Entry and Welfare in Search Markets

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Introduction

- Extensive economic literature on markets with consumer search. (e.g., Stigler, 1961; Stahl, 1989; Wolinsky, 1986).
- Virtually all these studies take the number of sellers in the market as exogenously given.
- New technologies and new market institutions such as the Internet can substantially reduce entry costs and increase the number of sellers.
- This paper: how does entry affect the performance of search markets?

Introduction

- There are also extensive studies on the effects of entry.
- What makes entry in search markets potentially different?
- Consumers need to incur search costs to find out whether a seller's product matches their needs, the value of the product, and/or its price.
- More active sellers will increase the options available to a consumer.
- But they can also reduce search efficiency if the marginal entrant lowers the expected product quality in the market.
- Entry can thus affect price and welfare by affecting both the scope and efficiency of consumer search.

Introduction

Main Findings:

- When sellers are vertically (and horizontally) differentiated ex ante, consumer welfare is an inverted-U function of the expected number of entrants, or equivalently, of entry cost.
  - In the existing literature, entry generally *increases* consumer welfare, with ambiguous effects on total welfare (consumer gain vs. business stealing)
- When a consumer's matched sellers are also horizontally differentiated ex post, market price is *lower* when the expected quality of sellers is *higher*.
  - Usual intuition suggests that price is *higher* with higher product quality.

The Model

- Unit mass of consumers, each demanding one unit of a product.
- n potential entrants can choose to become active sellers, and the entry cost for each seller is $c > 0$. No production cost.
- With probability β_i, potential entrant i's product matches a consumer's need. β_i follows distribution function G.
- A consumer derives utility u from a matched product. u is an independent draw from distribution F. Zero utility if no match.
  - following several recent papers on consumer search (e.g., Athey and Ellison, 2011; Chen and He, 2011; Eliaz and Spiegler, 2011).
  - one interpretation: sellers may carry multiple brands, and a seller that offers more brands will have a higher β_i.
- Firms differ both vertically and horizontally. Higher β_i means higher quality.
  - if all β_i were ex ante identical, only horizontal differentiation.

The Model

Timing of the model:

- First, β_i of each potential entrant i is realized and is known privately by i.
- Second, each potential entrant decides whether to enter the market, based on her β_i. Entry decisions are made simultaneously.
- Third, the market structure is determined, with $k \geq 0$ (active) sellers. Focus on situations where $k \geq 1$.
- Fourth, (active) sellers simultaneously and independently set prices.
- Fifth, each consumer can choose sequential search to discover whether any particular seller offers a matched product, her u, and the seller's price.
- Each search costs s. At least one search is needed for purchase.

The Model

- Assume that G and F satisfy the monotonic hazard-rate condition:

$$\frac{d\left(\frac{g(\beta)}{1-G(\beta)}\right)}{d\beta} \geq 0; \qquad \frac{d\left(\frac{f(u)}{1-F(u)}\right)}{du} \geq 0. \tag{1}$$

- Let

$$p^o = \arg \max_p \{p\left[1-F\left(p\right)\right]\}; \quad \pi^o = p^o\left[1-F\left(p^o\right)\right]. \tag{2}$$

- We consider symmetric perfect Bayesian equilibrium of this game.
- For a given entry cost c, there will be a unique threshold match probability t, such that i will enter iff her $\beta_i \geq t$.
- We then consider the effects of changes in t, as well as the underlying exogenous parameters, c and n.

Market Equilibrium

- Given t, the expected match probability (quality) of an active seller is

$$\gamma \equiv \gamma(t) = \frac{\int_t^1 xg(x)\,dx}{1 - G(t)}, \tag{3}$$

where $\gamma > t$ for all $t \in [0,1)$ since $\int_t^1 xg(x)\,dx > t[1 - G(t)]$.

- From standard argument, equilibrium price will be p^o, independent of the number of the sellers, k, and consumers will search if

$$\gamma \int_{p^o}^1 (u - p^o) f(u)\,du - s \geq 0. \tag{4}$$

- Assume s is small enough to ensure a search equilibrium.

Market Equilibrium

- In equilibrium, seller $i's$ expected profit is

$$\pi_k(\beta_i) = \beta_i p^o \left[1 - F(p^o)\right] \phi_k, \tag{5}$$

where

$$\phi_k = \frac{1 - (1-\gamma)^k}{k\gamma}$$

is the number of consumers who come to seller i for the first time (after sampling $j \in \{0, 1, ..., k-1\}$ other sellers).

- A seller's expected profit is increasing in β_i. Thus, given c, only sellers with $\beta_i \geq t$ will become active.

Market Equilibrium

- To determine t, we consider the decision of seller i with β_i. The post-entry expected profit for seller i is

$$E\left(\pi|\beta_i\right) = \sum_{k=1}^{n} \delta_k\left(t\right) \pi_k\left(\beta_i\right),$$

where

$$\delta_k\left(t\right) = \binom{n-1}{k-1} \left[1 - G\left(t\right)\right]^{k-1} G\left(t\right)^{n-k} \tag{6}$$

is the probability that $k-1$ other sellers are active.

- $\pi_k\left(\beta_i\right)$ is the expected profit for seller i if she chooses entry simultaneously as $k-1$ other sellers do.

- An increase in the marginal entrant's quality (t) will raise the average quality of all entrants (γ), but the increase in t exceeds that in γ.

Market Equilibrium

- The expected profit for the marginal entrant is higher if it has a higher match probability. Therefore, $E(\pi|t)$ is increasing in t.
- For $c \in (0, \pi^o)$, there exists a threshold $t \equiv t(c) \in [0, 1)$ that satisfies

$$E(\pi|t(c)) = c. \tag{7}$$

$t(c)$ increases in c, with $t(0) = 0$ and $t(\pi^o) = 1$.

Proposition

For any given $c \in (0, \pi^o)$, there exists a unique symmetric equilibrium where: (i) potential seller i will enter the market if and only if $\beta_i \geq t(c)$, where $t(c)$ is an increasing function, and each (active) seller will charge price p^o;(ii) consumers will search sequentially and purchase from the first matched seller, provided that $u \geq p^o$.

Welfare Effects of Entry

- The study of entry effects typically considers how the number of entrants affects conduct and performance.
- In our model, the number of entrants is uncertain, depending on the number of potential entrants (n), the realizations of β_i, and entry cost (c).
- For our model, a proper measure of entry is the expected number of entrants, determined by the match probability of the marginal entrant, t.
- Given t, the expected number of active sellers is $n\left[1-G\left(t\right)\right]$ Hence a lower t corresponds to a higher expected number of active sellers in the market.
- Furthermore, since t is an increasing function of c, the effects of t also correspond to the effects of entry cost.

Effects of Entry: Consumer Welfare

For a given t, consumer welfare can be written as

$$V = \left[1 - M\left(t\right)^{n}\right]\left(\Phi - \frac{s}{\gamma}\right), \tag{8}$$

where

$$\Phi = \int_{p^o}^{1} \left(u - p^o\right) f\left(u\right) du; \qquad M\left(t\right) = 1 - \gamma\left[1 - G\left(t\right)\right]. \tag{9}$$

- The probability that a match will occur for the consumer is $1 - M\left(t\right)^{n}$.
- Since Φ is the expected surplus to a consumer from a matched seller and s/γ is the search cost adjusted by the expected match probability, $\Phi - \frac{s}{\gamma}$ reflects the expected net benefit from a search.
- Consumer welfare is the expected net benefit from the entry of firms.

Effects of Entry: Consumer Welfare Decomposition

Proposition

Consumer welfare is an inverted-U function of t, first monotonically increasing and then monotonically decreasing.

$$\frac{dV}{dt} = \underbrace{-nM(t)^{n-1}(\gamma\Phi - s)\,g(t)}_{\text{variety effect}} + \underbrace{\frac{1}{\gamma}\left[\frac{1-M(t)^n}{\gamma}s + nM(t)^{n-1}(\gamma\Phi - s)(1-G(t))\right]\frac{d\gamma}{dt}}_{\text{quality effect}}. \quad (10)$$

- Positive variety effect: a lower t leads to a larger expected number of entrants, increasing search opportunities.
- Negative quality effect: a decrease in t reduces the average match probability of sellers in the market, lowering consumer search efficiency.

Effects of Entry: Consumer Welfare

- As t decreases (as entry cost decreases), more sellers choose to be active, but the marginal entrant has a lower quality (match probability).
- Holding other things constant, an increase in the number of sellers is beneficial to consumers (the variety effect).
- However, the addition of low-quality sellers reduces the average quality, which harms consumers due to reduced search efficiency (the quality effect).
- When t is high, the marginal entrant has a relatively high quality, so the variety effect from a decrease in t dominates.
- When t is low, the quality of marginal entrants is low, and the benefit from more search opportunities also diminishes. Thus the quality effect dominates.

Effects of Entry: Total Welfare

Total welfare can be written as

$$W = \left[1 - M\left(t\right)^{n}\right]\left[\left(\Phi - \frac{s}{\gamma}\right) + \left(1 - \frac{t}{\gamma}\right) p^{o}\left[1 - F\left(p^{o}\right)\right]\right].$$

Proposition

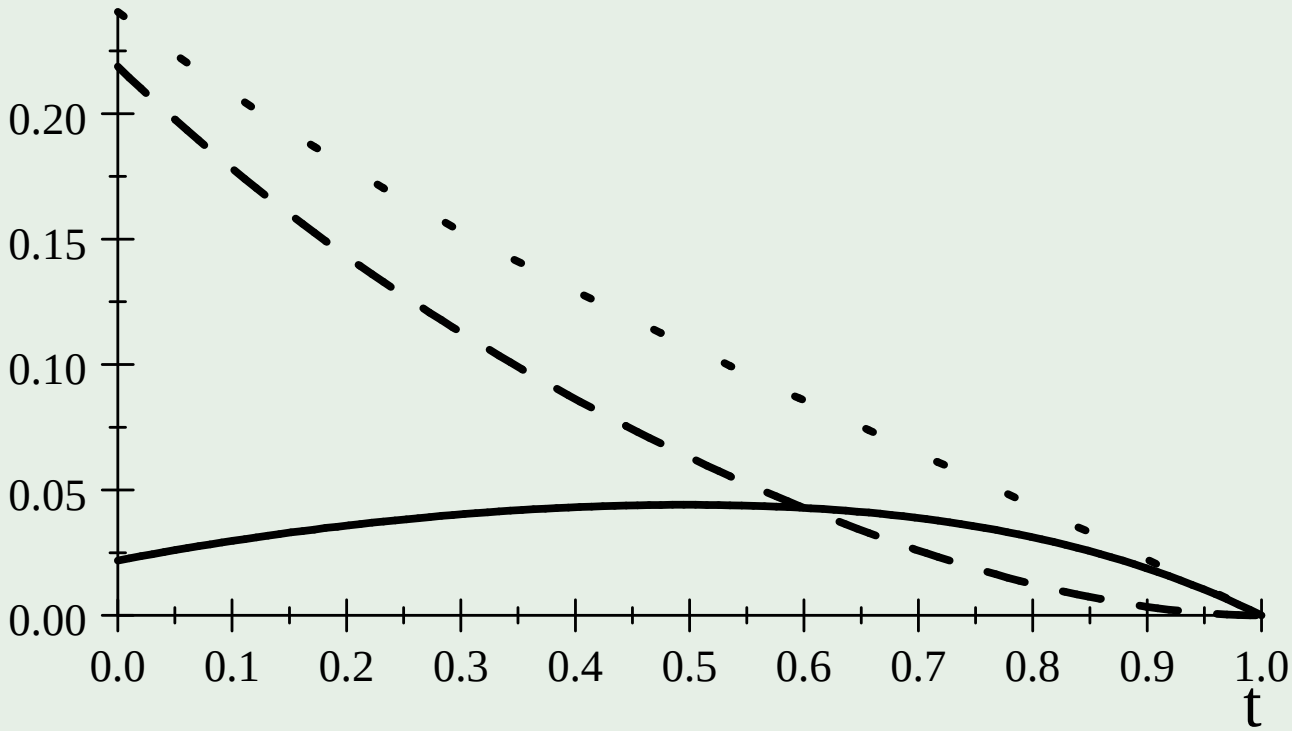
(i) Industry profit decreases in t. (ii) Total welfare decreases in t when s is sufficiently small or t is sufficiently high.

- An increase in the expected number of sellers raises industry profit.
  - higher probability of sales without lowering price.
  - This benefit outweighs the increase in total entry cost.
- When t is large, more entry (lower t) raises consumer welfare, so total welfare is higher.
- For small t, since lower t reduces consumer welfare, total welfare may be lower with more entry.

Welfare Effects of Entry

Example

Suppose that $n = 3$, $s = 0.05$, and both β_i and u are uniformly distributed on $[0, 1]$.



solid curve-V; dash curve-Π; dot curve-W.

Welfare Effects of Entry

Effects of Entry Cost (c):

Corollary

For $c \in (0, \pi^o)$: (i) consumer welfare is an inverted-U function of c, first increasing and then decreasing. (ii) total welfare decreases in c when c is sufficiently large.

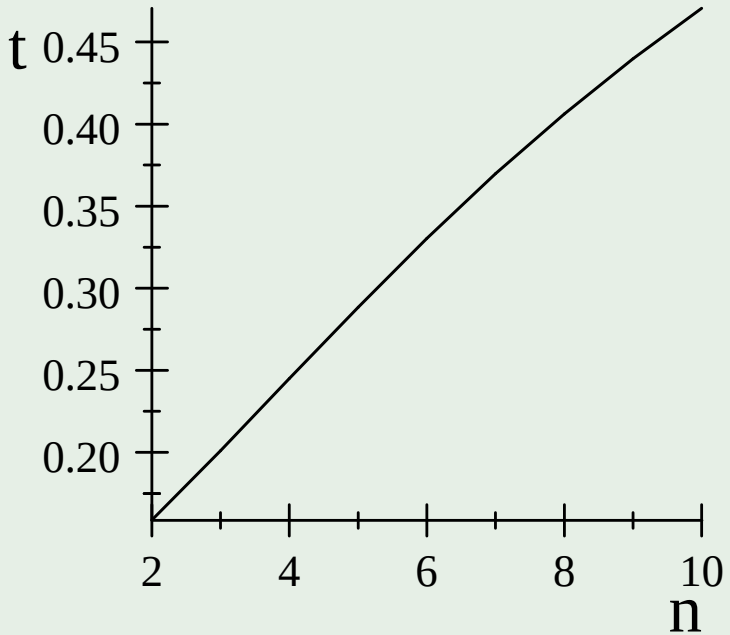
Effects of the Number of Potential Entrants:

- Consumer welfare V depends on both t and n.
- n affects V both directly and indirectly via t — holding t constant, V increases in n, but changes in n also affect t, which in turn affects V.
- In examples, when n is relatively small ($n \leq 10$), as n increases, both t and V increase; but Π and W first increase and then decrease.

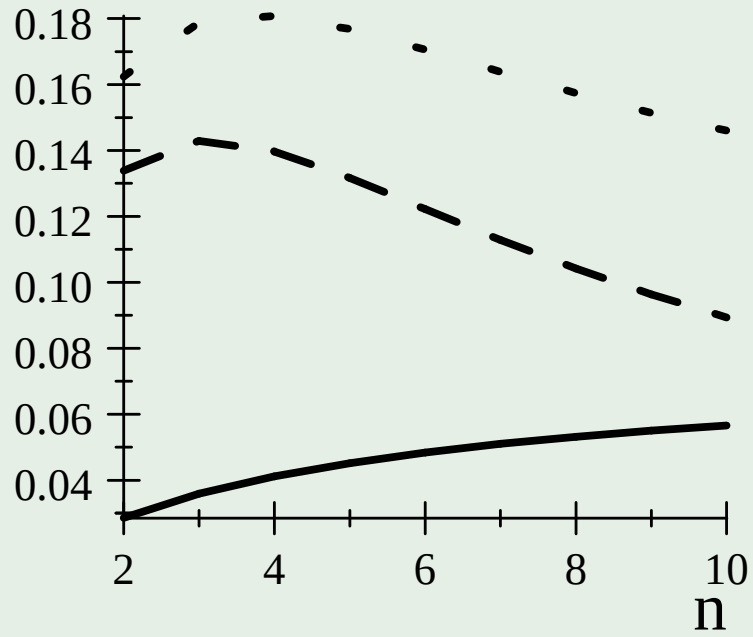
Welfare Effects of Entry

Example

Suppose that $s = 0.05$, $c = 0.03$, and β_i and u are uniformly distributed on $[0, 1]$. Figure 2 shows the impact of n on t and welfare.



t changes in n



solid curve-V; dash curve-Π; dot curve-W.

Welfare Effects of Entry

- The direct effect of more potential entrants is to benefit consumers.
- Indirectly, an increase in n leads to more potential competition, which decreases the expected profit of entry.
- Hence, t increases, which leads to a higher V when t is relatively small.
- When n is relatively small, t is also small, so V tends to increase in n.
- But Π and W first increase and then decrease in n.
  - an increase in n has a direct positive impact on industry profit, and hence also on total welfare.
  - This effect dominates the rise in aggregate entry cost and the possible fall in consumer welfare when n is relatively small.
- Contrasting the effects of entry cost c: Π and W monotonically decrease in c.

Alternative Model: Differentiated Matched Sellers

- We also consider an alternative setting where a consumer has heterogeneous values for products that match her needs.
- There is product differentiation among matched sellers. Everything else is the same as in the main model.
- Following Wolinsky (1986), a consumer's value for a matched seller i's product, u_i, is independently drawn from distribution F.
- A key difference in the alternative framework is that entry will now also affect market price.
- This alternative model serves two purposes:
  - reveal the relationship between product quality and price in search markets;
  - show that the inverted-U relationship between consumer welfare and entry holds beyond the main model.

Alternative Model: Differentiated Matched Sellers

Equilibrium in the Alternative Model:

- Suppose that the market has $k \leq n$ active sellers.
- Consumers' optimal search strategy is to sample sellers sequentially, with reservation value $a(\gamma)$ that satisfies

$$\gamma \int_a^{\bar{u}} (u_i - a) f(u_i) du_i = s. \tag{11}$$

- The market is active only when sellers are expected to charge $p_k \leq a$.
- A consumer stops searching when she finds a product with $u_i \geq a$; if no such product is found, she buys the product with the highest $u_i \geq p_k$, and she buys nothing if $u_i < p_k$ for all matched sellers.
- If only one seller is active ($k = 1$), then he optimally charges $p_1 = p^o$. So suppose that $k \geq 2$ sellers are active.

Alternative Model: Differentiated Matched Sellers

- Equilibrium price p_k is given by

$$p_k = \frac{\left[1 - F\left(a\right)\right]\varphi_k + \int_{p_k}^{a}\left[1 - \gamma + \gamma F\left(u_i\right)\right]^{k-1} f\left(u_i\right) du_i}{f\left(a\right)\varphi_k - \int_{p_k}^{a}\left[1 - \gamma + \gamma F\left(u_i\right)\right]^{k-1} f'\left(u_i\right) du_i}, \tag{12}$$

  where

$$\varphi_k = \frac{1 - \left[1 - \gamma + \gamma F\left(a\right)\right]^k}{k\gamma\left[1 - F\left(a\right)\right]}$$

  is the number of consumers who come to seller i for the first time.

- For a given entry cost, there exists an equilibrium analogous to the one in the main model. For any $c \in (0, \pi^o)$:
  - (i) Only sellers with $\beta_i \geq t \equiv t\left(c\right)$ are active, each of whom charges p_k defined as in (12) if k sellers are active;
  - (ii) Consumers will search sequentially with reservation value a satisfying (11).

Proposition

In the alternative model: (i) given k active sellers, an increase in γ leads to a decrease in p_k; (ii) given γ, an increase in k leads to a decrease in p_k.

- An increase in the expected quality of sellers increases consumers' incentive to search.
- Consequently, consumers raise their reservation (net) value $(v - p)$.
- This increased search intensity motivates firms to lower prices.

Alternative Model: Consumer Welfare and Entry Cost

- In our main model, consumer welfare is an inverted-U function of entry cost.
- In the alternative model, changes in entry cost affect consumer welfare also through the price effect, in addition to the variety and quality effects.
- Numerical examples indicate that the inverted-U relationship between consumer welfare and entry cost still holds for the parameter values we have considered.

Conclusion

- In search markets, entry expands consumer search choices, but it can also reduce search efficiency.
- In a model with both vertical and horizontal differentiation, consumer welfare has an inverted-U relationship with entry cost.
- Higher average product quality in a search market can benefit consumers by lowering prices through increasing search incentives.
- A policy application: consumer privacy protection.
  - The entry cost under some medium level of privacy protection could be most beneficial to consumers.