INDUSTRY STRUCTURE, MARKET STRUCTURE AND INTERNATIONAL TRADE:
THEORETICAL AND EMPIRICAL OBSERVATIONS

by

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ABSTRACT

This paper describes international trade activity as affected by the structure of markets and industries. The paper builds upon recent international economic literature that models international trade within imperfect markets. Arguments for trade intervention by national governments in order to shift industry rents to the home nation are further surveyed. Similar trade models are used to explain economic growth from both a national and global standing. A Cournot perception of competitive behaviour is employed within a basic model developed of two-country, intra-industry, oligopolistic trade of a homogeneous good. The model predicts that lower marginal costs lead to higher output and lower relative costs lead to higher relative market share than of the foreign rival industry. However, firm number within the relative industry can offset cost effects. If fixed costs are present, gains from rationalization may be realized through trade and result in higher industry concentration. In order to test the hypothesis that higher concentration of industry leads to greater trade, particularly export trade, the paper applies regression technique to measure the relationship between Canadian industry exports and a variety of concentration variables. Results show more highly concentrated industries to have greater export volume. When standardized export and concentration variables are used, weak evidence is presented that export and concentration in Canada are positively related. However, analysis of United States industries confirms that concentration explains a significant amount of industry propensity to export. Based on testing and other empirical results, it is concluded that rationalization of costs associated with export trade and/or ability to discriminate between markets motivates trade in concentrated industries. Under imperfect market conditions, government may want to intervene in trade by promoting higher concentration of industry if net social surplus gains through trade can be realized. Competition policy may promote not only combine activity but also cooperation between firms in order to reduce duplication of international trading costs. If competition policy affects international trade partners, regulators of world trade activity may take interest in national policy related to industry structure and competition as it affects global welfare.
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DEDICATION

This paper is dedicated with all my love to Rick.
I. INTRODUCTION

International trade flows are a significant part of economic activity for most nations. Since trade is an important component of national economic wealth, governments take a keen interest in the exporting and importing enterprise within national boundaries and may seek to intervene in trading sectors in order to effect gains in state wealth. Exporting industries are of particular interest to nations seeking to increase economic benefits derived from international trade since they represent a means of expanding Gross Domestic Product (GDP). Although consumption as a measure of national welfare may also be raised through low priced imports, exporting industries provide additional benefits to a nation of employment, national treasury earnings in foreign exchange and growth through expanded market activity.

The means and tools used in the pursuit of economic wealth by nations as it relates to both export and import trade is the subject of much debate on trade policy. National trade policies focus on the welfare of domestic constituents. By definition, however, international trade is multilateral and the policies implemented by one nation will have repercussions on the trading activity of others. Friction results when government seeks to maximize the wealth of its own constituents at the expense of foreigner enterprise or consumers who in turn cry out that such policies make the international playing field "unfair". Indeed, international economic relations
are often characterized by trade wars and major corporate and/or state negotiations (Jacquemin, 1989).

Before any level of government undertakes policymaking regarding trade, a solid understanding of trade flows and their effect on both domestic and foreign welfare must first be achieved. Modelling trade then becomes an important first step toward understanding and helps describe the determinant conditions for trade to take place. If economic parameters of trading sectors are unique and separate from those of non-trading industries, then these parameters should be of utmost significance to policy makers and trading firms alike.

It is the economic importance of international trade, particularly export trade, and the role of government within the activity that provided prime motivation for this academic study. It then attempts to focus on export trade and describes a simple relation between exports and industry structure. The first three sections of the paper give a brief review of the theory and literature relating to international trade models of imperfect competition. The fourth section emphasizes these trade models under conditions of economic growth. The following two sections describe trade in imperfect markets using a simple two-country trade model. The model parameters and implications are explored. The seventh and eighth sections provide empirical evidence linking industry structure to export trade in both Canada and the United States. Conclusions from this analysis are that imperfect market theories are indeed compatible with empirical findings for these two countries. Implications of the theoretical and empirical observations for national trade policy are given in the ninth section and final remarks are included in the tenth and final section.
II. FINDING A MODEL FOR INTERNATIONAL TRADE

The traditional model of trade within perfectly competitive markets is useful for explaining trade activity on the basis of country comparative advantage. The theory of comparative advantage was first described by David Ricardo (1817) and states that producers within each country that are relatively more efficient than their foreign counterparts at providing a good will export that commodity. The assumption that international markets are perfectly competitive places several conditions on the Ricardian model. Included are that all producers yield sufficiently small output as to not affect market price, each has perfect market information, firms freely enter and exit, and production takes place with constant or decreasing returns to scale. In reality, a significant amount of global trade takes place within imperfect markets in which oligopoly or even pure monopoly equilibriums persist (Dixit, 1983).

Modelling trade based on comparative advantage and perfect competition fails to explain several empirical observations. Traditional theory may, therefore, no longer be sufficient for explaining international trade flows. Specifically, the model cannot account for volume and composition trade, role and volume of intrafirm trade, foreign direct investment, and effects on social welfare from trade liberalization (Helpman and Krugman, 1985:2).

Trade models incorporating economies of scale and imperfect competition allow greater understanding of the empirical observations that makes the conventional trade model weak. Given this additional view of model parameters, increasing use is being made of industrial
organization analyses, imperfect competition and game theory to describe oligopolistic firms and
governments competing in a strategic trade environment for a share of global economic wealth
(Jacquemin, 1989).

The problem of modelling imperfect competition is that there does not exist one general model
of oligopoly that can be consistently applied. As firms seek to maximize profits they may
collude, either explicitly through cartels and formal agreements or tacitly through "follow the
leader" strategies, or they may forego cooperation and choose to embrace competition of various
degrees. The conjectured responses of firms will also affect individual firm behaviour as well
as the choice of strategic variable with which to compete (Helpman and Krugman, 1985).
Indeed, Jacquemin (1982) points out that there are too many ways in which imperfect market
structure can be modelled, leading to too many different welfare implications. Although extreme,
his thoughts do encompass the daunting scope of possibilities when attempting to predict
interactive firm behaviour and market equilibrium outcomes. Some discussion of relative
competition within imperfect markets as they relate to trade may, therefore, be warranted.

Cooperation in Oligopolies

Cooperation within oligopolistic industries can be described in one manner by the formation of
cartels. Cartels are frequently encountered in international trade and cover both primary goods
such as rubber, sugar, bauxite, petroleum, and cement; as well as secondary goods such as air
and sea transports, electrical and telephone cables, cinema films and television films. Some
economists argue that because cartels are inherently unstable, a model of firms maintaining this
collusive form would not be a good one (Brander, 1983). Others suggest that although unstable, the fact is that cartels do exist and, especially export cartels, continue to increase in number (Jacquemin, 1989). Consequently, this form of imperfect market structure cannot be ignored in exploring the behaviour of firms within imperfect markets.

**Non-cooperation in Oligopolies**

Oligopolistic competition may be strong such that monopolistic distortions are removed and price and output levels result at or near to the perfectly competitive equilibrium. Contestable markets may provide one theory of this type of firm behaviour. The theory predicts that where barriers to entry currently exist, the threat of potential entry or other means of increased output by competitors reduces monopoly distortions and forces average cost pricing (Helpman and Krugman, 1985).

**Monopolistic Competition**

Proposed imperfect market models often presume industry production of a homogenous good or some output that is perfectly substitutable between firms. Monopolistic competition replaces this presumption with one of product heterogeneity. The theory argues that firms within an industry can differentiate their products such that it is no longer a perfect substitute for existing or potential competitors' goods. With a differentiated and therefore unique good, a firm faces a downward sloping demand curve for its product and can exert market power using price or output variables.
Helpman and Krugman (1985) have developed a trade theory based on monopolistic competition. Following Chamberlin (1933), Helpman and Krugman argue that in an industry facing increasing returns to scale from specialization, or where each of a variety of industry goods is produced under decreasing average costs, firms operating in different countries within a global industry will end up producing a different type of the good. Firms maximize profits by choosing to produce a specific product variety at a certain price. The existence of heterogeneous industry product is predicated by the assumption that diversity is demanded by all consumers. Given decreasing cost from specialization and a preference for variety, intraindustry trade will occur between countries. Each country will export the good in which it's firm has specialized in production and import the remaining industry products demanded. The monopolistic or differentiated product approach can be taken further to explain not only world trade patterns but also volume and composition of trade and welfare effects from trade (Helpman and Krugman, 1985).

**Cournot Model of Competition**

A Cournot model of imperfect markets is an intuitively attractive model since equilibrium output is measured somewhere between monopoly and perfectly competitive levels. The Cournot solution is a Nash equilibrium in outputs. Each firm responds to a best estimate output level of its rival(s) when choosing their own output level for maximum profit. Deriving the Cournot equilibrium offers a reflection of a rational process undergone by firms who use all relevant information in assessing their own and competitors' production activity.
Application of this relation has mathematically simple properties since adversary output is taken as exogenous or fixed, however, the model does contain drawbacks despite its simplicity. In reality, firms are not restricted to competing on the basis of output quantity and may use different competitive strategies incorporating price or quality adjustments that affect output and, consequently, overall market price.

Determining an empirically supported and precise model for international trade and imperfect competition may remain a research task for many years. Despite its limitations, however, the Cournot model remains the most widely used for describing firm behaviour in imperfect markets (Brander, 1986).

The application of imperfect market models has taken place within empirical studies measuring various aspects of international trade. Imperfect market models free the investigator of relying on traditional sources of comparative advantage and factor endowments as assumed determinants of trade. Using imperfect market parameters, patterns of international trade activity have been explained by Saxonhouse (1989) and Fung (1991); trade policy outcomes by Brown and Stern (1989), Aw (1991), Roberts and Tybout (1991) and Fung (1991), and Schembri (1989) has employed an imperfect market model to illustrate international pricing behaviour of firms.

The above discussion certainly does not cover the entire vector of possible market structures and competitive relations under the rubric of imperfect competition. However, it does identify various market possibilities within a range of competitive equilibriums extending from monopoly
outcomes to levels closer to that of perfect competition. It is therefore possible to conjecture that the scope of the set of possible international trade policy alternatives will be similarly broad and accommodating to the characteristics of imperfect markets. Even if this is unrealistic, government should at least pay attention to the behaviour of firms within markets in order to devise reasonable trade policy and gain some accuracy in predicting outcomes from implementation.

III. IMPERFECT MARKETS AND GOVERNMENT TRADE POLICY

Government intervention in trade, or "strategic" trade policy is opposed, on the whole, by professional economists (Brander, 1985). As Brander points out, this may be due to the traditional view of trade theory that supports international trade and investment as determined by comparative advantage, rather than the intercedence of government. However, by examining trade under imperfect markets, argument for interventionist trade policy can be made.

Trade in imperfect markets may give indication that economic rents are being earned. Government intervention is one means of channelling those rents to components of the national economy. Typically, policy relies on the use of price or output instruments such as taxes, tariffs, quotas, export subsidies or production subsidies. Mandated firm behaviour as reflected in competition (Canada) or anti-trust (United States) policy may also be included in the list of policy means available to government. The instrument chosen will depend on a variety of imperfect market factors including barriers to entry, economies of scale, imperfect information
and heterogeneity of product such that trade intervention arguments may be justified solely on a case by case basis. Common to each of these cases and interventionist tactics is the national purpose of shifting economic rents from foreign rivals to domestic constituents.

The opportunity for rent-shifting trade policy does not imply that government intervention is required for nations to experience gains from trade. Non-interventionist policies may be socially optimal over interventionist ones within imperfect markets. The presence of imperfect markets alone is not a sufficient condition for government intervention. Before continuing discussion of government trade policy effecting rent-shifting, perusal of some of the theories supporting free trade in imperfect markets may provide some balance to the rationale for strategic intervention.

Gains from Free Trade in Imperfect Markets

Uninhibited trade provides domestic exposure to international competition that in turn tempers the inefficiencies of imperfectly competitive domestic markets (Kruegar, 1978). Following Kruegar's argument, Brander (1981) develops a two-country, two-firm model that shows trade will take place within the oligopolistic market as long as price markups over marginal cost exceed transportation costs. The international rivalry between oligopolist firms will act as a cause of two-way trade. Competitive rivalry produces more efficient equilibrium price and output levels than under autarky.

Brander's model is expanded under Brander and Krugman (1983) to consider the same duopolist, two-country world operating under conditions of imperfect competition. Specifically, firms are
able to price discriminate between the domestic and foreign market and make price and output decisions according to profit maximization requirements. Each country's monopolist has positive output levels within each of the domestic and foreign market at the standard monopolist solution of marginal revenue (MR) = marginal cost (MC), although foreign market output decisions are made under perceived greater MR and higher costs due to transportation. Consequently, each firm's price markup over cost for the export market is lower than that of the domestic and reciprocal "dumping" occurs. Again, global gains from trade result since competition forces lower prices and greater output in each market than what would have occurred under autarky. Resultant increased market competition supports the case for non-interventionist trade policy.

In imperfect markets with increasing returns to scale, potential gains from trade stem from rationalization within the industry where export output has cost-reduction consequences. Graham (1923) suggested that to ensure rationalization gains are maintained within the country is to ensure that expansion of production occurs within that country. Otherwise, increased production occurring outside the nation could feasibly cause relative domestic cost increases, national firms would not be cost competitive with foreign rivals whose expanded operation caused decreased average cost. Although Graham's suggestion of trade intervention in order to protect the home market and induce domestic gains (or at least prohibit domestic producer losses) is intuitively appealing, trade intervention may not be a necessary condition.

Under conditions of free trade, Krugman (1992) employs a monopolistic competition model to demonstrate that there may be both domestic and global gains from trade. Benefits result from
both rationalization and world diversification of goods. Consumer surplus is realized due to greater product choice. Even if scale economies are not realized (but are not negative), consumer surplus gains alone, if they are realized in the domestic market, are a sufficient argument for non-interventionist trade policy. Under monopolistic competition, Graham’s concern for domestic market protection is tempered.

Krugman expands his argument to explain that under scale economies and product differentiation, production within the home nation will take place near the largest foreign market in order to minimize transportation costs. If domestic markets are large and there are sufficiently dissimilar tastes between countries then domestic producers will specialize in the home market preferred good and become a net exporter of that good. Patterns of net export trade may therefore follow home market preferences (Krugman, 1992).

Gains from Trade Intervention in Imperfect Markets

While laissez-faire strategies can induce gains from trade under imperfect market conditions, opportunity for governments to intervene and extract global industry rents may also be present. Following are descriptions of models of trade that yield such opportunity. The cases provide examples of the variety of circumstances under which interventionist policies can yield optimal welfare benefits.

Krugman (1992b) builds a case for import protection based on rationalization gains only. The principal of Graham’s argument is somewhat reiterated here. Focusing on a duopoly industry
facing declining average costs and consisting of a domestic and foreign firm, Krugman argues that a protectionist import policy can shift domestic sales to the home firm and away from the foreign firm. Costs of the home firm should decrease and those of the foreign firm increase. Output to the foreign market supplied by the domestic firm will also increase and market share of the rival will decrease due to lower relative production costs effected in the protected domestic market. Krugman’s argument is a circular cause and effect of increasing economies causing increasing output causing further reductions in output costs. Krugman does not provide any welfare analysis. Welfare analysis may indeed have revealed consumer surplus losses from high domestic prices as a result of import protection. Losses could conceivably be large enough that a national negative impact from the protectionist policy results. Krugman does not, therefore, generalize the import protection approach as an applicable strategy for all industries. Rather, the argument demonstrates that such import protection policy can at least be modelled as a first step to evaluating protectionist trade policy and welfare effects under imperfect market conditions.

Aw (1991) provides empirical investigations of import protection under imperfect market conditions. Voluntary export restraints (VERs) placed on Taiwanese and Korean footwear manufacturers were investigated to determine if any price affects resulted within the United States (US) domestic market. Aw highlights the Krugman (1992b) caveat that domestic market protection within an imperfect market may harm the consumer through raised industry prices. Empirical results of Aw show that neither the foreign importers nor domestic industry engaged in non-competitive pricing behaviour. However, the reduction in foreign supply brought on by
the VERs did raise domestic industry prices above those of the period when VERs were not in place. This price-cost margin increase was the result of market scarcity brought on by the VERs. Although no welfare analysis was explicitly undertaken, the price increase and quantity decrease would indicate that there was some consumer surplus loss on the part of the US footwear consumers.

Brander and Spencer (1984) focus attention on the use protectionist policies; specifically import tariffs, subsidies or cartelized domestic export industries; as methods of extracting rents from imperfectly competitive international markets. The optimal policy tools recommended will depend on cost and demand circumstances. Import tariffs are predicted to shift rents from imperfect foreign imports in the domestic market to the national treasury. These rents can be large enough to offset reduced consumer surplus from lower domestic supply. Domestic export cartels may also be used to extract these industry rents from foreign competitors. A significant point of the Brander and Spencer paper is that economic rents provide strong incentive for national governments to intervene in trade and act unilaterally to secure national social benefits.

Eaton and Grossman (1986) use similar argument to Brander and Spencer above but isolate the case of non-domestic consumption within imperfect markets. Both trade policy and industrial policy are demonstrated to effect rent-shifting. The authors state that domestic competition amongst home producers has a negative effect on national welfare since opportunity for the national industry to move closer to monopolistic equilibrium levels is foregone. Either a production or export tax decreases domestic industry output such that the home-country exploits
monopoly power in trade. Note here that a policy allowing domestic industry firms to form a cartel would also achieve the desired national welfare results.

Richardson (1990) supports a case for exports subsidies to encourage trade by influencing domestic market structure. An incumbent monopolist in the domestic market is assumed to make expenditures that deter the entry of rival firms. The monopolist exports only surplus production and makes pricing and output decisions based on the domestic market alone. Under such circumstances, export subsidies or promotion may well be welfare improving. In effect, they increase the good’s world price as realized by the monopolist and increase the export sales margin. By altering the relative profitability of export markets, the monopolist may choose to compete as a duopolist in the domestic market, conceding domestic market share and price for gains in export activity. Domestic consumer gains are realized through increased competition and producer gains are realized by reduced cost from entry-prevention expenditures no longer incurred. Although fairly specific, the Richardson argument places important focus on the possible inter-relation of trade policy and domestic market activity and structure.

Eaton and Grossman (1986) use their previous argument for intervention by way of trade and industrial policy to warn against the complications of domestic industry structure on policy results. Endogenous entry and exit of firms is assumed along with the previous postulate of no domestic consumption. If a trade or industrial policy causes profit-shifting to the domestic industry and attracts additional domestic firm entrants, rents could be dissipated through increased competition that negates any national benefit. Economic rents may also be lost to
payment of additional entry fees or the increase of firms could raise the industry average cost of production. Under these conditions, incremental policy deterring firm entry is required, either through export or production taxes. The authors draw opposite conclusions if there exists residual demand within the industry. As such, the promotion of domestic firm entry, say through export or production subsidies, deters foreign firm entry or causes their exit and, therefore, industry benefits accrue to the greater number of national producers. The important point of the case presented by Eaton and Grossman is that industry structure variables must be considered before rent-shifting or other trade policies can be implemented. These variables could cause optimal policies to vary between tax and subsidy under similar trading conditions.

Brander and Spencer (1985) provide an interesting rationale for rent-shifting policy through production subsidies under the rubric of international strategy. If a potential international market is efficiently served by only one firm, then monopoly rents from that industry will be sought by national governments as well as the potential domestic entrant. Government should be willing to provide a subsidy to the firm up to the amount of monopoly rents available within the industry if the subsidy guarantees domestic firm victory in securing the monopoly position. Each domestic firm, before any subsidy, faces potential losses from entry if the market is eventually lost to the foreign rival. If the domestic government were to subsidize potential entry losses then the foreign firm would face the greater risk of market entry and may not pursue an entry strategy. The credibility of governments providing subsidies within international markets may consequently deter foreign competition and yield monopoly rents to the domestic firm and nation.
Further Considerations

Each of the trade scenarios reviewed above gives possible rationale for laissez-faire and/or trade interventionist strategies. Some concerns regarding trade policy and imperfect markets, however, remain. The first consideration of the models proposed was initially raised by Dixit (1983). If capital markets are efficient and shareholders are international (ie. there exists a distribution of shareholders across countries) then rent-shifting policies would be pointless if wealth was distributed to shareholders. Producer rents paid to the firms owners in the form of dividends would dissipate outside of national boundaries and the original government objectives of country wealth maximization would be thwarted. If, however, shareholders are predominantly domestic then the accrued industry rents should remain within the country and wealth maximization goals should be achieved.

A second consideration is that of policy retaliation. Of the rent-shifting models described, none consider retaliation by foreign governments. Each assumes that the foreign government continues to pursue a laissez-faire policy strategy while the domestic government applies interventionist strategies. From the global perspective, rent shifting should have no impact as long as output and price levels are unaffected overall, ie. that the domestic social gain equals foreign social losses. Many of the strategies discussed, however, create monopoly distortions in markets for the benefit of domestic constituents. From a global perspective, if the loss of the foreign nation is not offset by equal or greater gains within the domestic, global welfare is reduced. If both countries pursue rent-shifting strategies, then both nations may be worse off than if each were to follow a laissez-faire strategy. Unilateral rent-seeking by nations is cause for global concern.
over optimal world trade policy. Such actions give multinational institutions such as the General Agreement on Tariffs and Trade (GATT) a legitimate role in tempering the intervention of governments within international imperfect markets.

A third concern relates to the variety of specific models explaining international trade strategies in imperfect markets. Seemingly the number of scenarios justifying policy intervention is potentially as great as the modeller’s imagination in describing a number of combinations and permutations of industry, market and trade parameters. Helpman and Krugman (1985) are more explicit in their criticism and state that the body of international trade theory in general has left a proliferation of models each with its particular assumptions whose implications for trade policy are often inconsistent. This result will be emphasized further by work of additional authors described below.

Fourth, the models do not consider the distributional effects and subsequent political impact of trade policies as they influence various sectors or groups within the national economy. Baldwin (1989), for example, discusses economic self-interest as an explanation for general trade policy or even industrial trade policy when groups support politicians whose proposed trade policy shift a greater proportion of rents to them. Another distributional effect is the cost of redistributing wealth between the national winners and losers such that a potentially pareto improving trade policy can be truly pareto efficient.

Finally, net effects of producer and consumer welfare changes resultant of trade policies must
be considered. Trade policies directed at national producers become viable only if producer surplus gains exceed any consumer surplus losses, or net social benefit results. From a cost-benefit analysis perspective, the assumption of net welfare gains is usually sufficient. Realistically, policymakers may not weigh producer and consumer welfare equally, especially if costs or benefits are concentrated within a domestic constituent group, making optimal trade policy difficult to implement.

Discussion of these more complex interactions is beyond the scope of this paper and may be better served if addressed as a refinement of trade policy once general effects have been isolated. General effects may also be difficult to determine, however, as outlined below.

Trade Policy in Imperfect Markets: Conflicting Results

Markusen and Venables (1988) complete a theoretical analysis under fairly strict assumptions that test trade policy effects under opposing assumptions of industry structure (oligopoly versus free entry) and market structure (segmented markets versus an integrated world market). Mixing and matching the opposing assumptions yields a quadrant of possible industry/market combinations (actually five propositions were made within the paper) in each of which import tariffs and export taxes are evaluated. We would expect each policy instrument to have a similar effect on domestic wellbeing. Results show, however, that within each quadrant one policy has no or an ambiguous effect and the other yields conflicting results for total domestic welfare. Results under each of the quadrants generated are not necessarily robust and general results for market structure are made independent of industry structure considerations and vice versa.
However, one purpose of drawing attention to the Markusen and Venables (1988) work is that it highlights the models' dependence on specific parameter assumptions. Changing those assumptions can lead to conflicting policy recommendations. The work is also useful as a means of integrating and organizing thinking about market and industry variables in light of policy evaluation.

Eaton and Grossman (1986) also conduct theoretical analysis to determine optimal trade policy in oligopolistic international markets. Their results vary between a tax, subsidy or free trade depending on the model of strategic behaviour of firms chosen. The models employed to evaluate the various policies assumed Nash-Cournot, Bertrand or consistent conjectural behaviour.

The significance of models and model assumptions is concluded to be non-trivial when evaluating trade policy. The lack of a robust model makes determination of government policy effects difficult since model choice may lead to conflicting results. This difficulty underlines the importance of understanding the market structure, industry structure and behaviour of competing firms before trade and trade policy can be effectively illustrated.

IV. TRADE IN IMPERFECT MARKETS AND GROWTH

National welfare and social benefits from trade cannot be fully discussed simply by demonstrating gains through static, one-time increases in country wealth. Continual wealth is
also a goal of national government policy and can be achieved through trade under imperfect market conditions.

During the five year period ending in 1989, the volume of world trade experienced a substantial increase (United Nations Centre on Transnational Corporations, 1991). Grossman and Helpman (1991) suggest that a linkage exists between the recent historic trends of growth in global economic well-being and increased contributions of technical innovation. The link between world growth and technology can be explained on the grounds of rapid communication between innovators in different countries facilitating the spread of new ideas. These same authors identify a number of studies that name factors correlated to growth in national output. Many are related to a nation's collective human knowledge such as literacy rates, the number of science and engineers in society and school enrolment rates. Others relate to trade factors, specifically, Michaely (1977) and Feder (1982) find that growth rates are greater for nations that export a large share of their output.

Traditional growth theory describes the formation of "capital" in the economy which induces rises in labour productivity and is the major cause of economic growth (Grossman and Helpman, 1991). The theory narrowly refers to capital as machinery and equipment of production technology that yields constant returns to scale. Capital, however, can also be interpreted to represent knowledge accumulation. Knowledge yields technological progress and innovation that enables capital formation to continue and economic growth to take place. The studies noted above support the notion that knowledge and technology can each be interpreted as growth
producing "capital". Traditional growth models have historically treated technological growth determinants as exogenous, or even explained national growth through technological "spillovers" from one industry or sector to another.

Traditional trade models assuming perfect competition cannot very easily handle large investment in physical capital, human capital or technology through research and development (R&D). Trade models of imperfect competition, however, can be used to model these activities. For example, Grossman and Helpman (1991) refer to the Helpman and Krugman (1985) trade model of product specialization and monopolistic competition to explain the linkage between trade in imperfect markets and domestic growth. In the trade model, fixed production costs incurred are part of total production costs. Applied as a growth model, fixed costs can take the form of up-front investment in R&D. The country making that particular expenditure in R&D will create and export unique goods resulting from the research outlay and import goods from another country making different R&D expenditures resulting in different goods produced. The specialization assumption also allows gains from trade to be realized due to increased efficiency, specifically, lack of duplication of innovative activities results.

Many of the preceding arguments for both non-interventionist and interventionist trade strategies describe benefits from trade due to directed expansion of the domestic industry and the resulting one-time productivity gains from rationalization. These economies of scale specifically describe economies in production. At the firm level, opportunity to expand wealth through trade is limited since we would expect such gains to soon be exhausted in light of a large global market (Dixit,
Krugman (1992) moves beyond production scale using his argument of import protection as a means of securing domestic industry growth in output. Cost decreases due to expanded output at the expense of reduced foreign firm sales provide incentives for R&D or growth producing expenditures. Greater R&D investments made by the domestic firm than the foreign rival can be amortized over higher output in both home and foreign markets. The same argument can be applied to industries characterized by some learning curve in production, where higher cumulative output influences greater current productivity. Greater home than foreign firm sales achieved today yields greater productivity gains and growth of domestic producers. Krugman, therefore, shows that a protected domestic market may encourage welfare as well as growth opportunities.

Trade itself may cause economic growth. By exchanging product, equipment or information the producer may deliberately (or not) share innovative ideas and speed the process of information exchange leading to higher industry growth rates. In the short term, possession of technology and information may give firms some monopolistic advantage in the global market that leads to higher levels of trade.

The motivation of monopolistic trade is the subject of much of the current dispute over the international disregard for patent laws. When laws are violated, future trade can possibly be deterred since the innovator risks losses of the proprietary right to the economic rents earned through trade. Effects on further investment in R&D may be ambiguous, depending on many factors including the risk aversion of the innovator. Katz (1986) confirms that since the
externality of technology spillovers confers benefits on competitors, firms may have a tendency to underinvest in R&D. The easier the dissemination of information, the greater the spillovers are likely and the larger, we would expect, the underinvestment in innovation (Baumol, 1992) and, therefore, economic growth.

Baumol (1992) makes the argument that technology cartels and collusion in R&D offers increased rents by reducing the positive externality of technology spillovers and reducing the dissemination of rents from innovation. If innovative technology is produced in international markets then spillovers may provide positive externalities to foreign competitors and opportunity to earn industry rents. Policy that encourages formation of domestic technology cartels and collusion as described by Baumol may exemplify a form of trade intervention that shifts or maintains rents within the domestic industry.

Caves and Khalilazdeh-Shirazi (1977) reveal a number of empirical linkages between firm innovation and trading activity. Results showed the following: that proprietary information was found to be important to a larger proportion of exporting than import-competing businesses; that one third more of exporters' sales were accounted for by new products introduced in the three years preceding the study; and, that R&D outlays, as a percentage of sales, were larger for exporting businesses. Another conclusion drawn by the authors is that trade-related business (both exporting and import-competing) are more innovative than producers not exposed to trade. Trade may therefore provide stimulation for growth through innovation, and exporting industries in particular may be an engine for national growth through innovation.
Based on the previous theoretical and empirical literature, strong argument exists that trade may lead to increased investment and innovation that generates dynamic welfare benefits enjoyed from either a national or global standing. Linking the areas of trade and growth, Helpman and Grossman (1991) argue that dynamic models of growth can be made analogous to static trade models using imperfect market assumptions, specifically with reference to trade models of product specialization explaining patterns of intra-industry trade. Since externalities are seemingly an inherent attribute of innovative activities, trade within innovative industries may be characterized as imperfect. Therefore, argument for some form of rent-shifting trade or industrial policy exists if "spillovers" to foreign producers are to be minimized and industry rents are to be maintained by domestic firms.

Market imperfections are significant variables in assessing trade elements of national welfare, growth and government policy. Industry structure is a factor of market imperfections and is also a critical element of model assumptions predicting and evaluating trade. The remainder of this paper will focus on industry and market structure variables that influence trade and trade policy.

V. ANALYZING IMPERFECT MARKETS AND TRADE: INTRODUCTION TO THE BASIC MODEL

A model of oligopolistic international trade was designed in order to better understand trade in imperfect markets and the influence of market structure on trade. The purpose of the model is to simplify conditions under which trade takes place in order to clearly illustrate some of the
industry structure influences on trade.

The basic model consists of trade between two countries in each of which firms produce a homogeneous good. Consumption takes place in the two markets, one referred to as "domestic" and the other as "foreign", such that markets clear. The domestic and foreign country together comprise the global industry. The model describes one period of output and consumption.

There exists $n$ domestic firms and $m$ foreign firms within the respective countries. Each firm has a Cournot perception and seeks to maximize profit within the model by taking rival firm output as fixed for the period. A domestic firm produces output $x$ for domestic consumption and output $x^*$ for delivery to the foreign market. Similarly, $y$ and $y^*$ are produced by the foreign firm for domestic and foreign market consumption respectively. Consumers in both markets have identical preferences and tastes represented by identical linear inverse demand curves. Marginal cost, $c$, is at first assumed to be constant for all firms in the global industry. Transport costs are incurred in exporting the good from one country to the other and are identical for all firms in the global industry. Transport costs are applied within the model in the form of a "tax" on output where $t \geq 0$.

Caveats of the basic model

Assuming a one period model:

The analysis looks at a one period, static model without considering reactionary effects from past or future output by own or rival firms. If the model was more dynamic, expected actions of
competitors in one period would affect firm and therefore industry output levels in subsequent periods. Such a model could conceivably be built starting with a Cournot perception written in general functional form for a given firm, i, in some single period, n, as;

\[ \Pi_i = p(x_i,x_k) \cdot f(x_{i,m},x_{k,m}) - C_i(x_i), \]

where:

- \( f = \) output function of firm i in the current period n
- \( x_i = \) output of firm i for the period n
- \( x_{i,m} \) and \( x_{k,m} = \) output of firm i,k for all previous periods m
- \( x_k = \) output of all other firms k where \( k \neq i \) and where \( x_i + x_k = \) total industry output for the period n
- \( P(x_{i,k}) = \) inverse demand function for the period

Further conjecture could also be incorporated into the model in order to generate an equilibrium Cournot solution over a number of periods. Without continuing to speculate on the dynamic possibilities, the point to be offered is that dynamic models offer much more comprehensive behavioral information not included in the basic model described\(^1\). The basic model sacrifices these considerations in order to generate simple solutions that clearly demonstrate a specified relation.

The Cournot model, although a static one-period model, is rational and yields an equilibrium that results from each firm’s best response to it’s rivals’ actions considering all information. It may

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\(^1\) see Axelrod (1984) for work on dynamic models of interactive firm behaviour.
therefore serve as a close approximation for more dynamic industry behaviour while still serving the purpose of allowing analysis to focus on specific variables in the environment.

Assumption of a homogeneous product:
Oligopolistic industries may tend to offer differentiated products in order to capitalize on monopolistic market opportunities or increasing returns from specialization, testing the reasonableness of the assumption of homogeneous product within the basic model. It is not unrealistic, however, to observe industries where a homogenous product is produced under conditions of increasing returns to scale. Primary goods or commodities such as steel and oil may be produced within industries having barriers to entry due to large initial capital investment, geographic restrictions, or some proprietary process technology. Therefore, gains from rationalization may be available to such extent that oligopolies do tend to arise in homogeneous product industries and the model’s assumption of homogenous product may be considered viable.

Additional Caveats:
In addition to the homogeneous and static period assumptions discussed, further weakness of the model must be identified. First, the model does employ general functional forms and depends on specific linear functions to describe demand and firm output. Second, trade does not consider the effects of substitute or complement goods as prices and output levels change within the market. Third, consumers are indifferent to aspects of the good other than price. Country of origin, quality and other effects on the purchase decision are ignored. This same argument is the basis of the final caveat. The output decision is the only strategic variable employed within the
model and quality, pricing and other effects indirectly affecting output are assumed to remain constant.

VI. ANALYSIS OF THE BASIC MODEL

The general profit maximizing conditions under which each domestic firm, $i$, and foreign firm, $j$, operates can be written as:

\[ \Pi_i = x \cdot P(X) + x^* \cdot P(Y) - c(x + x^*(1 + t)) - F, \]  
\[ \Pi_j = y^* \cdot P(X) + y \cdot P(Y) - c(y + y^*(1 + t)) - F, \]

where asterisks denote production for export and $F$ represents fixed costs to the firm. Market price is dependent on total consumption within the domestic ($X$) or foreign ($Y$) market. The demand functions for each market are assumed to be linear and identical;

\[ P(X) = a - bX \]
\[ P(Y) = a - bY \]

where $X = A + x_i + y_i^*$, and

\[ X = \sum_{k \neq i} x_k + \sum_{j} y_j^* \]
\[ Y = B + x_i^* + y_j \]

where $A = \sum_{k \neq i} x_k + \sum_{j} y_j^*$ and $B = \sum_{k \neq i} y_k + \sum_{j} x_i^*$.

Due to the assumption of identical price and cost structures across all firms within the domestic
or foreign industry, each of these industry's firms will have identical output. Therefore each of
x, x*, y and y* represents "typical" firm output such that the subscripts i and j are no longer
required for firm differentiation.

Since there are n domestic firms and m foreign firms, and costs within each industry are equal,
total output for the domestic market, X, and the foreign market, Y, can be written as:

\[ X = nx + my^* \]  \hspace{1cm} (7)
\[ Y = nx^* + my. \]  \hspace{1cm} (8)

From equations (7) and (8) we can rewrite equations (4) and (6) as:

\[ A = (n-1)x + (m-1)y^*, \]  \hspace{1cm} (9)
\[ B = (n-1)x^* + (m-1)y. \]  \hspace{1cm} (10)

Since profit functions for each firm are additive, segregating them into profit from foreign and
domestic activity yields two equations for each firm d and f. The first order conditions of these
profit functions yields four symmetric equations in a, b, c, t, n, and m for each of the output
variables x, x*, y and y*. These equations are:
\[ x = a - bmy^* - c, \quad \text{(11)} \]
\[ b(1+n) \]
\[ x^* = a - bmy - c(1+t), \quad \text{(12)} \]
\[ b(1+n) \]
\[ y = a - bnx^* - c, \quad \text{and} \]
\[ b(1+m) \]
\[ y^* = a - bnx - c(1+t). \quad \text{(13)} \]
\[ b(1+m) \]

**Effects of the cost function**

Since equations are symmetric, results are equally applicable to either country's firms facing foreign and domestic markets. Using equations (11) and (14) to describe the relative output of the typical domestic foreign firm in the domestic market, \( X \), the relation can be written as:

\[ x = y^* + ct/b. \quad \text{(15)} \]

Note that each variable \( c, t, \) and \( b \) are positive by definition. Equation (15) shows that domestic output will be equal to foreign exports to the market only in the absence of transportation costs \((t=0)\). Otherwise, domestic firm output is greater than that of the foreign counterpart for \( t > 0 \).
In the absence of transportation costs, domestic and foreign firms will share the market equally, each controlling 50%. When \( t > 0 \) then domestic firm market share will exceed that of the foreign firm. Therefore, the presence of transport costs creates a wedge between domestic and foreign supply to the domestic market that also increases the market share differential of foreign and domestic firms.

The relationship of cost and output has interesting implications for firms in exporting industries. It is recognized that some increase in marginal costs over and above transportation may be directly attributable to exporting. These costs can be accommodated by the basic model and may include compliance with regulation (i.e. documentation), increased advertising and distribution costs in the foreign market, higher financing charges or costs from product adaptation for sale in the foreign market. By simply re-expressing \( t \) as the sum of all incremental costs due to exporting, including transportation, these costs are incorporated. By re-evaluating equation (15), these additional positive costs affecting the exported goods increase the wedge between domestic and foreign firm output.

Notice that trade still takes place within the industry even though the cost disadvantage due to transportation or incremental costs exists for foreign firms in the domestic market. Brander (1981) first described this phenomena by showing that within an imperfect market with market price exceeding total marginal cost of both firms, including transportation, each firm has a profit maximizing solution for the foreign market at some positive output level and intra-industry trade will continue.
In order for firms in exporting industries to maximize their own welfare, producers facing same production costs as their foreign rivals and same transport (and other export marginal) costs as their domestic competitors must minimized these costs. Only under conditions of identical total marginal costs between the rival and foreign industry can the domestic industry move towards a maximum 50% market share in the foreign market.

By relaxing the cost constraint equating domestic and foreign firm production costs, equation (15) can be rewritten using different marginal cost values across the two national industries - \( c_x \) represents a domestic firm's marginal cost and \( c_y \) represents a foreign firm's marginal cost. Therefore;

\[
x = y^* + (c_y - c_x)/b + c_yt/b.
\]

Equation (16) implies that in order for domestic and foreign firm output to be equal, costs of domestic production must be equal to total costs of export production, or:

\[
c_y(1+t) = c_x.
\]

Equation (17) shows that any affect of transportation or other incremental export costs on the foreign producer must be offset by lower production costs if equal per firm output and equal market share is to be maintained. As costs increase and output falls, demand in the market is increasingly met by the lower cost/higher output country. Assuming that transport costs and
other incrementals are inevitable, one strategy that firms within an exporting industry may pursue is to offset marginal influences from exporting with lower relative marginal production costs. Such a strategy would also lower domestic output costs below those of the rival level. Focus on lower relative production costs, therefore, represents a means for expanding output, market share and profit in both the foreign and domestic market.

The same cost-output relationship exists between firms within an industry. Looking solely at domestic firms’ export production, variant costs across domestic firms result in variant firm output levels. Output for firms i and k within the domestic industry is represented as follows:

\[ x^*_{i} = a - bA - by - c_i(1+t), \]  
\[ x^*_{k} = a - bA - by - c_k(1+t). \]  

Analysis of equations (18) and (19) shows that for output across firms to be equal, firm costs must be equal or \( c_i = c_k \). Lower production costs in either firm i or k bear correspondingly higher export output of that firm. We note too that firms facing dissimilar transportation costs, perhaps due to some advantage of proximity to the export market, may enjoy greater export output than their domestic firm rivals all other things equal.

Not all firms within an industry can be expected to be exactly identical, therefore, industry exports may not be evenly distributed across all firms. The relevance of this point for the
industry will be pursued further under considerations of relative firm number within each industry. Indeed, not all firms within the industry may export if costs relative to foreign rivals are large and exceed foreign market price levels.

Note that the analysis so far has only considered marginal cost. Fixed costs of the firm for purposes of export or production have not been considered to affect the firms’ output decisions. Fixed costs present in the model indicate that, within some range, decreasing average production costs and increasing returns to scale are present. Consequently, any increase in output would yield additional profits to the firm if expanded operations occurred within the declining cost range.

**Effects of Scale Economies**

The original model’s annual fixed cost component, F, may represent some initial start-up or operating investment during the period relating to production for both the domestic and export market. As stated previously, this factor implies that average costs of production are falling over some output range even though marginal costs are constant. If average costs are falling within the relevant output range for all firms then industries are subject to economies of scale. Gains from trade including rationalization of output within an industry were discussed in detail within previous sections of the paper. It would be useful here, however, to reiterate these arguments as related to discussion of the basic model and some welfare analysis.

Due to fixed costs, output increases within the domestic industry yield total producer surplus
increases. Rent-shifting policies may focus on allowing domestic output to increase at the expense of foreign rival's such that greater gains from rationalization are realized within the domestic industry while reduced output in the foreign industry reduces producer surplus from higher cost production. Marginal cost differentials may, therefore, also contribute to national industries' realization of economies of scale. Consider the case of the domestic industry. If export marginal costs are minimized and/or marginal production costs differentials between domestic and foreign firms offset export marginal costs, then domestic industries may be able to achieve at least as great or greater market output and market share at the expense of foreign rivals within the foreign market. Any additional output may drive the domestic industry operations further down its average cost curve than foreign firms with the same production technology and investment. Therefore, marginal cost advantages may serve to reinforce gains from rationalization due to trade.

One effect of industry rationalization is to reduce the total number of firms competing and allow industry concentration to grow. The issue of industry structure as described by firm number is discussed in the following section.

Effects of firm number

Thus far the analysis has assumed equal number of firms n and m within domestic and foreign industries. The effect of firm number within an industry on domestic or foreign market output has not been isolated. By assuming the cost relationship of (15) holds and is strict, ie. \( x > y^* \) for \( t > 0 \), the effects of firm number can be explored.
First let us assume that the number of domestic firms, \( n \), is greater than or equal to the number of foreign firms, \( m \). Since \( x \) is strictly greater than \( y^* \) then \( n \times x \) will be strictly greater than \( m \times y^* \). The aggregate domestic industry supply to the domestic market will be greater than that of the aggregate foreign industry. Further, since \( X = n \times x + m \times y^* \) the domestic industry’s market share will be greater than the foreign industry market share. Assuming \( X \) is constant (i.e. there are no price effects), any increase in domestic firm market supply must, by definition of \( X \), come at the expense of the rival foreign industry. Due to the presence of declining average costs, a shift in industry rents from foreign firms to domestic would take place.

Only by strictly defining relative firm output and directing the relative sizes of \( n \) and \( m \) can any clear relation between firm number and industry output be described. If \( n \leq m \) given \( x > y^* \) then the lower foreign per firm output may be offset in the industry aggregate by a higher number of firms such that foreign industry output is equal to or greater than that of the domestic industry. This aggregate output ambiguity is demonstrated in the matrix shown in Figure 1. The industry having the greater share of the domestic market, \( X \), under various assumptions about the relative sizes of output, \( x \) and \( y^* \), and firm number, \( n \) and \( m \), is denoted within the matrix cells.
Figure 1. Greater Industry Market Share

<table>
<thead>
<tr>
<th></th>
<th>n &gt; m</th>
<th>n = m</th>
<th>n &lt; m</th>
</tr>
</thead>
<tbody>
<tr>
<td>x &gt; y*</td>
<td>domestic</td>
<td>domestic</td>
<td>?</td>
</tr>
<tr>
<td>x = y*</td>
<td>domestic</td>
<td>equal</td>
<td>foreign</td>
</tr>
<tr>
<td>x &lt; y*</td>
<td>?</td>
<td>foreign</td>
<td>foreign</td>
</tr>
</tbody>
</table>

where;
- domestic = domestic output has dominant share of market
- foreign = foreign output has dominant share of market
- equal = domestic and foreign output has equal share of market
- ? = ambiguous outcome

Cases where cost effects may be offset in the aggregate by the number of firms in the industry are illustrated in Figures 2 through 5. Total domestic and foreign industry output to the domestic market is graphed by plotting individual firm output on the vertical against the rank order of firm size as measured by per firm output from highest to lowest. The total area under each curve represents some total equilibrium output for the domestic market X. These cases are equally applicable for the foreign market Y using output of x* and y. If area under the aggregate domestic industry curve is greater than that of the foreign then domestic industry market share will be greater.

If costs are equal across the global industry then relative industry output as shown in Figures 2 and 3 are simple to determine. These figures essentially depict the upper-middle and middle-left cells of the matrix of Figure 1. Figures 4 and 5 show how costs variant across the industry skew the output curve to the left and create some downward sloping curve describing aggregate
industry output for the market. The figures depict the ambiguous effects described in the lower left and upper right cells of the matrix in Figure 1. Integrating the area under the curves is the only means of specifically determining relative industry output.

Figure 2. Relative Aggregate Industry Output, \(x = y^*, \ n > m\)

![Figure 2](image2.png)

Figure 3. Relative Aggregate Industry Output, \(x > y^*, \ n = m\)

![Figure 3](image3.png)
Figure 4. Relative Aggregate Industry Output, $x, y^*$, $n < m$

Figure 5. Relative Aggregate Industry Output, $x, y^*$, $n > m$

Firm Number and Industry Seller Concentration

Using the cost-output relationships of the original model we can explore the effect of industry concentration in the domestic market and its effects on trade within the foreign market. Recall
that the domestic market share of the domestic industry is expressed as:

\[ \frac{nx}{X}, \text{ where } X = nx + my^* \]

and \[ \frac{nx}{X} + \frac{my^*}{X} = 1 \]

Combining this linear example with the cost relationship of the basic model described in (15), foreign and domestic industries should each enjoy a 50% market share in both their own and foreign markets in the absence of transportation costs, i.e. \[ \frac{nx}{X} = \frac{my^*}{X} \] given \( x = y^* \). As transportation costs increase, export output falls and domestic market share increases. Given a constant number of firms, domestic concentration levels would increase as the same number of firms supply a greater share of the domestic market.

However, since the relationship is symmetric, increased transportation costs imply lower foreign market share for the higher concentrated domestic industry. High levels of domestic industry concentration due to high transportation costs would therefore be associated with low levels of exports since each country's industry supplies the majority of their own markets.

Extending the argument from transportation costs to total marginal costs of export output, firms with lower costs in either the domestic or foreign markets will achieve higher relative market share in both markets. Higher domestic industry concentration would therefore be associated with higher export levels given a fixed number of firms. The additional market shares come at the expense of foreign rivals whose market participation decreases with higher total costs.
If a domestic industry is imperfectly competitive such that increasing returns are present, then rationalization within the domestic industry should yield higher per firm domestic market share and therefore higher industry concentration. Lower costs for export production yield similar results. In conclusion, the presence of economies of scale within an industry should yield a positive relationship between domestic industry concentration and export trade. Since the model assumes that the same number of domestic firms now have a greater global market share, welfare effects from increased producer surplus achieved through relatively greater global output must be weighed against any loss in consumer surplus from reduced foreign competition within the domestic market that may raise market prices.

As concentration increases, benefits from rationalization increase until some socially optimal number of firms exist and gains from rationalization are exhausted, i.e., the minimum efficient scale for the industry is reached. This scale is achieved considering the global industry, not just the domestic market, such that rationalization could conceivably result in the existence of only one firm that supplies the global industry in order to move as far along the decreasing average cost curve as possible. This is the case described by Brander and Spencer (1985) where national firms vie to become the global monopolist. The national perspective of gains from trade in this case, however, must consider the monopoly distortions within the domestic market and their effect on national welfare.

The pattern of trade can also be explained by rationalization within the basic model. The domestic industry should be a net exporter if the extent of rationalization within allows greater
cost reductions than the foreign industry. Given equal market size and firm number before rationalization, some difference in the extent of rationalization between similar domestic and foreign industries could be caused by unlike competition policy or anti-trust legislation between nations. In countries with stricter legislation impeding the concentration of industries, these policies may serve to raise industry costs and reduce opportunity to gain domestic producer surplus from both domestic and export markets.

Dixit (1983) argues that the importance of economies of scale and scope can be expected to decrease at the level of production technology as trade expands market size. Considering intangible assets, however, such as knowledge or specific managerial skills, economies of scale in these variables may become increasingly important at the international level (Caves, 1982). If economies of scale are present for such intangible assets then domestic industry rationalization and consequent concentration would still provide gains from trade. If economies are present across national boundaries then rationalization of firms within the global industry as a whole would provide global gains from international trade. As such, domestic concentration indices could conceivably increase if some domestic firms exited the industry and others acquired foreign rivals. These assumptions, however, are specific. Domestic industry concentration may not necessarily capture the relation between international industry concentration and rationalization from trade. Also, opportunity for national policies effecting rent shifting may not be present since the loss of producer surplus from domestic firms exiting may be less than the addition of producer surplus from foreign acquired firms.
If domestic industry concentration is increased by way of fewer foreign imports then higher producer surplus would still be realized by the domestic firms. Again, price effects caused by greater market power of fewer total firms competing must be considered in light of consumer surplus changes before any net gains from concentration and trade can be determined.

No doubt there also exists cases of the domestic industry experiencing increased export market share without any change in domestic firm number and market concentration. These cases may reflect changes in variables considering the export market only, such as cooperative domestic firm ventures in order to reduce export associated costs. Similarly, export subsidies provided by government would affect export trade without affecting domestic market structure as long as additional firms did not enter the industry seeking rents from government policy.

If the number of firms increase rather decline or remain constant, domestic industry foreign and home country market share should also increases, all other things equal. In domestic markets with increasing costs of production, the increase in number of competitors causing decreased industry concentration and rising foreign market share means concentration should be inversely related to export activity.

The above analysis demonstrates that industry concentration may be either positively or negatively related to export trade, depending on the cost structure and entry barriers assumed for the industry as well as the assumptions of the basic model. Study of empirical evidence may serve to resolve or at least clarify alternative outcomes. Evidence, however, is also mixed.
regarding domestic market structure and trade. Examples of empirical work are outlined below.

**Empirical Evidence of Concentration and Trade**

Industry concentration is often used as an indicator of the magnitude of the domestic industry price-cost margin or industry levels of profitability. Indices also represent oligopolistic interdependency as measured by the relative output of firms competing within the industry. Concentration measures give indication of both market and industry structure.

The discussion so far has focused on international markets and their oligopolistic structure yet if domestic market structure is in some way related to international trade then the importance of domestic concentration in trading industries is emphasized and may help explain both trade activity and patterns of trade.

Basically, three linkages between trade movement and industry concentration are cited. As noted above, one means of increasing domestic industry concentration is through the contraction in the number of firms given a level of demand. One cause of contraction could be the exit or merger of firms due to industry rationalization. Another could be caused by barriers to entry where the lack of increase in firm number given increasing demand would result in high industry concentration. If export trade takes place under conditions of increasing returns or high barriers to entry, then we would expect to find a positive relation between exports and domestic industry concentration. If trade instead takes place under conditions of increased competition within the global market from a greater number of firms, either at home or abroad, then export activity
should be negatively related to domestic industry concentration. Finally, trade may be motivated by increased rents. If firms within the industry can price discriminate between foreign and domestic markets such that rents are earned in both destinations, a concentrated or oligopolistic industry would be able to earn increased rents from export. In this case, export activity and industry profitability, indicated by industry concentration, should also be positively related. Research relating to each of these three hypotheses is discussed below.

**Concentration and Economies of Scale:**

Bernstein and Mohnen (1991) apply a model of industry concentration and export production to three Canadian manufacturing industries and show that where economies of scale exist, exporting yields firm benefits. Welfare improvements realized by the firms studied accrued from lower costs since cost complementarities existed between domestic and export output. Also, Canadian industries studied exhibited higher price-cost margins in the domestic market than foreign markets. This may have indicated that the Canadian industries studied faced flattened foreign market curves due to greater international competition, while greater market power was enjoyed within domestic markets. The existence of rationalization gains from trade lends credence to the argument that domestic concentration is positively linked to international trade. Existence of foreign and domestic price-cost differentials offers indirect proof that oligopolies can price discriminate and earn additional rents in foreign markets and are thereby motivated to trade.

Caves and Khalilzadeh-Shirazi (1977) predicted that domestic concentration of exporting industries would be higher than other industries. The authors base their hypothesis on results
characterizing exporting sectors by higher levels of capital intensity and labour skill than non-trading industries. These characteristics would dispose exporting firms toward greater firm size. Larger firms within industries are correlated to higher concentrated industries given a level of demand. Firm size considerations include not only scale economies in asset levels but may also include costs of information, advertising and distribution, and risk-bearing specific to exporting. Empirical research supports the hypothesis that relative exports and firm size are positively related (see Bain (1966), Saving (1961), and Eastman and Stykolt (1967)). Evidence also exists for various countries that exports increase more than proportionately with firm size indicating further economies of scale realized through trade (see Rapp (1976), Glesjer et.al (1980) and Auquier (1980)). Finally, Caves and Kahlilzadeh-Shirazi (1977) show that export oriented industries in the US have higher barriers to entry that non-export oriented industries, providing further indirect evidence that domestic market structure is linked to international trade, specifically export trade.

Caves (1981) tested a variety of variables affecting intra-industry bilateral trade flows. Relating to concentration, effects of scale economies and joint marketing functions (arguably this is an indirect means of expressing "fewer firms" since cooperative firm behaviour can rationalize output) were analyzed for their effects on international trade patterns between the US and other economies. Caves hypothesized and showed that the more extensive scale economies, the less was the amount of intra-industry trade. This result was achieved since extensive scale confined production of a good to a few locations, limiting the amount of inter-country trade. We would expect the volume of export trade, however, to be significant. Increasing exports as scale effects
within the home country firm are realized results in benefits to the producer nation.

Another interesting result of the Caves study was the statistically significant positive effect of jointness of production on intra-industry trade. This was effected mainly by affiliated companies operating multinationally and sharing integrated distribution and marketing systems. Trade flows would, therefore, include goods for resale to fill out the affiliate’s product line.

Finally, Robert and Tybout (1991) dispute the positive effects of trade liberalization on industry efficiency with research of trade impacts on manufacturing plants in Columbia and Chile. Although theory would predict that increased import and export opportunities would bring about industry efficiency in the form of fewer plants operating lower down their declining average cost curves, in the Robert and Tybout study plant size (firm size) actually decreased due to greater import competition.

Concentration and Industry Competition:

Caves (1974) argues that a domestic oligopolist who cannot differentiate between domestic and export markets and faces increasing marginal costs will be constrained by the export market to output and pricing levels closer to those of perfect competition. Increased competition is brought on by international trade and the greater number of firms in both domestic and foreign markets. As such, profits generated by the global industry should be driven closer to zero. If profit margins move to zero, industry concentration as a measure of price-cost differentials should also decrease. For this reason, Pagoulatos and Sorensen (1976), in their study of European Common
Market countries, predicted that trade in domestic oligopolistic industries would show a negative relation to industry profitability. On the other hand, if oligopolistic firms can differentiate their product on world markets then rents captured by the firms would be indicated by a positive relation between concentration and trade activity. From the latter argument we would expect to see a positive relation between industry concentration and export activity. Pagoulatos and Sorensen (1976) tested concentration and trade measures and found that exports as a percentage of shipments was negatively (but insignificantly) related to firm price-cost margins in eight of the ten European countries studied. These results support the first hypothesis of Caves that international competition drives industry rents to zero due to flattened international demand curves.

However, Caves and Kahlilzadeh-Shirazi (1977) show that in the UK, exports as a percentage of industry output were found to have a positive relation to the industry price-cost margins, a counter result to the Pagoulatos and Sorensen information. The UK results lend support to the hypothesis that oligopolistic exporters can earn industry rents with the ability to market discriminate.

Jacquemin and Cardon deLichtbuer (1973) showed that industry concentration increased following the increased exporting opportunities provided by the formation of the European Economic Community (EEC). The difference in these results may be due to the different measures employed from the Pagoulatos and Sorensen study.
In summary, industry concentration as a measure of domestic industry structure may be an indicator of international trade activity. Domestic concentration may be positively linked to international trade under conditions of increasing returns to various scales of assets, information or other trading costs, although evidence exists to show this result is not robust. Price discrimination abilities of domestic oligopolies in foreign markets may also positively link concentrated domestic structure and trade. Concentration may be negatively related to trade if price discrimination is not possible and international market demand is flatter than domestic demand under autarky. The link of profit margin reduction and trade is made using industry concentration as a proxy measure only. No change in domestic industry firm number need actually take place. However, concentration levels, therefore industry structure, would be diluted from increased foreign competition.

In order to focus specifically on the link between industry structure and trade activity, an examination of Canadian and US industry structure and trade data was undertaken. The study is modest yet specific in its objectives. It attempts only to determine if a relation between domestic industry structure and export trade exists, and if so, the directional characteristic of the relation. Since only exports are studied under the rubric of trade, results offer only partial explanation of trading patterns.
VII. EMPIRICAL STUDY

Statistical analysis was used to determine if aspects of industry structure explain export trade. It is recognized that other variables may determine the pattern and volumes of international trade, however, these aspects were not covered within the analysis. Of particular note, the traditional explanation of international trade based on the relative factor endowments of nations is not explicitly included within any testing. Instead, any effect of factor endowments or other variables is assumed to show up in the error term of regression models tested. The following empirical analysis abstracts from the traditional theory to focus only on parameters describing the industry in order to determine if these variables explain export trade.

All statistical testing completed and described within the paper was generated using Minitab Statistical Software (1991). All regression analysis estimates model intercept and coefficient parameters using ordinary least squares (OLS) regression techniques.

A. CANADIAN INDUSTRY EXPORTS, INDUSTRY FIRM NUMBER, ASSETS AND AVERAGE FIRM SIZE

Data Selection
The unit of measurement for the analysis is one manufacturing industry as classified by the Standard Industrial Classifications (SIC) code of Statistics Canada. Industry units are based on either two or three digit SIC classifications, since data availability was a limiting factor of the
study. Export measures are not recorded by Statistics Canada under SIC codes but rather using the Harmonized System of classification. Exports are therefore estimates for each of the three digit manufacturing industries and on occasion were estimated at the two-digit industry classification level. Further discussion of Export data is provided within this section.

Three samples were generated representing each of the years 1977, 1982 and 1987. Various years were studied in order to investigate any changes during the 15 year period described and to determine if results were robust such that consistency across years was evidenced. Sample size in each year is 27 industries.

Characteristics of the data measured are meant to include both trade and industry structure. Measured were annual industry Export sales to the world (Ex), industry size in Assets (A), Number of firms in the industry (N) and average industry Firm Size (S), used as a proxy measure of industry concentration, where \( S = \frac{A}{N} \). Each characteristic, except for firm Number, is measured in absolute nominal Canadian dollar values.

Exports to the world measure the outward volume of trade activity for a particular industry. Employment of Import variables within the analysis may have given indication of intra-industry trade patterns related to domestic industry structure versus the strictly export orientation taken in this study. Consequently, any policy implications born out of this analysis would be directly aimed at exports to effect national wealth and welfare improvements.
Industry size in Assets was measured not only to generate average firm size data but also to determine if export volumes were necessarily linked to the size of a domestic industry as a whole. Average Firm Size measures to some extent the degree of concentration within an industry, with larger sized firms representing a more concentrated structure. Firm Number is the final variable included in the analysis both on its own and as a determinant of Firm Size. By including this variable, changes in Firm Size and industry concentration could be explained either through an expansion or shrinkage of the industry asset base or by changes in the aggregate number of firms. Caution is warranted here, however. Since nominal Asset values were used, changes in industry and firm size includes the effect of inflation.

The 27 manufacturing industries analyzed are listed in Appendix 1. Some liberties in measurement of industry data were taken due to the problem of Export classifications mentioned above. In order to acquire a sizeable enough sample to provide meaning to statistical results, some industries have been "double counted", however, instances of double counting are few. These instances occur in only two industries, Chemicals and Machinery, where sub-industries represent the three-digit industry level and included within the sample are the noted two-digit industries noted. Aggregate industry statistics were determined to hold significant information over and above the sub-industry data. It was, therefore, expected that double counting would have a minimal impact on the overall analytical results. The relative asset measures of sub-industries double counted are presented in Table 7.1 below.
Table 7.1 Sub-industry Asset Size as a Percentage of Aggregate Industry Classification

<table>
<thead>
<tr>
<th>Sub-industry</th>
<th>1977</th>
<th>1982</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Machinery (as % of Machinery)</td>
<td>32.7%</td>
<td>45.8%</td>
<td>42.2%</td>
</tr>
<tr>
<td>Fertilizers (as % of Chemicals)</td>
<td>3.5</td>
<td>2.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Pharmaceutical (as % of Chemicals)</td>
<td>9.5</td>
<td>9.6</td>
<td>12.7</td>
</tr>
</tbody>
</table>

Source: Statistics Canada, various years

Description of the Data

The distribution of industry raw data is extremely skewed for each of Exports, Assets, Number and Size in each of the three years studied. The data was transformed to log values in order to normalize the distribution and provide meaning to statistical testing. Both raw data and the transformed log data plots of distributions are shown in Appendices 2 through 5.

Once transformed, the log data showed fairly normal distribution as indicated by the plots through Appendices 2 through 5 and descriptive information of the log data listed in Table 7.2. Variance within samples is low and similar between years.

Table 7.2 Description of Canadian Export, Asset, Firm Size and Firm Number Data

Log Data ($000s)

<table>
<thead>
<tr>
<th>1977</th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>exports</td>
<td>27</td>
<td>13.098</td>
<td>13.093</td>
<td>13.105</td>
<td>1.697</td>
<td>0.327</td>
</tr>
<tr>
<td>assets</td>
<td>27</td>
<td>14.434</td>
<td>14.200</td>
<td>14.431</td>
<td>1.145</td>
<td>0.220</td>
</tr>
<tr>
<td>number</td>
<td>27</td>
<td>5.666</td>
<td>5.969</td>
<td>5.680</td>
<td>1.347</td>
<td>0.259</td>
</tr>
<tr>
<td>size</td>
<td>27</td>
<td>8.768</td>
<td>8.754</td>
<td>8.710</td>
<td>1.413</td>
<td>0.272</td>
</tr>
</tbody>
</table>

53
Table 7.2  Description of Canadian Export, Asset, Firm Size and Firm Number Data (cont’d)

<table>
<thead>
<tr>
<th></th>
<th>1982</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exports</td>
<td>27</td>
<td>13.827</td>
<td>14.015</td>
<td>13.850</td>
<td>1.633</td>
</tr>
<tr>
<td></td>
<td>assets</td>
<td>27</td>
<td>14.977</td>
<td>14.779</td>
<td>14.982</td>
<td>1.214</td>
</tr>
<tr>
<td></td>
<td>number</td>
<td>27</td>
<td>5.848</td>
<td>5.991</td>
<td>5.872</td>
<td>1.365</td>
</tr>
<tr>
<td></td>
<td>size</td>
<td>27</td>
<td>9.129</td>
<td>9.038</td>
<td>9.073</td>
<td>1.447</td>
</tr>
<tr>
<td></td>
<td>1987</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>exports</td>
<td>27</td>
<td>14.094</td>
<td>14.582</td>
<td>14.101</td>
<td>1.758</td>
</tr>
<tr>
<td></td>
<td>assets</td>
<td>27</td>
<td>15.422</td>
<td>15.275</td>
<td>15.427</td>
<td>1.141</td>
</tr>
<tr>
<td></td>
<td>number</td>
<td>27</td>
<td>5.913</td>
<td>6.172</td>
<td>5.938</td>
<td>1.363</td>
</tr>
<tr>
<td></td>
<td>size</td>
<td>27</td>
<td>9.509</td>
<td>9.560</td>
<td>9.468</td>
<td>1.497</td>
</tr>
</tbody>
</table>

Exploration of the Data

Twosample-T Tests:

Cross-year data of industry variables was gathered in order to explore the relationship between trade and industry structure over a number of periods of time. Before this specific relationship was tested, exploration of the industry variables themselves was completed. Data was measured to determine if any indication of change in means during the ten year period between 1977 and 1987 was present based on two-period comparisons of the sample means and variance.

Twosample t-tests were performed to test the null hypothesis that the means of the populations in two different years were equal. The null hypothesis is written as;

\[ H_0: \mu_{Ex_{82}} = \mu_{Ex_{87}} \]

Each of Exports, Assets, Number and Size and were tested across each of the five year periods extending, from 1977-82 and 1982-87, and the ten year period extending from 1977-87. Table
7.3 provides resulting p-values from twosample testing.

Table 7.3 Two-Sample Statistical Testing p-Values

<table>
<thead>
<tr>
<th>Interval</th>
<th>77-82</th>
<th>82-87</th>
<th>77-87</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports</td>
<td>.11</td>
<td>.57</td>
<td>.04</td>
</tr>
<tr>
<td>Assets</td>
<td>.097</td>
<td>.17</td>
<td>.0025</td>
</tr>
<tr>
<td>Size</td>
<td>.36</td>
<td>.35</td>
<td>.067</td>
</tr>
<tr>
<td>Number</td>
<td>.62</td>
<td>.86</td>
<td>.51</td>
</tr>
</tbody>
</table>

Testing leads to the conclusion that at the 95% confidence level a change in industry Assets and annual Exports has occurred in the ten year period between 1977 and 1987. Although statistically weak for the second five year period, industry Assets seem to have changed in each of the five year periods as well. One-sided testing for an increase in Assets and Exports during the ten year period was statistically significant at the 95% confidence level (p=.0013 and p=.02 respectively). A change in average firm size over the same period is significant at the 90% confidence level where an increase has taken place (p=.033). The null hypothesis of a change in number of firms across all industries could not be rejected within the two-five year periods or throughout the ten year period ending in 1987 due to statistical insignificance.

Since export and asset change is apparent over the longer ten year period it may be reasonable to hypothesize that there were no shocks to the Canadian economy during this time, at least none with lasting effects, that would have caused rapid growth or contraction in domestic and international trade and thus confounded further statistical testing of export and industry parameters. Also, a consistent number of firms across industries does not give any evidence of shocks to affect industry structure on average, although changes within an individual industry may have taken place. Finally, the increase in assets and no change in firm number is consistent
with the increase in firm Size noted for the sample. Nominal asset growth within all industries has seemingly not come from the addition of enterprises. Since nominal values were employed, real expansion of firms was not measured. If real expansion did take place, however, the above analysis may provide indirect evidence of increased industry productivity from rationalization, higher capital intensities required by improved technology or increased investment activity stimulated by other macro-economic variables in the environment.

ANOVA Testing:
Further testing of industry characteristics during the ten-year period was carried out through Analysis of Variance testing (ANOVA). ANOVA testing for each of the three sample years showed that the null hypothesis of all means equal could only be rejected at the lower 90% confidence level for Exports (p=.089), at the 95% level for Assets (p=.01) and could not be rejected for firm Size (p=.179). In summary, the data is consistent. Asset change over the ten year period is apparent, however, firm number was not. The expected results of some change in firm size were not confirmed by all three years compared using ANOVA testing, however, two-year comparisons did show the expected change in firm size. Note again that changes may be inflationary only.

Regression Analysis
Final statistical testing was undertaken in order to measure the relationships between exporting and domestic industry variables. Assets, Size and Number were regressed on the dependent variable, Exports, for each of 1972, 1977 and 1982 in order to determine if these factors
explained export activity.

A number of models were proposed in order to test the data thoroughly. Within the models conjectured, we would expect to see Exports increasing with firm Size and industry size as measured by Assets. Empirical evidence described previously indicated several studies where industry exports were positively related to firm size. These results gives indirect evidence of rationalization occurring within the industry as international trade increases. Since Assets are an indicator of output potential, we would also expect to see Exports increase with industry Assets. Therefore, within the regression models Asset and Size coefficients are expected to be positive. Coefficients for firm Number could be positive if increased participation by enterprises increases industry export output, or negative if rationalization within the industry occurs under export trade and firms exit.

**Model 1**

The first model testing for both Assets and average firm Size as explanatory variables of trade is described below. The model becomes a simple linear relation when log data is employed which previous data exploration showed to have a better, normal distribution for use in statistical testing.

\[ \text{Exports} = a \cdot \text{Assets}^b \cdot \text{Size}^c \cdot \text{error} \]

Only the Size coefficient, c, was statistically significant at the 5% testing level in each of the
three years tested showing exports increase as industry concentration increases. Although the
Asset coefficient, b, and the constant were not significant, the sign of b was correct in two of
the three years. Results are summarized in Table 7.4.

Table 7.4  Regression Results of Model 1

<table>
<thead>
<tr>
<th>Year</th>
<th>constant/coefficient</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>R²(adj)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>value</td>
<td>2.36</td>
<td>0.1657</td>
<td>0.9706</td>
<td>49.2%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>-0.79</td>
<td>0.88</td>
<td>4.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.439</td>
<td>0.39</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>value</td>
<td>-0.523</td>
<td>0.0853</td>
<td>0.9061</td>
<td>46.7%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>-0.18</td>
<td>0.46</td>
<td>4.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.858</td>
<td>0.648</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>value</td>
<td>-2.745</td>
<td>-0.609</td>
<td>1.1294</td>
<td>46.1%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>-0.80</td>
<td>-0.31</td>
<td>4.43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.431</td>
<td>0.757</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis of the residuals indicated non-normal distribution and slight heteroscedasticity with
slight tails or step formations within in the standardized normal distribution plot. In conclusion,
the model does not explain much of the data and violates the linear assumptions of the regression model. Since Size is derived from Asset data, some interaction between variables may be present. Interaction may also explain insignificant results for Model 1 yet significant coefficients for models regressing Assets and Size separately (see Models 2 and 3). Results for 1987 are unexpected, showing a negative coefficient relating industry Assets and Exports, although this relationship is insignificant.

**Model 2**

Since both industry and firm size together did not explain export activity well, each factor was regressed separately against the independent variable, Exports. The second model relates only Assets to Exports and is written below. Recall that actual log data is used within each model.

\[
\text{Exports} = a \cdot \text{Assets}^b \cdot \text{error}
\]

Regression analysis results for all three years of Model 2 are given in Table 7.5. The second model yields important information. A consistently positive sign for the Asset coefficient results in each year and is highly significant. Industry assets therefore provide at least some explanation of industry exports. The magnitude of the coefficient is also interesting to note since it is approximately unity in each of the three years tested. Since the model uses log data, coefficient values represent elasticity measures of export activity given industry Asset size. The unity coefficient indicates that a change in Assets would yield a proportionate change in Exports, or that the magnitude of Exports movements is perfectly elastic with respect to movements in
industry Assets.

Table 7.5 Regression Results of Model 2

<table>
<thead>
<tr>
<th>Year</th>
<th>constant/COEFFICIENT</th>
<th>a</th>
<th>b</th>
<th>R²(adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>value</td>
<td>-2.27</td>
<td>1.07</td>
<td>49.7%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>-0.76</td>
<td>5.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.45</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>value</td>
<td>-0.48</td>
<td>0.96</td>
<td>48.4%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>-0.17</td>
<td>5.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.87</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>value</td>
<td>-2.72</td>
<td>1.09</td>
<td>48.1%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>-0.81</td>
<td>5.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.43</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

Since the sample under study consists of manufacturing industries it would not be unreasonable to assume that many of the Assets measured represent capital investment. Under this assumption, the model indicates that exporting industries are capital intensive which supports previous conclusions of Caves and Khalilzadeh-Shirazi (1977). Industries characterized by asset intensity should also face declining average costs in increased production and, therefore, be subject to economies of scale. Economies of scale assumes that firms do not operate at full capacity utilization all of the time. If an industry is characterized by increasing returns then exports
represent a means of realizing scale economies and lower average cost through increased industry output. Industry assets positively correlated with industry exports lends indirect evidence that imperfect trade models are compatible with empirical evidence of industry trade.

Conversely, the greater value of assets correlated to industry exports may simply give indication of greater industry output to the global market which is supported by a larger aggregate asset base. Asset intensity is better described with reference to the number of firms employing industry assets for use in export. Firm Size is a better measure of asset intensity and results for this variable are given below.

**Model 3**

The third model employs firm Size as the sole independent variable and Exports as the dependent and is written below.

\[
\text{Exports} = a \cdot \text{Size}^b \cdot \text{error}
\]

Firm Size differs from industry Assets in that firm concentration of assets within the industry is captured within the Size measurement. Considering the rationalization arguments already made, we would expect larger firms to have larger capital investment and possibly larger fixed operating costs. Given these imperfect market conditions, trade would provide opportunity to realize increasing returns to scale, therefore we would expect firm Size and Exports to be positively correlated.
The model is another attempt to improve precision over Models 1 and 2 explaining exports with Assets and both industry Assets and firm Size. Results show that Model 3 is fairly accurate although the $R^2$ is relatively low compared to Model 2. Other relative measures of significance are that the constant and the b-coefficient are both statistically significant at the 95% confidence level for 1977 and 1982. Measurement for the final year, 1987, is nearly significant at the 90% level for both coefficient and constant. Regression results are listed in Table 7.6.

### Table 7.6 Regression Results of Model 3

<table>
<thead>
<tr>
<th>Year</th>
<th>constant/coefficient value</th>
<th>a</th>
<th>b</th>
<th>$R^2$(adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td></td>
<td>8.46</td>
<td>0.53</td>
<td>16.1%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>4.42</td>
<td>2.45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.00</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td></td>
<td>9.69</td>
<td>0.45</td>
<td>12.8%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>5.07</td>
<td>2.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td>10.63</td>
<td>0.36</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>t-stat</td>
<td>4.95</td>
<td>1.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.00</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

The data exhibited three outliers for industry cases of Tobacco, Petroleum and Coal and Total Mining in each of the years studied. By weighting the data (these three cases for were given 0 weight), the precision of the model was improved overall. Most notably, the b-coefficient value
became statistically significant at the 95% confidence level for 1987 (p=.02). Revised model parameters are listed below.

<table>
<thead>
<tr>
<th>Year</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>6.59</td>
<td>0.76</td>
</tr>
<tr>
<td>1982</td>
<td>7.14</td>
<td>0.77</td>
</tr>
<tr>
<td>1987</td>
<td>8.17</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Results from Model 3 show the Size coefficients to be of the expected sign. One notable piece of information from Model 3 different from Model 2 is the magnitude of the coefficient. Whereas Model 2’s Asset coefficients were close to unity, Size coefficients are roughly half the order of magnitude or, in the weighted case, roughly three-quarters of those of Model 2. This indicates that Exports change less than proportionately with changes in firm Size. These results are in line with previously empirical study already noted, but disagree with those studies showing exports to increase more than proportionately with increases in firm size. This relationship may, therefore, vary across countries.

The coefficient magnitude indicates that industry Exports are less sensitive to the Size of firms within the industry than to the size of the industry itself. The lower responsiveness of Exports to firm Size may be due to variability within each industry of the number of firms exporting. If not all firms within an industry export, yet all firms increase in size, then a less than proportionate change in exports would result. Asset changes at the industry level are fully captured and compared with exports of the industry. However, asset changes at the firm level are diluted over the total number of industry participants and are therefore less responsive to
industry export activity.

**Model 4**

The positive relation between firm Size and Exports gives indirect evidence of rationalization under conditions of export trade. If firm size can be used as a proxy measure of industry concentration, then arguments for increased trade from increased industry concentration can be posed. Indeed, this is the central theme that will be studied in further models. Increased firm Size as a measure of industry concentration would also indicate greater oligopolistic interdependencies amongst fewer, larger firms. Since one of the basic components of industry concentration is the number of firms, Model 4 below was constructed in an attempt to illustrate the relation between industry firm number and export activity.

\[ \text{Exports} = a \cdot \text{Number}^b \cdot \text{error} \]

If industry rationalization indeed takes place under trade, we would expect Exports to have no positive relation or to be negatively related to firm number. If instead Exports are fuelled by a greater number of industry participants, the model coefficient is predicted to be positive.

The results of the regression analysis are shown below in Table 7.7.
The b-coefficients of firm Number have a positive sign in each of the three sample years analyzed. This result lends weak support to the hypothesis that Exports are fuelled by the number of industry participants, each producing similar levels of output. Pursuing this hypothesis, analysis would suggest that a significant number of firms within the industry export such that industry export activity would be sensitive to the number of firms within. The low magnitude of the model coefficient contradicts this hypothesis.

If firm Size can be presumed to be representative of concentration, then Models 3 and 4 provide conflicting information regarding industry concentration and trade. Model 4 suggests that increased firm number, resulting in dilution of industry concentration, is positively related to export trade. This dilemma was discussed within the basic theoretical model when ambiguous
effects of firm number were described under conditions of varying output across firms. In conclusion, however, none of the Model 4 coefficients are significant, suggesting that any explanation of industry export activity described by firm number alone is weak.

Part A. Conclusion

From the industry data analyzed and regressed against industry Exports there exists cross-year evidence that trade activity is explained by both the size of an industry and the size of firms within. These size considerations support previous empirical results. Exports increase with both industry and firm capital intensity and can be concluded to take place in the presence of production or other returns to scale. Firms may, therefore, be motivated to trade under conditions of industry rationalization. Rationalization within an industry should in turn cause greater concentration, creating a link between industry structure and export trade.

The previous regression analyses do not give any indication of market power derived from industry structure. The ability of firms to price-discriminate within foreign or domestic markets is not captured within the above analysis. As well, firm Size is a very narrow descriptor of industry structure. The next section of statistical analysis will look specifically at Canadian manufacturing industries' industry structure and market power as measured by industry concentration.
B. CANADIAN INDUSTRY EXPORTS AND INDUSTRY CONCENTRATION MEASURES

In order to better explore the relationship between industry structure, market structure and export activity, concentration data for the 27 industries was gathered and regressed against industry export information for the years 1982 and 1987. Again, analysis was limited by data availability, however, concentration measures are consistent with other independent variables measured since each corresponds to SIC three-digit codes.

Data Selection

A number of measures of industry concentration were made available for employment within regression models in order to test the robustness of the hypothesis that industry structure is related to export trade. Two sources of data were used to measure industry concentration. The first data source is the Statistics Canada (1985) publication of Industrial Organization and Concentration (IOC) in the Manufacturing, Mining and Logging Industries, available for 1982. The IOC measures concentration as shipments of the leading four and eight enterprises as a percentage of total industry shipments. Industry shipments are classified under the 1980 SIC four-digit industry codes.

Concentration Ratio is a proxy measure of both industry structure and the degree of market power measured through market share of the largest producer enterprises. Both the four firm (CR4) and eight firm (CR8) concentration ratios were incorporated into the analysis.
measuring concentration within the same data source is the Herfindahl index. The Herfindahl index uses a similar means of calculating degree of concentration based on market share, however, indices are calculated by summing the squares of the market share of each industry enterprise. Indices tend to be smaller than concentration ratios for any more than one firm supplying 100% of the market due to squaring. For example, a monopolist industry would show a Herfindahl index of 1, the maximum scale number of the index, and an industry of two firms with equal market share would show an index of \((1/2)^2 + (1/2)^2 = 0.5\). A similar figure would result within an \(m\)-firm industry dominated by two firms, where \(m > 2\). Although the Herfindahl measures contain more information regarding the market structure of an industry, each of the Herfindahl and Concentration Ratio measures indicate a more highly concentrated industry with a relatively higher index measure.

Industry Export data estimated did not match industry concentration data within the IOC source due to differences in classification and aggregation of industry information. IOC sources gave Concentration Ratio and Herfindahl measures for the four-digit SIC coded industries and export data was estimated on a three-digit basis. To make the sources comparable, a weighted average concentration ratio was calculated of the four-digit industries within the three-digit code based on the values of shipments. Where concentration data was missing due to confidentiality, the concentration ratio for that four-digit industry was assumed to be that of the weighted average of the other sub-industry classifications. Only in two of the 23 cases used was it necessary to estimate this figure, therefore, overall impact on the analysis should be minimal.
The Export data of the previous study was re-expressed as a percentage of total 1982 industry shipments as provided within the IOC information. The resulting export propensity variable is the dependent variable used in the regression analysis of CR4, CR8 and Herfindahl models to follow. Export propensity provides a standardized industry export variable for comparison to standardized industry concentration data.

The second class of industry concentration measure was sourced from Statistics Canada's Corporate and Labour Union Returns Act (CALURA) information. The top four and eight firms’ industry sales and asset measurements for each of 1982 and 1987 were used as an alternative measures of industry concentration (CALURA 4, CALURA 8) over 13 three-digit SIC industries.

Description of the Data

The 1982 and 1987 CALURA data for assets (CALURA 4) and sales (CALURA 8) is described in Appendices 6 and 7 respectively. Dotplots of the 1982 and 1987 raw and log data are provided in Appendices 8 and 9 respectively. Within six of the eight samples, only 12 data points (industries) are used. Variation within 1987 samples is high compared to that of the 1982 samples where distribution of assets is much tighter, although a few outliers exist. The standard error of the CEx sample is particularly large, indicating that the mean is not a good estimator of the population. All raw data for CALURA sales and asset information is skewed to the left. Although log transformations did not yield exactly normal distributions, log forms were determined to give better results than other transformations attempted. Statistical test results may
therefore be viewed with some caution due to the small sample size and poor normal distribution that violates test assumptions.

Export Propensity (CEx), Concentration Ratio (CR4, CR8) and Herfindahl (H) is described in Appendix 10 and distributional plots are given in Appendix 11. Comparison of the standard errors and standard deviations of the raw sample data gives interesting results. There exists much greater variation within the CR8 sample than the CR4. Variation within the export propensity is very large as noted by the considerable standard error. The CR4 sample has a relatively tight distribution compared to other concentration and export propensity samples. Log plots show fairly normal distributions for all CEx and concentration indices. A better presentation of distribution is given by the log normal plots for each of the CR4, CR8 and Herfindahl data in Appendix 12. All log sample plots have curves and data exhibits heteroscedasticity. Although distributions are not perfectly normal, log transformations yielded better results than other transformations attempted. Due to distributional problems, statistical results must be treated with caution.

**Statistical Testing**

We can hypothesize that increasingly concentrated industries would have a greater propensity to export if trade took place under conditions of increasing returns. A positive relation between export propensity and industry concentration may also support related theories of international firm specialization in a limited variety of industry goods. This cannot be fully tested here, however, since import data from intra-industry trade is not present. Intra-industry trade
measurements and domestic structure may be an interesting consideration for further study.

A final hypothesis supported by positive export propensity and industry concentration relation is that oligopolistic industries may be able to price discriminate between domestic and foreign markets, earning rents in each. Using concentration as an indicator of the price-cost margin or market power within the domestic industry, ability to earn export market rents provides motivation for trade. We would, therefore, expect a positive relation between export propensity and concentration of domestic industries.

A negative relation between concentration and trade may show that domestic oligopolistic industries cannot price discriminate between domestic and foreign markets and face flatter global demand curves. It may also indicate an increasing collective industry inability to participate within the more competitive global industry. This inability may be linked to domestic industry structure. Barriers to industry entry may have caused inefficiencies within industries weakening a firm's ability to compete globally. Finally, industry export propensity may depend on the number of firms exporting. Under this condition, a negative concentration/export relation would also result since firm number would dilute industry concentration.

Regression Analysis

Model 5

Regression analysis testing the relationship between industry concentration and export activity was undertaken by first testing CALURA data within the following model:
Exports = a \cdot (\text{CALURA Industry Concentration Measure}^*)^b \cdot \text{error}

where;

*Industry Concentration Measure is indicated by:
- CALURA 4 and 8 Sales - 1982, 1987
- CALURA 4 and 8 Assets - 1982, 1987

Given previous results of Models 3 showing a positive relation between industry export quantities and industry firm size, we may speculate that since industries characterized by larger firms tend to have greater exports, industries' largest firms will also show a positive relation to industry exports.

CALURA Sales and Assets measures showed both a positive and statistically significant relation to industry exports. One insight provided by both the CALURA Sales and Asset models is that the larger industry firms drive export activity of that industry. This would have to be confirmed by further study regressing separate samples of small and large CALURA firm size on export activity separately to identify any difference in their relation to exports. However, the magnitude of the Model 5 coefficient may give indirect evidence of this result. Recall that overall average firm Size regression coefficients from Model 3 in previous analysis ranged from approximately one-half to three-quarters depending on the weighting of the data. CALURA coefficients are each greater than one and highly significant. The magnitude of the Model 5 coefficient indicates that industry exports are more highly sensitive to large firms' characteristics of size than overall industry measures. This may show that an industry's largest firms do drive exports and exports are subsequently more responsive to changes within these firms than changes measured across the industry as a whole. Regression results are given in the Table 7.8 below.
Table 7.8 Regression Results of Model 5

<table>
<thead>
<tr>
<th>Total Dollars</th>
<th>b</th>
<th>p-value</th>
<th>t-statistic</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALURA SALES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-1982</td>
<td>1.36</td>
<td>.001</td>
<td>4.46</td>
<td>61.1%</td>
</tr>
<tr>
<td>8-1982</td>
<td>1.42</td>
<td>.000</td>
<td>4.71</td>
<td>65.9</td>
</tr>
<tr>
<td>4-1987</td>
<td>1.25</td>
<td>.001</td>
<td>4.38</td>
<td>59.5</td>
</tr>
<tr>
<td>8-1987</td>
<td>1.26</td>
<td>.002</td>
<td>4.23</td>
<td>60.8</td>
</tr>
<tr>
<td>CALURA ASSETS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-1982</td>
<td>1.22</td>
<td>.005</td>
<td>4.99</td>
<td>71.2</td>
</tr>
<tr>
<td>8-1982</td>
<td>1.25</td>
<td>.000</td>
<td>5.37</td>
<td>71.7</td>
</tr>
<tr>
<td>4-1987</td>
<td>.795</td>
<td>.028</td>
<td>2.57</td>
<td>33.7</td>
</tr>
<tr>
<td>8-1987</td>
<td>.860</td>
<td>.023</td>
<td>2.69</td>
<td>36.2</td>
</tr>
</tbody>
</table>

One area for further exploration of the CALURA data is to test the null hypothesis that no difference exists between the four firm and eight firm model in describing industry exports. This may lend proof to the theory that a relatively few number of firms drive industry exports, such that the largest four firms would have a stronger relation to exports than the largest eight, or that the next largest four firms make no difference in explaining export activity. In order to test this relation, the null hypothesis was written as the b-coefficient estimated by the four firm regression model equal to the hypothesized value determined to be that of the b-coefficient estimated by the eight firm model. This hypothesis is written as;

\[ H_0: b(\text{four firm}) = b(\text{eight firm}), \]

and the test statistic is calculated as;
Results of the comparative tests are given in Table 7.9 below. For the four firm and eight firm CALURA Assets and Sales in each of 1982 and 1987 the null hypothesis tested could not be rejected at the 90% or 95% level of confidence. The regression model estimate of the magnitude of b-coefficient is therefore the same whether the top four or eight firms are used to explain export activity for the industry.

Table 7.9 Test Statistic Results of Model 5 b-Coefficient

<table>
<thead>
<tr>
<th>4 &amp; 8 Firms Model Comparison</th>
<th>t-stat calculations</th>
<th>t-stat 90% confidence</th>
<th>t-stat 95% confidence</th>
<th>Reject H₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALURA -Sales</td>
<td>-0.197</td>
<td>-1.28</td>
<td>-1.65</td>
<td>yes</td>
</tr>
<tr>
<td>-Assets</td>
<td>-0.133</td>
<td>-1.28</td>
<td>-1.65</td>
<td>yes</td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALURA -Sales</td>
<td>-0.034</td>
<td>-1.28</td>
<td>-1.65</td>
<td>yes</td>
</tr>
<tr>
<td>-Assets</td>
<td>-0.210</td>
<td>-1.28</td>
<td>-1.65</td>
<td>yes</td>
</tr>
</tbody>
</table>

Model 6

In order to explore in greater depth the relation between an industry’s propensity to export and its relative degree of concentration, the four and eight firm concentration ratio as well as Herfindahl measures were regressed against relative industry exports using the following model (data represents measures for 1982 only):

\[
    t = \frac{(\text{estimate}) - (\text{hypothesized value})}{(\text{estimated standard deviation of the estimate})}
\]
Export Shipments/Total Industry Shipments = a*(Concentration Ratio Measure*)^b*error

where;
* Industry Concentration Ratio as indicated by:
  - CR4
  - CR8
  - Herfindahl

Results of the regression analysis are given in Table 7.10 below.

<table>
<thead>
<tr>
<th>Ratio</th>
<th>b</th>
<th>p-value</th>
<th>t-statistic</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR4</td>
<td>2.81</td>
<td>0.404</td>
<td>0.85</td>
<td>1.1%</td>
</tr>
<tr>
<td>CR8</td>
<td>0.697</td>
<td>0.420</td>
<td>0.82</td>
<td>0%</td>
</tr>
<tr>
<td>Herfindahl</td>
<td>0.256</td>
<td>0.615</td>
<td>0.51</td>
<td>0%</td>
</tr>
</tbody>
</table>

Model 6 regression results give only weak indirect evidence that industry structure and export propensity are positively related. Statistical results may be poor in the model due to a number of reasons. The export propensity information used is of poor quality. Recall that export propensity values use data derived from two different sources. Industry Export Shipments were based on the Harmonized System of tariff classifications from Statistics Canada and then estimated at the three-digit SIC code level. Total Industry Shipments data was taken from actual export shipments in 1982 measured at the three-digit SIC code level. This difference in data source and classification yielded somewhat inaccurate estimates for export propensity used.

Other reasons for insignificant model results may be due to the interaction of domestic and
foreign industry factors not controlled for within Model 6. Concentration indicators do not account for foreign imports into the national market that dilute domestic firm market power. Definition of an industry by the SIC codes at the three-digit level may be too broad and based on disparate products. Cross-industry participation by firms may also not give accurate indication of a firm's market power, since the same firm may exert influence in some markets but not in others. Multi-collinearity may also be present within the model, affecting significance. Finally, the size of an economy in which the industries operate may exert considerable influence over concentration, where smaller economies are more highly concentrated than larger economies with similar technology or similar sized firms.

CR4 and CR8 models show a large difference in magnitude of the concentration coefficient. Testing for this difference, however, shows that the null hypothesis that the model's CR4 and CR8 coefficients are different cannot be rejected. Given that the model is subject to large errors it is largely insensitive to differences in the order of magnitude of the coefficient between models. It may be inaccurate to infer any systematic cause of this result. The conclusion that CR4 measures are more sensitive to industry export propensity than CR8 measures cannot be drawn. Similar results and conclusions can be made for the Herfindahl model coefficient measure.

Part B. Conclusion

The regression results of Models 5 corroborate with previous results showing a positive relation between the size of firms within an industry and that industry's export level. It can be tentatively
concluded that an industry’s largest firms drive export volumes. Moving to standardized industry concentration and export data, Model 6 gave only weak indirect evidence that increasingly concentrated industries tend to have higher export propensities, or export relatively more of the total industry output. Testing of industry structure and export activity in general provides indirect evidence in support of the theory that imperfect market structure is not only compatible with but may provide motivation for export trade. The distribution of market power within an industry does not provide systematic evidence that links it to industry export activity and any indication of a relationship is weak.

Concentration and firm size data as evidence of Canadian industry structure may be biased since the Canadian economy is relatively small compared to other industrialized nations. The smaller the boundaries imposed upon an area of economic activity, the greater the concentration will be within that boundary and the greater the volume of trade measured between the bounded area and outside economies. It would be useful, therefore, to analyze the market structure and export activity relation within a large economy. The following section of the paper explores data from United States (US) manufacturing industries for signs of a relation between domestic market structure and international trade.
C. CONCENTRATION AND EXPORT OBSERVATIONS OF US MANUFACTURING INDUSTRIES

Data Selection

Data was sourced from the 1987 Census of Manufacturers (the Census) measuring four firm and eight firm Industry Concentration Ratios as well as Exports from Manufacturing Establishments. The unit of measure is one industry as described by the US Standard Industrial Classification Code (SIC) of 1987 at the three digit level. Total sample size is 140 industries.

Industry Concentration Ratios provided by the Census at the four digit level and were averaged, weighted according to the total value of industry shipments, in order to arrive at a three-digit industry concentration measure for comparison to Canadian information. Industry Concentration Ratios measure the sum of the share of industry shipments of the four (US CR4) and eight (US CR8) largest enterprises within.

Direct Exports from Manufacturing Established were expressed as a percentage of Total Industry Shipments (USEx) providing an industry measure of export propensity. This relative indicator is required in order standardize data across industries and to compare relative export data with relative market values expressed by concentration measures.

Description of the Data

Appendix 13 describes the raw and log US data samples of USEx, USCR4 and USCR8. Included
are descriptions of the sample means and standard deviations. Variance within the export sample is high although the mean is a good estimator as shown by a low standard error value. Raw data distributions of concentration ratio samples are slightly skewed to the left. The USEx sample is extremely skewed in the same direction. All Census samples were transformed to logs in order to normalize the data and for ease of comparison to previous Canadian study undertaken. Appendix 14 provides plots of the raw and log data for visual display of sample distribution. After normalizing concentration data, skewedness is still present and oriented towards the right. Appendix 15 provides Normal Plots of log and raw data comparing the changes in distribution brought on by transformations. For the CR4 data the log normal plot shows a very tight distribution around the 45 degree line indicating a normal dispersion. Distribution of the CR8 and USEx data exhibits slight tails and subsequent non-normalcy. Logs may have overcompensated for the skewedness of the original data, however, distribution of the samples is not considered to be a deterrent to statistical analysis.

Exploration of the Data

Analysis of Variance:

One issue explored within the US data concerned the similarity of samples of the four firm and eight firm concentration ratios. Analysis of variance (ANOVA) of the CR4 and CR8 data tested the null hypothesis that sample means were equal, indicated as follows:

\[ H_0: \mu_{(US \ CR4)} = \mu_{(USCR8)} \]
This testing was done in order to determine if four firm concentration index was a significantly different measure than the eight firm measure of industry structure. Results were expected to give some insight into the overall structure of US industry and to determine if the extent of concentration varied between these two measurement levels. For example, if a US industry was characterized by four or less firms enjoying significant market share then when aggregating over the larger number of eight firms we would expect the eight firm concentration measure to impose little difference on the CR4 industry concentration measure. Given roughly equal firm market share within an industry, we would expect greater aggregation at the eight firm level to yield greater measures of industry concentration than at the four firm level. An indicator of this same issue was given when testing the difference in b-coefficients of Model 5 using four firm and eight firm CALURA sales and asset levels. Within Canadian industry, concentration coefficients did not change between the four firm and eight firm model. ANOVA testing applies this same query to the US data.

Results of ANOVA testing for the US industry data are statistically significant (p slightly > 0.000), therefore, concentration ratios are different at the four firm and eight firm levels. Table 7.11 below gives statistical results for the ANOVA test. Market share of the more highly aggregated eight firms is concluded to be greater than of the top four enterprises. This may give some indication of low concentration levels of US industry. The domestic US market may be sizeable enough to allow plant or firm production efficiency while still allowing a high number of firms to participate within an industry. It is this difference which makes US and Canadian comparisons interesting, since domestic market size in the US case may not constrain the
relationship between domestic market structure and international trade.

Table 7.11  USCR4 and USCR8 ANOVA Testing Results

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACTOR</td>
<td>1</td>
<td>6.720</td>
<td>6.720</td>
<td>32.58</td>
<td>0.000</td>
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<tr>
<td>ERROR</td>
<td>276</td>
<td>56.932</td>
<td>0.206</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>277</td>
<td>63.652</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INDIVIDUAL 95 PCT CI'S FOR MEAN BASED ON POOLED STDEV

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>N</th>
<th>MEAN</th>
<th>STDEV</th>
<th>--</th>
<th>--------</th>
<th>+--------+-------+--------+-------</th>
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</tr>
</thead>
<tbody>
<tr>
<td>IgUSCR4</td>
<td>140</td>
<td>3.5121</td>
<td>0.4854</td>
<td>(-*-~)</td>
<td>+-----------------+-----------------</td>
<td>----</td>
<td></td>
</tr>
<tr>
<td>IgUSCR8</td>
<td>138</td>
<td>3.8231</td>
<td>0.4202</td>
<td>(-*-~)</td>
<td>+-----------------+-----------------</td>
<td>----</td>
<td></td>
</tr>
</tbody>
</table>

POOLED STDEV = 0.4542

3.45 3.60 3.75 3.90

Comparison of US and Canadian Data: Export Propensity

ANOVA testing was continued in order to examine the null hypothesis that US and Canadian propensity to export (CEx) for 1987 are the same. Results yielded were statistically significant (p slightly > 0.000) and allowed the null hypothesis to be rejected. Canadian and US manufacturing industries, therefore, have different export propensities. Table 7.12 provides statistical and graphical results of the ANOVA test run.

Table 7.12  US and Canadian Export Propensity ANOVA Testing Results

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACTOR</td>
<td>1</td>
<td>74.77</td>
<td>74.77</td>
<td>49.03</td>
<td>0.000</td>
</tr>
<tr>
<td>ERROR</td>
<td>158</td>
<td>240.98</td>
<td>1.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>159</td>
<td>315.75</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INDIVIDUAL 95 PCT CI'S FOR MEAN BASED ON POOLED STDEV

| LEVEL   | N | MEAN | STDEV | --|--|--------|-----------------|--------|
|---------|---|------|-------|---|--------|-----------------|--------|
| IgUSEx  | 135| 1.485 | 1.220  | (--*--) | +-----------------+-----------------|----|
| IgCEx87 | 25 | 3.367 | 1.314  | (--*----) | +-----------------+-----------------|----|

POOLED STDEV = 1.235

1.40 2.10 2.80 3.50

81
As a more intuitive indicator than logs, the average US industry exports approximately 7.6% of total output according to the 1987 Census. This figure is extremely low compared to the Canadian average derived for 1982 of nearly 42%. Recall that the problems of accuracy within the Canadian data as well as the larger and, therefore, more accurate US sample size. These factors, along with the different methods of aggregating and classifying industries between the US and Canada, means exact comparison is impossible. However, the magnitude of the two samples must be appreciated. This difference in export propensity gives strong indication of the effect that size of an economy may have on trade variables. To appreciate any effect on concentration, ANOVA testing was undertaken for relative Canadian and US concentration measures and is discussed below.

Comparison of US and Canadian Concentration Data
The null hypothesis was tested that US and Canadian industries have, on average, the same concentration levels. ANOVA testing yielded statistical evidence that this hypothesis could not be rejected using both the CR4 (p=.144) and CR8 measures (p=.364). The 1987 US concentration data was compared to 1982 Canadian information due to the unavailability of Canadian information for that year. It may be reasonable to assume that industry concentration on a national average basis would not change significantly within a five year period. If so, the 1982 Canadian data may be used as proxy measures for 1987 for the purpose of comparison.

Results of ANOVA analysis used to test the null hypothesis of same industry concentration is
given below in Table 7.13.

Table 7.13 US and Canadian Industry Concentration ANOVA Testing Results

FOUR FIRM CONCENTRATION

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACTOR</td>
<td>1</td>
<td>0.442</td>
<td>0.442</td>
<td>2.16</td>
<td>0.144</td>
</tr>
<tr>
<td>ERROR</td>
<td>161</td>
<td>32.922</td>
<td>0.204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>162</td>
<td>33.363</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INDIVIDUAL 95 PCT CI'S FOR MEAN
BASED ON POOLED STDEV

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>N</th>
<th>MEAN</th>
<th>STDEV</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>lgUSCR4</td>
<td>140</td>
<td>3.5121</td>
<td>0.4854</td>
<td>(-----*-----)</td>
<td></td>
</tr>
<tr>
<td>lgCCR4</td>
<td>23</td>
<td>3.6616</td>
<td>0.0890</td>
<td>(--*------------)</td>
<td></td>
</tr>
<tr>
<td>POOLED STDEV</td>
<td>0.4522</td>
<td>3.48</td>
<td>3.60</td>
<td>3.72</td>
<td>3.84</td>
</tr>
</tbody>
</table>

EIGHT FIRM CONCENTRATION

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACTOR</td>
<td>1</td>
<td>0.140</td>
<td>0.140</td>
<td>0.83</td>
<td>0.364</td>
</tr>
<tr>
<td>ERROR</td>
<td>159</td>
<td>26.829</td>
<td>0.169</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>160</td>
<td>26.969</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INDIVIDUAL 95 PCT CI'S FOR MEAN
BASED ON POOLED STDEV

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>N</th>
<th>MEAN</th>
<th>STDEV</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>lgUSCR8</td>
<td>138</td>
<td>3.8231</td>
<td>0.4202</td>
<td>(-----*-----)</td>
<td></td>
</tr>
<tr>
<td>lgCCR8</td>
<td>23</td>
<td>3.9073</td>
<td>0.3467</td>
<td>(--*------------)</td>
<td></td>
</tr>
<tr>
<td>POOLED STDEV</td>
<td>0.4108</td>
<td>3.80</td>
<td>3.90</td>
<td>4.00</td>
<td></td>
</tr>
</tbody>
</table>

Intuitively we would expect the smaller Canadian economy to have more highly concentrated industries than within the US. This expectation is supported by the greater average concentration measures using both CR4 and CR8 indicators. However, Canadian sample variance is great and statistically significant results were not achieved. Although we cannot draw any firm conclusion that concentration of industries differs between the two countries, comparing the magnitude of
the relative concentration measures does give weak indication that Canadian industries tend to be more concentrated within the economy than US industries.

Conclusions:
US concentration measures of CR4 and CR8 are different. The additional four firms' market share within the CR8 calculation imply that concentration within US industries may be low such that a very few firms do not dominate industries. The additional CR8 concentration measure should provide supportive evidence testing US industry structure as first measured by the CR4 index and trade.

After comparing the US and Canadian data it can be only tentatively concluded that US manufacturing industries are less concentrated than their Canadian counterparts. Although more robust measurement was not possible, Perrakis (1990) states that empirical study of Canada and the US during the early 1980s shows that Canadian industries are indeed less competitive than their US counterparts as measured by industry concentration. Insignificant differences in US and Canadian concentration measures as tested above may therefore be due to poor or insufficient sample data.

Considering exports, Canadian manufacturing industries tend to greater export propensity than their US counterparts. This may demonstrate the effect of small economy size on trading patterns and activity. In general, country comparisons are important to determine if differences within each national market affect any possible relation between industry structure and trade.
Regression Analysis

Model 7

Regression analysis was performed in order to determine if 1982 US industry structure explained the export propensity of industries in that year. The premise of the analysis has not changed from the Canadian market study and the regression model is the same as Model 6, rewritten for the US case as Model 7 below.

\[
\text{US Industry Exports/Total Industry Shipments (USEx) = } a \cdot (\text{US Industry Concentration Ratio})^b \cdot \text{error}
\]

where;
* US Industry Concentration Ratio is:
  USCR4
  USCR8

Results of the model analysis are given in Table 3.4.

<table>
<thead>
<tr>
<th>Concentration Ratio</th>
<th>Coefficient/Constant</th>
<th>p-value</th>
<th>t-statistic</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>USCR4</td>
<td>b = 0.741</td>
<td>0.001</td>
<td>3.55</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>a = -1.12</td>
<td>0.132</td>
<td>-1.52</td>
<td></td>
</tr>
<tr>
<td>USCR8</td>
<td>b = 0.869</td>
<td>0.001</td>
<td>3.57</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>a = -1.86</td>
<td>0.05</td>
<td>-1.98</td>
<td></td>
</tr>
</tbody>
</table>

The USCR4 model constant is insignificant based on poor \( R^2 \) and an insignificant constant value, however, the p-value for the concentration coefficient is of the expected sign and is significant at the 5% testing level. The USCR8 data fits the model slightly better as shown by both a
significant constant value and b-coefficient value at the 5% testing level. Normal plots of the model residuals are given in Appendix 16. Although some heteroscedasticity exists as noted by slight curves in the plots, each illustrates a fairly normal distribution for both the USCR4 and USCR8 models. The model is concluded to be a good descriptor of the export and concentration data.

The magnitude of the concentration coefficient is less than one. The model predicts a smaller proportional increase in US export propensity for a given increase in US industry concentration. This elasticity measure is interesting to note as an indicator of export sensitivity to domestic industry structure. Further study could explore various country elasticity measures to determine if these elasticity measures generated for the US industries are relatively high or low.

Compared to Canada, US industries show lower sensitivity to export propensity. Canadian elasticity measures were greater than unity when testing proxy measures of industry concentration, however, these measures are not equal since standardized or relative export and concentration measures were not used. Concentration ratio elasticity of Canadian exports could not be determined with any precision and model parameters indicated both large (greater than three) and small magnitudes for the concentration coefficients. Since the significant Canadian and US models measure different data, direct comparisons are difficult.

The final test conducted within Model 7 was to determine if the USCR4 model coefficient differed from the USCR8 model. A difference would indicate varying sensitivity of the eight
firm concentration measure to the four firm concentration measure. If US industry exports are driven by a very few large firms, then we would expect the b-coefficient of the four firm model to be greater than that of the eight firm since the four firm measure would be more highly sensitive to export activity. If the top eight firms participate relatively equally in export trade, both models will be equally sensitive and the b-coefficients should be the same.

Similar to the Canadian analysis undertaken with Model 5, the hypothesized coefficient value as determined from the CR8 model was used to calculate a test statistic which indicated a difference between the USCR4 and USCR8 model coefficients. Testing revealed no difference between the USCR4 and USCR8 models, therefore the top four firms do not have a different propensity to export than the top eight firms within an industry.

Conclusions:

The strong significance of the US concentration coefficients supports the hypothesis that domestic industry structure is related to international, specifically export, trade. Since a relation is evident it may be useful to re-explore various hypotheses explaining imperfect market structure and export trade within the context of the US economy.

Since manufacturing industries were tested, industries may be subject to production economies of scale which are realized under conditions of increasing industry concentration when firms face larger global markets. However, the US domestic market is large, possibly large enough to allow firms to reach their minimum efficient scale (MES) without export production. Also, the export
propensity of industries was found to be fairly low, at least compared to the Canadian economy. One indication that the industry MES may be reached by a number of firms within the domestic economy was the difference between four firm and eight firm concentration measures, where an additional four firms over the USCR4 measure significantly changed the aggregate market share measure. If rationalization gains had been exhausted with only four firms, eight firms would either not exist or would include marginal producers whose production would not significantly affect industry concentration. As industry output increased, concentration would decrease since additional firms must enter the market to expand deliveries. The opposite was demonstrated with Model 7, export propensity increased with higher concentration. Therefore, either opportunity for gains from rationalization are still present within US oligopolistic industries through export trade, or possibly non-production economies of information, technology, managerial skill or other trading costs are realized through trade.

The above argument must be made with careful qualification. Export propensity, not export volumes, are increasing with industry concentration. This means that higher concentrated industries simply direct a greater proportion of their output to foreign markets versus domestic. It is intuitively appealing to think of firms first supplying domestic demand and operating on some residual demand curve within foreign markets. Conceivably, however, a single US enterprise could have no sales to the domestic market yet exhibit a strong correlation between export propensity and market dominance. Also, export activity does not necessarily mean that industries are net exporters, only that firms are engaged in international trade. Intra-industry trade could conceivably be on such a scale that the US industry would be a net importer.
The hypothesis of intra-industry trade due to firm specialization put forth by Krugman (1992) may be supported within the regression evidence. As rationalization and consequent concentration increase, firms export greater amounts to global consumers while maintaining some constant supply to domestic markets as dictated by domestic preference, therefore, both concentration and export propensity move together.

The final hypothesis supported by US Model results is that oligopolistic industries can price-discriminate in foreign markets and earn export rents which provide incentive to engage in export trade. This hypothesis does not necessarily explain the degree of industry concentration affecting trade, other than to further a hypothesis that the greater the domestic industry market power, the greater the ability to price discriminate in foreign markets.

**Model 8**
Insignificant results were generated by testing the relation of industry concentration with total absolute industry exports (US Totex) shown as Model 8 below. Although comparing a relative and absolute measure is difficult, a relation would be explainable if, for example, larger industries with greater export volumes tend toward higher concentration levels. The model, although insignificant, did show the expected sign for the b-coefficient.

\[
\text{US Total Industry Exports} = a \cdot (\text{Industry Concentration Ratio}^*)^b \cdot \text{error}
\]

where;
*Industry Concentration Ratio is measured by;
USCR4
USCR8
Statistical results of the testing are given in Table 7.15 below.

Table 7.15  Regression Results of Model 8

<table>
<thead>
<tr>
<th>Concentration Ratio</th>
<th>Coefficient/Constant</th>
<th>p-value</th>
<th>t-statistic</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>USCR4</td>
<td>b = 0.159</td>
<td>0.306</td>
<td>1.03</td>
<td>3.1%</td>
</tr>
<tr>
<td></td>
<td>a = 1.74</td>
<td>0.002</td>
<td>3.16</td>
<td></td>
</tr>
<tr>
<td>USCR8</td>
<td>b = 0.246</td>
<td>0.054</td>
<td>1.36</td>
<td>2.7%</td>
</tr>
<tr>
<td></td>
<td>a = 1.36</td>
<td>0.177</td>
<td>1.94</td>
<td></td>
</tr>
</tbody>
</table>

It is difficult to predict the relation between industry structure and export activity from the model since it relies on specific export volumes correlating to specific concentration values. Therefore, specific industry structure, as measured by concentration, would predict a specific dollar volume of export activity versus a relative measure of export propensity. If the model could explain export volumes through concentration measures then we may expect industries with very large output to be subject to very large economies of scale and as well to be very highly concentrated. Obviously industries are variant in terms of volume output and concentration. One industry may be represented by a domestic monopolist, however, the size of the industry and therefore the monopolist’s output could be relatively small. It would be reasonable to assume that for these or similar reasons concentration does not explain export volume and Model 8 is insignificant.

VIII. EMPIRICAL STUDY: REMARKS

Conclusions drawn from the variety of statistical testing are that measures of industry structure explain export industry trade. Other aspects of export trade such as factor endowments or competitive advantage, employed within traditional trade models, are not explicitly included
within the model and instead have been assumed to be influence the error term of regression models.

In Canada, export volumes increase not only with firm and industry size but are also positively related to the size of the largest firms within the industry. This evidence supports the hypothesis that increased concentration leads to increased export output. Export intensity was also shown to increase with the degree of industry concentration, however, this evidence is weak in the Canadian case. By testing the larger US manufacturing economy, evidence was found that a positive relationship exists between industry concentration and export levels.

Conclusions drawn from empirical data support the theory that export trade takes place within imperfect markets, where market imperfections are characterized by large firm size and industry structure is characterized by high industry concentration. By understanding this relationship between market structure and trade, government policy directed at trading industries may be better focused on strategies seeking to maximize national social welfare.

 IX. IMPLICATIONS FOR GOVERNMENT POLICY

Government trade or industrial policy must be made with cognizance of conditions under which international trade takes place. Through increased understanding of the conditions under which trade takes place, welfare effects of policies can be determined and wealth maximizing policies designed. The empirical study described within this paper shows that trade takes place within
imperfect markets. Both market and domestic industry structure define two of the parameters of trade.

Implications from the Basic Model

Trade and Industry Costs:
The basic theoretical model presented of trade under oligopolistic market conditions showed that any total marginal cost advantage of domestic producers over their foreign rivals yielded higher equilibrium market share for the domestic industry than the foreign in any given market. The model predicted that increases in foreign costs relative to those of domestic producers causes shrinkage in foreign output and domestic firm output increases.

As domestic output rises relative to foreign, rents are shifted to the home-country nation. Therefore, any policy directed at decreasing domestic firm marginal costs increases producer profits through output expansion. Example policies may be production subsidies or direct subsidization of marginal export costs. Any policy directed at increasing foreign firm costs could be implemented for the domestic market only. An import tariff or tax would shrink foreign supply to the domestic market and increase domestic supply with expansion causing increased producer profits and tariff revenue improving the wealth of the national treasury.

If markets are imperfect due to high fixed or large investment costs then policies causing increased output within these industries will yield gains from rationalization. Such policies may be politically driven, such as the North American Free Trade Agreement which seeks to provide
secured access to larger markets for Canada. Production subsidies would also result in increased output. Since any subsidy represents a transfer from government to producers, national welfare gains would only result if rationalization gains exceeded the amount of the subsidy. Similarly, domestic market protection through import tariffs or taxes would decrease foreign market share of the domestic industry and allow higher domestic output which in turn would allow efficiency gains. If domestic and export market output costs are complementary, these lower costs could also yield producer surplus increases from expanded export market shares.

Scale efficiencies effected by increased output from trade may include rationalization of tangible fixed production costs or less tangible costs of Research and Development (R&D), marketing investment in domestic and international distribution networks, management skill in foreign markets, and/or indivisible information costs of exporting. Concentration in exporting industries may be the result of firms seeking to rationalize theses indivisible costs incurred by trade. This prediction is supported particularly well by the empirical results provided for US industries where higher degrees of concentration correlated with higher export propensity. Policy effects on industry concentration will be discussed in greater detail later.

**Trade and Firm Number:**

The policy question considering industry firm number can be made dichotomous in order to further analyze welfare effects from trade from the perspective of producers - should domestic industry expansion in both domestic and foreign markets be achieved through a large number of firms producing relatively little output, or a small number of firms delivering a larger amount
of the good, each considering their own profit maximization?

Government should be indifferent to the high number (of firms), low (per firm) output versus the low number, high output alternative if the marginal and average cost of production is constant across all firms in the exporting industry. Under each alternative, aggregate producer surplus for the industry would be the same and divided amongst some number of firms, n. If, however, firms face economies of scale then expansion not only yields increased producer welfare given some market price but also gains from rationalization. Under increasing returns, government policy would prefer trade expansion to be carried out by a low number of firms with high output.

Implications from Empirical Evidence for Rent Shifting

The conduct of trade within imperfect markets as shown by theoretical and empirical study means opportunity exists for shifting economic rents from foreign to domestic producers. Within imperfect markets, increased domestic output to the global market (either domestic or foreign import-competing) implies increased share in industry rents and decreased market share of foreign competitors.

Under conditions of imperfect competition, policy directed at the concentration of domestic industries may represent a viable means of maximizing national welfare through increased producer surplus. Specifically, policy to decrease domestic industry competition may reduce the average costs of exporting industries and improve the ability of firms within to compete
internationally and accrue greater economic profit from international markets than foreign competitors.

Industry concentration is affected in one manner by national competition policy relating to merger and acquisition activity. If exporting firms seek to merge then profit motivations must be present such that the combined firm profit is at least as great as the aggregate profit of firms operating at arms length from one another. By internalizing market transactions within a larger firm, synergies or larger profits are realized. Internalized transactions may yield economies of scale in production activities as well as those specifically relating to export such as information costs, marketing, distribution and finance. Cost reductions relative to foreign rivals yield greater domestic output and greater global market share at the expense of foreign rivals. If production technologies and costs are relatively constant across international markets, more liberal competition policy within the domestic regime may yield net increases in national welfare. Greater domestic industry rationalization and consequent concentration could allow governments to shift rents within international markets where foreign country policies are stricter. As concentration and export market share increases, profits are earned at the expense of foreign rivals.

Additionally, concentrated domestic industries may also be able to exert market power in foreign countries and increase national producer surplus through the acquisition of international market rents. Policies increasing domestic industry concentration, therefore, need not be motivated on the basis of cost rationalization only.
Strategic alliances within imperfect markets represent an alternative means to increasing domestic concentration. Alliances seek to exact a pareto optimal solution from the producer standing of combined project (or alliance firm) profits greater than aggregated individual project profits. Alliances are not a permanent firm merger and as such do not technically affect industry concentration measures. Effectively, however, concentration is increased. If profit increases are the result of increased global market share for the combined firms' project then policies to promote strategic alliances will cause rent shifting and improve national domestic welfare.

Rents may also be shifted by causing industry expansion within the domestic market. As industry size increases, exports increase and therefore greater global rents are earned. Expansion may yield gains from rationalization as well and give domestic firms cost advantages over foreign rivals. Protection of home markets through import tariffs, production subsidies to exporters or export subsidies applied directly would each work to reduce firm costs and shift rents to domestic producers from foreign market participants.

Analyzing Producer and Consumer Welfare Effects
The above implications for rent shifting and other trade policies implicitly assume that prices effects are not large enough to effect reductions in industry producer surplus. Also, changes in consumer surplus are not considered. Possibly no change in consumer surplus would result if production simply shifted from foreign to domestic suppliers and no industry output or price change was effected. However, deadweight losses may be incurred if higher domestic market share causes increased market power such that domestic market prices rise and output is
reduced. These monopolistic distortions cause producer surplus that may outweigh resultant consumer losses. Analysis must, therefore, consider each of the producer and surplus effects from trade and industrial policy and focus on maximizing net social welfare. Any losses in consumer surplus as a result of trade policy promoting producer interests must be outweighed by increases in producer benefit.

One means of effecting greater oligopolistic interdependencies and greater producer surplus from world markets without necessarily reducing consumer welfare may be the promotion of inter-firm non-price cooperation. Cooperation represents a viable means of reducing industry costs and directly affecting output variables without increasing domestic market power as long as firms do not restrict supply in an effort to raise prices. Policy directed at non-price cooperation may be the promotion of shared industry investment such as R&D, marketing investment or shared industry finance. Indeed, the imperfect trade model employed within this analysis could be applied to industry rationalization not through firm exit or merger but through reduced average costs by reduced duplicate industry investment.

X.FINAL REMARKS

The existence of imperfect international markets represent opportunity for national governments to intervene in international trade with policies that allow improved national social benefit from economic rents shifted from foreign constituents. A variety of government policy implications for trade in imperfect markets and industries have been discussed, however, a few general
themes can be summarized. Note beforehand that all policy implications do not consider foreign government retaliation. If all governments gave advantage to domestic constituents at some cost to foreigners, markets would be distorted and global welfare losses may easily result. Rational for international agreements on the conduct of governments effecting trade policy, therefore, exists.

The first general theme of the paper is that industry costs lower than foreign rivals causes higher global output and higher global market share. Policies working to lower costs relative to foreign industry rivals, therefore, accrue a greater majority of global industry rents to the nation.

Where firms face increasing returns to scale, lower costs can be influenced by expanding both domestic and export output within the domestic industry. Efficiency gains as well as expanded producer surplus may result. Policies affecting higher industry concentration may also allow for efficiency gains from trade. Industry non-price cooperation between firms to reduce export and other costs and increase international competitiveness may be an alternative policy option in order to realize gains from trade without increasing domestic industry concentration and market power resulting in market inefficiencies. Benefits from concentration need not be restricted to production rationalization. Concentrated domestic industries may exert market power in foreign nations and extract industry rents from additional export sales under conditions of high foreign market price-cost margins.

A variety of trade policy tools may be applied to industry depending on the various assumptions
regarding industry structure and oligopolistic interdependencies. For this reason, trade policy must be designed and applied with cognizance of the particular aspects motivating trade within each industry. For example, trade policy directed at increasing industry concentration or restricting industry imports may have negative welfare implications if industries do not face increasing returns to scale since resultant domestic market power may harm domestic consumers. Impacts of trade policy must be measured from both producer and consumer standing. Trade policies generally applied may not necessarily improve net social welfare.

Finally, domestic structure and export trade are positively related. Under conditions of imperfect markets, domestic competition policy may affect international trade. Policy affecting merger and acquisition activity or promotion of inter-firm cooperation falls under the rubric of competition policy. International agreements may, therefore, take interest in these strategies currently implemented within the domestic policy regime. By moving domestic competition policy to the international realm, world utility should not be as easily jeopardized by domestic rent-seeking activities.
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CANSIM - Statistics Canada, Merchandise Trade with All Countries, Summary of International Trade. v. 65.001, Supply and Services Canada, 1992


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APPENDIX 1
Sample Data Points

Canadian Industries as Described by
Standard Industrial Classification (SIC) Codes

Chemicals and Allied Products
1. Chemical and Allied Industries
2. Fertilizers
3. Pharmaceutical Products

Communication Equipment
4. Total Communication Equipment

Electrical Products
5. Radio and TV Receivers

Food Industry
6. Dairy Products
7. Meat Products
8. Fish Products
9. Grain Mills
10. Total Beverages

Leather Products
11. Total Leather Products

Machinery
12. Total Machinery
13. Farm Machinery

Metal Industry
14. Primary Metal Products
15. Total Metal Mining

Nonmetallic Mineral Industry
16. Total Nonmetallic Mineral Products
17. Petroleum and Coal Products

Paper and Allied Industries
18. Total Paper and Allied Industries

Publishing and Printing Industries
19. Total Publishing and Printing Industries
APPENDIX 1(cont’d)
Sample Data Points

Canadian Industries as Described by
Standard Industrial Classification (SIC) Codes

Rubber Products
20. Total Rubber Products

Textile Industry
21. Total Textile and Knitting Mills

Tobacco Industry
22. Total Tobacco Products

Transport Industry
23. Aircraft and Parts
24. Motor Vehicles and Parts
25. Miscellaneous Transport Equipment

Wood Industry
26. Sawmills and Planing Mills
27. Veneer and Plywood
APPENDIX 2
Raw and Log Data Plots
Canadian Industry Data - Export Shipments to the World ($000s)

PLOT 1

Raw Data - Exports 1977

Log Data - Exports 1977

PLOT 2

Raw Data - Exports 1982

Log Data - Exports 1982

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APPENDIX 2 (cont’d)
Raw and Log Data Plots
Canadian Industry Data - Export Shipments to the World ($000s)

PLOT 3

Raw Data - Exports 1987

Log Data - Exports 1987

10.8  12.0  13.2  14.4  15.6  16.8
APPENDIX 3
Raw Data and Log Data Plots
Canadian Industry Data - Total Value of Industry Assets ($000s)

PLOT 1
Raw Data - Assets 1977

Log Data - Assets 1977

PLOT 2
Raw Data - Assets 1982

Log Data - Assets 1982
APPENDIX 3 (cont'd)
Raw Data and Log Data Plots
Canadian Industry Data - Total Value of Industry Assets ($000s)

PLOT 3

Raw Data - Assets 1987

Log Data - Assets 1987

13.60 14.40 15.20 16.00 16.80 17.60
APPENDIX 4
Raw Data and Log Data Plots
Canadian Industry Data - Average Firm Size Measured in Assets ($000s)

PLOT 1

Raw Data - Size 1977

\[
\begin{align*}
\text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} \\
+ & \quad \quad & \quad \quad & \quad \quad & \quad \quad & \quad \quad \\
0 & \quad 50000 & \quad 100000 & \quad 150000 & \quad 200000 & \quad 250000
\end{align*}
\]

Log Data - Size 1977

\[
\begin{align*}
\ldots & \quad \ldots & \quad \ldots & \quad \ldots & \quad \ldots & \quad \ldots \\
+ & \quad \quad & \quad \quad & \quad \quad & \quad \quad & \quad \quad \\
6.0 & \quad 7.2 & \quad 8.4 & \quad 9.6 & \quad 10.8 & \quad 12.0
\end{align*}
\]

PLOT 2

Raw Data - Size 1982

\[
\begin{align*}
\text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} & \quad \text{\ldots} \\
+ & \quad \quad & \quad \quad & \quad \quad & \quad \quad & \quad \quad \\
0 & \quad 70000 & \quad 140000 & \quad 210000 & \quad 280000 & \quad 350000
\end{align*}
\]

Log Data - Size 1982

\[
\begin{align*}
\ldots & \quad \ldots & \quad \ldots & \quad \ldots & \quad \ldots & \quad \ldots \\
+ & \quad \quad & \quad \quad & \quad \quad & \quad \quad & \quad \quad \\
7.2 & \quad 8.4 & \quad 9.6 & \quad 10.8 & \quad 12.0 & \quad 13.2
\end{align*}
\]
APPENDIX 4 (cont’d)

Raw Data and Log Data Plots

Canadian Industry Data - Average Firm Size Measured in Assets ($000s)

PLOT 3

Raw Data - Size 1987

```

```

Log Data - Size 1987

```

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APPENDIX 5
Raw Data and Log Data Plots
Canadian Industry Data - Number of Firms

PLOT 1

Raw Data - Number 1977

```
...:...
+--------+--------+--------+--------+--------+--------+
0        700     1400    2100    2800    3500
```

Log Data - Number 1977

```
...:...
+--------+--------+--------+--------+--------+--------+
2.4      3.6     4.8     6.0     7.2     8.4
```

PLOT 2

Raw Data - Number 1982

```
...:...
+--------+--------+--------+--------+--------+--------+
0        1000    2000    3000    4000    5000
```

Log Data - Number 1982

```
...:...
+--------+--------+--------+--------+--------+--------+
2.4      3.6     4.8     6.0     7.2     8.4
```
APPENDIX 5 (cont'd)
Raw Data and Log Data Plots
Canadian Industry Data - Number of Firms

PLOT 3

Raw Data - Number 1987

+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|     |     |     |     |     |     |     |     |     |     |     |     |
| 0   | 1200| 2400| 3600| 4800| 6000|

Log Data - Number 1987

+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|     |     |     |     |     |     |     |     |     |     |     |     |
| 2.4 | 3.6 | 4.8 | 6.0 | 7.2 | 8.4 |
APPENDIX 6
Canadian Industry CALURA ($000's)
1982 Concentration Data Description

**RAW CALURA DATA**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>sales4</td>
<td>13</td>
<td>3330692</td>
<td>1885000</td>
<td>2328545</td>
<td>4550184</td>
<td>1261994</td>
</tr>
<tr>
<td>assets4</td>
<td>12</td>
<td>4392833</td>
<td>1563500</td>
<td>3705900</td>
<td>4970416</td>
<td>1434835</td>
</tr>
<tr>
<td>sales8</td>
<td>12</td>
<td>4880334</td>
<td>2533500</td>
<td>3437300</td>
<td>6406566</td>
<td>1849416</td>
</tr>
<tr>
<td>assets8</td>
<td>12</td>
<td>6535334</td>
<td>2647500</td>
<td>5241400</td>
<td>7832752</td>
<td>2261121</td>
</tr>
</tbody>
</table>

**LOG CALURA DATA**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>sales4</td>
<td>13</td>
<td>14.460</td>
<td>14.449</td>
<td>14.452</td>
<td>1.081</td>
<td>0.300</td>
</tr>
<tr>
<td>assets4</td>
<td>12</td>
<td>14.664</td>
<td>14.262</td>
<td>14.763</td>
<td>1.294</td>
<td>0.374</td>
</tr>
<tr>
<td>sales8</td>
<td>12</td>
<td>14.870</td>
<td>14.745</td>
<td>14.862</td>
<td>1.052</td>
<td>0.304</td>
</tr>
<tr>
<td>assets8</td>
<td>12</td>
<td>15.042</td>
<td>14.760</td>
<td>15.081</td>
<td>1.247</td>
<td>0.360</td>
</tr>
</tbody>
</table>

* sales4 = total annual sales of the 4 top industry enterprises
  sales8 = " " 8 "
assets4 = total assets of the 4 top industry enterprises
assets8 = " " 8 "

114
APPENDIX 7
Canadian Industry CALURA ($000s)
1987 Concentration Data Description

<table>
<thead>
<tr>
<th>RAW DATA</th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>sales4</td>
<td>13</td>
<td>4635000</td>
<td>2632000</td>
<td>3423000</td>
<td>5989000</td>
<td>1661000</td>
</tr>
<tr>
<td>assets4</td>
<td>12</td>
<td>6700083</td>
<td>2806500</td>
<td>5230900</td>
<td>8534234</td>
<td>2463621</td>
</tr>
<tr>
<td>sales8</td>
<td>12</td>
<td>6569000</td>
<td>3986000</td>
<td>5171000</td>
<td>7449000</td>
<td>2150000</td>
</tr>
<tr>
<td>assets8</td>
<td>12</td>
<td>8569917</td>
<td>4638500</td>
<td>7027801</td>
<td>9834992</td>
<td>2839118</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOG DATA</th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>lgsal4</td>
<td>13</td>
<td>7.826</td>
<td>7.875</td>
<td>7.836</td>
<td>1.195</td>
<td>0.331</td>
</tr>
<tr>
<td>lgass4</td>
<td>12</td>
<td>8.023</td>
<td>7.928</td>
<td>8.110</td>
<td>1.463</td>
<td>0.422</td>
</tr>
<tr>
<td>lgsal8</td>
<td>12</td>
<td>8.244</td>
<td>8.285</td>
<td>8.278</td>
<td>1.174</td>
<td>0.339</td>
</tr>
<tr>
<td>lgass8</td>
<td>12</td>
<td>8.372</td>
<td>8.441</td>
<td>8.477</td>
<td>1.391</td>
<td>0.402</td>
</tr>
</tbody>
</table>

* sales4 = total annual sales of the 4 top industry enterprises
  sales8 = " " 8 " "
  assets4 = total assets of the 4 top industry enterprises
  assets8 = " " 8 " "

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APPENDIX 8
Raw Data and Log Data 1982 CALURA Plots ($000s)

PLOT 1

Raw Data - Sales4

```
.............
+---------+---------+---------+---------+---------+---------+ sales4
0 3500K 7000K 10500K 14000K 17500K
```

Log Data - Sales4

```
.............
+---------+---------+---------+---------+---------+---------+ lgsal4
12.80 13.60 14.40 15.20 16.00 16.80
```

PLOT 2

Raw Data - Assets4

```
.............
+---------+---------+---------+---------+---------+---------+ assets4
0 3000K 6000K 9000K 12000K 15000K
```

Log Data - Assets 4

```
.............
+---------+---------+---------+---------+---------+---------+ lgass4
12.0 13.0 14.0 15.0 16.0 17.0
```
APPENDIX 8 (cont’d)
Raw Data and Log Data 1982 CALURA Plots (cont’d)

PLOT 3
Raw Data - Sales8

+-----------+-----------+-----------+-----------+-----------+-----------+
0   5000K   10000K   150000K   200000K   250000K

Log Data - Sales8

12.80   13.60   14.40   15.20   16.00   16.80

PLOT 4
Raw Data - Assets8

+-----------+-----------+-----------+-----------+-----------+-----------+
0   5000K   10000K   15000K   20000K   25000K

Log Data - Assets8

12.0   13.0   14.0   15.0   16.0   17.0
APPENDIX 9
Raw Data and Log Data 1987 CALURA Plots ($000s)

PLOT 1

Raw Data - Sales4

```
+-----------+-----------+-----------+-----------+-----------+-----------+
|            |            |            |            |            |            |
| 0 5000K    | 10000K    | 15000K    | 20000K    | 25000K    |            |
```

Log Data - Sales4

```
+-----------+-----------+-----------+-----------+-----------+-----------+
|            |            |            |            |            |            |
| 5.0 6.0    | 7.0 8.0    | 9.0 10.0   |            |            |            |
```

PLOT 2

Raw Data - Sales8

```
+-----------+-----------+-----------+-----------+-----------+-----------+
|            |            |            |            |            |            |
| 0 5000K    | 10000K    | 15000K    | 20000K    | 25000K    |            |
```

Log Data - Sales8

```
+-----------+-----------+-----------+-----------+-----------+-----------+
|            |            |            |            |            |            |
| 5.0 6.0    | 7.0 8.0    | 9.0 10.0   |            |            |            |
```
APPENDIX 9 (cont’d)
Raw Data and Log Data 1987 CALURA Plots ($000s)

PLOT 3

Raw Data - Assets4

```
.. :.. :
+---------+---------+---------+---------+---------+
0     6000K 12000K 18000K 24000K 30000K
```

Log Data - Assets4

```
-+---------+---------+---------+---------+---------+
5.0    6.0  7.0    8.0  9.0    10.0
```

PLOT 4

Raw Data - Assets8

```
.. :.. :
+---------+---------+---------+---------+---------+---------+
0     6000K 12000K 18000K 24000K 30000K
```

Log Data - Assets8

```
-+---------+---------+---------+---------+---------+---------+
5.0    6.0  7.0    8.0  9.0    10.0
```
APPENDIX 10
Canadian Industry Export and Concentration Ratio Data

RAW DATA

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEx</td>
<td>24</td>
<td>41.80</td>
<td>32.00</td>
<td>38.18</td>
<td>39.08</td>
<td>7.98</td>
</tr>
<tr>
<td>cr4</td>
<td>23</td>
<td>39.07</td>
<td>39.04</td>
<td>39.04</td>
<td>3.46</td>
<td>0.72</td>
</tr>
<tr>
<td>cr8</td>
<td>23</td>
<td>52.72</td>
<td>49.60</td>
<td>51.74</td>
<td>18.66</td>
<td>3.89</td>
</tr>
<tr>
<td>H</td>
<td>23</td>
<td>11.29</td>
<td>9.73</td>
<td>10.53</td>
<td>7.48</td>
<td>1.56</td>
</tr>
</tbody>
</table>

LOG DATA

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ClgEx</td>
<td>24</td>
<td>3.147</td>
<td>3.465</td>
<td>3.208</td>
<td>1.302</td>
<td>0.266</td>
</tr>
<tr>
<td>logcr4</td>
<td>23</td>
<td>3.6616</td>
<td>3.6646</td>
<td>3.6619</td>
<td>0.0890</td>
<td>0.0186</td>
</tr>
<tr>
<td>logcr8</td>
<td>23</td>
<td>3.9073</td>
<td>3.9040</td>
<td>3.9044</td>
<td>0.3467</td>
<td>0.0723</td>
</tr>
<tr>
<td>logH</td>
<td>23</td>
<td>2.250</td>
<td>2.275</td>
<td>2.231</td>
<td>0.587</td>
<td>0.122</td>
</tr>
</tbody>
</table>

1 CEx = Industry Export Shipments/Total Industry Shipments
2 CR4 = Top 4 Enterprises' Shipments/Total Industry Shipments
CR8 = "8 "
H = Herfindahl Index Measure (sum of the squares of top 4 enterprises' market share)
APPENDIX 11
Raw Data and Log Data Plots
1982 Canadian Export and Industry Concentration

PLOT 1

Raw Data - CR4

```
32.5  35.0  37.5  40.0  42.5  45.0
```

Log Data - CR4

```
3.500  3.570  3.640  3.710  3.780  3.850
```

PLOT 2

Raw Data - CR8

```
30  45  60  75  90  105
```

Log Data - CR8

```
3.25  3.50  3.75  4.00  4.25  4.50
```
APPENDIX 11 (cont'd)
Raw Data and Log Data Plots
1982 Canadian Export and Industry Concentration

PLOT 3

Raw Data - Herfindahl

Log Data - Herfindahl

PLOT 4

Raw Data - CEx

Log Data - CEx
APPENDIX 12
Normal Plots of Industry Export and Concentration Log Data

PLOT 1

Normal Plot - CEx Log Data

\[ \text{lgCEx} \]

\[ \begin{array}{c}
1.40 & -1.40 \\
0.70 & 0.70 \\
0.00 & 0.00 \\
-0.70 & -1.40 \\
-1.40 & \end{array} \]

\[ \text{Nscore} \]

\[ N^* = 3 \]
APPENDIX 12 (cont’d)
Normal Plots of Industry Export and Concentration Log Data

PLOT 2

Normal Plot - CR4 Log Data

3.84 +
- logcr4 - -
- 3.72 +
- - -
- 3.60 +
- - -
- 3.48 +
- -- +---------+---------+---------+---------+---------Nscore
-1.40 -0.70 0.00 0.70 1.40
N* = 4
APPENDIX 12 (cont'd)
Normal Plots of Industry Export and Concentration Log Data

PLOT 3

Normal Plot - CR8 Log Data

- 4.50+
- logcr8 - 2 ****
- 4.00+
- 3.50+
- *
- *
- *
- *
------------------------------
--- ------- ------- ------- ------- C40
--- -1.40  -0.70   0.00   0.70   1.40
N* = 4
APPENDIX 12 (cont’d)
Normal Plots of Industry Export and Concentration Log Data

PLOT 4

Normal Plot - Herfindahl Index Log Data

logH  -
      -
      -
      -
      3.20+
      -
      -
      -
      -
      2.40+
      -
      -
      -
      -
      1.60+
      -
      -
      -
      -------+--------+--------+--------+--------+--------Nscore
         -1.40  -0.70  0.00  0.70   1.40

N* = 4
### RAW DATA

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>USEx</td>
<td>135</td>
<td>7.642</td>
<td>5.483</td>
<td>6.792</td>
<td>7.552</td>
<td>0.650</td>
</tr>
<tr>
<td>uscr4</td>
<td>140</td>
<td>37.39</td>
<td>34.05</td>
<td>36.41</td>
<td>17.30</td>
<td>1.46</td>
</tr>
<tr>
<td>uscr8</td>
<td>138</td>
<td>49.53</td>
<td>47.60</td>
<td>49.05</td>
<td>18.67</td>
<td>1.59</td>
</tr>
</tbody>
</table>

### LOG DATA

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>TRMEAN</th>
<th>STDEV</th>
<th>SEMEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>lgUSEx</td>
<td>135</td>
<td>1.485</td>
<td>1.702</td>
<td>1.556</td>
<td>1.220</td>
<td>0.105</td>
</tr>
<tr>
<td>lguscr4</td>
<td>140</td>
<td>3.5121</td>
<td>3.5278</td>
<td>3.5269</td>
<td>0.4854</td>
<td>0.0410</td>
</tr>
<tr>
<td>lguscr8</td>
<td>138</td>
<td>3.8231</td>
<td>3.8628</td>
<td>3.8427</td>
<td>0.4202</td>
<td>0.0358</td>
</tr>
</tbody>
</table>
APPENDIX 14
US Industry Raw and Log Data Plots

PLOT 1

Raw Data - USCR4

Log Data - USCR4

2 Points missing or out of range

PLOT 2

Raw Data - USCR8

128
APPENDIX 14 (cont’d)
US Industry Raw and Log Data Plots

PLOT 2 (cont’d)
Log Data - USCR8

PLOT 3
Raw Data - USEX
5 Points missing or out of range

Log Data - USEX
5 Points missing or out of range

129
APPENDIX 15
US Industry Export and Concentration Data Normal Plots

Normal Plot - Raw Data USCR4

90+                   * 2
uscr4 -                * ***
-                     *22*
-                     *22*
60+                    *24*
-                     *2442
-                     *3643
-                     *25662
30+                    *645563
-                     *3443
-                     *3223*
-                     *22****
-                     *3
0+                     +---------+---------+---------+---------+---------+
-3.0 -2.0 -1.0 0.0 1.0 2.0

Normal Plot - Log USCR4

lgrcr4 -                * 2 *
-                     *2322
-                     *3443
4.00+                  *442
-                     *65642
-                     *36556
-                     *6452
3.20+                  *443
-                     *3
-                     *23
-                     *23*
-                     *23
-                     *2
2.40+                  *2
-                     *2
-                     *2
+---------+---------+---------+---------+---------+---------+---------normalN=140
-3.0 -2.0 -1.0 0.0 1.0 2.0

130
APPENDIX 15 (cont’d)

Normal Plot - Raw Data USCR8

-  
-  
90+  
-  
uscr8  
-  
60+  
-  
30+  
-  
256*  
-  
46464  
-  
4376*  
-  
253*  
-  
4376*  
-  
253*  
-  
46464  
-  
256*  
-  
uscr8  
-  
90+  

N* = 2

Normal Plot - Log USCR8

lgcr8  
-  
-  
4.20+  
-  
3*3  
-  
245  
-  
23  
-  
2*  
2.80+  
-  
2*  
-  

N* = 2

131
Normal Plot - Raw Data USEx

- 45+
- USEx -
- 30+
- -
- 15+
- -
- 0+

---

N* = 5

Normal Plot - Log Data USEx

- lgUSEx -
- 2.5+
- -
- 2.0+
- -
- 1.0+
- -
- 0.0+
- -
- -
- ---

N* = 5

132
APPENDIX 16
Residual Plots of US Industry Exports and Concentration

Normal Plot - Residuals of US CR4 Regression Model 7

- 2.0+ * ***
- 333222*2
Res USCR4 -
- 2534
- 355552
0.0+ 25653
- 44553
- 243*
- *33*
- *2*
-2.0+ ** ***
- * ***
- *
- *
-4.0+ ** * ***
------- + ------- + ------- + ------- + ------- + ------- Nscore

-2.0 -1.0 0.0 1.0 2.0

Normal Plot - Residuals of US CR8 Regression Model 7

- 2.0+ * ***
- 232222
Res USCR8 -
- 24433
- 565543
0.0+ 3655
- 25452
- 3342
- 232*
- *2
-2.0+ **2*
- * *
- *
- *
-4.0+ ** * ***
------- + ------- + ------- + ------- + ------- + ------- Nscore

-2.0 -1.0 0.0 1.0 2.0