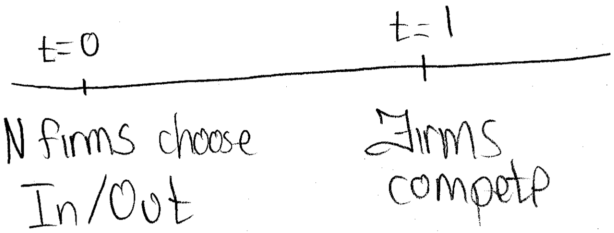
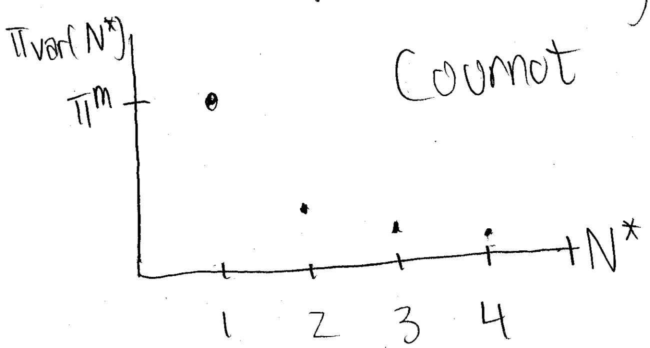
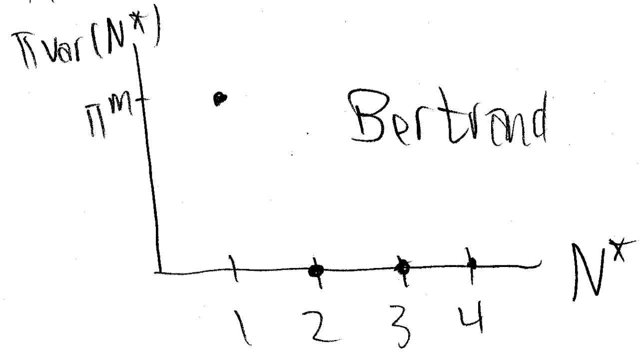
Entry



- Suppose N is very large, so some firms will choose not to enter

- Homogeneous good
  - Demand $Q(p)$ downward sloping
- Sunk cost K of entry
- Cost $C(Q)$ of producing Q units
- assume competition at $t=1$ produces:
  - $p^*(N^*)$
  - $Q^*(N^*)$ - output for individual firm
  - $\underbrace{\Pi^*_{var}(N^*)}_{\text{variable profit}} = Q^*(N)P^*(N) - C(Q^*(N))$
  - where N^* = # entering firms





- In a pure strategy SPE, it must be that $\Pi^*_{var}(N^*) \geq K \geq \Pi^*_{var}(N^*+1)$
  - sometimes, people assume $\Pi^*_{var}(N^*) = K$, where N^* need not be an equilibrium
    - Not highly recommended

- In a mixed strategy SPE, generically at least two firms mix
  - $\tilde{N}$ - the realized N^* is a random variable
  - Sometimes, $\pi^*_{var}(\tilde{N}) > K$, and sometimes $\pi^*_{var}(\tilde{N}) < K$
  - Each firm is indifferent between entering and not entering.

<u>Observations:</u>

1. Lower fixed costs $\Rightarrow$ more firms in equilibrium
2. If $\pi^*_{var}(N^*) > 0 \quad \forall N^*$, then $N^* \to +\infty$ as $K \to 0$
3. In this model, profits are a rounding error, not directly related to toughness of competition.

Welfare effects of entry

- Suppose N, not N^*, is the \# firms that enter. (Notation change)

$$\underbrace{W_N}_{\text{welfare with } N \text{ firms in mkt}} = \sum_{i=1}^{N} \pi^*_{var}(N) + CS(N) - NK$$

- usually talk about 2nd-best welfare
  - optimal N given $p^*(N)$, $q^*(N)$
  - obviously the optimal N would be 1 if we could ensure MC pricing.

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

$$\Delta W = W_{N+1} - W_N$$
$$= \left[\Pi_{var}^*(N+1) - K\right] + \underbrace{\sum_{i=1}^{N}\left(\Pi_{var}^*(N+1) - \Pi_{var}^*(N)\right)}_{\text{change in } \Pi \text{ of incumbent firms} \equiv A}$$
$$+ CS(N+1) - CS(N)$$

Reasons for departure from optimality

1] Business stealing effect. Entering firm will not take into account $A<0$
- Negative externality (N will be too high)

2] Firms also ignore $CS(N+1) - CS(N) > 0$.
- Positive externality. (N will be too low)

3] Discreteness

Proposition: Consider homogeneous good model with no discreteness issues. That is N^* satisfies $\Pi_{var}^*(N^*) = K$. If

1] $\frac{\partial}{\partial N} NQ^*(N) > 0$ aggregate output increases

2] $\frac{\partial}{\partial N} Q^*(N) < 0$ individual output decreases

3] $p^*(N) - C'(Q^*(N)) > 0 \quad \forall N$

Then, $N^* \geq N^{SB}$, where N^{SB} maximizes W_N. (ie $N^{SB} = \arg\max_N W_N$)

Proof: $N^{SB} = \arg\max_N \underbrace{\int_0^{NQ^*(N)} p(s)\,ds}_{\text{gross consumer surplus}} - \underbrace{NC(Q^*(N)) - NK}_{\text{total costs}}$

$$
\begin{aligned}
(N):\ 0 &= W'(N^{SB}) \\
&= P(N^{SB}Q^*(N^{SB}))[Q^*(N^{SB}) + N(Q^*)'(N^{SB})] \\
&\quad - [C(Q^*(N^{SB})) + N^{SB}C'(Q^*(N^{SB}))](Q^*)'(N^{SB}) - K \\
&= \underbrace{P(N^{SB}Q^*(N^{SB}))Q^*(N^{SB}) - C(Q^*(N^{SB}))(Q^*)'(N^{SB})}_{\pi^*_{var}(N^{SB})} - K \\
&\quad + N^{SB}\underbrace{(Q^*)'(N^{SB})}_{(-)}\underbrace{[P(N^{SB}(Q^*(N^{SB})) - C'(Q^*(N^{SB}))]}_{(+)}
\end{aligned}
$$

$\Rightarrow \pi^*_{var}(N^{SB}) - K > 0$

Since N^* is s.t. $\pi^*_{var}(N^*) - K = 0$, assuming a single crossing property (ie $\pi^*_{var}(N)$ is decreasing in N), then $N^* \geq N^{SB}$.

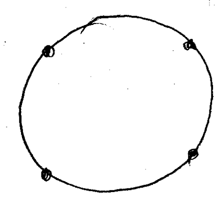
Remark:
- Too many firms due to business stealing.
- Can easily have $N^* < N^{SB}$ with discreteness taken into account.
- Suppose $D(p) = 1 - p$, $c = 0$, Bertrand competition

- $N=1 \Rightarrow p = \frac{1}{2}$, $\pi = \frac{1}{4}$, $CS = \frac{1}{8}$ $\Rightarrow W_1 = \frac{3}{8} - K$
- $N=2 \Rightarrow p = 0$, $\pi_1 = \pi_2 = 0$, $CS = \frac{1}{2}$ $\Rightarrow W_2 = \frac{1}{2} - 2K$
  - For $K \in (0, \frac{1}{8})$, 2 firms is better than 1, but $\pi_2 - K < 0$, so we will only have one firm.

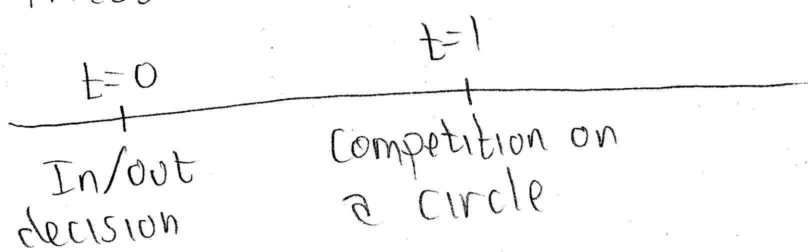
  $\Rightarrow N^{SB} = 2$, $N^* = 1$ $\Rightarrow N^* < N^{SB}$.

Entry with Horizontal Differentiation

Consider competition on a circle



- circle circumference 1
- values $v - td$
- mass m of consumers



- $p^*(N) = c + \frac{t}{N}$
- $\pi^*_{var}(N) = \frac{M}{N} \cdot \frac{t}{N} = K$ in equilibrium

$$\Rightarrow N^* = \sqrt{\frac{Mt}{K}}$$

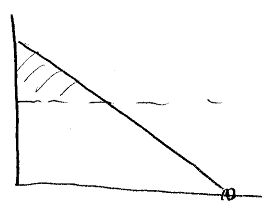
Note

1] $N^* \to +\infty$ as $K \to 0$

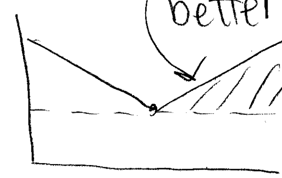
2] Larger $M \Rightarrow$ Larger firms

3] Extra CS effect relative to homogeneous good model.

$N=1$



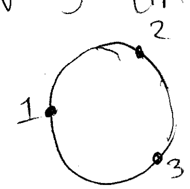
$N=2$



Extra CS due to better match b/t tastes and products

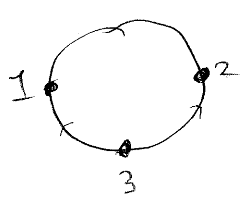
4] If firms are allowed to choose location, get greater scope for rounding errors.

- $N=3$ and uniformly located, we get



$\pi = \frac{Mt}{9}$

- $N=3$, but if firms 1 and 2 were already uniformly located,



$\pi \neq \frac{Mt}{9}$. This will introduce additional problems.

Entry with vertical differentiation

- Consumers have value $\theta v_i - p_i$, $\theta \sim U[a,b]$
- Firms choose location $v_i \in [\underline{v}, \bar{v}]$

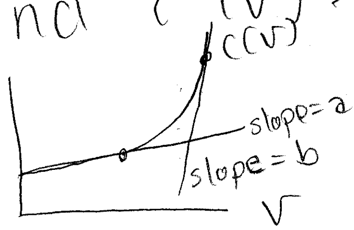
- Fixed cost K, marginal cost $c(v)$ (constant)
  - fixed cost same no matter what the quality. Marginal cost depends on quality.

<u>Case 1</u>: Suppose $c'(v) < a$ $\forall v$ or $c'(v) > b$ $\forall v$. Then, only a finite number of firms enter for any given K. (i.e. $\exists \bar{N}$ s.t. $N^*(K) < \bar{N}$ $\forall K$)

<u>Intuition</u>: Suppose $c'(v) < a$ $\forall v$. Then $\bar{v}$ is the efficient product quality.

- If $N \to \infty$ as $K \to 0$, Then $p(v) \to c(v)$. at $c(v)$, only $\bar{v}$ is purchased. This implies $\pi^* = 0$ for many firms.

<u>Case 2</u>: Suppose $c'(v) < a$ for some $v \in [\underline{v}, \bar{v}]$ and $c'(v) > b$ for some $v \in [\underline{v}, \bar{v}]$.



Then $\exists$ equilibria in which $N^* \to +\infty$ as $K \to 0$.

- all firms choose v's with $c'(v) \in [a, b]$

Next time:
- Jovanovich paper
- Empirical papers (Barry, Waldfogel, and others)