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By Robert Innes, University of Arizona*

Abstract

This paper studies a model of product variety with flexible manufacturers when, contrary to prior work, atomistic entry occurs prior to horizontal integration. In this model, more lax antitrust laws that allow for fewer and more concentrated merged firms lead to a greater extent of excess entry. Optimal policy permits no horizontal mergers when demand is perfectly inelastic, but may permit some horizontal integration when demand is price responsive. The order of entry is shown to play an important role in determining the effect of flexible (vs. inflexible) manufacturing on economic welfare.

JEL: D42, D43, L11, L12, L13

Keywords: Entry, Market Structure, Horizontal Merger, Flexible Manufacturing

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Flexible Manufacturing, Entry, and Competition Policy

Flexible manufacturing systems that customize products for a wide range of consumer preferences are increasingly prevalent in a number of industries, including electronics, construction equipment, machine tools, construction materials, clothing, automobiles, furniture, computers, software, and aerospace (Norman and Thisse, 1999). In a small and growing literature, economists have studied implications of these systems for market structure, beginning with the initial work of MacLeod, Norman and Thisse (1988) and Lederer and Hurter (1986).¹ How do these systems affect equilibrium entry? And what are the attendant implications for economic welfare and antitrust policy?

To address these questions, scholars study market settings characterized by either exogenous pure competition (the “interlaced stores” of Brander and Eaton (1984) and Norman and Thisse (1999)) or an incumbent firm (or firms) that has the first opportunity to proliferate products before any other firm can enter the market. The purpose of this paper is to study the entry and welfare effects of flexible manufacturing when there is a different ordering of who enters when. Specifically, we envision first a phase of differentiated product development wherein many firms work to identify local niches in product space; this entry phase is then followed by opportunities for horizontal mergers, subject to antitrust constraints. We thus assume that entry occurs *first*, before horizontal concentration takes place. Concentration occurs by horizontal merger, rather than by initial monopolization of the market.

There is reason to think that concentration by merger, as modeled here, is very relevant in certain markets. For example, food markets often fit the description for flexible production. Large numbers of differentiated food products are tailored to consumer tastes, with conventional U.S. supermarkets today selling between fifteen and

¹For related work on flexible manufacturing systems, see Norman and Thisse (1996), Roller and Thombak (1990), Eaton and Schmitt (1994), Reitzes and Levy (1995), Anderson and Engers (2001). Other work studies flexibility in production quantities, rather than product attributes (e.g., Boyer and Moreaux, 1997).

twenty thousand items.² Moreover, in these markets, new product introductions are made both by dominant firms and proportionately more by a large number of much smaller firms. In 1993, the ten largest U.S. food companies accounted for less than seven percent of all new food product introductions, but over fifty percent of total U.S. market share (among all publicly traded food companies).³ The smaller food companies that are responsible for the vast majority of new product introductions may ultimately anticipate future mergers with other producers.⁴ These firms are precisely the sorts of apriori entrants that we model in this paper.

The ordering of entry has quite sharp implications for antitrust policy. In a model of flexible manufacturing wherein an incumbent monopolist can saturate the product space before any outside entry occurs, the monopolist preempts all subsequent entry (Eaton and Schmitt, 1994; Norman and Thisse, 1999). Moreover, when the monopolist cannot relocate its “base” product offerings post-entry (see Norman and Thisse, 1999) and when demand is perfectly inelastic (a standard premise in spatial models), Eaton and Schmitt (1994) show that the incumbent monopoly outcome is cost-benefit optimal. With completely inelastic demands, all that matters for efficiency is that the number and location of products, or “stores,” minimize total costs; as an incumbent monopolist faces all costs, it structures its production efficiently and a laissez faire antitrust policy optimally allows the monopoly to flourish. When demand is not perfectly inelastic, however, there are deadweight costs of monopoly pricing; even then, however, monopoly outcomes can sometimes yield higher economic welfare than the equilibrium that arises

²See www.fmi.org and Progressive Grocer (60th Annual Report of the Grocery Industry, 72:104, April 1993).

³These statistics are derived from COMPUSTAT sales data for companies in the food industry's two digit SIC class 20 (food and kindred products) for 1988-1995 and data on new product introductions reported in Prepared Foods (162:24, November 1993).

⁴Between 1997 and 2002, for instance, there was an annual average of 646 mergers in the food industry and 294 mergers in food processing, production and wholesaling businesses alone (The Food Institute Report, January 20, 2003). Prominent recent examples of food company mergers include acquisitions of Snapple by Cadbury (a leading soft drink producer) in 2000, Celestial Seasonings by the Hain Group (a leading natural foods producer) in 2000, and Earth's Best baby foods by Heinz (a leading baby food producer) in 1996.

when no horizontal concentration is allowed; the reason is that the latter competitive equilibrium can yield too many products.

In our analysis, in contrast, monopoly outcomes are always welfare dominated by those in which more than one firm is required to compete. Here, entry occurs in response to profits anticipated from subsequent mergers. In the initial entry phase, monopolistic competition yields entry until anticipated profits (net of entry costs) are zero. As in Reitzes and Levy (1995) and others, locally merged firms can charge higher prices to consumers in their market area, vis-a-vis unmerged firms that must compete for these customers; as a result, a greater degree of merger, for a given set of differentiated products, yields higher profit per product and, hence, more entry. When monopoly is allowed by antitrust laws -- so that an industry-profit-maximizing merger process leads to a monopoly outcome -- the highest possible amount of entry occurs as firms seek a share of the monopoly rents. Conversely, when no horizontal integration is allowed, the minimum possible amount of entry is obtained. When demands are completely inelastic, the latter "competitive" amount of entry is higher than optimal because firms enter in pursuit of revenues that are irrelevant to the economic welfare calculus. The best that can be done is to minimize the extent of excess entry by allowing no horizontal integration at all -- the extreme opposite of *laissez faire*.

When demands are price responsive, matters are complicated by the welfare effects of pricing. However, because entry erodes all profits in our model, aggregate economic welfare reduces to consumer surplus. With monopoly pricing uniformly higher than competitive pricing -- that which prevails when no horizontal integration is allowed -- consumers are strictly better off under competition. Hence, a *laissez faire* antitrust policy can never be optimal. Interestingly, however, *some* horizontal integration can be desirable. All else the same, mergers raise prices; however, they also spur more entry and can spur firms to locate their products close to the borders of their market areas, both of which have the effect of lowering prices. In this paper, we show that the latter

(pro-competitive) effects of small mergers can dominate the former (anti-competitive) effects – perhaps our most surprising result.

Like the present paper, but for different reasons, Norman and Thisse (1999) argue that a monopoly market structure will often give rise to excessive product variety, contrary to Eaton and Schmitt (1994). When costs of reanchoring products is sufficiently small (as is consistent with the present analysis), a monopolist will optimally respond to entry by relocating its base products, thus to some extent accommodating the entrant. Ex-ante, this accommodation raises profits from entry; as a result, entry deterrence by the incumbent monopolist requires a greater extent of product proliferation – that is, excessive variety. However, this cost of monopoly need not vitiate the Eaton and Schmitt (1994) motive for a laissez faire antitrust policy; for example, when reanchoring costs are zero, Norman and Thisse (1999, Corollary 1) conclude that monopoly and competitive/interlaced market structures produce the same number of products and, hence, the same level of economic welfare. Our conclusions are thus quite different in both their source (the ordering of entry) and their implications.

Our arguments also relate to a rather large literature on horizontal concentration and entry with “inflexible” technologies. In this literature, debate has centered on the effects of industry concentration on *subsequent* entry. The spatial preemption literature, for example, studies whether and how incumbent firms can preempt future entry.⁵ The horizontal merger literature studies whether horizontal mergers in Cournot-Nash markets will, by reducing competition, spur subsequent entry that thereby mitigates or eliminates the adverse consequences of mergers for consumer welfare (e.g., Werden and Froeb, 1998; Spector, 2003; Cabral, 2003).⁶ We focus instead on how the anticipation of the

⁵See, for example, Eaton and Lipsey (1979), Judd (1985), Hadfield (1991), Reitzes and Levy (1995).

⁶The general conclusion from these studies is that, anticipating entry effects, firms will merge only if the merger nevertheless raises prices and thereby raises profits and harms consumers. Gowrisankaran (1999) comes to a similar conclusion when studying a general dynamic Cournot-Nash model wherein firms merge, entry occurs, and the process repeats. In Gowrisankaran (1999), unlike other work, entry can occur in anticipation of possible future mergers; however, unlike the apriori entry of the present paper, entry does not stem from unexploited gains from mergers, but rather from potential rents created by prior mergers and random entry costs, draws from which can be low. Other related work studies how mergers in spatial

ability to merge, as dictated by antitrust law, affects entry apriori.⁷ Subsequent (post-merger) entry is endogenously preempted and, hence, not at issue.

I. The Model

We consider a Hotelling (1929) address model wherein each differentiated good is described by a point x on the unit interval $[0,1]$. To avoid endpoint problems, it is convenient to assume that this interval is the circumference of a circle (as in Salop, 1979). Consumers buy only one type of good (one x) and are also characterized by an address on the circle, $x^* \in [0,1]$. A consumer's address represents the most preferred good; in particular, if a consumer buys an $x \neq x^*$, then she bears a per-unit cost that is proportional to the product's distance from the most-preferred x^* . Formally, an x^* consumer buying product x at price $p(x)$ obtains the indirect utility, $U(p(x) + t|x - x^*|) + y$, where y is consumer income and $t > 0$. The consumer attribute x^* is uniformly distributed on $[0,1]$ with unit density.

An unmerged firm, or "store," is defined by a base product, $X \in [0,1]$. The cost of establishing a single base product production capability is $k > 0$. Given a base product location X , firms can adapt the good to mimic attributes of other differentiated goods -- other x 's. Unit costs of adaptation are proportional to the distance from the base product. Specifically, a store located at X can produce good x at constant marginal cost,

$$C(x) = c + r|x - X|,$$

where $r > 0$. For simplicity, we assume that the unit "base" production cost, c , is zero.

More importantly, we assume that product adaptation to consumer preferences is less costly than consumer "adaptation" to product specifications; that is, $r < t$. Hence, firms supply consumers with their most-preferred products.

markets affect apriori location decisions, but not entry (e.g., Heywood, et al., 2001), effects of vertical foreclosure by an upstream monopolist in a downstream horizontally differentiated market (Kuhn and Vives, 1999), and entry deterrence effects of non-horizontal mergers (Innes, 2006).

⁷Our arguments are related to Rasmussen's (1988) classic "entry for buyout" in the sense that entry occurs in anticipation of future rents. However, our analysis is substantially different. In Rasmussen, a firm enters even when entry is otherwise unprofitable because the entrant can "hold up" an incumbent firm for ransom. In this paper, we explicitly rule out such "hold up" problems (see Section I below) and focus instead on how the merger process -- and hence, the antitrust treatment of mergers -- affects entry incentives.

In prior work, an incumbent firm (or firms) establishes whichever base products that it likes, both number and location, and then subsequently faces potential entry and possible reanchoring opportunities (Norman and Thisse, 1999). We instead consider a contestable process of entry, with the game proceeding in four stages. First (Stage 1), each of a large number of potential producers enters (or not) by establishing at most one base product at an initial location X . The number of entering firms will be denoted by N . Firms are assumed to be risk neutral. Second (Stage 2), the entered "stores" can horizontally merge subject to the constraints imposed by antitrust laws. At the time that mergers take place, we assume that antitrust law requires that no more than n stores can merge, where $n = N/\underline{N}$. \underline{N} ($\leq N$) is chosen by the government apriori and is the minimum number of allowed horizontally merged firms. For example, if \underline{N} equals one -- the least restrictive antitrust policy -- then monopoly is allowed; conversely, if $\underline{N} = N$, then no horizontal mergers are allowed. Third (Stage 3), as in Norman and Thisse (1999), a firm can relocate / reanchor any of its stores. For simplicity, we assume that a one-time relocation is costless within a relevant neighborhood of the initial location. (See below for elaboration on the motivation for this relocation process.) And fourth (Stage 4), product pricing, production, and trade occur.

In a game such as this, there can be many subgame perfect equilibria.⁸ We focus on the simplest – and arguably most plausible – of these equilibria. First, for simplicity, we assume that the number of (Stage 1) entering firms, N , is sufficiently large that it can be treated as approximately continuous and integer-divisible by \underline{N} .⁹ Second, as in related prior work, we focus on equilibria that are symmetric (in a sense that will become precise in a moment). And third, we posit a merger process that is efficient in that the most profitable mergers are made, subject to antitrust constraints.

⁸See Kamien and Zang (1990) and Gowrisankaran (1999).

⁹We thus abstract from the integer and remainder issues studied in Anderson and Engers (2001).

To be more specific, let us consider each of the four stages, proceeding by backward induction. Stage 4 gives rise to firm profits for the pre-determined configuration of store locations and ownership. There are two well-known properties of these profits (each of which is easily verified as we proceed): (1) adding a contiguous store to a merged firm increases the joint (merged firm plus added store) profit; and (2) serving a contiguous / continuous market area of given size is more profitable than serving a non-contiguous / non-continuous market area of the same size. Hence, efficient mergers will contain contiguous (rather than non-contiguous) stores, will serve a continuous market area, and will be as large as possible, subject to antitrust constraints.

In Stage 3, costless relocation opportunities imply that each merged firm will locally relocate its stores to maximize its profits. We focus on Stage 3 equilibria that are symmetric in the sense that merged firms with the same number of stores serve market areas of the same size. However, stores need not be symmetrically located within a firm's market area, as asymmetric locations can be profit-maximizing.

In Stage 2, we envision a merger process by non-cooperative bargaining that achieves Pareto efficient outcomes for participants in each merger agreement (as in Rubinstein, 1982; Shaked, 1986; and many others). We assume that nature randomly assigns an order of play (as in Menezes and Pitchford, 2003), so that firms are symmetric at the time of entry (Stage 1). Specifically, let us suppose that at the start of Stage 2, nature randomly selects a point on the market circle, with each point having an equal probability of selection; proceeding clockwise from this point, firms are indexed from one to N . Firm 1 is the first mover and, subject to the antitrust constraint ($n^* \leq n$), selects both the number of neighboring firms, (n^*-1) , and which (n^*-1) neighboring firms, with whom to bargain. The selected n^* firms play a unanimity bargaining game wherein the order of play is determined by the order of firms' indices (see, for example, Chatterjee and

Sabourian, 2000).¹⁰ Exempting all firms tagged for participation in the first merger game, the store with the next highest index becomes the first mover in the next bargaining game, first selecting the neighboring firms with whom to bargain (excluding those participating in the first game) and then playing a unanimity bargaining game with these players. This process continues until all firms have participated. It is well known (Shaked, 1986) that a unique stationary subgame perfect equilibrium (SSPE) to a unanimity bargaining game with pie of size one and n^{**} players yields no delay and the allocation, $(1/Q, \delta/Q, \dots, \delta^{n^{**}-1}/Q)$, where $Q=1+\delta+\dots+\delta^{n^{**}-1}$, and δ =discount factor between bargaining rounds. Here, the first mover in each game chooses her bargaining partners to maximize the “size of the pie” (the net gains to merger) subject to antitrust constraints; this is done by selecting $n^*=n$ contiguous stores.

As of Stage 1, when the indexing of play is unknown, each entrant expects an equi-proportionate share of the gains from an n -store contiguous merger – that is, an equal probability $(1/n)$ of being the i th player ($i=1, \dots, n$) in a bargaining game with n contiguous players, and obtaining the corresponding share of merger profits (δ^{i-1}/Q) .

This structure gives rise to a monopolistically competitive equilibrium with three properties:¹¹ (1) there are \underline{N} merged firms, each with $n=N/\underline{N}$ neighboring stores that serve a continuous market area of size $1/\underline{N}$; (2) given (equilibrium) rival store locations, the n

¹⁰In this game, firm 1 offers an allocation of the joint gains from merger (vs. no merger) and the (n^*-1) other firms sequentially accept or reject the offer; any rejection defeats the bargain and inaugurates a second round wherein the second player in line offers an allocation, and so on. If no agreement is reached, then no merger takes place and all firms are left with their no-merger profits.

¹¹ See Kuhn and Vives (1999) for another model of monopolistic competition in a contestable market. In a model with fixed initial locations and no mergers, Eaton and Wooders (1985) have a continuum of possible simultaneous-move symmetric Nash entry equilibria, including the monopolistically competitive outcome (see also MacLeod, et al., 1988). However, as in Anderson and Engers (2001), the unique sequential-entry equilibrium in their model is different: entry occurs until a firm located midpoint between any two of N symmetrically located firms is no longer profitable, thus making positive profits possible for the prior entrants (the “spatially noncontestable” outcomes of Norman and Thisse, 1996). When mergers are possible in our analysis (because antitrust law does not preclude them), the prospective “midpoint entrant” that is deterred in the Eaton and Wooders (1985) sequential equilibrium nevertheless anticipates benefits of merger and, hence, enters. We model these merger profit anticipations in the simplest possible way by allowing for plausible post-entry relocation possibilities that ensure a Pareto optimal post-merger configuration of stores. Restricting attention to symmetric equilibria thus yields the monopolistically competitive outcomes characterized in this paper. See Section IV below for comparison to inflexible technologies and entry preemption games that can give rise to spatially noncontestable equilibria.

stores are located so as to maximize the merged firm profit; and (3) each Stage 1 entrant anticipates an equi-proportionate share of the n -store merged firm profit, and entry occurs until this profit equals the entry cost k , so that further entry is unprofitable.

Some elaborations on this structure are in order. First, why do we have the store relocation stage of the game? As observed by Norman and Thisse (1999), the posited ability of flexible manufacturers to locally reanchor their base products, at little or no cost, is a natural by-product of flexible technologies that enable low-cost local customization. Moreover, beyond the realism of relocation opportunities, their absence may motivate a firm to select a Stage 1 location that enhances its bargaining payoff in the merger game, even when this choice reduces merged firm profit. This strategic location incentive could lead to inefficiencies driven purely by the merger process.¹² Clearly, such inefficiencies do not arise if no mergers are allowed. Stage 3 relocation opportunities avoid handicapping mergers by such location inefficiencies and thereby focus our attention on the entry implications of antitrust policy.

Second, the game could be repeated ad infinitum. A key insight of prior work (e.g., Eaton and Schmitt (1994), Reitzes and Levy (1995), Norman and Thisse (1999)) is that merged firms will deter further entry. This observation holds here as well and implies that there will be no action in a repeated game, absent exogenous changes in the market. However, this conclusion relies upon the implicit premise that there is no hold-up by future entrants, or firms that refuse to merge. Even when the entry and operation of another store is not profitable, entry and operation of a one-store firm would reduce the profits of neighboring merged firms; anticipating bargaining with these neighbors, and obtaining a share of the avoided losses, a potential future store may find entry profitable. Like others, we rule out such "hold-ups" -- Rasmussen's (1988) classic "entry for buyout." One way to do so endogenously is to have merger agreements stipulate that, if there is any future entry in the merged firm's territory, then the merger agreement is terminated and a

¹²For example, see Heywood, et al. (2001) for a study of these location inefficiencies.

new merger bargaining process ensues. Similarly, hold-up by firms that refuse to merge is avoided if any merger agreement is terminated when any store targeted for merger fails to join; this is true in the unanimity bargaining game described above.

II. Completely Inelastic Demands

Consider first the case of completely inelastic demands, where

$$(1) \quad U() = U^*(x, p(x)) = V - p(x) - t |x - x^*|$$

and each consumer demands one unit of the good x that maximizes $U^*(x, p(x))$, provided this maximal $U^*(\cdot)$ value is positive; if the maximum is negative, then no good is purchased. For simplicity, to ensure that all consumers are served in this market, we assume the following:

Assumption 1: $V \geq r/2$.

Assumption 1 implies that the maximum willingness to pay, V , is at least as high as the maximum unit cost of supplying each consumer with her most-preferred product, $r/2$.

A. Pricing (Stage 4). Given inelastic demands and $r < t$, a Stage 4 monopoly firm will supply each consumer with her most-preferred (x^*) product at the choke price, V . Pricing policies when there are multiple merged (or unmerged) firms (with $\underline{N}=2$) are only slightly more complicated. With $r < t$, firms again supply consumers with their most-preferred products. Moreover, to maximize profits, tailored products are priced at the maximum of (i) the firm's minimum unit cost of supply (the cost from the firm's closest store) and (ii) the minimum unit cost of all rival producers. Figure 1 illustrates this pricing policy for any given merged firm facing the proximate rival stores \underline{X} and \bar{X} .

B. Profit Maximizing Store Locations (Stage 3). The following is easily shown (see Appendix):

Lemma 1. When demand is perfectly inelastic, a profit maximizing merged firm locates its stores equi-distant from one another and from proximate rival stores. Hence, in equilibrium, stores are symmetrically spaced in the unit circle.

C. Mergers (Stage 2). Merging of proximate stores is always profitable because it permits higher prices to be charged without altering costs of supply. Hence (given Lemma 1), an equilibrium will yield \underline{N} merged firms that each have $n=N/\underline{N}$ equally spaced stores servicing an equal share of the consumer market. For $\underline{N} \geq 2$, merged firm profit can thus be defined as:

$$(2) \quad \pi(N, \underline{N}) = 2r \left\{ \int_0^{(2\underline{N})^{-1}} [(2\underline{N})^{-1} + (2\underline{N})^{-1} - x] dx - (N/\underline{N}) \int_0^{(2\underline{N})^{-1}} x dx \right\} = r \left\{ (4\underline{N}^2)^{-1} + (4N\underline{N})^{-1} \right\},$$

where the first term (in the first right-hand expression) gives the firm's revenues over its market area (of length $(\underline{N})^{-1}$) with proximate rival stores located the distance $(2\underline{N})^{-1}$ from the edges of this market area; the second term gives the firm's costs, with stores each located the distance $(N)^{-1}$ from one another. Similarly, for a monopoly ($\underline{N}=1$), we have:

$$(3) \quad \pi(N, 1) = V - 2Nr \int_0^{(2N)^{-1}} x dx = V - r(4N)^{-1}.$$

Let us further define joint industry profit as:

$$(4) \quad \pi^*(N, \underline{N}) = \underline{N} \pi(N, \underline{N}).$$

Equations (2)-(4) directly imply:

Lemma 2. With inelastic demands, joint industry profit falls with tighter antitrust restrictions (higher \underline{N} , provided $\underline{N} < N$).

Proof. From equations (2)-(4), we have, for $\underline{N} \geq 2$,

$$(5) \quad \partial \pi^*(N, \underline{N}) / \partial \underline{N} = - (r/4) \underline{N}^{-2} < 0,$$

and, for $\underline{N} \geq 2$,

$$(6) \quad \pi^*(N, 1) - \pi^*(N, 2) = V - \frac{3r}{8N} - \frac{r}{16} \geq \frac{7r}{16} - \frac{3r}{8N} > 0,$$

where the first inequality in (6) is due to Assumption 1. QED.

D. Entry (Stage 1). Entry occurs until it is no longer profitable, given that entrants anticipate an equal share of prospective merged firm profit:

$$(7) \quad [\pi^*(N, \underline{N}) / \underline{N}] - k = 0 \Leftrightarrow N^e(\underline{N}).$$

From Lemma 2 and equation (7), tighter antitrust restrictions (higher \underline{N}) reduce prospective merged firm profits and thereby reduce entry incentives: $\partial N^e / \partial \underline{N} < 0$. In the extreme, when no horizontal mergers are allowed at all (so that $\underline{N} = N$), the fewest possible number of entrants is obtained:

$$(8) \quad \pi(N, N) - k = 0 \Rightarrow N^e(\underline{N}^{\max}) = \underline{N}^{\max} = (r/2k)^{.5}.$$

Let us compare this minimum number of entrants to its welfare-maximizing (cost-minimizing) counterpart (MacLeod, Norman and Thisse, 1988),

$$(9) \quad N^* = \operatorname{argmin} 2Nr \int_0^{(2N)^{-1}} x \, dx + kN \Rightarrow N^* = (r/4k)^{.5}.$$

Equations (7)-(9) imply that, for $\underline{N} < \underline{N}^{\max}$,

$$(10) \quad N^e(\underline{N}) > N^e(\underline{N}^{\max}) > N^*.$$

Even the minimum possible number of entrants is excessive because firms enter to obtain rents from consumers, rents that are irrelevant to the social (cost minimization) calculus.

Hence, to get as close as possible to the optimal number of stores, we have:

Proposition 1. When demand is completely inelastic, a constrained optimal antitrust policy minimizes excess entry by allowing no horizontal mergers ($n=1$).

For the case of inelastic demand, Eaton and Schmitt (1994) show that an incumbent monopolist, when allowed to establish a profit-maximizing set of stores before other firms can enter, preempts all entry and achieves cost-benefit optimality, $N=N^*$. In addition, an antitrust policy that requires multiple incumbent firms to operate (rather than a single monopolist) will, while also preempting further entry, lead to an excessive number of stores, $N > N^*$.¹³ Hence, with inelastic demands and entry preemption, an

¹³Although Eaton and Schmitt (1994) do not show this, it is a natural by-product of their analysis. Specifically, suppose that each of $\underline{N} \geq 2$ firms (rather than one) are allowed to establish stores before further entry can take place. To characterize the symmetric equilibrium number of stores, consider the choice problem of one of the \underline{N} firms, given a distance Δ between proximate rival stores. (Δ represents the potential market area for the firm of interest.) If the firm operates n stores, optimally equally spaced, then its profit will be

$$\pi = 2 \int_0^{\Delta/2} rx \, dx - \frac{(\Delta - n^{-1})/2n}{(2n)^{-1}} \int_0^{(\Delta - n^{-1})/2n} rx \, dx - kn.$$

optimal antitrust policy is no policy at all -- unfettered monopolization. With contestable entry, this conclusion is completely reversed (Proposition 1); increased concentration leads to more entry, not less, and is socially disadvantageous.

III. Responsive Demands

Let us now suppose that consumer demand is price responsive,

$$(11) \quad D(p) = -U_p(p), \quad D' < 0.$$

For this general demand, we will consider two extreme cases: (1) *monopoly*, with no antitrust regulation, and (2) *pure competition*, under which no horizontal merger of any stores is allowed.

A. Pricing. For the first case, define the monopoly price $P^m(z)$ as the solution to the maximization,

$$(12) \quad J(z) = \max_p (p-z) D(p).$$

For simplicity -- and because it is generally realistic -- we will assume that monopoly pricing does not vitiate consumers' incentives to purchase their most-preferred product:

Assumption 2. $dP^m(z)/dz \leq (t/r)$ for $z \in [0, r/2]$.¹⁴

Hence, a monopolist prices at $P^m(c(x))$, where $c(x)$ is the unit cost of supplying the tailored product x from the nearest store. Purely competitive firms likewise tailor their products to consumer preferences and charge a price equal to the maximum of their own unit cost of supply and the minimum rival cost of supply.

B. Store Locations. The following can be shown to hold (see Appendix):

Maximizing profit by choice of n and substituting (by symmetry) for $\Delta = \underline{N}^{-1} + n^{-1}$ and $n = N/\underline{N}$ gives the first order condition that implicitly defines the equilibrium number of stores (\underline{N}),

$$(r/2)(\underline{N}/N)^3(1-\underline{N}^{-1}) + (r/4)N^{-2} - k = 0.$$

Evaluated at N^* , the left-hand-side of this condition reduces to the first term, $(r/2)(\underline{N}/N)^3(1-\underline{N}^{-1}) > 0$, implying that the equilibrium \underline{N} is higher than N^* .

¹⁴Alternate sufficient conditions for this assumption to hold include: (1) demand is weakly price inelastic in a relevant region, and there is a fixed consumer choke price V ; or (2) at $p = P^m(z)$ (for relevant z),

$$D'(p)(2-\varpi) - (D(p)D''(p)/D'(p)) \leq 0, \quad \varpi = (r/t) \in (0, 1);$$

or, more specifically, (3) demand is linear; or (4) demand is log linear, $D(p) = a - b \ln p$, with $D(p) \leq b(2-\varpi)$ for relevant p ; or (5) demand has constant elasticity ϵ , with $\epsilon \leq -(1-\varpi)^{-1}$.

Lemma 3. A profit maximizing monopoly locates its stores equi-distant from one another. Under pure competition, profit maximizing firms may not locate their stores equi-distant from one another, but will do so if demand is weakly price inelastic in a relevant region.

Even when a purely competitive firm's store is a different distance from its two proximate neighbors, the equilibrium is symmetric in the sense that the total distance between each store's proximate neighbors is the same, as are the market areas served and the two (different) distances from proximate neighbors. Symmetric equilibrium per-store profits, given N , are thus:

$$(13) \quad \pi(N,N) = \max_{\delta \leq \Delta} r \left\{ \int_{\delta/2}^{\delta} [2x-\delta] D(rx) dx + \int_{\delta}^{\Delta} \delta D(rx) dx + \int_{\Delta-(\delta/2)}^{\Delta} [2x-(2\Delta-\delta)] D(rx) dx \right\},$$

where $\Delta=N^{-1}$ = equilibrium firm market area and δ = distance to closest proximate rival.

C. Entry and Welfare. Under pure competition, entry occurs until the symmetric per-store profit of equation (13) equals the set-up cost k :

$$(14) \quad N^c = N: \pi(N,N)=k.$$

Likewise under monopoly, entry occurs until the per-store monopoly profit, $\pi(N,1)/N$, equals k .

Social welfare is the sum of total consumer surplus in the industry and net industry profit after set-up costs,

$$(15) \quad W = CS + N[\pi(N,N)-k] = CS,$$

where the second equality follows from entry; and

$$CS = \text{consumer surplus} = \int_0^1 \int_{p(x)}^{\infty} D(z) dz dx.$$

Because the entry process erodes away all firm rents, social welfare reduces to consumer surplus. In view of this reduction, a plausible and simple condition ensures that monopoly outcomes will be welfare-dominated by those of pure competition:

Assumption 3. $P^m(0) \geq r/N^c$ (where N^c is defined in equation (14)).

Assumption 3 states that the minimum monopoly price (when there are no costs of tailoring a product to consumer preferences) is at least as high as the maximum price charged under pure competition. For example, Assumption 3 will hold if demand is weakly price inelastic over the interval $[0, r/N^c]$. Assumption 3 implies that consumer surplus is necessarily higher under pure competition.

Proposition 2. If demand is price responsive and Assumption 3 holds, then an antitrust policy that prohibits any horizontal merger (requiring pure competition) is cost-benefit optimal relative to a policy that allows unfettered mergers (monopoly).

D. Can Some Horizontal Integration Be Optimal? From the foregoing, one might suspect that allowing any horizontal integration -- even if requiring more than one firm to operate -- will lead to higher consumer prices and thereby lower social welfare. This is not the case in general. The reason is that, although horizontal integration leads to higher prices for a given set of stores, it also induces entry that sharpens competition at the borders of merged firms' territories and thereby leads to some lowering of prices.

To document that some horizontal integration can be desirable, we now consider the example of a unit elastic demand subject to the choke price V :¹⁵

$$(16) \quad D(p) = \begin{cases} (1/p) & \text{if } p \leq V \\ 0 & \text{otherwise} \end{cases}$$

Furthermore, we will compare two possible policies: (1) pure competition (no horizontal mergers), and (2) an antitrust rule allowing the merger of any two stores, but no more than two. We will show that welfare is higher under the second policy.

¹⁵Eaton and Schmitt (1994) use this example to investigate welfare effects of monopoly preemption with responsive demands.

By Lemma 3 (equal spacing when demand is weakly inelastic), pure competition gives rise to the following consumer surplus and welfare:

$$(17) \quad W^c = CS^c = 2N^c \int_0^{(2N^c)^{-1}V} \int_{r[(N^c)^{-1}-x]} (1/z) dz dx.$$

Solving for N^c (of equations (13)-(14)) for the demand in equation (16) gives:

$$(18) \quad N^c = (2/k)[1-\ln(2)] = \text{number of stores under pure competition.}$$

Substituting (18) into (17) yields:

$$(17') \quad W^c = CS^c = 1 - \ln(k) + \ln(V) - \ln(r) + \ln(1-\ln(2)).$$

The case of two-store mergers is more complicated. For this case, symmetric spacing of stores is not profit-maximizing. Rather, merged firms locate their stores closer to the borders of their territories because prices are lower toward the borders, and demands are greater; firms thus want to keep costs of supplying the borders lower by locating more closely.¹⁶ Formally, if $\Delta = |\bar{X} - \underline{X}|$ is the distance between proximate rival stores and δ is the distance of a two-store firm's stores from these proximate rivals (Figure 2), then firm profits are:

$$(19) \quad \pi = 2 \left\{ \int_0^{(\Delta/2)-\delta} r\delta D(r((\Delta/2)-x)) dx + \int_{(\Delta/2)-\delta}^{(\Delta-\delta)/2} [2r((\Delta/2)-x)-r\delta] D(r((\Delta/2)-x)) dx \right\}.$$

Differentiating (using the Leibnitz Rule),

$$(20) \quad \partial\pi/\partial\delta = 2r \left\{ \int_0^{(\Delta/2)-\delta} D(r((\Delta/2)-x)) dx - \int_{(\Delta/2)-\delta}^{(\Delta-\delta)/2} D(r((\Delta/2)-x)) dx \right\}.$$

Setting (20) to zero (and verifying second order conditions) for our equation (16) demand gives:

$$(21) \quad \delta^* = \Delta/4.$$

¹⁶By locating nearer to borders, a firm can also steal customers from its rivals. However, because net profits from serving border customers are zero, these customer-stealing benefits vanish in the firm's location calculus.

Substituting for δ from (21), $\Delta=(2/N)+\delta=8/(3N)$,¹⁷ and $D()$ from (16) into equation (19) yields the equilibrium per-store profit,

$$(22) \quad \pi/2 = \frac{2}{3N} .$$

Entry occurs until this per-store profit is equated with the set-up cost k ,

$$(23) \quad N^I = \frac{2}{3k} = \text{number of stores with two-store mergers.}$$

Consumer surplus can now be written as follows:

$$(24) \quad W^I = CS^I = N^I \int_0^{(N^I)^{-1}} \int_{r[(N^I)^{-1}+(\delta/2)-x]}^V (1/z) dz dx = 1 - \ln(k) + \ln(V) - \ln(r) - (5/3)\ln(2),$$

where the second equality is obtained by substituting for N^I from (23) and $\delta=2(3N^I)^{-1}=k$.

Subtracting (17') from (24),

$$(25) \quad W^I - W^c = -(5/3)\ln(2) - \ln(1-\ln(2)) > 0.$$

Equation (25) implies:

Proposition 3. An antitrust policy that allows some horizontal integration ($n=2$) can be cost-benefit optimal.

IV. Flexible vs. Inflexible Technologies

What are the effects of flexible manufacturing, vis-à-vis inflexible counterparts, on entry and economic welfare? And how are these conclusions affected by the order of entry (pre-merger, as in this paper, or post-product-proliferation, as in prior work)? To address these questions, we confine attention to (1) the standard model of perfectly inelastic demands, (2) a comparison of two policy extremes, perfect competition (no contiguous horizontal integration) and monopoly (*laissez faire*), and (3) a comparison of outcomes with either all production operations / stores flexible, or all inflexible. For convenience, we refer to our model of entry as one of “entry-for-merger,” vs. the conventional model of “entry preemption” (e.g., Norman and Thisse, 1996, 1999; Eaton and Schmitt, 1994; and many others). Following Norman and Thisse (1999), we refer to

¹⁷With symmetric two-store firms, each merged firm’s market area equals $(2/N)$. From the definition of Δ (see Figure 2), we have that $\Delta=(2/N)+\delta$.

“inflexible” manufacturing as “designated technologies” (DT), vs. flexible counterparts (FT). The former are characterized by lower costs of establishing “base” products / stores, $k^d < k = k^f$, an inability to customize products (or a cost of doing so that makes customization uneconomical), and consumer preference costs of consuming base products equal to $t > r$ per-unit-distance, as described in equation (1). With DT (as with FT), we focus on symmetric equilibria (following standard practice in the literature).¹⁸

A. Flexible vs. Designated Technologies Under Entry-for-Merger. We begin with a simple benchmark:

Proposition 4. When the number of symmetric base products is chosen efficiently, the flexible technology is more (less) efficient than the designated technology when $rk^f < (>) tk^d$.

Remark 1 reflects the tradeoff between benefits of flexible technologies in delivering products to consumers at lower cost, $r < t$, and higher costs of establishing flexible production operations, $k^f > k^d$.

i. Competition. Of course, absent a benevolent government monopoly of the market (which we rule out), the government cannot simply choose the number of products. Consider first a policy that allows no contiguous horizontal integration – the case of competition. Under this policy, the costs of excess entry are not the same under the two technologies, as shown by Norman and Thisse (1996). Under FT, entry yields the zero-profit symmetric equilibrium (from equation (8) above):

$$(26) \quad N = N_{SC}^{ef} = (r/2k^f)^{-5} \Rightarrow \text{Welfare Cost} = C_{SC}^{ef} = (t/4N) + k^f N = (rk^f)^{-5} (3/4)2^{-5}.$$

¹⁸With the DT technology (unlike the FT technology), Stage 3 relocation is likely to be prohibitively costly. However, it is intuitive (and can be shown) that, whether in a competitive (no merger) situation or under laissez faire (when firms merge to monopoly), symmetric Stage 1 locations satisfy (subgame perfect) best response requirements. Specifically, suppose $(N-1)$ firms are located the distance $(1/N)$ from one another, and one remaining firm chooses the distance from its left proximate rival, $l \leq (1/N)$, and the corresponding distance, $(2/N)-l$, from its rightward rival. If merging to monopoly, the “remaining” firm (call it firm j)

anticipates the payoff, $D_j(l) + (1/N)(\pi_m(l) - \sum_{i=1}^N D_i(l))$, where $\pi_m(l)$ = monopoly profit and $D_i(l)$ = disagreement (no merger) profit for firm i . This payoff is maximized by $l = 1/N$.

Under DT, post-entry store relocations are likely to be costly and, as a result, there is a range of possible equilibria. Following Norman and Thisse (NT, 1996), the two extremes in this range are (1) “spatially contestable” (SC) outcomes wherein entry bids away all producer rents and (2) “spatially noncontestable” (SNC) outcomes; SNC yields the minimum number of producers / stores such that a prospective midpoint entrant will obtain non-positive profit. In an SC equilibrium, DT entry yields the zero-profit equilibrium (as in Salop, 1979):

$$(27) \quad N_{SC}^{cd} = (t/k^d)^{.5} \Rightarrow \text{Welfare Cost} = C_{SC}^{cd} = (t/4N) + k^d N = (tk^d)^{.5} (5/4).$$

Comparing (26) and (27) gives:

Proposition 5 (NT, 1996). Suppose that there is no horizontal integration (symmetric competition) and an SC equilibrium under the designated technology (DT). Then the flexible technology (FT) is more (less) efficient than DT when

$$(28) \quad rk^f < (>) tk^d (25/18)$$

The relatively “tough pricing” of FT operations (NT, 1996) yields a relatively lesser extent of excessive entry under this technology (*ceteris paribus*). Hence, there is an added efficiency motive for flexible technologies, vis-à-vis the Proposition 4 case of first-best product variety.

If the DT technology instead spurs SNC (vs. SC) competition, then the welfare ordering of flexible and designated technologies is reversed. From Norman and Thisse (NT, 1996), we have

$$(29) \quad N_{SNC}^{cd} = (t/k^d)^{.5} \{3/[2(2+3^{.5})]\}^{.5} \Rightarrow C_{SNC}^{cd} = (tk^d)^{.5} [8+3^{.5}]/[24(2+3^{.5})]^{.5}.$$

Comparing (26) and (29):¹⁹

Proposition 6 (NT, 1996). Suppose that there is symmetric competition and an SNC equilibrium under the DT technology. Then DT is more (less) efficient than FT when:

¹⁹Proposition 6 compares SC outcomes under FT to NSC outcomes under DT. NT (1996) instead compare SC (NSC) outcomes under both technologies. However, Proposition 6 follows directly from the NT analysis.

$$(30) \quad tk^d < (>) rk^f (27)(2+3^{-.5})/[8+3^{-.5}]^2 \approx rk^f (1.064).$$

SNC permits entry deterrence with fewer firms, thus overcoming the excess entry disadvantage of DT (vs. FT) technologies.

While Propositions 5 and 6 describe when FT is more (or less) efficient, when can an equilibrium with all FT operations prevail? Necessary and sufficient is that none of the N entering stores would choose the DT technology (in Stage 1) when its $(N-1)$ rivals are FT.²⁰

Proposition 7. With no horizontal integration in the entry-for-merger game, there is a symmetric equilibrium in which all firms choose a flexible (vs. designated) technology in Stage 1: (A) if the following (sufficient) condition holds:

$$(31) \quad rk^f \leq k^d (t+r);$$

(B) if and only if the following (necessary and sufficient) condition holds:

$$(31') \quad rk^f \{r(r+t)/[r^{1.5}+2(r^5-(2k^f)^5)]^2\} \leq k^d (t+r);$$

and (C) whenever the all-FT symmetric equilibrium (with exogenous technology) is more efficient than its all-DT / SC counterpart (provided $N^f=(r/2k^f)^{.5} \geq 3$).

Although any efficient all-FT outcome is supported in equilibrium (provided SC equilibria prevail under DT), there are cases wherein an all-FT equilibrium exists even though the all-DT equilibrium is more efficient.²¹ In such cases, there may be a potential role for government policy to inhibit FT technologies, a topic we leave to future research.

ii. Monopoly. Under monopoly (*laissez faire*), the welfare ordering of flexible and designated technologies is also reversed (vs. the competitive SC benchmark of Remark

²⁰Norman and Thisse (NT, 1999, Propositions 6-7) consider a different thought experiment: whether DT entry, given N symmetric FT stores, is deterred. This is also a necessary condition for an all-FT equilibrium to prevail. However, vis-a-vis condition (31), the relevant analog to the NT condition (with $\alpha=2$) is weaker and not sufficient for an all-FT equilibrium; moreover, vis-à-vis (31'), this analog does not account for the FT relocation opportunities that are costless and crucial here (see proof of Proposition 7).

²¹Specifically, if an SC equilibrium prevails under DT, $r > .39t$, and $(rk^f/tk^d) \in (1.39, 1+(r/t))$, then the all-FT equilibrium exists even though the all-DT equilibrium is more efficient. Likewise if an SNC equilibrium prevails under SNC, and $(rk^f/tk^d) \in (.94, 1+(r/t))$.

2). For FT, equilibrium entry is determined by the zero profit condition (using equation (3)),²²

$$(32) \quad \begin{aligned} \pi(N,1) - k^f N &= 0 \Rightarrow 4VN - r - 4k^f N^2 = 0 \Rightarrow N_{SC}^{mf} = [V + (V^2 - rk^f)^{.5}] / 2k^f \\ \Rightarrow \text{Welfare Cost} &= C_{SC}^{mf} = (1/2) \{ [V + (V^2 - rk^f)^{.5}] + (rk^f / [V + (V^2 - rk^f)^{.5}]) \} \end{aligned}$$

Under DT, we again have SC and SNC equilibria. In both cases, it can be shown that, with the equilibrium number of stores, the monopolist will choose its “mill” prices so as to fully cover the customer population, $P = V - (t/2N)$. Hence, for DT, equilibrium SC entry is implicitly defined by the zero profit condition,

$$(33) \quad \begin{aligned} V - (t/2N) - k^d N &= 0 \Rightarrow 2VN - t - 2k^d N^2 = 0 \Rightarrow N_{SC}^{md} = [V + (V^2 - 2tk^d)^{.5}] / 2k^d \\ \Rightarrow \text{Welfare Cost} &= C_{SC}^{md} = (1/2) \{ [V + (V^2 - 2tk^d)^{.5}] + (tk^d / [V + (V^2 - 2tk^d)^{.5}]) \} \end{aligned}$$

Here, for obvious reasons, we impose a standard regularity restriction:

Assumption 4. Under either FT or DT, positive monopoly profits are possible:

$$rk^f < V^2 \text{ and } tk^d < V^2/2. \text{ }^{23}$$

Assumption 4 ensures real-valued equilibrium entry numbers in equations (32)-(33).

Comparing welfare costs in (32)-(33) gives

Lemma 4. If $rk^f = tk^d$, then $C_{SC}^{md} < C_{SC}^{mf}$.

Proposition 8. Under laissez faire (monopoly), designated technology (DT) outcomes under spatially contestable Stage 1 competition are more (less) efficient than flexible technology (FT) counterparts when, for some $\omega > 0$, $rk^d < (>) tk^f (1 + \omega)$.

Intuitively, the price discrimination made possible by the flexible FT technology gives the monopolist greater scope to capture market rents (ceteris paribus). As a result, incentives for excess entry, in pursuit of these rents, is more acute under FT, imparting an efficiency advantage to the designated DT technology.

²²With some tedious mathematics, one can show that per-store profit, $(\pi(N,1)/N - k^f)$, rises with N at the other root to equation (32) (i.e., $[V - (V^2 - rk^f)^{.5}] / 2k^f$). Hence, only the root reported in (32) can be an equilibrium. Likewise with the other root to equation (33) below.

²³Assumption 4 is necessary and sufficient for maximized monopoly profit (by choice of N) to be positive under FT and DT, respectively. For example, for DT, evaluating equation (33) profit at the monopoly-optimal $N = (t/2k^d)^{.5}$, and requiring this profit to be positive, gives: $tk^d < V^2/2$. See Salop (1979, eq. (31)).

This DT advantage is enhanced in SNC equilibria. The reason is that, under SNC, midpoint entry can be deterred with fewer firms than deplete all entrant profit (the SC case). Hence, the extent of excess entry is reduced.

Lemma 5. In an all-DT SNC equilibrium, the number of firms is N_{SNC}^{md} that satisfies: $N^{*d}=(t/4k^d)^5 < N_{SNC}^{md} < N_{SC}^{md}$. Hence, welfare costs are $C_{SNC}^{md} < C_{SC}^{md}$.

B. Entry-for-Merger vs. Entry Preemption. With competition in flexible technologies, our entry-for-merger game leads quite naturally to “spatially contestable” (SC) outcomes wherein entry bids away all producer rents. However, a competitive entry preemption game may also give rise to other FT equilibria, the most profitable of which is the “spatially noncontestable” (SNC) outcome characterized by Norman and Thisse (NT, 1996) and Anderson and Engers (2001). SNC competition in FT technologies yields:

$$N_{SNC}^{ef} = (r/8k^f)^5 \Rightarrow C_{SNC}^{ef} = (rk^f)^5 (3 \cdot 2^{-5}/4) = C_{SC}^{ef}.$$

Interestingly, under FT, SNC competition yields too little entry, but exactly the same welfare cost as under SC competition. Hence, Propositions 5 and 6 apply in both entry preemption and entry-for-merger games.

Under a monopoly market structure, however, the welfare ordering of flexible and designated technologies is reversed when the order of entry is reversed. With DT production and an entry preemption game, there are two key cases to consider: (1) when it is possible to sign franchise contracts that achieve credible spatial preemption (Hadfield, 1991), and (2) when such contracts are not possible. Hadfield (1991) franchise contracts implicitly precommit monopoly franchisees to compete as independent retailers when entry occurs; as a result, we can show:

Lemma 6. Under DT and entry preemption, Hadfield (1991) contracts can support the monopoly optimum, $N^{md*}=(t/2k^d)^5$.

Absent franchise contracts, a monopolist will accommodate entry ex-post by lowering prices or closing proximate stores, the famous point of Judd (1985). As a result,

monopoly optima can generally not be sustained; that is, in view of rational post-entry monopoly accommodation, an unfettered monopoly solution cannot deter entry.

Lemma 7. Without franchise contracts, a monopolist who operates $N=N^{md*}$ symmetric DT stores will not deter mid-point DT entry. Hence, to deter entry, a monopolist must operate $N>N^{md*}$ DT stores.

Under FT, the commitment problem is not one of pricing, per se, but rather one of location. With costless (local) relocation opportunities, a monopolist will optimally respond to entry by relocating / reanchoring away from the entrant (NT, 1999). Indeed, whether the incumbent is an integrated monopolist or a set of independent retailers, NT (1999) show that entry will spur relocation to a new symmetric distribution of stores. Entry preemption thus leads to $N=(r/2k^f)^5$, regardless of ownership.

Hadfield (1991) contracts, as initially conceived, do not help a monopolist surmount this commitment problem. However, contracts may be able to precommit franchisees not to relocate in the event of entry (with contractual reanchoring penalties, for example). An incumbent will then be able to sustain the monopoly (and social) optimum of $N^{mf*}=(r/4k^f)^5 = N^{*f}$ symmetric stores (as in Eaton and Schmitt, 1994).

Proposition 9. Consider an entry preemption game with an incumbent monopolist.

(A) If franchise contracts can support monopoly optima, then the flexible technology (FT) is more (less) efficient than the designated technology (DT) when

$$C^f = (r/4N^f)+N^fk^f < (>)(r/4N^d)+N^dk^d = C^d \Leftrightarrow rk^f < (>) tk^d \quad (9/8).$$

(B) Absent monopoly franchise contracts, there is a $\omega>0$ such that FT is more efficient than DT when $rk^f < tk^d (1+\omega)$.

In both cases, entry effects impart efficiency advantages to flexible technologies. With franchise contracts, the advantage of FT is due to the monopolist's ability to extract all market rents using discriminatory prices; as a result, it chooses an efficient number of base products. Under DT, in contrast, perfect price discrimination is not possible; as a result, the monopolist maximizes its profits with excessive product variety. Without

franchise contracts, the flexible technology confronts prospective entrants with tougher price competition, thus inhibiting entry; however, it also permits base product relocations that accommodate entry. On balance, the former effect dominates, giving the FT technology a net entry deterrence advantage (Proposition 9(B)).

In sum, the welfare ordering of flexible and designated technologies depends on the order of entry under monopoly, but not under competition. Under monopoly, entry effects impart efficiency advantages to designated technologies in the entry-for-merger game, and to flexible technologies in the entry preemption game. Moreover, in both games, the welfare orderings of the two technologies can be reversed when moving from competition to monopoly. Welfare tradeoffs between the two technologies thus depend crucially on both market structure and the order of entry.

IV. Conclusion

Spatial models of product variety often imply that free entry produces excess entry and that market concentration, by reducing entry, can yield efficiency dividends (Lancaster, 1990; Salop, 1979). In the context of a spatial model of flexible production, this paper explores the robustness of such conclusions to an entry process in which concentration occurs by merger, after product proliferation by atomistic entrants. The main message imparted by this alternative model of entry is very simple: Because more concentrated markets are more profitable, and because prospective entrants can anticipate obtaining a share of profits from post-entry mergers, concentration tends to spur more entry, not less. Hence, the problem of excess entry is exacerbated, not mitigated, by allowing more market concentration.

As noted in the introduction, food markets fit the description for flexible production quite well. Beyond heuristic evidence that new food products are predominantly launched by small (atomistic) firms – as accords with our model of entry-for-merger – there is also empirical evidence that the positive predictions of this model are borne out in these markets. Specifically, recent work by Roder, Herrmann and

Connor (2000) and Bhattacharya and Innes (2006) documents that higher levels of market concentration are associated with significantly higher numbers of new food product introductions.²⁴

This paper also identifies a variety of more subtle implications of entry-for-merger games, including potential reversals in the welfare effects of flexible vs. inflexible production technologies. Among the more subtle results, perhaps the most interesting is an implication of price-responsive demands: despite the adverse entry promotion and price-raising effects of mergers, some horizontal integration can increase economic welfare due to the price-cutting effects of integrated firms' product location choices. Hence, to the extent that it applies in practice, our model argues against an antitrust policy that allows for substantial monopolization of a market, but may also argue for some horizontal concentration, despite an absence of scale economies in production.

This analysis can be criticized for posing a pure model of entry-for-merger wherein all potential market participants are atomistic apriori. Clearly, in practice, product innovators come in many forms, both large and small. In our defense, this analysis is offered as a counterpoint to standard modeling wherein an initial incumbent (or incumbents) has the first opportunity to proliferate products and thereby preempt entry; this work rules out any small innovator/entrants, just as we rule out any large ones. Understanding both of these extremes is, we believe, a necessary antecedent to understanding more mixed environments. Further work could usefully explore implications of having both incumbent firms and atomistic entrants making risky investments in potential new products. However, it is unlikely that such extensions will undermine the fundamental entry-promotion effects of anticipated post-entry mergers that we stress in this paper.

²⁴Although new product introductions (NPIs) are likely to include both new base products and new "customizations" of existing base products, there is almost certainly a monotonic relationship between total NPIs and base NPIs. Hence, this empirical evidence supports the positive links between concentration and base NPIs predicted by this paper's model.

Appendix

Proof of Lemma 1. Consider first interior stores (those that do not have a rival store as a proximate neighbor) and suppose (toward a contradiction) that one store is not equi-distant from its two proximate neighbors, with distance δ_L from its leftward neighbor (X_L) and δ_R from its rightward neighbor (X_R). Then costs of supplying customers in the interval $[X_L, X_R]$ are

$$2r \left\{ \int_0^{(\delta_L/2)} x \, dx + \int_0^{(\delta_R/2)} x \, dx \right\} = (r/4) \{ \delta_L^2 + \delta_R^2 \}.$$

Minimizing these costs (by choice of δ_L and δ_R , subject to $\delta_L + \delta_R = |X_R - X_L|$) yields $\delta_L = \delta_R$, the desired contradiction.

Consider next the edge stores (those that have a rival store as a proximate neighbor, like X_1 and X_3 in Figure 1). Again, suppose (toward a contradiction) that an edge store (X_1) is not equi-distant from its proximate neighbors, with distance δ_R from its rival neighbor (X_R) and δ_F from its "own firm neighbor" (X_F). Net profits from serving firm customers in the $[X_R, X_F]$ interval are:

$$\begin{aligned} \text{Revenues} &= \int_{(\delta_R/2)}^{\delta_R + \delta_F} r x \, dx, \quad \text{Costs} = 2r \int_0^{(\delta_F/2)} x \, dx + r \int_0^{(\delta_R/2)} x \, dx \\ &\Rightarrow \text{Profit} = r \{ (\delta_R^2/4) + (\delta_F^2/4) + \delta_R \delta_F \} \end{aligned}$$

Maximizing this profit (by choice of δ_F and δ_R , subject to $\delta_F + \delta_R = |X_F - X_R|$) yields $\delta_F = \delta_R$, the desired contradiction. Finally, the last statement in Lemma 1 now follows because neighboring firms cannot simultaneously have equi-distant stores and different between-store distances. QED.

Proof of Lemma 3. (1) Monopoly. Suppose (toward a contradiction) that one store is not equi-distant from its two proximate neighbors, with distances δ_L and δ_R from leftward (X_L) and rightward (X_R) neighbors respectively. Then net profits from supplying customers in the interval $[X_L, X_R]$ are:

$$2 \left\{ \int_0^{\delta_L/2} [P^m(rx)-rx] D(P^m(rx)) dx + \int_0^{\delta_R/2} [P^m(rx)-rx] D(P^m(rx)) dx \right\}.$$

Maximizing (by choice of δ_L , with $\delta_R = |X_R - X_L| - \delta_L$) yields the first order condition derivative, $J(\delta_L/2) - J(\delta_R/2)$ (where J is as defined in equation (12)). By revealed preference, J is a decreasing function; hence, profits are maximized when $\delta_L = \delta_R$, the desired contradiction.

(2) Competition. Suppose that a store is to be located between two proximate neighbors that are the total distance, 2Δ , from one another. Further suppose that the store locates a distance $\delta \leq \Delta$ from one neighbor (and $2\Delta - \delta$ from the other). Then store profit is as described by the maximand in equation (13), which we will denote by $J^*(\delta, \Delta)$.

Differentiating gives:

$$\partial J^*/\partial \delta = r \left\{ - \int_{(\delta/2)}^{\delta} D(rx) dx + \int_{\delta}^{\Delta} D(rx) dx + \int_{\Delta-(\delta/2)}^{\Delta} D(rx) dx \right\}.$$

Clearly, $\partial J^*/\partial \delta = 0$ at $\delta = \Delta$ and $\partial J^*/\partial \delta > 0$ at $\delta = 0$. Hence, to show that $\delta^* = \Delta$, it suffices to show that $\partial^2 J^*/\partial \delta^2 \leq (<) 0$ for $\delta \leq (<) \Delta$; conversely, to show that $\delta^* \in (0, \Delta)$, it suffices to show that $\partial^2 J^*/\partial \delta^2 > 0$ at $\delta = \Delta$. Differentiating,

$$\begin{aligned} \partial^2 J^*/\partial \delta^2 &= r \left\{ (1/2)[D(r\delta/2) + D(r(\Delta - (\delta/2)))] - 2D(r\delta) \right\} \leq r \left\{ D(r\delta/2) - 2D(r\delta) \right\} \\ &= -2r \int_{1/2}^1 \{d[\alpha D(\alpha r\delta)]/d\alpha\} d\alpha = -2r \int_{1/2}^1 D(\alpha r\delta)(1 + \epsilon^D(\alpha r\delta)) d\alpha, \end{aligned}$$

where $\epsilon^D(p) = d \ln D(P) / d \ln p$ is the price elasticity of demand; and the first inequality (i) follows from $\Delta - (\delta/2) \geq \delta/2$ (with $\delta \leq \Delta$) and $D' < 0$, (ii) holds with equality when $\delta = \Delta$, and (iii) holds with strict inequality when $\delta < \Delta$. When demand is weakly price inelastic in a relevant region, so that $\epsilon^D(p) \geq -1$, then $\partial^2 J^*/\partial \delta^2 \leq (<) 0$ for $\delta \leq (<) \Delta$; hence, $\delta^* = \Delta$.

Conversely, if demand is price elastic in a relevant region, so that $\epsilon^D(p) < -1$, then $\partial^2 J^*/\partial \delta^2 > 0$ at $\delta = \Delta$; hence, $\delta^* < \Delta$. QED.

Proof of Proposition 4. Evaluated at the optimal number of firms, $N^f = (r/4k^f)^{-5}$, welfare costs under FT are $C^* = (r/4N) + Nk^f = (rk^f)^{-5}$. Likewise, evaluated at the optimal

number of firms, $N^d=(t/4k^d)^{.5}$, welfare costs under DT are $C^{*d}=(t/4N)+Nk^d=(tk^d)^{.5}$.

Comparing yields Proposition 4. QED.

Proof of Proposition 7. (B) Given $N^f=(t/2k^f)^{.5}$ firms, (N^f-1) of which are FT, we need to show that Stage 1 DT entry by the remaining firm (vs. FT entry) is unprofitable under condition (31'). To do so requires constructing the equilibrium that prevails with the one DT entrant and (N^f-1) FT firms. Recalling that the latter firms can freely relocate, all FT firms will be optimally equidistant from one another (Lederer and Hurter, 1986); however, the DT firm's two neighbors may not be the same distance from their FT neighbor as from their DT rival. Consider the choice problem of the DT firm's closest FT neighbor (FT1), with d_F denoting the distance to this firm's (fixed) FT neighbor and d_D denoting distance to the (fixed) DT neighbor (see Figure A1). Because the rivals' (equilibrium) locations are taken to be fixed, FT1 chooses d_D and d_F subject to the constraint that they sum to the given total distance between the rivals, $d_F+d_D=\Delta$. By symmetry and equidistance of FT firms from one another, we have the relationship:

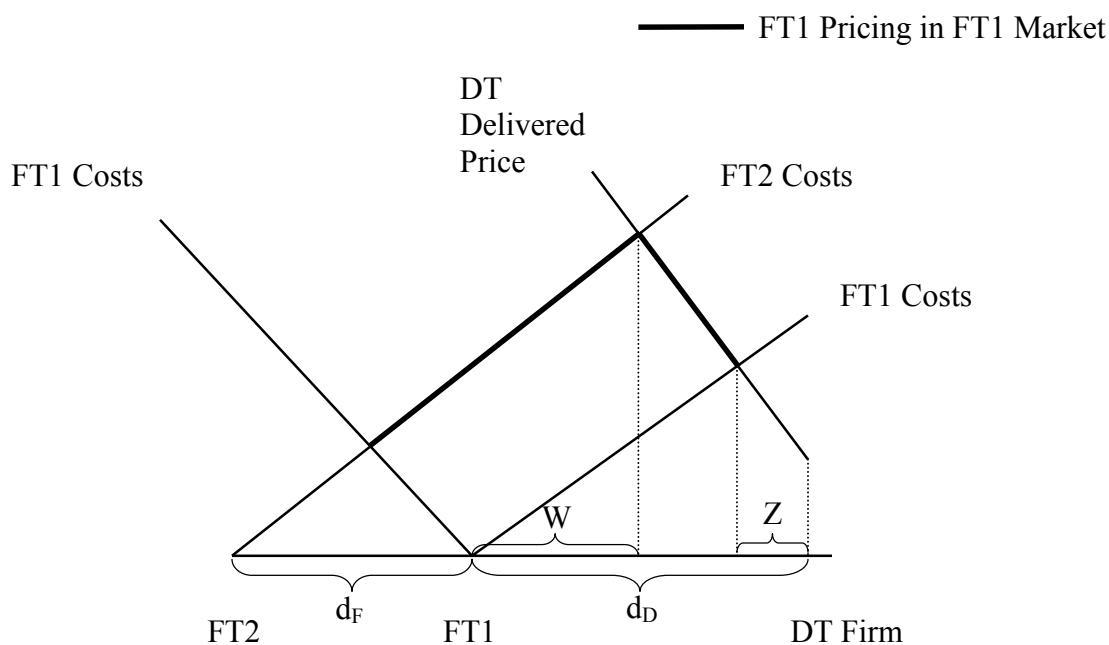


Figure A1

$$(A1) \quad 2d_D + (N-2)d_F = 1 \Rightarrow \Delta = [d_D(N-4)+1]/(N-2),$$

where we substitute for $d_F = \Delta - d_D$ and solve. To construct FT1's revenues and costs, we use the following parameters for the market served, as indicated in Figure A1:

$$(A2) \quad z = [rd_D - P_e]/(t+r) \quad , \quad w = d_D + \{[P_e - r\Delta]/(r+t)\},$$

where P_e is the mill price of the DT entrant. Using these constructs and the optimal pricing indicated in Figure A1, FT1 profits are

$$(A3) \quad \pi_{FT1} = \int_{d_F/2}^{d_F} r x \, dx + \int_0^w r(d_F+x) \, dx + \int_z^{d_D-w} (P_e+tx) \, dx - \left\{ \int_0^{d_F/2} r x \, dx + \int_0^{d_D-z} r x \, dx \right\},$$

where the first three terms are revenues and the last two are costs. Substituting for $d_F = \Delta - d_D$, z , and w , and differentiating with respect to d_D gives the optimality condition,

$$(A4) \quad \Delta - d_D \{1 + [2t/(t+r)]\} - [2P_e/(t+r)] = 0.$$

Now note that the DT entrant chooses P_e to maximize its profits (given symmetry of the neighbors), $\pi_{DT} = 2zP_e - k^d$, yielding

$$(A5) \quad P_e = (rd_D/2) \quad , \quad \pi_{DT} = (rd_D)^2/[2(r+t)] - k^d.$$

Substituting P_e from (A5) into (A4) and solving:

$$(A6) \quad d_D = [(r+t)/(2r+3t)] \Delta.$$

Solving (A6) and (A1) gives:

$$(A7) \quad \Delta^* = [(2r+3t)/[Nr+2(N-1)t]] \quad , \quad d_D^* = (r+t)/[N(r+t)+(N-2)t].$$

Evaluating DT of (A5) at d_D^* of (A7) and $N = N^f = (r/2k^f)^{.5}$ yield the DT firm profit,

$$(A8) \quad \pi_{DT} = \{[r^2(r+t)k^f]/[r^{1.5}+2(r^{.5}-(2kf)^{.5})t]2\} - k^d.$$

By (31'), π_{DT} is non-positive, implying that the FT technology choice (yielding zero profit) is a best response to the FT choice by the (N^f-1) rivals. With DT entry deterred for any one of the N^f entrants, additional DT and/or FT entry (beyond $N = N^f$) is also deterred.

(A) If (31) holds, $d_D = 1/N$, and $N = (r/2k^f)^{.5}$, then $\pi_{DT} \leq 0$ in (A5). Now note that $\partial \pi_{DT} / \partial d_D > 0$ and $d_D^* < 1/N$; hence, if (31) holds, $d_D = d_D^*$ and $N = (r/2k^f)^{.5}$, then $\pi_{DT} \leq 0$.

(C) Define $\alpha=(r/t)\in(0,1)$ and $\kappa=(k^d/k^f)\in(0,1)$. Condition (28) requires: $(\alpha/\kappa)<(25/18)$. Given this condition, we need to show that (31') is satisfied. Substituting α and κ into (31') and rewriting, we require:

$$(\alpha/\kappa) \leq [(\alpha t)^{1.5} + 2t((\alpha t)^5 - (2k^f)^5)]^2 / [\alpha t^3(1+\alpha)] \equiv A.$$

It suffices to show that $A \geq (25/18)$. Now note that, for $N=(r/2k^f)^5 \geq 3$ (and with $r=\alpha t$),

$$2(r^5 - (2k^f)^5) = 2(2k^f)^5(N-1) \geq (4/3)r^5 \Leftrightarrow 2(N-1) \geq (4/3)N \Leftrightarrow N \geq 3).$$

Hence,

$$\begin{aligned} A &\geq [(\alpha t)^{1.5} + (4/3)(\alpha t)^5]^2 / [\alpha t^3(1+\alpha)] = [\alpha^2 + (16/9) + (8/3)\alpha] / (\alpha + 1) \equiv B(\alpha) \\ &> B(0) = (16/9) > (25/18), \end{aligned}$$

where the penultimate inequality is due to $\partial B/\partial \alpha > 0$ and $\alpha > 0$. QED.

Proof of Lemma 4. Define $z(\alpha) = V + (V^2 - \alpha r k^f)^5$ and $C(z) = (r k^f / 2z) + (z/2)$, with $\alpha \in [1, 2]$. Then, with $r k^f = t k^d$, $C_{SC}^{mf} = C(z(1))$ and $C_{SC}^{md} = C(z(2))$. Differentiating $C(z)$ gives:

$$(A9) \quad \partial C(z) / \partial z > 0 \Leftrightarrow z^2 > r k^f \Leftrightarrow (2/(1+\alpha))(V^2 + V(V^2 - \alpha r k^f)^5) > r k^f.$$

By Assumption 4 and $r k^f = t k^d$, we have:

$$(A10) \quad r k^f = t k^d < V^2/2 < (2/(1+\alpha))V^2 \quad \text{and} \quad \alpha r k^f \leq 2 t k^d < V^2.$$

(A10) implies the right-hand inequality in equation (A9); hence, we have $\partial C(z) / \partial z > 0$.

Therefore, with $z(1) > z(2)$, $C_{SC}^{mf} = C(z(1)) > C(z(2)) = C_{SC}^{md}$. QED.

Proof of Lemma 5. (A) $N_{SNC}^{md} < N_{SC}^{md}$. Suppose not, $N_{SNC}^{md} \geq N_{SC}^{md}$. Then by the definition of N_{SC}^{md} , per-store monopoly profit with $N = N_{SNC}^{md}$ is

$$\pi_{SNC} = (V - (t/2N)) / N - k^d \leq 0.$$

Now, faced with midpoint entry (and entrant price P_e), it always pays for the monopolist to limit the entrant's market by setting the closest neighboring store prices at $P_1 < P_e + (t/2N)$. Hence, because entrant profit is increasing in P_1 and the entrant's market is limited to the area between its closest proximate rival stores (total distance $(1/N)$), entrant profit is:

$$\begin{aligned} \pi_e &< \{ \max P_e(1/N) - k^d \quad \text{s.t.} \quad P_e + (t/2N) \leq V \} \\ &= \{ \max 2P_e z - k^d \quad \text{s.t.} \quad z = (V - P_e) / t \leq (1/2N) \} = \pi_{SNC}, \end{aligned}$$

where the equalities are due to a binding constraint ($z=(1/2N)$ at the solution to the second maximization (by Assumption 4 and $N \geq N_{SC}^{md} \geq N^{md*}=(t/2k^d)^{.5}$). Because $\pi_{SNC} \leq 0$ when $N_{SNC}^{md} \geq N_{SC}^{md}$, we have the contradiction, $\pi_e < 0$.

(B) $N_{SNC}^{md} > N^{*d}=(t/4k^d)^{.5}$. N_{SNC}^{md} is described in (A19) below. Hence,
 $N_{SNC}^{md} > N^{md*}=(t/2k^d)^{.5} > N^{*d}$. QED.

Proof of Lemma 6. It suffices to show that, with $N=N^{md*}$ symmetric stores and interlaced DT competition (stimulated when entry occurs), DT entry is not profitable. NT (1996, 1999) show that the minimum N that deters entry, given symmetric interlaced competition, is $N^{\min}=N^{md*} [3/(2+3^{.5})]^{.5}$. Hence, with $N=N^{md*} > N^{\min}$, entry is indeed unprofitable. QED.

Proof of Lemma 7. Absent contracts, the monopolist's choice of N symmetric stores must deter mid-point entry between any two stores. To determine prospective entrant profit, consider the monopolist's post-entry pricing problem for its N symmetric stores, indexed $i=1, \dots, N/2$ and $i=-1, \dots, -N/2$, with the entrant between stores 1 and -1 (as in Eaton and Wooders (1985), excepting our circular market space):

$$(A11) \quad \max_P 2 \sum_{i=1}^{N/2} D_i(P, P_e) P_i,$$

where $P=(P_1, \dots, P_{N/2})$ = monopoly store prices, P_e = entrant price (taken as parametric by the monopolist) and D_i = i -store demand, as follows,

$$(A12a) \quad D_1 = [(P_e + P_2 - 2P_1)/2t] + (3/4N),$$

$$(A12b) \quad D_i = [(P_{i-1} + P_{i+1} - 2P_i)/2t] + (1/N) \quad , \quad \text{for } i=2, \dots, (N/2)-1$$

$$(A12c) \quad D_i = [(P_{i-1} - P_i)/2t] + (1/N) \quad , \quad \text{for } i=N/2.$$

Maximizing yields the first order conditions (assuming the reservation price V is sufficiently high that it does not bind),

$$(A13a) \quad P_1: [(.5 P_e + P_2 - 2P_1)/t] + (3/4N) = 0,$$

$$(A13b) \quad P_i: [(P_{i-1} + P_{i+1} - 2P_i)/t] + (1/N) = 0 \quad , \quad \text{for } i=2, \dots, (N/2)-1$$

$$(A13c) \quad P_i: [(P_{i-1} - P_i)/t] + (1/N) \quad , \quad \text{for } i=N/2.$$

Multiplying by (-1) and writing in matrix form gives:

$$(A14) \quad AP = b \quad , \quad \text{where } b = ((3t/4N)+(P_e/2), t/N, t/N, \dots, t/N)'$$

Using Cramer's Rule to solve for P_1 gives (after exceptionally tedious manipulations)

$$(A15) \quad P_1 = (P_e/2) + (t/2)(1-(1/2N)).$$

Entrant profit can be written,

$$(A16) \quad \pi_e = \max P_e [P_1 - P_e + (t/2N)]/t.$$

Solving for P_e and substituting,

$$(A17) \quad P_e = (P_1/2) + (t/4N) \Rightarrow \pi_e = (P_1 + (t/2N))^2/4t.$$

Solving (A15) and (A17) gives post-entry equilibrium prices and entrant profit,

$$(A18) \quad P_e = (t/3)(1+(1/2N)) \quad , \quad P_1 = (t/6)(4-(1/N)), \quad \pi_e = (t/9)(1+(1/2N))^2$$

Setting π_e of (A18) equal to the entry cost k^d gives the minimum number of monopoly stores that deters midpoint entry,

$$(A19) \quad N_{SNC}^{md} = t^5/[6(k^d)^5 - 2t^5].$$

It is easily seen that, with $N^{md*} = (t/2k^d)^5 \geq 2$, $N_{SNC}^{md} > N^{md*}$. QED.

Proof of Proposition 9. Welfare costs can be written as

$$C(r, k, N) = (r/4N) + Nk,$$

with C^f =welfare costs under FT = $C(r, k^f, N^f)$ and C^d =welfare costs under DT = $C(t, k^d, N^d)$.

With franchise contracts, $N^f = (r/4k^f)^5$ and $N^d = (t/2k^d)^5$, implying Proposition 9(A).

Note that, if $rk^f = tk^d$, $N^f = (r/2k^f)^5 \equiv N^{mf**}$ and $N^d = (t/2k^d)^5 \equiv N^{md*}$, then $C^f = C^d$.

Moreover, when $N > (r/4k)^5$, $C(r, k, N)$ rises with N . Hence, if $rk^f = tk^d$, $N^f = N^{mf**}$ and $N^d > N^{md*}$, then $C^f < C^d$. Absent contracts, we have $N^f = N^{mf**}$ and $N^d = N_{SNC}^{md} > N^{md*}$ as

described in equation (A19). Therefore, if $rk^f = tk^d$, then $C^f < C^d$. Proposition 9(B)

follows. QED.

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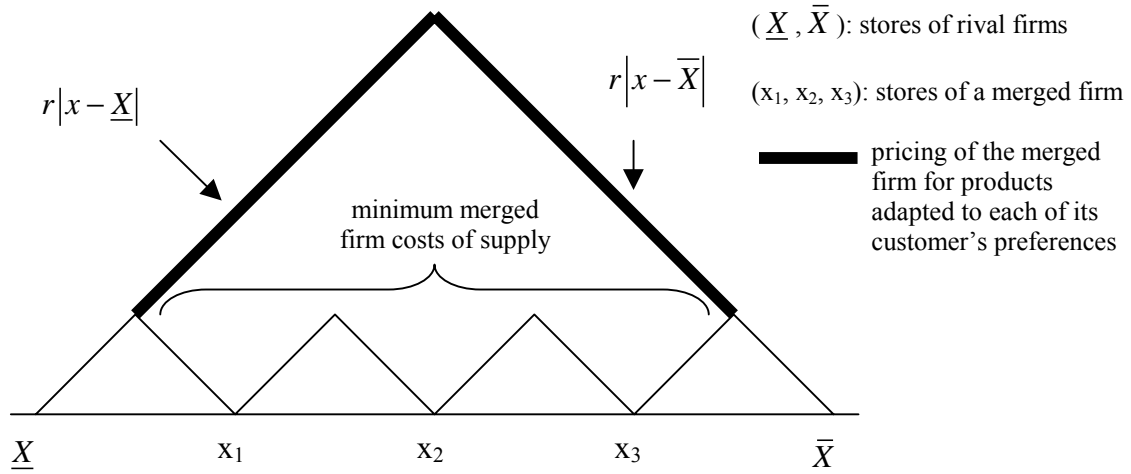


Figure 1: Pricing and Costs with Flexible Production

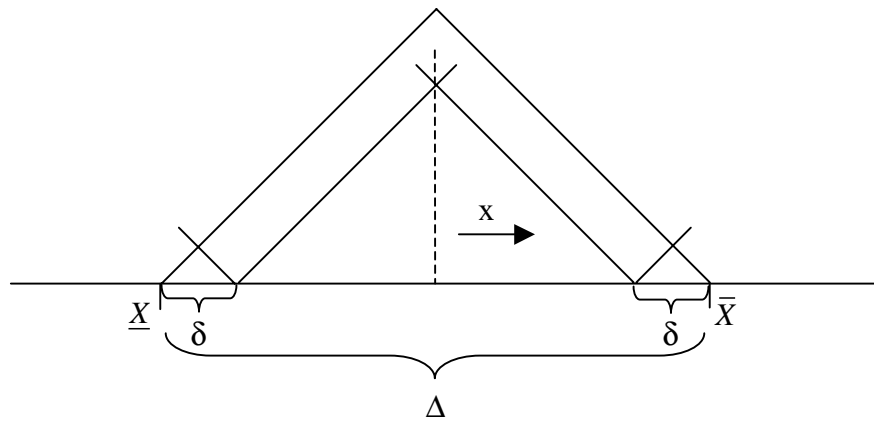


Figure 2: Two-Store Mergers