NBER WORKING PAPER SERIES

MARKET STRUCTURE AND INTERNATIONAL TRADE: BUSINESS GROUPS IN EAST ASIA

Robert C. Feenstra
Tzu-Han Yang
Gary G. Hamilton

Working Paper No. 4536

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November, 1993

The research on this paper has been supported by the Pacific Rim Business and Development Program (PACBAD) at the Institute of Governmental Affairs, University of California, Davis. Financial support from the Ford Foundation is gratefully acknowledged. This paper is part of NBER's research program in International Trade and Investment. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #4536
November 1993

MARKET STRUCTURE AND INTERNATIONAL TRADE: BUSINESS GROUPS IN EAST ASIA

ABSTRACT

In this paper we study the effect of market structure on the trade performance of South Korea, Taiwan, and Japan. We center our analysis on Korea and Taiwan, countries which have very different market structures: Korea has many large, vertically-integrated business groups known as *chaebol*, whereas business groups in Taiwan are smaller and horizontally-integrated in the production of intermediate inputs. The exports of these countries to the United States are compared using indexes of product variety and "product mix", which are constructed at the 5-digit industry level. It is found that Taiwan tends to export a greater variety of products to the U.S. than Korea, and this holds across nearly all industries. In addition, Taiwan exports relatively more high-priced intermediate inputs, whereas Korea exports relatively more high-priced final goods. We argue that these results confirm the importance of market structure as a determinant of trade patterns.

Robert C. Feenstra
Department of Economics
University of California - Davis
Davis, CA 95616-8578
and NBER

Tzu-Han Yang
Council for Economic Planning and Development
Executive Yuan, TAIWAN R.O.C.

Gary G. Hamilton
Department of Sociology
University of California - Davis
Davis, CA 95616-8578

1. Introduction

Since the early 1980's, imperfectly competitive market structures have been incorporated into theories of international trade.[1] These new theories were motivated by empirical observations such as the large amount of "intra-industry" or two-way trade in similar products between countries, and relied on the development of tractable models of monopolistic competitior It is now common to incorporate intra-industry trade, due to monopolistic competition, into the specification of equations explaining trade flows. However, it can be argued that these estimating equations depend to a rather limited extent on the market structure. For example, Helpman (1987) notes that his specification of trade volume equations consistent with monopolistic competition *also* applies when countries are specialized in different products *for any other reason*.[2] In other words, these empirical methods that incorporate intra-industry trade do not directly test the importance of market structure.[3]

Market structure has also been a focus of current research in sociology dealing with the "network" structure of modern economies (see the survey by Powell, 1990). A network refers to linkages among firms arising from relationships based upon common ownership, shared production or distribution of a commodity, or shared fiscal control, such as through a holding company or bank. For example, a production network represents the firms linked together, from the early to final stages of production, to produce a finished product; a distribution network would trace the firms that take the product to the final consumers.

Particular attention has been paid to the differences among network structures within the rapidly developing countries in East and Southeast Asia, as well as the differences between these countries and other parts of the world.[4] It has been found that business networks in Japan and South Korea consist of interlinkages among many sizes of firms, with the larger firms integrating and coordinating the activities of the smaller firms in the production and distribution of many major commodities. The largest firms, in turn, are connected through common ownership. By contrast, production networks in Chinese areas, such as in Taiwan and Hong Kong, typically consist of close linkages among similarly sized, mostly small and middle-sized, independently owned firms. These production networks rely, at an arm's length, on other firms and other networks to supply inputs and to distribute products.

Although these sociological studies have been reasonably effective at documenting the differences among networks across countries, they have not demonstrated that these networks have any direct economic impact, such as on international trade. In this paper we propose to combine the sociological data on networks with economic hypotheses about the performance of firms, in order to demonstrate that market structure indeed has a significant economic impact on international trade.

We shall focus on one particular type of network - the common ownership of firms within a "business group" - and contrast the influence of these groups on the trade performance of South Korea, Taiwan, and Japan. We will center our analysis on Korea and Taiwan, countries which have very different market structures. Korea has many large, vertically-integrated business groups known as *chaebol*, whereas business groups in Taiwan are smaller and horizontally-integrated in the production of intermediate inputs, but do not participate in the production or distribution of final products. Because the two countries are at roughly similar stages of development (measured by per-capita GNP), the sharp difference in the market structures between these two economies are ideal for a comparative study (as also conducted by Levy, 1991, and Rodrik, 1993). Since the *keiretsu* are so well-known, we shall also include Japanese business networks in our analysis.[5] Including Japan allows us, moreover, to contrast the trade performance of a more developed economy with that of developing economies.

In section 2, we describe the business groups in the three countries more carefully. In section 3, we use this information to construct a stylized model of business groups and trade performance. The essential features of the model are that new intermediate inputs can be created to enhance the productivity of downstream purchasers. The business groups in Korea are treated as vertically integrated, i.e. they supply some of their own inputs, whereas the firms in Taiwan purchase all inputs from non-affiliated firms. The model suggests that the production of final goods in Korea is subject to increasing returns to scale within a group, so that firms will choose to focus production on a narrow *range* of products, but at a potentially high *volume*. In contrast, firms in the stylized Taiwan economy will produce a greater range of product varieties.

In section 4 we consider how to empirically test the hypotheses from the stylized model. The data used are U.S. imports of highly disaggregate products from Korea, Taiwan and Japan. Using the techniques from Feenstra (1993), indexes of product variety are constructed at the 5-digit industry level to reflect the range of products sold from each country. In addition, "product mix" indexes are constructed to reflect whether each country tends to export high-priced or low-priced products within each 5-digit category. We show that both indexes can be theoretically interpreted as a measure of consumption services provided by the imports.

Our results are presented in section 5. We find that Taiwan tends to export a greater variety of products to the U.S. than Korea, and this holds across nearly all industries. In addition, Taiwan has a higher product mix in industries producing intermediate inputs, whereas Korea has a higher product mix in the final goods industries. This results are discussed in relation to the theoretical hypotheses, and in relation to the business group structure of the two economies. We argue that the results confirm the importance of market structure as a determinant of trade patterns. A comparison with the Japanese trade pattern is presented, and our conclusions are summarized in section 6.

2. Business Groups in East Asia

2.1 Descriptions of the Groups

One of the most important features of Korea's industrial organization is the business groups, or *chaebol*.[6] These groups, consisting of legally-independent firms, are affiliated under a common group name and are centrally controlled through direct family ownership and mutual shareholding among member firms. As shown in Table 1, the 50 largest business groups accounted for 45% of total sales in the manufacturing sector in 1983, and even more in other sectors. These sales figures give an inflated estimate of the importance of the *chaebol*, however, because transactions of semi-finished goods between firms within a group are included. In Table 1, the figures in parentheses give the *value-added* shares accounted for by the business groups within each sector, and these figures are not affected by the frequency of intra-group transactions.[7] Overall, the value-added of the top 50 business groups accounted for one-fifth of GDP in 1983 (Zeile, 1991).

In the manufacturing sector, the *chaebol* spread across many industries. As shown in Table 2, there were five manufacturing industries in which the *chaebol* accounted for more than 50% of the total sales, and eight others in which they accounted for between 25 and 50%. Many of these are chemical or heavy industries. This pattern of concentration is a direct result of the government's credit policy. During the 1970s, the Korean government applied discriminatory interest rates and controlled both domestic and foreign loans in order to influence industrial development. It supplied a large amount of credit with low interest rates to business groups for investment in the heavy and chemical industries, with the result that these industries and groups grew rapidly.

In general, the *chaebol* are strongly vertically-integrated. They internalize many of the production processes (from raw materials to final products) and distribution processes (domestic and foreign trade) within the business group.[8] They form a self-sufficient system known in the Asian business literature as "the one-set principle" (Gerlach 1992, p. 85). Since the ownership and policy-making power are concentrated in the hands of only a few individuals for each group, their member firms coordinate and cooperate quite well. Transactions with non-affiliated firms are limited to those inputs that are not available internally.

In Taiwan, business groups are much less dominant in the final export sector.[9] The total sales of the 96 largest Taiwanese business groups accounts for only 19% of sales in the manufacturing sector (see Table 1). As shown in Table 2, they are influential in a smaller number of manufacturing industries, principally those producing *intermediate goods*.[10] There is only one industry - textiles - in which the group share of total sales is over 50%, and another three industries - chemical materials, non-metallic mineral products, and food products - in which they have a share between 25 and 50%.

The shares shown in parentheses in Table 2 include the sales of both business groups and enterprises owned by the state government. The state-owned enterprises are also concentrated in intermediate goods. Two out of the five industries with significant government shares - basic metal and petroleum - are obvious upstream industries. In the food industry, state-controlled enterprises mainly produce sugar, salt, and animal feeds - all raw materials. In transportation industries, the state is involved in shipbuilding and highway construction. Adding up the shares of Taiwanese business groups and state-owned enterprises in the overall economy, their dominance in intermediate goods industries is quite apparent, with the exception of fabricated metal, a category that includes both intermediate and final goods.

The smaller size of Taiwanese business groups and their nearly exclusive focus on intermediate inputs are two of the major distinctions between the Taiwanese and Korean business groups. Although both economies are heavily export oriented (Taiwan even more so than Korea), the largest business groups in each economy occupy very different structural locations: The Korean *chaebol* dominate in the export sector, and the biggest business groups in Taiwan produce intermediate goods that are sold domestically. These domestic sales are primarily to small and medium size firms that have only an "arm's length" relationship with the producers of intermediate inputs. Unlike the case in Korea, in Taiwan small and medium sized firms produce and export on their own without direct assistance from the state or from big businesses. Closer inspection of the holding of the large business groups in Taiwan shows that they typically concentrate their investments in a single core upstream business, and then diversify additional investments in unrelated areas.[11] Based on self-reported information, over 40% of Taiwan's business groups reported that none of their member firms were linked by ongoing business transactions. An additional 33% reported five or fewer routine transaction linkages among member firms.[12]

In Japan, the independent firms in intermarket business groups mutually own each other shares. For any one firm, the controlling interest is held only by the group as a whole (Orru, Hamilton, and Suzuki 1990; Gerlach 1992). Typically, individual ownership, whether through stock or through private holdings, accounts for very little of the total ownership of Japanese business groups. Most firms are publicly listed on one of Japan's large stock exchanges, but only a small percentage of the total shares are actually available for purchase. Most equity in business group firms is held by other firms in the same business group.

Structurally speaking, there are two types of business groups in Japan: one a horizontally and the second a vertically arranged network among firms (Orru, Hamilton, and Suzuki 1989; Gerlach 1992). The first type, known as "intermarket groups," or "intermarket *keiretsu*" have ownership and loan relationships that extend across unrelated industries. The major firms in these groups, along with a set of relatively autonomous, very large firms (e.g. Toyota), organize a second type of ownership network, called "*keiretsu*" or "vertical *keiretsu*." These networks illustrate the "one set" principle." They consist of interlinkages among many small, medium, and large independent firms so that inter-firm networks overlaps directly with production sequences. The activities of these production networks are coordinated by the large firms in the network. The data in Tables 1 and 2 includes the sales of the six major "intermarket" groups along with ten other *vertical keiretsu*.[13] In comparison with Korea, the Japanese business groups are more specialized across industries, and account for substantial shares of sales in intermediate industries, chemicals, machinery, electronics and transportation equipment.

2.2 Explanations for the Groups

From this brief description, it is apparent that the business groups across the East Asian countries differ quite substantially. What causes the differences in market structures among the countries? One can distinguish two principal categories of explanation: transaction costs, drawing especially on the difference in entrepreneurial talent and ties within the countries; and government support provided to the industries through various policy instruments.

The transactions cost approach seeks to explain the market structure in terms of the efficiency of making transactions in the market versus the firm. The work of Williamson (1975, 1985) and others has formalized the nature of these costs - including *ex-ante* and *ex-post* negotiation costs - and how they might differ across industries. It has also been recognized that transactions costs can differ substantially across countries, a point that Williamson (1985, p. 9) attributes to Arrow: "Arrow insisted that the problem of economic organization be located in a larger context in which the integrity of trading parties is expressly considered (1974). The efficacy of alternative modes of contracting will thus vary among cultures because of differences in trust (Arrow, 1969, p. 62)." Levy (1991) provides some evidence at this point for the Korea-Taiwan comparison.

Ex-ante contracting costs, such as the costs of collecting information and negotiating, should depend on the education level and the number of people involved in commercial activities. In education, the percentage of people in Taiwan having more than twelve or more years of education was almost triple that in Korea in both 1960 and 1970. The absolute number of this educated group was also higher in Taiwan than in Korea, even though the Korean population was more than double that of Taiwan. Furthermore, Taiwan has had a greater percentage of the total population engaged in commercial activity since before the turn of the century.[14] In addition, those engaged in independently run businesses in Taiwan constitute a higher percentage of the total number of people engaged in business. By contrast, in Korea, the percentage of employees in the total labor force, as opposed independent entrepreneurs, is much higher. From a transaction cost perspective, the higher density of those making independent commercial decisions in Taiwan facilitates the rapid dissemination of information and encourages entrepreneurship in general.

In the stage of *ex-post* contracting, the transaction costs arise from the exercise of opportunistic behavior. To compare these costs across countries, we adopt Granovetter's (1985) emphasis of the role of social relations in "generating trust and discouraging malfeasance" (p. 490). In a society with dense interpersonal networks and frequent personal interaction, having a reputation for honesty and reliability becomes an important business asset. In field interviews with Taiwanese firms, many researchers (Kao, 1991; Numazaki ,1991; Shieh, 1992; Hamilton, 1993) have found interpersonal *trust* to be the characteristic most emphasized in developing business relations. The Chinese words *xin* (trust-worthiness), *guanxi* (reciprocal personal relationships), and *renching* (human emotions) denotes the set of personal traits that informants say are evoked to create and assess reliable business associates.[15] The *guanxi* relationships are personal networks among peers, especially drawn from extended family, friends, classmates, and those from the same towns, which form the basis of many business relations. The networks generated through personal relationships are always more important for conducting business than are legal contracts (Kao, 1991; Numazaki, 1991). In contrast, in Korea the social relations are more hierarchical in nature

(Biggart, 1990), with family, friends or persons from the same region being hired as subordinates within a business group. An implication of this is that in Korea (or Japan) it would be unacceptable for an individual to leave one firm and start a competing firm, whereas this is commonplace in Taiwan, where workers will leave an enterprise to develop related products.

Thus, the differences in the type of social relation networks found in Taiwan and Korea appear to mirror the differences in the business group structures. We would be reluctant to conclude that one factor causes the other, however, and both features may reflect other underlying differences in the countries. For example, institutional differences between the countries, such as those governing kinship, inheritance, and property rights, establish parameters to social relationships that in turn shape the business strategies people use.[16] Among the Chinese, for instance, the presence of a patrilineal kinship system with partible inheritance (i.e., all sons divide the father's estates equally) means that it is difficult for a family's holding to remain under central control for more than a few generations (Wong Siu-lun, 1985). In contrast, the inheritance pattern in Korea gives a dominant share to the eldest son, who often retains control over the entire family holdings.

The transaction cost interpretation is directly related, and is complementary, to the political economy explanation for the differences in market structure among East Asian countries: market structure results from state intervention. The very active government support given the *chaebol* in the 1970s, through credit policies and other forms of industrial promotion, helps considerably to explain the market structure of the Korean economy (Amsden, 1989; Koo, 1984). State support for business groups has been demonstrated for many other countries, including Japan (Hadley, 1970; Johnson, 1982) and also Taiwan (Pang, 1992; Numazaki, 1986; Gold, 1987). This link between political and business powers is unquestionably an important factor in the development of the business groups.

3. Model of Business Groups

To develop the implications of the business groups for economic performance, we return to a feature of the Korean *chaebol:* whenever possible, inputs are obtained from firms within the group. Profit maximization for the group as a whole implies that these inputs will be supplied at marginal cost to other firms within the group. Therefore, the vertical-integration leads to an efficiency gain within the group, resulting in internal economies of scale: as output increases, more inputs can be produced within the group and sold at marginal cost, leading to reductions in the cost of producing final goods. Intuitively, we could expect these internal economies of scale to results in longer production runs over a more narrow range of output varieties. For this reason, we might expect an economy such as Korea, with the vertically-integrated groups, to produce less output varieties than a non-integrated economy, such as Taiwan. In the section, we will theoretically confirm this hypothesis in a model of monopolistic competition.

We will suppose that both final goods and intermediates inputs are produced in many varieties. While the final goods are traded, we will treat the intermediate inputs as *nontraded* internationally, as with producer services, for example. Helpman and Krugman (1985, pp. 220-222) have used such nontraded intermediate inputs to introduce the idea of "industrial complexes," in which the production of inputs and the final goods using them must occur in the same country, and we will encompass these activities within a business group. For simplicity, we do not allow for other intermediate inputs that are traded across borders.

Labor is the only primary factor, and is chosen as the numeraire, with one unit of labor producing one unit of an intermediate input. Production of any variety of the final good uses both labor and a CES aggregate of the intermediate inputs. Then the cost of producing one unit of output can be written as $\phi[c(\cdot)]$, where $c(\cdot)$ denotes the CES unit-cost function:

$$c(\cdot) = \left[\int_0^M p(z)^{1-\sigma} dz \right]^{1/(1-\sigma)} . \qquad (1)$$

and $p(z)$ is the price of an intermediate input of type z; $\sigma > 1$ is the elasticity of substitution; and $[0,M]$ is the range of intermediate inputs available to a firm (as will be specified more fully below). We also adopt a CES utility function to obtain demand for the differentiated outputs, with the elasticity of substitution $\eta > 1$.

It is useful to first solve for the equilibrium product diversity in the *absence* of any vertical-integration: we use the subscript "a" for this case. We make the standard assumption that each firm produces only a single variety of the output or input, and is therefore infinitesimally small compared to the total range of varieties. It follows that the elasticity of demand for the input varieties is σ, and for the output varieties is η. Setting marginal revenue equal to marginal cost, the price of the intermediate inputs is $p_a = \sigma/(\sigma-1)$. Substituting this into (1) we obtain the unit-costs $c_a(\cdot)$, and then the price of the output is $q_a = \eta\phi[c(\cdot)]/(\eta-1)$. Thus, the profits earned by each of these firms are:

$$\pi_{xa} = (p_a - 1)x_a - k_x = (x_a/\sigma) - k_x , \qquad (2a)$$

$$\pi_{ya} = \{q_a - \phi[c_a(\cdot)]\}y_a - k_y = \{\phi[c_a(\cdot)]/(\eta-1)\}y_a - k_y , \qquad (2b)$$

where x_a and y_a are the equilibrium quantities sold by the input and output-producing firms, and k_x and k_y are their respective fixed costs. Under free entry, the profits in (2) will be zero, and we will denote the equilibrium range of input and output varieties by M_a and N_a, respectively.

In order to determine the range of product varieties, we could use the full-employment condition in the economy. As a short-cut, however, we can instead appeal to the equality of GNP measured as the payment to factors or the value of final output (where we assume the trade is balanced in the final goods sector). This equality is stated as:

$$L = N_a q_a y_a = N_a y_a \phi[c_a(\cdot)]\eta/(\eta-1). \tag{3}$$

Making use of (3) and (2b) with $\pi_y = 0$, we immediately solve for the equilibrium range of output varieties:

$$N_a = L/\eta k_y . \tag{4}$$

Our next task is to determine how vertical-integration will influence the number of output varieties.

A business group (denoted with the subscript "b") will maximize profits over the ranges of outputs and inputs produced, which implies marginal-cost pricing of the inputs sold internally. This pricing scheme will have an impact on the unit-costs $\phi[c(\cdot)]$ only if the group produces a positive range (measure) of inputs $M_b > 0$, as we shall assume is the case. These inputs may or may not be sold to other firms, as we shall discuss below. We will argue below that each group will find it optimal to produce a positive range of outputs $N_b > 0$, because the economies of scale from producing inputs internally also creates economies of scope. The number of business groups is denoted by G, which will be determined by a zero-profit condition for the groups. We will also allow for the production of inputs and outputs by non-integrated firms.

The profits of a business group producing M_b inputs and N_b outputs are:

$$\pi_b = N_b\{q_b - \phi[c_b(\cdot)]\}y_b - N_b k_y + \tilde{M}_b x_b(p_b - 1) - M_b k_x, \tag{6}$$

where $\tilde{M}_b \leq M_b$ denotes the range of inputs that the group sells to outside firms, at the price p_b and quantity x_b. The reason that the group might sell less than the full range of inputs is that each input leads to a reduction in costs $c_b(\cdot)$ for another business group, which will be competing with the selling group in the output market.

To see how the sale of inputs will affect costs, notice that the CES unit-costs for a group can be written as:

$$c_b(\cdot) = \left[M_a\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} + M_b + (G-1)\tilde{M}_b p_b^{\;1-\sigma}\right]^{1/(1-\sigma)}. \qquad (1')$$

where M_a denote the range of inputs sold by non-integrated firms at the price $\sigma/(\sigma-1)$; M_b is the range of inputs produced by the business group and supplied to itself at marginal cost; and $(G-1)\tilde{M}_b$ are the inputs supplied from all other groups at the price p_b. An increase in the range of inputs $\tilde{M}_b$ supplied from one business group to another will lower unit-costs in (1'), and therefore increase the competition in the output market. It is quite possible that groups will choose to not sell any inputs to each other, or sell only a portion of the inputs that they produce, depending on whether the profits from selling exceed the losses induced by the competition in differentiated outputs. While we have worked through some examples to determine that these various outcomes are possible, our principal results will not depend on whether business groups sell to each other or not.

Profits of the non-integrated firms producing inputs and outputs can be written as in (2), where we continue to use the subscript "a" to denote non-integrated firms. The variables M_a, x_a, N_a, and y_a are still interpreted as the varieties and outputs produced by the non-integrated firms, though of course, their values will change when there are also business groups in the economy. We must have $\pi_{xa} \leq 0$ and $\pi_{ya} \leq 0$ in equilibrium, and several additional results can be obtained on the sign pattern of profits.

Consider a business group that sells its full range of inputs M_b to other groups or non-integrated firms. Since this decision may not be optimal, we denote its profits by $\tilde{\pi}_b \leq \pi_b$, where $\pi_b = 0$ from free entry of business groups. The group selling all of its inputs must have higher profits than a combination of M_b non-integrated firms selling inputs, and N_b non-integrated firms selling outputs, so that $\tilde{\pi}_b > N_b\pi_{ya} + M_b\pi_{xa}$. This result follows from the efficiency gain within a group from pricing inputs sold internally at marginal cost, which results in a rise in profits over the non-integrated firms. However, since $\tilde{\pi}_b \leq 0$, it follows that at least one of π_{xa} or π_{ya} must be *strictly negative:* in addition to the business groups in the economy, there can be non-integrated firms producing either inputs or outputs, but not both.

A second result is obtained by comparing $M_b\pi_{xa} \leq 0$ with the expression $[\tilde{M}_b x_b(p_b - 1) + M_b k_x]$, which is a component of group profits in (6). The term $[x_b(p_b - 1) - k_x]$ is the profits of the business group from selling one input variety to all outside firms, not including sales to itself (where profits are zero). Because the internal sales are *not* included in the quantity x_b, it can be argued that these profits must be strictly less than π_{xa}, earned by a non-integrated firm from sales to all groups and other output-producing firms.[17] Then using $\tilde{M}_b \leq M_b$, it follows that $[\tilde{M}_b x_b(p_b - 1) + M_b k_x] < M_b\pi_x \leq 0$, so the component of group profits in (6) that reflect the profits earned from selling inputs must be *strictly negative.* With $\pi_b = 0$ from free entry, it follows immediately that the profits earned from sale of outputs, or $[N_b\{q_b - \phi[c_b(\cdot)]\}y_b - N_b k_y]$, must be *strictly positive.*

This latter result is a critical feature of the equilibrium. The positive profits earned from sale of outputs reflect an internal economies of scale from production of intermediate inputs, thereby lowering costs, but leads to economies of scope in producing a greater variety of outputs. That is, each additional output variety that is produced will generate positive profits for the group, *ceteris paribus.* As groups become large, however, the expansion of output varieties will draw demand away from those varieties already produced, and this will serve to determine the optimal size of a group.

To develop this idea formally, we can write the CES demand, from both domestic and foreign consumers, for a single output variety j as:

$$y_j = \frac{(L + w^*L^*)q_j^{-\eta}}{\left[GN_b q_b^{1-\eta} + N_a q_a^{1-\eta} + N^*(q^*)^{1-\eta}\right]} \quad . \tag{7}$$

where w^*L^* in the numerator is foreign income, and N^* in the denominator are the range of foreign varieties, sold at price q^*. Due to trade balance, the foreign wage (relative to the domestic wage) is endogenous, and if we solve for its equilibrium value, the demand expression is simplified as:[18]

$$y_j = \frac{Lq_j^{-\eta}}{\left[GN_bq_b^{1-\eta} + N_aq_a^{1-\eta}\right]}. \tag{7'}$$

If business groups treat the foreign wage as exogenous in their optimization, then we use the demand equation (7), and let $s_{by} \equiv N_bq_by_b/(L + w^*L^*)$ denote the share of world expenditure on the products of one group. Conversely, if groups treat the foreign wage as endogenous, then we use (7') and let $s_{by} \equiv N_bq_by_b/L$ denote the share of domestic output accounted for by the products of one group. Our analysis below will apply under either assumption.

Differentiating profits π_b with respect to N_b, using (7) or (7') and holding q_b, M_b, and $\tilde{M}_b$ fixed at their optimal values, we obtain the following expression for the optimal size (measured by the expenditure share) of each business group:

$$s_{yb} = \frac{\{q_b - \phi[c_b(\cdot)]\}y_b - N_bk_y}{\{q_b - \phi[c_b(\cdot)]\}y_b} > 0. \tag{8}$$

From our discussion above, this expression is strictly positive, implying that a group will produce a positive measure of outputs. The higher are the profits earned from the sale of each output variety in equilibrium, the greater will be the share of expenditure on the outputs of each group, and the smaller will be the equilibrium number of groups.

We can now solve for the extent of product variety in the economy that include business groups. It is again convenient to use the condition that total income will equal total domestic product:

$$L = GN_bq_by_b + N_aq_ay_a\,. \tag{9}$$

where GN_b are the total output varieties produced by business groups, and N_a are the varieties produced by non-integrated firms, if they occur. The latter will price at $q_a = \phi_a\eta/(\eta-1)$, and from $\pi_{ya} = 0$ it follows that $q_a y_a = \eta k_y$. In contrast, the business groups will charge prices higher than $\phi_b\eta/(\eta-1)$, since they produce multiple output varieties. The optimal price for the groups is $q_b = \phi_b\varepsilon_{yb}/(\varepsilon_{yb}-1)$, where $\varepsilon_{yb} \equiv \eta + s_{yb}(1-\eta)$ is the elasticity of demand for the entire range of outputs produced. Substituting these prices into (5), we obtain $\phi_b y_b = k_y(\varepsilon_{yb}-1)/(1-s_{yb}) = (\eta-1)k_y$. Then using the positive profits from the sale of outputs by the group, we find that $q_b y_b > \phi_b y_b + k_y = \eta k_y$. Using this in (10), it follows immediately that,

$$GN_b + N_a < L/\eta k_y. \tag{10}$$

Thus, by comparing this result with (4), we see that the economy with vertically-integrated business groups will produce a smaller variety of outputs than the non-integrated economy. The explanation for this result is that the efficiency resulting from integration is reflected in positive profits on the sale of outputs (with zero profits overall). These positive profits can be obtained only if the business groups produce higher output quantity, or longer production runs, than would a non-integrated firm with the same costs. From the resource constraint for the economy, these higher output quantities mean that fewer product varieties are produced in equilibrium.

This hypothesis will be tested empirically in the remainder of the paper. In addition, we will consider the "product mix" of each country over high-priced and low-priced import varieties, which is often used as a proxy for product quality. Rodrik (1993) argues that reputational considerations for the large Korean *chaebol* should lead them to produce at higher qualities than the smaller Taiwanese firms. This hypothesis is consistent with our model, where the business groups produce multiple output varieties, and should therefore be more concerned about their reputation, and we also test for differences in product mix.

4. Empirical Model

4.1 Product Variety and Mix Indexes

In this section, we develop indexes of product variety and product "mix" for U.S. imports from South Korea, Taiwan and Japan. For each industry, treat the U.S. imports from each of these countries as differentiated across $i=1,\dots,N$ varieties, where each country $j=1,\dots,J$ may supply only a subset $I_j \subseteq \{1,\dots,N\}$ of these varieties. Let $y_j=(y_{1j},y_{2j},\dots,y_{Nj})$ denote the vector of import quantities from country j, where a zero element denotes no import of that variety. Finally, let the total services obtained from imports of country j for the industry in question be obtained as the CES function $g(y_j,I_j)$:

$$g(y_j,I_j) = \left(\sum_{i \in I_j} a_i \, y_{ij}^{(\eta-1)/\eta} \right)^{\eta/(\eta-1)}, \quad a_i > 0, \tag{11}$$

where the elasticity of substitution is $\eta > 1$. If the product in question is a consumer good, then $g(\cdot)$ represents the utility function for the varieties from country j, and otherwise it is a production function of importing firms. We assume that total utility or output from imports are obtained from the function:

$$U=F[g(y_1,I_1),\dots,g(y_J,I_J)], \tag{12}$$

which aggregates the services obtained from each country. Equation (12) assumes that the import varieties from each country are weakly separable from each other in F, which is convenient in developing our indexes.

Let $Y_j=\sum_{i \in I_j} y_{ij}$ denote the total quantity of country j's imports, measured in physical units. Then the services obtained per unit of import is obtained by dividing total services by the physical quantity Y_j:

$$A_j \equiv g(y_j,I_j)/Y_j \, . \tag{13}$$

The term A_j may be interpreted as the "quality" of country j's overall imports, i.e. total services obtained per ton of steel imports. Then (12) can be rewritten as:

$$U=F(A_1Y_1,\ldots,A_JY_J). \qquad (12')$$

While the quality variable A_j cannot be measured directly, since it depends on the unknown level of service $g(y_j,I_j)$, an empirical measure can be obtained by considering the ratio of relative qualities A_j/A_k. Letting $q_j > 0$ denote the price vector from country j, this ratio can be measured by:[19]

$$\frac{A_j}{A_k} = \left(\frac{E_j/Y_j}{E_k/Y_k}\right) / \left(\frac{c(q_j,I_j)}{c(q_k,I_k)}\right). \qquad (14)$$

where E_j denotes total expenditure on imports from country j, and $c(q_j,I_j)$ is the unit-cost function dual to (11):

$$c(q_j,I_j) = \left(\sum_{i\varepsilon I_j} b_i q_{it}^{1-\eta}\right)^{1/(1-\eta)}, \quad b_i = a_i^{\eta}. \qquad (15)$$

Expression (14) is the ratio of *unit-values* of imports from country j and k, divided by the ratio of unit-costs from the two countries. While the unit-values are directy obtained from import data, the unit-costs are not observed. However, their ratio can be measured by an exact price index. In particular, suppose that y_j and y_k are the cost-minimizing quantities with prices q_j and q_k, respectively, and that the set of *common* goods $I \equiv (I_t \cap I_{t-1})$ imported from both countries is not empty. Then from Feenstra (1993), the ratio of unit-costs can be measured as:

$$c(q_j,I_j)/c(q_k,I_k) = P(q_j,q_k,y_j,y_k,I)\,(\lambda_j/\lambda_k)^{1/(\eta-1)}, \qquad (16)$$

where:

(a) $P(q_j,q_k,y_j,y_k,I)$ is the price index of Sato (1976) and Vartia (1976), constructed over the common goods I;[20]

(b) $\lambda_j \equiv \sum_{i\varepsilon I} q_{ij}y_{ij} / \sum_{i\varepsilon I_j} q_{ij}y_{ij}$, with the same formula applying for λ_k.

The result in (16) states that the ratio of unit cost of service equals the price index of the common goods times the additional term $(\lambda_j/\lambda_k)^{1/(\eta-1)}$. To interpret this term, note that λ_j is the proportion of the expenditure on the common goods $i\epsilon I$ relative to the entire set of goods $i\epsilon I_j$. Alternatively, λ_j measures one minus the expenditure share of the goods outside the set I. If country j has a larger share of revenue from selling the products other than the common goods, so that $\lambda_j > \lambda_k$, it tends to lower the unit-cost ratio by an amount depending on the power $1/(\eta-1)$. The higher is the substitution elasticity η, the lower is the impact of varieties supplied by only one country on its unit-costs.

We rewrite the quality ratio in (14) using (16):

$$\frac{A_j}{A_k} = \left[\frac{(E_j/Y_j)/(E_k/Y_k)}{P(q_j,q_k,y_j,y_k,I)}\right]\left(\frac{\lambda_k}{\lambda_j}\right)^{1/(\eta-1)}$$

$$= (\text{Product Mix}) \times (\text{Product Variety})^{1/(\eta-1)}. \qquad (14')$$

Thus, the overall quality ratio of the two countries is decomposed into two sources. The first term on the right of (14') is the ratio of the unit-values to the price index, or "product mix." A higher value for this term indicates that country j sells relatively more of the higher-priced varieties than does country k. The second term represents the relative effect of product variety. Note that the expenditure share ratio λ_k/λ_j in (14') has inverse subscripts to the quality ratio A_j/A_k. Therefore, the greater (smaller) is the expenditure share on varieties from country j (k) that are outside the set of common goods I, the higher will be the variety index.

The product mix index has sometimes been used as a proxy for product quality, though (14') shows that *both* the product mix and variety are components of A_j/A_k, the quality of country j imports relative to those of country k. Our derivation shows that both these indexes are well-motivated in terms of the preferences of importing consumers or firms.

4.2 Data and Hypothesis Tests

To contrast the product structures of south Korea, Taiwan and Japan in product variety and mix, we will use disaggregate U.S. import statistics for 1978-88. Since the U.S. is the largest destination market for both countries (more than 30% of Korean exports and 40% of Taiwanese exports came into the U.S. in the last decade) their performances in this market should reflect the features of their production quite well. We shall take each 7-digit TSUSA (Tariff Schedule of the United States) number as a variety, and then construct the product mix and variety indexes within each 5-digit SIC classification.[21] In other words, the 5-digit SIC level is taken as the "industry" for which product variety and mix are measured.[22]

The total sample of 1978-88 was broken into the two periods 1978-82 and 1983-88, to check for changes in product variety and mix that may have occurred. The 5-digit industries used are those more than three varieties exported by both countries in the full first or second period. For each of these industries, the product variety and mix indexes are calculated in each year. To determine which country dominates in product variety or mix, we compute the *mean* of each index (measured in logs) over the years within each period, and test whether the log index is greater or less than zero at the 10% level, using a one-sided t-test. More formally, letting z_{nt} denote the log of the product variety or mix index in year t, and μ_n denote its mean value, we assume that:

$$z_{nt} = \mu_n + \varepsilon_{nt}, \text{ where } \varepsilon_{nt} \text{ is distributed } N(0,\sigma_n^2), \tag{17}$$

and t lies in the ranges 1978-82 or 1983-88. Then we test the hypotheses:

$$H_0: \mu_n \leq 0 \quad \text{versus } H_1: \mu_n > 0 \ ,$$

$$\text{and also,} \quad H_0': \mu_n \geq 0 \quad \text{versus } H_1': \mu_n < 0 \ . \tag{18}$$

H_0 or H_0' are rejected if $\overline{z}_n/S > t_{0.9}(\tau-1)$ or $\overline{z}_n/S < -t_{0.9}(\tau-1)$, respectively, where $\overline{z}_n$ is the sample mean, S is its standard deviation and τ is the number of years in each period. We have described this familiar test in detail because we shall generalize it below.

For example, measuring the indexes as Taiwan (T) relative to Korea (K) as in Table 3, if the null hypothesis that $\mu_n = \ln(\lambda_{nK}/\lambda_{nT}) \leq 0$ is rejected, indicating that Taiwan has greater expenditure on varieties not in the set of common goods, then we conclude that Taiwan has greater product variety (denoted T>K); if on the contrary, the null hypothesis that $\mu_n = \ln(\lambda_{nK}/\lambda_{nT}) \geq 0$ is rejected, then we conclude that Korea has greater product variety (denoted K>T); and if neither of these hypotheses are rejected, then the conclusion is uncertain (denoted U). The same is done for the product mix index. In Table 3, we have summarized the results of these hypothesis tests by 2-digit categories, each of which contain multiple 5-digit industries. Entries in the columns marked T>K (K>T) show the number of 5-digit industries for which the hypothesis $\mu_n \leq 0$ ($\mu_n \geq 0$) was rejected, while entries in the columns marked U are the number of 5-digit industries for which neither hypothesis was rejected.

In addition, we shall test the joint hypotheses that *all 5-digit industries within a 2-digit category* have a log index that is positive, or negative. Letting n index the 5-digit industries, and $n \epsilon N$ denote the 2-digit category, these joint hypotheses are stated as:

$$H_0: \mu_n \leq 0 \text{ for all } n \epsilon N, \quad \text{versus } H_1: \mu_n > 0 \text{ for some } n \epsilon N,$$

$$\text{and also,} \quad H_0': \mu_n \geq 0 \text{ for all } n \epsilon N, \quad \text{versus } H_1': \mu_n < 0 \text{ for some } n \epsilon N \;. \tag{19}$$

For example, if there are three 5-digit industries within the 2-digit category, then these are hypotheses on the vector $\mu = (\mu_1, \mu_2)$. The null hypothesis H_0 specifies that μ must lie in the negative quadrant of R^2, while the alternative H_1 allows μ to lie anywhere else in R^2, i.e. one mean could be positive and one negative, or both can be positive.

The test statistic for either hypothesis in (19) is constructed as a likelihood ratio using the model in (17). In particular, the likelihood ratio for H_0 is constructed as:

$$L = \prod_{n \varepsilon N} \left[\frac{\Sigma_t (z_{nt} - \bar{z}_n)^2}{\min\limits_{\mu_n \leq 0} \Sigma_t (z_{nt} - \mu_n)^2} \right]^{\tau/2} . \qquad (20)$$

where τ denotes the number of years in each sample, and $\bar{z}_n$ is the sample mean of z_n. The expression in the numerator of (19) is simply the sum of squared residuals (SSR) from (17), with $\bar{z}_n$ as the optimal choice for μ_n, while the expression in the denominator is the SSR when the choice of μ_n is constrained to be non-positive.

The likelihood ratio L is less than unity, and will be smaller if $\bar{z}_n$ is positive and large for some n, so that forcing $\mu_n \leq 0$ in the denominator substantially increases the SSR. For large τ, -2logL is asymptotically distributed as $\chi^2(q)$, where q is the number of industries within the 2-digit class N. Then a low value for L will make it more likely that H_0 is rejected, as should occur when $\bar{z}_n$ is large for some n. Like the hypotheses in (18), it is possible that neither of (19) are rejected; but in contrast to (18), it is also possible that *both* the hypotheses in (19) are rejected.

In Table 3A, we report the results of the testing hypotheses (19) when the indexes are measured as Taiwan relative to Korea. If H_0 (H_0') is rejected at the 10% level and H_0' (H_0) is not rejected at the 25% level then we conclude that Taiwan (Korea) has higher product variety or mix, which is denoted by T (K). Borderline cases occur when first hypothesis is not rejected at the 10% level, but is rejected at the 25% level; or when the second hypothesis is not rejected at the 25% level, but is rejected at the 10% level; and these are denoted by U followed by the letter of the country that has the higher index at the weaker significance level. Cases where the hypotheses in (19) are both rejected or both accepted are denoted by U, indicating that the conclusion is uncertain.

5. Empirical Results

5.1. Taiwan-Korea Comparison

A. Product Variety

The sharpest results in Table 3 are obtained for the product variety index, where Taiwan had greater variety in more industries within each 2-digit category than Korea. In the 5-digit industries, it had higher product variety in 42-44% of the industries in each period (bottom of Table 3), while Korea showed greater diversity in only 5-8%. For the other half of the industries, the hypothesis test was inconclusive.

In the 2-digit results in Table 3A, Taiwan was found to have greater product variety in 10 industries for the first period and 12 industries for the second, while Korea did not show greater diversity in any of the industries during both periods. In addition, when we checked the absolute number of varieties exported, Taiwan always provided more in every industry across the years, without exception. These results strongly confirm that Taiwan, with non-vertically-integrated business groups supplying inputs to 'the export sector, provides greater product variety than the Korean economy. An interpretation of these results is that the small export firms in Taiwan fill many more "market niches" than the large, vertically-integrated business groups in Korea.

B. Product Mix

From the product mix indexes reported in Table 3, we find that Korea specializes in higher-value final (consumption and capital) goods, while Taiwan specializes in higher-value intermediate goods. The evidence can be found in the textile, wood, paper, and metal products industries. In textile mill products, Korea and Taiwan had their own specialization's in different, but about the same number of 5-digit industries, which made the 2-digit category uncertain; but Korea had a clear lead in apparel, which uses the former as the intermediate input and creates the final products. In the lumber and wood industry, Taiwan was ahead in lumber and wood products for both periods, while Korea was leading in furniture during the second period. The third example is paper products. Korea and Taiwan had their own strength in particular materials of paper, paperboard and paper boxes, but Korea obviously excelled over Taiwan in the printing and publishing industry, which is the last step to make paper products ready to be consumed. The last case is the metal products sector. Taiwan had higher product mix in fabricated metal for both periods and in primary metal during the first, while Korea led in industrial machinery.

By dividing industries into intermediate and final products, the respective specialization's of the two countries becomes more evident. In Table 3, for the first period, there are 18 intermediate product industries in which Taiwan has higher product mix, versus seven in Korea; but for final products, Korea had higher product mix in 37 industries versus 17 for Taiwan. Korea moderately increases its product mix for intermediate goods over time, and in the second period Taiwan has higher product mix in 19 industries versus 14 for Korea; while for final products, Korea had higher product mix in 57 industries and Taiwan in 28. If we check this finding with the results in Table 3A, all of the 2-digit categories in which Taiwan had higher product mix are intermediate goods (with the exception of a weak result in food products), for both the first and the second period. In contrast, Korea has higher product mix in nearly one-half of the 2-digit final products, with the other final goods categories being uncertain.

These results of the product mix index can be associated with the business groups shares in Table 2. After adding up Taiwanese business group and state-owned shares, there are six industries whose shares are greater than 30% of the total sales - food (40.7%), textile mill products (50.7%), chemical materials (42.4%), stone, clay & glass products (47.6%), primary metal (30.7%) and transportation equipment (39.0%). Except for transportation equipment,[23] in all other cases Taiwan was either ahead or equivalent to Korea in product mix in the first period.

even though Korea had similar or even greater business group shares. Taiwan's lead in some cases was overtaken by Korea in the second period, particularly in food and primary metal, where Korea had *chaebol* shares of 33.7% and 28.0%, respectively. Both of these were higher than the Taiwanese business group shares, but lower than the sum of the Taiwanese business group and state-owned shares.

Summarizing, the sectors in which Taiwan maintains a lead in product mix are nearly all intermediate inputs, where it also has high business groups shares. In contrast, Korea has higher product mix in many final products, where it also has high *chaebol* shares. Thus, the presence of business groups in either case appear to be closely related to the production of high-value product varieties. One explanation for these results could be that the multiple-output business groups, as found in both economies, are more concerned with reputation and hence strive for higher product quality (Rodrik, 1993).

5.2. Comparison with Japan

Since Korea is less diversified and the comparison above is based on the products that Korea and Taiwan both exported, the index results reflect Korea's performance in exports better than Taiwan's. To present the overall performance of Taiwan, we need a country with broader production range as the benchmark, and Japan is used for that purpose.

A. Variety Index

Japan dominated both Taiwan and Korea in product variety. In the Taiwan-Japan comparison, among 18 2-digit industries (Table 4A, bottom), Japan dominated in 11 industries in the first period, but Taiwan caught up slightly and narrowed down Japan's lead to 9 industries in the second period. Taiwan itself had greater product variety in two cases, and the ranking was inconclusive in seven other industries in this latter period. The industries in which Taiwan led - lumber and wood products, leather products, and weakly in food products - were all light industries; four of the other 2-digit industries that could not be ranked with Japan in variety were also light industries. Japan had greater variety than Taiwan across nearly all of the heavy industries, however. In addition, Japan had greater product variety than Korea in all 2-digit industries except leather products (Table 5A). From our model of section 3, higher product variety is expected from an economy that is much larger in its resource base, and this is confirmed by the comparison of either Taiwan or Korea with Japan.

B. Product Mix Index

For the product mix index, reported in Tables 4-5, Taiwan and Korea each led Japan within some 5-digit industries within most 2-digit categories, and Japan led in other 5-digit industries. As a result, for the 2-digit hypothesis tests reported in Tables 4A-5A, neither Taiwan nor Korea could be ranked with Japan in the vast majority of cases.

Considering the results in Table 3A, during the first period Taiwan had higher product mix than Japan in chemicals (weakly) and rubber and plastic industries, but its leads in these two industries were overtaken by Japan in the second period. In heavy industries, Taiwan had higher product mix only in fabricated metal (second period), and weakly higher mix during only one period in chemical products and transportation equipment (consisting of mainly bicycles and parts and auto parts).

For the Korea-Japan comparison in Table 5A, we find that Korea had higher product mix in some of the light industries - food and leather products - as well as heavy industries - industrial machinery in the first period, and transportation equipment. For the latter, Korea had an advantage in selling more higher-value bicycles and parts, while its auto parts could not be ranked with Japan; automobiles are not included because Korea did not continuous export them in the full first and second periods. Generally, Korea leads Japan in product mix only in selected final goods industries, while Japan leads in a number of the intermediate products, especially in the second period.

6. Conclusions

We have applied the product variety and mix indexes, derived from the CES aggregator function, to Korean and Taiwanese exports to the U.S. market. These indexes were used to test the hypothesis that Taiwan contributed more product varieties, due to its non-vertically-integrated market structure, and also observe the differences in product mix. The results presented above strongly confirm the high product variety of Taiwan relative to Korea. In product mix, Korea led especially in final (consumption and investment) goods, while Taiwan led in a number of intermediate products.

By comparing these results with the business group shares among industries, it appears that the large scale of the Taiwan business groups in intermediate products served to facilitate the exporters of the same industries, making these industries equivalent with Korea in product mix. On the other hand, the integration of production in Korean *chaebol* make their final product exports relatively stronger in product mix than their intermediate product exports. We feel that these results confirm the importance of market structure in determining trade patterns, and also demonstrate the usefulness of using business groups as a measure of market structure. Business groups of various types are found in many other Asian and Western countries, and lead to large differences in market structure, as described by Caves (1989). It can be hoped that these international comparisons may be used to more fully determine the impact of market structure on international trade, and on other aspects of economic performance.

Footnotes

[1] These theories are comprehensively analyzed in Helpman and Krugman (1985).

[2] For example, complete specialization may occur due to technological differences across countries, as modeled by Davis (1991).

[3] Indeed, Hummels and Levinsohn (1993) test a key hypothesis from Helpman's model over a set of OECD countries, and over a set of non-OECD countries for which intra-industry trade should not be important. They find substantial support for the hypothesis in *both* sets of countries, suggesting that something other than monopolistic competition explains the results.

[4] See Granovetter (forthcoming) for a general review of the literature on business groups. For research on business networks in Asia, see Gerlach (1992), Futatsugi (1986), Hamilton and Biggart (1988), Orru, Hamilton, and Suzuki (1990), Orru, Biggart and Hamilton (1991), and the papers in Hamilton (1991).

[5] Fung (1991) and Lawrence (1991) have examined the effects of the *keiretsu* on Japanese trade; see also the papers in Krugman (1991).

[6] The *chaebol* are described in Amsden (1989), Biggart (1991) Hamilton and Biggart (1988), Hamilton, Zeile, and Kim (1990), Kim (1991,1993,forthcoming), Orru, Biggart, and Hamilton (1991), Steers et al. (1989) and Zeile (1991).

[7] Value-added figures were not available for the other countries in Table 1.

[8] This internalization is explored in precise detail in our current research.

[9] The literature on business groups in Taiwan is relatively small when compared with the literature on the Korean chaebol. However, see Chou (1985), Greenhalgh (1988), Hamilton and Biggart (1988), Hamilton and Kao (1991), and Numazaki (1986,1991).

[10] Some of the industries in Table 2 include both intermediate and final goods, such as pulp & paper, printing & publishing (SIC 26+27) and lumber and wood products (SIC 24+25). In these cases, we have classified the industry according to the principal output in the country with the largest business group share.

[11] This is based on current research, which is found in Hamilton, Orru and Biggart (unpublished).

[12] Hamilton, Zeile and Kim (1989, p. 122). This data is based upon the information found in China Credit Information Service (1983).

[13] The six "intermarket" groups are Mitsubishi, Mitsui, Sumitomo, Fuyo, DKB, and Sanwa, while the ten other *keiretsu* are Tokai Bank, IBJ, Nippon Steel, Hitachi, Nissan, Toyota, Matsushita, Toshiba-IHI, Yokyu and Seiba.

[14] See Levy (1991), Table 9, p. 166.

[15] These notions of personal traits are described in greater detail in the chapters on Chinese business networks in Hamilton (1991). Also see Hamilton and Kao (1991) and Hamilton, Biggart, and Orru (unpublished).

[16] For examples of an institutional, "social economy" explanation for business group structures in East Asia, see Gereffi and Hamilton (1992), Hamilton and Biggart (1988) and Whitley (1992).

[17] The quantity x_a denotes the total sales of the intermediate input by a non-integrated firm at the price $p_a = \sigma/(\sigma-1)$, and let s_{xb} denote the share of total sales accounted for by one business group. If the business groups charged the same price for intermediates as non-integrated firms, then we would have $x_b = x_a(1-s_{xb})$, since x_b excludes sales of the input within the group. In fact, the business group will charge a higher price for the inputs when they produce a positive measure of them, so that $x_b < x_a(1-s_{xa})$. The optimal price for the group is $p_b = \varepsilon_x/(\varepsilon_x - 1)$, where $\varepsilon_x \equiv \sigma + s_{xb}(1-\sigma)$ is the elasticity of demand for the entire range of inputs produced. If follows that the profits earned on each unit sold are $(p_b - 1) = 1/[(\sigma-1)(1-s_{xb})] =$

$(p_a-1)/(1-s_{xb})$. Profits over all units are then $(p_b-1)x_b - k_x < (p_a-1)x_a - k_x = \pi_{xa}$.

[18] Trade balance in final goods implies $LN^*(q^*)^{1-\eta}/\left[GN_bq_b^{1-\eta} + N_aq_a^{1-\eta} + N^*(q^*)^{1-\eta}\right] =$

$w^*L^*\left[GN_bq_b^{1-\eta} + N_aq_a^{1-\eta}\right]/\left[GN_bq_b^{1-\eta} + N_aq_a^{1-\eta} + N^*(q^*)^{1-\eta}\right]$, where the left-side is home import expenditure and the right-side is home exports. Using this equality in (7), we immediately obtain (7').

---

19 Expression (14) follows directly from (13), because total expenditure equals unit-costs multiplied by output, or $E_j = c(q_j, I_j)g(y_j, I_j)$.

20 From Sato (1976) and Vartia (1976), the formula for this price index is $P(q_j, q_k, q_j, q_k, I) = \prod_{i \in I} (p_{ij}/p_{ik})^{w_i(I)}$, where the weights $w_i(I)$ are computed using the expenditure shares of the two countries, as follows: $s_{ij}(I) = q_{ij}y_{ij}/\sum_{i \in I} q_{ij}y_{ij}$,

$$s_{ik}(I) = q_{ik}y_{ik}/\sum_{i \in I} q_{ik}y_{ik}, \text{ and } w_i(I) = \left(\frac{s_{ij}(I) - s_{ik}(I)}{\ln s_{ij}(I) - \ln s_{ik}(I)}\right) / \sum_{i \in I} \left(\frac{s_{ij}(I) - s_{ik}(I)}{\ln s_{ij}(I) - \ln s_{ik}(I)}\right).$$

The numerator in the definition of $w_i(I)$ is a *logarithmic mean* of s_{ij} and s_{ik}, and lies between these cost shares. Then the weights $w_i(I)$ are a normalized version of the logarithmic means, and add up to unity.

21 The value and quantity of each 7-digit TSUSA commodity are reported in U.S. Bureau of the Census (1978-88), which was obtained on magnetic tape. The price of each variety is a unit-valub, computed by dividing total import value by total quantity at the 7-digit TSUSA level. A concordance file matching TSUSA categories with import-based SIC code numbers was used to construct the product groups.

22 An example of a 5-digit SIC category is "men's and boy's suits, coats and overcoats." We also calculated all indexes using the 8-digit SIC as the "industry" level, an example of which is "men's and boy's suits." The 5-digit and 8-digit SIC levels gave very similar results for product mix and vareity; see Yang (1993).

23 The transportation industry is a special case in which Taiwanese business groups' production is concentrated in automobile manufacturing and state-owned in shipbuilding, most of which is for domestic consumption rather than export.

References

Amsden, Alice H (1989) South Korea and Late Industrialization. New York: Oxford University Press.

Arrow, Kenneth J. (1969) "The Organization of Economic Activity: Issues Pertinent to the Choice of Market versus Nonmarket Activity," in The Analysis and Evaluation of Public Expenditure: The PPB System, Vol. I, U.S. Joint Economic Committee, 91st Congress, 1st Session. Washington, D.C.: Government Printing Office, 59-73.

Arrow, Kenneth J. (1974) The Limits of Organization. New York: W.W. Norton.

Biggart, Nicole Woolsey (1990) "Institutionalized Patrimonialism in Korean Business." In Comparative Social Research 12: 113-133.

Caves, Richard E. (1989) "International D·fferences in Market Structure," in Richard Schmalensee and Robert D. Willig, ed. Handbook of Industiral Organization, New York: North-Holland, vol. II, chapter 21.

China Credit Information Service (1983) Business Groups in Taiwan 1983-84. Taipei: China Credit Information Service, Ltd.

Chou, Tein-Chen (1985) Industrial Organization in the Process of Economic Development: The Case of Taiwan, 1950-1980. *Louvain-la-Neuve: Universite Catholique de Louvain, Faculte des Science Economiques, Sociales et Politiques.*

Davis, Donald (1991) "Explaining the Volume of Intra-industry Trade: Are Increasing Returns Necessary?" International Finance Discussion Paper #411, Board of Governors of the Federal Reserve System, Washington, D.C.

Feenstra, Robert C. (1993) "New Product Varieties and the Measurement of International Prices," American Economic Review, forthcoming.

Fung, K.C. (1991) "Characteristics of Japanese Industrial Groups and Their Potential Impact on U.S.-Japanese Trade," in Robert E. Baldwin, ed. Empirical Studies of commercial Policy. Chicago: Univ. of Chicago and NBER, 137-164.

Futatsugi, Yusaku (1986) Japanese Enterprise Groups. Kobe, Japan: School of Business, Kobe University.

Gereffi, Gary and Gary G. Hamilton (1992) "The Social Economy of Global Capitalism." Paper presented at the annual meetings of the American Sociological Association, Pittsburgh, PA, August.

Gerlach, Michael (1992) Alliance Capitalism: The Strategic Organization of Japanese Business. Berkeley: University of California Press.

Granovetter, Mark (1985) "Economic Action and Social Structure," American Journal of Sociology 91:481-510.

Granovetter, Mark. Forthcoming. "Business Groups," in Neil Smelser and Richard Swedberg (eds.), Handbook of Economic Sociology. Princeton: Princeton University Press.

Greenhalgh, Susan (1988) "Families and Networks in Taiwan's Economic Development." Pp. 224-245 in Contending Approaches to the Political Economy of Taiwan. Edwin Winckler and Susan Greenhalgh (eds.). Armonk, NY: M.E. Sharpe.

Hamilton, Gary G. and Nicole Woolsey Biggart (1988) "Market, Culture, and Authority: A Comparative Analysis of Management and Organization in the Far East," American Journal of Sociology, Special Issue on Economic Sociology, 94, July, S52-S94.

Hamilton, Gary G., William Zeile and Wan-Jin Kim, (1990) "The Network Structures of East Asian Economies" in S.R. Clegg and S.G. Redding (eds.), Capitalism in Contrasting Cultures. Berlin: de Gruyter.

Hamilton, Gary G. and Kao Cheng-shu, (1990) "The Institutional foundations of Chinese Business: The Family Firm in Taiwan," Comparative Social Research vol. 12.

Hamilton, Gary G., ed. (1991) Business Networks and Economics Development in East and Southeast Asia. Hong Kong: Center of Asian Studies.

Hamilton, Gary G., Nicole Woolsey Biggart, and Marco Orru. Unpublished Manuscript. Network Capitalism: Economic Organization in Industrial East Asia.

Helpman, Elhanan and Paul Krugman (1985) Market Structure and Foreign Trade. Cambridge: MIT Press.

Helpman, Elhanan (1987) "Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries," Journal of the Japanese and International Economies 1(1), 62-81.

Helpman, Elhanan and Paul Krugman (1985) Market Structure and Foreign Trade. Cambridge: MIT Press.

Hummels, David and James Levinsohn (1993) "Product Differentiation as a Source of Comparative Advantage?" American Economic Review, Papers and Proceedings. 83(2), May, 445-449.

Kao, Cheng-shu (1991) "Personal Trust in the Large Businesses in Taiwan: A Traditional Foundation for Contemporary Economic Activities." Pp. 66-76 in Business Networks and Economic Development in East and Southeast Asia, edited by Gary G. Hamilton. Hong Kong: Center of Asian Studies, University of Hong Kong.

Kim, Eun Mee (1993) "Contradictions and Limits of a Developmental State: With Illustrations from the South Korean Case." Social Problems (May).

Kim, Eun Mee (1991) "The Industrial Organization and Growth of the Korean Chaebol: Integrating Development and Organizational Theories," in Business Networks and Economic Development in East and Southeast Asia, Gary G. Hamilton (ed.). Hong Kong: Center of Asian Studies, University of Hong Kong, 272-299.

Kim, Eun Mee. Forthcoming. Big Business, Strong State: Collusion and Conflict in Korean Development, 1960-1990. Berkeley: University of California.

Krugman, Paul (1991) Trade With Japan. Chicago: Univ. of Chicago and NBER.

Numazaki, Ichiro (1986) "Networks of Taiwanese Big Business." Modern China 12, 487-534.

Lawrence, Robert Z. (1991) "Efficient or Exclusionist? The Import Behavior of Japanese Corporate Groups," Brooking Papers on Economic Activity, 311-341.

Levy, Brian (1991) "Transactions Costs, The Size of Firms and Industrial Policy," Journal of Development Economics 34, 151-178.

Numazaki, Ichiro (1991) "The Role of Personal Networks in the Making of Taiwan's Guanxiqiye (Related Enterprises)." pp. 77- 93 in Business Networks and Economic Development in East and Southeast Asia, edited by Gary G. Hamilton. Hong Kong: Center of Asian Studies, University of Hong Kong.

Orru, Marco, Gary G. Hamilton, and Mariko Suzuki (1990) "Patterns of Inter-Firm Control in Japanese Business," Organizational Studies 10(4), 549-574.

Orru, Marco, Nicole Woolsey Biggart, and Gary G. Hamilton, (1991) "Organizational Isomorphism in East Asia: Broadening the New Institutionalism," in Walter W. Powell and Paul J. DiMaggio (eds.), The New Institutionalism in Organizational Analysis, Chicago: Univ. of Chicago Press.

Powell, Walter W. (1990) "Neither Market Nor Hierarchy: Network Forms of Organization," Research in Organizational Behavior, 12: 295-336.

Rodrik, Dani (1993) "Industrial Organization and Product Quality: Evidence from South Korean ad Taiwanese Exports," in Paul Krugman and Alasdair Smith, eds., Empirical Studies of Strategic Trade Policy. Chicago: Univ. of Chicago and NBER.

Sato, Kazuo (1976) "The Ideal Log-change Index Number," Review of Economics and Statistics 58, May, 223-228.

Steers, Richard M., Yoo, Keun Shi, and Gerardo Ungson (1989) The Chaebol: Korea's New Industrial Might. New York: Harper and Row.

Vartia, Yrjo O. (1976) "Ideal Log-change Index Numbers," Scandinavian Journal of Statistics 3, 121-126.

Whitley, Richard (1992) Business Systems in East Asia. London: Sage.

Williamson, Oliver E. (1975) Markets and Hierarchies. New York: The Free Press.

Williamson, Oliver E. (1985) The Economic Institutions of Capitalism. New York: The Free Press.

Wong, Siu-Lun (1985) "The Chinese Family Firm: A Model," British Journal of Sociology 36, 58-72.

Yang, Tzu-Han (1993) "Industrial Structure and Trade Patterns: Evidence from South Korea and Taiwan," Ph.D. Dissertation, University of California, Davis.

Zeile, William (1991) "Industrial Policy and Organizational Efficiency: The Korean Chaebol Examined," in Gary G. Hamilton (ed.) Business Networks and Economics Development in East and Southeast Asia. Hong Kong: Center of Asian Studies.

U.S. Bureau of the Census (1978-88) U.S. General Imports for Consumption. Schedule A, FT135, Commodity by Country, Washington, D.C.: U.S. Department of Commerce, Government Printing Office.

Table 1 **Business Group Shares by Major Sector, 1983 (Percent)**

Sector	**Korea** Sales Share of 50 largest *chaebol* (value-added)[a]	**Taiwan** Sales Share of 96 largest business groups	**Japan** Sales Share of 16 largest *keiretsu*[b]
Mining	10.6 (4.1)	0.0	17.6
Manufacturing	45.4 (28.3)	19.0	33.2
Construction	66.0 (31.9)	5.6	14.7
Transport & Storage	23.1 (19.7)	1.8	22.1
Banking & Finance	n.a. (n.a)	5.8	84.6
Trading & Commerce	n.a. (17.0)	4.1	24.2

Source:
Hamilton (1988), Table 3; Hamilton, Zeile and Kim (1991), Table 4.

Notes:
a. Figures in parantheses give value-added of all firms in business groups selling in that sector, relative to total value-added of the sector, for the year 1986.
b. Figures for Japan are for fiscal year 1982.

Table 2 Business Group Shares by Industry, 1983 (Percent)

Industry (SIC code)	Korea 50 largest *chaebol*	Taiwan 96 largest groups (& state)[a]	Japan 16 largest *keiretsu*
Intermediate Products			
Textile Mill Products (22)	38.4	50.7	n.a.
Pulp & Paper;Printing & Publishing (26+27)	6.7	20.1[b]	17.7
Chemical Materials (28)	54.3	42.4	40.0[c]
Petroleum & Coal Products (29)	91.9	0.0(95.9)	40.2
Stone, Clay & Glass Products (32)	44.6	47.6	29.0
Primary Metal (33)	28.0	7.8(30.7)	58.1
Fabricated Metal (34)	26.7	6.0	4.0
Final Products			
Food Products (20)	33.7	26.3(40.7)	18.2[d]
Beverage & Tobacco (21)	27.6	3.8	n.a.
Apparel & Textile Products (23)	12.6	12.0	0.0
Lumber & Wood Products; Furniture (24+25)	31.5[e]	4.0	0.0
Chemical Products (28)	24.0	8.4	n.a.
Rubber Products (30)	76.8	13.0	37.5
Plastic Products (30)	0.1	5.4	n.a.
Leather Products (31)	15.2	9.1	n.a.
Industrial Machinery (35)	34.9	3.6(9.8)	19.5
Electronic Products (36)	50.9	22.7	55.4
Transportation Equipment (37)	79.0	23.6(39.0)	80.7
Precision Instruments (38)	14.0	0.0	12.3
Misc. Manufacturing (39)	5.2	10.7	3.0

Source:
Hamilton, Zeile and Kim (1991), Table 5, p.116.

Notes:
a. The figures in parentheses include the sales of state-owned businesses, computed from the Yearbook of Financial Statistics of the Republic of China, and the Report on 1983 Industrial and Commercial Census of the Republic of China.
b. The Taiwanese business group share is principally in Pulp and Paper.
c. Includes Chemical Products.
d. Includes Beverage and Tobacco.
e. The Korean *chaebol* share is principally in Wood Products and Furniture.

Table 3 Hypothesis tests for 5-digit SIC: Taiwan versus Korea

Industry (SIC)	Variety Index						Product Mix Index					
	1978-82			1983-88			1978-82			1983-88		
	T>K	K>T	U	T>K	K>T	U	T>K	K>T	U	T>K	K>T	U
Intermediate Products												
Textile Mill Products (22)	2	0	4	5	3	3	2	2	2	3	3	5
Lumber & Wood Products (24)	2	0	0	2	0	1	2	0	0	1	0	2
Pulp & Paper Products (26)	0	0	2	1	0	3	1	1	0	1	1	2
Chemical Products (28)	0	0	2	2	0	3	1	0	1	2	0	3
Stone, Clay & Glass (32)	3	1	3	6	0	4	2	2	3	4	3	3
Primary Metal (33)	1	1	3	2	3	2	4	1	0	1	4	2
Fabricated Metal (34)	8	0	3	9	1	7	6	1	4	7	3	7
Subtotal	16	2	17	27	7	23	18	7	10	19	14	24
Final Products												
Food Products (20)	4	1	1	6	1	0	2	1	3	2	3	2
Apparel & Textile Prod.(23)	8	0	8	9	1	13	4	9	3	4	13	6
Furniture (25)		----		0	0	1		----		0	1	0
Printing & Publishing (27)	2	0	2	1	0	3	1	3	0	1	3	0
Rubber & Plastic Prods.(30)	1	0	2	2	1	7	2	1	0	2	7	1
Leather Products (31)	3	1	4	4	0	5	2	3	3	2	3	4
Industrial Machinery (35)	1	0	3	5	1	5	0	2	2	3	5	3
Electrical Equipment (36)	4	1	9	11	1	12	3	8	3	7	10	7
Transportation Equip. (37)	1	0	0	1	0	1	0	1	0	0	2	0
Precision Instruments (38)	2	0	4	3	0	3	1	3	2	1	4	1
Misc. Manufacturing (39)	4	0	9	5	1	9	2	6	5	6	6	3
Subtotal	30	3	42	47	6	59	17	37	21	28	57	27
Total												
Industries by Test	46	5	59	74	13	82	35	44	31	47	71	51
Number of industries		110			169			110			169	
Percentage	42%	5%	54%	44%	8%	49%	32%	40%	28%	28%	42%	30%

Note: T>K (K>T) means the hypothesis that the Taiwan index is less (greater) than the Korean index at the 5-digit level was rejected at the 10% level; U means that both these hypotheses could not be rejected.

Table 3A Hypothesis tests for 2-digit SIC: Taiwan versus Korea

Industry (SIC)	Number of Common Goods		Variety Index		Product Mix Index	
	1980	1985	78-82	83-88	78-82	83-88
Intermediate Products						
Textile Mill Products (22)	44	157	U(T)	U	U(K)	U
Lumber & Wood Products (24)	14	18	T	T	T	T
Pulp & Paper Products (26)	7	16	U	U	T	U(T)
Chemical Products (28)	9	39	U	U(T)	U(T)	T
Stone, Clay & Glass Prod.(32)	51	72	T	T	U	U
Primary Metal (33)	35	74	U	K	T	K
Fabricated Metal (34)	151	222	T	T	T	T
Subtotal	311	598	T--3 K--0 U--4	T--3 K--1 U--3	T--4 K--0 U--3	T--3 K--1 U--3
Final Products						
Food Products (20)	58	67	T	T	U(T)	U
Apparel & Textile Prods. (23)	376	1170	T	T	U	U
Furniture (25)	--	15	--	U	--	K
Printing & Publishing (27)	19	25	T	U(T)	K	K
Rubber & Plastic Prods. (30)	29	76	U(T)	U(T)	U	U
Leather Products (31)	93	159	T	T	K	U
Industrial Machinery (35)	17	62	U(T)	T	K	U(K)
Electrical Equipment (36)	191	236	U(T)	T	U	U
Transportation Equipment (37)	10	22	T	T	K	K
Precision Instruments (38)	71	68	U(T)	T	U	K
Misc. Manufacturing (39)	94	132	T	T	K	U
Subtotal	958	2032	T--6 K--0 U--4	T--8 K--0 U--3	T--0 K--5 U--5	T--0 K--4 U--7
Total	1269	2630	T--10 K--0 U--7	T--12 K--0 U--6	T--4 K--5 U--10	T--3 K--5 U--10

<u>Note</u>: T (K) means the hypothesis that the Taiwan index is less (greater) than the Korean index for all 5-digit industries within each 2-digit group was rejected at the 10% level; U means that these two hypotheses were both accepted or both rejected; U(T) and U(K) are borderline cases.

Table 4 Hypothesis tests for 5-digit SIC: Taiwan versus Japan

Industry (SIC)	Variety Index						Product Mix Index					
	1978-82			1983-88			1978-82			1983-88		
	T>J	J>T	U	T>J	J>T	U	T>J	J>T	U	T>J	J>T	U
Intermediate Products												
Textile Mill Products (22)	0	8	7	1	10	7	6	6	3	4	[illegible]	[illegible]
Lumber & Wood Products (24)	2	0	1	3	0	0	2	1	0	1	1	1
Pulp & Paper Products (26)	0	1	3	0	1	6	0	1	3	1	2	4
Chemical Products (28)	0	6	0	2	15	2	3	1	2	6	11	3
Stone, Clay & Glass (32)	0	5	6	1	6	5	3	5	3	5	5	2
Primary Metal (33)	0	4	2	0	10	3	3	2	1	4	7	2
Fabricated Metal (34)	0	7	6	2	5	13	6	3	4	9	6	5
Subtotal	2	31	25	9	47	36	23	19	16	30	38	24
Final products												
Food Products (20)	1	1	6	6	2	1	3	4	1	4	5	0
Apparel & Textile Prod.(23)	4	4	8	5	5	15	5	6	5	8	7	10
Furniture (25)		----		0	0	1		----		0	1	0
Printing & Publishing (27)	0	2	2	0	1	3	1	2	1	2	1	1
Rubber & Plastic Prods.(30)	0	2	4	0	1	9	4	1	1	4	5	1
Leather Products (31)	3	0	3	6	0	2	3	2	1	3	3	2
Industrial Machinery (35)	1	7	6	0	13	11	3	8	3	4	15	5
Electrical Equipment (36)	0	9	11	0	13	12	3	14	3	4	17	4
Transportation Equip. (37)	1	1	1	0	0	3	2	1	0	2	1	0
Precision Instruments (38)	0	5	2	0	4	3	0	5	2	0	5	2
Misc. Manufacturing (39)	0	7	9	0	3	13	5	7	4	7	8	1
Subtotal	10	38	52	17	42	73	29	50	21	38	68	26
Total												
Industries by Test	12	69	77	26	89	109	52	69	37	68	106	50
Number of Industries		158			224			158			224	
Percentage	8%	44%	49%	12%	40%	49%	33%	44%	23%	30%	47%	22%

Note: T>K (K>T) means the hypothesis that the Taiwan index is less (greater) than the Korean index at the 5-digit level was rejected at the 10% level; U means that both these hypotheses could not be rejected.

Table 4A Hypothesis tests for 2-digit SIC: Taiwan versus Japan

Industry (SIC)	Number of Common Goods		Variety Index		Product Mix Index	
	1980	1985	78-82	83-88	78-82	83-88
Intermediate Products						
Textile Mill Products (22)	127	248	J	J	U	U
Lumber & Wood Products (24)	25	22	T	T	U	U
Pulp & Paper Products (26)	17	40	U(J)	U(J	J	J
Chemical Products (28)	51	195	J	J	U(T)	U
Stone, Clay & Glass Prod.(32)	93	115	J	J	U(J)	U
Primary Metal (33)	45	126	J	J	U	U
Fabricated Metal (34)	217	289	J	J	U	T
Subtotal	575	1035	T--1 J--5 U--1	T--1 J--5 U--1	T--0 J--1 U--6	T--1 J--1 U--5
Final products						
Food Products (20)	95	98	U	U(T)	U	U
Apparel & Textile Prods. (23)	407	1256	U	U	U	U
Furniture (25)	--	16	--	U	--	J
Printing & Publishing (27)	25	27	J	U(J)	U(J)	U(J)
Rubber & Plastic Prods. (30)	61	86	J	U(J)	T	U
Leather Products (31)	71	120	T	T	U	U
Industrial Machinery (35)	89	193	J	J	U	U
Electrical Equipment (36)	257	297	J	J	U(J)	U
Transportation Equipment (37)	26	35	U	U	U	U(T)
Precision Instruments (38)	106	126	J	J	J	J
Misc. Manufacturing (39)	139	164	J	J	U	U
Subtotal	1276	2418	T--1 J--6 U--3	T--1 J--4 U--6	T--1 J--1 U--8	T--0 J--2 U--9
Total	1851	3453	T--2 J--11 U--4	T--2 J--9 U--7	T--1 J--2 U--14	T--1 J--3 U--14

Note: T (K) means the hypothesis that the Taiwan index is less (greater) than the Korean index for all 5-digit industries within each 2-digit group was rejected at the 10% level; U means that these two hypotheses were both accepted or both rejected; U(T) and U(K) are borderline cases.

Table 5 Hypothesis tests for 5-digit SIC: Korea versus Japan

Industry (SIC)	Variety Index						Product Mix Index					
	1978-82			1983-88			1978-82			1983-88		
	K>J	J>K	U	K>J	J>K	U	K>J	J>K	U	K>J	J>K	U
Intermediate Products												
Textile Mill Products (22)	0	9	0	0	10	2	2	2	5	2	5	5
Lumber & Wood Products (24)	0	2	0	0	1	1	0	1	1	0	1	1
Pulp & Paper Products (26)	0	0	2	0	2	3	1	1	0	1	2	2
Chemical Products (28)	0	5	0	0	8	1	0	1	4	2	5	2
Stone, Clay & Glass (32)	0	4	4	0	8	2	2	5	1	1	6	3
Primary Metal (33)	0	8	1	0	11	2	2	4	3	3	7	3
Fabricated Metal (34)	0	10	2	0	12	6	1	6	5	4	8	6
Subtotal	0	38	9	0	52	17	8	20	19	13	34	22
Final products												
Food Products (20)	0	4	4	0	3	7	3	1	4	5	0	5
Apparel & Textile Prod.(23)	2	8	5	3	7	13	3	6	6	9	7	7
Furniture (25)		----		0	1	0		----		1	0	0
Printing & Publishing (27)	0	2	2	0	2	2	2	2	0	2	1	1
Rubber & Plastic Prods.(30)	0	2	2	0	5	4	2	2	0	3	3	3
Leather Products (31)	1	0	5	3	0	5	4	2	0	5	2	1
Industrial Machinery (35)	0	4	2	0	11	3	3	1	2	5	3	6
Electrical Equipment (36)	0	10	6	0	15	9	3	8	5	5	12	7
Transportation Equip. (37)	0	1	0	0	1	1	1	0	0	1	0	1
Precision Instruments (38)	0	4	2	0	6	1	2	3	1	2	2	3
Misc. Manufacturing (39)	0	6	6	1	4	9	6	2	4	6	5	3
Subtotal	3	41	34	7	55	54	29	27	22	44	35	37
Total												
Industries by Test	3	79	43	7	107	71	37	47	41	57	69	59
Number of Industries		125			185			125			185	
Percentage	2%	63%	34%	4%	58%	38%	30%	38%	33%	31%	37%	32%

Note: T>K (K>T) means the hypothesis that the Taiwan index is less (greater) than the Korean index at the 5-digit level was rejected at the 10% level; U means that both these hypotheses could not be rejected.

Table 5A Hypothesis tests for 2-digit SIC: Korea versus Japan

Industry (SIC)	Number of Common Goods		Variety Index		Product Mix Index	
	1980	1985	78-82	83-88	78-82	83-88
Intermediate Products						
Textile Mill Products (22)	76	226	J	J	U(J)	U
Lumber & Wood Products (24)	12	11	J	U(J)	J	J
Pulp & Paper Products (26)	[illegible]	20	U	J	J	J
Chemical Products (28)	38	90	J	J	U(J)	J
Stone, Clay & Glass Prod. (32)	62	75	J	J	U(J)	J
Primary Metal (33)	32	167	J	J	U	U
Fabricated Metal (34)	160	229	J	J	J	J
Subtotal	437	818	K--0 J--6 U--1	K--0 J--6 U--1	K--0 J--3 U--4	K--0 J--5 U--2
Final products						
Food Products (20)	77	95	J	J	K	K
Apparel & Textile Prod. (23)	333	1114	J	J	U	U
Furniture (25)	--	15	--	J	--	K
Printing & Publishing (27)	20	25	J	J	U	U
Rubber & Plastic Products (30)	32	73	J	J	U	U
Leather Products (31)	60	116	U	K	U(K)	K
Industrial Machinery (35)	28	81	J	J	K	U
Electrical Equipment (36)	208	247	J	J	U	U
Transportation Equipment (37)	10	24	J	J	K	K
Precision Instruments (38)	82	80	J	J	U	U
Misc. Manufacturing (39)	102	127	J	J	U	U
Subtotal	952	1997	K--0 J--9 U--1	K--1 J--10 U--0	K--3 J--0 U--7	K--4 J--0 U--7
Total	1389	2815	K--0 J--15 U--2	K--1 J--16 U--1	K--3 J--3 U--11	K--4 J--5 U--9

Note: T (K) means the hypothesis that the Taiwan index is less (greater) than the Korean index for all 5-digit industries within each 2-digit group was rejected at the 10% level; U means that these two hypotheses were both accepted or both rejected; U(T) and U(K) are borderline cases.