The Economics of the Long Tail

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Abstract

Anderson (2006) argues that e-commerce and other new technologies improve efficiency by encouraging the entry of new producers and innovations, creating a “long tail” of niche products while reducing the market share of previously popular products. We study the strategic interaction between hits and niches in their pricing, entry, and innovation decisions using a model of competition under product differentiation and generalized cost structure. In contrast to the popular view, we show that improvements in information and communication technology can lead to either the long tail effect or an opposite “superstar” effect (Rosen, 1981), depending on (a) how the structure (not simply the level) of producer costs changes, and (b) how disparate are consumer preferences. These two factors also determine whether there is excessive or insufficient product diversity. Post-entry product and technology innovation incentives may be inefficient in the long tail market structure because producers can soften price competition by engaging in excessive product differentiation and adopting technologies with high variable costs. These results have implications for various competition-related policies.

KEYWORDS: long tail, superstars, differentiation

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1 Introduction

The effects of the internet on price levels and dispersion in various industries have been explored extensively. Of equal interest, however, is the role of internet technology in changing the number and market shares of producers in these industries. An influential trade book by Anderson (2006) considers this question and contends that e-commerce is creating a “long tail” of entry by individually-minor (through collectively important) niche suppliers in many industries, while reducing the relative importance of mainstream products. He argues for important normative effects from this effect, both because it implies greater variety and satisfaction of niche preferences, and because it increases the likelihood that unknown, but talented individuals will enter markets where they can generate valuable innovations.

In this paper, we provide a simple unified theoretical framework to consider the effects of the internet on industrial structure, efficiency, and innovation incentives. Our baseline duopolistic model enables us to show how progress in information and communication technology may create long tails in some cases, and superstars in others, depending on how the structure (not simply the level) of producer costs changes with the introduction of the new technology, and how disparate are consumer preferences. In particular, we show that technological innovations that reduce fixed costs relative to variable costs encourage entry by marginal producers, and thus generate long tail effects in industries with horizontal differentiation. By contrast, technologies that reduce variable costs relative to fixed costs in relatively vertically-differentiated industries lead to strategic exclusion of marginal entrants, and thus, superstar effects. Intuitively, high variable costs serve as a mechanism to soften price competition and customer-stealing among competing suppliers, while high fixed costs reduce contestability by potential entrants. This implies that an improvement in technology that reduces total costs has ambiguous effects on producer profitability and entry depending on how the cost structure is changed.

Given this result, it is unsurprising that the internet and other new technologies appear to have had different effects in different industries. One of the contributions of our paper is that we believe it can consolidate some of these disparate results.

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1 See Ellison and Ellison (2005) for a review of the literature.
2 “Today, millions of ordinary people have the tools and the role models to become amateur producers. Some of them will also have talent and vision. Because the means of production have spread so widely and to so many people, the talented and visionary ones, even if they’re just a small fraction of the total, are becoming a force to be reckoned with” (Anderson 2006, p. 65).
For instance, Brynjolfsson et al. (2011) find that e-commerce had a long tail effect in women’s clothing, while Goldmanis et. al. (2010) claim a superstar effect from e-commerce in the airfare travel agency industry. Tastes in fashion tend to be idiosyncratic, and once a customer learns about a particular brand or designer, she may become a repeated customer in the next season. Therefore, marketing costs in this case may include an important fixed component, which e-commerce can plausibly reduce. Knowledge about air travel prices, however, has a very high depreciation rate because of frequent changes in prices and flight schedules. It is not difficult to see how online travel agencies may have substantially reduced the variable cost of acquiring airline ticket information.

Our model also provides a qualification of Rosen’s (1981) predictions regarding the effects of information and communication technology, which supplies the quote that headlines this paper. Radio, television, and recording media technology improvements over the first half of the 20th century emphasized relative declines in variable costs in comparison to fixed costs, for instance by lowering dramatically the per-unit variable cost of reaching additional consumers of performances, relative to pre-existing stage and auditorium technology. However, the fixed costs of performance did not decline much, and may even have increased, since studios and other broadcasting and recording equipment represent significant capital outlays. Whether the internet and other new technologies will have similar effects in the future as those Rosen considered in 1981 depend on how these technologies affect fixed and variable costs of production.

Section 2 exposits our duopoly model with endogenous entry and considers the effects of exogenous technological change in generating long tail and superstar effects. Although our framework is stylized in some ways, it highlights the key mechanisms that drive the changes described by Anderson (2006), and how these operate to a greater or lesser extent in various industries. Section 3 considers the efficiency of market equilibria relative to that which would be selected by a social planner, and Section 4 considers incentives of producers to innovate by reducing costs. In Section 5 we conclude by briefly outlining how our model could be used to shed light on key policy debates related to long tail effects, including the policies to promote cultural diversity in movie industry, and the internet’s effect on optimal ownership restrictions for television and radio stations.
2 A Duopoly Model of Differentiated Products with Fixed and Variable Costs of Production

According to Anderson (2006), the internet reduces the cost of reaching niche pockets of consumers, and thus, a long tail is created as product selection switches from a few “hit” products to a multitude of varied “niche” products. To capture this idea, we present a model, the formal structure of which is an adaptation of the duopoly model used in Davis, Murphy, and Topel (2004) (hereafter, “DMT”). This duopoly setting is simple, but it highlights the strategic interaction between incumbents and new entrants — in particular, their pricing, entry, and innovation decisions. We shall argue, however, that our key intuitions can be generalized to some standard oligopoly models with free entry, which suggests the robustness of our conclusions to these assumptions and the solution concept.

The major novelty in our model is to introduce a generalized cost structure in this framework, which highlights how a reduction in the costs of marketing niche products can have ambiguous effects on entry, pricing, and innovation decisions, and how declines in cost interact with product differentiation in consumer preferences, which we argue is crucial in understanding the nature and implications of the long tail.

Subsection 2.1 exposits notation and describes the equilibrium concept we employ. We present our main result in subsection 2.2, which also includes the robustness of our major findings in other theoretical frameworks.

2.1 Theoretical Framework and Equilibrium Concept

Consider a market with two single-product producers, each of whom sets a single price and maximizes profits. We will refer to them as the “hit” producer \( h \) and the “niche” producer \( n \), indicating their relative popularity in a market when both supply positive output, as discussed below.

The production technology is defined by fixed costs \( \theta_F F \), paid if a producer enters the market, and variable costs, \( \theta_V C(\cdot) \), where \( \theta_F \) and \( \theta_V \) are parameters which shift the cost structure. We also assume that \( C(\cdot) \) is increasing and convex, and thus, average variable cost, denoted \( \overline{C}(\cdot) \), is increasing. To focus on the effects of changes in the cost structure, we also assume for now that both producers have access to the same technology; however, our results are robust to this assumption, which will be relaxed in Section 4 when we study strategic technology innovation.

There are \( N \) consumers, of which \( N_f \) have “fringe” tastes, and \( N_p = N - N_f \) have “popular” tastes. Denote the relative number of fringe customers by \( \lambda = N_f/N_p \), which is assumed to be strictly less than one so that when there is a niche...
market it is meant to serve the minority of consumers with fringe tastes. Consumers have unit demand, so that each of them will purchase at most one unit of either the hit or the niche product. Let \( V_p \) and \( V_f \) be the valuations of the hit product by popular- and fringe-taste consumers, respectively. Similarly, denote consumers’ valuations of the niche product by \( W_p \) and \( W_f \).

To distinguish consumers, assume that popular-taste consumers value the hit product more highly than fringe consumers, i.e., \( V_p > V_f \). Thus, the majority of consumers (popular-taste) prefer the hit product. It is also natural to interpret these demand parameters in terms of the degree of product differentiation. An increase in \((V_p - W_p)\) or \((V_f - W_f)\) represents an increase in the hit’s vertical differentiation over the niche, as both consumer types increasingly prefer the hit product. Similarly, an increase in \((V_p - V_f)\) or \((W_f - W_p)\) represents an increase in horizontal differentiation between the two products, as the valuations consumer types place on the two products diverge. A necessary condition for the long tail equilibrium (defined below) is that \( V_p - W_p > V_f - W_f \), which we will assume for the rest of the analysis.

Denote the producers’ chosen prices by \( P_h \) and \( P_n \). The hit and the niche play a simultaneous price-setting game. After prices are selected, each consumer chooses to buy either the hit’s product or the niche’s (or neither). In the model, a supplier can choose not to enter the market by setting a sufficiently high price that neither consumer type chooses to buy its product. We will focus throughout on potential entry by the niche, while assuming the hit always enters.

When producers compete in price under this flexible demand specification and general cost structure, our model has no pure-strategy Nash equilibrium in general. This is a common difficulty in models of spatial price competition, and the two alternative approaches for dealing with the non-existence problem are (a) mixed-strategy equilibria, and (b) alternative solution concepts based on conjectural variation. In this paper, we adopt the second approach by borrowing a solution concept from DMT, “price-cut immune” (PCI) equilibrium, which assumes buyers always have the right to purchase at a previously announced price and hence producers are only ready to reduce their prices whenever undercutting and grabbing their rivals’ customers is profitable. This solution concept is also known as “undercut-proof equilibrium” in the industrial organization literature (Shy, 2001). Formally,

\[ N_i V_i \geq \theta_i F + \theta_i C(N_i) \quad \text{and} \quad N_i W_i \geq \theta_i F + \theta_i C(N_i) \]

for \( i = p, f \).

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3Participation by popular-taste consumers requires \( V_p \geq P_h \) or \( W_p \geq P_n \); similarly, fringe consumer participation requires \( V_f \geq P_h \) or \( W_f \geq P_n \). We will assume throughout that these constraints do not bind. We will also assume that each producer could feasibly sell to either consumer type and cover its costs: \( N_i V_i \geq \theta_i F + \theta_i C(N_i) \) and \( N_i W_i \geq \theta_i F + \theta_i C(N_i) \) for \( i = p, f \). These assumptions make the problem non-trivial.

4The set of primitives for which this is true is broad: see DMT for a fuller analysis of entry incentives for incumbent suppliers.

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**Definition 1 (Price-Cut Immune Prices).** A set of prices \( P_h^*, P_n^* \) is price-cut immune (PCI) if

\[
\Pi_h(P_h, P_n^*) \leq \Pi_h(P_h^*, P_n^*) \text{ for all } P_h < P_h^*
\]

and

\[
\Pi_n(P_h^*, P_n) \leq \Pi_n(P_h^*, P_n^*) \text{ for all } P_n < P_n^*,
\]

where \( \Pi_h \) and \( \Pi_n \) represent the hit and the niche’s profits, respectively.

In other words, a set of prices is price-cut immune when, given all competitors’ prices, no individual producer wishes to cut its own price (although it may, however, wish to raise its price).\(^5\) Define \( \Psi_i(P_{-i}) \) as the set of all price-cut immune prices for producer \( i = h, n \), given the price set by its competitor (“\(-i\)”). Then,

**Definition 2 (Price-Cut Immune Equilibrium).** A PCI equilibrium is defined as a set of prices \( P_h^*, P_n^* \) such that

\[
\Pi_h(P_h^*, P_n^*) = \max_{P_h \in \Psi_h(P_n^*)} \Pi_h(P_h, P_n^*)
\]

and

\[
\Pi_n(P_h^*, P_n^*) = \max_{P_n \in \Psi_n(P_h^*)} \Pi_n(P_h^*, P_n).
\]

One intuitive way of justifying this form of equilibrium is by assuming producers make binding price announcements (for example, through advertising), after which consumers perceive further price increases as “reneging on a deal,” although price reductions are, naturally, acceptable to consumers. When producers face difficulty raising prices above previously announced levels, PCI equilibrium is a natural solution concept and forms an extension to ordinary Bertrand competition.\(^6\)

### 2.2 The Rise and Fall of Superstars

For the purpose of this section, we assume that new technology is adopted exogenously; we relax this assumption by explicitly studying producers’ incentives to innovate in Section 4. The main theoretical result of our paper is as follows.

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\(^5\)If no producer wished to either cut or raise its price, these prices would correspond to the traditional Nash-Bertrand outcome.

\(^6\)Alternatively, Morgan and Shy (2000) argue that in an undercut-proof equilibrium environment, firms assume that rival firms are more sophisticated in that they are ready to reduce their prices whenever undercutting and grabbing their rivals’ customers is profitable.
Proposition 1 (Determinants of Superstar and Long Tail Effects). Technological improvements that reduce variable costs relative to fixed costs support superstar effects, while those that reduce fixed costs relative to variable costs support long tail effects. Moreover, for any given technological improvement, the tendency to shift from a superstar equilibrium towards a long tail equilibrium is greater when (a) the product is relatively horizontally differentiated, (b) the product is relatively vertically undifferentiated, (c) the size of the niche market is not too small, and (d) the initial fixed costs are relatively large and the initial degree of diseconomies in production is relatively small.

The remainder of this section sketches the proof of Proposition 1, with some of the technical details left to the appendix.

Consider first an equilibrium in which both the hit and the niche products are produced and sold in the market — what we will refer to as a “long tail” equilibrium. More specifically, we will focus on a sorting equilibrium in which popular-taste consumers purchase the hit product and fringe-taste consumers purchase the niche product.7

Lemma 1 (Comparative Statics in a Long Tail Equilibrium). In a long tail equilibrium, (a) a decrease in variable costs, \( \theta_V \), leads to lower prices and profits of both producers. (b) A decrease in fixed costs, \( \theta_F \), has no effect on prices, but increases both producers’ profits. Furthermore, (c) an increase in horizontal differentiation between the two products raises the prices and profits of both producers.

The fact that profits are lower when variable costs decrease follows from the convexity of the cost function. As variable costs fall, it becomes less costly for each supplier to expand output to the other supplier’s customers, making price competition more rigorous.

To prove Lemma 1, we first note that an equilibrium of this sort requires that popular-taste consumers prefer the hit product (i.e. \( V_p - P_h \geq W_p - P_n \)) and fringe-taste consumers prefer the niche product (i.e. \( W_f - P_n \geq V_f - P_h \)). Rearranging, these conditions can be written as:

\[
P_h \leq P_n + (V_p - W_p).
\]

and

\[
P_h \geq P_n + (V_f - W_f).
\]

7It is also possible under some parameterizations for the hit supplier to sell to fringe-taste consumers only and the niche supplier to sell to popular-taste consumers only (see DMT), but we ignore this possibility for simplicity here.
Also, in equilibrium, the hit must receive higher profits selling to popular-taste consumers exclusively, compared with cutting its price to $P_n + (V_f - W_f)$ in order to attract the fringe-taste consumers as well. This implies $P_h N_p - C(N_p) - \theta F \geq [P_n + (V_f - W_f)]N - \theta V C(N) - \theta F$, which can be rearranged as

$$P_h \geq \frac{1}{N_p} \{[P_n + (V_f - W_f)]N - \theta V [C(N) - C(N_p)]\}.$$  

(3)

Similarly, the niche producer prefers selling only to fringe consumers:

$$P_h \leq (W_p - V_p) + \frac{1}{N} \{[P_n N_f + \theta V [C(N) - C(N_f)]]\}.$$  

(4)

Note that since $V_p - W_p > V_f - W_f$, equations (1) and (2) cannot simultaneously bind. Moreover, any pair of prices satisfying equations (3) and (4) is price-cut immune because neither supplier wishes to cut its price to attract additional customers, given the other’s price. Indeed, (3) and (4) form a system of two equations that imply prices in a long tail equilibrium given by:

$$P^L_h = \frac{1 + \lambda}{1 + \lambda + \lambda^2} \{(1 + \lambda)(V_p - W_p) - \lambda(V_f - W_f) + \theta V [(1 + 2\lambda)C(N) - \frac{\lambda}{1 + \lambda} C(N_p) - \lambda C(N_f)]\}$$

and

$$P^L_n = \frac{1 + \lambda}{1 + \lambda + \lambda^2} \{(V_p - W_p) - (1 + \lambda)(V_f - W_f) + \theta V [(2 + \lambda)C(N) - C(N_p) - \lambda C(N_f)]\}.$$  

Lemma 1 follows from these two expressions.

Now consider an equilibrium in which the hit producer sells to all consumers and the niche producer does not enter — what we will refer to as a “superstar”

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8Note that when equations (3) and (4) bind, equations (1) and (2) automatically hold when

$$\frac{\lambda^2}{1+\lambda}(V_f - W_f) - \lambda(V_p - W_p) - \theta V \left[\tilde{C}(N) - \frac{\lambda}{1+\lambda} \tilde{C}(N_f)\right] - \theta V \left[\tilde{C}(N) - \frac{\lambda}{1+\lambda} \tilde{C}(N_p)\right] \leq \frac{\lambda^2}{1+\lambda}(V_p - W_p) - (V_f - W_f).$$

Note that the term on the far left is decreasing, and the term on the far right is increasing, in the degree of horizontal differentiation. For simplicity, we will maintain this assumption throughout the rest of the paper. Very little depends upon this assumption, and a generalized analysis of cases in which this expression does not hold is available upon request from the authors.
equilibrium.  

Lemma 2 (Comparative Statics in a Superstar Equilibrium). In a superstar equilibrium, (a) a decrease in variable costs, $\theta V$, lowers the hit’s price but raises its profits. (b) A decrease in fixed costs lowers the hit’s price and profits. Furthermore, (c) an increase in the hit’s vertical differentiation over the niche raises its price and profit.

The surprising result that the hit’s profit rises in fixed costs follows from the fact that higher fixed costs reduce the niche’s entry threat (see, similarly, Baumol, et al., 1982).

To prove Lemma 2, note that in order for the hit to exclude the niche from entering the market, it must set $P_h$ such that the niche producer cannot profitably sell to either type of consumer alone, nor to both. In order to sell to fringe-taste consumers, equation (2) implies that $P_h$ must be no higher than $P_h - (V_f - W_f)$, in which case the niche producer would make profit no greater than $[P_h - (V_f - W_f)]N_f - \theta V C(N_f) - \theta F F$. Thus, in a superstar equilibrium, this expression must be non-positive, i.e., the hit producer must set its price such that

$$P_h \leq (V_f - W_f) + \theta V C(N_f) + \frac{1 + \lambda \theta F F}{N}.$$  

Similarly, to prevent the niche producer from profitably selling to popular-taste consumers (and hence fringe-taste consumers as well), the hit product cannot be sold at a price higher than

$$P_h \leq (V_p - W_p) + \theta V C(N) + \frac{\theta F F}{N}.$$  

If a superstar equilibrium exists, then the equilibrium price for the hit, $P_h^S$, is the minimum of the above two values.  

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9It is also possible for the niche producer to monopolize the market, and one could more generally endogenize the identity of the producer who becomes the superstar. Given our assumptions on the demand structure, however, it will always be the hit producer who monopolizes the market in any superstar equilibrium.

10Thus, the niche’s “price” in a superstar equilibrium is $P_h^S - (V_f - W_f) = \theta V C(N_f) + \frac{1 + \lambda \theta F F}{N}$, although at this price the niche does not sell to any customers (recall our definition of entry involved setting a price such that some customers buy the product). It can be checked that these prices do indeed form a PCI equilibrium: since the hit monopolizes the market at price $P_h^S$, it has no incentive to lower prices below this level, and cannot increase profits while maintaining its superstar status above this price. Similarly, by construction, the niche would receive non-positive profits by lowering its price to attract either group of customers, so its maximum profit level is zero, which it attains in the equilibrium.
In the appendix, we provide formal proofs that, for any given technology \((\theta_V, \theta_F)\), either a long tail or a superstar equilibrium exists (but not both) and that the comparative statics implied by Proposition 1 holds. Here we assume existence and uniqueness and provide intuition for the proposition.

The distinction between a long tail and a superstar equilibrium is the entry of the niche seller. An intuitive (and correct) condition for the niche’s entry is that its profitability in a long tail equilibrium is positive:

\[
\Pi_n^L \geq 0.
\]

Given the expression for \(P_n^L\) derived above, the niche’s zero iso-profit line, \(\Pi_n^L = 0\), can be written as

\[
\theta_V = m_n \theta_F + b_n,
\]
where \(m_n = \frac{(1+\lambda+\lambda^2)F}{\lambda(2+\lambda)C(N) - C(N_F) - (1+\lambda)C(N_p)}\) and \(b_n = \frac{(1+\lambda)(V_f-W_f)-(V_p-W_p)}{(2+\lambda)C(N) - C(N_F) - (1+\lambda)C(N_p)}\).

Lemma 1 implies that \(m_n\) is positive because \(\Pi_n^L\) is increasing in \(\theta_V\) and decreasing in \(\theta_F\).

Figure 1 plots this zero iso-profit curve for the niche in \(\theta_V\)-\(\theta_F\) space. Consider an industry currently operating under technology defining the variable and fixed cost structure associated with point \(a\) in Figure 1. This lies above the zero-profit line, so the industry would initially be in a long tail equilibrium.

Now consider a change in technology that lowers total costs, but reduces variable costs relative to fixed costs, moving the cost structure from point \(a\) to point \(b\).
Under the new technology, the niche producer can no longer make profit in any long tail equilibrium; thus, the industry evolves to a superstar equilibrium. Now suppose that total costs further decline through technological innovation to point $c$. In this case, fixed costs have fallen relative to variable costs, and the industry moves back to a long tail equilibrium.

Such dynamics can operate repeatedly as technology progresses, so that the industry moves back and forth between long tail and superstar effects, even as total costs are declining throughout. What is relevant for the market structure is how each new technological innovation changes the mixture of variable and fixed costs. Generally speaking, the niche producer’s profit can switch from negative to positive when technological improvement reduces fixed costs relative to variable costs, and can switch from positive to negative when technological improvement reduces variable costs relative to fixed costs.\(^1\)

Lemma 1 also shows that horizontal differentiation increases the niche’s profit in a long tail equilibrium. Therefore, an industry with more horizontal differentiation will have a lower zero-profit line, and hence a long tail equilibrium is more likely to prevail.

The model we have used to derive our central findings is admittedly very simple, with only two competitors and two consumer types, and it employs a relatively non-standard solution concept. These features have allowed us to isolate the impacts of changes in the cost structure on the entry or exit of niche producers when both vertical and horizontal differentiation are important, and will allow a clearer focus on the efficiency and endogenous technology innovation questions we address later. However, one may be concerned that these aspects of the model make our findings ungeneralizable. To address this concern, consider the first part of Proposition 1, which states that relative declines in fixed costs lead to entry while relative declines in variable costs lead to exclusion. First, it is straightforward to see how changes in the cost structure similarly are associated with entry or exit in a homogeneous-good, free-entry Cournot model.\(^2\) Therefore, our result is likely

\(^1\)Throughout this discussion, we have considered uniform changes in variable costs. It is straightforward to generalize the analysis to allow for non-uniform changes. More generally, we can parametrize the variable cost function at different output level by $\theta_1C(N), \theta_2C(N_p), \text{and } \theta_3C(N_f)$. Then, the niche’s long tail profit is $\Pi^L_n = \left(\lambda(V_p - W_p) - (1+\lambda)(V_f - W_f) + (2+\lambda)\theta_1C(N) - \theta_2C(N_p) - (1+\lambda)\theta_3C(N_f)\right)N - \theta_pF$. Technological progress can reduce $\theta_1, \theta_2, \text{and } \theta_3$ differently. When the decline in $\theta_1$ is small relative to the decrease in $\theta_2, \theta_3, \text{and } \theta_p, \Pi^L_n$ is likely to increase Therefore, a small (large) reduction in $\theta_1$ relative to $\theta_2, \theta_3 \text{and } \theta_p$, and hence an increase (decrease) in cost elasticity of output, tends to generate a long tail (superstar) effect.

\(^2\)For simplicity, assume linear demand (i.e., $P = a - Q$) and quadratic variable costs (i.e., $C(Q_i) = \theta_F + \theta_VQ_i^2$). When the number of producers is fixed at $n$, Cournot competition on
to hold even when consumers have elastic demands, because the key variable is the relative importance of fixed versus variable costs rather than the level of total cost. As an alternative to Cournot, consider the effect of changes in fixed search costs in a hedonic competitive framework (Rosen, 1981). In the hedonic model, goods are vertically differentiated, and the price of quality for a good with quality \( z \) can be written as \( \frac{p(z)}{s} + s \), where \( p(z) \) is the market price of the good and \( s \) is a fixed cost which does not depend on \( z \). Because consumers substitute imperfectly between quality and quantity, a decline in \( s \) in this model leads to a flatter distribution of sales across producers of different qualities — essentially, a “long tail” effect.\(^{13}\)

### 3 Market Efficiency Implications

As in other models of entry under strategic competition, the number of firms in equilibrium may be inefficient (Mankiw and Whinston, 1986). Our model supplies conditions under which long tail is socially excessive or insufficient with differentiated products.

**Proposition 2 (Inefficient Product Diversity and Post-Entry Excessive Product Differentiation).** (a) When fixed and variable costs are high, the superstar effect tends to lead to insufficient entry of the niche product. (b) When fixed and variable costs are low, the long tail effect tends to lead to excessive entry of the niche product. (c) In a long tail equilibrium (though not in a superstar equilibrium), both the hit and niche producers engage in excessive product differentiation; therefore, relative declines in fixed costs can lead to excessive product differentiation.

To analyze market efficiency in our model, note that the social surplus, defined as the difference between consumer value and firm costs, in a superstar equilibrium is

\[
S_h^S = \frac{1}{1 + \lambda} V_p N + \frac{\lambda}{1 + \lambda} V_f N \theta_h C(N) N - \theta_f F.
\]

quantities implies a unique Nash equilibrium in which each producer sets \( Q_i = \frac{a}{1 + n + \theta_V} \). Under free entry, the number of producers is determined by the zero profit condition. It is then straightforward to show that \( n = \frac{-4\theta_f - 4\theta_V \theta_p + 2a \sqrt{(4\theta_f + 2\theta_V \theta_p)}}{4\theta_f} \), which is decreasing in the fixed cost \( \theta_f \), but increasing in the variable costs \( \theta_V \) provided the demand is sufficiently high (in particular, \( a^2 > 8\theta_f (2 + \theta_V) \)). In other words, a reduction in fixed costs induces entry and hence reduces market concentration, whereas a reduction in variable costs discourages entry, leading to higher market concentration.

\(^{13}\)Empirically, Crain and Tollison (2002) find evidence for this theory. They show that artist concentration in the music industry is positively correlated with earnings (and hence value of time).
In a long tail equilibrium, social surplus is

\[ S^L = \frac{1}{1+\lambda} V_p N + \frac{\lambda}{1+\lambda} W_f N - \theta_V \left[ \frac{1}{1+\lambda} \bar{C}(N_p) + \frac{\lambda}{1+\lambda} \bar{C}(N_f) \right] N - 2\theta_F F. \]

Setting \( S^S_h = S^L \), we can then define an iso-efficient line in \( \theta_V - \theta_F \) space — that is, a set of technologies for which a social planner would be indifferent to entry by the marginal supplier:

\[ \theta_V = m^* \theta_F + b^*, \]

where \( m^* = \frac{F}{[\bar{C}(N)-\frac{1}{1+\lambda} \bar{C}(N_p)-\frac{\lambda}{1+\lambda} \bar{C}(N_f)]N} \) and \( b^* = \frac{\lambda(V_f-W_f)}{(1+\lambda)[\bar{C}(N)-\frac{1}{1+\lambda} \bar{C}(N_p)-\frac{\lambda}{1+\lambda} \bar{C}(N_f)]}. \)

For technologies \( (\theta_F, \theta_V) \) above this iso-efficient line, a social planner would prefer entry — that is, a long tail equilibrium. For technologies below the line, the social planner would prefer a superstar equilibrium.

Figure 2 plots the iso-efficient line against the niche’s zero iso-profit line in a long tail equilibrium. When \( \lambda \) is small, the niche’s zero-profit line is steeper than the iso-efficient line, and cuts it from below, as in the Figure.

Since the size of the customer pool is fixed at \( N \), the niche enters by “stealing” business from the hit. Entry duplicates fixed costs, and this business-stealing effect is not internalized. For some technologies, then, this leads to conditions of exces-
sive entry, just as in Mankiw and Whinston (1986). However, note from Figure 2 that this inefficiency is only evident when variable and fixed costs are relatively low. When variable costs are high, the profitability of lowering prices to exclude entrants is low, and so price competition between the firms is weakened. In this case, the “business-stealing” externality is dominated by the inability of the entrant to fully internalize the consumer surplus niche customers receive from entry as profit, in the sense of Spence (1976).

In other words, with high variable costs and low fixed costs, product entry leads to substantial cost savings, and some of these are passed along to consumers instead of being realized as niche profit. On the other hand, when both fixed and variable costs are high, the hit finds it profitable to exclude the niche by pricing aggressively even when the outcome is socially inefficient. Therefore, as in other models of differentiated products under imperfect competition, it is generally possible to have both excessive and insufficient product entry. Our model provides a simple cost structure-based framework for distinguishing when each is likely to occur.

Finally, our model also generalizes DMT’s result that post-entry product design incentives in a long tail equilibrium are inefficient. So far, we have assumed consumer valuations of the products to be exogenous; however, producers also have some ability to vary the characteristics of their products in order to appeal to particular groups of consumers. In particular, there are strong incentives to engage in socially-excessive product differentiation in a long tail equilibrium since \( \frac{d\Pi_h}{dV_p} > \frac{dS_L}{dV_p} \) and \( \frac{d\Pi_n}{dW_f} > \frac{dS_L}{dW_f} \), while \( \frac{d\Pi_h}{dV_f} < \frac{dS_L}{dV_f} \) and \( \frac{d\Pi_n}{dW_p} < \frac{dS_L}{dW_p} \). However, there are no distortions to efficient product design in a superstar equilibrium. We consider the incentives to reduce costs in the next section.

4 Endogenous Technological Innovation and Efficiency

Because it has been alleged that long tail effects foster innovation, and also because key public policy questions associated with the long tail emphasize incentives to innovate, we now consider explicitly the returns to cost-reducing technological change in long tail and superstar equilibria. To study each producer’s technology innovation incentives within each equilibrium type, consider the general case in which the hit and niche produce using different technologies, \((\theta_V^h C_h(\cdot), \theta_V^h F_h)\) and \((\theta_V^n C_n(\cdot), \theta_V^n F_n)\). We show in the appendix the following:

\[ \text{Similarly, note that the size of the gap between the iso-efficient and zero-profit lines is increasing in the degree of horizontal differentiation, and so the likelihood of inefficient entry is higher the greater is the diversity in tastes between popular and fringe consumers. In the limit, the firms do not compete on price at all, and so the traditional problem of insufficient product entry by monopolists arises.} \]
Proposition 3 (Strategic Technology Innovation). In a long tail equilibrium, producers face inefficiently low incentives to reduce variable costs, while incentives to reduce both variable and fixed costs are socially efficient in a superstar equilibrium.

Proposition 3 shows that, contrary to some contentions, industries characterized by long tail effects do not necessarily generate higher levels of innovation. Once again, the intuition is that, even when producers are using different technologies, a decline in variable costs will intensify price competition and hence reduce profits in a long tail equilibrium.

Of course, it may be the case that innovation itself is what creates long tail effects. As suggested by Proposition 1, a niche producer in a superstar equilibrium may be able to move the industry into a long tail equilibrium if it is able to innovate a technology with a sufficiently low fixed cost and sufficiently high variable cost. To see why, note that in a superstar equilibrium, $\Pi_n^S = 0$. Therefore, the niche will innovate to create a long tail equilibrium if $\Pi_n^L$ under the new technology is positive and greater than the cost of innovation. Because, as we show in the Appendix, $\Pi_n^L$ is decreasing in its own fixed costs, $\theta_n^m$, and increasing in its own variable costs, $\theta_n^v$, the niche producer may be able to strategically innovate a low fixed cost/high variable cost technology and profitably push the industry into a long tail equilibrium. This may be why “long tail” industries are often associated with innovation.

However, note that a hit producer in a long tail equilibrium also faces incentives to innovate high fixed cost/low variable cost technologies in order to move the industry into a superstar equilibrium. Indeed, the hit producer may be willing to incur a substantial increase in fixed costs if it allows a sufficiently large decline in variable costs in order to exclude the niche. In general, therefore, it is not clearly the case that long tail industries will always be more innovative than superstar industries.

Note also that this discussion illustrates the robustness of Proposition 1 to endogenous and strategic technological innovation. As we have shown, industries in which firms innovate low variable/high fixed cost technologies tend to move toward superstar effects, while those where firms innovate low fixed cost/high variable cost technologies tend to move toward long tails effects.

5 Policy Applications and Conclusion

In this section, we conclude with a brief outline of policy questions to which the results above may apply, realizing that a full analysis of these issues would require substantially more detailed analyses than we provide here.

As shown in Section 3, whether there is insufficient, optimal, or excessive entry in an industry depends on the cost structure faced by firms in the industry, as well
as on consumer preferences. To illustrate the complications this raises, consider the case of movie industry, in which some have argued that policies to promote cultural diversity in film have become unnecessary in the digital age because of the long tail effect. Whether this is so, however, depends on how digital technologies have affected the fixed and variable costs of filmmaking and film distribution. We suspect that these technologies have largely acted to reduce the fixed costs of producing a film, although one could argue that variable costs of distribution may have fallen as well, in which case, new technology may in fact have heightened the need for policies to promote cultural diversity. Even if, in fact, fixed costs have fallen and product variety increased, the long tail effect also raises the possibility of excess entry in certain cases, and excessive product differentiation may raise concerns about social fragmentation and polarization between majority and minority groups.

As another illustration of related policy issues, consider the restrictions on ownership consolidation of television and radio stations and newspapers, such as that promoted in the U.S. by the Federal Communications Commission, intended to increase variety in the number of media products. The rise of the internet as an alternative source of media variety has often been cited as a rationale for loosening such regulations to allow more consolidation. However, our model shows that this conclusion depends on how the rise of the internet has changed the fixed and variable costs of publishing unique local content. Self publishing may reduce the variable costs of reaching additional customers through low-cost electronic delivery; alternatively, it may also reduce the fixed costs of establishing a media outlet through self-publishing technology which does not require a broadcast license or newspaper equipment. As shown in Figure 2, depending on the initial level of fixed and variable costs, new technology may either lead to excessive entry, in which case consolidation raises efficiency, or it may lead to insufficient entry, in which case the adoption of the internet could even provide a rationale for stricter prohibitions against consolidation.

We provide these two examples only as illustrations; more generally, we believe our results could be applicable to a wide range of policy issues related to long tail issues, such as questions regarding whether new technologies increase social fragmentation or generate excessive choices for consumers. One result from our model that we believe applies to all such policy questions is that the ability of policy to improve market efficiency is limited by the knowledge that policymakers hold regarding the cost structure and other parameters of the affected industries. Given the substantial ambiguities and political considerations that are inherent in even relatively simple regulations, our results provide further reason for humility on the part of policy authorities regarding their ability to consistently improve market efficiency.
Appendix

Proof of Proposition 1 (Existence and Uniqueness of Equilibrium):

Suppose that the niche producer chooses a price of $P^L_n$, as defined by the long tail equilibrium. If the hit producer then chooses the long tail equilibrium price $P^L_h$, equation (3) (which binds in a long tail equilibrium) implies that its profit would be

$$\Pi^L_h = [P^L_n + (V_f - W_f) - \theta V \bar{C}(N)]N - \theta F F.$$

Alternatively, the hit producer could choose a price just low enough to exclude the niche producer and move into a superstar equilibrium, receiving profit

$$\Pi^S_h = [P^S_h - \theta V \bar{C}(N)]N - \theta F F$$

$$\leq [(V_f - W_f) + \theta V \bar{C}(N_f) + \frac{1 + \lambda \theta F F}{N} - \theta V \bar{C}(N)]N - \theta F F$$

$$= [(V_f - W_f) + \theta V \bar{C}(N_f) - \theta V \bar{C}(N)]N + \frac{\theta F F}{\lambda}.$$

Comparing these two expressions, it is straightforward to show that a necessary and sufficient condition for the hit to have higher profit under the long tail price response than the superstar price response is actually $\Pi^L_n \geq 0$.

Proof of Proposition 3:

Equations (3) and (4), which define prices in a long tail equilibrium now become

$$P_h N_p - \theta V h C_h(N_p) \geq [P_n + (V_f - W_f)]N - \theta V h C_h(N)$$

and

$$P_n N_f - \theta V n C_n(N_f) \geq [P_h - (V_p - W_p)]N - \theta V n C_n(N).$$

As before, this system can be solved to identify long tail prices, which in turn specify the profits for the hit and niche in a long tail equilibrium:

$$\Pi^L_h = \frac{1}{1 + \lambda + \lambda^2}[(1 + \lambda)(V_p - W_p) - \lambda(V_f - W_f)]N$$

$$+ \frac{\theta V h}{1 + \lambda + \lambda^2}[\lambda \bar{C}_h(N) - (1 + \lambda)\bar{C}_h(N_p)]N$$

$$+ \frac{\theta V n}{1 + \lambda + \lambda^2}[(1 + \lambda)\bar{C}_n(N) - \lambda \bar{C}_n(N_f)]N - \theta F F.$$
and

\[ \Pi^L_n = \frac{\lambda}{1 + \lambda + \lambda^2} [(V_p - W_p) - (1 + \lambda)(V_f - W_f)]N + \frac{\lambda \theta^h_V}{1 + \lambda + \lambda^2} [(1 + \lambda)\bar{C}_h(N) - \bar{C}_h(N_p)]N + \frac{\lambda \theta^n_V}{1 + \lambda + \lambda^2} [\bar{C}_n(N) - (1 + \lambda)\bar{C}_n(N_f)]N - \theta^h_F F_n. \]

We can use these expressions, along with expressions for social surplus analogous to those in Section 3, to show that suppliers do not always design the most efficient technology. To see this note that the marginal benefits to reducing variable costs for each producer are, respectively,

\[ \frac{\partial \Pi^L_n}{\partial (-\theta^h_V)} = -\frac{[\lambda \bar{C}_h(N) - (1 + \lambda)\bar{C}_h(N_p)]N}{1 + \lambda + \lambda^2} \]

and

\[ \frac{\partial \Pi^L_n}{\partial (-\theta^n_V)} = -\frac{[\lambda \bar{C}_n(N) - (1 + \lambda)\bar{C}_n(N_f)]N}{1 + \lambda + \lambda^2} \]

On the other hand, social surplus in a long tail equilibrium is:

\[ S^L = \frac{1}{1 + \lambda} V_p N + \frac{\lambda}{1 + \lambda} W_f N - \frac{\theta^h_V}{1 + \lambda} \bar{C}_h(N_p) N - \frac{\lambda \theta^n_V}{1 + \lambda} \bar{C}_n(N_f) N - \theta^h_F F_h - \theta^n_F F_n, \]

and hence the marginal social benefits to reducing variable costs for each producer are, respectively,

\[ \frac{\partial S^L}{\partial (-\theta^h_V)} = \frac{\bar{C}_h(N_p) N}{1 + \lambda + \lambda^2} > 0 \]

and

\[ \frac{\partial S^L}{\partial (-\theta^n_V)} = \frac{\lambda \bar{C}_n(N_f) N}{1 + \lambda + \lambda^2} > 0 \]

The above inequalities show that producers in a long tail equilibrium may face suboptimal post-entry incentives to innovate variable cost-reducing technologies. Therefore, contrary to Anderson’s (2006) contention, the long tail economy is not necessary always pro-innovation. Suppliers’ incentives to reduce fixed costs are however, efficient, because

\[ \frac{\partial S^L}{\partial (-\theta^h_V)} = F_i = \frac{\partial S^L}{\partial (-\theta^n_V)}, \text{ for } i = h, n. \]

By contrast, in a superstar equilibrium, the hit’s profit is

\[ \Pi^S_{h} = \begin{cases} 
(V_f - W_f)N - [\theta^h_V \bar{C}_h(N) - \theta^n_V \bar{C}_n(N_f)]N & \text{if } V_f - W_f + \frac{\theta^h_F F_n}{\lambda N} < V_p - W_p + \theta^n_F [\bar{C}_n(N) - \bar{C}_n(N_f)] \\
\frac{1 + \lambda^2}{\lambda} \theta^h_F F_n - \theta^h_F F_h \end{cases} \]

Therefore,

\[ \frac{\partial \Pi^S_{h}}{\partial (-\theta^h_V)} = \frac{\bar{C}_h(N) N}{1 + \lambda} \] and \[ \frac{\partial \Pi^S_{h}}{\partial (-\theta^h_V)} = F_h = \frac{\partial S^S_{h}}{\partial (-\theta^h_V)}, \text{ where } S^S_h = \frac{1}{1 + \lambda} V_p N + \frac{\lambda}{1 + \lambda} V_f N - \theta^h_V \bar{C}_h(N) N - \theta^n_F F_h \text{ is the social surplus in a superstar equilibrium.} \]
equilibrium. Cost-saving technology innovation incentives are therefore efficient in a superstar equilibrium.

References


Morgan, Peter B., and Oz Shy, ”Undercut-Proof Equilibria.” Manuscript, University of Haifa, 2000.


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