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Do firms' product lines include too many varieties?

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A firm that offers an additional product can capture business from rival firms for other *products when consumers prefer to concentrate their purchases at a single supplier. This may lead firms to offer excessive product variety from the social standpoint. A firm may even completely foreclose competing firms from the market by introducing a new product. Forbidding new product introductions (e.g., forbidding universal banking or forbidding a new airline route), forbidding mergers that broaden firms' product lines (as, e.g., the EC forbade a merger of commuter aircraft manufacturers), and forbidding Sunday shopping may sometimes be appropriate public policies.*

1. Introduction

■ Shops exist to reduce consumers' transactions costs by offering a variety of products at a single location. Similarly, an important reason why firms manufacture and market product lines rather than single products is that purchasers, whether consumers or other businesses, prefer to concentrate their business with a single supplier. This preference may be the result of transaction costs of establishing new trading relationships, the costs of learning to use goods from a new supplier, costs caused by incompatible products, uncertainty about the quality of untested brands, or simply psychological feelings of loyalty.[1,2] To cite just one instance, airlines prefer to concentrate their aircraft purchases with a single manufacturer because this economizes on

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[1] See Klemperer (1995) for examples of these different types of costs.

[2] Michael Porter (1985) writes: "A firm may also differentiate itself through the *breadth* of its activities, or competitive scope. Crown Cork and Seal offers crowns (bottle caps) and filling machinery plus cans. It thus offers a full line of packaging services to its buyers . . . Citicorp's breath of activities in financial services . . . [allows] its sales channels to offer a broader product range . . . . Differentiating factors [that] can result from broad competitive scope [include]: ability to serve buyer needs anywhere; simplified maintenance for the buyer if spare parts and design philosophies are common for a wide line; single point at which the buyer can purchase; single point for customer service; superior compatibility among products" (pp. 121–123).

training and maintenance costs, and the Airbus consortium explained that its reason for producing a full line of aircraft is that "without a family of aeroplanes to rival Boeing's, Airbus would be at a serious disadvantage in the market."[3] In the same way, most shoppers mainly patronize a small number of shops with which they are familiar.

Following Klemperer (1992), we will refer to consumers' real or perceived costs of using additional suppliers as *shopping costs*.[4] The point of this article is to show that suppliers may have an incentive to offer too much variety from the social point of view, when purchasers have shopping costs and so prefer to concentrate their business with a single supplier.[5] The reason is that a firm that offers an extra product captures not only consumers' business for that product, but also consumers' business from rival firms for *other* products. Likewise, a shop that opens on Sundays may also win the regular Monday-to-Saturday business of consumers who prefer to visit stores with which they are familiar.

Of course, it is a standard result that it may be socially undesirable for a second firm to enter a market for a product. This arises when the second firm "steals" sufficient business from the first that the reduction in the first firm's profits exceeds the benefit to consumers.[6] What distinguishes our model is that it can be socially undesirable for even one firm to offer a new product for which demand, absent shopping costs, would be independent of demand for existing products. The reason is that the *indirect* business-stealing effect of introducing the new product hurts rivals' profits on existing products more than the benefit to consumers of the new product.

A further implication of our model is that a firm may expand into a new area of business as a means of predation against rivals in existing businesses: Monopoly power in a new product can foreclose sales in, and thereby monopolize existing, previously competitive, markets.[7] Thus, it has been alleged that some stores have opened on Sundays even though the immediate effect has been to reduce profits (calculated over the whole week), in the hope of driving rivals out of weekday business (see Section 4).

Similarly, it has sometimes been argued that mergers that broaden firms' product lines have anticompetitive implications when consumers prefer to patronize a single supplier. For example, it was largely for this reason that the European Commission prohibited the proposed merger between the commuter aircraft manufacturers Aerospatiale-Alenia and de Havilland (see Section 4).

Other possible applications of our theory include analysis of the number of routes airlines offer (Section 4); the issue of how many activities regulators should permit banks to undertake (Section 4); the current concern that London's stock exchange may

[3] Quoted from the *Economist*, September 3, 1988, survey p. 9.

[4] The economies of scope of buying related products, arising from these shopping costs, are similar to the economies of scale in repeat-purchasing a product that are discussed in the "switching costs" literature (e.g., Klemperer, 1987a, 1987b and 1989; Farrell and Shapiro, 1988; Beggs and Klemperer, 1992; Padilla, 1992 and 1995). Thus, the latter literature developed economic reasons for (and implications of) "brand loyalty" but concentrated on intertemporal issues in the context of a single product. This contrasts with our current focus on the costs of using more than one supplier even in a single period, and on multiproduct issues. See also footnote 22.

[5] Lal and Matutes (1989) examine multiproduct firms' pricing strategies when consumers have transport costs of using different additional suppliers, but they do not ask whether such costs lead firms to produce too many or too few products from a social viewpoint. See also Gilbert and Matutes (1990), especially pp. 26–27. Klemperer (1992) considers product-line decisions in the presence of shopping costs, when each firm's number of varieties is exogenously fixed.

[6] See especially, Mankiw and Whinston (1986), and also Spence (1976), Dixit and Stiglitz (1977), and Bulow, Geanakoplos, and Klemperer (1985, sec. VI E).

[7] Here our results parallel Bulow, Geanakoplos, and Klemperer's (1985) demonstration that when there are production economies of scope between markets, a firm may enter one market because of the strategic advantage thereby conferred in another market.

be stifling continental competitors because of the much greater range of financial products that can be traded in London;[8] and the U.S. Justice Department's investigation of the inclusion of the new online service Microsoft Network inside Windows 95.[9]

Section 2 builds a very simple model in which we can obtain our basic results. Section 3 shows that natural extensions do not alter our basic message. Section 4 illustrates our argument with applications, including several of those discussed above. Section 5 concludes.

2. A simple model

■ We begin with a very simple model. We will then relax many of its assumptions in Section 3.

□ **The basic model.** Firms $i = 1, \ldots, n$ can each produce a homogeneous good X. Firm 1, only, chooses whether or not to pay a sunk cost K that allows it to produce a second good, Y.[10] After firm 1 has made this choice, which is observed by all other firms, all firms then simultaneously and noncooperatively choose quantities of the goods that they are able to produce.[11] We assume both goods are produced at constant marginal costs, without loss of generality equal to zero.

We assume that the qth consumer has reservation price $f(q)$ for one unit of good X, net of any shopping or startup costs for this good. All consumers have reservation price $v > 0$ for one unit of good Y, but any consumer who purchases this good from a supplier from which he does not buy X must pay an (additional) shopping cost. Our basic model assumes all consumers' shopping costs exceed v, so that in equilibrium no consumer will buy X and Y from different suppliers, and no consumer will buy only Y.

We write x_i for firm i's output of X, y_1 for firm 1's output of Y, p_i^x for the equilibrium price of a unit of X from i, p_1^y for the equilibrium price of a unit of Y from 1, and Π_i for firm i's profits, $i = 1, \ldots, n$. We write $X = \sum_{i=1}^{n} x_i$ and S for consumer surplus. We assume $f'(q) < 0$ and that the n-firm Cournot equilibrium when all firms produce X only is unique and stable,[12] and we restrict attention to the (subgame-perfect) Nash equilibrium.

□ **Analysis of the basic model.** First note that $p_i^x = f(X)$ for $i \neq 1$ and $\Pi_i = p_i^x x_i$ for $i \neq 1$, exactly as in a standard model. (The marginal consumer must, in equilibrium, be indifferent between buying from any firm and buying from no firm, exactly as in a standard model.) Now, clearly $p_1^y \leq v$, so if $y_1 \geq x_1$, then $p_1^x = f(X) + (v - p_1^y)$, since a consumer who buys X from firm 1 rather than from another firm benefits by $(v - p_1^y)$ by being able to also buy Y at p_1^y (because shopping costs are so large that no consumer who does not buy X from firm 1 will buy Y). Also if $y_1 > x_1$, then $p_1^y = 0$, since the last $(y_1 - x_1)$ units of Y go unsold (so also $p_1^x = f(X) + v$). And if $y_1 < x_1$, then $p_1^x = f(X)$, since the marginal consumer of X from firm 1 cannot also buy Y (so also $p_1^y = v$). In either case, $p_1^x + p_1^y = f(X) + v$, and if $y_1 = x_1$, then all of firm 1's

[8] In 1986 the London stock exchange liberalized access to stock-exchange membership to induce non-U.K. companies to trade their stocks in London, and thus expand its range of financial products. This and other deregulation decisions have increased the London stock exchange's competitive advantage over its continental competitors. (For example, the volume of French stocks traded in London jumped from being negligible to 17% of the total Paris Bourse turnover in 1987; see Pagano and Roell (1993).)

[9] By saving consumers the small shopping costs they would incur by buying a rival's service (such as America Online or Compuserve), Microsoft made it hard for the rivals to compete.

[10] In the corollary to Proposition 1, we consider the case in which all firms can introduce good Y.

[11] The order of choices reflects the fact that product-line decisions are typically long-term decisions that cannot easily be modified. The levels of production of a firm's products are short-term variables that the firm can easily change.

[12] Uniqueness and stability require $(n + 1)f'(X) + Xf''(X) < 0$.

consumers buy both X and Y and any p_1^x and p_1^y satisfying $p_1^x + p_1^y = f(X) + v$ are an equilibrium. Therefore $\Pi_1 = f(X)\, x_1 + v \min\{x_1, y_1\} - K$, so firm 1 chooses $y_1 = x_1$ in the case that it can produce good Y at all.[13] That is, $\Pi_1 = (f(X) + v)x_1 - K$ if firm 1 chose to produce Y, and $\Pi_1 = f(X)x_1$ otherwise. In either case, consumer surplus $S = \int_0^X [f(q) - f(X)]\, dq$, as in a standard model, since if firm 1 chooses to produce Y, then $p_1^x + p_1^y = f(X) + v$, implying that firm 1 appropriates all the surplus generated by the introduction of product Y.[14]

Since K is independent of x_1, it is elementary comparative statics that if firm 1 produces Y, then x_1 is larger than otherwise, and (by stability) the total industry output of X and therefore consumer surplus S are larger than otherwise. However, the profits of each firm $i \neq 1$ are lower than otherwise.

The intuition is that in the presence of shopping costs, a firm that sells good Y is a more attractive firm for consumers to buy good X from. Thus, the firm sells more of good X and so lowers its rivals' profits in the market for good X.[15,16]

The fall in the rivals' profits constitutes what we shall call the "indirect business-stealing effect." This effect hinges upon the existence of shopping costs, since if consumers were able to purchase from additional suppliers at no cost, the profits of any given firm would be unaffected by the expansion of its rivals into unrelated products. It thus contrasts with the standard business-stealing effect (see Mankiw and Whinston, 1986) that arises when a rival introduces a product that is a substitute for the products already being offered.

We are interested in comparing the numbers of products in firms' equilibrium product lines with the numbers that would maximize social welfare as conventionally measured by the sum of profits and consumer surplus. In particular, does firm 1 offer two products (both X and Y) when it would be socially preferred for it to offer only one product (X)?[17]

The benefit to firm 1 from introducing product Y exceeds the social benefit if the introduction has a negative external effect on consumers and rival firms. In this case, firm 1's product line includes either the socially correct number of varieties or too many varieties. Firm 1's product line includes the correct number of varieties (that is, the social benefit of introducing good Y is positive) if the net external effect is smaller than firm 1's private benefit from introducing good Y; the product line includes strictly too many varieties when the net external effect is negative and exceeds the private benefit.

Write $d\Pi_i$ for the change in profits of firm i, and dS for the change in consumer surplus resulting from the production of Y. The net external effect of producing Y equals $\Sigma_{i \neq 1}\, d\Pi_i + dS$, while the private benefit for firm 1 is $d\Pi_1$. Unfortunately, these are complex nonlinear functions of v, which are difficult to sign even in the simplest cases, and completely intractable in general. To overcome this we use

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[13] Strictly, because we have assumed zero costs of production, firm 1 is indifferent between all $y_1 \geq x_1$, but $y_1 = x_1$ is uniquely optimal with any positive constant marginal cost.

[14] Extension 8 discusses relaxing the assumption of horizontal demand for Y.

[15] An alternative perspective is that the firm earns an increased profit margin on the sum of goods X and Y, so since the existence of shopping costs means that it cannot sell Y independently of X, it expands output of both goods.

[16] In this simple model any nonnegative prices p_1^x and p_1^y such that $p_1^x + p_1^y = f(X) + v$ are consistent with equilibrium when $y_1 = x_1$, and the intuition in the text would not apply if $p_1^y = v$ (see footnote 15). However, p_1^y is strictly less than v in the extensions of the model (2, 3, and 8) that determine p_1^y uniquely.

[17] When computing the number of products that a social planner would choose, as well as when computing the number of products chosen in the market equilibrium, we assume that firms' outputs in the second (production) stage will be a Nash equilibrium. This is consistent with the view that public policy may restrict the products that firms offer but cannot in general directly affect the output levels firms choose.

comparative statics techniques, but the disadvantage of this is that our formal proposition applies only for small v.[18]

Proposition 1. The benefit to firm 1 from introducing product Y exceeds the social benefit, and hence firm 1's product line includes either the (socially) correct number of varieties or too many varieties (and includes strictly too many varieties for a range of values of K), if v is not too large and any of the following conditions holds:

(i) $f(X)$ is concave at the equilibrium value of X,

(ii) industry marginal revenue for $f(X)$ is downward sloping at the equilibrium value of X and $n > 3$,

(iii) the elasticity with respect to output of the slope of $f(X)$ is bounded below and n is sufficiently large.

Proof. Let firms' equilibrium outputs be $x_i = x_i^*$ when all firms produce good X only. By symmetry $x_1^* = \ldots = x_n^* = x^*$, and let $X^* = n\,x^*$. By offering good Y, if v is small, firm 1 induces small changes dx_i, $i = 1, \ldots, n$, in all firms' outputs relative to this case. The effect on firm i's profits is $d\Pi_i \approx x^* f'(X^*) \sum_{j \neq i} dx_j$, for each $i \neq 1$, by the envelope theorem, and the effect on consumer surplus is $dS \approx -X^* f'(X^*) \sum_{i=1}^{n} dx_i$ (omitting terms of second order). The private benefit to firm 1 of introducing good Y exceeds the social benefit when the sum of these effects, $\sum_{i \neq 1} d\Pi_i + dS$, is negative, that is,

$$\sum_{i \neq 1} \left(x^* f'(X^*) \sum_{j \neq i} dx_j \right) - X^* f'(X^*) \sum_{i=1}^{n} dx_i < 0. \tag{1}$$

This inequality can be rewritten as $-x^* f'(X^*)[1 + 2 \sum_{i \neq 1} (dx_i/dx_1)]dx_1 < 0$, so noting that $f'(X^*) < 0$ and $dx_1 > 0$ (by stability), (1) is equivalent to

$$[1 + 2 \sum_{i \neq 1} (dx_i/dx_1)] < 0.$$

Substituting for the slope of the reaction functions

$$(dx_i/dx_1) = -(f'(X^*) + x^* f''(X^*))/(nf'(X^*) + (n - 1)x^* f''(X^*))$$

so (1) holds if and only if

$$[((n - 2)f'(X^*) + (n - 1)x^* f''(X^*))/(nf'(X^*) + (n - 1)x^* f''(X^*))] > 0.$$

Rearranging yields that the private benefit of introducing good Y exceeds the social benefit if and only if

$$X^* f''(X^*)/f'(X^*) > [-n(n - 2)/(n - 1)]. \tag{2}$$

(Equation (1) would also be satisfied by $X^* f''(X^*)/f'(X^*) < -n^2/(n - 1)$, but this would violate stability.)

Note that the left-hand side of (2) is the elasticity with respect to X of the slope of $f(X)$ evaluated at X^*.

[18] The results apply only for small changes because comparative statics techniques linearize profits and consumer surplus around the equilibrium. Farrell and Shapiro (1990) use the same approach in a similar context, when they study the competitive and welfare effects of (small) asset sales.

Condition (2) applies under any of (i), (ii), or (iii) (since (ii) $\Rightarrow 2f'(X^*) + X^*f''(X^*) < 0$), so under any of these conditions $\Sigma_{i\neq 1}\, d\Pi_i + dS < 0$. Therefore, since $d\Pi_i$ is decreasing in K, under any of these conditions there is a range of K such that the private benefit of introducing good Y is positive but the social benefit is negative, i.e.,

$$d\,\Pi_1 > 0 > d\,\Pi_1 + \left[\sum_{i\neq 1} d\,\Pi_i + dS\right]. \qquad \textit{Q.E.D.}$$

The reason for Proposition 1 is that introducing product Y raises firm 1's profits and raises consumer surplus, but the indirect business-stealing effect reduces other firms' profits by more than those gains: provided $f(\cdot)$ is not too convex, the contraction in each other firm's output per additional unit of firm 1's output, $-dx_i/dx_1$, is sufficiently large that the indirect business-stealing effects on the other firms' profits are large, and consumers do not benefit too much.

If the number of firms, n, is larger, this increases the likelihood that the introduction of a new product is socially undesirable because there are $(n - 1)$ indirect business-stealing effects to set against the additional consumer surplus generated by a single firm's new product introduction.

Our result extends immediately to the case in which every firm simultaneously and noncooperatively chooses whether or not to pay the sunk cost, K, to produce the second good, Y, after which all firms observe all other firms' choices and simultaneously and noncooperatively choose quantities of the goods that they are able to produce.

Corollary 1. If all firms $i = 1, \ldots, n$ have the option to introduce good Y, then the benefit to firm i from introducing product Y exceeds the social benefit, for all i, and hence all firms' product lines include either the (socially) correct number of varieties or too many varieties (and all firms' product lines include strictly too many varieties for a range of values of K), if v is not too large and any of the conditions (i), (ii), or (iii) in Proposition 1 holds.

Proof. For small v, the private and social implications of the introduction of product Y by a firm are, to first order, independent of whether or not the other firms introduce product Y. The argument of Proposition 1 therefore applies. *Q.E.D.*

Proposition 1 and Corollary 1 focus on the small-v case, which is the relevant one in considering whether, for example, a store's marginal product or an airline's marginal route is socially excessive. For larger v (so that our comparative statics approach is no longer valid), excess entry is less likely than for small v if only one firm can introduce good Y,[19] but excess entry is more likely than for small v when all firms introduce good Y. The reason is that when a firm i introduces good Y, the loss in other firms' profits is generally smaller (larger) relative to the gain in consumer surplus when the other firms' outputs are smaller (larger) relative to i's output; when the first firm introduces Y, other firms' outputs change from equal to, to smaller than, i's output, whereas

[19] For example, for the strictly concave demand curve $f(X) = 1 - X^2$ and $n = 2$, there is a bias toward excess entry if and only if v is smaller than $\approx .4$. However, as n increases, the cutoff value of v for which there is a bias to excess entry increases, and for all $v < 1$ there is a bias toward excess entry if n is large enough (and the statements of this sentence are also true for linear demand $f(X) = 1 - X$).

when the last firm introduces Y, other firms' outputs change from larger than, to equal to, i's output.[20]

Note that when all firms offer product Y when it is socially preferred that none should, the firms also would be better off if none of them was able to produce good Y, that is, the firms are in a prisoners' dilemma.[21]

3. Extensions

■ The model in the preceding section is, we think, the simplest model that captures the most important feature of product-line extension in an environment with shopping costs—the indirect business-stealing effect.[22] This section explains that the results are considerably more general.

□ **Extension 1: Large numbers of products.** In Proposition 1 the social planner's choice of firms' product lines differs from the market outcome only if the setup cost K is in a specific range. Consider, however, the case in which a firm can choose how many of a large number of products, each of which is "small," to introduce. For example, an airline can choose how many routes to operate, or a store can choose how many products to offer or (we will argue our model also applies to this) how many minutes of the day to open. Each firm will then continue to add product varieties until the marginal profit from the last variety is zero.[23] Therefore, applying Proposition 1 to each firm's last variety offered, each firm's product line is unambiguously too long from the social point of view if any of the conditions (i), (ii), or (iii) holds.

□ **Extension 2: Heterogeneous shopping costs.** We do not require the assumption that all consumers have large shopping costs: Appendix A shows that Proposition 1 continues to apply when consumers' shopping costs are continuously distributed over a range including zero. The intuition is that only consumers who have small shopping costs and buy the two products from different firms obtain surplus from the ability to buy the new good. (Consumers with larger shopping costs pay v more, in equilibrium, for buying both goods from the multiproduct firm 1 than for buying only good X from a single-product firm, and so are indifferent between these options.) It follows that, for small v, this gain in consumer surplus is of second order, and so the proof of Proposition 1 applies exactly as before.[24]

□ **Extension 3: Small shopping costs.** Our results also do not depend on assuming that v is small relative to (most) consumers' shopping costs. Consider a model of the

[20] When all firms simultaneously introduce Y, the welfare effect of the marginal firm can be thought of as if this firm were the last firm to introduce Y. The welfare effects of the first firm (last firm), i, introducing a new product with "large v" can be computed as the integral over a series of "small v" product introductions, for the first of which each other firm's output is equal to (is larger than) i's output, and for the last of which each other firm's output is smaller than (is equal to) i's output.

[21] To see this, note that consumer surplus increases in the number of firms introducing Y, so $dS > 0$ when all firms introduce Y. So, if from the social viewpoint no firm should introduce Y, that is, $\sum_{i=1}^{n} d\Pi_i + dS < 0$, then $\sum_{i=1}^{n} d\Pi_i < 0$, and (by symmetry) $d\Pi_i < 0$ for all i.

[22] Introducing a new product in our simple model is directly analogous to credibly committing to make the existing single product cheaper or higher quality in a future period in a market with switching costs. The existing switching-cost literature (see footnote 4) typically assumes such commitments are difficult to make. Similarly, introducing a new product in our context is analogous to investing, prior to production, in improved quality or in lower marginal costs in a single-product context.

[23] One very simple way to model this is to let a firm introducing m new products increase consumers' willingness to pay by $v(m)$ (each firm chooses m so that the marginal value to it of the mth variety is zero).

[24] Of course, the extra gain in consumer surplus makes excess entry a less likely outcome when v is larger.

opposite extreme in which consumers' shopping costs are small enough that when firm 1 introduces product Y, *every* consumer buys Y from firm 1. Assume, for simplicity, that all consumers have the same shopping cost, $s < v$. Then in equilibrium $p_1^y = v - s$, $p_1^x = f(X) + s$, and $p_i^x = f(X)$ $i \neq 1$. Note that no consumer gains any surplus directly from the ability to buy Y, because all consumers are indifferent between buying only good X at price $f(X)$ from firm $i \neq 1$ and buying both goods, whether they buy both goods from firm 1 or buy Y from firm 1 and X from another firm. Therefore our result is essentially unchanged: Proposition 1 holds under exactly the same conditions as previously except that the condition "v is not too large" is replaced by the condition "s is not too large."[25]

□ **Extension 4: Excess variety without sunk costs.** Our basic model requires sunk costs of introducing good Y for its introduction to be welfare reducing (because total output of X increases and firms have equal constant marginal costs of producing X, so welfare is increased if $K = 0$). However, if firms' costs of producing X are asymmetric, then even with constant returns to scale in producing Y (i.e., $K = 0$), introducing Y can be welfare reducing if firm 1 has the highest costs, so production of X is shifted from more efficient firms to a less efficient firm.[26] Conversely, introducing product Y is more likely to be welfare enhancing than in our basic model if firm 1 has lower costs than other firms do.

□ **Extension 5: Foreclosure.** Our analysis has thus far assumed that the number of competitors, n, is unaffected by firm 1's producing a new product (or merging with a firm in another market). Note, however, that introducing the new product reduces all other firms' outputs and profits even when the conditions of Proposition 1 are not satisfied (assuming the equilibrium is stable). It may therefore cause a competitor to exit the industry and thus lower welfare and raise firm 1's profits even if social welfare would not have been reduced, and perhaps even if firm 1's profits would not have been increased, if all firms had continued to operate.[27]

Thus, a firm's decision to expand its product line (or to enter a new market by merger) may be motivated by its desire to foreclose and so monopolize existing markets. The existence of shopping costs can therefore make sense of the claim that firms can "leverage" monopoly power in a new market to increase market power in a previously existing market.[28]

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[25] Likewise the proof is unchanged except for substituting "if s is small" for "if v is small." The extension to allowing all firms to produce Y is no longer immediate, because the equilibrium outputs of Y are not unique in this case. However, if we assume that the symmetric equilibrium (among firms producing Y) is the one chosen, then there is unambiguously excess entry under the conditions of Corollary 1.

[26] An example in which firm 1's introduction of Y is welfare reducing with $K = 0$ has $f(X) = 1 - X$, $n = 2$, firm 1's marginal costs of $X \in (\frac{9}{11}, \frac{1}{2})$, firm 2's marginal costs equal to zero, and v sufficiently small.

[27] This cannot happen if there are constant returns to scale in producing X, in which case x_i $(i \neq 1)$ decreases continuously in v until $x_i = 0$ so i does not exit the industry until it is in any case irrelevant. However, if there are fixed costs of producing X (or other economies of scale), then firm i's profits can be zero at an n-firm equilibrium in which $x_i > 0$, and a small change in v may then cause i to exit (i.e., a discontinuous change to $x_i = 0$). Of course, foreclosing a competitor does not necessarily reduce social welfare when there are economies of scale (see Mankiw and Whinston, 1986; Bulow, Geanakoplos, and Klemperer, 1985), but typically will do so if v is small and K is such that the foreclosing firm gains little (since consumer surplus as well as the foreclosed firm's profits generally fall if v is small).

[28] Antitrust and competition policy laws in several countries make use of the "leverage" theory that a firm may abuse a dominant position in one market to obtain market power in a second market. (See, for instance, art. 86 of the EC Treaty of Rome and section 2(1) of the 1980 UK Competition Act. For a review of the relevant legal literature see Kaplow (1985).) The theory has often been criticized using the argument that "a seller cannot get two monopoly profits out of one monopoly," but our article rebuts this argument.

Similarly, a firm may expand its product line simply to deter further entry into its existing markets.

Note the connection between shopping costs causing foreclosure and Whinston's (1990) explanation of how bundling can foreclose a market. (Bundling can be thought of as endogenously imposing an infinite shopping cost.) Thus, increasing the importance to consumers of shopping costs (e.g., of the kinds described in Section 4) may achieve the same effect as tying while attracting less notice from antitrust authorities.[29]

□ **Extension 6: Price competition.** Our model assumes quantity competition which typically results in strategic substitutability (in the terminology of Bulow, Geanakoplos, and Klemperer (1985)). That is, when firm 1 introduces good Y and so becomes a more attractive supplier of good X, its competitors typically behave less aggressively in the market for X, so consumer surplus is not much increased. In a model with price competition,[30] strategic complementarity would be more usual, so firm 1's introduction of Y would typically result in all firms behaving more aggressively, and hence a larger increase in consumer welfare. Therefore, although the result that firm 1's competitors suffer in market X when firm 1 introduces good Y is robust, the result that the introduction of good Y is socially costly is less likely to hold with price competition than with quantity competition, unless foreclosure results. However, the working paper version of this article gives an example of a model with price competition (and strategic complements) in which the introduction of product Y is socially costly without foreclosure in market X. (The example uses differentiated products as in extension 7.) Furthermore, foreclosure seems both more likely, and likely to be more socially costly, with price competition (since price competition typically leads to more competitive outcomes, which also make it easier to drive out a rival).

□ **Extension 7: Differentiated products.** One of the advantages of our quantity-competition model was that it was easy to work with homogeneous products in market X. However, a model with differentiated varieties of good X, and consumers who are heterogeneous in their preferences between these varieties, would reveal additional effects. For example, excess variety is more likely if the new product, Y, is more highly valued by firm 1's marginal customers (that is, the customers who are close to indifferent between firm 1's variety of X and another firm's variety of X) than by the average customer. (See the working paper version of our article.)

□ **Extension 8: Downward-sloping demand for Y.** Our result is less robust to consumers having heterogeneous values for good Y (i.e., downward-sloping demand for Y). In this case the introduction of Y will directly generate consumer surplus. Therefore there is less likely to be excessive product variety, and it is hard to obtain general results about when the bias toward too many goods that this article identifies continues to be the dominant effect. However, Appendix B generalizes our model so that the consumer who has reservation price $f(q)$ for one unit of X has reservation price $vg(q)$, with $g'(q) \leq 0$, for one unit of Y (i.e., our main result is the special case in which $g(q) = 1$ for all q). Then our result continues to hold for large n, that is, part

[29] However, our article has also shown that (for a given size of the shopping costs) the introduction of a new product can both be privately profitable and reduce social welfare without excluding competitors, whereas bundling never arises in Whinston's model unless foreclosure can be achieved. (Analogously to Whinston's result, in our model a firm that would anyway introduce a new product generally prefers no shopping costs to large shopping costs unless foreclosure can be achieved.)

[30] See Klemperer and Meyer (1986, 1989), and the references therein, for discussion of whether oligopoly is best modelled assuming price competition or quantity competition.

(iii) of Proposition 1 continues to hold. For smaller n, excessive product variety is more likely with more concave $g(\cdot)$.

Note also that if the nature of product Y is endogenous, then firm 1 will select a product Y that is particularly highly valued by the marginal consumer of good X.[31] Then the consumer surplus gained from the new product may be particularly small relative to the effects on which we are focusing.

In the case in which consumers' shopping costs are small relative to v (see extension 3) it is again true that heterogeneous values for good Y means that Y will directly generate consumer surplus so that there is less likely to be excessive product variety. Another possibility, however, is that firm 1 merges with a preexisting firm that was already selling good Y. In this case, downward-sloping demand for Y need not imply an additional gain in consumer surplus relative to the premerger position,[32] in which case the private incentive for firm 1 to enter market Y through merger exceeds the social benefit under any of the conditions (i), (ii), or (iii) of Proposition 1 when s is small.

4. Illustrations

■ **Competition in deregulated airline markets.** There is extensive evidence that when an airline serves more routes at an airport, it becomes a stronger competitor on any given route originating at that airport. For example, in 1986 American Airlines carried 40% of the round-trip Atlanta-Dallas traffic that originated in Dallas (where operations were dominated by American), but only 11% of the traffic on this route that originated in Atlanta (where Delta and Eastern dominated).[33] This results from frequent flyer programs[34] and travel agent commission override programs (TACOs), whose nonlinear payoff schedules induce individual customers and travel agents, respectively, to concentrate their business with one or a few airlines, as well as from informational and reputational effects. There are also weaker effects on an airline's whole network; in addition to the above reasons, passengers prefer to fly the different segments of a journey using a single airline in order to obtain single responsibility for ticketing and baggage handling and help in making connections.[35,36] It has in the past—e.g., in the

[31] An extreme example would have only consumers around X^*—the marginal consumer when only X is produced—having any positive valuation for Y; note that the effects on which we are focusing are unaffected by other consumers' valuations of Y.

[32] In the simplest case to analyze, the consumer with the yth-highest valuation of Y has a reservation price $g(y)$ net of shopping costs for one unit of Y. (We do not require the consumers with high valuations for Y to be the same as those with high valuations for X.) Assume all consumers have shopping cost s, and that the preexisting firm previously sold quantity y_0 at price $p_0^y = g(y_0)$. Then in the postmerger equilibrium $p_1^x = p_0^y$, $p_1^y = f(X) + s$, and $p_i^y = f(X)$ for $i \neq 1$, provided that s is not too large and that the number of consumers who purchased both X and Y in the premerger equilibrium exceeds x_1. In this case, because $p_1^y = p_i^y + s$, $i \neq 1$, no consumer gains surplus directly from the ability to buy X and Y from a single firm.

[33] Borenstein's (1991) empirical results show that an airline's share of passengers on any particular route from an airport is increased when its share of aircraft departures on all other routes from that airport is increased, and Berry (1990) finds that both the average price charged by an airline on a given route and its market share on that route increases with the number of routes served by that airline. (There may also be cost effects. However, both studies control for economies of scope. Borenstein also finds that an airline's share of passengers on a route increases by ¼% when its share of passengers on all other routes from that airport is increased by 1%.)

[34] In a survey conducted by the U.S. General Accounting Office in 1990, more than half of travel agents stated that their business customers selected flights to match their frequent flyer programs "always or almost always." Morrison and Winston (1989) estimate that in 1983, frequent flyer miles were valued by consumers at an average of 2.7 cents per mile, or about 20% of the average fare paid per mile at that time.

[35] The importance of this is illustrated by the recent dispute (*Financial Times*, February 27, 1993, p. 2) about whether the U.S.-U.K. bilateral aviation agreement gives British Airways the right to "code-share" with USAir. "Code-sharing involves two airlines using the same code letters . . . for connecting services. . . .

USAir-Piedmont merger case[37]—been argued that these effects leave airlines with smaller networks at a competitive disadvantage. Our analysis, see especially extension 1, suggests that they may also lead to a socially excessive supply of routes.

□ **The commuter aircraft merger case.** In an important case, the European Commission in October 1991 prohibited Aerospatiale-Alenia's proposed acquisition of de Havilland. This was the first deal to be outlawed under the EC's 1989 Merger Regulations, and the Commission's arguments for blocking the deal were primarily those that our analysis has formalized.

The two companies each produced small-capacity turbo-propeller "commuter" aircraft for regional transport, and the proposed merged entity would have produced a "full line" in this market, that is, would have competed in all three of its submarkets according to the generally accepted subdivision of the market, when none of its competitors (Fokker, British Aerospace, Deutsche Aerospace, and CASA) could offer a full line (see Table 1). According to the European Commission, "one of the stated main objectives of the parties in acquiring de Havilland is to obtain coverage of the whole range of commuter aircraft" and "having a complete range of products would give [the merged entity] a significant advantage [because] airlines derive cost advantages from buying different types [of aircraft] from the same seller" (section 32).[38] The Commission therefore judged that the merged firm would achieve a dominant position in the market (sections 51, 52, 69, 72) in breach of the 1989 EC Merger Regulation (article 2(3)), and since the Commission did not believe that there would be significant cost synergies (sections 65–66), it prohibited the merger.

Extension 8 of our analysis shows that the Commission's argument *may* be economically justified. However, although this extension demonstrates that the private benefits of a merger exceed the social benefits (if the assumed conditions are satisfied), this does not imply that the social benefits are necessarily negative. Although a firm's marginal expansion should have zero private benefit, this is not the case for a significant merger. If shopping costs are important, the increase in the merging firms' revenues will be significant and is likely to dominate any diseconomies of scope or transaction costs of the merger, so the private benefits of the merger may be large. Therefore a net welfare loss, although possible, seems unlikely from this line of reasoning.[39]

Airlines reckon connecting flights with the same codes are four times more likely to be booked than connections that are clearly with different airlines—probably because some would-be passengers believe they will be making their entire journey with the same airline." (*Economist*, December 26, 1992, p. 84.)

[36] Carlton, Landes, and Posner (1980) estimate that "the provision of single-carrier service [but not single-plane service, so that passengers must still change planes] on a city pair now receiving only multicarrier service (and assuming single and multiple carriers have the same number of flights, scheduled travel time, and unobservable factors) would be worth between $13.10 and $17.75 per traveler [in 1978 dollars, which] represents about 11.2 to 15.2 percent of the average fare in [their] sample city pairs."

[37] See Borenstein (1989) and U.S. Department of Transportation, Docket 44719, USAir-Piedmont Acquisition Case, May 22, 1987.

[38] References are to sections of the *Official Journal of the European Communities* no. L 334, pp. 42–61 (December 5, 1991). The benefits from "commonality"—the savings in training costs and maintenance facilities from buying aircraft from a single manufacturer—are said to create cost advantages to a commercial airline on the order of 10%–20% of the aircraft's price, according to the *Economist* (January 30, 1988, p. 51).

[39] Of course, our welfare criterion (profits plus consumer surplus) may not reflect the European Commission's. Some authors consider that the welfare objective underlying the European legislation on competition is to maximize consumer surplus, while there are also instances (e.g., Michelin vs. Commission (*Official Journal of the European Communities* no. 353, 1981) and United Brands vs. Commission (Case 26/27, ECR 207, 1978)) where the Commission and the European Court of Justice have seemed concerned to protect competitors, irrespective of consumer welfare (see Whish, 1989).

TABLE 1 The Commuter Aircraft Market

Firm	20–39 Seats	40–59 Seats	60 Seats and Over
de Havilland	X	X	
Aerospatiale-Alenia		X	X
British Aerospace	X		X
Saab	X	X	
Embraer	X		
Deutsche Aerospace	X		
Fokker		X	
CASA		X	

Note: As of October 1991, de Havilland's shares of the markets for 20–39 seats and for 40–59 seats were approximately 25% and 19%, respectively, and Aerospatiale-Alenia's share of the markets for 40–59 seats and 60 seats were approximately 45% and 76%, respectively. (Source: *Official Journal of the European Communities* no. L. 334, p. 44 and sections 8–19, December 5, 1991.)

However, the Commission also claims that the merged firm's dominant position would "seriously jeopardize the survival of [its competitors]" so that "there is a high risk that in the foreseeable future, the dominant position of Aerospatiale-Alenia/de Havilland would be translated into a monopoly" (section 69). In other words, as we showed in extension 5, the merger could lead to foreclosure of the market. Although it is hard to evaluate the likelihood of this occurrence (it is discussed only in sections 69–70),[40] this leg of the Commission's argument seems to us to be the more plausible one.

□ **Sunday trading: do shops open too many days?** For some years, there has been considerable controversy about the desirability of Sunday trading restrictions. In the United Kingdom, a long and emotional debate led up to a Parliament vote in December 1993 to allow large shops to open for six hours on Sundays and small shops to open all day; Parliament had on several previous occasions refused to repeal the law that had banned Sunday trading, even though the government had renounced enforcement of this law. In Spain, Sunday trading was legal in some regions but not in others until 1995, and is now illegal in all regions for a transition period ending in 2000. The situation is equally varied over much of the rest of the European Community, and the European Parliament recently (in 1992) passed a resolution asking the European Commission to tighten Sunday trading restrictions. The United States and Japan have disputed the effects of Japanese regulations that place tighter limits on larger shops regarding the hours and days of opening (the United States regards these regulations as an unfair trade barrier), while in the United States itself many of the "blue laws" that previously restricted trading hours have now been lifted.

Viewing opening for an additional period of time as an additional service that a shop can offer, our analysis (see extension 1) suggests that if—as many shopkeepers argue—customer loyalty to shops is important,[41] then shops will open for a (socially) excessive number of hours (under conditions (i), (ii), or (iii) of Proposition 1).

[40] For example, the possibility of competitors of the merged entity themselves merging is not discussed.

[41] Anecdotal evidence from interviews with retailers suggests that customer loyalty is most important in the food and mixed-goods sector (especially department stores).

Frank (1991) has recently made an informal argument similar to ours.[42] He notes that "Ithaca, a town of 30,000 people in central New York, has seven large supermarkets. Five of them are open twenty-four hours a day. On the rare occasions when I have patronized one of these stores in the middle of the night, I have been almost the only shopper." His explanation, like ours, is that "Most people do the bulk of their shopping at a single store. Grocery shopping, after all, is largely a matter of habit, and going to a store with even a slightly unfamiliar layout can upset the normal routine . . . if all stores are equally attractive except for their hours of business, many people will choose the one with the longest hours." Much earlier, Edgeworth (1925) noted that "there are many arrangements which it is the interest of all combined to adopt, but of each acting in competition to violate; e.g., Sunday rest, or early closing of shops."

However, permitting a previously regulated shop to open on Sundays may not result in a "small" change in the sense required by Proposition 1, so we cannot presume that the social gains of Sunday trading are negative relative to the original equilibrium.[43] Furthermore, if firms' costs are unequal, Sunday trading could be desirable if, for example, it moves business from less efficient "local shops" to more efficient supermarkets (see extension 4).

As in our previous example (the commuter aircraft case) deregulating trading hours seems most likely to reduce welfare if it results in some shops being foreclosed from the market (see extension 5). In fact, there may be a particular risk of smaller shops being foreclosed,[44] because smaller shops face high fixed costs of opening on a Sunday[45,46] and so may have to exit if they cannot operate profitability by opening only on weekdays.[47] Thus our analysis provides some support for the arguments against Sunday trading that have been made by unions of small shopkeepers.[48]

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[42] We discovered Frank's work after completing the first draft of our article. He does not formalize the theory.

[43] Of course, Sunday shopping is a substitute, albeit imperfect, for weekday shopping, so that there is also a standard direct business-stealing effect (winning the business of consumers who prefer to shop on Sunday but were previously forced to shop on weekdays) as well as the indirect business-stealing effect (winning the regular weekday business of loyal consumers who also buy on Sundays). This direct effect may make excess entry more likely. Previous formal economic analyses (de Meza, 1984; Kay and Morris, 1987) have focused only on the direct effects.

[44] The U.K. National Chamber of Trade (representing smaller businesses) says "We urgently want action . . . to enforce the law [that currently prohibits Sunday trading] to stop our members being driven bankrupt by the illegal activities of the superstores." (*Times*, June 26, 1992). There is some evidence from Sweden (*Financial Times*, May 22, 1991) that liberalization of trading hours has made it harder for smaller firms to survive.

[45] Small shops cannot open on Sundays unless their owners either sacrifice their leisure time or hire part-time employees (which is both costly and risky for a small shop when the law makes layoffs expensive), while department stores can simply establish rota working systems. Also, purchasing economies of scope make it more difficult for any single small (specialized) shop to compete with a (multiproduct) department store on that day, so that successful Sunday opening by a small shop may require coordinating with other small shops.

[46] By contrast, small shops need not have higher weekday costs than department stores. (Of course, if they do, then the foreclosure of small shops by department stores might be desirable.)

[47] Foreclosure may be either innocent or predatory (according to whether the profits of the firm opening on Sundays would increase or decrease if the rival did not exit the weekday market). In the former case we expect foreclosure to be a less likely outcome if the rival has the ability to open on Sunday (and so recover some of its profits). In the latter case the ability to open on Sunday is less likely to help a rival, although it will do so for some $f(\cdot)$ and v.

[48] Even these arguments do not imply that prohibiting Sunday opening is necessarily optimal. It may be that the exclusionary consequences (if any) can be mitigated by government action (such as facilitating part-time employment or reducing hiring-and-firing costs) that reduce small firms' setup costs. (The examples use differentiated products as in extension 7.) Furthermore there are, of course, many other social and economic aspects of Sunday trading (one example is congestion and noise externalities) that our model does not address.

□ **Universal banking.** There has been considerable recent debate about the desirable scope of banks' activities: are the "universal" banks, which are typical of northern Europe and each offer a full range of financial products (including e.g., insurance, brokerage, security design and commercialization, and long-term financing to industry), socially preferable to the more narrowly focused commercial banks that are typical of the United States and simply concentrate on the ordinary business of deposit taking and lending?

Survey evidence shows that a substantial proportion of businesses and individuals "cluster" most of their financial services at a single institution because of "shopping costs" including transportation costs, search costs, costs of transferring funds between accounts and of other additional transactions, costs of signalling creditworthiness, etc.[49,50]

Consistent with our model, "activities that are chronically unprofitable are carried on [by European banks] in the belief that they help a bank to keep its customers."[51] Although banks may find this privately desirable ("a bank that gave up unprofitable activities may find itself losing customers in healthier areas and failing to attract new business"),[52] our model shows that it may be socially undesirable, especially since this strategy is likely to help universal banks crowd out other financial institutions.[53]

5. Conclusion

■ This article has shown that the presence of consumer shopping costs increases firms' incentives to extend their product lines. A firm with a longer line not only makes direct gains from its additional products, but also steals consumers from its rivals in *other* markets. The result may be that firms provide excessive numbers of products from the social point of view.

Whether firms' product lines are in fact too long in the presence of shopping costs depends on the other details of the market: excessive product proliferation is more likely where the number of firms is larger and demands are more concave (equation (2) in the proof of our main result), where firms produce a large number of "small" products (extension 1 and discussion in first subsection of Section 4), where a new product is specifically targeted toward marginal consumers who are close to indifferent between firms' existing product lines (extension 7), and especially where extending a product line may completely foreclose competitors' sales in other markets (extension 5). Excessive product proliferation is less likely if the new products directly yield substantial consumer surplus (extension 8), if the new products are offered by lower-cost firms (extension 4), and especially if a longer product line is created through merger[54] when shopping costs are large (see discussion of commuter aircraft case in Section 4). Without the detailed information that our model uses, it is hard to say much

[49] See, especially, Elliehausen and Wolken (1992), Petersen and Rajan (1994), and references therein. The importance of shopping and switching costs in banking has also been extensively recognized by practitioners, see for example the *Financial Times*, June 15 and 16, 1991, and Calem (1992).

[50] Antitrust decisions have already relied explicitly on this fact. For example, the Supreme Court's 1963 decision in *United States* v. *Phillipsburg National Bank* noted that "a customer who uses one service usually looks to his bank for others as well . . . [C]ustomers are likely to maintain checking and savings accounts in the same local bank even when higher interest is available elsewhere." See Ayres (1985) for further discussion.

[51] Quoted from the *Economist*, August 21, 1993, p. 57.

[52] See the *Economist*, August 21, 1993, p. 57.

[53] For example, in the second half of the 19th century, large universal banks (such as the Deutsche Bank) appeared in Germany and soon acquired a dominant position in the German banking industry, driving out of business a large number of small local banks and private bankers, who until then had provided most financial intermediation services.

[54] Of course a merger that generated cost synergies would be desirable for that reason also.

more than that the presence of shopping costs should make policy makers more cautious than otherwise about the value of a new product introduction.

Furthermore, even where firms offer too many products, this does not necessarily mean that the market offers too much variety. Klemperer (1992) showed that firms restricted to offering a fixed number of products may choose to offer the same set of varieties as their rivals, if consumers have shopping costs.[55] Taken together with our results, this suggests the possibility that although each firm may produce too many products, there is too little variety in the industry as a whole.

Appendix A

■ **Heterogeneous shopping costs.** This Appendix analyzes extension 2 by generalizing the basic model of Section 2 so that consumers' shopping costs are distributed according to the distribution function $\Gamma(s)$ independently of consumers' reservation prices and $\Gamma(s)$ is the number of consumers who have shopping costs $\leq s$. (We assume $\Gamma(s)$ is differentiable and $\Gamma(0) = 0$.) For small v the number of consumers for whom $s < v$ is small, so in equilibrium the marginal buyer of X from firm 1 has $s > v$, thus $p_1^s = f(X) + (v - p_1^s)$ as before (and $p_i^s = f(X)$) when firm 1 sells Y. So also, all consumers with $s < v - p_1^s$ buy Y from firm 1 but either buy X from firm $i \neq 1$ or do not buy X. Therefore, p_1^s is determined by the equilibrium condition $\Gamma(v - p_1^s) = y_1 - x_1$ (and so $y_1 = \text{argmax}_y(y - x_1)(v - \Gamma^{-1}(y - x_1))$. It remains true that the effect of firm 1 introducing Y on i's profits, $i \neq 1$, is $d\Pi_i \approx x^* f'(X^*) \sum_{j \neq i} dx_j$, and the slope of the reaction functions (dx_i/dx_1) is unaffected. The effect on consumer surplus is also as before, except that there are additional gains to the consumers with low shopping costs who buy Y but not X from firm 1. However, these additional gains equal $\int_{s=0}^{v-p_1^s} [v - p_1^s - s]d\Gamma(s) < (v - p_1^s)\Gamma(v - p_1^s)$, which term is of second order, so to first order the effect on consumer surplus is as before, and the argument of Proposition 1 follows as before.

Appendix B

■ **Heterogeneous valuations for good Y.** This Appendix analyzes extension 8 by generalizing the basic model of Section 2 so that the qth consumer (who has reservation price $f(q)$ for one unit of X) has reservation price $vg(q)$ for one unit of Y net of any shopping costs. Without loss of generality, we assume $g(0) = 1$, and we assume $g'(q) \leq 0$ and $g'(q)$ bounded below.

As before, $\Pi_i = x_i f(X)$, $i \neq 1$, and $\Pi_1 = x_1 f(X) + y_1 vg(y_1) - K$ when firm 1 produces Y. For small v, the effect of firm 1 introducing Y on i's profits, $i \neq 1$, is $d\Pi_i \approx x^* f'(X^*) \sum_{j \neq i} dx_j$ as before, and the effect on consumer surplus is as before, $(-X^* f'(X^*) \sum_{i=1}^n dx_i)$ in market X plus the additional gains $\int_0^{y_1} [vg(q) - vg(y_1)]dq$ to the inframarginal consumers of Y who have higher valuations than $vg(y_1)$. So the private benefit to firm 1 of introducing good Y exceeds the social benefit if (see (1))

$$\sum_{i \neq 1} \left(x^* f'(X^*) \sum_{j \neq i} dx_j \right) - X^* f'(X^*) \sum_{i=1}^{n} dx_i + \int_0^{y_1} [vg(q) - vg(y_1)]\, dq < 0. \tag{B1}$$

The terms dx_1, and hence (by stability) $\sum_{i=1}^n dx_i$, are positive if firm 1's marginal customer buys both X and Y in equilibrium. This will be the case if $g(x^*) + x^* g'(x^*) > 0$, that is, firm 1's marginal revenue from Y is positive at x^* so it wishes to increase its sales of X in order to sell more Y (consumers cannot buy Y without X). This condition holds for x^* sufficiently small, and hence for n sufficiently large, since $g'(\cdot)$ is bounded below.

So for small v and large n we have $x_1 = y_1 \approx x^*$ and in this case, at $v = 0$,

$$(dx_1/dv) = -(g(x^*) + x^* g'(x^*))(nf'(X^*) + (n - 1)x^* f''(X^*))/((n + 1)(f'(X^*))^2 + nx^* f''(X^*)),$$

while the slope of the reaction functions dx_i/dx_1 is as before. So if (B1) holds after substituting $dx_i \approx (dx_i/dx_1)dx_1$ and $dx_1 \approx (dx_1/dv)v$, then the private benefit of producing Y exceeds the social benefit for all sufficiently small v. But it is easy to check that this does in fact hold when condition (iii) in Proposition 1 holds, and $g'(\cdot)$ is bounded below. Furthermore, for any given $f(\cdot)$, n, and $g'(x^*)$, a more concave $g(\cdot)$ reduces the left-hand side of (B1).

[55] Competing "head to head" gives consumers no incentive to pay the shopping costs of using more than one supplier and can thus reinforce brand loyalty and reduce price competition.

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