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BUSINESS GROUPS AND TRADE IN EAST ASIA: PART 1, NETWORKED EQUILIBRIA

Robert C. Feenstra
Deng-Shing Huang
Gary G. Hamilton

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ABSTRACT

We propose an economic model of business groups that allows for the cooperative behavior of groups of firms, where the number and size of each group is determined endogenously. In this framework, more than one configuration of groups can arise in equilibrium: several different types of business groups can occur, each of which is consistent with profit-maximization and is stable. This means that the economic logic does not fully determine the industrial structure, leaving scope for political and sociological factors to have a lasting influence. In a companion paper, we argue that the differing structures of business groups found in South Korea, Taiwan and Japan fit the stylized results from the model, and contrast the impact of these groups on the product variety of their country exports to the United States.

Robert C. Feenstra
Department of Economics
University of California
Davis, CA 95616
and NBER
rcfeenstra@ucdavis.edu

Deng-Shing Huang
Institute of Economics
Academia Sinica
Nankang, Taipei
TAIWAN 11529

Gary G. Hamilton
Department of Sociology
DK 40
University of Washington
Seattle, WA 98195

1. Introduction

Why does economic organization differ across countries, and does it matter? These are the questions our research addresses, focusing on the business groups found in East Asia. The rapid growth common to many of these countries hides the very substantial, and we believe important, differences in how their firms interact. The dominance of the *keiretsu* in Japan is now common knowledge even in the west, having been popularized by novels and movies such as *The Rising Sun*. What is less understood is that business is conducted along completely different lines in other countries of Asia. While the *chaebol* in Korea share certain hierarchical features with the *keiretsu* (but are even more tightly controlled), the Chinese economies of Hong Kong and Taiwan rely heavily on arms-length transactions between unrelated firms. The business groups that occur in these economies are typically less vertically-integrated than their counterparts in Korea or Japan, and are also involved in different stages of the production and distribution process. What factors account for these differences?

In section 2, we briefly review various theories that address the emergence of business groups, or more generally, of vertical and horizontal-integration among firms. Foremost among these are the transactions cost approach of Williamson (1975, 1985) and the "embeddedness" approach of Granovetter (1985). While there are many differences between these, we ague that they are alike in ignoring the role of the *price system* in creating incentives for firm to integrate into business groups. This is a surprising omission, in view of the fact that both theories arose from a dissatisfaction with the Arrow-Debreu paradigm of equilibrium with perfectly competitive pricing. By allowing for business groups to form in a model of monopolistic competition, we find that the price system limits the types of organizational structures that can arise, but does not uniquely determine the structure: there are several type of business groups or "networks" of firms that can occur in equilibrium, each of which is stable. To choose between these multiple equilibria then requires appeal to historical, political or sociological factors.

In section 3, we outline the basic model, which consists of two sectors (upstream and downstream), both of which produce differentiated input. While the final good can be traded internationally, the intermediate inputs are not, and this creates an important role for vertical-integration. Helpman and Krugman (1985, pp. 220-222) used nontraded intermediate inputs to introduce the idea of "industrial complexes," and we will use the same concept to motivate a business group, which is defined as a set of firms that jointly maximize their profits. For sales within a group, the intermediate inputs are priced at marginal cost, whereas for sales outside the group the price includes a markup. This creates an incentive for firms to integrate, so as to allow for the efficient transfer of the intermediate input. The "networked equilibrium" that we solve for determines the prices of all goods, and the number and size of each group, along with the number of firms unaffiliated with any group.

Allowing for vertical and horizontal-integration in the model introduces a level of complexity not usually present in the monopolistic competition framework. Indeed, our finding of multiple equilibrium seems to illustrate nicely the "complexity" theme that Krugman (1995) describes as a general feature of nonlinear systems, including recent models in international trade. Solving these models generally requires numerical methods, and our case is no exception. In section 4 we numerically solve for the networked equilibria, and illustrate these. We establish a general characterization of the business groups according to whether they are primarily located in the upstream market (U-groups), the downstream markets (D-groups), or fully vertically-integrated across both markets (V-groups). In section 5 we discuss testable hypotheses that arise from the model, while the proofs of Propositions are gathered in a separate Appendix.

2. Explanations for Business Groups

There is certainly no shortage of theories to explain the presence of business groups in these economies. According to the political explanation, the rise of these groups is due to 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, 1993). 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, 1986; Wade, 1990). While this link between political and business powers is unquestionably important, it does not appear to account for the observed differences across the countries, nor does it suggest whether the business groups would arise in the absence of government intervention.

Within economics and sociology, there are two principal explanations: the transactions cost approach of Williamson (1975, 1985), and the "embeddedness" approach of Granovetter (1985). The first builds on Coase (1937), and explains economic organization in terms of the efficiency of making transactions in the market versus the firm. The work of Williamson has formalized the nature of these costs and how they might differ across industries, including *ex-ante* and *ex-post* negotiating costs, asset specificity, etc. In order for this approach to explain the differences in market structure across entire economies, however, there needs to be some fundamental difference in the transactions costs across the societies. Williamson (1985, p. 9) allows for this possibility, and in fact attributes it to Kenneth 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 (Arrow, 1974). The efficacy of alternative modes of contracting will thus vary among cultures because of differences in trust (Arrow, 1969, p. 62)." While some researchers have pursued the transactions cost approach to explain the differing market structures across Asian countries (e.g. Levy, 1991), it does not seem to be ideally suited to explain the business groups, which represent neither purely market nor purely firm transactions. Thus, Williamson (1991) creates a new "hybrid" category to account for these groups, lying between the market and the firm.

Trust is also emphasized by Granovetter (1985), who examines the role of social relations in "generating trust and discouraging malfeasance" (p. 490). He argues that the economic behavior in general must be considered as "embedded" within broader social relations, which determine the range of acceptable actions. Thus, 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 interviewees say are evoked to create and assess reliable business associates.[1] 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.[2]

There are many fundamental points of contrast between the transactions cost and embeddedness explanations for economic organization. To name just one, Williamson would assert that the institutional structure develops so as to *minimize* transactions costs, whereas no such claim of optimality is made by Granovetter. But as we have observed above, both theories ultimately rely on some societal differences in trust to explain contrasting market structures across countries. This appears to be an unsatisfactory basis when taken alone on which to explain economic organization, because it ignores a role for the *price system* itself in creating incentives for firms to integrate, and thereby contribute to organizational structure.[3] This omission is surprising in view of the fact that both the transactions cost and embeddedness approach arose from a dissatisfaction with the Arrow-Debreu paradigm of equilibrium with perfectly competitive pricing. It was in this context that Granovetter made his cutting observation that the Arrow-Debreu model was both *under-socialized,* as might be expected from an economic model, but also *over-socialized,* due to the assumed willingness of all agents to play by the rules of the competitive pricing system. To remedy this defect led Granovetter and Williamson alike away from the pricing system, to non-market considerations of trust, bargaining, opportunistic behavior, social norms, and the like.

In abandoning the pricing system, we believe that an important contributing factor to economic organization has been lost. This is especially true when one considers the motivation behind the work of Arrow and Debreu: to explain the simultaneous interaction of many firms, consumers and markets in a *general* equilibrium. It is in this context that we believe the pricing system will create particular incentives for firms to integrate into business groups or not, and that these incentives are independent of either transactions costs or social relations. This is not to say that social or political considerations have nothing to contribute to economic organization. On the contrary, such considerations take on special significance in our framework because the economic system allows for a *multiplicity* of equilibria, each of which has a different organizational structure.[4] The economic logic does not by itself determine which equilibria will arise in any country or context, but only narrows the choice to a few alternatives that satisfy all the prerequisites of fully rational behavior.

These ideas will be developed in the following sections, in the context of a stylized model of business groups. We will consider an economy with two sectors (upstream and downstream), each of which have many firms producing differentiated products, and in which firms can choose to integrate into business groups or not. All firms within a business group act so as to jointly maximize their profits, but new groups and new unaffiliated firms are always allowed to enter. The criteria for an equilibrium will therefore be that all groups and unaffiliated firms, acting in their own best interests, end up earning zero economic profits, so that no further entry takes place. The equilibrium solves for not only prices charged by all firms, but also the number of firms belonging to each group. We will refer to this as a "networked equilibrium," in view of current research in sociology dealing with the "network" structure of modern economies (see the survey by Powell, 1990). Generally, 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. We shall focus on one particular type of network - the common ownership of firms within a business group. We will argue that several structures of business groups can arise in a networked equilibrium, and that these can be distinguished by the degree of vertical and horizontal-integration within the groups, as well as by the extent of product variety that occurs in equilibrium.

3. A Stylized Model of Business Groups

We will consider a simply economy divided into two sectors: an upstream sector producing intermediate inputs from labor, and a downstream sector using these intermediate inputs (and additional labor) to produce a final good. The final good could be sold to firms (as a capital good) or to consumers, but for concreteness, we will consider only the latter case. The intermediate inputs are not be traded internationally, but the final good is traded. Suppose that both the sectors are characterized by product differentiation, so that each firm retains some limited monopoly power by virtue of the uniqueness of its product, and therefore charges a price that is above its marginal cost of production. As usual under monopolistic competition, we will allow for the free entry of firms in both the upstream and downstream sectors, to the point where economics profits are driven to zero. Thus, the profits earned by firms through charging prices above marginal cost go to cover their fixed costs of production, where these fixed costs can represent that research, development, marketing or any other lump-sum costs associated with having a differentiated product.

In contrast to conventional treatments of monopolistic competition, we will also allow firms to align themselves with other firms when this is advantageous. In particular, there will be an incentive for upstream and downstream firms to so align themselves, because in the absence of any such integration the market prices for intermediate inputs are above marginal cost, which indicates that agents could do better by internalizing the sale and pricing the input at exactly its marginal cost of production. By internalizing the sale, the upstream and downstream firms will obtain higher joint profits than if the input was just traded at its market price, and we take this to be the definition of a business group: a set of firms that maximize their joint profits. In the same way that we allow for the free entry of individual firms, we will also allow for the free entry of business groups. Thus, we are abstracting for the moment from the many political and social factors that will influence the configuration of a business group, but simply ask what outcomes we might expect from the pure economics, focusing on the pricing decisions of the firms in general equilibrium.

The model we have described is visually represented in Figure 1, where the upstream and downstream sectors are shown at the top and bottom portions, respectively, with products labeled x_i and y_i. Each dot in the figure represents one differentiated product. Two business groups are illustrated, labeled as groups *a* and *b*, each of which produce the same number M_b of intermediate inputs and N_b of final goods. Profits of each business group are denoted by Π_b, and the total number of groups is G. In addition, we illustrate several unaffiliated (or "competitive") upstream firms, producing M_c inputs and earning profits Π_{xc}, together with a number of unaffiliated downstream firms, producing N_c final goods and earning profits Π_{yc}. In the free entry equilibrium, all these profits must be non-posi'ive. We will suppose that there is a single factor of production called labor, and choose the wage rate as the numeraire.

With this notation, the profits of a business group are denoted by,

$$\Pi_b = [N_b y_b(q_b - \phi_b) - N_b k_{yb}] + [\tilde{x}_b \tilde{M}_b(p_b - 1) - M_b k_{xb}] - \alpha, \tag{1a}$$

where: y_b is the output of each final good, sold at price q_b and produced with marginal cost ϕ_b and fixed costs k_{yb}; $\tilde{M}_b$ is the number and $\tilde{x}_b$ is the quantity sold of each intermediate input, at the price p_b and produced with marginal costs of unity and fixed costs of k_{xb}; the number of intermediate inputs sold cannot exceed the number developed, so that $\tilde{M}_b \leq M_b$; and α is the level of fixed or "administrative" costs associated with the running of a business group. To motivate these costs, we will argue below that the operation of a group will involve the transfer of funds between firms, that would inevitably involve some deadweight loss in the absence of perfect information on firm costs. While we do not model this agency problem explicitly, the fixed costs α reflect these costs, and any other resources devoted to the coordination of group activities.[5] To the extent that these coordination costs depend on the size of the group, measured by N_b and M_b, then this would be a reason for the fixed costs k_{yb} and k_{xb} to differ between business groups and unaffiliated firms, as we shall allow.

Each business group will be able to choose whether to sell all of the inputs that it has developed or not, and of course, chooses the price for these inputs and its outputs. The marginal cost of producing each output variety is assumed to be given by the CES function:

$$\phi_b = w^{\beta}\left[M_b + (G-1)\tilde{M}_b p_b^{1-\sigma} + M_c p_c^{1-\sigma}\right]^{\left(\frac{1-\beta}{1-\sigma}\right)}, \qquad (1b)$$

where: w is the wage rate, and labor is a proportion β of marginal costs; M_b inputs are purchased internally at the price of unity; $\tilde{M}_b$ are inputs purchased from (G-1) other business groups at the price of p_b; and M_c inputs are purchased from unaffiliated upstream firms at the price of p_c. We will set w=1 by choice of numeraire, and suppress it in all that follows. The elasticity of substitution σ is assumed to exceed unity, so that it is meaningful to think of changes in the number of inputs available from each source.

Turning to the unaffiliated firms, the upstream firms have profits:

$$\Pi_{xc} = x_c(p_c - 1) - k_{xc}, \tag{2a}$$

where x_c is the output of each intermediate input, sold at price p_c and produced with marginal cost of unity and fixed costs k_{xc}. The elasticity of demand facing these firms is σ, so that they will choose the prices:

$$p_c = \left(\frac{\sigma}{\sigma - 1}\right). \tag{2b}$$

Substituting these into (2a) and setting profit equal to zero, we obtain the level of output in the free-entry equilibrium:

$$x_c = (\sigma - 1)k_{xc}. \tag{2c}$$

The unaffiliated downstream firms have profits given by:

$$\Pi_{yc} = y_c(q_c - \phi_c) - k_{yc} \;, \tag{3a}$$

where y_c is the output of each final good, sold at price q_c, and produced with marginal cost ϕ_c and fixed costs k_{yc}. The marginal cost of producing each output variety is:

$$\phi_c = \left[G\tilde{M}_b p_b^{1-\sigma} + M_c p_c^{1-\sigma}\right]^{\left(\frac{1-\beta}{1-\sigma}\right)} \;, \tag{3b}$$

where $\tilde{M}_b$ are inputs purchased from G other business groups at the price of p_b, and M_c inputs are purchased from unaffiliated upstream firms at the price of p_c. Recalling that we have normalized w=1, it is apparent that the marginal costs for a business group in (1b) are *less than* those for an unaffiliated firm in (3b), because the business groups are able to purchase their own inputs at the cost of unity.

On the demand side, we will assume a constant elasticity of substitution between output varieties, denoted by η. Then each unaffiliated downstream firm will choose the optimal price,

$$q_c = \left(\frac{\eta}{\eta - 1}\right)\phi_c. \tag{3c}$$

Substituting (3c) into (3a) and setting profits equal to zero, we obtain the level of output:

$$y_c = (\eta - 1)k_{yc} / \phi_c. \tag{3d}$$

We will also need to derive rules for the optimal prices p_b and q_b charged by the business group, as well as derive the level of output in a free-entry equilibrium; this is done below. The complete model will then consist of a number of business groups G, and nonaffiliated firms M_c and N_c, such that the profits earned by each group are non-positive. To close the model we will use a full-employment condition for labor. There are several ways to write this condition, but one that will be convenient is the equality of national product measured by the value of final goods, and total wages income received. The latter is just L, or the labor supply. The former is the total value of final goods produced by business groups and any nonaffiliated downstream firms, so that,

$$L = GN_b q_b y_b + N_c q_c y_c. \tag{4}$$

Turning to the pricing and product variety decision for a business group, we will allow each group to develop its optimal range of inputs and outputs, taking the range of varieties developed by every other group, and by unaffiliated firms, as given. Note that there is a natural limit on the range of varieties that any group will want to produce. Starting with a group of some size, if it were to develop another differentiated final product for sale to consumers, then this would involve the usual fixed costs, but the revenue received from the sale of the good would in part come by drawing demand away from other products sold by the same group. Thus, after it has reached some size a group would no longer find it profitable to expand its range of final goods, even though an unaffiliated firm might choose to enter the market.

In addition to developing its own product varieties, we should also consider the incentives for the acquisition of other firms and their products through merger. This could occur through the merger of a business group with an unaffiliated firm, or through the merger of groups. To keep our model tractable, we will rule out the former activity by supposing that unaffiliated firms have slightly lower fixed costs associated with product development, which are automatically increased if that firm is part of a group: that is, we will assume that $k_{yb} > k_{yc}$ and $k_{xb} > k_{xc}$. These extra fixed costs associated with the business group should be interpreted as administrative costs that are additional to the fixed costs of α. This still leaves the possibility of mergers across groups. In order to rule out this activity we need to appeal to some extra costs associated with governing a group of increasing size, that lie outside the notation of our model.

To establish the optimal size of a group, we consider the demand for differentiated final products. We have already assumed that this arises from a CES demand system with elasticity η, and that the final products are traded internationally. It follows that the demand for a single output variety from a business groups can be written as:

$$y_b = \frac{q_b^{-\eta}(L + w^*L^*)}{[GN_b q_b^{1-\eta} + N_c q_c^{1-\eta} + N^*(q^*)^{1-\eta}]} \quad , \tag{5}$$

where w*L* in the numerator is foreign income, and N* in the denominator is the range of foreign varieties, sold at the price of q*. Since the intermediate inputs are not traded, trade is balanced in the final goods sector. Due to trade-balance, the foreign wage in (5) is endogenous, and if we solve for its equilibrium value, the demand expression is simplified as,[6]

$$y_b = \frac{q_b^{-\eta}L}{(GN_b q_b^{1-\eta} + N_c q_c^{1-\eta})}. \tag{5'}$$

Thus, making use of the trade-balance condition, the total (domestic plus foreign) demand for each final product with trade in (5) is identical to the domestic demand in the absence of trade in (5'): while trade benefits consumers through increased product variety, it does not affect the pricing decisions of firms.

Each business groups sells a positive range N_b of final product varieties, and it follows from (5') that the elasticity of demand with respect to a change in the price of all its products are,

$$\frac{\partial y_b}{\partial q_b}\frac{q_b}{y_b} = -[\eta + s_{yb}(1-\eta)], \tag{6a}$$

where the market share of its products is,

$$s_{yb} = \frac{N_b q_b^{1-\eta}}{(GN_b q_b^{1-\eta} + N_c q_c^{1-\eta})}. \tag{6b}$$

With the elasticity in (6b), the business group will sell its output at the price,

$$q_b = \left(\frac{1}{\eta - 1}\right)\left[\eta + \left(\frac{s_{yb}}{1 - s_{yb}}\right)\right]\phi_b, \tag{7}$$

which can be compared to the pricing formula for an unaffiliated firm in (3c).

To determine the optimal number of output varieties, we can differentiate (5) with respect to the number of varieties for a *single* group:

$$\frac{d\Pi_b}{dN_b} = y_b(q_b - \phi_b) - k_{yb} - s_{yb} y_b (q_b - \phi_b) = 0, \tag{8a}$$

which implies,

$$[y_b(q_b - \phi_b) - k_{yb}] = \left(\frac{s_{yb}}{1 - s_{yb}}\right) k_{yb} > 0. \tag{8b}$$

The first terms on the right of (8a) are the direct gain in profits from selling another output variety, less the fixed costs of production. However, expanding product variety will also have the effect of reducing the demand for other varieties sold by the same group, which is the last term on the right of (8a). The optimal choice for the number of product varieties will just balance these two effects, giving the equality in (8b). By combining (7) and (8b) we obtain the optimal quantity of output for any differentiated final product,

$$y_b = (\eta - 1)k_{yb} / \phi_b. \tag{9}$$

Before solving for the remaining equilibrium conditions, it is useful to consider the possible configurations of business groups and unaffiliated firms that can arise in a zero-profit equilibrium. It is convenient to focus on a special case in which the administrative costs α are very small, and similarly, the fixed costs k_{yb} and k_{xb} for a business group and nearly the same as k_{yc} and k_{xc} for unaffiliated firms. In this case, the business groups will tend to drive out either the upstream or downstream unaffiliated firms (or both). The reason is that, except for the extra administrative costs, a business group producing N final goods and M intermediate inputs is more efficient than a set of unaffiliated firms selling the same number of products, since the business group prices its intermediate inputs internally at their marginal cost. It follows that in a zero-profit equilibrium with sufficiently small administrative costs, the upstream unaffiliated firms and the downstream unaffiliated firms cannot both occur: in our notation, $\Pi_b = 0$ with α sufficiently small and $k_{yb} \approx k_{yc}$, $k_{xb} \approx k_{xc}$, implies that either $\Pi_{xc} < 0$ or $\Pi_{yc} < 0$.

Thus, an equilibrium organization with very small administrative costs has three possible configurations: **(1)** ***U-groups*** - business groups are the only firms in the upstream sector (M_c=0) and are vertically-integrated downstream, but also compete with some unaffiliated downstream firms $(N_c > 0)$; **(2)** ***D-groups*** - business groups are the only firms in the downstream sector (N_c=0) and are vertically-integrated upstream, while purchasing inputs from some unaffiliated upstream firms $(M_c > 0)$; **(3)** ***V-groups*** - the business groups drive out unaffiliated producers in both the upstream and downstream sectors (M_c=N_c=0), and are therefore fully vertically integrated. In the latter case, the business groups must decide whether they will sell intermediate inputs to each other or not.

These possible configurations of the business groups are illustrated in Figure 2. In the first case, the *U-groups* sell inputs to unaffiliated downstream firms, as indicated by the solid arrow. For convenience we have illustrated only a single business group, but of course, in equilibrium there will generally be multiple groups. In the second case, the *D-groups* purchase inputs from unaffiliated upstream firms, as illustrated again by the solid arrow. In the final case, only business groups occur in the *V-group* equilibrium, and they may or may not sell inputs to each other, as indicated by the dashed arrows. These three type of equilibria can still arise when the level of administrative costs is not necessarily small, but in that case there would also be a fourth possibility not illustrated in Figure 2: the business groups could coexist with *both* upstream and downstream unaffiliated firms.

From this description of the "networked equilibria," we see the price system itself imposes some structure on the organization of the economy, but equally important, does not necessarily determine which of these equilibria will arise: in principle, an economy with the same underlying conditions (such as labor endowments and consumer tastes) could give rise to more than one possible equilibrium structure of the business groups. We will need to check whether each of these configurations can actually arise and is locally stable, meaning that once they are established there is no reason for it to change, even as the economy experiences some degree of change in underlying conditions. This will be done in the next section, where we solve for the remaining equilibrium conditions in each of the configurations illustrated in Figure 2, and then compute whether these equilibria occur for various parameter values. We will not solve for the complete equilibrium conditions when business groups coexist with both upstream and downstream unaffiliated firms, but in the computations we will still find that this equilibrium structure can arise for some parameter values.

4. Determination of Networked Equilibria

To explore the possibility of multiple equilibria more closely, we need to consider the incentives for firms to vertically-integrate within a business group. As we have already argued, the gains from integration are that intermediate inputs can be sold at their marginal cost, leading to greater efficiency. It follows, therefore, that the incentive to integrate will depend on how far the market price for an input differs from its marginal cost. This in turn depends on the degree of concentration in the upstream sector. But now there is a circularity in the argument: the incentive to vertically-integrate is strongest when there is a high degree of concentration in the upstream sector, but this concentration could simply reflect that presence of a *small* number of business groups dominating that sector. Conversely, if there were a *large* number of business groups (and unaffiliated firms) selling in the upstream market, then the markups would be correspondingly lower, as would be the incentive to vertically-integrate. This kind of circular reasoning is precisely what gives rise to multiple equilibria in any economic model, and ours is no exception. In the stylized economy we therefore expect to observe both equilibria with a small number of business groups that are highly concentrated/integrated, and those with a large number of groups (and unaffiliated firms) that are less concentrated/integrated. The economics of the situation does not select further between these possible organizational structures: both can arise, and could be locally stable.

To solve for the possible equilibria, we begin by determining the range of inputs developed by each group (M_b) and the range of inputs sold by each group ($\tilde{M}_b$). This are obtained by maximizing profits in (1), with the results:

<u>Lemma 1</u>

(a) $$\frac{d\Pi_b}{dM_b} = \frac{x_b}{(\sigma-1)} - k_{xb},$$

(b) $$\frac{d\Pi}{d\tilde{M}_b} = \frac{\tilde{x}_b}{(\sigma-1)} \text{ if } p_b \text{ is finite.}$$

Part (a) of Lemma 1 reflects the gain in profits from developing a new product and using it *internally*, while part (b) reflects the additional profits from selling the input *externally*. The expression in (b) is positive whenever the optimal price p_b is finite, and implies that the group will choose to sell all of its inputs, so that $\tilde{M}_b = M_b$. In this case, summing (a) and (b) and setting the total change in profits equal to zero, we obtain,

$$x_b + \tilde{x}_b = (\sigma-1)k_{xb}, \tag{10}$$

which shows that a business group will sell the same quantity of each input as an unaffiliated upstream firm, as in (2c).

We next need to determine whether a group will ever decide to price $p_b = +\infty$, meaning that it will not sell to other firms.[7] It would be impossible for this situation to arise in a *U-group* equilibrium, since in that case there are no unaffiliated upstream producers, so that if the business groups decided to not sell intermediate inputs then no unaffiliated downstream producers could survive (and the equilibrium would be one of *V-groups*). Thus, to determine whether the groups will choose to sell to other firms, we focus on the case of either *V-groups* or *D-groups*, so that $N_c = 0$:

Lemma 2

Suppose that $N_c = 0$. Then each group will sell inputs to the other groups if and only if,

$$G > \left(\frac{\sigma}{\sigma - 1}\right). \tag{11a}$$

When (11a) holds, the optimal prices are given by:

$$\left(\frac{p_b - 1}{p_b}\right) = \frac{1}{[\sigma + s_{xb}(1-\sigma)]}\left(\frac{G}{G-1}\right). \tag{11b}$$

In (11b), s_{xb} is the share of total sales of intermediate inputs made by each business group, and is given by,

$$s_{xb} = \left[\frac{M_b p_b^{1-\sigma}}{(G-1)M_b p_b^{1-\sigma} + M_b + M_c p_c^{1-\sigma}}\right]. \tag{12}$$

Then $[\sigma + s_{xb}(1\text{-}\sigma)]$ is the elasticity of demand for input varieties from one group. Equation (11b) differs from the standard Lerner pricing formula by the extra term G/(G-1). This reflects the fact that when a group sells an input, it will give competing firms a cost advantage, thereby lowering profits in the final goods market. Accordingly, it will charge a higher price than usual. If G is too small, so that (11a) is violated, then profits will continually increase as p_b is raised and the group optimally chooses $p_b = +\infty$. In this situation the groups sells none of its inputs externally, which is equivalent to choosing $\tilde{M}_b = 0$.

The line G=σ/(σ-1) is illustrated in Figure 3 as "G=S/(S-1)", and groups will not sell to each other for equilibrium points below this line. Taking this possibility into account, we have the following characterization of *V-group* equilibria:

Proposition 1

Assume $N_c = 0$. Then the *V-group* equilibria can take one of two forms. Either:

(a) the business groups do not sell inputs to each other ($\tilde{M}_b = 0$), and the number of groups is given by the unique positive solution to,

$$G^2\left(\frac{\Delta\alpha\eta}{L}\right) + G\left[1 - \frac{(\eta-1)\Delta\alpha}{L}\right] - (1+\Delta) = 0\,, \tag{13}$$

provided that $G \leq \sigma/(\sigma\text{-}1)$, where $\Delta \equiv (\sigma-1)/[(\eta-1)(1-\beta)]$;

(b) the business groups do sell to each other ($\tilde{M}_b = M_b$), while the number of groups is given by any positive solution to,

$$G^2\left(\frac{\tilde{\Delta}\alpha\eta}{L}\right) + G\left[1 - \frac{(\eta-1)\tilde{\Delta}\alpha}{L}\right] - (1+\tilde{\Delta}) = 0\,, \tag{14a}$$

provided that $G > \sigma/(\sigma\text{-}1)$, where $\tilde{\Delta} \equiv [(\sigma / f(p_b)) - 1] / [(\eta-1)(1-\beta)]$, and,

$$f(p_b) \equiv 1 - (\sigma - 1)\left[\frac{(p_b - 1)p_b^{-\sigma}(G-1)}{1 + (G-1)p_b^{-\sigma}}\right]. \tag{14b}$$

This Proposition is illustrated in Figure 3, where we numerically solve for the equilibria using the parameter values α=0.2, β=0.5, η=5, k_{xb}=k_{yb}=5, L=1000, and incremental values of σ from unity to 3.5. The *V-group* equilibria are illustrated by triangles. Beginning in the lower-left corner of the figure, the V-group equilibria described in part (a) of Proposition 1 are shown by the (approximately) straight line that slopes upward to meet the G=S/(S-1) curve at about σ=2.5. This line is a graph of the positive solutions to (13), and along that portion of the V-group equilibria, the business groups are not selling inputs to each other. For higher values of σ the V-group equilibria crosses the G=S/(S-1) curve, at which point the groups begin selling inputs and the equilibrium is described by equation (14) in part (b). For each value of σ, this equation has multiple solutions for G, which is illustrated by the graph of the V-group equilibria bending back on itself around σ=3.2, and then again sloping upward around σ=2.8.

We have numerically checked the stability of the equilibria along all portions of the V-group graph. To do so, we allow an exogenous increase in the number of business groups G, and calculate the corresponding profits of a group Π_b after allowing all other variables to adjust to their equilibrium values. If these profits are negative, then some business groups would be induced to leave and the economy would return to its initial equilibrium, so the system is *stable*; but if the profits are positive following an increase in G, then even more groups would enter, and the initial equilibrium is *unstable*. The result of this calculation is that all equilibria along the lower-portion of the V-group graph are stable, whereas the middle-portion where the graph bends back on itself are unstable, and then the top-portion where it again slopes upward is stable.

The contrast between the stable and unstable branches of the V-group graph can also be seen in Figure 4, where we illustrate the equilibrium price p_b charged by the business groups for external sales of the intermediate inputs. The stable portion corresponds to a high price for the intermediate input, whereas the unstable branch corresponds to a low price for the input. The occurrence of these high-priced and low-priced equilibria, with a small and large number of business groups, respectively, corresponds quite closely to the intuition for multiple equilibria described in the beginning of this section. We have also checked that at all the V-group equilibria illustrated, the profits of both upstream and downstream unaffiliated firms are negative when they have fixed costs of $k_{xc}=k_{yc}=5$ or slightly less. The point at which unaffiliated firms begin to earn positive profits occurs at the top-portion of the V-group graph, where it makes a transition to both D-group and U-group equilibria, as described below.

We next consider the case where unaffiliated upstream firms occur along with the business groups, so the equilibrium is one of *D-groups:*

Proposition 2

Assume $N_c = 0$. Then in the *D-group* equilibrium unaffiliated upstream firms are profitable ($M_c > 0$), and the business groups also sell to each other ($\tilde{M}_b = M_b$), while the number of groups is given by:

$$G = \left(\frac{k_{xc}}{k_{xb}}\right)\left(\frac{\sigma}{\sigma-1}\right)^{\sigma}\left[1+(G-1)p_b^{-\sigma}\right] \tag{15a}$$

which implies,

$$G = (p_b^{\sigma}-1)\Big/\left[\left(\frac{p_b(\sigma-1)}{\sigma}\right)^{\sigma}\left(\frac{k_{xb}}{k_{xc}}\right)-1\right], \tag{15b}$$

provided that this expression *exceeds* that given in (14).

The equilibrium number of groups given by (15a) satisfies $G>\sigma/(\sigma-1)$, needed to ensure that the groups sell their inputs externally, provided that k_{xc} is not too much smaller than k_{xb}. The D-group equilibria obtained from (15) are illustrated near the top of Figure 3. Beginning at the left this equilibrium first appears around $\sigma=1.8$, where the other parameter values are the same as used above: $\alpha=0.2$, $\beta=0.5$, $\eta=5$, $k_{xb}=k_{yb}=5$, and $L=1000$. We choose k_{xc} slightly less that 5 so that it is unprofitable for business groups to take over the upstream unaffiliated firms and face the slightly higher fixed costs of $k_{xb}=5$.[8] For higher values of σ the number of groups declines along the D-group graph, and up to the value $\sigma=2.6$ we have confirmed that the D-group equilibria are stable, in the sense that a slight increase (decrease) in the number business groups will lower (raise) their profits from zero.

For values of σ exceeding 2.6, however, there is a bifurcation in the D-group equilibria, with the lower and upper branches as illustrated. Both these branches have special features which make them inconsistent with a stable D-group equilibrium. Along the *lower* branch, the D-group equilibrium is *unstable* in two senses: an increase (decrease) in the number business groups will raise (lower) their profits; but also, it is impossible to find a value for k_{xc} that will ensure that there is no incentive for the business group to take over the unaffiliated upstream firms. This unstable branch appears to be an extension of the unstable portion of the V-group equilibria. The *upper* branch of the D-group graph for $\sigma>2.6$, which we have labeled with a *question mark* in Figure 3, satisfies all the conditions of a stable D-group equilibrium except for one: profits of the *downstream* unaffiliated firms are positive along this branch, so that they would want to enter. In these region, therefore, we expect to see business groups coexisting with both upstream and downstream unaffiliated firms. As we have already noted, such an equilibrium is possible whenever the business groups have positive administrative costs. We have not solved for the complete equilibrium conditions in this case, and it lies outside of the taxonomy of configurations we are focusing on.

Finally, we turn to the case of *U-groups*, in which case $N_c > 0$. We assume that the business group cannot discriminate in its sales to other groups or to downstream unaffiliated firms. Then the optimal price for external sales of the intermediate input is:

Lemma 3

With $M_c = 0$ and $N_c \geq 0$, the optimal price p_b will satisfy:

$$\left(\frac{p_b - 1}{p_b}\right) = \left\{ \frac{1 + \frac{\theta}{(G-1)}\left[1 + \left(\frac{s_{yc}}{1 - s_{yb}}\right)(\lambda - 1)\right]}{\sigma + (1-\sigma)\left[\theta s_{xb} + \frac{(1-\theta)}{G}\right]} \right\} \tag{16}$$

where θ is the fraction of external sales $\tilde{x}_b$ that are sold to other groups, and,

$$\lambda = \left[\frac{1 + (G-1)p_b^{1-\sigma}}{G p_b^{1-\sigma}}\right]. \tag{17}$$

In the denominator of (16), s_{xb} is still given by (12) but with $M_c = 0$, and is interpreted as the share of total demand for intermediates by a group (including internal demand) coming from *one* other group. We could analogously define the share of total demand for intermediates by a unaffiliated downstream firm supplied by *one* group, which is simply (1/G). Thus, the weighted average $[\theta s_{xb} + (1-\theta)/G]$ appearing in the denominator of (16) can be interpreted as the share of total demand for intermediates supplied by one group, so that the entire denominator is simply the elasticity of demand for the inputs of a group. If the numerator were unity, then (16) would be a conventional Lerner pricing formula. Instead the numerator exceeds unity, reflecting the fact that when a group sells an input, it will give competing firms a cost advantage, thereby lowering profits in the final goods market. Accordingly, the business group charges a higher price for its inputs than would a firm that is not vertically-integrated across both markets.

The amount by which the numerator of (16) exceeds unity depends on $\theta/(G-1)$, which is interpreted as the fraction of external sales of a group made to *one* other business group. This amount is, in turn, related to the vertical-integration of a group. To see this, initially measure the degree of vertical-integration by the ratio of internal purchases of the input x_b to the value of external sales, $p_b\tilde{x}_b$. This ratio $(x_b / p_b\tilde{x}_b)$ differs from the fraction of external sales provided to one other business group, $\theta/(G-1)$, only because the internal purchases are at the price of unity. Making this adjustment for prices, we therefore find that the ratio of internal to external sales of the input is $(x_b / p_b\tilde{x}_b) = p^{\sigma-1}\theta/(G-1)$. Thus, the term $\theta/(G-1)$ appearing in (16) is related to the degree of vertical-integration, and the higher is this term, then the higher will be the price charged for intermediate inputs. The other terms appearing in the numerator of (16) are more difficult to interpret, but λ is defined in (17), while s_{yb} is the downstream market share of *one* business group and s_{yc} is the downstream share of *all* unaffiliated firms.

The measure of vertical-integration we shall adopt differs slightly from our discussion above, and is the ratio of internal purchases to the *total* value of purchases for a business group. For any configuration of the business groups, this is measured by:

$$\text{Internalization Ratio} = \left(\frac{x_b}{x_b + \theta p_b \tilde{x}_b + p_c x_c (M_c / G)} \right). \tag{18}$$

In the denominator, the term $\theta p_b \tilde{x}_b$ measures the sales by one group to all other groups, which by symmetry equals the purchases of that group from all others, while $p_c x_c (M_c / G)$ equals the purchases of one group from all unaffiliated upstream firms. Empirically, the numerator of (18) is measured by the value of internal sales within a group, while the denominator can be measured by the total sales of a group minus the value-added of all its firms, yielding the total purchases of intermediate inputs.

Returning to the case of *U-groups,* with the prices given by Lemma 3 the equilibrium is determined by:

Proposition 3

Assume $M_c = 0$. Then in the *U-group* equilibrium the business groups sell inputs to unaffiliated downstream firms ($N_c > 0$) and to each other ($\tilde{M}_b = M_b$), while the number of groups is given by any positive solution to:

$$\frac{\alpha\tilde{\Delta}G^2}{L}\left[\left(\frac{s_{yb}}{1-s_{yb}}\right)+\eta\right]+G\left[1-\left(\frac{s_{yb}}{1-s_{yb}}\right)\tilde{\Delta}+\frac{\alpha\tilde{\Delta}\eta}{L}\left(\frac{N_c k_{yc}}{N_b k_{yb}}\right)\right]+\left(\frac{N_c k_{yc}}{N_b k_{yb}}\right)=0, \tag{19a}$$

provided that $G > \sigma/(\sigma\text{-}1)$, where $\tilde{\Delta} \equiv [(\sigma / g(p_b)) - 1] / [(\eta - 1)(1 - \beta)]$ and,

$$g(p_b) = 1 - (\sigma - 1)(p_b - 1)\left\{ \frac{p_b^{-\sigma}[(G-1) + \lambda(N_c k_{yc} / N_b k_{yb})]}{1 + p_b^{-\sigma}[(G-1) + \lambda(N_c k_{yc} / N_b k_{yb})]} \right\}. \tag{19b}$$

The number of business groups in this equilibrium is shown along the U-group graph in Figure 3. This is a natural extension of the stable portion of the V-group graph for values of σ exceeding 2.9, and arises because the profits of unaffiliated downstream firms in the V-group equilibrium then become positive. In the U-group equilibrium, these downstream firms enter until they earn zero profits. We have adjusted the value for $k_{yc}<5$ along these equilibria so that it is just unprofitable for the business groups to take over the downstream unaffiliated firms and pay the higher fixed costs of $k_{yb}=5$.[9] The presence of the downstream unaffiliated firms means that the business groups themselves are not strongly vertically-integrated. This is reflected is a low price for the intermediate input, shown along the U-group graph in Figure 4, and also by the internalization ratio (18) illustrated in Figure 5.

Along the V-group equilibria for low value of σ, the business group are not selling any of the intermediate inputs ($p_b=+\infty$), so the internalization ratio is unity in Figure 5. It begins to fall for σ exceeding 2.5, as the business groups begin selling to each other. The internalization ratio is considerably smaller along the unstable branch of the V-group graph, reflecting both the higher number of business groups and lower price for the intermediate input. This ratio is smaller yet along the U-group equilibrium, and smallest along the D-group equilibrium, due to the larger number of business groups in those situations. Thus, when business groups are primarily located in the upstream or downstream markets, they will display a lower internalization ratio then the stable equilibria consisting of vertically-integrated groups. This offers an operational method to distinguish U-groups and D-groups from V-groups in practice, in addition to their sales in the different market segments.

5. Testable Hypotheses

Will the difference in the organizational structure have an effect on other characteristics of the economy? We can argue that it will have an important impact on the *total product variety* of the final good. To see how this can arise theoretically, note that with the value of fixed costs higher for the business groups than an unaffiliated downstream firm, $k_{yb}>k_{yc}$, then from (3d) and (9) the same inequality applies to the value of variable costs for the group and unaffiliated firm, $\phi_b y_b > \phi_c y_c$. But since costs are lower for the business group, and output prices are higher, this implies that the business groups choose a higher output level for each product variety and also earn higher revenue,

$$y_b > y_c \text{ and } q_b y_b > q_c y_b \,. \tag{20}$$

With the business groups producing longer production runs, we might expect that there is some tradeoff in terms of having less product variety. To determine this, we use the overall full-employment condition for the economy (4), to solve for product variety as:

$$GN_b + N_c = \frac{L}{q_b y_b} + N_c\left(1 - \frac{q_c y_c}{q_b y_b}\right). \tag{21}$$

The left-side of (21) measures total product variety, and from our results in (20), the final term on the right-hand side of (21) is positive. Thus, if we compare two different equilibria with the same parameter values (same L, η, etc.), but differing values for the number of unaffiliated downstream firms N_c, the equilibrium with the *larger* value of N_c will tend to have the *higher* total product variety in the economy: increasing N_c on the right of (21), *ceteris paribus*, will increase total product variety on the left. This result occurs because the unaffiliated downstream firms produce shorter production runs than the business groups, so that the economy achieves greater product variety. It applies in particular to a comparison of an economy with *V-groups* (meaning there are no downstream unaffiliated firms), to that with *U-groups* (so that downstream unaffiliated firms exist): *the U-group equilibrium will tend to have greater product variety.*

This theoretical prediction needs to be qualified, however, since in comparing different equilibria the value of $q_b y_b$ in (21) can differ, which would have a further impact on product variety and could reverse our result. Thus, the tendency for the economy with more unaffiliated downstream firms to have greater product variety needs to be checked numerically in our model. This characteristic of the networked equilibria is displayed in Figure 6, where we show the extent of product variety in the final goods market, as defined by (21).

In Figure 6 we see that the extent of product variety rises continuously for higher values of σ in the V-group equilibria, but that these levels are always less than the product variety in either the D-group or the U-group equilibria. Product variety in the D-group and U-group equilibria themselves are roughly comparable.[10] Thus, when the business groups sell to downstream unaffiliated firms, as in the U-group configuration, the economy will achieve a greater variety of the final product than in any *stable* equilibria consisting of vertically-integrated groups. This confirms the theoretical prediction made above. 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.[11]

The differing levels of product variety illustrated in Figure 6 have a direct impact on the welfare of the representative consumer in the economy. This can be computed by dividing the wage by the CES cost of living index, which reflects the price and range of product varieties available. Performing this calculation, we find that a graph of welfare in the economy (not illustrated) is visually quite similar to Figure 6: the level of welfare rises for larger value of σ along the V-group equilibria, and is rises further in either the D-group or U-group equilibria. However, we also find that welfare in the U-group equilibria is *higher* than in the D-group equilibrium. This reflects the fact that while the level of product variety is similar in these two cases, the prices of final goods are lower in the U-group equilibrium due to the sales of unaffiliated downstream firms, providing an welfare gain to consumers.

In the companion paper, we test this hypothesis on product variety using data from South Korea, Taiwan, and Japan, which we argue have differing structures of business groups. The comparison of Korea and Taiwan is simplified because these economies are of roughly similar size. We present evidence to argue that the Korean business groups are strongly vertically-integrated (like V-groups), while the Taiwanese groups are located mainly in the upstream sector (U-groups). According to our hypothesis, we therefore expect to observe greater product variety in final goods from Taiwan, which we shall confirm empirically. We also argue that the business groups in Japan combine aspect of vertical-integration (V-groups) and downstream orientation (D-groups). However, since Japan is much larger than either Taiwan or Korea, in order to apply our model in that case we must consider the impact of country size on product variety. As is evident from (21), an increase in country size, *ceteris paribus*, will lead to an increase in product variety. Thus, Japan can be expected to have greater product variety than either Taiwan or South Korea, as we shall also confirm empirically.

Footnotes

[1] 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 Orru, Biggart and Hamilton (1997).

[2] 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, with workers leaving an enterprise to develop related products.

[3] This argument is developed in detail in Hamilton and Feenstra (1996), where we trace the development of both the transactions cost and embeddedness theories.

[4] These features also appear in the work of Avner Greif (1994).

[5] Williamson (1975,1985) refers to these as "governance" costs. Note that they are the opposite of transactions costs, since they arise from conducting economic activity within an organization but would not arise from conducting these activities on the market.

[6] Trade balance in final goods implies that $LN^*(q^*)^{1-\eta}/[GN_b q_b^{1-\eta} + N_c q_c^{1-\eta} + N^*(q^*)^{1-\eta}]$ $= w^* L^* (GN_b q_b^{1-\eta} + N_c q_c^{1-\eta})/[GN_b q_b^{1-\eta} + N_c q_c^{1-\eta} + N^*(q^*)^{1-\eta}]$, where the left-side is home import expenditure and the right-side is home exports. Using this equality in (5), we immediately obtain (5').

[7] We do not allow a group to charge different prices to various purchasers, meaning that it cannot price discriminate between selling to other groups and selling to unaffiliated downstream producers.

[8] The stable D-group equilibria illustrated in Figure 3 were calculated for values for k_{xc} ranging from 4.905 to 4.92. For σ less than 1.8, it was not possible to find a value for k_{xc} such that in the D-group equilibrium there would be no incentive for the groups to take over the unaffiliated upstream firms.

[9] The U-group equilibria illustrated in Figure 3 were calculated for values for k_{yc} ranging from 4.73 to 4.82. We have also confirmed that the profits of the upstream unaffiliated firms are strictly negative along these equilibria, and that these equilibria are stable, with a slight increase (decrease) in the number of groups leading to negative (positive) group profits. The U-group equilibria continue to exist for higher values of σ beyond those illustrated in Figure 3.

[10] While product variety appears slightly higher in the U-group equilibria than the D-group equilibria in Figure 6, this is partially due to using slightly lower values of fixed costs for the unaffiliated downstream firms than for the business groups.

[11] A related result in a quite different setting is obtained by Pakes and McGuire (1994), who find that collusion between firms in a model with differentiated products leads to less product variety than obtained in a non-collusive, Nash equilibrium.

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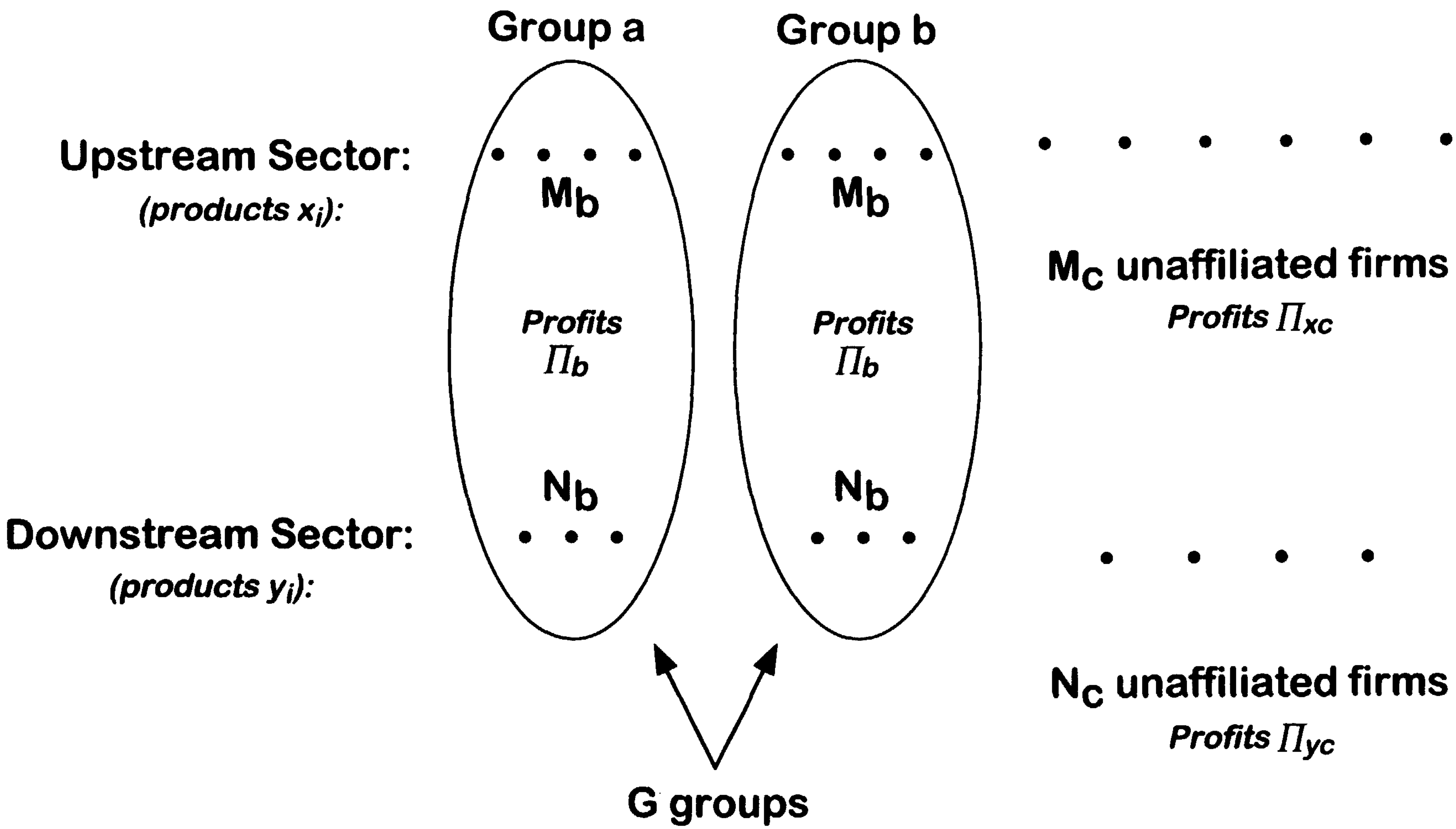
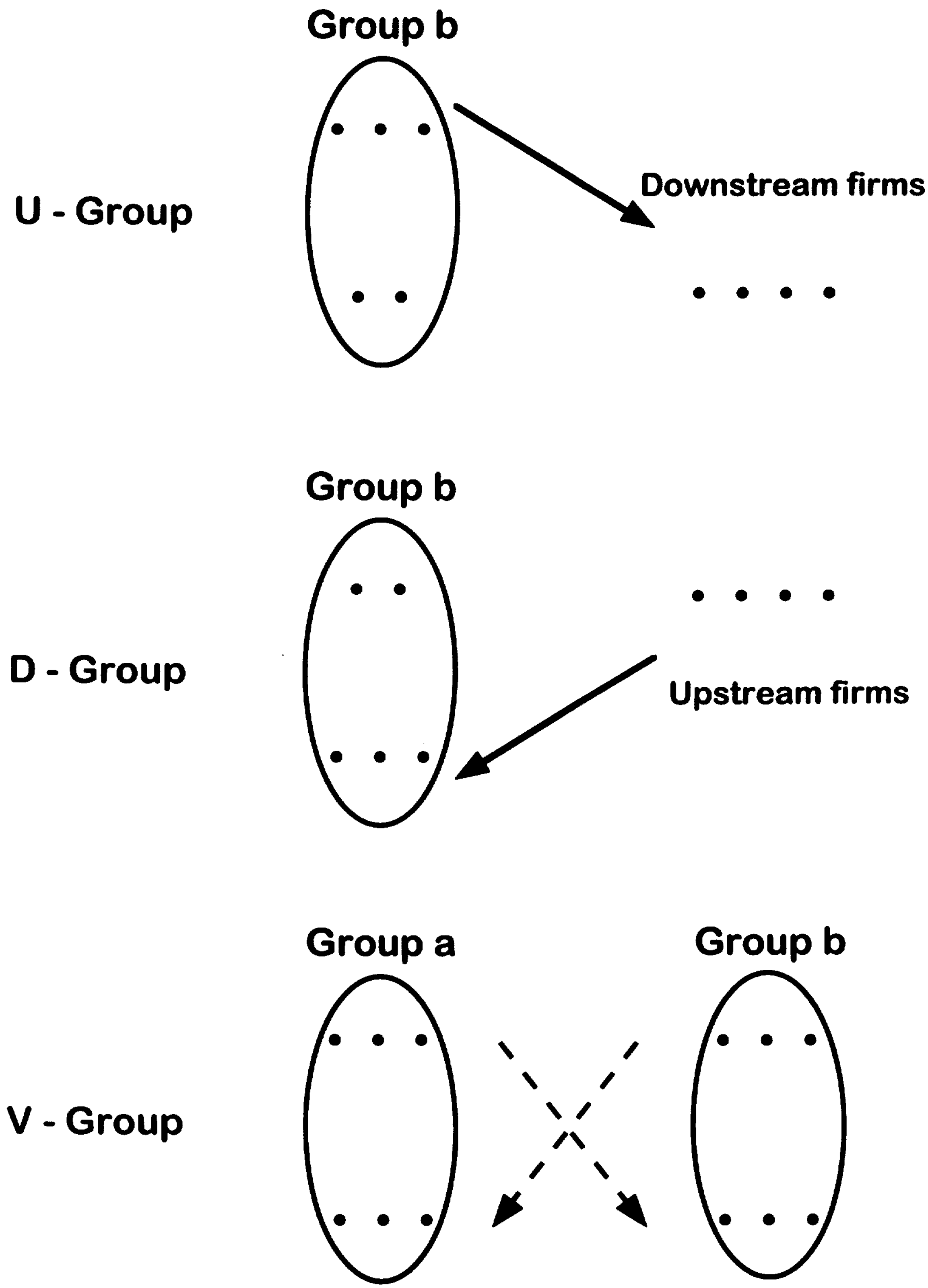


Figure 1: Model of Business Groups



<u>Figure 2</u>. Types of Business Groups

Figure 3: Number of Business Groups

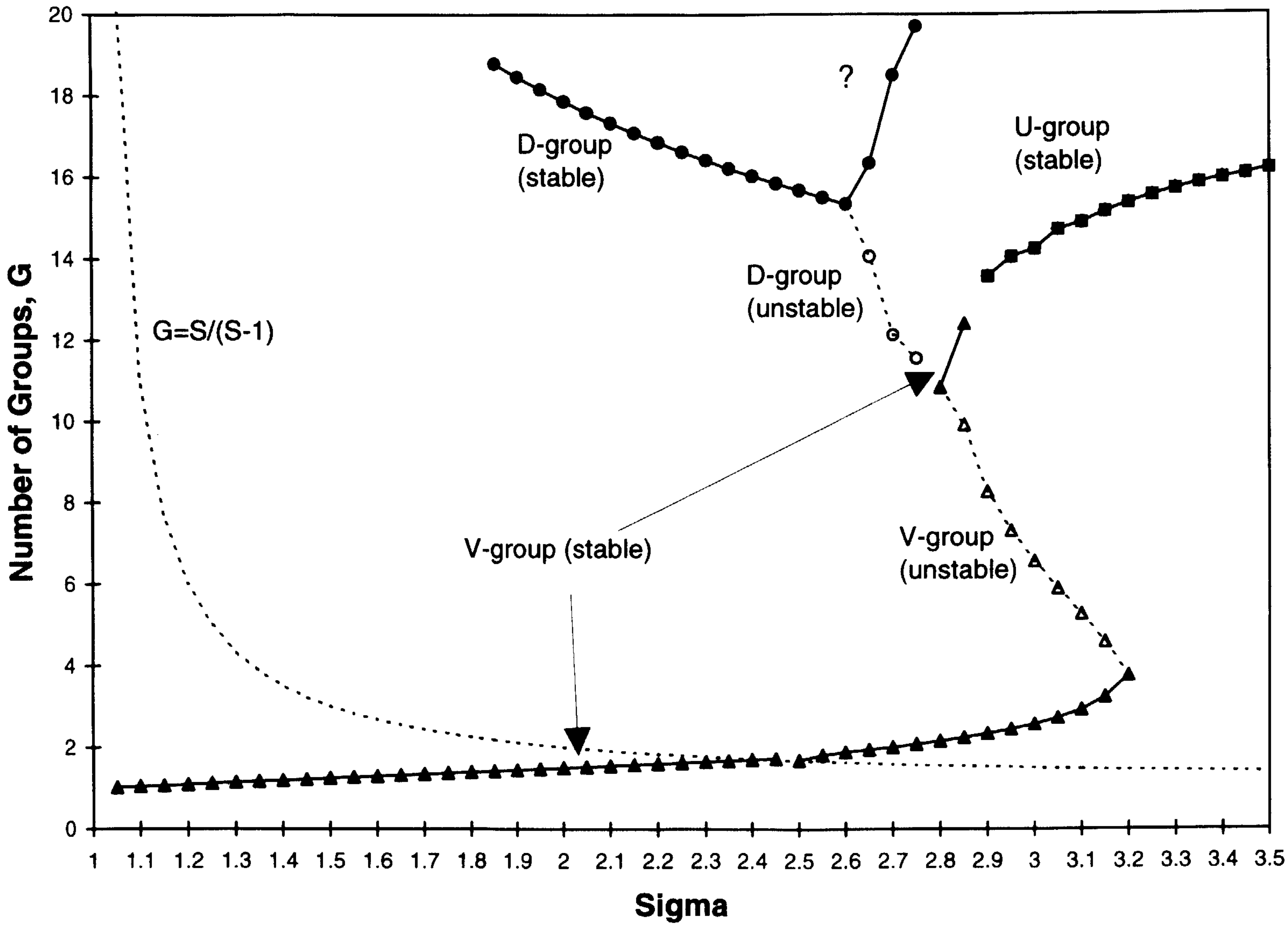


Figure 4: Price of Intermediate Input

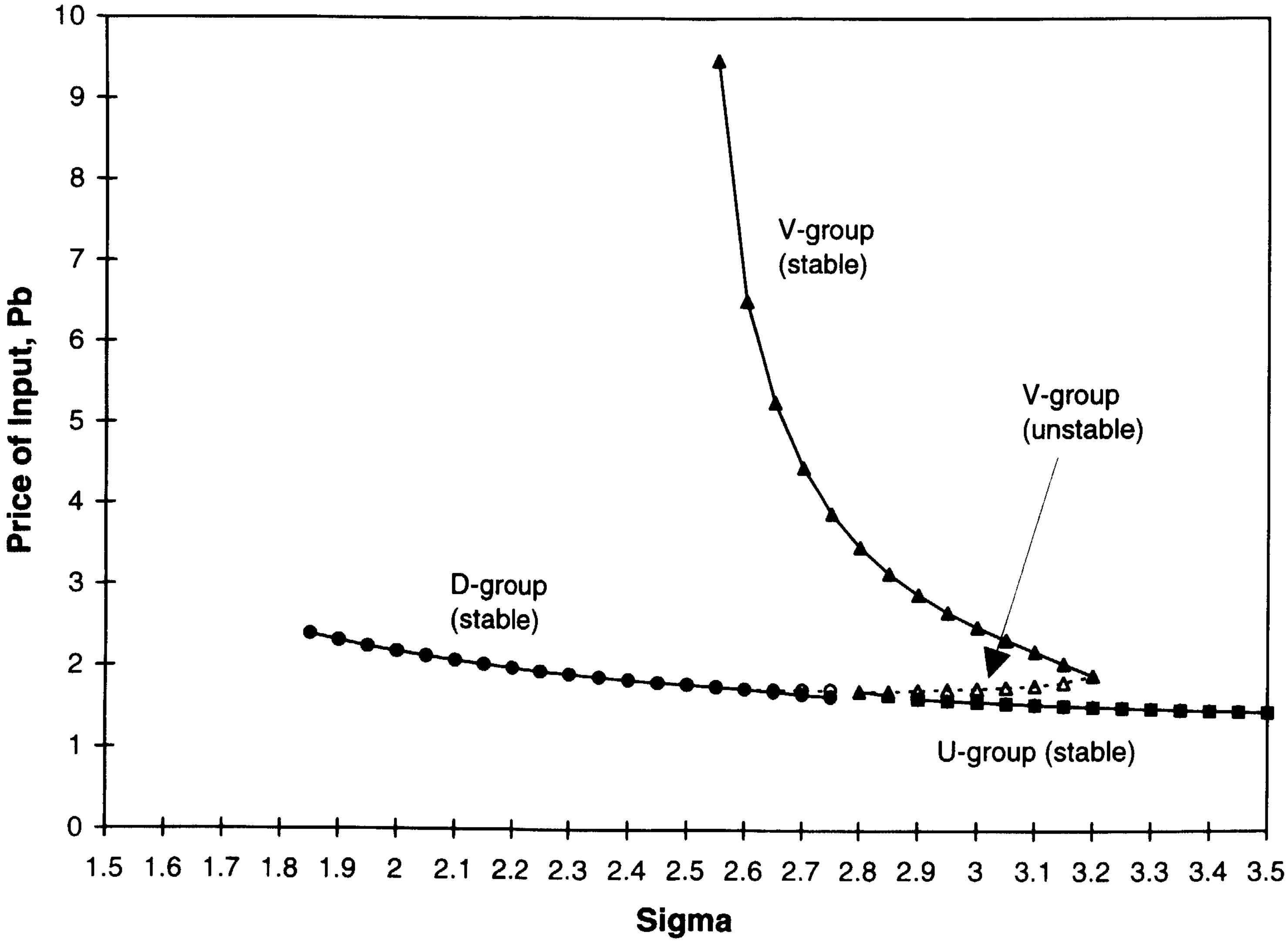


Figure 5: Internal Purchases

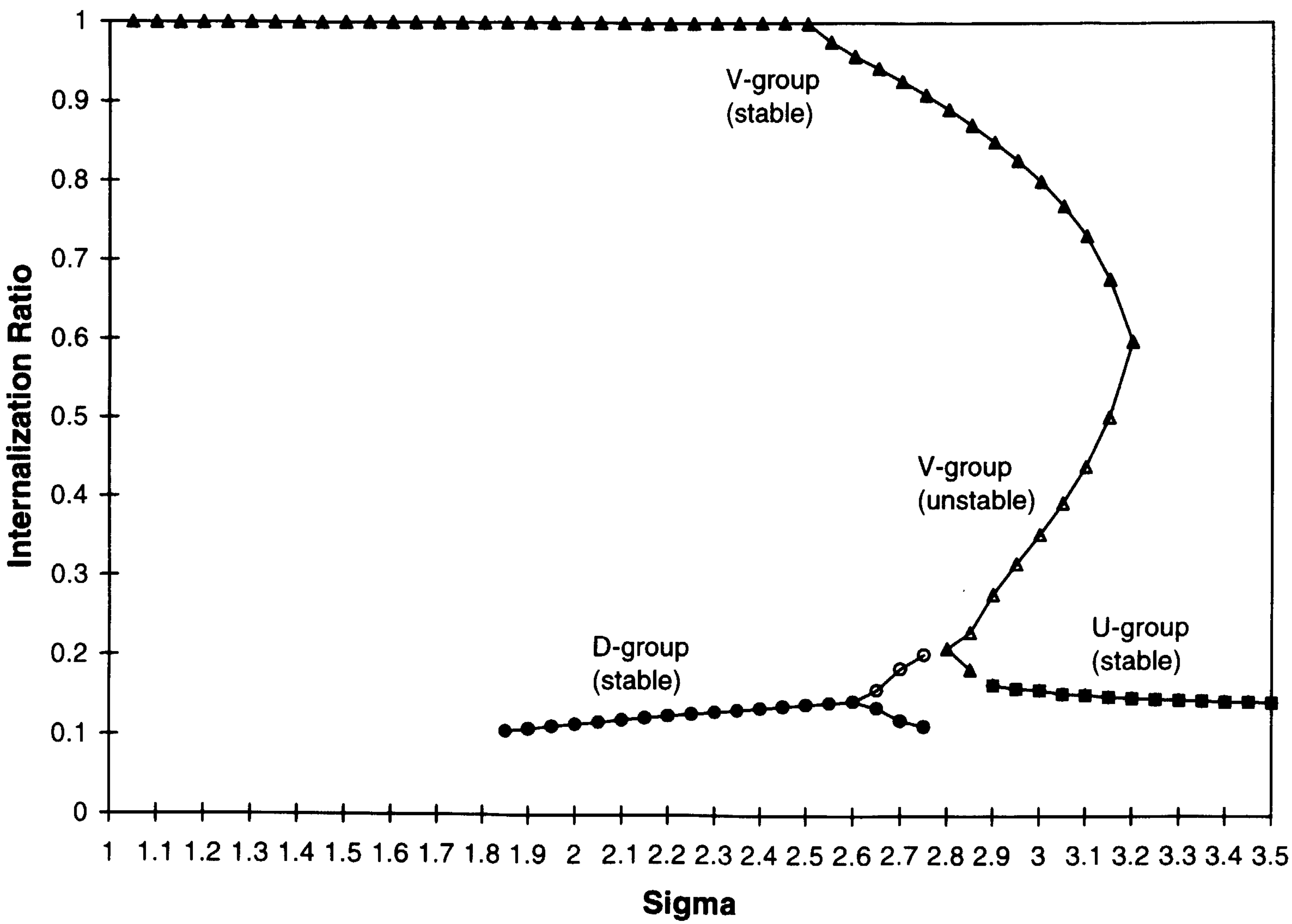


Figure 6: Product Variety