Price Competition Under Product Differentiation

Introduction

- In a wide variety of markets firms compete in prices
  - Internet access
  - Restaurants
  - Consultants
  - Financial services
- Without product differentiation competing in prices yields negative consequences for firms with market power
  - The Bertrand Paradox
- However, firms usually compete on product location and prices
- Hence we consider product differentiation under oligopoly

The Bertrand Paradox

- Take a simple example
  - two firms producing an identical product (spring water?)
  - firms choose the prices at which they sell their products
  - each firm has constant marginal cost of *c*
  - inverse demand is $P = A – B.Q$
  - Equilibrium is such that
    - $p_1 = p_2 = c$
    - Both firms make normal profits

Product differentiation

- The Bertrand Paradox is due to homogeneous products
- It creates incentives for firms to *differentiate* their products
  - to generate consumer loyalty
  - do not lose all demand when they price above their rivals
    - keep the “most loyal”

An example of product differentiation

Coke and Pepsi are similar but not identical. As a result, the lower priced product does not win the entire market.

Econometric estimation gives:

$Q_C = 63.42 - 3.98P_C + 2.25P_P$

$MC_C = \$4.96$

$Q_P = 49.52 - 5.48P_P + 1.40P_C$

$MC_P = \$3.96$

There are at least two methods for solving this for P_C and P_P

Bertrand and product differentiation

Method 1: Calculus

Profit of Coke: $\pi_C = (P_C - 4.96)(63.42 - 3.98P_C + 2.25P_P)$

Profit of Pepsi: $\pi_P = (P_P - 3.96)(49.52 - 5.48P_P + 1.40P_C)$

Differentiate with respect to P_C and P_P respectively

Method 2: MR = MC

Reorganize the demand functions

$P_C = (15.93 + 0.57P_P) - 0.25Q_C$

$P_P = (9.04 + 0.26P_C) - 0.18Q_P$

Calculate marginal revenue, equate to marginal cost, solve for Q_C and Q_P and substitute in the demand functions

Bertrand and product differentiation 2

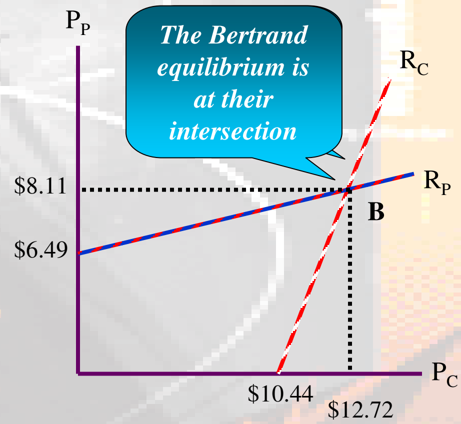
Both methods give the best response functions:

$P_C = 10.44 + 0.2826P_P$

$P_P = 6.49 + 0.1277P_C$

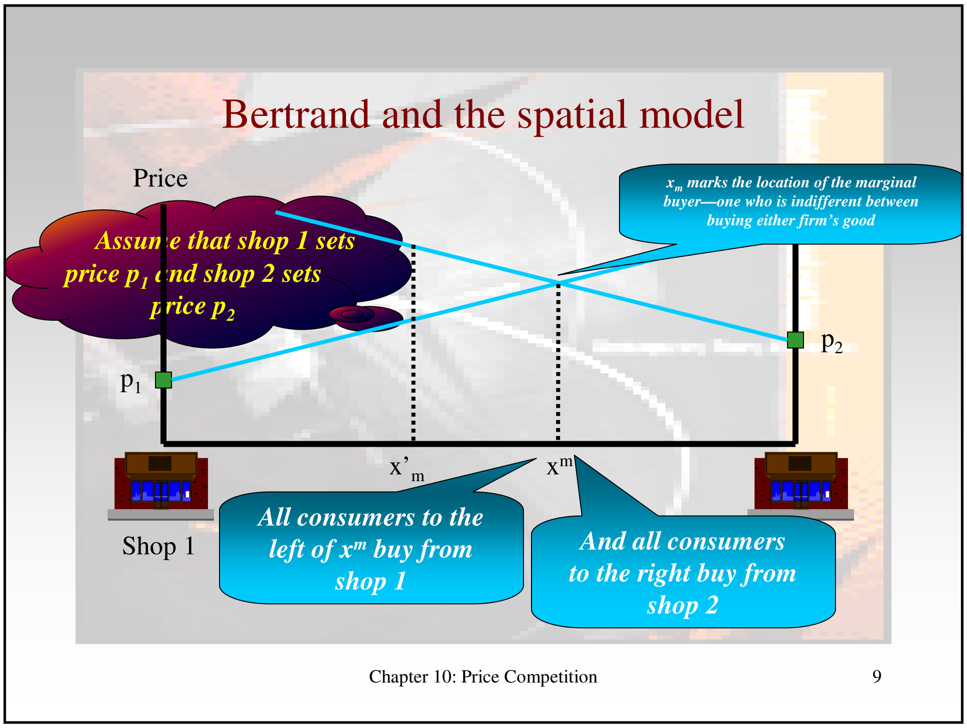
These can be solved for the equilibrium prices as indicated

The equilibrium prices are each greater than marginal cost



Bertrand competition and the spatial model

- An alternative approach: spatial model of Hotelling
  - a Main Street over which consumers are distributed
  - supplied by two shops located at opposite ends of the street
  - but now the shops are competitors
  - each consumer buys exactly one unit of the good provided that its full price is less than V
  - a consumer buys from the shop offering the lower full price
  - consumers incur transport costs of t per unit distance in travelling to a shop
- Recall the broader interpretation
- What prices will the two shops charge?


Bertrand and the spatial model
Price
Assume that shop 1 sets price p1 and shop 2 sets price p2
xm marks the location of the marginal buyer—one who is indifferent between buying either firm's good
p1
p2
x'm
xm
Shop 1
All consumers to the left of xm buy from shop 1
And all consumers to the right buy from shop 2
Chapter 10: Price Competition
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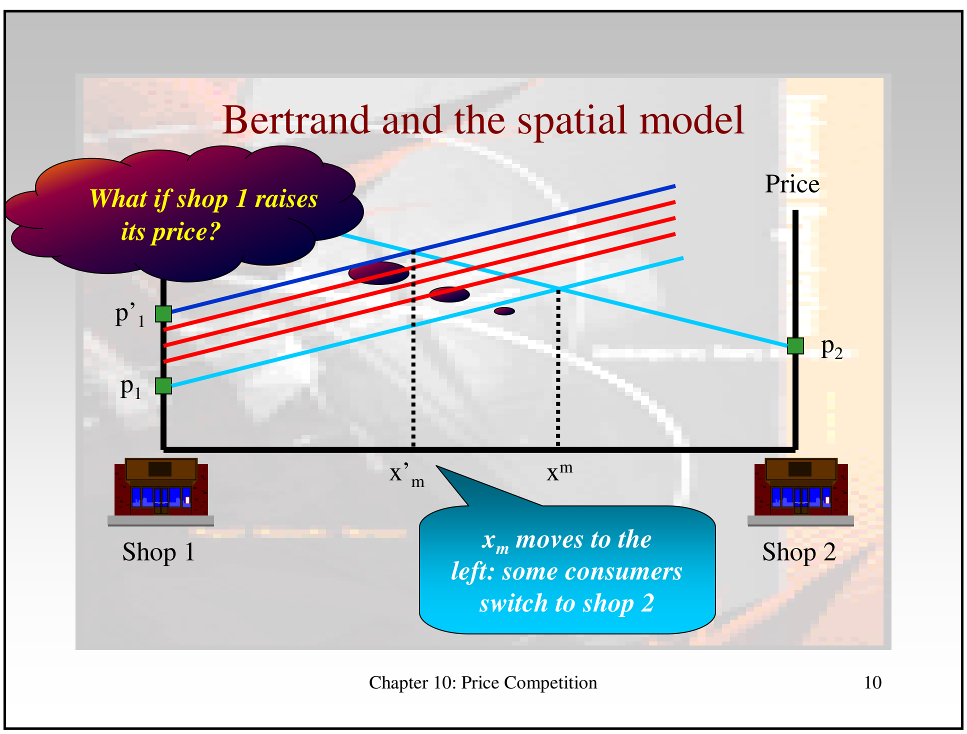
Bertrand and the spatial model
What if shop 1 raises its price?
Price
p'1
p1
p2
x'm
xm
Shop 1
Shop 2
xm moves to the left: some consumers switch to shop 2
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Bertrand and the spatial model 2

$p_1 + tx^m = p_2 + t(1 - x^m)$ $\quad \therefore 2tx^m = p_2 - p_1 + t$

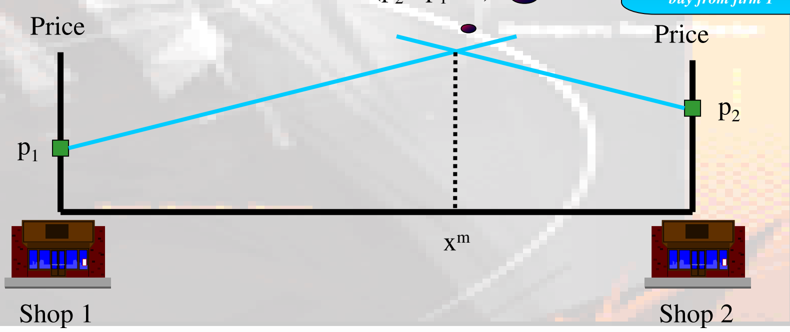
$\therefore x^m(p_1, p_2) = (p_2 - p_1 + t)/2t$

There are N consumers in total

So demand to firm 1 is $D^1 = N(p_2 - p_1 + t)/2t$

How is x^m determined?

This is the fraction of consumers who buy from firm 1



Bertrand equilibrium

Profit to firm 1 is $\pi_1 = (p_1 - c)D^1 = N(p_1 - c)(p_2 - p_1 + t)/2t$

$\pi_1 = N(p_2p_1 - p_1^2 + tp_1 + cp_1 - cp_2 - ct)/2t$

Differentiate with respect to p_1

$$\partial\pi_1/\partial p_1 = \frac{N}{2t}(p_2 - 2p_1 + t + c) = 0$$

Solve this for p_1

$p^*_1 = (p_2 + t + c)/2$

This is the best response function for firm 1

What about firm 2? By symmetry, it has a similar best response function.

$p^*_2 = (p_1 + t + c)/2$

This is the best response function for firm 2

Bertrand equilibrium 2

$p^*_1 = (p_2 + t + c)/2$

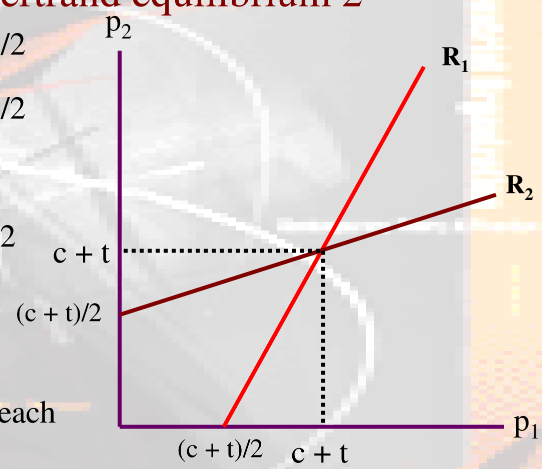
$p^*_2 = (p_1 + t + c)/2$

$2p^*_2 = p_1 + t + c$

$= p_2/2 + 3(t + c)/2$

$\therefore\ p^*_2 = t + c$

$\therefore\ p^*_1 = t + c$



Profit per unit to each firm is t

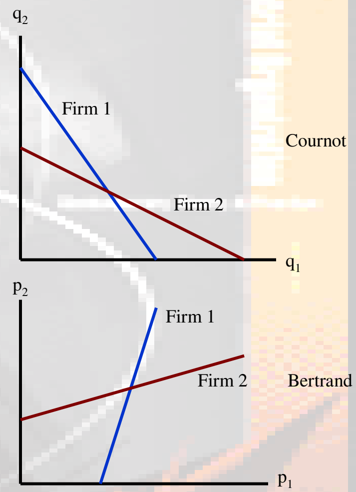
Aggregate profit to each firm is Nt/2

Bertrand competition 3

- Two final points on this analysis
- *t* is a measure of transport costs
  - it is also a measure of the value consumers place on getting their most preferred variety
  - when *t* is large competition is softened
    - *and profit is increased*
  - when *t* is small competition is tougher
    - *and profit is decreased*
- Locations have been taken as fixed
  - suppose product design can be set by the firms
    - balance "business stealing" temptation to be close
    - against "competition softening" desire to be separate

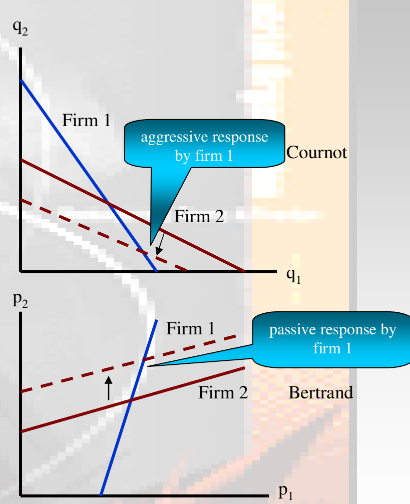
Strategic complements and substitutes

- Best response functions are very different with Cournot and Bertrand
  - they have opposite slopes
  - reflects very different forms of competition
  - firms react differently e.g. to an increase in costs



Strategic complements and substitutes

- suppose firm 2's costs increase
- this causes Firm 2's Cournot best response function to fall
  - at any output for firm 1 firm 2 now wants to produce less
- firm 1's output increases and firm 2's falls
- Firm 2's Bertrand best response function rises
  - at any price for firm 1 firm 2 now wants to raise its price
- firm 1's price increases as does firm 2's



Strategic complements and substitutes 2

- When best response functions are upward sloping (e.g. Bertrand) we have *strategic complements*
  - passive action induces passive response
- When best response functions are downward sloping (e.g. Cournot) we have *strategic substitutes*
  - passive actions induces aggressive response
- Difficult to determine strategic choice variable: price or quantity
  - output in advance of sale – probably quantity
  - production schedules easily changed and intense competition for customers – probably price