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**INDUSTRIAL CONCENTRATION, AGGLOMERATION,
AND EXPORT INTENSITY: EVIDENCE FROM THE
AMERICAN MANUFACTURING SECTOR**

**By
ANDREW PAIZIS**

A dissertation submitted to the Graduate Faculty in Economics
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy, The City University of New York

1997

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4/24/97
Date

David J. Gabel
Dr. David J. Gabel,
Chair of Examining Committee

4/22/97
Date

Linda Edwards
Dr. Linda Edwards,
Executive Officer

Michael Edelstein
Dr. Michael Edelstein,

David J. Gabel
Dr. David J. Gabel,

Robert E. Lipsey
Dr. Robert E. Lipsey,
Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

INDUSTRIAL CONCENTRATION, AGGLOMERATION,
AND EXPORT INTENSITY: EVIDENCE FROM THE
AMERICAN MANUFACTURING SECTOR

By

Andrew Paizis

Adviser: Professor David J. Gabel

This dissertation investigates the relationship between industry concentration and export intensity for the entire American manufacturing sector in 1982 and for durable and non-durable goods industries. Export intensity is defined as value of exports divided by value of shipments. The effects of agglomeration and transportability on export intensity are examined through the use of a geographic concentration index. The model consists of a three-equation framework which also allows for the simultaneous determination of industry concentration and the tariff rate.

The major conclusion is that there is a positive and significant effect of industry concentration on export intensity both for the entire manufacturing sector and its two subsets. A non-linear specification of the four-firm concentration ratio as a measure of concentration showed

that the industry concentration/export share relationship has an inverted "U" shape. This was true both for all industries and durable and non-durable goods industries. In all three cases, export share peaked at a concentration ratio in the 64% - 70% range. In each case, around 11% of the observations were to the right of the peak.

The non-linear specification of the industry concentration/export share relationship was also tested using the Herfindahl-Hirschman index (H) as a measure of concentration. The inverted "U" relationship was still observed but was weaker on account of a small cluster of very high H observations which, when removed, resulted in the weakening of the relationship.

Tariff/industry concentration and industry concentration/geographic concentration interactions were also used in the export intensity equation. The first interaction was designed to test whether the positive effect of industry concentration on export share is reinforced through protection. This interaction was negative and significant for all industries and durable goods industries. It was positive and weakly significant for non-durable goods industries. The industry concentration/geographic concentration interaction was negative and significant for the entire manufacturing sector and its subsets, suggesting that the positive effects of industry concentration and agglomeration do not reinforce each other. Finally, average elasticities of export share with respect to concentration were calculated and were all well below one.

To My Parents
Orestis and Amalia

My
Grandmother
Catherine

and to
Dr. Harold M. Hochman

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CHAPTER 1: PURPOSE OF THE STUDY AND GENERAL ASPECTS.

The purpose of this study is to examine the relationship between producer concentration and industry export intensity for the American manufacturing sector for 1982. Export intensity is measured as a proportion of total sales. This study will examine whether a positive relationship exists between industrial producer concentration and export intensity. Also, this study will investigate the relationship between regional concentration and export intensity by examining whether regionally concentrated industries export a greater proportion of their output. In sum, this study will investigate whether industry concentration (and the resulting internal economies of scale) and agglomeration (and the resulting external economies of scale) are significant determinants of American manufacturing export intensity.

The present study is a combination of industrial organization and international trade aspects. The study of industrial concentration that began with Bain (1951) proceeded in a purely domestic context and this resulted in a dichotomy with the field of international trade. This is probably because industrial organization follows a partial equilibrium approach, as opposed to the general equilibrium aspects of international trade (Caves and Khalilzadeh-Shirazi, 1977). Since the Bain study, virtually all subsequent studies ignored the role of foreign trade flows but, increasingly, the economics profession came to recognize

this deficiency and moved toward a synthesis based on both fields. However, the studies that have included a trade component have concentrated mainly on the effects of import intensity on price-cost margins.¹ It is hoped that the present thesis will offer a modest contribution to the synthesis between industrial organization and international trade.

Regarding regional concentration, it has received greater attention by the field of international trade (Krugman 1991a, 1991b, 1993) compared to industrial organization, which has emphasized industrial concentration. This relative lack of attention by industrial organization practitioners is reinforced by the absence of government-published measures of regional concentration.²

There are theoretical predictions which point to a positive relationship between industrial concentration and export intensity. Although these theoretical aspects will

1 Esposito and Esposito (1971), Pagoulatos and Sorensen (1976b), Caves and Khalilzadeh-Shirazi (1977), Marvel (1980), and Pugel (1978, 1980) for the United States, and Shepherd (1972b), Caves and Khalilzadeh-Shirazi (1977), and Morgan and Hart (1977) for Great Britain, and Bloch (1974) for Canada. Briefly speaking, the consensus from these studies was that price-cost margins are negatively related to the level of import penetration, an effect that is stronger in concentrated markets.

2 The complete absence of regional concentration indices in the Census of Manufactures and the withholding of a significant quantity of regional data (employment by state) by the government in order to avoid disclosing data for individual companies often severely limits the ability of researchers to calculate regional concentration indices. A regional concentration index will be included in this study.

be elaborated in detail in the main body of this dissertation, at this point it is sufficient to say that such a relationship is to be expected: First, when there is market power in the domestic industry and some protection from imports, there will be an incentive to increase exports by price discrimination between domestic and foreign markets and, second, the market power that is derived from concentration allows exporters to better withstand the risks associated with selling in foreign markets. This hypothesized relationship between producer concentration and export share will be investigated in a three-equation framework that allows for simultaneous determination of industrial concentration and the tariff rate for the 448 four-digit SIC industries of the American manufacturing sector. In order to examine whether the hypothesized relationship is stronger for particular groups of industries, the model will also be applied to two subcategories of the manufacturing sector, durable and non-durable goods industries. The reason for the distinction between durable and non-durable goods is that, in 1982, durable goods exports accounted for 68.80% of all exports of domestic merchandise by the American manufacturing sector.³ This breakdown may shed some light to the debate about concentration, antitrust, efficiency, and export performance, to which I shall now turn.

³ Calculated by the author, using data from Table 4 of U.S. COMMODITY EXPORTS AND IMPORTS AS RELATED TO OUTPUT, 1982 AND 1981.

A possible implication for the exports of the American manufacturing sector may be that the strict federal antitrust enforcement designed to alter industry structure may affect the pattern of exports by constraining the ability of our companies and industries to compete abroad. Policymakers often argue that the performance of American industries in export markets may be improved if there is a relaxation in antitrust enforcement, especially as far as mergers are concerned. However, a point that has been overlooked in the few previous studies that related industry structure and trade performance [Marvel (1980), Pagoulatos and Sorensen (1976a), and Pugel (1978, 1980)] concerns the kind of data used. These data were cross-sectional: That is, trade performance was examined across industries at a point in time. In contrast, exports are a time-series, macroeconomic variable. In general, time-series data reflect short-run behavior while cross sectional data reflect long-run behavior (Intriligator, Bodkin, and Hsiao, 1996). Therefore, although such analyses can be used to provide researchers with some preliminary ideas, one should exercise care in drawing broad policy conclusions about a macroeconomic variable based on microeconomic, cross-sectional, data.

Industry concentration has always played a very important role in studies of market structure, conduct, and performance. Beginning with the seminal study of J. Bain (1951), the impact of concentration on pricing behavior has been extended and refined over the last forty years to include economies

of scale, advertising, research and development, geographic dispersion, capital intensity, and barriers to entry. Concerns about concentration, however, did not begin with Bain's work.⁴ Policymakers and the public have been uncomfortable with concentration since the late nineteenth century, as evidenced by the passage of the Sherman Antitrust Act of 1890. But even though antitrust is a uniquely American phenomenon, our nation has been characterized by an ambivalence toward the large corporation ever since the American economy started its rapid industrialization and large corporations began their formation: On one hand it is admired as proof of American ingenuity and efficiency and on the other hand its motives are often questioned amidst great suspicion and hostility. The debate about concentration centers on its relationship with higher profitability, collusion, and efficiency effects. The vast literature on concentration and profitability initially showed a small positive effect of concentration on profitability for industries [for example, Bain (1951), Collins and Preston (1969), Strickland and Weiss (1976)] and somewhat larger positive effects at the firm level when product differentiation and firm market share were included as explanatory variables (Shepherd, 1972a). The evidence from the multitude of studies was interpreted as

⁴ A seminal study of *aggregate* concentration was completed by Berle and Means (1932).

resulting from collusion in concentrated industries that drove prices up.⁵

The positive relationship between industry concentration and profitability, however, came under increasing attack in the 1970s,⁶ especially by adherents of the Chicago School, who argued that monopoly reflects superior efficiency, that market dominance causes little or no harm and that collusion, if it occurs, does not last long due to the incentive to cheat [McGee (1971), Demsetz (1973, 1974), Brozen (1982)]. Econometric studies of the concentration-profitability relationship by Chicago School adherents showed a weak or sometimes non-existent link [for example, Brozen (1971), Peltzman (1977)]. The result of such studies was a set of policy recommendations ranging from complete dismantling of the U.S. antitrust structure (Armentano, 1982) to emphasis only on horizontal constraints and predatory behavior (Bork, 1978), to avoidance of across-the-board deconcentration to avoid sacrificing the efficiencies of large scale operation (Demsetz, 1974). These pro-concentration arguments were soon

5 The concern emanating from these studies was highlighted in the early 1970s by the proposal of Senator Philip Hart (D-MI) to deconcentrate industries whose four-firm concentration ratio exceeded 50 percent or to break firms whose after-tax return on stockholders' equity exceeded 15 percent for five years in a row (Goldschmid et al., 1974).

6 This was not the only attack on the structuralist school. Contestability theory which was developed in the early 1980s argued that, even in highly concentrated markets, firms have no control over entry if entry and exit are rapid and cheap (Baumol, 1982).

extended to include possible beneficial effects on export performance.

Antitrust legislation is now commonplace in all industrialized nations. The attitudes of other advanced economies, though, are in contrast to the American public policy discomfort toward size. First, size may be reduced by restricting or prohibiting mergers. Second, the dissolving of large companies may be implemented. Third, the market system may be allowed to determine size. Finally, growth in firm size may be promoted. This last approach has not been implemented in the United States because public officials and the media tend to equate size with the potential for abuse. In contrast, foreign countries encourage the growth of domestic large firms [Audretsch (1989), Servan-Schreiber (1968), Scherer (1990)]. Foreign governments believe that large size can result in economies of scale, more innovation, and expansion of exports. Large firm size as a precondition for innovation and technological improvement has been mainly associated with Schumpeter (1942). Government attitudes toward large firms can be illustrated by the example of the European Economic Community (EEC). European firms are typically smaller than American firms. Also, although in the early 1980s the EEC and the U.S. had about the same number of firms in the Fortune Top 100 list (19 and 23 respectively), the European firms had much lower productivity and profitability ratios compared to American firms (Geroski and

Jacquemin, 1984). The EEC closely monitored mergers throughout the 1970s and 1980s, preventing concentration by minimizing merger activity. But as the completion of the 1992 unified market approached, merger activity increased sharply.⁷ This increase in the number of mergers was not challenged by antitrust authorities because of the potential for efficiency gains through economies of scale. Of course, this caused an increase in concentration, which had already been anticipated since the early 1970s (Pryor, 1972). Although, as far as mergers are concerned, both national and EEC laws apply and mergers can be prohibited, in sum, the EEC as a whole has applied less severe standards compared to the U.S. because of the desire of the authorities to achieve economies of scale through larger size in order to compete more effectively with international competitors.

The other main American competitor, Japan, is also less restrictive as far as size is concerned. The Japanese government gives special assistance to the formation of large companies through merger and growth and its antitrust laws exempt a variety of vertical and horizontal restraints that remain closely regulated in the United States (Dick, 1993). Japanese antitrust emphasis is on conduct and specific practices rather than intent and there are many

⁷ From about two hundred horizontal mergers in 1984, the number increased to three hundred by 1986, close to six hundred in 1988, and over eight hundred by 1990 (de Jong, 1993).

exemptions concerning cartel behavior: Export cartels are permitted (Dick, 1993). The powerful Ministry of International Trade and Industry (MITI) follows the policy of promoting firm size without caring very much about structure because of the belief that Japanese firms must be as large as their American competitors in order to compete with them effectively (Caves and Uekusa, 1976). Thus, the Japanese (much like the Europeans) place great emphasis on economies of scale as a tool of competition in international markets. The antitrust legislation imposed on Japan at the end of WWII has been modified so as not to conflict with industrial policy. While this does not mean that competition policy in Japan is an exercise in futility, concerns about market structure play mostly a secondary, supplementary, role in the design of industrial policy.

The implication from this discussion is that the stricter American attitude compared to our main competitors in regards to structure may be creating problems for our export sector. Larger firms, on average, export a greater portion of their output because of their greater ability to collect information, enjoy scale economies, and withstand the possible adverse shocks that can result when participating in international trade. The possible negative effects of strict antitrust action on American competitiveness abroad were recognized a long time ago: In 1918 Congress passed the Webb-Pomerene Act which, although not aiming to change industry structure, allowed American firms to form export

cartels and encouraged small domestic firms to enter foreign markets (Scherer, 1990). Its main purpose was to allow domestic producers to exercise power over export prices from a collective point of view. Needless to say, Webb-Pomerene associations are prohibited from restraining trade within the U.S. The contribution of the Webb-Pomerene legislation to our balance of payments is at most marginal. First, by the late 1970s, only 1.5 percent of American exports were covered by the legislation.⁸ Second, the legislation may be irrelevant for the American manufacturing sector because its provisions have been invoked mostly by American primary producers, not manufacturers (Larson, 1970). One main reason why manufacturers have not taken advantage of the Act is that there is hesitation on the part of businessmen to join because of the fear that if their association is challenged on legal grounds the result will be a protracted and expensive court fight (Carbaugh, 1985). It is interesting to note that a detailed analysis of the Webb-Pomerene Act showed that, instead of being utilized by small firms as intended, participants were mostly large firms in concentrated industries producing homogeneous products (thus reducing the possibilities of price competition) and that the behavior of these firms entailed domestic anticompetitive effects because members of the export cartels often attempted to

⁸ Quoted in Scherer (1990), p. 324.

divide and control their domestic markets (Larson, 1970).⁹ This clearly shows that it is often hard to distinguish business behavior in regards to domestic and foreign markets and shows that the U.S. government is correct in applying antitrust laws to American firms with international connections.

Turning to geographic concentration, its effect on export share is mainly the result of the advantages of spatial concentration, also known as agglomeration, which results in external scale economies. These are economies which arise in the environment surrounding the enterprise rather than inside the enterprise itself. The effect of geographic concentration on export share should be positive because regional concentration suggests easy transportability, which means that goods are tradable. The benefits of geographic concentration are actually a combination of transportation considerations, labor market considerations, specialized input needs, and agglomeration economies. The benefits arising from these factors in turn cause geographic concentration to be self-sustaining: Because of transportation costs, each individual producer has the incentive to locate where demand is large or inputs are convenient, which in general is the location chosen by other producers. Over time, these factors create an efficient environment which may

⁹ In contrast to the U.S., evidence from Japan shows that export cartels are centered in unconcentrated industries and are predominantly composed of small and medium-sized producers. No anticompetitive effects have been discerned (Dick, 1993).

allow the industry to obtain a competitive edge in international trade.¹⁰ In sum, the effect of geographic concentration on export share should be positive.

Regarding policy implications concerning geographic concentration, state and local governments are mostly the ones to promote it by offering tax breaks to businesses in order to attract them. Nevertheless, the government sector in general has been much less active regarding geographic concentration relative to industrial concentration.

As a final matter, I would like to touch upon the issue of export intensity, which I defined as value of exports divided by total industry sales, and upon areas that will not be covered by this study. Export share is not a "proper" measure of comparative advantage.¹¹ In fact, it may not be appropriate to call it a measure of comparative advantage because the term "comparative" means comparison with other countries, something this dissertation will not do for reasons that shall be explained shortly. Also, an industry may export a smaller than average share of its output and still have a distinct comparative advantage in producing the product (Maskus, 1983).¹² Therefore, it may be better not to

10 Porter (1990) provides numerous case studies which show how geographic concentration improves the cost and quality performance of industry.

11 A common measure of comparative advantage is net industry exports [Baldwin (1971), Pagoulatos and Sorensen (1976a)].

12 This will occur if the industry is at the beginning of the product life cycle.

consider export share as an indicator of comparative advantage and instead consider it a simple measure of industry competitiveness. Export share was selected because this study is closer to the industrial organization orbit rather than the factor proportions/international trade orbit. This was also the reason for not considering imports.

In this study there was no attempt to compare U.S. industry export shares with those of other countries because of concordance problems. Although all industrialized countries have industrial classification systems, in many cases these systems are not only not directly comparable but also they use different measures of industry concentration.¹³ Even if such measures were uniform, the comparison with other countries would have resulted in the discarding of large numbers of observations. Attempts have been made to establish a concordance between industrial classifications¹⁴ but the inclusion of other countries, as initially planned, would have taken the present research from the realm of a dissertation to that of an extensive book. An additional problem is that international

13 For example, the British use the five-firm concentration ratio.

14 INTERNATIONAL CONCORDANCE BETWEEN THE INDUSTRIAL CLASSIFICATIONS OF THE U.N. (ISIC REV. 3), CANADA (1980 SIC), THE EUROPEAN UNION (NACE REV. 1), AND THE U.S. (1987 SIC). Note that the 1987 SIC is used here; the 1982 SIC data I used in this thesis were based on a previous SIC classification.

concordances correspond roughly to the three-digit SIC industry group level; this thesis is based on the four-digit SIC industry level.

Recapping, this study will examine whether there is a positive relationship between producer concentration and export intensity for the industries of the American manufacturing sector. The study will also examine whether geographic concentration, and the resulting agglomeration, will have a positive effect on industry export share. Regarding industry concentration, our attitude toward large size may have adversely constrained our productivity growth (Lustgarten, 1984). We tend to believe that imperfect market structure automatically implies collusion; imperfect market structure may facilitate collusion. The industrial organization literature in recent years has been finding the link between industry concentration and profitability weak or sometimes nonexistent. This has resulted in opposing arguments for across-the-board deconcentration through tougher antitrust enforcement and for lessened enforcement or even dismantling of our antitrust laws on the grounds of efficiency and export competitiveness. Although the caveat concerning the drawing of policy conclusions about a macroeconomic variable (exports) from cross-sectional microeconomic data (industries) should be borne in mind, it is hoped that this study will shed some light concerning which broad groups of industries (durable and non-durable goods industries) may benefit from more lenient antitrust

enforcement and which groups are not affected by the presence of industry concentration.

CHAPTER 2: PRODUCER CONCENTRATION AND ITS EFFECT ON EXPORT INTENSITY, THE DETERMINANTS OF TARIFFS, OF PRODUCER CONCENTRATION, AND OF REGIONAL CONCENTRATION: THEORETICAL ASPECTS AND REVIEW OF THE LITERATURE.

Since the relationship between export intensity and producer concentration will be investigated in a framework which shall include the determination of industrial concentration and the tariff rate, we shall now proceed with a theoretical discussion on industry structure and export determination and then continue with discussions of tariff determinants and industry concentration determinants. A discussion of the latter two is appropriate because I am treating them as endogenous variables. I conclude this chapter with a discussion of the reasons why industries become geographically concentrated. After each theoretical discussion, the review of the relevant literature will follow.

2A. Industry Concentration and Export Intensity, and the Effect of Protection

The effect of concentration on export intensity may be positive or negative. Higher concentration increases the probability of coordinating exports among producers because it facilitates collusion and cooperation. Also, general efficiencies associated with size (such as economies of scale) can increase exports. On the other hand, exports may decline if a concentrated industry is unable to discriminate between home and foreign markets, as shall be seen shortly.

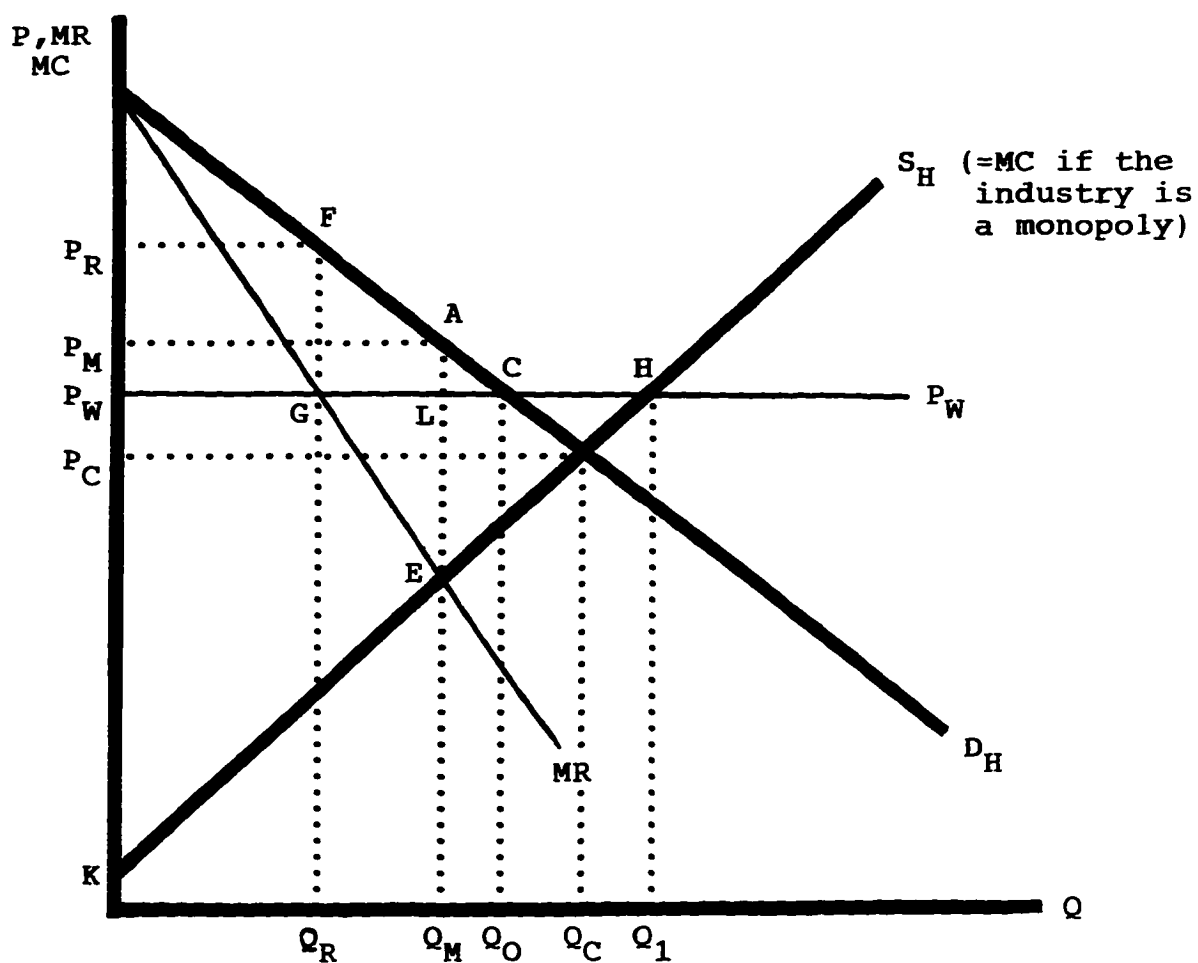
Before proceeding, it is imperative to explain the concept of producer concentration. The concept of producer concentration is associated with an industry while, for the similar-sounding seller concentration, the relevant concept is the one of a market. The concentration measures published in the Census of Manufactures refer to domestic producers. Markets include imports so the actual *seller* concentration is lower.¹ For the purposes of this study, since the establishment of a link between producer concentration and export intensity is investigated, the relevant concept is the industry.

We shall now develop the effects of industry structure on export share by utilizing the approach developed by White (1974). In Figure 2.1, S_H and D_H represent the home market industry supply and demand curves. S_H is also the marginal cost curve if the industry is a monopoly. If there is no foreign market, the competitive industry would produce Q_C and sell it at a price of P_C per unit and a monopoly will produce Q_M and charge a price of P_M per unit. Let us now assume there is a foreign market. With no barriers to trade, the export volume will be the same for both the monopoly and the competitive industry² if the world price

1 The discrepancy is more important for small economies like Belgium, the Netherlands, and Switzerland.

2 We assume that, in this open economy, domestic producer(s) cannot affect the world price. The *domestic* monopolist becomes just another competitor in the world market. The issue of a domestic monopolist who is also a monopolist abroad will be addressed later on.

FIGURE 2.1
COMPETITION, MONOPOLY, AND EXPORT SHARE



Source: Adapted from White (1974).

is P_W (bigger than the domestic price P_C). The industry will supply Q_O to the domestic market and export Q_OQ_1 .³ Now, if a tariff exists, exports depend on industry structure. At P_W the competitive industry will export Q_OQ_1 . But if the industry is a *domestic* monopoly⁴ and can engage in price discrimination, exports will expand. This will occur because price discrimination requires the equalization of marginal revenues in the segmented markets (home and foreign). MR is the domestic marginal revenue but P_W is the marginal revenue from the foreign market because the world price is taken as given by the monopolist (as a reminder, we have assumed that the foreign market is competitive at this stage). This equalization is represented by point G. The monopolist supplies Q_R to the domestic market (at the price of P_R per

3 At a world price below the competitive price, imports would of course occur to satisfy domestic demand.

4 This qualification is important: If the monopolist also operates abroad the effects become ambiguous because we now enter the realm of the multinational corporation (MNC). An interesting question to examine would be the effect of American foreign direct investment (FDI) on export share and to see whether exports and FDI are substitutes or complements. Unfortunately, FDI cannot be used in this study because of the absence of FDI data at the four-digit SIC industry level. FDI data are available through the IRS Statistics of Income Corporations but this roughly corresponds to the three-digit SIC level (industry groups). There were 143 such groups of industries in the U.S. manufacturing sector in 1982. I could not take three-digit data and use them with four-digit industries because the aggregation bias would be severe. FDI Department of Commerce estimates are even worse because they are also very broad and not classified by SIC. Therefore, FDI was not included in the model.

unit) and exports the additional quantity of $Q_R Q_O$.⁵ Thus, price discrimination leads to a higher export volume when compared to a monopolized but unprotected industry. Of course, expanded exports come at the expense of consumers, who now have to pay a higher price.⁶ In short, export share and high concentration are positively related, especially if there is industry tariff protection. To see whether this conclusion concerning the reinforcing effect of tariffs is robust or limited to White's analysis I plan to incorporate an interaction term in the regression equation that will attempt to explain export share. This interaction term will be the measure of concentration⁷ multiplied by the average tariff rate for each industry. If the hypothesis is true, the coefficient of this interaction term should be positive and significant. If it is negative, it means that tariff protection contributes to the inefficiency of concentrated industries by robbing them of the element of competition. When the empirical results are presented, a more detailed analysis will be made.

5 The domestic price under discrimination is *higher* now than in the absence of exports ($P_R > P_M$).

6 Caves and Jones report that the disclosure that Japanese color TV sets were sold in the U.S. at prices much below those in Japan prompted a boycott by irate Japanese customers [Caves and Jones (1977), p. 172].

7 I will be using the Herfindahl-Hirschman index. A detailed analysis will be presented in the next chapter when the variables of the model will be discussed.

The above analysis has assumed that the domestic monopolist is a perfect competitor in the world market. Let us now turn to the possibility of the domestic monopolist dealing in an oligopolistic foreign market or, in the extreme case, in a world market in which he is the only producer and therefore a price maker. If the monopolist is the only world producer and sells some of his output abroad, the volume of exports will depend on price and on world demand (Jacquemin, 1982). He will maximize profits by equating domestic marginal cost to the marginal revenue in each of the two markets (Katrak, 1980). The monopolist gains and foreign consumers lose. But there are domestic welfare implications because the excess of price over marginal cost imposes a deadweight loss on domestic consumers. The optimal policy would be to force the monopolist to sell to domestic consumers at a price equal to marginal cost but governments have no effective instruments to enforce such a policy (Caves, Frankel, and Jones, 1990).⁸ In the extreme case when the monopolist sells all of his output abroad, although from the national point of view there is a gain, the world as a whole will lose because of the reduced consumer surplus of the foreign buyers plus the deadweight loss from the monopoly (Jacquemin, 1982).

Turning to the possibility of oligopolistic foreign markets, we are entering the orbit of oligopolistic

⁸ At least as far as the U.S. is concerned, an export tax cannot be used because such taxes are expressly prohibited by the Constitution. A substitute device, the Webb-Pomerene Act, was discussed in the previous chapter.

interdependence, with all the problems that this entails. Suffice it to say that the theory of oligopolistic markets is often indeterminate since the players can interact with each other in a number of ways. Assume that we are dealing with a domestic monopolist who faces only one foreign competitor located abroad, resulting in a duopoly situation. For the domestic duopolist the volume of exports will depend on their price, the price charged by the foreign duopolist, and on the nature of the world demand. The question here is whether the duopolists will cooperate or not. The familiar Cournot or Bertrand models may be used to model the situation. Under Cournot, it is assumed there will be no change in the rival's output if the domestic duopolist expands his output. This will be implausible for a duopoly but makes more sense in oligopolies with enough firms that one rival holds no systematic expectation concerning other players' responses (Caves, Frankel, and Jones, 1990). Under Bertrand, it is assumed that each seller will set his price assuming that the rival will keep his price unchanged. Theoretical equilibria in both models can be found but the problem is that such models, and others which are very esoteric, do not come very close to characterizing the behavior of any particular oligopoly (Caves, Frankel, and Jones, 1990). It was to avoid such problems of oligopolistic interdependence that it was assumed that the monopolist deals in a perfectly competitive world market.

A final thought concerning monopoly power over exports in international markets. Because the monopolist has a certain control over his export price, a higher such price will mean a lower export volume. The effect on receipts will depend on elasticities of demand and no *a priori* conclusions can be reached.

The discussion has assumed that the monopolist can engage in price discrimination. If of course discrimination is impossible because such behavior has been ruled out as dumping⁹ then the effect on export share may be ambiguous because the monopolist has two choices: Either to export the same amount as the competitive industry (Caves and Jones, 1973) or to abandon the foreign market altogether. Going back to Figure 2.1, the monopolist would supply Q_0 at home and Q_0Q_1 abroad at the world price P_W if the first case applies. In the second case, he would set MR equal to MC (point E) and produce Q_M and sell it at a unit price of P_M , assuming his market is protected. The course of action depends on which producer surplus he gains under each approach: P_MAEK if he confines himself to the domestic market and P_WHK if he sells abroad. Given that P_WLEK is common to both producer surpluses, his course of action will depend on whether P_MALP_W (the extra surplus if he

⁹ The most succinct definition of dumping is the one given by Jacob Viner in his seminal study "Dumping: A Problem in International Trade": Dumping is price discrimination between national markets. Viner (1923) [Reprinted 1966], p. 3.

confines himself to the domestic market) or LHE (the extra surplus from exporting) is larger. If the monopolist gains more producer surplus in the domestic market, exports will be zero. Thus, exports may lower prices in the absence of a tariff and the ability to discriminate: The domestic price declines to world levels (Caves and Jones, 1973). Pagoulatos and Sorensen (1976b) point out that the same can happen to oligopolists because the presence of export markets may open new opportunities to producers and this may cause them to be less willing to maintain their domestic pricing arrangements. Assuming that the oligopolists are unable to price discriminate between domestic and foreign markets, the implication is that exports can reduce an industry's market power and reduce prices. Logically, export opportunities are expected to raise the profits of a monopolist or oligopolist because they will otherwise be ignored (Marvel, 1980). The effect of price discrimination on exports can be illustrated by using the example provided by Parsons and Ray (1975). According to Parsons and Ray, the creation of the U.S. Steel (now USX) monopoly had little effect on foreign trade in pig iron because price discrimination was not practicable in the pig iron field but it had a great effect on the market for steel rail exports in which discrimination was substantial.

An important point to address here is the prevalence of dumping in international trade. One must keep in mind that the natural reaction of manufacturers is to label as "dumping" practically all foreign imports but, judging by

the many complaints about dumping that are made to government agencies, we can conclude that price discrimination is prevalent in international trade (Utton and Morgan, 1983). Therefore, given that domestic market power is required to price discriminate, such market power will lead to a greater export volume relative to output especially if there is tariff protection.

This conclusion is reinforced by theoretical predictions which show that larger firms export a greater portion of their output compared to smaller firms. Of course, larger firms increase the size disparity within an industry, thereby raising the level of concentration. There are several reasons why exports are more feasible for larger firms. First, there is the issue of costly information: In order to collect information about the foreign market and business culture, large fixed costs must be incurred. Larger firms can spread out these fixed costs over a greater volume of output.¹⁰ Of course, a larger firm can have access to the more sophisticated information required for exporting. Second, economies of scale can lower the cost of exporting by contributing to the industry's comparative advantage (Das, 1982) and these can be realized by larger firms. Third, larger firms may have an advantage over smaller firms in selling abroad because of their ability to raise capital at a lower cost due to the fact that they are considered better risks. Finally, larger and more diversified firms

¹⁰ Joint selling companies can reduce such costs in some cases.

are better able to bear the risks involved in exporting (exchange rate fluctuations, political instability in the target country, and so on).¹¹ In short, these factors point to larger firms exporting more.

Turning to the empirical literature, studies can be classified into two categories, one dealing with the relationship between export share and concentration at the industry level and the other dealing with the relationship between export share and firm size. As it shall be seen, with few exceptions, the relationship is positive and significant not only at the industry level but also at the firm level. I shall first discuss industry-level studies and then continue with their firm-level counterparts.

Pagoulatos and Sorensen (1976a) examined the relationship between industry structure and export share for a sample of eighty-eight Standard International Trade Classification (SITC) three-digit industry groups.¹² They used a weighted concentration ratio (weights being industry values of shipments) and an entropy measure of concentration. Their

11 One can connect the political risk aspect with the issue of costly information: It is very expensive to purchase country risk profiles from organizations whose business is to forecast potential instability in various countries. Larger companies can better afford to buy such profiles.

12 The sample was selected as follows: When it was possible to locate figures in the American SIC system that were comparable with those of the SITC, the industry group was included in the sample [Pagoulatos and Sorensen (1976a), p. 49].

results pointed to a positive relationship between industry structure and export share but only the entropy coefficient was statistically significant.¹³ They concluded that, although greater industry concentration appeared to improve export performance, at the same time it impaired the performance of industries in import-competing situations and suggested that more lenient antitrust enforcement to favor exports could thus be counterproductive.

Marvel (1980) examined three hundred and eighty-two four-digit SIC industries for the American manufacturing sector and found a positive but very insignificant relationship between the four-firm concentration ratio and the export share (value of exports divided by value of shipments).¹⁴ He concluded that the price discrimination arguments associated with domestic structure and export intensity are second order effects and interpreted this as providing little support for the view that high industrial concentration stems from superior efficiency since one would expect the efficiency advantage of American producers to be reflected in international as well as domestic markets.

Utton and Morgan (1983) examined the relationship

13 Although Pagoulatos and Sorensen offered no explanation for the insignificance of the concentration ratio, it may be because weighted concentration ratios are biased measures of industry structure (Boyle, 1973).

14 The t-value was a low 0.38.

between concentration and foreign trade in the United Kingdom. Using data for 121 products for the period 1958-1977,¹⁵ they concluded that there was a positive and significant relationship between concentration and export intensity: Exports accounted for one-third of the sales for the products produced by industries characterized as persistent oligopolies.

Finally, Hughes (1986) reported a negative effect of industry concentration on export share for Great Britain. In seven different regressions, the coefficient for the five-firm concentration ratio was always negative but significant only once. Hughes believes that this is the result of firms with monopoly power choosing not to export because of their inability to discriminate between domestic and foreign markets. But she also points out that this negative value may just reflect inefficiencies in the British manufacturing sector. She interpreted the negative sign as suggesting caution in advocating large size as potentially beneficial to exports if increased firm size causes higher concentration.

Before continuing with the studies that examined the relationship between export intensity and firm size (instead of industry size), I would like to address the issue of exports and plant size. The effect of exports is to expand the market horizon for a domestic firm. Therefore,

15 They could not use the maximum of 335 products because concentration statistics did not cover all 335.

this may create an incentive to build a larger plant or to expand an existing plant. The effect of information is also important here, as argued earlier, besides the technical aspects of large size: A lot of information is needed in order to prepare for export entry in a foreign market and its fixed costs will increase the optimal size of a firm. Thus, there should be a positive relationship between export intensity and plant size. This has been confirmed by the evidence: Scherer et al. (1975) found a significant positive relationship between export intensity and plant size in their analysis of twelve industries across six industrial countries. Since concentrated industries tend to have larger establishments, we can see the link between concentration and export intensity.

A set of studies examined the relationship between export intensity and firm size for developed countries other than the United States [Rapp (1976), Auquier (1980), and Glejser, Jacquemin, and Petit (1980)]. Rapp (1976) found that larger companies in Japan export a larger share of their output compared to smaller ones. In addition, in examining a breakdown by industry of the two hundred leading exporters, he found that they belonged to highly concentrated industries. Rapp attributed his results to the fact that larger firms possess more financial and material resources than smaller firms, thus helping them to compete abroad, and to the fact that larger firms implement their export strategies once they decide on them.

Auquier (1980) confirmed the same result (that is, a positive relationship between export share and firm size) for the French manufacturing sector. He argued that the increase in exports as firm size increases can be explained either by scale economies in production or by market structure influences like concentration and product differentiation. He constructed and empirically tested two models. The first model postulated that differences among firms were internal and solely due to economies of scale in production or exporting. The second model contemplated differences external to the firm and looked at the role of concentration and product differentiation by asserting that large firms produce low-cost goods for large numbers of consumers while small firms carve a portion of the market for themselves by producing those goods whose features appeal to much smaller groups at higher costs. He concluded that both forces exert a positive effect on export share although he assigned greater importance to concentration and product differentiation. In other words, he did not accept the view that exporting was only caused by economies of scale. He concluded that if larger export shares by larger firms are the result of market power, the pro-concentration argument is flawed because higher concentration will increase market power and raise the probability of collusion. This suggests that care must be applied in the U.S. when advocating across-the-board pro- or anti-concentration policies.

Finally, Glejser, Jacquemin, and Petit (1980) examined

the Belgian manufacturing sector and found that larger firms export a greater share of their output (in terms of total sales), *ceteris paribus*. But they also found evidence that high domestic concentration may negatively affect firm export share because dominant firms may reap economies of scale in the domestic market and thus "crowd out" small competitors from attaining the critical size that may be required for exports. In addition, dominant firms may avoid the export market if they are forced to act as price-takers in the world market; this is particularly true if dominant firms lack the ability to discriminate and if there is no tariff protection.¹⁶

Although the above studies deal with firms, in the context of this research the connection can be made between firm and industry: Larger firms within an industry increase the size inequality between large and small firms and thus the level of measured concentration.

Up to this point, both the theory and the review of the literature just concluded point to a positive effect of concentration on industry export share. Is it possible, though, for the relationship to be negative? That is, at high levels of concentration will the export share decline (in other words, is there a concentration threshold beyond which export share will level off or decline)? None of the

¹⁶ These conditions fit Belgium: It is a member of the EEC and a small economy [Glejser, Jacquemin, and Petit (1980), p. 509].

studies reviewed above examined this possibility. First, I would like to provide a brief theoretical foundation for such a non-linear relationship and then I shall explain how such a relationship can be tested econometrically.

The theoretical aspects of this relationship can be divided into two parts, one dealing with innovation and the other dealing with efficiency. This thesis will not deal with innovation because of lack of data at the four-digit SIC level.¹⁷ The efficiency aspect concerns the issue of tariffs. Establishments in a concentrated industry which also enjoys protection from imports may lack the incentive of cost minimization because they have secure market shares and can thus become X-inefficient. Going back to Figure 2.1, this means that the supply curve S_H cannot be attained and that the true supply curve falls to the left of S_H . Industries characterized by X-inefficiency find it of course difficult to compete in foreign markets. Thus, there is a theoretical possibility that the relationship between industry concentration and export share is non-linear. This can be tested by adding in the regression equation that

17 Scientists and engineers as a percentage of total employment can be used as a measure of innovation. Such data are available for many industries in the 1980 Census of Population (CP). However, this information is not applicable to this dissertation because CP industries are not comparable to Census of Manufactures (CM) four-digit SIC industries. CP industries are extremely broad. There are only 58 CP industries (personal count by the author) while there are 448 CM four-digit industries. The CP system is thus in poor concordance with the CM SIC system. Therefore, it was decided not to include innovation issues in the dissertation.

has export share as its dependent variable the measure of industry concentration, squared.¹⁸ So the measure of concentration will be introduced twice: Once by itself and once squared. If what we have hypothesized concerning the non-linear relationship is true, the coefficient of the concentration measure must be positive while the coefficient of the concentration measure squared must be negative. Then it will be easy to determine, through partial differentiation, at which level of concentration export share is at a peak. We cannot say *a priori* what level of high concentration would be required to have a negative effect on export share because this is fundamentally an empirical question. If this relationship is verified by the empirical part of this research this means that the argument for encouraging high concentration in order to improve performance in export markets will be weakened, lending support to those who believe in rigorous enforcement of antitrust laws. On the other hand, if our hypothesized relationship is not verified by the empirical results and the coefficient of the concentration measure squared turns out to be insignificant, this may mean that high concentration contributes to our export trade.

This section developed a framework for testing the effect

18 For example, if CR_4 is the four-firm concentration ratio and H is the Herfindahl-Hirschman index, the term $(CR_4)^2$ or H^2 will be used. As it shall be seen in the empirical results, the export share equation will be tested using both H and H^2 and again using CR_4 and $(CR_4)^2$. The reason for this will be elaborated on then.

of industrial concentration on export intensity, defined as value of exports divided by total sales. There are theoretical considerations which point to a positive effect of concentration on export share, especially if there is industry protection.¹⁹ With few exceptions, the literature shows this effect to be positive not only at the industry level but also at the firm level (that is, larger firms export a greater share of their output than smaller firms). The measure of industrial concentration to be used, discussed in the next chapter, will be utilized (in different regressions) to attempt to explain export share by itself, by letting it interact with the tariff rate in order to see whether the hypothesized positive effect of concentration is reinforced through protection, and by also introducing it squared in order to test whether a non-linear relationship exists, namely whether for highly concentrated industries export share declines.

We shall now proceed by examining the determinants of tariffs and will briefly delve on the relevant literature.

2B. Determinants of Tariffs

An extensive theoretical and empirical literature, summarized below, shows that tariffs are clearly affected by industry and political characteristics. This means that

¹⁹ Throughout this thesis, the terms "export share" and "export intensity" are used interchangeably.

tariffs ought not to be treated as exogenous variables in empirical analyses.

To answer the question about the determinants of tariffs, one must begin by asking why tariffs exist. Following the seminal works of Downs (1957) and Buchanan and Tullock (1962), we can surmise that voters and their elected representatives pursue their self-interest by maximizing their utility within the constraints of the democratic process. In regard to commercial policy, we can surmise that domestic producers attempt to obtain protection in order to increase their income through reduced imports because, when protection is imposed, the redistribution effect shifts income from domestic consumers to domestic producers. The elected representatives of course also wish to maximize their own utility by maximizing their chances for reelection and thus are likely to support arguments for protection coming from their constituents.

A simple model can be constructed in order to explain the tariff rate for each industry as a function of unskilled labor intensity, structural characteristics (that is, industrial concentration and geographic concentration), and Congressional influence. Let us begin with unskilled labor intensity. If an industry is labor-intensive in a two-factor Heckscher-Ohlin framework, the Stolper-Samuelson theorem states that the factor used intensively in the import-competing sector (that is, labor) will gain in real income terms from protection while the other factor will

lose (Stolper and Samuelson, 1941). Therefore, labor-intensive industries will press for higher protection, thus creating a positive relationship between labor intensity and the tariff rate. As far as unskilled labor intensity is concerned, if the political process aims to help lower-income groups that have been hurt by foreign competition, there should be a positive relationship between unskilled labor intensity and the tariff rate. That is, tariffs should protect industries that employ low-skill and low-wage labor. Because the U.S. has abundant skilled labor relative to other countries while unskilled labor is relatively scarce (Ball, 1967), unskilled labor will benefit from protection according to the Stolper-Samuelson theorem. In short, on theoretical grounds, the effect of unskilled labor intensity on the tariff rate should be positive.

Regarding industry concentration, it is safe to assume that producers are more interested in and more responsive to trade policy than consumers. This is because, first, consumers do not have the financial resources, time, or technical knowledge to familiarize themselves with the costs and benefits of tariff policy and, second, they are much more numerous than producers. It is well-known that consumers are the losers from trade restrictions but, given their large number, the cost to each individual is very small, thus virtually eliminating the incentive to campaign against such restrictions. In contrast, because producers are much fewer than consumers, the benefits of protection are much

greater for each individual producer, thereby creating a much greater incentive for a group of producers to organize in order to obtain protection (Olson, 1965). Thus, the smaller the number of producers (and, consequently, the higher the concentration) the greater the incentive to seek protection. Also, since more concentrated industries are, on average, more profitable relative to less concentrated ones, they are better able to expend the resources necessary to inform Congress about their needs and to exert pressure in favor of protection. Furthermore, a concentrated industry with few sellers has by definition a smaller number of beneficiaries from tariff protection, thereby mitigating or eliminating any free rider effects that are usually observed in groups of large size: The bigger the number of firms, the more costly and difficult it is to organize them. All these factors point to a positive effect of industry concentration on the tariff rate. Another theoretical prediction, however, implies that industry concentration can be negatively related to protection. This is because, if there are many firms in an industry (thus making it less concentrated), more members of Congress can be influenced in favor of protection. That is, decentralized economic activity (not in the spatial sense) can have greater weight when the votes are added (Caves, 1976). So the theoretical predictions of the effect of industry concentration on the tariff rate conflict. My feeling is that the higher cohesiveness of more

concentrated industries and the mitigation of any free rider effects will probably more than offset any voting-bloc benefits of less concentration, thus making the effect of industry concentration on the tariff rate positive.

In the case of regional concentration, there are theoretical considerations which point to its positive effect on the tariff rate. That is, the more geographically concentrated an industry is, the greater the tariff rate, *ceteris paribus*.²⁰ First, geographically concentrated industries may be significantly affected by foreign competition more compared to less geographically concentrated ones: A possible economic decline will hit a geographical region particularly hard, thus creating a strong incentive to lobby for protection.²¹ Second, the proximity that exists in geographically concentrated industries improves communication among the interested parties and reduces any free rider problems associated with spatially dispersed industries.²² Third, geographically concentrated industries can better monitor the activities of their elected representatives, thus creating additional

20 This of course does not apply to regionally concentrated industries that have no need for protection.

21 The local government has a strong incentive to call for protection because loss of area jobs and general economic decline will erode the area's tax base, causing a decline in tax revenues and, consequently, create havoc with local finances.

22 In spatially dispersed industries, monitoring against free rider proclivities is harder.

pressure on members of Congress to grant protection. In sum, these theoretical considerations point to a positive relationship between geographic concentration and the tariff rate. Alas, the relationship may also be negative. This is because geographical dispersion may generate more political pressure because geographically dispersed industries can try and influence more Congressmen (Baldwin, 1989). Because, however, more geographic concentration can exert greater pressure due to its importance on election time, the effect should be positive.

Finally, I address the effect of political influence on tariff rates. Regardless of whether an industry is regionally concentrated, political influence confers benefits to districts. Congressmen maximize their utility by maximizing their chances for reelection. Therefore, they have a direct interest in taking into account the preferences of their constituents. The question here is how often they do so. Members of Congress do not follow a consistent pattern in their voting in regard to their constituents (Halper, 1981). They may act as *delegates* or *trustees*. Some legislators view themselves as *delegates*. That is, they act according to the preferences of their constituents, either out of conviction or out of the desire for reelection. In contrast, *trustees* view themselves as representatives beholden to no one who have to follow their own judgment and conscience. Of course, the cost of such behavior may be defeat at the

polls.²³ For many issues, though, constituents have neither the knowledge nor the interest to try and influence their elected representatives. Members of Congress may not have enough knowledge and time either, given the complexity of issues facing the federal legislative branch. Therefore, a third role comes into play, the *partisan* role. Here, members of Congress will take their cue from their party. In the case of tariffs, however, this may not be true because protection and loss of jobs are issues that their constituents understand and feel strongly about. Even if regional concentration is low, the existence of even a small number of threatened jobs within their districts will spur Congressmen into action, either because of a genuine desire to save these jobs or because of the positive publicity involved. When jobs are threatened, there is evidence that House members break with the party line (Baldwin, 1989). Since House members from a state will likely act as a bloc,²⁴ larger Congressional delegations will have more influence both within Congress and with the Chief Executive. Because our Presidential election system gives much greater weight to more populous states through the Electoral College, the

23 The delegate/trustee distinction is of course not absolute; members of Congress act as delegates in some cases and as trustees in others, depending on the particular case and on whether their seat is relatively safe or precarious.

24 This may be out of conviction, loyalty, or by the desire to create a popular base that can be utilized in potential campaigns for higher office (many House members aspire to a seat in the Senate).

President, especially in his first term, has a vested interest in being responsive to the needs of large states. Also, large state delegations have more influence within the House because they can exert more pressure and call in for the reciprocity of past favors and past support by other members. That is, because of the existence of logrolling, larger delegations have a greater number of votes and favors to trade and rely upon for reciprocity. These factors point to a positive relationship between Congressional influence and the tariff rate. Because of logrolling, however, the picture is a bit complicated since it is an unobservable and non-quantifiable variable and since it is possible for small state delegations to have disproportionate influence. This will be particularly true if a delegation member occupies the chairmanship of a crucial committee or he or she holds a party leadership position.

A large literature has attempted to explain tariff rates as a function of industry and regional structure, labor characteristics, and political influences [Cheh (1974), Ray (1981), Ray and Marvel (1984), and Godek (1985) for the United States, and Caves (1976) and Helleiner (1977) for Canada]. Although sometimes conflicting results have been reported, the consensus is that it is mainly structural and labor input characteristics that affect the level of tariffs.

Cheh (1974) analyzed the exemptions awarded to American industries from the across-the-board 50 percent tariff cut that resulted from the Kennedy Round. He concluded that

declining industries and industries with a high proportion of unskilled workers were treated favorably by receiving lower reductions (that is, tariffs were not cut by much, thereby maintaining higher levels of protection). So here we see a positive relationship between unskilled labor intensity and tariff rates.

The remaining studies paid closer attention to variables like industrial and regional concentration and therefore are closer to the intent of the present study. Ray (1981) found that tariffs are positively and significantly related to labor intensity while being unrelated to producer concentration and geographical dispersion.²⁵ The concentration ratio, while insignificant, was consistently positive. The same was true for geographic dispersion. As it shall be seen in the empirical part of this thesis, geographical and industrial structure variables will be used in attempting to explain tariff rates for the American manufacturing sector.

Ray and Marvel (1984) used four-digit SIC manufacturing data to examine nominal and effective tariff protection for the United States, Japan, Canada, and the EEC. No measure of geographic concentration was included in their study but, regarding the four-firm concentration ratio, they found that its coefficient was negative and very insignificant in both the nominal and effective tariff regressions for the U.S.

25 Geographical dispersion was defined as the sum of the absolute deviation between the share of value of shipments and the share of population for the four regions of the U.S. (North, South, Central, and Western). Ray's study used four-digit SIC industries.

Insignificant coefficients with fluctuating signs were reported for Japan, Canada, and the EEC.

Godek (1985) used average wage in industry to measure labor intensity, geographic concentration (defined as the sum of squared shares in production in the five largest production states), and industry concentration to determine nominal tariff rates for American manufacturing. He defined concentration as the logarithm of the number of firms. The expected sign here is negative because more firms reduce the level of concentration.²⁶ His industry concentration variable was negative and significant, meaning that given the inverse aspect of the variable, concentration is positively related to protection. The effect of geographic concentration on the tariff rate was positive and weakly significant. Godek also found the expected positive and significant relationship between tariffs and labor intensity.

Turning briefly to Canada, Caves (1976) found a negative and significant relationship between the four-firm concentration ratio and the tariff rate. He attributed this on the grounds that the benefits of protection will obtain more votes if they are more widely dispersed. Labor intensity fluctuated in sign and significance because of collinearity with the concentration ratio. Geographic

26 According to Godek, there are also some free rider effects here: The bigger the number of firms the more costly and difficult it will be to organize them into a group for political influence purposes [Godek (1985), pp. 690-91].

concentration was always negative but insignificant.²⁷

Finally, Helleiner (1977) found that unskilled labor intensity (defined as average industry wage) was the most significant explanatory variable in Canada's tariff structure. Using the same measure of industry concentration as Caves, he found that concentration was consistently positive but insignificant in regards to nominal protection and positive and significant regarding effective protection.

In closing, the picture that has emerged from the literature is that labor intensity is a significant positive determinant of tariffs while for industry concentration diverse results have been reported: For some studies it is positive (Ray, 1981), for others it is negative (Ray and Marvel, 1984) but is often insignificant. Regional concentration is positive (Ray, 1981) but often weakly significant (Godek, 1985). Nevertheless, Godek suggests that structural variables must be included in empirical analyses and that this may be particularly true for geographic concentration because of the political influence of geographic units in federal systems (Godek, 1985).

The chapter shall now proceed with a brief discussion of the determinants of industrial concentration.

27 The definition of this variable is specific for Canada. It was defined as the percentage of workers outside Québec and Ontario.

2C. Determinants of Industrial Concentration

Industrial concentration is the main independent variable of this thesis. Because, however, the model framework will include the simultaneous determination of concentration and the tariff rate and because there is a large theoretical and empirical literature which points to the endogeneity of concentration, this bare-bones section will address its determinants, along with a brief empirical summary.

The determinants of industrial concentration are many²⁸ but, in the context of this dissertation, a simple theoretical model can be formulated by making concentration a function of entry conditions such as advertising and economies of scale, market growth, and government policy (here, the level of tariffs).

Among industries, advertising intensity (defined as advertising expenditures as a percentage of sales)²⁹ is likely

28 The list of determinants can be rather large. For example, government policies can include the granting of patents, licences, and the effects of procurement policy (that is, the government may award large contracts to certain producers, thus encouraging concentration if those producers are large. Mergers may also affect the level of concentration. In this dissertation, variables like these will be excluded due to data limitations at the four-digit SIC level. Nevertheless, it shall be seen in the empirical section of this dissertation that the results of the simple model are quite robust.

29 A problem with using advertising expenditure as a percentage of sales to denote advertising intensity is that if an industry is large sales-wise and spends, in absolute terms, huge amounts of money in advertising, the actual advertising/sales ratio is low, thus giving the misleading impression that the industry does not advertise much.

to have a positive effect on industry concentration. There are several ways for this to happen. First, advertising wars can have a positive effect on concentration because a firm or group of firms, regardless of size, may be successful in advertising and can thus expand at the expense of other companies in the industry. This will of course invite retaliation and competitive rounds of advertising may continue, causing higher costs, losses, bankruptcies, mergers, and, consequently, higher industry concentration (Greer, 1992). Second, there may be a positive effect of advertising on concentration because of economies of scale in advertising. Such economies have two components (Waterson, 1984). The first component is financial and has to do with the fact that larger companies can obtain larger discounts for bigger quantities of advertising (be it on television or in the print media). The second component is technical and is associated with the idea that if, say, the number of advertising messages is doubled, the effect on sales will more than double. For this to happen, a minimum number of messages may be needed to have an effect on the consumer. Third, advertising may have a positive effect on industry concentration because larger firms may be better able to afford higher advertising expenditures either because they have deeper pockets or because they plan to act as predators.³⁰

30 This predatory explanation is slightly different from the advertising wars explanation mentioned above in the sense that one large firm starts the fracas while in advertising wars any firm can be the point of origin.

In short, advertising wars, economies of scale in advertising, and the greater financial flexibility and possible predatory designs of large firms point to a positive effect of advertising on industry concentration.³¹

Turning to economies of scale, these have a positive effect on industry concentration. To begin with, when fixed cost is large, average cost will decline as output increases, giving the long-run average cost curve a downward-sloping shape. These economies of scale originating at the plant level must be distinguished from economies occurring at the firm level. Plant economies of scale arise from specialization and the learning curve effect while firm economies are mainly the result of organizational efficiencies.³² The size of the firm will influence the degree of efficiency. Size will affect efficiency through plant economies of scale, firm (or multiplant) economies, and diseconomies of scale at the firm level (Bain and Qualls, 1987). The main economies of scale are realized at the plant level. At the plant level, the combination of specialized labor, specialized machinery, and specialized management will result in declining costs per unit as output expands. This reduction will continue up

31 It is possible for higher advertising to be a cause of declining concentration if concentration is initially very high. This is because an entrant may spend a much higher portion of sales in advertising compared to established firms in order to obtain a foothold in the market and to keep expanding his or her share. Because this is not a dissertation about concentration and advertising, this effect will not be considered here.

32 This does not mean that technical factors are irrelevant for economies at the firm level.

up to the point known as the Minimum Efficient Scale (MES). Now, if the MES increases *per se* this will cause a reduction in the number of plants in long-run equilibrium. This will consolidate production in a smaller number of plants and may reduce total resources devoted to fixed costs (Martin, 1994). Even if these resources are not reduced, the fact that there are fewer plants causes the fixed cost per plant to become larger. Larger fixed costs per plant cause the equilibrium number of firms to fall (Martin, 1994). The lower number of firms increases the level of concentration. Therefore, there is a positive relationship between economies of scale and concentration.

At the firm level, costs may be further reduced by operating several MES plants to take advantage of economies of large scale management and large scale distribution.³³ Diseconomies of very large scale will eventually be encountered because it will be hard to manage progressively larger organizations. Planning becomes more complex and costly as the number of activities to be coordinated increases (Coase, 1937).³⁴ However, with today's sophisticated computer and communications technology it is much easier to manage large organizations. The question is

33 These firm economies can be obtained in addition to the plant economies.

34 One must not consider only diminishing returns in managing. Workers express less satisfaction and excitement about their jobs in larger establishments than in small ones because large establishments tend to be more impersonal.

about how soon MES will be reached. There are three options. First, diseconomies may set in as soon as MES is reached. Unit costs will start rising, giving the long-run average cost curve a U-shape and thus resulting in a single unique efficient scale. Second, after MES is reached, the firm may expand indefinitely without any changes in unit cost (the average cost curve is a horizontal line after MES). Third, after MES is reached, the average cost curve may be approximately horizontal over a large range before diseconomies set in. The first outcome is not very common; the second and third cases are more realistic (Scherer, 1980). So the more likely case is that unit costs decline until the optimal MES is reached, then there is a (more or less) constant range, and then managerial diseconomies set in when the enterprise expands too much.

Here we ought to address a counterargument. If economies of scale are causing unit costs to decline (and then stay approximately constant over a large range) then why has one firm not driven out all the others by expanding output and lowering costs? Many firms exist in different industries. This is made possible by the demand facing the industry: The greater the demand relative to the firm's output at MES, the greater the number of firms will be and vice versa. Highly concentrated industries result from industry demand which is insufficient to support a large number of firms at MES size.

Earlier it was established on theoretical grounds that the relationship between industry concentration and scale economies is positive. But how close this correspondence is? If concentration is directly dictated by economies of scale then antitrust authorities can do very little because technical considerations determine industry structure. However, studies such as the one by Scherer (1974) show that actual concentration, as measured by the four-firm concentration ratio, is much larger than MES would dictate. Estimates of MES³⁵ indicate that most industries have relatively small MES and roughly constant costs at the firm level. So concentration is much higher than dictated by economies of scale, resulting in excess market share for the firms in the industry. Concentration increases with the need to operate large efficient plants but efficient plants are not the only cause of concentration. Concentration is a means to cause plant size but it is acting as a proxy. So technical economies of scale do not explain all the actual market shares and industry concentration. For companies with excess market share above MES, their large size may often lead to the costs of monopoly power, such as inhibited innovation and X-inefficiency. Whether the concentration

35 MES estimates are based on cost studies, engineering studies, and "survivor" studies. The literature is extensive. Because these methods are time-consuming, expensive, cumbersome, and have been criticized on methodological grounds, Census of Manufactures plant size distributions are often used to estimate MES. Such an approach will be used in this dissertation, as it shall be seen in the next chapter.

made possible by excess market share adversely affects export intensity because of the inefficiencies of large size will of course be examined in the next two chapters by utilizing the measure of concentration by itself and itself squared, as described in detail in the first section of this chapter.

Turning to market growth, there are certain reasons why it will have a negative effect on concentration. First, the faster the demand for the product rises, the less relevant the plant scale requirements and, on average, the greater the pressure toward declining concentration due to the bigger number of firms that can be accommodated by the market. Second, growth often destabilizes an industry, making it easier for new and small firms to enter and thus reducing concentration. Of course, the leading firms may use a rapid growth rate in order to maintain their market shares, especially if they plan to increase their dominance in the future. It is thus unlikely that the leading firms will not retaliate in some way in the face of market share erosion caused by small entrants. The magnitude of the reaction by the leading firms will of course depend on the particulars of each industry, on whether they are affected by the complacency and inefficiency that often accompanies large market size, and by the fear of possible antitrust prosecution in case of aggressive retaliation. In short, the effect of higher industry growth on concentration should be negative, *ceteris paribus*.

Finally, I address the effect of tariffs on industry concentration. The effect may be positive or negative.³⁶ Tariffs may insulate imperfectly competitive industries from foreign competition, thereby maintaining high industrial concentration. At the same time, protection may rob the industry of the incentive to adopt an efficient industrial structure. Bloch (1974) has suggested that this has been the case for Canada. On the other hand, protection will not only reduce imports but may attract domestic firms to enter the industry. Because of protection, inefficient firms can thus survive (Horstmann and Markusen, 1986). So the end result is that the number of producers expands, thereby reducing concentration. Eastman and Stykolt (1960) have shown this to be the case for Canada while Carlsson (1972) found the same result for Sweden. In the case of the United States, Zerbe (1969) has used the example of the late nineteenth and early twentieth century sugar trust to show that the high domestic tariff on sugar insulated producers from competition and helped them collude but the higher profit margins caused by tariff policy encouraged entry by beet sugar producers, resulting in rapidly expanding output and falling prices.

It is unlikely that high industrial concentration will be maintained as a result of a tariff because the inefficiencies of the protected industries are highly likely

36 If the late nineteenth century adage stating that the tariff is the mother of trusts is still true, the effect of tariffs on concentration should be positive.

to attract entry. In short, even though there is a theoretical possibility for higher tariffs to have a positive effect on concentration, the theoretical justifications for a negative effect on concentration are much stronger. Thus, we should expect the effect of tariffs to be negative.

The empirical literature dealing with the determinants of industrial concentration is immense. The general picture that emerges is that the level of concentration is determined by entry conditions such as economies of scale and advertising. Market growth and government policies are also important. Some representative studies are those of Nelson (1963), Ornstein et al. (1973), Strickland and Weiss (1976), Martin (1979), Mueller and Rogers (1980, 1984), and Ray and Marvel (1984).

In his 1963 book,³⁷ Nelson found that industry growth will cause the level of concentration to decline: He calculated that each 100 percentage point increase in industry value added between 1935 and 1954 resulted in an 1.45 percentage point decline in the four-firm concentration ratio.³⁸ This suggests that a measure of industry growth has to be included in the model of this dissertation.

Ornstein et al. (1973) estimated a logarithmic model with the logarithm of the four-firm concentration ratio as the dependent variable and concluded that there is a positive

37 R.L. Nelson, Concentration in the Manufacturing Industries of the United States. New Haven, CT: Yale University Press, 1963.

38 Quoted in Scherer (1990), p. 120.

and significant relationship with advertising intensity. They also found that the growth rate of the industry was not significant in affecting concentration. They did not use any measures of minimum efficient scale (MES) but they reviewed the behavior of MES in various studies from the late 1960s and early 1970s and found that it positively and significantly affected concentration in all of them.³⁹

Strickland and Weiss (1976) investigated the relationship between advertising and concentration in a simple framework as part of a larger examination of concentration, advertising, and price-cost margins. They estimated a simple equation of the concentration ratio as a function of advertising intensity and MES and found both variables to be strongly significant.

Martin (1979) estimated that changes in the four-firm concentration ratio were positively and significantly associated with the minimum efficient scale as a fraction of industry output but did not find a significant relationship with advertising intensity.

Mueller and Rogers (1980) found a positive and significant relationship between the concentration ratio and advertising intensity. The same two authors (1984) estimated that, for the 1947-1977 period, each 100 percentage point increase in current dollar value added caused the four-firm concentration ratio to decline by 0.7 percentage points. This trivial decline reinforces the modest effect reported by Nelson (1963).

³⁹ Ornstein et al. (1973), p. 621, Table IV.

Finally, in the context of this dissertation, one has to include an international aspect, which is also the result of government action. I have decided to include the tariff rate as a determinant of concentration for two reasons: First, because the model is to include the simultaneous determination of concentration and the tariff rate and, second, to see whether tariffs positively or negatively affect the level of concentration. Some of the studies of the previous section found an insignificant relationship between tariff rates and the level of concentration [Ray and Marvel (1984), for example]. All of those studies, however, had a measure of industry concentration as the independent variable while the tariff rate was the dependent variable. Here I will be including the tariff rate as a determinant of industry concentration.

The chapter will now conclude with a brief discussion of the determinants of regional concentration.

2D. Determinants of Regional Concentration and its Effect on Export Intensity

This dissertation is not about the determinants of geographic concentration but, because this is a relatively overlooked variable in industrial organization/international trade studies and because it will be included in the study as a determinant of export intensity, some discussion is warranted about its causes.

The factors leading an industry to become geographically

concentrated⁴⁰ are many and complex and, therefore, a detailed extensive discussion is beyond the scope of this research.⁴¹ The classic discussion on the subject is due to Alfred Marshall (1920). According to Marshall, there are three distinct reasons for geographic concentration. First, when an industry is concentrated in one place, this creates a pooled market for specially skilled workers. Good examples are Silicon Valley and New York City, a great center of higher learning and provider of educated labor to the city's financial sector. The cost, productivity, availability, and stability⁴² of labor will be important factors in determining the location of firms in an industry. A good example is the movement of jobs from the Northeast to the South since Southern wages are lower because Southern labor is less unionized. Second, geographically concentrated industries can support the production of non-tradable specialized inputs. That is, support industries will be created in order to supply needed inputs to the "mother" industry. A good example is the automobile industry that is concentrated in the Midwest: Michigan is the center while adjacent states not only have auto factories but also many industries that

⁴⁰ Throughout this thesis, I am using the terms "geographic concentration" and "regional concentration" interchangeably.

⁴¹ The literature is enormous. Detailed texts include Chapman and Walker (1991), and Miller (1977), not to mention hundreds of articles.

⁴² By stability I mean the incidence of strikes, absenteeism, tardiness, sabotage by disgruntled employees, and the like.

produce outputs specific to the auto industry's final product. Third, the clustering of firms can generate positive technological and informational externalities. That is, there are savings in production when firms locate close to each other, giving rise to economies of agglomeration. Agglomeration consists of three types [Hoover (1937), Chapman and Walker (1991)]. First, scale economies can contribute to larger plants and thus lower unit costs. Second, localization economies will provide benefits when small independent businesses locate close to each other. An example that comes to mind is Manhattan's jewelry/diamond district. Finally, when many different businesses locate in a dense area, commercial activity improves in both variety and quality, and supply, marketing, and distribution channels improve. In general, business interaction improves economic activity, giving rise to urbanization economies. Once agglomeration begins, its initial advantage will create a snowballing effect and the urban structure will expand (Pred, 1966).

One should not ignore transportation costs. These play a very important role in the location of industries: Every significant manufacturing center in the United States is also a major transportation center. According to Miller (1977), this can be illustrated by the manufacturing zone along the Penn Central railroad from New York to Chicago through the New York state lowlands and south of the Great Lakes, encompassing cities such as Schenectady, Syracuse, Rochester, Buffalo, and onward to Cleveland and Chicago. As

far as transportation costs are concerned, industries can be classified as resource oriented, market oriented, or neutral ("footloose"). Resource oriented industries are generally weight-losing, meaning that the final product has less weight than its inputs, creating an incentive to locate close to the resource. This is because final product transportation costs are lower than input transportation costs to the production site. Lumber and the American steel industry that is concentrated in Pennsylvania, West Virginia, and Kentucky are examples. Market oriented industries are mostly weight-gaining, meaning that the product gains weight during the production process, as in soft drinks. The result is that the transportation cost of the final product is higher than the transportation cost of the inputs, thereby making it efficient to locate close to the market. Neutral industries are not particularly affected by resource or market demand considerations. This may be because the product is neither weight-gaining nor weight-losing or because it is valuable, like electronic equipment.

Speaking of markets, and this is a corollary to the transportation cost factor, it pays to locate in areas with the greatest market potential. Even though the American manufacturing belt has been losing employment,⁴³ it is no

43 The states in the belt are Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Michigan, and Wisconsin. Using Census state data, Paizis (1989) estimated that its share in manufacturing employment was as follows: 1972: 51.94%, 1977: 49.09%, 1982: 45.86%. I also calculated that from 1972 to 1982 only Massachusetts, Connecticut, and Wisconsin gained employment (3.87%, 6.26%, and 39.12% gain, respectively).

coincidence that it overlaps the area of the country with the greatest market potential, namely a broad, densely populated zone extending from Massachusetts through the large industrial states to Illinois and southern Michigan, with the maximum potential located of course in New York City. Such a situation will create a "circular causation" effect, whereby manufacturing production will tend to concentrate where there is a large market and the market will be large because manufacturing production is concentrated (Myrdal, 1957).

Regarding the effect of the above factors on export intensity, we can conclude the following: The lower costs resulting from agglomeration economies in general and the transportability benefits will both have a positive effect on the efficiency and competitiveness of exporting enterprises. Therefore, since geographic concentration is the result of a combination of agglomeration economies and transportation cost considerations, its effect on export intensity should be positive.

I shall now address some empirical aspects of geographic concentration and summarize two studies that examined its effect on export intensity. Although Bain's (1951) seminal study led to a plethora of subsequent studies in which all aspects of concentration were investigated, these studies ignored the effect of geographic concentration. The blame for this omission lies not with the economics profession but with the federal government. It is well-known that the concentration measures published by the government are

misleading because they are based on the assumption that markets are national. Since many industries are regionally concentrated, this means that reported measures understate the level of true industry concentration. Newspapers provide an excellent example: For 1982, the four-firm concentration ratio for the industry (nationally) was reported as 22%.⁴⁴ It is well-known that many cities have two or even one newspaper; the real concentration ratio thus reaches 100%.⁴⁵ The fur industry is another excellent example: For 1982, the industry four-firm concentration ratio was only 12%⁴⁶ but 88% of employment was located in New York state.⁴⁷ So it is possible for an industry to be relatively unconcentrated in the industrial sense but highly concentrated in the geographic sense. The government, though, has not adjusted its national concentration measures to reflect regional patterns.

⁴⁴ U.S. Department of Commerce, Bureau of the Census, 1982 Census of Manufactures: Concentration Ratios in Manufacturing, MC82-S-7 (U.S.G.P.O., 1984), p. 22, Table 5.

⁴⁵ An 100% concentration ratio is unlikely because many important newspapers like the New York Times, Washington Post, and the Wall Street Journal, have wide regional or national circulation, so there is an element of competition, however, minor, with the local paper(s).

⁴⁶ Concentration Ratios in Manufacturing, p. 16, Table 5.

⁴⁷ 1982 Census of Manufactures, Industry Series: Miscellaneous Apparel and Accessories, MC82-I-23D (U.S.G.P.O., 1984), p. II.

The government has not published regional concentration measures in tabular form and has apparently no intention of doing so.⁴⁸ Therefore, economists have included a proxy measure of regional concentration in their analyses. The result is that different researchers have constructed different concentration indices but have mostly used such indices to explain price-cost margins [for example, Weiss (1974)].

In the context of export intensity, Marvel (1980) included

⁴⁸ The 1982 Census of Manufactures, in each Industry Series booklet, briefly discussed each four-digit SIC industry in the introduction. There it listed, in passing, the top four states in each industry and their share in national employment ("four-state" concentration ratios). The 1982 Census listed such information for the vast majority of the 448 four-digit industries. This policy was not continued with the 1987 Census: Examination by this author showed that the Census lists the top three states and their share, the top two states and their share or just four, three, or two states without giving their employment share (sometimes even one state was given). A simple count revealed that, from the 459 industries (the Census redefined some industries for 1987 so their number increased compared to 1982), 231 did not list the employment share at all. Of the remaining 228 industries with reported shares, 29 listed three states or less. The problem for researchers is aggravated by the fact that the state employment figures that can be utilized instead are often suppressed for confidentiality reasons. In the empirical part of this dissertation, this problem will be addressed in detail when an index of geographic concentration will be constructed.

a geographic index⁴⁹ in his analysis of the composition of trade flows. Assuming that demand per capita is constant across regions, the geographic concentration of production in one area suggests that the industry's products are easily transported, meaning that they are tradable. He found a positive and significant relationship between export intensity (defined as exports divided by value of shipments) and the geographic index.⁵⁰ An earlier study by Pugel (1978) found the same positive and significant relationship between export share and a measure of transportability (defined as the mile radius within which 80 percent of industry shipments are made) for seventy-one industries that were based on the IRS classification system. IRS industries are roughly equivalent to three-digit SIC industry groups.

The above studies stress tradability but one should not lose sight of the agglomeration effects in creating an

49 The index, which was actually suggested by Collins and Preston in the late 1960s, was defined as follows:

$$\sum_{i=1}^4 |s_i - p_i|,$$

where s_i was the share of shipments originating in region i and p_i was the share of the U.S. population in region i . There were four Census regions (North, South, Central, and western). The same index was used by Ray (1981). See note 25, *supra*. This index, also used by Weiss (1974) in his price-cost margin study mentioned above, was defined so that increases in its value were associated with increased manufacturing activity in one region of the country.

50 This measure used by Marvel and considered an indicator of geographic concentration should be better called a measure of the disparity between production location and demand location.

efficient environment for exports. The agglomeration economies generated by spatial concentration provide a cost advantage that makes it possible to export to international markets (Porter, 1990). I shall avoid elaborating further on the extensive agglomeration literature because it is well beyond the scope of this dissertation.

Summary

This chapter examined the theoretical relationship between industrial concentration and export intensity, the determinants of tariffs, the determinants of industrial concentration, and the factors that lead industries to become regionally concentrated. The literature in each case was also reviewed.

Regarding the effect of industry concentration on export share, it is positive if the industry is able to price discriminate. This effect may be reinforced by the presence of tariffs. If the (non-competitive) industry is unable to price discriminate, however, the effect will be ambiguous since its choice will be to either behave like a perfect competitor or to abandon the export sector altogether (assuming the world market is competitive). Also, arguments were presented in support of a possible non-linear relationship between industry concentration and export share, on the grounds of inefficiencies of large size. A detailed framework was built on how to test such a relationship.

The picture that emerged from the literature is one of a mostly positive and significant relationship between industry concentration and export share. This hypothesized relationship will be tested both for the entire American manufacturing sector and for its two subgroups of durable and non-durable goods industries.

A tariff rate determination model was developed and theoretical and empirical reasons pointed to a positive effect of unskilled labor intensity. The effect of industry concentration was shown to be ambiguous, although more likely to be positive than negative due to the greater cohesiveness of more concentrated industries. The same conflicting theoretical predictions were present regarding the effects of regional concentration. As before, however, the effect is more likely to be positive than negative given that geographically concentrated industries can exert greater pressure, especially on election time. Given these conflicting views, the literature has reported diverse results concerning the sign and significance of these two structural variables. Finally, theoretical considerations point to a positive effect of Congressional influence on tariff rates but the issue is a bit complicated because of the unobservable influence of logrolling.

In the case of industrial concentration, advertising intensity and economies of scale are expected to have a positive effect on it. Market growth should have a negative effect on concentration due to its destabilizing influence

and the fact that it can make economies of scale less relevant. Lastly, the tariff rate may have a positive or negative effect on concentration because it can either maintain it or insulate inefficient companies, thereby attracting entry. The second effect is the more probable one, thus making the influence on industry concentration negative. The literature supports these theoretical predictions.

Finally, an analysis of the determinants of geographic concentration pointed to the direction of labor market considerations, specialized input considerations, agglomeration economies, transportation costs, and market potential. The combination and interaction of agglomeration efficiencies and transportation costs points to a positive effect of geographic concentration on export intensity, and this has been supported by the empirical literature.

The discussion will now proceed with an analysis of the econometric model and its extensions, a detailed analysis of each variable, and the method of estimation. Then, in the following chapter, the empirical results will be presented.

CHAPTER 3: THE ECONOMETRIC MODEL AND ITS EXTENSIONS, THE VARIABLES, THE METHOD OF ESTIMATION, AND OTHER ISSUES.

This chapter will discuss the basic econometric model and its extensions, the variables, the method of estimation, and the issue of the measure of industry concentration that was briefly alluded to in the previous chapter.¹ First, the model will be introduced, followed by a detailed discussion of the construction of each variable and its source(s). Two variables are introduced here for the first time; they will be accompanied by brief discussions on their expected effect on export intensity. The chapter will then proceed with an analysis of the method of estimation, some other related issues, and will conclude with an analysis of the measure of industry concentration, which will set the foundation for the testing of an extended version of the export share equation by using a different measure of concentration.

3A. The Econometric Model

The basic model shall consist of the following three equations. The "boxed" variables are endogenous while all others are exogenous. ϵ_1 , ϵ_2 , and ϵ_3 , of course, represent the error terms:

¹ See note 18, Chapter 2, *supra*.

$$\boxed{\text{TARIFF}} = \beta_0 + \beta_1 \text{LAB} + \beta_2 \boxed{\text{H}} + \beta_3 \text{RGN} + \beta_4 \text{POL} + \varepsilon_1 \quad (1)$$

$$\boxed{\text{H}} = \beta_5 + \beta_6 \text{AS} + \beta_7 \text{MES} + \beta_8 \text{DGR} + \beta_9 \boxed{\text{TARIFF}} + \varepsilon_2 \quad (2)$$

$$\boxed{\text{XVS}} = \beta_{10} + \beta_{11} \boxed{\text{H}} + \beta_{12} \text{VI} + \beta_{13} \text{AS} + \beta_{14} \text{RGN} + \beta_{15} \text{HUM} + \varepsilon_3 \quad (3)$$

TARIFF is a proxy for the tariff rate, LAB is unskilled labor intensity, H is the Herfindahl-Hirschman index of industry concentration, RGN is an index of regional concentration, POL is a measure of political influence, AS is advertising intensity,² MES is a proxy measure for minimum efficient scale, DGR is industry growth over the period 1977-1982, XVS is export intensity, VI is a measure of vertical integration, and HUM is a measure of human capital. Brief definitions of each variable, along with means and standard deviations, are provided in Table 3.1. In addition, the relationships between the variables can be illustrated in Figure 3.1.

The basic model, along with later extensions, will be tested using data from the entire manufacturing sector, which consisted of 448 4-digit SIC industries in 1982. Then the entire data set will be broken down into durable and non-durable goods industries. The durable/non-durable classification was based on a breakdown by the 1982 Census

2 The reason for the inclusion of AS in the export share equation will be provided when AS is analyzed later on.

TABLE 3.1

DEFINITIONS OF VARIABLES AND THEIR MEANS
AND STANDARD DEVIATIONS

TARIFF	Tariff rate proxy, defined as import duties divided by value of imports, ($\mu = 5.955$, $\sigma = 5.951$).
LAB	Unskilled labor intensity, defined as unskilled wage for 1982 (\$9,327, found in 1983 Current Population Reports) multiplied by industry employment divided by industry value added, ($\mu = 25.314$, $\sigma = 10.987$).
H	Herfindahl-Hirschman index of industry concentration, ($\mu = 746.236$, $\sigma = 813.989$).
RGN	Index of regional industry concentration. The definition is involved and will not be explained here. Please see the discussion for details. ($\mu = 14.670$, $\sigma = 11.156$).
POL	Total number of House members in the top four states, in terms of industry employment, divided by the total number of House members (435), ($\mu = 19.646$, $\sigma = 6.322$).
AS	Advertising intensity, defined as expenditures on advertising divided by industry value of shipments, ($\mu = 1.809$, $\sigma = 1.844$).
MES	Proxy measure for minimum efficient scale. The definition and calculation will be explained in the text. ($\mu = 0.492$, $\sigma = 1.012$).
DGR	Industry growth, defined as the percentage change in <i>real</i> value of shipments, 1977-82, ($\mu = -0.425$, $\sigma = 35.924$).
XVS	Export intensity, defined as exports divided by value of shipments, ($\mu = 7.785$, $\sigma = 8.715$).
VI	Vertical integration, defined as industry value added divided by industry value of shipments, ($\mu = 48.008$, $\sigma = 13.756$).

(continued)

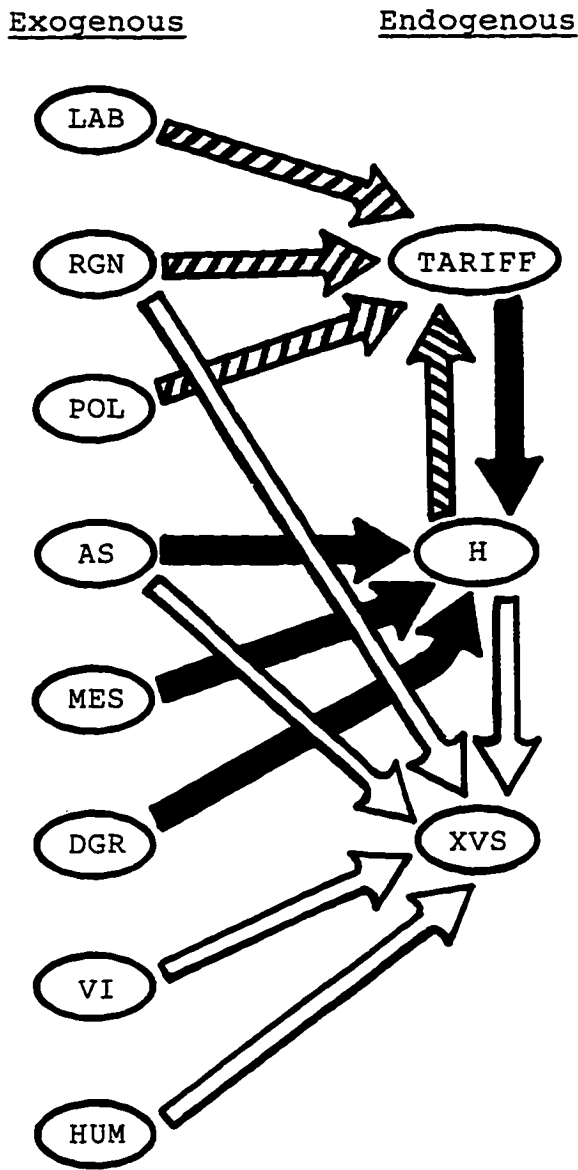
TABLE 3.1

(continued)

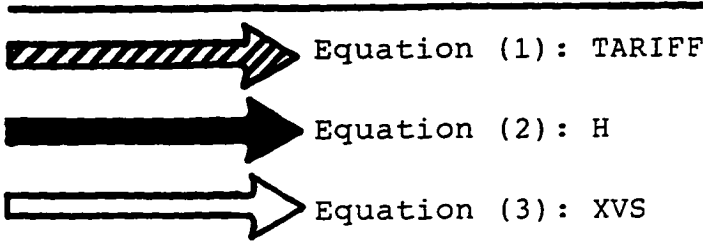
HUM	Measure of human capital, defined as $(w - \tilde{w})L / .10$, where w is the industry wage, $\tilde{w}$ is the median wage of a person with less than eight years of education for 1982 (\$9,327), L is industry employment, and $.10$ is a discount factor. This is the conventional measure of human capital in the human capital production function literature (Griliches, 1970). ($\mu = 4,187.811$, $\sigma = 7,849.400$).
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<u>Note:</u>	All the variables that are shares (TARIFF, LAB, POL, AS, MES, DGR, XVS, and VI) are expressed in percentage terms.
--------------	---

FIGURE 3.1
RELATIONSHIPS AMONG THE VARIABLES



LEGEND: EQUATIONS AND THEIR
DEPENDENT VARIABLES.



of Manufactures: Fuels and Electric Energy Consumed, App. 1, Subject Series MC82-S-4 (Part 1), which used major groups (2-digit SIC level) to break down the American manufacturing sector into durables and non-durables. Given the structure of the SIC system, which disaggregates from major groups (2-digit) into industry groups (3-digit), industries (4-digit) and so on until 7-digit products, it was very easy to decide which 4-digit SIC industries were durable goods industries and which were non-durable goods industries.³

We shall now begin the detailed analysis of each variable: Its definition, its construction (if constructed), advantages and disadvantages if any, and its source(s).

3A.1. TARIFF (Tariff Rate Proxy)

This is a proxy for the nominal tariff rate and is defined as import duties divided by the value of imports for 1982. It is a proxy because the proper way to calculate tariff rates is on a production-weighted or consumption-weighted basis (Pugel, 1978). The present proxy was selected because the tariff schedules of the United States are extremely detailed and complex and this makes it impossible to calculate a production-weighted or consumption-weighted measure. Imports and import duties at the four-digit product

3 After all classifications were completed, there were 251 durable goods and 197 non-durable goods industries (251+197=448).

level⁴ were both found in the U.S. Commodity Exports and Imports as Related to Output, 1982 and 1981, published by The Bureau of the Census. A small degree of aggregation was inevitable. Complete data were available for 233 out of the 448 observations; this left 215 observations. Out of the 215 observations, 62 had data available but it was slightly defective in the sense that 4-digit data were combined with 5-digit data. The problem was not that important and there was nothing that could be done about it. Then, 62 additional observations had combined data. That is, 4-digit codes were combined, sometimes two and three together, due to the great similarity in the nature of the products. 58 other observations had complete data but at the 5-digit level. Given the nature of the SIC system, it was easy to sum upwards to create 4-digit data. The data for the remaining 33 observations were found by using data for the previous year where applicable, by assigning numbers after closely

⁴ A complication that arises in studies such as the present one that have both an international trade and an industrial organization component is that manufacturing statistics are found at the 4-digit *industry* level while trade data are found at the 4-digit *product* level. Briefly speaking, industry value of shipments refers to the total value of products made by an industry. Product shipments refers to the value of the specific product made by all industries. The same issue will arise in the discussion of the export share variable and, therefore, a detailed discussion will be postponed until then. The value of exports represents *product* exports. This will create a minor problem: Which denominator to use, product value of shipments or industry value of shipments, given that all other variables (with the exception of tariffs) are at the industry level? It shall be seen that the difference between the two measures of value of shipments is small and therefore it will change the results very little.

examining a closely related industry,⁵ and by utilizing various issues of Current Industrial Reports. Accounting for these 215 observations proved to be an enormous undertaking but it was worth it because it shall be seen that the variable performs very well in the regressions.

3A.2. LAB (Unskilled Labor Intensity)

Unskilled labor intensity has been defined as the median unskilled wage for 1982 (\$9,327 for a person with less than eight years of education) multiplied by industry employment and then divided by industry value added. The unskilled wage was taken from Current Population Reports⁶ and the industry employment and value added from the 1982 Census of Manufactures Industry Series. As we have seen, the effect of this variable on the tariff rate should be positive.

3A.3. H (Herfindahl-Hirschman Index of Industry Concentration)

The H index, defined as the sum of the squares of the market shares of the firms in the industry, was taken from the Census publication Concentration Ratios in Manufacturing

5 For example, SIC 2351 (Millinery) had data but SIC 2352 (Hats and caps) did not, so I assigned the Millinery tariff rate to Hats and caps due to their great similarity.

6 U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-60 (No. 146) (Consumer Income), Money Income of Households, Families, and Persons in the U.S., 1983, Table 1, which showed data for 1982 and 1983.

for 1982. It is well-known that H is a superior measure of concentration relative to the four-firm concentration ratio (CR_4) because it takes into account the disparity among the top four firms and uses all firms in the industry in the calculation instead of the top four.⁷ The index has some shortcomings. First, the fact that we square the market share has no basis in theory or empirical analysis. one could cube market share but the second power is more convenient. Second, H is a pure number. This means that it is hard to ascertain its meaning. It must often be translated into equivalent concentration ratios to have meaning. This last problem will be addressed later on, developing a justification for the testing of the export share equation by using the four-firm concentration ratio as a measure of concentration.

The Census suppressed the H index for 11 industries for confidentiality reasons.⁸ There was no reason to discard these observations since the problem could be corrected. A literature has developed in industrial organization that uses published concentration ratio data in order to estimate the suppressed H index [Schmalensee (1977), Michelini and Pickford (1985), and Sleuwaegen and

⁷ The H index first published in the 1982 Census of Manufactures is actually a truncated one: It uses only the largest 50 firms in each industry. This truncation introduces an imperceptible upward bias in the index but it can be safely ignored because the smallest firms have a low market share which, when squared, results in an effect on the index that is barely registered.

⁸ The index is suppressed for highly concentrated industries to avoid disclosing data about individual companies.

Dehandschutter (1986)]. This approach was partly used here, using the method of Sleuwaegen and Dehandschutter, but it was also supplemented by trade sources. There are various business and trade sources which often use the SIC system to classify business firms (for example, Manufacturing USA, Dun's Business Rankings, Million Dollar Directory, and Market Share Reporter). The Market Share Reporter is in my opinion among the better ones. For 2 out of the 11 industries, very good H indices were calculated from this publication and, in one case, were checked against shares provided in Shepherd's (1990) industrial organization text.⁹ For the remaining 9 industries, I used the approach developed by Sleuwaegen and Dehandschutter (from here on, S-D). The S-D method was supplemented with laborious H calculations from the Million Dollar Directory (from here on, MDD). The S-D approach is based on the establishment of minimum and maximum boundaries for H. Letting CR_4 be the four-firm concentration ratio, S-D established boundaries given by the following formulae:¹⁰

9 The two industries were the breakfast cereal industry (SIC 2043) and the chewing gum industry (SIC 2067). For the cereal breakfast industry, the H was calculated from the Market Share Reporter. Another set of firm shares was provided by Shepherd, which was used as an additional confirmation. The two estimates were very close (2,496 from the Market Share Reporter and 2,650 from Shepherd). I did not use the Shepherd H because his company shares were approximations over a long period of time. Regarding the chewing gum industry, business data banks state that Wrigley has 71.5% of the market, Warner-Lambert 27.2%, and RJR Nabisco 1% (Market Share Reporter, for example). This makes for an H index of 5,853.

10 S-D proved the boundaries mathematically but their calculations were involved and therefore will not be presented here.

Minimum $H = (CR_4)^2/4$, 4 of course being the number of
firms in the concentration ratio

Maximum $H = (CR_4)^2$ If $CR_4 \geq 1/4$

Maximum $H = (CR_4)/4$ If $CR_4 \leq 1/4$

Using this method, upper and lower H bounds were calculated for the remaining 9 industries. I also calculated the H index for those industries by using information from the MDD to serve as a cross-check. I then averaged the H upper and lower bounds from the S-D method to arrive at a final H estimate. This approach was used for 5 out of the 9 industries and the S-D H conformed well with the back-up H from MDD. For the remaining 4 industries, I assigned the S-D lower H bound because the average of the S-D upper and lower bounds was much higher compared to the H from the MDD. When the lower bound was taken, the conformity with the MDD estimate was close. Thus, H estimates for all 11 industries were obtained.

As explained in the theoretical discussion, the effect of H on the tariff rate should be positive. The same is true for its effect on export share but later on a non-linear framework of the H/export share relationship will be developed.

3A.4. RGN (Index of Geographic Concentration)

The geographic concentration index proved hard to calculate because of the suppression of state employment data for many industries due to confidentiality reasons.

In constructing a geographic concentration measure, actual geographic characteristics must be used. The "four-state" concentration ratio¹¹ available from the 1982 Census of Manufactures Industry Series is not enough. To see why, a simple example will suffice: Assume that two industries, A and B, have ten thousand employees each nationwide. The top four states, by employment, and their employment levels are as follows:

<u>Industry A</u>	<u>Industry B</u>
NY 3,000 (30%)	NY 4,000 (40%)
CT 2,000 (20%)	FL 2,000 (20%)
MA 1,400 (14%)	IL 600 (6%)
RI 600 (6%)	CA 400 (4%)

The numbers in parentheses are the state shares in national employment. Both "four-state" concentration ratios are 70% (30% + 20% + 14% + 6% = 70% for industry A and 40% + 20% + 6% + 4% = 70% for industry B) but industry A is more concentrated geographically: NY, CT, MA, and RI form a cluster together. If an H index based on the top four states is constructed, it will of course be higher for B,

¹¹ See note 48, Chapter 2, *supra*.

2,052 versus 1,532 for industry A.¹² But it still ignores the fact that NY, FL, IL, and CA are dispersed.

The index used in this study utilized the top four states in each industry in terms of employment and it was calculated as follows:

$$\frac{\begin{matrix} 2 \\ D(E_1+E_2) \end{matrix} + \begin{matrix} 3 \\ D(E_1+E_3) \end{matrix} + \begin{matrix} 4 \\ D(E_1+E_4) \end{matrix} + \begin{matrix} 3 \\ D(E_2+E_3) \end{matrix} + \begin{matrix} 4 \\ D(E_2+E_4) \end{matrix} + \begin{matrix} 4 \\ D(E_3+E_4) \end{matrix}}{(E_1+E_2) + (E_1+E_3) + (E_1+E_4) + (E_2+E_3) + (E_2+E_4) + (E_3+E_4)},$$

where $\begin{matrix} 2 \\ D \\ 1 \end{matrix}$ is the linear distance between the biggest cities (in terms of population) of state 1 and state 2, $\begin{matrix} 3 \\ D \\ 1 \end{matrix}$ is the linear distance between the biggest cities of state 1 and state 3, and so on. $E_1, E_2, E_3,$ and E_4 are the levels of employment (in thousands) for each of the top four states.¹³ For a detailed discussion about the construction of the index, please refer to Appendix A at the end of this dissertation.

Because of the way the index was constructed, it has

12 Given our example, if we square the shares and sum, we get :

Industry A			Industry B		
NY	30%	900	NY	40%	1,600
CT	20%	400	FL	20%	400
MA	14%	196	IL	6%	36
RI	6%	36	CA	4%	16
		1,532			2,052.

13 Thus, this is a weighted index: The employment levels for each pair of states are acting as weights.

the property that the higher the concentration, the lower the index.¹⁴ I inverted it to produce a direct relationship between the index and geographic concentration. So the final index was the result of an inversion and subsequent multiplication by 10,000 to avoid dealing with proportions.

In closing, on the basis of the theoretical analysis, we should expect this index to positively affect both the tariff rate and the export share, the first one on the grounds of interest group behavior and the second on the grounds of agglomeration efficiencies, transportability and, therefore, tradability.

3A.5. POL (Measure of Political Influence)

This variable is defined as the total number of Representatives in the top four states (in terms of number of employees) in each industry divided by 435 (the House membership).¹⁵ The number of Representatives in each state was found in the 1984 Statistical Abstract of the U.S. The relevant Congress was the 97th, elected in 1980 and serving 1981-83, because it had to include the members who served

¹⁴ In this respect the index is like the entropy index of industrial concentration. The entropy index declines as the level of concentration increases.

¹⁵ I am not adding Representatives and Senators and dividing by 535 because there are two Senators from each state, so the top four states will always have eight Senators.

in 1982.¹⁶ Then, on the basis of the four states, the number of House members was summed up, divided by 435, and multiplied by 100 to get a percentage.

This measure is an attempt to capture political influence. In a federal republic, politicians from larger, more populous states, are supposed to have more influence when compared to politicians from small states. Therefore, the effect of this variable on the tariff rate ought to be positive.

3A.6. AS (Advertising Intensity)

This variable was defined as advertising expenditures as a percentage of value of shipments. The value of advertising purchased by each industry was obtained from the 1982 Benchmark Input - Output (I-O) Accounts of the United States. Value of shipments came from the Census of Manufactures Industry Series. The I-O follows an entirely different classification system but, fortunately, a detailed concordance with the SIC was provided in those accounts so that I was able to determine the appropriate amounts of advertising corresponding to each SIC industry. For 2 out of the 448 industries the I-O tables did not provide data. But the *ratio* of advertising to sales was

¹⁶ For the 98th Congress (elected in 1982 and serving 1983-85) the number of House members from each state changed compared to the previous Congress because of the redistricting resulting from the 1980 Census of Population.

obtained from a 1973 Line of Business Report, published by the Federal Trade Commission. In several cases, SIC industries were combined in the I-O tables but this slight aggregation problem did not affect the results.

As explained in the theoretical analysis, the product differentiation effects of advertising should have a positive effect on industry concentration. But advertising intensity was also included as a regressor in the export share equation presented in the very beginning of this chapter. It is possible that the effect of advertising intensity on export share is negative because advertising acts as a barrier to trade in the same way it acts as a domestic entry barrier (Pugel, 1978). If an industry is characterized by high advertising intensity, it may be necessary for its products to also be heavily advertised abroad in order to gain market share there (and increase exports). Firms in high advertising-intensity industries tend to produce abroad for their foreign markets, a fact that may explain low exports. Advertising abroad is expensive and less certain of results so producers may forego such advertising outlays and, consequently, a higher level of exports. Also, export-oriented businesses advertise less because they have less need to do so given that they often sell to commission merchants abroad who employ their own sales forces and do their own advertising (Caves and Khalilzadeh-Shirazi, 1977). In short, the effect of advertising intensity on export share should be negative.

3A.7. MES (Minimum Efficient Scale Proxy)

This measure was calculated from 1982 Census plant size distributions (General Summary, Part 2: Industry Statistics by Employment Size of Establishment). It will be explained shortly.

There have been three general approaches in estimating MES: Engineering estimates, cost estimates, and "survivor" estimates. Each approach has its specific disadvantages but all three tend to be expensive, cumbersome, and time-consuming. Therefore, plant size distributions are used to estimate MES. There are variations in the method: One approach is to take the median plant size relative to aggregate industry size (from here on, median plant size approach). Another approach is to take the average plant size among the largest plants that account for the top 50% of output as a fraction of industry output¹⁷ [called the relative plant size approach, RPS, by Scherer et al. (1975)].

In a large data set one could use one of these proxies or the other without a lot of harm being done. There is a potential for harm, though, because both methods have their problems. First, both utilize the median as a cut-off point. This automatically assumes that in all industries half of the output is supplied by inefficient plants. There is evidence that suboptimal plants account for between 10% and 30% of output (Bain, 1956). Second, in concentrated

¹⁷ One of course could use another measure of industry size, like value added.

industries, large firms tend to operate large plants; therefore, even if the average cost curve were horizontal above some minimal level of operation, the median plant estimates would be higher where concentration is higher (Davies, 1980). Third, both measures can be interpreted as measures of plant size concentration: Davies (1980) has shown mathematically¹⁸ that both are inversely related to plant numbers and positively related to size inequalities in the plant size distribution. That is, it is possible to engage in some kind of tautology when associating those proxies with concentration. In short, these two variations of the median plant size approach are widely used as MES proxies but they have shortcomings which ought to be kept in mind.

Empirical evidence shows that economies of scale are small: Scherer et al. (1975) calculated relative plant sizes for 155 4-digit SIC industries and found that in only 14 of them did the RPS exceed 10% of industry sales.¹⁹ Also, Schmalensee (1981) has shown that MES is generally under 10% of industry demand. Finally, the evidence presented in the previous chapter showed that MES is generally small.

Therefore, because of these results and because of the potential problems plaguing estimates that use the median, I decided to utilize the plant size distributions to estimate

¹⁸ His calculations were involved and beyond the scope of this thesis; therefore, they will not be presented here.

¹⁹ I took the 155 Scherer et al. RPS estimates and constructed a frequency distribution. Using the tools for calculating descriptive statistics for grouped data, I found the mean to be 5.96%, the median 3.54%, and the mode 2.90%.

the plant size above which 90% of industry output is produced, in order to confine only 10% of industry output to suboptimal plants. This is consistent with the above-mentioned research (also, compare Bain's evidence on the lower bound of the share of suboptimal plants given earlier).²⁰

20 The following is a well-known formula in statistics that can be used to calculate the median from grouped data:

$$\text{MEDIAN} = \text{LL}_{\text{MEDIAN}} + \left[\frac{N/2 - \sum f_{\text{PREVIOUS}}}{f_{\text{MEDIAN}}} \right] (w_{\text{MEDIAN}}),$$

where $\text{LL}_{\text{MEDIAN}}$ is the lower limit of the median class, N is the number of items in question, $\sum f_{\text{PREVIOUS}}$ is the cumulative sum of all the previous frequencies, f_{MEDIAN} is the frequency of the median class, and w_{MEDIAN} is the median class width. To find $\text{LL}_{\text{MEDIAN}}$, we calculate $N/2$ and then find, through the cumulative frequency, which class contains it. We can modify the above formula to calculate the decile:

$$\text{LL}_{\text{LOWER 10\%}} + \left[\frac{N/10 - \sum f_{\text{PREVIOUS}}}{f_{\text{LOWER 10\%}}} \right] (w_{\text{LOWER 10\%}}),$$

where all terms have their previous meaning. The Census plant size distributions are given in terms of employees. Because this is so, it should be kept in mind that they are susceptible to the bias resulting from the more rapid pace of mechanization of the larger plants, but we cannot do anything about it. The total number of plants in each industry is also provided by the Census, along with the value added and value of shipments. The measure of industry size I shall be using is value added. The 10% MES plant size will be in terms of employees. Then it will be divided by national employment to arrive at the final MES proxy for the industry. This calculation was performed for all 448 industries. Table 3.2 illustrates the procedure, using SIC industry 2032 (Canned Specialties).

TABLE 3.2

ILLUSTRATION OF 10% MES PROXY CALCULATION (SIC 2032)

Establishments with an average of -	Value Added	Cumulative Frequency of Value Added	Plants
1 to 4 employees	3.6	3.6	48
5 to 9 employees	7.3	10.9	28
10 to 19 employees	16.8	27.7	34
20 to 49 employees	39.6	67.3	22
50 to 99 employees	45.7	113.0	16
100 to 249 employees	143.7	256.7	22
250 to 499 employees	529.9	786.6	18
500 to 999 employees	197.3	983.9	4
1,000 to 2,499 employees	785.4	1,769.3	6
	1,769.3		198

National employment is 23,400.

Now, $N/10 = 1,769.3/10 = 176.93$ (this is in the 100-249 class).

$$LL_{\text{LOWER 10\%}} + \left[\frac{N/10 - \Sigma f_{\text{PREVIOUS}}}{f_{\text{LOWER 10\%}}} \right] (w_{\text{LOWER 10\%}}) =$$

$$100 + \left[\frac{176.93 - 113.0}{143.7} \right] (149) = 100 + \left[\frac{63.93}{143.7} \right] (149) =$$

$$100 + 66.287 = 166.287 \approx 166 \text{ employees.}$$

Now, 166 employees is the size of the minimum efficient plant.

To finally arrive at the lower 10% MES proxy, we have:

$$166/23,400 = \boxed{0.709\%}.$$

I also calculated the conventional median plant size for each of the 448 industries.²¹ This was done in order to test the reliability of my 10% plant size measure. After calculating the conventional median plant size (in terms of employees and before dividing it with total employment), I examined whether the employee class that contained it had the *highest absolute frequency density* of all establishments (that is, whether it was the class with the most establishments). I found that this was true for only 29 of the 448 industries (6.47%). But when I looked at the 10% plant size that was used for the regressions in this thesis, I found that the employee class that contained it had the highest absolute frequency density in 112 out of the 448 industries (25%).²² This, in my opinion, is an additional confirmation that a 10% plant size instead of the median plant size may be a more appropriate proxy for MES.

I would like to close this discussion on two points.

21 In the context of the SIC 2032 example, $N/2 = 1969.3/2 = 884.65$, which is included in the cumulative frequency 983.9. Therefore, the lower limit of the median class is 500. Now:

$$\text{MEDIAN} = LL_{\text{MEDIAN}} + \left[\frac{N/2 - \sum f_{\text{PREVIOUS}}}{f_{\text{MEDIAN}}} \right] (w_{\text{MEDIAN}}) =$$

$$500 + \left[\frac{884.65 - 786.6}{197.3} \right] (499) = 747.98 \approx 748 \text{ employees (this is the median plant size).}$$

Now: $748/23,400 = 3.196\%$. This is the median MES proxy. Its mean for all industries was 2.577%.

22 I statistically tested the difference between these two percentages. The test came out very strongly significant.

First, in regards to my median plant estimates, Table 3.3 compares them to the estimates of Culbertson and Morrison (1983). Their proxies apply to industries from the food sector in 1977. They used value of shipments as the industry measure; I used value added. Note the very high correlation coefficient between the two proxies.

In 36 cases the median plant size was in the highest employee class, which has no upper limit (2,500 employees or more). So I estimated the upper limit by using the total number of employees in each class except the highest, the number of plants, and total employment. To see whether my final median MES estimates were on the right track, I compared them to the Scherer et al. (1975) RPS estimates for the relevant industries. Table 3.4 shows the comparison. In all cases except the last one, their estimates are higher than mine. This is because RPS takes the average plant size among the largest plants that account for 50% of the output while I am using only the median plant size. Also, they are using value of shipments while I am using value added. Finally, their data are much older than mine (from 1963). Nevertheless, the correlation coefficient is very high.

3A.8. DGR (Demand Growth)

In order to calculate growth in demand, we can calculate the growth in value of shipments. Before this is done, the

TABLE 3.3

MEDIAN PLANT SIZE ESTIMATES: FOOD SECTOR

<u>SIC</u>	<u>Culbertson & Morrison (1983)</u>	<u>Paizis</u>
2013	0.26	0.283
2032	2.59	3.196
2033	0.17	0.336
2034	2.26	2.323
2037	0.92	0.932
2041	0.68	0.841
2043	9.47	4.930
2047	3.02	1.896
2051	0.12	0.183
2052	2.04	1.655
2062	12.01	9.325
2063	1.87	1.524
2065	0.64	0.811
2079	1.75	1.704
2082	1.37	2.400
2086	0.08	0.144
2087	1.23	0.672
2095	5.82	3.194
2899	0.43	0.249

(n = 19)

Pearson correlation coefficient: 0.9500.

TABLE 3.4

COMPARISON OF SCHERER ET AL. RPS ESTIMATES AND MEDIAN
PLANT SIZE ESTIMATES FOR INDUSTRIES WITH MISSING
UPPER LIMITS

<u>SIC</u>	<u>Scherer et al (1975)</u>	<u>Paizis</u>
2082	2.80	2.400
2111	16.70	13.465
2824	7.10	3.161
3011	5.30	3.674
3312	1.50	1.343
3511	9.00	8.364
3531	2.50	1.197
3632	15.00	13.102
3633	10.50	7.987
3661	4.20	1.938
3671	7.40	4.943
3674	6.90	1.765
3694	10.00	4.270
3861	7.00	7.298

(n = 14)

Pearson correlation coefficient: 0.9136.

data must be corrected for inflation. The Bureau of Economic Analysis (BEA) has published not only price indices for all 4-digit SIC industries but also real values of shipments for all such industries for the period 1977-1990. Given that my year of study is 1982, the real rate of growth from 1977 to 1982 was calculated for each industry. After contacting the BEA, a detailed printout was mailed to the author. It contained both price indices and real and nominal values of shipments. So, I calculated for each industry the percentage change in real value of shipments for 1977-1982 and took this as the measure of industry growth.

A comment is in order. 1982 was a year of serious recession in the United States: The late 1970s and early 1980s were a period of considerable disequilibrium in the American economy and, therefore, one cannot describe American industry as slowly evolving over this period. This is partly borne out by the data: In examining the growth rate for each industry, I found that 263 4-digit industries out of the total of 448 exhibited negative growth from 1977 to 1982, a figure that represents 58.79% of the total number of industries. Furthermore, I examined the change in the absolute number of firms in each industry over the same period:²³ Of the 448 industries, in 214 the number of firms went up, in 218 it went down, and in 16 it stayed the same. Some interesting patterns emerged upon

23 This is not a measure of growth; it is only a rough indicator of entry or exit because it does not take into account mergers and acquisitions.

further investigation. Of the 214 industries whose number of firms increased, 110 exhibited negative growth (51.40%) but of the 218 industries whose number of firms decreased, 141 exhibited negative growth (64.67%). In short, although it has been hypothesized that the effect of industry growth on concentration is negative, the volatile state of the American economy in the late 1970s and early 1980s should be kept in mind.

3A.9. XVS (Export Intensity)

This is the main dependent variable of the dissertation. It is defined as the value of product exports divided by the value of 4-digit SIC *product* shipments. As explained earlier,²⁴ there is a minor problem here: Since the other variables (besides tariffs) were at the industry level, should product shipments or industry shipments be used as the denominator when calculating the export share? Depending on which denominator is used, a different export share value will be obtained. Industry shipments refer to the total value of products made by an industry. Product shipments refer to the value of a specific product made by all industries. It shall be seen shortly that there is little difference between the two. The concepts will be best illustrated with an example: Assume there are two industries, 1 and 2, and two products, A and B. Also, assume that the industry value of shipments

²⁴ See note 4, *supra*.

is the same in both industries. This is illustrated in Figure 3.2 (Note: I have made this graph to represent *actual* industry values of shipments; this is not a percentage component bar chart). I shall be concentrating on industry 1 and product A (which is highlighted). For industry 1, industry value of shipments is $A_1 + B_1$. Now, a product which has the highest dollar value within an industry is considered primary to the industry. That is, product A is primary to industry 1 (and product B is primary to industry 2). For product A, product value of shipments is $A_1 + A_2$ (the entire shaded area). So, given exports X , the two choices for export intensity are:

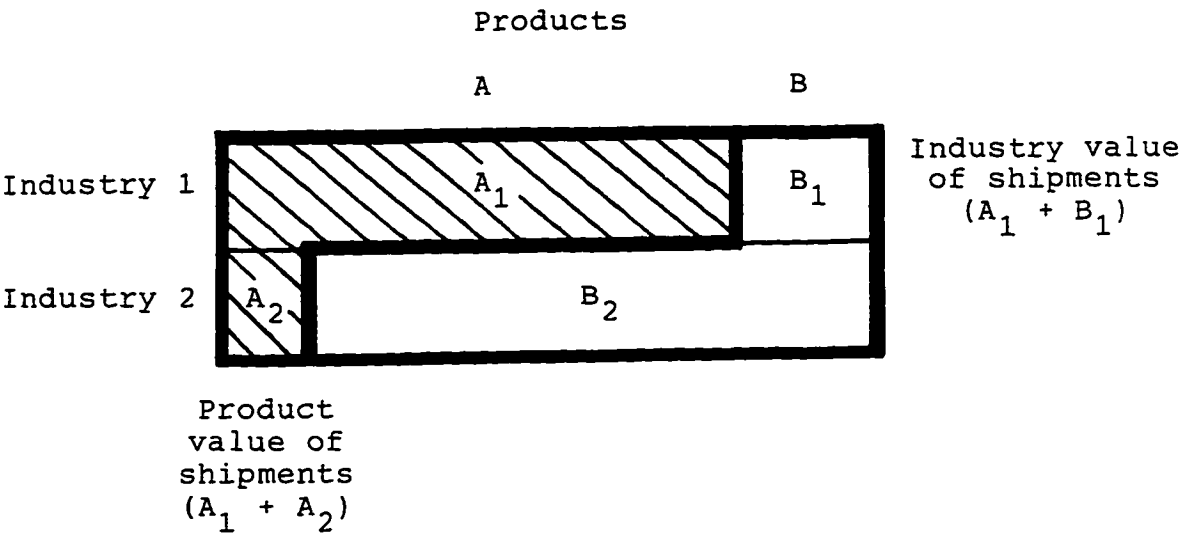
Industry basis	Product basis
$\frac{X}{A_1 + B_1}$	$\frac{X}{A_1 + A_2}$

Industry values of shipments and product values of shipments are not much different due to the care taken by the Census of Manufactures in its classification. The Census calculates primary product specialization ratios and coverage ratios.²⁵ The primary product specialization ratio is the proportion of total *industry* shipments made up of primary products. For industry 1, the specialization ratio is A_1 divided by industry shipments (that is, $A_1 / (A_1 + B_1)$). The coverage ratio is the value of shipments of primary products made up by plants classified in the industry, divided by the total shipments of primary products made by

25 1982 Concentration Ratios in Manufacturing.

FIGURE 3.2

INDUSTRY AND PRODUCT VALUES OF SHIPMENTS



all producers both in and out of the specified industry. For industry 1, the coverage ratio is A_1 divided by product shipments (that is, $A_1/A_1 + A_2$). the Census tries to maintain very high specialization and coverage ratios: In general, they are at least 90%.²⁶

Since the export numerator was on a 4-digit product basis, I decided to use product value of shipments as the denominator. This was supplemented by an additional examination: For each of the 448 observations, I calculated the percentage difference between product value of shipments and industry value of shipments (using industry values as the base). The mean absolute difference was 8.16% and the median 6.34%.²⁷

Both export values and values of product shipments were found in the U.S. Commodity Exports and Imports as Related to Output, 1982 and 1981. Complete 4-digit export data existed for 353 product codes. This left 95 observations. For 52 of them, I used the 5-digit data available and added them to arrive at the 4-digit level. 21 additional cases had 4-digit codes combined in twos and threes, so their

26 I could not add up all the specialization and coverage ratios and then divide by 448 to find the averages because this would have been an enormous undertaking. However, using a random numbers table, I drew a sample of 50 industries from the population of 448 and calculated the averages: The average specialization ratio was 93%; the average coverage ratio 90%.

27 These numbers verify the statement made in the 1983 U.S. Industrial Outlook, p. XIII, that the difference between industry and product value of shipments is relatively small, being less than 10%.

export shares were derived from their proportion in the combined product shipments. Subtractions from already available data corrected incomplete information for an additional 11 codes. 3 other observations were found in various issues of Current Industrial Reports. The remaining 8 observations were corrected by utilizing one of three methods: By assigning the export share after closely examining very similar industries; by considering the nature of the product; and by simple averaging between the 1981 and 1983 values when 1982 was missing.

A final adjustment needed to be made. The value of exports was exports at port while the value of 4-digit product shipments was value at f.o.b. plant. The value of exports at port included transportation and insurance costs and wholesale and retail trade margins. This had to be adjusted in order to make export value also at f.o.b. plant (that is, producers' value). This was done by multiplying exports by a f.o.b. factor which was the ratio of producer prices to purchased prices. Purchased prices included producer prices plus transportation costs, insurance costs, and wholesale and retail trade margins. This f.o.b. factor was found at the 3-digit level in the 1983 Annual Survey of Manufactures: Origin of Exports of Manufactured Products, Appendix B (Comparison of Value of Exports at Port of Exportation to the Value of Exports at Producing Plant by

Industry Group: 1983).²⁸ Then, for each 4-digit observation, the export figure was multiplied by the adjustment factor corresponding to its 3-digit aggregate.

The adjustment did not change the figures by much but it had to be done. Although, in general, the adjustment factor is .8909 and reaches as high as .9617, there were cases in which it was rather low: For farm and garden machinery it was a low .7320; for construction machinery, .7981; and for refrigeration equipment, .8209. These are goods with high transportation costs. So the adjustment had to be done for all observations.

3A.10. VI (Measure of Vertical Integration)

Vertical integration is defined as industry value added divided by industry value of shipments. Both variables are readily available in the 1982 Census of Manufactures Industry Series. If establishments in an industry produce all their inputs themselves, this ratio would be 100%. The more

28 The f.o.b. adjustment factor in turn had been based on the 1977 Input-Output (I-O) Structure of the U.S. Economy, published in the May 1984 issue of the Survey of Current Business (SCB). The 1982 I-O Structure was published in the April 1988 issue of SCB but did not contain the figures necessary to calculate the f.o.b. values. The 1982 benchmark I-O Accounts did not contain such figures either. Annual I-O studies published by the SCB are less comprehensive compared to the benchmark ones which are published every five years - corresponding to Census of Manufactures years. Thus, the 1977 figures were the closest. I do not think it was a problem to use them: They were used in the 1983 Annual Survey of Manufactures.

establishments rely on outside producers in other industries, the more their sales will reflect value added in other industries. This will cause the value added/sales ratio to be smaller. The bigger the ratio, the greater the degree of vertical integration.

This measure of vertical integration²⁹ is problematic and it is being used here only because no other measure is readily available. I am using it with a heavy heart because its problem is that it tends to be smaller, the closer an industry is to final consumer demand. Adelman (1955), as reported in Scherer (1980), has given an excellent example of this: Assume there are three disintegrated firms, a raw materials producer, a fabricator, and a distributor, and that each firm contributes a third of total value added. If the raw materials producer does not buy anything from outside suppliers, its value added/sales measure will equal 100%, giving the impression that it is totally vertically integrated.³⁰ The fabricator has a value added/sales ratio of 50% because it buys raw material valued at 33% and adds its own labor at another 33% $[33\% / (33\% + 33\%)]$. Finally, the distributor has a value added/sales ratio of 33% because it buys inputs valued at two thirds and adds another one third of value added $[33\% / (33\% + 33\% + 33\%)]$. So, the closer

29 The mean of this variable from my calculations is 48.00%. Scherer (1980, p. 79) reports the mean of the value added/sales ratio for the manufacturing sector to be 47.00%, so this means my calculations are correct. The difference is probably due to rounding.

30 A reminder: Integration here is defined with reference to the final consumer.

a firm is to raw materials, the higher the value added/sales ratio.

Efficiency and market power considerations are the main motivations for vertical integration. In the context of this dissertation, if a vertically integrated industry is more efficient, then this may bestow upon it a comparative advantage, thereby increasing its export share.³¹ The existence of vertical integration points to significant advantages. To begin with, there are efficiency considerations because transaction costs can be reduced, uncertainty can be mitigated, and if there is a small number of suppliers, their market power can be checked. Also, technical considerations may result in vertical integration. Finally, market power considerations may facilitate vertical integration. This is the case when vertical integration precludes competitors from

31 Vertical integration is not without its disadvantages. First, it may reduce flexibility because it results in doing business with specific suppliers. While this may reduce transaction costs through better coordination and may reduce the uncertainty over future supplies, changing market conditions may provide better, lower-cost, alternatives: Economic events change faster than legally binding contracts. Second, vertical integration may increase the cost of operation because it often implies increased financial commitments. Third, when different stages of production are concentrated in the hands of a single executive or team of executives, bounded rationality (the limited ability of people to digest information and use it for decision-making purposes) will result in managerial diseconomies. Such disadvantages can be more or less corrected through quasi-integration (that is, legal links which are less inflexible than common ownership) or through improved communication and decentralization of the various branches of a vertically integrated enterprise.

doing business with a previously non-integrated company or when vertical integration increases the possibility of collusion because it reduces the number of firms at different stages of production. In short, the effect of vertical integration on export share ought to be positive.

3A.11. HUM (Measure of Human Capital)

For each 4-digit SIC industry, this measure was calculated as follows:

$$HC = \frac{(w - \tilde{w})L}{.10},$$

where w is the average annual wage for the industry, $\tilde{w}$ is the median unskilled wage for a person with less than eight years of education, L is total industry employment (in thousands) and .10 is a discount factor. This is the standard way to calculate human capital in the human capital production function literature (Griliches, 1970).³² The variable is measured in the millions of dollars.

w , the average annual wage, was obtained from the BLS 1982 Employment and Wages: Annual Averages, which classifies all industries according to the SIC system. $\tilde{w}$, the median

³² A minor drawback of this approach is that, by utilizing a single discount rate, it assumes that income differences are only the result of education and ignores ability, experience, and socioeconomic considerations.

unskilled wage was \$9,327 for 1982 and was taken from Current Population Reports, Series P-60. Industry employment, L, was taken from the 1982 Census of Manufactures Industry Series.

This method of calculating human capital is relatively uncommon in international trade studies [one example is Branson and Monoyios (1977)]. Instead, trade studies measure human capital by utilizing skill distributions regarding total employment [Baldwin (1971), Kravis and Lipsey (1992)]. That is, this approach utilizes the employment breakdown in each industry into different classes, as published by the Census of Population. This approach, however, cannot be used in this study because, as explained earlier, the classification systems of the Census of Population and the Census of Manufactures are not comparable.³³ Therefore, it was decided to utilize the present approach.

Given the considerable evidence that human capital has a strong positive effect on exports [Keesing (1965), Kenen (1965), Baldwin (1971), Kravis and Lipsey (1992), for example], the coefficient of human capital in the export share equation should be positive.

We shall now proceed with a discussion of the method of econometric estimation of the model and then shall continue with its extensions.

³³ Census of Population industries are very broad. For a discussion, see note 17, Chapter 2, *supra*.

3B. The Method of Estimation

As we have seen, the model has three equations. The discussion shall proceed as follows: First, I will discuss the identification of the model and the method of estimation. Then, in the following section, I will discuss the model's extensions, which shall include non-linearities and interactions (these shall apply only to the export share equation) and the test that was performed to determine whether these extensions needed to be included in the equation.

All three equations were overidentified: In econometrics it is rare not to have overidentified equations. In identifying a system of equations there are two conditions, the rank condition and the order condition. The rank condition states whether an equation is identified or not. In order to know whether it is exactly identified or overidentified the order condition is needed. The rank condition showed all three equations to be identified; the order condition showed all three to be overidentified.

There are three methods of estimation available for this thesis: Ordinary Least Squares (OLS), Two-Stage Least Squares (2SLS), and Three-Stage Least Squares (3SLS). The first two methods were used and an investigation was made about the third, which showed that it was unnecessary.

OLS is the basic method in econometrics and it often compares quite favorably with more sophisticated methods despite the possibility of bias when the system is

simultaneous. 2SLS is a single-equation method because it can be applied to each equation in the system separately without taking into account the other equations in the system. Due to its low computational cost, it has proved to be the most popular method in dealing with simultaneous equations. 3SLS is an extension of 2SLS and is due to Zellner and Theil (1962). It is a systems method in the sense that it estimates all equations as a set simultaneously. 3SLS may be a better method because it incorporates all available information from all equations simultaneously. But this is also a drawback because, if an equation is mis-specified, the simultaneous determination of the parameters will spread the mis-specification throughout the system (Kennedy, 1985) while in the case of 2SLS it will contain the mis-specification in the particular equation. 3SLS is also computationally very expensive, which is an additional drawback. To use 3SLS, one first has to estimate each equation with 2SLS, obtain the residuals of each 2SLS equation, form the residual variance-covariance matrix³⁴ and then use it to transform the large super-equation that represents all the equations in the system (Kennedy, 1985). As I said earlier, I used both OLS and 2SLS in the estimation of the model and then examined the 2SLS residuals to see whether the efficiency of 2SLS could be improved with 3SLS. 3SLS were unnecessary, as shall

³⁴ This matrix contains the variances of each equation's disturbances on its diagonal and the covariance between the disturbances of each pair of equations in the off-diagonal cells.

be seen below.

Before continuing, I would like to repeat the model here for the reader's convenience:

$$\boxed{\text{TARIFF}} = \beta_0 + \beta_1 \text{LAB} + \beta_2 \boxed{\text{H}} + \beta_3 \text{RGN} + \beta_4 \text{POL} + \epsilon_1 \quad (1)$$

$$\boxed{\text{H}} = \beta_5 + \beta_6 \text{AS} + \beta_7 \text{MES} + \beta_8 \text{DGR} + \beta_9 \boxed{\text{TARIFF}} + \epsilon_2 \quad (2)$$

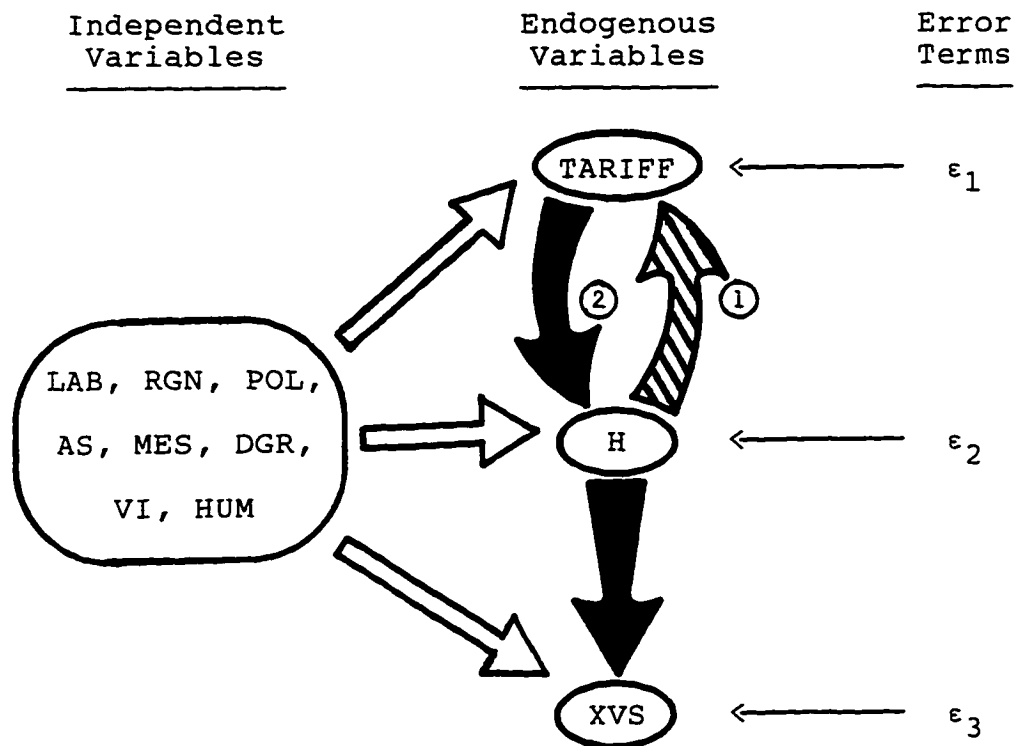
$$\boxed{\text{XVS}} = \beta_{10} + \beta_{11} \boxed{\text{H}} + \beta_{12} \text{VI} + \beta_{13} \text{AS} + \beta_{14} \text{RGN} + \beta_{15} \text{HUM} + \epsilon_3 \quad (3)$$

Figure 3.3 illustrates the relationship between the endogenous and independent variables in a more compact way than Figure 3.1 that was presented earlier. Figure 3.3 illustrates the direction of causation among the dependent variables and will thus set the foundation for the method of estimation that shall be used.

We shall now show that, in the above model, equation (3) can be estimated with OLS. Looking at equation (3), we can see that H is the only endogenous variable on the right-hand side. We can use OLS assuming that H is uncorrelated with ϵ_3 . This assumption is correct because ϵ_2 that affects H is by assumption uncorrelated with ϵ_3 : This is the assumption of zero contemporaneous correlation (that is, the error terms of the different equations are uncorrelated). Looking at Figure 3.3, we can see that H affects XVS (shown by the black arrow running from H to XVS) without in turn being affected by XVS. Here we see a unilateral dependence from H to XVS, so we can estimate equation (3) with OLS.

FIGURE 3.3

RELATIONSHIPS AMONG THE VARIABLES:
A MORE COMPACT ILLUSTRATION



Let us examine the model further by constructing the matrix of the coefficients of the endogenous variables in each equation (this is being done in order to see what is happening with the first two equations):

$$\begin{array}{lcl}
 & \text{TARIFF} & \text{H} & \text{XVS} \\
 \text{Equation 1} & \left[\begin{array}{ccc} 1 & \beta_2 & 0 \\ \vdots & & \end{array} \right. & & \\
 \text{Equation 2} & \left[\begin{array}{ccc} \beta_9 & 1 & 0 \\ \vdots & & \end{array} \right. & & \\
 \text{Equation 3} & \left[\begin{array}{ccc} 0 & \beta_{11} & 1 \end{array} \right] & &
 \end{array}$$

Now, if the cross-hatched arrow ① in Figure 3.3 were removed (that is, if H were dropped from the first equation) then β_2 would be equal to zero in the above matrix and we would have had only the black arrows in Figure 3.3, thereby establishing a unilateral causal dependence between the endogenous variables. In that case we would have had a causal, or triangular, model. It would have been a triangular model because if β_2 were equal to zero, there would be only zeros above the diagonal of the preceding matrix. Such matrices are called triangular matrices (in our case it would have been a lower triangular matrix; it is shown above). If what we just described were true, then we could apply OLS to each equation separately.

But this is not the case. Because we do not have only zeros above the diagonal, the model is not causal. We can apply OLS to the third equation but the first two equations need further examination. According to these two equations, TARIFF affects H and H in turn affects TARIFF. In the context

of Figure 3.3, this can be seen with arrows ① and ②. So this model contains a subset of equations (that is, the first and the second) which simultaneously determine industry concentration, H , and the tariff rate, $TARIFF$.

This leads us to the method of estimation for the first two equations. $TARIFF$ and H depend on ϵ_1 and ϵ_2 only but do not depend on ϵ_3 . So we have to examine the need for their joint estimation. Taking these two equations together, we can determine whether simultaneity exists by a straightforward application of the Hausman test [Hausman (1978), Berndt (1991)]. For the first equation, I estimated the reduced form equation first, which had H as a function of the exogenous variables in the subsystem. After estimating the fitted values, $\hat{H}$, I introduced $\hat{H}$ as an additional regressor in the first equation and used OLS. The null hypothesis that H and ϵ_1 are uncorrelated can be tested by looking whether the coefficient of the additional regressor $\hat{H}$ is statistically significant. In my case it was not significant at all,³⁵ which pointed to the direction of no simultaneity. But we should not stop here; the Hausman test can be used to test the hypothesis that $TARIFF$ and ϵ_2 are uncorrelated. [Equation (2)]. I first estimated the reduced form equation, which had $TARIFF$ as a function of the exogenous variables in the subsystem. After obtaining $\hat{TARIFF}$, I introduced it (that is, $\hat{TARIFF}$) as an additional regressor in the second

³⁵ It was .383 before correcting for heteroskedasticity and .326 after the correction. The method of correcting for heteroskedasticity will be explained in detail in Section 3D later on.

equation and, after using OLS, examined whether its coefficient was statistically significant: It was very significant,³⁶ which pointed to the existence of simultaneity (both Hausman tests were based on all 448 observations).

The results of the above Hausman tests point to estimating equation (1) with OLS and equation (2) with 2SLS. These are the results I shall be presenting in the next chapter. I estimated each equation with both OLS and 2SLS. The result was a minimum of 36 regressions. The OLS and 2SLS results were very close and I will therefore present only one set of results. In short, I will be presenting OLS results for equation (1), 2SLS results for equation (2) because of the significant Hausman test, and OLS results for equation (3).

My results were consistent with the discussion I have presented thus far: Although the results were close, for the first and third equation OLS provided a better fit than 2SLS. For the second equation, 2SLS was a superior fit compared to OLS, which dovetails with the strongly significant result of the second Hausman test.

I would like to close the discussion by explaining why 3SLS was unnecessary. 3SLS can be used to improve the efficiency of 2SLS. By examining the contemporaneous variance-covariance matrix (based on all 448 observations) that can be formed from the 2SLS residuals, one can determine whether it is worth the agony of using 3SLS. Given

³⁶ It was -3.589 before correcting for heteroskedasticity and -2.750 after the correction, still highly significant.

the relationship between correlation and covariance,³⁷ it is actually better to look at the correlation matrix³⁸ of 2SLS residuals. If the correlations are very low, then this means that using 3SLS is almost worthless because the correlation matrix will be very close to a diagonal one (a diagonal matrix has zeros everywhere except on its diagonal). Letting ϵ_1^* , ϵ_2^* , and ϵ_3^* be the 2SLS residuals from the three equations, I was happy to obtain the following contemporaneous Pearson correlation matrix:

$$\begin{array}{c} \epsilon_1^* \\ \epsilon_2^* \\ \epsilon_3^* \end{array} \begin{bmatrix} \epsilon_1^* & \epsilon_2^* & \epsilon_3^* \\ 1.0000 & & \\ 0.0455 & 1.0000 & \\ -0.0898 & 0.0958 & 1.0000 \end{bmatrix}.$$

Its Spearman correlation equivalent was:

$$\begin{array}{c} \epsilon_1^* \\ \epsilon_2^* \\ \epsilon_3^* \end{array} \begin{bmatrix} \epsilon_1^* & \epsilon_2^* & \epsilon_3^* \\ 1.0000 & & \\ 0.0786 & 1.0000 & \\ 0.0067 & 0.0690 & 1.0000 \end{bmatrix}.$$

These matrices clearly show that proceeding with 3SLS estimation would have been unnecessary. 3SLS would be worth it if the above correlations were high.

The discussion will now proceed with the extensions of

37 If there are two variables X and Y, σ_{xy} is their covariance, σ_x and σ_y are their standard deviations, and ρ is the correlation coefficient, then $\rho = \sigma_{xy}/\sigma_x\sigma_y$.

38 The correlation is better because the problem with the covariance is that it is very sensitive to the units of measurement of the pair of variables that it examines.

the third equation.

3C. Extensions: Interactions and Non-linearities for the Export Share Equation

The export share equation can be extended with interactions, one of which will test for the theoretical supporting effect of tariffs in concentrated industries, and with the non-linearity of industry concentration. The export share equation will include interactions first and then will be repeated for non-linearities. I will first discuss the general principles of these extensions and then I shall elaborate on the use of the Lagrange Multiplier (LM) test that pointed to the direction of including these extensions in the third equation.

Let us discuss interactions first. In Chapter 2, it was shown that on theoretical grounds there is a positive effect of industry concentration on export share and that this effect will be reinforced if there is industry protection. This can be tested by introducing an interaction term in the third equation: The measure of industry concentration multiplied by the average tariff rate. That is, the following term will be introduced as a regressor in the export share equation:

$$(H) \times (\text{TARIFF}).$$

If the hypothesis is true, its coefficient should be positive and significant. If it turns out to be negative, this means that tariff protection contributes to the inefficiency of

concentrated industries by robbing them of the element of competition. That is, concentrated industries which are also heavily protected may export a lower share of their output due to the complacency caused by the tariff. It shall be seen in the empirical results that non-durable goods industries have this interaction effect positive while durable goods industries have it negative.

The second interaction that I shall be testing, introduced here for the first time, is an industry concentration/geographic concentration interaction. The following term will be included in the third equation:

$$(H) \times (RGN),$$

where RGN is the index of geographic concentration explained earlier.³⁹ The purpose of this interaction term is to test whether the (theoretically) positive effects of industry concentration on export share are reinforced if the industry is also geographically concentrated. A regionally concentrated industry means that the good in question is easily transportable and therefore tradable. Also, there are benefits of agglomeration and scale when production is concentrated in specific areas. If the interaction term comes out to be positive, this means that the advantages of concentration are reinforced by the benefits of concentrating production in a few locations. If, on the other hand, it

39 Scherer (1990) suggests that industry concentration and geographic concentration measures should interact multiplicatively (like in the discussion here) but states that the point is uniformly overlooked.

turns out to be negative, it may mean two different things: First, it may mean that the benefits of geographic concentration are somehow offset by the inefficiencies associated with industrially concentrated industries. Second, it may mean that the benefits of industrial concentration can be offset by the inflexibility that can result from concentrating production in a few places.

A note is in order concerning the presentation of the regressions with the interaction terms in the next chapter. Along with the estimated coefficients, the t-ratios will of course be presented. t-ratios of the individual components of the interaction $(H) \times (RGN)$ will be presented for the reader's convenience only: Once the interaction is statistically significant, the t-ratios of the individual components are unnecessary because the significant interaction implies that both components are important.

Turning now to the non-linear specification of the effect of industry concentration on the export share, in the previous chapter it was theorized that the relationship between industry concentration and export share was non-linear in the sense that there could be a threshold beyond which export share may decline. This may be because of innovation and efficiency considerations, as explained in the previous chapter. That is, at higher levels of concentration innovative activity may decline and inefficiency may set in because, in more concentrated industries (which are also protected) there is less

incentive for cost minimization. The result is X-inefficiency. In short, the concentration-export share relationship may have the shape of an inverted "U". This can be tested by introducing H^2 as an additional regressor in the third equation. If the inverted "U" hypothesis is correct, the coefficient of H will be positive while the coefficient of H^2 will be negative. Then, taking the partial derivative of the export share with respect to H will give us the level of concentration at which the export share is at a peak.

I will also be testing for non-linearity by using the four-firm concentration ratio as a measure of concentration [that is, CR_4 will replace H and $(CR_4)^2$ will be introduced as an additional regressor] in the third equation. Section 3E below will elaborate in detail why it may be better to examine the non-linearity aspect of the concentration/export share relationship by using both the Herfindahl-Hirschman index and the four-firm concentration ratio.

In closing, I would like to explain how it was determined to include the interactions and the non-linearity in the export share equation. A Lagrange Multiplier (LM) test was utilized. For the interactions, it worked as follows; First, I applied OLS to equation (3) (the basic one), using all 448 observations. The LM test is based on the OLS residuals: If the interactions were to be present, their effect would be captured by the residuals. Then, a new regression was run, with the residuals as a function of all the variables in equation (3) plus the two interaction terms. These two

interaction terms were statistically significant. Now, if N is the number of observations and R^2 is the *unadjusted* coefficient of determination from the regression that used the residuals as the dependent variable, the quantity NR^2 follows the χ^2 distribution with two degrees of freedom.⁴⁰ In the LM test, if NR^2 exceeds the critical χ^2 value, then this means that the interaction terms must be included in the original equation. In this case, at the 5% level of significance, NR^2 exceeded the critical value, which pointed to the existence of the interaction effects.

Similarly, I used an LM test to determine the need for including the non-linear aspect, H^2 , in the export share equation. Specifically, I obtained the OLS residuals from the basic equation, ran the auxiliary regression with them as a function of all variables plus H^2 (which was strongly significant), calculated NR^2 and found it to exceed the 5% critical χ^2 value at one degree of freedom,⁴¹ and concluded that a version of equation (3) with a non-linear component was appropriate.

We shall now proceed with a discussion of the problems of heteroskedasticity and multicollinearity and then shall conclude the chapter with a discussion of the Herfindahl-Hirschman index in the non-linear export share framework and the problems that may arise from its use in determining antitrust/merger guidelines.

⁴⁰ This is because two terms were added.

⁴¹ There is one degree of freedom because only H^2 was added.

3D. Heteroskedasticity and Multicollinearity

Given that the data set is a cross-sectional one that deals with industries of different sizes, heteroskedasticity is a possibility.

To test for heteroskedasticity, I used White's general test (H. White, 1980). Before proceeding, I would like to point out that I did not use the White test only to test the three equations in the 448-observation set: Every regression presented in this dissertation (the three equations of the model and the extensions of the third equation), in both subsets (durable and non-durable goods industries), was tested for heteroskedasticity.

The White test's mechanics are as follows: First, the equation to be tested was estimated with OLS and its residuals were obtained and squared. Then these squared residuals were regressed against all the variables in the original equation, their squares, and the cross-products of every pair. Then, from this auxiliary regression, NR^2 was calculated. This NR^2 statistic follows the χ^2 distribution with $k-1$ degrees of freedom, where k is the number of coefficients in the auxiliary regression (that is, the constant is excluded). If NR^2 exceeds the critical χ^2 value then this means that heteroskedasticity is present.⁴² This is exactly what happened here: Every equation in every

⁴² Note that the White test is slightly different from the LM test presented in the previous section.

subset was heteroskedastic, which was to be expected.

In general, various tests for heteroskedasticity require that something must be known about its causes.⁴³ To investigate each variable in a large model, the researcher will soon run into a quagmire. This is what makes the White test so helpful: One can use it without assuming anything about the precise nature of the heteroskedasticity.

Heteroskedasticity is a problem for the researcher because its precise nature is unknown most of the time (Greene, 1990). Textbooks offer various weight schemes to correct it but these require knowledge of its precise nature. H. White (1980) has helped the profession once again because he has shown that one can still use the estimates based on OLS by estimating a covariance matrix that is heteroskedasticity-consistent even if the precise form of the heteroskedasticity is unknown. Nowadays, this heteroskedasticity-consistent covariance matrix is easily calculated by computer.⁴⁴ Now this matrix can be used to

⁴³ Another test, the Goldfeld-Quandt test, requires that the variable that causes the heteroskedasticity be identified. Then the data must be arranged according to increasing values of this variable. Then the observations are divided such that the middle group is discarded. Then separate regressions are run on the remaining subsamples and the ratio of their explained sums of squares is taken (after adjustment for degrees of freedom). I did not use this test for three reasons: First, it requires that the nature of the heteroskedasticity be known; second, it is a bit cumbersome and, third, I am uncomfortable with the fact that the number of observations that must be discarded is essentially arbitrary. This will affect the power of the test (Johnston, 1984).

⁴⁴ It can be generated through the ACOV option in SAS.

obtain correct standard errors for the OLS regression coefficients:⁴⁵ They are the square roots of its diagonal elements. Using these corrected standard errors, one can obtain heteroskedasticity consistent t-ratios on the basis of OLS. This was the procedure that was used to correct for heteroskedasticity in all equations.

A further comment needs to be made. After the above correction, one cannot use the F test anymore to test the overall significance of a regression because the F test relies on the assumption of homoskedasticity. Greene (1990) states that we can use a χ^2 Wald test instead, of the form:

$$W = (Rb)' \{R(\text{Est.Var}[b])R'\}^{-1} (Rb),$$

where b is the $k \times 1$ regression coefficient matrix, $\text{Est.Var}[b]$ is the White $k \times k$ heteroskedasticity-consistent covariance matrix, and R is a $(k-1) \times k$ matrix of the form (k is the number of coefficients including the constant):

$$R = \begin{bmatrix} 0 & 1 & 0 & 0 & \dots & 0 \\ 0 & 0 & 1 & 0 & \dots & 0 \\ 0 & 0 & 0 & 1 & \dots & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \dots & 1 \end{bmatrix}.$$

(k-1) × k

In the end, W (a scalar) will follow the χ^2 distribution with $k-1$ degrees of freedom. The Wald test was calculated

⁴⁵ The OLS standard errors are biased because of the heteroskedasticity.

for every regression that will be presented in the next chapter.

Turning to multicollinearity, formal examination was done to each regression. Two methods were used. First, the conventional correlation matrix of the independent variables was examined. High pair-wise correlations, usually .80 or above, indicate a problem (Gujarati, 1988). This was not the case even once, indicating no serious multicollinearity problem. In fact, all pair-wise correlations were rather low. Second, a more formal approach, due to Belsley et al. (1980) was utilized. It is based on a condition index which is defined as the square root of the ratio of the maximum eigenvalue to the minimum eigenvalue from the matrix that gives the sums of squares and cross products of the independent variables.⁴⁶ The general consensus is that a condition index in excess of 30 indicates serious multicollinearity problems [Gujarati (1988), Johnston (1984), Judge et al. (1985), Kennedy (1985)]. This is only a simple rule of thumb but it gives a good indication of potential problems. In all my regressions, the condition index never exceeded 30.⁴⁷

⁴⁶ This matrix has the sum of squares of each independent variable on its diagonal and the cross products between pairs in the off-diagonal positions.

⁴⁷ For all equations that will be presented, including the H^2 non-linearity, it fluctuated between 4.54 and 16.96. When, however, the non-linearity with the four-firm concentration ratio was applied, the condition index exceeded 20 and reached as high as 27.05. Nevertheless, it was still below 30 so it was no problem. The results came out robust.

Finally, an examination was made for potential multicollinearity in the first stage of the 2SLS regressions. Again, it was not a problem.⁴⁸ The first stage of the 2SLS regressions will not be presented here to avoid clutter.

3E. The Relationship between the Herfindahl-Hirschman Index and the Concentration Ratio: Antitrust Aspects and Implications for the Non-linear Concentration/Export Share Relationship

The H index is often compared favorably to the conventional four-firm concentration ratio (CR_4). This is because it utilizes all firms in its calculation while CR_4 uses only the top four.⁴⁹ Also, another advantage of the H index is that it takes into account the disparity among the top firms while the CR_4 does not.

The decision to rerun the export share equation with CR_4 as a non-linear measure of concentration instead of H came as the result of calculating the values of H at which export share is at a maximum. To understand why the results needed an extension, one should look at the 1982 Justice Department Merger Guidelines (released 1984). These Guidelines used the H index for the first time in determining whether to

⁴⁸ The minimum was 14.97 and the maximum 20.68. Even if multicollinearity were present in the first stage, it would again be no problem because in the first stage of 2SLS the object is prediction only and not estimation of the significance of the parameters.

⁴⁹ See also note 7, *supra*.

allow or challenge a merger.⁵⁰ First, the Guidelines have to define the market. The market is defined as the smallest group of firms that could, if acting collusively, raise prices from their current levels by 5 percent and maintain the increase profitably for one year (White, 1987). The Guidelines divide industries into three segments:

$H < 1,000$:	Unconcentrated;
$1,000 \leq H \leq 1,800$:	Moderately concentrated;
$H > 1,800$:	Highly concentrated.

If two companies wish to merge, the Guidelines will examine the pre- and post-merger H index. If the industry post merger H index is still below 1,000 there will be no challenge. If the industry is moderately concentrated, the government will challenge any merger that raises the H index by 100 points. In the highly concentrated category, a merger will be challenged if it raises the H index by 50 points.

As it shall be seen in the next chapter, each H value at which export share peaks, in both the entire data set and the subsets, occurs in the highly concentrated category (in fact, they all exceed 2,700). A further examination will be made in the next chapter in order to see whether this is the result of the influence of a few observations.

⁵⁰ This action by the Justice Department caused the popularity of the H index to rise; an additional impetus to popularity was that the Census of Manufactures started publishing it in 1982. Before 1982, the H index was overshadowed by the CR_4 due to the ready availability of CR_4 and the heavy data requirements needed to calculate it.

The question here is what boundaries like 1,000 and 1,800 mean. In other words, do these boundaries have a precise economic meaning? Any H index is a pure number. It must often be translated into a numbers equivalent or into equivalent concentration ratios, as shall be explained shortly. Also, the raising of market shares to the second power has no basis in economic theory. In fact, both Herfindahl and Hirschman⁵¹ cautioned against heavy reliance on H (Greenhut and Benson, 1989). It is unlikely that the boundaries have any real economic significance (Schmalensee, 1987). One could translate the H index into a numbers equivalent (Adelman, 1969), which is 10,000 divided by the H index (10,000 is the theoretical maximum of H). The result shows the number of firms that could produce the H index if, more or less, all of them had equal market shares. Under this assumption, an H of, say, 1,750 results in about 6 equal-sized firms (it is actually 5.7; $10,000/1,750 = 5.7$). But, say, H is 1,900: Then the numbers equivalent is 5 firms ($10,000/1,900 = 5.2$ firms). Why should we expect a "highly concentrated" industry with 5 firms to act differently from a "moderately concentrated" one with 6 firms? And how do we know that the boundaries are correct? 1,800 may be too low. Why not 2,000? That is, we do not know whether the 1,800 cut-off is the right one: Fisher (1987) states that to determine the correctness of this cut-off we must know

51 Although the two scholars discovered the index independently, Hirschman developed it about five years before Herfindahl (Hirschman, 1964).

exactly how H relates to anticompetitive behavior and reinforces his argument by pointing that the relationship between anticompetitive behavior and market structure is very complex to be captured in a single index. On the other hand, we cannot set a high cut-off point because anticompetitive mergers will escape scrutiny. Theoretically, though, we may set the cut-off point at, say, 2,500 (a numbers equivalent of four firms) or even over 3,000 since there is evidence that effective competition may exist with as few as three firms [Paulter (1981), as reported in Greenhut and Benson (1989)].

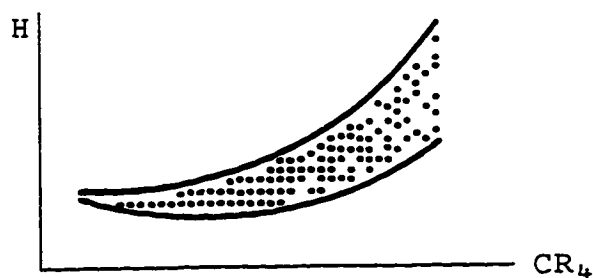
I am not advocating a change in the boundaries here. The purpose of this discussion is to illustrate that, for the intuitive meaning of concentration, one may have to utilize the humble CR_4 . A rough correspondence between the H index and CR_4 is that the 1,000 H level corresponds to a CR_4 of 50% and the 1,800 H level to a CR_4 of 70% [Blair and Kaserman (1985), White (1987)]. Let us elaborate about the relationship between H and CR_4 . There is evidence that the two are highly correlated: Scherer (1990, p. 72) reports that the correlation coefficient between H and CR_4 for 437 4-digit SIC industries for 1982 was 0.954. Note that he used the published data. When I corrected for the eleven industries with the suppressed H and recalculated the correlation coefficient for all 448 industries, the result was 0.8854.⁵²

52 My Spearman rank correlation coefficient between H and CR_4 for all 448 industries was 0.9917.

My H/CR_4 graph comparison verified the non-linear horn-shaped relationship between the two measures that Scherer (1990, p. 74) shows for 1982.⁵³

The decision to examine the non-linear aspect of the concentration/export share relationship by using the CR_4 was taken for two reasons.⁵⁴ First, the use of a second measure will provide a better insight to the relationship. Second, I decided to examine the relationship using CR_4 because of the fact that the H value at which the export share peaks is at the highly concentrated category, as mentioned earlier ($H > 1,800$). This may not automatically imply a strong inverted "U" relationship because it is possible to have a few very high H values clustered together,

53 In fact, the relationship looks as follows:



It can be seen that at higher values of CR_4 there is much greater H disparity. I calculated the 0.8854 Pearson and 0.9917 Spearman correlation coefficients for information purposes only: I felt a little guilty doing this because the correlation coefficient is a measure of linear relationship and therefore it should not be applied to non-linear relationships like the horn above. To account for the non-linear pattern, Scherer (1990) took logarithms: The correlation coefficient increased from 0.954 to 0.992. I did not take logarithms for my comparison but I expect my Pearson coefficient to well exceed .90 if I were to do so.

54 For all 448 observations, the mean CR_4 was 38.88% and its standard deviation was 20.99% (1982 Census of Manufactures: Concentration Ratios in Manufacturing was the source for the data used in the calculation).

and these may be influential observations. These may "pull-down" the regression line when squared (H^2), giving rise to an inverted "U" relationship and a statistically significant negative coefficient for H^2 in the export share equation. Extremely high H observations are rare in the manufacturing sector, so this is a possibility. In contrast, the range of CR_4 is more sharply defined (1% - 100%) and it is unlikely to have only a handful of observations at its highest range. That is, compared to the H case, industries will be more evenly distributed over the entire CR_4 range.

This discussion does not imply that one concentration measure is better than the other. Also, the issue connecting the two measures is an empirical one because their non-linearity is not relevant to the theory of industry structure and export performance. But it is better to have a more complete picture of the industry concentration/export share relationship and thus both the H index and the CR_4 have been utilized.

Summary

This chapter explained the three-equation econometric model and discussed each variable, its construction, and its sources. The method of estimation was determined to be OLS for the first and third equations and 2SLS for the second equation, on the basis of a Hausman test.

The third equation was extended to include interactions

and a non-linear aspect of the effect of industry concentration on export share. This was tested by first using the Herfindahl-Hirschman index and then the four-firm concentration ratio in order to get a more complete picture of the industry structure/export share relationship.

Heteroskedasticity in all regressions was verified through White's general test and it was corrected using his method of adjusted standard errors. Multicollinearity was not shown to be a problem.

The presentation of the empirical results shall now commence.

CHAPTER 4: THE EMPIRICAL RESULTS.

Before presenting the empirical results, I would like to briefly give the order of presentation. The results will be presented by equation: Equation (1) first, equation (2) second, and equation (3) third. Then the interactions of the third equation shall be presented and, following that, the non-linear specifications of H and CR_4 . Within each equation or extension there will be two tables: The first will show the results for all 448 industries and the second for durable and non-durable goods industries. A total of 18 regressions will be presented. Just in case the reader is interested in examining an equation in an order of his own choosing, Table 4A presents a summary of all regression tables.¹ Furthermore, Table 4B summarizes the hypothesized relations among the variables in the basic model, as determined in the theoretical discussion.

4A. Some Brief Thoughts Concerning t-values

A problem often faced by econometricians is the large sample size problem. That is, as the number of observations gets larger, the variance and standard error get smaller. The falling standard error causes the calculated t-value to

¹ Note that the numbering of preliminary tables in this chapter does not begin with "1" but with "A". This is because, for reasons of order, it is better for the regression tables to begin with "1".

TABLE 4A

ORDER OF PRESENTATION OF RESULTS

Table 4.1: Eq. 1 OLS: All Industries

Table 4.2: Eq. 2 OLS: Durables & Non-durables

Table 4.3: Eq. 2 2SLS: All Industries

Table 4.4: Eq. 2 2SLS: Durables & Non-durables

Table 4.5: Eq. 3 OLS: All Industries

Table 4.6: Eq. 3 OLS: Durables & Non-durables

Table 4.7: Eq. 3 OLS (Interactions): All Industries

Table 4.8: Eq. 3 OLS (Interactions): Durables & Non-durables

Table 4.9: Eq. 3 OLS (Non-linear H): All Industries

Table 4.10: Eq. 3 OLS (Non-linear H): Durables & Non-durables

Table 4.11: Eq. 3 OLS (Non-linear CR_4): All Industries

Table 4.12: Eq. 3 OLS (Non-linear CR_4): Durables & Non-durables

TABLE 4B

HYPOTHESIZED RELATIONS AMONG THE VARIABLES

Equation & Dependent Variable	LAB	RGN	POL	AS	MES	DGR	VI	HUM	H	TARIFF
Equation 1 (TARIFF)	+	+	+						+	
Equation 2 (H)				+	+	-				-
Equation 3 (XVS)		+		-			^a +?	+	+	

a Since VI is supposed to enhance efficiency, its effect on export share should be positive. However, the disadvantages of VI may give opposite results for some groups of industries.

increase even if the independent variable in question may have a very small influence on the dependent variable (Kennedy, 1985). One can thus reject almost any null hypothesis. This problem is common in data sets with thousands of observations: An informal cut-off is 5,000 observations (Zellner, 1984). Nevertheless, it is possible for this problem to exist in much smaller data sets, whose size may be in the low hundreds (McCloskey, 1985). I thus decided to investigate this possibility. Leamer (1978, 1983) suggests that the significance level must be adjusted downward as the number of observations increases and provides a way (Leamer, 1983) to calculate critical t-values which incorporate the number of observations:² The higher the number of observations, the higher the critical t-value. Comparison of my t-values with the Leamer t-values did not change my results. Also, some brief experiments concerning the power of my tests showed that it was high. In short, there was no large sample size problem. So, the critical t-values provided in the regression tables are the conventional ones and not Leamer's. Furthermore, the coefficient p-values were very low or virtually nil in the cases of highly significant coefficients, which indicated

2 No further elaboration shall be given here to avoid unnecessarily complicated material because, if I elaborate in detail, the discussion will take us to the field of Bayesian statistical inference, which is beyond the scope of this dissertation.

that the results were not a statistical accident.³

4B. The Results

We shall now begin examining the results. All regressions are significant since W exceeds the critical χ^2 value (both are presented for each regression), unless otherwise noted. The $\bar{R}^2$, the multicollinearity condition index, and critical t-values are also shown.⁴ For each regression coefficient,

³ These were not the computer-calculated p-values because my results have been corrected for heteroskedasticity, which caused the t-ratios to change. To find the corresponding p-values, I went back to the highly extensive old *Biometrika* t-tables. t-tables in contemporary econometrics texts proved completely inadequate. p-values are not presented in the regression tables to avoid clutter.

⁴ These critical t-values were not taken from the t-tables that abound in econometrics and statistics texts. Looking at any such table, it can be seen that the greatest numbers of degrees of freedom (df) are as follows (2 tails, 5% level):

df	t critical value
200	1.972
∞	1.960.

(Keller, Warrack, and Bartel, 1994). But the largest data set for this thesis had 448 observations. For example, for the first equation, there are five coefficients (the constant, LAB, H, RGN, and POL); this translates into 443 df. Instead of taking the highest value in the table (1.960), I applied the method of Wonnacott and Wonnacott (1979), which can closely interpolate the appropriate critical value. The method was as follows:

df		t-value	
200	1/200=0.005	1.972	(given)
443	1/443=0.00225	1.960+(1.972-1.960)	$\left[\frac{0.00225-0}{0.005-0} \right] =$
∞	1/ ∞ =0	1.960	(given)
			1.965.

So, for 443 df the critical t-value is 1.965. Applying this method extensively, I calculated critical t-values for all df needed. All critical values in all tables have been calculated by this method.

its t-ratio is in parentheses.

Looking at Table 4.1, all the variables have the correct sign, except POL. As expected, labor intensity (LAB) is strongly significant. H is positive as expected but barely misses significance at the 10% level ($1.261 < 1.283$, which is the critical t-value). RGN is positive, as expected, and strongly significant. In Table 4.2, H is significant with the correct sign but at the 10% level for the non-durables category while the durables regression is not significant at all. RGN is significant only for the non-durables category. Note, though, that POL is significant even though the entire durables regression is not. We can see that, of the three regressions in these two tables, H is significant only once (the non-durables regression) while RGN is significant twice (for all industries and non-durables). This confirms the results of Ray (1981) on the effects of these variables on tariffs: He found both industrial and geographic concentration to be insignificant. The fact that RGN is positive and significant in two cases is in accordance with the results of Godek (1985), who found geographic concentration to be positively affecting tariff rates. Also, note how unskilled labor intensity is insignificant for durable goods and strongly significant for non-durables (Table 4.2). With one exception (in the otherwise insignificant durable industries regression), POL was insignificant, albeit with the correct positive sign in two out of three cases.

TABLE 4.1

EQUATION 1 (N=448)

Dependent Variable: TARIFF (OLS):

INTERCEPT	-2.047 (-1.367)
LAB	0.263 (7.187)
H	0.00039 (1.261)
RGN	0.075 (2.736)
POL	-0.0033 (-0.070)

Condition Index	14.20
$\bar{R}^2$	0.2478
W	72.553
$\chi^2_{\text{critical}} (5\%)$	9.487

Critical t-values:

1 tail (5%)	1.648
2 tails (5%)	1.965
1 tail (10%)	1.283

TABLE 4.2

EQUATION 1

Dependent Variable: TARIFF (OLS):

	<u>DURABLES (N₁=251)</u>	<u>NON-DURABLES (N₂=197)</u>
INTERCEPT	1.979 (1.267)	-3.792 (-1.723)
LAB	0.018 (0.743)	0.340 (9.326)
H	-0.0000087 (-0.040)	0.00074 (1.409)
RGN	0.027 (1.089)	0.135 (2.559)
POL	0.077 (1.854)	0.016 (0.211)
Condition Index	16.96	13.04
$\bar{R}^2$	0.0054	0.3953
W	4.701	118.142
$\chi^2_{\text{critical}} (5\%)$	9.487	9.487
<u>Critical t-values:</u>		
1 tail (5%)	1.651	1.653
2 tails (5%)	1.969	1.972
1 tail (10%)	1.285	1.286

Turning to the second equation, in Table 4.3 all the 2SLS coefficients except DGR have the correct signs. Industry growth, DGR, turns out to be positive but insignificant, which is consistent with the previous finding that the effect of growth on concentration is weak. The effect of the tariff rate is negative and strongly significant, which means that protection results in the perpetuation of inefficient industries which attract entry by firms that wish to take advantage of the protection rents, thereby reducing concentration. This negative effect persists in both durable and non-durable goods industries (Table 4.4). Note that, in both absolute magnitude and significance, the negative effect of the tariff rate is stronger for the non-durable goods industries. Many such industries are at a comparative disadvantage. Therefore, the effect of greater protection relative to durable goods industries⁵ aggravates their inefficiency and probably attracts entry to a greater degree than durables. The effect of minimum efficient scale is, as expected, positive and strongly significant across the board. Advertising intensity, AS, is positive and significant for all industries (Table 4.3) and durable goods industries but at the 10% level (Table 4.4). A surprising result was the insignificance of advertising intensity for non-durable goods industries (Table 4.4). This is probably because it is sometimes observed that the concentration/

⁵ The average tariff rate is 4.41% for durable goods industries and 7.92% for non-durable goods industries (author's calculations).

TABLE 4.3

EQUATION 2 (N=448) - SECOND STAGE

Dependent Variable: H (2SLS):

INTERCEPT	623.123 (7.170)
AS	56.828 (2.023)
MES	428.704 (3.169)
DGR	1.351 (0.897)
TARIFF (PREDICTED)	-31.938 (-3.165)

Condition Index	4.961
$\bar{R}^2$	0.3238
W	33.550
$\chi^2_{\text{critical}} (5\%)$	9.487

Critical t-values:

1 tail (5%)	1.648
2 tails (5%)	1.965
1 tail (10%)	1.283

TABLE 4.4

EQUATION 2 - SECOND STAGE

Dependent Variable: H (2SLS):

	<u>DURABLES (N₁=251)</u>	<u>NON-DURABLES (N₂=197)</u>
INTERCEPT	807.157 (4.296)	464.126 (6.565)
AS	74.287 (1.535)	19.279 (0.872)
MES	327.294 (2.637)	752.147 (7.458)
DGR	1.952 (1.183)	-0.158 (-0.091)
TARIFF (PREDICTED)	-1.672 (-1.804)	-15.308 (-2.592)
Condition Index	10.64	4.54
$\bar{R}^2$	0.2361	0.5570
W	11.847	72.098
$\chi^2_{\text{critical}} (5\%)$	9.487	9.487
<u>Critical t-values:</u>		
1 tail (5%)	1.651	1.653
2 tails (5%)	1.969	1.972
1 tail (10%)	1.285	1.286

advertising relationship breaks down when a large data set is disaggregated into finer categories (Scherer, 1980).

Turning to equation (3), it can be seen that all coefficients are significant and have the expected signs, except VI, the measure of vertical integration (Table 4.5). Note how advertising intensity is negative, which is consistent with the hypothesis that export-oriented industries advertise less given that they sell abroad to companies which employ their own sales forces and do their own advertising. This may also mean that industries with high advertising intensity also produce abroad, which can explain low exports. In Table 4.6, advertising intensity is negative and strongly significant for durable goods industries but insignificant for non-durable goods industries. The geographic concentration index, RGN, is positive and significant for all industries, signifying the importance of agglomeration effects and transportability of goods in international trade (Table 4.5). RGN is also significant for durable and non-durable goods industries but at the 10% level in the case of durables (Table 4.6). It is interesting to note how the coefficient of human capital changes from positive and significant to negative and insignificant as we move across Table 4.6, from durable to non-durable goods industries.

Industrial concentration, H, is significant in all categories of industries and has the expected positive sign in all categories. Also, note how both its magnitude and

TABLE 4.5

EQUATION 3 (N=448)

Dependent Variable: XVS (OLS):

INTERCEPT	5.614 (2.776)
H	0.0014 (2.322)
VI	-0.0166 (-0.430)
AS	-0.334 (-2.013)
RGN	0.120 (2.182)
HUM	0.00018 (2.556)

Condition Index	10.61
$\bar{R}^2$	0.0648
W	26.216
$\chi^2_{\text{critical}} (5\%)$	11.070

Critical t-values:

1 tail (5%)	1.648
2 tails (5%)	1.965
1 tail (10%)	1.283

TABLE 4.6

EQUATION 3

Dependent Variable: XVS (OLS):

	DURABLES ($N_1=251$)	NON-DURABLES ($N_2=197$)
INTERCEPT	0.404 (0.146)	11.765 (3.956)
H	0.0017 (2.033)	0.00095 (1.713)
VI	0.113 (1.979)	-0.191 (-3.967)
AS	-0.533 (-2.514)	0.0382 (0.154)
RGN	0.114 (1.415)	0.129 (1.660)
HUM	0.00020 (2.414)	-0.0000057 (-0.077)
Condition Index	12.28	9.56
$\bar{R}^2$	0.1109	0.1307
W	31.221	24.362
$\chi^2_{\text{critical}} (5\%)$	11.070	11.070
Critical t-values:		
1 tail (5%)	1.651	1.653
2 tails (5%)	1.969	1.972
1 tail (10%)	1.285	1.286

its significance are greater for durable goods industries compared to non-durable goods industries (Table 4.6).

Finally, vertical integration, VI, is negative and insignificant for all industries (Table 4.5) but positive and significant for durable goods industries while negative and strongly significant for non-durable goods industries (Table 4.6). This may mean that the efficiencies of vertical integration improve the comparative advantage of durable goods industries while vertical integration acts as a retardant to exports in non-durable goods industries.

Recapping, the most important relationship this thesis is examining, namely the effect of industry concentration on export share, has been shown to be positive for the entire manufacturing sector and its two subcategories (durable and non-durable goods industries) and statistically significant in all three cases. So the hypothesized relationship holds. The explanatory power of the regressions is low but large cross-sectional data sets are characterized by low $\bar{R}^2$, yet they have robust coefficients with the correctly expected signs (Gujarati, 1988), as in this case.

Turning to the export share equation with interactions, the important variables are the interaction terms, $(H) \times (RGN)$ and $(H) \times (TARIFF)$. In Table 4.7, both are negative and significant, although the second one is significant at the 10% level. The negativity and significance of $(H) \times (RGN)$ means that the advantages of agglomeration and purported advantages of industry concentration do not reinforce each

TABLE 4.7

EQUATION 3 (INTERACTIONS) (N=448)

Dependent Variable: XVS (OLS):

INTERCEPT	4.164 (1.917)
H	0.0034 (2.555)
VI	-0.0095 (-0.248)
AS	-0.313 (-1.848)
RGN	0.215 (2.481)
HUM	0.000178 (2.584)
(H) × (RGN)	-0.000142 (-2.309)
(H) × (TARIFF)	-0.000102 (-1.503)

Condition Index	12.81
$\bar{R}^2$	0.0775
W	22.891
$\chi^2_{\text{critical}} (5\%)$	14.067

Critical t-values:

1 tail (5%)	1.648
2 tails (5%)	1.965
1 tail (10%)	1.283

other. The same situation applies to both durable and non-durable goods industries (the latter at the 10% level) (Table 4.8). Both H and RGN lose their separate significance for non-durable goods industries while they retain it for durable goods industries (Table 4.8).

Turning to $(H) \times (TARIFF)$, its negative sign at the 10% level (Table 4.7) means that concentrated industries which are protected by tariffs become inefficient and complacent and unable to compete effectively. Note how strongly significant the negative sign is for durable goods industries (Table 4.8). Looking again at Table 4.8, we can see that $(H) \times (TARIFF)$ is positive in the case of non-durable goods industries but barely significant at the 10% level. So we can conclude that the hypothesis according to which concentration has a positive effect on exports particularly when it is reinforced through protection does not apply in general, except in the case of non-durable goods and even then the effect is very weak.

We shall now discuss the non-linear aspect of industry concentration in the third equation. In Table 4.9, the coefficient of H is positive and strongly significant while the coefficient of H^2 is negative and, again, strongly significant. For all industries, export share peaks at an H of about 2,923 (Table 4.9). The inverted "U" relationship just described persists for both durable and non-durable goods industries (Table 4.10). In both cases, the coefficients of H and H^2 have the expected signs (positive

TABLE 4.8

EQUATION 3 (INTERACTIONS)

Dependent Variable: XVS (OLS):

	DURABLES ($N_1=251$)	NON-DURABLES ($N_2=197$)
INTERCEPT	-4.529 (-1.782)	12.569 (4.327)
H	0.00737 (4.186)	-0.00011 (-0.101)
VI	0.149 (2.938)	-0.183 (-3.744)
AS	-0.559 (-2.321)	0.00134 (0.005)
RGN	0.363 (3.018)	0.0568 (0.626)
HUM	0.000207 (2.650)	-0.000029 (-0.403)
(H) × (RGN)	-0.000347 (-2.457)	-0.000104 (-1.465)
(H) × (TARIFF)	-0.000294 (-3.087)	0.000118 (1.291)
Condition Index	15.32	11.73
$\bar{R}^2$	0.1829	0.1333
W	45.152	26.979
$\chi^2_{\text{critical}} (5\%)$	14.067	14.067
Critical t-values:		
1 tail (5%)	1.651	1.653
2 tails (5%)	1.969	1.972
1 tail (10%)	1.285	1.286

TABLE 4.9

EQUATION 3 (NON-LINEARITY, H MEASURE) (N=448)

Dependent Variable: XVS (OLS):

INTERCEPT	4.183 (2.170)
H	0.00416 (3.617)
VI	-0.0068 (-0.180)
AS	-0.314 (-1.907)
RGN	0.103 (1.768)
HUM	0.00017 (2.548)
H ²	-0.000000712 (-3.545)

Condition Index	11.50
$\bar{R}^2$	0.0801
W	39.990
χ^2_{critical} (5%)	12.591

Critical t-values:

1 tail (5%)	1.648
2 tails (5%)	1.965
1 tail (10%)	1.283

Peak H	2,922.75
--------	----------

TABLE 4.10

EQUATION 3 (NON-LINEARITY, H MEASURE)

Dependent Variable: XVS (OLS):

	<u>DURABLES (N₁=251)</u>	<u>NON-DURABLES (N₂=197)</u>
INTERCEPT	-0.549 (-0.204)	10.390 (3.677)
H	0.00389 (2.408)	0.00334 (2.360)
VI	0.115 (2.028)	-0.176 (-3.819)
AS	-0.458 (-2.285)	-0.0313 (-0.119)
RGN	0.103 (1.216)	0.113 (1.398)
HUM	0.00019 (2.353)	0.000000515 (0.071)
H ²	-0.000000553 (-2.044)	-0.000000609 (-2.392)
Condition Index	12.92	10.97
$\bar{R}^2$	0.1174	0.1402
W	39.298	24.418
$\chi^2_{\text{critical}} (5\%)$	12.591	12.591
<u>Critical t-values:</u>		
1 tail (5%)	1.651	1.653
2 tails (5%)	1.969	1.972
1 tail (10%)	1.285	1.286
Peak H	3,517.17	2,744.66

and negative, respectively) and are statistically significant. For durable goods industries, the H at which export share peaks is approximately 3,517 while for non-durable goods industries it is 2,745 (Table 4.10).⁶

These results merit further examination. Judging from the peaks, an observer may conclude that an H index above 2,923 for all industries, 3,517 for durable goods industries, and 2,745 for non-durable goods industries will be associated with falling export share. The question here is, how many observations fall to the right of the H peak that was determined by partial differentiation in each case?

Examination of the H/export share scattergram for all industries showed a positive relationship between the two variables. It also showed a small cluster of five observations with low export shares at the higher range of H and well away from the rest of the observations (their average export share was 3.46%, as opposed to the average of 7.78% for the entire manufacturing sector). Their H ranged from 4,950 to 6,126. Coincidentally, these were H values estimated by me

⁶ A point concerning the absolute magnitude of H and H^2 . The values appear to be small (very close to zero in the case of H^2) because of the units of measurement that were used: H came from Census data; the government multiplies the H index by 10,000 (for example, 1,520). Regressions were also run with the decimal measure (say, 0.1520). The zeros disappeared and the magnitudes increased but the t-values of course did not change (Gujarati, 1988). This point applies to the entire discussion on H, its square, and the influential data points, to be elaborated on shortly.

because H was suppressed for certain industries for confidentiality reasons.⁷ For all 448 industries, there were 7 industries to the right of the 2,923 H peak. For durable goods industries, there were only 4 to the right of the 3,517 peak. Also, 4 industries were to the right of the 2,745 peak for non-durable goods industries.

I examined whether, in each case, the extreme values were influential observations. I will not present the relevant regressions to avoid unnecessarily cluttering the dissertation, but the general framework was as follows: First, a distinction must be made between outliers and influential observations. Outliers may not be influential and influential observations may not be outliers (Donald and Maddala, 1993). Influential observations are those which have a large impact on some aspect of the estimation of the model of interest. Outliers are points away from the rest of the data. To determine influence, a modified version of Cook's D was used.⁸ If $D > 1$, the observation is considered

7 See Section 3A.3, Chapter 3, *supra*.

8 Cook's D is defined as:

$$D_i = \frac{1}{(k+1)} \cdot \frac{\hat{e}_i^2}{s^2} \cdot \frac{h_{ii}}{(1-h_{ii})^2},$$

where k is the number of predictors, $\hat{e}_i^2$ is the squared residual, s^2 is the residual variance, and h_{ii} is the diagonal element of the hat matrix, which is defined as $H = X(X'X)^{-1}X'$ (Cryer and Miller, 1994).

influential. This, however, is an inflexible cut-off because it disregards the fact that the greater the number of observations, the smaller the chance that an influential observation will affect the parameters. An absolute cut-off risks missing influential observations. Therefore, I used the cut-off $D > 4/(n-k-1)$, as suggested by Chatterjee and Hadi (1988). Not all outliers were influential according to this criterion, as applied first to all 448 industries and then to durable and non-durable goods industries. There is no justification in discarding outliers solely on the grounds of being located away from the rest of the data. Discarding is appropriate only when the H value in question was entered incorrectly into the computer during the data processing stage: I double-checked all my outliers and this was not the case at all. In general, the regressions did not change by much. The peaks changed but were still in the highly concentrated category ($H > 1,800$). The new peaks were 2,565 for all industries (the old peak was 2,923), 3,458 for durable goods industries (the old peak was 3,517), and 2,466 for non-durable goods industries (the old peak was 2,745). For all industries, the observations to the right of the peak increased to 12, for durable goods declined to 2, and for non-durable goods increased to 7.

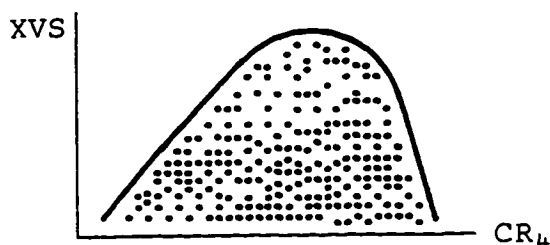
Additional regressions with *all* the outliers omitted showed a positive relationship between H and export share; the coefficient of H^2 was negative but insignificant and the relationship leveled off at an H of about 3,140 (only 1

observation was to its right). For the other two cases, for non-durable goods industries the H peak came out to be 1,652 with a significant negative coefficient for H^2 (15 observations were to its right) while for durable goods industries the coefficient of H^2 came out positive but insignificant.

As I said earlier,⁹ in light of the above results and to get a more complete picture, I ran the export share regression with the four-firm concentration ratio, CR_4 , as a measure of structure. Examination of the CR_4 /export share scattergram for all industries and durable and non-durable goods industries showed a sharply defined inverted "U" relationship.¹⁰ This is confirmed by the regression results: For the entire manufacturing sector, export share is maximized at a CR_4 of 64.88% (Table 4.11). 57 observations, or 12.72% of all 448 observations, were to the right of the peak. This means that, at concentration ratios above 65%, inefficiencies of concentration may set in and produce a falling export share. Durable goods industries have a peak

9 See Section 3E, Chapter 3, *supra*.

10 In fact, in all three cases, the relationship looked as follows (XVS is the export share):



The scattergram tilts to the right (the upper limit of the concentration ratio is of course 100%).

TABLE 4.11

EQUATION 3 (NON-LINEARITY, CR_4 MEASURE) (N=448)Dependent Variable: XVS (OLS):

INTERCEPT	-0.106 (-0.047)
CR_4	0.273 (4.173)
VI	-0.00245 (-0.065)
AS	-0.365 (-2.314)
RGN	0.0976 (1.680)
HUM	0.000189 (2.754)
$(CR_4)^2$	-0.00213 (-3.107)

Condition Index	23.17
$\bar{R}^2$	0.0943
W	53.307
$\chi^2_{\text{critical}} (5\%)$	12.591

Critical t-values:

1 tail (5%)	1.648
2 tails (5%)	1.965
1 tail (10%)	1.283

Peak CR_4	63.88%
-------------	--------

CR_4 of 69.53% and non-durable goods industries a peak of 67.42% (Table 4.12). Table 4.12 shows clearly that the inverted "U" relationship persists for both industry groups. For durable goods industries, 27 observations, or 10.62% of all 251 observations were to the right of the peak of 69.53%. For non-durable goods industries, 18 observations were to the right of the 67.42% CR_4 peak, which represents 9.13% of all 197 observations. The remaining coefficients did not change from when the H measure was used as a measure of concentration.

From Tables 4.11 and 4.12 it can be seen that in both the case of the manufacturing sector and its two subcategories, a tightly oligopolistic industry will result in a maximum export share if one uses the 60% threshold of a CR_4 for a tight oligopoly. Finally, in comparing the two measures of concentration in the non-linear form of the third equation, it can be seen that CR_4 provides a slightly better fit in all three cases.

I shall now conclude the discussion of the empirical results by presenting a brief discussion of elasticities and standardized coefficients.

4C. The Coefficients of the Concentration Measure in the Export Share Equation: A Reinterpretation

Given that H is a pure number, in order to get a more complete picture of the impact of industry concentration on

TABLE 4.12

EQUATION 3 (NON-LINEARITY, CR_4 MEASURE)

Dependent Variable: XVS (OLS):

	DURABLES ($N_1=251$)	NON-DURABLES ($N_2=197$)
INTERCEPT	-3.778 (-1.204)	7.084 (2.173)
CR_4	0.236 (2.885)	0.192 (2.230)
VI	0.111 (1.929)	-0.170 (-3.651)
AS	-0.497 (-2.649)	-0.0372 (-0.146)
RGN	0.095 (1.132)	0.112 (1.436)
HUM	0.00020 (2.412)	0.0000319 (0.431)
$(CR_4)^2$	-0.00169 (-1.920)	-0.00142 (-1.683)
Condition Index	21.38	27.05
$\bar{R}^2$	0.1283	0.1450
W	49.930	28.149
$\chi^2_{\text{critical}} (5\%)$	12.591	12.591
Critical t-values:		
1 tail (5%)	1.651	1.653
2 tails (5%)	1.969	1.972
1 tail (10%)	1.285	1.286
Peak CR_4	69.53%	67.42%

export share, I took the concentration coefficients for each group of industries and standardized them for ease of comparison. If $\hat{\beta}_j$ is the regression coefficient, its standardized counterpart is:

$$\hat{\beta}_j^* = \hat{\beta}_j \cdot \frac{S_{x_j}}{S_y},$$

where S_{x_j} is the standard deviation of the independent variable in question and S_y is the standard deviation of the dependent variable (in our case, export share). The standardized coefficient gives the standard deviation change in the dependent variable which results from an one standard deviation change in the independent variable.¹¹ Table 4.13 shows the standardized coefficients of the concentration measure for all industries, durable goods industries, and non-durable goods industries for the first order model which uses H as a measure and the two second order models [which use H and H^2 and CR_4 and $(CR_4)^2$, respectively]. In Table 4.13 I have also calculated the estimated elasticity of the export share with respect to the measure of concentration for all 448 industries, durable goods industries, and non-durable goods industries. The elasticity in each case was the product of the partial derivative of the export share with respect to the concentration measure, multiplied by the ratio of the average values of the two variables:

¹¹ For example, if the standardized coefficient is .50, an one standard deviation change in the independent variable will cause a half standard deviation change in the dependent variable.

TABLE 4.13

STANDARDIZED COEFFICIENTS AND ELASTICITIES

FIRST ORDER MODEL (H ONLY)

	ALL INDUSTRIES (N=448)	DURABLES (N ₁ =251)	NON-DURABLES (N ₂ =197)
Standardized Coefficient: H:	0.1307	0.1581	0.0932
<i>Elasticity:</i>	<i>0.1341</i>	<i>0.1381</i>	<i>0.1183</i>

SECOND ORDER MODEL (H AND H²)

	ALL INDUSTRIES (N=448)	DURABLES (N ₁ =251)	NON-DURABLES (N ₂ =197)
Standardized Coefficient: H:	0.3885	0.3618	0.3277
" H ² :	-0.2883	-0.2220	-0.2608
<i>Elasticity:</i>	<i>0.2967</i>	<i>0.2488</i>	<i>0.3033</i>

SECOND ORDER MODEL [CR₄ AND (CR₄)²]

	ALL INDUSTRIES (N=448)	DURABLES (N ₁ =251)	NON-DURABLES (N ₂ =197)
Standardized Coefficient: CR ₄ :	0.6575	0.5676	0.4841
" (CR ₄) ² :	-0.4881	-0.3869	-0.3404
<i>Elasticity:</i>	<i>0.5362</i>	<i>0.4417</i>	<i>0.5309</i>

If XVS is export share and C is the measure of concentration, then:

$$\epsilon = \frac{\partial XVS}{\partial C} \cdot \frac{\bar{C}}{\bar{XVS}}.$$

Looking at both the standardized coefficients and the elasticities, it can be seen that in all cases we have what might be termed an inelastic response of export share to changes in concentration. For example, in the case of the four-firm concentration ratio, an 1% increase in CR will cause about half a percentage increase in export share for all industries (the elasticity is 0.5362). The results of the Table show that the arguments for increased concentration are partially correct since increased concentration has a positive effect, up to a point, on export share but the effect on export share is not that pronounced. Pro-concentration arguments would have received a better boost if the elasticities were much closer to 1 or, better, were to exceed 1. And even then the elasticities would only be part of the story because policymakers need to consider the costs and benefits to society: The benefits from higher concentration versus the costs from the higher deadweight loss that will result from increased monopolization.

Summary

This chapter presented the empirical results of the econometric model, along with extensions for the export

share equation which included interactions between industrial and geographic concentration and industrial concentration and the tariff rate, as well as a non-linear specification of two different industry concentration measures.

The picture that emerged was that industrial and geographic concentration interact negatively in affecting export share. The same was true for industrial concentration and the tariff rate in all cases except the one for non-durable goods. This suggests that the hypothesis that the positive effect of industrial concentration on export share is reinforced through protection is weak, to say the least.

There was evidence, both from scattergrams and regressions, which pointed to the direction of a statistically significant non-linear relationship between industry concentration and export share, with export share first increasing, peaking, and then declining. This relationship was true when the four-firm concentration ratio was used. In the case of the Herfindahl-Hirschman index, a few very high H observations pointed to a non-linear relationship, but this was weakened when they were removed from the model. The non-linear relationship suggests that, at higher levels of concentration, a lower share of output is exported for reasons of either inefficiency or reduced innovative activity or both.

Another finding was that the tariff rate negatively affects industry concentration because it protects

inefficient industries and thereby attracts entry. This finding applied to the entire manufacturing sector and to durable and non-durable goods industries (the effect was much stronger for non-durables).

In closing, it was found that unskilled labor intensity is a very strong determinant of tariff rates while the effect of industrial concentration was weak and often significantly positive. The same was true for geographic concentration, although its effect was stronger. Finally, political influence was mostly insignificant, the exception being durable goods industries, suggesting hidden logrolling effects.

CHAPTER 5: CONCLUSIONS, IMPLICATIONS, AND AREAS FOR FURTHER RESEARCH.

The purpose of this dissertation was to examine the relationship between producer concentration and industry export intensity for the American manufacturing sector in 1982. It was hypothesized that the relationship would be positive. In a secondary examination, it was hypothesized that there would be a positive relationship between geographic concentration and export share on the grounds of agglomeration, transportability, and tradability effects. A detailed measure of geographic concentration that incorporated the aspect of distance was constructed for this purpose. The regression results showed that geographic concentration had a positive impact on export share.

The hypothesized relationship between industrial concentration and export share was investigated in a three-equation framework which allowed for the simultaneous determination of industrial concentration and the tariff rate. The main data set was also subdivided into durable and non-durable goods industries: The purpose of this breakdown was motivated by the desire to discover possible insights in the debate about concentration and efficiency, and the possible importance of concentrated industries for the American export sector. The results showed that indeed there is a significant positive effect of industry concentration on export share for both the entire manufacturing sector and durable and non-durable goods

industries. The elasticity of exports with respect to concentration, however, is not substantial since it is well below one in all cases.

Along with the hypothesized positive relationship between industrial concentration and export intensity, an interaction model was tested which allowed for the interactions of industrial and regional concentration and industrial concentration and the tariff rate. The results were that, in most cases, these two interactions were negative. This means that, although geographic and industrial concentration separately have positive effects on export share, when they interact the inflexibilities of too much concentration begin creating efficiency problems. Also, and this is much more relevant to the central idea of this thesis, the negative concentration/tariff interaction term means that sheltered concentrated industries become inefficient and unable to compete internationally. This conclusion is reinforced by the finding that, for the manufacturing sector as a whole and for durable goods industries, tariff protection exercises a negative significant effect on the level of concentration because it will attract entry by inefficient firms that wish to take advantage of the protection rents. The interaction term was weakly positive only in the case of non-durable goods industries, which means that the hypothesis stating that the positive effect of concentration on export share is reinforced through protection receives very weak support.

Another important finding with possible implications for policy was the testing of a non-linear specification for concentration, which concluded that there is a statistically significant inverted "U" relationship between industry concentration and export share when the four-firm concentration ratio is used. This suggests that highly concentrated industries, on average, export a lower proportion of their output because they suffer from inefficiencies of large size and by the complacency that results from high market shares. It seems that a moderately concentrated tight oligopoly industry is the form of industry structure that maximizes export share. This applies to the manufacturing sector as a whole and to durable and non-durable goods industries. When the Herfindahl-Hirschman index is used, the relationship weakens because of a few very high H values which act as influential observations. Keeping the caveat about drawing macroeconomic conclusions from microeconomic, cross-sectional, data in mind, the policy implication may be that the government should not be lenient in its antitrust considerations when dealing with highly concentrated industries on the grounds that such industries will export a much greater portion of their output than less concentrated industries. The government may afford to be lenient in its policy applications at the middle levels of industry concentration because the concentration/export share relationship is positive when concentration increases from low to moderate. That is,

consideration should be shown to moderately concentrated industries, particularly when they can demonstrate the effects of efficiency on both their domestic and foreign performance. In short, as in the case of technological progressiveness, the best market structure for export performance is the moderately concentrated industry.

The division of the manufacturing sector into two classes in this thesis had the purpose of attempting to provide some broad guidelines about particular groups of industries. However, one should not keep disaggregating into smaller and smaller groups because, by doing this, important theoretical considerations are lost since increasing disaggregation will eventually obscure important differences among industries. It should be kept in mind that it would be a good idea to first use results like the ones from this study and then to examine each industry carefully on a case by case basis because industries are often unique entities and the complex interrelationships between structural variables cannot be examined and evaluated by simply changing numbers in an equation.

Future research would be greatly helped if United States foreign direct investment data were available at the four-digit SIC level. This would allow the examination of whether foreign direct investment and exports are substitutes or complements. It was a pity that such data were not available to be used in this study.

Also, the industry concentration/export share

relationship could be extended to test for the effect of excess concentration on export share. That is, assuming that a satisfactory measure of minimum efficient scale exists (usually the median plant size is taken in this case), multiplying MES by four (since there are four firms in the concentration ratio) will give us an indication of the level of concentration that is consistent with economies of scale. Subtracting this result from the actual concentration ratio will give us the excessmarket share in each industry. If this excess market share is used in an export share regression by allowing it to act in a non-linear fashion, it shall be seen whether excess market share benefits or harms export performance.

Finally, a government-published index of geographic concentration will go a long way in achieving uniformity in studies of industrial organization, international trade, and regional development policy.

It is hoped that this study will contribute to the growing literature on industrial concentration and international trade that has finally ended the unfortunate dichotomy between the two fields by improving the understanding of the relationship between industry structure, protection, and export performance both for the American manufacturing sector as a whole and for broad subdivisions of industry groups.

APPENDIX A

CONSTRUCTION OF THE GEOGRAPHIC CONCENTRATION INDEX

This appendix elaborates on the construction of the geographic concentration index and explains how the distances between states were calculated and how the problem of data unavailability for employment figures by state was corrected.

First, I used a huge easel pad with rows and columns to construct a 50 × 50 matrix of numbers, representing the fifty states. 1,225 cells out of the 2,500 (50 × 50) were actually filled because of the symmetric nature of the matrix.¹ These 1,225 cells were filled as follows: A detailed map of the U.S. was used and, with a ruler, linear distances were measured between each pair of states, using the most populous city in each state as a frame of reference.² The biggest city in each state was selected on

1 That is, schematically,

	AL	AK	AZ	...	...	...	...	WV	WI	WY
AL										
AK	x									
AZ	x	x								
...	x	x	x							
...	x	x	x	x						
...	x	x	x	x	x					
...	x	x	x	x	x	x				
WV	x	x	x	x	x	x	x			
WI	x	x	x	x	x	x	x	x		
WY	x	x	x	x	x	x	x	x	x	

(50×50)

where AL is Alabama, AK is Alaska, AZ is Arizona, and all the way to the end with WV (West Virginia), WI (Wisconsin), and WY (Wyoming). The highlighted area (with "x") represents the 1,225 cells that were filled (note that the diagonal is blank). The diagonal represented a distance of zero. So the first column had 49 cells, the second 48, and so on. Therefore, 49+48+47+...+ 3+2+1+0 = 1,225 cells.

2 Population figures were obtained from the Statistical Abstract of the United States, 1982.

the safe assumption that it is the center of the greatest economic activity in the state. The distance between cities was in centimeters and I used the scale of the map³ to transform it into miles. The resulting number was placed in the appropriate cell. One by one, I thus filled all 1,225 cells.⁴

I then proceeded with the employment figures, E_1 , E_2 , E_3 , and E_4 , for the top four states. The data were found in the 1982 Census of Manufactures Industry Series, which presented employment by state for the 4-digit SIC industries. Because of disclosure limitations, no employment figures were given for many states.⁵ So I had to estimate them or collect them from other sources. For the 448 industries, the situation was as follows:

- 192 industries reported employment figures for all 4 states;
- 104 industries reported employment figures for 3 states;
- 72 industries reported employment figures for 2 states;
- 52 industries reported employment figures for 1 state;
- 28 industries gave no employment figures for the 4 states.

³ The scale was 1 cm = 100 miles.

⁴ I also looked at a road atlas to obtain another set of estimates as a cross-reference. The atlas figures were bigger than mine because they represented non-linear commonly travelled routes. In most cases the numbers were close to each other. Not all the cases I needed were covered.

⁵ The Census instead presents ranges of employment when the data for a state are suppressed. These ranges are:

AA: 150-249 employees
 BB: 250-499 employees
 CC: 500-999 employees
 EE: 1,000-2,499 employees
 FF: 2,500 or more employees.

It shall be seen later that these were utilized to estimate missing state employment levels in several cases.

I knew which the top four states were, having obtained them, as I said earlier, from the Industry Series. I would now like to elaborate on how I corrected the problem for each category listed above.

The first category of 192 industries had complete and perfect data and therefore nothing else was needed.

The 3-state case for the 104 industries presented no particular problem. It was a simple first degree equation situation: Since national employment, the top four states in each industry, their share in national employment (that is, the "four-state" concentration ratio), and the employment figures in three states were known, it was very simple to solve for the employment level of the missing state.⁶

The remaining 152 industries ($72 + 52 + 28$) were more complicated. A combination of mathematical methods, other government sources, and the assigning of lower bounds were used. In all cases I had the Census ranges mentioned above as a cross-reference. As we just saw, partial information was given for most industries, the exception being the 28 industries with no employment data at all. With this explanatory point, we shall now proceed.

⁶ And, of course, in each case the employment figure that was calculated for the missing state fell within the range that was presented by the Census Bureau (see previous footnote).

608 state employment cells were needed (152 industries × 4 employment cells each). Out of these, 196 cells were available.⁷ This left 412 cells (608 - 196). Two government sources were used: The Bureau of Labor Statistics (BLS) publication 1982 Employment and Wages: Annual Averages and the Census publication County Business Patterns, 1983 (from here on, CBP). Both of them suppress data. Thankfully, in many cases they did not suppress what I needed. From Employment and Wages I was able to obtain employment figures for 126 cells (states). Now, CBP does not follow a January-December cycle: Its 1982 employment figures included numbers for the week of March 12, 1983 (CBP also presented data by county, where of course there was plenty of suppression). So no pure 1982 data were available but that was no problem. CBP withholds data but the ranges it provides are much more extensive compared to the Census of Manufactures.⁸ This

7 196 cells were available because:
 72 industries × 2 available cells = 144
 52 industries × 1 available cell = 52
 28 industries × 0 available cells = 0
 196

8 The CBP employee ranges were as follows (Census ranges are repeated for comparison):

Census	CBP
.....	A: 0-19
.....	B: 20-99
AA: 150-249	C: 100-249
BB: 250-499	E: 250-499
CC: 500-999	F: 500-999
EE: 1,000-2,499	G: 1,000-2,499
FF: 2,500 or more	H: 2,500-4,999
.....	I: 5,000-9,999
.....	J: 10,000-24,999
.....	K: 25,000-49,999
.....	L: 50,000-99,999
.....	M: 100,000 or more.

was good because CBP ranges provided a superior cross-reference when the highest range of the Census of Manufactures (FF, 2,500 employees or more) happened to apply to a state. This was a problem because this highest range has no upper limit. So I looked at the equivalent CBP range to find the upper limit.⁹ The CBP provided data for an additional 94 cells.

In 46 cases, I assigned the lower bound of the Census of Manufactures relevant range;¹⁰ no harm was done. Ellison and Glaeser (1994) state that setting employment in Census cells to its lower bound identifies the location of 90% of employment in the median industry and 80% on average.

Finally, mathematical calculations were used for the remaining 146 cells. In most cases, when the employment figure for a state or states was found by using one of the above methods, simple calculation solved for the missing state since three states, their employment figures, the top 4 states, their share in national employment, and national employment were known. But in many other cases (46 to be exact), a form of linear programming was used.¹¹ This applied when two state employment levels were known in an industry and two were missing. The "four-state" ratio and

9 Comparisons were easy because both publications use the SIC system. Even though the lack of upper boundary also applies to the highest CBP range (M, 100,000 employees or more), this was never encountered.

10 This approach was used when the others were unworkable.

11 This method was tested with states that had complete data and worked very well.

national employment were of course known. The approach will be best illustrated with an actual example, SIC industry 3297 (Nonclay Refractories): National employment was 6,800 employees and the top four states accounted for 65% of national employment. The top four states and their employment data were as follows:

PA	1,400
OH	1,800
MD	BB
NY	CC.

I proceeded as follows: $6,800 \times .65 = 4,420$. This is the total employment for the top four states. We now have:

$$PA + OH + MD + NY = 4,420 \Rightarrow$$

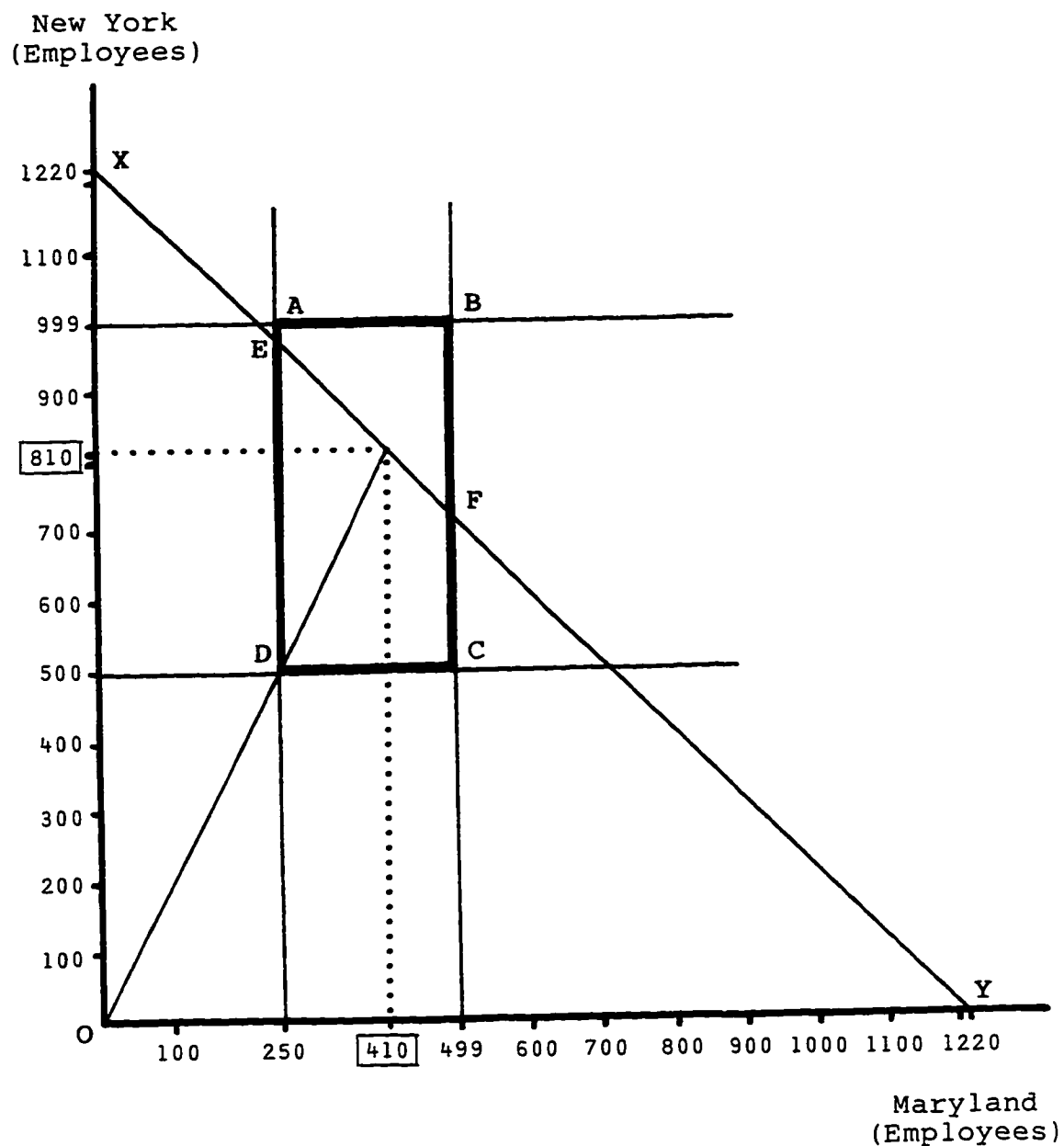
$$1,400 + 1,800 + BB + CC = 4,420 \Rightarrow$$

$$3,200 + BB + CC = 4,420 \Rightarrow BB + CC = 1,220.$$

Figure A.1 illustrates the approach. Since the ranges are known and their upper and lower bounds are given (BB: 250-499, CC: 500-999), a rectangle can be constructed which will include the solution (the rectangle, ABCD, is highlighted). Now, $BB + CC = 1,220$. This can be plotted in the graph as line XY. This line has a segment, EF, which passes through ABCD. Theoretically, there is a very large number of solutions along this segment. To select a solution that will not unduly favor one state at the expense of the other (this would happen if point E or point F were to be selected) while at the same time maintaining the disparity in favor of the state that has the highest range (here NY), a ray from

FIGURE A.1

ILLUSTRATION OF LINEAR PROGRAMMING METHOD



Maryland: BB: 250 - 499 employees

New York: CC: 500 - 999 employees

(based on SIC industry 3297).

the origin through point D is drawn: The solution is at the point of intersection of the ray with the segment EF. So the solutions are 410 employees for Maryland and 810 employees for New York.

Using all those approaches, I thus completed the data for the 152 industries and, along with the 104 industries which required only the solution of a first degree equation, and the 192 industries with complete data, I used the information to calculate the index of geographic concentration.

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