8. MONOPOLISTIC COMPETITION AND OLIGOPOLY

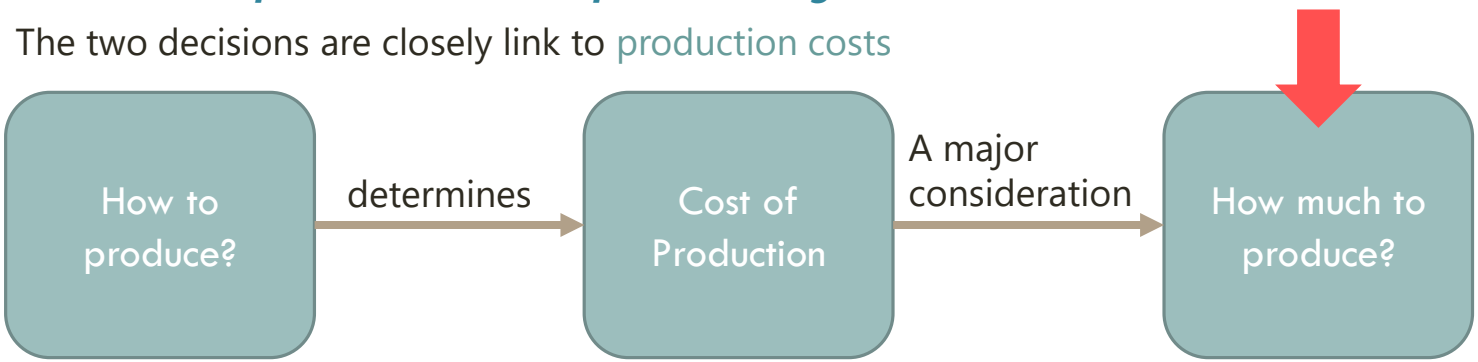
ECON1005 Principles of Economics I (Microeconomics)

MARKET STRUCTURE AND FIRMS' DECISIONS

- A firm is any business entity that turns inputs into outputs.
  - The major objective of the firm is assumed to be **profit maximization.**
  - Profit is the firm's total revenue minus total cost:

$$\text{Profit } (\pi) = \text{Total Revenue } (TR) - \text{Total Cost } (TC)$$

- *What decisions firms have to make?*
  - ***How to produce (which input combination to be used in production)?***
  - ***How much to produce (and what price to charge)?***
  - The two decisions are closely link to production costs



MARKET STRUCTURE AND FIRMS' DECISIONS

- When making output decisions, firms have two main considerations:
  - **Cost** Consideration: How much it costs to produce different output levels
    - The relationship between total cost and the amount produced is described by ***cost curves***, which apply to all firms in any market. (Discussed in Topic 4)
  - **Revenue** Consideration: How much revenue it can make to sell different output levels
    - The relationship between total revenue and the amount produced is determined by *the **demand facing the firm***.
      - Depends on the characteristics of the market the firm operates in, i.e. the **market structure**.

- Economists usually divide markets into four basic types:
  - Perfect competition (Competitive Market)
  - Monopoly
  - **Monopolistic competition (Topic 8)**
  - **Oligopoly (Topic 8)**

The main difference is the demand curve facing the firm

1. IMPERFECT COMPETITION

- Markets differ on three important dimensions:
  - Number of firms
  - Product differentiation
  - Entry conditions
- Most real-world markets are **imperfectly competitive**:
  - Multiple firms sell similar but not identical products, so they are not price takers (unlike perfect competition).
  - Thus, each firm faces a downward-sloping demand curve for its own product, it has some **monopoly power**.

	Perfect Competition	**Monopolistic Competition**	**Oligopoly**	Monopoly
Number of firms	Many			One
Product differentiation	Homogeneous			No close substitute
Entry condition	Free entry			No entry

2. MONOPOLISTIC COMPETITION

- **Monopolistic competition** refers to a market with:
  - Large number of small buyers and sellers
  - **Differentiated product**
    - Products are similar but not identical.
    - *What creates product differentiation?*
      - Tangible Features (design, quality, packaging, location, time, …)
      - Advertising
      - New products launches
      - Niche marketing
  - Free entry and exit



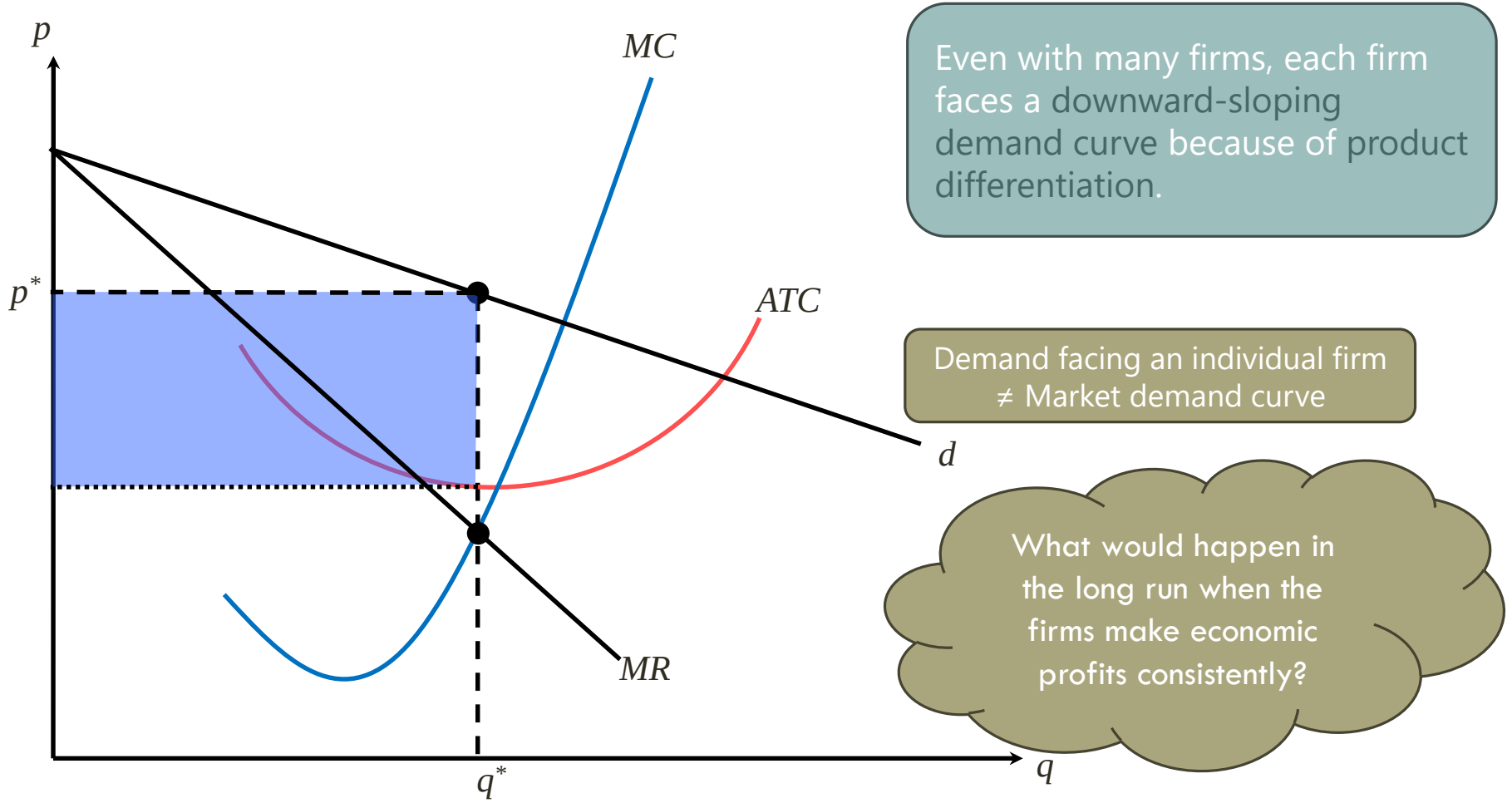






GreenPrice: targeting eco-conscious and budget-savvy consumers by selling products near or past their "best-before" dates to reduce waste and promote sustainable consumption.

2. MONOPOLISTIC COMPETITION



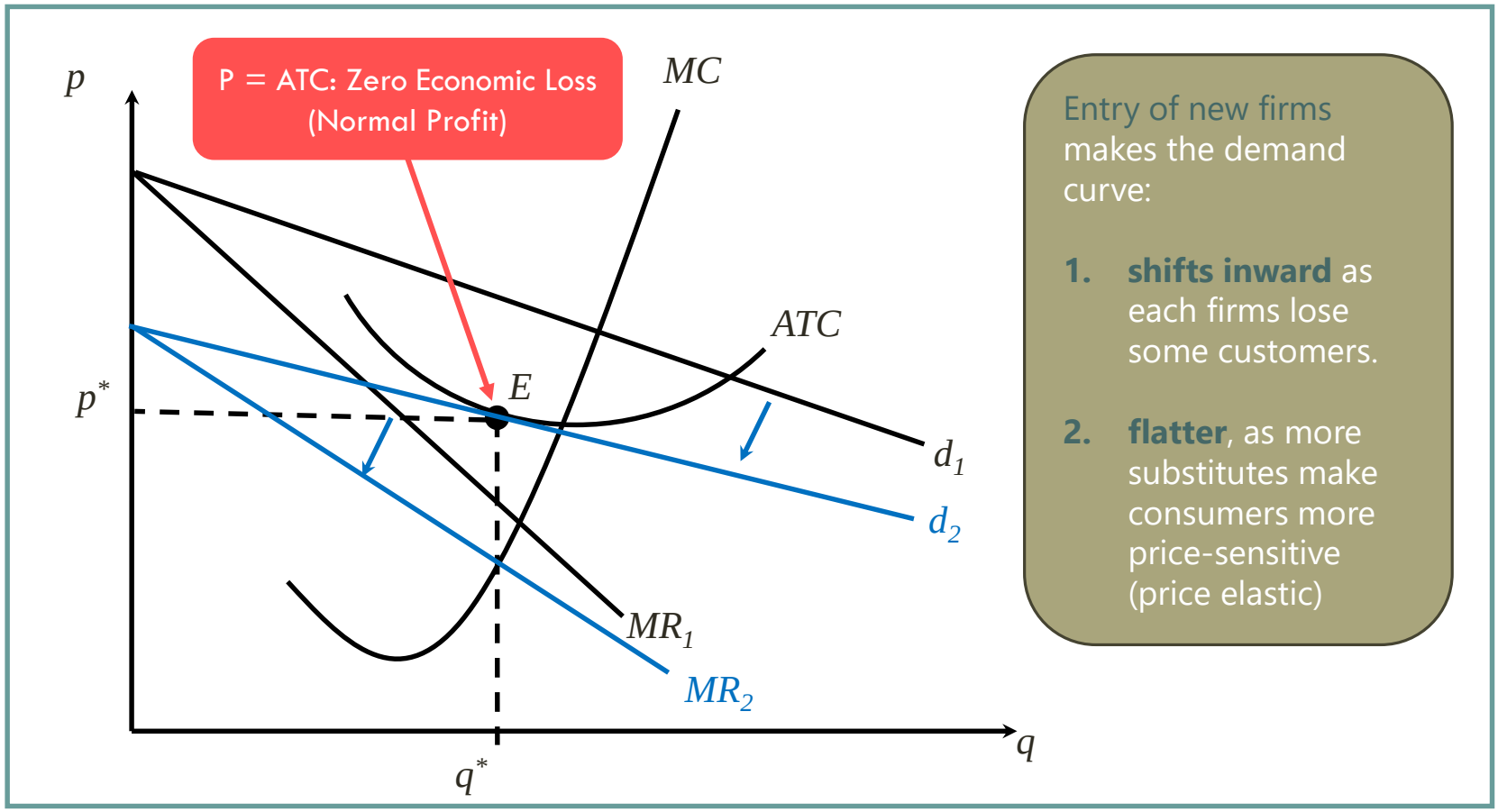
Even with many firms, each firm faces a downward-sloping demand curve because of product differentiation.

Demand facing an individual firm ≠ Market demand curve

What would happen in the long run when the firms make economic profits consistently?

2. MONOPOLISTIC COMPETITION

- **Free entry and exit** is the main difference between monopolistic competition and monopoly.
  - As there are no barriers to entry, firms will enter the market until economic profit drops to zero.



Entry of new firms makes the demand curve:

1. **shifts inward** as each firms lose some customers.
2. **flatter**, as more substitutes make consumers more price-sensitive (price elastic)

APPLICATION: HOT MESS

- David Tran, a Vietnamese immigrant, started selling **Sriracha sauce** (Sweet and spicy with a sour tinge) in America in the 1980s with his company, Huy Fong Foods.
  - By 2020, his Sriracha business was worth $1 billion!

- In 2024, Huy Fong Foods' 28-year supplier for its main ingredient, fresh jalapeños, stopped working with them.
  - Production was stopped for three months.
  - Loyal customers complained the sauce no longer tasted the same.

- ***How would the crisis at Huy Fong Foods affect its competitors?***
  - It results in an increase in demand for other Sriracha brands.



New competitors jumped in.

- McIlhenny (the maker of Tabasco) launched their own sriracha sauce.

- Even Underwood Ranches (the original jalapeños supplier) of Huy Fong Foods, started selling its own product.

(Source: Hot Mess, *The Economist*, Jun 20th , 2024.)



Business | Hot mess

The cautionary tale of Huy Fong's hot sauce

What went wrong for America's favourite sriracha brand?

Jun 20th 2024

Sweet and spicy with a sour tinge, sriracha sauce was an instant hit
Vietnamese refugee, brought it to America in the 1980s under the
Foods. Asian eateries were the first to snap up Mr Tran's hot sauce
the green-nozzled bottle, with its distinctive rooster logo, had becc
restaurants and pantries alike. Within just a few years Mr Tran wei
wares out of a Chevy van in Los Angeles to walking the floor of a
metre factory. By 2020 his business was worth $1bn.

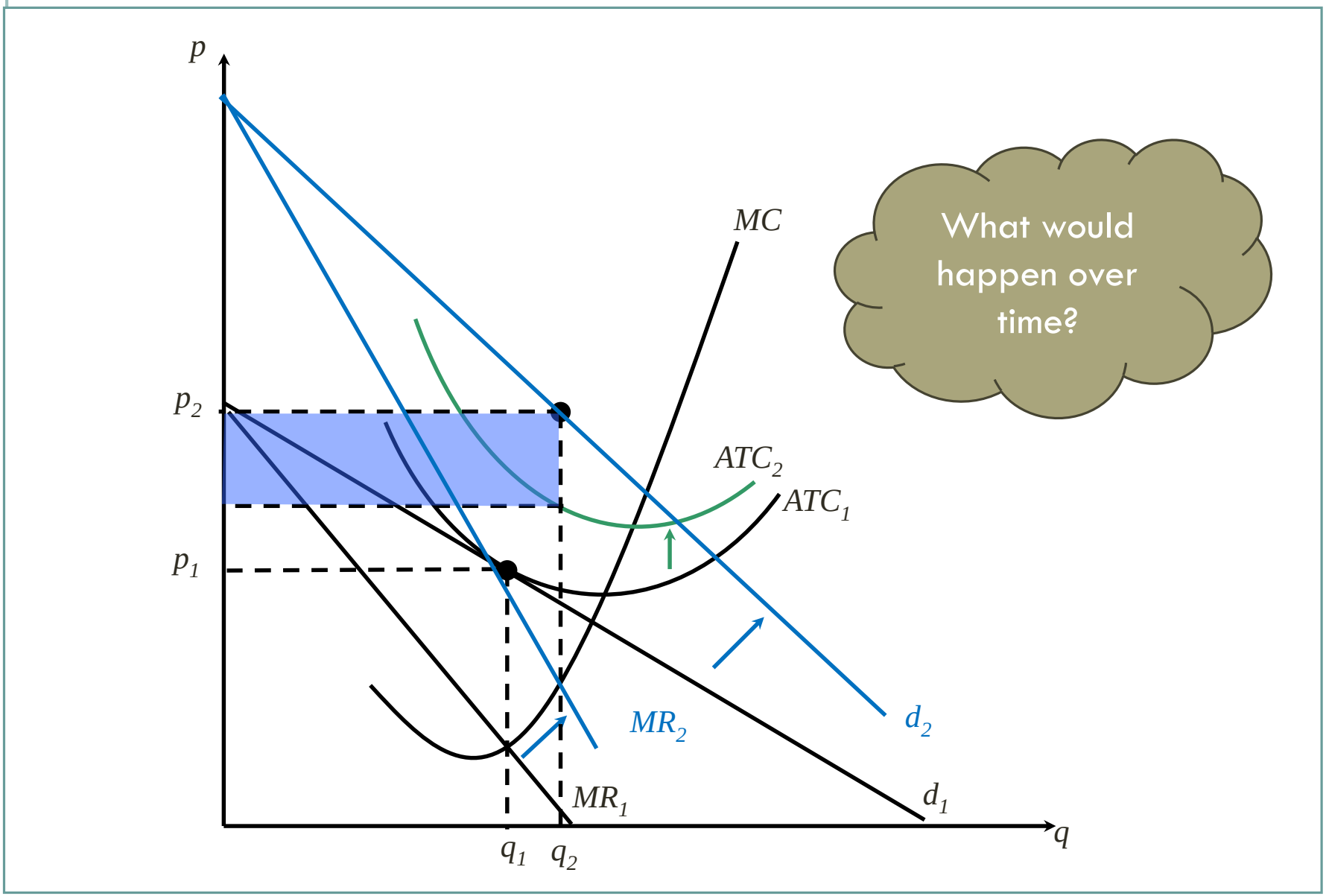
Since then, however, it has suffered a meltdown. First came grumb
the condiment had lost its vibrant crimson colour and peppery pun
shortages. Enthusiasts soon panicked and began to hoard the stuff.
year resale prices for Huy Fong's sauce on eBay, an e-commerce s
as $150 per bottle. To cap it off, last month the company announce
production until at least September.

For decades Huy Fong set its sriracha apart with fresh jalapeños re
a difficult commodity to grow at scale. Competitors turned to drie
turned to Craig Underwood, a Californian with a penchant for pep
Underwood Ranches, his company, met all Huy Fong's jalapeño n
producing close to 45,000 tonnes a year. To fill Huy Fong's bottle
Ranches expanded its acreage ten-fold. The two men became chun

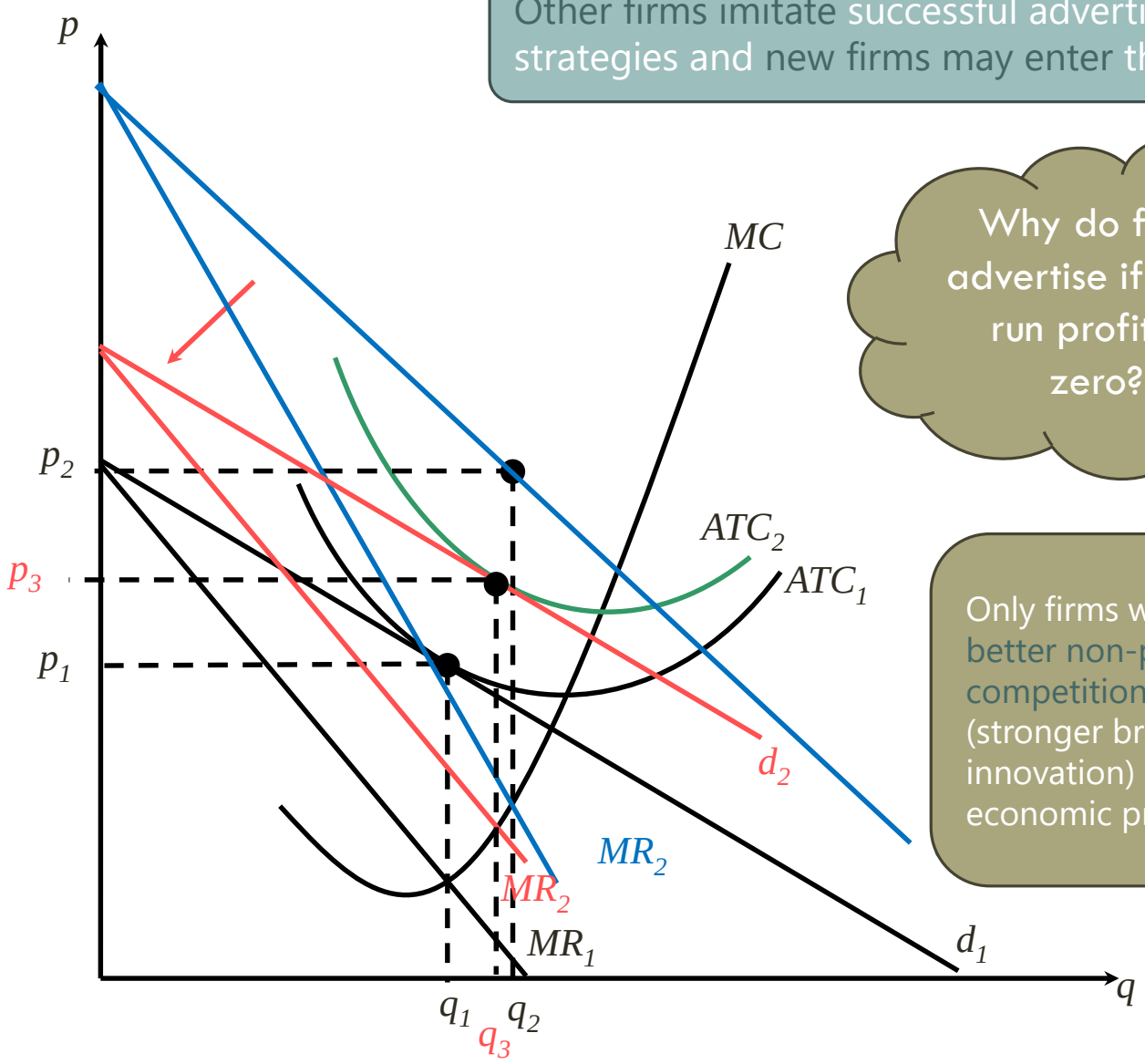
3. HOW DO FIRMS COMPETE WITHOUT CUTTING PRICES?

- Monopolistically competitive firms often rely on **non-price competition** to make their product stand out.
  - Actions firms take to attract more customers without changing their prices
  - Examples: advertising, content marketing, customers engagement, improving product quality, better packaging, better services, …

- **Effects of advertising** (and other non-price competition strategies):
  - Increase the demand for its product.
  - Higher fixed costs
    - Some forms of non-price competition (e.g. improving product and service quality) may also increase variable costs.


p
MC
What would happen over time?
p_2
ATC_2
ATC_1
p_1
MR_2
d_2
MR_1
d_1
q
q_1
q_2

Other firms imitate successful advertising strategies and new firms may enter the market,



Why do firms advertise if long-run profits is zero?

Only firms with consistently better non-price competition strategies (stronger brands, ongoing innovation) can earn economic profits.

4. OLIGOPOLY

	Perfect Competition	**Monopolistic Competition**	**Oligopoly**	Monopoly
Number of firms	Many	Many		One
Product differentiation	Homogeneous	Differentiated		No close substitute
Entry condition	Free entry	Free entry		No entry

- **Oligopoly** is a market with:
  - A small number of dominant firms
  - Homogenous (e.g. oil) or differentiated product (e.g. smartphones)
  - Limited entry (some barriers to entry)
    - E.g. high startup investment costs, strict regulations, …

- In an oligopoly, firms are **strategically interdependent**.
  - Firms do not make decisions in isolation. Each firm must consider how its rivals will respond when it makes its own decisions.
    - For example, if one firm lowers prices, others might do the same
  - This creates a "game" where firms must anticipate competitors' moves.

4. OLIGOPOLY

- Traditionally, oligopolies have been analyzed as extensions of the monopoly and perfect competition models.
  - **Oligopoly behavior is harder to analyze** because a firm must anticipate how rivals will respond to its decisions.

- Economists developed a variety of oligopoly models:
  - Noncooperative models: Cournot (compete by choosing output), Bertrand (compete by setting price), Stackelberg (one firm leads, others follow) …
  - Cooperative model: Cartel

  - *Which best explains the reality?*
    - It depends on the real-world context. The interactions in most industries don't perfectly fit just one model.

- **Game theory** helps economists predict outcomes when firms act strategically, responding to rivals' choices.
  - Since real-world firms engage in various strategic actions, game theory is often used to analyze oligopoly behavior more realistically.

5. WHY DO FIRMS IN OLIGOPOLIES COOPERATE? COLLUSION AND CARTEL

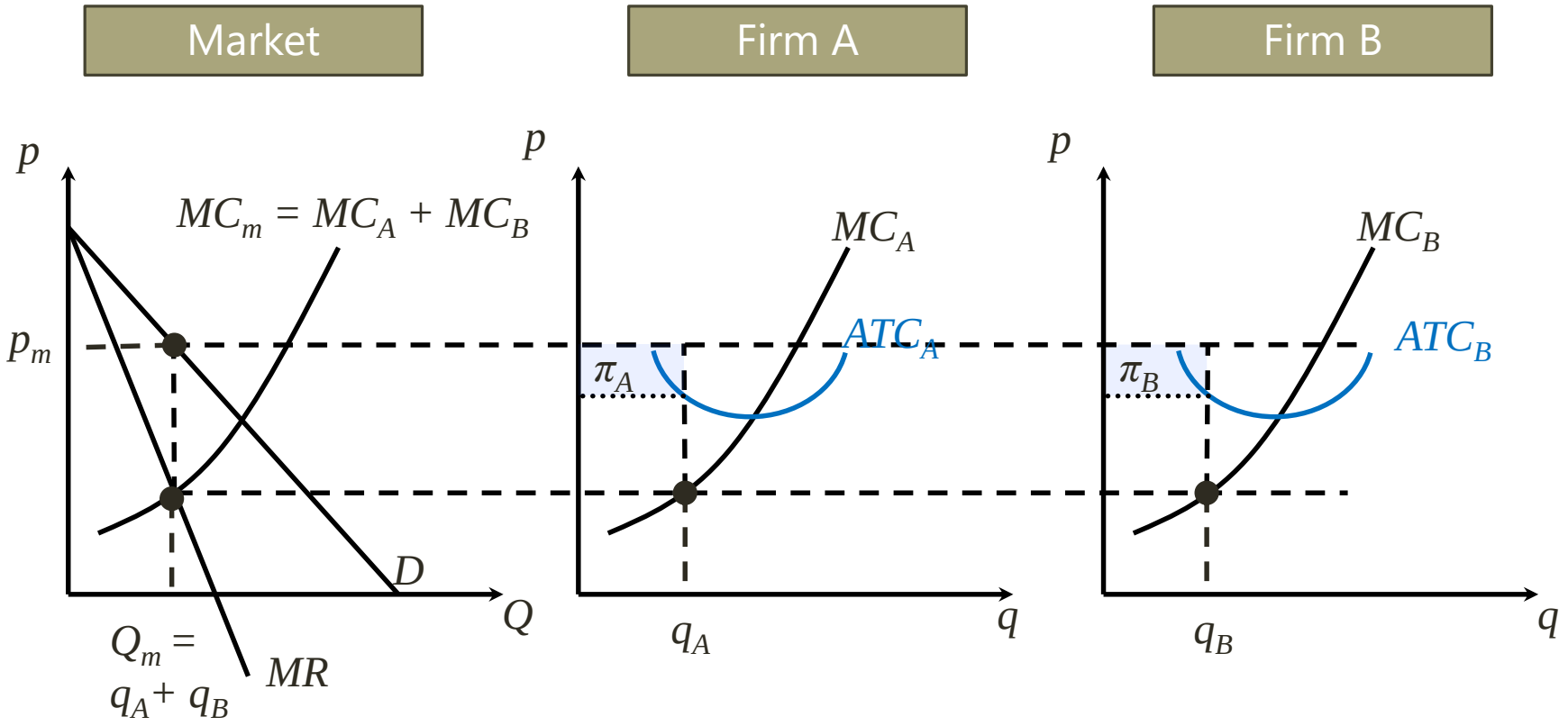
- This model assumes that the firms work together, instead of competing, to coordinate and control the total output and set prices, just like a single monopoly would do, by forming a **cartel**
  - This behavior is also called **collusion**.

- To understand how it works, consider a simplifying case with:
  - Two firms only (i.e., **Duopoly** market)
  - Homogeneous products

- Two firms, A and B, form a cartel and agree to act together as if they are a single firm with two factories, i.e. a multi-plant monopoly.

- As a group, they face the market demand curve and choose output to maximize joint (monopoly) profit.

5. WHY DO FIRMS IN OLIGOPOLIES COOPERATE? COLLUSION AND CARTEL



APPLICATION: OPEC

- **OPEC (Organization of the Petroleum Exporting Countries)** was founded in 1960.
  - Purpose: Control oil prices by coordinating supply among member countries
- As of 2024, OPEC has 13 member countries
  - Controls about 60% of global oil exports
  - Holds around 80% of the world's proven crude oil reserves
- Major members: Saudi Arabia, Iraq, Iran, UAE, Kuwait, Venezuela
- **OPEC+**: Larger Alliance (since 2016)
  - Includes OPEC and non-OPEC producers to better manage oil markets
  - Notable non-OPEC members: Russia, Kazakhstan, Mexico, Oman, Azerbaijan





Source: CNBC, Sep 17th, 2020.

OIL

OPEC and non-OPEC allies urge 'full conformity' with production cuts as oil prices falter

PUBLISHED THU, SEP 17 2020 3:35 AM EDTUPDATED THU, SEP 17 20201:37 PM EDT

Sam Meredith@SMEREDITH19

OPEC and non-OPEC allies, sometimes referred to as OPEC+, held an online meeting on Thursday to review the market and discuss compliance with deep production cuts.

The meeting comes shortly after OPEC and the IEA, two prominent forecasters, trimmed their 2020 outlook for oil demand.

"In the current environment, the JMMC [Joint Ministerial Monitoring Committee] emphasised the importance of being pro-active and pre-emptive and recommended that participating countries should be willing to take further necessary measures when needed," a statement from OPEC said.

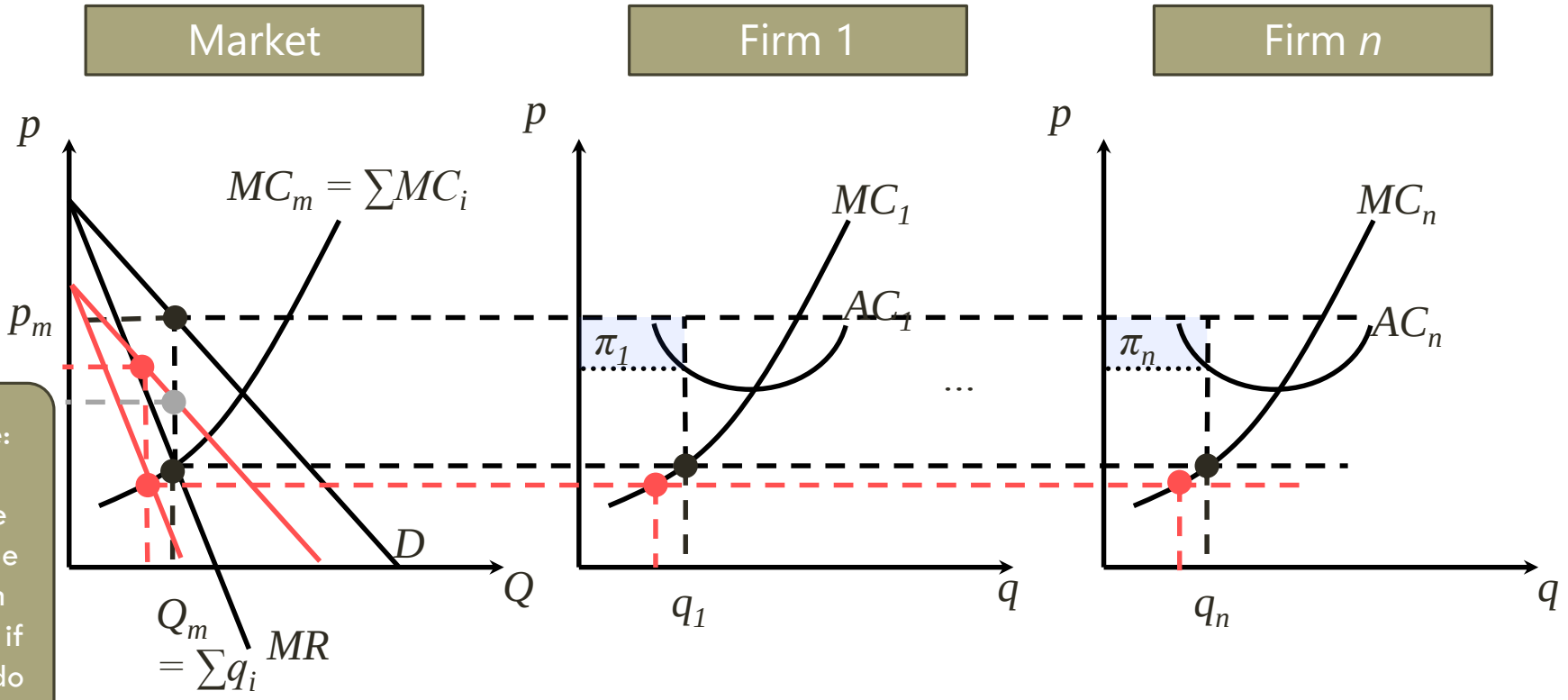
(Source: *CNBC*, Sept 17th, 2020.)

APPLICATION: OPEC+

- Due to lower global oil demand because of the pandemic driven recession, OPEC and its non-OPEC allies, so-called OPEC+, held an online meeting to respond to the crisis.
- In July, they agreed to cut output by 7.7 million barrels per day from August to December.
- ***Why do OPEC+ allies cut production?***

(Source: OPEC and non-OPEC allies urge "full conformity" with production cuts as oil prices falter, *CNBC*, 17 September, 2020.)

APPLICATION: OPEC+ TO CUT PRODUCTION



Note: Oil price will be even lower if they do not cut!

The alliance agreed to cut output by 7.7 million barrels per day from August to December, in an effort to prop up oil prices by limiting supply.

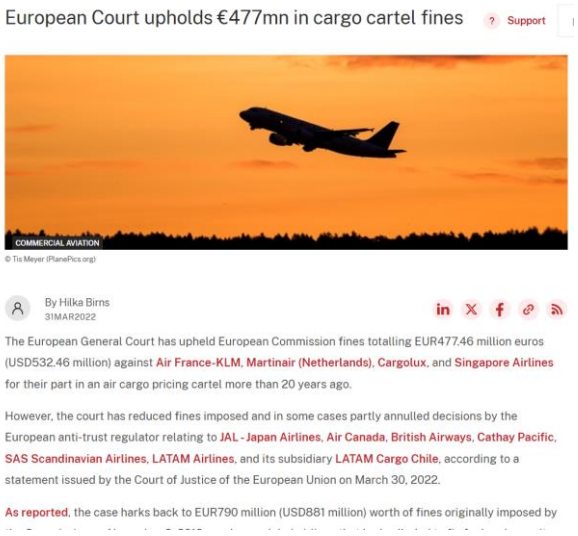
6. WHY DO CARTELS SUCCEED OR FAIL?

- **Antitrust Laws**: Many countries have strong antitrust laws that can break up cartels and punish firms for collusion.
  - To protect consumers from high prices and limited choices; encourage fair competition; and prevent monopolies.

APPLICATION: ANTITRUST

- **Airlines Air Cargo Cartel**
  - 11 major airlines, including Air France-KLM, British Airways, Singapore Airlines, Japan Airlines, Lufthansa, Cathay Pacific, and so on, coordinated on fuel and security surcharges for air cargo services.
  - European Commission fines totaling over €750 million (2022 updates)

- **Chicken Producer Cartel**
  - U.S. chicken producers, including Tyson Foods, Pilgrim's Pride, Perdue Farms, Sanderson Farms and others, conspired to fix prices of broiler chickens (2012 – 2019).
  - Over $200 million in fines and major lawsuits; several executives indicted.



European Court upholds €477mn in cargo cartel fines

Support

COMMERCIAL AVIATION

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By Hilka Birns
31MAR2022

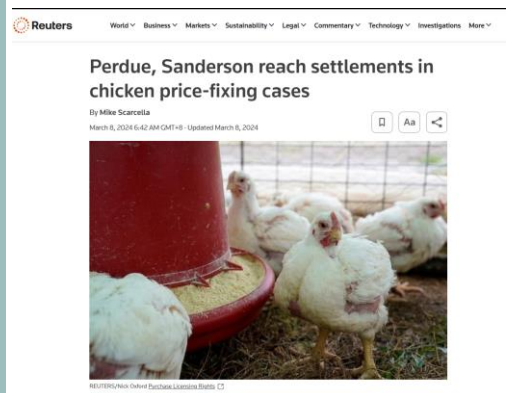
The European General Court has upheld European Commission fines totalling EUR477.46 million euros (USD532.46 million) against Air France-KLM, Martinair (Netherlands), Cargolux, and Singapore Airlines for their part in an air cargo pricing cartel more than 20 years ago.

However, the court has reduced fines imposed and in some cases partly annulled decisions by the European anti-trust regulator relating to JAL - Japan Airlines, Air Canada, British Airways, Cathay Pacific, SAS Scandinavian Airlines, LATAM Airlines, and its subsidiary LATAM Cargo Chile, according to a statement issued by the Court of Justice of the European Union on March 30, 2022.

As reported, the case harks back to EUR790 million (USD881 million) worth of fines originally imposed by

(Source: European Court upholds€477m in cargo cartel fines, *ch-aviation*, 31 March 2022.)

(Source: Perdue, Sanderson reach settlements in chicken price-fixing cases, 8 March, 2024.)



Reuters

World Business Markets Sustainability Legal Commentary Technology Investigations More

Perdue, Sanderson reach settlements in chicken price-fixing cases

By Mike Scarcella

March 8, 2024 6:42 AM GMT+8 · Updated March 8, 2024

6. WHY CARTELS SUCCEED OR FAIL?

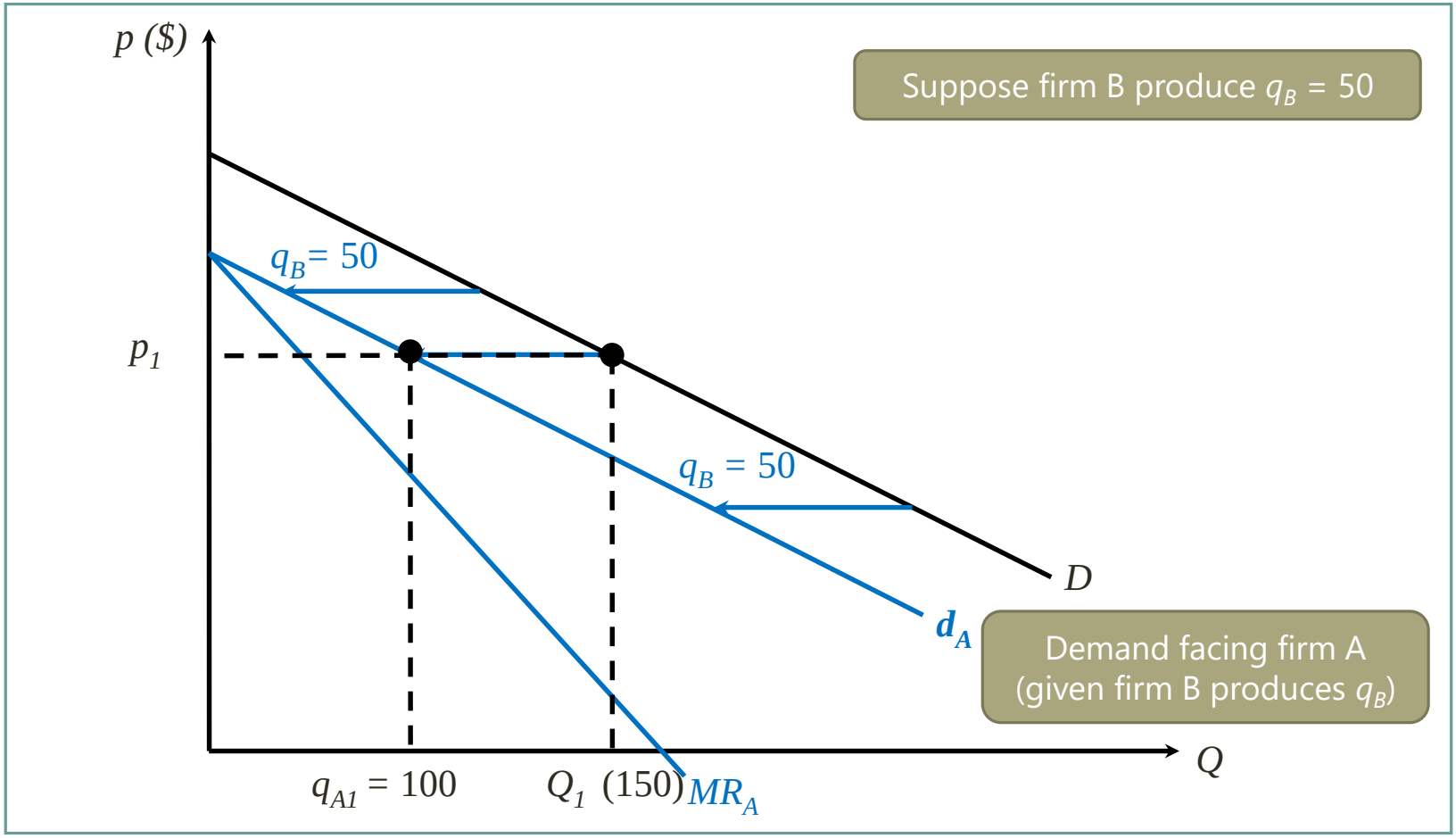
- **Antitrust Laws**: Many countries have strong antitrust laws that can break up cartels and punish firms for collusion.
  - To protect consumers from high prices and limited choices; encourage fair competition; and prevent monopolies.

- ***Why do some cartels still exist in the real world*?**
  - Not all countries have antitrust laws.
  - Some cartels operate internationally (e.g. OPEC) or have government support
  - Collusion can be **explicit collusion** (open agreements) or **tactic collusion** (e.g. price leadership, silent cooperation)

- **Limits of Collusion**:
  - Many well-established cartel eventually fail because each member has an **incentive to cheat**
    - If other members stick to the agreement, a firm can earn even more by secretly increasing its own production.

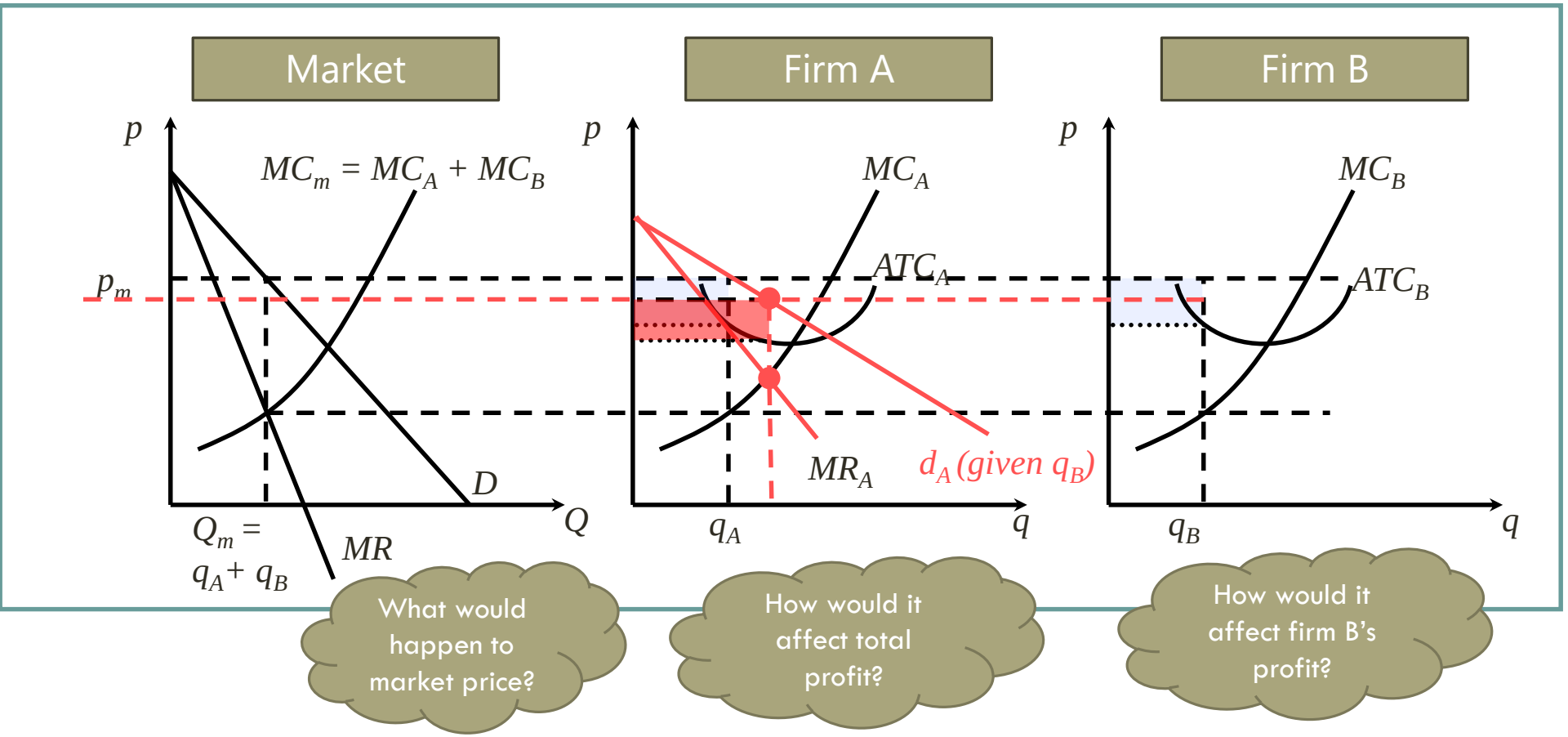
6. WHY CARTELS SUCCEED OR FAIL?

- Consider firm A: If firm A knows that firm B produces q_B, we can derive the demand curve facing firm A, d_A.



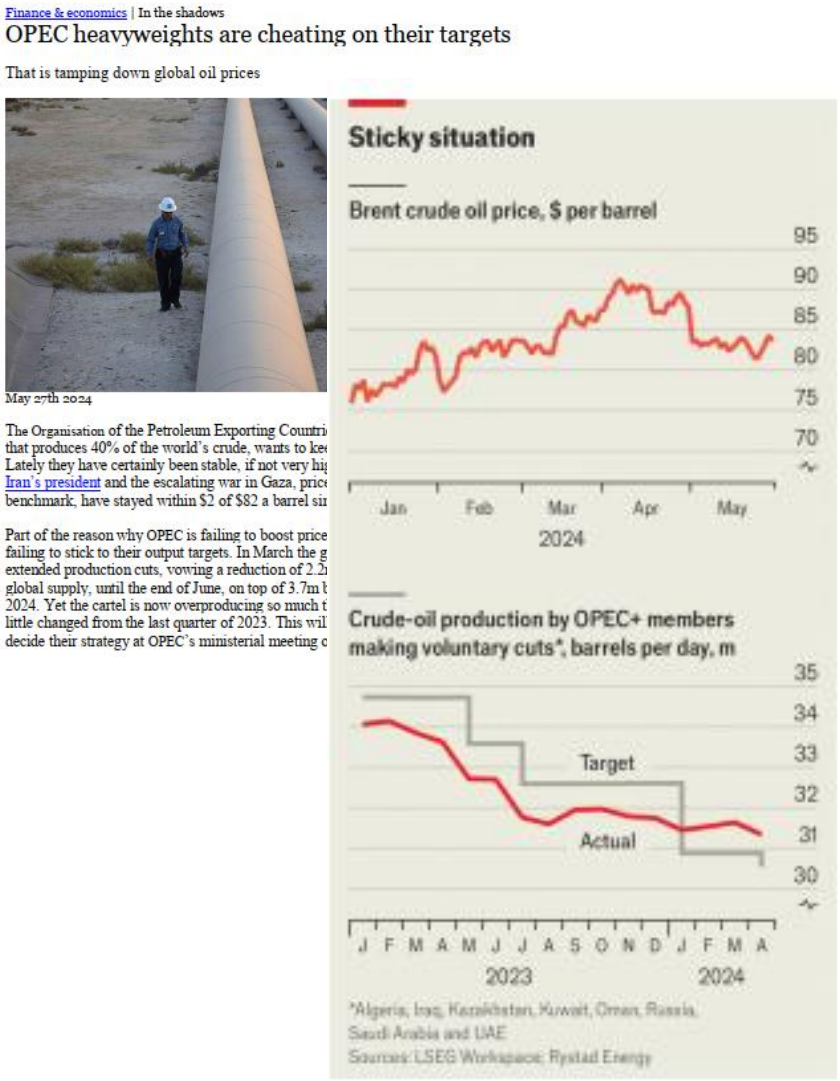
6. WHY CARTELS SUCCEED OR FAIL?

- Each cartel member has an **incentive to cheat**:



APPLICATION: IN THE SHADOWS

- OPEC and Russia agreed to cut oil production by 2.2 million barrels a day (about 2% of global supply) until June 2024.
  - However, actual oil output is about the same as last year because many cartel members are producing more than their output targets.
- Iraq and Kazakhstan, in particular, have often produced above their assigned quotas.
- Russia also doesn't stick to its cuts. It likes the effect of announcing cuts but dislike selling less, possibly to fund its war.
- Even Saudi Arabia, the cartel's de facto leader, is overproducing slightly according to some estimates.



Finance & economics | In the shadows

OPEC heavyweights are cheating on their targets

That is tamping down global oil prices

May 27th 2024

The Organisation of the Petroleum Exporting Countri
that produces 40% of the world's crude, wants to kee
Lately they have certainly been stable, if not very hig
Iran's president and the escalating war in Gaza, price
benchmark, have stayed within $2 of $82 a barrel sin

Part of the reason why OPEC is failing to boost price
failing to stick to their output targets. In March the g
extended production cuts, vowing a reduction of 2.2
global supply, until the end of June, on top of 3.7m b
2024. Yet the cartel is now overproducing so much t
little changed from the last quarter of 2023. This wil
decide their strategy at OPEC's ministerial meeting o

Sticky situation

Brent crude oil price, $ per barrel

95
90
85
80
75
70

Jan Feb Mar Apr May
2024

Crude-oil production by OPEC+ members making voluntary cuts*, barrels per day, m

35
34
33
32
31
30

Target
Actual

J F M A M J J A S O N D J F M A
2023 2024

*Algeria, Iraq, Kazakhstan, Kuwait, Oman, Russia, Saudi Arabia and UAE

Sources: LSEG Workspace; Rystad Energy

(Source: In the shadows, *The Economist*, 27 May, 2024.)

6. WHY CARTELS SUCCEED OR FAIL?

- For a cartel to succeed, it needs ways to enforce and monitor its agreement.

- Some important factors:
  - Cost and difficulty of making and keeping an agreement
    - Number of firms (more firms make collusion harder).
  - If the cartel is making high profits, new firms might want to join.
    - *How would new entry affect the existing cartel and its members?*
    - Entry Barriers (low entry barriers makes collusion harder)
  - Stability of demand (unpredictable demand makes collusion harder)

APPLICATION: PRICE-MATCH GUARANTEE?

- The four biggest British supermarket all offer price-match guarantees, promising customers won't find lower prices elsewhere.
  - But economists have long been worried these promises can actually hurt consumers.
  - This can lead to "**tactic collusion**": high prices are kept without explicit communication between firms.
- Researchers have found similar promises elsewhere to sustained high prices for groceries, tyres, and even shares. Works have confirmed the finding in the laboratory experiments too.

(Source: Source: Guaranteed Profits, *The Economist*, 12 February 2015.)

Finance & economics | Free exchange

Guaranteed profits

Price-match guarantees prevent rather than provoke price wars



Feb 12th 2015

"YOUR shopping would have been cheaper elsewhere, so here's a voucher for the difference." Anyone who has recently visited a British supermarket will be familiar with such seemingly generous deals, typically extended to shoppers after they pay. The four biggest British supermarket chains all offer some form of price-match guarantee, promising that their customers could not save any money by shopping elsewhere. On the face of it, they seem like a good thing: a sign that fierce competition is lowering prices. But economists have long been suspicious of such promises, which can leave consumers worse off.

7. GAME THEORY AND STRATEGIC PLAY

- **Game theory** is the study of how strategically interdependent decision-makers make choices. To apply game theory, we need to know:
  - How to describe the strategic situation as a "game"
  - How to predict what is the likely outcome

- Any situation where people's choices depend on what others do can be viewed as a **game.** All games have three key elements:

- **The Players**
  - Each decision-makers in a game.

- **The Strategies**
  - The possible actions or plans that players can choose.

- **The Payoffs**
  - The player's valuation of the outcome of the game (such as profits or satisfaction).



7.1 SIMULTANEOUS-MOVE GAME: THE PRISONERS' DILEMMA

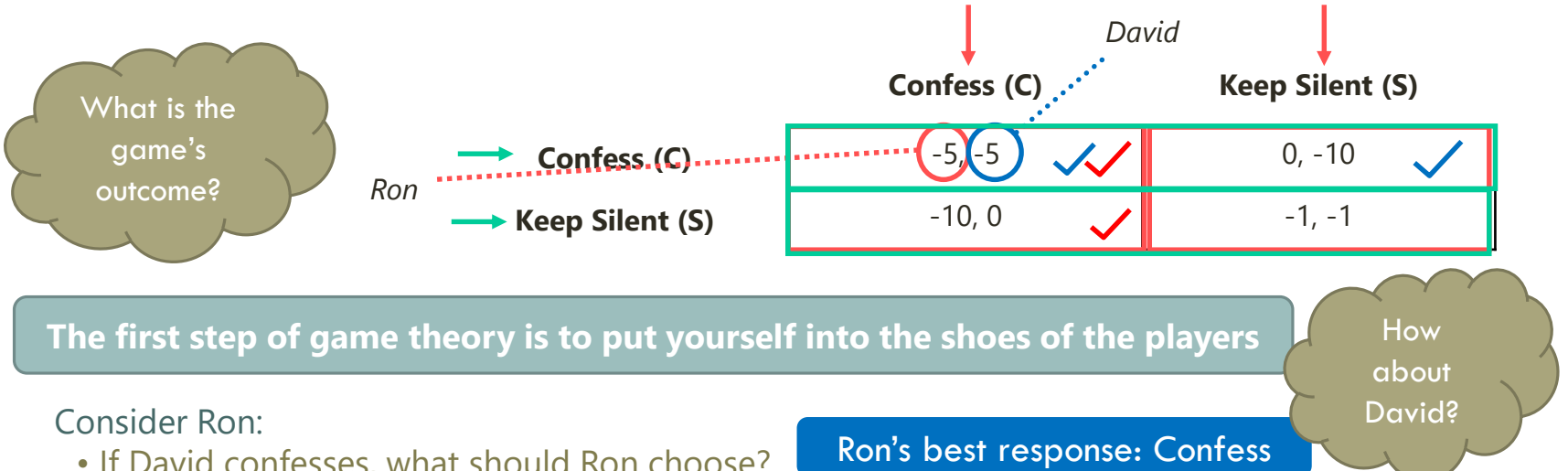
- Let's looks at a classic example called **The Prisoner's Dilemma**. In this game, two people make their decisions simultaneously and only play once.

- **The scenario**:
  - David and Ron are arrested for a crime and put in separate rooms.
  - The police don't have enough evidence, so they offer each prisoner a deal: confess and blame the other, or stay silent.

- **The possible outcomes**:
  - If both stay silent: Both are found guilty of a minor crime and each gets 1 year in jail.
  - If both confess: Both get a heavier sentence, but receive some mercy for confessing. Each gets 5 years in jail.
  - If one confesses and the other stays silent: The one who confesses goes free, and the silent one gets 10 years in jail.

7.1 SIMULTANEOUS-MOVE GAME: THE PRISONERS' DILEMMA

- The Prisoners' Dilemma is an example of a **simultaneous-move game** because players choose their actions without knowing the other player's choice.
- The following table, which shows payoffs for this game, with jail terms corresponding to negative payoffs, is called the **payoff matrix**:



The first step of game theory is to put yourself into the shoes of the players

How about David?

Consider Ron:

- If David confesses, what should Ron choose? **Ron's best response: Confess**
- If David does not confess, what should Ron choose? **Ron's best response: Confess**

In this game, **(Confess)** is Ron's **dominant strategy** because it is his best response, *regardless of other players' strategies*.

7.1 SIMULTANEOUS-MOVE GAME: THE PRISONERS' DILEMMA

- **(Confess)** is also David's dominant strategy.

- In the Prisoners' Dilemma game, both players have a dominant strategy (Confess). So, **(Confess, Confess)** is the outcome predicted for this game.
  - When every player has a dominant strategy, the result is called **dominant strategy equilibrium**.
  - However, many games do not have a dominant strategy equilibrium.

- **The striking feature about the Prisoners' Dilemma is that both players end up choosing strategies that do not maximize their total payoffs.**

Let's not study together for the exam?

Dominant Strategy Equilibrium

		David	
		Confess (C)	**Keep Silent (S)**
Ron	**Confess (C)**	-5, -5	0, -10
	Keep Silent (S)	-10, 0	-1, -1

Outcome that maximizes total payoffs

APPLICATION OF THE PRISONERS' DILEMMA: COLLUSION

- The prisoner' dilemma can explain how two firms in a cartel make decisions about whether to stick or break the agreement.
- Imagine two firms, *A* and *B*, form a cartel to coordinate output decisions to maximize the combined profit. But after the cartel is formed, each firm can choose to comply with the agreement or cheat on the agreement.

What is the game's outcome?

Firm A \ *Firm B*	**Comply**	**Cheat**
Comply	$100, $100	$25, $125
Cheat	$125, $25	$80, $80

Why is there some cartels in the real world?

- Dominate Strategy Equilibrium: Both firms choose to cheat, i.e. **(Cheat, Cheat)**
- This helps us to understand why cartels are hard to maintain – each firm has an incentive to cheat!

7.1 SIMULTANEOUS-MOVE GAME: THE PRISONERS' DILEMMA

- So far, we have assumed the game is played only once. But in a **repeated game**, the same game is played repeatedly. Each time, both players make their decisions simultaneously.
  - But now, players know what happened in previous rounds.

- **How do players escape from the Prisoner's Dilemma in repeated game?**
  - If two firms play the game just once, both firms will cheat.
  - But *if the game is repeated, each firm knows what the other did before. If one cheat, the other can punish them in future rounds*.
  - This possibility of punishment can encourage the players to cooperate, especially if they use special strategies (like a **trigger strategy**), where a player cooperates until other cheats, and never cooperates again in all future rounds.

Cooperation is more likely in repeated games!

- **The scenario**:
  - Ann and Boris, a girlfriend and boyfriend, are choosing between two vacation spots: Japan and Thailand. Ann prefers Japan, and Boris prefers Thailand.
  - However, both would rather go **together** than go to their favorite place alone.
- **The possible outcomes**:
  - If both chooses Japan, Ann gets a satisfaction of 3 and Boris gets a satisfaction of 1.
  - If both chooses Thailand, Ann gets a satisfaction of 1 and Boris gets a satisfaction of 3.
  - If they choose different spots, each gets a satisfaction of 0.



7.2 SIMULTANEOUS-MOVE GAME: BATTLE OF THE SEXES

7.2 SIMULTANEOUS-MOVE GAME: BATTLE OF THE SEXES

- The Battle of the Sexes game is represented by the following payoff matrix:

What is the game's outcome?

Ann → **Japan (J)**

Ann → **Thailand (T)**

	Boris: **Japan (J)**	*Boris*: **Thailand (T)**
Japan (J)	3, 1	0, 0
Thailand (T)	0, 0	1, 3

Consider Ann:
- If Boris chooses Japan, what is her best response?
- If Boris chooses Thailand, what is her best response?

Ann's best response: Japan

Ann's best response: Thailand

In this game, neither Ann nor Boris has a dominant strategy. Each player's best response depends on what the other chooses. What is the equilibrium of this game?

Dominant strategy?

7.3 NASH EQUILIBRIUM



John Nash
Nobel Laureate in 1994

- Recall: An equilibrium is a situation where no one has an incentive to change their decision, as long as other things remain unchanged.

- **Nash Equilibrium**: (named after John Nash, who won the Nobel Prize in 1994):
  - It is a situation where each player's strategy is the best response to the strategies of other players.
  - No player has an incentive to change from its strategy unilaterally (on his own).

Boris

Ann	**Japan (J)**	**Thailand (T)**
Japan (J)	3, 1	0, 0
Thailand (T)	0, 0	1, 3

How to find the Nash Equilibrium?

- Nash Equilibria: **(Japan, Japan) and (Thailand, Thailand)**
- *For players who can coordinate their beliefs*, they will coordinate to go together, either to Japan or Thailand.

How could players coordinate their belief? Which outcome is more likely?

APPLICATION: DVD STANDARDS BATTLE



- Two groups of companies are competing to set the new DVD standard:
  - A group led by Toshiba and NEC (with Microsoft) supports **HD DVD**.
  - Another group led by Sony (with Dell, HP, Panasonic, Samsung, Sharp) supports **Blu-ray**.
- Each group believes that they can make more profits if all manufacturers adopt the same format, but each group wants it to be their own format.

What is the game's outcome?

HD DVD Group → **HD DVD (H)**

HD DVD Group → **Blu-ray (B)**

	Blu-ray Group **HD DVD (H)**	*Blu-ray Group* **Blu-ray (B)**
HD DVD Group	$5, $2	$1, $1
Blu-ray (B)	$1, $1	$2, $5

What is the result in the real world?



- Nash Equilibria: **(H, H) and (B, B)**
- Sony decided to include a Blu-ray player in every PlayStation 3 game console, helping to make Blu-ray the winning DVD format. This was an expensive move: Sony lost over $200 on each console sold, for a total loss of about $3 billion. However, experts believed Sony would earn back much more money in the future by making Blu-ray the industry standard.

7.4 SEQUENTIAL GAMES

- In a **sequential game**, there is a strict order of play and players take turns making decisions one after another.
  - Each player knows what choices the previous players made before deciding what to do.

- In additional to the basic elements of any game (players, strategies, payoffs), a sequential game also describes when players move and what information they have. This is usually shown as a **game tree**.

- In a sequential game, a player's **strategy** is a complete plan of action. For example:
  - If the other firm sets a high price, we will set a high price;
  - If the other firm sets a low price, we will also set a low price.

This complete plan of action is called a "Strategy"



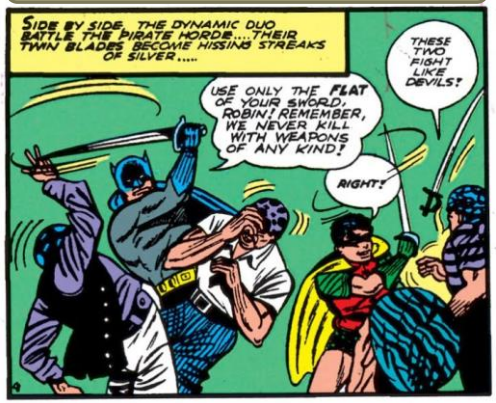
APPLICATION: THE DARK KNIGHT (2008)

- **The scenario**:
  - In one scene from the movie The Dark Knight (2008), Batman is trying to find the Joker.
  - Batman captures Sal Maroni, a mob boss, at a nightclub. He interrogates Maroni by holding him over the side of a building, threatening to drop him if he doesn't reveal the Joker's location.

What should Maroni do?

7.4 SEQUENTIAL GAMES

Batman's "no kill rule"

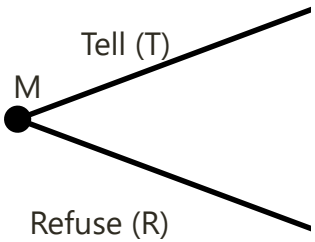


- Batman's and Maroni's preferences are shown using their satisfaction:

Maroni's Choice	Batman's Choice	For Maroni	For Batman
Refuse (R)	Not Kill (N)	4	3
Tell (T)	Not Kill (N)	3	4
Refuse (R)	Kill (K)	2	1
Tell (T)	Kill (K)	1	2

- The sequential game is shown by the following game tree:

Payoffs (U_M, U_B)



What is the game outcome?

7.4 SEQUENTIAL GAMES

- The easiest way to solve any sequential game is to use **backward induction** (**Look forward; Think backward**):
  - Suppose you are the first-mover. First, ask yourself: "What will the last player do?"
  - Then, use that answer to decide what earlier players should do.

