Entry

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Entry with Homogeneous Products

The models we have looked at so far illustrate a number of factors that affect equilibrium markups for a given market structure.

In the longer run, however, entry will affect the number of competitors and this can greatly alter conclusions about how market characteristics affect profits.

Consider a simple two stage model of entry with homogeneous goods.

Stage 1: A large number of potential entrants choose In/Out with entry cost K.

Stage 2: Firms that chose to enter play some game like Bertrand, Cournot, price competition with search, etc. Assume firms have variable costs c(Q).

We solve by backward induction. The second stage game results in prices $p^*(N)$ and variable profits $\pi^{v*}(N)$ if N firms enter.

We then find N^* from the first stage.

Entry with Homogeneous Products

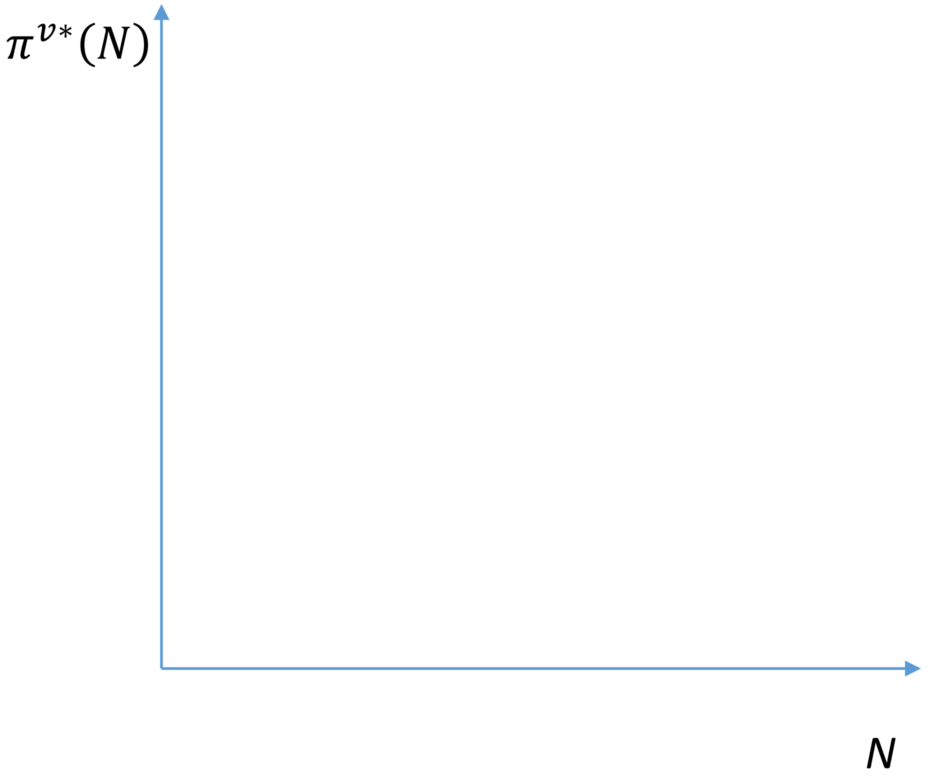
Stage 2: The shape of the entry-profits relationship will depend on the second-stage game.

Stage 1: We can consider pure or mixed NE.

In a pure SPE we have

$$\pi^{v*}(N^*) \geq K$$
$$\pi^{v*}(N^* + 1) \leq K$$

In a symmetric or asymmetric mixed SPE the firms that are mixing must have $E(\pi^{v*}(N)) = K$, with the expectation conditional on entry.

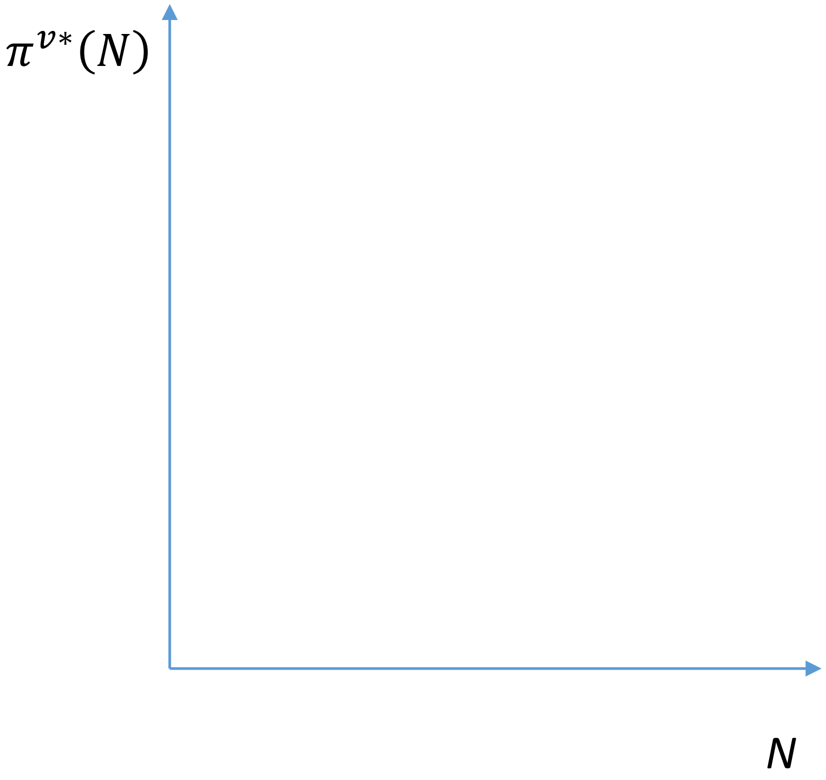


Entry with Homogeneous Products

Observations:

1. With lower fixed costs we get more entry.
2. In many models $N^* \to \infty$ as $K \to 0$.
3. Equilibrium profits are a rounding error, so profits are not directly related to all of the factors that we noted increase markups conditional on *N*.
4. In many models the equilibrium firm size is increasing in the market size.

   For example, in Cournot competition with demand $mD(p)$, if we set $m = 2$ and double the number of firms in the market, then profits decrease because equilibrium prices are lower.



Efficiency of Entry with Homogeneous Products

We can compare equilibrium entry with multiple benchmarks.

The <u>first best</u> will often be to have a single firm pricing at marginal cost. This is unrealistic unless we also have price regulation.

The <u>second best</u> maximizes welfare taking $p^*(N)$ as given.

$$N^{2B} = \max_N W(N) \equiv \int_0^{Nq^*(N)} P(s)ds - Nc\big(q^*(N)\big) - NK$$

A basic result on this model is that entry is excessive (apart from rounding errors).

Proposition:

Suppose $W(N)$ is concave , $\pi^{v*}(N)$ is decreasing and $p^*(N)$ and $q^*(N)$ can be extended to differentiable functions with (1) $\frac{\partial}{\partial N} Nq^*(N) > 0$, (2) $\frac{\partial}{\partial N} q^*(N) < 0$, and (3) $p^*(N) - c'\big(q^*(N)\big) > 0$. Then $N^* \geq N^{2B} - 1$.

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<u>Proof</u>:

Extend $W(N)$ to a differentiable function using $p^*(N)$ and $q^*(N)$. Let $\widehat{N}^{2B}$ be the solution to $W'\big(\widehat{N}^{2B}\big) = 0$. The second best will have $N^{2B} \leq \lceil \widehat{N}^{2B} \rceil$ if W is single peaked. The FOC defining $\widehat{N}^{2B}$ gives

$$P\big(Nq^*(N)\big)\left(q^*(N) + Nq^{*'}(N)\right) - c\big(q^*(N)\big) - Nc'\big(q^*(N)\big)q^{*\prime}(N) - K|_{N=\widehat{N}^{2B}} = 0$$

$$\Longrightarrow \pi^{v*}(N) + N(p^*(N) - c'\big(q^*(N)\big))q^{*\prime}(N) - K|_{N=\widehat{N}^{2B}} = 0$$

$$\Longrightarrow \pi^{v*}\big(\widehat{N}^{2B}\big) - K > 0 \qquad \Longrightarrow N^* > \lfloor \widehat{N}^{2B} \rfloor$$

Efficiency of Entry with Homogeneous Products

Intuition: Welfare benefits of entry come purely from quantity increases. Marginal benefits are $\approx \Delta Q(p^* - c)$. The entering firm captures more than this because other firms' quantities decrease so excessive fixed entry costs are incurred. This is referred to as **business stealing**.

Observations:

1. In numerical examples one often finds that many more firms enter than is socially optimal because most of the marginal entrant's demand is business stealing, e.g. in *N* firm Cournot with $D(p) = 1 - p$ we have $q^*(N) = \frac{1}{N+1}$. The increase in total output from the N^{th} firm is just $\frac{N}{N+1} - \frac{N-1}{N} = \frac{1}{N(N+1)} = \frac{1}{N} \cdot \frac{1}{N+1}$.
2. We can get one firm too few in Bertrand-like environments and the welfare loss from the slightly insufficient entry can be large. In a pure SPE of a Bertrand model only one firm enters, so free entry leads to monopoly. If *K* is not to large the social planner would prefer to have two firms enter, leading to $p^* = c$.

Welfare Effects of Entry

Beyond the homogeneous goods environment entry can be too high or too low.

$$W_N = \sum_{i=1}^{N} \pi_i^{v*}(N) + CS(N) - NK$$

$$W_{N+1} = \sum_{i=1}^{N+1} \pi_i^{v*}(N+1) + CS(N+1) - (N+1)K$$

The change in welfare from the last entrant is

$$\Delta W = (\pi_{N+1}^{v*}(N+1) - K) + \sum_{i=1}^{N} (\pi_i^{v*}(N+1) - \pi_i^{v*}(N)) + CS(N+1) - CS(N)$$

Entry is socially optimal $\Leftrightarrow \Delta W > 0$. Free entry may differ from this for two reasons:

1. Business stealing can lead to excessive entry.
2. Firms do not internalize gains in consumer surplus. This can lead to insufficient entry.

Our previous theorem implied that with homogeneous goods the second is outweighed by first (except perhaps for leading to one firm too few). On the margin, a reduction in price is just a transfer that increases CS by the same amount by which it reduces profit.

Entry with Horizontal Differentiation

In models with product differentiation there is an additional effect of entry on consumer surplus: consumers get products that are better matched to their tastes.

Consider a Hotelling-like model with mass m of consumers who get utility $v - p_j - td_{ij}$ from buying at distance d_{ij} arranged around a circle of circumference one.

If *N* firms enter and are arranged evenly, $p^* = c + \frac{t}{N}$ and $\pi_i^{v*} = m\frac{1}{N}\frac{t}{N} \Longrightarrow N^* = \sqrt{mt/_K}$.

Social welfare with *N* firms is $W_N = m\left(v - t\frac{1}{4N} - c\right) - NK$.

Maximizing over N the FOC is $\frac{mt}{4}\frac{1}{N^2} - K|_{N=N^{2B}} = 0 \Longrightarrow N^{2B} = \sqrt{mt/_{4K}} = \frac{1}{2}N^*$.

Intuitively, the extra channel exists, but is fairly weak with these preferences, and most of the marginal firm's demand is still due to business stealing.

Things can work out differently with other distributions of idiosyncratic tastes.

Entry with Vertical Differentiation

- Consumers with types $\theta \sim U\left[\underline{\theta}, \overline{\theta}\right]$ have unit demands with utility $u_i(\theta) = \theta s_i - p_i$.
- Firms have fixed entry costs K and constant marginal cost $c(s)$.

Consider a game where firms simultaneously choose In/Out and $s_i \in [\underline{s}, \overline{s}]$, then compete in prices in a second stage.

Shaked and Sutton (1982) show that the entry depends on the cost function.

<u>Case 1</u>: Natural Oligopoly

If $c'(s) < \underline{\theta}$ for all *s* or $c'(s) > \overline{\theta}$ for all *s*, then there is a finite upper bound on the number of firms that enter in a pure strategy equilibrium even in the $K \to 0$ limit.

Intuition: One product is efficient and $p^*(s) \to c(s)$ if $N \to \infty$.

<u>Case 2</u>: Specialization

If c is convex with $c'\left(\underline{s}\right) < \underline{\theta}$ and $c'(\overline{s}) > \overline{\theta}$, then we will have $N \to \infty$ as $K \to 0$. Firms serve small neighborhoods where their product is approximately efficient.

Firm Dynamics with Learning

Jovanovic (1982) discussed entry, growth, and exit in a model with learning.

- Continuum of small potential entrants. Fixed cost K of entry. Liquidation value w.
- Firms have unknown types $\theta_i \sim N\left(\theta_0, \sigma_\theta^2\right)$.
- Firm i's period t cost is $c(q_{it})f(\theta_i + \varepsilon_{it})$, with c is convex and f increasing and bounded.
- Firms don't know their types, but get a signal every time they produce and update beliefs.

Treats entrants as continuum per period so the price sequence $p_1, p_2, \cdots$ is deterministic and firms act as price takers:

$$q_{it} \in \underset{q}{\operatorname{argmax}}\, E_{\theta_i}(p_t q - c(q)f(\theta_i + \varepsilon_{it}))$$

Optimal behavior depends both on the mean and variance of a firm's posterior:

Low $E(\theta_i) \Rightarrow$ high q_{it}

Medium $E(\theta_i) \Rightarrow$ low q_{it}

High $E(\theta_i)$ with high uncertainty $\Rightarrow$ low q_{it}

High $\mathrm{E}(\theta_i)$ with low uncertainty $\Rightarrow$ exit

Firm Dynamics with Learning

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High $E_t(\theta_i)$ with high uncertainty $\Rightarrow$ low q_{it} High $E_t(\theta_i)$ with low uncertainty $\Rightarrow$ exit

The model makes a number of predictions about observable firm dynamics:

1. Small firms grow faster and fail more often.
2. Bigger firms have higher profits.
3. Industry concentration correlated with high profits.
4. Larger firms' profits are more serially correlated.
5. Industry concentration correlated with cross-sectional variance in profits.

A large empirical literature following Dunne, Roberts, and Samuelson discusses such facts.

Vellodi, "Ratings Design and Barriers to Entry"

Vellodi analyzes the effects of policies of rating intermediaries, e.g. Amazon or Yelp, on firm dynamics. A challenge in platform design is that most reviews will be of large, successful firms about which there is little uncertainty.

- Continuum of small potential entrants. Fixed cost K of entry. Flow cost c of operation. Exogenous death rate δ. Discount rate ρ.
- Firms have unknown types $\theta_i \in \{0,1\}$. Prior mean p_0. Capacity 1. Set prices q_{it}.
- Posterior p_{it} on Prob$\{\theta_i = 1\}$ evolves according to $dp_{it} = \sqrt{\lambda_{it}} p_{it}(1 - p_{it}) dZ_{it}$, where λ_{it} is the review arrival rate and dZ_{it} is a Brownian motion (motivated by normal errors).
- Each consumer j decides which firm to visit. If excess consumers visit any type of firm service is rationed. Consumers get utility $\theta_i + \varepsilon_{ij}$ if served. In equilibrium they get served with probability 1 at rating $\tilde{p}$ firms and higher prices keep them indifferent to going to higher-rated firms: $q^*(p) = p - w$ for some w. Also unmodeled ε flow of visits to all firms from some other source.

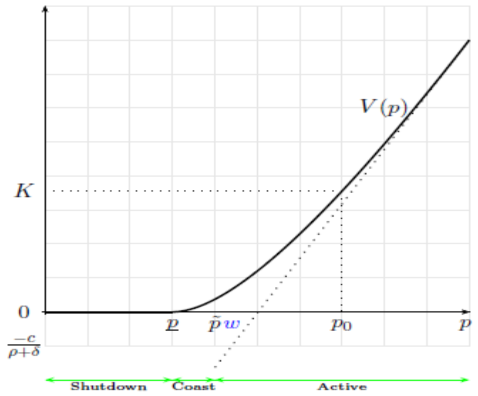
Write $V(p)$ for the value function of a firm with posterior p. Free entry implies that $V(p_0) = K$. Optimal exit occurs when $p_{it} = \underline{p}$ where $V(\underline{p}) = 0$.

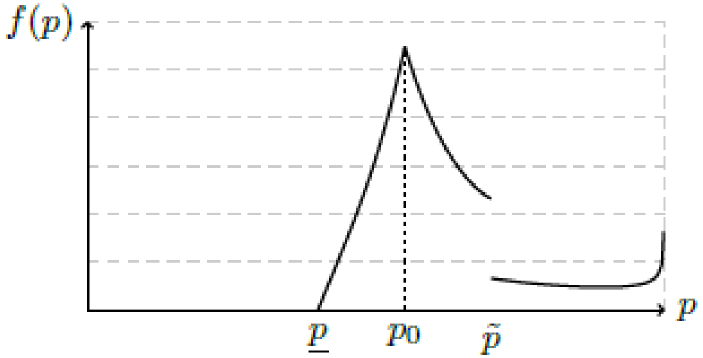
Vellodi, “Ratings Design and Barriers to Entry”

Observations:

1. Firms will price somewhat below cost to attract consumers.
2. With full information ratings, learning about new entrants is very slow (only the ε flow) and firms exit after just a little bad news.

Firm value function





Density of beliefs p_{it}

Courtesy of NIkhil Vellodi. Used with permission.

3. Consumer welfare under any policy is the w that arises given the policy. Hence, consumer optimality is about giving firms an incentive to have consumers learn.
4. The consumer-optimal policy fully reveals information for all firms with posteriors below some $\bar{p}$ and reveals nothing once a firm has reached rating $\bar{p}$. This transfers surplus from firms that would have higher ratings to firms that would have lower ratings. This is good for new entrants. (Free entry implies zero firm surplus so social and consumer welfare coincide.)

On Wednesday I'll discuss some empirical papers on entry including

- Bresnahan and Reiss
- Berry and Waldfogel
- Bronnenberg, Dhar, and Dubé
- Bronnenberg, Dubé, and Gentzkow

See you then!