Profitability, Concentration and Trade Flows in the Canadian Manufacturing Sector

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ABSTRACT

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This thesis deals with the determinants of industrial profitability. First, I specify and estimate two profit equations within the traditional structure-conduct-performance framework. Econometric estimations and statistical tests suggest that the relationship between profitability and two different measures of concentration is non-linear, non-monotonic, but exhibits an overall upward trend. Empirical evidence regarding the role of imports does not support the import competition hypothesis. A series of exogeneity tests suggest that at least one instrument, for the advertising intensity variable, is required for the consistent estimation of both profit models.

Second, I specify and estimate two theoretical profit equations which are derived from open economy oligopoly models. These equations link profitability with appropriate measures of concentration and trade flows. The corresponding econometric estimations indicate that the differences in profitability across concentration classes are smaller than the ones suggested by the traditional models. Further, the results indicate that imports constrain domestic profitability in the majority of Canadian

industries. Non-nested specification tests favour the second theoretical profit equation which is based on a model of generalized international duopoly.

All estimations are performed using a cross-section sample of 110 Canadian manufacturing industries for the period 1972-1976.

DEDICATION

To my mother, Aspa.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Recently, a number of studies for Canada have estimated profitability equations in the context of the structure-conduct-performance (S-C-P) paradigm. These studies have generated conflicting empirical evidence regarding the determinants of profitability.

Jones et al. (1973), McFetridge (1973) and Gupta (1983) find a positive linear relationship between industry price-cost margins and concentration when the ordinary least squares estimation technique is used. On the other hand, Caves et al. (1980) and Gupta (1983) find no significant linear relationship between margins and concentration when two and three stages least squares estimation techniques are used.

Another empirical discrepancy concerns the sign of the coefficient of import intensity. Previous studies based on Canadian data, have found this coefficient to be both positive and significant (Jones et al., 1973) and insignificant (Gupta, 1983). These results contradict the theoretical expectations of the authors that imports constrain domestic profitability. Moreover, they are at odds with results obtained for most other countries.

These conflicting empirical findings raise some interesting questions. First, can the insignificance of the concentration parameter in Caves et al. (1980) and Gupta (1983) be attributed to the employment of the wrong functional form? That is, could the true equation be non-linear in concentration? The issue of the appropriate functional form is particularly important for policy purposes, because it embodies the intervention guidance rule (Donsimoni et al., 1984). For example, if there is evidence of a positive monotonic relationship between profitability and concentration, anti-monopoly policies should be directed towards industries that exhibit a high degree of concentration. On the other hand, if the relationship is irregular, no simple rule is possible.

Second, which variables should be considered endogenous for the purpose of the consistent estimation of the profit equation? Caves et al. (1980) and Gupta (1983), following a simultaneous equations approach, find that their results are sensitive to assumptions about the exogeneity of explanatory variables. However, none of the Canadian studies test the exogeneity assumptions.

This thesis attempts to resolve these issues using two distinct approaches and a large sample of Canadian manufacturing industries. First I specify and estimate profit equations within the traditional S-C-P framework. The focus in this part of the study is on econometric estimation, with particular emphasis on non-linearities in concentration and the statistical determination of the exogenous variables. The purpose of this exercise is to obtain consistent estimates of the coefficients of concentration and import intensity. The market power-efficiency issue will not be explored empirically.

Second, I specify and estimate profit equations which are derived from open economy oligopoly models. There are several advantages to this approach: a) it directly tackles theoretical questions regarding the specification of traditional profit equations in the case of an open economy (Zeelenberg, 1986). These questions relate to the theoretically appropriate variables and functional form, and the exact interpretation of coefficients b) it sheds light on the role of imports as a source of competitive discipline and c) it provides a formal framework for analyzing the welfare implications of trade and competitive policies. In emphasizing formal economic theory, this approach is in line with a trend that emerged in the field in the 1970s, and which Schmalensee (1982) has called the new industrial organization (IO). Finally, the thesis examines the extent to which alternative specifications of the profit equation make a difference with respect to either the results or conclusions obtained in each case. The results of this study are then compared to those of previous profitability studies for Canada.

The thesis is organized in the following manner: Chapter 2 contains a critical review of profitability studies which are based on the traditional S-C-P approach. The chapter goes on to specify two traditional profitability models which express profits as a function of the concentration ratio and the Herfindahl index respectively. The theoretical justification for expecting non-linearities in concentration is discussed.

Chapter 3 deals with the estimation of the two traditional models using a cross-section sample of 110 Canadian manufacturing industries. Both models are estimated with linear ordinary least squares and with a non-linear, dummy variables technique. Next, the profit equation is viewed as only one equation in a larger five-equation simultaneous equations model. The econometric analysis proceeds with the application of a series of Wu tests in order to determine the minimum number of instruments required for the consistent estimation of the profit equation.

One of the interesting results in this chapter is that the relationship between profitability and concentration is significant and non-linear, exhibiting an upward trend. These non-linearities persist even when an instrumental variables estimation technique is applied to eliminate simultaneity bias.

Chapter 4 deals with the derivation of two estimable profit equations that link profitability with an index of market structure and trade flows. These equations are strictly derived via manipulation and aggregation of the first order maximization conditions of oligopolistic firms in an open economy environment.

The first profit equation is derived from an extension of the dominant firm model (Savings, 1970). The second profit equation is derived from a model of generalized international duopoly. This model is an extension of the model of international duopoly (Brander, 1981), where the individual industries exhibit the characteristics of the Cowling-Waterson (1976) closed economy model. The parametrization of conjectures is similar to that of Clarke and Davies (1982).

Chapter 5 deals with the linear and non-linear estimation of the equations, developed in the previous chapter, using the same sample of 110 Canadian manufacturing industries. The empirical findings in this chapter again suggest that the profit-concentration relationship is characterized by non-linearities. There is also evidence suggesting that imports are an important source of competitive discipline for a large number of Canadian industries. Chapter 5 also deals with the application of non-nested tests. These tests select the best model on the basis of statistical criteria.

Chapter 6 summarizes the study's major findings and discusses their policy implications. Suggestions for future research are also presented.

CHAPTER 2

SPECIFICATION OF TRADITIONAL PROFIT EQUATIONS

2.1 Review of the Traditional Approach and Results for Canada.

A large number of empirical studies in the field of industrial economics have attempted to determine the factors that affect industry profitability. The majority of studies follow the structure-conduct-performance (S-C-P) organizational framework developed by Mason (1939) and Bain (1951, 1956, 1959). The S-C-P framework of analysis assumes that structure determines industry performance through its effects on the conduct of firms. This approach is often termed "structuralist" because of the importance it assigns to the structural characteristics of the industry in shaping the behaviour of firms within it.

During the early 1960s, the case study method which had predominated since the 1930s, but whose generalization value was being questioned (Bain, 1959), gave way to regression analyses. The new method of analysis favoured the formulation and testing of simple hypotheses, the abstraction from industry detail and the use of cross-section data.

The typical profitability equation during the 1960s and early 1970s, expressed industry profits as a linear function of a concentration index and other structural characterístics of the industry. It was estimated using the ordinary least squares technique. The postulated direction of causality was from exogenously determined structure to performance.

Although the definition of structure in this literature is somewhat vague, generally accepted elements of market structure that are considered important include the number and size distribution of firms, entry barriers, diversification, regionality and demand growth. In addition, it is recognized that some elements of market structure may be interdependent. That is, high concentration may be associated with large scale economies, or high product differentiation may be associated with high concentration.

In principle, the concept of conduct embraces all types of firm behaviour ranging from perfect competition to monopoly, but conduct is treated implicitly because of the difficulties in devising appropriate variables to measure it. The concept of performance used is profitability which serves as an indicator of allocative efficiency.

The typical empirical model which is based in the above organizational scheme can be expressed in the following general form:

$$(2.1) \qquad \pi = \pi \text{ (CONC, EB}', Z')$$

where π and vector EB′ represent respectively, measures of profitability and entry barriers. CONC is a measure of industry concentration and vector Z′ includes variables that represent other structural characteristics of the industry.

In practice, π is measured by the industry price-cost margin or the rate of return on capital. CONC is often measured either by the four-firm concentration ratio or the Herfindahl index of concentration. The choice of the particular concentration measure is usually based on the amount of information it conveys about the number and size distribution of firms, its comparative static properties (Curry and George 1983, Encaoua and Jacquemin 1980), and the constraints imposed by available data. Vector EB′ usually contains the following structural features: scale economies, proxied by measures of the minimum efficient size (MES) and the slope of the long-run average cost (LAC) curve; product differentiation, proxied by advertising expenditure over sales; and research and development (R+D), proxied by R+D expenditure over sales. Finally, Z′ includes measures of other structural characteristics of the industry.[1] An implicit assumption in the early empirical studies is that the industry is not exposed to the influence of trade flows. Thus, variables capturing the intensity of international trade are absent.

The majority of these early profitability studies indicated a positive linear relationship between industry profits and concentration, particularly when concentration exceeds a "critical limit" and when there are substantial entry barriers (Scherer, 1980: chap. 9; Weiss, 1974). The conventional interpretation of this finding is that firms in concentrated industries are able to earn above-normal profits by restricting output through recognition of their interdependence.

Thus, while the structuralist approach advances the testable hypothesis that certain elements of market structure determine performance, the conventional interpretation of profitability equations shifts attention to the notion that concentration indices are useful predictors of deviations of price from marginal cost.

The conventional interpretation of the link between profitability and concentration has not gone unchallenged. Demsetz (1973, 1974), expressing an alternative "view of the world," argues that high industry profitability is the result of the superior efficiency of a few large firms. These large firms are simply earning rents not attributable as payments to any particular factor of production. Superior efficiency also leads to higher concentration.

Despite problems of interpretation, profitability studies using the traditional S-C-P framework have continued to flourish. The more recent work is distinguished by two main characteristics. First, there is an increased sophistication in the econometric techniques employed. Phillips (1974, 1976), Scherer (1970) and others, have suggested that there may be feedback effects from performance to conduct and structure. These suggestions have led to the formulation of simultaneous equations systems in which the profit equation appears as one structural form equation (Gupta, 1983; Intriligator et al., 1975; Jacquemin et al., 1980; Strickland and Weiss, 1976). The estimation techniques used are two and three stages least squares. Other investigators have applied non-linear estimation methods and a variety of statistical tests of specification (Geroski, 1981, 1982; Sleuwaegen and Dehandschutter, 1986).

Second, this recent work has recognized that trade flows have a significant effect on the workings of industries (Caves, 1983). The expectation that imports may be an important source of competitive discipline raises the possibility that trade policies could complement, or even substitute, for policies designed to curb domestic monopoly power. Thus, investigators have started to include variables measuring the intensity of foreign trade in their profit equations. Halilzadeh-Shirazi (1974), Esposito and Esposito (1971) and Pagoulatos and Sorensen (1976a, 1976b) were among the first to do so.

Empirical work in the context of the S-C-P framework has in the past, and still continues to contribute to the accumulation of stylized facts about the inter-relationships among industry variables. However, it should be stressed that the specification of the traditional equations is somewhat ad hoc since it is not rigorously derived from a unifying micro theory of oligopoly, although the inclusion of some explanatory variables is supported by specific oligopoly models.

Saving (1970) demonstrates formally that the industry price-cost margin can be expressed as a function of the concentration ratio, using the dominant firm model of oligopoly. Cowling and Waterson (1976) derive an expression linking the industry price-cost margin with the Herfindahl index of concentration using a generalized Cournot model. Huveneers (1981) justifies the inclusion of the import intensity variable in the profit equation using a Cournot model which also contains a group of competitive import suppliers. Finally, Gaskins (1971) links the industry price-cost margin with minimum efficient size using a dynamic limit pricing model in which a dominant cartel maximizes long-run profits by setting a price which also regulates entry.

Nevertheless, the lack of a general oligopoly model raises a number of issues which relate to the theoretically appropriate specification of the profit equation (Phillips, 1974, 1976). More specifically, there is uncertainty regarding the appropriate definitions of the explanatory variables and the interpretation of coefficients in different market circumstances. In addition, tnere is uncertainty regarding the appropriate functional form since the traditional approach does not address this issue.[2]

Furthermore, the inclusion of both the concentration and minimum efficient size terms in the profit equation is methodologically weak. The use of the concentration variable is based on static models in which oligopolists are short-run profit maximizers. In contrast, the use of the minimum efficient size variable is supported by long run dynamic models which allow for entry of firms (Sawyer, 1982, 1983).

There are a number of criticisms that can be directed specifically at open economy profitability studies. The inclusion of foreign trade variables is usually based on intuitive arguments and not on a theoretical derivation (Zeelenberg, 1986). It is not therefore clear, in cases where the industry is exposed to the influences of trade flows, what the appropriate index of concentration would be. In addition, there is uncertainty regarding the interpretation of coefficients of the trade terms since the specification of the profit equation is the result of a literature search for explanatory variables.

However, the traditional approach suppresses these theoretical problems. As Caves et al. (1980:4) put it:

> Rather than hold out for a deterministic model of oligopoly rich enough to capture the complex deterrents to a competitive outcome, Bain proposed that we organize this taxonomy of forces and proceed with the work of studying oligopoly. The resulting structure-conduct-performance paradigm develops the taxonomy in terms of measurable concepts that can be used to express testable propositions about industrial competition.

Moreover, Schmalensee (1985) expresses the opinion that work in the context of the traditional, or what he calls the classical framework, which focuses on the industry as the unit of analysis, is important. This is because cross-section industry studies can yield useful stylized facts to guide specific intra-industry empirical analysis and general theorizing.

A large number of empirical studies for the U.S., beginning with Bain (1951) and reviewed by Scherer (1980: chap. 9) and Weiss (1974), indicate a positive (linear) relationship between concentration and profits. This generally positive relationship found for the U.S. has also been confirmed empirically by a number of early studies for Canada. More specifically, profitability studies conducted in the S-C-P framework that use Canadian data include the following:

Schwarzman (1959), in a pioneering paper, selected a sample of comparable Canadian and U.S. manufacturing industries that were assumed to be similar in terms of cost and demand conditions. Schwarzman found that differences in concentration (Canadian industries were more concentrated than their U.S. counterparts) had price increasing effects which were reflected in profit figures as well.

McFetridge (1973) selected cross-section data on 43 manufacturing industries and regressed the price cost margin on capital intensity, industry growth rate, concentration, plant concentration (a crude measure of scale economies), an index of regionality, a consumer good dummy, advertising intensity and the effective rate of tariff protection. He found that the price cost margin and various measures of concentration (the four and eight firm concentration ratios, and the Herfindahl index of concentration) were positively and significantly related. This linear relationship was stronger in the case of consumer rather than producer goods industries. The fit of the profitability equation improved slightly but significantly when the squared concentration indices were used. Finally, the coefficients of all the other explanatory variables were insignificant, with the exception of the coefficient of capital intensity which was positive and significant.

Jones et al., (1973) estimated a linear profitability equation by using a sample of 30 consumer goods industries. They regressed the profit rate on the four-firm concentration ratio, advertising intensity, a measure of scale economies, the absolute capital requirement entry barrier, a regional dummy, the industry growth rate and import competition dummy variables. The coefficients of all explanatory variables were positive and significant with the exception of the coefficient of the economies of scale entry barrier, which was negative and insignificant. The surprising result was the positive and significant coefficient of the high import intensity dummy, which contradicted their theoretical expectations.

Bloch (1974), using a static theoretical model which was based on the work of Eastman and Stykolt (1967), suggested that industry price, cost and profits are influenced by the simultaneous interaction of concentration and tariff. He found that first, the ratio of the Canadian to U.S. price index was significantly higher in the high tariff - high concentration industry group, consisting of seven industries, than in the other three groups, consisting of 13 industries (high tariff-low concentration, low tariff - high concentration and low tariff - low concentration). Secondly, he found that for a sample of 14 industries, the ratio of the Canadian to U.S. profit index was high in the high concentration groups, irrespective of the tariff level.

Thirdly, for the initial sample of 20 industries, the ratio of the Canadian to U.S. per unit direct cost index was significantly higher in the high tariff and high concentration industry group. These findings suggest that although concentration exerts price rising effects, the combination of high concentration and high tariff protection also leads to high costs. However, Gupta (1983) found that the effective rate of tariff protection was not one of the determinants of suboptimal capacity.

Thus, these early studies for Canada indicate that concentration exerts a positive effect on profitability. However, two more recent studies for Canada, following a simultaneous equations approach, find no statistically significant relationship between profitability and concentration.[3]

Gupta (1983) estimated a five equation model using a sample of 67 manufacturing industries. He found the coefficient of the four-firm concentration ratio in the price-cost margin equation to be positive and significant when OLS was used, but insignificant when 2SLS and 3SLS were used. The coefficients of import and export intensities were in all cases significant. Import and export intensities were assumed to be exogenous.

Caves et al. (1980) estimated a larger simultaneous equations model. Again, the coefficient of the concentration variable in the price-cost margin equation was insignificant when 2SLS was used. But the OLS and 2SLS estimates of the coefficient of export intensity were negative and significant. Also, foreign trade variables were assumed to be endogenous. Both Gupta (1983) and Caves et al., (1980) assumed that the empirical model is linear and did not test for the endogeneity of the explanatory variables.

One possible explanation for the mixed results obtained by Gupta (1983) and Caves et al. (1980) may have to do with the imposition of an inappropriate functional form on data that cannot capture the "true" underlying relationship between profits and concentration. The theoretical expectation of non-linearities in concentration and the specification of two traditional profitability models will be discussed in the two sections that follow.

2.2. Traditional Model 1: The Profit-Concentration Ratio Relationship.

The theoretical justification for the profit-concentration ratio relationship is provided by the (closed economy) dominant firm model of oligopoly. This model has k dominant firms acting jointly as a Stackelberg leader vis-a-vis a competitive fringe. The resulting profit equation (Saving 1970) can be written as:

$$M_i = a_i \, CR_{ki} \tag{2.2.1}$$

where,

M_i	=	$(P - MC/P)(X_k/X)$ is the industry price-cost margin
P	=	the industry price
MC	=	the cartel marginal cost (assumed constant)
X_k	=	the cartel output
X	=	total industry output
CR_{ki}	=	X_k/X is the k-firm concentration ratio
a_i	=	$CR_{ki}/n_i + e_i\,(1 - CR_{ki})$
n_i	=	the industry demand elasticity ($n_i > 0$)
e_i	=	the elasticity of supply of the fringe
i	=	industry

Geroski (1981) makes several important points regarding this profit equation. First, for (2.2.1) to be a reasonable model, a_i must be relatively stable over time. This is likely to be true for older and relatively stable industries. Second, a_i is expected to vary across industries. Specifically, it seems reasonable to assume that CR_{ki} and $1/n_i$ are positively associated since industries with inelastic demands are more likely to be monopolized. Thus, overall, a_i is likely to vary positively with CR_{ki}.[4]

The theoretical expectation of varying a_i has impcrtant implications for estimation. Fitting a linear equation on cross-section industry data amounts to assuming that a_i is constant across industries. But if the model is non-linear in concentration (i.e., a_i varies across industries), the estimated coefficients of the linear equation will be biased.

Geroski (1981) argues that the model developed so far is very partial and that the industry price-cost margin M_i is unobservable. Furthermore, the observed industry margin π_i will deviate from M_i due to the systematic influence of other factors represented by a vector X. In accordance with the traditional IO approach, vector X may include additional structural characteristics of the industry.

Thus, assuming that vector X enters equation (2.2.1) linearly we obtain:

$$(2.2.2) \qquad \pi_i = a_i \, CR_{ki} + b \, X_i$$

For the purposes of this study, vector X contains seven additional explanatory variables. These variables are: imports, exports, advertising, industry demand growth, diversification, degree of market regionality and capital intensity. The theoretical justification for their inclusion in the profit equation and the expected sign of the associated coefficients are as follows:

Imports (IMIN): Recent theoretical work in the context of open oligopoly models suggests that competitive imports constrain the ability of domestic oligopolists to charge a high price and extract monopoly profits in the domestic market. Huveneers (1981), Geroski and Jacquemin (1981), and Jacquemin (1982) examine the role of imports as a competitive discipline using a model in which domestic oligopolists exhibit Cournot behaviour and imports are supplied by a competitive foreign fringe. This model predicts that the import share and the domestic industry price-cost margin are negatively related.

Pugel (1980) and Huveneers (1981) demonstrate that a negative relationship between the domestic industry price-cost margin and the import share can be obtained from a model in which domestically produced goods and imports are differentiated. The domestic output is produced by a perfect cartel (Pugel, 1980) or Cournot oligopolist (Huveneers, 1981) and imports are generated by a fringe of competitive foreign suppliers.

Some studies (for example, Gupta, 1983) include in their profit equation, a variable measuring the level of tariff protection. This does not seem appropriate because the degree of import penetration should reflect the height of trade barriers. In other words, lower tariff protection should lead to lower domestic profitability through increased imports, ceteris paribus.

Finally, one should recognize the possibility that imports may not represent a competitive force. In cases where imports are not competitive, the relationship between profitibility and imports can be positive. This could occur if the domestic oligopolistic group of sellers consists wholly or partly of importers (Geroski and Jacquemin, 1981).

Exports (EXIN): The relationship between the price-cost margin and the export intensity of the domestic industry is more complex. First, if the domestic industry is protected and small relative to the foreign market, domestic oligopolists could dump output in the foreign market by treating the foreign price parametrically. Re-imports could be prevented by a high domestic tariff. In this case, the price-cost margin on exports will be zero, although the profits of the domestic industry will increase (Huveneers, 1981).

Second, if the domestic oligopolists also have some market power abroad and they can apply price discrimination between the domestic and foreign markets, the price-cost margin on foreign sales will be positive.

However, the aggregate price-cost margin on total sales is a weighted average of the margins on domestic and export sales (Pugel, 1980). Therefore, in the first case, exports will tend to depress the margin on total industry sales. In the second case, the effect of exports on the overall industry margin will depend on the magnitude of the price-cost margin on foreign sales relative to the margin on domestic sales. Specific predictions about the influence of exports obviously require explicit assumptions about the demand and cost structures of the domestic and foreign industries. Also, one can arrive at a similar conclusion in the case where domestic and foreign goods are differentiated (Pugel, 1980; Huveneers, 1981).

Advertising (ADIN): The main reason for including a measure of advertising intensity is that the measure of profitability used is not purged from advertising expenditures.[5] Therefore, the coefficient of ADIN is expected to be positive for statistical reasons.

However, the usual justification in the literature for including ADIN is that it serves as an entry barrier.[6] Potential entrants may face difficulties associated with economies of scale in advertising expenditures and with the time required for advertising to produce its desired effects while established firms have already acquired their reputation (Commanor and Wilson, 1967). Furthermore, advertising expenditures represent investment with high sunk costs and thus constitute a credible commitment on the part of established firms which deters entry (Waterson, 1984: chap. 4; Salop, 1979). Finally, ADIN is used in the literature as a measure of product differentiation. This interpretation, however, is not consistent with the Saving model which assumes product homogeneity.

Diversification (DIV): In general, the impact of diversification on profitability is uncertain. Firms may diversify for a variety of reasons which could include the pursuit of high profits, reduction of profit variability associated with demand fluctuations, and exploitation of specific advantages such as brand names (see Clarke, 1985: chap. 9 for additional motives). Diversification may also make oligopolistic coordination more difficult, because it increases and complicates the objectives of firms in different markets. Thus, high diversification may be associated with a lower degree of tacit collusion and profitability.

Market growth (GROW): Many profitability studies use the rate of market growth as an additional explanatory variable to capture aspects of market disequilibrium and its effects on profits. If there is unexpected market growth over the relevant period, one might suppose that there could have been excess demand in the industry that would have inflated profitability. Similarly, if the industry is declining in terms of size and sales, the decline is likely to be accompanied by excess supply and depressed profitability.

Degree of regionality (REG): Markets that are geographically segmented may allow firms to exercise a higher degree of monopoly power, ceteris paribus, because potential competition will probably be weaker. Therefore, the relationship between profitability and the degree of market regionality is expected to be positive.

Capital intensity (KI): The theoretical margin M and the measure of profitability used in this study includes the cost of capital.[7] Therefore, a measure of capital intensity is included in the profit equation to control for inter-industry differences in capital intensity.

One explanatory variable that appears in earlier profitability studies is minimum efficient size (MES). The justification for including MES in the profit equation is based on the argument that MES represents an entry barrier. However, recent profitability studies (Domowitz et al., 1986;[8] Geroski, 1981, 1982; Jacquemin et al., 1980; Sleuwaegen and Dehanschutter 1986) exclude MES from the profit equation, the theoretical justification being that MES is a determinant of concentration. MES is excluded from vector X.[9]

Thus, by adding a constant and an error term, model (2.2.2) can be rewritten as:

$$(2.2.3) \qquad \pi_i = C + a_i\, CR_{ki} + b_1\, IMIN_1 + b_2\, EXIN_i + b_3\, ADIN_i + b_4\, DIV_i + b_5\, GROW_i + b_6\, REG_i + b_7\, KI_i + u_i$$

where u_i is assumed to be normally and independently distributed with zero mean and constant variance.

2.3 Traditional Model 2: The Profit-Herfindahl Index Relationship.

Starting with the Clarke and Davies (1982) profit equation, which is based on the (closed economy) generalized Cournot model by Cowling and Waterson (1976):

$$(2.3.1) \qquad M_i = (a_i/n_i) + (1 - a_i/n_i)\, H_i$$

where, $M = \sum_{j=1}^{k} (P - MC_j/P)(X_j/X)$ is the industry price-cost margin

P = the industry price

MC = marginal cost (assumed constant)

X = output

a = the degree of implicit collusion in the industry[10]

H	=	$\sum_{j=1}^{k} (X_j/X)^2$ is the Herfindahl index of concentration
n	=	the industry elasticity of demand ($n > 0$)
i	=	industry i
j	=	firm j ($j = 1,\dots.k$)

It is reasonable to assume that across industries, H is likely to vary positively with a (see for example Stigler 1964). This assumption implies that the higher the concentration level, the higher the degree of implicit collusion in an industry. Furthermore, H and a are likely to be positively associated with $1/n$, since industries with inelastic demand are more likely to be monopolized. Thus, this oligopoly model suggests that the relationship between the industry price-cost margin and the Herfindahl index of concentration may be non-linear.

However, the observed industry margin π will deviate from the theoretical margin M due to the systematic influence of other factors which are not taken into account by the above oligopoly model. Representing these additional factors by vector X and assuming that they enter profit equation (2.3.1) linearly, we obtain:

$$\pi_i = (a_i/n_i) + (1 - a_i/n_i) H_i + bX_i \quad (2.3.2)$$

where X contains the same explanatory variables as in section (2.2). Thus, adding an error term the profit equation (2.3.2) becomes:

$$(2.3.3) \qquad \pi_i = c_i + g_iH_i + b_1IMIN_i + b_2EXIN_i + b_3ADIN_i + b_4DIV_i + b_5GROW_i + b_6REG_i + b_7KI_i + u_i$$

where u_i is assumed to be normally and independently distributed with zero mean and constant variance.

Chapter 3 deals with estimations of profitability models (2.2.3) and (2.3.3).

2.4 Summary.

One of the central concerns in industrial economics has been the empirical investigation of factors that determine industry performance. The corresponding quantitative research in the field proceeds with the specification and estimation of cross-section profitability models which are based on the traditional S-C-P paradigm. This traditional framework maintains that certain structural characteristics of the industry impede competition, facilitate collusion and thus, lead to monopoly profits and misallocation of resources.

In general, specifications in the context of the traditional framework represent a departure from strict microeconomic modeling, the major reason being the lack of a unifying theory of oligopoly sufficiently rich to capture the different aspects of oligopolistic interdependence. This limitation generates theoretical problems regarding the appropriate functional form, definition of explanatory variables and interpretation of coefficients in the traditional profit equation.

Despite these problems, economists in the field have convincingly argued that cross-section profitability studies are useful because they contribute to the accumulation of empirical regularities, which in turn stimulate the formulation of theoretical explanations and guide intra-industry empirical work.

Recent linear econometric estimations for Canada have generated conflicting empirical evidence regarding the influence of two important determinants of profitability, namely concentration and imports. In order to explore this issue empirically, two fairly conventional profitability models were specified. It was argued that the profit-concentration relationship may not be linear. This view is supported by two corresponding (closed economy) oligopoly models that theoretically justify the link between industry profitability and measures of industrial concentration.

NOTES

1. Profitability models used in the empirical studies differ in the specification of vector Z'. The variables that appear in these studies include diversification, demand growth, risk, foreign ownership, tariff rate, regional dummies and consumer goods dummies. Furthermore, investigators have experimented with alternative proxies for variables which are not available.

2. The majority of traditional studies ignore the issue of the appropriate functional form, and arbitrarily impose a linear function on the data. Geroski's (1981) study, in tackling this problem empirically, is an exception.

3. Investigators using data for the U.K. have also produced mixed results regarding the profitability-concentration relationship. The relationship is often statistically insignificant and sensitive to alternative specifications of the profit equation (Clarke, 1985: Chap. 5; Hart and Clarke, 1979).

4. In addition, Geroski (1981) assumes the elasticity or supply of the domestic fringe is likely to vary

inversely with concentration. Although this assumption is questionable, the general argument that a_i varies across industries is valid.

5. The measure of industry profitability used is: value added minus wages and salaries over value of shipments. This measure contains advertising expenditures (see Appendix A).

6. Waterson (1981) and Clarke (1985: Chap. 4) discuss alternative definitions of entry barriers which have been used in the literature.

7. Since marginal cost is assumed to be constant, the numerator of the theoretical industry price-cost margin M_i is equal to the value of industry output minus variable cost.

8. Domowitz et al. (1986) establish an important empirical finding by using panel data on 284 U.S. manufacturing industries for the 1958-1981 period. They find that the considerable difference in the price-cost margins of concentrated relative to unconcentrated industries for the pre-1970 years narrows dramatically during the 1970s. Domowitz et al. (1986) argue that price-cost margins move

procyclically, but that the margins of concentrated industries are relatively more responsive to business cycles. This accounts for the narrowing of the difference between the margin of concentrated and unconcentrated industries, since the 1970s were characterized by relative stagnation. The study also suggests that the coefficient of concentration in cross-section profitability studies is likely to vary over time following fluctuations in economic activity.

9. The introduction of both concentration and MES in the profit equation usually generates multicollinearity problems. Further, the estimated coefficient of MES is negative (see for example, Jones et al., 1973 and McFertridge, 1973). This does not support the entry barrier justification for including it. When MES was included in the linear OLS estimation of the profit equation, the associated coefficient was negative and significant. The coefficient of concentration was positive and insignificant.

10. Clarke and Davies (1982) define a as a conjectural elasticity term which can also be thought of as the degree of apparent collusion in the market. Equation (2.3.1) yields the Cournot and monopoly solutions as a = 0 and a = 1 respectively.

CHAPTER 3

ESTIMATION OF TRADITIONAL PROFIT EQUATIONS

3.1 Non-Linear Estimation.

Profit equations (2.2.2) and (2.3.3) that were specified in the previous chapter can be written in general as:

$$(3.1.1) \qquad \pi_i = a_0 + a_i CONC_i + bX_i$$

where CONC is a concentration index, X is a vector of other explanatory variables and a_0 is a constant. One of the important conclusions in Chapter 2 was that a_i is likely to vary across industries. Therefore, the employment of a linear profit equation is likely to result in biased estimates of the coefficients. There are three methods that could resolve this estimation problem:

a) Expressing a_i as an n degree polynomial in concentration and substituting in the profit equation.

b) The linear spline method (Poirier 1976). This method involves estimating linear regressions for groups of industries with similar concentration levels and forcing the linear segments to meet at end points.

c) The dummy variables technique. This method involves estimating a_i for industries with similar levels of concentration.

The first method is not very promising because it will create multicollinearity problems associated with CONC and its higher powers. Furthermore, any structural break in the profit-concentration relationship will not be detected.

The second and the third methods are similar and since imposing continuity was not considered necessary, the dummy variables technique was finally chosen.

The general estimating procedure involves the following steps:

First, $CONC_i$ is partitioned into a relatively large number of equal sized classes and an equation of the following form is estimated by ordinary least squares (Maddala 1977: chap. 9).

$$(3.1.2) \qquad \pi = a_0 + a_1 CONC_i + a_2 D_2 + a_3 D_3 + \ldots + a_k D_k + Xb + U$$

where D_i $(i = 2, 3, \ldots, k)$ is an appropriate vector containing concentration indices of the ith size class and zeros. That is:

$$D_2 = \begin{bmatrix} 0 \\ CONC_2 \\ 0 \\ . \\ . \\ . \\ 0 \end{bmatrix} \qquad D_3 = \begin{bmatrix} 0 \\ 0 \\ CONC_3 \\ 0 \\ . \\ . \\ 0 \end{bmatrix} \qquad D_k = \begin{bmatrix} 0 \\ . \\ . \\ . \\ . \\ 0 \\ CONC_k \end{bmatrix}$$

Then, dummy variables (D_i's) with similar sized coefficients are compressed into groups. Finally, groupings that maximize the adjusted coefficient of determination are selected.[1]

This estimation technique has two desirable advantages. First, instead of imposing a specific functional form on the data, this procedure allows the data to determine the estimated profit-concentration relationship. Second, the linear equation is nested in the non-linear model (3.1.2). Thus, one can test the assumption of linearity versus nonlinearity by using the familiar F test. Failure to reject the null hypothesis that the coefficients of the dummies are jointly zero, implies that the assumption of non-linearity is rejected in favour of linearity. It should be noted that all explanatory variables are assumed to be exogenous in this section. However, this assumption will be relaxed in section (3.2).

3.1.1 Estimation of the Profit-Concentration Ratio Relationship.

The estimation is based on a sample consisting of 110 Canadian manufacturing industries at the 4-digit level of standard industrial classification. The dependent variable is the industry price-cost margin for 1976 (MARG76). The explanatory variables used to estimate equation (2.3.3) are as follows:

CR476 : four firm concentration ratio, 1976
IMIN : imports to sales ratio, 1974
EXIN : exports to sales ratio, 1974
ADIN : advertising to sales ratio, 1972
GROW : average industry growth rate, 1972-1976
DIV : index of industry diversification, 1972
REG : regional industry dummy variable, 1972
KI : capital intensity, 1972
(see Appendix A for details).

Equation (i) in Table 3.1.1 shows the results of the linear OLS estimation of the profit equation. The coefficient of CR476 is very small and insignificant. The only coefficients with relatively high t statistics are those associated with ADIN and KI. These coefficients also

Table 3.1.1

OLS: Dependent variable MARG76

Independent Variables	Linear equation (i) (coef.)	(t)	Non-linear equation (ii) (coef.)	(t)
const	0.177*	5.96	0.115*	2.92
CR476	- 0.015	- 0.49	0.619**	2.25
IMIN	0.025	1.48	0.017	0.96
EXIN	- 0.032	- 1.15	- 0.025	- 0.92
ADIN	0.240*	6.61	0.237*	6.64
KI	0.972*	4.45	1.081*	5.01
GROW	0.030	0.91	0.310	0.94
REG	0.007	0.94	0.012	0.82
DIV	- 0.011	- 0.39	- 0.023	- 0.85
D1			- 0.408**	- 2.108
D2			- 0.086***	- 1.678
D3			- 0.175*	- 2.675
			d1 = 0.211[a]	
			d2 = 0.533[b]	
			d3 = 0.444[c]	
	$R^2 = 0.40$		$R^2 = 0.45$	
	$\bar{R}^2 = 0.352$		$\bar{R}^2 = 0.388$	

* Statistically significant at 1% level (two-tail test)

** Statistically significant at 5% level (two-tail test)

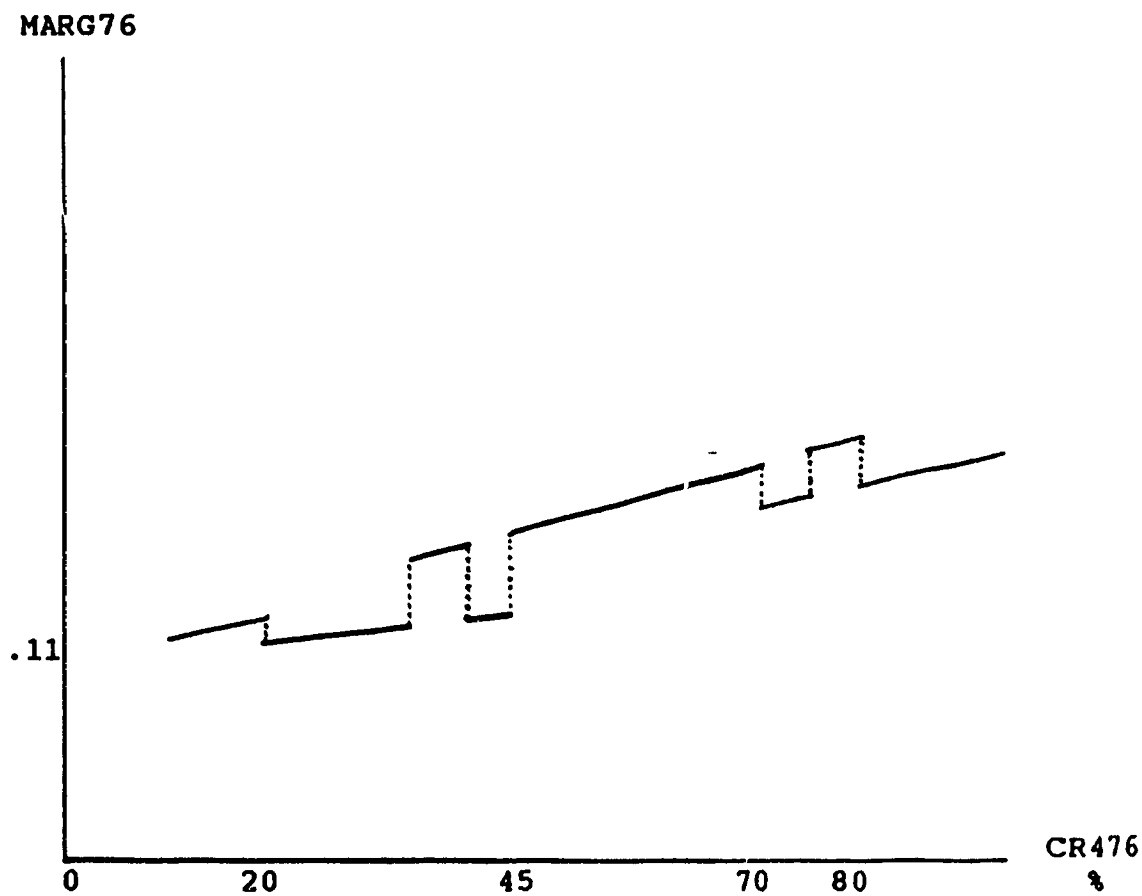
*** Statistically significant at 10% level (two-tail test)

a CR476 slope in classes 5, 6, 7, 9

b CR476 slope in classes 8, 10, 11, 12, 13, 14 ,16

c CR476 slope in classes 3, 4, 15, 17, 18, 19

FIGURE 3.1.1



have the expected positive sign. Note that the impact of IMIN on profitability is positive and significant at .10 level when a one-tailed t test is used.

In order to employ the non-linear estimation procedure, the concentration variable was initially partitioned into 20 equal classes of size .05. No observations were available for the first and the twentieth size classes (i.e., CR476 < .05 and .95 ≤ CR476 < 1.00) so that the data allowed the construction of 18 dummy variables. However, only 17 dummies were added to the linear version of the profit equation in order to avoid perfect multicollinearity and consequent bias. The excluded dummy corresponds to the second size class (i.e., .05 ≤ CR476 < .10).

Thus, a profit equation containing 25 explanatory variables, plus a constant term, was estimated by OLS. The residual sum of squares of the unrestricted (i.e., non-linear) model decreased markedly, but an F test indicated that the assumption of linearity could not be rejected due to the high loss of degrees of freedom.

Thus, in order to economize on degrees of freedom while keeping the residual sum of squares of the unrestricted model relatively low, dummy variables with similar slopes were grouped together. Among the different groupings the one that was selected maximized the adjusted coefficient of determination. This regression appears in Table 3.1.1 as equation (ii).

The number of dummy variables was reduced to three and the correspondence between dummies (D's) and concentration size classes is as follows: D1 corresponds to size classes 5, 6, 7, 9; D2 corresponds to size classes 8, 10, 11, 12, 13, 14, 16; D3 corresponds to size classes 3, 4, 15, 18, 19. The coefficient of CR476 for a given size class (denoted by di in Table 3.1.1) is obtained by adding the coefficient of CR476 to the coefficient of the dummy that corresponds to this class.

The null hypothesis that the coefficients of all three dummies are jointly zero was rejected, using an F test: the calculated F = 2.95 > critical F (3,98) at .05 probability level. Further, a series of tests for heteroskedasticity (Breusch and Pagan, 1979) indicated that the assumption of homoskedasticity could not be rejected.

The sample used suggests that the profit-concentration relationship is non-monotonic, but exhibits an overall upward trend (see Figure 3.1.1) which cannot be captured by the linear function. (Note the upward bias of the constant in the linear equation (i) in Table 3.1.1).

As far as the coefficients of the other variables are concerned, the estimates of equations (i) and (ii) are very similar. The coefficients of ADIN and KI are significant and of similar size in both regressions, whereas the impact of the trade variables is positive and insignificant.

3.1.2. Estimation of the Profit-Herfindahl Index Relationship

The explanatory variables used in the previous section were also used in this section with one exception: The four-firm concentration ratio CR476 was replaced by the Herfindahl index of concentration for 1976 (HH76). Thus, MARG76 was regressed on HH76, IMIN, EXIN, ADIN, GROW, DIV, REG and KI.

The results of the linear OLS estimation appear in Table 3.1.2 as equation (i). The coefficient of HH76 is insignificant, while the coefficients of ADIN and KI have the expected sign and high t statistics.

Next, the profit equation was estimated non-linearly, using the dummy variables technique. Although the corresponding theoretical model suggests that both the coefficient of HH76 and the constant are likely to vary across industries, only the former was allowed to change in the estimation. The constant was kept fixed because the use of appropriate dummies together with the regional dummy variable generated perfect multicollinearity.

Thus, in order to take into account the non-linearity in concentration, HH76 was partitioned into 35 classes of

Table 3.1.2

OLS: Dependent variable MARG76

Independent Variables	Linear equation (i) (coef.)	(t)	Non-linear equation (ii) (coef.)	(t)
const	0.144*	6.102	0.262*	6.54
HH76	- 0.035	- 0.385	- 9.653**	- 2.73
IMIN	0.025	1.45	0.031***	1.81
EXIN	- 0.032	- 1.14	- 0.031	- 0.14
ADIN	0.240*	6.6	0.230*	6.68
KI	0.966*	4.43	0.938*	4.45
GROW	0.03	0.923	0.026	0.85
REG	0.071	0.484	0.01	0.72
DIV	- 0.011	- 0.431	- 0.003	- 0.137
D1			4.709***	1.76
D2			7.411**	2.45
D3			8.590**	2.62
D4			9.000**	2.63
D5			9.494**	2.76
D6			9.206**	2.66

	d1 = - 4.95[a]
	d2 = - 2.23[b]
	d3 = - 1.06[c]
	d4 = - 0.65[d]
	d5 = - 0.16[e]
	d6 = - 0.45[f]
R^2 = .3938	R^2 = .4991
$\bar{R}^2$ = .3523	$\bar{R}^2$ = .4253

---

* Statistically significant at 1 level (two-tail test)

** Statistically significant at 5 level (two-tail test)

*** Statistically significant at 10 level (two-tail test)

a HH76 slope in classes 2, 3

b HH76 slope in classes 4, 5, 6

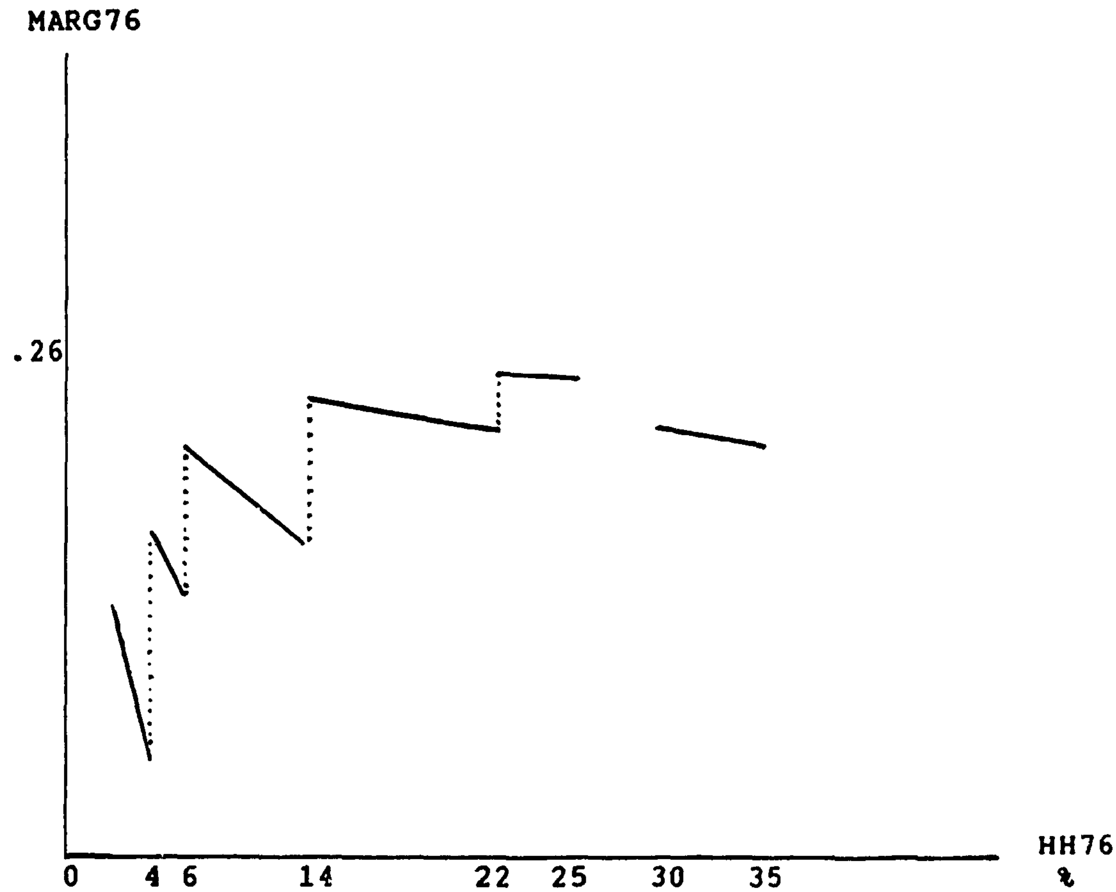
c HH76 slope for classes 7 to 13

d HH76 slope for classes 14 to 22

e HH76 slope for classes 23 to 25

f HH76 slope for classes higher than 25

FIGURE 3.1.2



size .01 each. Size classes 24 (i.e., when $.23 \leq HH76 < .24$), 26, 27, 28, 29, 30 (i.e., when $.25 \leq HH76 < .30$) and 32, 33, 34 (i.e., when $.31 \leq HH76 < .35$) contained no observations. Excluding the first and using the remaining size classes, 25 appropriate dummy variables were constructed containing zeros and the corresponding Herfindahl indices. The dummy corresponding to the first size class was excluded in order to avoid perfect multicollinearity and subsequent bias.

The 25 dummy variables were added to the linear version of the profit equation which was estimated by OLS. However, an F test indicated that the restricted (linear) model could not be rejected in favour of the unrestricted (non-linear) model.

In order to preserve degrees of freedom while keeping the unrestricted residual sum of squares low, dummy variables with similar sized coefficients were compressed into groups. Among a large number of estimated equations containing different dummy groupings, the one that was selected maximized the adjusted coefficient of determination. This regression appears in Table 3.1.2 as equation (ii).

The correspondence between dummies and concentration size classes is as follows: DH1 corresponds to classes 2, 3; DH2 corresponds to classes 4, 5, 6; DH3 corresponds to classes 7, 8, 9, 10, 11, 12, 13; DH4 corresponds to classes

14, 15, 16, 17, 18, 19, 20, 21, 22; DH5 corresponds to classes 23, 25; DH6 corresponds to classes 31, 35.

The coefficient of concentration for a given size class (denoted by di in Table 3.1.2) is obtained by adding the coefficient of HH76 and the coefficient of the dummy that corresponds to this class.

An F test indicated that the assumption of linearity can be rejected in favour of non-linearity: the calculated F = 3.12 > the critical F (6, 95) at .01 probability level. Further, a test for heteroskedasticity (Breusch and Pagan, 1979) indicated that the assumption of homoskedasticity could not be rejected.

The non-linear equation (ii) in Table 3.1.2 suggests that the profit-concentration relationship resembles a quadratic function consisting of steps. The price-cost margins reach a global maximum when HH76 is between .23 and .25. Figure 3.1.2 provides the corresponding graph of this relationship.

The important feature of Figure 3.1.2 is the relative height of different linear segments across all size classes. The negative slope of the linear segments simply means that within size classes the relationship is negative, possibly reflecting the fact that the constant term of the regression was kept fixed.

Thus, overall, the location of the linear segments indicates that the margins increase with concentration across size classes until and including the fifth size class (i.e., when $.23 \leq HH76 < .25$). The margins corresponding to the sixth size class exhibit a mild decline.

Further, the coefficients of ADIN and KI retain the expected signs and their statistical significance. The impact of IMIN is positive and the associated t statistic is larger than in the linear equation. All other coefficients remain insignificant and have the same signs as in the linear case.

3.2 Consistent Estimation.

The linear and non-linear estimations were performed in the previous sections under the assumption that the explanatory variables are not correlated with the error term. This assumption is likely to be violated if some of the explanatory variables are endogenous, rendering the OLS estimates of the coefficients biased and inconsistent.[2] Thus, one should consider the possibility of contemporaneous feed-back effects from the margins to the explanatory variables.

The relevant oligopoly models (Saving, 1970; Cowling and Waterson, 1976; Huveneers, 1981) suggest that the industry price and the market shares of firms are simultaneously determined for exogenously given demand and cost conditions. This implies that the industry price-cost margin, concentration, and import and export shares are endogenous. Intuitively one would expect an increase in the domestic price to be followed, after a short time lag, by a change in concentration and a disturbance of the levels of trade flows.

In addition, advertising is subject to endogeneity if it enters the contemporaneous decision-making process of profit maximizing oligopolists as a choice variable.

Although diversification and capital intensity may be affected by profitability, this is likely to occur with a relatively long time lag (Geroski, 1982). Therefore, DIV and KI will be taken as exogenous.

Thus, the presence of four potentially endogenous explanatory variables calls for the application of an instrumental variable estimation in order to deal with the problem of simultaneity bias.

At this point, the profit equation is viewed as only one equation in a larger simultaneous equations model (Caves, 1980; Geroski, 1982; Gupta, 1983) containing five structural form equations and five endogenous variables (i.e., π, CONC, IMIN, EXIN, ADIN).

Further, it is assumed that the system contains five exogenous variables which do not appear in the profit equation. These variables are: minimum efficient size (MES), cost disadvantage ratio (CDR), nominal tariff rate

(TAR), foreign ownership (FCHH), research and development (RND) (see Appendix A for variable definitions).

MES and CDR are variables reflecting the shape of the long run average cost (LAC) curve of the industry which is determined by technology. MES measures the minimum efficient scale, and CDR may be thought of as a proxy for the slope of LAC curve at small scale.

FCHH and RND may be affected by profitability and other endogenous variables, but this seems likely to occur with a relatively long time lag. Therefore, the likelihood of observing contemporaneous feed-backs between FCHH, RND and π is reduced.[3]

To summarize, at this stage it is assumed that the profit equation contains eight explanatory variables (i.e., CONC, IMIN, EXIN, ADIN, GROW, REG, DIV, KI) four of which (i.e., CONC, IMIN, EXIN, ADIN) are potentially endogenous. Furthermore, it is assumed that the complete simultaneous equations system contains five exogenous variables which are excluded from the profit equation.

Checking the order condition for identification, the profit equation is over-identified, since the number of the excluded variables from the profit equation is larger than the number of equations of the system minus one (i.e., $5 > 4$).

However, before applying the two stages least squares estimation, it would be appropriate to perform tests in order to determine the minimum number of instruments required for the consistent estimation of the profit equation.

The Wu error specification test[4] that will be employed involves estimating (Nakamura and Nakamura, 1981):

$$(3.2.1) \qquad \pi_i = a_0 + a_1 CONC_i + \Sigma\, b_j X_{ji} + \Sigma\, g_j e_{ji} + u_i$$

where (3.2.1) is the profit equation augmented with the addition of e_j's. e_j is the reduced form residual corresponding to the equation that contains the potentially endogenous variable X_j. Rejection of the null hypothesis $g_j = 0$ implies that X_j is endogenous.[5]

This test has the advantage of requiring the detailed specification of the profit equation only. But it also has certain weaknesses. First, the rejection of the null hypothesis $g_j = 0$ is possible under a variety of circumstances which include non-linearity in some X_j, errors in variables etc. (Judge et al., 1980:617). Therefore, it is possible to confuse misspecification with endogeneity. Second, the test is conditional upon the choice of exogenous variables and their inclusion or exclusion from the profit equation (Geroski, 1982).

3.2.1. Wu Tests and Instrumental Variable Estimation of the Profit-Concentration Ratio Relationship.

In section 3.1.1 statistical criteria indicated that the non-linear function provides a better representation of the data. Non-linearity is also supported by the corresponding theoretical model. However, it was argued in section 3.2, that certain explanatory variables in the profit equation may be endogenous, thus generating problems of simultaneity bias.

The task in this section is to determine the minimum number of instruments required for the consistent estimation of the non-linear profit equation using a series of Wu tests. Also, the results of the two stages least squares estimations[6] will reveal the sensitivity of the estimated coefficient to the alternative endogeneity specifications.

Thus, using the relevant profit equation with the concentration ratio dummies D1, D2, and D3 as specified in equation (ii), Table 3.1.1, the Wu tests are as follows:

Test 1: Is CR476 exogenous (Ho), assuming that IMIN, EXIN and ADIN are endogenous? The calculated $F = .94 <$ critical F (1, 97) at .05 significance level. Thus, Ho is accepted. The restricted residual sum of squares RRSS is calculated on the basis of the 2SLS estimates of the profit equation using instruments for IMIN, EXIN, ADIN from the appropriate full reduced form (ie. under the assumption that CR476 is exogenous). The unrestricted residual sum of squares URSS is calculated on the basis of the 2SLS estimates of the profit equation which includes the residuals for CR476. These residuals are obtained from the corresponding reduced form equation for CR476 (which does not include dummies).

The following tests will examine the question of whether all three variables IMIN, EXIN, and ADIN need to be considered as endogenous. Using the result of the first test, it will be maintained that CR476 is exogenous, until test 8.

Test 2 to Test 4, test the hypothesis that one of the variables AMIN, EXIN or ADIN is exogenous, assuming that the other two are endogenous.

Test 2: Is ADIN exogenous (Ho), assuming that IMIN and EXIN are exogenous? The calculated F = 7.8 > critical F (1, 97), at .05 significance level. Thus, Ho is rejected. The RRSS is calculated on the basis of the 2SLS estimates of the profit equation using as instruments the fitted values of IMIN and EXIN from the appropriate reduced form equations (i.e., under the assumption that ADIN is exogenous). The URSS is calculated on the basis of the 2SLS estimates of the profit equation which includes the residuals for ADIN. These residuals are obtained from the reduced form equation for ADIN which contains all exogenous variables.

Test 3: Is EXIN exogenous (Ho), assuming that ADIN and IMIN are endogenous? The calculated F = 4 > critical F (1, 97), at .05 significance level. Thus, Ho is rejected.

Test 4: Is IMIN exogenous (Ho), assuming that ADV and IMIN are endogenous? The calculated F = .46 < critical F (1, 97) at .05 significance level. Thus, Ho is accepted.

The following three cases examine the hypothesis that two of the variables IMIN, EXIN, and ADIN are jointly exogenous, assuming the third variable is endogenous.

Test 5: Are ADIN and EXIN jointly exogenous (Ho), assuming that IMIN is endogenous? The calculated F = 5.9 > critical F (2, 96) at .05 significance level. Thus, Ho is rejected.

Test 6: Are ADIN and IMIN jointly exogenous (Ho), assuming that EXIN is endogenous? The calculated F = 7.45 > critical F (2,96) at .05 significance level. Thus, Ho is rejected.

Test 7: Are IMIN and EXIN jointly exogenous (Ho), assuming that ADIN is endogenous? The calculated F = 2.10 < critical F (2,96) at .05 significance level. Thus, Ho is accepted. Test 7 suggests that IMIN and EXIN can be taken as exogenous, assuming that ADIN is endogenous and that CR476 is exogenous.

Finally, we test the assumption that CR476, IMIN and EXIN are jointly exogenous (Ho), assuming that ADIN is endogenous. The calculated F = 1.71 < critical F (3, 95) at .05 level of significance. Thus, Ho is accepted. Further tests concerning the joint exogeneity of either CR476, IMIN, ADIN or CR476, EXIN, ADIN or CR476, IMIN, EXIN, ADIN, indicated the rejection of Ho. On the basis of the above tests, it is concluded that the minimum number of instruments required for the consistent estimation of the non-linear profit equation is one, that is, one instrument for ADIN.

A series of Wu tests was also performed using the linear profit equation for comparison with the non-linear cases. The test corresponding to test 7 above, revealed that the hypothesis that CR476, IMIN and EXIN are jointly exogenous (Ho), assuming that ADIN is endogenous, is rejected. The calculated F = 3.13 > critical F (3,98) at .05 level of significance.

Further tests indicated that at least two instruments are required for the consistent estimation of the linear equation. These tests suggest that the non-linear function reduces the number of instruments required by one (vis-a-vis the linear function). It should be noted that the Wu tests cannot indicate conclusively if the additional bias associated with linear case is due to non-linearity. However, relying on the indications of the relevant underlying theory, we accept that the non-linear function estimated with at least one instrument for ADIN, provides a better representation of the data.

Table 3.2.1 contains the results of the non-linear equations (ii), (iii) and (iv) and linear equations (iv) and (v), instrumental variable estimations. Equation (i) is estimated by simple OLS and is included for comparison. The non-linear equation in Table 3.2.1 suggests that the use of instruments affects the coefficients of CR476 and the dummies only slightly. The same applies to the coefficient of IMIN, which varies from a minimum value of .01 (equation iii) to a maximum of .101 (equation ii). The positive sign of this coefficient suggests that imports do not constrain domestic profitability. A theoretical explanation of this finding may be that the sellers of imports exhibit collusive behaviour. (Note that Jones et al., 1973 find this coefficient to be positive.) Of course, there is also the possibility that a model containing interactive terms could be more appropriate (see Chapters 4 and 5).

The use of instruments affects the coefficients of ADIN and EXIN markedly. First, the coefficient of ADIN is positive, as expected, but varies from .237 (equation i) to

Table 3.2.1

Instrumental Variable Estimation

Dependent Variable: MARG76

	Non-linear equations				Linear equations	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
const	0.115*	0.87**	0.099**	0.092**	0.160*	0.176*
	(2.92)	(2.04)	(2.36)	(2.216)	(4.91)	(4.766)
CR476	0.619**	0.724**	0.68**	0.765**	0.033	-0.044^
	(2.25)	(2.42)	(2.33)	(2.6)	(0.77)	(-0.465)
IMIN	0.017	0.101^	0.01	0.05	0.093^	0.123^
	(0.96)	(1.261)	(0.562)	(1.83)	(1.35)	(1.614)
EXIN	-0.025	-0.265^**	0.001	-0.23^	-0.324^*	-0.328^*
	(-0.92)	(-1.99)	(0.044)	(-1.88)	(-2.8)	(-2.84)
ADIN	0.237*	0.446^*	0.495^*	0.48^*	0.422^*	0.417^*
	(6.64)	(3.93)	(5.21)	(5.2)	(3.66)	(3.618)
GROW	0.031	0.307	0.029	0.042	0.049	0.043
	(0.94)	(0.784)	(0.842)	(1.199)	(1.32)	(1.165)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
KI	1.081*	1.425*	1.200*	1.400*	1.410*	1.530*
	(5.01)	(5.62)	(5.16)	(5.57)	(5.54)	(5.28)
REG	0.012	0.02	0.017	0.010	0.005	0.007
	(0.82)	(0.931)	(1.13)	(0.662)	(0.26)	(0.331)
DIV	-0.023	-0.043	-0.061	-0.056	-0.041	-0.026
	(-0.85)	(-1.152)	(-1.92)	(-1.79)	(-1.17)	(-0.667)
D1	-0.408**	-0.455**	-0.439**	-0.480**		
	(-2.108)	(-2.155)	(-2.12)	(-2.336)		
D2	-0.086***	-0.141**	-0.120**	-0.120**		
	(-1.678)	(-2.362)	(-2.19)	(-2.27)		
D3	-0.175*	-0.154**	-0.190*	-0.160**		
	(-2.675)	(-2.153)	(-2.74)	(-2.271)		

t-statistics in parenthesis

^ indicates instrumental variable

* Statistically significant at 1 level (two-tail test)

** Statistically significant at 5 level (two-tail test)

*** Statistically significant at 10 level (two-tail test) levels above .446 in all other non-linear estimations. Further, EXIN has a relatively high and negative coefficient in equations (ii) and (iii), where instruments for EXIN are used. The negative sign of this coefficient suggests that price cost margins on sales in the foreign markets are relatively lower than the margin achieved in the domestic market. Finally, the coefficient of REG and DIV are respectively positive and negative in all cases.

The results of 2SLS estimation for the linear equations (v) and (vi) are provided for comparison, although they are not of much interest. The sensitivity of the coefficient of CR476 when an instrument for CR476 is used, however, should be noted.

3.2.2 Wu Tests and Instrumental Variable Estimation of the Profit-Herfindahl Index Relationship.

In section 3.1.2 it was found, using statistical tests, that the non-linear profit equation provides a better fit than its linear version. This finding is also consistent with the relevant theoretical model which predicts non-linearity in the Herfindahl index. The series of Wu tests that follow will determine the minimum number of instruments needed for the consistent estimation of the non-linear profit equation, since it may be argued that certain explanatory variables are endogenous (see Section 3.2).

Test 1: Is HH76 exogenous (Ho), assuming that IMIN, EXIN, and ADIN are endogenous? The calculated F = .118 < critical F (1, 94) at .05 level of significance. Thus, Ho is accepted.

The following three tests examine the hypothesis that one of the variables IMIN, EXIN or ADIN is exogenous, assuming that the other two are endogenous. HH76 is assumed to be exogenous.

Test 2: Is IMIN endogenous (Ho), assuming that EXIN and ADIN are exogenous? The calculated F = .72 < critical F (1, 94) at .05 level of significance. Thus, Ho is accepted.

Test 3: Is EXIN exogenous (Ho), assuming that ADIN and IMIN are endogenous? The calculated F = 5.8 > critical F (1, 94) at .05 level of significance. Thus, Ho is rejected.

Test 4: Is ADIN exogenous (Ho), assuming that IMIN and EXIN are endogenous? The calculated F = 4.1 > critical F (1, 94) at .05 level of significance. Thus Ho, is rejected.

Next, the hypotheses that two of the variables IMIN, EXIN or ADIN are jointly exogenous, assuming that the third variable is endogenous were all rejected. The rejection was stronger when ADIN was included in the pair that was tested for exogeneity. Three indicative tests follow:

Test 5: Are IMIN and EXIN jointly exogenous (Ho), assuming that ADIN is endogenous? The calculated F = 3.5 > critical F (2, 93) at .05 level of significance. Thus, Ho is rejected.

Test 6: Are IMIN and ADIN jointly exogenous (Ho), assuming that EXIN is endogenous? The calculated F = 6.2 > critical F (3, 92) at .05 level of significance. Thus, Ho is rejected.

Test 7: Are IMIN, EXIN and ADIN jointly exogenous (Ho). The calculated F = 5.5 > critical F (3,92) at .05 level of significance. Thus, Ho is rejected.

Test 8: Are HH76, IMIN and EXIN jointly exogenous (Ho), assuming that ADIN is endogenous. The calculated F = 2,36 < critical F (3,92) at .05 level of significance. Thus, Ho is accepted. Test 8 suggests that the non-linear profit equation can be estimated consistently by using only one instrument for ADIN. Also, two tests concerning the joint exogeneity of HH76, IMIN, ADIN and second, HH76, EXIN and ADIN revealed that the null hypothesis of joint exogeneity is rejected.

Further Wu tests were performed using the corresponding linear profit function. These tests indicated that at least two instruments are needed for the consistent estimation of the linear profit equation. In particular, the hypothesis that HH76, IMIN and EXIN are jointly exogenous, assuming that ADIN is endogenous, was rejected. (The calculated F = 3.00 > F (3, 98) at .05 level of significance.) Thus, the reduction of the number of instruments required for the consistent estimation of the non-linear vis-a-vis the linear equation could be attributed to the employment of the more appropriate non-linear functions. This interpretation is also supported by the corresponding theoretical oligopoly model which predicts non-linearity in concentration.

Table 3.2.2 contains the results of the non-linear (equations ii, iii, iv) and linear (equations v, vi) instrumental variable estimations. The simple OLS estimation of the non-linear function (equation i) is also included in Table 3.2.2 for comparison.

The coefficient most affected by the use of instruments in the non-linear cases are ADIN and EXIN. The coefficient of IMIN exhibits less variation, but it is,

Table 3.2.2

Instrumental Variable Estimation

Dependent variable MARG76

	Non-Linear equations			Linear equations		
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
const	0.262	0.289	0.248	0.289	0.157	0.150
	(6.54)	(6.25)	(5.60)	(6.24)	(4.52)	(4.33)
	*	*	**	*		
HH76	-9.653	-13.881	-8.202	-12.045	-0.092	0.434^
	(-2.73)	(-3.01)	(-2.09)	(2.919)	(-0.97)	(1.01)
	***	***		*		
IMIN	0.031	0.147^	0.022	0.081	0.119^	0.073^
	(1.81)	(1.841)	(1.17)	(2.70)	(1.71)	(0.97)
		*	**	*	*	**
EXIN	-0.031	-0.357^	-0.009	-0.330^	-0.371^	-0.338^
	(1.14)	(-2.64)	(-2.49)	(-3.01)	(-3.01)	(-2.44)
	*	*	*	*	*	*
ADIN	0.230	0.358^	0.434^	0.429^	0.427^	0.435^
	(6.68)	(2.947)	(4.63)	(4.68)	(3.75)	(3.67)
	*	*	*	*	*	*
KI	0.938	1.498	1.044	1.469	1.539	1.240
	(4.45)	(5.21)	(4.44)	(5.13)	(5.7)	(4.74)
					**	***
GROW	0.026	0.031	0.030	0.043	0.085	0.070
	(0.85)	(0.86)	(0.88)	(1.29)	(2.36)	(1.97)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
REG	0.01 (0.72)	0.023 (1.04)	0.013 (0.86)	0.009 (0.58)	0.001 (0.05)	0.01 (0.5)
DIV	-0.003 (-0.13)	-0.024 (-0.67)	-0.036 (-1.15)	-0.041 (-1.32)	-0.033 (-0.96)	-0.062 (-1.51)
DH1	*** 4.709 (1.76)	** 8.026 (2.33)	3.806 (1.28)	** 6.714 (2.15)		
DH2	** 7.411 (2.48)	* 11.000 (2.77)	*** 6.157 (1.83)	* 9.382 (2.66)		
DH3	* 8.590 (2.62)	* 12.360 (2.93)	*** 7.192 (1.183)	* 10.760 (2.81)		
DH4	* 9.000 (2.65)	* 13.040 (2.97)	** 7.612 (2.027)	* 11.353 (2.86)		
DH5	* 9.494 (2.76)	* 13.637 (3.04)	** 8.070 (2.12)	* 11.860 (2.85)		
DH6	* 9.206 (2.66)	* 13.861 (3.02)	** 7.814 (2.03)	* 12.050 (2.93)		

t-statistics in parenthesis

^ indicates instrumental variable

* Statistically significant at 1 level (two-tail test)

** Statistically significant at 5 level (two-tail test)

*** Statistically significant at 10 level (two-tail test) again, positive in all cases, suggesting that imports do not exert a competitive discipline. The coefficients of GROW and REG are small with low t statistics in all cases.

The linear equations (v) and (vi) are provided for inspection. It is interesting to note the change in the magnitude and sign of the coefficient of HH76 when an instrument for HH76 is used in the linear case.

3.3 Summary.

This chapter dealt with the econometric estimation of two traditional profitability equations which involve the four-firm concentration ratio and the Herfindahl index of concentration respectively. In the first section of the chapter both equations were estimated using linear and non-linear techniques. In addition, nested statistical tests indicated that the non-linear functions provide a better representation of the data. The second section of the chapter examined the issue of consistent estimation. Using economic theory and a series of statistical tests, it was concluded that at least one instrument (for ADIN) is required for the consistent estimation of both profitability models.

The estimation results of the first traditional model indicate that the relationship between profits and the four-firm concentration ratio is statistically significant, fairly irregular, and exhibits an overall upward trend. In contrast, the second traditional model generated clearer empirical findings which indicate that profitability and the Herfindahl index of concentration are positively related across concentration classes. The conventional interpretation of this result is that high concentration facilitates oligopolistic coordination, which results in output restrictions and above-normal profits.

The findings concerning the impact of imports do not support the import competition hypothesis, since the coefficient of the import intensity variable was found to be positive. It is worth mentioning that none of the previous studies for Canada (Gupta, 1983; Jones et al., 1973), have found this coefficient to be negative and significant. One explanation is that trade flows are introduced in the profit equations inappropriately. This issue is explored theoretically in the following chapter.

NOTES

1. Some empirical studies have identified the existence of a "critical" level of concentration after which the profit concentration relationship becomes more pronounced (Rhoades and Cleaver, 1973; White, 1976; Dalton and Penn, 1976; Sleuwaegen and Dehandschutter, 1986). These studies approximate the profit-concentration relationship by fitting only two linear segments. Obviously, this method is a special case of the general non-linear procedure that will be followed in this chapter.

2. The ordinary least squares estimates of the coefficients may still be consistent, even if some explanatory variables in the equation are endogenous. That is, endogeneity does not necessarily imply inconsistency.

3. Note that while time lags tend to eliminate simultaneity among current variables, anticipatory behaviour on the part of firms may re-introduce simultaneity.

4. This test is used in the form suggested by Houseman (1978). Nakamura and Nakamura (1981) demonstrate that

the computationally more convenient Houseman test is identical to Wu's T2 test (Wu, 1973).

5. Failure to reject the null g = 0 does not necessarily imply that X is not endogenous. It simply means that no instrument for X is required for the consistent estimation of the profit equation.

6. The 3SLS estimator is also consistent and asymptotically more efficient than the 2SLS estimator, but it was not used because it requires the detailed specification of all structural equations. However, Monte Carlo studies suggest that the 2SLS estimator satisfies a number of desirable criteria even in the presence of problems like specification errors (Judge et al., 1985, chap. 15).

CHAPTER 4

THEORETICAL PROFITABILITY MODELS

4.1 Closed Economy Oligopoly Models and Extensions for Open Economies.

A recent development in the field of industrial economics has been the derivation of profit equations that link profitability with various structural characteristics of the industry. This research has been stimulated by the theoretical shortcomings of the traditional S-C-P approach, and has provided the microeconomic foundations of profit equations that appear in the IO literature.

In this section I briefly review a number of oligopoly models that provide the theoretical justification for including specific structural variables in the profitability equation. In the remaining two sections of this chapter, I extend two closed economy oligopoly models by taking into account trade relations between the domestic country and the rest of the world. I also derive two corresponding profit equations that take trade flows explicitly into account. These equations are estimated in Chapter 5. The important theoretical oligopoly models found in the profitability literature can be classified methodologically into two categories:

Oligopoly models in the first category treat firms as short run profit maximizers. The profit equation is derived from the first order conditions of the static profit maximization problem.

Oligopoly models in the second category treat firms as long run profit maximizers that are threatened by domestic entrants. The profit maximization problem is formally set up in terms of dynamic optimization. The determination of both the optimal oligopoly price and non-price policies (i.e., level of advertising) is made using the Pontryagin's maximum principle (Encaoua and Jacquemin, 1980; Sawyer, 1982).[1] However, the resulting profitability equations, although theoretically interesting, are highly non-linear and therefore difficult to apply directly in empirical work.

Theoretical studies in the context of static (closed economy) oligopoly models include the following: Saving (1970) links the industry price-cost margin with the concentration ratio using the dominant firm model of oligopoly. Cowling and Waterson (1976) show that the price cost margin can be expressed as a function of the Herfindahl index of concentration when the Cournot model is used. Clarke and Davies (1982) refine the Cowling-Waterson formula in a way that makes it a useful vehicle for the estimation of oligopolistic behaviour (see Clarke et al., 1984). Neumann and Haid (1985) develop a complicated model in which k dominant Cournot oligopolists exhibit Stackelberg behaviour vis-a-vis a domestic competitive fringe. The resulting profitability equation contains both the k-firm concentration ratio and Herfindahl index. This equation yields the Saving, and Clarke and Davies formulae as special cases.[2]

The closed economy oligopoly models have been adjusted for the case of open economies. This analysis necessarily combines elements of the economic theory of the industry and the theory of international trade. From the point of view of industrial economics, these models are significant for several reasons: They allow for the derivation of profit equations that link industry price cost margins with concentration indices and trade flows. They shed light on the role of imports as a source of competitive discipline. Finally, they provide a formal framework for examining the extent to which trade policies (i.e., tariff reductions, reduction of quotas, etc.) are a good substitute for industrial policies designed to curb domestic market power. Some of the relevant oligopoly models and related issues are considered by Caves (1983), Dixit (1984) and Venables and Smith (1986).

Huveneers (1981), Geroski and Jacquemin (1981) and Jacquemin (1982) extend the Cournot oligopoly model by allowing for imports. Their model consists of K domestic oligopolists who exhibit simple Cournot behaviour (i.e., zero conjectural variations) and a competitive foreign fringe represented by an upward sloping import supply curve. Manipulation and aggregation of the first order conditions of the profit maximization problem of oligopolists yields a profit equation which is a function of the Herfindahl index and a measure of import penetration. This equation indicates that the industry price-cost margin and import intensity are negatively related.[3]

The dominant firm model of oligopoly can also be adjusted to allow for competitive imports. This adjusted model seems to be implicit in the analysis of Caves et al. (1980, chap. 9). The theoretical derivation of the corresponding profitability equation in the presence of trade flows, as well as some welfare implications of this model, will be discussed in section 4.2.1.

A second model that will be generalized in section 4.2.2 is that of Brander (1981). The generalized model can yield a profitability equation that links the industry price-cost margin with an index of concentration and trade flows. However, before moving on, it would be useful to outline the basic assumptions and results, as well as some interesting welfare implications of the Brander model.

Brander (1981) presents a formal theory of international duopoly. The model has two countries with one oligopolist established in each. The two oligopolists face an identical cost structure consisting of (constant) marginal and fixed costs. Demand curves in the two countries are assumed to be identical, linear and downward sloping. Firms maximize profits by following the Cournot strategy in each market separately. That is, they choose the profit maximizing output for a given market by assuming that the other firm's output in the market will remain constant. The assumption of "segmented" markets is crucial and corresponds to the idea that Toyota, for example, decides separately on the number of cars to be produced for domestic consumption and the number of cars to be exported to the U.S. (Brander and Spencer, 1984).

The solutions (i.e., equilibrium pairs of quantity and price) to the above maximization problem will be independent for each market as long as marginal costs are assumed to be constant (i.e., marginal costs do not depend on total output produced by each firm). These solutions reveal that if transport costs are zero, the two firms will be symmetrically placed in each market, supplying half of the total output. Higher transport costs will lead to lower intra-industry trade and reciprocal dumping, since the F.O.B. price on exports is below the domestic price. Also, for a given linear demand curve, the firm with the lower costs (marginal plus transport costs) will have a greater market share. The greater market share will decline however, if the market is experiencing demand growth represented by a parallel shift to the right of the market demand curve. Brander (1981) demonstrates that the Cournot solution is inferior to the planning solution because the former involves unnecessary waste in terms of transport costs. The planning solution has firms producing the Cournot levels of output, but solely for their corresponding home markets.

Brander and Krugman (1983) extend the Brander (1981) model by showing that under certain conditions a unique, stable, two-way trade equilibrium obtains for arbitrary non-linear demand functions. Furthermore, they investigate the question of whether a movement from a position of autarky to a position of free trade represents a Pareto improvement.

In the position of autarky, the two firms are the sole monopolists in their corresponding domestic markets because the level of trade barriers (tariffs or quotas) are assumed to be prohibitive. Elimination of trade barriers leads to the position of free trade with the two firms engaging in intra-industry trade. The welfare effect of this change however, is uncertain and depends on magnitudes of the gains and losses involved. Under free trade, prices fall and output increases because of increased competition (two firms competing in the same market) leading to higher consumer surplus. But there are also higher costs associated with transport that tend to decrease welfare.

The relationship between tariff protection and welfare under international duopoly conditions is examined by Brander and Spencer (1984). They define world welfare as total surplus in the two countries plus total profits earned by the two firms. Tariff revenues are irrelevant for the calculation of world welfare because they represent gains for one country and losses for the other which cancel out. Maximization of world welfare may involve a positive domestic tariff if foreign marginal cost, including transport cost, is higher than domestic cost. In this case, a positive domestic tariff results in net gains by reducing intra-industry trade and replacing high cost foreign production by low cost domestic production. As a consequence, a domestic tariff will decrease world welfare if foreign marginal cost is lower than or equal to the domestic marginal cost (Proposition 4, p. 203). It is worth noting that domestic pressure for tariff protection is usually strongest precisely when the domestic industry has high costs.

Another interesting result (Proposition 5, p. 203), indicates that the tariff that maximizes domestic welfare may be higher than the optimal tariff consistent with world welfare maximization. Domestic welfare is defined as the sum of profits of the domestic firm plus, domestic consumer surplus, plus tariff revenues. Tariff revenues in this welfare calculation represent redistribution of rents arising from sales of foreign firms in the domestic market. Thus, although the imposition of high tariffs may be desirable from the point of view of the domestic country, co-operation leading to multilateral tariff reductions will result in a world welfare improvement.

Furthermore, unilateral tariff reduction may well result in lower domestic welfare. Assuming that the foreign marginal cost is higher than the domestic marginal cost, a fall in the domestic tariff will unambiguously lead to lower domestic surplus, defined as domestic profits plus domestic consumer surplus. Thus, domestic welfare falls, even without taking into account a potential fall in tariff revenues. The point is that in the context of Cournot duopoly, tariff reductions do not necessarily bring about a domestic welfare improvement. This implies that policies of trade liberalization may not be good substitutes for competition policies designed to curb domestic monopoly power. It is worth noting that the conclusions discussed so far do not change qualitatively in the cases of large numbers of oligopolists in each market or non-zero conjectures (Ross, 1986).

The Brander model, apart from giving rise to interesting results, is a significant contribution to the theory of international trade because it provides an alternative explanation of intra-industry trade between similar countries.[4] An extended version of this model and the corresponding industry price-cost margin equation will be developed in section 4.2.2 of this chapter.

4.2. The Dominant Firm Model with Competitive Imports and Exports.

The model that will be presented below is an extension of the dominant firm model for the case of an open economy. This section discusses the basic characteristics of the extended dominant firm model and develops the corresponding industry price-cost margin equation.

It is assumed that the domestic industry is dominated by a small number of domestic producers who form a perfect cartel. Further, foreign firms make up a competitive fringe represented by an upward sloping import supply curve.

Let D(P) and MC_k denote correspondingly, the total domestic demand curve, and the marginal cost of the cartel which is assumed to be constant. The supply of imports can be written as S = S(P, t). It is assumed to be a positive function of the domestic price P and a negative function of the tariff t.

The domestic cartel sets the profit maximizing output by equating the residual marginal revenue MR_k to its (constant) marginal cost MC_k. Assuming that OB < MC_k < OD (see Figure 1), the industry equilibrium will be consistent with positive domestic production and imports. If MC_k > OD,

FIGURE 4.2.1

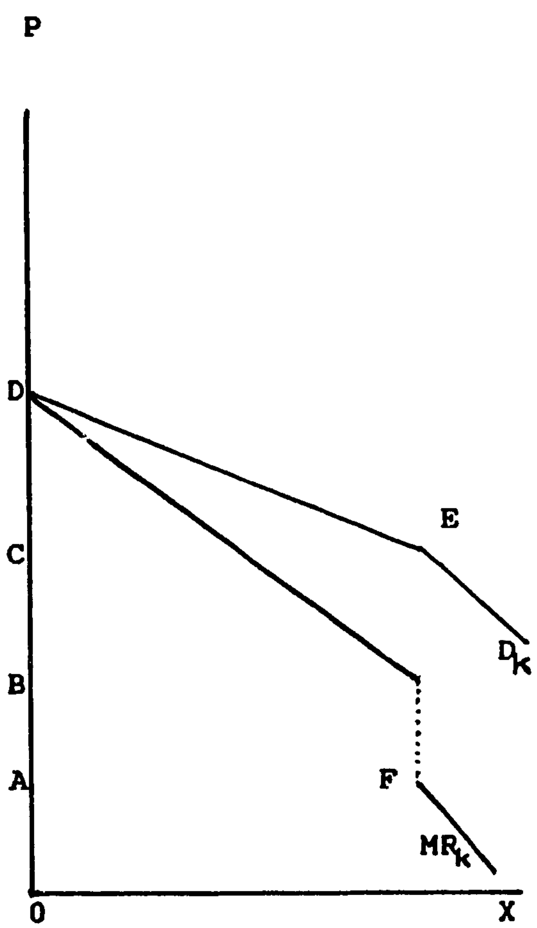
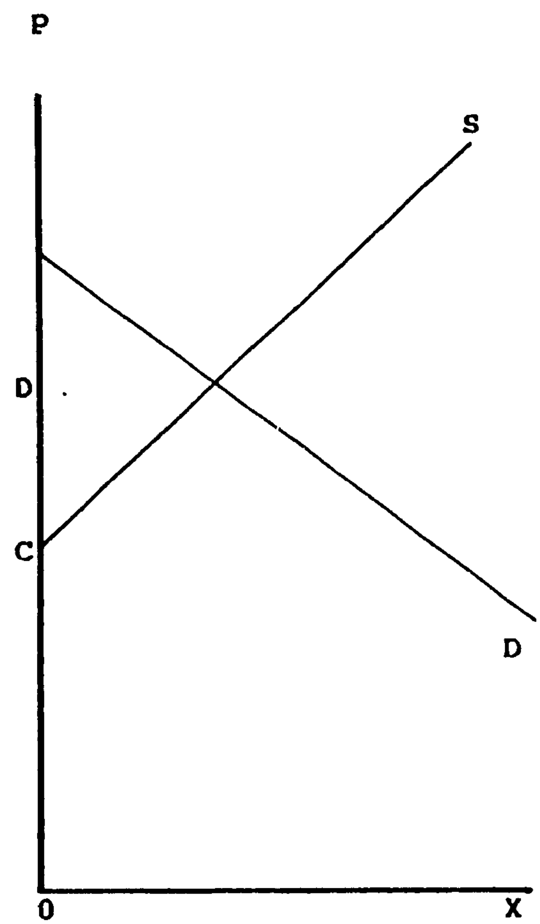


FIGURE 4.2.2



then the domestic market will be served only by imports. If OB < MC_k < OA, the profit maximizing strategy of the cartel would involve charging a price slightly lower than OC, so that imports would not penetrate the domestic market. Finally, imports would again be zero if MC_k < OA. Hence, it is clear that in order to obtain a domestic equilibrium which has both domestic production and imports, MC_k must be between OB and OD [5].

In contrast to perfectly competitive models, it is possible to show with this model that trade liberalization, in the form of a lower tariff, may lead to a deterioration of domestic welfare. A decrease in the tariff will increase the domestic price and lower consumers surplus, if the elasticity of the residual demand curve, n_k, is larger than H [= P (d/dP) (dS/dP) / (dS/dP)], where H is a measure of the steepness of the import supply curve. Further, a decline in tariff may also result in lower cartel profits (see Appendix B for derivations).

Loosely speaking, the condition for domestic welfare deterioration is an import supply curve which steepens quickly at higher prices. In this case, a tariff reduction will shift the import supply curve down and make the residual demand curve less elastic, resulting in a higher equilibrium price. The shape of the supply curve required, implies that the costs of imports must rise quite sharply when the quantity of imports increases. This high cost may be associated with capacity constraints, transport and additional expenses that foreign firms incur in order to secure higher sales. A tariff reduction will also result in a decrease in tariff revenues for the domestic country, if the percentage increase in imports is lower than the percentage fall in the tariff.

Before deriving the industry price-cost margin equation, the model can be modified slightly so that the supply curve S represents both a domestic and a foreign fringe with corresponding outputs denoted by X_d and X_s. The profit function of the cartel can be written as:

$$PR_k = PX_k - MC_k X_k - F_k \quad (4.1.1)$$

where:

$X_k = D_k(P, t)$

F_k = fixed cost of the cartel

Differentiating 4.1.1 with respect to X_k we obtain the familiar first order condition for maximum PR_k:

$$MR_k = MC_k \quad (4.1.2)$$

which can be written as:

$$\frac{P - MC_k}{P} = \frac{1}{n_k} \quad (4.1.3)$$

where:

n_k = elasticity of residual demand, ($n_k > 0$)

But,

$$n_k = - \frac{dD_k}{dP} \frac{P}{D_k}$$

or,

$$(4.1.4) \qquad n_k = \frac{n}{CR_k} + \frac{1 - CR_k}{CR_k} e$$

Thus, using 4.1.4, equation 4.1.3 becomes:

$$(4.1.5) \qquad \frac{P - MC_k}{P} = \frac{1}{n + (1 - CR_k)\, e} \; CR_k$$

where:

$\frac{P - MC_k}{P}$ = cartel price-cost margin

$CR_k = X_k / X_k + X_d + X_s$

= k-firm concentration ratio

n = elasticity of the domestic demand

e = elasticity of supply of the fringe

Multiplying both sides of (4.1.5) by $X_k / X_k + X_d$ we obtain:

$$(4.1.6) \qquad PCM_d = \frac{X_k \;/\; X_k + X_d}{n + (1 - CR_k)\; e}\; CR_k$$

or

$$(4.1.7) \qquad PCM_d = a\; CR_k$$

where,

$PCM_d = PX_k - MC_kX_k \;/\; P(X_k + X_d)$ = industry price-cost margin on domestic sales

Thus, in the context of this model, CR_k is defined as the ratio of domestic sales of the largest k firms to the sum of domestic sales of domestic firms plus imports.

Without using an explicit oligopoly model, Cannon (1978:133) defines an identical concentration ratio (the Cannon "ideal" measure of five-firm concentration) and argues that it reveals the intensity of competition in the domestic market if there are trade flows. The Cannon "ideal" measure implicitly assumes that imports are competitive, that is, that foreign firms compose the competitive fringe. If a foreign seller has oligopoly power in the domestic market, Cannon's measure is no longer appropriate.

Huveneers (1981:218) argues that this type of model (his model assumes that domestic oligopolists exhibit simple Cournot behaviour), can be consistent with the existence of exports. If domestic firms can apply price discrimination against the domestic market, they will expand output and exports until their marginal cost, plus increasing[6] marginal costs associated with exporting, MC_E, equal the foreign price P_F. Positive exports will increase the total profits of domestic firms, but the aggregate price cost margin on exports will be zero, since domestic firms act as price takers in the foreign market. This type of practice may be ruled out as dumping by international agreements.

However, Utton and Morgan (1983) argue that there is sufficient evidence to suggest that price discrimination in international trade continues on a fairly large scale. Huveneers (1981:211) points out that this type of model provides an appropriate and realistic framework for analyzing the relationships between performance, concentration and trade flows in the case of small open economies. His country of interest is Belgium.

Noting that the domestic industry price cost margin on total sales PCM is a weighted average of the margins achieved in the domestic and foreign market (Pugel, 1980), we can write, in general:

$$\text{(4.1.8)} \qquad PCM = (1 - W)\, PCM_d + W\, PCM_X$$

where:

$$PCM = \frac{(P - MC_k)\ X_k + (P_F - MC_k - MC_E)\ X_E}{P\ (X_k + X_d) + P_F X_E}$$

$$PCM_d = \frac{P - MC_k}{P} \quad \frac{X_k}{X_k + X_d}$$

$$PCM_X = \frac{P_F - MC_k - MC_E}{P_F} \quad \frac{X_E}{X_E}$$

$$W = \frac{P_F X_E}{P\ (X_k + X_d) + P_F X_E}$$

However, since we have assumed that the domestic firms behave as price takers in the foreign market $PCM_X = 0$.

Thus, using equations 4.1.7 and 4.1.8:

(4.1.9) $$PCM = a\ CR_k\ (1 - W)$$

The theoretical profitability equation 4.1.9 is an equilibrium relation describing the joint determination of margins, concentration and trade flows. This implies that the correlation between margins and concentration cannot be given a causal interpretation running from structure to performance.

Model 4.1.9 also suggests that an observed positive correlation between PCM and CR_k cannot be given the structuralist interpretation that higher concentration leads to increased profitability by facilitating collusion. Assuming that marginal cost is constant, the only factors that can result in an equilibrium position with higher margins and concentration are different demand and supply elasticities. There is no change in the behaviour (in the structuralist sense) of firms in this model.

The constraining role of imports is captured by the elasticity of supply of the fringe, e, which appears in the denominator of term a. High elasticity of import supply is associated with low profitability, ceteris paribus.

Finally, one could point out the differences between the theoretical model 4.2.9 and the corresponding traditional profitability model 2.2.1, which contains the concentration ratio. The definitions of the concentration variable and the association coefficients are not identical. CR_k in equation 4.2.9, by excluding exports and including imports, involves output sold in the domestic market only. The import variable does not appear as a separate additive term in equation 4.2.9; instead, imports are incorporated in the denominator of CR_k. Exports enter this equation multiplicatively through the term (1 - W).

Thus, it is clear that the detailed handling of imports and exports in the context of the dominant firm model, makes an important difference regarding the appropriate specification of the industry price cost margin equation.

Profitability equation 4.1.9 will be estimated in section 5.1 of the following chapter.

4.3 Generalized International Duopoly.

In this section I develop an extension of the model of international duopoly (Brander, 1981) and I derive the corresponding industry price-cost margin equation. The extended model is characterized by the following features: a) the number of oligopolists in each country is greater than one, b) the oligopolists are allowed to have non-zero conjectural variations, and c) conjectures are parametrized so that they can be interpreted as degrees of implicit collusion in each market.

It is assumed that there are two countries, domestic country A and foreign country B. The total domestic demand is:

$$X(P) = \sum_{i=1}^{k} x_i^k (P) + \sum_{i=1}^{s} x_i^s (P)$$

and it is served by K domestic and S foreign oligopolists who produce a homogeneous product. The inverse domestic demand function is:

$$P = P\ (X_1{}^k,\ X_2{}^k,\ \ldots,\ X_k{}^k,\ X_1{}^s,\ X_2{}^s,\ \ldots,\ X_s{}^s) = P\ (X^k,\ X^s)$$

where:

$$X^k = \sum_{i=1}^{k} X_i{}^k \quad \text{and} \quad X^s = \sum_{i=1}^{s} X_i{}^s$$

The profit function of domestic firm i is:

$$PR_i = PX_i{}^k + P_B Y_i{}^k - C_i\ (X_i{}^k + Y_i{}^k) - F_i$$

where:

P, P_B = domestic and foreign price respectively

$X_i{}^k$, $Y_i{}^k$ = outputs sold in the domestic and foreign market respectively

C_i = constant marginal cost

F_i = fixed cost

Assuming that the domestic and foreign markets are "segmented" (Brander, 1981), domestic firm i maximizes profits by setting output for the domestic and foreign market separately. Profit maximization with respect to domestic sales implies that the following first order condition must hold:

(4.3.1) $\quad MR_i = C_i$

where:

MR_i = marginal revenue of domestic firm i in the domestic market.

But,

$$MR_i = P\left(1 - \frac{1}{e_A}\,\frac{X_i^k}{X}\,\frac{dX}{dX_i^k}\right)$$

or

(4.3.2) $$MR_i = P\left[1 - \frac{1}{e_A}\,\frac{X_i^k}{X}\left(1 + a\,\frac{X^k}{X_i^k} - a + b\,\frac{X^s}{X_i^k}\right)\right]$$

where:

e_A = numerical value of the elasticity of total domestic demand.

$$a = \frac{dX_j^k/X_j^k}{dX_i^k/X_i^k} \qquad \text{for every } i,\ j\ ;\ i \neq j$$

$$b = \frac{dX_j^s/X_j^s}{dX_i^k/X_i^k} \qquad \text{for every } i,\ j$$

(for detailed derivation see Appendix C)

Terms a and b are conjectural elasticity terms suggested by Clarke and Davies (1982). Term a implies that each domestic firm i expects a constant proportionate response, a, from each of domestic firms in the domestic market. Similarly, term b describes the proportionate output response of foreign firms expected by domestic oligopolists in the domestic market. These two terms can be interpreted as degrees of implicit collusion inherent in the market.

Using 4.3.1 and 4.3.2, we can express the price-cost margin of firm i as:

$$(4.3.3) \qquad \frac{P - C_i}{P} = \frac{1}{e_A}\left[(1 - a)\frac{X_i^k}{X} + a + (b - a)\ \text{IMPA}\right]$$

The industry price cost margin on sales in the domestic market PCMd can be obtained by multiplying 4.3.3 by X_i^k/X^k and aggregating over K. Note that this operation has important implications regarding the formation of the industry price-cost margin equation. First, the industry margin PCMd is defined as a weighted average of the individual Lerner indices of firms, the weights being the corresponding market shares. The choice of market shares as weights is arbitrary and incorporates a value judgement as to the type of information an industry index of performance should contain (Geroski, 1983; Donsimoni et al., 1984). In this case, PCMd depends on both the degree of monopoly power (i.e., individual Lerner indices) and the distribution of power among firms (i.e., market shares). Second, this particular weighing system generates, on the right hand side of 4.3.3, the Herfindahl index which is commonly used as a measure of industry concentration.[7] The resulting equation for PCMd is:

$$\text{(4.3.4)} \qquad PCMd = \frac{a}{e_A} + \frac{1 - a}{e_A} (Hd)\ (1 - IMPA) + \frac{b - a}{e_A} IMPA$$

where:

$$PCMd = \sum_{i=1}^{k} (P - C_i)\ (X_i^{k})\ /\ PX^k$$

= aggregate price cost-margin on sales in the domestic market.

$$Hd = \sum_{i=1}^{k} (X_i^{k})^2\ /\ (X^k)^2$$

= domestic Herfindahl index of concentration.

$$IMPA = \frac{X^s}{X} = \text{ import intensity.}$$

As already mentioned, terms a and b can be interpreted as degrees of implicit collusion in the market. If a and b are equal to one, the perfect cartel solution is obtained. That is, domestic and foreign firms extract maximum profits by exploiting the domestic market monopolistically. If a and b are equal to zero, the Cournot solution is obtained. Also, terms a and b can be negative, thus generating a more competitive solution.[8]

The total foreign demand Y is served by S foreign and K domestic oligopolists. That is:

$$Y = \sum_{i=1}^{s} Y_i{}^s + \sum_{i=1}^{k} Y_i{}^k$$

Profit maximization by domestic firm i with respect to sales in the foreign market implies that the following first order condition must hold:

$$(4.3.5) \qquad MR_i{}^B = C_i + t_i$$

where:

MR_i = marginal revenue of domestic firm i in the foreign market

t_i = additional marginal cost associated with transport and tariff

The industry price cost margin on sales in the foreign market can be obtained by manipulating (4.3.5) and aggregating over K. The resulting equation is:

$$\text{(4.3.6)} \qquad PCMx = \frac{g}{e_B} + \frac{1 - h}{e_B} (Hx)\ (EXPA) + \frac{h - g}{e_B} EXPA$$

where:

$$PCMx = \sum_{i=1}^{k} (P_B - C_i - t_i)\ (Y_i^k) \ / \ P_B Y^k$$

= aggregate price cost-margin on the foreign market

$$Hx = \sum_{i=1}^{k} (Y_i^k)^2 \ / \ (Y^k)^2$$

= domestic Herfindahl index of exports

$$EXPA = \frac{Y^k}{Y} = \text{export intensity}$$

Y^k = total exports of country A

e_B = elasticity of total foreign demand ($e_B > 0$)

$$g = \frac{dY_j^s / Y_j^s}{dY_i^s / Y_i^s} \qquad \text{for every } i, j$$

$$h = \frac{dY_j^k/Y_j^k}{dY_i^k/Y_i^k} \qquad \text{for every } i, j ; \quad i \neq j$$

where, g and h are conjectural variation terms.

Term g can be interpreted as the degree of implicit collusion of domestic and foreign oligopolists in the foreign market. Similarly, term h can be interpreted as the degree of implicit collusion of domestic oligopolist competing in the foreign market.

The domestic aggregate price-cost margin on total sales PCM can be obtained by using the identity (Pugel, 1980):

$$(4.3.7) \qquad PCM = (1 - W)\ PCMd + W\ PCMx$$

where:

$$W = \frac{P_B Y}{PX + P_B Y^k} = \text{export share}$$

Thus, substituting in the above identity the expressions for PCMd and PCMx, we obtain:

$$(4.3.8) \qquad PCM = (1-W)[\frac{a}{e_A} + \frac{1 - a}{e_A}(Hd)(1 - IMPA)$$

$$+ \frac{b - a}{e_A} \text{IMPA}] + W [\frac{g}{e_B} + \frac{1 - h}{e_B} (Hx)(\text{EXPA}) + \frac{h - g}{e_B} \text{EXPA}]$$

The industry price-cost margin equations 4.3.4, 4.3.6 and 4.3.8, are original and differ from all existing open economy profitability equations by simultaneously combining the following three features. First, structural and behavioral determinants of profitability are clearly defined and appear separately on the right hand side of these equations. Second, the behavioral parameters (i.e., conjectural elasticities) and demand elasticities comprise the coefficients of the profitability equations. This feature is convenient for estimation purposes, since it is commonly assumed in the relevant empirical literature (Iwata, 1974; Appelbaum, 1982; Clarke et al., 1984), that conjectures and demand elasticities are constant, unknown and subject to econometric investigation. Third, the conjectural elasticity terms provide a natural indicator of the degree of collusive behaviour of firms.

If the conjectural elasticities of the domestic and foreign oligopolists competing in the same market are equal, then equation 4.3.8 can be simplified. Furthermore, by treating the foreign firms symmetrically, we can obtain a corresponding equation for the foreign aggregate price cost margin on total sales.

Equation 4.3.4 reveals that for values of a between -1 and 1, domestic profitability is positively related with the appropriately defined concentration index Hd, ceteris paribus.

The relationship between profitability and imports is a little more complex. First, assuming that a = b, imports constrain domestic profitability. Furthermore, the constraining effect of imports is higher, the higher the level of domestic concentration, since Hd and IMPA enter equation 4.3.4 interactively. Second, if b < a, the constraining effect of imports is even greater due to the increased degree of competition between domestic and foreign firms. However, if b > a, imports exert a positive influence on PCMd through the third additive term in equation 4.3.4.

The influence that exporting activities exert on industry margin PCM can be examined by using identity 4.2.7. If PCMx is low relative to PCMd, then exporting leads to a lower domestic industry price-cost margin, since PCM is simply a weighted average of PCMd and PCMx. However, if PCMx is high relative to PCMd, then export activities exert a positive influence on PCM.

Equation 4.3.4 also reveals that PCMd, P, Hd and IMPA (= EXPB) are simultaneously determined for exogenously given conjectures, costs and domestic demand conditions. Therefore, the structuralist interpretation that concentration determines performance in a causal sense, is not valid in this model.

It is interesting to note that equation 4.3.8 can yield a simpler profit equation as a special case. Assuming no trade flows and a $\neq$ 0, the Clarke and Davies (1982) equation is obtained.

Also, one can distinguish between the theoretical equation 4.3.8 and the corresponding traditional equation 2.3.3, which contains the Herfindahl index. Unlike the traditional equation, the theoretical equation exhibits the following characteristics which are the result of the detailed specification of the underlying open economy oligopoly model. The explanatory variables of interest, that is, concentration and trade intensities, are well defined and the corresponding coefficients can be given meaningful and unambiguous interpretations. The Herfindahl index Hd involves only domestic output sold in the domestic market, while the import intensity IMPA is defined as the ratio of imports to domestic disappearance. Furthermore, the functional form of the theoretical equation is more complex, since it contains interactive terms, that is, concentration interacting with trade variables.

This model can be viewed as an extension of the model of international duopoly (Brander, 1981), where the individual industries exhibit the characteristics of the Cowling-Waterson (1976) closed economy model; the parametrization of conjectures is similar to that of Clarke and Davies (1982). Equation 4.3.8 will be estimated in a slightly modified form. The results of this estimation are presented in section 5.2.

4.4 Summary.

This chapter has concerned itself with the derivation of two theoretical profit equations in the context of two corresponding open economy oligopoly models (i.e., the dominant firm model and generalized internalized duopoly). The main purpose of this exercise was to link the industry price-cost margin with measures of industry concentration and trade flows. The approach that was followed placed emphasis on formal microeconomic modeling and resulted in profit equations with several advantages over the traditional S-C-P approach. These advantages relate to the appropriate definition of the explanatory variables, the clear interpretation of coefficients and the functional form of the profit equations.

More specifically, it was shown that the theoretically appropriate explanatory variables differ from those employed in traditional studies. Also, the theoretical profit equations contain interactive variables, and coefficients that incorporate elasticity terms and conjectures. Moreover, it was argued that profitability, concentration and trade flows are simultaneously determined for exogenously given conjecture, demand and cost conditions.

One interesting result of the second model presented in this chapter (i.e., the generalized international duopoly) concerns the nature of the profitability-imports relationship: imports may not constrain domestic profitability if foreign firms exhibit collusive behaviour in the domestic market. Finally, both models predict that under certain conditions, a policy of domestic tariff reduction may well result in a deterioration of domestic welfare.

NOTES

1. These dynamic models are extensions of the work by Gaskins (1971) who reformulated the limit pricing theory of Bain (1956), Modigliani (1958) and Sylos-Labini (1962). Encaoua and Jacquemin (1980) and Sawyer (1982) show that the industry price cost margin can be expressed as a function of the concentration ratio, advertising intensity and minimum efficient size. An additional feature of this approach is that it yields a system of simultaneous equations. In principle, these dynamic models can be adjusted to allow for trade flows. The technical requirement for this, is an additional constraint reflecting the behaviour of foreign entrants.

2. All theoretical profit models involve demand elasticity terms which are ignored by the traditional approach (Cowling, 1976). In addition, the theoretical models reveal that profitability and concentration are endogenous variables (Geroski, 1982b).

3. Also, models have been developed within the same simple Cournot framework that incorporate differentiated imports. Huveneers (1981) examines the case where a group of Cournot domestic oligopolists faces competition from a fringe of import suppliers. It is assumed that domestic firms produce a homogeneous good and that imports and domestic output are similar, but differentiated (i.e., not identical). The resulting profitability equations are fairly complicated, but again, yield the prediction that the Herfindahl index and import intensity are respectively positively and negatively associated with the domestic price-cost margin. Pugel (1980), Huveneers (1981) and Zeelenberg (1986) examine the special case in which domestic consumers are assumed to have a separable utility such that a fixed fraction of their income is spent on domestic and similar, but differentiated goods.

4. Statistical evidence has indicated that certain aspects of world trade cannot be explained adequately by conventional theories of comparative advantage. These aspects include: a) trade between developed countries with similar factor endowments and b) two-way trade in similar products, that is, intra-industry trade. This is particularly true for

trade among the EEC countries. There are two models that explain intra-industry trade between similar countries. Both assume conditions of monopolistic competition and increasing returns to the firm. But they differ in the specification of consumer preferences. The first is the Krugman (1980, 1981) model, which is based on general equilibrium reformulation of the monopolistic competition theory (Dixit and Stiglitz, 1977). The second is the Lancaster (1980) model. These models indicate that gains from trade are possible due to larger product diversity and exploitation of scale economies. The Brander (1981) model provides an alternative explanation of intra-industry trade between similar countries.

5. Some authors (Bloch, 1974; Caves et al., 1980) have used a variant of this model to examine the relationship between profits, concentration and tariff. These authors assume that the supply of imports is perfectly elastic at OC in Figure 4.1. Therefore, the residual demand curve becomes CED_K. Further, it is assumed that the domestic industry is dominated by a cartel whose marginal cost curve intersects the residual marginal revenue curve between points E and F. Since the profit maximizing price of

the cartel is slightly below OC, this equilibrium has the unattractive property of zero imports. In addition, the above equilibrium situation cannot be described by a continuous function linking the price-cost margin with a concentration index. This is because the domestic demand curve becomes kinked at the point of intersection with the horizontal import supply curve and therefore, it is not continuously differentiable (Dickson, 1978).

6. This assumption is required to set a limit to the amount of exports of domestic firms.

7. This implies that the choice of the Herfindahl index as a measure of concentration is subjective even in the context of the Cournot model. For example, Jacquemin (1987:57), using a closed economy Cournot model, shows that if the industry margin is defined as the geometric mean of the individual margins of firms, the industry margin can be expressed as a function of the entropy measure of concentration.

8. Assuming that $a = b$, the second order condition of profit maximization for firm i holds if $a > -1 /[(1/S_i)-1]$, where S_i is the market share of domestic firm i. This inequality can be equivalently expressed in terms of aggregate variables as $a > - Hd(1 - IMPA) / 1 - Hd(1 - IMPA)$ (see Appendix C for derivations).

CHAPTER 5

ESTIMATION OF THEORETICAL PROFIT EQUATIONS

5.1 The Dominant Firm Model with Competitive Imports and Exports.

In section 4.2.1 it was demonstrated that the dominant firm model of oligopoly, adjusted for competitive imports and exports, yields the theoretical profitability equation (4.1.9). That is:

$$(5.1.1) \qquad \pi = a \ CR_k \ (1-W)$$

and

$$a = \frac{X_k \ / \ X_k + X_d}{n + e \ (1-CR_k)}$$

where all variables are as defined in the relevant section 4.2.1.

Before proceeding with the cross-section estimation of this profit equation, it should be noted that parameter a is unlikely to be constant across industries. The numerator of a is equal to the ratio of cartel to total domestic output sold in the domestic market, which may be assumed to be positively related with CR_k. Further, CR_k and the elasticity of the total demand curve, n (which appears in the denominator of a), should be inversely related since industries with more inelastic demands are more likely to be monopolized. Therefore, unless e and CR_k are positively related, the relationship between a and CR_k is expected to be positive. Adding a constant and an error term to equation (5.1.1), the statistical model becomes:

$$(5.1.2) \qquad \pi_i = a_0 + a_i \, CON_i + u_i$$

where u_i is assumed to be normally distributed with zero mean and constant variance and $CON_i = CR_{ki} \, (1-W_i)$.

Equation 5.1.2 was estimated using a sample of 110 Canadian manufacturing industries at the 4-digit level of Standard Industrial Classification. The dependent variable is the industry price-cost margin for 1976 (MARG76). In order to construct CON, a proxy for CR_4 was derived using Statistics Canada data for the four-firm concentration ratio CR4. The measure of CR4 provided by Statistics Canada is the percentage of industry shipments accounted for by the four largest enterprises. Since it includes exports and excludes imports, it is not the concentration measure implied by this model. Appropriate correction requires knowledge of the total industry imports and exports (which is available), and knowledge of the share of exports of the largest four firms (which is not available). Consequently, the available CR4 data were corrected only for imports.

It is interesting to note that adjusting CR4 only for imports amounts to assuming that the four largest domestic producers are responsible for the same share of industry exports and domestic production.[1]

Finally, since the measure of profitability used (MARG76) includes the cost of capital and advertising expenses, two more regressors, ADIN and KI, were added to equation (5.1.2). The signs of the corresponding coefficients are expected to be positive.

To summarize, the variables used are as follows:

MARG76:	industry price-cost margin, 1976
CON:	ACR4 (1 - W)
ACR4:	four-firm concentration ratio adjusted for imports, 1976 (ie. value of shipments of four largest firms divided by total shipments of domestic firms plus imports)
W:	share of exports, 1974
ADIN:	advertising to sales ratio, 1972
KI:	Capital intensity, 1972 (see Appendix A for details).

Equation (i) in Table 5.1 shows the results of the linear OLS estimation of the profit equation. The

Table 5.1

OLS: Dependent variable MARG76

Independent variables	equation (i) (coef)	equation (i) (t)	equation (ii) (coef)	equation (ii) (t)
const	.179*	13.135	.174*	12.818
CON	.002	.176	.035	.804
ADIN	.244*	6.953	.228*	6.527
KI	.926*	4.454	.906*	4.406
CONX[a]			-.076**	-1.781
CONY[a]			.626**	1.420
	R^2 = .3740		R^2 = .4123	
	$\bar{R}^2$ = .3563		$\bar{R}^2$ = .3841	

* Statistically significant at 1 level (two-tail test)

** Statistically significant at 5 level (one-tail test)

*** Statistically significant at 10 level (one-tail test)

a indicates dummy variables. The correspondence between dummy variables and ACR4 classes is :

CONX: ACR4 size classes 10, 12, 16, 17

CONY: ACR4 size classes 4, 9, 14

ACR4 size classes are defined by the following relations :

class 10 when $.45 \leq$ ACR4 $< .50$; class 12 when $.55 \leq$ ACR4 $< .60$; class 16 $.75 \leq$ ACR4 $< .80$; class 17 when $.80 \leq$ ACR4 $< .85$; class 4 when $.15 \leq$ ACR4 $< .20$; class 9 when $.40 \leq$ CR4 $< .45$; class 14 when $.65 \leq$ ACR4 $< .70$.

coefficient of CON is very small and insignificant, probably reflecting the fact that parameter a varies across industries. The coefficients of ADIN and KI are positive and significant, as expected.

In order to take non-linearity in CON into account, the dummy variables technique was employed (Maddala, 1977: chap. 9). For this purpose, the adjusted for imports concentration ratio ACR4 was partitioned into twenty equal classes of size 0.05 each. The first and last two size classes contained no observations (i.e., when $0 < ACR4 < .05$ and $.90 \leq ACR4 < 1$).

Excluding the second size class (i.e., when $.05 \leq ACR4 < .1$) and using the remaining equal sized classes, sixteen appropriate dummy variables were constructed and added to the linear version of the profit equation which was estimated by OLS. Although the residual sum of squares of the non-linear (unrestricted) equation declined markedly, an F test indicated that the assumption of linearity could not be rejected in favour of non-linearity due to a high loss of degrees of freedom.

Next, dummies with similar sized coefficients were compressed into groups and equations containing alternative dummy groupings were estimated. The equation that was selected maximized the adjusted coefficient of determination. This regression appears in Table 5.1 as equation ii, with dummy variable CONX corresponding to the adjusted concentration classes 10, 12, 16 and 17 (i.e., when $.45 \leq ACR4 < .50$; $.55 \leq ACR4 < .60$; and $.75 \leq ACR4 < .85$) and dummy variable CONY corresponding to the adjusted concentration classes 4, 9 and 14 (i.e.. when $.15 \leq ACR4 < .20$; $.40 \leq ACR4 < .45$ and $.65 \leq ACR4 < .70$).

An F test concerning the joint significance of the coefficients of CONX and CONY indicates that the assumption of linearity can be rejected in favour of non-linearity, since the calculated $F = 3.38 >$ critical $F(2, 104)$ at .05 significance level.

The results of the non-linear estimation suggest that the relationship between margins and CON is fairly weak and does not exhibit any predominant trend. The difference in profitability across adjusted concentration classes is small, since for most of the industries (ie. excluding classes 4, 9, and 14), the corresponding values for a are either .035 or $-.037$.

In terms of our model, this finding is consistent with the view that imports constrain the ability of domestic oligopolists to achieve a high price-cost margin in the domestic market. The disciplinary effect of imports, which operates through the elasticity of supply of the fringe e, is reflected in the low values of parameter a for industries that exhibit high domestic concentration.

Although the estimated profit equation does not distinguish between the domestic and foreign fringes, it is clear that the competitive role of imports is more important in industries where the elasticity of supply of the domestic fringe is relatively low.

The profit equation was also estimated directly using the non-linear procedure available in the TSP program in order to obtain estimates of the elasticities n and e. For this purpose, the sample was divided into groupings characterized by different degrees of concentration (i.e., low, medium and high) and import intensities (i.e., low and high). Then the profit equation was estimated for different subsets of the data. However, the results of these estimations were somewhat disappointing because the estimated parameters did not satisfy the theoretical restriction of the model. In all cases, either one or both of the elasticities were negative.

Finally, setting problems associated with the adequacy of data aside, two additional points should be mentioned. First, the results of the OLS estimation may be biased, since CON and perhaps ADIN are endogenous in the model. Second, the adjusted concentration ratio ACR4 used in the estimation contains exports and therefore, deviates from the theoretically appropriate concentration index.

5.2. Generalized International Duopoly.

The theoretical profitability equation that corresponds to the generalized international duopoly model is equation (4.2.8). After some manipulation, and with the addition of an error term, equation (4.2.8) yields the following statistical model:

$$(5.2.1) \qquad PCM_i = c + a_1 AWEI_i + a_2 CIMH_i + a_3 CHH_i + a_4 HHFX_i + a_5 HHFXA_i + u_i$$

where u is assumed to be normally distributed with zero mean and constant variance, and

$$c = \frac{a}{e_A} \quad ; \quad a_1 = \frac{g}{e_B} - \frac{a}{e_A}$$

$$a_2 = \frac{1-a}{e_A} \quad ; \quad a_3 = \frac{b-a}{e_A}$$

$$a_4 = \frac{1-h}{e_B} \quad ; \quad a_5 = \frac{h-g}{e_B}$$

AWEI = W

CIMH = (1-W) (Hd) (1-IMPA)

CHH = (1-W) (IMPA)

HHFX = (W) (Hx) (EXPA)

HHFXA = (W) (EXPA)

The definitions of the variables are provided in the relevant theoretical section 4.3.

Equation (5.2.1) was estimated using the same cross-section sample of 110 Canadian manufacturing industries. Since the dependent variable used (MARG76), is not purged from capital costs and advertizing expenses, two additional regressors measuring capital and advertizing intensities (i.e., KI and ADIN) were added to (5.2.1). Further, data for the domestic Herfindahl index of concentration Hd, and the Herfindahl index of exports Hx were not available. Thus, the Herfindahl index of concentration HH76, provided by Statistics Canada, was used as a proxy for both variables. Finally, note that EXPA is defined as exports over foreign disappearance (i.e., total output sold in the foreign market). Since this variable is not available, the ratio of exports to domestic disappearance divided by ten, was used as a proxy for EXPA. Hence, it is assumed that the foreign market is ten times larger than the domestic market. (For other data details, see Appendix A.)

The results of the OLS estimation of the profit equation appear as equation (i) and (ii) in Table 5.2. Most of the estimated coefficients are insignificant. But this is not surprising because the parameters incorporated in the coefficients are conjectures and demand elasticities which are likely to vary across industries.

Table 5.2

OLS: Dependent variable MARG76
(t-statistics in parentheses)

Independent variables	equ. (i)	equ. (ii)	equ. (iii)
c	0.165* (5.25)	0.169* (6.35)	0.161 (7.06)
AWEI	0.012 (0.373)	0.014 (0.482)	0.079** (2.53)
CIMH	-0.029 (-0.226)	0.278 (0.781)	-7.843** (-2.555)
CIMHA[a]			6.381** (2.25)
CIMHB[a]			7.24** (2.491)
CIMHC[a]			6.84** (2.3)
CIMHD[a]			7.39** (2.476)
CIMHE[a]			7.723** (2.567)
CHH	0.050 (1.15)	-0.049 (-0.386)	0.0739*** (1.366)
CHHA[a]			-0.146** (-2.522)
CHHB[a]			0.221** (2.381)
HHFX	-0.498 (-0.712)	-0.537 (-1.283)	-0.438 (-1.221)
HHFXA	-0.0008 (-0.011)		
ADIN	0.235* (6.62)	0.239* (6.8)	0.213* (7.951)

KI	0.993* (4.49)	0.992* (4.561)	1.022* (5.47)
	R^2=.399R	R^2=.3935	R^2=.5878
	$\bar{R}^2$=.3577	$\bar{R}^2$=.3582	$\bar{R}^2$=.5319

* Statistically significant at 1 level (two-tail test)

** Statistically significant at 5 level (two-tail test)

*** Statistically significant at 10 level (one-tail test)

a indicates dummy variables. The correspondence between dummy variables and HH76 size classes is : CIMHA: 2, 3, 4, 5, 6, 21; CIMHB: 7, 8, 9, 10, 11; CIMHC: 13, 14, 16; CIMHD: 17, 18, 19, 20, 22; CIMHE: 15, 23, 25, 31, 35; CHHA: all HH76 classes except 1, 8, 10, 14, 18, 20, 23, 25; CHHB 8, 14.

The HH76 size classes are defined by the following relationships: class 2 when .015 < HH76 < .02; class 3 when .02 < HH76 < .03; class 4 when.03 < HH76 <.04; ....; class 35 when .34 < HH76 < .35

In order to tackle this problem, it was assumed that across industries, conjectures and concentration are positively related and that the domestic elasticity of demand and concentration are inversely related. Further, the dummy variables technique was employed in order to capture non-linearities associated with variables CIMH and CHH. The estimation procedure involved the steps outlined in section 3.1.

Among a large number of estimated equations containing alternative dummy groupings, the one that maximized the adjusted coefficient of determination is presented as equation iii in Table 5.2. The correspondence between dummy variables and concentration classes is summarized at the bottom of the same table.

An F test involving equation (ii) and (iii) indicates that the assumption of linearity is rejected in favour of the non-linear function, since the calculated F = 6.2 > critical F (7, 96) at .01 significance level.[2]

Although it would be desirable to obtain estimates of the degrees of collusive behaviour in the domestic market (i.e., a, b), this task is impossible at this level of aggregation. Nevertheless, the results of the non-linear estimation seem to suggest the following: First, the relationship between profitability and concentration is non-linear and non-monotonic. Second, the differences in margins across concentration classes are smaller than those suggested by the corresponding S-C-P model which does not contain interactive terms (i.e., concentration interacting with imports). Third, the constraining influence of imports on domestic profitability is also exercised through the term CHH, since the corresponding coefficient is negative for the majority of industries that is, industries which are included in the dummy variable CHHA.

The dummy variable CHHB which corresponds to the concentration size classes 8 and 14 (i.e., when $0.07 < HH76 < 0.08$ and $0.13 < HH76 < 0.14$ respectively), has a positive coefficient. Consequently, the slope of the relationship between the margins and CHH is positive and equal to 0.294. In terms of our model, this finding implies an increased degree of collusive behaviour among the domestic and foreign oligopolists in the domestic market. The industries that are included in the concentration class 8, and the corresponding SIC codes are: (1020) Fish products industry; (2520) Veneer and plywood mills; (2543) Pre-fabricated buildings; (2890) Publishing and printing; (3690) Petroleum and coal products; (3370) Toilet preparation; (3782) Manufactures of inorganic industrial chemicals. Concentration class 14 contains only one industry: (3994) Sound recording and musical instruments.

The coefficient of CHH is the slope of the relationship between the margins and CHH for the concentration size classes 1, 10, 18, 20, 23, 25. Note that this coefficient is relatively small, positive, and significant at a ten percent probability level using a one-tail test.[3] The industries included in these classes are as follows. Class 1: (1650) Plastics fabricating industry nes; (2431) Men's clothing factories; (2441) Women's clothing factories; (2541) Sash, door and other millwork nes; (2619) Household furniture; (2870) Platemaking, typesetting etc; (3150) Misc. machinery and equipment manufactures. Class 10: (1091) Soft drink manufactures; (2732) Corrugate box manufactures; (3360) Electrical industrial equipment manufactures; (3511) Clay products; (3730) Manufactures of synthetic and plastic resins; (3970) Signs and displays industries. Class 18: (1094) Wineries; (3391) Batteries manufactures. Class 20: (3580) Lime manufactures; (3914) Ophthalmic goods manufactures. Class 23: (1092) Distilleries; (1880) Automobile fabric accessories industry; (2920) Steel pipe and tube mills. Class 25: (3350) Communications equipment manufactures; (3520) Cement manufactures; (3652) Lubricating oils and greases manufactures.

The profit equation was also estimated directly for subsets of the data using the non-linear routine available in the TSP program. The data groupings selected included combinations characterized by different degrees of concentration (i.e., low, medium and high) and import intensities (i.e., low and high). However, in all cases some estimated parameters (ie. elasticities or conjectures) violated the theoretical restrictions of the model.

Finally, it should be mentioned that the results of the OLS estimation may be affected by simultaneity bias since most of the explanatory variables are endogenous.

5.3 Specification Error Tests.

Up to this point we have specified and estimated two traditional and two theoretical models. The empirical results of the first traditional model (i.e., the profit-concentration ratio relationship) are somewhat disappointing, since the relationship between the margins and concentration was found to be quite irregular across concentration classes. In addition, the coefficient of the import intensity variable was always positive, suggesting that imports do not exert a competitive pressure on the domestic industry. The dominant firm model, which can be viewed as the theoretical counterpart of the traditional model 1, also presents some difficulties: The non-linear profit function passes the F test marginally and the relevant t-statistics are fairly low. Furthermore, it is difficult to identify which elasticities, incorporated in the coefficient a_i vary across industries and to what extent.

On the other hand, the second traditional model (i.e., the profit-Herfindahl index relationship) generated more indicative stylized results regarding the influence of concentration: It was found that profitability increases with the Herfindahl index across concentration classes. However, the theoretical expectation that imports represent a competitive force is again rejected since the coefficient of the import intensity variable is positive. Another set of interesting results was obtained using the generalized international duopoly model, which can be viewed as the theoretical counterpart of the second traditional model. In this case, the relationship between the margins and concentration becomes somewhat irregular. But interestingly enough, the last estimation also implies that imports exert a competitive discipline to the majority of Canadian industries.

Although none of the above four specifications is completely problem-free, the last two profitability models seem to offer a better explanation of the variation of the margins, at least on statistical grounds (i.e., in terms of R^2, t-statistics and nested tests). Consequently, the question that naturally arises is the following: Given that we have two competing models to explain the same phenomenon which model is true and which is false? There are several econometric procedures that could be used to detect false models vis-a-vis non-nested[4] alternatives. The J test that will be used below has the advantage of being computationally parsimonious and easy to apply in the case of linear regressions.

The general framework of the J test is as follows. Suppose our theories suggest two alternative linear specifications which purport to explain y:

$$H_0 : \quad y = f(X, b) + e_0$$

and

$$H_1 : \quad y = g(Z, c) + e_1$$

where X, Z are vectors of exogenous explanatory variables, some of which may be overlapping; b, c are parameters to be estimated; and e_0, e_1 error terms, assumed to be normally independently distributed with zero mean and constant variance. Davidson and MacKinnon (1981) nest these two models in a compound model using a mixing parameter a:

$$H_c : \quad y = (1 - a) f + a g + e$$

Note that the last specification implies that if a = 0, we obtain the model under H_0. Davidson and MacKinnon (1981) replace g by its OLS estimate $\hat{g}$, which is asymptotically independent of e, and argue that the conventional t or the likelihood ratio test can be used to test whether a = 0. Davinson and MacKinnon refer to this procedure as the J test because it involves estimating a and b jointly, and present evidence indicating that its ability to reject false hypotheses may be good in practice.

However, Judge et al. (1985: 885) suggest that we need to be cautious about the use and interpretation of the J and other non-nested tests: The small sample properties of these tests are not well known, although there are some results based on Monte Carlo studies. Also, little is known about the properties of these tests when both the null and the alternative hypothesis are misspecified. This point is particularly important in economics where investigators frequently work with misspecified models. Finally, there is a symmetry problem in the sense that the results of these tests could change if the choice of the null and the alternative hypothesis are reversed. For example, a test of H_0 against H_1 can lead to the rejection of H_0, but also a test of H_1 against H_0 may lead to the rejection of H_1.

Despite the above limitations, the J test was used to check the performance of the two profitability models that contain the Herfindahl index, that is the traditional model 2 (TM2) and the generalized international duopoly (GID). Table 5.3 contains the results of these tests.

While the second traditional model (TM2) can be rejected in favour of the generalized international duopoly (GID), at 5 percent significance level, the theoretical model GID cannot be rejected in favour of the traditional

Table 5.3

Tests of Separate Regressions: t-statistics for J tests

Model under test (H_0)	Alternative model (H_1): TM2	Alternative model (H_1): GID
TM2	----	4.99
GID	1.53	----

alternative TM2 at the same level of significance.[5] On the basis of the above statistical tests, we can select the generalized international duopoly model which indicates that imports exert a competitive pressure in the majority of Canadian industries.

5.4 Summary.

This chapter dealt with the estimation of the two theoretical profit equations that were specified in Chapter 4. One of the important features of these specifications is that the coefficients of the profit equations involve elasticity terms and conjectures which are unlikely to be the same across industries. Therefore, the application of a non-linear estimation procedure seems to be more appropriate on theoretical grounds.

Nevertheless, both profit equations were estimated linearly and non-linearly. In both cases, statistical tests indicated that the non-linear functions provide a better fit than their linear counterparts. The results of the first profit model showed no strong relationship between profitability and the adjusted for imports four-firm concentration ratio. The relationship between profitability and the Herfindahl index was statistically stronger, but somewhat irregular. In addition, the differences in profitability across concentration classes were smaller than suggested by the corresponding traditional model that contains the Herfindahl index. The empirical evidence regarding the role of imports suggests that imports exert competitive pressure in many Canadian industries. Unfortunately, the cross-section industry data used in this study constrained our ability to extract more specific information about the intensity of competition in different industries. In other words, it was impossible to obtain estimates of behavioral parameters and elasticities without using data at a lower level of aggregation.

Finally, the two profitability models that contain the Herfindahl index were compared statistically using non-nested tests. These models were selected for comparison because they generated relatively clearer and statistically stronger stylized facts. The results of the non-nested tests suggest that the dominant firm model should be rejected in favour of the generalized international duopoly.

NOTES

1. If CR4 = Q4/Q , where Q4 = output of four largest domestic firms and Q = total domestic output, then the adjusted for imports CR4 is equal to the following expressions:

$$\text{adjusted CR4} = \frac{Q4-(Q4/Q)X}{Q-X+M} = \frac{Q4}{Q+M}$$

where, X = exports, M = imports. (Utton and Morgan, 1983:7).

Another interesting formula which, again, requires additional information regarding the distribution of export shares, is the estimate of the Cannon "ideal" measure of concentration Ce (Cannon, 1978):

$$Ce = \frac{CR4\ \{1-a(X/Q)\}}{Q-X+M}$$

where, a = average propensity to export of the largest four domestic producers relative to that of all domestic producers, X = exports, M = imports.

2. Two additional nested tests yielded the following results. First, an F test involving equation ii and the profit equation containing the five dummies

associated with CIMH, reveals that non-linearity in CIMH cannot be rejected; the calculated F = 3.72 > critical F (5, 98). Second, an F test involving equation iii and the profit equation containing the dummy variables associated with CIMH reveals that non-linearity in CHH cannot be rejected: the calculated F = 10.8 > critical F (2,96) at .01 significance level.

3. When concentration size classes 10, 18, 20, 23, 25 enter the equation through five separate dummy variables, the coefficient of CHH is approximately equal to .04 and the values of the slopes that correspond to the above classes are all positive and take values between 0.03 and 0.10. Also, note that concentration classes 24, 26, 27, 28, 29, 30, 32, 33, 34 contained no observations.

4. Two model are said to be non-nested if the one cannot be obtained from the other through the imposition of appropriate restrictions or through a limiting approximation.

5. Note that Davinson and Mackinnon (1981) demonstrate that the t-statistic for a in the compound model H_C is asymptotically valid under the assumption that X and Z

contain exogenous variables. However, in the same paper they apply the J test to consumption functions where one of the regressors (i.e., current income) is, at least in theory, endogenous. The same remark applies to other applications of the J test that have appeared in the recent literature (see Gregory and McAleer, 1983 and Backus, 1984). In our case too, vectors X and Z contain endogenous variables.

CHAPTER 6

SUMMARY AND CONCLUSIONS

This study has concerned itself with the specification and estimation of profitability models in an open economy context. The focus of the study was on two important determinants of industry profitability, namely concentration and imports, about which recent Canadian intra-industry studies have yielded contradictory empirical results. To this end, the thesis adopted two distinct methodological approaches in order to specify four price-cost margin equations. These equations were estimated using the appropriate econometric procedures, which involved linear, non-linear, OLS and 2SLS estimations, and a series of consistency tests. Furthermore, nested and non-nested model selection rules were employed to compare the performance of different models on statistical grounds. All estimations were based on observations of 110 Canadian manufacturing industries for the period 1972-1976. This sample is much larger than any other sample previously used in cross-section profitability studies for Canada.

In this chapter I summarize the advantages and limitations of the different methodologies that were adopted. Further, I briefly review the major empirical findings and their policy implications. Finally, I provide some suggestions for future research.

Chapter 2 dealt with the specification of two traditional profit equations on the basis of the S-C-P paradigm, which is the organizational framework commonly used in empirical cross-section industry studies. This approach embodies the idea that the conduct and performance of firms in an industry are mainly influenced by a number of important environmental factors or structural characteristics of the industry. Moreover, this approach attaches particular importance to industry concentration, higher levels of which are assumed to facilitate collusive behaviour. The resulting statistical models can be used to test the legitimate structuralist hypothesis, and are also useful in detecting empirical correlations among industry variables.

The specification of the traditional profit equation in Chapter 2 assumed that the entry barrier variables affect profitability through concentration; further, the theoretical expectation of non-linearities in concentration was based on two partial oligopoly models that provide the theoretical justification for the link between profitability and concentration. It was also emphasized that traditional models of this type, which frequently appear in the empirical literature, are not rigorously derived from some unifying theory of oligopoly. This disadvantage creates problems regarding the selection and appropriate definition of variables, the interpretation of coefficients and the functional form of the relationship.

Chapter 3 dealt with the linear and non-linear estimation of the two traditional profit equations. Both linear OLS estimations yielded disappointing results with respect to the coefficients of concentration and import intensity. The coefficient of concentration was found to be very small and insignificant; the coefficient of the import intensity variable was small and positive, and the associated t-statistics were fairly low.

These results changed considerably when the non-linear dummy variables technique was employed to take into account non-linearities in concentration. The relationship between margins and the four-firm concentration ratio was found to be non-linear and somewhat irregular, but exhibited an overall upward trend. In addition, statistical criteria favoured the non-linear function over the linear one. The non-linear estimation of the second traditional model revealed that the relationship between the margin and the Herfindahl index of concentration is fairly regular across concentration classes, indicating that profitability increased with concentration. But again, the influence of imports on profitability was found to be positive and of low statistical significance. In this case too, an appropriate F-test favoured the non-linear function as a better approximation of the underlying relationship.

The second part of Chapter 3 dealt with the statistical determination of the minimum number of instruments required for the consistent estimation of the two traditional profit equations. The results of the relevant Wu tests indicated that in both cases, an instrument for the advertising intensity variable is needed for consistency. The corresponding 2SLS estimations (ie. using one instrument for ADIN), revealed no major differences vis-a-vis the OLS results, although the coefficient of ADIN exhibited an increase of approximately twenty percentage points.

Comparing the results of the two traditional models, the second profit equation, which involved the Herfindahl index, generated clear empirical findings regarding the influence of concentration. This was not the case with the first model, which involved the concentration ratio. In addition, all of the results concerning the influence of imports were unsatisfactory: The associated coefficient is always positive, suggesting that imports do not increase the degree of competition in the domestic market; and the relevant t-statistics are relatively low. One plausible explanation for this result may be that imports do not exert the same influence across different industries, so that the linear specification of imports cannot capture these effects. This possibility was explored theoretically and empirically in subsequent chapters.

The traditional approach was abandoned in Chapter 4, where two profit equations were derived from two corresponding static, open economy oligopoly models. The objective was to link profitability with concentration and trade flows. This micro-theoretical approach yielded a number of interesting conclusions that could not have been reached within the framework of the traditional paradigm. These conclusions include the following: a) The theoretical models suggest that profitability, concentration and trade flows are simultaneously determined for exogenously given costs, demand conditions and beliefs about the reaction of rival firms. b) The coefficients of the theoretical profit equations are likely to vary across industries. This implies that fitting linear profit functions on cross-section industry data is likely to generate poor results. c) The definitions of the explanatory variables and the functional form of the theoretical profit equations differ from the traditional specifications and d) The open economy oligopoly models also yield specific predictions about the welfare changes brought about by a decrease (or an increase) in the tariff: In general, a decrease in tariffs is expected to increase domestic welfare, which is defined as domestic consumer surplus, plus profits. However, unlike perfectly competitive models, these models also suggest that a decrease in the tariff may lower domestic welfare if foreign competitors have relatively high marginal cost.

Chapter 5 dealt with the estimation of the two theoretical profit equations. The results of the corresponding linear estimations were, in both cases, poor. But as explained above, this was not unexpected. The non-linear estimation of the theoretical equation, which corresponds to the dominant firm model, did not capture any strong relationship between profitability and the adjusted for imports four-firm concentration ratio. This finding is consistent with the view that imports constrain domestic profitability.

However, this empirical application involves a serious limitation which is frequently present in other similar studies in the field, and which should not be ignored. The dominant firm model postulates a type of rigid behaviour for the largest firms (ie. perfect cartel), which is unlikely to hold across all concentration classes.

The above limitation is less severe in the case of the generalized international duopoly. Here, although all firms are assumed to be quantity setting profit maximizers, the parametrization of conjectures is such that it allows a wide variety of market solutions, ranging from perfect cartel to perfect competition.

The estimation results of the corresponding, more flexible profitability model, revealed a number of interesting findings: a) In general, the relationship between profitability and concentration is somewhat irregular, although industries characterized by low concentration are clearly less profitable. b) The differences in profitability across concentration classes are smaller than the ones suggested by the traditional model, which contains the Herfindahl index. c) Imports contain domestic profitability in the majority of Canadian industries. Also, the disciplinary effect of imports becomes stronger in industries where foreign firms adopt a more aggressive behaviour. Unfortunately, the level of aggregation at which these estimations were performed, does not permit the direct estimation of the conjectural elasticities which would have provided a clearer indication of the degrees of implicit collusion in different markets.

Finally, Chapter 5 contains the results of two non-nested tests, performed using the two profitability models, containing the Herfindahl index. The results indicated that the second traditional model should be rejected in favour of the generalized international duopoly model.

One of the principle aims of this, and other cross-section studies, is the detection of empirical regularities that hold across a large number of industries. However, the statistical results of this study indicate that the influence of concentration and imports on industrial profitability is not uniform. This, in turn, suggests that anti-merger or tariff policies should be based on detailed analyses of the industries for which they are intended. In addition, the two theoretical models clarify certain points regarding the significance of industrial concentration and import penetration for competition policy purposes.

High concentration is not a reliable indicator of the existence of monopoly profits and misallocation of resources. For a monopolistic outcome to obtain, some type of collusive behaviour must also be present. However, this seems more likely to occur, both on theoretical and empirical grounds, in more concentrated industries.

If competitive imports are added to the picture, then any attempt on the part of domestic oligopolists to restrict output will be partly offset by increased imports that will be attracted by the higher domestic price. In this case too, influences regarding the intensity of domestic competition, which are based solely on measure of industry concentration and ignore the effect of imports, are bound to be misleading. However, the possibility that imports may not provide a competitive discipline, should not be ignored. If importers exhibit collusive behaviour, there may be no significant downward pressure on the domestic price.

Moving on to the question of the policy implications of this research, in 1986, the Canadian government enacted a series of significant amendments to its anticombines law, in the form of Bill C-91. The objectives of the new law were to protect and promote fair competition, to eliminate restrictive trade practices, and to minimize the need for direct government intervention in the economy. Although competition is not viewed as an end in itself, it is recognized that effective competition results in both lower prices and better quality, and that it provides a strong stimulus to efficiency and industrial growth.

The section of the Bill that relates directly to the theoretical and empirical issues examined in this study, deals with mergers, and more specifically, with the effects of mergers. The tribunal that the law empowers to monitor merger cases is forced to consider more that just market shares and concentration in making its decisions. A number of additional criteria are introduced, including foreign trade and efficiency considerations. In deciding whether domestic competition would be lessened by a merger, the tribunal is directed to consider the extent to which foreign competition exerts a competitive discipline. However, the new legislation also provides a defense for mergers in cases where the exploitation of scale economies and other efficiencies could improve domestic competitiveness and lead to increased exports.

Overall, the new provisions of the law, especially those dealing with mergers and abuse of dominant position, avoid a strict structuralist spirit by placing emphasis on behavioural aspects of competition. They also recognize explicitly, the importance of foreign trade for the domestic economy. These innovations make good sense in terms of the theoretical models developed in Chapter 4.

Another policy issue, which has dominated both the professional literature and the popular press in recent years, relates to the proposed liberalization of trade between Canada and the United States. The conclusions of this study suggest that reductions in Canadian tariffs will not have a uniform effect on domestic competition in all industries. For the majority of industries, where imports provide a competitive stimulus, lower tariffs will result in decreased domestic prices and consumer gains. But inefficient firms, especially those in sectors that have been protected by high tariffs, may not be prepared to meet the challenge of increased import competition.

For some industries, where imports are associated with monopoly power and collusive behaviour, tariff reductions are not expected to strengthen competition and substantially reduce prices. Unfortunately, the inter-industry nature of this study, and the empirical irregularities that appear to characterize the effect of imports across industries, do not allow for more specific statements to be made. However, it seems likely that imports of a non-competitive nature may be found in industries where foreign companies command large shares in the domestic market, either directly or through their Canadian subsidiaries.

As far as future research is concerned, this study points in a number of different directions. Future specifications of profitability equations in the context of the S-C-P paradigm, should consider the possibility of non-linearities in the import intensity variable. This specification is supported by the second theoretical model in Chapter 4, which links the effect of imports with the behaviour exhibited by foreign firms. A non-linear estimation procedure is likely to generate additional information regarding the extent to which imports stimulate competition in different industries.

Another question concerns the behaviour of the profit-concentration relationship over the business cycles. Empirical evidence for the U.S. suggests that margins move procyclically, with those in concentrated industries being more responsive to economic fluctuations. If this is also the case for Canadian industries, one would expect the uppertail of the profit-concentration schedule to shift significantly upwards during expansionary and boom periods. This has yet to be examined empirically.

A point that was not previously emphasized, relates to the magnitude of the advertising intensity variable, ADIN. Since ADIN is used as a control variable (i.e.. advertising expenditures are not included in the margins), the associated coefficient should be equal to one. However, the size of this coefficient was found to be smaller than unity in all estimations. Unlike other profitability studies for Canada, which employ data for previous periods,[1] our findings suggest a changing and more competitive role for advertising. This requires further investigation and empirical confirmation.

Formal modeling of industries within the static oligopolistic framework, accompanied by intra-industry estimations, are also potentially useful. Firm-level profit equations, such as those developed in Chapter 4, are well defined, avoid complication associated with aggregation, and can be used directly to estimate behavioural parameters. Moreover, these equations can be easily modified to incorporate parameters reflecting other industry-specific features, such as product differentiation.

Alternatively, profitability can be studied in the context of longer-term, dynamic oligopoly models that take the reactions of rivals and the possibility of foreign and domestic entrants explicitly into account. This dynamic approach, however, would generate a more complex system of equations and might not be suitable for estimation purposes.

Clearly, our understanding of the determinants of profitability can be enhanced by further inter- and intra-industry research. To this end, the improvement of the quality of cross-section industry data and the wider availability of firm level statistics, such as market shares, would be most helpful.

REFERENCES

Appelbaum, E. 1982. The Estimation of the Degree of Oligopoly Power. Journal of Econometrics 19: 287-299.

Backus, D. 1984. Empirical Models of the Exchange Rate: Separating the Wheat from the Chaff. Canadian Journal of Economics XVII (November): 824-846.

Bain, S. J. 1951. Relation of Profit Rates to Industry Concentration. Quarterly Journal of Economics 65 (August): 293-324.

__________. 1956. Barriers to New Competition. Cambridge, Massachusetts: Harvard University Press.

__________. 1959. Industrial Organization. New York: Wiley and Sons.

Bloch, H. 1974. Price, Costs, and Profits in the Canadian Manufacturing: The Influence of Tariffs and Concentration. Canadian Journal of Economics 7 (November): 594-610.

Brander, J. A. 1981. Intra-industry Trade in Identical Commodities. Journal of International Economics 11: 1-14.

______________ and P. Krugman. 1983. A "Reciprocal Dumping" Model of International Trade. Journal of International Economics 15: 313-321.

______________ and B. J. Spencer. 1984. Tariff Protection and Imperfect Competition. Pp. 194-206 in H. Kierzkowski (ed.). Monopolistic Competition and International Trade. Oxford: Oxford University Press.

Breusch, T. and A. Pagan. 1979. A Simple Test for Heteroskedasticity and Random Coefficient Variation. Econometrica 47: 1287-1294.

Brozen, Y. 1971. Bain's Concentration and Rates of Return Revisited. Journal of Law and Economics 14 (October): 351-370.

Cannon, C. M. 1978. International Trade, Concentration, and Competition in U.K. Consumer Goods Markets. Oxford Economic Papers 30 (1): 130-137.

Caves, R. E. 1983. International Trade and Industrial Organizations: Problems Solved and Unsolved. Paper prepared for the European Association for Research on Industrial Economics, Bergen, Norway.

______________, Michael E. Porter, A. Michael Spence and John T. Scott. 1980. Competition in the Open Economy. Cambridge, Massachusetts: Harvard University Press.

Clarke, R. and S. W. Davies. 1982. Market Structure and Price Cost Margins. Economica 49 (August): 277-287.

___________, Stephen Davies and Michael Waterson. 1984. The Profitability-Concentration Relation: Market Power or Efficiency? Journal of Industrial Economics XXXII (June): 435-449.

__________. 1985. Industrial Economics. Oxford, England: Basil Blackwell Ltd.

Commanor, W. S. and T. C. Wilson. 1967. Advertising, Market Structure and Performance. Review of Economics and Statistics. 49 (November): 423-440.

Cowling, K. 1976. On the Theoretical Specifications of Industrial Structure-Performance Relationships. European Economic Review. 8 (January): 1-14.

__________ and M. Waterson. 1976. Price Cost Margins and Market Structure. Economica 43 (August): 267-274.

Curry, B. and K. D. George. 1983. Industrial Concentration: A Survey. Journal of Industrial Economics. XXXI (March): 203-255.

Dalton, J. A. and D. W. Penn. 1976. The Concentration Profitability Relationship: Is There a Critical Concentration Ratio? Journal of Industrial Economics. LXIII: 346-353.

Davidson, R. and J. G. MacKinnon. 1981. Several Tests for Model Specification of Alternative Hypotheses. Econometrica. 49 (May): 781-793.

Demsetz, H. 1973. Industrial Structure, Market Rivalry and Public Policy. Journal of Law and Economics 16 (April): 1-10.

__________. 1974. Two Systems of Belief About Monopoly. Pp. 164-184 in H. C. Goldschmid, H. Michael Mann and J. Fred Weston (eds.). Industrial Concentration: The New Learning. Boston: Little, Brown and Co.

Dickson, V. A. 1978. Foreign Competition and the Degree of Monopoly - Comment and Extension. Journal of Economic Studies. 5 (1): 71-74.

Dixit, A. K. and J. E. Stiglitz. Monopolistic Competition and Optimal Product Diversity. American Economic Review 67 (3): 297-308.

__________. 1984. International Trade Policy for Oligopolistic Industries. Economic Journal, Supplement: 1-16.

Domowitz, I., R. G. Hubbard and B. C. Petersen. 1986. Business Cycles and the Relationship Between Concentration and Price-Cost Margins. Rand Journal of Economics 17 (1): 1-17.

Donsimoni, M. P., P. Geroski, and A. Jacquemin. 1984. Concentration Indices and Market Power: Two Views. Journal of Industrial Economics XXXII (4): 419-434.

Encaoua, D. and A. Jaquemin. 1980. Degree of Monopoly, Indices of Concentration and Threat of Entry. International Economic Review 21 (1): 87-105.

Esposito, L. and F. F. Esposito. 1971. Foreign Competition and Domestic Industry Profitability. Review of Economics and Statistics 53 (November): 343-353.

Eastman, H. C. and S. Stykolt. 1967. The Tariff and Competition in Canada. Toronto: Mcmillan.

Gaskins, D. W. Jr. 1971. Dynamic Limit Pricing: Optimal Pricing Under Threat of Entry. Journal of Economic Theory 3: 306-322.

Geroski, P. A. 1981. Specification and Testing the Profits-Concentration Relationship: Some Experiments for the U.K. Economica 48 (November): 279-288.

______________. 1982. Simultaneous Equations Models of the Structure, Performance Paradigm. European Economic Review 19 (September): 145-158.

______________. 1982b. Interpreting a Correlation Between Market Structure and Performance. Journal of Industrial Economics XXX (March): 318-326.

______________. 1983. Some Reflections on the Theory and Application of Concentration Indices. International Journal of Industrial Organization 1: 79-94.

______________ and A. Jacquemin. 1981. Imports as a Competitive Discipline. Recherches Economiques deLouvain 47 (September): 197-208.

Gregory A. W. and M. McAleer. 1983. Testing Non-nested Specifications of Money Demand for Canada. Canadian Journal of Economics XVI (November): 593-602.

Gupta, V. 1983. Simultaneous Determination of Structure, Conduct and Performance in Canadian Manufacturing. Oxford Economic Papers 35 (July): 281-301.

Hart, P. and R. Clarke. 1979. Profit-margins, Wages and Oligopoly: A Survey of Evidence for the U.K. Working Paper, University of Reading, England.

Hausman, J. A. 1978. Specification Tests in Econometrics. Econometrica 46: 1251-1271.

Huveneers, C. 1981. Price Formation and the Scope of Oligopolistic Conduct in a Small Open Economy. Recherches Economique de Louvain 47 (September): 209-242.

Intriligator, Michael D., J. F. Weston and H. De Angelo. 1978. A Simultaneous-Equations Model of Industrial Organization Relationships. Pp. 475-480 in M. D. Intriligator (ed.). Econometric Models: Techniques and Applications. Englewood Cliffs, New Jersey: Prentice-Hall Inc.

Iwata, G. 1974. Measurement of Conjectural Variations. Econometrica 42 (5): 947-966.

Jacquemin, A. 1982. Imperfect Market Structure and Industrial Trade: Some Recent Research. Kyklos 35 (1): 75-93.

______________, E. DeChellinck and C. Huveneers. 1980. Concentration and Profitability in a Small Open Economy. Journal of Industrial Economics XXIX (2): 131-143.

______________. 1987. The New Industrial Organization. Cambridge, Massachussets: The M.I.T Press.

Jones, J. C. H., L. Laudadio and M. Percy. 1973. Market Structure and Profitability in Canadian Manufacturing Industry: Some Cross-Section Results. Canadian Journal of Economics 6 (August): 356-368@.

Judge, G. G., W. E. Griffiths, R. C. Hill, H. Lutkepohl and Tsoung-Chao Lee. 1985. The Theory and Practice of Econometrics. New York: John Wiley and Sons.

Khalilzadeh-Shirazi, J. 1974. Market Structure and Price Cost Margins in U.K. Manufacturing Industry. Review of Economics and Statistics 56 (February): 67-76.

Krugman, P. R. 1980. Scale Economies, Product Differentiation and the Pattern of Trade. American Economic Review 70 (5): 950-959.

_____________. 1981. Intra-industry Specialization and Gains from Trade. Journal of Political Economy 89 (5): 959-973.

Lancaster, K. J. 1980. A Theory of Intra-Industry Trade Under Perfect Monopolistic Competition. Journal of International Economics 10 (2): 151-175.

Maddala, G. S. 1977. Econometrics. New York: McGraw-Hill.

Mason, E. S. 1939. Price and Production Policies of Large Scale Enterprise. American Economic Review, Supplement (March): 61-74.

McFetridge, D. G. 1973. Market Structure and Price-Cost Margins: An Analysis of the Canadian Manufacturing Sector. Canadian Journal of Economics 6 (August): 344-355.

Modigliani, F. 1958. New Developments on the Oligopoly Front. Journal of Political Economy 66 (June): 215-232.

Mueller, D. C. and J. E. Tilton. 1969. Research and Development Cost as a Barrier to Entry. Canadian Journal of Economics 2 (November): 570-579.

Nakamura, A. and M. Nakamura. 1981. On the Relationships Among Several Specification Error Tests Presented by Durbin, Wu and Hausman. Econometrica 49 (6): 1583-1588.

Neumann, M. and A. Haid. 1985. Concentration and Economic Performance: A Cross-Section Analysis of West German Industries. Pp. 61-84 in J. Schwalbach (ed). Industry Structure and Performance. International Institute of Management/Industrial Policy, Berlin: Edition Sigma.

Orr, D. 1974. The Determinants of Entry: A Study of the Canadian Manufacturing Industry. Review of Economics and Statistics 56 (February): 58-66.

Pagoulatos, E. and R. Sorenson. 1976a. International Trade, Investment and Industrial Profitability of U.S. Manufacturing. Southern Economic Journal 42 (January): 425-434.

________________ 1976b. Foreign Trade, Concentration and Profitability in Open Economies. European Economic Review 8: 255-267.

Phillips, A. 1974. Commentary. Pp. 409-413 in H. C. Goldschmid, H. Michael Mann and J. Fred Weston (eds.). Industrial Concentration: The New Learning. Boston: Little, Brown and Co.

______________. 1976. A Critique of Empirical Studies of the Relation Between Market Structure and Profitability. Journal of Industrial Economics 24 (4): 241-294.

Poirier, D. J. 1976. The Econometrics of Structural Change. Amsterdam: North Holland.

Pugel, T. A. 1980. Foreign Trade and U.S. Market Performance. Journal of Industrial Economics 29 (December): 119-129.

Rhoades, S. and J. Cleaver. 1973. The Nature of the Concentration-Price/Cost Margin Relationship for 352 Manufacturing Industries: 1967. Southern Economic Journal XXXIX: 90-102.

Ross, T. W. 1986. The Role of Competition Policy in an Economy Moving Toward Trade. Unpublished Report. Consumer and Corporate Affairs Canada.

Salop, S. C. 1979. Strategic Entry Deterrence. American Economic Review, Papers and Proceedings 69: 335-338.

Saving, T. 1970. Concentration Ratios and the Degree of Monopoly. International Economic Review 11 (February): 139-146.

Sawyer, M. C. 1982. On the Specification of Structure-Performance Relationships. European Economic Review 17: 295-306.

_____________. 1983. On the Specification of Structure-Performance Relationships: A Reply. European Economic Review 23: 257-259.

Scherer, F. M. 1970. Industrial Market Structure and Economic Performance. Chicago: Rand McNally.

_____________. 1980. Industrial Market Structure and Economic Performance. Chicago: Rand McNally.

Schmalensee, R. 1985. Do Markets Differ Much? American Economic Review. 75 (February): 341-351.

_____________. 1982. The New Industrial Organization and the Economic Analysis of Modern Markets. Pp. 253-285 in W. Hildenbrand (ed.). Advances in Economic Theory. Cambridge, England: Cambridge University Press.

Schwartzman, D. 1959. The Effect of Monopoly on Price. Journal of Political Economy. 67 (August): 352-362.

Sleuwaegen, L. and W. Dehandschutter. 1986. The Critical Choice Between the Concentration Ratio and the H-Index in Assessing Industry Performance. Journal of Industrial Economics. XXXV (2): 193-208.

Stigler, G. 1964. A Theory of Oligopoly. Journal of Political Economy LXXII (1): 44-61.

Strickland, A. D. and L. W. Weiss. 1976. Advertising, Concentration and Price-cost Margins. Journal of Political Economy 84: 1109-1021.

Sylos-Labini, P. 1962. Oligopoly and Technical Progress. Cambridge, Massachusetts: Harvard University Press.

Utton, M. A. and A. D. Morgan. 1983. Concentration and Foreign Trade, National Institute of Economic Research Occasional Papers: 35. Cambridge, England: Cambridge University Press.

Waterson, M. 1981. On the Definition and Meaning of Barriers to Entry. Antitrust Bulletin 26: 521-539.

___________. 1984. Economic Theory of the Industry. Cambridge, U.K.: Cambridge University Press.

Venables, A. J. and A. Smith. 1986. Trade and Industrial Policy Under Imperfect Competition. Economic Policy 3 (October): 622-672.

Weiss, L. W. 1974. The Concentration-Profits Relationship and Anti-Trust. Pp. 184-233 in H. C. Goldschmid, H. Michael Mann and J. Fred Weston (eds.). Industrial Concentration: The New Learning. Boston: Little, Brown and Co.

White, L. 1976. Searching for the Critical Industrial Concentration Ratio: An Application of the Switching of Regimes Technique. Pp. 5-35 in S. Goldfeld and R. Quandt (eds.). _Studies in Non-Linear Estimation_. Boston: Ballinger.

Wu, D. 1973. Alternative Tests of Independence Between Stochastic Regressors and Disturbances. _Econometrica_ 41: 733-750.

Zeelenberg, C. 1986. _Industrial Price Formation_. Amsterdam, The Netherlands: Elsevier Science Publishers B. V.

APPENDIX A

DATA SOURCES AND CONSTRUCTION OF VARIABLES

All econometric analyses in this thesis were performed using a sample of 110 Canadian manufacturing industries. The data base contains published and unpublished Statistics Canada data; the unpublished data were obtained from the Department of Consumer and Corporate Affairs. Table A.1 at the end of this appendix lists all the industries included in the sample and the corresponding SIC code. The framework of classification is consistent with the revised 1970 Standard Industrial Classification issued by Statistics Canada in October 1970.

The available industry statistics are the result of compilations of data collected by the Censuses of Manufactures, Mines and Logging. The basic statistical unit in these surveys is the establishment which is defined as the smallest unit in a firm that is a separate operating entity capable of reporting a basic set of industrial statistics. This unit is usually equivalent to a plant, factory or mill. Establishments are classified in particular industries on the basis of the commodities they produce.

However, industry variables (i.e., concentration indices, value of shipments etc.) relate to groups of establishments that comprise the unconsolidated enterprises.

The unconsolidated enterprise is defined as a group of establishments and ancillary units under common control, operating in a single industry. The basic information required to set the boundaries of enterprises is provided by the Corporations and Labour Unions Act Administration (CALURA) which is part of the Business Finance Division of Statistics Canada. A detailed discussion of the classification methods, various concepts and definitions of industry statistics is found in the following Statistics Canada publications: Catalogue 31-528, Concepts and Definitions of the Census of Manufactures, 1979 and Catalogue 61-517, Inter-corporate ownership, 1980.

Industry statistics at the 3 and 4-digit SIC levels are commonly used in cross-section structure-conduct-performance analyses. However, these statistics are not ideal for the study of industrial competition, despite the fact that they relate to enterprises which are fairly homogeneous industrially. The following limitations should be taken into account when these statistics are used in industry studies.

First, the definition of the industry does not correspond exactly to the economist's notion of the market. Some industries are too broadly defined and are really a collection of several separate and distinct markets. Other industries are too narrowly defined so that goods that are really competing products, are classified in different industries (for example glass and tin containers). These "inconsistencies" arise because the boundaries of the markets are changing over time and the limits of industries are set periodically so that the data can serve a variety of purposes.

Second, some establishments produce a number of distinct products. In such cases the establishment is coded to a specific 4-digit SIC industry according to the industry in which the majority of its sales are made. Consequently, some establishments which are classified in a specific industry also produce secondary outputs, that is, outputs which are defined as primary to some other industry. This classification procedure introduces an element of inaccuracy in the industry statistics; the degree of inaccuracy varies across industries, but declines at lower digit SIC levels as the boundaries of industries are extended.

Finally, industry statistics include exports and exclude imports and therefore, the concentration indices do not reflect the influence of foreign trade on domestic concentration. Separate merchandise trade statistics are recorded and tabulated by Statistics Canada on the basis of a commodity classification. These commodity statistics have been allocated to the most nearly appropriate industry; for details see <u>Commodity Trade by Industrial Sector, Historical Summary 1966-1984</u>, Department of Regional Expansion, Ottawa 1985.

The variables used in the statistical part of the thesis and the corresponding definitions are as follows:

ACR4: Four firm concentration ratio adjusted for imports, 1976. ACR4 is equal to the value of shipments of the four largest enterprises divided by the total shipments of domestic enterprises plus imports.

ADIN: Advertising expenditures to shipments ratio, 1972.

CDR: Cost disadvantage ratio, 1972. This measure is calculated as the value added per worker in the smallest enterprises accounting for 50 percent of industry employment, to the value added per worker in the largest enterprises accounting for 50 percent of industry employment.

CR476: Four firm concentration ratio, 1976. This measure equals the ratio of the value of shipments of the four largest enterprises to total industry shipments. CR476 includes exports and excludes imports.

DIV: Index of diversification, 1972. DIV is measured as the inverse of the primary product specialization ratio (PPSR). The variable 1-PPSR was also used, yielding similar results.

EXIN: Export intensity, 1974. EXIN is measured as the ratio of exports to shipments.

EXPA: Exports divided by domestic disappearance times 10. Domestic disappearance is defined as value of shipments minus exports, plus imports.

FCHH: Foreign component of the Herfindahl index, 1972. The Herfindahl index of concentration can be decomposed into the sums of squared shares of enterprises that are foreign (FCHH) and Canadian controlled (CCHH). Details on the method of decomposition are provided in Statistics Canada Catalogue 31-523, Structural Aspects of Domestic and Foreign Control in Manufacturing, Mining and Forestry Industries, 1970-1972.

GROW: Industry growth rate, 1972-1976. GROW is equal to log (value of shipments, 1976) - log (value of shipments, 1972) / log (value of shipments, 1976).

HH76: Herfindahl index of concentration, 1976. HH76 is equal to the sums of squares of market shares of individual enterprises. It includes exports and excludes imports.

IMIN: Import intensity, 1974. IMIN is measured as imports divided by the value of shipments.

IMPA: Imports divided by domestic disappearance, 1974. Domestic disappearance is defined as value of shipments, minus exports plus imports.

KI: Capital-output ratio, 1972. Since capital data were not available, fuel and electricity expenditures were used as a proxy.

MARG76: Price-cost margin, 1976. Price-cost margins are calculated as value added, minus wages and salaries, as a fraction of value of shipments. This measure of margins includes advertising expenditures and the cost of capital. This limitation is discussed in Statistics Canada Catalogue 31-523 (p. 45), where it is suggested that whenever margins are used as an independent variable in multiple regressions, both capital and advertising intensities should be included in the analysis to neutralize their inclusion in the margins.

MES: Minimum efficient plant size as a percentage of industry size, 1972. The minimum efficient plant size is measured as the average size of largest plants accounting for 50 percent of industry employment.

REG: Dummy variable = 1, if the industry is judged to be regional, 1972.

RND: Research and development expenditures to shipments ratio, 1972.

TAR: Nominal tariff rate, 1972. The effective tariff rate was not used because it was available only for a small number of industries. The correlation coefficient between the nominal and the effective tariff rate for these industries was approximately .8.

W: Export share, 1974. Exports divided by the value of shipments.

Table A.1

Industries Included in the Sample

S. No.	Industry	SIC code
1	Slaughtering and meat processors	1011
2	Poultry processors	1012
3	Fish products industry	1020
4	Fruit & veg. canners & preservers	1031
5	Dairy products industry	1040
6	Flour & breakfast products industry	1050
7	Feed industry	1060
8	Biscuit manufactures	1071
9	Bakeries	1072
10	Confectionery manufacturers	1081
11	Vegetable oil mills	1083
12	Soft drink manufactures	1091
13	Distilleries	1092
14	Wineries	1094
15	Rubber product industries	1620
16	Plastic fabricating industry nes	1650
17	Leather tanneries	1720
18	Shoe factories	1740
19	Leather glove factories	1750

S. No.	Industry	SIC code
20	Boot and shoe finding manufactures	1792
21	Wool yarn and cloth mills	1820
22	Throwsterns, spun yarn & cloth mills	1832
23	Fibre processing mills	1851
24	Pressed and punched felt mills	1852
25	Carpet, mat and rug industries	1860
26	Canvas products manufactures	1872
27	Automobile fabric accessories manufactures	1880
28	Narrow fabric mills	1892
29	Embroidery, pleating etc. manufactures	1893
30	Hosier mills	2310
31	Knitted fabric manufactures	2391
32	Men's clothes factories	2431
33	Women's clothing contractors	2441
34	Children's clothing industry	2550
35	Foundation garment industry	2480
36	Shingle mills	2511
37	Sawmills and planing mills	2513
38	Veneer and plywood mills	2520
39	Sash, door and other millwork nes	2541

S. No.	Industry	SIC code
40	Pre-fabricated buildings (wood frame)	2543
41	Wooden box factories	2560
42	Wood preservation industry	2591
43	Wood handles and turning industry	2591
44	Manufacturers of particle board	2593
45	Household furniture manufactures nes	2619
46	Office furniture manufactures	2640
47	Misc. furniture and fixture manufactures	2660
48	Electric lamp and shade manufactures	2680
49	Pulp and paper mills	2710
50	Folding carton and set-up box manufactures	2731
51	Corrugated box manufactures	2732
52	Paper and plastic bag manufactures	2733
53	Misc. paper converters	2740
54	Commercial printing	2860
55	Platemaking, typesetting etc. industries	2870
56	Publishing and printing	2890
57	Iron and still mills	2910
58	Steel pipe and tube mills	2920
59	Smelting and refining	2950

S. No.	Industry	SIC code
60	Aluminum rolling, casting etc.	2960
61	Metal rolling, casting etc. nes	2980
62	Fabricated structural metal industries	3020
63	Metal door and window manufactures	3031
64	Metal coating industry	3041
65	Metal stamping and pressing industries	3042
66	Wire and wire products manufactures	3050
67	Hardware, tool and cutlery manufactures	3060
68	Heating equipment manufactures	3070
69	Machine shops	3080
70	Misc. metal fabricating industries	3090
71	Agriculture implement industry	3110
72	Misc. machinery and equipment manufactures	3150
73	Commercial refrig. air condit. manufactures	3160
74	Motor vehicle manufactures	3230
75	Truck body manufactures	3241
76	Non-commercial trailer manufactures	3242
77	Motor vehicle parts and accessories	3250

S. No.	Industry	SIC code
78	Shipbuilding and repair	3270
79	Manufactures of household radio and tv	3340
80	Communications equipment manufactures	3350
81	Electrical industrial equip. manufactures	3360
82	Manufactures of electric wire and cable	3380
83	Battery manufactures	3391
84	Clay product manufactures (domestic clays)	3511
85	Clay product manufactures (imported clays)	3512
86	Cement manufactures	3520
87	Concrete pipe manufactures	3541
88	Mfrs. structural concrete products	3549
89	Concrete product manufactures nes	3549
90	Ready-mix concrete manufactures	3550
91	Lime manufactures	3580
92	Mfrs. lubricating oils and greases	3650
93	Misc. petroleum and coal products	3690
94	Manufactures of mixed fertilizers	3720
95	Manufactures of plastic and synthetic raisins	3730

S. No.	Industry	SIC code
96	Mfrs. pharmaceuticals and medicines	3740
97	Paint and varnish manufactures	3750
98	Mfrs. of toilet preparations	3770
99	Mfrs. industrial chemicals nes-inorganic	3782
100	Mfrs. industrial chemicals nes-organic	3783
101	Manufactures of printing inks	3791
102	Instruments and related products mfrs.	3911
103	Ophthalmic goods manufacturers	3914
104	Jewellery & silvery industry	3920
105	Sporting goods manufactures	3931
106	Toys and games manufactures	3932
107	Signs & displays industry	3970
108	Button, buckle and fastener manufactures	3992
109	Floor tile, linoleum etc. manufactures	3993
110	Sound recording musical instruments	3994

APPENDIX B

THE DOMINANT FIRM MODEL (DERIVATIONS)

The profit function of the cartel can be written as:

(1) $$PR_k = (P - MC_k)\ D_k(P, t) - F_k$$

where:

$$D_k(P, t) = D(P) - S(P, t)$$

Differentiating equation 1 with respect to price, we obtain the following first order condition for maximum PR_k

$$D_k + (P - MC_k)\ D_{kp}(P, t) = 0$$

or equivalently:

(2) $$(D - S) + (P - MC_k)\ (D_p - S_p) = 0$$

The second order condition of the profit maximization problem is:

(3) $$2(D_p - S_p) + (P - MC_k)\ (D_{pp} - S_{pp}) < 0$$

In order to find the effect of a decline in t on P, we totally differentiate equation 2:

$$(4) \qquad (D_p - S_p)dP - S_t dt + [(P - MC_k)(D_{pp} - S_{pp}) + (D_p - S_p)]dP - (P - MC_k)S_{pt}dt = 0$$

solving for dP/dt we find:

$$(5) \qquad dP/dt = \frac{(P - MC_k)S_{pt} + S_t}{2(D_p - S_p) + (P - MC_k)(D_{pp} - S_{pp})}$$

The denominator on the right hand side of equation 5 is the expression for the second order condition which must be negative for a maximum. Thus, dP/dt is negative if the numerator of equation 5 is positive. That is:

$$(6) \qquad (P - MC_k)S_{pt} + S_t < 0$$

or

(7) $$\frac{S_{pt}}{S_t} P < - \frac{P}{P - MC_k}$$

Using the equilibrium relationship $P - MC_k/P = -1/n_k$ $(n_k > 0)$, inequality 7 becomes:

(8) $$H < n_k \quad ; \quad \text{where, } H = PS_{pt} / S_t$$

If t is a specific tariff then $S(P, t) = S(P - t)$ and $S_{pt} = -S_{pp}$, $S_t = -S_p$. Thus, if inequality 8 holds, the effect of a decline in tariff on price will be positive.

Further, note that:

i) for $S_{pp} < 0$, H is negative and the supply of imports becomes steeper at higher prices.

ii) for $S_{pp} > 0$, H is positive and the supply of imports becomes flatter at higher prices.

iii) for $S_{pp} = 0$, H is equal to zero and the supply of imports is linear.

Finally, the following expression can be obtained by totally differentiating the profit function 1:

$$(9)\qquad dPR_k/dt = (D - S)\, dP/dt + (P - MC_k)\, D_p\, dp/dt -$$

$$(P - MC_k)\, S_p\, dP/dt + (P - MC_k)\, S_p$$

(where, $S_t = -S_p$)

The sign of dPR_k/dt can in principle be positive or negative depending on the particular functions used.

APPENDIX C

GENERALIZED INTERNATIONAL DUOPOLY (DERIVATIONS)

The revenue function of domestic firm i for sales in the domestic country A is:

$$R_i = PX_i^k$$

and the (expected) marginal revenue function is:

$$MR_i = P + X_i^k \frac{dP}{dX} \frac{dX}{dX_i^k}$$

or

$$(1) \qquad MR_i = P\left(1 - \frac{1}{e_A} \frac{X_i^k}{X} \frac{dX}{dX_i^k}\right) \quad ; \quad e_A = -\frac{dX}{dP} \frac{P}{X}$$

The conjectural variations term can be written as:

$$(2) \qquad \frac{dX}{dX_i^k} = 1 + \frac{\sum_{j=1}^{k} dX_j^k}{dX_i^k} + \frac{\sum_{j=1}^{s} dX_j^s}{dX_i^k}$$

parameter a is defined by:

$$\frac{dX_j{}^k}{dX_i{}^k} = a\,\frac{X_j{}^k}{X_i{}^k} \qquad \text{for every } i,\ j\ ;\quad i = j$$

or,

(3) $$\frac{\sum_{j=1}^{k} dX_j{}^k}{dX_i{}^k} = a\,\frac{X^k - X_i{}^k}{X_i{}^k} = a\left(\frac{X^k}{X_i{}^k} - 1\right)$$

parameter b is defined by;

(4) $$\frac{dX_j{}^s}{dX_i{}^k} = b\,\frac{X_j{}^s}{X_i{}^k} \qquad \text{for every } i,\ j$$

or,

$$\frac{\sum_{j=1}^{s} dX_j{}^s}{dX_i{}^k} = b\,\frac{X^s}{X_i{}^k}$$

Using equations 3 and 4, equation 2 can be written as:

$$(5) \qquad \frac{dX}{dX_i{}^k} = 1 + a\,\frac{X^k}{X_i{}^k} - a + b\,\frac{X^s}{X_i{}^k}$$

substituting equation 5 into 1 we obtain:

$$MR_i = P[1 - \frac{1}{e_A}\,\frac{X_i{}^k}{X}\,(1 + a\,\frac{X^k}{X_i{}^k} - a + b\,\frac{X^s}{X_i{}^k})]$$

$$= P\{1 - \frac{1}{e_A}\,[(1 - a)\,\frac{X_i{}^k}{X} + a + (b - a)\ \mathrm{IMPA}]\}$$

Using the first order maximization condition:

$$(6) \qquad MR_i = C_i$$

we obtain:

$$(7) \qquad \frac{P - C_i}{P} = \frac{1}{e_A}\,[(1 - a)\,\frac{X_i{}^k}{X} + a + (b - a)\ \mathrm{IMPA}]$$

Multiplying both sides of equation 7 by $X_i{}^k/X^k$ and aggregating over K (domestic) firms we obtain:

$$(8) \qquad PCMd = \frac{1}{e_A} + \frac{1 - a}{e_A} Hd\ (1 - IMPA) + \frac{b - a}{e_A} IMPA$$

Similarly, the marginal revenue of domestic firm i for sales in the foreign country B is:

$$(9) \qquad MR_i^B = P_B \left(1 - \frac{1}{e_B} \frac{Y_i^k}{Y} \frac{dY}{dY_i^k}\right)$$

where,

$$(10) \qquad \frac{dY}{dY_i^k} = 1 + \frac{\sum_{j=1}^{k} dY_j^k}{dY_i^k} + \frac{\sum_{j=1}^{s} dY_j^s}{dY_i^k}$$

parameter g is defined by:

$$\frac{dY_j^s}{dY_i^k} = g \frac{Y_j^s}{Y_i^k} \qquad \text{for every i, j}$$

or,

$$(11) \qquad \frac{\sum_{j=1}^{s} dY_j{}^s}{dY_i{}^k} = g \frac{Y^s}{Y_i{}^k}$$

parameter h is defined by:

$$\frac{dY_j{}^k}{dY_i{}^k} = h \frac{Y_j{}^k}{Y_i{}^k} \quad \text{for every } i,\ j \quad ;\ i \neq j$$

or

$$(12) \qquad \frac{\sum_{j=1}^{k} dY_j{}^k}{dY_i{}^k} = h \frac{Y^k - Y_i{}^k}{Y_i{}^k}$$

using the equilibrium condition $MR_i{}^B = C_i + t_i$ and equations 11 and 12 we obtain:

$$(13) \qquad \frac{P_B - C_i - t_i}{P_B} = \frac{1}{e_B} [1 + \frac{Y^k - Y_i{}^k}{Y_i{}^k} + g \frac{Y^s}{Y_i{}^k}]$$

Multiplying both sides of equation 13 by Y_i^k/Y^k and aggregating over K we obtain (after some manipulation):

$$(14)\qquad PCMx = \frac{g}{e_B} + \frac{1-h}{e_B}(Hx)(EXPA) + \frac{h-g}{e_B} EXPA$$

The first order condition 6 can be re-written as:

$$(15)\qquad P + \frac{dP}{dX}\ \frac{dX}{dX_i{}^k}\ X_i{}^k - C_i = 0$$

Assuming that conjectural variations and C_i are constant, the second order maximization condition is:

$$2\ \frac{dP}{dX}\ \frac{dX}{dX_i{}^k} + \frac{d(dP/dX)}{dX}\ (dX/dX_i{}^k)^2\ X_i{}^k < 0$$

or,

$$(16)\qquad \frac{dX}{dX_i{}^k}\ (2\ \frac{dP}{dX} + \frac{d^2P}{dX^2}\ \frac{dX}{dX_i{}^k}\ X_i{}^k) < 0$$

Using the constant elasticity demand function $X = AP^n$ (where $n = - e_A < 0$), we obtain:

$$\frac{dP}{dX} = \frac{1}{n} \frac{P}{X} \quad \text{and} \quad \frac{d^2P}{dX^2} = \frac{1}{n} (1 - \frac{1}{n}) \frac{P}{X^2}$$

using these two results condition 16 can be written as:

$$(17) \qquad \frac{dX}{dX_i^k} \frac{1}{n} \frac{P}{X} [2 + (\frac{1}{n} - 1) \frac{dX}{dX_i^k} \frac{X_i^k}{X}] < 0$$

Clearly, the second order condition is violated if $dX/dX_i^k \leq 0$ and therefore, we require $dX/dX_i^k > 0$. Assuming for simplicity $a = b$, equation 5 implies that dX/dX_i^k is greater than zero when:

$$(18) \qquad a > - \frac{S_i}{1 - S_i} \quad , \quad \text{where} \quad S_i = X_i^k/X$$

Furthermore, using equation 8, $PCMd \geq 0$ as:

$$(19) \quad a \geq - \frac{Hd\ (1 - IMPA)}{1 - Hd\ (1 - IMPA)}$$

However, the equality in 19 is rejected by the second order condition, since inequality 18 can be re-written as:

$$a\ (1 - S_i) > - S_i$$

$$\text{or} \quad a[1 - \frac{X_i^k}{X^k}(1 - IMPA)] > - \frac{X_i^k}{X^k}(1 - IMPA)$$

$$\text{or} \quad a[1 - Hd\ (1 - IMPA)] > - Hd\ (1 - IMPA)$$

$$\text{or} \quad a > - \frac{Hd\ (1 - IMPA)}{1 - Hd\ (1 - IMPA)}$$