Motivation

- The Great Depression caused a rethinking of the Classical Theory of the macroeconomy. It could not explain:
  - Drop in output by 30% from 1929 to 1933
  - Rise in unemployment to 25%
- In 1936, J.M. Keynes developed a theory to explain this phenomenon.
- We will learn a version of this theory, called the ‘IS-LM’ model.

Context

- 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
Context

- 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:

\[ E = C + I + G \]
\[ Y = \text{real GDP} \]

- Difference between actual & planned expenditure: _______________

Elements of the Keynesian Cross

- Consumption function:

\[ C = c(Y - T) \]

- Government policy variables:

\[ G = \bar{G}, \ T = \bar{T} \]

- For now, investment is exogenous:

\[ I = \bar{I} \]

- Planned expenditure:

\[ E = C + \bar{I} + \bar{G} + \bar{T} \]

- Equilibrium condition:

Actual expenditure = Planned expenditure
Graphing planned expenditure

income, output, Y

Graphing the equilibrium condition

income, output, Y

The equilibrium value of income

income, output, Y

E = Y

E = C + I + G
The equilibrium value of income

\[ E = Y \]

\[ E = C + I + G \]

\( E > Y: \) ______ inventories: must produce more.

\( E < Y: \) ______ inventories: must produce less.

An increase in government purchases

\[ E = Y \]

\[ E = C + I + G \]

\[ \Delta G \]

\[ \Delta Y > \Delta G \]

\[ E_1 = Y_1 \]

... so firms increase output, and income rises toward a new equilibrium.

Why the multiplier is greater than 1

- Def: Government purchases multiplier: \( \frac{\Delta Y}{\Delta G} \)
- Initially, the increase in \( G \) causes an equal increase in \( Y \): \( \Delta Y = \Delta G \).
- But \( \Delta Y \rightarrow \Delta C \)
  - \( \Rightarrow \) further \( \Delta Y \)
  - \( \Rightarrow \) further \( \Delta C \)
  - \( \Rightarrow \) further \( \Delta Y \)
- So the government purchases multiplier will be ______.
An increase in government purchases

\[
\Delta Y = \Delta G + (MPC \cdot \Delta G) + MPC (MPC \cdot \Delta G) + MPCMPCMPCMPCMPCMPCG \ldots
\]

This is a standard geometric series from algebra:

So the multiplier is:

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

Solving for \(\Delta Y\)

\[
Y = C + I + G \quad \text{equilibrium condition}
\]

\[
\Delta Y = \Delta C + \Delta I + \Delta G \quad \text{in changes}
\]

\[
= \Delta C + \Delta G \quad \text{because } I \text{ exogenous}
\]

\[
= MPC \cdot \Delta Y + \Delta G \quad \text{because } C = MPC Y
\]

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

\[
(1 - MPC) \cdot \Delta Y = \Delta G
\]

Finally, solve for \(\Delta Y\):
Algebra example

Suppose consumption function: \( C = a + b(Y - T) \)
where \( a \) and \( b \) are some numbers (MPC = \( b \))
and other variables exogenous:
\( I = I, T = T, G = G \)

Use Goods market equilibrium condition:
\( Y = C + I + G \)

Algebra example

\[ Y = C + I + G \]
\[ Y = a + b(Y - T) + I + G \]

Solve for \( Y \):
\[ (1 - b)Y = a - bT + I + G \]
\[ Y = \frac{1}{1-b} G + \frac{1}{1-b} I + \frac{a}{1-b} - \frac{b}{1-b} T \]

So if \( b = \text{MPC} = 0.75 \), multiplier =

An increase in taxes

Initially, the tax increase reduces consumption, and therefore \( E \)
\[ \Delta C = ____ \]

... so firms reduce output, and income falls toward a new equilibrium
\[ E_1 = Y_1 \]
Tax multiplier

Define tax multiplier:

Can read the tax multiplier from the algebraic solution above:

\[ Y = \frac{1}{1-b}G + \frac{1}{1-b}I + \frac{a}{1-b} - \frac{b}{1-b}T \]

So: \[ \Delta Y = \left( -\frac{b}{1-b} \right) (\Delta T) \] where \( b \) is the MPC.

If \( b=0.75 \), tax multiplier =

Solving for \( \Delta Y \)

\[ \Delta Y = \Delta C + \Delta I + \Delta G \] eq'm condition in changes

\[ = \Delta C \] \( I \) and \( G \) exogenous

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

Solving for \( \Delta Y \):

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

Final result:

The Tax Multiplier

Question: how is this different from the government spending multiplier considered previously?

The tax multiplier:

...is __________:

An increase in taxes reduces consumer spending, which reduces equilibrium income.

...is __________:

(in absolute value) 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 \( G \).
A question to consider:

- Using the Keynesian Cross, what would be the effect of an increase in investment on the equilibrium level of income/output.

Building the IS curve

def: ____________________________________________________

def: i.e. actual expenditure (output) = planned expenditure

The equation for the IS curve is:

\[ Y = C(Y - T) + I(r) + G \]

Deriving the IS curve

\[
\begin{array}{c|c|c}
\text{r} & \Rightarrow \uparrow & \Rightarrow \uparrow \Rightarrow \uparrow \\
\end{array}
\]

\[ E = Y \]

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

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

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: ΔG

At any value of r,
↑G ⇒ ↑E ⇒ ↑Y

so the IS curve shifts to the right.

The horizontal distance of the IS shift equals

ΔY = ___________
**Algebra example for IS curve**

Suppose the expenditure side of the economy is characterized by:

\[ C = 95 + 0.75(Y - T) \]
\[ I = 100 - 100r \]
\[ G = 20, \quad T = 20 \]

Use the goods market equilibrium condition

\[ Y = C + I + G \]
\[ Y = 215 + 0.75(Y - 20) - 100r \]

**IS:**

or write as

\[ IS: \]

**Graph the IS curve**

**IS:**

\[ r = 2 - 0.0025Y \]

**Slope of IS curve**

Suppose that investment expenditure is “more responsive” to the interest rate:

\[ I = 100 - 100r - 200r \]

Use the goods market equilibrium condition

\[ Y = C + I + G \]
\[ Y = 215 + 0.75(Y - 20) - 200r \]
\[ 0.25Y = 200 - 200r \]

**IS:**

\[ Y = 800 - 800r \]

or write as

\[ IS: r = 1 - 0.00125Y \]

(slope is lower)

So this makes the IS curve ______: A fall in \( r \) raises \( I \) _____, which raises \( Y \) _____.

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**CHAPTER 10 Aggregate Demand I**
Building the LM 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:

\[
\left(\frac{M}{P}\right)^s = \bar{M}/\bar{P}
\]

Money Demand

Demand for real money balances:

\[
\left(\frac{M}{P}\right)^d = L(r)
\]
Equilibrium

The interest rate adjusts to equate the supply and demand for money:

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

How the Fed raises the interest rate

To increase $r$, the Fed reduces $M$.

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?
The effects of a monetary tightening on nominal interest rates

<table>
<thead>
<tr>
<th>model</th>
<th>short run</th>
<th>long run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquidity Preference (Keynesian)</td>
<td>(Classical)</td>
<td></td>
</tr>
<tr>
<td>prices</td>
<td>sticky</td>
<td>flexible</td>
</tr>
<tr>
<td>prediction</td>
<td>Δi &gt; 0</td>
<td>Δi &lt; 0</td>
</tr>
<tr>
<td>actual outcome</td>
<td>8/1979: i = 10.4%</td>
<td>4/1980: i = 15.8%</td>
</tr>
</tbody>
</table>

The effects of a monetary tightening on nominal interest rates

Volcker’s Monetary Tightening, cont.

The LM curve

Now let’s put \( Y \) back into the money demand function:

\[
\left( \frac{M}{P} \right)^d = L(r, Y)
\]

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:

Deriving the LM curve

(a) The market for real money balances

(b) The LM curve
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.

Deriving LM curve with algebra

Suppose a money demand: \[ \frac{M}{P} = eY - fr \]
- Where \( e \) describes the responsiveness of money demand to changes in income.
- And \( f \) describes responsiveness to interest rate.

Suppose money supply: \[ \frac{M}{P}^* = \frac{\bar{M}}{\bar{P}} \]

Use money market equilibrium condition:
\[ \frac{M}{P} = \frac{M}{P}^* \]
So:
\[ \frac{\bar{M}}{\bar{P}} = \]

or write as:

Graph the LM curve

\[ r = \frac{e}{f} Y - \left( \frac{1}{f} \right) \frac{M}{P} \]

A steep LM curve (__________) means that a rise in output implies a _____________ to maintain equilibrium.

Causes of this:
- Money demand is _____________ to interest rate (\( f \) is small)
- Money demand _____________ to output (\( e \) large)
How $\Delta M$ shifts the LM curve

(a) The market for real money balances

(b) The LM curve

The short-run equilibrium

The short-run equilibrium is the combination of $r$ and $Y$ that simultaneously satisfies the equilibrium conditions in the goods & money markets:

$$Y = C(r - \bar{T}) + I(r) + G$$

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

The Big Picture

Keynesian Cross → IS curve

Theory of Liquidity Preference → LM curve

IS-LM model → Explanation of short-run fluctuations

Model of 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

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.