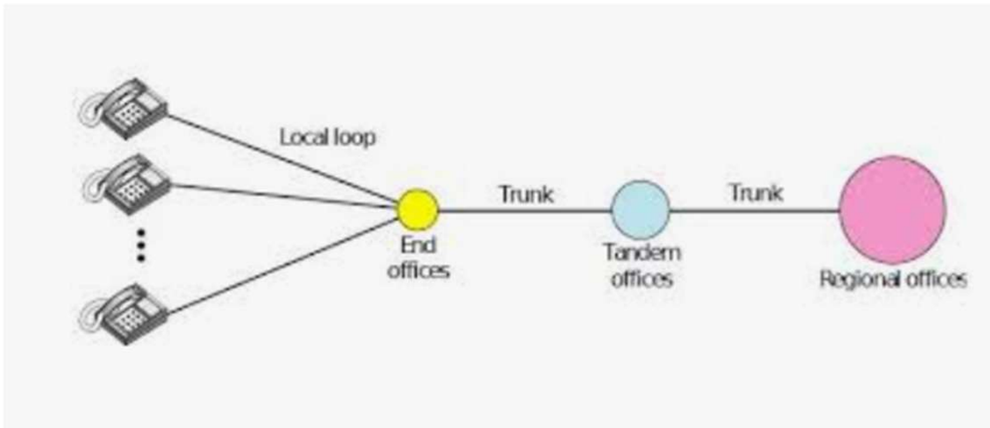
ECON3133
Microeconomic Theory II

Tutorial #12: Imperfect Competition – privatizing the telephone industry in the UK

Today's tutorial:

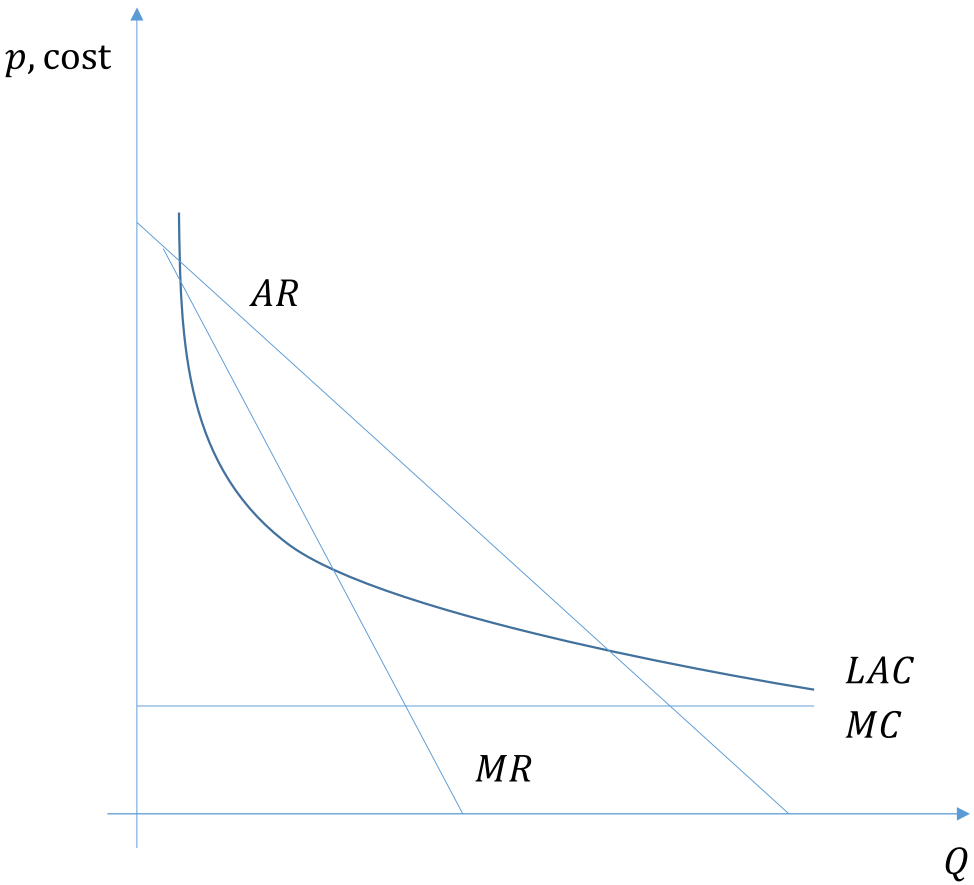
- Imperfect competition and the case of privatising the landline telephone monopoly
  - Landline telephony is a homogenous product
  - Can be analysed in terms of the models of imperfect competition that we have looked at
  - The analysis is inspired by the case of the UK, where the privatisation of British Telecom (BT) in 1984 was the first privatisation of the Thatcher government
  - The initial privatisation was accompanied by the creation of Mercury Communications in 1982
    - Intended as a competitor to BT
  - We model the privatisation in a Stackelberg framework

Structure of the telephone industry:



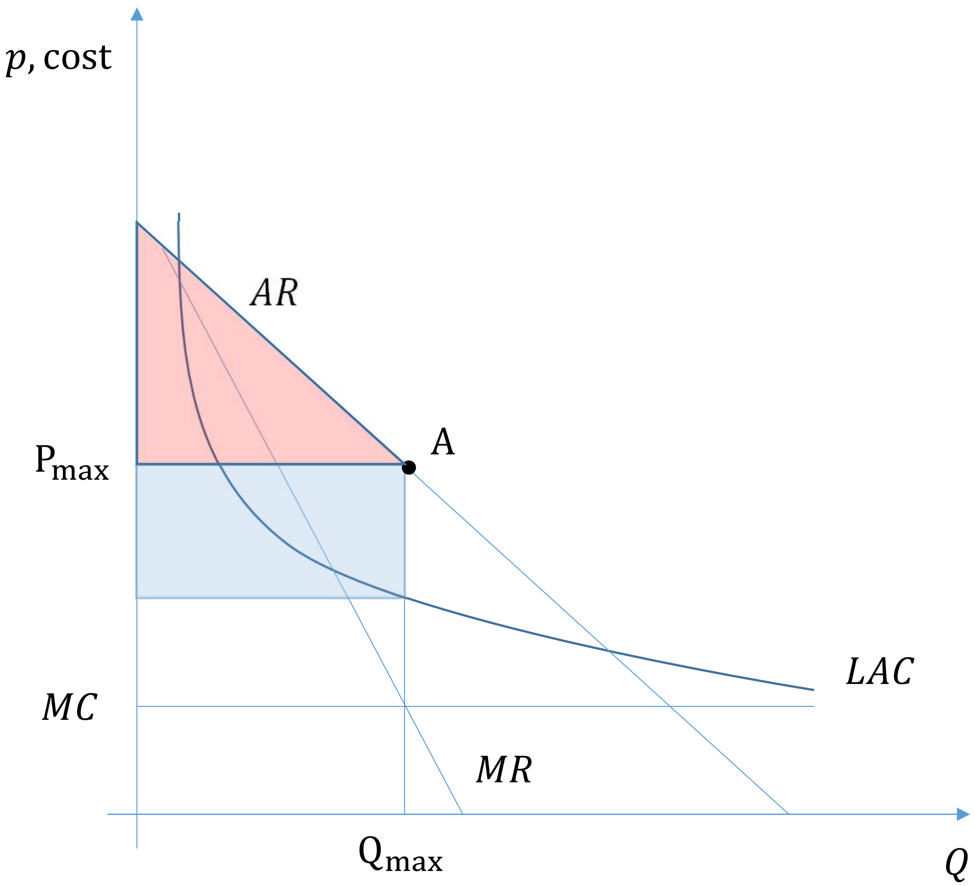
- The landline telecommunications industry traditionally consists of
  - Access network: Connects the switching network to the consumer – "the last mile"
  - Switching network: Centralized points on a network to enable communication between points on the network
  - Transmission network: Transmits calls between points on the switching networks

The starting point: a monopoly telephone company



- Assume that a single firm is responsible for the telephone industry
- Suppose that the firm has total costs
  - $TC = 10000 + 4Q$
- Then $LAC = \frac{10000}{Q} + 4$ and $MC = 4$
- Also suppose that the market demand curve is given by $Q^D = 500 - \frac{1}{2}p$
- Assume that the firm maximises profits
- What is the equilibrium output, Q, price, p, profits, Π and consumer surplus in this case?

The starting point: a monopoly telephone company



- The firm's optimisation problem:

$$\max_Q \Pi = pQ - TC$$
$$= 1000Q - 2Q^2 - 10000 - 4Q$$
$$= 996Q - 2Q^2 - 10000$$

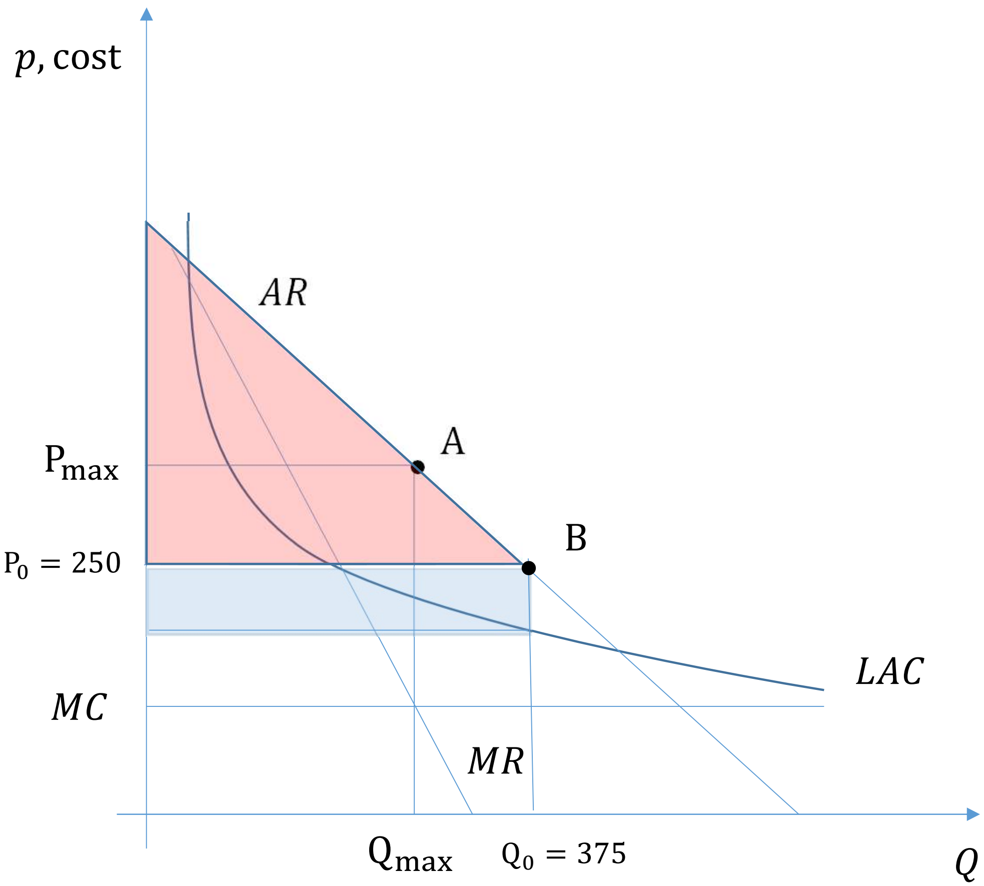
- FOC: $\frac{d\Pi}{dQ} = 996 - 4Q = 0$

$$Q_{max} = 249$$
$$P_{max} = 1000 - 2 \times Q_{max}$$
$$= 502$$
$$\Pi_{max} = 249 \times 502 - 10000 - 4 \times 249$$
$$= 114{,}002$$

$$CS_{max} = \frac{1}{2}(1000 - 502) \times 249$$

=62,001

The starting point: a monopoly telephone company

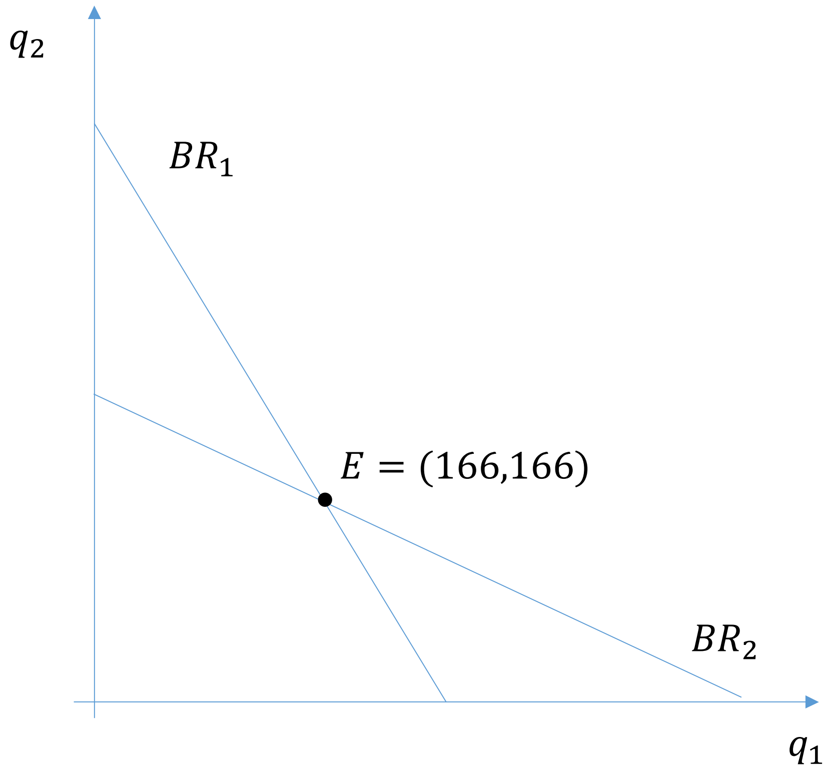


- Now suppose that the government decides that 502 is too high a price to pay for telephone calls, and fixes the price at 250
- What are output, profits and consumer surplus in this case?
- The firm now produces $\mathrm{Q_0} = 500 - \frac{1}{2}p_0 = 375$ (from 249 previously)
- Note that the firm maximises profits in this case by producing on the demand curve ($MR = p_0 > \mathrm{MC}$ for $Q \le Q_0$)
- Profits are now $\Pi = 250 \times 375 - 10000 - 4 \times 375 = 82{,}250$ (from 114,002 previously)
- CS is now $\frac{1}{2}(1000 - 250) \times 375 = 140{,}625$ (from 62,001 previously)

Privatisation and the introduction of a competitor: duopoly

- Now suppose that instead of price controls, the government believes that the introduction of a competitor will reduce prices for the consumer
- A consortium consisting of Cable & Wireless, Barclays and BP believes that entering the UK telephone market could be profitable, and creates Mercury Communications to compete with BB
- The competitor has cost function
- $C(q_2) = 4q_2 + F_2$
- We now have a duopoly in the UK telephone industry

The Cournot equilibrium in a duopoly



- Suppose that both BT (firm 1) and Mercury (firm 2) decide output, q_1 and q_2, and let the market decide price
- Cost function: $C_i(q_i) = cq_i + F_i$
- Market demand: $P = a - bQ$
- This is now a Cournot problem:
- Firm 1: $\max_{q_1} \pi_1(\, q_1, q_2) = \pi_1(q_1, BR_2(q_1))$
- Firm 2: $\max_{q_2} \pi_2(\, q_1, q_2) = \pi_2(BR_1(q_2), q_2)$
- With solution:
  - $q_1^{NE} = q_1^{NE} = \frac{1}{n+1}\left[\frac{a-c}{b}\right]$
- With $a = 1000, b = 2, c = 4$ we have in this case:
  - $q_1^{NE} = q_1^{NE} = 166$

The Cournot equilibrium in a duopoly

- The Cournot equilibrium gives the following results
  - $q_{NE}(\mathrm{n,c}) = \frac{1}{n+1}\left[\frac{a-c}{b}\right]$
  - $Q^{NE}(n,c) = n \times q_{NE}$
  - $p^{NE}(\mathrm{n},c) = 1000 - 2 \times Q^{NE}(n)$
  - $\pi_i(n,c) = p^{NE}(\mathrm{n},c) \times q_{NE}(n,c) - \mathrm{c} \times q_{NE}(n,c)$
  - $\Pi(n,c) = n \times \pi_i(n,c)$
  - $n = 2$
  - $a = 1000$
  - $b = 2$
  - $c = 4$
  - $q_{NE}(\mathrm{n,c}) = \frac{1}{3}\left[\frac{1000-}{2}\right] = 166$
  - $Q^{NE}(n,c) = 2 \times q_{NE} = 332$
  - $p^{NE}(\mathrm{n},c) = 1000 - 2 \times Q^{NE}(n) = 336$
  - $\pi_i(n,c) = p^{NE}(\mathrm{n},c) \times q_{NE}(n,c) - \mathrm{c} \times q_{NE}(n,c) - F_i$
  - Firm 1: $\pi_1(2,4) = 45{,}112$
  - Firm 2: $\pi_2(2,4) = 55{,}112 - F_2$
  - $\Pi(n,c) = 100{,}224 - F_2$
  - $CS = \frac{1}{2}(1000 - 336) \times 332 = 110{,}224$

The Cournot equilibrium in a duopoly compared to the monopoly case

- Would there be benefits to privatisation and the introduction of a duopoly?

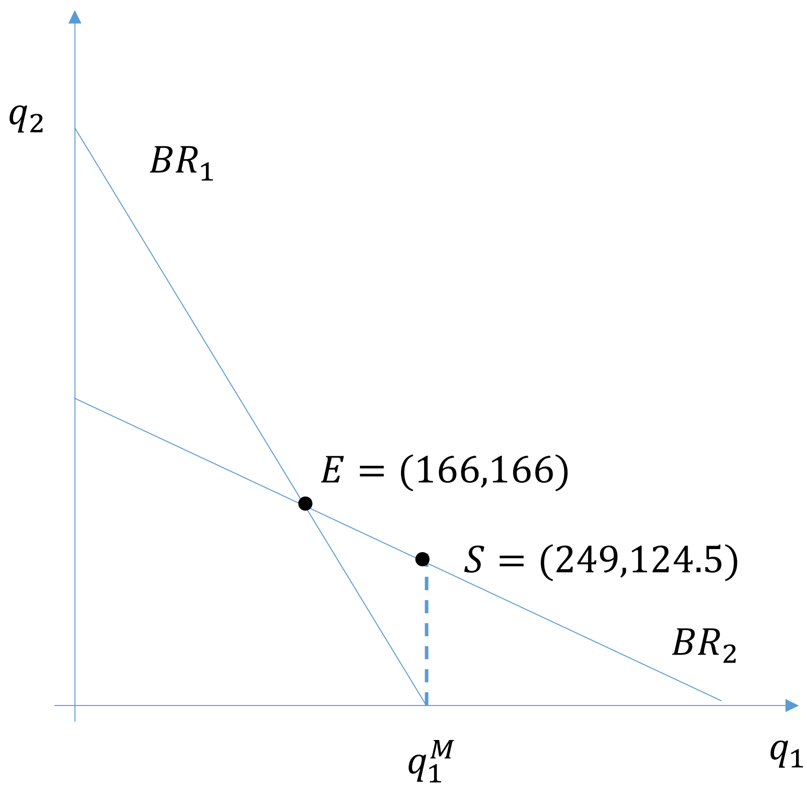
	Before privatisation: monopoly		**Privatisation and duopoly**
	Without price control	With price control	2 firms: Cournot
q_i	-	-	166
Q	249	375	332
P	502	250	336
π_1	-	-	45,112
Π	114,002	82,250	100,224$-F_2$
CS	62,001	140,625	110,224

- Under the duopoly, market output would be close to that under monopoly with price control, whilst price would be roughly half-way between monopoly with and without price control
- Profits depend on fixed costs, but would be roughly half way between the monopoly cases
- Consumer surplus is higher than under the basic monopoly but below what it was under price controls

Extending the analysis: BT as incumbent and Mercury as entrant

- In practice, BT was the incumbent in the industry, and Mercury the entrant
- Therefore, we may model this in the Stackelberg framework with:
  - BT: Leader, firm 1
  - Mercury: Follower, firm 2
- Control case: Assume that Mercury has no fixed costs
- The framework:
  - $t = 1$: Incumbent chooses q_1
  - $t = 2$: Entrant chooses q_2 after observing q_1
- Solve using backward induction

Extending the analysis: BT as incumbent and Mercury as entrant



- With no fixed costs for firm 2, the Stackelberg problem is:
  - Firm 2: $\max_{q_2} \pi_2(q_1, q_2) = [a - b(q_1 - q_2) - c]\, q_2$
    - $q_2^F = \frac{a - bq_1 - c}{2b}$
  - Firm 1: $\max_{q_1} \pi_1(q_1, BR_2(q_1)) = \left[a - b\left(q_1 - BR_2(q_1)\right) - c\right] q_1$
    - $q_1^L = \frac{a-c}{2b} = 249$
  - Then Firm 2's output is then $q_2^F = \frac{a-c}{4b} = 124.5$
  - Note:
    - $q_1^L = 249 =$ monopoly output (with linear demand and cost functions)
    - $q_1^L > q_1^{NE}$
    - $q_2^F < q_2^{NE}$

Extending the analysis: BT as incumbent and Mercury as entrant

- The basic Stackelberg equilibrium

	Duopoly firms	
	BT (Incumbent)	Mercury (entrant)
q_i	249	124.5
Q	373.5	
P	253	
π_i	52,001	31,000.5

- Under the duopoly, market output would be close to that under monopoly with price control (375), whilst price would be roughly half-way between monopoly with (250) and without (502) price control
- Profits depend on fixed costs, but would be roughly half way between the monopoly cases

Extending the analysis: BT as incumbent and Mercury as entrant

	Before privatisation: monopoly		Privatisation		
	Without price control	With price control	Cournot	Duopoly: BT	Duopoly: Mercury
q_i	-	-	166	249	124.5
Q	249	375	332	373.5	
P	502	250	336	253	
π_i	-	-	45,112	52,001	31,000.5
Π	114,002	82,250	100,224$-F_2$	83,001.5	
CS	62,001	140,625	110,224	139,502.3	

- Under Stackelberg, profits for BT have increased, but profits for Mercury have fallen compared to the Cournot equilibrium; total profits are lower under Stackelberg (note that we've assumed zero fixed costs for Mercury in the basic Stackelberg case)
- First mover advantage has increased BT's profits by 15%
- Price and output are close to their levels under price control: Stackelberg is good for consumers!

Extending the analysis: BT as incumbent and Mercury as entrant

- In practice, the new entrant will have fixed costs, which will reduce profits
- Assuming that we are still in a leader/follower framework, we need to address the following questions:
  - What is the relationship between firm 2's profits and fixed costs in a Stackelberg framework?
  - What is BT's optimal behaviour in this framework?
  - What should the government do to achieve its objective of greater competition leading to an increase in consumer welfare?

Extending the analysis: BT as incumbent and Mercury as entrant

- The relationship between firm 2's profits and fixed costs in a Stackelberg framework
- Suppose now that Mercury/firm 2 incurs fixed costs of F_2
- Mercury may decide whether or not to enter the market; its total costs will be:
- $C_2(q_2) = \begin{cases} 0 & q_2 = 0 \Rightarrow \text{ Mercury does not enter the market} \\ F_2 & q_2 > 0 \Rightarrow \text{ Mercury enters the market} \end{cases}$
- Mercury's decision process may be summarised:
  - $t = 1$: BT produces q_1
  - $t = 2$: Mercury observes q_1 and decides whether to enter
  - $t = 3$ (or simultaneously at $t = 2$): Mercury chooses q_2

Extending the analysis: BT as incumbent and Mercury as entrant

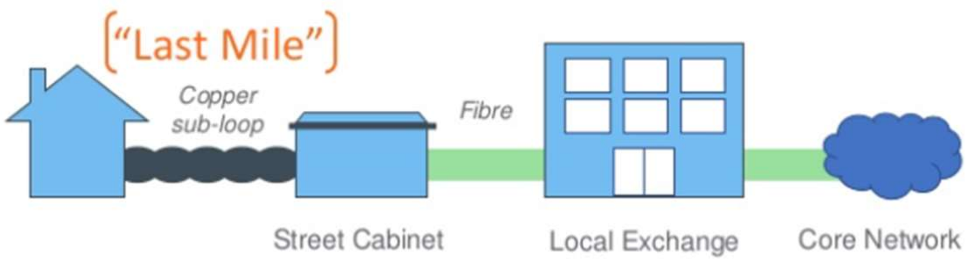
- Mercury's profit maximisation problem is now:
- $\max_{q_2} \pi_2(q_1, q_2) = (a - b(q_1 + q_2) - c)q_2 - F_2$
- $q_2^F = BR_2(q_1) = \begin{cases} \frac{a-c-bq_1}{2b} & q_2 > 0 \Rightarrow \text{ Mercury enters the market} \\ 0 & q_2 = 0 \Rightarrow \text{ Mercury does not enter the market} \end{cases}$
- Mercury's profits under the optimal response are:
  - $\pi_2^F = (a - q_1^L - q_2^F - c)q_2^F - F_2$, with:
    - $q_1^L = \frac{a-c}{2b}$; $q_2^F = \frac{a-c}{4b}$
  - ie $\pi_2^F = \frac{1}{b}\left(\frac{a-c}{4}\right)^2 - F_2$
- Mercury will enter the market as long as:
  - $\pi_2^F > 0$ ie as long as $\frac{1}{b}\left(\frac{a-c}{4}\right)^2 > F_2$ to give $F_{2,crit} < 31{,}000.5$

Extending the analysis: BT as incumbent and Mercury as entrant

- Therefore, Mercury can make profits as long as its fixed costs are not more than 31,000.5
- However, Mercury tells the government:
  - Its best estimate of its fixed costs as a new entrant is approximately 20,000
  - This generates expected profits of $\frac{1}{b}\left(\frac{a-c}{4}\right)^2 - F_2 = 11{,}000.5$
  - Mercury's weighted average cost of capital requires profits of 15,000 to make the whole project worthwhile
- With BT producing $\frac{a-c}{2b} = 249$ and Mercury producing $\frac{a-c}{4b} = 124.5$, Mercury's profits with fixed costs 20,000 are at 11,000.5, not high enough to justify the consortium's investment
- What can the government do in this case?

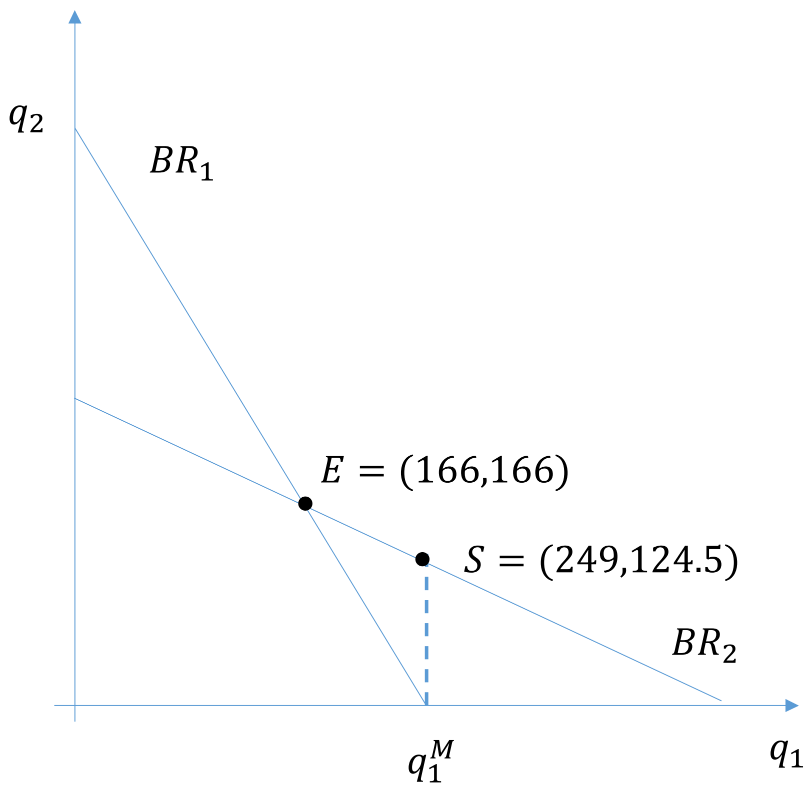
Extending the analysis: BT as incumbent and Mercury as entrant

- The government does not want to see a public monopoly become a private monopoly, and so is very keen that Mercury enter and remain in the market
- The government proposed the following:
  - Mercury pay BT to use BT's network, except for the 'last mile': the part of the network from the local exchange to consumers' homes/offices



  - How much should Mercury pay?
    - Half the value of the fixed costs (ie 5,000)?
    - Less? More?

Extending the analysis: BT as incumbent and Mercury as entrant



- The government decides that Mercury should pay BT 5,000 to use BT's network
- BT wants the fee to be higher than 5,000 to compensate BT for the risk to its business that the new entrant brings
- Mercury also has fixed costs of 10,000 for the 'last mile', so total fixed costs = 15,000
- So now Mercury's expected profits are $\frac{1}{b}\left(\frac{a-c}{4}\right)^2 - F_2 =$ $16{,}000.5$
- This is enough to keep Mercury's shareholders happy
- BT's profits are now 57,001

Extending the analysis: BT as incumbent and Mercury as entrant

	Before privatisation: monopoly		**Privatisation**				
	Without price control	With price control	Cournot	Leader: BT	Follower: Mercury (fixed costs 20,000)	Leader: BT with fixed fee	Follower: Mercury with fixed fee
q_i	-	-	166	249	124.5	249	124.5
Q	249	375	332	373.5		373.5	
P	502	250	336	253		253	
π_i	-	-	45,112	52,001	11,000.5	57,001	16,000.5
Π	114,002	82,250	$100{,}224 - F_2$	63,001.5		73,001.5	
CS	62,001	140,625	110,224	139,502.3		139,502.3	

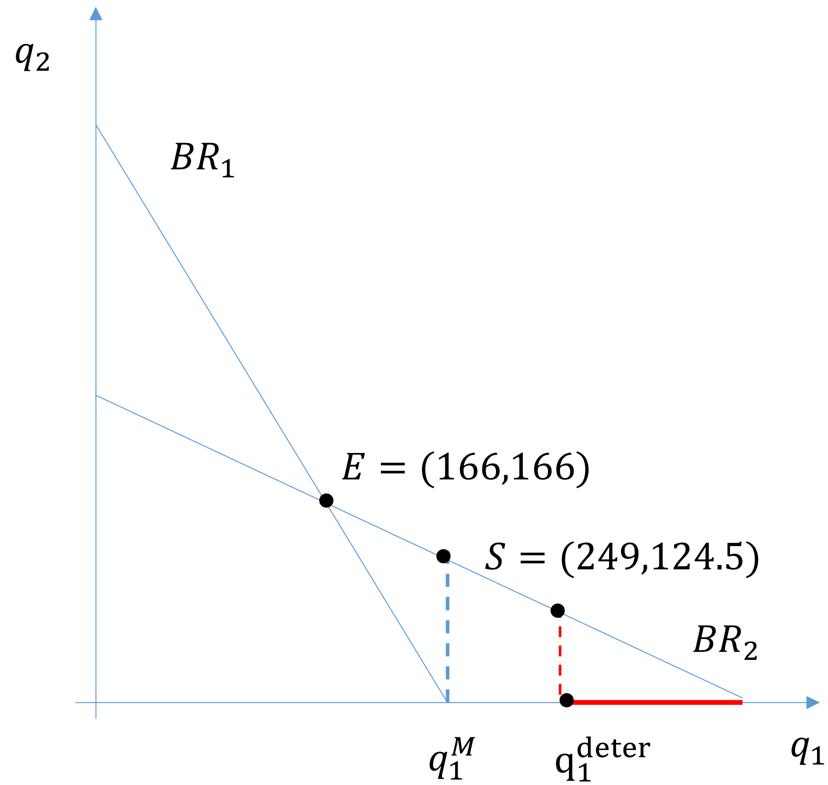
- Both BT and Mercury benefit from the fixed fee arrangement: profits are higher for both
- Do you think BT is happy with the overall outcome?
- BT did much better when it was a monopoly…

Extending the analysis: BT as incumbent and Mercury as entrant

- BT's management begin to feel nostalgic about the past
- They wonder if there's any way that they could increase profits
- What could they do?
    - 1)
    - 2)
    - 3)
    - 4)

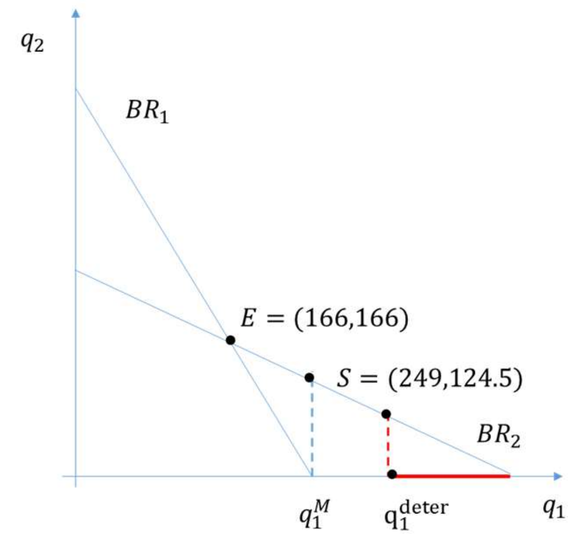
Extending the analysis: BT as incumbent and Mercury as entrant

- BT wonders whether it has a deterrence strategy to drive Mercury out of the market
- Deterrence strategy given by:
- $q_2 = BR_2(q_1) = \begin{cases} \frac{a-c-bq_1}{2b} & \text{If } q_1 < q_1^{\text{deter}} \\ 0 & \text{If } q_1 \geq q_1^{\text{deter}} \end{cases}$
- Firm 2's profit function in this case is:
- $\pi_2^F(q_1, q_2 = BR_2(q_1)) = \frac{1}{b}\left(\frac{a-c-bq_1}{2b}\right)^2 - F_1$
- And
- $\pi_2^F \leq 0$ for deterrence to work
- Then BT will produce q_1^{deter} if:
  - $\pi_1^{L,\text{deter}} > \pi_1^L$



Extending the analysis: BT as incumbent and Mercury as entrant

- We have:
- $q_1^{\text{deter}} = \frac{a-c-2\sqrt{F_2 b}}{b} \approx 325$
- And
- $P = 1000 - 2 \times q_1^{\text{deter}} = 350$
- $\pi_1^{\text{L,deter}} = 107{,}500$
- $\pi_1^{L} = 57{,}001$
- So BT has every incentive to produce q_1^{dete} to drive Mercury out of the market!
- Also, CS here $= 105{,}492$, from 139,502 in the initial Stackelberg equilibrium
- So should the government allow BT to play this strategy?



Extending the analysis: BT as incumbent and Mercury as entrant

- It's likely that this situation will prove temporary: Mercury will likely lose interest eventually, leaving BT as a private sector monopoly
- So this is unlikely to benefit consumers for longer than the short run
- What could/should the government do instead?
  - 1) Prohibit BT from overproducing?   Impossible to measure and enforce
  - 2) Manage Mercury's fixed costs more aggressively?   Mercury already gets a good deal
  - 3) Encourage BT and Mercury to differentiate their products? Difficult with such a homogeneous product, but there was evidence of this

What happened to BT and Mercury?

- Mercury Communications went out of business in 1997
- BT's power as the incumbent proved too strong
- BT agreed a range of global alliances, arguing to the UK government that it was now national champion and should be encouraged rather than discouraged
- Successive governments were stricter with BT, especially as telecommunications completely changed
- BT now faces competition in all its business lines