Lecture 16
Game Theory IV:
Changing the game

15.011/0111 Economic Analysis for Business Decisions
Oz Shy

Quantity (capacity) competition in the news

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TODAY IN THE SKY Ben Mutzabaugh 11:28 a.m. EDT August 11, 2015

Quantity (capacity) competition in the news

THE WALL STREET JOURNAL.

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Oil Prices Climb as Production Capacity Falls

Baker Hughes reported a drop in number of rigs drilling for oil in the U.S.

By NICOLE FRIEDMAN and GEORGI KANTCHEV

8 COMMENTS

Updated Sept. 21, 2015 3:18 p.m. ET

Oil prices climbed Monday on expectations that a drop in U.S. production would help shrink the domestic glut of crude.

Light, sweet crude for October delivery settled up $2, or 4.5%, at $46.68 a barrel on the New York Mercantile Exchange.

Quantity (capacity) competition in the news (bad education?)

Forbes / Business

SEP 30, 2015 @ 07:00 AM 39,259 VIEWS

Overcapacity Drives Down Marijuana Prices In Colorado

- Overcapacity in dispensaries in Colorado is driving down marijuana prices
- Retail prices for marijuana have dropped over the past year
- Beginning of 2014: there were 156 retail marijuana stores and 204 retail cultivation facilities
- End of 2014: there were 322 retail stores and 397 retail cultivations

Quantity (capacity) determination: Review of cartel (collusion)

- Market demand: $Q = 60 - p \Leftrightarrow p = 60 - Q$
- Individual firms' output levels: $q_1 + q_2 = Q$
- Assume no production cost: TFC = MC = 0
- The cartel manager sets aggregate output at the monopoly level to satisfy: $MR^m = 60 - 2Q = MC = 0 \Rightarrow Q^m = 30$
- Monopoly price and profit:

$$\Rightarrow p^m = 60 - Q^m = \$30 \Rightarrow \pi_1 + \pi_2 = \$900$$

- The two firms now bargain over how to split the profit (we will have a class on negotiations later on in this course)
- Firms can negotiate 'weights' of how to split the cartel's profit:
- $\pi_1 = \alpha\Pi = \alpha\$900$ & $\pi_2 = (1-\alpha)\Pi = (1-\alpha)\$900$
- Example: If the cartel splits the profit equally, then:

$$\alpha = \frac{1}{2} \Rightarrow \pi_1 = \pi_2 = \frac{\$900}{2} = \$450$$

$$MR_2 = (60 - q_1) - 2q_2 = MC = 0 \Rightarrow q_2 = BR_2(q_1) = 30 - \frac{1}{2}q$$

competition: Best-response functions

- New concept: Residual demand is the demand facing each firm 1 (similarly, firm 2)
- $$p_1 = (60 - q_2) - q_1 \;\&\; p_2 = (60 - q_1) - q_2$$
- That is, we subtract the output of the rival firm from the intercept of the inverse demand functions.
- Firm 1 takes q_2 as given and solves:

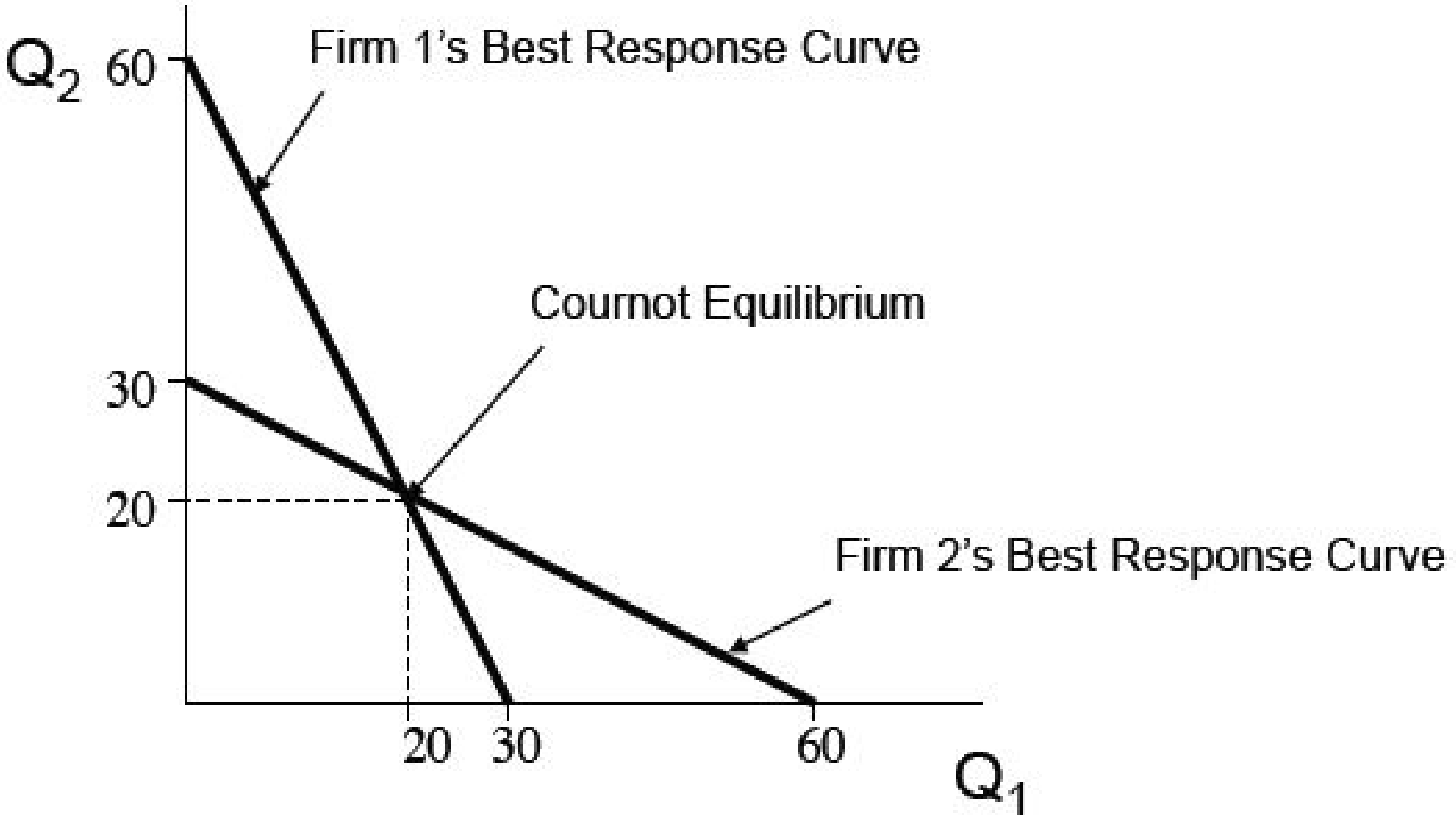
$$MR_1 = (60 - q_2) - 2q_1 = MC = 0 \Rightarrow q_1 = BR_1(q_2) = 30 - \frac{1}{2}q_2$$

- Firm 2 takes q_2 as given and solves:

$$MR_2 = (60 - q_1) - 2q_2 = MC = 0 \Rightarrow q_2 = BR_2(q_1) = 30 - \frac{1}{2}q_1$$

Remark: The BR functions are downward sloping meaning that quantity settings are strategic substitutes, see graphs next slide

Cournot-Nash equilibrium: Graphical solution



Cournot-Nash equilibrium

Solving the two best-response functions

$$q_1 = 30 - \frac{1}{2}q_2 \;\&\; q_2 = 30 - \frac{1}{2}q_1$$

Yields: $q_1^c = q_2^c = 20 \Rightarrow Q^c = 40 > Q^m = 30$

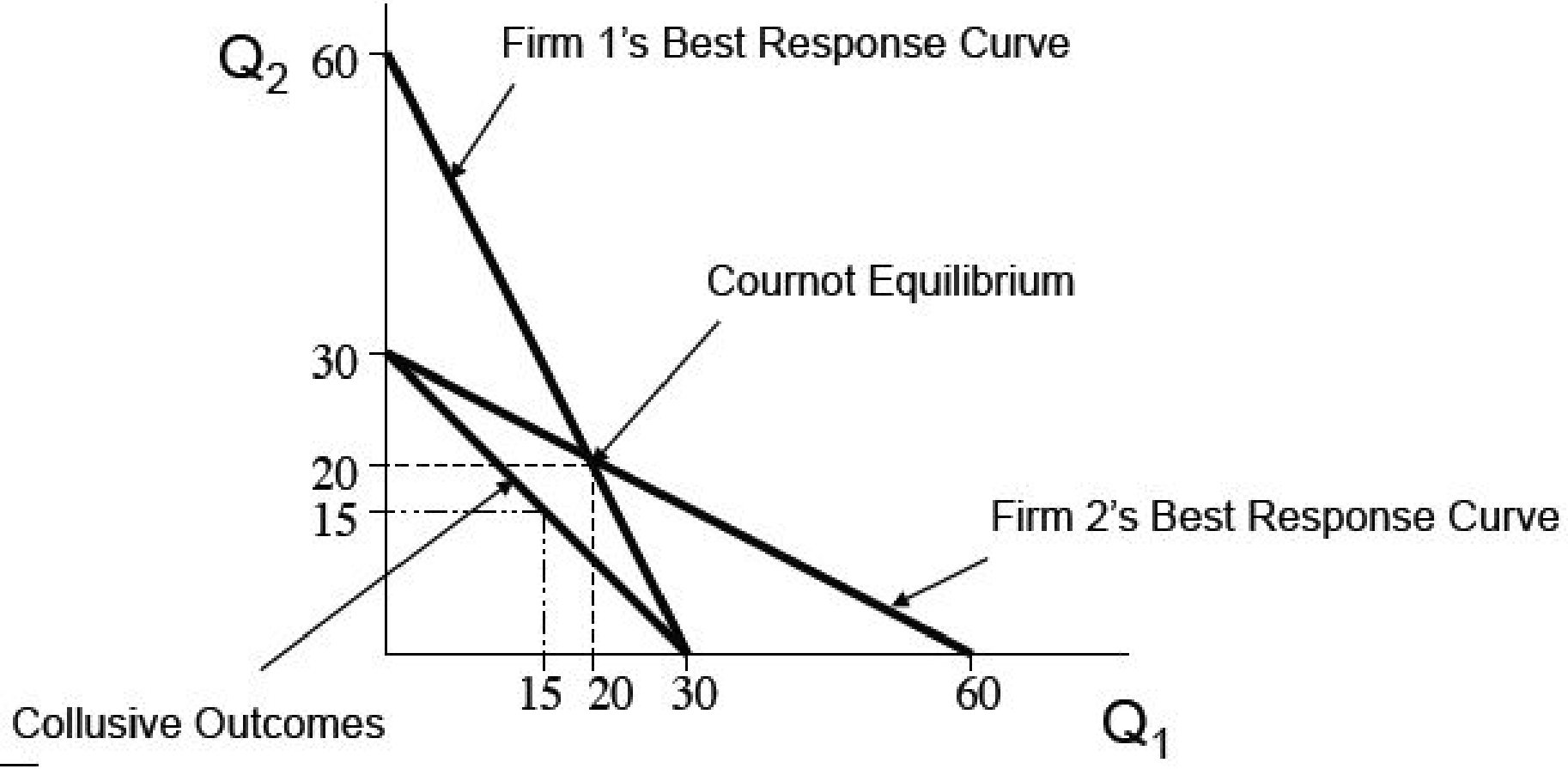
$$p^c = 60 - 40 = \$20 < \$30 = p^m$$

Hence, quantity (Cournot) competition yields higher aggregate industry output and lower price

Finally, equilibrium profits are:

$$\pi_1^c = \pi_2^c = \$20 \cdot 20 - 0 = \$400 < \$450 = \frac{\Pi^m}{2}$$

Cournot-Nash output levels versus collusive output levels



Aggregate industry output under Cournot (Q=40) exceeds aggregate output under collusion (monopoly output level, Q=30)

Cournot-Nash output levels versus collusive output levels (matrix representation of profits)

$$\pi_1 = p \cdot q_1 = (60 - q_1 - q_2)q_1$$

$$\pi_2 = p \cdot q_2 = (60 - q_1 - q_2)q_2$$

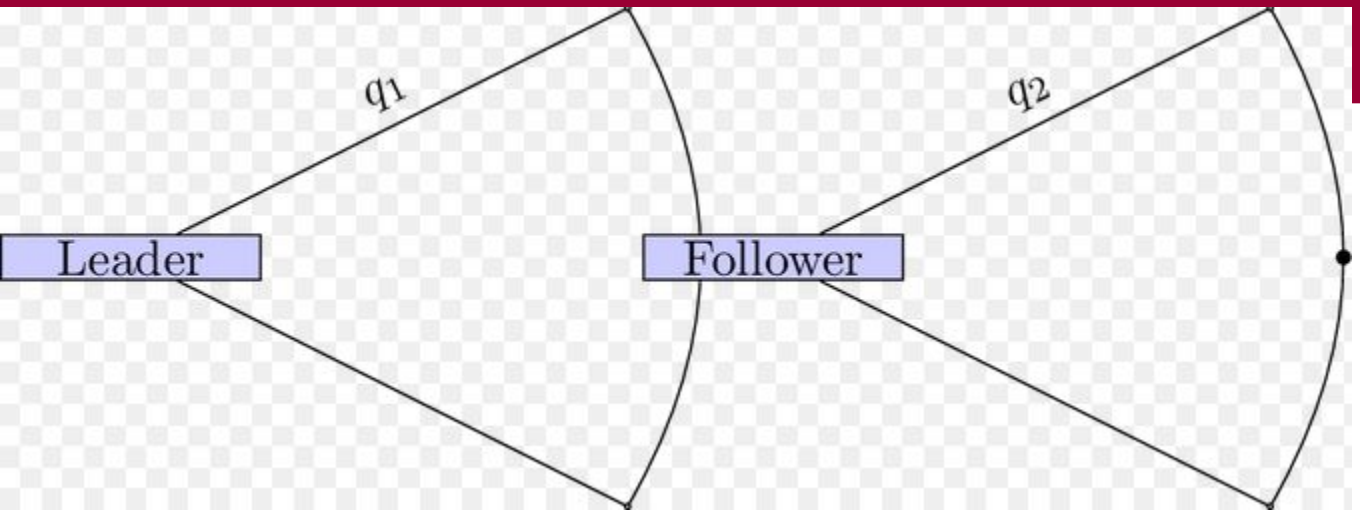
Firm 2 sets q_2

Firm 1 sets q_1	15		20		22.5		30	
15	450	450	375	500	338	506	225	450
20	500	375	400	400	350	394	200	300
22.5	506	338	394	350	338	338	169	225
30	450	225	300	200	225	169	0	0

Collusion $(q_1, q_2) = (15, 15)$

Cournot $(q_1, q_2) = (20, 20)$

The leader-follower (Stackelberg) model: Setup



- Sequential-move game: Firm 1 sets q_1 before firm 2 sets q_2
- Firm 1 is called the 'leader' Firm 2 is called the 'follower'
- Firm 1 anticipates firm 2's best response

- Firm 1 sets q_1 knowing that: $q_2 = BR_2(q_1) = 30 - \frac{1}{2}q_1$

In-class problem: Go back to the previous slide and choose the leader's (firm 1) profit-maximizing output level

The leader-follower (Stackelberg) model: Firm 2 (follower's) best response profit levels given q_1 [Note: Red arrows are firm 2's best response profits]

Firm 2 (follower) chooses q_2

Firm 1 (leader) sets q_1	15		20		22.5		30	
15	450	450	375	500	338	506	225	450
20	500	375	400	400	350	394	200	300
22.5	506	338	394	350	338	338	169	225
30	450	225	300	200	225	169	0	0

The leader-follower (Stackelberg) model: Firm 2 (follower's) best response profit levels given q_1 [Note: Red arrows are equilibrium output levels]

- Stackelberg equilibrium: Firm 1 chooses q_1=30
- Firm 2 (follower) responds with q_2=15.
- Total output: Q^s=45 > Q^c =40 > Q^m = 30
- Market price: p^s=$15 < p^c = $20 < p^m = $30

Firm 2 (follower) chooses q_2

Firm 1 (leader) chooses q_1	15		20		22.5		30	
15	450	450	375	500	338	506	225	450
20	500	375	400	400	350	394	200	300
22.5	506	338	394	350	338	338	169	225
30	450	225	300	200	225	169	0	0

$$\pi_1^{SL} = \$15 \cdot 30 = \$450 > \pi_1^C$$

$$\pi_2^{SF} = \$15 \cdot 15 = \$225 < \pi_2^C$$

Hence, 1st mover advantage

Duopoly overview (equal MC)

	Compete on:	Timing	Strategic	Margins
Bertrand	P	Simultaneous	Complements	P=MC
Cournot	Q	Simultaneous	Substitutes	P>MC
Stackleberg	Q	Sequential	Substitutes	P>MC

- Price competition generates the lowest profits (zero profits if MC are equal among all firms)
- Quantity competition generates positive profits (but less than the collusive (monopoly) profit
- Second-mover advantage under price competition
  Second-mover disadvantage under quantity (capacity) competition (Stackelberg)

Play video GB-II
6:24 min