should be viewed only as a starting point. The causal inter-relationships between selected determinants suggest further research involving construction of a simultaneous model of factors affecting concentration may be fruitful. Further analysis of sub-sample differences in the effects of selected factors on concentration may provide additional insights. The analysis of sub-samples of industries with different market characteristics also indicates the need for renewed emphasis on industry-specific research - particularly studies conducted in a dynamic framework.

APPENDIX A: STATISTICAL TABLES

TABLE A-1: Selected Enterprise Concentration Measures and Related Statistics in 80 Canadian Manufacturing Industries, 1948-72.

TABLE A-2: Selected Measures of Establishment Size in 66 Canadian Manufacturing Industries, 1948-72.

TABLE A-3: Enterprise and Establishment Entry, Exit and Horizontal Acquisition in 51 Canadian Manufacturing Industries During Selected Time Periods, 1948-72.

TABLE A-4: Enterprise Multi-Plant Statistics in 80 Canadian Manufacturing Industries, 1948-72.

APPENDIX B: NOTES ON DERIVATION OF SELECTED VARIABLES.

APPENDIX C: NOTES ON HISTORICAL COMPARABILITY OF CANADIAN CENSUS OF MANUFACTURING INDUSTRIES, 1948-72.

For reasons of economy, the above appendices are not printed as part of this study. However, copies of these appendices can be obtained by writing to the author, c/o Research Branch, Bureau of Competition Policy, Consumer and Corporate Affairs Canada, Ottawa-Hull, K1A 0C9, Canada.

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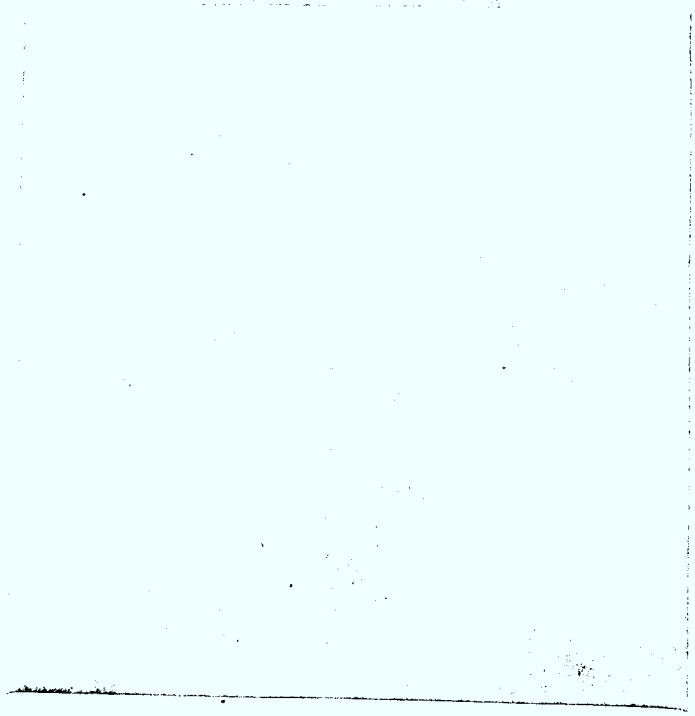

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