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Department of Economics
Tufts University
Medford, MA 02155
(617) 627 – 3560
http://ase.tufts.edu/econ

Versioning, Brand-Stretching, and the Evolution of e-Commerce Markets[§]

George Norman, Lynne Pepall and Dan Richards

Department of Economics,

Tufts University,

Medford,

MA 02155, USA

e-mail: george.norman@tufts.edu, lynne.pepall@tufts.edu, dan.richards@tufts.edu

Abstract

This paper offers an analysis of the evolution of e-commerce markets. We develop a model in which an initial group of small, no-name "click" firms create such markets by offering horizontally differentiated customized or "versioned" products and competing in prices. Subsequently, a traditional "brick" firm enters by stretching its brand name into the digital marketplace. Such entry causes many initial entrants to exit. Contrary to much popular and formal literature, we show that the volume of initial entry may well be inefficiently low despite the anticipated later exit. In addition, the conventional relationship between sunk cost and market structure is substantially weakened.

JEL Classification Codes: L11, L86

Key Words: Versioning, Brand-Stretching, Price Discrimination, Market Structure

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1. Introduction

This paper offers a rational analysis of the recent and widely noted boom and bust cycle of dot.com firms. Many observers have viewed this cycle as potent evidence of market inefficiency. In this view, the initial rapid entry of firms into untested dot.com markets and the easy financing such firms initially obtained are clear evidence of the market's "irrational exuberance." The recent collapse of many of these same firms is then seen as the inevitable correction that had to come when investors eventually came to their senses. By contrast, the perspective taken in this paper suggests that the entry decisions of the many small e-commerce firms can be viewed as rational choices of profit-maximizing firms. Indeed, we find that social welfare may have been enhanced if more rather than fewer firms had initially entered the e-commerce sector even though many of these were doomed to fail.

At the core of our analysis lie the unique characteristics that distinguish the way business is done in electronic markets from the more traditional "brick and mortar" setting. The most notable of these is the ability of a "click" seller to become inexpensively informed about each individual buyer's preferences. This combined with flexible, computer-based modern production technologies enables an e-commerce firm to customize or *version* its product offerings.[1] Dell and Amazon were pioneers in bringing such versioning to computers and book selling, respectively. Yet the mass customization that characterizes the products of these two firms is now a feature of virtually all web-based companies, including not only other computer and book-selling firms, but also those active in other markets such as online information services, auction sites, and diet and nutrition web pages.[2] By contrast, product versioning is generally not feasible for traditional sellers for at least two reasons. First, it is simply too costly to collect information about individual buyers' preferences in order to customize products and prices given the available technology. Secondly, until recently the available manufacturing technologies did not allow versioning at reasonable costs.[3]

[1] See Varian and Shapiro (1998).
[2] See E-Commerce Report, ***The New York Times***, Monday April 30, 2001, C8.
[3] An exception is where firms can employ *flexible manufacturing systems*: see Eaton and Schmitt (1994), Mansfield (1993), Röller and Tombak (1990, 1993), Norman and Thisse (1999).

A further distinctive feature of electronic commerce that has also been noted by many commentators and that is incorporated into our model is that, in contrast to traditional “brick and mortar” stores, e-commerce firms do not provide shoppers with a social experience. This, however, is a disadvantage for the digital firm. Brick sellers provide shoppers with a real as opposed to a virtual experience—one in which shoppers can touch or taste the store’s goods, enjoy the establishment’s amenities and, perhaps most importantly, interact with each other as well as with store employees. In our view, the fact that e-commerce firms do not offer such an experience is a disadvantage because consumers value it. To put it somewhat differently, the ability to create a real experience for shoppers permits traditional “brick” sellers to develop distinctive brand names that consumers value. Because so much of that experience is based on meeting and interacting with other consumers, we take the next step of assuming that consumers obtain more such value the better *known* the “brick” good is to other consumers. That is, the creation of a social shopping experience makes it possible for a traditional firm to develop a brand name that confers a complementary consumption benefit in the same way that advertising does in Becker and Murphy (1993).

With these features, we are able to offer an explanation of the evolution of the digital marketplace that is rational yet still consistent with actual observations. Early entrants play the useful role of opening up a new e-market. These are purely “click” sellers who version their products and who, as a result, can practice price discrimination in the sense that the prices charged to different customers do not fully reflect the difference in customization costs. However, the difficulty of building brand name recognition when offering only a virtual shopping experience means that after the online market is established, it will be good target for entry by a traditional “brick” firm wishing to extend or “stretch” its brand names into “click” activities.[4] When the brand-stretching “brick” firm enters, there is an inevitable shake-out in which many of the initial entrants exit. Yet, this cycle of mass entry followed by almost as many departures is not irrational. In our model, the initial entrants fully anticipate the subsequent entry of the brand-stretching “brick” firm and the shakeout that accompanies it. Indeed, we show that it is quite

[4] See Pepall and Richards (2001) for an analysis of brand-stretching into markets with existing incumbents. See Cabral (2000) for an analysis of brand-stretching into a new, previously non-existent market.

possible that far from being excessive, the number of initial "click" entrants may actually be less than the socially efficient level.

As noted, our analysis is consistent with much of the observed evolution of e-commerce markets. The widespread practice of versioning and associated discriminatory pricing can explain the finding that electronic markets are characterized by significant price dispersion [Brynjolfsson and Hitt, 2000]. Our model is also consistent with the observation that the mass exit of small dot.com's has coincided with the entry into specific electronic markets of well-established "brick and mortar" firms, ranging from IBM to Williams-Sonoma. For example, ***The McKinsey Quarterly*** recently reported that in 2001, 86 percent of the e-tailers in the best performing quartile are "brick" firms that have gone online, integrating their "brick" operations with "click" activities so as to exploit their established reputations and brand names in the electronic marketplace. Indeed, our analysis implies that e-commerce markets are likely to end up quite concentrated, dominated by the formerly purely "brick" sellers even for a wide range of sunk costs. We think this is what the data indicate is actually happening but it stands in sharp contrast to the early predictions of many analysts, who suggested that the advent of e-commerce would result in markets close to the economist's idea of perfect competition: see, for example, Litan and Rivlin (2000). To a lesser but still important extent, our analysis also contrasts with the work of Sutton (1991) on the relationship between sunk cost and market structure.

The remainder of the paper is structured as follows. In the next section we present the essential elements of the formal model. In section 3, we determine the equilibrium predicted by the model in which the market is first organized by many, identical "click" firms with no established brand identities followed by the subsequent entry of a well-known brand- stretching firm. In section 4, we present some welfare comparisons and in the final section we present our summary and conclusions.

2. The Basic Elements: Versioning, Price-Discrimination, and Brand-Stretching Entry

The model is a two-period game with each period having two stages. In the first stage of the first period, a set of identical, risk-neutral "click" sellers with no established brand identities decide whether or not to enter a new online market that will last for two periods. These initial entrants compete in prices in the second stage of the first period. The two stages of the second period are similarly structured. In the first stage of this second period, a firm with a recognized brand name established in a "brick" market, decides whether or not to enter the online market and the initial entrants decide whether to stay or to exit. In the second stage, the brand name firm offers a branded version of the product or service and competes in prices with the initial entrants who choose to remain. The market closes at the end of the second period and we assume for simplicity that each "click" seller has a discount factor of unity.

We solve for the perfect equilibrium to this game. In other words, when making their initial entry decisions the "click" sellers are foresighted in that they anticipate the outcome of price competition in both periods and the possibility of brand-stretching entry in the second period. Nevertheless, brand-stretching entry is uncertain since we assume that the precise strength of the late entrant's brand name in the new market is unknown in the first stage of the game. As a result, such entry can be expected to lead to the exit of some incumbent "click" firms once the identity and type of the brand-stretching firm are realized.

In each active market stage (the final stage of each period), firms compete by versioning their products to the most preferred specifications of consumers. To model product versioning we use a variant of the familiar Hotelling/Salop model of horizontal product differentiation. Eaton and Schmitt (1994) and Norman and Thisse (1999) show that this is a particularly useful and powerful tool for analyzing competition when firms employ technologies that can version the products being offered to the most preferred specifications of consumers.[5] The new online market is assumed to be a one-dimensional circular space Λ whose length we can normalize to unity without loss of generality. Consumers are uniformly distributed over this space at density d. The "location" of consumer s is defined to be that consumer's most preferred product specification. For each consumer s the surplus obtained from buying a product with specification x at price $p(x)$ from a seller with no established brand identity is:

$$U(x,s) = V - p(x) - t|x - s| \qquad (1)$$

[5] See also Lederer and Hurter (1986) and MacLeod, Norman and Thisse (1988) for earlier analysis along these lines.

V is the consumer's reservation price and t is the value of the loss of utility per unit distance that the consumer incurs in buying a product other than her most preferred product. We assume that V is sufficiently great that it imposes no constraints on the firms' prices. Each consumer is assumed to buy exactly one unit of the product that offers her the greatest surplus. In case of a tie we assume that consumer purchase decisions are randomly distributed over the tied products. In equilibrium this occurs for a zero measure set of consumers.

2.1 Versioning and Price Equilibrium

To enter this market a "click" seller incurs a sunk cost of F. The "location" x_i of an early entrant firm i on the circle is the specification of the basic product (MacLeod *et al*, 1988) upon which its versioning decisions are centered. We assume that n "click" sellers enter the market in the first period, that they establish a symmetric distribution of their basic products and that relocation costs are prohibitive.[6] The determination of n is discussed in detail below. For the moment it is sufficient to note that n is determined by the free entry condition.

The unit cost of producing basic product x_i is assumed to be identical across all firms and is normalized to zero. Firms also incur costs of versioning or customizing their basic products to the precise specifications of consumers. Specifically, to customize its basic product to the product specification x, a firm with basic product x_i incurs the cost

$$MC_i(x_i, x) = r|x_i - x| \tag{2}$$

The versioning technology has two essential features. First, a consumer is indifferent between a basic product s and a basic product x_i versioned to s if they are offered at the same price. Secondly, we assume that $r < t$. Accordingly, firms always have a profit incentive to version their products to the precise requirements of each consumer. Note that such versioning effectively implements price discrimination in that the differences in the prices paid by different consumers will not simply be due to

[6] Since the location of a firm is the specification of its basic product this is not an unreasonable assumption.

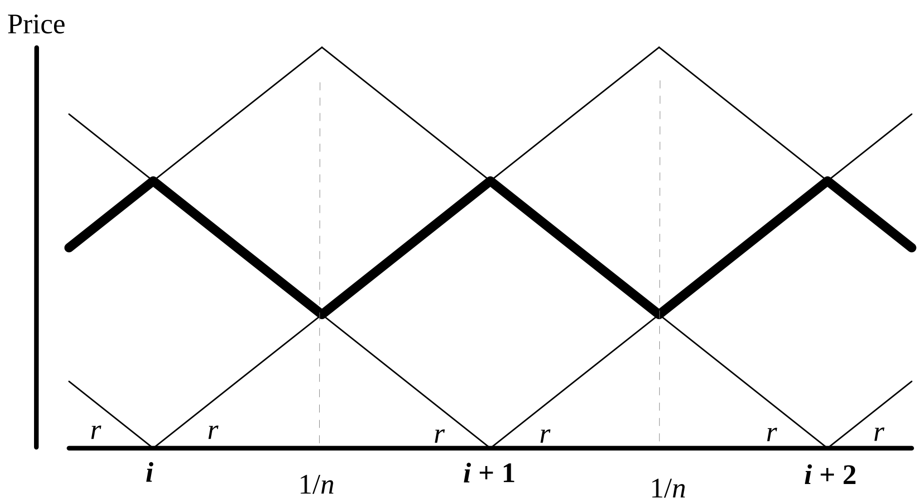
incorporation of the versioning costs. More precisely, the Bertrand-Nash equilibrium set of prices generated by competition among the *n* sellers is described by [see Eaton and Schmitt, 1994]:

$$p_i^*(s) = \min\left(V, \max\left(r|x_i - s|, \min_{j \neq i} r|x_j - s|\right)\right) \qquad \forall i = 1,\ldots,n \tag{3}$$

The bold line in Figure 1 illustrates this market outcome. Simply put, competition between sellers drives price at each consumer location down to the costs of the seller whose basic product is second nearest to that location. It is straightforward to show that with *n* firms uniformly distributed in the market, each offering a single basic product, the market share of each firm is 1/*n* and the profit to each firm in the first period (ignoring sunk costs of entry) is

$$\pi_i^1 = dr/2n^2 \tag{4}$$

Figure 1: Price Equilibrium with *n* Early Entrants



2.2 Brand-Stretching Entry

In the first stage of the game's second period, entry by a brand-stretching firm *b* may occur. If the brand stretcher enters it too will version its basic product to meet consumers' preferred specifications and compete in price with the incumbent firms. However, the brand-stretcher has the additional advantage that its "brick" establishment has provided consumers the tangible shopping experience necessary to develop a brand name. In a sense, the "brick" store has been an investment aimed at building an intangible asset. Because consumers value visibility or brand name recognition they will be willing to pay more for the brand stretcher's product if it has a stronger brand image.

We follow much of the marketing literature and use market share as a proxy for brand strength. For example, the market research firm *Interbrand* compiles a comparative ranking of brand strength based on an index in which the most heavily weighted factor by far is the brand's market share. Court, Leiter, and Loch (1999) also link brand strength to market share.

After the first period market activity, each of the n early entrant firms will have brand strength equal to $1/n$. The late brand-stretching entrant, on the other hand, does not have a share of this market in the first stage of the game but it does have brand recognition in its home or base market. However, that brand recognition or visibility from the home market may not translate fully into similar recognition in the new market. To capture this, we assume that the strength of the brand stretcher's brand name in the new market can be described by the parameter α, where $0 \leq \alpha \leq 1$. As noted, it is reasonable to suppose that α will depend upon the brand stretcher's market share in its home market, but it will also depend upon other factors, such as the degree of commonality between the brand stretcher's home market and the new market. This could include, for example, the degree to which the two markets have common consumers, or the degree to which the products in the two markets share similar attributes. The carry-over power or transferability of the brand stretcher's brand name might also depend upon the absolute size of the brand stretcher's home market. The larger the market, the greater is the carry over power.

We do not model the determination of α explicitly. Rather, we assume that the "click" sellers are imperfectly informed about α when they make their initial entry decisions in the first stage of period one. At that stage they know only that α is uniformly distributed on the interval [0, 1]. This might arise, for example, because the initial entrants know that there is a population of brand-stretchers who might enter the new market but do not know in advance which one of these firms will actually choose to enter. By contrast, the value of α is perfectly observed by consumers and the incumbent firms after b's entry and by *b* itself prior to its entry decision. In other words brand-stretching entry is a probabilistic event with a random selection by nature of the late entrant's brand strength.[7]

As in Pepall and Richards (2001) we assume that the increase in consumer willingness to pay for a brand-stretcher's product depends upon the *relative difference* in brand recognition between the brand-stretcher's product and an incumbent's product. That is, if the brand stretcher enters, the increase in consumer willingness to pay for the brand-stretcher's product depends upon the *difference* in brand recognition, as measured by $\alpha - 1/n$. Accordingly, we assume that the brand-stretcher enters in the second stage if and only if $\alpha - 1/n > 0$.[8] Since $\alpha \leq 1$, this means, of course, that the brand stretcher will not enter a monopolized market. If $\alpha - 1/n > 0$ then we assume that the brand stretcher will enter at the beginning of the second period with a basic product x_b located midway between some pair of incumbents. The surplus that consumer *s* gets from consuming the brand stretcher's product with specification x_b offered at price $p(x_b)$ is:

$$U(x_b, s) = V + \left(\alpha - \frac{1}{n}\right) - p(x_b) - t|x_b - s| \qquad (5)$$

Because the brand stretcher is already established in another market, it is likely to face lower sunk costs of entry. However, we assume that the brand stretcher has the same variable costs of production as the incumbent firms. Moreover, we assume that the size of the versioning cost parameter *r* is such that: $1 - \frac{1}{n} > \frac{r}{2}$ for $n \geq 2$. This ensures that if the brand-stretcher has the maximum brand strength $\alpha = 1$ then it will be able to monopolize the market. This assumption simplifies the calculation of expected profit for the incumbent firms in period 2. Relaxing it complicates the analysis without altering our qualitative conclusions.

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[7] We could of course allow for 2 or more brand-stretching entrants. However, the introduction of additional brand-stretchers complicates the analysis considerably without materially illuminating the issues on which we focus. For example, more than one brand-stretcher raises timing issues regarding the entry decision of each. It also makes the market's second period evolution dependent on the joint probability distribution of the entrants' brand strengths.

[8] An equivalent approach is to assume that the sunk costs for the brand-stretcher are $K_b = d.r/8n^2$.

What is the impact of entry by the brand-stretching firm on price competition in the market? The first point to note is that because all firms version their products, and because entry occurs only at one point on the circle, the brand-stretcher's entry will, in equilibrium, affect *only* the prices of its surviving neighbors immediately to its left and to its right. Versioning and price discrimination permit firms to compete intensely on one side of their market without having to do so on the other. As a result, the two surviving firms located either to the immediate left or the immediate right of b can lower their prices to consumers for whom they compete with b without lowering them to consumers for whom they compete with other incumbents more distant from b. This means that the prices set by the remaining firms who are not neighbors of the brand stretcher will not be affected by its entry.

A second and related point is that the brand stretcher's left- and right-hand neighbors are not necessarily the two firms between which b entered and located its basic product x_b. For these two firms - and possibly others to their left and right - will exit the market if the brand stretcher's entry makes price competition so tough that they cannot cover their variable costs of production. Depending upon its relative brand strength firm b's entry may in fact cut a wide swath through the market and eliminate a number of nearby competitors.

To show the impact of brand-stretching entry on prices more formally, we proceed as follows. Consider a firm on the "left-hand side" of b at the time of entry. Number the incumbent firms such that this is firm j with basic product x_j. If there were initially $n = 2m$ incumbents, then $j \leq m$ while if there are $2m + 1$ incumbents then $j \leq m + 1$. The distance between b and j is therefore $j(n) = \frac{(j-1)}{n} + \frac{1}{2n}$.

Firm j faces three possible outcomes in the wake of b's entry. One is that nothing changes. This will happen if there is at least one surviving firm in both directions between j and b because, as noted above, versioning and the associated price discrimination localizes all competition. The second possible outcome is that the competition with b is so intense that firm j exits. The final possibility is that all the incumbents between j and b exit so that j is the left-hand survivor that directly competes with b. For this last case, consider a consumer *s* whose most preferred product specification is $s \in [x_i, x_b]$. Competition between *j* and *b* for this consumer leads to the following post-equilibrium prices on this interval:

$$p_j^*(s) = \max\left(r|x_j - s|, r|x_b - s| - \left(\alpha - \frac{1}{n}\right)\right) \qquad s \in [x_j, x_b] \qquad (6)$$

$$p_b^*(s) = \max\left(r|x_b - s|, r|x_j - s| + \left(\alpha - \frac{1}{n}\right)\right) \qquad s \in [x_j, x_b] \qquad (7)$$

Beyond this interval, i.e., for consumers to the left of *j*, prices are unaffected by *b*'s entry.

The bold line in Figure 2 illustrates the prices in equations (6) and (7). In this diagram the early entrants 1 and 2 choose to exit the market in the second period. The intuition is simply explained. The brand-stretching entrant can win consumer $s \in [x_i, x_b]$ at a price that is α - 1/*n* greater than the incumbent firm *i*'s versioning costs. By contrast, in order to win this consumer's demand, the incumbent firm *i* must undercut the brand-stretcher's versioning costs by α - 1/*n*. If offering this discount means that *i* must sell to all potential customers at a loss then *i* would rather exit the market in the final market period.

It is straightforward to show that if *j* =1, so that *b* enters immediately next to firm *j* separated only by the distance 1/2*n* then, if firm *j* survives, it earns the profit:

$$\pi_1^2(n, r, \alpha) = \frac{d}{2n}\left(\frac{1}{n} + \frac{r}{2n} - \alpha\right) \qquad (8)$$

Otherwise it will exit and earn nothing. If *j* ≥ 2, then firm *j* will either exit and earn nothing or, if it survives, it will either earn the same profit in the final period as it did in first, $\pi_j^1 = rd/2n^2$ or it will earn

$$\pi_j^2(n, r, \alpha) = \frac{d}{2n}\left(\frac{1}{n} + \frac{(2j-1)r}{2n} - \alpha\right), \forall\ 2 \le j \le m\ [or\ (m+1)] \qquad (9)$$

3. Brand Stretching Entry and Final Market Structure

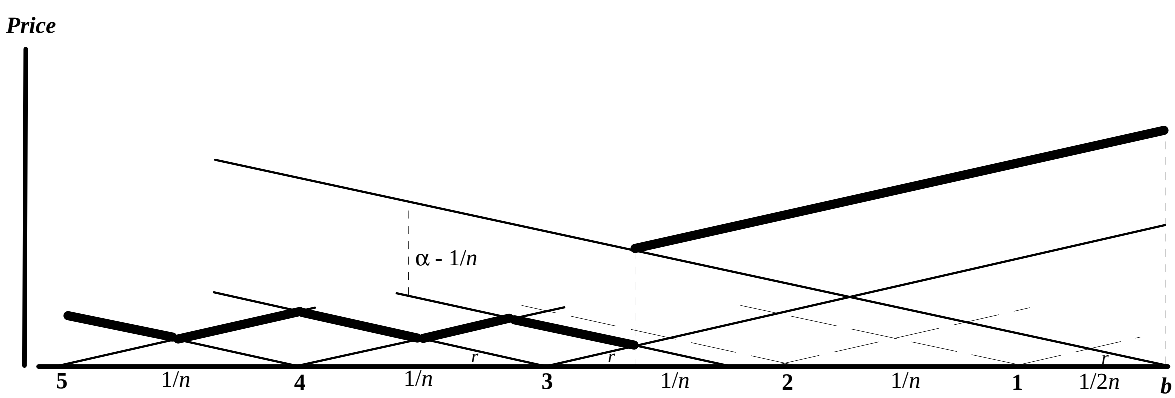
We can now identify the equilibrium number n^e of early entrants in the first period and the expected final market structure in second, final period. To do this we first calculate the expected profit of an initial, no-name incumbent firm in the final stage of the game, after any brand-stretching entry. We then define the equilibrium value n^e to be that n^e that satisfies the profit conditions $E(\Pi(d,r,F,n^e)) \geq 0$ and $E(\Pi(d,r,F,n^e+1)) < 0$.

Because the number of initial entrants *n* is discreet, we need to distinguish the case of *n* being even from that of *n* being odd. Assume that *n* is even, with $n = 2m$. Number the incumbent firms such that the first firm to the left of *b*'s entry point is 1, the second firm is 2 and so on. Now consider the expected profit of firm $j \leq m$ in the active market stage of the second period of the game. For firm 1 this is:

$$E(\pi_1^2)=\frac{rd}{2n^2}\int_0^{\frac{1}{n}} d\alpha+\frac{d}{2n}\int_{\frac{1}{n}}^{\frac{1}{n}+\frac{r}{2n}}\left(\frac{1}{n}+\frac{r}{2n}-\alpha\right)d\alpha \qquad (10)$$

The first term in (10) is expected profit if there is no-brand-stretching entry, which happens so long as $\alpha \leq 1/n$. The second term is expected profit given that entry takes place but α is not so large that firm 1 chooses to exit the market.

Figure 2: Brand-Stretching Entry and Price Equilibrium



For firm $2 \leq j \leq m$ expected profit is:

$$E(\pi_j^2)=\frac{rd}{2n^2}\int_0^{\frac{1}{n}+\frac{(2j-3)r}{2n}} d\alpha+\frac{d}{2n}\int_{\frac{1}{n}+\frac{(2j-3)r}{2n}}^{\frac{1}{n}+\frac{(2j-1)r}{2n}}\left(\frac{1}{n}+\frac{(2j-1)r}{2n}-\alpha\right)d\alpha \qquad (11)$$

The first term in (11) is *j*'s expected profit given that firm $j-1$ remains in the market and the second term is expected profit given that firm $j-1$ exits but firm *j* does not. Equation (11) simplifies to:

$$E\left(\pi_j^2\right) = \frac{rd}{2n^2}\left(\frac{1}{n} + \frac{(2j-3)r}{2n}\right) + \frac{r^2 d}{4n^3} \tag{12}$$

If n is odd with $n = 2m + 1$ equations (10) and (12) hold for $j \leq m$. Now consider firm $m + 1$, the firm furthest from the brand-stretcher. This firm's expected profit is:

$$E\left(\pi_{m+1}^2\right) = \frac{rd}{2n^2}\int_0^{\frac{1}{n}+\frac{r(n-1)}{2n}} d\alpha + \frac{d}{2r}\int_{\frac{1}{n}+\frac{r(n-1)}{2n}}^{\frac{r}{2}+\frac{1}{n}-\alpha}\left(\frac{r}{2}+\frac{1}{n}-\alpha\right)^2 d\alpha = \frac{dr(24+r(12n-11))}{48n^3} \tag{13}$$

where $2m + 1 = n$.

Recall that the actual location of the brand-stretcher along the circle is uncertain, occurring with equal probability between any pair of incumbents. If n is even equal to $2m$, then an incumbent firm i has probability $1/n$ of being $j < m$ firms to the left of the actual entry point and $1/n$ of being j firms to the right of that entry point. Therefore, when n is even, firm i has an overall probability $2/n$ of being the jth-nearest firm to the brand-stretcher. When n is odd, $n - 1 = m$ of the possible entry points are symmetrically situated about the position of any one incumbent. Therefore, focusing just on these points again leads to the conclusion that firm i has an overall probability $2/n$ of being the jth-nearest firm to the brand-stretcher for $j \leq m$. However, there is also the $1/n$ probability that the entrant will choose that one entry spot that is furthest from the incumbent. This implies that the expected profit to an incumbent firm in the final stage of the game is:

$$\begin{aligned} E\left(\Pi_i^2\right) &= \frac{2}{n}\sum_{j=1}^{m} E\left(\pi_j^2\right) \qquad if\ n = 2m \\ E\left(\Pi_i^2\right) &= \frac{2}{n}\sum_{j=1}^{m} E\left(\pi_j^2\right) + \frac{1}{n}E\left(\pi_{m+1}^2\right) \quad if\ \ n = 2m+1 \end{aligned} \tag{14}$$

Evaluating (14) using equations (8) - (13) and adding the first period profit in equation (4) gives the expected profit for an early entrant. If the number of early entrants n is even we have:

$$E(\Pi(d,r,F,n)) = \begin{cases} \dfrac{dr(8(n+1)+r)}{16n^3} - F & if\ n = 2 \\ \dfrac{dr\left(2n(2-r)+r+n^2(4+r)\right)}{8n^4} - F & if\ n > 2 \end{cases} \tag{15}$$

If n is odd with $n = 2m + 1$ the overall expected profit is equation (15) plus the additional profit from equation (13) with probability $1/n$.

As noted, we assume that the equilibrium value n^e is characterized by the profit conditions $E\left(\Pi\left(d, r, F, n^e\right)\right) \geq 0$ and $E\left(\Pi\left(d, r, F, n^e + 1\right)\right) < 0$.[9] Evaluating the zero profit entry condition requires that we solve equations (13) and (15) for n. However, these equations are too complex to allow an analytical solution for n^e. Instead we use numerical simulations over the parameters d, r and F to describe the equilibrium.

Table 1 identifies the critical values of the sunk entry cost F for which n^e is the equilibrium number of early entrants for different values of the versioning cost r and given that consumer density $d = 10$. For example, if $r = 1$ and $F \in (0.143777, 0.18615)$ then $n^e = 6$. Since the solution for n^e is linearly homogeneous in F/d, Table 1 can also be used to identify the critical ranges of F for every value of d.[10] The critical entry costs F in Table 1 confirm the basic intuition that there will be greater entry when sunk costs are low and/or when consumer density is high.

Table 1 also shows the impact on n^e of changes in versioning costs.[11] This Table 1 and an extensive grid search indicate that there will be more entry the higher is the versioning cost parameter r. Again, this accords with intuition. Low versioning costs intensify price competition by effectively shrinking the distance between rival firms. In turn, this reduces profits and thereby discourages entry.

It will prove useful in later analysis to consider the market structure that would emerge in the first period if the initial entrants were myopic or assumed that brand-stretching entry would not occur. In either of these events expected profit for each initial entrant over the two periods would be

[9] Given that we have assumed that relocation costs are prohibitive, we know from MacLeod *et al* (1988) that there is a range of possible equilibria. We focus on the "maximum packing" equilibrium since this is the one that generates the greatest number of initial entrants.

[10] For example, if $r = 1$ and $d = 1$ then $n^e = 6$ for $F \in (0.0143777, 0.018615)$.

[11] Recall that we assume throughout that $r < t$, so that any thought experiment that raises r also requires that we raise t. This can be justified since, in the product differentiation interpretation of the model, t is a direct measure of the

$\Pi^{ne}(d,r,n) = rd/n^2 - F$ with equilibrium requiring $\Pi^{ne}(d,r,n^{ne}) \geq 0$ and $\Pi^{ne}(d,r,n^{ne}+1) < 0$. As we would expect, there would be more entry. The threatened later emergence of a brand-stretching firm constrains initial no-name entry to the new market.

Table 1: Critical Values of *F* for *d* = 10

n	*r*			
	0.5	0.75	1	1.25
2	0.957031	1.450195	1.953125	2.46582
3	0.432742	0.672743	0.928498	1.200006
4	0.206299	0.317688	0.43457	0.556946
5	0.136083	0.213188	0.296333	0.385521
6	0.087047	0.135091	0.18615	0.240222
7	0.065619	0.103131	0.143777	0.187557
8	0.047684	0.074329	0.102844	0.133228
9	0.038493	0.060603	0.084623	0.110551
10	0.030031	0.046945	0.065125	0.08457
11	0.025275	0.039836	0.05568	0.072806
12	0.020631	0.032315	0.04491	0.058417
13	0.017858	0.028168	0.039397	0.051546
14	0.015041	0.023592	0.032831	0.042758
15	0.013285	0.020965	0.029337	0.038401
16	0.011449	0.017978	0.025043	0.032645
17	0.010268	0.01621	0.022691	0.029712
18	0.009005	0.014153	0.019731	0.025739
19	0.008173	0.012907	0.018072	0.02367
20	0.007268	0.01143	0.015945	0.020813

Whether the initial entrants are myopic or foresighted, it remains the case that there are typically so many of them that brand-stretching entry can be expected to lead to the exit of some, in extreme cases all, of them. In other words, the brand-stretcher's entry leads to the exit of firms even though these firms made their initial entry decisions anticipating that entry.

We pursue this point further by considering the equilibrium market structure in the wake of late entry by the brand-advantaged "brick" firm. To do this, we need to identify the expected number n^s of early entrants that choose to continue operations in the second market period. Suppose that there are *n* initial entrants with *n* = 2*m* if *n* is even and $2m+1$ if *n* is odd. Now consider the incumbent that is the *j*th

degree of specialization of consumer preferences. It seems reasonable to suggest that versioning to meet highly specialized tastes will be greater than versioning to meet weak consumer preferences.

nearest firm to the brand-stretching entrant. This firm will continue to operate in the third period if and only if $\frac{r}{2n}+\frac{r(j-1)}{n}+\frac{1}{n}>\alpha$ since only then can it sell at a positive price. It follows that the expected number of firms to survive brand-stretching entry, n^s, is:

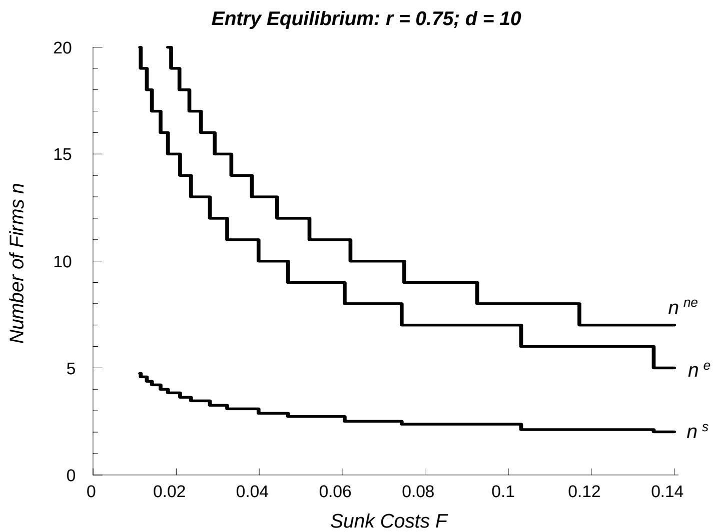
$$n^s = \begin{cases} E\left(n^s \middle| n^e = 2m\right) = \int_0^{\frac{r}{2n}+\frac{1}{n}} n\,d\alpha + \sum_{j=1}^{m-1} \int_{\frac{(2j-1)r}{2n}+\frac{1}{n}}^{\frac{(2j+1)r}{2n}+\frac{1}{n}} (2m-2j)\,d\alpha = 1 + \frac{rn^e}{4} \\ E\left(n^s \middle| n^e = 2m+1\right) = E(2m) + \int_{\frac{(n-1)r}{2n}+\frac{1}{n}}^{\frac{r}{2}+\frac{1}{n}} d\alpha = E\left(n^s \middle| n = 2m\right) + \frac{r}{2n^e} \end{cases} \tag{16}$$

From our assumption on r it follows that $n^s \leq 1/2 + n^e/2$. Thus, for example, if the number of initial entrants were $n^e = 9$, then *at most* five of these firms would be expected to survive in the wake of brand-stretching entry. To put it somewhat differently, there is an upper bound on the fraction of initial entrants that can be expected to survive and this bound approaches one-half fairly rapidly as n^e gets large.

Equation (16) also reveals that the number of initial entrants that can be expected to survive brand-stretching entry is increasing in both versioning costs r and the number of entrants n^e. It follows that the number of surviving early entrants is decreasing in sunk costs F and increasing in consumer density d. These relationships are illustrated in Figure 3.

The top curve in Figure 3 describes the number of initial entrants as a function of the sunk entry cost F when entrants are myopic and do not anticipate second period entry by a brand-stretcher. The next curve illustrates the number of entrants when these firms anticipate the entry of a brand-stretching firm of random brand strength. The lowest curve shows the number of firms that survive the brand-stretcher's entry. The diagram provides strong, visual support for the argument given above. Whether entrants are myopic or not, the expected number of initial firms surviving through the second, final period is much lower than the actual number of initial entrants. The fact that the initial entrants come into the market anticipating the likelihood of later brand-stretching entry does not avoid the considerable shakeout when such entry actually occurs. Note also that while the expected number of survivors n^s increases as the sunk cost F decreases, the overall slope of the survival curve is relatively flat. That is, the number of survivors ranges between 2 and 5 for a very large range of sunk costs. This result stands in some contrast to Sutton's (1991, 1998) extensive work linking market structure to (possibly endogenous) sunk cost. Our findings imply that when an industry follows a development path in which many small firms open the market followed later by a well-known brand from another industry, then the natural outcome is an asymmetric oligopoly with relatively few (small) initial entrants and one large dominant one, the brand stretcher. This result gives some formal theoretical support to the argument of Galambos (1994) based on historical evidence that oligopoly is typically an inevitable market structure.

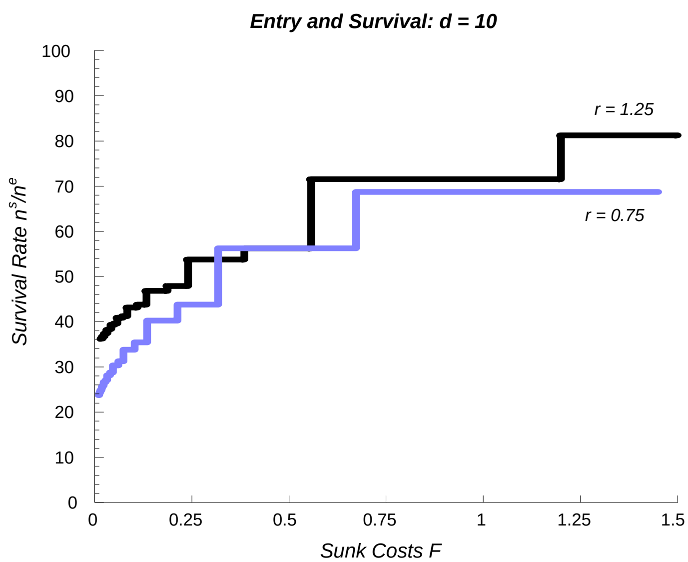
Figure 3: Myopic and Foresighted Entry



Rather than focus on the absolute number of survivors, we could instead use equation (16) to determine the *probability* of survival, $h = n^s/n^e$. From (16) the survival rate h is decreasing in n^e. In the limit this proportion approaches $r/4$. I follows that h is increasing in F and decreasing in d. This is illustrated in Figure 4 where we plot the survival rate h against sunk cost F for two different values of versioning cost: $r = 0.75$ and $r = 1.25$.

Figure 4 also makes clear that the probability of survival does not bear a simple relationship to versioning costs. Generally speaking, the survival rate is higher when the cost of versioning is higher, compare the cost parameter $r = 1.25$ and $r = 0.75$. As can be seen, however, there is a range of F values where this is not the case. This ambiguous relationship reflects the tension between the two conflicting effects of increasing the versioning cost parameter *r*. On the one hand, a fall in *r* decreases initial entry and thereby allows those firms who do enter to obtain a larger market share, lowering the probability of brand-stretching entry. On the other hand, the lower *r* also makes it easier for the brand stretcher to version its product and thereby compete with the initial entrants more fiercely. This factor of course exerts a depressing effect on the probability that an early entrant will survive.

Figure 4: Proportion of No-Name Firms that Survive



Again, we emphasize that the exit of no-name firms that is induced by the entry of a brand-stretcher is not evidence of irrational exuberance on the part of the initial entrants. Each no-name firm in making its entry decision is making a considered judgment *ex ante* regarding how close it will be to the brand-stretcher in the second period. Once the relative locations of the two types of firms are realized, some of the no-name firms are closer than they expected to be to the entrant while others are farther away. The former firms choose to exit the market in the second period rather than incur losses while the latter firms remain. These surviving firms earn positive profit over the complete two-period life of the market.

For the no-name firms that are forced to exit as a result of brand-stretching entry to break even on just their first-period profits it is necessary from (4) and Π^{ne}, that $n^{ne}/n^{e} > \sqrt{2}$. Given the zero-expected-profit condition that determines n^e this is unlikely to be the case.

4. Some Comments on the Welfare Effects of Brand-Stretching

Determining that initial entry well in excess of the number of firms who eventually survive is individually rational is of course quite different from saying that such a large number of initial entrants is optimal from a social welfare perspective. Indeed, much of the popular commentary on the dot.com collapse is arguably predicated on the notion that the initial entry wave reflected a collective irrationality rather than an individual one. Excessive entry is a common feature of spatial models with free entry. Moreover, Frank and Cook (1995) have argued that such suboptimally excessive entry is particularly common when, as here, the complementary value that consumers attach to a product with a strong brand identity works to create a sort of network externality that gives the market a "winner-take-all" or at least "winner-take-most" feature. Thus, the conclusion of popular analysis may have some basis in formal economic theory.

In truth, however, there are conflicting forces at work in our model that make it difficult to determine the welfare-maximizing volume of entry *a priori*. On the one hand, a large number of initial entrants yields benefits by way of intensified price competition and greater consumer surplus. In this respect, the later brand-stretching entry has two negative effects. First, the anticipation of such entry suppresses entry in the first period. Second, the actual entrance of the brand-stretching firm leads some of the initial entrants to exit. On the other hand, as the popular view suggests, myopic entry that does not anticipate the later emergence of the brand-stretching firm may well be excessive. Hence, the fact that entry is suppressed by the anticipation of that entry may move the non-cooperative equilibrium closer to the socially optimal configuration. Moreover, consumers value the brand-stretcher's product more than other products. Hence, brand-stretching entry increases the total surplus in the part of the market that the brand-stretcher captures.

It should be clear from the foregoing that intuition alone will not permit a definitive judgment regarding the welfare implications of our model. There is, in other words, no substitute for formal analysis to identify the socially optimal number of basic products that maximizes social surplus. In doing so we assume that the social planner, in common with the initial entrants, does not know the α of the specific brand-stretcher that actually enters but simply its distribution.

Given the inelastic nature of individual demand, the number of basic products that maximizes total surplus in the absence of brand stretching entry is the number that minimizes total costs. However, this well-known result does not hold once brand-stretching entry is permitted. The brand-stretcher increases surplus by $2d(\alpha - 1/n)S_b(n)$ where $S_b(n)$ is the market radius that the brand-stretcher captures. It follows that the socially optimal number of basic products minimizes the difference between expected total costs and the additional expected surplus created by the brand stretcher, which we refer to as *expected net cost*.

The social planner has to decide which initial entrants to continue to operate in the second period and how to allocate consumers between the brand-stretcher and the nearest surviving firm. However, resolving these issues is not so difficult as it may at first seem. Suppose that firm j is the nearest surviving neighbor to the brand-stretcher and consider a consumer $s \in [x_i, x_b]$. For this consumer to be allocated to firm j it is necessary that $V - rs \geq V + \left(\alpha - \frac{1}{n}\right) - r\left(j(n) - s\right)$. It follows that the criteria determining the planner's choice of which incumbent firms continue to operate and the allocation of consumers between the incumbent firms and the brand-stretcher are exactly those that govern the private decisions of firms on whether to continue in operation and of consumers on from which firm to purchase.

Define:

$$\begin{aligned} &s_i : V - rs_i = V + \left(\alpha - \frac{1}{n}\right) - r\left(\frac{1}{2n} - s_i\right) \Rightarrow s_i = \frac{1}{4n} - \frac{1}{2r}\left(\alpha - \frac{1}{n}\right) \\ &s_b = \frac{1}{2n} - s_i = \frac{1}{4n} + \frac{1}{2r}\left(\alpha - \frac{1}{n}\right) \end{aligned} \tag{17}$$

and

$$NC_j = dr\int_{\frac{1}{n}+\frac{(2j-1)r}{2n}}^{\frac{1}{n}+\frac{(2j+1)r}{2n}} \left(s_i^2 + \left(s_b + \frac{j}{n}\right)^2 + \frac{n - (2j+1)}{2n^2} - \frac{2}{r}\left(\alpha - \frac{1}{n}\right)\left(s_b + \frac{j}{n}\right)\right) d\alpha \tag{18}$$

The first three terms in (18) are total costs (excluding sunk costs) incurred by the brand-stretcher and the initial entrants in the second period, given that α is such that the jth nearest neighbor to the brand-stretcher continues in operation. The final term is the additional surplus created by the brand-stretcher. From these equations and using the same techniques as in section 2, expected net cost is

$$E(NC(2)) = \frac{dr}{2n}\int_0^{\frac{1}{n}} d\alpha + dr\int_{\frac{1}{n}}^{\frac{1}{n}+\frac{r}{2n}}\left(s_i^2 + s_b^2 + \frac{n-1}{2n^2} - \frac{2}{r}\left(\alpha - \frac{1}{n}\right)s_b\right)d\alpha$$
$$- d\int_{\frac{1}{n}+\frac{r}{2n}}^{1}\left(\left(\alpha - \frac{1}{n}\right) - \frac{r}{4}\right)d\alpha + \frac{dr}{2n} + nF \qquad \text{if } n = 2 \qquad (19)$$

and

$$E(NC(n)) = E(NC(2)) + \sum_{j=1}^{m} NC_j \qquad \text{if } n > 2 \qquad (20)$$

where $n = 2m + 1$ if n is odd and $2(m + 1)$ if n is even.

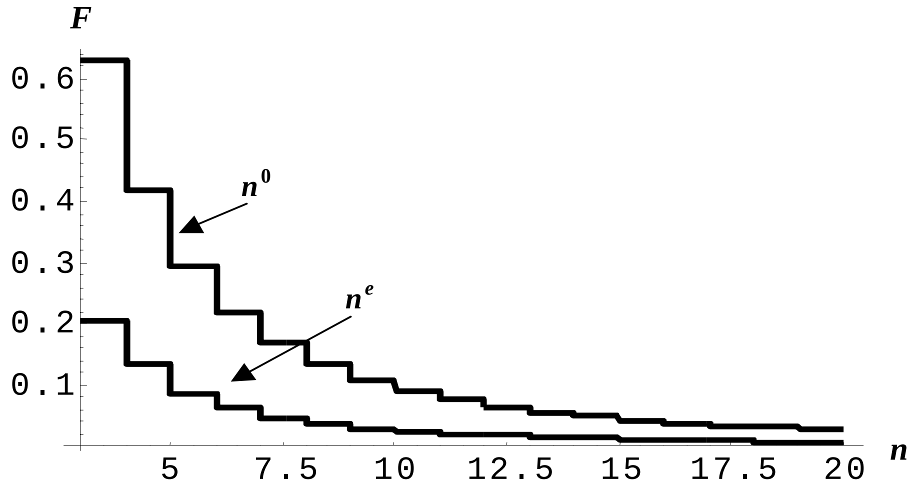
The social planner chooses n^0 to minimize $E(NC(n^0))$.[12] As before, these equations are too complex to allow analytical solution. Numerical simulation, however, is (relatively) straightforward. Typical comparisons of n^0 and n^e are presented in Figure 5. These and extensive grid search confirm a surprising result. *The equilibrium number of initial entrants is less than the socially optimal number*. In addition, *the degree to which there is insufficient entry of no-name firms decreases as versioning costs r rise*.

What lies behind the above result? We have seen that in the non-cooperative equilibrium brand-stretching entry leads to "substantial" exit by the no-name firms, with those firms that are forced to exit generally failing to recover their initial sunk entry costs. Why would a social planner prefer even more initial entry despite the fact that, given the substantial exit in the second period this will imply an even greater "waste" of sunk costs.

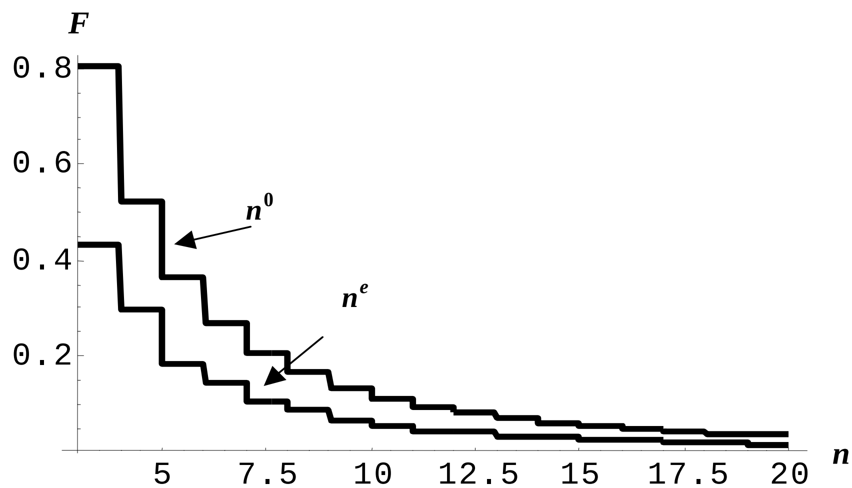
[12] Since we assume a single brand-stretching entrant we can ignore the sunk costs of the brand-stretcher.

Figure 5: Equilibrium and Socially Optimal Entry

***d* = 10; *r* = 0.5**



***d* = 10; *r* = 1**



The intuition for the first of these results is two-fold. First, the planner places positive value on the additional surplus α - 1/*n* that the brand-stretching entrant creates for every consumer that it serves whereas the incumbent firms see this additional surplus as a threat. Secondly, there is a subtle externality in that the additional surplus created by the brand-stretcher's entry increases with *n*. Implicitly, the more firms that go into creating the market in the first place, the more valuable the good ultimately is to consumers. On balance, these valuation gains outweigh the sunk cost losses. Hence, the welfare optimizing number of initial entrants exceeds that number generated by the market.

In light of the foregoing, it is easy to understand why increases in the versioning cost parameter r reduce the entry inefficiency. Entry is encouraged by higher versioning costs since this leads to less intensive price competition and insulates the initial entrants to at least some extent from competition with the brand-stretcher. Because entry is suboptimally low, increasing r moves the non-cooperative equilibrium closer to the social optimum.

5. Summary and Conclusions

The historic development of many markets can be described by the pattern of early and late entry in which there is first a period of market opening with many firms competing, followed by the late entry of a dominant firm and the simultaneous exit of many of the initial, founding firms. A recent and dramatic example of this pattern is the dot.com boom and bust. In the wake of the numerous failures of many small dot.coms, a number of commentators have been persuaded that the "shakeout" is largely a needed correction to irrationally optimistic expectations. That is, had these founding "click" firms realized that traditional "brick" stores might respond to the success of the digital marketplace by opening their own "click" operations, these small firms would never have entered the market in the first place.

In this paper, we have presented a model in which widespread entry and nearly as widespread exit in the wake of entry by a brand-advantaged firm from another market is rational. The analysis is set in the context of a circle model of a product-differentiated market as originally developed in Salop's seminal article. While each firm in this market has a base product, we capture the essential customization advantages of the Internet by permitting firms to version their products and to price discriminate.

We show that a large number of firms will enter the market early despite the fact that many of these firms will exit with the later, anticipated entry of a brand-stretching "brick" firm. The actual survival rate among the early entrants depends on various factors, including sunk entry costs, versioning costs and the comparative strength of the brand-stretcher's brand. In general the survival rate is low with somewhere between 25 and 50 percent of the original entrants surviving. In other words, the familiar dot.com market scenario can be claimed to be a rational one.

More formally, our analysis generates two results that are somewhat at odds with much of the literature. First, we find that, far from being excessive, the volume of initial entry may well be too low from a social welfare viewpoint. This is because each initial entrant ultimately increases the value that consumers attach to the product of the later entrant and this external benefit of initial entry is not considered. Second, we find that the final market concentration bears a much weaker relationship to the level of sunk entry costs than is traditionally thought. While the number of initial entrants declines as sunk cost rises just as Sutton (1991,1998) predicts, the relationship between sunk costs and final market structure is more complex. The number of surviving firms lies within the narrow range of two to five firms for an extremely wide range of sunk cost values. To put it another way, asymmetric oligopoly seems to be an almost inevitable outcome in these kinds of markets.

References

Becker, G. and Murphy, K. (1993). A Simple Theory of Advertising as a Good or Bad. ***Quarterly Journal of Economics*** 15: 498-517.

Brynjolfsson, E. and L. M. Hitt (2000). "Beyond Computation: Information Technology, Organizational Transformation and Business Performance". ***Journal of Economic Perspectives***, **14,** (Fall), 23 – 48.

Cabral, L. (2000). "Stretching Firm and Brand Reputation". ***Rand Journal of Economics,*** **31** (2000), 658-673.

Court, D. C., Leiter, M. G. and Loch, M. A. (1999). "Brand Leverage". ***The McKinsey Quarterly*** No. 2: 100-09.

Eaton, B.C. and N. Schmitt (1994). "Flexible Manufacturing and Market Structure." ***American Economic Review***, **84**, 875-888.

Frank, R. and P. J. Cook (1995). ***The Winner-Take-All Society***. New York: The Free Press.

Galambos, Louis (1994). "The Triumph of Oligopoly." T. Weiss and D. Shaefer, eds., ***American Economic Development in Historical Perspective,*** (Stanford: Stanford University Press).

Lederer, P.J. and A.P. Hurter, (1986). "Competition of Firms: Discriminatory Pricing and Location". ***Econometrica***, **64**, 623-640.

Litan, R. and A. Rivlin, (2001). ***Beyond the Dot.coms: The Economic Promise of the Internet***. Washington: Brookings Institute Press.

MacLeod, W.B., G. Norman and J.-F. Thisse (1988). "Price Discrimination and Equilibrium In Monopolistic Competition". ***International Journal of Industrial Organization,*** **6**, 429-446.

Mansfield, E. (1993). "The Diffusion of Flexible Manufacturing Techniques In Japan, Europe And The United States". ***Management Science***, **39**, 149-159.

Norman, G. and J.-F. Thisse (1999). "Technology Choice and Market Structure: Strategic Aspects of Flexible Manufacturing". ***Journal of Industrial Economics***, **37**, 345-372.

Pepall, L. and D. Richards (2001). "The Simple Economics of Brand-Stretching". ***Journal of Business***, (forthcoming).

Röller, L.-H. and M.H. Tombak (1990). "Strategic Choice of Flexible Manufacturing Technology and Welfare Implications". ***The Journal of Industrial Economics***, **37**, 417-431.

Röller, L.-H. and M.H. Tombak (1993). "Competition and Investment In Flexible Technologies". ***Management Science***, **39**, 107-114.

Shankar, V., A. Rangaswamy, and M. Pusateri (1990). "The Online Medium and Customer Price Sensitivity." Working Paper #45, E-Commerce Research Forum, MIT.

Smith, D. and Park, C. (1992). "The Effect of Brand Extensions on Market Share and Advertising Efficiency". ***Journal of Marketing Research,*** **29**: 296-313.

Varian, H. and C. Shapiro (1998). ***Information Rules: A Strategic Guide to the Network Economy***. Cambridge: Harvard Business School Press.

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