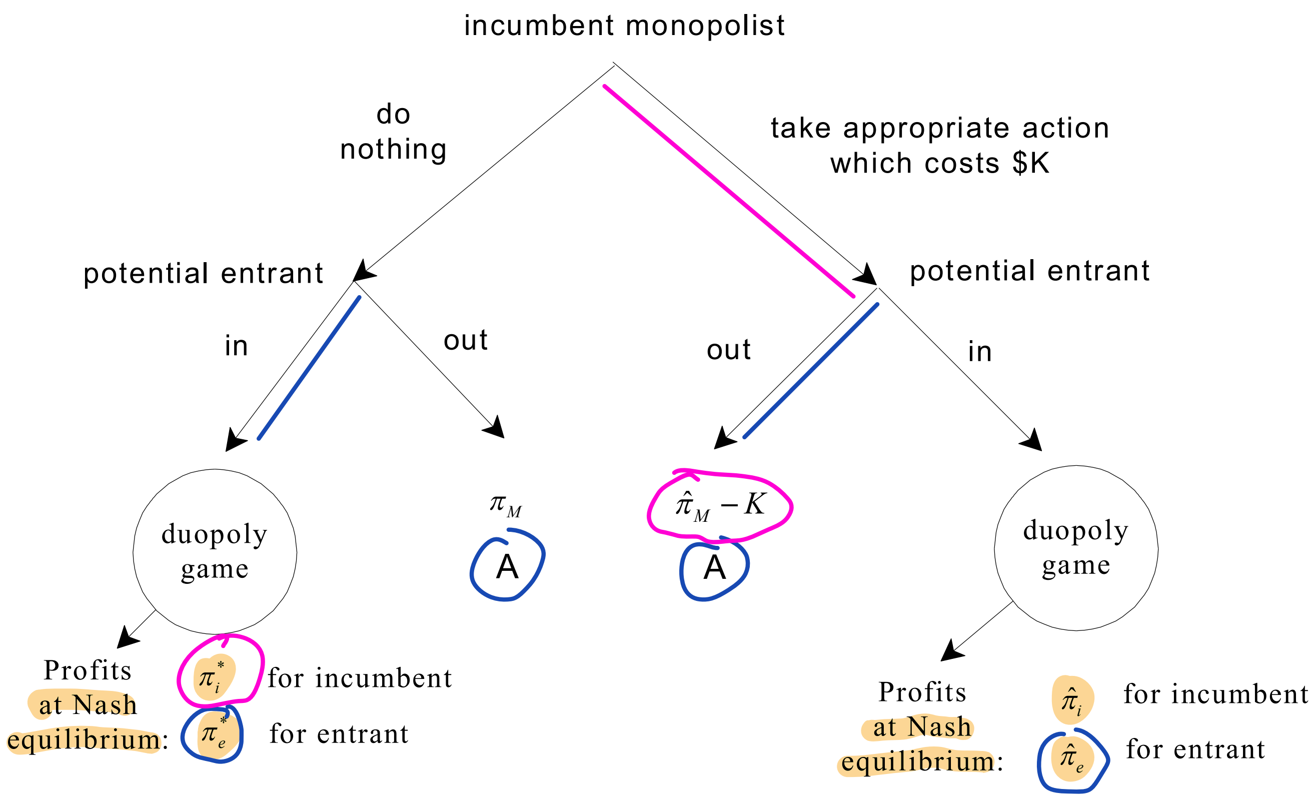
Strategic Entry Deterrence

π_M denotes monopoly profits in the "unmodified industry" and $\hat{\pi}_M$ monopoly profits in the "modified industry" – modified by the incumbent's action; A is the opportunity cost of entry (the return on the best alternative investment for the PE).



1. When is entry a real threat?

   Yes if $\pi_e^* > A$ ✓ $2.11 > 1$

2. When is entry deterrence possible?

   Yes $\hat{\pi}_e < A$ ✓ $0 < 1$

3. When is entry deterrence in the incumbent's interest?

   $\hat{\pi}_M - K > \pi_i^*$ $\hat{\pi}_M - K = 21.25 - 10 = 11.25 > \pi_i^* = 2.11$

4. Is it a case of strategic entry deterrence?

   Yes if $\pi_M > \hat{\pi}_M - K$

Example: expenditure on R&D

Let $A = 1$. Inverse demand: $P = 12 - Q$.
Current cost function: $C(q) = 2q + 9$. $K=10$

The incumbent has the opportunity to spend 10 in R&D which will lead to: $\overline{C}(q) = q + 9$.

CASE 1: the firm is protected from entry (e.g. by a patent)

$$\pi_M = Q(12-Q) - 2Q - 9 \qquad \frac{d\pi_M}{dQ} = 0 \qquad \begin{matrix} Q=5 \\ P=7 \end{matrix} \qquad \pi_M = 16$$

$$\hat{\pi}_M = Q(12-Q) - Q - 9 \qquad \frac{d\hat{\pi}_M}{dQ} = 0 \qquad Q = 5.5 \qquad \hat{\pi}_M = 21.25$$

Compare $\pi_M = 16$ to $\hat{\pi}_M - 10 = 11.25$

$>$

CASE 2: the firm is not protected from entry

The entrant would have the cost function C(q) (the old technology).

Game on left (old technology)

$$\pi_i = q_i(12 - q_i - q_e) - 2q_i - 9$$

$$\pi_e = q_e(12 - q_i - q_e) - 2q_e - 9$$

$$\frac{\partial \pi_i}{\partial q_i} = 0 \qquad q_i = q_e = \frac{10}{3} \rightsquigarrow \pi_i^* = 2.11$$

$$\frac{\partial \pi_e}{\partial q_e} = 0 \qquad \pi_e^* \; 2.11$$

✓

$A = 1$

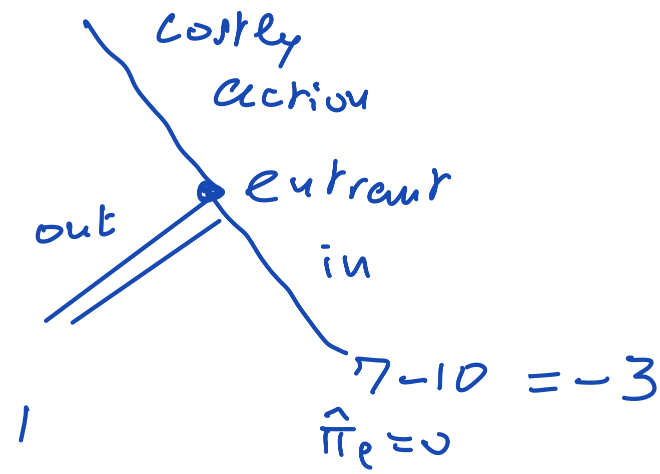
Game on right: $\pi_i = q_i(12 - q_i - q_e) - q_i - 9$

$$\pi_e = q_e(12 - q_i - q_e) - 2q_e - 9$$

$\dfrac{\partial \pi_i}{\partial q_i} = 0$ $\qquad q_i = 4 \qquad P = 5 \qquad \hat{\pi}_i = 7$

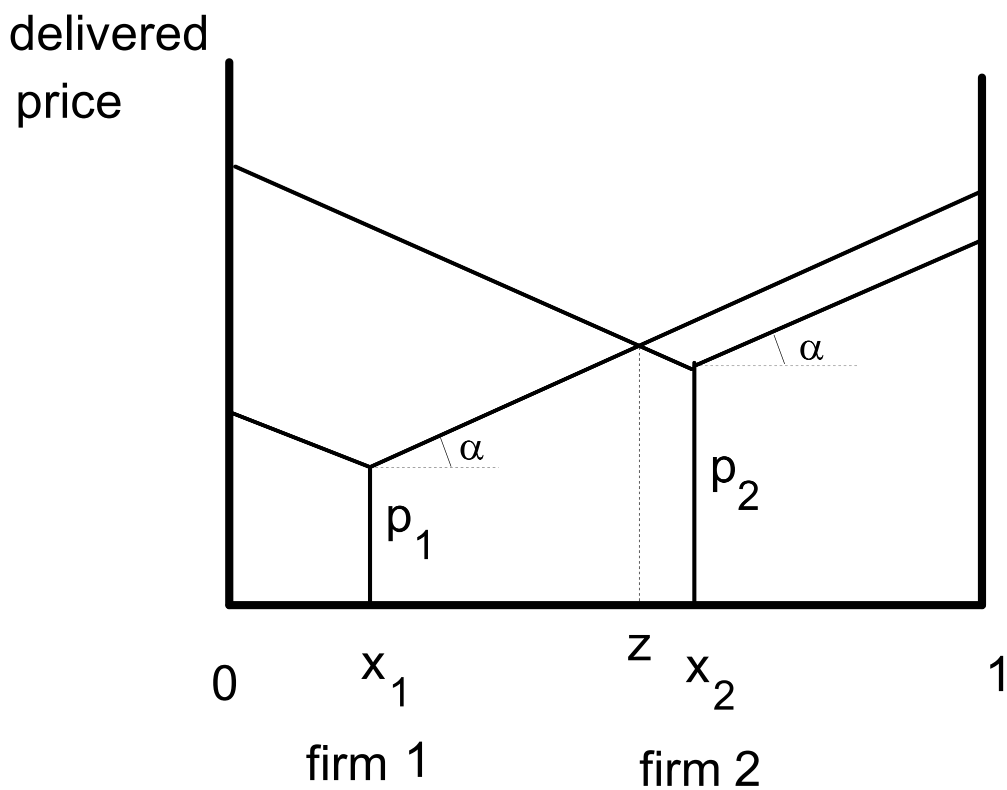
$q_e = 3 \qquad \hat{\pi}_e = 0$

$\dfrac{\partial \pi_e}{\partial q_e} =$



Differentiated Products: Hotelling's model (1929)

Imagine a town with a Main Street of length 1. There are N consumers living on this street and they are uniformly distributed along the street, that is, on a segment of length x there are xN consumers. Each consumer has an infinite reservation price and will buy exactly one unit (from the firm that offers the best deal). Two firms offer the same product and have zero production costs. Consumers have a roundtrip transportation cost of α per unit of distance.

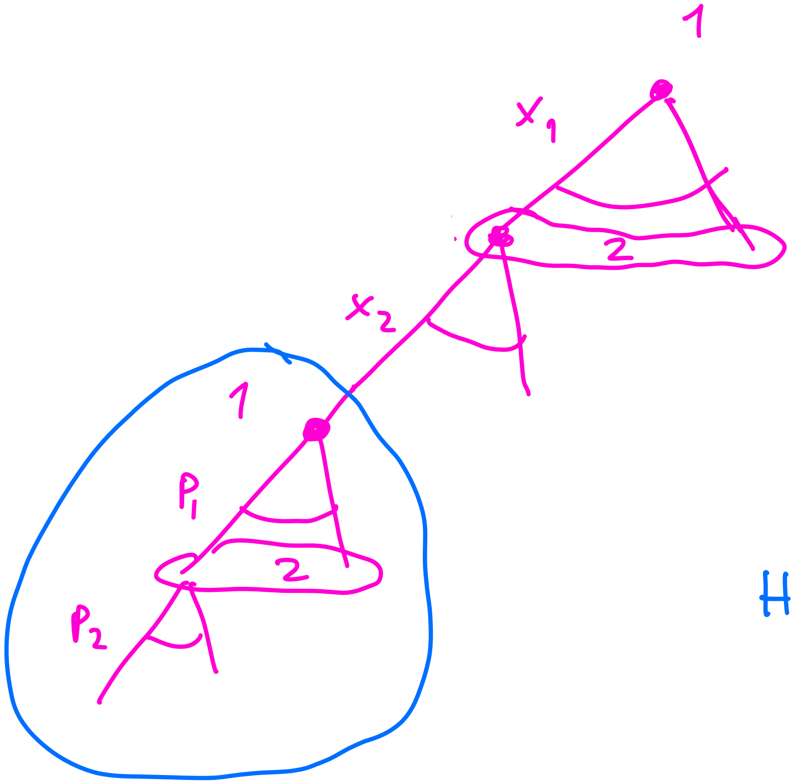


$$z = \frac{x_1 + x_2}{2} + \frac{p_2 - p_1}{2\alpha}$$

$$\Pi_1(p_1, p_2) = zN = \left(\frac{x_1 + x_2}{2} + \frac{p_2 - p_1}{2\alpha}\right)N$$

$$\Pi_2(p_1, p_2) = (1 - z)N = \left(1 - \frac{x_1 + x_2}{2} - \frac{p_2 - p_1}{2\alpha}\right)N$$

The solution to $\begin{cases} \dfrac{\partial \Pi_1}{\partial p_1} = 0 \\ \dfrac{\partial \Pi_2}{\partial p_2} = 0 \end{cases}$ is $\begin{cases} p_1^* = \frac{\alpha}{3}(x_1 + x_2 + 2) \\ p_2^* = \frac{\alpha}{3}(4 - x_1 - x_2) \end{cases}$



$x_1 \in [0, 1]$

$x_2 \in [x_1, 1]$

Hotelling's conclusion

$$x_1^* = x_2^* = \frac{1}{2}$$

A. Subjective uncertainty.

Player 2

Player 1	C	D
A	z_1	z_2
B	z_3	z_4

Suppose that **Player 1's ranking** of the outcomes is:

$$z_1 \succ z_4 \succ z_3 \succ z_2$$

best worst

If Player 1 believes that Player 2 will play C 1 will choose A

If Player 1 believes that Player 2 will play D 1 will choose B

If Player 1 believes that Player 2 is equally likely to play C or D

$$A \rightarrow \begin{pmatrix} z_1 & z_2 \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}$$

$$B \rightarrow \begin{pmatrix} z_3 & z_4 \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}$$

need to compare lotteries

Objective uncertainty

First price auction

1	\$10	\$20
\$10	$\begin{pmatrix} z_1 & z_2 \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}$	z_4
\$20	z_3	$\begin{pmatrix} z_3 & z_4 \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}$

z_1 = Player 1 wins and pays \$10

z_2 = 2 "

z_3 = 1 wins \$20

z_4 = 2 \$20

Player 1's ranking : best z_1

z_3

worst z_2, z_4

1 is secretly informed that 2's bid is \$10

$\$10 \to \begin{pmatrix} z_1 & z_2 \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}$

$\$20 \to \begin{pmatrix} z_3 \\ 1 \end{pmatrix}$

$$m = 4 \qquad \begin{pmatrix} z_1 & z_2 & z_3 & z_4 \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \end{pmatrix} \qquad \begin{pmatrix} z_1 & z_2 & z_3 & z_4 \\ \frac{1}{3} & 0 & \frac{2}{3} & 0 \end{pmatrix} = \begin{pmatrix} z_1 & z_3 \\ \frac{1}{3} & \frac{2}{3} \end{pmatrix}$$

$$\begin{pmatrix} z_1 & z_2 & z_3 & z_4 \\ 0 & 1 & 0 & 0 \end{pmatrix} = \begin{pmatrix} z_2 \\ 1 \end{pmatrix} = z_2$$

on Z

Theorem 1 Let $Z = \{z_1, z_2, ..., z_m\}$ be a set of basic outcomes and $\mathcal{L}$ the set of lotteries over Z. If $\succsim$ is a von Neumann-Morgenstern ranking of the elements of $\mathcal{L}$ then there exists a function U, called a *von Neumann-Morgenstern utility function*, that assigns a number (called utility) to every basic outcome and is such that, for any two lotteries $L = \begin{pmatrix} z_1 & z_2 & \dots & z_m \\ p_1 & p_2 & \dots & p_m \end{pmatrix}$ and $M = \begin{pmatrix} z_1 & z_2 & \dots & z_m \\ q_1 & q_2 & \dots & q_m \end{pmatrix}$,

$$L \succ M \quad \text{if and only if} \quad \underbrace{p_1 U(z_1) + p_2 U(z_2) + \dots + p_m U(z_m)}_{\text{expected utility of lottery } L} > \underbrace{q_1 U(z_1) + q_2 U(z_2) + \dots + q_m U(z_m)}_{\text{expected utility of lottery } M}$$

and

$$L \sim M \quad \text{if and only if} \quad \underbrace{p_1 U(z_1) + p_2 U(z_2) + \dots + p_m U(z_m)}_{\text{expected utility of lottery } L} = \underbrace{q_1 U(z_1) + q_2 U(z_2) + \dots + q_m U(z_m)}_{\text{expected utility of lottery } M}$$

2.25 3.33

EXAMPLE 1. $Z = \{z_1, z_2, z_3, z_4\}$ $L = \begin{pmatrix} z_1 & z_2 & z_3 & z_4 \\ \frac{1}{8} & \frac{5}{8} & 0 & \frac{2}{8} \end{pmatrix}$ $M = \begin{pmatrix} z_1 & z_2 & z_3 & z_4 \\ \frac{1}{6} & \frac{2}{6} & \frac{1}{6} & \frac{2}{6} \end{pmatrix}$

Suppose we know that $U = \begin{cases} z_1 & z_2 & z_3 & z_4 \\ 6 & 2 & 8 & 1 \end{cases}$

$$E[U(L)] = \frac{1}{8}6 + \frac{5}{8}2 + 0 \cdot 8 + \frac{2}{8}1$$

$$E[U(M)] = \frac{1}{6}6 + \frac{2}{6}2 + \frac{1}{6}8 + \frac{2}{6}1$$

EXAMPLE 2.

$$A = \begin{pmatrix} \overset{z_1}{\text{paid 3-week vacation}} & \overset{z_3}{\text{no vacation}} \\ 50\% & 50\% \end{pmatrix} \qquad B = \begin{pmatrix} \overset{z_2}{\text{paid 1-week vacation}} \\ 100\% \end{pmatrix}$$

Suppose Ann says $\boxed{B \succ A}$ How would she rank

$$C = \begin{pmatrix} \text{paid 3-week vacation} & \text{no vacation} \\ 5\% & 95\% \end{pmatrix} \text{ and } D = \begin{pmatrix} \text{paid 1-week vacation} & \text{no vacation} \\ 10\% & 90\% \end{pmatrix} ?$$

Suppose Ann says: $C \succ D$ Ann violates EUT

Basic outcomes		utility
best	z_1	a
	z_2	b
worst	z_3	c

$a, b, c \in \mathbb{R}$ $\quad a > b > c$

Since $B \succ A$ by Thm 1

$$E[U(B)] > E[U(A)]$$

$$E[U(B)] = 1 \cdot U(z_2) = b$$

$$E[U(A)] = \frac{1}{2} U(z_1) + \frac{1}{2} U(z_3) = \frac{1}{2} a + \frac{1}{2} c$$

$$b > \frac{1}{2} a + \frac{1}{2} c$$

$$\boxed{2b > a + c}$$

$C = \begin{pmatrix} \text{paid 3-week vacation} & \text{no vacation} \\ 5\% & 95\% \end{pmatrix}$ and $D = \begin{pmatrix} \text{paid 1-week vacation} & \text{no vacation} \\ 10\% & 90\% \end{pmatrix}$?

From $C \succ D$ by Thm 7

$$\underbrace{E[U(C)]}_{} > \underbrace{E[U(D)]}_{}$$

$$\frac{5}{100} a + \frac{95}{100} c > \frac{10}{100} b + \frac{90}{100} c$$

$$5a + 95c > 10b + 90c$$

$$5a + 5c > 10b$$

$$\boxed{a + c > 2b}$$

contradiction

$2b > a+c$

EUT: if $B \succ A$ then you must $D \succ C$

if $A \succ B$ then you must $C \succ D$

$$L = \begin{pmatrix} z_{best} & z_{worst} \\ p & 1-p \end{pmatrix} \qquad M = \begin{pmatrix} z_{best} & z_{worst} \\ q & 1-q \end{pmatrix}$$

Monotonicity Axiom: $L \succ M$ iff $p > q$