Price Competition

Introduction

- Price is an important competition instrument
- This chapter:
  - Considers ***strategic pricing***: pricing decisions by a few firms (e.g., airline companies, Pepsi and Coke, gas stations) who supply similar (even identical) products
  - Uses ***game theory***: simultaneous-move games and Nash equilibrium

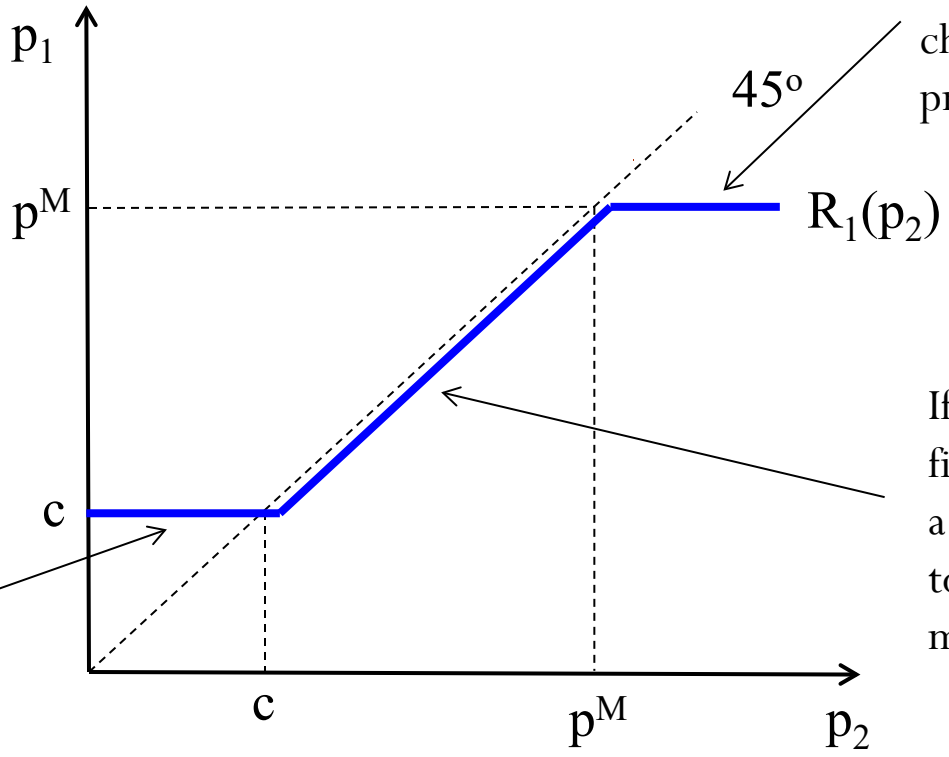
Benchmark: Bertrand Competition

- Players: two firms (1 and 2) produce *identical* products at the same marginal cost c (e.g., c=$5)
- Strategies and rules:
  - Firms set prices p_1 and p_2 simultaneously
  - Consumers know both firms' prices perfectly
  - If one firm prices lower, it gets the whole market
  - If prices are the same, firms split the market
- Total demand is Q = D(p) (e.g., 10-p), where $p=\min\{p_1,p_2\}$ is the lower price between p_1 and p_2
- Referred to as "*Bertrand*" game after its inventor Joseph Bertrand (1822-1900)

Bertrand Competition …

c: marginal cost

p^M: monopoly price



But if firm 2 sets a too high price, firm 1 can occupy the whole market by just charging the monopoly price.

If firm 2 sets p_2<c, firm 1 will make a negative profit if it follows. But charging p_1=c can ensure a zero profit.

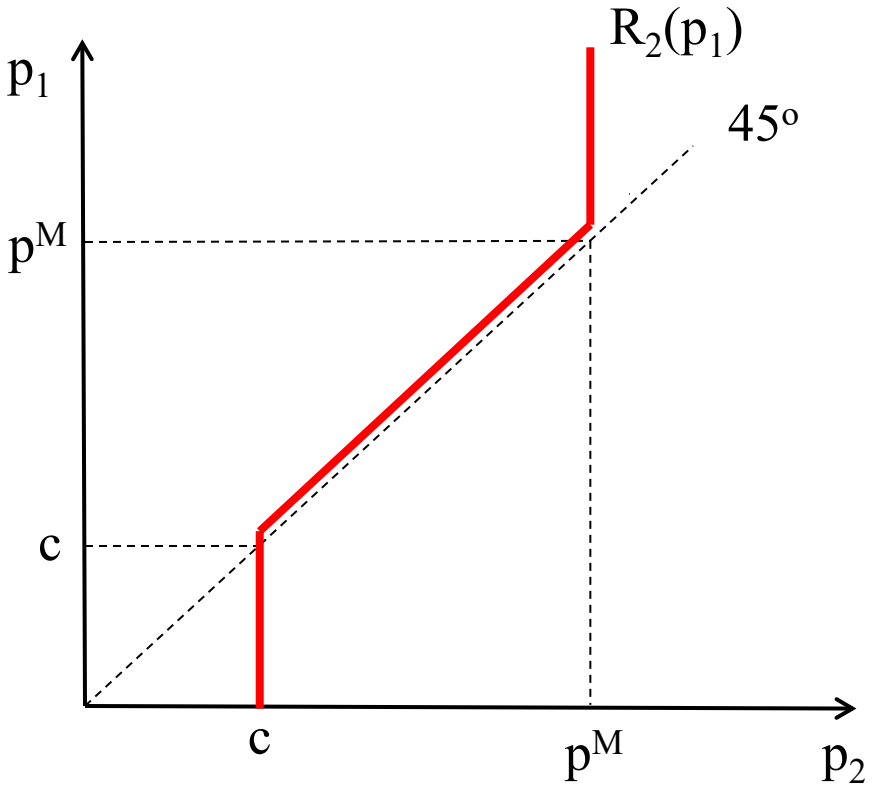
If firm 2 sets p_2>c, firm 1 wants to charge a slightly lower price to occupy the whole market.

Firm 1's *best-response* $R_1(p_2)$: optimal p_1 for each possible p_2

Bertrand Competition …

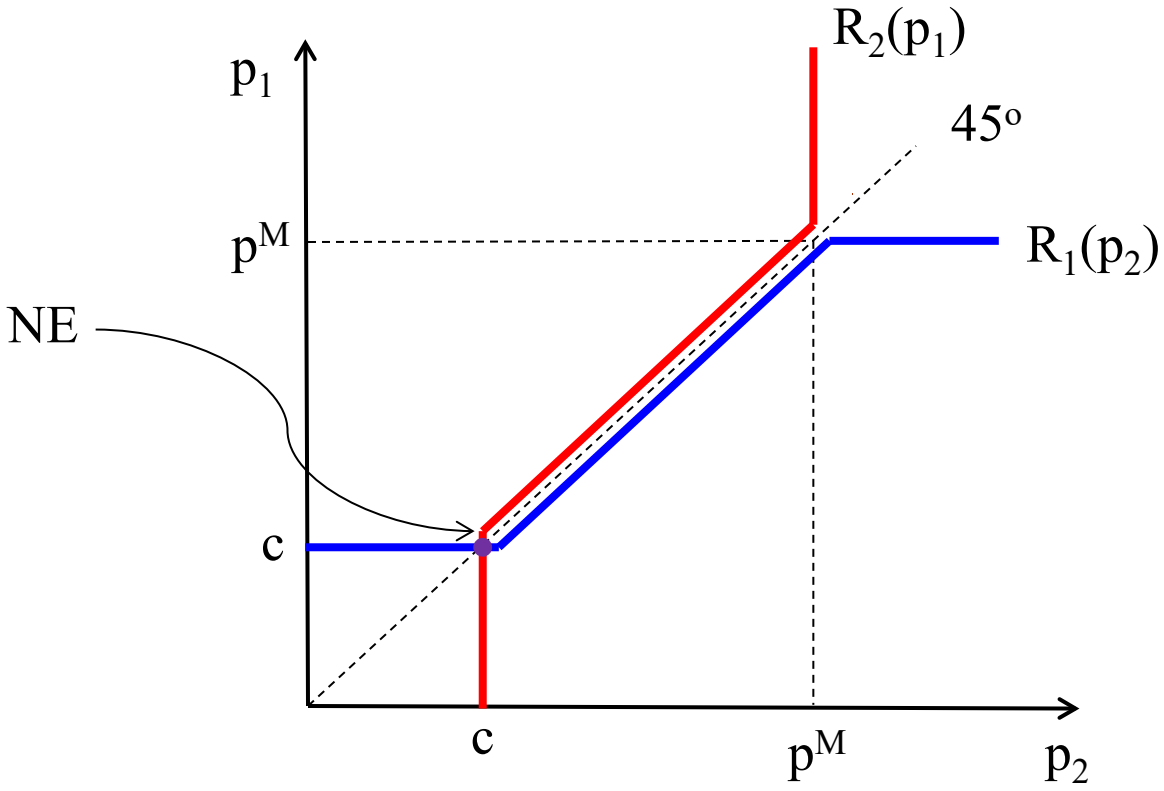
c: marginal cost

p^M: monopoly price



Firm 2's *best-response* $R_2(p_1)$: optimal p_2 for each possible p_1

Bertrand Competition …



Practically,
$p_1=p_2=\$5.01$ if $c=\$5$

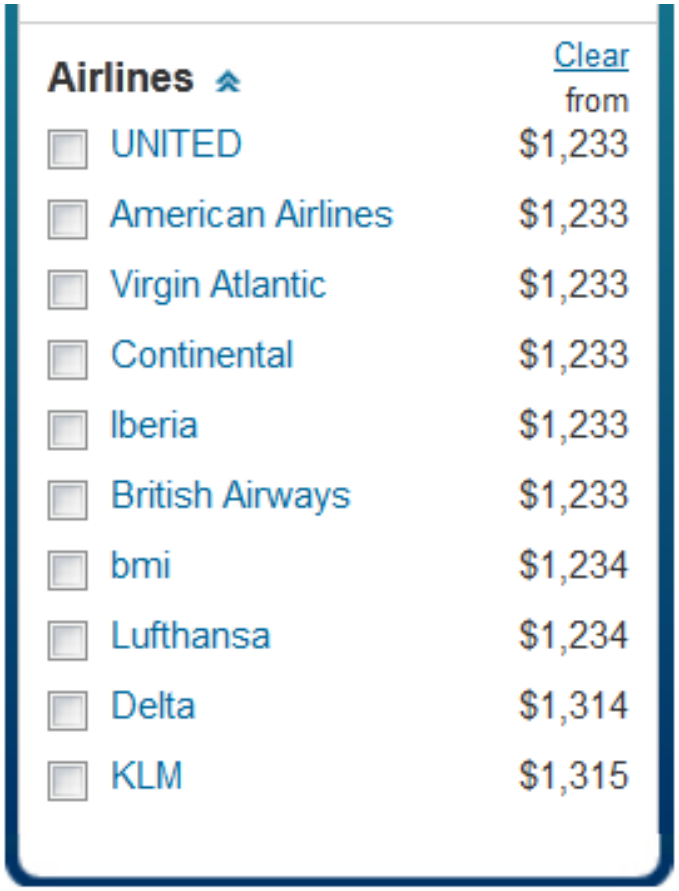
Nash Equilibrium: the intersection of best responses: $p_1=p_2=c$

No firm has a *unilateral* incentive to charge a different price!

The "Bertrand Trap"

- Even with two firms, price is driven down to the *competitive price=marginal cost*
  - Firms would be better off if they could charge some common price above the marginal cost
- Examples (?):
  - airlines competing in the same route
  - online bookstores selling the same book …
- Comments:
  - Which aspects of the model are not so realistic?
  - But still a useful benchmark to show the danger of the price-cutting game

Online Flight Prices



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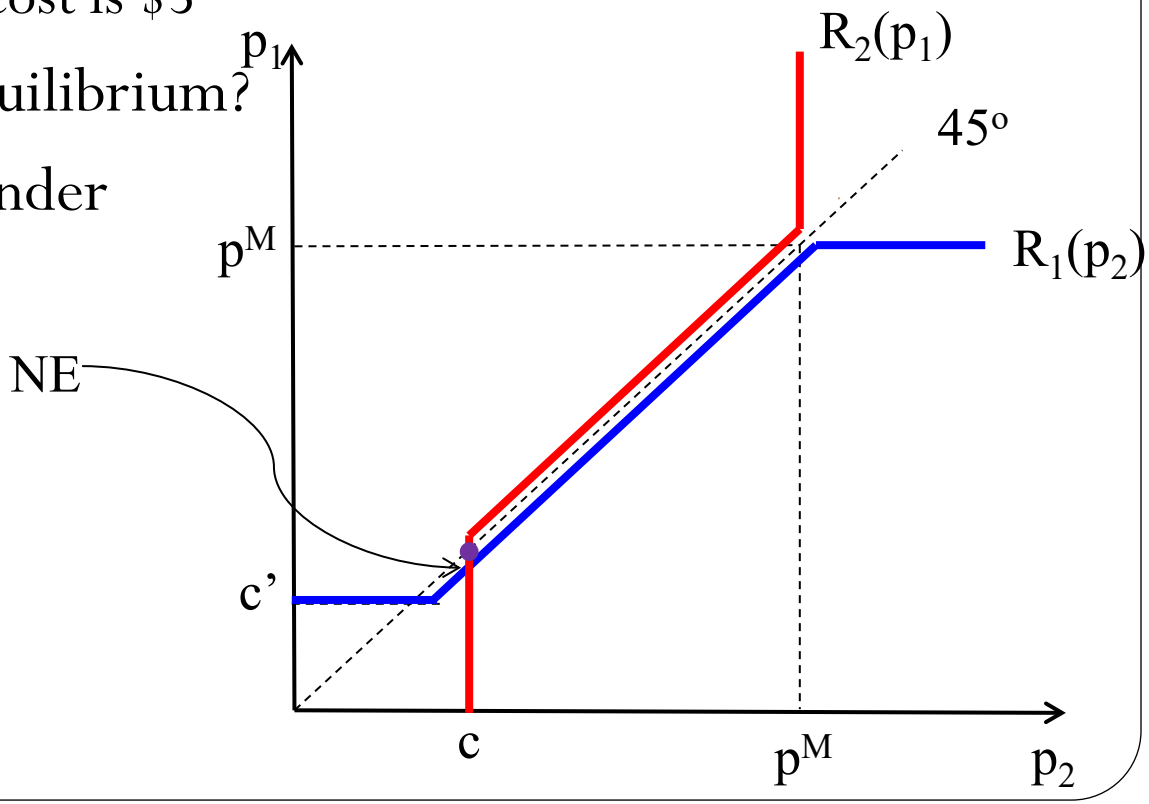
Ways Out of the Trap

- Eliminate competition:
  - Buy your competitors (may not permitted by competition authority)
  - Price agreement (illegal practice)
- Make competitors less aggressive:
  - Be the cost leader
  - Limiting capacity: with a limited capacity, a firm has less incentive to undercut its rivals
  - Clever pricing strategies such as price matching
  - Long-term interaction and implicit cooperation
- Make consumers less price sensitive:
  - Product differentiation
  - Informational friction
  - Complicated pricing schemes and consumer confusion

Benefits of Having Lower Cost

- Consider the Bertrand game, but now assume different marginal costs across firms
  - Firm 1's marginal cost is $4
  - Firm 2's marginal cost is $5
- What's the Nash Equilibrium?
- Firm 1 prices just under Firm 2's costs.



Limited Capacity

Consider a simplified version of the Bertrand game:

- Only two potential buyers: each of them wants to buy one unit of the product, and they are willing to pay up to $10
- Two firms: each can supply only one unit of the product
- Buyers patronize the cheaper firm, unless its product has sold out
- What's the Nash Equilibrium?
  - c.f., what if firms had capacity of 2?

BUSINESS DAY

Airlines' Unwanted Fleet Grows in the Desert

By EDWARD WONG JUNE 7, 2003

Correction Appended

No better barometer of the fortunes of the airline industry exists than 1,200 acres of parched brown earth here, baking at 102 degrees.

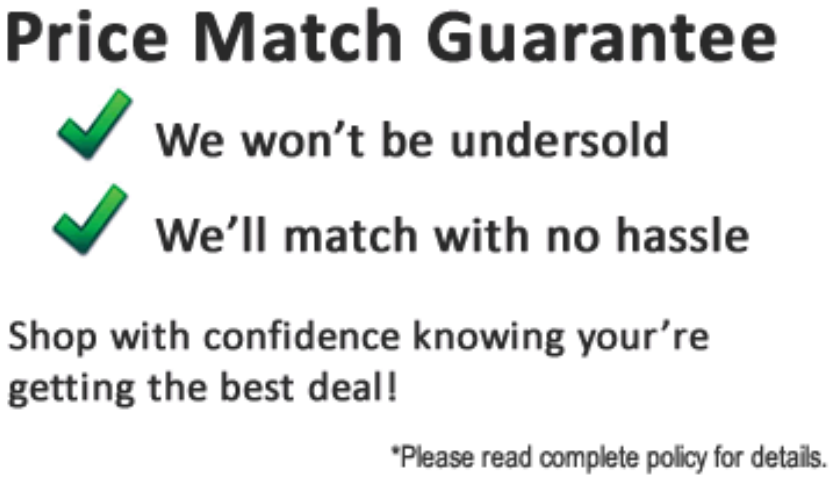
Row upon row of jetliners sit idle in three lots, their engines sealed with silver or black Mylar, their rudders rising from the flat desert like shark fins protruding from an ocean's glassy surface.

Rattlesnakes slither in the shadows of nose cones and tortoises inch their way past landing gear. A yellow school bus carrying a dozen mechanics barrels between planes, kicking up dust.

About 230 jets have been consigned to this purgatory, a storage and maintenance yard operated by Avtel Services. That number is four times what it was before the terror attacks of Sept. 11, 2001. When the airline business is poor, the money here can be good, and the general manager, Justin Loucks, says his business will only get better.

Price Matching

- **Price matching**: a firm offers a price and a ***promise*** to match any lower price offered by a competitor
- Revisit the Bertrand game. But suppose now that each firm is using the price-matching strategy. What's the Nash Equilibrium?



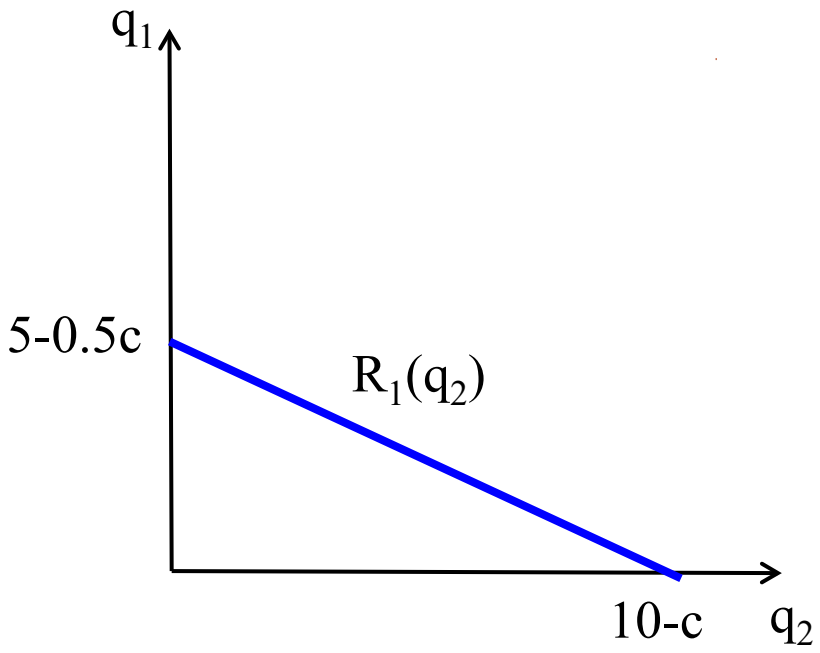
Quantity Competition

- Even when firms sell identical products, if production decisions need to be made prior to pricing decisions, p>MC.

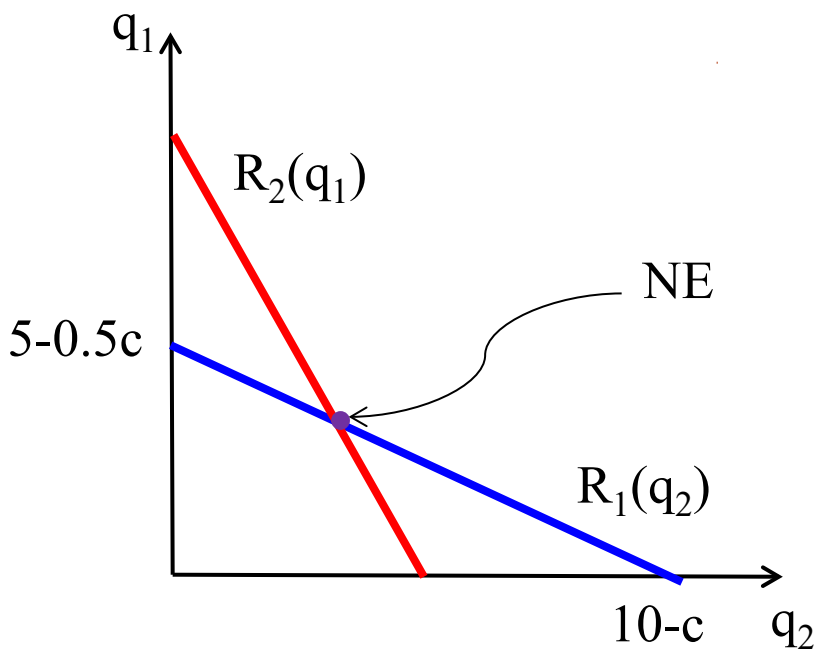
- 2 Firms choose q_1 and q_2.
- Total quantity is $Q = q_1+q_2$.
- Total demand is $Q = D(p)=10-p$
- Marginal cost is c.
- Find the Nash Equilibrium. Find the associated prices.

- Fix q_2. Consider best response for Firm 1.
- Once q_2 is fixed, it is similar to the monopoly problem.
- Total quantity is q_1+q_2.
- Price is $p=10-Q=10-(q_1+q_2)$.
  - Demand is given by $Q = D(p)=10-p$
- Think of monopoly pricing where demand is given by
  - $p=(10-q_2)-q_1$.
- Revenue is $=(10-q_2-q_1)\,q_1$.
- MR is $(10-q_2)-2q_1$
- MC is c.

- MR is $(10 - q_2) - 2q_1$
- MC is c.
- Set MR = MC: $(10 - q_2) - 2q_1 = c$
  - $q_1 = 0.5(10 - q_2 - c)$



- Fix q_1 and now consider best response for Firm 1.
- Similar exercise yields
  - $q_2 = 0.5(10 - q_1 - c)$



- Simply solve
- $q_2 = 0.5(10 - q_1 - c)$
- $q_1 = 0.5(10 - q_2 - c)$

We get

- $q_1 = q_2 = (1/3)(10-c)$
- $P = 10 - (q_1 + q_2)$

  $= 10 - (2/3)(10 - c)$

  $= 10/3 + (2/3)c$

  $> c$ (for $c<10$)

Product Differentiation

- *Horizontal differentiation*: differentiation in characteristics such as colors, styles, and locations
  - Different consumers often have different tastes for these characteristics
  - So for equal prices, different consumers prefer different products
- *Vertical differentiation*: differentiation in quality (e.g., durability, shipping speed …)
  - All else equal, all consumers prefer a high-quality product over a low-quality one
- Comments:
  - In most cases, both kinds of differentiation exist
  - Sometimes product differentiation could be purely *spurious*, e.g., due to advertising and branding(e.g., generic drugs vs brand names)

Example: Differentiated Products

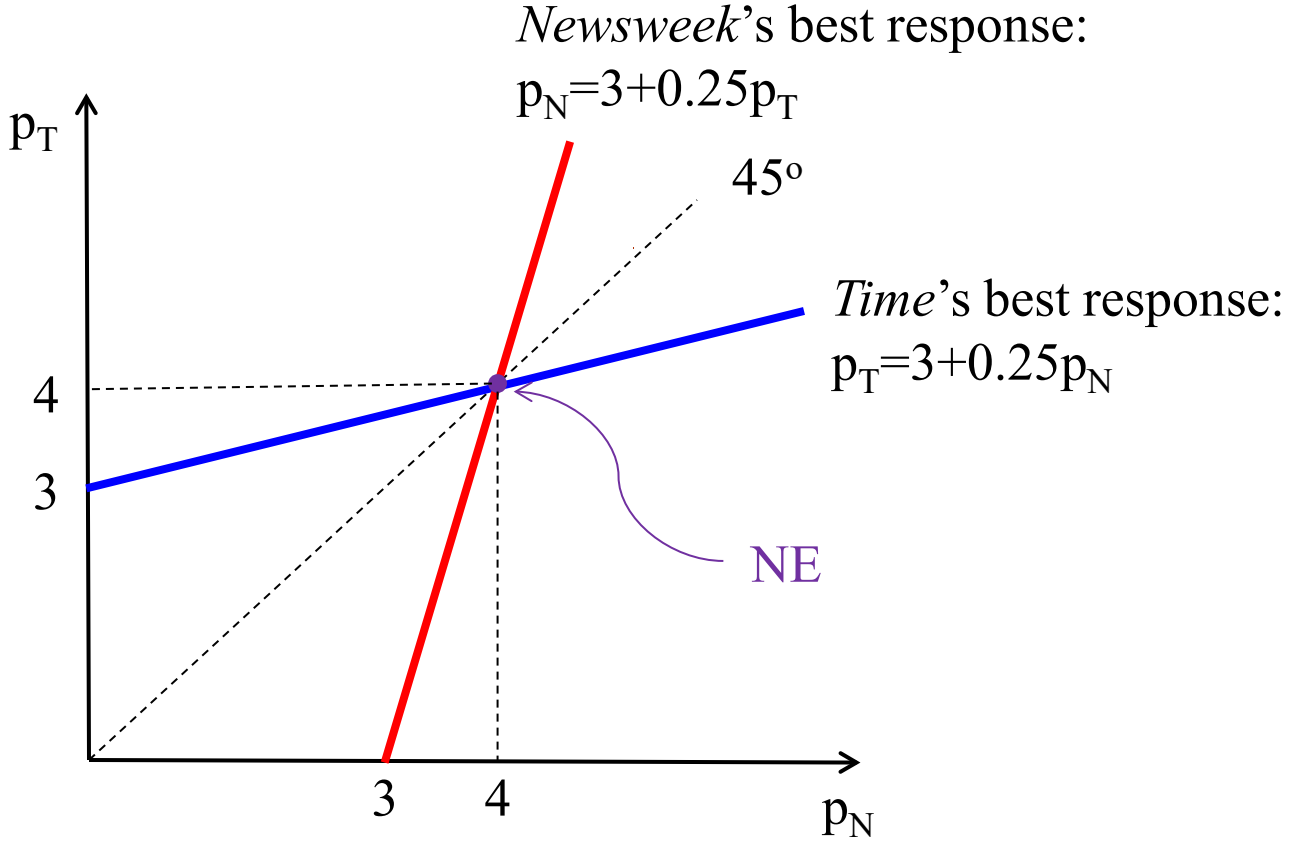
- Two firms (e.g., *Time vs Newsweek*) supply differentiated products
  - Marginal cost: \$1; set prices simultaneously
- Demand:

$$\begin{cases} q_T = 5 - p_T + 0.5p_N \\ q_N = 5 - p_N + 0.5p_T \end{cases}$$

  - Quantity demanded decreases with a firm's own price but *increases* with its rival's price
  - Demand is no longer as elastic as with homogenous products: even if *Time* charges a higher price than *Newsweek*, it still has some demand
- Is $p_T = p_N = 1$ a NE?
  - If *Newsweek* sets a price at \$1, will *Time* cut price to \$1 too?

Example: Differentiated Products

Example: Differentiated Products ...



NE: each firm charges $p_T=p_N=4$ > marginal cost

Complicated Pricing and Confusion

- Pricing schemes for some products and services have complicated structure (e.g., mortgages, insurance, bank accounts, cell phone service)
  - Innately complicated, or firms' intentional practice
- Ordinary consumers may get confused in comparison and even opt for expensive deals

Lender	Initial rate	Subsequent rate	Overall cost for comparison	Max% LTV	Lender fee
First Direct	3.34%	3.69%	3.9% APR	60%	£1498
Leek United	3.39%	5.19%	5.2% APR	75%	£1495
Britannia	4.34%	4.24%	4.5% APR	60%	£599
Chelsea	4.80%	5.79%	5.5% APR	65%	£995
Co-operative Bank	5.29%	4.24%	5.2% APR	60%	£995

www.confused.com

Discussion: E-Commerce

- E-commerce makes the Bertrand trap particularly dangerous.
- How can e-commerce firms avoid the trap?
  - What advantages are there to firms selling online relative to those selling offline?

Consumer Awareness of Prices

- More price transparency > More likely consumers are aware of different prices.
- Brynjolfsson and Smith (1999) studies how online-offline prices

Table 2 *t* tests on Mean Store Prices

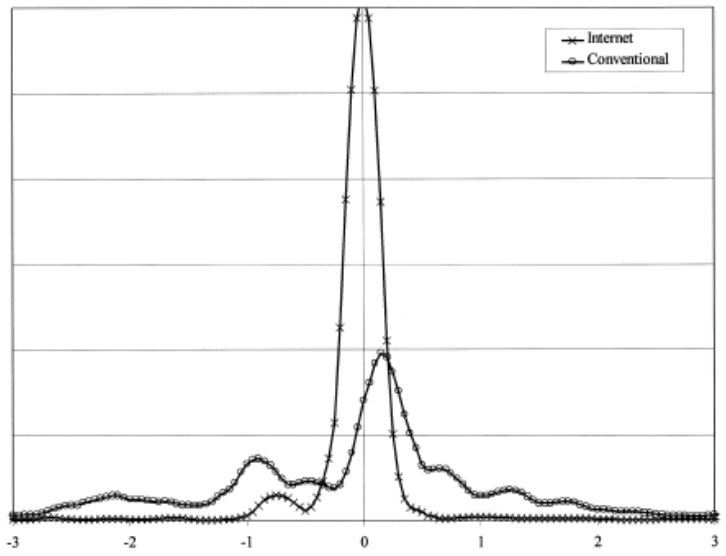
Product Market	Conventional Price Mean	Internet Price Mean	Alternative Hypothesis	*t* test Significance
Books	13.90	11.74	$P_{INET} < P_{PHYS}$	0.001
CDs	16.07	13.49	$P_{INET} < P_{PHYS}$	0.001

Table 3 Proportion of the Time the Minimum Internet Price (of Eight Sample Stores) Is Less Than or Equal to the Minimum Conventional Price (of Eight Sample Stores)

Product Market	Min. Internet Price < Min. Conventional Price	Min. Internet Price = Min. Conventional Price	Alternative Hypothesis	*P*-Value Significance*
Books	92.0%	4.5%	$P_{INET} < P_{PHYS}$	0.05
CDs	84.6%	5.1%	$P_{INET} < P_{PHYS}$	0.05

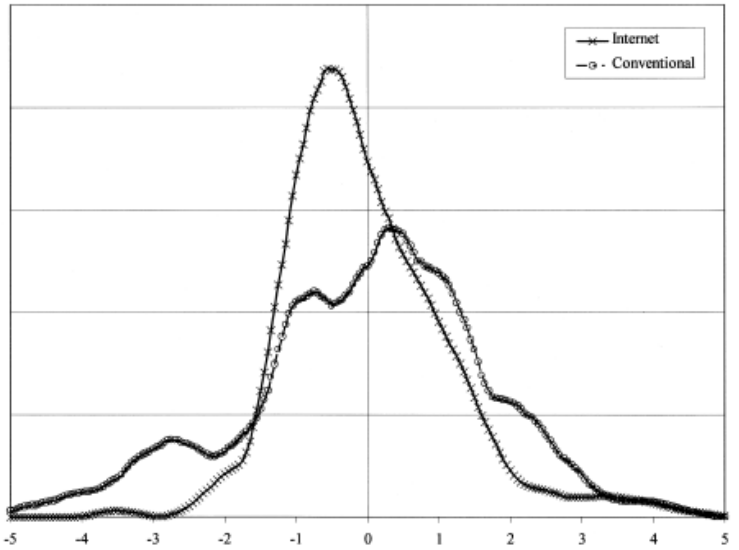
Consumer Awareness of Prices

Figure A7 Kernel Density for De-Meaned Full Prices for Books, Observations Weighted by Screen/Market Share (Epanechnikov Kernel)



De-meaned prices, books

Figure A8 Kernel Density for De-Meaned Full Prices for CDs, Observations Weighted by Screen/Market Share (Epanechnikov Kernel)



De-meaned prices, CDs

Drug prices from NY pharmacies

- Study by Sorensen (2000) analyses price dispersion of various drugs
- Finds smaller price dispersion for drugs for chronic conditions
- Larger price dispersion for one-off drugs

TABLE 2
PRICE DISPERSION AND PURCHASE FREQUENCY

	Dispersion Measure			
	Range (1)	Standard Deviation (2)	Residual Range (3)	Residual Standard Deviation (4)
Purchase frequency	−.336	−.173	−.266	−.102
	(.123)	(.076)	(.061)	(.016)
Wholesale cost	.280	.180	.215	.069
	(.033)	(.020)	(.043)	(.014)
Branded with generic competition	−.803	−1.480	−1.842	−.362
	(1.037)	(.641)	(.861)	(.248)
Branded without generic competition	−1.505	−2.010	−1.967	−.772
	(2.108)	(1.303)	(1.060)	(.339)
Newburgh dummy	−2.686	−3.172	−1.493	−.916
	(.633)	(.314)	(.791)	(.271)
Constant	20.070	7.321	14.570	5.283
	(4.343)	(2.563)	(1.062)	(.448)
R^2	.371	.447	.258	.253
$\hat{\rho}$	.338	.585	.149	.648

Drug prices from NY pharmacies

- Sorensen (2000) also finds lower margins (price close to cost) for chronic drugs

TABLE 3
AVERAGE MARGINS AND PURCHASE FREQUENCY

	Dependent Variable		
	Average Margin (1)	Average Price (2)	Average Relative Margin (3)
Purchase frequency	−.262	−.137	.001
	(.102)	(.105)	(.003)
Wholesale cost	...	.994	...
		(.032)	
Wholesale cost × generic dummy	...	−.208	...
		(.059)	
Branded with generic competition	2.101	−.668	−.235
	(.720)	(1.056)	(.020)
Branded without generic competition	3.415	−.123	−.255
	(1.660)	(1.891)	(.046)
Newburgh dummy	1.681	1.648	.047
	(.174)	(.140)	(.005)
Constant	12.69	11.86	.463
	(2.435)	(2.581)	(.068)
R^2	.229	.895	.510
$\hat{\rho}$	.915	.936	.898

Summary

- Price cutting is a dangerous game
  - Price competition can be severe, even with a small number of firms
- Ways to weaken price competition
  - Make your rivals less aggressive
  - Make consumers less price sensitive
- When production decision predates price, we also have p>c even when selling homogenous products..