Reading map:

The Cournot and Stackelberg models are discussed in Chapter 6 of the Carlton and Perloff text book. The basic Cournot model discussed in class is discussed in pages 161-166, and the Stackelberg model is discussed in pages 176-180. However, the Carlton and Perloff text does not do a good job of discussing the algebra that we have discussed in class, and you will have to rely on the Power Point file and the solution to the tutorial for that.

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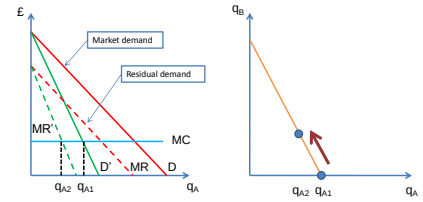
<td>Cournot duopoly – strategic behaviour
• Firm behaviour
• Reaction function
 
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<td>A firm's strategy is reflected in its reaction function. Consider a firm which is the incumbent and a monopolist. The demand for its output is then given by the market demand curve (solid red). It sets MC = MR to maximise profit, and the corresponding output level is q_{A1}. Suppose now a new firm enters the market. The incumbent firm no longer caters to the market demand on its own. Its <u>residual demand curve</u> (dotted red) is the difference between the market demand and the output of the new entrant. Given this new demand curve, the incumbent once again sets MC = MR, and the resultant output level s q_{A2}. Note that $q_{A2} < q_{A1}$, i.e., as the new entrant increases its output from zero to some positive amount, the incumbent reduces its own output. (The underlying logic is that if the incumbent maintains its output level when the new entrant increases its output then there will be a glut in the market and hence the price will fall significantly, and this is what the incumbent is trying to avoid.) The incumbent's strategy is therefore if my competitor produces more, I should produce less. (The strategy of the new entrant is exactly the same.) In other words, there is a negative relationship between q_A and q_B, and this is captured by the negatively sloped reaction function.</td>
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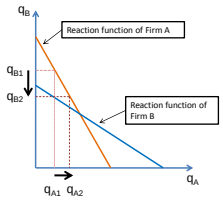
<td>Cournot duopoly – Nash equilibrium
 

• Each firm's output depends on the output choice of the other firm: <u>Nash strategy</u>
• At the quantity levels defined by the intersection of the two reaction functions, neither firm has any incentive to change output: <u>equilibrium</u></td>
<td>Note that in Cournot competition the strategy adopted by both firms is a Nash strategy; the action of each firm is dependent on the action of its competitor. Hence, any equilibrium that we get out of it would be a Nash equilibrium. We get this equilibrium by drawing the reaction functions of both the firms in the same diagram. The Nash equilibrium is given by the intersection of the two reaction functions. Once the firms are this point, neither has any incentive to change its output. If, by contrast, you choose any q_A or q_B that is to the left or to the right of this point, each firm will have an incentive to change its output in a way that will drive them to the intersection of the two reaction functions. For example, if Firm B produces q_{B1}, Firm A would react by producing</td>
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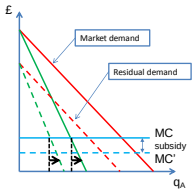
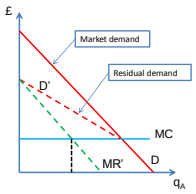
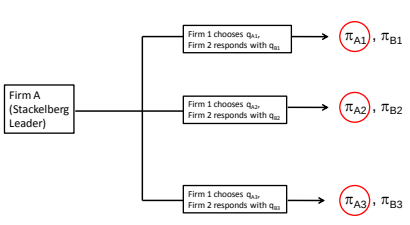
	q_{A1}. But for that output level of Firm A, Firm B should produce q_{B1}, and Firm A's reaction to it would be q_{A2} level of output. This will continue until both firms are at the intersection point of the reaction functions.
Strategy II – impact of subsidy  • Subsidy reduces marginal cost of production • The new marginal cost equals the marginal revenue at a higher output level • The optimum output level of the firm is higher	When one firm (lobbies for and) gets a subsidy from the government, its de facto cost of production decreases. In the diagram, the marginal revenue curve shifts down from MC to MC', and the distance between the two curves is the subsidy. You can easily verify that irrespective of whether a firm caters to the entire market demand (solid red) or to the residual demand that is the difference between the market demand and the output of its competitor (dotted red), the decline in marginal cost will increase the output level. Note that if the firm receiving the subsidy increases its output, given the nature of the Nash strategy in the Cournot model, its rival will necessarily reduce its output. In other words, a subsidy allows the recipient of this subsidy to expand its market share at the expense of its competitors.
Strategy III – become a Stackelberg leader  • Firm A (the Stackelberg leader) takes the strategic behaviour of Firm B into consideration • Note the difference in the residual demand curve (relative to the Cournot competition scenario) • In equilibrium, Firm A (the leader) would be better off and Firm B (the follower) would be worse off	A Stackelberg leader understands the nature of Nash strategy in the Cournot model. It knows that its competitor's output will decline if it maintains or increases its output. In other words, the leader knows that the residual demand for its output is not characterised by a parallel shift of the market demand curve to the left. When q_A is high, q_B is low and hence there is virtually no difference between the market demand curve and the residual demand curve. But then q_A is low, q_B is high, and hence there is a large difference between the market demand curve and the residual demand curve. The numerical example discussed in class should tell you that as a consequence the leader's profit maximising output is higher in the Stackelberg model than in the Cournot model, while its competitor's output is lower.
Strategy III – become a Stackelberg leader  	The game tree of the Stackelberg model can easily be explained. Firm A (or Firm 1), the Stackelberg leader, knows the strategy (and hence the reaction function) of Firm B (or Firm 2), its competitor. For example, it knows that if it chooses output level q_{A1}, then Firm B (or Firm 2) will respond with output q_{B1}. The outcome will then be profit of π_{A1} for Firm A and π_{B1} for Firm B. Since the leader knows the outcome for each combination of q_A and q_B, it will choose whichever

	level of q_A that will maximise its profit. For example, if $\pi_{A2} > \pi_{A1} > \pi_{A3}$, the leader will choose output level q_{A2}. Firm B will passively respond with q_{B2}.