Topic 1B: Supply and Demand

Business Economics, Organization, and Management
(BUEC 211)

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Agenda

- The Supply-and-Demand Model
  - Demand
  - Supply
  - Market Equilibrium
- Using the Model
  - Effects of changing tastes, costs, prices of other goods
  - Effects of government intervention
- Applying the model in practice
  - When it works (and when it fails)
- Based on **Chapter 2** of the textbook. Use practice problems from this chapter.

The Supply-and-Demand Model

- Supply and demand is the core of almost every economic model.
- Works particularly well in markets with **many buyers and sellers**.

  We will study monopolies and other structures later on in the course
- Useful for predicting how changes in market conditions affect market outcomes (prices, production levels).
- Some important limitations: know when it works and when it fails

Demand

Demand

- First piece of the model: **Demand**
- **Demand** measures consumers' desire, willingness, and ability to purchase goods and services.
- Representations:
    - Demand schedule (table)
    - Demand curve (graph)
    - Demand function (equation)

Q: What factors affect consumers' desire to purchase a good? Why?

Quantity Demanded

- Many factors can affect demand; the most important of these factors is the **own price**.

Definition (Quantity Demanded)

The *quantity demanded* is the amount of a good or service that consumers are **willing to buy** at a given price, **holding all other factors constant**.

Demand Schedule

- A **demand schedule** is a table showing the quantity demanded at different prices.

Price of gasoline ($\$/L$)	Quantity demanded (L/month)
2.00	40
1.75	60
1.50	80
1.25	100
1.00	120

Table 1: Example demand schedule for gasoline

Law of Demand

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Definition (Law of Demand)

Consumers demand a **higher** quantity of a good or service when the price is **lower**, and a **lower** quantity when the price is **higher**, **holding all other factors constant**.

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- We illustrate this relationship with a **demand curve**.

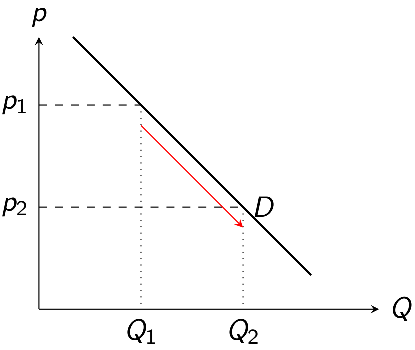

Figure 1: The Demand Curve for Gasoline

The Demand Curve for Gasoline

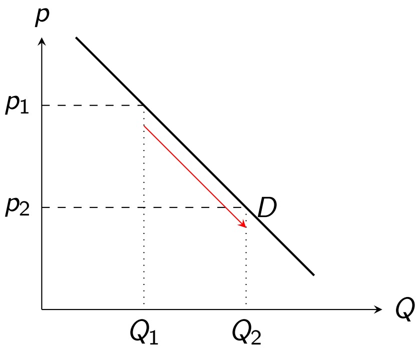

Figure 1: The Demand Curve for Gasoline

- The demand curve shows the relationship between the price of gasoline and the quantity demanded.

The Demand Curve for Gasoline

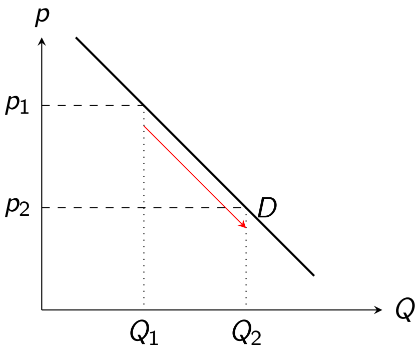

Figure 1: The Demand Curve for Gasoline

- A change in price causes a **movement along** the demand curve.

The Demand Curve for Gasoline

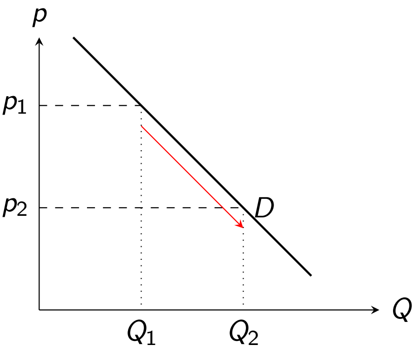

Figure 1: The Demand Curve for Gasoline

Q: Why is the demand curve downward sloping?

Movements Along vs. Shifts of Demand

- The demand curve tells us how a **change in price** affects quantity demanded.
  - Change in $p \Rightarrow$ **movement along** the demand curve.
- But other factors also affect demand:
  - income,
  - prices of related goods (**substitutes** and **complements**),
  - tastes and preferences,
  - government rules/regulations.
- A change in any of these **other factors** shifts the **entire** demand curve.

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Q: Consider an increase in household income. How would you expect that to change gasoline demand?

Income and the Demand for Gasoline

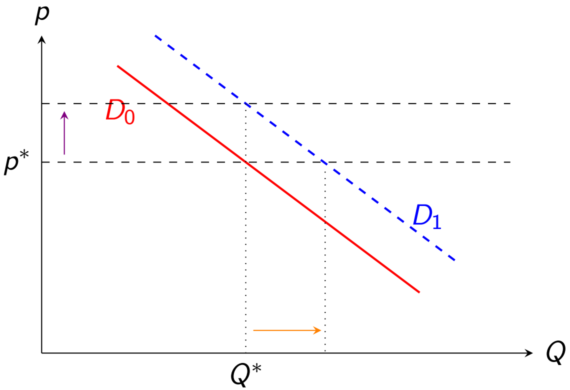


Figure 2: Income and the Demand Curve for Gasoline

Income and the Demand for Gasoline

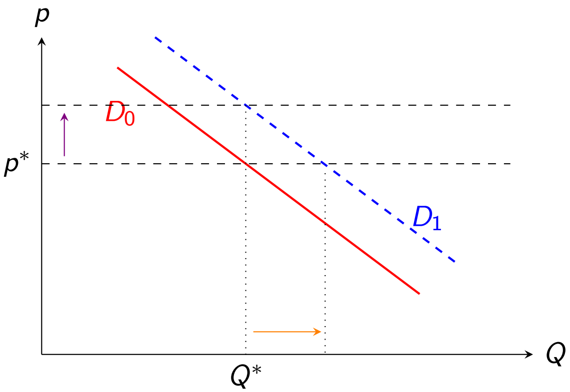
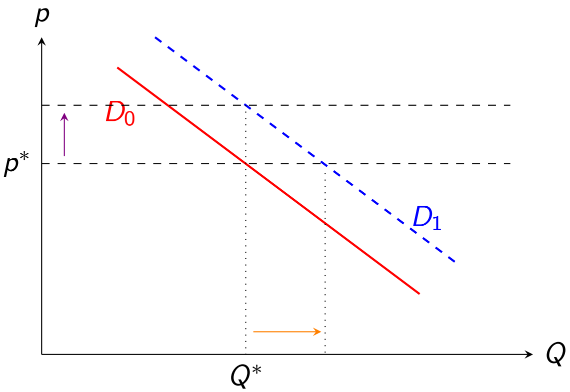


Figure 2: Income and the Demand Curve for Gasoline

- For a normal good, an **increase in income** shifts demand to the right: $D_0 \rightarrow D_1$.



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- At the same price p^*, consumers now demand a larger quantity.

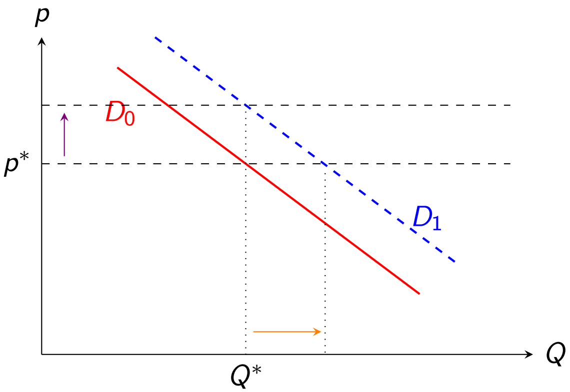

Figure 2: Income and the Demand Curve for Gasoline

- At the same production level Q^*, consumers are willing to pay a higher price for an additional unit.

Shifts of Demand

- Other factors also affect demand:
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  - government rules/regulations: Governments may ban, restrict, tax, or subsidize goods and services

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Q: Consider an increase in the **toll paid on a highway**. How would you expect that to change gasoline demand?

Price of a Complement and Gasoline Demand

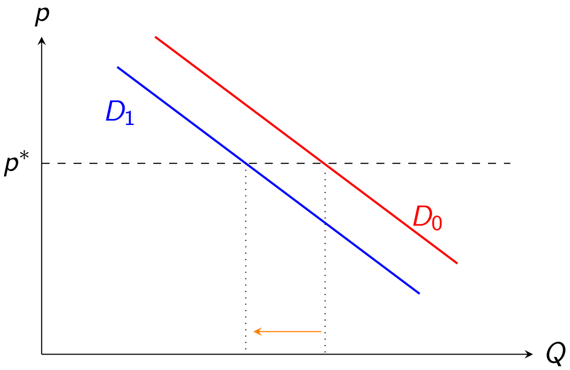

Figure 3: Complements and the Demand Curve for Gasoline

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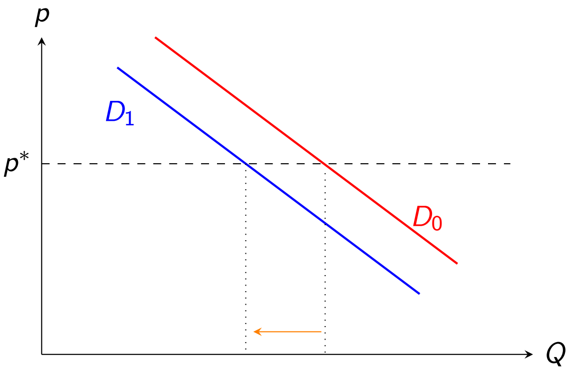

Figure 3: Complements and the Demand Curve for Gasoline

- If tolls (a **complement** to driving) become more expensive, the demand for gasoline shifts **left**.

Price of a Complement and Gasoline Demand

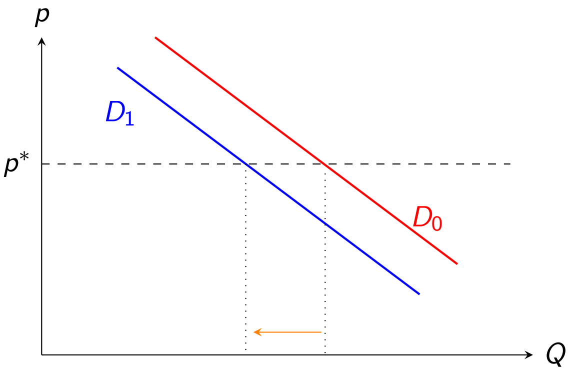

Figure 3: Complements and the Demand Curve for Gasoline

- At price p^*, consumers now demand a smaller quantity of gasoline.

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Q: How will changes in each of these other factors affect gasoline demand?

Demand Function

- The demand curve can also be written as a **demand function**:

$$Q = D(p, Y, X)$$

where:

- Q = quantity demanded,
- p = own price,
- Y = income,
- X = other demand factors (prices of related goods, tastes, government rules, etc.)

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Later: We will derive the demand function from a model of **consumer choice**.

Demand Function: Numerical Example

- Often, we will work with **linear** demand functions in this course. For example

$$Q = 30 - 0.2p + 0.1Y$$

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  - $\frac{\Delta Q}{\Delta p} = -0.2$ which is **negative**. Law of Demand holds!
  - $\frac{\Delta Q}{\Delta Y} = 0.1$ which is **positive**. Higher income means higher demand for all prices.
  - Constant term ($X = 30$ in this case) **reflects all other factors** we hold fixed.

Demand Function: Numerical Example

We can obtain the demand curve for gasoline by substituting for income Y (measured in thousands of dollars per year).

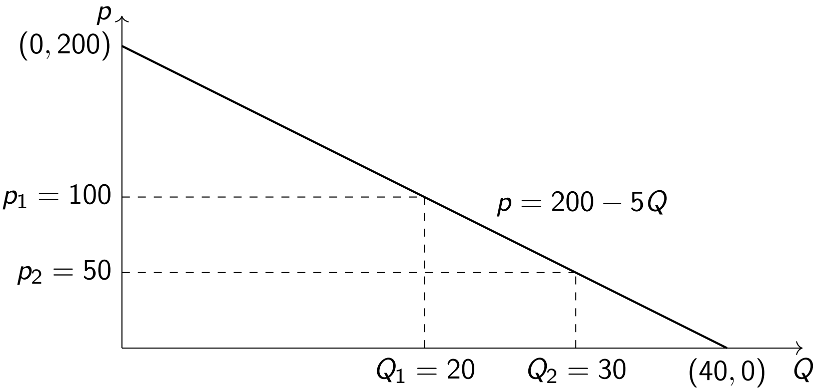
If household income is \$100,000, the demand for gasoline is:

$$Q = 30 - \frac{p}{5} + 0.1 \times 100$$
$$\implies Q = 40 - \frac{p}{5}$$

With some algebra we can obtain the **inverse demand curve**:

$$Q = 40 - \frac{p}{5}$$
$$\implies 5Q = 200 - p$$
$$\implies p = 200 - 5Q$$

Inverse Demand for Gasoline



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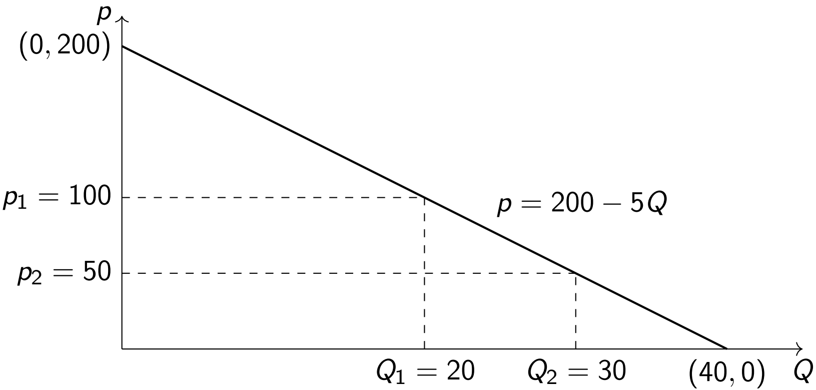

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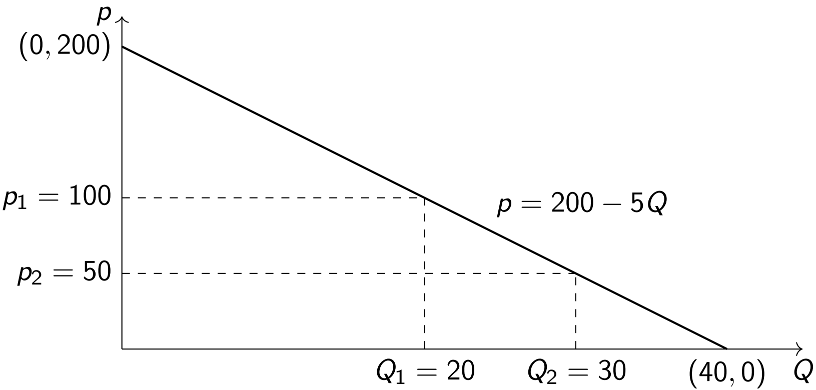
Inverse Demand for Gasoline



Q: How do we know the demand curve intersects the points $(0, 200)$ and $(40, 0)$?
Solve for the intercepts!

Numerical Example of a Price Change

The demand function allows us to think precisely about how quantity demanded responds to a change in price, holding income (and all other factors) fixed.

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- Consider two price–quantity pairs from the figure:

$$p_1 = 100, \qquad p_2 = 50$$

- Quantity demanded at the initial price:

$$Q_1 = D(p_1) = 40 - \frac{p_1}{5} = 40 - \frac{100}{5} = 20$$

- Quantity demanded at the lower price:

$$Q_2 = D(p_2) = 40 - \frac{p_2}{5} = 40 - \frac{50}{5} = 30$$

- These values help us understand how quantity responds to changes in price.

Numerical Example of a Price Change

- In our gasoline example, if the price changes from p_1 to p_2, the change in quantity demanded is:

$$\Delta Q = D(p_2) - D(p_1) = \left[40 - \tfrac{p_2}{5}\right] - \left[40 - \tfrac{p_1}{5}\right]$$

- Simplifying:

$$\Delta Q = \frac{p_1}{5} - \frac{p_2}{5}$$

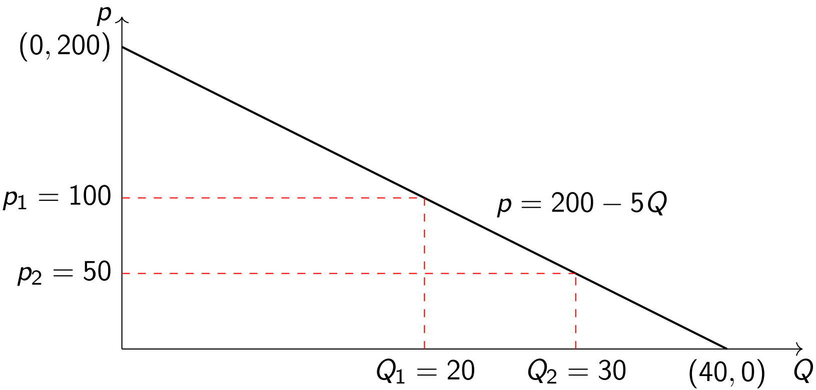
- Using $\Delta P = p_2 - p_1$, we obtain:

$$\Delta Q = -\tfrac{1}{5}\,\Delta P$$

- Therefore, for any change in price ΔP, the quantity demanded changes by:

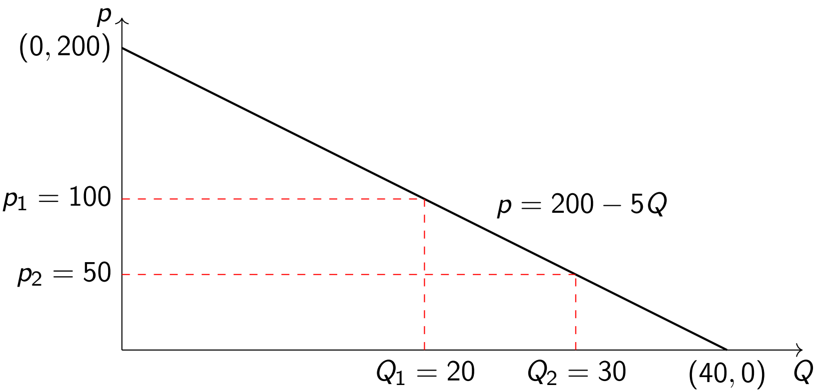
$$\Delta Q = -\tfrac{1}{5}\,\Delta P$$

Numerical Example of a Price Change



Changing the price from 100 to 50 increases Q from 20 to 30, so $\Delta Q = 10$

Numerical Example of a Price Change



- From the previous slide, $\Delta Q = -\frac{1}{5}\Delta P = -\frac{-50}{5} = 10$.

From Individual to Market Demand

- Sometimes we know only **individual** demand functions. Can we use these to know the **market demand function**?

From Individual to Market Demand

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Yes: Need to "add up" demand from each consumer

- **Market demand** at a given price is the **sum of all individuals' quantities demanded** at that price.

Market Demand: Example

- Suppose there are **two people** in the market for gasoline. Each person has the following individual demand function:

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$$Q^M(p) = \underbrace{\left(40 - \frac{p}{5}\right)}_{\text{Person 1}} + \underbrace{\left(40 - \frac{p}{5}\right)}_{\text{Person 2}} = 80 - \frac{2p}{5}$$

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- Therefore, the market demand curve is:

$$\boxed{Q^M(p) = 80 - \frac{2p}{5}}$$

Market Demand: Example Graphic

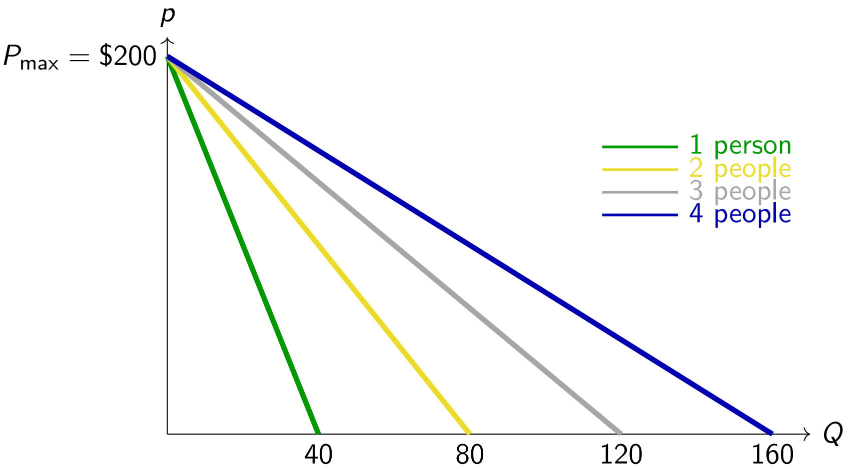

Figure 4: Market Demand as we add more individuals

Horizontal Summation of Demand

Definition (Horizontal Summation)

When summing demand for a private good, we add up the quantity demanded of each individual **at each price**.

- At every price p, compute total demand as:

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- A common trap: do not sum inverse demand functions vertically

  Remember: If no individual is willing to purchase gasoline above some price P_{max} (\$200 in this case), then the **market** also demands zero at all prices above P_{max}.

Supply

Supply

- The second piece of the model: **Supply**.
- Supply reflects producers' **willingness** to sell goods and services at a given price.

Q: What factors affect producers' willingness? How?

As with demand, economists focus on how the **price** of a good or service affects the quantity supplied.

Definition (Quantity Supplied)

The quantity supplied is the amount of a good or service that producers are willing to sell at a given price, holding other factors that influence supply decisions constant.

Supply

- We can illustrate the relationship between price and quantity supplied using:
  - A **supply schedule**
  - A **supply curve**
  - A **supply function**

Q: Is there a Law of Supply? Why or why not?

Supply Schedule and the Law of Supply

Supply Schedule for Gasoline

Price ($\$/L$)	**Quant. Supplied (L/day)**
1.00	1000
1.25	2000
1.50	3000
1.75	4000
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Producers are generally willing to sell **more output at higher prices** and **less output at lower prices**, holding all other factors constant.

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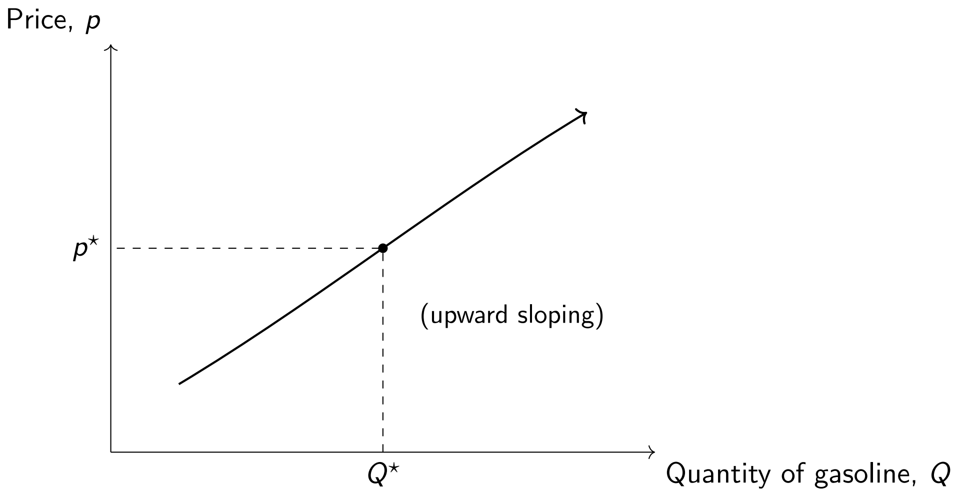
Intuition

- Higher prices mean higher profitability
- Higher prices justify higher production costs

The (Inverse) Supply Curve



The Supply Curve

- The supply curve tells us how a change in the price of a good or service affects the quantity supplied.
  - Change in price $\Rightarrow$ movement **along** the supply curve
  - Change in other factors $\Rightarrow$ **shift** of the supply curve

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Ex: Suppose the price of a **key input** to gasoline production, crude oil, increases.

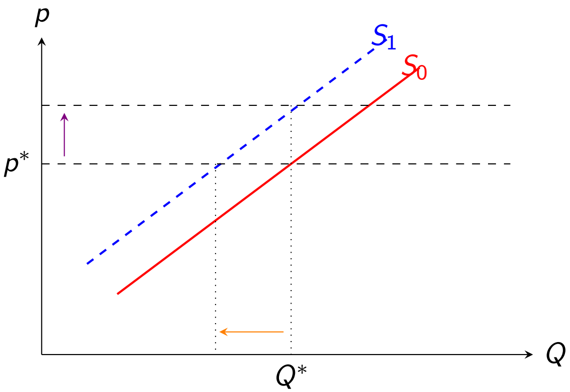
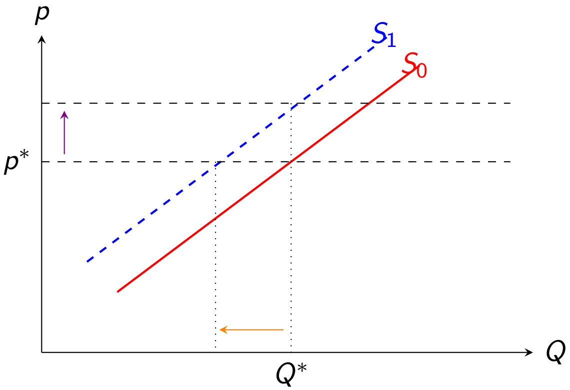


Figure 5: An Increase in Input Costs Shifts the Inverse Supply Curve Up (Left)

Input Costs and the Supply of Gasoline



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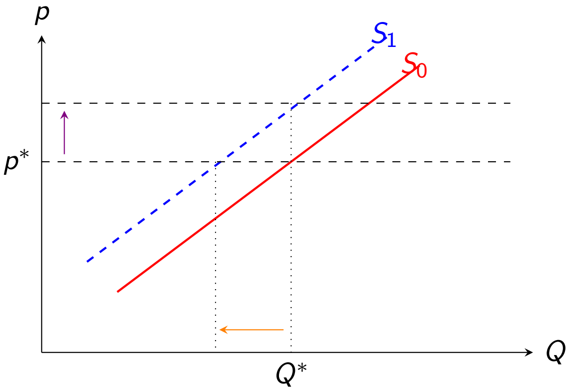
- An **increase in input costs** shifts supply up/left: $S_0 \to S_1$.

Input Costs and the Supply of Gasoline



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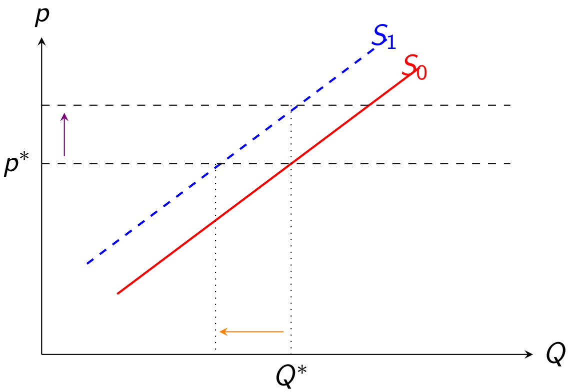
Input Costs and the Supply of Gasoline



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- At the same production level Q^*, producers require a higher price to supply an additional unit.

The Supply Curve

Q: How does the supply curve shift depending on the factor being considered?

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Key determinants of supply include:

- Prices
- Production costs
- Technological change
- Government regulation

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In what follows, we will certainly hold X constant (as with the demand case)

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The supply function allows us to think precisely about how price changes affect the quantity supplied, holding all other factors fixed.

- Example of a plant's supply curve:

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$$Q_2 = S(p_2) = 2p_2$$

Then, the change in supply is

$$\Delta Q = Q_2 - Q_1 = 2(p_2 - p_1) = 2\Delta p$$

Determining Market Supply

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$$Q^M(p) = \underbrace{2p}_{\text{Plant 1}} + \underbrace{3p+1}_{\text{Plant 2}} = 5p + 1 \tag{1}$$

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Q: What is the inverse supply curve? Derive it.

Horizontal Summation of Supply Curves

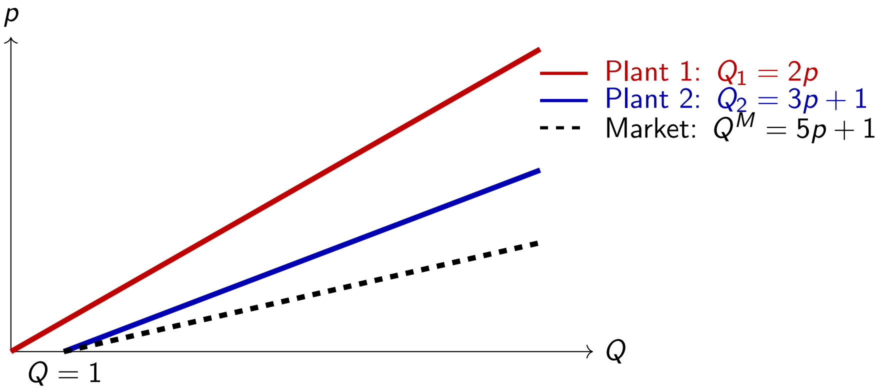

Figure 6: Market Supply with 2 Plants with Different Supply Curves

Market Equilibrium

Once we know supply and demand in the market, we can determine the **market equilibrium**.

Definition (Market Equilibrium):

The market is in equilibrium when all market participants are able to **buy or sell as much as they want** at the prevailing price, and no participant has an incentive to change their behaviour.

Equilibrium Price and Quantity

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The equilibrium price, p^*, is the price at which **quantity demanded equals quantity supplied**.

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At equilibrium:

- There is no market shortage (not enough production given demand)
- There is no market surplus (goods produced that nobody purchases)

Market Equilibrium Graphically

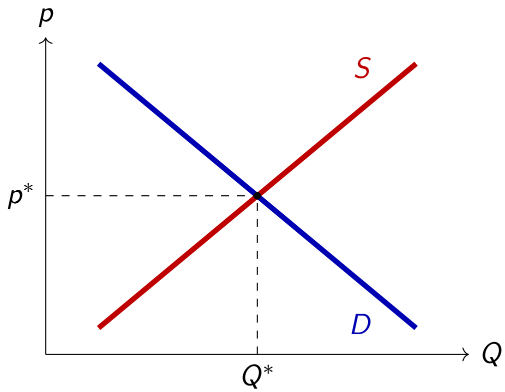

Figure 7: Equilibrium in the market

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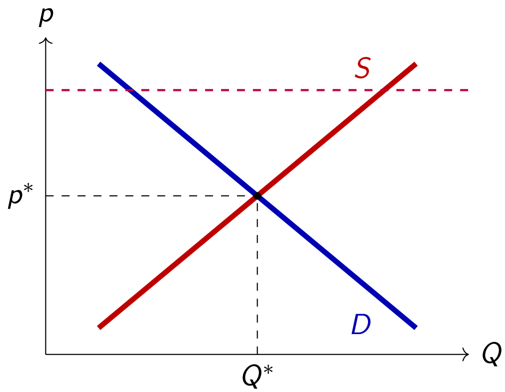

Figure 7: Equilibrium in the market

- Why isn't this price an equilibrium?

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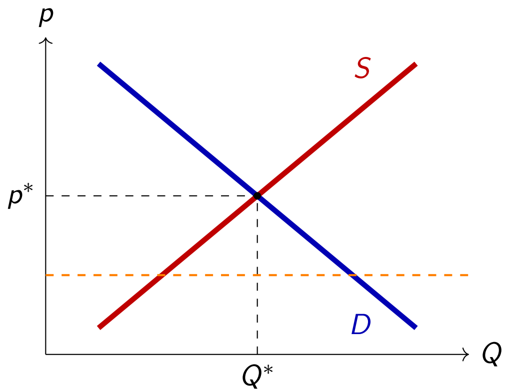

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- Prices above p^* create surpluses $\Rightarrow$ downward pressure on prices: rather than allow their unsold coffee to get stale, firms lower the price to attract additional customers.

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As a result, the market naturally moves toward equilibrium – Adam Smith's *invisible hand*.

Solving for a Market Equilibrium

Suppose market demand and supply are given by the following functions:

$$Q^D(p) = 100 - 2p$$
$$Q^S(p) = 20 + p$$

Here:

- $Q^D(p)$ is quantity demanded
- $Q^S(p)$ is quantity supplied
- p is the market price

Solving for the Equilibrium Price

- In equilibrium, quantity demanded equals quantity supplied:

$$Q^D(p^*) = Q^S(p^*)$$

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$$100 - 20 = 2p + p$$

$$80 = 3p$$

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- Substitute the demand and supply functions:

$$100 - 2p = 20 + p$$

- Collect like terms:

$$100 - 20 = 2p + p$$
$$80 = 3p$$

- Solve for the equilibrium price:

$$p^* = \frac{80}{3}$$

What about other prices?

- Consider a price **below equilibrium**, $p = 20 < p^*$:

$$Q^D(20) = 100 - 2(20) = 60$$
$$Q^S(20) = 20 + 20 = 40$$

  - Quantity demanded exceeds quantity supplied $(60 > 40)$
  - **Excess demand (shortage)** of 20 units

What about other prices?

- Consider a price **below equilibrium**, $p = 20 < p^*$:

$$Q^D(20) = 100 - 2(20) = 60$$
$$Q^S(20) = 20 + 20 = 40$$

  - Quantity demanded exceeds quantity supplied ($60 > 40$)
  - **Excess demand (shortage)** of 20 units

- Now consider a price **above equilibrium**, $p = 40 > p^*$:

$$Q^D(40) = 100 - 2(40) = 20$$
$$Q^S(40) = 20 + 40 = 60$$

  - Quantity supplied exceeds quantity demanded ($20 < 60$)
  - **Excess supply (surplus)** of 40 units

An important question

Q: In our previous graphical example, is there a **unique equilibrium**?

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Q: In our previous graphical example, is there a **unique equilibrium**?

Q: How might your answer change if the Law of Supply did not hold?

Using the Equilibrium Model

Using the Supply-and-Demand Model

- The supply-and-demand model tells us the price and quantity that will prevail in equilibrium, holding all other factors fixed.
- Changes in these other factors will change the market equilibrium by shifting:

  the supply curve,

  the demand curve,

  or both!

- We can use the model to make **precise predictions** about how changes in these factors alter market outcomes.
- We will consider two sets of factors:

  Market fundamentals (e.g. income, inputs, preferences, technology)

  Government intervention (e.g. taxes, subsidies)

Shifts in Demand

- Consider a demand and supply model for gasoline with

$$
\begin{aligned}
Q^D &= 30 - \frac{P}{5} + 0.1Y \\
Q^S &= P
\end{aligned}
$$

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Shifts in Demand

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$$Q^D = 30 - \frac{P}{5} + 0.1Y$$
$$Q^S = P$$

Q: How does an increase in household income Y affect equilibrium?

- Suppose household income increases from:

$$Y = 100 \quad \text{to} \quad Y = 200$$

(in thousands of dollars per year).

Income Increase: Demand Shift (Algebra)

- Initial income: $Y = 100$ (i.e., \$100,000)

$$\begin{aligned} Q_0^D(P) &= 30 - \frac{P}{5} + 0.1(100) \\ &= 30 - \frac{P}{5} + 10 \\ &= 40 - \frac{P}{5} \end{aligned}$$

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- New income: $Y = 200$ (i.e., \$200,000)

$$\begin{aligned} Q_1^D(P) &= 30 - \frac{P}{5} + 0.1(200) \\ &= 50 - \frac{P}{5} \end{aligned}$$

Income Increase: Demand Shift (Algebra)

- Initial income: $Y = 100$ (i.e., \$100,000)

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$$\begin{aligned} Q_1^D(P) &= 30 - \frac{P}{5} + 0.1(200) \\ &= 50 - \frac{P}{5} \end{aligned}$$

  - At every price P, quantity demanded increases by **10 units** $\Rightarrow$ demand shifts right.

Solving for the Equilibrium (Algebra)

Initial equilibrium when $Y = 100$:

$$Q^D = 40 - \frac{P}{5}$$

$$Q^D = Q^S \Rightarrow 40 - \frac{P}{5} = P$$

$$40 = \left(1 + \frac{1}{5}\right) P = \frac{6}{5} P$$

$$P_0^* = \frac{200}{6} \approx 33.33, \qquad Q_0^* = P_0^* \approx 33.33$$

Solving for the Equilibrium (Algebra)

New equilibrium when $Y = 200$:

$$
\begin{aligned}
Q^D &= 50 - \frac{P}{5} \\
Q^D = Q^S \;\Rightarrow\; 50 - \frac{P}{5} &= P \\
50 &= \frac{6}{5}P \\
P_1^* &= \frac{250}{6} \approx 41.66, \qquad Q_1^* = P_1^* \approx 41.66
\end{aligned}
$$

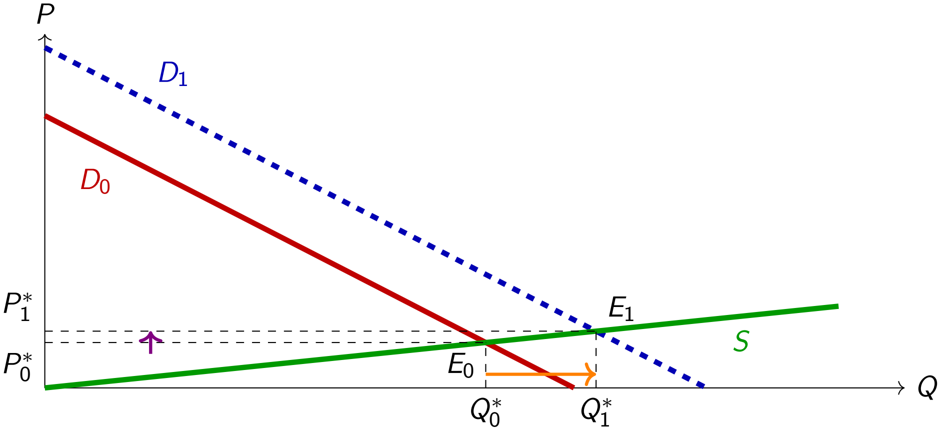

Figure 8: A larger income increase shifts demand further right, leading to larger increases in equilibrium price and quantity. **Exercise: label the graph with numbers we solved for.**

Shifts in Supply

- Instead, suppose the price of crude oil increases, causing the supply function to become
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- **Important:** $Q_1^S = 0$ only when $P \leq 20$. We call this the **shut down price**.

Q: Does supply increase or decrease? Why?

Equilibrium with Shifted Supply after Crude Oil Prices Rise

- Solve:

$$
\begin{aligned}
Q^D &= Q_1^S \\
40 - \frac{P}{5} &= P - 20 \\
60 &= P + \frac{P}{5} \\
60 &= \frac{6}{5}P \\
P_1^* &= 300/6 = 50, \quad Q_1^* = 50 - 20 = 30
\end{aligned}
$$

Equilibrium with Shifted Supply after Crude Oil Prices Rise

- Solve:

$$\begin{aligned} Q^D &= Q_1^S \\ 40 - \frac{P}{5} &= P - 20 \\ 60 &= P + \frac{P}{5} \\ 60 &= \frac{6}{5}P \\ P_1^* &= 300/6 = 50, \quad Q_1^* = 50 - 20 = 30 \end{aligned}$$

- Compare to initial equilibrium:

$$P_0^* \approx 33.33, \qquad Q_0^* \approx 33.33$$

$\Longrightarrow$ Prices rose, quantities fell!

Crude Oil Price Increase: Shift in Equilibrium

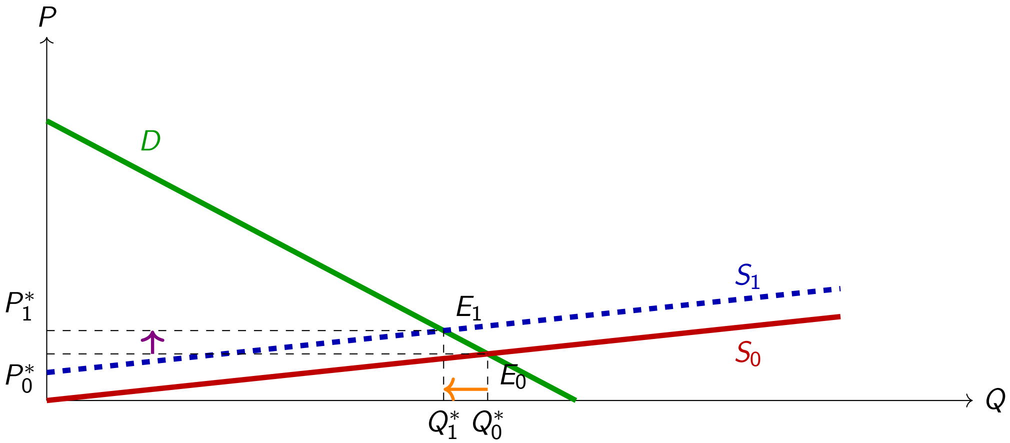

Figure 9: An increase in input prices moves inverse supply to the left. Result: higher prices and lower quantities. **Exercise: label the graph with numbers we solved for.**

Concurrent Shifts in Supply and Demand

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  Equilibrium price increases
  The effect on equilibrium quantity is ambiguous
- If **demand and supply both increase**:
  Equilibrium quantity increases
  The effect on equilibrium price is ambiguous
- If **supply decreases and demand decreases**:
  Equilibrium quantity falls
  The effect on equilibrium price is ambiguous

Governments use **three main approaches to shift curves:**

- Limits on who can buy.
  - Governments can restrict who can buy certain products (e.g. cigarettes to children). This shifts the demand curves for these products to the left by shrinking the market, and thus decreases the quantity demanded at any price.
- Restrictions on imports or exports.
  - Governments can restrict the flow of imports or exports. Import restrictions artificially shifts the importing country's supply curve to the left, while restrictions on exports shift the exporting country's demand curve to the left.
- Government purchases.
  - Governments can buy goods directly, increasing the quantity demanded at each price. This shifts the demand curve to the right.

Q: Why would governments enact these policies?

Shifts in Equilibrium: Price Controls

- Sometimes governments intervene by controlling prices in a market.
- Two main forms:

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- Two main forms:

- Price ceiling
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Q: What are popular price ceilings and floors you know of? List them.

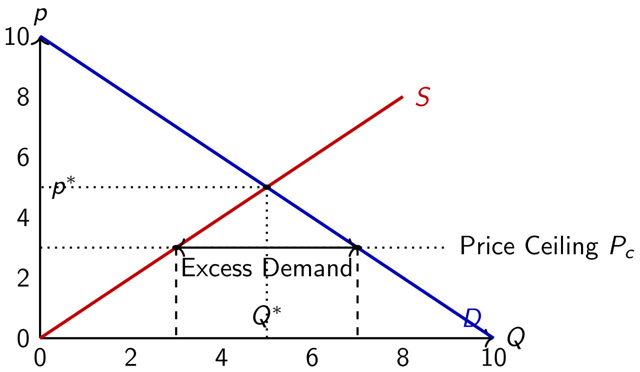

Figure 10: Price ceiling P_c causes excess demand, and lower production relative to the free market equilibrium p^*, Q^*.

Shifts in Equilibrium: Price Ceiling

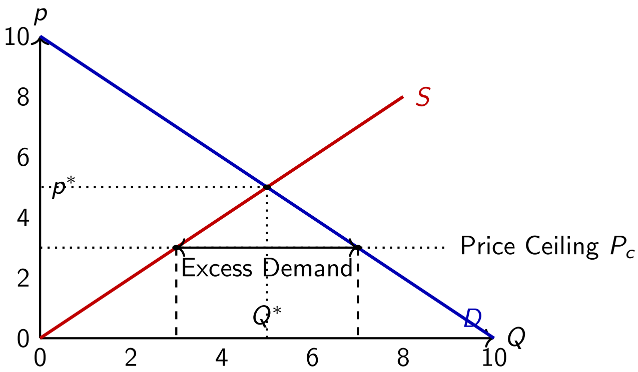

Figure 10: Price ceiling P_c causes excess demand, and lower production relative to the free market equilibrium p^*, Q^*.

Exercise: Calculate excess demand where $Q^D = 10 - P$, $Q^S = P$, and a price ceiling of $P_c = \$3$.

Shifts in Equilibrium: Price Floor

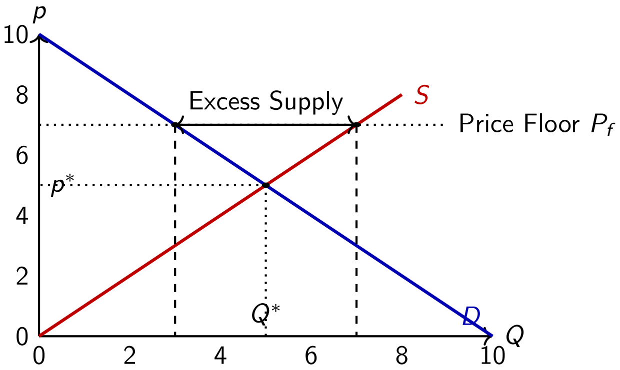

Figure 11: Price floor P_f causes excess supply, and lower consumption relative to the free market equilibrium p^*, Q^*.

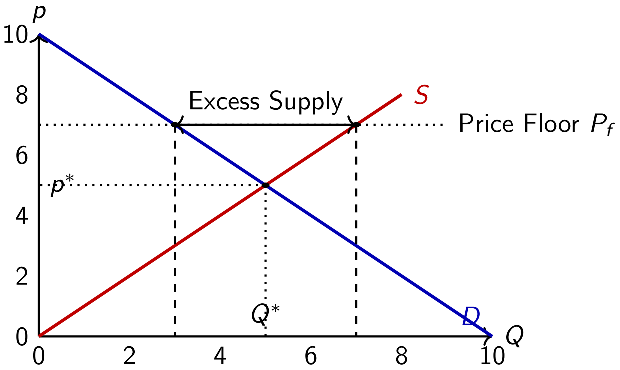

Figure 11: Price floor P_f causes excess supply, and lower consumption relative to the free market equilibrium p^*, Q^*.

Exercise: Calculate excess supply where $Q^D = 10 - P$, $Q^S = P$, and a price floor of $P_f = \$7$.

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- In the absence of government intervention, supply equals demand, and the market clears.
- With government intervention, the quantity demanded and quantity supplied need not equal the actual quantity that is bought and sold.

Note: A price floor could be **below the free-market equilibrium price** (and vice versa for a price ceiling)

In this case, we say that the price floor or ceiling is **non-binding**. It does not affect market equilibrium.

Shifts in Equilibrium: Taxes/Subsidies

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  - A specific tax is a tax charged per unit of output (e.g. \$/litre of gasoline).

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- As an example, we will examine the effects of a specific tax in the market for gasoline.
  - A specific tax is a tax charged per unit of output (e.g. $/litre of gasoline).

  Q: How will the supply curve shift in response to a tax on retail gasoline paid by gas stations?

Shifts in Equilibrium: Specific Tax Collected from Producers

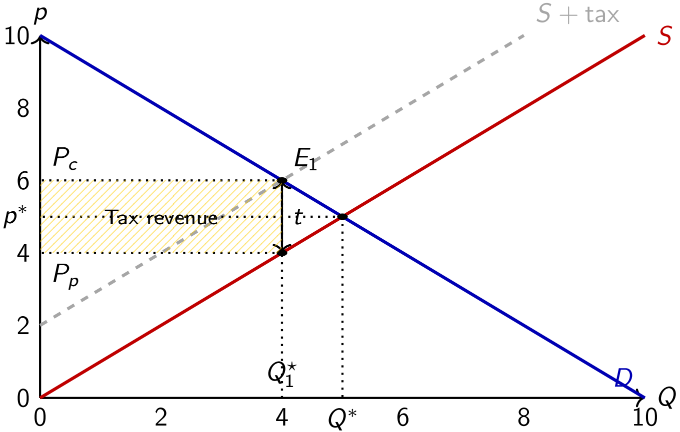

Figure 12: Effects of a specific tax on gasoline retailers of $t = \$2/\text{litre}$. Consumer price rises to P_c, producers receive P_p, and quantity falls to $Q_1^\star$.

Shifts in Equilibrium: Specific Tax Collected from Consumers

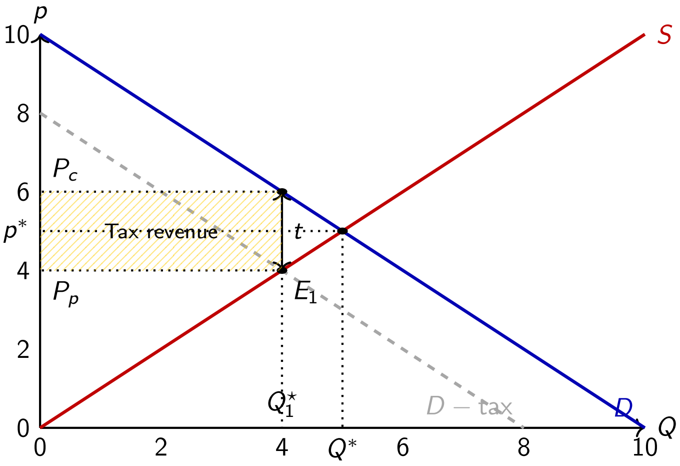

Figure 13: Effects of a per-unit consumer tax of \$2/litre: the demand curve shifts down, the consumer price rises to P_c, producers receive P_p, and quantity falls to $Q_1^\star$.

Shifts in Equilibrium: The Effects of A Specific Tax

Two key points:

- The imposition of specific sales tax yields the same equilibrium **regardless of who pays the tax**.

Q: Can you answer why?

- The figures also show that the tax need not be fully passed on to consumers.
  - Producers may bear some of the effects of a tax, even if consumers pay it
  - What determines the extent of who wins or loses from the sales tax? (**Next slide deck!**)

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Exercise: Calculate tax revenue (see previous graph) for $Q^D = 10 - P$, $Q^S = P$ and a specific tax of \$2 per litre.

Applying the Model in Practice

Applying the Model in Practice

- The supply-and-demand model is a simple, but powerful tool for understanding how markets will change in the future in response to shocks and changes in government policy.

- Unleashing the power of the model requires a deep understanding of the factors that will affect demand and supply.
  - Need to understand determinants of demand and supply/possible
  - government actions.

- We also need to know when the model is appropriate to use.

Applying the Model in Practice

- The supply-and-demand model works well as a tool for understanding markets that are **perfectly competitive**.
- Five characteristics of a perfectly competitive market:
    1. Many small buyers and sellers.
    2. Consumers believe all firms produce identical products.
    3. All market participants have full information about price and product characteristics.
    4. Transaction costs (expenses over and above the price) are negligible.
    5. Firms can easily enter and exit the market, so competition is high.
- The model does not work well in non-competitive markets where there are a few sellers that are "price setters".
    - For these markets, we need a different set of models (Topic 4)

Applying the Model in Practice

- In practice, no market necessarily meets all five criteria.
- Still, the model is useful if the market is "competitive enough".
- What are some markets for which the model would work well? (Textbook has a great discussion about this).

Chicago Board of Trade corn futures market (p 23) – market for contracts that specify a certain amount of corn be delivered at a future specified date.

Supply and Demand: Takeaways

- The supply-and-demand model is a **simple and powerful tool** for understanding many markets.
- Model relates the quantity consumers demand and the quantity producers supply to own prices and other factors.
- Using the model requires understanding how factors other than own price may shift demand and supply, and how government intervention may affect prices in the market.
- The model works well for understanding markets that are competitive enough.
- **Homework exercises**: Look at posted practice problems and selected problems from Chapter 2 of the textbook.