ECON2123-Tutorial 5
AS-AD Model

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Supply and Demand

In every commodity good market, there will be supply and demand, where

- Supply captures a positive relation b/w Price (P) and Supply (Y): the higher price, the more sellers will produce to supply.
- Demand captures a negative relation b/w Price (P) and Demand (Y): the higher the price, the less buyers can afford to buy.
- An upward sloping supply curve and a downward sloping demand curve uniquely determine the equilibrium level of price (P) and quantity (Y).
In every economy, there will be aggregate supply and aggregate demand, and above conditions still hold. And:

- Aggregate supply relation captures the implications of equilibrium in the labor market, it builds on WS and PS relation. (Medium Run)

- Aggregate demand relation captures the implications of equilibrium in both the goods market and financial markets; it builds on IS-LM relation. (Short Run)
Derivation of AS curve

Aggregate supply relation is derived from the labor market equilibrium. In the labor market:

- Wage setting equation is given as:
  \[ W = P^e F(u, z) \] (1)

- Price setting equation\(^1\) is given as:
  \[ P = (1 + m)W \] (2)

- Recall AS curve is a relation b/w \(P\) and \(Y\), so we replace \(W\) by combining equation (1) and (2):
  \[ P = (1 + m)P^e F(u, z) \] (3)

\(^1\)To derive the price setting equation, start from: price=markup * cost. Assume the production function is \(Y=AN\), where \(N\) represents labor, so that the cost of one unit of product is the wage for \(1/A\) unit of labor \((W/A)\). Normalize \(A\) to 1. The price setting equation is derived as \(P = (1 + m)W\).
### Derivation of AS curve

- But where is Y? We need to transform u to Y with the following condition:

\[
u = \frac{U}{L} = 1 - \frac{N}{L} = 1 - \frac{Y}{L}\]  

(4)

where the last equation utilizes the production function:

\[Y = AN\] and normalize A as 1. Now replace u in equation (3) with equation (4):

\[P = (1 + m)P^eF(1 - \frac{Y}{L}, z)\]  

(5)

- AS curve is an upward sloping curve. (figure 7-1, textbook 6e)
Derivation of AS curve

\[ P = (1 + m) P^e F(1 - \frac{Y}{L}, z) \]

- If \( (1+m) \) increases, AS curve shifts up. (Intuition)
- If \( P^e \) increases, AS curve shifts up. (Intuition)
- If \( L \) increases, AS curve shifts down. (Intuition)
- If \( z \) increases, AS curve shifts up. (Intuition)
Derivation of AD curve

Aggregate demand relation captures the implications of equilibrium in both the goods market and financial markets; it builds on IS-LM relation:

- IS relation is given as:

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

- LM relation is given as:

\[ \frac{M}{P} = YL(i) \]

- But equation (6) and (7) are relations of \( Y \) and \( i \) (interest rate), not of \( Y \) and \( P \) (price). We explore the IS-LM relation to see what happens to \( Y \) if \( P \) increases. (figure 7-3a, textbook 6e)
So it can be seen that if P increases, Y decreases, which implies a downward sloping AD curve. The AD relation can be summarized as:

\[ Y = Y\left(\frac{M}{P}, G, T\right) \]  

where \( Y() \) is an increasing function of \( \frac{M}{P} \), G and decreasing function of T.

AD curve is a downward sloping curve.  

(figure 7-3b, textbook 6e)
Derivation of AD curve

\[ Y = Y\left(\frac{M}{P}, G, T\right) \]

- If M increases, AD curve shifts to the right (up). (Intuition)
- If G increases, AD curve shifts to the right (up). (Intuition)
- If T increases, AD curve shifts to the left (down). (Intuition)
The upward sloping AS curve and downward sloping AD curve gives a unique solution to equilibrium Output and Price. (figure 7-5, textbook 6e)
Exercise 1

Assume wage setting equation is given as

\[ W = P^e(1 - u) \]

The production function is \( Y = 5N \). (In textbook we assume \( Y = N \).) Markup \((1+m)\) is 2.
Population in the labor market \((L)\) is 1.

a. Derive the AS curve.
b. What’s the natural level of output \((Y_n)\)?
Exercise 1-solution

a. Price setting equation is $P = (1+m) \times MC$. To produce 1 unit of $Y$, we need $1/5$ unit of labor, at a cost of $0.2W$. Therefore price setting equation is: $P = 2 \times 0.2W = 0.4W$.

Combining WS and PS equation:

$$P = 2 \times \frac{1}{5} Pe \left(1 - u\right)$$

Rewrite $u$ as a function of $Y$:

$$u = U/L = 1 - \frac{N}{L} = 1 - \frac{Y}{5L} = 1 - \frac{Y}{5}$$

Therefore the AS relation can be written as

$$P = 2.5P^e(1 - u)$$

b. The natural level of output is derived when $P = P^e$.

$$1 = 0.5Y_n; \quad \text{or} \quad Y_n = 2$$
Exercise 2

Assume consumption is given as \( C = 0.5(Y-T) \); Investment is given as \( I = 0.2Y - 100i \); \( G \) is a constant. \( T = 100 \).

Assume that money demand is given as \( M^D = P[0.2Y + (20 - 100i)] \). Money supply is exogenous as \( M \).

a. Derive the IS relation.
b. Derive the LM relation.
c. Derive the AS-AD relation.
d. What happens to the AD curve if \( G \) increases?
e. What happens to the AD curve if \( M \) increases?
Exercise 2-solution

a. IS relation captures the goods market equilibrium:
\[ Y = 0.5(Y - T) + 0.2Y - 100i + G = 0.7Y - 100i - 50 + G \]
b. LM relation captures the financial market equilibrium:
\[ \frac{M}{P} = 0.2Y + (20 - 100i) \quad \text{or} \quad -100i = \frac{M}{P} - 0.2Y - 20 \]
c. Combining IS and LM relation gives AD relation:
\[ Y = 0.7Y + \frac{M}{P} - 0.2Y - 20 - 50 + G = 0.5Y + \frac{M}{P} - 70 + G; \]
\[ Y = 2\frac{M}{P} - 140 + 2G; \]
d. If G increases, AD curve will shift to the right. That is, given P unchanged, increase in G will increase Y.
e. If M increases, AD curve will shift to the right. That is, given P unchanged, increase in M will increase Y.
From Short-Run to Medium-Run

AS relation:

\[ P = (1 + m)P^e F(1 - \frac{Y}{L}, z) \]

Aggregate supply curve AS is drawn for a given value of \( P^e \). It is upward sloping: The higher the level of output, the higher the price level.

AD relation:

\[ Y = Y(\frac{M}{P}, G, T) \]

Aggregate demand curve AD is drawn for given values of M, G, and T. It is downward sloping: The higher the price level, the lower the level of output.
In the medium run, $P = P^e$, and thus $Y = Y_n$. Note that the natural level of output, $Y_n$ is given as:

$$1 = (1 + m)F(1 - \frac{Y_n}{L}, Z) \quad (9)$$

If $Y_n$ doesn’t change, then no matter how the economy changes in the short run, eventually output will go back to the original natural level.

Now the question is, how does the economy adjust?

Answer: Through adjustment of $P^e$, expected price.
Case 1: Expansionary Fiscal Policy: G increases

Suppose originally the economy is at its natural level. Now a sudden shock hit AD relation, i.e., that G increases.

**The short-run effect of change:**
From AD relation:

\[ Y = Y\left(\frac{M}{P}, G, T\right) \]

If G increases, given level of P, Y will increase, thus AD curve shift to the right. AS curve remains unchanged. Therefore, the new short-run equilibrium output and price level will be higher.
Case 1: Expansionary Fiscal Policy: $G$ increases

**From the short-run to long-run:**
Note that after the change, actual price $P$ is higher than expected price $P^e$. So people adjust their expectation upward. During the adjustment, AS curve shifts up, until the intersection of AS curve and AD curve gives an equilibrium output at the natural level, while price further increases from short-run equilibrium. (Figure 7-6, textbook 6e)

*The effect will be similar on AS-AD if there is any increase in $M$, money supply.*

What if $Y_n$ changes?

**Answer:** In the medium run the economy will converge to the new natural level.
Case 2: Oil Price Crisis: \( m \) increases

Suppose originally the economy is at its natural level. Now a sudden shock hit AS relation, i.e., that \( m \) increases. By definition of natural level of output:

\[
1 = (1 + m)F(1 - \frac{Y_n}{L}, z)
\]

If \( m \) increases, \( Y_n \) will decrease. Therefore the new natural level of output, \( Y'_n \) is lower than original level.

**The short-run effect of change:**
From AS relation: \( P = (1 + m)P^e F(1 - \frac{Y}{L}, z) \)
If \( m \) increases, given level of \( P \), \( Y \) will decrease, thus AS curve shift to the left. AD curve remains unchanged. Therefore, the new short-run equilibrium output will be lower and price level will be higher.
Case 2: Oil Price Crisis: $m$ increases

From the short-run to medium-run:
Note that after the change, actual price $P$ is higher than expected price $P^e$. So people adjust their expectation upward. During the adjustment, AS curve shifts up, until the intersection of new AS curve and original AD curve gives an equilibrium output at the new natural level, $Y'_{n}$, while price further increases from short-run equilibrium.
(Figure 7-13, textbook 6e)
Linking AS-AD to IS-LM Curves

Big picture:
AS-AD: Relation b/w price (P) and output (Y).
IS-LM: Relation b/w interest rate (i) and output (Y).

\[ Y = C(Y - T) + I(Y, i) + G \quad (10) \]

\[ M/P = YL(i) \quad (11) \]

*Sometimes it is not enough to evaluate based on AS-AD curves alone, since variables such as investment may depend on interest rate.*

Here we revisit above two cases, incorporating both AS-AD and IS-LM curves.
Case 1: Expansionary Fiscal Policy: G increases

The short-run effect of change:
From AS-AD relation: If G increases, given level of P, Y will increase, thus AD curve shift to the right. AS curve remains unchanged. Therefore, the new short-run equilibrium output and price level will be higher.
From IS-LM relation: If G increases, IS curve shift to the right, which gives a higher interest rate and a higher output (direct effect). An indirect effect is on LM curve: since price level increases, real money supply decreases, thus LM curve shifts to the left, which has a positive effect on interest rate and a negative effect on output. The first effect dominates in the short run, thus from IS-LM curves output increases and interest rate increases further.
Case 1: Expansionary Fiscal Policy: G increases

**From the short-run to medium-run:**
From AS-AD relation: Note that after the change, actual price $P$ is higher than expected price $P^e$. So people adjust their expectation upward. During the adjustment, AS curve shifts up, until the intersection of AS curve and AD curve gives an equilibrium output at the natural level, while price further increases from short-run equilibrium.

From IS-LM relation: The adjustment of expected price will not affect IS or LM curves directly, but the shift of AS curve will increase the price level, which shifts LM curve to left. Therefore during the transition from short-run to medium-run equilibrium, the output gradually decreases to natural level, and interest rate increases further.
Case 2: Oil Price Crisis: m increases

The short-run effect of change:
From AS-AD relation: if m increases, given level of P, Y will decrease, thus AS curve shift to the left. AD curve remains unchanged. Therefore, the new short-run equilibrium output will be lower and price level will be higher.
From IS-LM relation: since m doesn’t enter the expression of IS or LM relation, so there is no direct effect. However, since price level increases, the indirect effect is that the LM curve will shift to the left, which gives a lower output and a higher interest rate.
Case 2: Oil Price Crisis: $m$ increases

**From the short-run to medium-run:**
From AS-AD relation: Note that after the change, actual price $P$ is higher than expected price $P^e$. So people adjust their expectation upward. During the adjustment, AS curve shifts up, until the intersection of new AS curve and original AD curve gives an equilibrium output at the new natural level, $Y'_n$, while price further increases from short-run equilibrium.

From IS-LM relation: The adjustment of expected price will not affect IS or LM curves directly, but the shift of AS curve will increase the price level, which shifts LM curve to left. Therefore during the transition from short-run to medium-run equilibrium, the output gradually decreases to the new natural level, and interest rate increases further.
I want to conclude this chapter by shedding some light on some of the skills to evaluate the change in different variables: 1. Y, output; 2. P, price level; 3. i, interest rate; 4. C, consumption; 5. I, investment.
To evaluate Y: You can do so from either IS-LM or AS-AD;
To evaluate P: You can do so from AS-AD;
To evaluate i: You can do so from IS-LM;
To evaluate C: You can do so from either IS-LM or AS-AD;
To evaluate I: You can do so from both IS-LM and AS-AD.