Module 5

Games & Strategic Behavior

AREC 310: Food and Agricultural Markets

Module 5: Market Power & Strategic Behavior

Overview

- Oligopoly & Intro to Game Theory (Lecture 5.1)
- Game Theory Models (Lecture 5.2)
- Market Power in the U.S. Beef Packing Industry (in-class activity)

Objectives

1. Apply game theory concepts (such as Nash Equilibrium, Prisoner's Dilemma, and sequential games) to analyze strategic decision-making in oligopolistic markets.
2. Compare and contrast the Kinked-Demand Curve, Collusive Pricing, and Price Leadership models of oligopoly behavior, explaining how each relates to different game theory scenarios.
3. Evaluate the efficiency implications of oligopolistic market structures, using game theory principles to explain why oligopolies may lead to productively and allocatively inefficient outcomes.

Lecture 5.1

Oligopoly and Intro to Game Theory

AREC 310: Food and Agricultural Markets

Oligopoly

- This is the most *realistic* market structure
- A few large producers
- Homogeneous or differentiated products
- Limited control over price
- Mutual interdependence
- Strategic behavior
- Entry barriers
- Mergers

Characteristics of Oligopoly

Characteristic	Oligopoly	
Number of Firms	Few	**A few large producers**
Product Differentiation	May be differentiated	**Homogeneous or differentiated products**
Barriers to Entry	Moderate to High	**Entry barriers exist (economies of scale, legal restrictions, high-cost entry)**
Market Power	Moderate	**Limited control over price**
Price Setting	Strategic Interaction	**Mutual interdependence / strategic pricing behavior**
Long-run Profits	Can be Positive	
Efficiency	Can be Inefficient	
Examples		**Food retail, technology companies, CPG companies**

Oligopolistic Industries

Four-firm concentration ratio

- 40% or more to be oligopoly

- Generally accepted thresholds:
  - CR4 < 40%: Low concentration
  - 40% ≤ CR4 ≤ 60%: Moderate concentration
  - CR4 > 60%: High concentration

Example of the Lerner Index in an Oligopoly Market

In an **oligopoly market**, firms may have significant pricing power, allowing them to charge prices above their marginal costs. The Lerner Index is greater than 0, indicating market power.

Example:

- **Price** P=15
- **Marginal Cost** MC=10
- Lerner Index=P−MC / P= (15−10) / 15 = 0.33

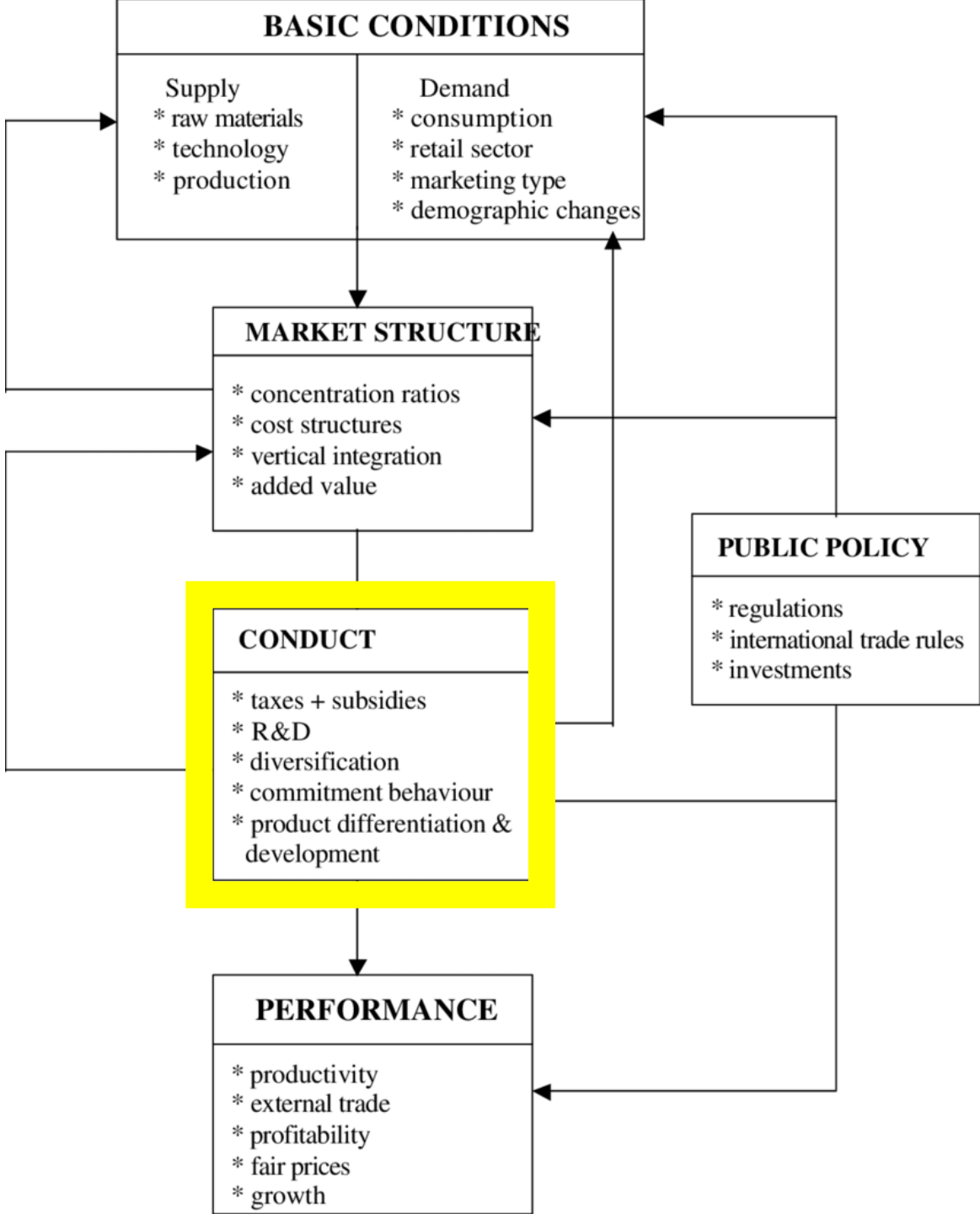
In this case, the firm has **some market power**, as the price is 33% higher than marginal cost.

What Makes Oligopolies Unique?

- PC firms are price takers
- Monopoly firms set prices
- Oligopoly markets (most of food and ag markets!) set prices ***strategically***

Recall: Conduct

- ***Conduct*** refers to the behavior, policies, and strategies used by the firms in the industry.
- To describe firms' conduct, economists consider the strategies used by firms as they affect:
  - Pricing strategies
  - Production strategies
  - Research and development
  - Advertising and marketing



Oligopolies display **strategic pricing behavior**

These are a series of strategic moves and countermoves among rival firms

The choices made by one firm affects all other firms

Each player has an incentive to *either* cooperate or compete (i.e., non-cooperative)

Cooperative vs. Non-Cooperative Strategies

Cooperative

- Cartel
- OPEC
- Looks a lot like a monopoly

Non-Cooperative

- More likely
- Drives profits down close to the perfectly competitive market

Introduction to Game Theory

Think of oligopolists as **engaging in a game**.

Need to know two things:

- What is the **strategy**?
- When is the game over? (i.e., the **equilibrium**)

First find the equilibrium, and that will tell us the strategy the players will use.

Game Theory – Key Terms

Game theory is the study of how interdependent decision-makers make choices.

Full list of components of a game:

- **Strategies**: rules telling each player which action to choose at each point in the game
- **Equilibrium**: strategy combination that consists of the best strategy for each player in the game, given the actions of the other players
- **Players**: the decision-makers (e.g., oligopolists)
- **Actions**: the moves the players can make
- **Payoffs**: profits or expected profits the players receive after all players pick a strategy
- **Outcome**: set of interesting results the modeler selects

Nash Equilibrium

Unlike Monopoly, there are no set of rules (as in MR = MC or MR < P) that govern oligopolists' price-setting behavior.

Instead, there is a concept that helps us understand pricing behavior of oligopolist firms.

- The most common is the "Nash Equilibrium"

The **Nash Equilibrium** is the point at which no player wants to change their strategy given what the other players are doing.

- The player will make the decision that is in their best interest.
- This is the rational choice

Let's use an example.

The Prisoner's Dilemma – Key Concepts

Prisoner's dilemma setup

- Two thieves
- Both are guilty of petty theft; both are *suspected* guilty of a more severe crime
- They are detained separately; cannot coordinate

Strategy

- Either can testify against the other person (betray them) or remain silent

Payoff matrix

- Table listing the rewards (this is how we think about decision-making) – in this case, years in jail

Dominant-strategy equilibrium

- Each player's action does not depend on what he thinks the other player will do

The Prisoner’s Dilemma – Let’s Play!

- I need two volunteers.

The Prisoner's Dilemma Payoff Matrix (years in jail)

		Student 1	
		Remain Silent	Talk (Betray)
Student 2	Remain Silent	S2 = 1 year S1 = 1 year	S2 = 3 years S1 = 0 years
	Talk (Betray)	S2 = 0 years S1 = 3 years	S2 = 2 years S1 = 2 years

The Prisoner's Dilemma – Dominant Strategy

In the Nash Equilibrium context, we ask:

Is there a strategy I would pursue regardless of what the other person does?

- If there is, I'll pursue that.

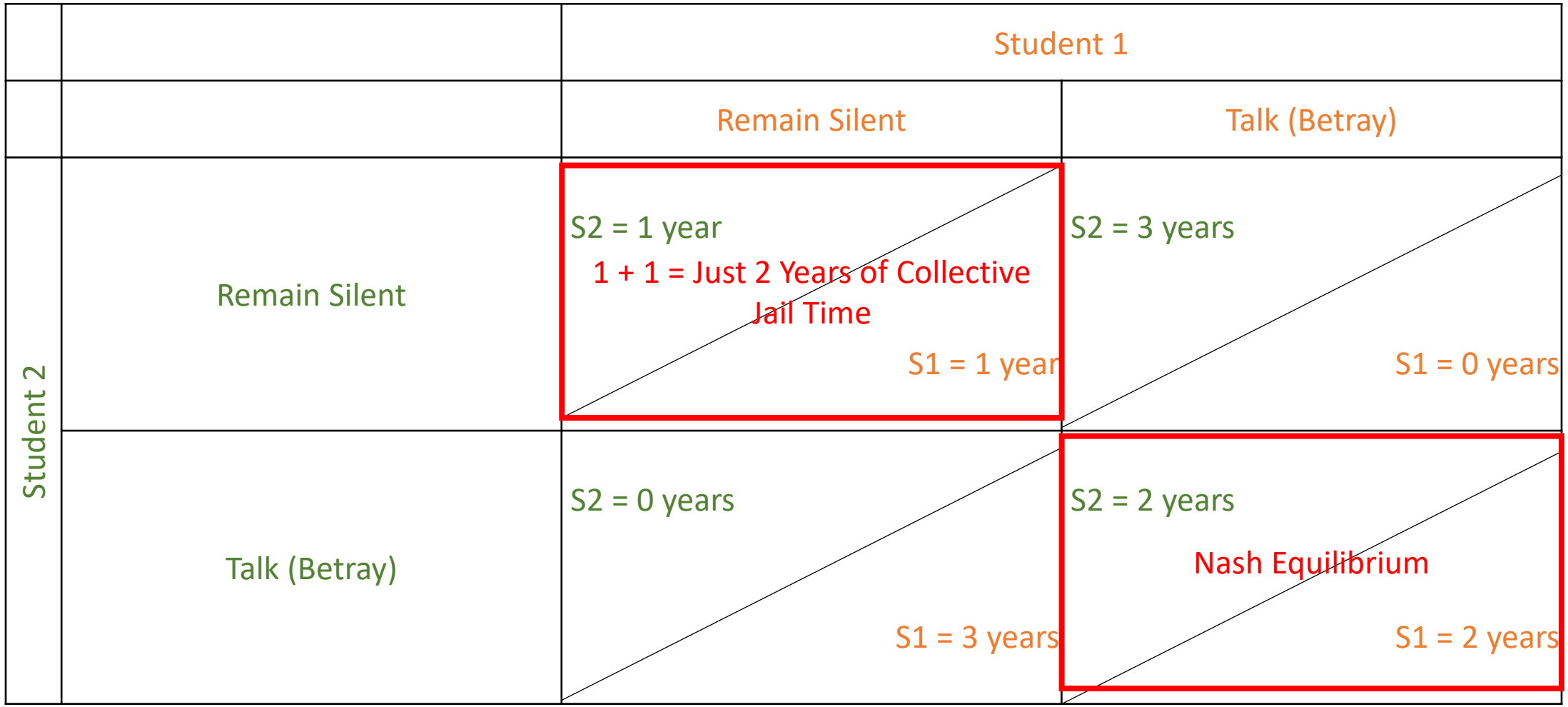
Recall, the N.E. concept = *I choose my strategy regardless of what the other person is doing.*

What is the dominant strategy?

1. Dominant cooperative strategy is to **remain silent**.
2. Dominant non-cooperative strategy is to **talk**.

The non-cooperative outcome is worse than if they could have cooperated.

The Prisoner's Dilemma Payoff Matrix (years in jail)



The Prisoner's Dilemma – Nash Equilibrium

The Nash Equilibrium from the Prisoner's Dilemma is for both players to defect (or "confess") (S1=Talk; S2=Talk)

- This is because, regardless of what the other player does, each individual player is better off confessing than remaining silent.
- This outcome is a stable but sub-optimal result, as mutual cooperation (both remaining silent) would have led to a better outcome for both individuals.

Why is this outcome so shocking?

- Because we typically we think more competition (non-cooperative) is better.
- But, in a N.E. context for oligopoly, the cooperative strategy leads to the best outcome (i.e., fewest years in jail).

Insights from the example:

1. Look at the payoff matrix to determine the dominant strategy
2. Find where the dominant strategies intersect

Economics Example – Coke and Pepsi

Two companies: Coke and Pepsi

Decision: How much to advertise?

Cooperative outcome: Forgo advertising altogether, and Coke and Pepsi agree to split the market (acting as a monopoly).

What if they don’t cooperate?

Cola War Payoff Matrix (annual profit in billions)

		Pepsi	
		Not Advertise	Advertise
Coke	Not Advertise	C = 8 P = 8	C = -2 P = 13
	Advertise	C = 13 P = -2	C = 3 P = 3

Assume total market is $16 B, cost of advertising is $5 B

What is the dominant strategy?

- Both advertise!

Cola War Payoff Matrix (annual profit in billions)

		Pepsi	
		Not Advertise	Advertise
Coke	Not Advertise	C = 8 Split $16B equally P = 8	C = -2 P = 13
	Advertise	C = 13 P = -2	C = 3 Nash Equilibrium P = 3

Assume total market is $16 B, cost of advertising is $5 B

What is the dominant strategy?

- Both advertise!

Takeaways so far

Game theory leads to bad outcomes for firms.

Is this always true?

- Not necessarily

Infinite Repeated Games

Imagine **Coke** says to **Pepsi**, "I promise not to advertise as long as you don't advertise. But, if you advertise, I will advertise forever."

If Pepsi advertises…
- Period 1: Pepsi makes $13 B (go back to payoff matrix)
- Period 2 onward: Pepsi makes $3 B forever

If Pepsi doesn't advertise…
- Period 1 onward: Pepsi makes $8 B forever

Not advertising is the better outcome!

By having this be a repeated game, Coke has solved the Prisoner's Dilemma because it has imposed a cooperative equilibrium.

		Pepsi	
		Not Advertise	Advertise
Coke	Not Advertise	C = 8 P = 8	C = -2 P = 13
	Advertise	C = 13 P = -2	C = 3 P = 3

Finite Repeated Games

However, this only works if the game never ends.

As soon as Coke or Pepsi think there's an end to the game, the solution breaks down.

Suppose Pepsi learns that in 10 years the government will outlaw soda. What is Pepsi's advertising decision in the 9th year?

- They will advertise
- But, Coke knows this, so they will advertise.

This process repeats for each preceding year, so the outcome is:

- Pepsi advertises: $3 B for 10 periods
- Coke advertises: $3 B for 10 periods

		Pepsi	
		Not Advertise	Advertise
Coke	Not Advertise	C = 8 P = 8	C = -2 P = 13
	Advertise	C = 13 P = -2	C = 3 P = 3

Mafia vs. Oligopoly: Strategic Parallels

Mafia Game	Oligopoly Market	Parallel Concept
A few “mafia” players hold power while most are civilians	A few dominant firms control most of the market	*Few key players → interdependence*
Mafia members know each other; civilians do not	Firms have private info about costs, strategies	*Information asymmetry*
Players act strategically, predicting others’ moves	Firms set prices/output based on rivals’ behavior	*Strategic interaction*
Mafia secretly coordinate actions	Firms may tacitly or explicitly collude	*Collusion & deception*
Betrayal risks collapse of the alliance	Firms tempted to undercut prices	*Trust & defection*
Game ends when one side dominates or trust breaks	Market stabilizes or breaks into price war	*Equilibrium or instability*

Behavioral (Informal) Models of Oligopoly

Three Models:

1. Kinked-demand curve
2. Collusive pricing
3. Price leadership

As we go through each model, consider questions such as:

- What are the “rules of the game” in each model?
- How do firms’ strategies and payoffs align with game theory concepts?
- Can we identify Nash Equilibria or dominant strategies within these models?
- How does the sequential or simultaneous nature of decision-making affect outcomes?

Model 1: Kinked-Demand Curve

Imagine you own a coffee shop in a small town with only one other coffee shop.

What happens if you change your price?

- If you **raise your price**, customers will go to the other shop. The other shop won't raise their price.
- If you **lower your price**, the other shop will quickly match your price. You won't gain many new customers.

Result: You're stuck! Raising prices loses customers, lowering prices doesn't help much.

Game Theory Analysis: Kinked-Demand Curve

Strategy & Equilibrium Outcome:

- The best move is not to move at all
- Both coffee shops end up keeping their prices the same
- This explains why prices often stay fixed in markets with few sellers

Common characteristics of markets that fit the **kinked demand curve model**:

- Few large competitors
- Similar products or services
- Easy for consumers to switch between providers
- Transparent pricing that competitors can easily monitor
- Examples: Supermarkets, Airlines, Smartphones, Breakfast Cereals, Soft Drinks

Example: Kinked-Demand Curve

Imagine two pizza shops on a college campus.

They've settled on charging $10 for a large pizza.

- If one shop raises its price, students will just go to the other shop.
- If one shop lowers its price, the other will quickly match to avoid losing customers.

Result: Prices tend to stick at $10, creating a "kink" in the demand curve at this price point.

Model 2: Collusive Pricing

Imagine two ice cream shops on a beach deciding to work together instead of competing.

1. They agree to charge high prices (e.g., $5 for a cone instead of $3).
2. They share the market, and both make more money.
3. This can happen openly (explicit) or without direct communication (tacit).

Temptation: Each shop might think, “If I secretly lower my price, I'll get all the customers!”

If one shop cheats, the other might find out and start a price war and both end up worse off than if they had cooperated.

Game Theory Analysis: Collusive Pricing

Strategy & Equilibrium Outcome:

- It’s like a friendship where both benefit by cooperating
- But there’s always a temptation to betray for a quick gain
- Repeated “game” (ongoing business) encourages good behavior

Common characteristics of markets that fit the collusive pricing model:

- Oligopoly structure with 2-5 major players dominating the market
- Difficult for new competitors to enter and disrupt existing market dynamics
- Similar or standardized products across firms, making price the primary differentiator
- Easy for firms to observe and monitor each other’s prices
- Examples: Gas Stations, Telecommunications, Cement, Pharmaceuticals

Example: Collusive Pricing Behavior

Picture two gas stations at an interstate exit.

- They could compete, constantly undercutting each other's prices.
- OR, they could agree to both charge a higher price, sharing the market and both making more profit.

Result: They might tacitly agree to keep prices high, effectively colluding without explicit communication.

Tacit means implied without directly being stated.

Overt Collusion

Collusion is an agreement among firms to divide the market and/or fix the price.

A **cartel** is a group of firms or nations that agree to collude.

- Act as monopoly
- Formally agree to a price
- Sets output levels for members
- Increase economic profit
- Example: OPEC

Illegal in U.S.

Obstacles to Collusion

- Demand and cost differences
- Number of firms
- Cheating
- Recession
- New entrants
- Legal obstacles

Model 3: Price Leadership Model

Imagine a big grocery store in town that always sets its prices first, and smaller stores follow.

1. The “leader” store decides on prices
2. Other stores watch and then set similar prices
3. This can happen for different reasons:
    - The leader is the biggest or smartest (dominant firm)
    - The leader is good at predicting market changes (barometric)
    - The firms are secretly cooperating (collusive)

The Strategy:

- Leader: “I’ll set a price that works best for me, knowing others will follow”
- Followers: “We’ll match the leader’s price to avoid a price war”

Game Theory Analysis: Price Leadership

Strategy & Equilibrium Outcome:

- It’s like a game of “follow the leader”
- The leader moves first, then others respond
- The leader’s choice sends a signal about market conditions

Common characteristics of markets that fit the price leadership model:

- One firm has a significantly larger market share or is widely regarded as the industry trendsetter
- Products are similar across firms, or consumers have strong loyalty to the leading brand
- Firms can easily observe each other’s prices, and smaller firms can quickly adjust their prices in response to the leader
- Examples: Automotive, Smartphones, Steel Industry

Example: Price Leadership

Imagine three main players in the corn seed market: AgriGiant, FarmSeed, CropCo, all selling premium corn seed at **$150 per bag.**

AgriGiant (the price leader) decides to raise its price to **$165 per bag**.

FarmSeed and CropCo observe and respond:

- FarmSeed new price: $160 per bag (follows trend but slightly lower)
- CropCo new price: $162 per bag (positions between leader and other follower)

Assuming initial market shares and a total market of 1 million bags.

Before price change:

- AgriGiant (40%): 400,000 bags * $150 = $60 M revenue
- FarmSeed (35%): 350,000 bags * $150 = $52.5 M revenue
- CropCo (25%): 250,000 bags * $150 = $37.5 M revenue

After price change:

- AgriGiant (38%): 380,000 bags * $165 = $62.7 M revenue
- FarmSeed (37%): 370,000 bags * $160 = $59.2 M revenue
- CropCo (25%): 250,000 bags * $162 = $40.5 M revenue

Result: All firms increase revenue, with the leader maintaining highest revenue despite some market share loss.

Obstacles to Price Leadership

- U.S. antitrust laws
- Product differentiation
- No guarantee others will follow
- Barriers to entry
- Cheating

Comparing the Models

- Kinked-Demand: Explains price stability
- Collusive Pricing: Shows potential for cooperation and its challenges
- Price Leadership: Demonstrates importance of move order and signaling

Recall: Productive and Allocative Efficiency

Productive efficiency: Making Stuff Right

- Goods are produced in the **least costly way**
- Competition forces producers to use the best techniques and combination of resources in producing their goods

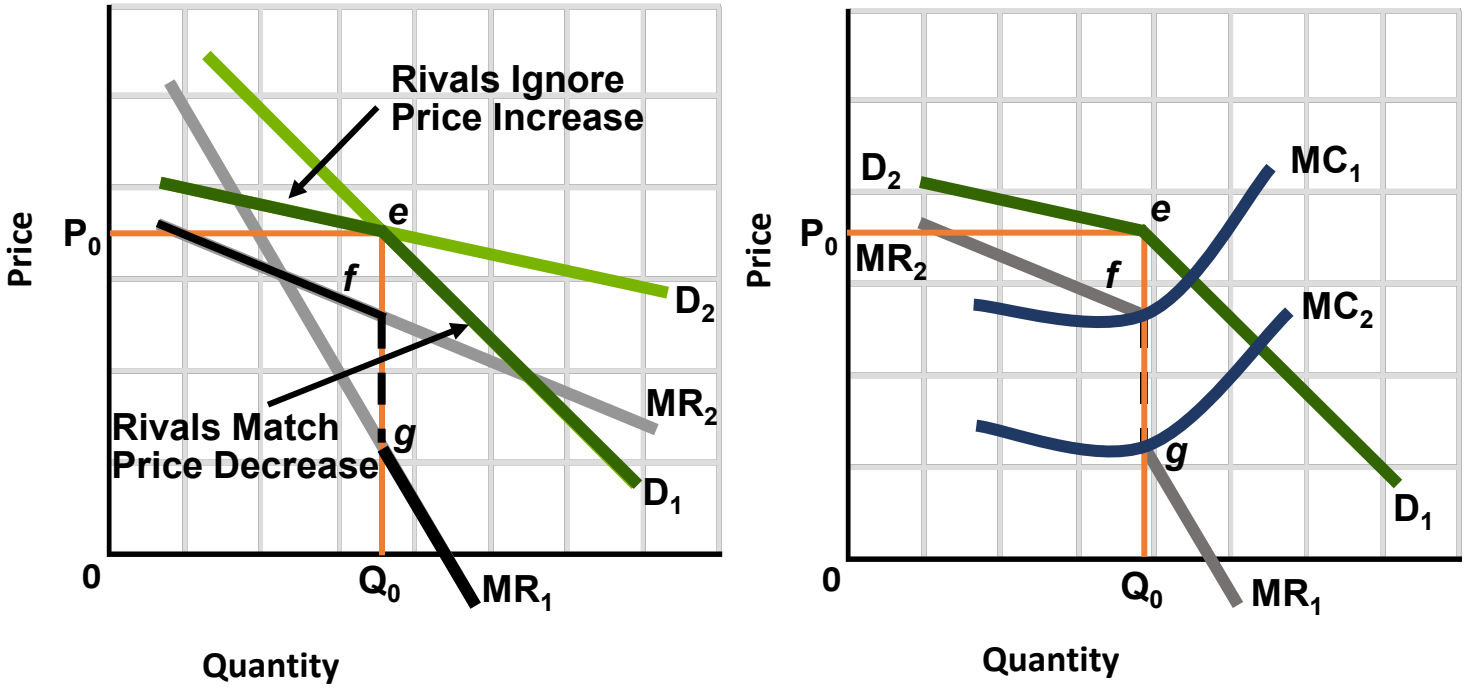
P = Minimum ATC

Allocative efficiency: Making the Right Stuff

- The **correct quantity of output** is produced relative to other goods and services
- Produce output that consumers value most
- This is achieved when it is impossible to obtain any net gains for society by simply altering the combination of goods and services

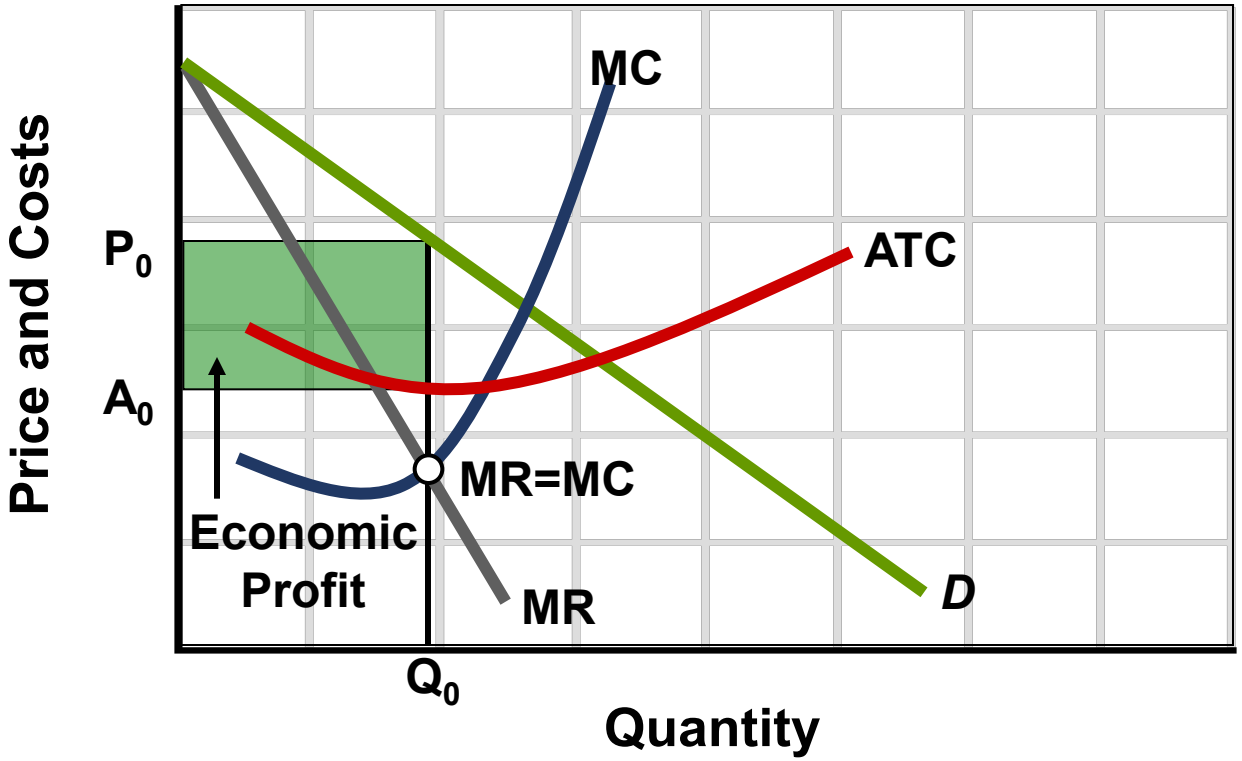
P = MC

Kinked-Demand Curve



Allocative inefficiency: P > MC

Cartels and Other Collusion



Productive inefficiency: P > Min ATC

Oligopoly and Efficiency

Efficiency in Oligopolies:

- Often productively inefficient: P > min ATC
- Often allocatively inefficient: P > MC

Strategic Considerations:

- Limit pricing to deter entry (predatory pricing game)
- R&D investment as a strategic move (innovation race)

Takeaways:

- Inefficiency often results from strategic behavior

Oligopoly vs. PC

Collusion Scenario:

- Strategy: Cooperative game
- Outcome: Higher price, lower output
- Challenge: Maintaining stable coalition (repeated game)

Price War Scenario:

- Strategy: Non-cooperative game
- Short-term: Lower price
- Long-term: Potential for higher profits (if competitors exit)

Recap: Comparison of Market Structures

Characteristic	Pure Competition	Monopoly	Oligopoly
Number of Firms	Many	One	Few
Product Differentiation	Homogeneous (i.e., identical)	Unique (i.e., no close substitute)	May be differentiated
Barriers to Entry	None	High	Moderate to High
Market Power	None	High	Moderate
Price Setting	Price Taker	Price Maker	Strategic Interaction
Long-run Profits	Zero	Positive	Can be Positive
Efficiency	Allocatively and Productively Efficient	Inefficient	Can be Inefficient
Example in Food/Ag	Wheat Farming	Patented GMO Seeds	Meat Processing

Game Theory – Takeaways

These examples form the basis of game theory.

Putting them into practice, we need to cover:

1. Cournot model
2. Stackelberg model
3. Bertrand model

We will cover these in Lecture 5.2.

Nonetheless, oligopoly behavior is highly strategic (the “C” in SCP), and game theory offers a way to conceptualize the strategic behavior of many industries.

Lecture 5.1

End

AREC 310: Food and Agricultural Markets