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**DOMESTIC MARKET STRUCTURE AND  
PERFORMANCE IN GLOBAL MARKETS:  
THEORY AND EMPIRICAL EVIDENCE FROM U.S.  
FOOD MANUFACTURING INDUSTRIES**

by

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## ABSTRACT

This paper formally articulates Porter's hypothesis that the degree of competition in domestic markets is positively linked to performance in international markets. Hypotheses are tested using data for U.S. food manufacturing industries, using measures of trade performance as proxies for international competitiveness. Empirical results are generally consistent with Porter's hypothesis, finding that net export share is negatively related to industry concentration. The competitiveness of agricultural inputs, R & D intensity, and trade barriers of other countries were also found to be important determinants of the performance of these industries in global markets.

## Introduction

Improving the international competitiveness of U.S. firms and industries has become a frequently embraced policy goal as imports have exceeded exports since the 1970s. Several studies have attempted to evaluate the competitive position of the U.S. and to identify the determinants of success in global markets.<sup>1</sup>

One approach to studying international competitiveness is to relate macro-economic variables to the performance of a nation in global markets. This research often assumes that increased trade deficits in the U.S. can be explained mainly by relatively high interest rates and overvaluation of the U.S. dollar during certain periods.

Although this approach is relevant for designing monetary and fiscal policies, it has limitations in explaining the global performance of industries or firms. At the industry or firm level, macro-economic variables may explain only a small portion of global success and failure. The performance of industries or firms in global markets appears to be more closely related to industry characteristics and trade barriers.

Traditional trade theories based upon comparative advantage also have limitations in explaining the success or failure of firms in international markets. Success in global markets appears to be less related to differences in factor endowments, and more a matter of firm strategies and technological progress, the means by which firms overcome disadvantages in factor endowments. By developing new products or processes, innovative firms have reduced

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<sup>1</sup> Relevant studies are The President's Commission on Industrial Competitiveness (1985), Scott and Lodge (1985), Spence and Hazard (1988), Hilke and Nelson (1988), Porter (1990a), and Lenz (1991), to name a few.

the importance of factor endowments. In short, a more micro level of analysis appears to be needed.

Domestic competition and government regulations are often cited as important influences on the success of firms or industries in global markets. Some researchers and business executives have asserted that U.S. antitrust policy hampers the competitiveness of U.S. firms in international markets. Antitrust regulations in the U.S. are regarded as a major impediment to U.S. firms rationalizing their production facilities or developing cooperative R & D programs (Zysman and Tyson, 1983; Baldrige, 1986; Hilke and Nelson, 1988; Jorde and Teece, 1990). To devotees of this point of view, "corporate consolidation and bigness is believed to be an essential prerequisite for global competitiveness" (Adams and Brock, 1987: 3).

A contrasting point of view contends that the lack of effective domestic competition in some industries has resulted in "bloated costs, few innovations and non-responsiveness to customer preferences" which has made the industries vulnerable to the market penetration of foreign firms (Marion, 1992: 46). Adams and Brock (1987), after examining firms and competition policies in Europe and Japan, concluded that "merger-induced corporate giantism is not likely the key to promoting operating efficiency, technological innovation, and international competitiveness" (p. 45).

Emphasizing the *creation* of factor advantages rather than static factor endowments, Porter (1990b) regards firm rivalry in domestic markets as the most important determinant of success in global markets. The presence of strong local rivals is arguably a "final and powerful stimulus to the creation and persistence of competitive advantage" (p. 82). In Porter's view, domestic competition is believed to be qualitatively different from competition with foreign

firms. Local competition facilitates information feedback and creates visible pressure on competitors (Porter, 1990a). The lack of local rivalry is likely to lead to inefficient use of resources and less incentive to engage in R & D activities.

Thus, we are faced with two competing hypotheses: one contends that giant firms, cooperation between competitors and a relaxation of antitrust laws will enhance performance in global markets; the second contends that intense domestic rivalry and tough enforcement of antitrust laws is the grist which prepares firms to be successful in global markets. This paper is a modest effort to test these competing hypotheses.

#### Defining and Measuring International Competitiveness

"International competitiveness" is a term fraught with ambiguity. We define international competitiveness as *the sustained ability of a nation's industries or firms to compete with foreign counterparts in foreign markets as well as in domestic markets under conditions of free trade*. In this study, the success of a nation's firms in global markets is used as a measure of "international competitiveness"; that success in turn is reflected in their market shares in home and foreign markets. We recognize that such measures of global performance may not accurately reflect true competitiveness when international trade or international business is distorted by government interventions.

The success of U.S. industries in global markets in this study was measured mainly by trade performance. Trade performance was measured by *net export share* (exports-imports as percentage of total world exports in the industry), and *relative trade performance index*, a measure of the trade performance of an industry relative to the performance of other industries

in a country. Since net export share and relative trade performance index<sup>2</sup> were highly correlated, we focus here on net export share. Assuming  $n$  different countries exist in the world, country  $i$ 's net export share (NXS <sub>$i$</sub> ) of world trade in an industry can be expressed as:

$$(1) \quad NXS_i = \frac{X_i - M_i}{\sum_j^n X_j}$$

where,  $X$  and  $M$  denote exports and imports, respectively. The world export levels of different industries vary greatly. Some industries have little trade because of perishability and/or freight costs (e.g., fluid milk and fresh bread), while other industries (e.g., wine) are characterized by high levels of trade. Net export share attempts to normalize trade activity in various industries by expressing them as a percent of world exports.

Net export share can also be measured for bilateral trade flows. Net export share of country  $i$  against country  $j$  is measured by:

$$(2) \quad NXS_{ij} = \frac{X_{ij} - X_{ji}}{X_{ij} + X_{ji}}$$

where  $X_{ij}$  denotes exports from country  $i$  to country  $j$ .

Unfortunately, trade data may provide a misleading measure of competitiveness in some industries where foreign direct investments or licensing are used instead of or in addition to

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<sup>2</sup> Relative trade performance index equals relative export advantage minus relative import disadvantage for an industry, where both exports and imports in an industry are expressed relative to the level of exports (imports) in a broad sector or the total economy.

trade. FDI and/or licensing occur for a variety of reasons, and may reflect either the success or lack of success of a nation's firms. In this study, we make a judgement of where FDI is significant and include an FDI variable in our analysis. However, we are mindful that this remains an important weakness of this and most research on global competition.

### Previous Research

The rapid growth of intra-industry trade has triggered the development of new trade theories which often incorporate market structure variables. Defined as the simultaneous presence of exports and imports in the same industry, intra-industry trade has often been rationalized by economies of scale and/or product differentiation. As a result, empirical models attempting to explain intra-industry trade have often included industry variables such as product differentiation, scale economies, industry concentration, transportation costs and foreign investment (Balassa, 1986; Marvel and Ray, 1987; Caves, 1981; and Pagoulatos and Sorenson, 1980).

Most empirical studies relating domestic industry concentration to international trade are based upon the theoretical framework of White (1974). In his model, White compared the magnitude of exports and imports under monopoly with those under a competitive market structure. Assuming homogenous products, he contended that a monopoly's impact on exports would be dependent on whether dumping is allowed or not. White indicated that a monopoly would export more than a competitive market structure only when it can price discriminate between the domestic market and foreign markets.

Motivated by White's theory, many studies related industry concentration to either exports or imports. Pagoulatos and Sorensen (1976) found a positive relationship between four-



firm concentration and both exports and imports. By contrast, Glejser et al (1980) found, based upon data from Belgian exporting firms, a negative relation between the Herfindahl index and export propensity. A negative relationship between industry concentration and exports was also reported in Henderson et al (1990), who used data from U.S. food manufacturing industries. Marvel (1980) expected a positive relationship between concentration and imports, based upon the dominant firm theory. This hypothesis was also supported by his empirical results.

Some studies related industry concentration to net exports (exports minus imports), a preferred measure of trade performance in our opinion. Baldwin (1971) and Koo and Martin (1984) reported negative relationships between industry concentration and net exports. Hilke and Nelson (1988) examined net imports (imports minus exports) and found a positive relationship to industry concentration.

#### Porter's Framework of National Competitive Advantage

Porter identifies four broad attributes of a nation or industry that contribute significantly to its competitive advantage.

- 1) "Factor conditions" refer to a nation's position in factors of production, focusing more on created factors such as skilled labor, infrastructure, and scientific bases than on a pool of human and natural resources.
- 2) "Demand conditions" are related to the nature and character of demand in the home country. Demand conditions give home firms "a clear and earlier picture of emerging buyer needs." A nation's companies gain competitiveness if its consumers are sophisticated and demanding buyers.

- 3) "Related and supporting industries" is an important determinant because internationally competitive home-based suppliers create advantages in downstream industries. Also, competitive end-using industries help upgrade supplying firms.
- 4) "Firm strategy, structure, and rivalry" refers to the way firms are created, organized, and managed, and how they compete in their home market. Strong local rivalry is expected to boost competitiveness by creating pressure to be efficient and to innovate. Domestic competition is arguably the most important determinant of international success because it has a strong stimulating effect on all other determinants.

This paper formally articulates Porter's hypothesis in trade models that incorporate market structure variables; the hypothesis is then tested empirically using data from U.S. food manufacturing industries. Understanding the impact of market structure on the global performance of food manufacturing industries is of particular interest because the concentration of these industries in the U.S. increased sharply after 1977. This was due at least in part to a decline in anti-merger enforcement in the 1980s (Marion and Kim).

### Theoretical Frameworks

The relationship between domestic market structure and trade performance is modeled separately in two cases: homogeneous goods and differentiated goods. The models suggest that while trade performance of homogenous goods is mainly determined by prices or costs, the performance of differentiated goods is also dependent on product diversity.

### *Homogenous Good Case*

Suppose that  $n$  firms produce homogeneous products in a country. Oligopolistic interactions of firms are modeled using conjectural variations.<sup>3</sup> Firm  $i$ 's profit is represented as  $\pi_i = P(Q)q_i - cq_i - F$  where  $P(Q)$  is inverse demand function,  $c$  = marginal cost, and  $F$  = fixed cost. Profit maximization requires

$$(3) \quad P(Q) + \frac{\partial P(Q)}{\partial Q} \alpha q_i = c$$

Since firms are symmetric, summation of condition (3) becomes

$$(4) \quad P(Q) = \left[1 - \frac{\alpha}{n\epsilon}\right]^{-1} c$$

where,  $\epsilon = -(\partial Q/\partial P)(P/Q)$ , represents (negative) elasticity of demand. We need a condition  $n\epsilon > \alpha$  so that price can be defined in the positive domain. In this expression, the existence of market power in oligopoly is explicitly represented by price distortions. As long as  $\alpha$  is greater

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<sup>3</sup> The term conjectural variation is defined as a firm's anticipation of the change in industry output as a result of a unit change in its own output). The mathematical expression would be  $\alpha_i = \partial Q/\partial q_i$ , where  $q_i$  denotes firm  $i$ 's output and  $Q = \sum q_i$ . Cournot competition and joint profit maximization (collusion) are represented by  $\alpha_i = 1$  and  $\alpha_i = n$ , respectively. Competitive or Bertrand behavior implies  $\alpha_i = 0$  since a firm's output change does not affect industry price. A conjectural variation is therefore defined when  $\alpha_i \geq 0$ . In this model, conjectural variation is also supposed to be identical ( $\alpha_i = \alpha$ ) across firms in an industry since all domestic firms are assumed identical.

than 0, equilibrium quantity and price are an increasing and a decreasing function of the number of firms, respectively ( $\partial Q/\partial n > 0$ ,  $\partial P/\partial n < 0$ ).<sup>4</sup>

For the analysis of international trade, it is assumed that there exist only two countries: the home country and the rest of the world. The model also assumes that domestic and foreign markets are segmented; each firm perceives each country as a separate market and makes distinct quantity decisions for each market (Brander and Krugman).<sup>5</sup> First, consider the case in which firms in the foreign country behave competitively. In many industries, there exist so many producers in the rest of the world that they are not able to exercise market power. In the case of exports, domestic oligopolist  $i$  will face both domestic demand and foreign demand. The profit of firm  $i$  is then represented as  $\pi_i = P(Q)q_i + P_w(X)x_i - cq_i - cx_i - F$ , where  $q_i$  and  $x_i$  represent domestic sales and export sales of firm  $i$ , respectively.  $P(Q)$  is the inverse demand in the home country and  $P_w(X)$  denotes the inverse of excess demand from the foreign country. Given the assumption of symmetry, the equilibrium export price is expressed as :

$$(5) \quad P_w(X) = \left[1 - \frac{\alpha}{n\epsilon_x}\right]^{-1}c$$

where,  $\epsilon_x$  represents the elasticity of excess demand from the foreign country. If firms in a country face downward sloping export demand curves from a foreign country and  $\alpha > 0$ , total exports of that country are positively related to the number of domestic firms ( $\partial X/\partial n > 0$ ).

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<sup>4</sup> Total differentiation of the first order condition leads to this property.

<sup>5</sup> Firms are allowed to price discriminate across different markets. Accordingly, prices are not necessarily equalized by international trade as predicted in free trade models. However, transportation costs are not explicitly considered for simplicity of the model.

In the case of imports, a group of domestic firms can be characterized as dominant firms.<sup>6</sup> Denoting  $D_d^*$  as residual demand for the home firms, the profit of firm  $i$  can be expressed as  $\pi_i = P(D_d^*)q_i - cq_i - F$ , where  $P(D_d^*)$  is the inverse of the residual demand. The price charged by the domestic firms would be:

$$(6) \quad P(D_d^*) = \left[1 - \frac{\alpha}{n\epsilon_d^*}\right]^{-1}c$$

where,  $\epsilon_d^*$  represents the elasticity of residual demand. If firms in a country face an upward-sloping import supply curve from a foreign country and  $\alpha > 0$ , the country's imports decrease as the number of domestic firms increase ( $\partial M/\partial n < 0$ , where  $M = ES_f$  represents imports by the home country).<sup>7</sup>

Next, consider the more general case in which domestic and foreign firms can interact in the domestic as well as the foreign market. This is the case where there are only a small number of producers in the world. Suppose that the number of consumers and demand elasticity are identical in both countries. In this case, firms have two strategies: participating and nonparticipating in trade. Among four possible combinations of strategies, the case in which

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<sup>6</sup> If imports are relatively small compared to domestic sales and imports are restricted by some trade barriers, domestic firms might be price leaders, and imports would follow the price that the domestic firms set. The domestic firms become dominant firms, and imports become a competitive fringe.

<sup>7</sup> This proposition can be proved as follows. Since  $M = ES_f(P) = D_d(P) - D_d^*(P)$ , where  $D_d^*(P)$  denotes residual demand for home firms. And,  $\partial ES_f(P)/\partial n = (\partial D_d(P)/\partial P)(\partial P/\partial n) - \partial D_d^*(P)/\partial P(\partial P/\partial n) = (\partial D_d(P)/\partial P - \partial D_d^*(P)/\partial P)(\partial P/\partial n)$ . By definition,  $|\partial D_d^*(P)/\partial P| > |\partial D_d(P)/\partial P|$ , and  $\partial P/\partial n < 0$ . Thus,  $\partial ES_f(P)/\partial n < 0$ .

both domestic firms and foreign firms sell in their home markets without cross-hauling results in the highest profits for each firm. However, domestic firms have strong incentives to export to the foreign market because that strategy directs more profits to home firms. Since this also is true for foreign firms, the strategic choice of firms collapses into the prisoner's dilemma game in which dominant strategies for both domestic firms and foreign firms are participating in trade. In a nutshell, intra-industry trade in identical products becomes a viable equilibrium when firms are in an international oligopoly situation as shown in Brander and in Brander and Krugman.

At equilibrium, the profit of firm  $i$  becomes

$$(7) \quad \pi_{d_i}^* = [P(Q_d + X_f) - c]q_{d_i} + [P(Q_f + X_d) - c]x_{d_i} - F$$

where,  $X_d$  and  $X_f$  denote total export of domestic firms to the foreign market, and total export of foreign firms to the domestic market, respectively.

Trade flows of the product in this case can be shown by examining a country's share of world market as in Helpman and Krugman. If there are  $n_d$  firms in the home market and  $n_f$  in the foreign market, symmetric equilibrium leads to identical output for each firm. A firm's share of the world becomes  $1/(n_d + n_f)$ . The domestic firms' aggregate share of the combined market is  $S_d = n_d/(n_d + n_f)$  and the foreign firms' aggregate share is  $S_f = n_f/(n_d + n_f)$ . Then, net exports of the home country ( $NX_d$ ) is expressed as:

$$(8) \quad NX_d = (S_c - S_f)(D_d + D_f)$$

where  $D_d$  and  $D_f$  denote domestic and foreign demand, respectively. From this, we can easily see that a country's net exports are an increasing function of the number of domestic firms if the number of foreign firms are fixed and  $\alpha > 0$  ( $\partial NX_d / \partial n_d > 0$ ).<sup>8</sup>

In short, we derive the proposition that market power associated with industry concentration has a dampening effect on net exports of the home country in the case of homogeneous goods. However, the theoretical prediction is sensitive to the shape of excess demand and excess supply curves that domestic producers face. If they are perfectly elastic as in the small country case, the effect of domestic competition is different. Furthermore, the assumption of firm behavior plays an important role in deriving the proposition. If firms behave competitively regardless of market structure (Bertrand's assumption), domestic industry concentration does not affect trade flow.

#### *Differentiated Good Case*

When products are differentiated, it is argued that this tends to encourage intra-industry trade (Krugman; Lancaster, 1980; Helpman; Helpman and Krugman). Firms in two different countries, for example, will produce different varieties of a product and then achieve product variety through trade.<sup>9</sup> At equilibrium under free trade, each variety of a differentiated good will

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<sup>8</sup> This comparative static holds even when we relax some assumptions. If marginal costs are different across countries, firms in the country with lower marginal costs have larger net exports. In addition, if transportation costs are small enough to allow trade, intra-industry trade across two identical countries would still be a plausible outcome of the model. The existence of transportation costs allows the market share of home firms to increase and those of foreign firms to decrease. Nevertheless, the effect on net exports of the number of domestic firms does not change in both cases.

<sup>9</sup> Autarky equilibrium before trade is, in most cases, characterized by a monopolistic competition model which assumes each firm produces only one product variety and has zero profit. Consumer preferences are specified on the Lancasterian product attribute space or using the Chamberlinian representative consumer model.

be produced in only one of the countries, while all varieties are consumed in both countries. With intra-industry trade in the differentiated good sector, consumers in both countries benefit from the increased number of varieties available and from the price decrease resulting from economies of scale.<sup>10</sup>

To see the effect of product variety on trade flows, assume first that the number of varieties offered in the market is exogenously fixed at  $n_d$  in the home country and at  $n_f$  in the foreign country. Although the equilibrium number of varieties are determined by the size of the country, cost conditions, consumer preferences, and the zero profit condition in the monopolistic competition model, it is widely argued that firms' provision of varieties is partly conditioned by market environments, such as the degree of firm rivalry, entry conditions, government regulations, and so on. Under free trade, both the home and foreign countries consume all the varieties available in the world market,  $n_d + n_f$ . For the home country,  $n_d$  varieties are produced at home and  $n_f$  varieties are imported from the foreign country. The home country, however, can consume only a part of total world production. Denoting  $x(x^*)$  as output of each firm in the home country (foreign) country, net exports of the home country can be expressed as

$$(9) \quad NX_d = (1 - s)n_d x - s n_f x^*$$

where  $s$  represents the share of world income accounted for by the home country. This expression clearly implies that net exports of a country is an increasing function of the number

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<sup>10</sup> Lancaster (1984) demonstrated the effects of free trade using a numerical example. A formal proof for the existence of gains from trade under reasonable assumptions is found in Helpman and Krugman (pp. 183-87).



of varieties produced in that country, other things being equal. The intuition behind this proposition is straightforward. If consumer preferences are specified on the Lancasterian characteristics space, more varieties imply that the preference spectrum is packed more densely with slightly differentiated products, so that the varieties offered in the market are more likely to fit any consumer's ideal variety. Hence, a country offering more varieties may have higher shares in the foreign market as well as in the domestic market if consumers in both countries have identical preferences and if all varieties are equal in share.<sup>11</sup>

Literature on product differentiation and R&D suggests that product variety or diversity is influenced by market structure. A plausible case can be made that a monopolist has incentives to provide fewer varieties than do competitive.<sup>12</sup> Since varieties of a product are only partially substitutable, producing more varieties increases the total revenue of the monopolist but may reduce its profits if costs increase more rapidly than revenues. Product diversity depends upon new product development. Product diversity in an industry and country might be enhanced if its firms develop new products containing attributes not present in existing varieties. Studies of R & D indicate that a more rivalrous market structure stimulates innovation activities and shortens the introduction time of new products (Sherer; Lee and Wilde; and Reinganum). It is

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<sup>11</sup> If the number of firms is fixed in the monopolistic model, firms can have positive profits. A country having higher profits will consume more and its trade performance may be worsened. While this point is addressed by Helpman and Krugman, it is ignored in the current framework.

<sup>12</sup> There is also an argument that oligopolistic market structure tends to produce more varieties than any other market structures. Some previous research suggests that the relationship between R&D and market structure is curvilinear, implying that moderately concentrated industries have the greatest efforts of innovation (Sherer; Mueller et al.). We expect a negative linear relationship because of the absence of unconcentrated industries in our data set.

therefore expected that neither monopolies nor atomistic industries are ideal for product diversity. Atomistic food manufacturing industries are rare; most are oligopolies of at least moderate concentration. Thus, for our data set, we hypothesize a negative relationship between industry concentration and product diversity.

From the above arguments, we also expect that industry concentration in the domestic market is negatively related to net exports in the case of differentiated products.

#### Data on the Global Performance of U.S. Food Manufacturing Industries

U.S. net export share was calculated from U.S. exports, imports, and world total trade, which are reported in U.N. D-series trade data.<sup>13</sup> The food processing industries in this study are basically four-digit SIC 20 industries. Since some SIC 20 industries do not have comparable trade data, thirty-two industries are used in the analysis. In order to aggregate trade data four digit industry level, the Standard International Trade Classification (SITC) system was matched to the U.S. Census SIC numbering systems.<sup>14</sup>

In the aggregate, U.S. *net exports* of 32 processed food categories accounted for a negative 3.5 percent of the 1967 world trade of these industries, a positive 0.5 percent of 1977 world trade, and a negative 4.2 percent of 1987 world trade (Table 1). The net export shares of individual industries were relatively stable for the period, 1967-1987 (Figure 1). The industries having net export shares over +10 percent (exports substantially exceeded imports) were poultry products (2015), dried vegetables and fruits (2034), flour milling (2041S), rice milling (2044), wet corn milling (2046), cereal breakfast foods (2043), soybean oil milling (2075), and animal

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<sup>13</sup> The "world" in this case consists of the countries reported in the U.N. data tape.

<sup>14</sup> For some industries in which SITC is more aggregated than SIC, two or three related SICs are combined to match SITC. For those industries, SIC code is followed by S.

and marine oils (2077). On the other hand, processed meats (2013), refined sugar (2060S), confectionery products (2064S), beer (2082), distilled liquor (2084), and wine and brandy (2085) had net export shares less than -10 percent. In these industries, imports into the U.S. substantially exceeded exports. In general, it appears that the U.S. has strong trade performance in the undifferentiated good industries in which the degree of processing is relatively low, and has negative net exports in the highly differentiated good industries. However, it is important to bear in mind that net export share might be a misleading indicator of competitiveness for industries in which governmental trade distortions are substantial.

The globalization of business encourages us to also consider outbound FDI when measuring global performance. Some industries operate production facilities in foreign countries for a variety of reasons, such as avoiding trade barriers, transaction costs associated with direct export, and the utilization of abundant/inexpensive resources in host countries. Many U.S. food manufacturing companies have substantial levels of FDI. In the aggregate, sales from the foreign subsidiaries of U.S. food processors are roughly three times the size of manufactured food exports from the U.S.<sup>15</sup> However, information on foreign sales and operations are generally not available for four-digit SIC industries. In addition, it is impossible to distinguish between FDI that reflects the competitive success of the home country and FDI that occurs

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<sup>15</sup> In 1987, sales of foreign subsidiaries of U.S. food manufacturers, in the aggregate, accounted for 13.2 percent of total sales, while exports were only 4.1 percent of U.S. value of shipment (*U.S. Direct Investment Abroad: Revised 1987 Estimates and Census of Manufactures*).

because the home country is not competitive. We therefore are severely limited in the extent to which we can analyze FDI.<sup>16</sup>

### Empirical Model: Variables and Related Hypotheses

The empirical analysis relates net export share (NXS) as the dependent variable to various industrial organization, comparative advantage and control variables. While several of the variables in the empirical model flow directly from our theoretical models, other variables are included as control variables to adjust for measurement problems, or because of their significance in previous empirical work.

The degree of domestic competition is represented by seller CR4 in the empirical model. Capital intensity and the competitiveness of raw material are included to be able to assess the influence of comparative advantage. R & D intensity, advertising intensity, shipment distance, and minimum efficient plant size (MES) are variables representing various industrial characteristics, such as innovativeness, product differentiation, characteristics of products, and technology. In addition, a foreign direct investment variable is included as an explanatory variable to examine the relationship between FDI and net exports.

Finally, since three years of data were pooled (1967, 1977, and 1987), dummy variables are included for the years of 1977 and 1987.

The empirical model is specified in a linear form as:

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<sup>16</sup> For example, since FDI sometimes occurs because of the locational and/or resource advantages of host countries, FDI can reflect the lack of competitiveness of the home country. In other instances, FDI reflects the competitive advantages of parent firms. Empirically, it is impossible to sort out various types of FDI from the published data.

$$(10) \quad \begin{aligned} \sqrt{XS} = & \beta_0 + \beta_1 K/L + \beta_2 RAW + \beta_3 MDS + \beta_4 YD77 + \beta_5 YD87 + \beta_6 FDI + \beta_7 CF \\ & + \beta_8 AS + \beta_9 RD + \beta_{10} MES. \end{aligned}$$

Construction of explanatory variables and related hypotheses are as follows:

*Four-Firm Concentration (CR)*: Since markets for processed foods are mostly national or regional, it appears that Census CR4 figures are appropriate proxies for the degree of competition in most U.S. food manufacturing industries.<sup>17</sup> The variable is constructed as the weighted average of product class CR4 and expected to have a negative sign. Data were from the *Census of Manufactures* for the three years.

*Capital-Labor Ratio (K/L)*: According to the Heckscher-Ohlin theorem, this variable is expected to have positive signs. For this variable, net assets are divided by the number of employees in the industry based upon data from the *Census of Manufactures*.

*Competitiveness of Raw Material (RAW)*: The trade performance of processed foods depends to some extent on the relative cost of agricultural commodities used as inputs. This variable reflects both the importance of agricultural inputs to different food industries and the relative competitiveness of the U.S. in the production of those agricultural inputs.

This variable is measured by the product of agricultural inputs' share of shipment value and the trade performance of related agricultural products. The share is obtained from 1982

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<sup>17</sup> The average shipment distance of most food manufacturing industries is about 300 miles (Connor, 1982), and the minimum efficient size plant is generally less than 5 percent of domestic shipment (Culbertson and Morrison, quoted from Connor et al., 1984, pp. 154-56). In addition, the magnitude of exports and imports in food manufacturing industries gives no indication that these are global markets. Exports and imports averaged 4.1 and 5.8 percent, respectively, of domestic shipments of U.S. food manufacturers in 1987.

*Benchmark Input-Output Account of the United States*, and the trade performance is measured by U.S. net exports as percentages of U.S. total trade (exports+imports) of related agricultural commodities. Trade performance equals +1 when exports exceed imports and a -1 when imports exceed exports for the related agricultural commodities. Trade data are taken from *Foreign Agricultural Trade in the United States* (FATUS). The variable is expected to be positively related to NXS.

*Mean Distance of Shipment* (MDS): International trade is restricted if the geographic extent of the market is local. However, the impact of shipment distance on net exports has no clear expected sign since both imports and exports would be affected. Shipment distances for four digit SIC are based on estimates of Connor.

*Yearly Dummies* (YD77 and YD87): These dummy variables are included to capture the effect of changes in macro-economic variables. The changes from 1967 are reflected in the intercepts for 1977 and 1987.

*Foreign Direct Investment* (FDI): Exports and outbound FDI can be hypothesized as either substitutes or complements. Since competitive firms may sell their products through either direct exporting or FDI, the expected relationship of FDI to net export share (NXS) is ambiguous. Constructed as a dummy variable, this variable is one when an industry has "significant" direct investment abroad, and zero otherwise.<sup>18</sup>

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<sup>18</sup> Information on foreign subsidiaries of individual firms were collected from various sources such as firm data compiled by the Economic Research Service, USDA, company annual reports, trade publications, and *Moody's Industrial Manual*. Determining what was "significant" FDI was a judgement call by the researchers.

*Advertising Intensity (AS)*: In processed food products, advertising is often used to create perceived product differentiation. Since advertising is largely specific to national culture, its effect on trade performance is unclear. However, advertising intensity does provide a proxy for the presence or absence of strong brands. Previous empirical studies have reported inconsistent signs on advertising variables (Caves; Lyons; Koo and Martin; Glejser et al.). Hence, no clear prior signs are expected. This variable is measured by advertising expenditures as a percent of sales in the U.S. for 1967, 1977, and 1987. The data were provided by Richard Rogers, University of Massachusetts, who aggregated advertising data from *Leading National Advertisers*.

*R & D Intensity (RD)*: Since U.S. food processing firms direct a large portion of R&D expenditures to new product development, R&D intensity might reflect the degree of an industry's product diversity. Since trade performance is expected to be positively related to the degree of product variety, a positive sign is hypothesized for R&D. This variable is represented by R&D expenditures divided by total sales; data were obtained from Federal Trade Commission, *Statistical Report: Annual Line of Business Report 1977*.

*Minimum Efficient Size of Plant (MES)*: The minimum efficient size plant was measured by the median size of plant in the industry as a percent of total industry output. This variable, however, does not have a hypothesized sign since international trade has market expansion effects which allow firms in small countries to realize scale economies. Culbertson and Morrison data (reported in Connor et al.) for 1972 were used for all three years.

### Estimation Results

The empirical model is estimated using the least square (LS) method. Parameter estimates for two specifications based upon four different samples are reported in Table 2. Equations A-1 and A-2 report results based upon the full sample of 32 food manufacturing industries. Equations B-1 and B-2 were estimated from a sample without local market industries. The relevant geographic markets of fluid milk (2026), prepared feeds (2048S), bakery products (2050S), soft drink bottling (2086), and manufactured ice (2097) are local since their shipment distances are extraordinarily small (Connor). Because these industries do not lend themselves to trade, net export share is often not a reliable measure of their global performance. The sample without local market industries is therefore a somewhat cleaner one. The regression results were also somewhat stronger.

The last two samples (C and D) are based upon the degree of product differentiation. If advertising expenditures in an industry are less than 1 percent of sales, that industry is classified as a homogenous good industry. Differentiated good industries had advertising expenditures that were equal to and greater than 1 percent of sales.

Some researchers argue that seller concentration is determined endogenously in the model and should be estimated using Two Stage Least Square (2SLS) or Three Stage Least Square (3SLS) methods. To see if this is true, exogeneity of CR is tested by the Wu-Hausman test. The test statistic is less than the critical value (17.3 in equation 1 and 13.4 in equation 2 at the 10 percent level) in every equation. Hence endogeneity of CR is not a problem in the current estimation.



The major explanatory variable of interest, seller concentration, is negative and significant in all equations except in the differentiated good industry sample. CR is more significant when AS, RD, MES are excluded from the full specification. As expected, the level of significance is greater in the sample without local market industries than in the full sample. Interestingly, while CR is negative and significant in the homogenous good industries, it is positive and insignificant in the differentiated good industries. These results suggest that domestic seller concentration has negative influence on global market performance in the homogenous good case, but has negligible effects in the case of differentiated goods.

A Heckscher-Ohlin determinant, capital-labor ratio ( $K/L$ ) is not significant in the samples of all industries. On the other hand, the competitiveness of raw agricultural commodities is the strongest and most consistent explanatory variable. The results suggest that U.S. trade performance of processed foods are strongly dependent on the competitiveness of the U.S. produced agricultural commodities used as inputs.

When the sample is divided into homogenous and differentiated good industries, the impact of comparative advantage variables changes. While capital intensity ( $K/L$ ) and the competitiveness of raw material is positively related to net exports in the case of homogenous goods, they do not play a major role in the case of differentiated goods. Apparently resource endowments and the cost advantages of raw agricultural commodities are not important determinants of trade performance in the case of differentiated products.

Shipment distance (MDS) is positive and significant in the equations for samples B and C. However, the results are heavily dependent on one industry.<sup>19</sup> The dummy variables representing 1977 and 1987 have insignificant parameter estimates, implying that no significant changes occurred in net export shares across years. Although the 1987 dummy is consistently negative, it is not significant.

In the samples of all food manufacturing industries, the degree of foreign direct investment had a significant positive relationship to net exports. The results imply that exports and outbound FDI are complements rather than substitutes in the case of U.S. food manufacturing industries. In wet corn milling, soybean crushing, breakfast cereal, and canned specialty industries, the U.S. had both strong trade performance and significant investments abroad.

The two variables measuring product variety and/or product differentiation show contradictory results. Advertising to sales ratio (AS), which represents promotional or perceptual differentiation, had negative and highly significant coefficients in all four samples. U.S. industries that advertised heavily in the U.S. had relatively weak trade performance.<sup>20</sup> This implies that advertising is country specific and does not spill over to other countries. On the other hand, research and development intensity (RD), which is used as a proxy for new product development, had positive coefficients. R & D was significant only in the differentiated good

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<sup>19</sup> The United States has higher net exports of products with large geographic markets and low net exports of products that have relatively small markets. Particularly, the U.S. is competitive in dried vegetables and fruits (2034) whose distance of shipment is very great. If this industry is dropped from the sample, MDS becomes insignificant in all equations.

<sup>20</sup> This result is largely attributable to the beer and liquor industries which had huge advertising expenditures but large trade deficits.

sample, implying that research and development is an important determinant of global performance of these industries.

As expected, minimum efficient size plant (MES) has insignificant coefficients in all equations. This provides empirical evidence that scale economies are not an important factor in the trade performance of food manufacturing industries.

The model is also estimated using two alternative dependent variables: U.S. export share of world exports, and U.S. import share of world exports (results not shown). While the export equations show similar results to the models with net export shares, the import equations have sharply different results, as might be expected. While the coefficients on seller concentration are negative in the export equations, they are significantly positive in the import equations.<sup>21</sup> The results suggest that higher concentration may have a stronger effect on encouraging imports than on hindering exports in the case of U.S. food manufacturing industries.

The empirical models are also estimated using bilateral trade data. The results of bilateral trade models have similar sign patterns to the original models, but smaller explanatory power (Table 3). US - EC, US - Canada, and US - Japan pairs are used since trade with these countries has accounted for large proportions of U.S. processed food trade. Industry concentration is negative in all pairs and significant in two of three equations (US-EC, and US-Japan pairs). Besides the industrial characteristics variables, the bilateral trade models include a trade impediment variable (TI).<sup>22</sup> Interestingly, trade impediment has significantly positive

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<sup>21</sup> The results of some variations in the basic model are not reported due to the space limit. They are available from the authors upon request.

<sup>22</sup> TI is assigned a value of one for the industries where a trade partner country impedes imports from the U.S.; otherwise it is zero. The trade impediment data were obtained from the U.S. Department of Agriculture, Foreign Agricultural Service, *Trade Policies*

coefficients in the US-EC and US-Canada models. Apparently, trade barriers in Canada and EC are highest for those food manufacturing industries in which the U.S. has a competitive advantage.<sup>23</sup> Absent trade impediments, the net exports for these industries might be even more favorable to the U.S.

### Summary and Conclusions

In general, the theoretical and empirical results of this research are consistent with Porter's hypothesis that domestic market competition is positively related to success in global markets. In the empirical estimation based upon 32 U.S. food manufacturing industries, seller concentration, measured by CR4, was negatively and significantly related to the net export share of those industries. The negative relationship holds through several models and sub-samples. Industry concentration was found to have a strong negative effect in homogenous goods industries and to have an insignificant effect in differentiated good industries.

Cross-sectional regression analysis also indicates that the trade performance of U.S. food manufacturing industries are positively and strongly related to the competitiveness of raw agricultural inputs and R&D. Thus, in addition to supporting Porter's hypothesis, the results also support the importance of comparative advantage and innovativeness.

In bilateral models, the variables representing the trade impediments of trade partners are positively related to U.S. net exports. Hence, the elimination of such trade barriers may benefit those industries already enjoying positive net exports. Unfortunately, in multilateral trade models it is difficult to include trade policy variables.

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*and Market Opportunities for U.S. Farm Exports.*

<sup>23</sup> Trade impediments were more numerous in Japan (13 of 32 industries) than in EC (10 industries) or Canada (5 industries).

Although the results of this research generally support Porter's hypothesis, we are mindful of the limitation of our work. We have measured the intensity of domestic competition by the concentration ratio for the U.S., recognizing that conceptually we would prefer to have a measure that compares the structure of an industry in the U.S. with its structure in other countries. For example, a concentrated oligopoly may perform well if it is competing in an international market of national monopolies. But data are simply not available to measure "relative" structure.

In addition, we are mindful of the relative importance of Foreign Direct Investment and licensing, both means of operating in global markets, that are not captured in trade data. Case studies of individual industries have demonstrated to us the enormous complexity of global markets and performance. We recognize that there is a good bit going on "behind the numbers" that our models have been unable to capture.

But--given these caveats, we believe our results make sense and have important policy implications. Porter's hypothesis and our empirical results are consistent with much that we have learned during the last 15 years as a result of privatizing markets, deregulation of industries, the consequences of cartels or conspiracies, the impact of major import competition, and many empirical studies of concentration-price relations: a lack of competition often results in bloated costs, inefficient use of resources, higher prices, slowness in innovation and lethargy in responding to customer demand. Protected industries/markets benefit no one in the long-run.

It makes sense that this lesson holds in global markets. Firms that encounter tough competition in their home markets are like athletes who compete against the top athlete in their sports. Their abilities grow as the level of competition increases.

Yet--there are some who argue that U.S. companies need to be allowed to consolidate and cooperate in order to be more successful in global markets. According to this view, antitrust laws should be abandoned for the sake of international competitiveness. The results of this research provide no comfort for this point of view. Our results point in the opposite direction: vigorously enforce the antitrust laws to maintain effectively competitive industries.

Table 1. Measures of Global Performance, 32 U.S. Food Manufacturing Industries, 1967, 1977, and 1987

Industry Code and Name	Net Export Share		
	1967	1977	1987
2011S (fresh and frozen meats)	-0.083	0.034	0.037
2013S (Sausages, other prepared meats)	-0.215	-0.191	-0.180
2015 (poultry processing)	0.165	0.160	0.143
2021 (creamy butter)	0.003	0.002	0.004
2022 (cheese)	-0.107	-0.083	-0.072
2023 (dry, condensed, evaporated milk)	0.107	0.037	0.046
2026 (fluid milk)	-0.077	-0.007	-0.003
2032 (canned specialties)	0.024	0.001	-0.031
2033S (canned or frozen fruits and vegetables)	0.095	0.051	-0.134
2034 (dry fruits and vegetables)	0.193	0.172	0.116
2035 (pickles, sauces, salad dressings)	0.083	0.053	-0.383
2041S (flour and flour products)	0.186	0.164	0.111
2043 (cereal breakfast foods)	0.195	0.122	0.107
2044 (rice milling products)	0.137	0.143	0.124
2046 (wet corn milling products)	0.172	0.314	0.523
2048S (prepared feeds and pet foods)	-0.062	0.055	0.038
2050S (bakery products, including cookies and crackers)	0.048	0.028	-0.103
2060S (refined sugar)	-0.561	-0.300	-0.136
2064S (confectionery products)	-0.115	-0.155	-0.144
2068 (salted and roasted nuts)	0.159	0.097	-0.100
2074S (other vegetable oil mill products)	-0.090	-0.103	-0.076
2075 (soybean oil mill products)	0.387	0.268	0.230
2077 (animal and marine fats and oils)	0.369	0.433	0.321
2079 (edible fats and oils)	0.063	0.076	0.032
2082 (malt beverages)	-0.162	-0.227	-0.476
2083 (malt)	0.020	-0.004	-0.001
2084 (wines, brandy)	-0.152	-0.155	-0.1782
2085 (distilled and blended liquors)	-0.564	-0.330	-0.280
2086 (soft drinks)	0.079	0.109	-0.047
2095 (roasted coffee)	-0.308	-0.306	-0.115
2097 (manufactured ice)	0.007	0.055	-0.219
2098 (macaroni and spaghetti)	-0.102	-0.104	-0.159
Average	-0.003	0.013	-0.031
Weighted Average	-0.035	0.005	-0.042

Source: U.N. trade data.

**Table 2. Least Square Regression Results Explaining Net Export Share, U.S. Food Manufacturing Industries, 1967, 1977 and 1987<sup>1</sup>.**

Variable	Full Sample		Sample without Local Market Industries		Homogenous Good Industry Sample		Differentiated Good Industry Sample	
	Eq. A-1	Eq. A-2	Eq. B-1	Eq. B-2	Eq. C-1	Eq. C-2	Eq. D-1	Eq. D-2
K/L	0.0003 (0.0004)	0.0004 (0.0003)	0.0004 (0.0004)	0.0006 (0.0004)	0.0008* (0.0004)	0.001* (0.0004)	-0.002* (0.0009)	-0.002* (0.001)
RAW	0.297** (0.063)	0.325** (0.061)	0.320** (0.069)	0.341** (0.066)	0.304** (0.055)	0.323** (0.056)	-0.430 (0.296)	0.395 (0.248)
MDS	0.126 (0.081)	0.094 (0.078)	0.203* (0.102)	0.168* (0.099)	0.195* (0.097)	0.229* (0.100)	0.202 (0.156)	0.023 (0.192)
YD77	0.0001 (0.041)	0.013 (0.042)	0.0009 (0.046)	0.012 (0.046)	-0.003 (0.047)	0.010 (0.048)	-0.038 (0.067)	0.019 (0.084)
YD87	-0.038 (0.050)	-0.032 (0.050)	-0.004 (0.057)	-0.007 (0.057)	-0.016 (0.059)	-0.004 (0.059)	-0.006 (0.096)	0.080 (0.118)
FDI	0.078* (0.041)	0.102* (0.040)	0.083* (0.048)	0.108* (0.044)	-0.014 (0.061)	0.082* (0.044)	-0.197* (0.080)	0.021 (0.086)
CR	-0.213 (0.148)	-0.273* (0.127)	-0.351* (0.206)	-0.431** (0.165)	-0.432* (0.253)	-0.643** (0.200)	0.255 (0.279)	0.258 (0.305)
AS	-0.020** (0.007)		-0.019* (0.009)		-0.056* (0.024)		-0.038* (0.014)	
RD	0.152 (0.095)		0.144 (0.111)		0.429 (0.185)		0.892** (0.263)	
MES	0.0002 (0.008)		0.005 (0.009)		-0.017 (0.012)		0.022 (0.026)	
Intercept	-0.026 (0.066)	0.016 (0.063)	-0.024 (0.097)	0.042 (0.084)	0.034 (0.109)	0.115 (0.101)	-0.464 (0.193)	-0.149 (0.177)
Size of Sample	96	96	81	81	48	48	33	33
R <sup>2</sup>	0.389	0.333	0.423	0.374	0.692	0.636	0.644	0.249
Wu-Hausman Test Statistic	1.75	1.85	1.81	1.79	0.15	2.06	0.827	0.028

<sup>1</sup> Full sample includes all thirty-two industries for the estimation. Sample without local market industries excludes such industries as fluid milk, prepared feeds, bakery products, soft drinks, and manufactured ice from the sample. Homogenous good industries are classified as industries whose advertising expenditures are less than 1 percent of sales. Differentiated good industries are industries whose advertising expenditures are equal to and more than 1 percent of sales.

\*\*,\* represent the significance levels at 1 and 10 percent, respectively.



**Table 3. Regression Results for Bilateral Trade Flows with E.C., Canada, and Japan, Local Market Industries Omitted<sup>1</sup>.**

Variable	Dependent Variables		
	NXSE	NXSC	NXSJ
K/L	0.0002 (0.002)	-0.0003 (0.002)	0.0007 (0.001)
RAW	0.157 (0.331)	0.021 (0.276)	-0.116 (0.227)
MDS	0.078 (0.466)	0.0004 (0.469)	-0.440 (0.334)
YD77	0.078 (0.212)	-0.148 (0.179)	-0.078 (0.153)
YD87	0.086 (0.268)	0.261 (0.224)	-0.064 (0.194)
FDI	0.250 (0.219)	0.148 (0.180)	0.160 (0.157)
CR	-1.673* (0.959)	-0.687 (0.797)	-1.956** (0.687)
AS	-0.025 (0.040)	0.012 (0.033)	0.037 (0.028)
RD	0.006 (0.519)	-0.544 (0.433)	-0.058 (0.371)
MES	0.123** (0.041)	0.048 (0.034)	0.064* (0.029)
TI <sup>2</sup>	0.689** (0.200)	0.715** (0.251)	0.174 (0.139)
Intercept	0.109 (0.458)	0.445 (0.395)	1.481* (0.332)
R <sup>2</sup>	0.286	0.251	0.186

<sup>1</sup> Dependent variables are defined as follows: NXSE = U.S. net export share of U.S. - E.C. trade, NXSC = U.S. net export share of U.S. - Canada trade, NXSJ = U.S. net export share of U.S. - Japan trade.

<sup>2</sup> TI stands for trade impediment of trade partners.

\*\*,\* represent the significance levels at 1 and 10 percent, respectively.

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