In this chapter you will learn

- the *IS* curve, and its relation to
  - the Keynesian Cross
  - the Loanable Funds model

- the *LM* curve, and its relation to
  - the Theory of Liquidity Preference

- how the *IS-LM* model determines income and the interest rate in the short run when $P$ is fixed
Chapter 9 introduced the model of aggregate demand and aggregate supply.

Long run
- prices flexible
- output determined by factors of production & technology
- unemployment equals its natural rate

Short run
- prices fixed
- output determined by aggregate demand
- unemployment is negatively related to output
This chapter develops the *IS-LM* model, the theory that yields the aggregate demand curve.

We focus on the short run and assume the price level is fixed.
The Keynesian Cross

- A simple closed economy model in which income is determined by expenditure. *(due to J.M. Keynes)*

- Notation:
  
  \[ I = \text{planned investment} \]
  
  \[ E = C + I + G = \text{planned expenditure} \]
  
  \[ Y = \text{real GDP} = \text{actual expenditure} \]

- Difference between actual & planned expenditure: unplanned inventory investment
Elements of the Keynesian Cross

consumption function: \( C = C(Y - T) \)

govt policy variables: \( G = \bar{G}, \quad T = \bar{T} \)

for now, investment is exogenous: \( I = \bar{I} \)

planned expenditure: \( E = C(Y - \bar{T}) + \bar{I} + \bar{G} \)

Equilibrium condition:

Actual expenditure = Planned expenditure

\( Y = E \)
Graphing planned expenditure

\[ E = C + I + G \]

planned expenditure

income, output, \( Y \)

MPC

1
Graphing the equilibrium condition

\[ E = Y \]

\[ 45^\circ \]
The equilibrium value of income

\[ E = Y = C + I + G \]

Equilibrium income

planned expenditure

income, output, \( Y \)
An increase in government purchases

At $Y_1$, there is now an unplanned drop in inventory...

...so firms increase output, and income rises toward a new equilibrium.
Solving for $\Delta Y$

\[ Y = C + I + G \]

\[ \Delta Y = \Delta C + \Delta I + \Delta G \]

\[ = \Delta C + \Delta G \]

\[ = \text{MPC} \times \Delta Y + \Delta G \]

Collect terms with $\Delta Y$ on the left side of the equals sign:

\[ (1 - \text{MPC}) \times \Delta Y = \Delta G \]

Finally, solve for $\Delta Y$:

\[ \Delta Y = \left( \frac{1}{1 - \text{MPC}} \right) \times \Delta G \]
The government purchases multiplier

Example: \( \text{MPC} = 0.8 \)

\[
\Delta Y = \frac{1}{1 - \text{MPC}} \Delta G
\]

\[
= \frac{1}{1 - 0.8} \Delta G = \frac{1}{0.2} \Delta G = 5 \Delta G
\]

The increase in \( G \) causes income to increase by 5 times as much!
The government purchases multiplier

Definition: the increase in income resulting from a $1 increase in $G$.

In this model, the $G$ multiplier equals

\[
\frac{\Delta Y}{\Delta G} = \frac{1}{1 - \text{MPC}}
\]

In the example with $\text{MPC} = 0.8$,

\[
\frac{\Delta Y}{\Delta G} = \frac{1}{1 - 0.8} = 5
\]
Why the multiplier is greater than 1

- Initially, the increase in $G$ causes an equal increase in $Y$: $\Delta Y = \Delta G$.
- But $\uparrow Y \Rightarrow \uparrow C$
  - $\Rightarrow$ further $\uparrow Y$
  - $\Rightarrow$ further $\uparrow C$
  - $\Rightarrow$ further $\uparrow Y$
- So the final impact on income is much bigger than the initial $\Delta G$. 
An increase in taxes

Initially, the tax increase reduces consumption, and therefore $E$:

$$\Delta C = -\text{MPC} \Delta T$$

...so firms reduce output, and income falls toward a new equilibrium.

At $Y_1$, there is now an unplanned inventory buildup...
Solving for $\Delta Y$

$\Delta Y = \Delta C + \Delta I + \Delta G$  

eq’m condition in changes  

$I$ and $G$ exogenous

$= \Delta C$

$= \text{MPC} \times (\Delta Y - \Delta T)$

Solving for $\Delta Y$: 

$(1 - \text{MPC}) \times \Delta Y = -\text{MPC} \times \Delta T$

Final result:

$\Delta Y = \left( \frac{-\text{MPC}}{1 - \text{MPC}} \right) \times \Delta T$
The Tax Multiplier

def: the change in income resulting from a $1 increase in $T$:

$$\frac{\Delta Y}{\Delta T} = \frac{-\text{MPC}}{1 - \text{MPC}}$$

If MPC = 0.8, then the tax multiplier equals

$$\frac{\Delta Y}{\Delta T} = \frac{-0.8}{1 - 0.8} = \frac{-0.8}{0.2} = -4$$
The Tax Multiplier

...is **negative**:
A tax hike reduces consumer spending, which reduces income.

...is **greater than one** (in absolute value):
A change in taxes has a multiplier effect on income.

...is **smaller than the govt spending multiplier**:
Consumers save the fraction \((1 - \text{MPC})\) of a tax cut, so the initial boost in spending from a tax cut is smaller than from an equal increase in \(G\).
The Tax Multiplier

...is \textit{negative}: An increase in taxes reduces consumer spending, which reduces equilibrium income.

...is \textit{greater than one (in absolute value)}: A change in taxes has a multiplier effect on income.

...is \textit{smaller than the govt spending multiplier}: Consumers save the fraction (1-MPC) of a tax cut, so the initial boost in spending from a tax cut is smaller than from an equal increase in G.
Exercise:

- Use a graph of the Keynesian Cross to show the impact of an increase in investment on the equilibrium level of income/output.
The IS curve

**def:** a graph of all combinations of \( r \) and \( Y \) that result in goods market equilibrium, 

**i.e.** actual expenditure (output) 
\[ = \text{planned expenditure} \]

The equation for the IS curve is:
\[
Y = C(Y - T) + I(r) + G
\]
Deriving the IS curve

\[ E = Y \]
\[ E = C + I(r_2) + G \]
\[ E = C + I(r_1) + G \]

\[ \downarrow r \Rightarrow \uparrow I \]
\[ \Rightarrow \uparrow E \]
\[ \Rightarrow \uparrow Y \]
Understanding the IS curve’s slope

- The IS curve is negatively sloped.
- Intuition: A fall in the interest rate motivates firms to increase investment spending, which drives up total planned spending ($E$).
To restore equilibrium in the goods market, output (a.k.a. actual expenditure, $Y$) must increase.
The IS curve and the Loanable Funds model

(a) The L.F. model

(b) The IS curve
Fiscal Policy and the IS curve

- We can use the IS-LM model to see how fiscal policy ($G$ and $T$) can affect aggregate demand and output.

- Let’s start by using the Keynesian Cross to see how fiscal policy shifts the IS curve...
Shifting the IS curve: $\Delta G$

At any value of $r$, $\uparrow G \Rightarrow \uparrow E \Rightarrow \uparrow Y$

...so the IS curve shifts to the right.

The horizontal distance of the IS shift equals

$$\Delta Y = \frac{1}{1-\text{MPC}} \Delta G$$
Exercise: Shifting the IS curve

- Use the diagram of the Keynesian Cross or Loanable Funds model to show how an increase in taxes shifts the IS curve.
The Theory of Liquidity Preference

- due to John Maynard Keynes.
- A simple theory in which the interest rate is determined by money supply and money demand.
Money Supply

The supply of real money balances is fixed:

\[(M/P)^s = \bar{M}/\bar{P}\]
Money Demand

Demand for real money balances:

\[(\frac{M}{P})^d = L(r)\]
The interest rate adjusts to equate the supply and demand for money:

\[
\frac{\bar{M}}{\bar{P}} = L(r)
\]
How the Fed raises the interest rate

To increase $r$, Fed reduces $M$

The graph shows the relationship between the interest rate $r$ and the money supply $M/P$. The Fed reduces the money supply to increase the interest rate from $r_1$ to $r_2$.
CASE STUDY
Volcker’s Monetary Tightening

- Late 1970s: $\pi > 10\%$
- Oct 1979: Fed Chairman Paul Volcker announced that monetary policy would aim to reduce inflation.
- Aug 1979-April 1980: Fed reduces $M/P$ 8.0\%
- Jan 1983: $\pi = 3.7\%$

How do you think this policy change would affect interest rates?
Volcker’s Monetary Tightening, *cont.*

The effects of a monetary tightening on nominal interest rates

<table>
<thead>
<tr>
<th>model</th>
<th>short run</th>
<th>long run</th>
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<tbody>
<tr>
<td></td>
<td>Liquidity Preference (Keynesian)</td>
<td>Quantity Theory, Fisher Effect (Classical)</td>
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<tr>
<td>prices</td>
<td>sticky</td>
<td>flexible</td>
</tr>
<tr>
<td>prediction</td>
<td>$\Delta i &gt; 0$</td>
<td>$\Delta i &lt; 0$</td>
</tr>
<tr>
<td>actual outcome</td>
<td>8/1979: $i = 10.4%$</td>
<td>1/1983: $i = 8.2%$</td>
</tr>
<tr>
<td></td>
<td>4/1980: $i = 15.8%$</td>
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</table>
The **LM curve** is a graph of all combinations of \( r \) and \( Y \) that equate the supply and demand for real money balances.

The equation for the **LM curve** is:

\[
\frac{M}{P}^d = L(r, Y)
\]
Deriving the LM curve

(a) The market for real money balances

\[ L(r, Y_1) \]

\[ L(r, Y_2) \]

(b) The LM curve

\[ r \]

\[ r_1 \]

\[ r_2 \]

\[ M/P \]

\[ M_1/P \]

\[ Y \]

\[ Y_1 \]

\[ Y_2 \]
Understanding the *LM* curve’s slope

- The *LM* curve is positively sloped.
- **Intuition:**
  An increase in income raises money demand.

Since the supply of real balances is fixed, there is now excess demand in the money market at the initial interest rate.

The interest rate must rise to restore equilibrium in the money market.
How $\Delta M$ shifts the LM curve

(a) The market for real money balances

(b) The LM curve
Exercise: Shifting the LM curve

- Suppose a wave of credit card fraud causes consumers to use cash more frequently in transactions.
- Use the Liquidity Preference model to show how these events shift the $LM$ curve.
The short-run equilibrium is the combination of $r$ and $Y$ that simultaneously satisfies the equilibrium conditions in the goods & money markets:

$$Y = C(Y - T) + I(r) + G$$

$$\frac{M}{P} = L(r, Y)$$

Equilibrium interest rate

Equilibrium level of income
The Big Picture

Keynesian Cross

IS curve

LM curve

IS-LM model

Agg. demand curve

Agg. supply curve

Explanation of short-run fluctuations

Model of Agg. Demand and Agg. Supply

Agg. Demand and Agg. Supply
Chapter summary

1. Keynesian Cross
   - basic model of income determination
   - takes fiscal policy & investment as exogenous
   - fiscal policy has a multiplied impact on income.

2. IS curve
   - comes from Keynesian Cross when planned investment depends negatively on interest rate
   - shows all combinations of $r$ and $Y$ that equate planned expenditure with actual expenditure on goods & services
Chapter summary

3. Theory of Liquidity Preference
   - basic model of interest rate determination
   - takes money supply & price level as exogenous
   - an increase in the money supply lowers the interest rate

4. $LM$ curve
   - comes from Liquidity Preference Theory when money demand depends positively on income
   - shows all combinations of $r$ and $Y$ that equate demand for real money balances with supply
5. *IS-LM* model

- Intersection of *IS* and *LM* curves shows the unique point \((Y, r)\) that satisfies equilibrium in both the goods and money markets.
In Chapter 11, we will

- use the *IS-LM* model to analyze the impact of policies and shocks
- learn how the aggregate demand curve comes from *IS-LM*
- use the *IS-LM* and *AD-AS* models together to analyze the short-run and long-run effects of shocks
- learn about the Great Depression using our models