Competitive equilibria in markets for heterogeneous goods under imperfect information: a theoretical analysis with policy implications

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This article characterizes necessary and sufficient conditions for heterogeneous search goods to trade at their competitive prices, and derives policy implications from these conditions. The model differs from earlier search equilibrium models in that it allows the existence of product heterogeneity. Our principal conclusions are that markets for heterogeneous search goods tend rather easily to segment into homogeneous subsets; when they do not, heterogeneity can work against the existence of competitive equilibria because it dilutes the effectiveness of search. Nevertheless, the likelihood of competitive equilibria obtaining in heterogeneous search goods markets can often be increased by reducing the costs to consumers of directly comparing purchase alternatives.

1. Introduction

■ For over a decade, the federal government has responded aggressively to apparent information imperfections in consumer markets. Examples of such responses include the Truth in Lending Law, the Magnusson-Moss Warranty-Federal Trade Commission Improvement Act, the Consumer Leasing Act, and the Real Estate Settlement Procedures Act. Congress has passed almost all of this regulation with no clear idea of what purposes it wanted to achieve, or could in fact achieve, or of the relation between various intervention strategies and the possible goals of government action. As a normative matter, imperfect information should be relevant to decisionmakers because high search costs can prevent markets from reaching competitive equilibria. The state thus should intervene in markets *on information grounds* only when noncompetitive outcomes obtain; and regulation should be directed to increasing the likelihood of competitive behavior.[1]

An important positive task that this normative analysis makes germane is to characterize the conditions under which competitive outcomes can obtain in environments where information is costly to acquire. Previous work dealing with this problem commonly modeled markets for homogeneous search goods—identical products, all of whose fea-

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[1] The normative case for intervening in markets on information grounds is more extensively developed in Schwartz and Wilde (1979).

tures consumers could observe before purchase. This work has increased understanding of how markets characterized by costly information behave, but it apparently has limited relevance to decisionmakers, for the conclusions that the earlier models reach apply directly only to such products as money or wheat.[2] This article extends previous analyses by considering competitive equilibria in markets for heterogeneous search goods.

Consumers in the model developed below shop pursuant to a fixed sample size strategy in a market that potentially supplies a search good at two qualities, "low" and "high." Although these consumers have preferences for low or high quality goods, they have imprecise information, when they begin to search, as to where either good can be found or what prices they are likely to face. Thus, consumers shop randomly across quality levels. The firms pursue relatively passive strategies, in that they do not advertise, but instead experiment with prices, changing them when changes would increase expected profits. We derive necessary and sufficient conditions for an equilibrium to obtain in which both the low and the high quality goods trade at their competitive prices.

Surprisingly, the earlier homogeneous search goods models turn out to have considerable generality because markets for high and low quality goods often will "segment," for two reasons. First, segmentation will occur unless consumers who prefer low quality goods will buy high quality goods that trade at their competitive price if the consumers' search reveals only high quality goods; if these consumers would not purchase high quality goods in this circumstance, they actually are shoppers only for low quality. Similarly, the two markets will segment unless consumers who prefer high quality goods will buy low quality goods that trade at their competitive price if the consumers' search reveals only low quality goods; if these consumers would not purchase low quality goods in this circumstance, they actually are shoppers only for high quality. If these conditions fail, low and high quality goods will trade in distinct markets. To see more vividly the restrictiveness of these conditions, consider the market for compact cars. Unless the consumers who shop in it and who prefer a BMW or a Mercedes are willing to purchase a Toyota or a Datsun that trades at its competitive price if the consumers' search fails to reveal a high quality dealer, the compact car market will segment.

Second, segmentation will occur unless the additional cost of producing high rather than low quality goods—the "marginal cost of high quality"—exceeds the marginal willingness of low quality preferers to pay for high quality goods, but is less than the marginal willingness of high quality preferers to pay for them. This results because if the marginal cost of high quality exceeded the marginal willingness to pay for it of both sets of consumers, everyone would buy low, while if the marginal cost of high quality was less than the marginal willingness to pay for it of both sets of consumers, everyone would buy high. No compelling reason exists, however, for the marginal cost of high quality goods always to exceed the marginal willingness to pay for them of one set of consumers but not the other. This second condition for the two markets to interact seems more difficult to satisfy than the first, but the first is nontrivial; and it often will be the case that one or both of these conditions will not be met, so that market segmentation is plausible for search goods. Thus, models that presuppose product homogeneity have applicability to a fairly wide range of cases.

This conclusion has normative significance as well, because the principal factor causing homogeneous goods markets to behave competitively is the extent of comparison shopping, and it apparently takes less comparison shopping to generate competitive outcomes than had previously been supposed (Schwartz and Wilde, 1979). On the other hand, when the markets for low and high quality goods do interact, product heterogeneity can work against the existence of competitive equilibria because heterogeneity dilutes the effectiveness of search. Prices are driven down to competitive levels in search equi-

[2] Many of these papers are reviewed in Schwartz and Wilde (1982).

librium models as a result of competition among firms for shoppers. Suppose, however, that some consumers who shop twice visit one high and one low quality firm. These consumers effectively are nonshoppers in both markets. In consequence, if as much shopping occurs in a heterogeneous as in a homogeneous goods market, firms in the former market may face fewer actual comparison shoppers and thus be more likely to find it profitable to deviate from the competitive price. Further, if the number of shoppers in one of the markets is increased, many of these new shoppers may "spill over" into the other market—that is, visit one or more firms that sell the less preferred quality. In certain cases, this loss of shoppers could actually cause a market to behave less competitively than before search costs in it were reduced.

Section 2 sets out the formal model and derives conditions for when the markets for low and high quality goods will interact. Sections 3, 4, and 5 derive necessary and sufficient conditions for when competitive equilibria will obtain in both markets and explain the intuition underlying these conditions. Section 6 then briefly discusses the policy implications and limitations of the analysis. In particular, we show that reducing the costs to consumers of directly comparing purchase alternatives is likely to lower noncompetitive prices. On the other hand, it is difficult for decisionmakers to identify the cases when information problems are likely to yield noncompetitive prices in heterogeneous goods markets. Because knowing this is a prerequisite to intelligent regulation, much room for further research remains.

2. A search equilibrium model with heterogeneous goods

■ This section develops a model for a heterogeneous search good—one described by price and "quality" but all of whose features are observable before purchase. This good is supplied at two quality levels, "low" and "high," the adjectives low and high actually being conventions; the formal model requires only that the two goods be differentiated members of the same (narrowly defined) product class.

The technology associated with producing the low quality good is described by a fixed cost, F_L, a constant marginal cost, c_L, and a capacity constraint on firm size, s_L. Similarly, the technology associated with producing the high quality good is described by a fixed cost, F_H, a constant marginal cost, c_H, and a capacity constraint on firm size, s_H. The capacity constraint is an analytically convenient substitute for the usual assumption of U-shaped average cost curves. In this model, $p_L^* = c_L + (F_L/s_L)$ and $p_H^* = c_H + (F_H/s_H)$ thus become the "competitive" prices associated with the two quality levels. The only assumption we make regarding the relationship between the two technologies is that the competitive prices differ; we here suppose that $p_L^* < p_H^*$. Each firm offers either the low quality good or the high quality good. The total number of firms is N, with N_L firms selling low quality goods and N_H firms selling high quality goods. We define $n_L = N_L/N$ and $n_H = N_H/N$. Firms do not advertise, but charge a price, wait to see who buys, and alter prices when this would increase expected profits.

Each consumer in the market lives for one period, demands one unit of the low quality good or one unit of the high quality good (but not both), and either purchases or gets a raincheck at the end of the period if he or she finds a firm whose price is acceptable. Consumers are partitioned in two distinct ways, according to those who shop and those who do not and according to those who "prefer" low quality and those who "prefer" high. The nature of this preference for quality is made clear below, but now let A_1 be the number of nonshoppers and A_2 be the number of shoppers, where $A_1 > 0$ and $A_2 > 0$. Also, let A_1^L be the number of nonshoppers who prefer low quality and A_2^L be the number of shoppers who prefer low quality. Using a similar notation for high quality, we have $A^L = A_1^L + A_2^L$ and $A^H = A_1^H + A_2^H$.

All consumers actually search pursuant to a fixed sample size strategy, in accordance with which each consumer creates a preset sample of firms before he or she begins to shop, and then exhausts this sample during search.[3] For some consumers—the "non-shoppers"—the sample size is one; for the others—the "shoppers"—the sample size is n, with n restricted to two for expositional convenience. Shoppers thus sample precisely two firms *at random across both quality levels* before purchasing. This shopping pattern is one of a set of sufficient conditions that allows the markets for the two quality types to interact.[4]

Suppose that if offered the opportunity to buy the goods at their competitive prices, denoted (p_L^*, p_H^*), members of A^L would buy the low quality good and members of A^H would buy the high quality good. Next let the price of the low quality good remain fixed at p_L^*, but the price of the high quality good rise. Members of A^L would still want the low quality good, but members of A^H at some point would switch from buying high to buying low quality. Let $\bar{p}_H$ be the price for the high quality good at which these latter consumers are just indifferent to switching. Similarly, suppose there is a price $\bar{p}_L > p_L^*$ such that, if offered the opportunity to buy the goods at prices (p_L, p_H^*), members of A^L will buy low quality if $p_L \leq \bar{p}_L$ and high quality if $p_L > \bar{p}_L$.

Consumers also have "limit prices" for both quality levels. If no high quality goods were available, l_L is the maximum price that a consumer who prefers low quality would pay for the low quality good and h_L is the maximum price that a consumer who prefers high quality would pay for this good. Similarly, if no low quality goods were available, l_H is the maximum price that a consumer who prefers low quality would pay for the high quality good and h_H is the maximum price that a consumer who prefers high quality would pay for this good.

The significant point respecting these limit prices is that since consumers are assumed to buy only one unit of the good, the difference between the limit price for a quality type and the purchase price of that quality type measures consumer surplus. This enables our assumptions concerning consumers' tastes for quality to be translated into constraints on the relationship between limit prices and competitive prices. We have already assumed that $\bar{p}_L > p_L^*$ and $\bar{p}_H > p_H^*$. It is also realistic to require the price that will induce consumers who prefer low quality to switch to high quality (given that high quality can be purchased at its competitive price) to be less than or equal to the maximum price consumers will pay for low quality rather than forego the good; and the price at which consumers who prefer high quality will switch to low quality (given that low quality can be purchased at its competitive price) to be less than or equal to the maximum price they will pay for high quality rather than forego the good. These assumptions yield two constraints on $\bar{p}_L$ and $\bar{p}_H$:

$$p_L^* < \bar{p}_L \leq l_L \,, \tag{1}$$

$$p_H^* < \bar{p}_H \leq h_H \,. \tag{2}$$

Using our notion of consumer surplus, we have by definition: $l_L - \bar{p}_L = l_H - p_H^*$. Rearranging this expression gives an analytical definition of $\bar{p}_L$:

$$\bar{p}_L = l_L - l_H + p_H^* \,. \tag{3}$$

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[3] We have explained elsewhere why consumers might use fixed sample size strategies. See Wilde and Schwartz (1979); Schwartz and Wilde (1979).

[4] An alternative shopping pattern that would also allow the markets for the two types of goods to interact would arise if consumers were aware of the quality each firm offered but not its price, if they would buy either type of good if offered the opportunity to do so at its competitive price, and if they chose deliberately to shop across quality levels to compare price-quality tradeoffs. We rule out a "cross-quality" shopping pattern in this article for two reasons. First, it is to some extent inconsistent with the model's formal assumption that consumers learn about prices and qualities only by direct sampling of firms. Second, the random shopping strategy has fairly broad application because low and high quality refer, as said above, only to differentiated members of the same (narrowly defined) product class.

Analogously, $h_H - \bar{p}_H = l_L - p_L^*$, or

$$\bar{p}_H = h_H - h_L + p_L^* . \tag{4}$$

Substituting (3) and (4) into (1) and (2) yields:

$$p_L^* < l_L - l_H + p_H^* \leq l_L , \tag{5}$$

$$p_H^* < h_H - h_L + p_L^* \leq h_H . \tag{6}$$

The right-hand inequalities in (5) and (6) reduce to $p_H^* \leq l_H$ and $p_L^* \leq h_L$. If these inequalities are not satisfied, the markets will necessarily segment—consumers who prefer low quality will never buy high quality and consumers who prefer high quality will never buy low quality.[5]

The left-hand inequalities in (5) and (6) can be summarized as

$$l_H - l_L < p_H^* - p_L^* < h_H - h_L . \tag{7}$$

The terms $l_H - l_L$ and $h_H - h_L$ are interpreted as the marginal willingness to pay for high quality by consumers who prefer low quality and consumers who prefer high quality, respectively. For the two markets to interact, this premium must be less than the marginal cost of high quality in competitive equilibrium for consumers who prefer low quality and greater than the marginal cost of high quality in competitive equilibrium for consumers who prefer high quality. While it may be realistic for low quality preferers to have a lower marginal willingness to buy high than high quality preferers do, no compelling reason exists for the two marginal willingnesses to pay often to have the peculiar relationship to the *marginal cost* of high quality that equation (7) requires. Thus, this constraint also suggests that segmentation is plausible.

Finally, equilibrium in this model is defined by a total consumer firm ratio, A/N, a distribution of firms across the two quality levels, (n_L, n_H), and a distribution of prices for each quality level such that (a) all consumers pursue specified shopping strategies, (b) given the equilibrium distribution of firms across the two quality levels, all firms earn zero expected profits, and (c) no firm can earn positive profits by changing its price offer or its quality level.[6]

3. Necessary and sufficient conditions for a competitive equilibrium I: balancing constraints

■ In a heterogeneous search goods model, two types of necessary and sufficient conditions are required to ensure that a competitive equilibrium exists. The first are derived by asking whether deviating from the competitive price would be a profitable strategy for any firm; the second are derived by asking whether expected demand equals capacity in the market for each type of good. The latter "balancing constraints" are developed in this section.

Suppose initially that all firms charge competitive prices and that N_L and N_H are given. To calculate expected demand for low and high quality firms, first realize that

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[5] We argued above that these conditions are strong, but we do not want to overstate the point. If consumer preferences for quality are heterogeneous, then some consumers might exist at the tail of the distribution of those who prefer low quality who would purchase high quality if they saw only it, and similarly for the distribution of those who prefer high quality. The importance of such "spillovers" is an empirical question.

[6] Under full information, the classical competitive equilibrium would satisfy these conditions. Because consumers can spill over into markets for less preferred goods, the model above permits only a "pseudo-competitive" equilibrium, in which firms earn zero profits and each good trades at its competitive price (p_L^*, p_H^*). In such an equilibrium, n_L need not equal A^L/s_L and N_H need not equal A^H/s_H; that is, an excessive number of firms may exist. For convenience, we use the phrase "competitive equilibrium" to refer to an equilibrium of this sort.

all firms get an equal share of the nonshoppers, A_1/N, but do not get an equal share of the shoppers, even though no price dispersion exists within quality levels. Members of A_2^L who sample two firms offering the high quality good will buy from one of them at random. Those who sample one firm offering the low quality good and one firm offering the high quality good will buy the *low* quality good. Those who sample two firms offering the low quality good will buy from one of them at random. Members of A_2^H behave similarly.

To calculate expected demand for firms offering the low quality good, first suppose that a member of A_2^L samples a firm offering the low quality good. The probability that this consumer buys from the firm is equal to the probability that his or her other observation is from a firm offering the low quality good times one-half plus the probability that his or her other observation is from a firm offering the high quality good; i.e. $[(N_L/N)(1/2) + (N_H/N)]$.[7] The probability that a member of A_2^L samples any given firm is $2/N$, because shoppers sample precisely two firms. Hence expected demand from members of A_2^L is

$$A_2^L(2/N)[(N_L/N)(1/2) + (N_H/N)] = (A_2^L/N)[(N_L/N) + (2N_H/N)].$$

A similar analysis shows that expected demand from members of A_2^H is

$$A_2^H(2/N)(N_L/N)(1/2) = (A_2^H/N)(N_L/N).$$

In consequence, total expected demand at firms offering the low quality good is

$$D_L = (A_2^L/N)[(N_L/N) + (2N_H/N)] + (A_2^H/N)(N_L/N) + (A_1/N).$$

Similarly,

$$D_H = (A_2^H/N)[(N_H/N) + (2N_H/N)] + (A_2^L/N)(N_H/N) + (A_1/N).$$

The zero-profit constraint implies that $D_L = s_L$, and $D_H = s_H$ in competitive equilibrium because demand persistently greater than capacity implies that entry is profitable, while demand persistently less than capacity implies negative profits or noncompetitive prices. This analysis yields the following necessary condition for a competitive equilibrium:

$$(A_1/N) + (A_2^L/N_L)[1 - (N_H/N)^2] + (A_2^H/N_L)(N_L/N)^2 = s_L$$

$$(A_1/N) + (A_2^H/N_H)[1 - (N_L/N)^2] + (A_2^L/N_H)(N_H/N)^2 = s_H .$$

Solving for N_L and N_H, we have[8]

$$N_L = [A(s_L - s_H) - s_H(A_2^L - A_2^H)]/(s_L - s_H)^2 \tag{8}$$

$$N_H = [s_L(A_2^L - A_2^H) - A(s_L - s_H)]/(s_L - s_H)^2. \tag{9}$$

Equations (8) and (9) imply that

$$N = (A_2^L - A_2^H)/(s_L - s_H). \tag{10}$$

We require $N_L \geq 0$ and $N_H \geq 0$. From (8) and (9), these constraints are equivalent to

$$s_L(A_2^L - A_2^H) \geq A(s_L - s_H) \geq s_H(A_2^L - A_2^H). \tag{11}$$

Condition (11) does not guarantee that the competitive equilibrium will occur, but does establish constraints on the mix of shoppers and nonshoppers that must be associated

[7] The text assumes sampling with replacement, because with a large number of firms the inaccuracy vanishes and calculations are easier. This is the standard approach in the search literature.

[8] The details of this and several other derivations are found in the appendix to Schwartz and Wilde (1981).

with a proper balance of firms offering each good for a competitive distribution of firms to be an equilibrium. These balancing constraints are strong. For example, equation (10) shows that for a competitive equilibrium in *both* markets to exist, the difference between the number of shoppers who prefer the low quality good and the number of shoppers who prefer the high quality good must have the same sign as the difference between the capacity constraint for firms offering the low quality good and the capacity constraint for firms offering the high quality good. This condition is necessary because firms with large capacity need to attract more consumers in competitive equilibrium than firms with small capacity. If capacity constraints are roughly similar—s_L is not much greater than s_H—but A_2^L is considerably larger than A_2^H, a competitive equilibrium could still occur through adjustments in the proportions of firms: n_L will increase and n_H will decline. These adjustments, however, could never overcome an absolute advantage in the opposite direction of the capacity constraints, because each firm has an inherent advantage in attracting those shoppers who prefer its own quality level. Thus, if $s_H > s_L$, while $A_2^L > A_2^H$, firms which offer high quality goods would experience persistent excess capacity.

4. Necessary and sufficient conditions for a competitive equilibrium II: breaking constraints

■ We wish to characterize conditions under which the competitive pair (p_L^*, p_H^*) is stable with respect to individual firms raising their prices. A firm that deviates from the competitive equilibrium has several pricing options, with the profitability of each depending on the relationships between switch prices and limit prices in the relevant market. Because the derivation of these breaking constraints is similar in the various cases, we shall do one case in detail, simply setting forth the results of the others.

□ **Deviations by low quality firms.** Suppose that all high quality firms charge p_H^* and all low quality firms except one charge p_L^*. The deviant firm has three pricing options, to charge $\bar{p}_L$, l_L, or h_L.

Case L1: $p_L^* < h_L < \bar{p}_L < l_L$. A firm selling the low quality good that raises its price to h_L will lose only those shoppers who have sampled both it and another firm offering the low quality good, regardless of whether they prefer low quality or high quality. The firm retains all nonshoppers and those shoppers who prefer low quality and sample one firm offering the low quality good and one firm offering the high quality good. Expected profits become

$$\pi_1^L(h_L) = [(A_1/N) + 2(A_2^L)/N)(N_H/N)](h_L - c_L) - F_L\,.$$

The competitive distribution at (p_L^*, p_H^*) is an equilibrium if expected profits from deviating (in this case charging h_L) are nonpositive; that is, if

$$(A_1/N) + 2(A_2^L/N)(N_H/N) \leq F_L/(h_L - c_L).$$

Recall that $n_L = N_L/N$ and $n_H = N_H/N$. Let $\bar{s} = n_L s_L + n_H s_H$ be "average" capacity under a competitive distribution. Then the constraint requisite for a competitive equilibrium is

$$a_1 + 2a_2^L n_H \leq F_L/\bar{s}(h_L - c_L), \tag{12}$$

where $a_1 = A_1/A$ and $a_2^L = A_2^L/A$.

Now suppose the deviant firm raises its price to $\bar{p}_L$. In this case it loses, in addition to shoppers who have sampled another low quality firm, those nonshoppers who prefer high quality, because $\bar{p}_L > h_L$. Expected profits become

$$\pi_1^L(\bar{p}_L) = [(A_1^L/N) + 2(A_2^L/N)(N_H/N)](\bar{p}_L - c_L) - F_L\,.$$

The associated constraint requisite for a competitive equilibrium is

$$a_1^L + 2a_2^L n_H \leq F_L/\bar{s}(\bar{p}_L - c_L), \tag{13}$$

where $a_1^L = A_1^L/A$.

Finally, suppose that the deviant firm raises its price to l_L. In this case, it loses all shoppers and those nonshoppers who prefer high quality, because $l_L > h_L$. Expected profits become

$$\pi_1^L(l_L) = (A_1^L/N)(l_L - c_L) - F_L .$$

The associated constraint requisite for a competitive equilibrium is

$$a_1^L \leq F_L/\bar{s}(l_L - c_L). \tag{14}$$

A low quality firm would have no incentive to depart from the competitive price in case L1 only if equations (12), (13), and (14) *all* hold.

Case L2: $p_L^* < \bar{p}_L < h_L < l_L$. With the deviant firm charging successively $\bar{p}_L$, h_L, and l_L, the constraints analogous to (12), (13), and (14) are:

$$a_1 + 2a_2^L n_H \leq F_L/\bar{s}(\bar{p}_L - c_L), \tag{15}$$

$$a_1 \leq F_L/\bar{s}(h_L - c_L), \tag{16}$$

$$a_1^L \leq F_L/\bar{s}(l_L - c_L). \tag{17}$$

Case L3: $p_L^* < \bar{p}_L < l_L < h_L$. The relevant constraints are:

$$a_1^H \leq F_L/\bar{s}(h_L - c_L), \tag{18}$$

$$a_1 + 2a_2^L n_H \leq F_L/\bar{s}(\bar{p}_L - c_L), \tag{19}$$

$$a_1 \leq F_L/\bar{s}(l_L - c_L). \tag{20}$$

□ **Deviations by high quality firms.** Suppose that all low quality firms charge p_L^* and all high quality firms except one charge p_H^*. The deviant firm has three pricing options, analogous to the low quality deviant analyzed above; it can charge $\bar{p}_H$, l_H, or h_H.

Case H1: $p_H^* < l_H < \bar{p}_H < h_H$.

$$a_1 + 2a_2^H n_L \leq F_H/\bar{s}(l_H - c_H), \tag{21}$$

$$a_1^H + 2a_2^H n_L \leq F_H/\bar{s}(\bar{p}_H - c_H), \tag{22}$$

$$a_1^H \leq F_H/\bar{s}(h_H - c_H). \tag{23}$$

Case H2: $p_H^* < \bar{p}_H < l_H < h_H$.

$$a_1 \leq F_H/\bar{s}(l_H - c_H), \tag{24}$$

$$a_1 + 2a_2^H n_L \leq F_H/\bar{s}(\bar{p}_H - c_H), \tag{25}$$

$$a_1^H \leq F_H/\bar{s}(h_H - c_H). \tag{26}$$

Case H3: $p_H^* < \bar{p}_H < h_H < l_H$.

$$a_1^L \leq F_H/\bar{s}(l_H - c_H), \tag{27}$$

$$a_1 + 2a_2^H n_L \leq F_H/\bar{s}(\bar{p}_H - c_H), \tag{28}$$

$$a_1 \leq F_H/\bar{s}(h_H - c_H). \tag{29}$$

The constraints reflected in equations (15)–(29) are roughly analogous to the single constraint derived in Wilde and Schwartz (1979) for the homogeneous search goods case. Together with equation (11), these constraints provide a set of necessary and sufficient conditions for the competitive distribution of firms at (p_L^*, p_H^*), defined by (8) and (9), to be an equilibrium; that is, they provide a set of necessary and sufficient conditions for a competitive outcome in both markets.

5. An analysis of the breaking constraints: the relevance of product heterogeneity

■ The markets for low and high quality goods interact in two distinct ways. First, a member of A_2^L can spill over "completely" into the market for high quality goods if both of his or her observations are taken at firms which offer only the high quality good. Such a member of A_2^L is effectively a comparison shopper in the market for high quality goods. A member of A_2^H similarly can spill over completely into the market for low quality goods. This complete spillover has less effect on the equilibrium that will obtain than a "partial" spillover: a member of A_2^L can spill over "partially" into the market for high quality goods if precisely one of his or her observations is taken at a firm which offers the high quality good. Such a member of A_2^L is effectively a nonshopper in both markets. A member of A_2^H similarly can spill over partially into the market for low quality goods. Partial spillover is another term for the dilution in the effectiveness of search that product heterogeneity creates. As an example, let $A_1 = 0$ so that all consumers are shoppers. Even in this case, a competitive equilibrium may not obtain for either good because, although everyone shops, some nonshoppers will inevitably exist in both markets.

Partial spillover helps explain the nature of the breaking constraints. Equations (15)–(29) reveal two kinds of breaking constraints, those that only include terms associated with nonshoppers (a_1, a_1^L, or a_1^H) on the left-hand side, and those that include additional terms associated with shoppers (a_2^L or a_2^H) on the left-hand side. The effect of changes in consumer shopping patterns on the likelihood that a competitive equilibrium will obtain is sensitive to which type of constraint is actually binding. To see why, we first increase the proportion of shoppers in such a way as to keep N_L and N_H constant. This is called a "balanced" change in shoppers. Second, we hold the total proportion of shoppers constant, but shift consumers between A_2^L and A_2^H. This is called an "unbalanced" change in shoppers.

□ **Balanced changes in shoppers.** Define $K_1 = a_2^L - a_2^H$. Suppose that a_2^L increases subject to two conditions; K_1 remains constant and neither a_1^L nor a_1^H rises (i.e., we allow no absolute redistribution between A_1^L and A_1^H). Then from (8) and (10), $n_L = [1/(a_2^L - a_2^H)] - [s_H/(s_L - s_H)]$ and from (9) and (10), $n_H = [s_L/(s_L - s_H)] - [1/(a_2^L - a_2^H)]$, so that

$$(\partial n_L/\partial a_2^L)|_{K_1} = 0 = (\partial n_H/\partial a_2^L)|_{K_1} .$$

Hence $\bar{s} = n_L s_L + n_H s_H$ is constant with respect to balanced changes in shoppers. When the operative constraints on both kinds of firms do not include terms associated with shoppers, a balanced increase in shoppers will never increase the left-hand side of these constraints and will usually lower it, since the increase in a_2^L and a_2^H comes at the expense of a_1^L and a_1^H. This implies that a decrease in the number of nonshoppers makes a competitive equilibrium more likely to occur in both markets. Respecting the intuition behind this result, the operative constraints fail to include a_2^L and a_2^H only when the price that maximizes profits for a deviant firm necessarily eliminates all shoppers from consideration. In such a case, that product heterogeneity can dilute the effectiveness of search is irrelevant; the deviant firm sells only to nonshoppers, and when their number is reduced, it can become unprofitable for the firm to deviate. This yields:

Proposition 1: If the operative constraints on both types of firm are independent of a_2^L and a_2^H, a balanced increase (decrease) in shoppers that does not increase (decrease) either a_1^L or a_1^H increases (decreases) the likelihood that both markets are competitive.

Next let the operative constraints on both kinds of firms include a_2^L or a_2^H and initially consider low quality firms. Most constraints which include a_2^L or a_2^H take the form $a_1 + 2a_2^L n_H$ on the left-hand side. The term $2a_2^L n_H$ is associated with partial spillovers; it only arises when the price associated with the operative constraint is less than or equal to the switchprice for consumers who prefer low quality ($\bar{p}_L$). When a deviant low quality firm charges a price above the competitive price but equal to or below the switchprice, it retains those members of A_2^L who have partially spilled over into the market for high quality. As long as the price it charges is less than or equal to min $\{l_L, h_L\}$, it also retains all members of A^l. The increase in a_2^L makes it more likely that the firm will wish to deviate from p_L^*, because of the effect of partial spillovers, but the decrease in a_1 makes such a motivation less likely. In this case, the latter effect dominates because a_2^L is weighted by n_H and balanced increases do not affect n_L or n_H. When the price that the deviant low quality firm charges is greater than min $\{l_L, h_L\}$, (e.g., case L2, $p_L^* < \bar{p}_L < h_L < l_L$), the net effect is ambiguous, depending on the extent to which the decrease in a_1 comes at the expense of a_1^L or a_1^H. A similar discussion applies to possible deviations by high quality firms. We thus have the following proposition:

Proposition 2: If the operative constraints on both types of firms depend on a_2^L or a_2^H, and p_L^D and p_H^D are defined as the prices that maximize profits for deviant firms, then (i) $p_L^D \leq$ min $\{l_L, h_L\}$ and $p_H^D \leq$ min $\{l_H, h_H\}$ imply that a balanced increase (decrease) in shoppers will make it more (less) likely that both markets are competitive, and (ii) $p_L^D >$ min $\{l_L, h_L\}$ and $p_H^D >$ min $\{l_H, h_H\}$ imply that a balanced increase in shoppers has ambiguous effects on the likelihood of a competitive equilibrium's occurring. Propositions 1 and 2 imply that balanced increases in shoppers generally tend to make it more likely that both markets are competitive.

□ **Unbalanced changes in shoppers.** Unbalanced changes in a_2^L and a_2^H induce changes in the mix of low and high quality firms. To begin to understand the effect of these changes, suppose that $s_L > s_H$ and consider an increase in a_2^L that comes entirely at the expense of a_2^H; that is, a_1^L and a_1^H are held constant, while some shoppers shift from the group that prefers high quality to the group that prefers low quality. Define $K_2 = a_2^L + a_2^H$. It is straightforward to show that

$$(\partial n_L/\partial a_2^L)|_{K_2} < 0 \qquad \text{and} \qquad (\partial n_H/\partial a_2^L)|_{K_2} > 0.$$

These derivatives imply that $\bar{s}$ must decrease, since we have assumed that $s_L > s_H$.

Constraints that do not depend on a_2^L or a_2^H are more likely to be satisfied—i.e., deviations from the competitive price are less likely—when the increase in a_2^L is unbalanced. This results because such a shift both increases the proportion of shoppers who are predisposed to buy low quality and decreases the number of low quality firms. Unless more of the shoppers who prefer low quality spill over totally into the market for high quality, excess demand will occur in the low quality market. To avoid this disequilibrium phenomenon—i.e., to facilitate total spillovers—the number of high quality firms must increase. When high quality firms are assumed to have lower capacity, the equilibrium consumer firm ratio thus must also decline. Such a decline makes deviations from competitive prices less profitable for firms that would depend only on the business of nonshoppers after the price rise, since with a lowered consumer firm ratio, each firm has fewer expected customers, including fewer nonshoppers, and so is less equipped to withstand loss of patronage. This leads to the following proposition:

Proposition 3: If $s_L > s_H$ and the operative constraints on both types of firms are independent of a_2^L and a_2^H, an unbalanced increase in $a_2^L(a_2^H)$ will increase (decrease) the likelihood that both markets are competitive.

When the operative constraints on both types of firms do depend on a_2^L or a_2^H, it can be shown that:

$$(\partial\bar{s}(a_1 + 2a_2^L n_H)/\partial a_2^L)|_{K_2} = (\partial\bar{s}(a_1^L + 2a_2^L n_H)/\partial a_2^L)|_{K_2} > 0$$

and

$$(\partial\bar{s}(a_1 + 2a_2^H n_L)/\partial a_2^L)|_{K_2} = (\partial\bar{s}(a_1^H + 2a_2^H n_L)/\partial a_2^L)|_{K_2} < 0.$$

These derivatives imply that an unbalanced increase in a_2^L will make it *less* likely that the market for low quality goods is competitive and *more* likely that the market for high quality goods is competitive. This is a somewhat startling result.

To see why it obtains, observe that the operative constraint for low quality deviants depends on a_2^L if and only if the price that maximizes profits for the deviant firm is less than or equal to the switchprice $\bar{p}_L$. In this case, partial spillover matters. Furthermore, while a shift from a_2^H to a_2^L increases the number of comparison shoppers who prefer the low quality good, it also increases the number of these consumers who will take only one observation in the market for low quality goods because some members of A_2^L will partially spill over into the other market. A firm offering the low quality good which wishes to deviate from p_L^* knows that it will lose all comparison shoppers but get all nonshoppers. Because of partial spillovers, the number of nonshoppers in the low quality market actually increases when a_2^L increases entirely at the expense of a_2^H. Thus, a firm offering the low quality good is more likely to deviate from p_L^*. In the market for high quality goods, as a_2^H decreases, the number of shoppers who will take only one observation in the market for high quality goods declines. So does the number of shoppers in this market who prefer high quality goods and take both observations in it. But from the point of view of a firm offering the high quality good, fewer nonshoppers exist as a result of the decline in a_2^H. Thus, this firm will find it less profitable to deviate from p_H^* and will be less likely to do so. In consequence, when a_2^L increases entirely at the expense of a_2^H, a competitive equilibrium in the market for low quality goods is less likely to occur while a competitive equilibrium in the market for high quality goods is more likely to occur. This yields a final proposition:

Proposition 4: If $s_L > s_H$ and the operative constraints on both types of firms depend on a_2^L or a_2^H, then an unbalanced increase (decrease) in a_2^L will decrease (increase) the likelihood that the market for low quality goods is competitive and will increase (decrease) the likelihood that the market for high quality goods is competitive.

6. Policy implications and limitations of the analysis

■ Heterogeneity dilutes the effectiveness of search because a consumer could take one observation in each of two markets and consequently be a nonshopper in both. This result derives from a model that allows but two qualities and two store visits. If the number of qualities is increased, holding sample size constant, the dilution effect is exacerbated and competitive equilibria become less likely. Thus our model reinforces Satterthwaite (1979), who showed in a very different analytical framework how an increase in the number of sellers of a differentiated service could cause prices for that service to rise. Respecting increases in the number of shoppers or in search intensity, holding quality levels constant, we showed that when firms are charging prices high enough to attract only nonshoppers—"monopoly prices"—an increase in the number of shoppers is likely to cause prices to fall. If firms are charging prices intermediate between monopoly and competitive prices, matters are less straightforward. This results because in the model above an increase in the number of shoppers can be decomposed into "balanced" and "unbalanced" increases, and some unbalanced increases can decrease the likelihood of competitive equilibria obtaining in one of the markets (see Proposition 4). This result, however, depends importantly on the shoppers' having a sample size of only two. If sample sizes were to increase, shoppers would be more likely to take enough observations in at least one market to be comparison shoppers in it, despite any observations they may also have made in the other market. Given that an increase in the number of consumers who shop could have anticompetitive effects only in a minority of cases even with the smallest sample size possible (see Propositions 1–3), this analysis suggests that increases in the number of shoppers or in search intensity will generally make competitive equilibria more likely.

From a policy viewpoint, it is easier and wiser to influence the extent and intensity of search than to influence firm entry. Thus the state should seriously consider reducing the costs to consumers of directly comparing purchase alternatives in markets that are badly behaved for information reasons.[9] Recent evidence supports this view. Devine and Marion (1979) provided consumers with some comparative price information and with a weighted index of prices on 65 common food items for supermarkets in a Canadian city for a five-week period. A weighted index of supermarket prices is analogous to a single price for a heterogeneous good. Prices in the sample market declined substantially, and price dispersion decreased during the experimental period, while prices and dispersion were largely unaffected in the control market.[10] Also, search intensity apparently increased. In addition, the Devine and Marion study tentatively suggested that the gain in consumer surplus from these price declines exceeded the sum of the program's administrative costs and the decline in producer surplus. Thus, reducing the costs of comparison shopping in badly behaved consumer markets seems a useful policy option.

We also show that plausible circumstances exist in which heterogeneous goods markets will segment into homogeneous subsets. These circumstances occur when consumers will not purchase their less preferred quality, or when consumers' marginal willingness to buy high quality does not bear that particular relationship to the marginal cost of high quality that is required for the two markets to interact. If quality density increases significantly, segmentation is less likely because consumers may be willing to purchase products that are quite close to their first choices. A large number of closely related qualities would seem necessary for this effect to be significant. Also, the likelihood of segmentation varies directly with increases in search intensity, since the more observations a consumer makes, the more likely he is to be a comparative shopper only for his most preferred quality.

From a policy viewpoint, decisionmakers can simplify the task of deciding when an intervention on information grounds is necessary by adopting a presumption of segmentation when segmentation seems intuitively plausible—that is, when physically distinct products trade at different prices. The simplification occurs because it is easier to decide

[9] We suggest that the state should increase the number of searchers and search intensity by reducing the costs to consumers of directly comparing purchase alternatives. For example, comparative price information could be made widely available. Such a policy prescription is to be distinguished from proposals that would provide consumers with "institutional knowledge" of the sort: "Only firms A, B, and C sell high quality." Providing consumers with institutional knowledge alone would be unwise, because some consumers could get trapped in the wrong market. To see how, suppose that a consumer with such knowledge perceives himself to prefer high quality before he begins to shop, and thus plans to sample only high quality firms. This consumer could end up paying his limit price for a high quality item, whereas, if he shopped randomly, he might have seen a low quality good selling at its competitive price, which in many cases would be preferred to buying a high quality good at the limit price.

[10] Other empirical studies also report price declines following induced reductions in the cost to consumers of directly comparing purchase alternatives. See McNeil, Nevin, Trubeck, and Miller (1979) (used cars); Russo, Kreiser, and Miyashita (1975) (dishwashing liquid, canned dog food, facial tissues).

what is going on in markets for (roughly) homogeneous goods. It may be that the saving in administrative costs from presuming segmentation could outweigh the errors that such presumptions always cause.

The positive and normative implications of our model should be qualified in three respects. First, the model only characterizes competitive equilibria; thus criteria cannot be formally derived from it that would enable decisionmakers better to recognize when heterogeneous goods markets are behaving badly. Second, we assume that consumers are aware of quality differences before they begin to search. Shopping, however, sometimes performs an educative function, in which persons learn about market options as they go along. Markets of this kind might be less well behaved than the markets described above, since search is more likely to involve wasted effort, but in the absence of formal analysis it is difficult to know. Third, we dealt with a heterogeneous search good, but many goods, including some used in our intuitive explanations, have important experience aspects. Whether our conclusions are applicable in these cases again is an open question.

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