Chapter 14

Oligopoly

Oligopoly

- **Oligopoly**: only a small number of firms are producing in a market with significant barriers to entry
  - Each firm makes up a substantial portion of the market and can affect prices with their choices over output levels
  - No one firm has enough power to fully select price/quantity combinations like a monopolist could
  - The market prices are determined jointly through a firm's decisions together with the output decisions of other firms — **strategic interdependence**

A Review of Market Structures

	Monopoly	Oligopoly	Monopolistic Competition	Competition
1. Profit-maximization condition	$MR = MC$	$MR = MC$	$MR = MC$	$p = MR = MC$
2. Ability to set price	Price setter	Price setter	Price setter	Price taker
3. Market power	$p > MC$	$p > MC$	$p > MC$	$p = MC$
4. Entry conditions	No entry	Limited entry	Free entry	Free entry
5. Number of firms	1	Few	Few or many	Many
6. Long-run profit	≥ 0	≥ 0	0	0
7. Strategy dependent on individual rival firms' behavior	No (has no rivals)	Yes	Yes	No (cares about market price only)
8. Products	Single product	May be differentiated	May be differentiated	Undifferentiated
9. Example	Local natural gas utility	Automobile manufacturers	Plumbers in a small town	Apple farmers

Profit Matrix for a Quantity-Setting Game

		American Airlines	
		$q_A = 64$	$q_A = 48$
United Airlines	$q_U = 64$	4.1 / 4.1	3.8 / 5.1
	$q_U = 48$	5.1 / 3.8	4.6 / 4.6

Note: Quantities are in thousands of passengers per quarter; (rounded) profits are in millions of dollars per quarter.

Parallel with Prisoner's Dilemma

- Just like the prisoner's dilemma game, both firms are worse off at the Nash equilibrium than if they each played the dominated strategy
- In a one-shot game, this is the end of the story
- Even though there is incentive to collude (cooperate) to increase profits, there are also incentives to cheat on a collusive agreement, so collusion is not stable

Collusion and Repeated Games

- However, the true game in real oligopoly/duopoly markets is not a simultaneous one-shot game
- **Supergame**: a game that is played repeatedly, allowing players to develop strategies for a given period that depend on rivals' actions in previous periods of play

Punishment

- Suppose American announced they would use a 2-part strategy:

  1. Begin by producing the smaller quantity (cooperating) in the first period

  2. For every period thereafter, continue to produce the smaller amount UNLESS United produces the larger amount, in which case American will produce the larger quantity in all subsequent periods

- Question: can this strategy be part of a new Nash Equilibrium?

- Question: What is the more common name for this type of strategy?

End Points and Infinitely Played Games

- As long as United values future profits as much as current profits, collusion is a sustainable Nash equilibrium **as long as the game will be repeated indefinitely**

- What if the game were going to be played for 100 rounds?

Economic Models of Oligopoly

- Cooperative/collusive models (cartels acting like monopolies)
    - With collusion they produce the monopoly output and split the monopoly profit
    - Solve collusion problems the same as a monopoly but divide the profit by 2 to find each firm's profit
- Non-cooperative production models
    - Cournot – firms choose quantity
    - Bertrand – firms choose price
    - Stackelberg – firms don't operate at the same time, one moves first

Cooperative Oligopoly Models and Cartels

- A **cartel** is a group of firms who act together to coordinate their output and pricing decisions
- Cartels engaging in collusive behavior will try to create a market outcome identical to the monopoly case
  - This **SHOULD** be unstable because:
    - There are always incentives to cheat on the agreement and take larger shares of current profits
    - They are illegal in most countries (Sherman Antitrust Act of 1890 and subsequent Federal Trade Commission Act of 1914 in the United States

Laws Against Cartels

The Sherman Antitrust Act (1890)

Section 1. Trusts, etc., in restraint of trade illegal; penalty

Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several States, or with foreign nations, is declared to be illegal. Every person who shall make any contract or engage in any combination or conspiracy hereby declared to be illegal shall be deemed guilty of a felony, and, on conviction thereof, shall be punished by fine not exceeding $10,000,000 if a corporation, or, if any other person, $350,000, or by imprisonment not exceeding three years, or by both said punishments, in the discretion of the court.

Section 2. Monopolizing trade a felony; penalty

Every person who shall monopolize, or attempt to monopolize, or combine or conspire with any other person or persons, to monopolize any part of the trade or commerce among the several States, or with foreign nations, shall be deemed guilty of a felony, and, on conviction thereof, shall be punished by fine not exceeding $10,000,000 if a corporation, or, if any other person, $350,000, or by imprisonment not exceeding three years, or by both said punishments, in the discretion of the court.

Laws Against Cartels

- Previously called trusts in the US and common in oil, railroad, sugar, and tobacco industries
- Sherman Antitrust Act (1890) and FTC Act (1914)
  - Prohibit firms from agreeing to take actions that reduce competition
  - Jointly setting price *per se* illegal
- Antitrust laws reduce probability that cartels form
- OPEC, the most famous cartel, formed in 1960 and is not illegal among the participating countries

Why do Cartels Exist?

- Despite being against the law, cartels exist because:

  1. International cartels are generally legal because they are not subject to national policies outlawing them

  2. They may operate in countries where no laws have been passed outlawing them

  3. Proving collusive behavior is hard

  4. Some firms are able to coordinate their activities without any actual formal contact — **tacit collusion**

Tacit Collusion in the Airline Market

Public Communication and Tacit Collusion in the Airline Industry*

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November 14, 2017

First draft, comments are welcome.

Abstract

We investigate whether the top management of all legacy U.S. airlines used their quarterly earnings calls as a mode of communication with other airlines to reduce the number of seats sold in the U.S. We build an original and novel dataset on the public communication content from the earnings calls and process it using Natural Language Processing techniques from computational linguistics, and we use it to estimate a causal relationship between communication and the carriers' market-level capacity decisions. The estimates show that when all legacy carriers communicate about artificially reducing the number of seats, i.e., engage in "capacity discipline," prior to a given quarter, it leads to a substantial reduction in the number of seats in that quarter. We find that the effect is driven entirely by legacy carriers, with a larger reduction in smaller markets. We also propose a novel approach to implement placebo falsification tests where our "treatment" (communication) is in the form of text, and, as a consequence, there can be numerous placebos to test against. Through these tests we verify that our result — legacy airlines use public communication regarding capacity discipline to collude — is not driven by placebo effects.

Does multimarket contact facilitate tacit collusion? Inference on conduct parameters in the airline industry

Federico Ciliberto*

and

Jonathan W. Williams**

We provide empirical evidence that multimarket contact facilitates tacit collusion among airlines using a flexible model of oligopolistic behavior, where conduct parameters are modelled as functions of multimarket contact. We find (i) carriers with little multimarket contact do not cooperate in setting fares, whereas carriers serving many markets simultaneously sustain almost perfect coordination; (ii) cross-price elasticities play a crucial role in determining the impact of multimarket contact on equilibrium fares; (iii) marginal changes in multimarket contact matter only at low or moderate levels of contact; (iv) assuming firms behave as Bertrand-Nash competitors leads to biased estimates of marginal costs.

Why do Cartels Fail?

- Cartels tend to fail if:
    - Producers outside the cartel can supply large quantities of the good
    - Cheating on the agreement occurs
        - Cheating is least likely when cheating can be easily observed and easily punished

Merger Policy

- The Federal Trade Commission reviews potential merger cases and is capable of blocking mergers it deems will lead to cases of significantly concentrated market power

- Question: why not just ban all mergers?

Mergers in the Beer Market

Understanding the Price Effects
of the MillerCoors Joint Venture*

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February 24, 2017

Abstract

We document abrupt increases in retail beer prices just after the consummation of the MillerCoors joint venture, both for MillerCoors and its major competitor, Anheuser-Busch. Within the context of a differentiated–products pricing model, we test and reject the hypothesis that the price increases can be explained by movement from one Nash-Bertrand equilibrium to another. Counterfactual simulations imply that prices after the joint venture are 6%–8% higher than they would have been with Nash–Bertrand competition, and that markups are 17%–18% higher. We relate the results to documentary evidence that the joint venture may have facilitated price coordination.

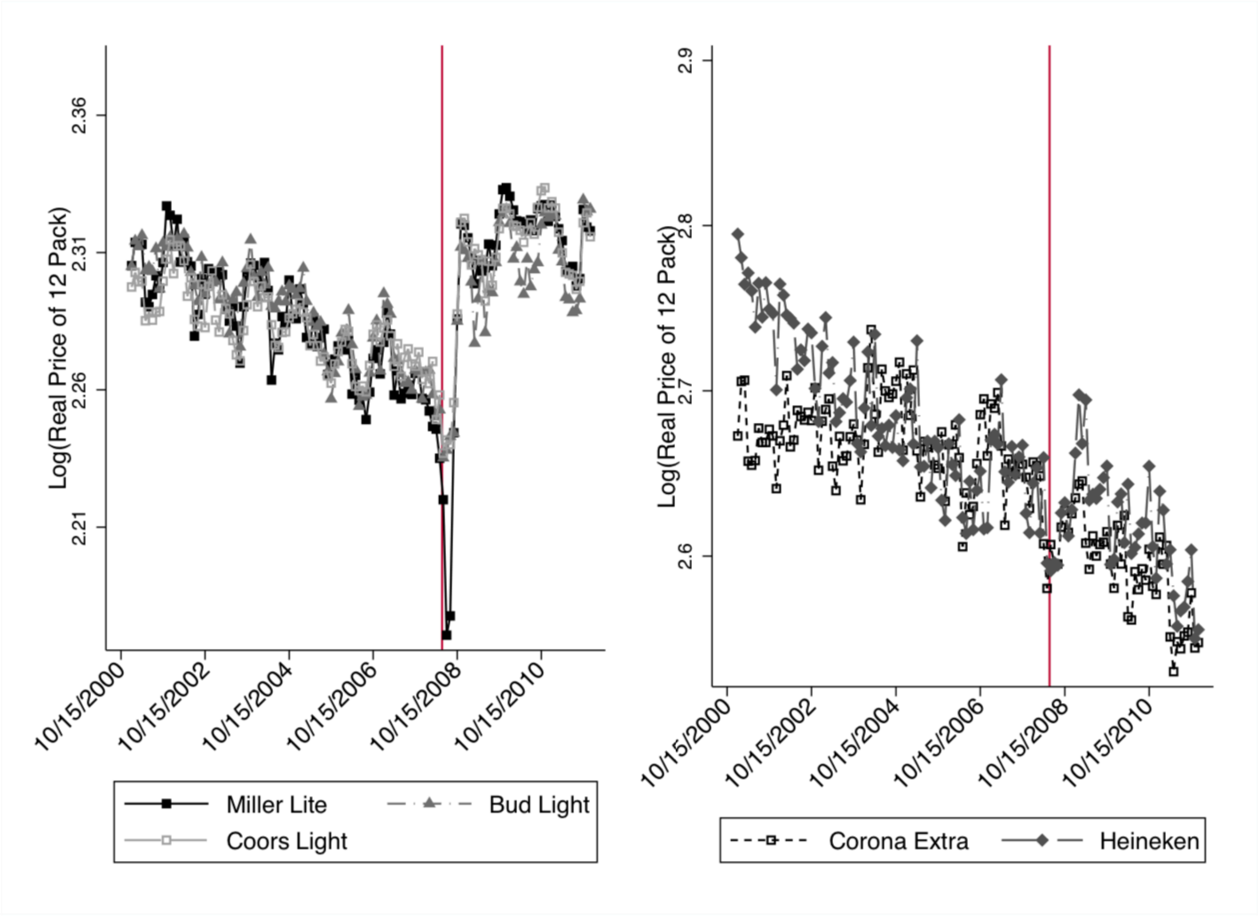


Figure 1: Average Retail Prices of Flagship Brand 12 Packs
Notes: This figure plots the average prices of a 12 pack over 2001–2011, separately for Bud Light, Miller Lite, Coors Light, Corona Extra, and Heineken. The vertical axis is the natural log of the price in real 2010 dollars. The vertical bar drawn at June 2008 signifies the consummation of the Miller–Coors merger.

Non-Cooperative Models of Oligopoly

- What if we assume that firms will actually compete against one another?
- Most of the examples so far have been examples of cartels and collusion, but lots of oligopoly markets have intense competition

Cournot Oligopoly Model

- The **Cournot** model explains how oligopoly firms behave if they simultaneously choose how much to produce

- Four main assumptions:

  1. There are two firms and no others can enter the market

  2. The firms have identical costs

  3. The firms sell identical products

  4. The firms set their quantities simultaneously

- **Cournot Equilibrium**: a set of quantities produced such that, holding all other firms' production constant, no firm can obtain a higher profit by choosing a different quantity

Choosing the Optimal Strategy

- In Cournot firms must choose an output level, which we will call their strategy

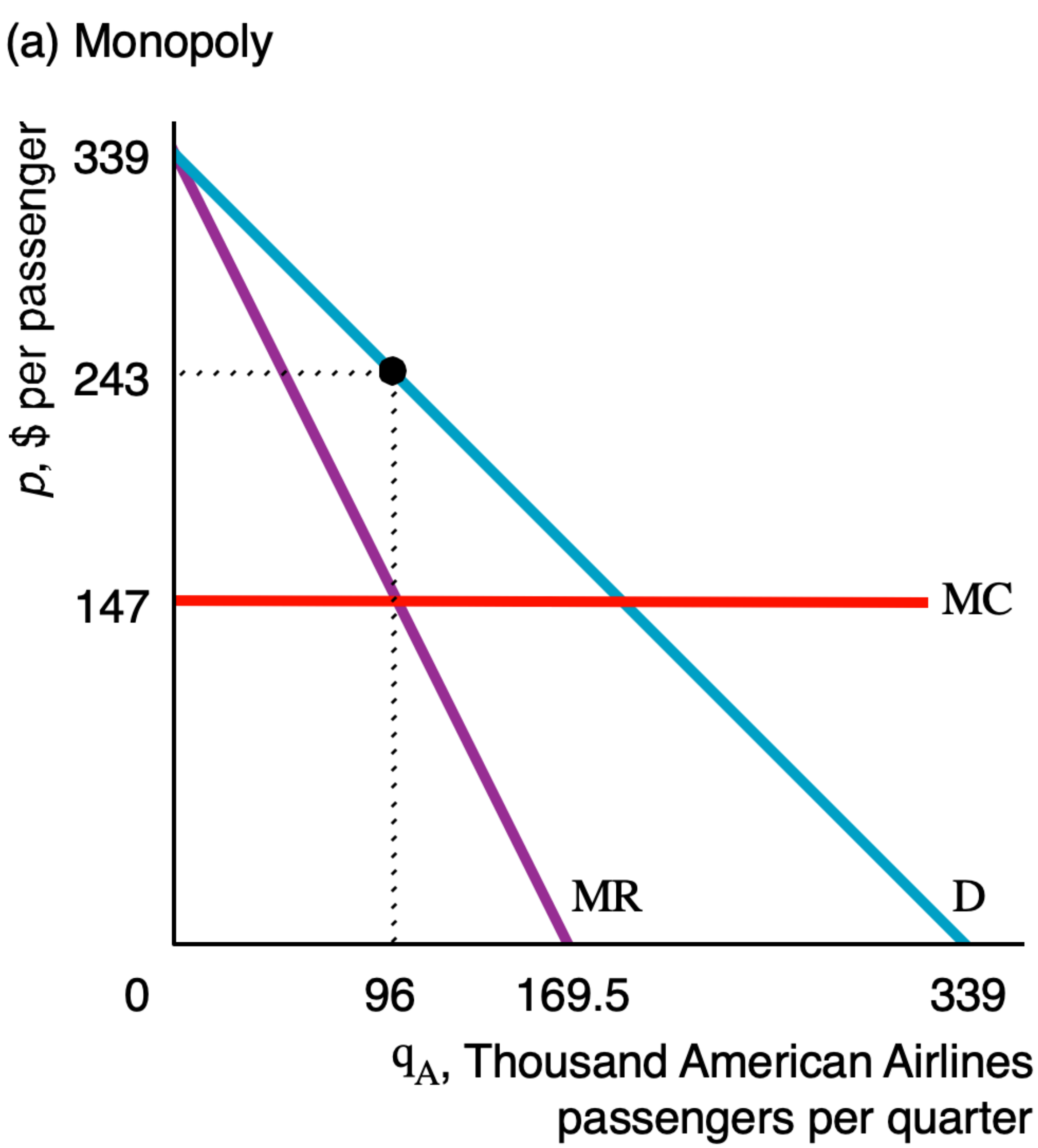
- Given that the market price depends on the actions of the rival firm, the optimal level solution lies on the **residual demand curve**

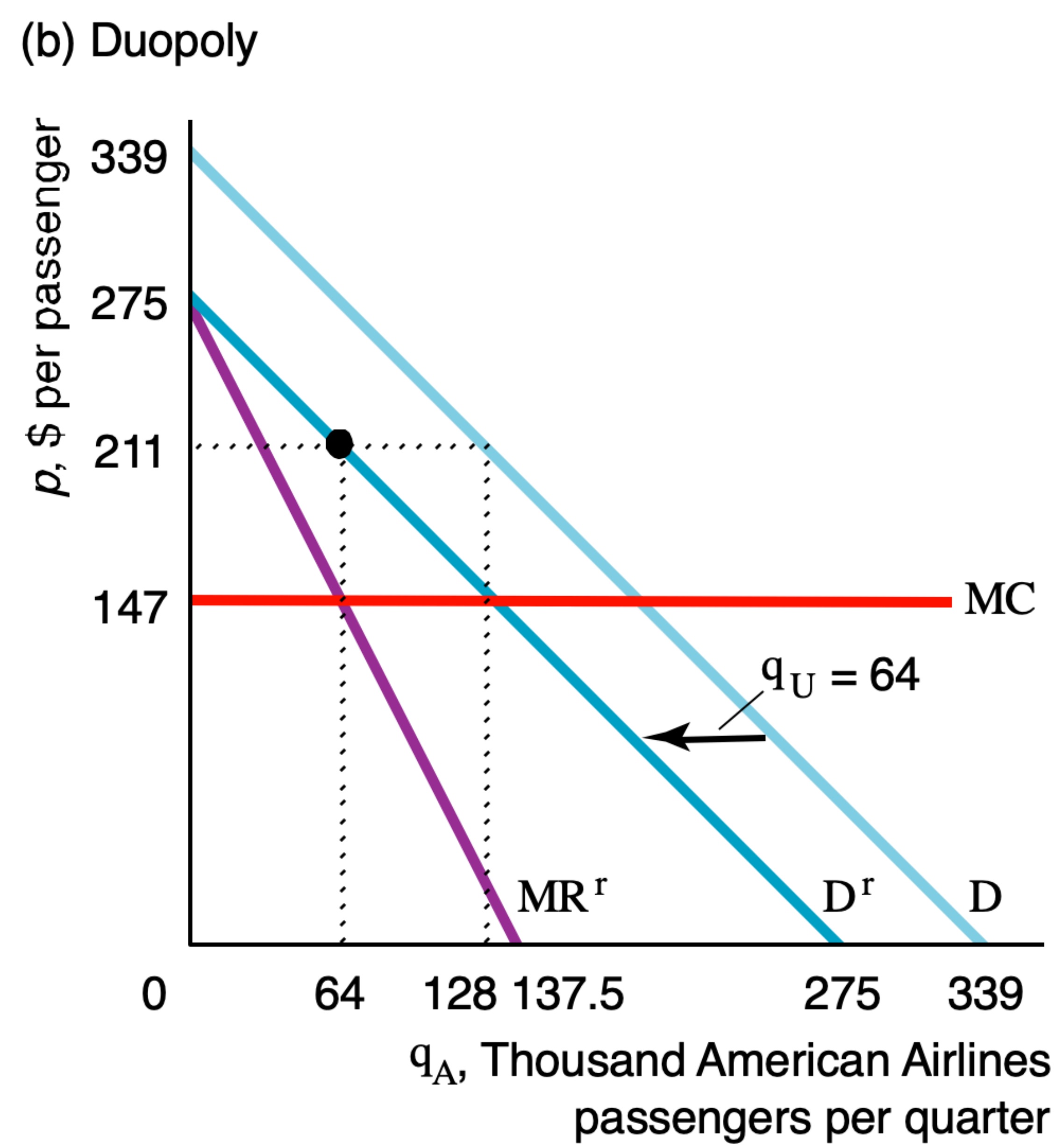
- **Residual demand curve**: the portion of the market demand curve not met by the rival firm

- Complication: we don't know the rival firm's output level

- This is where **beliefs** come in — game theory!

American Airlines' Profit Maximizing Output





Residual Demand Curves Linked to “Best Response” Curves

- We just found that the optimal production level for American when they believed United would produce 64 was 64
- Would the output of 64 have been optimal if they thought United would produce a level other than 64?
- We can find the optimal production level for American given any set of beliefs possible, and call that American’s **best response curve**

Cournot Model in the Airline Market

- The quantity each airline chooses depends on the residual demand curve it faces and its marginal cost
- Estimated airline market demand: $Q = 339 - p$
  - p is the price of a one-way flight, Q is the total number of passengers flying one-way on **both airlines**
- Assume each airline has costs $MC = \$147$ per passenger and no fixed costs
- How does the monopoly outcome compare to the duopoly (Cournot with two firms)?

Setting Up the Cournot Model

- Assume there are two firms in a Cournot oligopoly
  - Each firm has constant marginal cost c
  - Firms 1 and 2 simultaneously choose production quantities q_1 and q_2
- Inverse demand: $P = a - bQ;\ Q = q_1 + q_2$

Setting Up the Cournot Model

- Firm 1's profit is: $\pi_1 = q_1(P - c)$
  - Substituting in for P: $\pi_1 = q_1 \times [(a - b(q_1 + q_2)) - c]$
- Firm 2's profit is: $\pi_2 = q_2 \times [(a - b(q_1 + q_2)) - c]$
- **Notice**: each firm's profit depends on the actions of the other firm

Cournot Duopoly Solution

1. Identify the MC for each firm. If the MC is identical, note the symmetry

2. Write out the inverse demand curve

3. Note each firm's production independently,
   $p = a - q_1 - q_2$

4. Find the firm specific MR functions

$$MR_1 = a - 2q_1 - q_2 \text{ and } MR_2 = a - q_1 - 2q_2$$

Cournot Duopoly Solution

5. Set the MR equal to MC. If the MC is identical, only do these step once and refer to symmetry

6. The completion of step 5 produces a **best response (BR) function** for each firm. For a Cournot equilibrium you need both **BR** functions to simultaneously hold, which means plugging the information from one **BR** function into the other. Isolate either quantity variable and plug it into the other **BR** function.

7. Take the Cournot quantities and use them to calculate the market price

8. Firm level profits can be calculated if the cost functions were originally given, but not if only MC was given

Cournot Model in the Airline Market

- In a duopoly, if United flies q_U passengers, American flies the residual demand
  - American's residual demand: $q_A = Q(p) - q_U = (339 - p) - q_U$
- What is American's best response profit-maximizing output if it believes United will fly q_U passengers?
  - American behaves as if it has a monopoly over people who don't fly United — summarized by residual demand
  - American's residual inverse demand: $p = 339 - q_A - q_U$
- Residual inverse demand function is useful for expressing revenue (and MR) in terms of the rival's quantity

Cournot Model in the Airline Market

- Residual inverse demand function is useful for expressing revenue (and MR) in terms of the rival's quantity

$$R_A = p \times q_A = (339 - q_A - q_U) \times q_A$$

$$R_A = 339q_A - q_A^2 - q_A q_U$$

- Setting MR = MC yields American's BR function: $MR = 339 - 2q_A - q_U$ and $MC = 147$, so: $339 - 2q_A - q_U = 147$

$$2q_A = 192 - q_U$$

$$q_A = 96 - \frac{1}{2}q_U = BR_A(q_U)$$

Cournot Model in the Airline Market

- On the previous slide we solved for American's best response (BR) function, finding: $BR_A(q_U) = 96 - \frac{1}{2}q_U$

- By our symmetry assumption, United's BR function is analogous: $q_U = 96 - \frac{1}{2}q_A = BR_U(q_A)$

- Now we plug q_A into q_U to solve for each firm's quantity: $q_A = 96 - \frac{1}{2}(96 - \frac{1}{2}q_A) = 48 + \frac{1}{4}q_A$
    - Therefore, $q_A = 64$

Cournot Model in the Airline Market

- We found that $q_A = 64$ and we know that the two firms operate symmetrically, so we can assume that $q_U = 64$ also

    - You'll find this is true if you plug $q_A = 64$ into American's BR function and solve for q_U

- Now plug $q_A = 64 = q_U$ into either firm's inverse demand function to find p: $p = 339 - 64 - 64 = 211$

Cournot Model with Non-Identical Firms

- Differentiated products: AMD and Intel computer chips
- Inverse demand functions:
  $p_A = 197 - 15.1q_A - 0.3q_I$ and $p_I = 490 - 10q_I - 6q_A$
- $MC = m = 40$, AMD's $MC = m$ and Intel's $MC = m + x$
- The BR functions are $q_A = \dfrac{157 - 0.3q_I}{30.2}$ and $q_I = \dfrac{450 - 6q_A}{30.2}$
- Equilibrium output is $q_A \approx 5 < 21 \approx q_I$ and equilibrium prices are $p_A = \$115.20 < \$250 = p_I$

Cournot Example

- Suppose the inverse demand for tacos in Norman is $p = 30 - 3Q$ where Q is the total output in the market. There are only two restaurants that serve tacos: Torchy's and Pepe's. Each of the two firms have identical total cost functions $TC = 8 + 4Q$

- Solve for the Cournot equilibrium, denoting Torchy's quantity q_T and Pepe's q_P

  - Be sure to get: (1) each firm's residual demand curve, (2) each firm's MR curve, (3) each firm's BR function, (4) each firm's Cournot equilibrium strategy (optimal output), (5) the overall market output and price, and (6) each firm's profits

The Stackelberg Model

- The big difference between the Cournot and Stackelberg models is how the game plays out
- Under a Stackelberg equilibrium, one firm moves first (is the first-mover)
- Cournot is a simultaneous game and Stackelberg is a sequential game
    - How do we represent sequential games?
- Depending on the game, two firms could end up with different optimal quantities in equilibrium

The Stackelberg Model

- Suppose one of our firms in the airline example was a **leader** and set its output before its rival, the **follower**
- Does the firm that acts first have an advantage?
- How does this model's outcome differ from the Cournot oligopoly model?
- The Stackelberg model answers these questions
    - Once the leader sets its output, the rival firm will use its BR function to set its own output

Stackelberg Oligopoly Model

- General linear inverse demand function: $p = a - bQ$
- Two firms have identical MC, m
- Firm 1 (American Airlines) is the leader and chooses its output first
- Firm 2 (United Airlines) is the follower and chooses output using its BR function
- **The leader knows the follower will use its BR function to determine output, so the leader views the residual demand function in the market as its demand function**

Stackelberg Equilibrium in the Airline Market

- Assume American is the leader/first-mover, and we have the same BR functions as in the Cournot model:

$q_A = 96 - \frac{1}{2}q_U = BR_A(q_U)$ and $q_U = 96 - \frac{1}{2}q_A = BR_U(q_A)$

- American knows how United will respond, so they can use United's q_U and plug it into the inverse demand function:

$p = 339 - q_A - (96 - \frac{1}{2}q_A) = 243 - \frac{1}{2}q_A$

- We now have American's inverse demand function, so we can find their revenue function and MR, then set MR = MC

Stackelberg Equilibrium in the Airline Market

- American's inverse demand: $p = 243 - \frac{1}{2}q_A$

- Solving for its revenue and MR is the same as before:

$$R(q_A) = (243 - \frac{1}{2}q_A) \times q_A$$

$$MR = 243 - q_A$$

- $MC = 147$, so setting MR = MC: $243 - q_A = 147$

- Therefore the equilibrium output for American is: $q_A = 96$

Stackelberg Equilibrium in the Airline Market

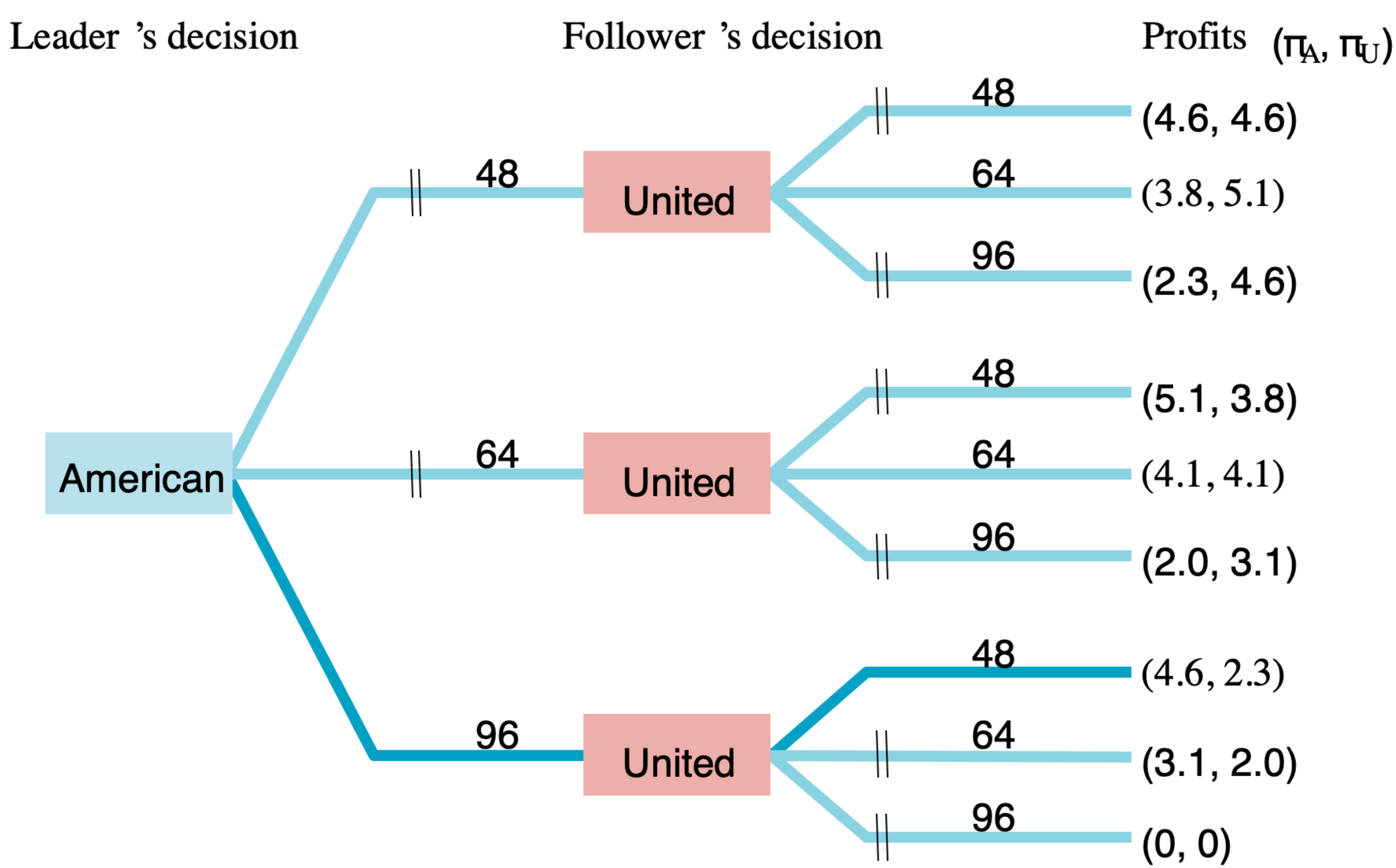
- Equilibrium output for American is: $q_A = 96$

- We can plug q_A into United's BR function to find q_U:
  $q_U = 96 - \frac{1}{2}(96)$, so $q_U = 48$

- The amount produced for United under the Stackelberg model is less than under Cournot ($q_U^{Stack} = 48 < 64 = q_U^{Cournot}$)

- We can now use the two q^{Stack} values to find equilibrium prices

Stackelberg Equilibrium in the Airline Market



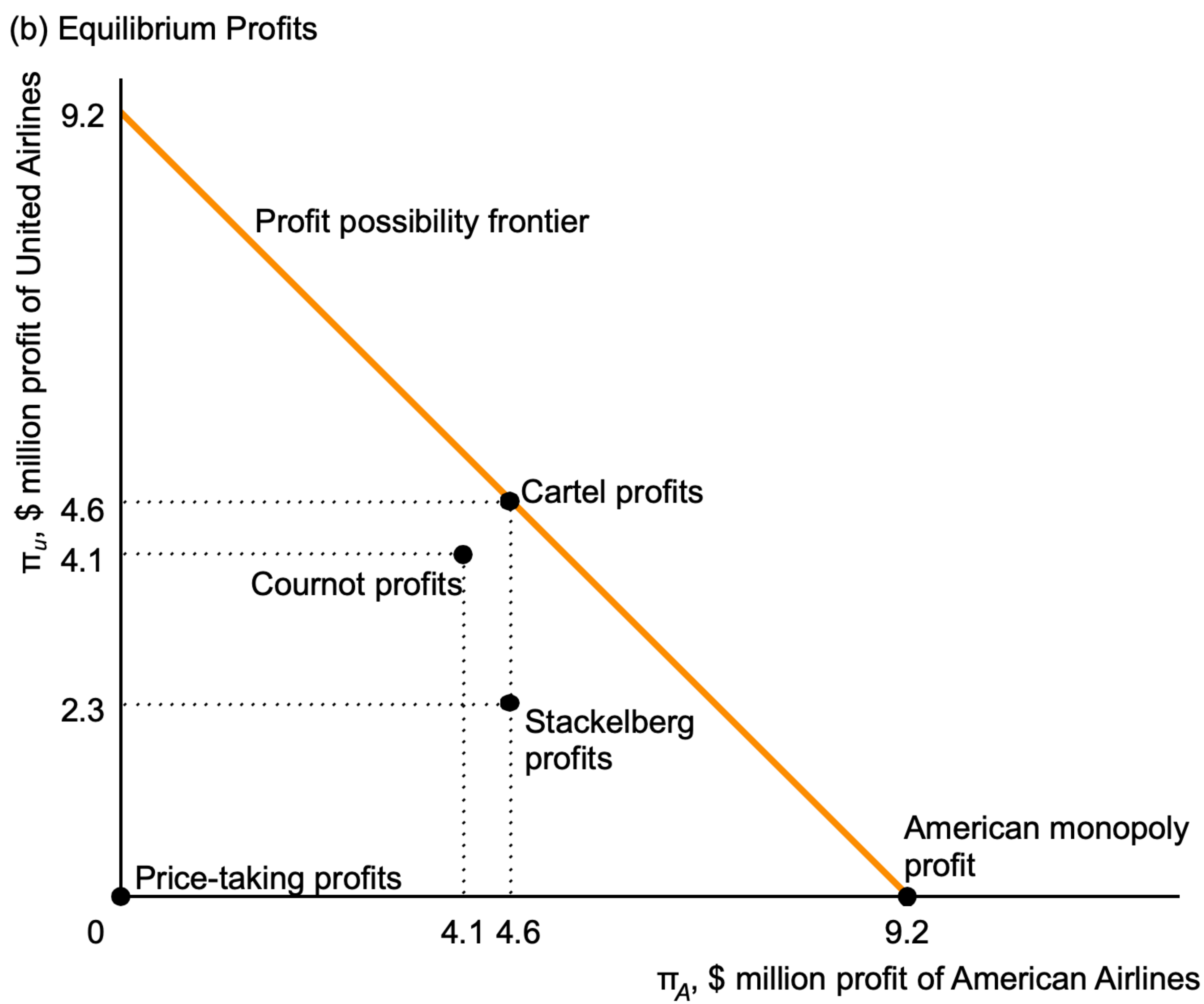
Comparing Collusive, Cournot, Stackelberg, and Competitive Equilibria

- Cournot and Stackelberg equilibrium outcomes (quantities, prices, and profits) fall between competitive outcomes and collusive ones

	Monopoly	Cartel	Cournot	Stackelberg	Price Taking
q_A	96	48	64	96	96
q_U	0	48	64	48	96
$Q = q_A + q_U$	96	96	128	144	192
p	\$243	\$243	\$211	\$195	\$147
π_A	\$9.2	\$4.6	\$4.1	\$4.6	\$0
π_U	\$0	\$4.6	\$4.1	\$2.3	\$0
Total profit $= \Pi = \pi_A + \pi_U$	\$9.2	\$9.2	\$8.2	\$6.9	\$0
Consumer surplus, CS	\$4.6	\$4.6	\$8.2	\$10.4	\$18.4
Welfare, $W = CS + \Pi$	\$13.8	\$13.8	\$16.4	\$17.3	\$18.4
Deadweight loss, DWL	\$4.6	\$4.6	\$2.0	\$1.2	\$0

Notes: Passengers are in thousands per quarter. Price is in dollars per passenger. Profits, consumer surplus, welfare, and deadweight loss are in millions of dollars per quarter.

Comparing Collusive, Cournot, Stackelberg, and Competitive Equilibria



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- Suppose the inverse demand for tacos in Norman is $p = 30 - 3Q$ where Q is the total output in the market. There are only two restaurants that serve tacos: Torchy's and Pepe's. Each of the two firms have identical total cost functions $TC = 8 + 16Q$.

- Solve for the Stackelberg equilibrium, **assuming Torchy's moves first.** Denote Torchy's quantity q_T and Pepe's q_P

  - Be sure to get: (1) each firm's residual demand curve, (2) each firm's MR curve, (3) each firm's BR function, (4) each firm's Stackelberg equilibrium strategy (optimal output), (5) the overall market output and price, and (6) each firm's profits

Monopolistic Competition

- Similar to a perfectly competitive market except now products are differentiated and each firm faces a downward-sloping demand curve for their product

- Two equilibrium conditions:

  1. MC = MR

  2. Price = Average Cost (firms are making zero economic profits)

Monopolistic Competition vs. Perfect Competition

- We've called perfect competition the efficiency benchmark, so how does monopolistic competition compare?
- Monopolistic competition has some disadvantages:
  - Slightly higher prices and smaller outputs
  - Leads to deadweight loss
- And some advantages:
  - Products differentiated to better cater to consumers' tastes/ preferences
  - If consumer preferences are different enough, differentiation could actually increase consumer surplus

Bertrand Model

- In the Cournot and Stackelberg models, rival firms compete in quantities
- Under a Bertrand model, firms compete on prices
- If we have a duopoly and one firm undercuts its rival in price, they steal the entire market
    - Then we have a cycle of retaliation until each firm is pricing at marginal cost and no profit is made
    - Resulting equilibrium looks exactly like perfect competition