LECTURE 3.7

OLIGOPOLY – THE STACKLEBERG MODEL

THE STACKLEBERG MODEL

In the Cournot model, firms choose output simultaneously

- but firms might move sequentially instead of simultaneously: e.g. one firm entered the market first, one firm is a recognised industry leader

The Stackelberg model

- sequential quantity competition
- firms produce identical products
- a leader is able to commit to output before the follower(s)
- followers choose output to maximise profits after observing the leader's output
- no entry

We will look for a sub-game perfect Nash equilibrium.

PEPSI V COCA COLA

Pepsi announces that it will wait to see how much Coke ships before determining its quantity.

Pepsi's executives argue that waiting will give Pepsi more information.

Is this a good idea?

THE STACKLEBERG MODEL

After the leader moves, competitors learn the leader's strategy and respond to it

This gives the leader an incentive to produce more:

- the extra units produced by the leader reduce the residual demand of its competitors
- this reduces the incentive for rivals to produce
- the reduced output of rivals increases the leader's profit
- the leader considers this effect when choosing output

This is called the first mover advantage in the Stackelberg model.

THE STACKLEBERG MODEL

The dominant firm is the Stackleberg leader (call this firm A) and others are the Stackleberg followers (the B firms).

Like Cournot, this is a model in which the choice variable is quantity.

Industry output equals the sum of each firm's output:

$$Q_A + Q_B = Q$$

and

$$MC_A = MC_B$$

THE STACKLEBERG MODEL

In the Stackleberg model we will consider the choice of the follower first. We solve this game backwards.

When the follower makes its decision it takes the decision of the leader as given and chooses a level of output to maximise profit:

$$\max_{Q_B} P(Q_A, Q_B)Q_B - Q_B c_B$$

In effect the follower will choose a level of output such that marginal revenue equals marginal cost. Importantly:

$$Q_B = f(Q_A)$$

THE STACKLEBERG MODEL

This expression $Q_B = f(Q_B)$ is called a reaction function

We can now consider the leaders problem, which involves choosing a level of output to maximise profit taking into account how the follower will behave.

That is, the leader must:

$$\max_{Q_A} P(Q_A, Q_B)Q_A - Q_A c_A$$

Or

$$\max_{Q_A} P\big(Q_A, f(Q_A)\big)Q_A - Q_A c_A$$

THE STACKLEBERG MODEL

Consider the following demand and cost conditions:

- demand: $P(Q) = 40-Q$, where $Q = Q_1+Q_2$
- costs: $C(Q_i) = 4Q_i$, $i = 1, 2$

By backward induction, we first solve Firm 2's problem:

- Firm 2 chooses an optimal output given the output of Firm 1. This is equivalent to finding the reaction function in the Cournot model

Profits: $\pi_2 = (40-Q_1-Q_2)Q_2-4Q_2$

Solve FOCs to find the reaction function:

$$0 = 40-Q_1-2Q_2-4$$

$$Q_2 =18-Q_1/2 \equiv r_2(Q_1)$$

THE STACKLEBERG MODEL

What about Firm 1?

Firm 1 is committed to Q_1 when Firm 2 produces, but Firm 1 chooses Q_1 strategically

$$\pi_1(Q_1, Q_2) = P(Q_1, Q_2)Q_1 - C(Q_1)$$
$$\pi_1(Q_1) = P(Q_1, R(Q_1))Q_1 - C(Q_1)$$
$$= (40 - (Q_1 + 18 - Q_1/2))Q_1 - 4Q_1$$
$$= 18\,Q_1 - Q_1^2/2$$

- Firm 1's first order conditions then give: $0 = 18 - Q_1 \Rightarrow Q_1 = 18$
- Substitute into Firm 2's reaction function:

$$Q_2 = 18 - \frac{Q_1}{2} = 9$$

STACKLEBERG VS COURNOT

Contrast this result with what we would have found under the Cournot model.

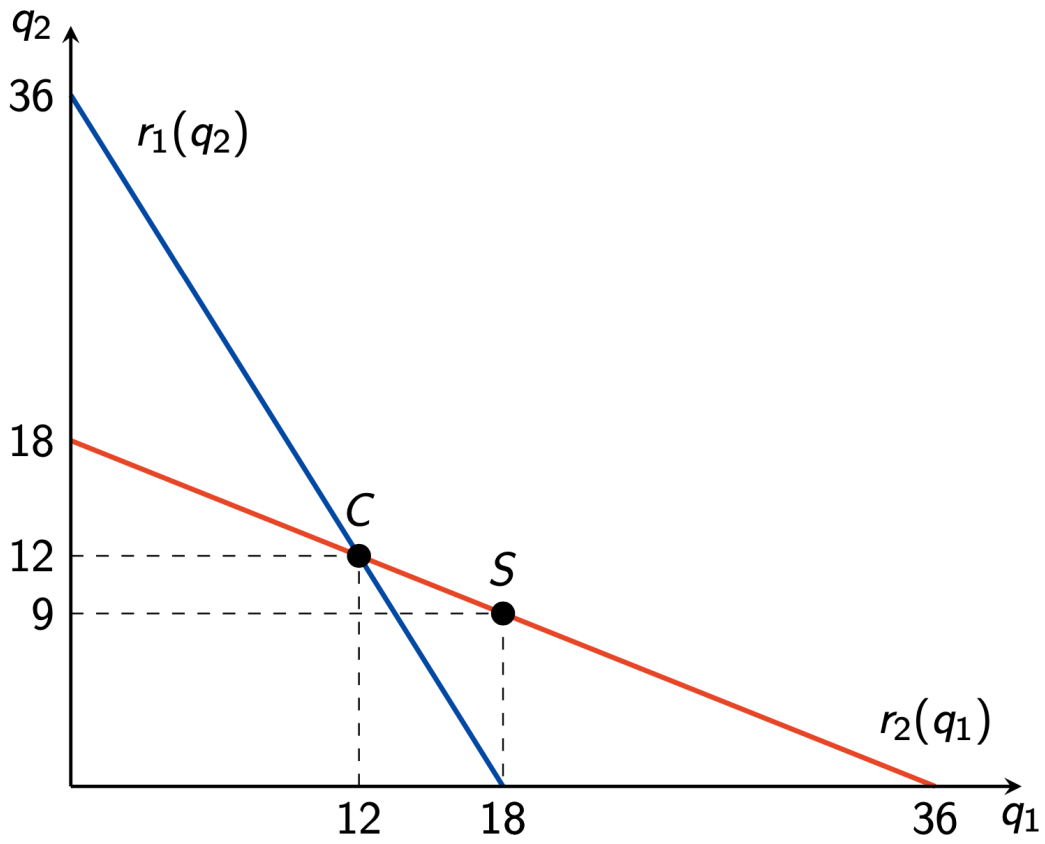
Under Cournot, Firm 1 has an equivalent reaction function to Firm 2:

$$Q_1 = 18 - \frac{Q_2}{2}$$

Substitute in Firm 2's reaction function:

$$Q_1 = 18 - \frac{\left(18 - \frac{Q_1}{2}\right)}{2} = 12 = Q_2$$

STACKLEBERG VS COURNOT



THE STACKLEBERG MODEL

What is going on here?

- Firm 1 wants to produce more to discourage Firm 2 from producing. How much more depends on the slope of demand and the slope of the reaction function.

Questions

- Is Firm 1 operating on their reaction function?
- Would Firm 1 be better off changing their output after observing Q_2?
- What if Firm 2 anticipates this?

THE STACKLEBERG MODEL

Players can benefit from the ability to commit

- the leader has a “first-mover advantage”
- the leader produces more than the Cournot equilibrium output
- the leader receives a larger market share and higher profits

The follower

- produces less than the Cournot equilibrium output
- receives a smaller market share and lower profits