Introduction

HISTORY OF MACROECONOMICS

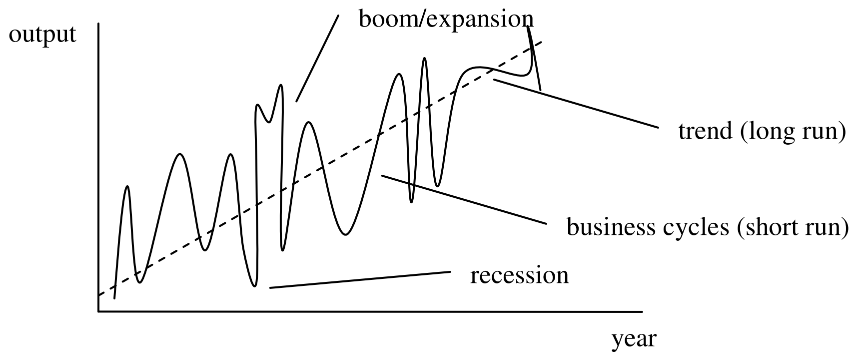
- In 1930, there is no macroeconomics – only classical economics (microeconomics).
- When the great depression came, it was not expected nor could be explained – started macroeconomics.
- M. Keynes is the father of macroeconomics – used mathematical models.

MACROECONOMIC VARIABLES

- Output – how to measure it?
- Unemployment rate.
- Inflation rate – affects purchasing power.

OBJECTIVES OF MACROECONOMICS

- Low unemployment.
- Low inflation.
- Stable but fast growing economy.



ANATOMY OF ECONOMIES

- There are four major players: households, government, foreigners, firms.
- They meet in three markets: factor, goods, financial.

OUTPUT

Have only one good that represents all goods – GDP (gross domestic product).

Definition of GDP

Market value of all final goods and services produced within a country in a given period of time.

- *Market value*: what the price should be.
- *of all*: legal, commercially sold.
- *final*: capital and consumption goods, but no intermediate goods.
- *Goods and services*: both tangible and intangible products.
- *produce*d: reselling doesn't count.
- *within a country*: geographical.
- *in a given period of time*: time constraint (ex: quarterly, yearly).

Approaches

- Output approach.
  - Final good approach: GDP = $\sum P_i Q_i$.
  - Value added approach: GDP = $\sum VA_i$. The value added is the value of output minus the value of used intermediate goods.
- Demand approach.
  - GDP = Private Consumption (C) + Gross Investment (I) + Government Spending (G) + Net Export (NX)
    - Private Consumption (60-70%): durable goods, nondurable goods, services.
    - Gross Investment (15-17%): fixed investment (machinery, building (residential, non-residential)), inventories.
    - Government Spending (15-20%): federal, provincial, local.
    - Net Export NX = X – Q (±5%): >0 (trade balance surplus), <0 (trade balance deficit), >0 (balanced trade).
- Income approach.
  - Idea: When output is sold, somebody in the economic earns it.
  - GDP ≈ Labor Compensation + Capital Return + Rent
  - Doesn't quite add up to GDP because of indirect taxes and depreciation.

INFLATION AND PRICES

GDP

- Nominal GDP$_t$ = $\sum P_t Q_t$ – has both price and quantity in it.
- Real GDP$_t$ = $\sum P_b Q_t$ – based on a base year, and yields the change of aggregate quantity.
- GDP deflator = $\frac{\text{nomial GDP}}{\text{real GDP}} \times 100$, or $P = \frac{\$Y}{Y}$ so $\$Y = PY$. This is the price of the aggregate good.
  - From here, we can calculate the inflation of P – GDP deflator inflation.

Chained Method

Real GDP Growth Rate$_t$ = $\left(\frac{\sqrt{\sum P_t Q_t \sum P_{t-1} Q_t}}{\sqrt{\sum P_{t-1} Q_{t-1} \sum P_t Q_{t-1}}} - 1 \right) \times 100$.

Cost of Living

- Cost of Living = $\sum P_t Q_b$ – Q_b (the bundle) is based in a base year.

- Note: The bundle contains only household goods and is different from GDP.
- Consumer Price Index: $\text{CPI} = \dfrac{\text{Cost of Living}}{\text{Base Year}} \times 100$.

UNEMPLOYMENT RATE

- Civilian Population = Labor Force + Not in Labor Force.
  - In symbols, $P = L + NL \Leftrightarrow 1 = \dfrac{L}{P} + \dfrac{NL}{P}$.
  - $\dfrac{L}{P}$ is the participation rate.
- Labor Force = Employed + Unemployed.
  - In symbols, $L = E + U \Leftrightarrow 1 = \dfrac{E}{L} + \dfrac{U}{L}$.
  - $\dfrac{E}{L}$ is the unemployment rate.

Economies in the Short Run

Assumptions

- The price level (P) is fixed.
- Capital stock (K) and labor force (L) are fixed.
- The output capacity $\overline{Y} = F\left(\overline{K}, \overline{L}\right)$ is fixed.
- Y can go above or below output capacity $\overline{Y}$ by over-utilization or under-utilization of capital stock and labor force.

GOODS MARKET

The demand for goods $Z = C + G + I$ (we assume closed economy, so $NX = 0$).

- Behavioral function for C is $C = C(Y_d) = c_0 + c_1 Y_d$. Since $Y_d = Y - T$, $C = c_0 + c_1(Y - T)$.
  - c_0: Autonomous consumption.
  - c_1: Marginal propensity to consume (MPC).
  - We assume the tax function $T = \overline{T}$ is a lump sum tax.
- Behavioral function for G is $G = \overline{G}$, an exogenous variable.
- Behavioral function for I is $I = \overline{I}$, an exogenous variable.

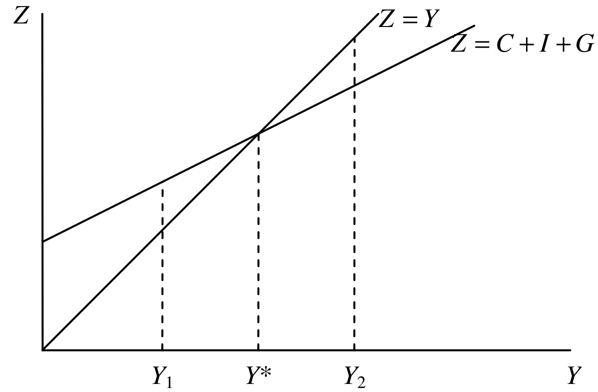
So finally, $Z = c_0 + c_1(Y - \overline{T}) + \overline{G} + \overline{I}$.

The supply equation is the sum of all value added Y.

So, by setting $Z = Y$, we can solve for equilibrium GDP.

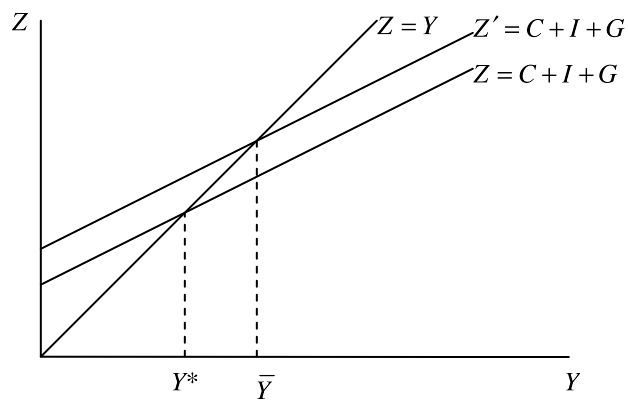
Stability

Inventories is the mechanism to stability in the short run.



- At Y_1, demand exceeds supply – inventory levels decrease. When firms see this, they increase output, which moves GDP back up to Y^*.
- At Y_1, supply exceeds demand – inventory levels increase. When firms see this, they decrease output, which moves GDP back down to Y^*.

Intervention



Notice that the equilibrium GDP (Y^*) may not be at the potential output ($\overline{Y}$).

- If $Y^* < \overline{Y}$, it is a recession.
- If $Y^* > \overline{Y}$, it is a boom/expansion.

How to bring economy to $\overline{Y}$? By shifting Z up through <u>interventions</u>.

- Shift G – fiscal policies.
- Shift C – ask people to consume more by campaigns.

Fiscal Policies

- Expansionary fiscal policies: increase G, decrease T.
- Contractionary fiscal policies: decrease G, increase T.

The G and T Multipliers

Notice $Y = c_0 + c_1(Y - T) + G + I \Rightarrow Y = c_0 + c_1 Y - c_1 T + G + I \Rightarrow Y(1 - c_1) = c_0 - c_1 T + G + I \Rightarrow$

$$Y^* = \frac{c_0 - c_1 T + G + I}{1 - c_1}.$$

- So $\frac{\Delta Y}{\Delta G} = \frac{1}{1-c_1} \Leftrightarrow \Delta Y = \frac{1}{1-c_1}\Delta G$, and $\frac{1}{1-c_1}$ is called the G-multiplier.
- So $\frac{\Delta T}{\Delta G} = -\frac{c_1}{1-c_1} \Leftrightarrow \Delta Y = -\frac{c_1}{1-c_1}\Delta T$, and $-\frac{c_1}{1-c_1}$ is called the T-multiplier.

FINANCIAL MARKET

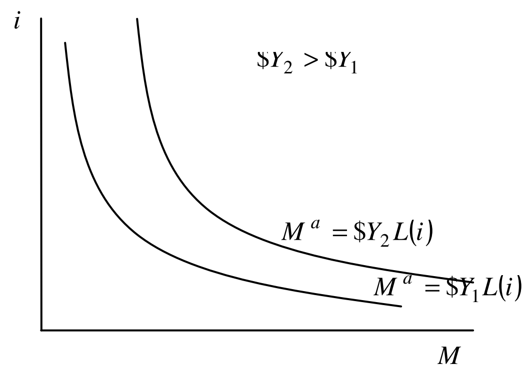
The financial market is the "place where extra resources are lent and borrowed" or the "demand and supply of assets".

Assets

- Extra resources earned by households is converted into assets to preserve the purchasing power for future.
- Assume two assets:
  - Money (cash, demand deposits): Good for transaction (liquid), but doesn't pay interest.
  - Bonds: Not good for transaction (not liquid), but pay interest.
- We need a combination/balance/portfolio of both assets – liquid vs. return.

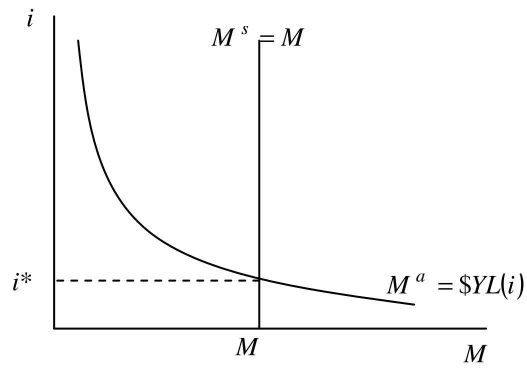
Demand for Money

The behavioral function for demand of money is $M^d = L\left(\underset{-}{i}, \underset{+}{\$Y}\right)$ (textbook uses $M^d = \$Y \cdot L\left(\underset{-}{i}\right)$. $\$Y$ is the transaction demand, and $L\left(\underset{-}{i}\right)$ is the speculative demand.



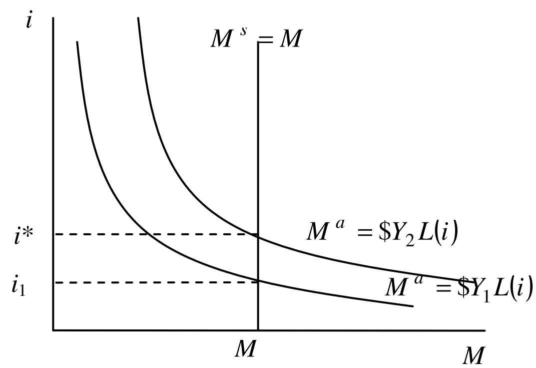
Supply of Money

$M^s = \overline{M}$ fixed supply decided by central bank.



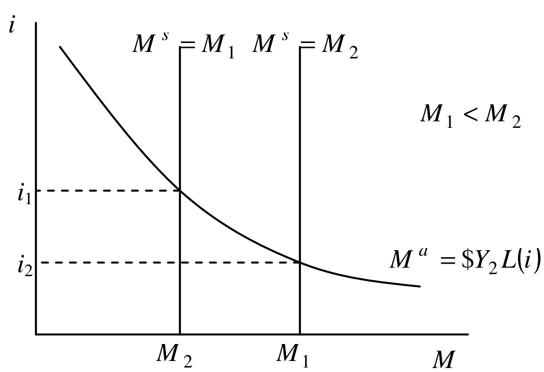
Changes in Equilibrium

If income increases $\$Y_1 < \$Y_2$, then:



Increase in income ⇒ increase in demand for money ⇒ demand for bonds decreases ⇒ selling of bonds increases ⇒ price of bonds decreases ⇒ interest rates increases.

Monetary Policies



Expansionary monetary policies: $\overline{M}$ increases.
Contractionary monetary policies: $\overline{M}$ decreases.

Note: Ideally, the central bank and the government should be independent.

The central bank can increase/decrease the money supply by <u>open market operations</u>.

- If the central bank buys bonds, then $\overline{M} \uparrow \Rightarrow P_B \uparrow \Rightarrow i \downarrow$.
- If the central bank sells bonds, then $\overline{M} \downarrow \Rightarrow P_B \downarrow \Rightarrow i \uparrow$.

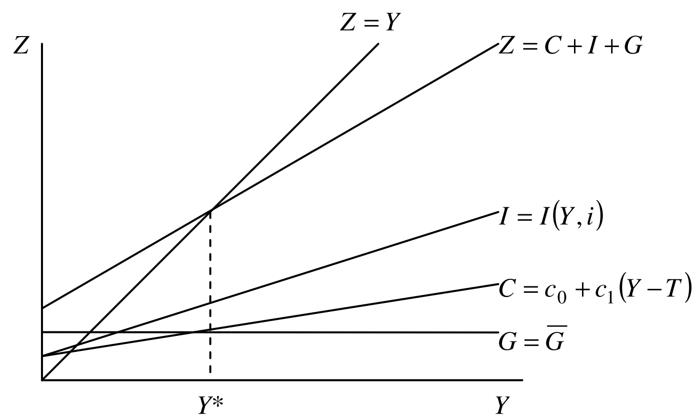
Money Multiplier

$M = \frac{1}{(r+e)(1-c)+c} H$, r is required reserve ratio, e is excess reserve retained, c is cash kept.

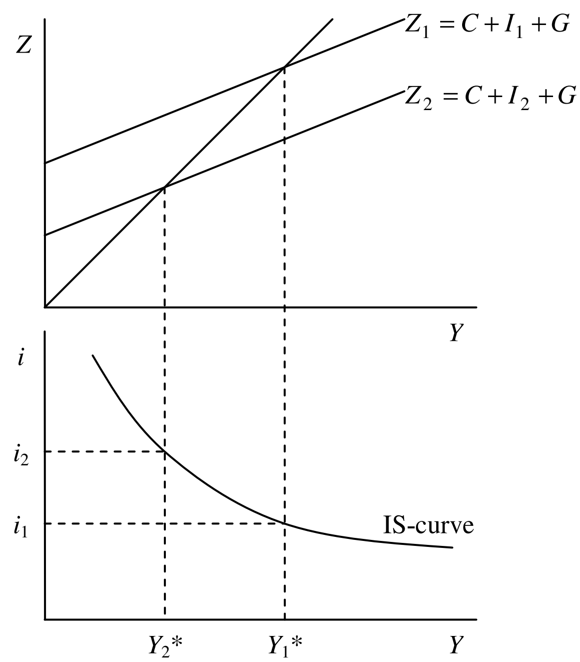
GOODS MARKET AND FINANCIAL MARKETS TOGETHER

Goods Market

Change the behavioral function for investment: $I = I\left(\underset{-}{i}, \underset{+}{Y}\right)$.



IS-curve (investment-saving curve): Gives all the possible equilibriums in the goods market.



Shocks: Changes not due to policy-makers. For example, consumer confidence (c_0 in $C = c_0 + c_1(Y - T)$, investor optimism (function change in $I = I(Y, i)$).

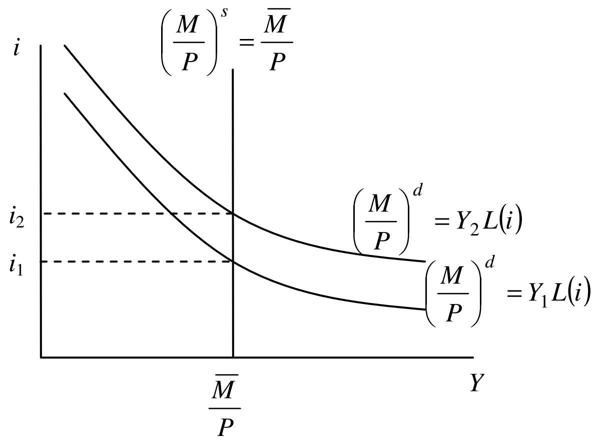
Note: Any expansionary shocks or policies will shift the IS-curve to the right.

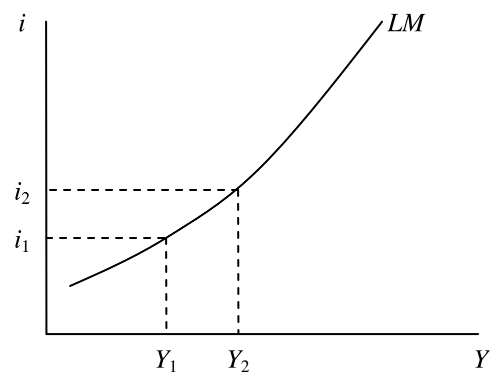
Financial Market

We had $\left.\begin{matrix} M^d = \$Y \cdot L(i) \\ M^s = \overline{M} \end{matrix}\right\} \Rightarrow M^d = M^s$ equilibrium. But goods market is measured in real GDP!

Since $Y = \dfrac{\$Y}{P}$, so change the model to $\left.\begin{matrix} \dfrac{M^d}{P} = Y \cdot L(i) \\ \dfrac{M^s}{P} = \dfrac{\overline{M}}{P} \end{matrix}\right\} \Rightarrow M^d = M^s$ equilibrium.

LM-curve: Gives all possible equilibriums in financial market.



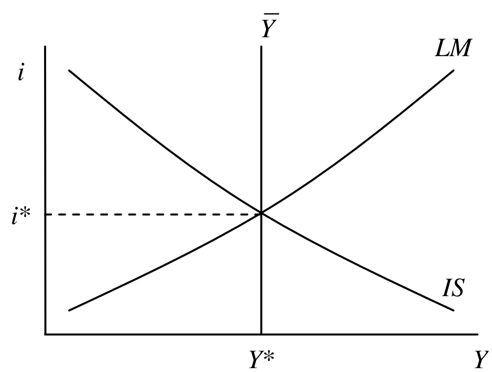


Note: Any expansionary shocks or policies will shift the IS-curve down.

Goods Market and Financial Market Linked

IS-curve: $Y = c_0 + c_1(Y - T) + I\left(\underset{+}{Y}, \underset{-}{i}\right) + G$.

LM-curve: $\dfrac{\overline{M}}{P} = YL\left(\underset{-}{i}\right)$.

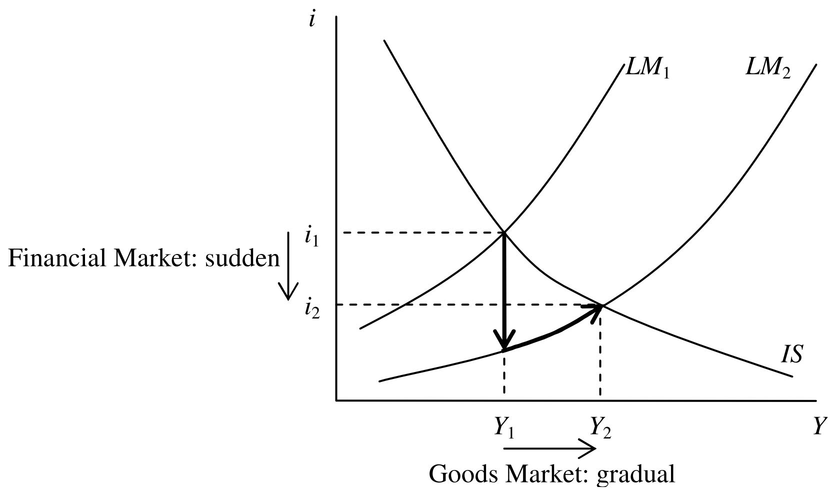


THE DYNAMICS OF CHANGES IN EQUILIBRIUM POINTS

Note

The financial market is always in equilibrium – always on the working LM-curve.

Example



OPEN ECONOMIES

- Open goods market – domestic and foreign goods.
- Open financial market – domestic currency and bonds, foreign currency and bonds.
- Open factor market – domestic labor and capital, foreign labor and capital.

Assumption

Free flow of goods (no tariffs, no quotas).

Nominal Exchange Rate

- Nominal exchange rate (NER) is the price of foreign currency in terms of domestic currency.
- E increases (market determined): depreciation; E decreases (market determined): appreciation.
- E increases (central bank determined or fixed): devaluation; E decreases (central bank determined or fixed): revaluation.

Real Exchange Rate

- Real exchange rate (RER) is the price of foreign goods in terms of domestic goods. $\varepsilon = \frac{EP^*}{P}$.
- ε increases: real depreciation; ε decreases: real appreciation.

Arbitrage

Suppose you want to invest $1 in bonds.

- Domestic bonds: $\$(1+i_t)$ after time t.
- Foreign bonds: $\$(1+i_t^*)\frac{E_{t+1}^e}{E_t}$ after time t.

By arbitrage, the expected return of all assets are equal. So $(1+i_t)=(1+i_t^*)\dfrac{E_{t+1}^e}{E_t}$ $\Rightarrow$

$(1+i_t)=(1+i_t^*)\left(\dfrac{E_{t+1}^e}{E_t}-1+1\right)$ $\Rightarrow$ $(1+i_t)=(1+i_t^*)\left(1+\dfrac{E_{t+1}^e-E_t}{E_t}\right)$ $\Rightarrow$ $i_t \approx i_t^* + \dfrac{E_{t+1}^e-E_t}{E_t}$. This is the uncovered interest parity (UIP) condition, and $\dfrac{E_{t+1}^e-E_t}{E_t}$ is the expected depreciation rate.

OPEN GOODS MARKET

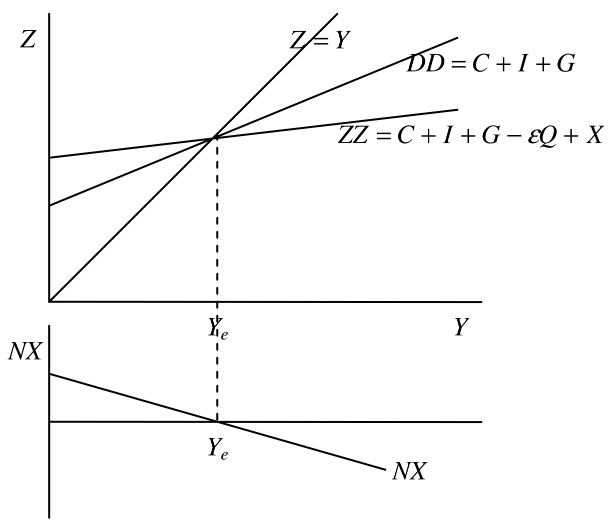
$Z = C + I + G - \varepsilon Q + X = C + I + G + NX$.

- Z is the demand for domestic goods.
- $C + I + G - \varepsilon Q + X = C + I + G + NX$ is the domestic demand for goods (including foreign goods).

Behavioral Functions

$Z = c_0 + c_1(Y-T) + I\Big(\underset{+}{Y}, \underset{-}{i}\Big) + G - \varepsilon Q\Big(\underset{+}{Y}, \underset{-}{\varepsilon}\Big) + X\Big(\underset{+}{Y^*}, \underset{+}{\varepsilon}\Big)$.

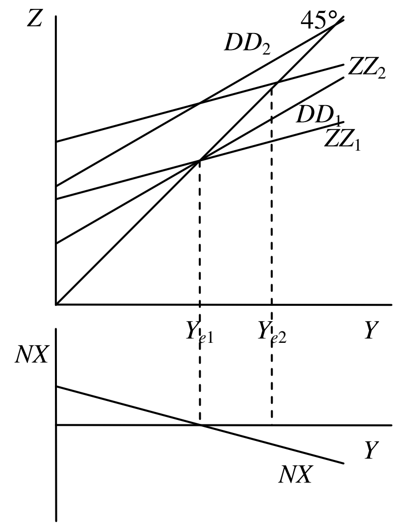
Equilibrium



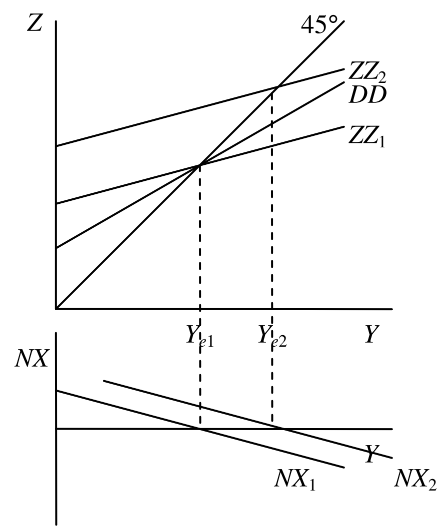
At equilibrium,
$\begin{cases} ZZ = C + I + G - \varepsilon Q + X = DD + NX \\ Z = Y \end{cases}$
gives $Y = C + I + G - \varepsilon Q + X$.

Fiscal Policies and Shocks

- Suppose expansionary fiscal policy: $G\uparrow$ or $T\downarrow$.
- Result: Deterioration of trade deficit.



- Suppose foreigners become richer: $Y^*\uparrow$.
- Result: Improvement of trade deficit.

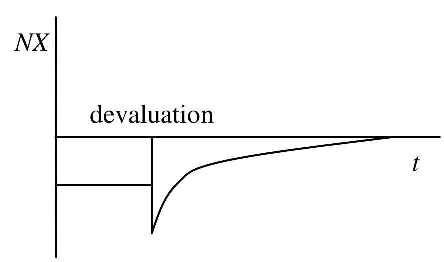


Marshall Lerner Condition

Consider an increase in ε (real depreciation). The effect on NX is unclear. However, if the import and export are elastic enough, then $X\left(\underset{+}{Y^*},\underset{+}{\varepsilon}\right)-\varepsilon Q\left(\underset{+}{Y},\underset{-}{\varepsilon}\right)=NX\left(\underset{+}{Y^*},\underset{-}{Y},\underset{+(\text{ML})}{\varepsilon}\right)$.

J-Curve

Suppose a country devalues its currency to reduce its trade deficit. Then in the very short run (ex: a few days), $NX=X\left(\underset{+}{Y^*},\underset{+}{\varepsilon}\right)-\varepsilon Q\left(\underset{+}{Y},\underset{-}{\varepsilon}\right)$ will decrease sharply since ε is lower, but import and exports cannot respond yet. So the economy is actually worse in the very short run, but will improve after that.



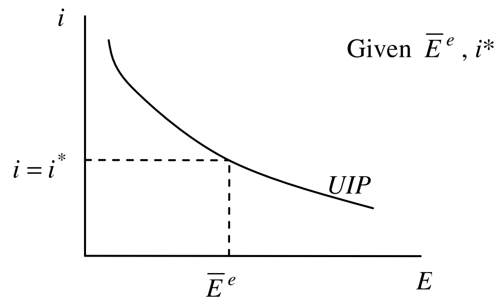
OPEN FINANCIAL MARKET

Uncovered Interest Parity Condition

Assuming the expected exchange rate is fixed (exogenous),

$$\left.\begin{array}{l} i_t = i_t^* + \dfrac{E_{t+1}^e - E_t}{E_t} \\ E_{t+1}^e = \overline{E}^e \end{array}\right\} \Rightarrow i = i^* + \frac{\overline{E}^e - E}{E}$$

. Solving for E, we get $E = \dfrac{\overline{E}^e}{1+i-i^*}$ (UIP condition).

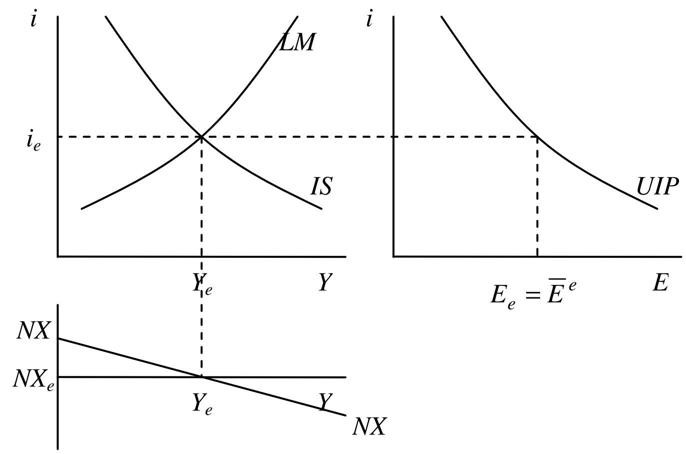


Shocks

1) If $i\uparrow \Rightarrow i > i^* + \dfrac{\overline{E}^e - E}{E}$ ⇒ switch to domestic bonds ⇒ capital inflow ⇒ demand for domestic currency increases ⇒ appreciation ($E\downarrow$). This is a movement along the UIP curve.
2) If $i\downarrow \Rightarrow i < i^* + \dfrac{\overline{E}^e - E}{E}$ ⇒ switch to foreign bonds ⇒ capital outflow ⇒ supply for domestic currency increases ⇒ depreciation ($E\uparrow$). This is a movement along the UIP curve.
3) If $i^*\downarrow \Rightarrow i > i^* + \dfrac{\overline{E}^e - E}{E}$ ⇒ switch to domestic bonds ⇒ capital inflow ⇒ demand for domestic currency increases ⇒ appreciation ($E\downarrow$). This is a downward shift of the UIP curve.
4) If $\overline{E}^e\uparrow \Rightarrow i < i^* + \dfrac{\overline{E}^e - E}{E}$ ⇒ switch to foreign bonds ⇒ capital outflow ⇒ supply for domestic currency increases ⇒ depreciation ($E\uparrow$). This is a rightward shift of the UIP curve.

GENERAL EQUILIBRIUM OF OPEN MARKETS

$$\begin{cases} IS: Y = c_0 + c_1(Y = T) + I\Big(\underset{+}{Y}, \underset{-}{i}\Big) + G + NX\left(\underset{+}{Y^*}, \underset{-}{Y}, \underset{+\,(\mathrm{ML})}{\frac{\overline{E}^e}{1+i-i^*}}\right) \\ LM: \dfrac{\overline{M}}{P} = YL\Big(\underset{-}{i}\Big) \end{cases}.$$



Exchange Rate Regimes

Flexible Exchange Rate Regime

Exchange rate determined by the market (supply and demand).

Pegged Exchange Rate Regime

Fix the exchange rate with a particular country (usually the US).

Crawling Pegged Exchange Rate Regime

Fixed, but revised once in a while. $\varepsilon = \frac{EP^*}{P} \Rightarrow \frac{\Delta\varepsilon}{\varepsilon} = \frac{\Delta E}{E} + \frac{\Delta P^*}{P^*} - \frac{\Delta P}{P}$, but since ε is fixed, so $\frac{\Delta\varepsilon}{\varepsilon} = 0 \Rightarrow \frac{\Delta E}{E} = \frac{\Delta P}{P} - \frac{\Delta P^*}{P^*}$.

Credible Pegged Exchange Rate Regime: Mundell-Fleming Model

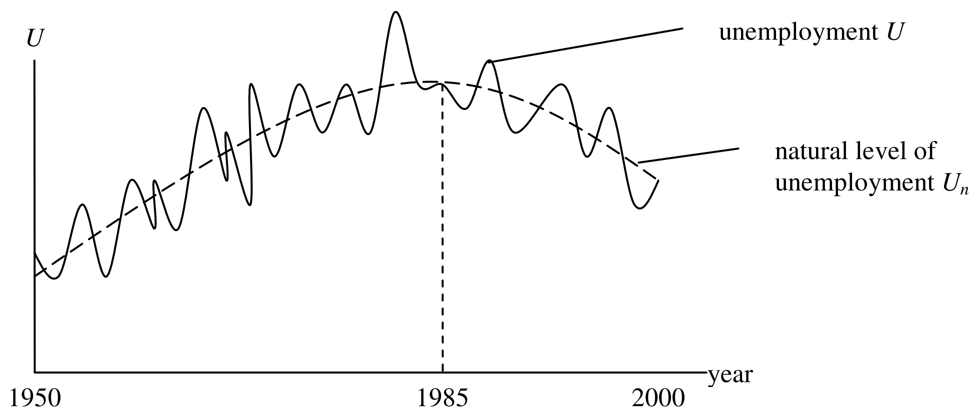
- Pegged $E = \overline{E}$, credible $\overline{E}^e = \overline{E}$.
- UIP condition $i = i^* + \frac{\overline{E}^e - E}{E} \Rightarrow i = i^*$.
- In this case, monetary policies are useless, i.e. *LM* curve fixed – central bank forced to defend the exchange rate. However, fiscal policies shifts both *IS* and *LM* curves.

Economies in Medium Run

Idea

We let *P* be endogenous instead of fixed.

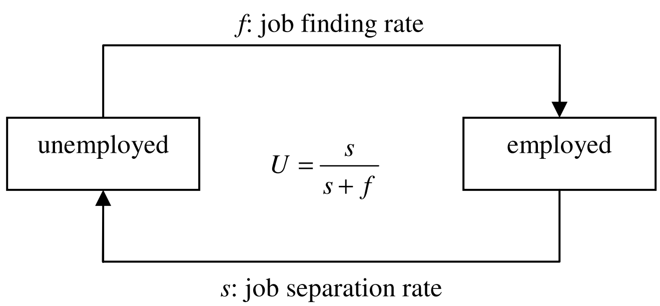
Labour Market, Unemployment Rate



In medium run, $\begin{cases} Y = \overline{Y} \\ U = U_n \end{cases}$. So in a boom $\begin{cases} Y > \overline{Y} \\ U < U_n \end{cases}$, and in a recession $\begin{cases} Y < \overline{Y} \\ U > U_n \end{cases}$.

Reasons For Unemployment

Frictional Unemployment (Job Search)



Wait Unemployment (Real Wage Rigidity)

- Minimum wage laws – market can't adjust.
- Labour market and collective bargaining – monopoly of workers.
- Efficiency wages – "if pay more, more productivity".
  - Nutritional and health issues.
  - Turnover issues – always have a pool of unemployed to "scare" the workers.
  - Adverse selection – hidden information.
  - Moral hazard – hidden action, lack of monitoring.

Equilibrium

Wage Setting Relation

$W = P^e F\left(\underset{-}{U}, \underset{+}{z}\right)$. z increases if a factor increases U at any W, or if a factor increases W at any U.

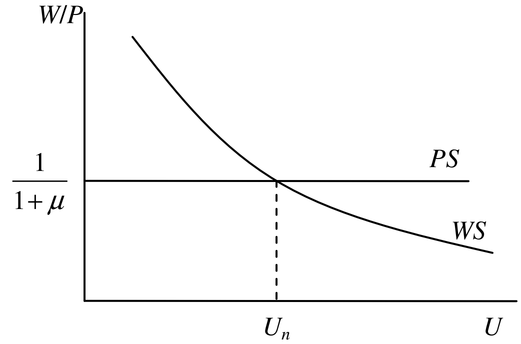
Price Setting Relation

If market competitive: $P = W$.
If market non-competitive: $P = W(1+\mu)$, where μ is the market (market power).

The Equilibrium

In the medium run, $\begin{cases} Y = \overline{Y} \\ U = U_n \\ P = P^e \end{cases}$. So we get

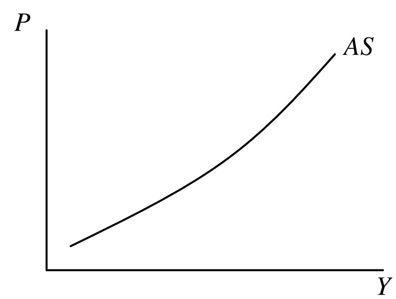
$$\begin{cases} WS: \dfrac{W}{P} = F\left(\underset{-}{U}, \underset{+}{z}\right) \\ PS: \dfrac{W}{P} = \dfrac{1}{1+\mu} \end{cases}.$$



AGGREGATE SUPPLY AND DEMAND CURVE

Aggregate Supply Curve

$AS: P = P^e(1+\mu) \cdot F\left(\underset{-}{1-\tfrac{Y}{L}}, \underset{+}{z}\right)$.



Increasing: $Y\uparrow \Rightarrow 1-\frac{Y}{L} = u$ (unemployment) $\downarrow \Rightarrow W$ production cost $\uparrow \Rightarrow P\uparrow$.

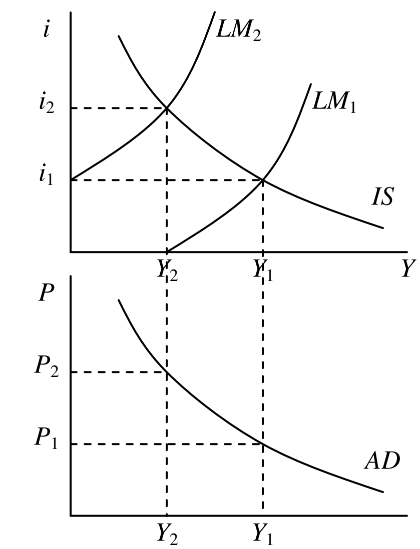
If $P^e\uparrow$, AS shifts up (ask for higher wages), so $P\uparrow$.

Aggregate Demand Curve

Use $\begin{cases} IS: Y = C + G + I(i, Y) \\ LM: \frac{\overline{M}}{P} = Y \cdot L(i) \end{cases}$ to derive

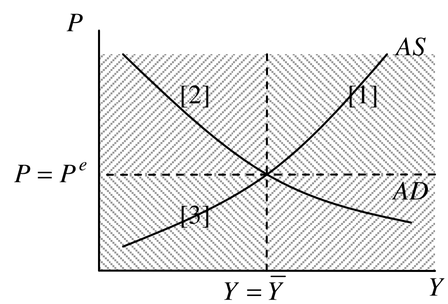
$AD: Y = Y\left(\underset{+}{G}, \underset{-}{T}, \underset{+}{\frac{\overline{M}}{P}}\right)$.

If $G\uparrow$ or $T\downarrow \Rightarrow IS$ shifts right $\Rightarrow$ all points shifts right $\Rightarrow AD$ shifts up.
If $\overline{M}\uparrow \Rightarrow LM$ shifts down $\Rightarrow$ all points shifts right $\Rightarrow AD$ shifts up.
So all expansionary policies shifts *AD* right.



Equilibrium

1) $Y > \overline{Y}$, $u < u_n$ – boom, danger of inflation.
2) $Y < \overline{Y}$, $u < u_n$ – stagflation, hell.
3) $Y < \overline{Y}$, $u > u_n$ – recession, high unemployment.



Shocks and Policies

Expansionary Monetary Policy

- Short run: $i\downarrow$, $Y\uparrow$, $P\uparrow$.
- From shout run to medium run: People adjust their $P^e\uparrow$, which will cause $P\uparrow$.
- Medium run equilibrium: When $P^e = P$, everything is the same, but only *P* higher! This phenomenon is called "neutrality of money" (money doesn't matter).

Supply Side Shocks and Policies

Suppose there is a technological progress. This will shift $\overline{Y}$ to the right.

Short Run: $i\downarrow$, $Y\uparrow$, $P\downarrow$, $\frac{W}{P}\uparrow$, $u_n\downarrow$.

Medium Run: $P\downarrow$, $Y\uparrow$ further.

So, a positive supply side shock will permanently increase $\overline{Y}$ and decrease u_n.

Example: Weaker Unions

This is characterized by $z\downarrow$.
In the short run, $z\downarrow \Rightarrow W\downarrow \Rightarrow$ production cost $\downarrow \Rightarrow P\downarrow \Rightarrow \frac{\overline{M}}{P}\uparrow \Rightarrow i\downarrow \Rightarrow I\uparrow \Rightarrow Y\uparrow \Rightarrow u\downarrow$ (partially offsets $W\downarrow$). Note that $\frac{W}{P}$ is constant.
In the medium run, $P^e\downarrow \Rightarrow W\downarrow \Rightarrow$ production cost $\downarrow \Rightarrow P\downarrow \Rightarrow \frac{\overline{M}}{P}\uparrow \Rightarrow i\downarrow \Rightarrow I\uparrow \Rightarrow Y\uparrow$. Note that $\frac{W}{P}$ is constant.

PHILLIPS CURVE, OKUN'S LAW, AND AGGREGATE DEMAND

Phillips Curve

The phillips curve is given by $\pi_t - \pi_t^e = -\alpha(u_t - u_n)$ or $\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$ if we assume $\pi_t^e = \pi_{t-1}$, where π_t is the rate of inflation. It is actually derived from the aggregate supply curve $AS: P = P^e(1+\mu)F(u,z)$. Note that if $u_t < u_n$, we have accelerated inflation.

Okun's Law

If the output growth rate is g_Y, then $u_t - u_{t-1} = -\beta(g_{Y_t} - \overline{g}_Y)$, where $\overline{g}_Y$ is the normal growth rate.

Aggregate Demand

$AD: g_{Y_t} = g_{M_t} - \pi_t \Leftrightarrow \pi_t = g_{M_t} - g_{Y_t}$. This is derived from the aggregate demand curve $AD: Y\left(G, T, \frac{\overline{M}}{P}\right)$.

Together

Putting the three relations together, we get $\begin{cases} \pi_t - \pi_{t-1} = -\alpha(u_t - u_n) \\ u_t - u_{t-1} = -\beta(g_{Y_t} - \overline{g}_Y) \\ \pi_t = g_{M_t} - g_{Y_t} \end{cases}$.

MEDIUM RUN EQUILIBRIUM WITH INFLATION IN CLOSED ECONOMIES

We have $\begin{cases} AS: P = P^e(1+\mu)F(u,z) \\ AD: Y = Y\left(\frac{\overline{M}}{P}, G, T\right) \end{cases}$ and

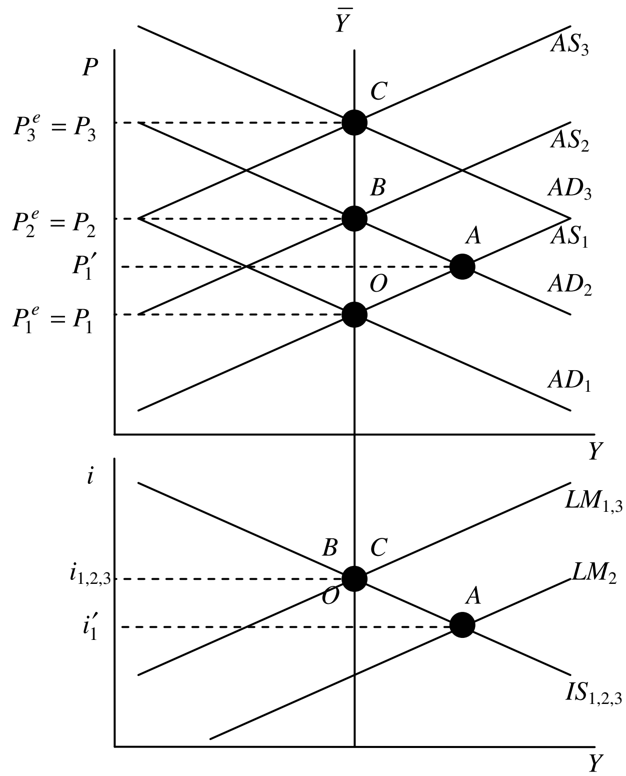
$$\begin{cases} FC: \pi_t - \pi_t^e = -\alpha(u_t - u_n) \\ OK: u_t - u_{t-1} = -\beta\left(g_{Y_t} - \overline{g}_Y\right). \\ AD: \pi_t = g_{M_t} - g_{Y_t} \end{cases}$$

Assume that before $t = 0$, $g_M = 0$ and $\overline{M}$ is fixed; at $t = 0$, unanticipated change $g_M > 0$.

In the first year, *O* to *A* unanticipated, then eventually *O* to *B*.

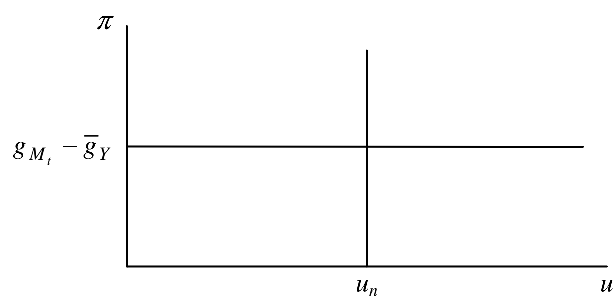
Next year, *B* to *C* anticipated;

$$\left.\begin{array}{l} \overline{M}\uparrow \Rightarrow \text{shift in } AD \\ P^e \uparrow \Rightarrow \text{shift in } AS \end{array}\right\} \Rightarrow \text{go straight to } C.$$



Fighting Inflation

Suppose in medium run $u_t = u_{t-1} = u_n \begin{cases} \overset{FC}{\Rightarrow} \pi_t = \pi_t^e \\ \overset{OK}{\Rightarrow} g_{Y_t} = \overline{g}_Y \overset{AD}{\Rightarrow} \pi_t = g_{M_t} - \overline{g}_Y \end{cases}$.



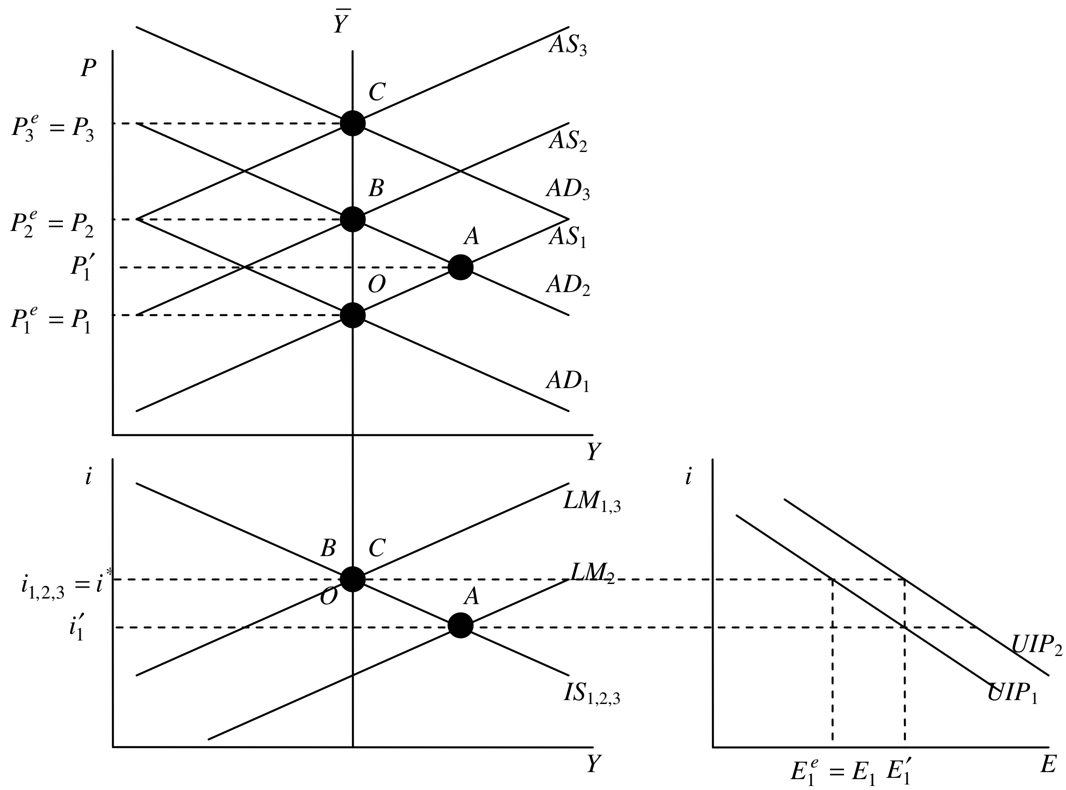
Consider $\begin{cases} FC: \pi_t - \pi_t^e = -\alpha(u_t - u_n) \\ OK: u_t - u_{t-1} = -\beta\left(g_{Y_t} - \overline{g}_Y\right) \\ AD: \pi_t = g_{M_t} - g_{Y_t} \end{cases}$. Want to reduce inflation to $\overline{\pi}$. How do we know π_t^e? There are three scenarios:

1) No credibility: $\pi_t^e = \pi_{t-1}$ (adaptive expectation theory).
2) Half credibility: $\pi_t^e = \frac{1}{2}\pi_{t-1} + \frac{1}{2}\overline{\pi}$.
3) Full credibility: $\pi_t^e = \overline{\pi}$.

To decrease inflation, have to decrease g_{M_t}, but this is costly! We measure the cost of different policies/scenarios by:

1) Extra unemployment rate.
2) Output fall.
3) Duration of policies.

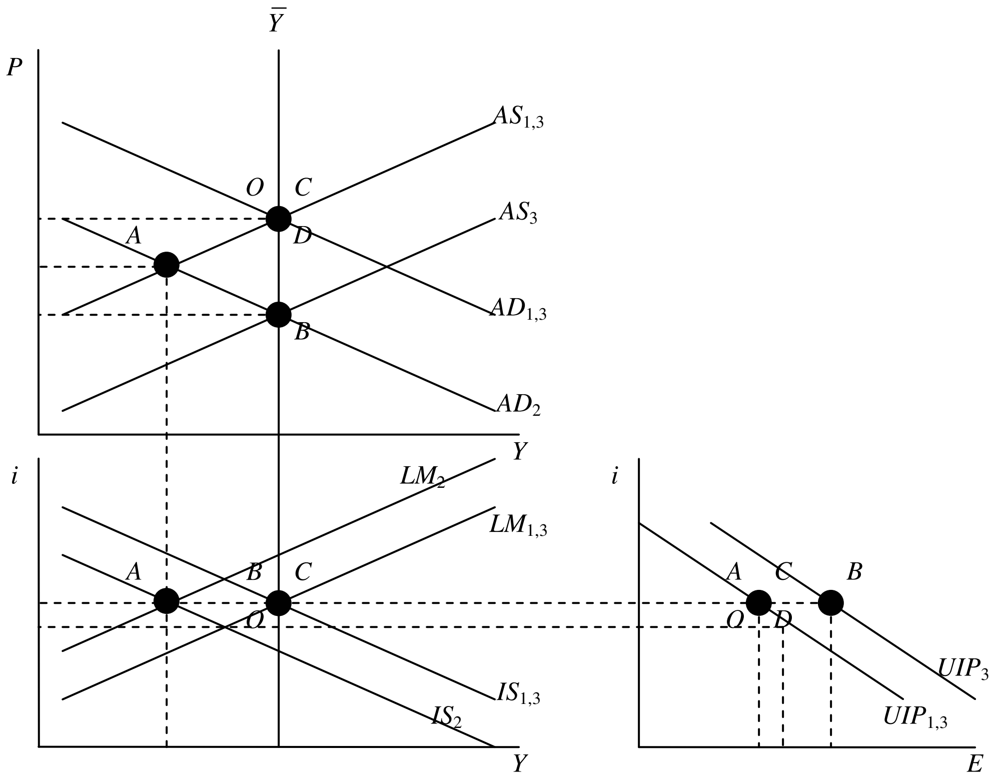
MEDIUM RUN EQUILIBRIUM WITH INFLATION IN OPEN ECONOMIES WITH FLEXIBLE EXCHANGE RATE REGIME



In medium run, $P\uparrow$, $P^e\uparrow$; ε, NX, i, I, C, G, Y the same.

MEDIUM RUN EQUILIBRIUM IN OPEN ECONOMIES WITH PEGGED EXCHANGE RATE REGIME

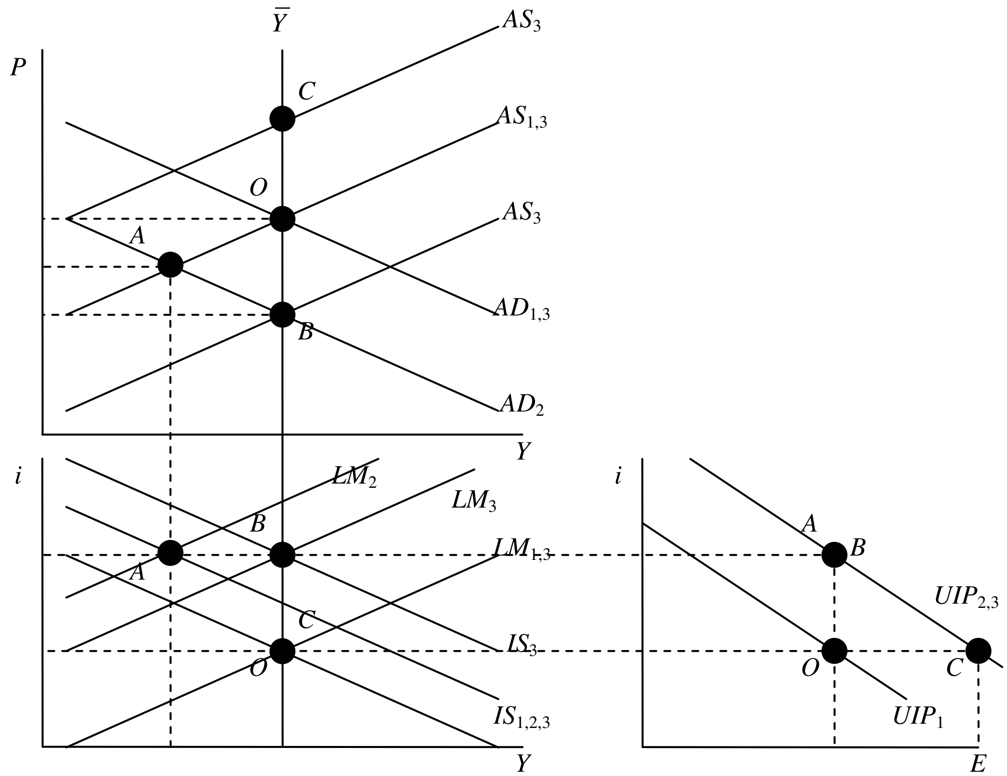
Credible Regime



Suppose "consumer pessimism" $c_0 \downarrow$. From the short-run equilibrium at point *A*:

1) Doing nothing policy *B*. In medium-run $P^e \downarrow \Rightarrow P \downarrow \begin{cases} \Rightarrow \frac{\bar{M}}{P} \uparrow \Rightarrow LM \downarrow \\ \Rightarrow \varepsilon = \frac{\bar{E}P^*}{P} \uparrow \Rightarrow NX \uparrow \Rightarrow IS \rightarrow \end{cases}$, so $Y = \underset{\downarrow}{C} + I + G + \underset{\uparrow}{NX}$.
2) Devaluation policy *C*. In medium-run $\bar{E} \uparrow \begin{cases} \Rightarrow E^e \uparrow \\ \Rightarrow \varepsilon = \frac{\bar{E}P^*}{P} \uparrow \Rightarrow NX \uparrow \Rightarrow IS \rightarrow \Rightarrow \begin{Bmatrix} \text{upward pressure} \\ \text{on } i \end{Bmatrix} \Rightarrow \begin{Bmatrix} \text{capital} \\ \text{inflow} \end{Bmatrix} \Rightarrow \begin{Bmatrix} \text{central bank buys} \\ \text{foreign exchange} \end{Bmatrix} \Rightarrow LM \downarrow \end{cases}$, so $Y = \underset{\downarrow}{C} + I + G + \underset{\uparrow}{NX}$.
3) Expansionary fiscal policy *D*. In medium-run $G \uparrow$, so $Y = \underset{\downarrow}{C} + I + \underset{\uparrow}{G} + NX$.
4) Tax cut policy *D*. In medium-run $T \downarrow$, so $Y = \underset{\downarrow\uparrow}{C} + I + G + NX$.

Non-Credible: Exchange Rate Crisis



Suppose "consumer pessimism" $c_0 \downarrow$. From the short-run equilibrium at point *A*:

1) Doing nothing policy *B*. $i < i^* + \dfrac{E^e - \overline{E}}{E}$, so capital outflow. Central bank must sell foreign exchange to keep $\overline{E}$, but must sell a lot, so it will collapse at some point.
2) Devaluation policy *C*. Capital inflow.

Long Run

Assumptions

1) $Y = F(K, L)$, *K* and *L* are now variables.
2) Money and price don't matter, only $\overline{Y}$ matters.

Stylized Facts

We develop models to explain these observed facts. For industrialized countries:

1) Output per capita growth rates have decreased over time.
2) Countries with lower output per capita grow faster.
3) Output per capita have had 2% increase in output per capita per year on average in past century.
   Note: 1 and 2 gives Conditional Convergence Theory — all countries goes to the same place.

THE PRODUCTION FUNCTION

$Y = F(K, N)$ is the aggregate production function.

Example: Cobb-Douglas Production Function

$Y = 2K^{0.3}N^{0.7}$ is the Cobb-Douglas production function.

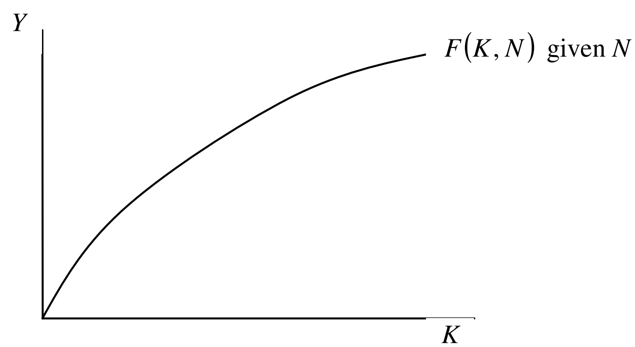
Example: Technological Progress

Original: $Y = 2K^{0.3}N^{0.7}$. $K = 100, N = 200 \Rightarrow Y = 324.9$.

New: $Y = 3K^{0.3}N^{0.7}$. $K = 100, N = 200 \Rightarrow Y = 487.4$.

Properties of the Production Function

1) Constant return to scale (CRTS): $\lambda Y = F(\lambda K, \lambda N)$.
2) Diminishing Returns to Factors (DRTF): Increase in only one factor will cause output to increase less every time.



Production Function per Capita

$Y = F(K, N)$ and $\lambda = \frac{1}{N}$ gives $\frac{Y}{N} = F\left(\frac{K}{N}, 1\right)$.

Notation: Denote $y = \frac{Y}{N}$ and $k = \frac{K}{N}$, then $y = f(k)$.

Example

$$Y = 2K^{0.3}N^{0.7} \Rightarrow \frac{Y}{N} = \frac{2K^{0.3}N^{0.7}}{N} = 2\left(\frac{K}{N}\right)^{0.3}\left(\frac{N}{N}\right)^{0.7} = 2\left(\frac{K}{N}\right)^{0.3} \Rightarrow y = 2k^{0.3} = f(k).$$

ENDOGENOUS GROWTH MODEL: SIMPLE SOLOW MODEL

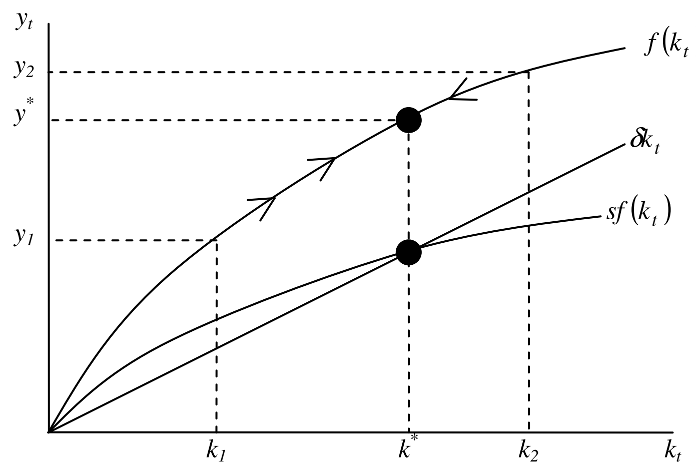
Assumptions

1) $Y_t = F(K_t, N_t)$ is CRTS and DRTF, so can rewrite $y_t = f(k_t)$.

2) Demand side GDP $Y_t = C_t + I_t + G_t$ and income side GDP $Y_t = C_t + T_t + S_t$ gives $I_t + G_t = T_t + S_t \Leftrightarrow I_t = S_t + (T_t - G_t)$. Assume no government, so $I_t = S_t$.
3) $C_t = c_0 + c_1(Y_t - T_t)$. Assume $T = 0$ and $c_0 = 0$, we get $C_t = c_1 Y_t \Rightarrow S_t = Y_t - C_t = Y_t - c_1 Y_t = \underbrace{(1-c_1)}_{s} Y_t$, so $S_t = sY_t$.
4) Capital accumulation dynamics: $\underbrace{K_{t+1}}_{\substack{\text{capital} \\ \text{next year}}} = \underbrace{K_t}_{\substack{\text{capital} \\ \text{this year}}} + \underbrace{I_t}_{\text{investment}} - \underbrace{\delta K_t}_{\text{depreciation}}$ (inflow - outflow).
5) $\frac{\Delta N_t}{N_t} = \frac{N_{t+1} - N_t}{N_t} = g_N$. Note: We first assume $g_N = 0$, so $N_{t+1} = N_t = N$.

Derivations

$$K_{t+1} - K_t = \underbrace{I_t}_{\substack{=S_t \\ =sY_t}} - \delta K_t \Leftrightarrow K_{t+1} - K_t = sY_t - \delta K_t \Leftrightarrow \frac{K_{t+1}}{N} - \frac{K_t}{N} = \underbrace{\frac{sY_t}{N}}_{=sf(k_t)} - \frac{\delta K_t}{N} \Leftrightarrow k_{t+1} - k_t = sf(k_t) - \delta k_t .$$



- At $k_t = k_1$, $sf(k_1) > \delta k_1 \Rightarrow k_{t+1} > k_t$, so capital will increase.
- At $k_t = k_2$, $sf(k_2) < \delta k_2 \Rightarrow k_{t+1} < k_t$, so capital will decrease.
- At $k_t = k^*$, $sf(k^*) = \delta k^*$ (inflow = outflow), therefore $k_{t+1} - k_t = 0$. The point (k^*, y^*) is called the steady state equilibrium.

Note

At the steady state equilibrium, the rate of growth of *y*, *k*, *Y*, *K* are all 0. This is the problem with Solow Model (see Stylized Facts 3).

Golden Rule Saving Rate

To maximize consumption, we need a "Golden Rule Saving Rate" s_g such that

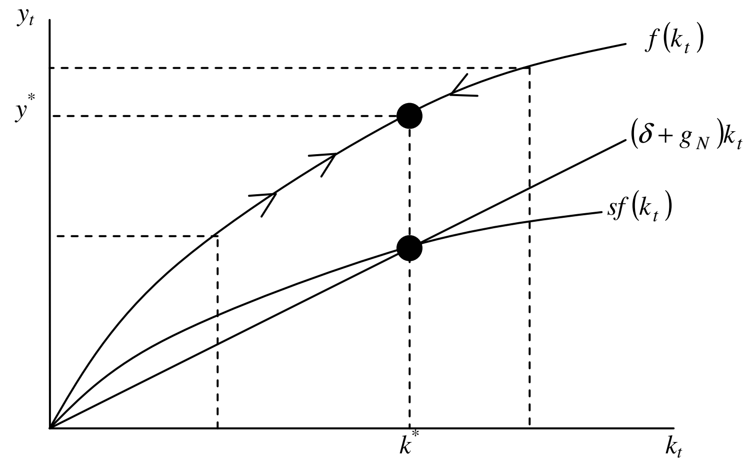
$$\begin{cases} f'(k) = \delta \\ s_g f(k) = \delta k \end{cases} \Rightarrow \frac{f'(k)}{s_g f(k)} = \frac{1}{k} \Rightarrow s_g = k \frac{f'(k)}{f(k)} .$$

Endogenous Growth Model: Solow Model With Population Growth

Assumption

Now we let $g_N = \frac{\Delta N_t}{N_t} = \frac{N_{t+1} - N_t}{N_t} \neq 0$. Then $k_{t+1} - k_t = sf(k_t) - (\delta + g_N)k_t$.

Steady State Equilibrium



At steady state equilibrium:

- Growth rates of k and $y = 0$.
- Growth rates of K and $Y = g_N$.

Endogenous Growth Model: Solow Model With Population Growth and Labour Augmenting Technological Progress

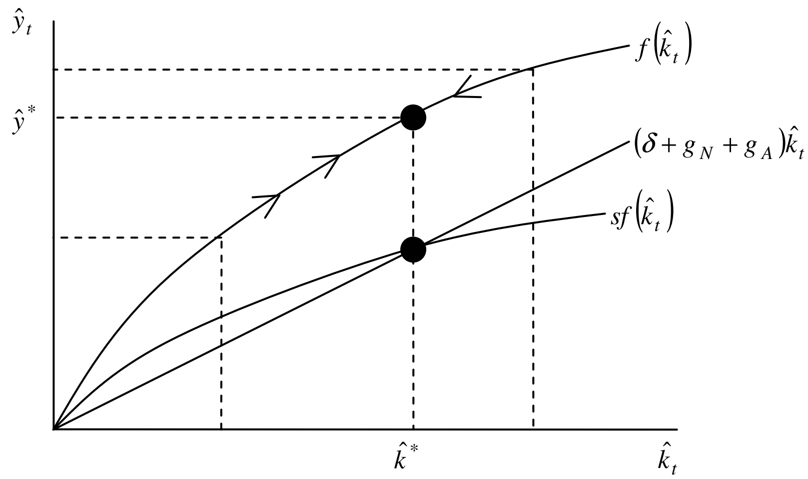
Assumptions

1) We change our production function from $Y = F(K, N)$ to $Y = F(K, AN)$ where AN is the "effective labour force".
2) $g_N = \frac{\Delta N_t}{N_t} = \frac{N_{t+1} - N_t}{N_t} \neq 0$, $g_A = \frac{\Delta A_t}{A_t} = \frac{A_{t+1} - A_t}{A_t} \neq 0$.

Derivation

$Y = F(K, AN) \Rightarrow \frac{Y}{AN} = F\left(\frac{K}{AN}, 1\right)$. Define $\hat{y} = \frac{Y}{AN}$ and $\hat{k} = \frac{K}{AN}$. Then $\hat{y}_t = f(\hat{k}_t)$. Thus, the capital accumulation dynamics is $\hat{k}_{t+1} - \hat{k}_t = sf(\hat{k}_t) - (\delta + g_N + g_A)\hat{k}_t$.

Steady State Equilibrium



At steady state equilibrium:

- Growth rates of per effective worker capital ($\hat{k}$) and per effective worker output ($\hat{y}$) are 0.
- Growth rates of per worker capital (k) and per worker output (y) are $g_A \neq 0$.
- Growth rates of total capital (K) and total output (Y) are $g_N + g_A \neq 0$.

ENDOGENOUS GROWTH MODEL: AK MODEL

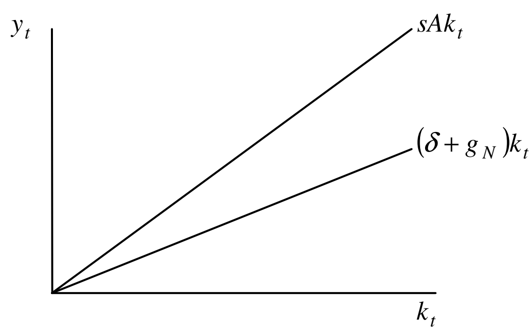
Assumptions

1) The production function is $Y = AK$ (CRTS, but not DRTF).
2) $g_N = \dfrac{\Delta N_t}{N_t} = \dfrac{N_{t+1} - N_t}{N_t} \neq 0$.

Derivations

$Y = AK \Rightarrow \dfrac{Y}{N} = A\dfrac{K}{N} \Rightarrow y = Ak$, and thus $k_{t+1} = sAk_t - (g_N + \delta)k_t$.

Result



There is no steady state equilibrium. It grows forever. $\dfrac{k_{t+1} - k_t}{k_t} = \Delta k_t = sA - g_N + \delta$ and

$\dfrac{y_{t+1} - y_t}{y_t} = \Delta y_t = sA - g_N + \delta$.

CONDITIONAL CONVERGENCE

Each country converges to its own steady state equilibrium.

TWO PERIOD ECONOMY

Note

Close economy: $\begin{cases} Y = C + I + G \\ Y = C + S + T \end{cases} \Rightarrow I = S + (T - G)$.

Open economy: $\begin{cases} Y = C + I + G + NX \\ Y = C + S + T \end{cases} \Rightarrow I = S + (T - G) - NX$.

Note

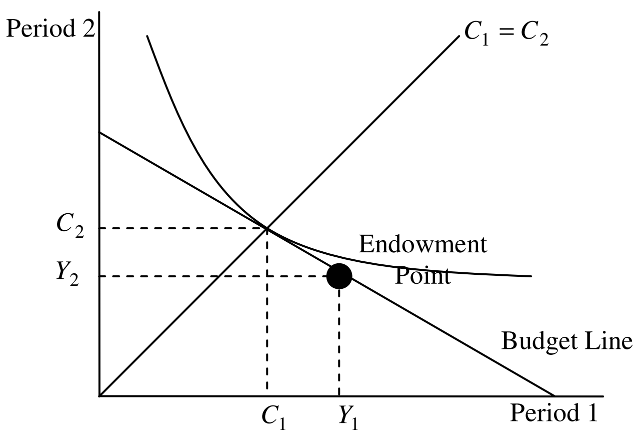
In an open economy, $NX = Y - C - I - G$. In long run, we assume $G = 0$, so $NX = Y - C - I$

Current and Capital Account Dynamics

Let β^f denote foreign assets. Then $\beta_t^f = \beta_{t-1}^f + \underbrace{i\beta_t^f}_{\text{return}} + \underbrace{(Y_t - C_t - I_t)}_{NX_t}$ or $\underbrace{\beta_t^f - \beta_{t-1}^f}_{\text{capital account}} = \underbrace{i\beta_t^f + (Y_t - C_t - I_t)}_{\text{current account} = CA_t}$.

Two Period Economy
Case 1 – Only Lending/Borrowing Possibilities, No Investment Possibilities

Use $C_1 = C_2$ to approximate the optimal point.



Note:

- Slope of budge line is $-(1+i)$.
- $\beta_0^f = \beta_2^f = 0$.

Two Period Economy
Case 2 – Only Investment Possibilities, No Lending/Borrowing Possibilities

Use $C_1 = C_2$ to approximate the optimal point.

Two Period Economy
Case 3 – Both Investment and Lending/Borrowing Possibilities
The optimal point is at $MPK = i$.

Expectations

Definition: Real Interest Rate
The real interest rate, *r*, is the rate of return to investment/goods.

Definition: Nominal Interest Rate
The nominal interest rate, *i*, is the real interest rate + inflation (+ risk).

Relationship Between Real and Nominal Interest Rates

$$\begin{array}{ccc} \text{Time } t & & \text{Time } t+1 \\ \text{1 unit of good} & \longrightarrow & 1+r_t \text{ units of good} \\ \Big\downarrow P_t & & \\ \$P_t & \longrightarrow & \$(1+i_t)P_t \text{ or } \dfrac{\$(1+i_t)P_t}{P_{t+1}^e} \text{ units of good} \end{array}$$

So, $1+r_t = (1+i)\frac{P_t}{P_{t+1}^e}$. We also have that $\pi_t^e = \frac{P_{t+1}^e - P_t}{P_t} = \frac{P_{t+1}^e}{P_t} - 1$. Therefore, $1+r_t = (1+i)\frac{1}{\pi_t^e + 1}$, and thus $r_t \approx i_t - \pi_t^e$ or $i_t \approx r_t + \pi_t^e$.

COMPOUNDING AND DISCOUNTING

Compounding
$FV_N = PV(1+i_t)(1+i_{t+1})\cdots(1+i_{t+N-1})$, where FN_N is the future value at time *N*, and PV is the present value.

Discounting
$$PV = \frac{FV_N}{(1+i_t)(1+i_{t+1})\cdots(1+i_{t+N-1})}.$$

Project Evaluation
1) Present Discounted Value: $\$V_t = Z_t + \frac{Z_{t+1}}{1+i_t} + \frac{Z_{t+2}}{(1+i_t)(1+i_{t+1})} + \cdots + \frac{Z_{t+N}}{(1+i_t)\cdots(1+i_{t+N-1})}$, where Z_t is the future value/cash flow.
2) Expected Present Discounted Value: $\$V_t^e = Z_t^e + \frac{Z_{t+1}^e}{1+i_t^e} + \frac{Z_{t+2}^e}{(1+i_t^e)(1+i_{t+1}^e)} + \cdots + \frac{Z_{t+N}^e}{(1+i_t^e)\cdots(1+i_{t+N-1}^e)}$.

Special Cases

1) Annuity. It pays $\$Z$ for N years starting next year with interest rate i. Thus its present value is
$$\$V = \frac{\$Z}{i} + \cdots + \frac{\$Z}{i^N} = \$Z\left[\frac{1-(1+i)^{-N}}{i}\right].$$
2) Annuity Due. It pays $\$Z$ for N years starting this year with interest rate i. Thus its present value is
$$\$V = \$Z + \frac{\$Z}{i} + \cdots + \frac{\$Z}{i^N} = \$Z\left[\frac{1-(1+i)^{-N}}{i} + 1\right].$$
3) Perpetuity. It pays $\$Z$ forever starting next year with interest rate i. Thus its present value is
$$\$V = \frac{\$Z}{i} + \frac{\$Z}{i^2} + \cdots = \lim_{N\to\infty} \$Z\left[\frac{1-(1+i)^{-N}}{i}\right] = \frac{\$Z}{i}.$$
4) Delayed Annuity. It pays $\$Z$ for N years starting at year K with interest rate i. Thus its present value is
$$\$V = \$Z\left[\frac{1-(1+i)^{-N}}{i}\right]\frac{1}{(1+i)^K} = \$Z\left[\frac{1-(1+i)^{-N}}{i(1+i)^K}\right].$$
5) Delayed Perpetuity. It pays $\$Z$ for ever starting at year K with interest rate i. Thus its present value is
$$\$V = \frac{\$Z}{i}\frac{1}{(1+i)^K} = \frac{\$Z}{i(1+i)^K}.$$

POLICY/SHOCKS ON REAL INTEREST RATE

Recall that $\begin{cases} IS: Y = C + G + I(Y, r) \\ LM: \frac{M}{P} = Y \cdot L(i) \\ r = i - \pi^e \end{cases}$. Suppose $\pi^e \uparrow \Rightarrow r\downarrow \Rightarrow I\uparrow \Rightarrow IS$ shifts right $\Rightarrow AD$ shifts right.

BOND AND STOCKS

Bonds	Stocks
Issued by government or by private sector (debt financing).	Issued by private sector (equity financing).
Predetermined payment (face value, coupons).	Paid out of company profits (dividends), but a company can choose to retain earnings.

Bonds

From discounting, we know $P_{1,t} = \frac{\$Z}{1+i_{1,t}}$, $P_{2,t} = \frac{\$Z}{(1+i_{1,t})(1+i_{1,t+1})} = \frac{P_{1,t+1}}{1+i_{1,t}}$, etc. So, for stripped coupon bonds (no coupons), $P_{N,t} = \frac{\$Z}{(1+i_{1,t})(1+i^e_{1,t+1})\cdots(1+i^e_{1,t+N-1})} = \frac{P_{N-1,t+1}}{1+i_{1,t}} = \frac{P_{N-2,t+2}}{(1+i^e_{1,t+1})} = \cdots$.

Yield To Maturity

The yield is the annual interest rate $i_{N,t}$ that is constant for N years.

Thus for bonds,

$$\frac{\$Z}{\left(1+i_{1,t}\right)\cdots\left(1+i^e_{1,t+N-1}\right)}=\frac{\$Z}{\left(1+i_{N,t}\right)^N}\Rightarrow\left(1+i_{N,t}\right)^N=\left(1+i_{1,t}\right)\cdots\left(1+i^e_{1,t+N-1}\right)\Rightarrow i_{N,t}\approx\frac{1}{N}\left(i_{1,t}+\cdots 1+i^e_{1,t+N-1}\right).$$

Also note that $i_{N,t}=\left(\frac{\$Z}{P_{N,t}}\right)^{\frac{1}{N}}-1$.

We can draw a yield curve, plotting yield against time. From this yield curve, one can conclude the market's expectation of future interest rates.

Stocks

Ex-dividend price $\$Q=\frac{\$D^e_{t+1}}{1+i_{1,t}}+\frac{\$D^e_{t+2}}{\left(1+i_{1,t}\right)\left(1+i^e_{1,t+1}\right)}+\cdots+\frac{\$D^e_{t+N}}{\left(1+i_{1,t}\right)\cdots\left(1+i^e_{1,t+N-1}\right)}+\cdots$.

The fundamentals that affect stock prices are: current interest rate, expected interest rates, expected output.

Expectations and Consumption

Consumption Theories

1) Keynesian Consumption Theory: $C_t=c_0+c_1Y_t$ (no taxes).
2) Milton Friedman: Permanent Theory of Consumption.
3) Franco Modigliani: Life Cycle Theory of Consumption.
   Permanent Theory of Consumption and Life Cycle Theory of Consumption arise because consumption does not depend only on current income; consumers are forward-looking (foresighted).

PERMANENT INCOME THEORY

Assumptions

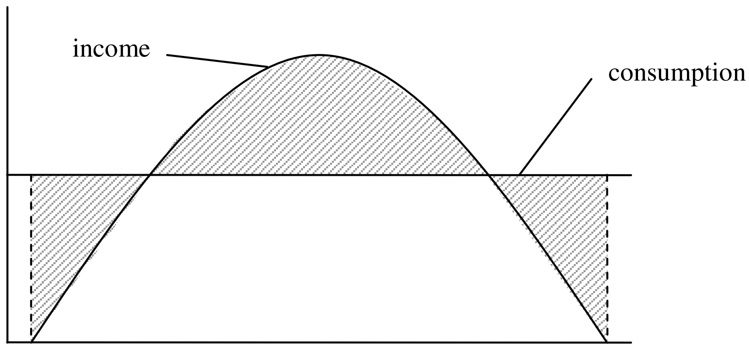
1) MPC out of permanent Y^P income is larger, closer to 1.
2) MPC out of transitory Y^T income is smaller, closer to 0.

Example

Suppose $\begin{cases} C_t=0.9Y_t^P \\ Y_t^P=\frac{1}{5}\left(Y_{t-2}+Y_{t-1}+Y_t+Y_{t+1}+Y_{t+2}\right)\end{cases}$. Then $C_t=0.18\left(Y_{t-2}+Y_{t-1}+Y_t+Y_{t+1}+Y_{t+2}\right)$ or

$C_t=\underbrace{0.18\left(Y_{t-2}+Y_{t-1}+Y^e_{t+1}+Y^e_{t+2}\right)}_{c_0}+\underbrace{0.18}_{c_1}Y_t$. Here, $MPC_P=0.9$ and $MPC_T=0.18$.

LIFE CYCLE THEORY



Assumptions
Consumption is a function of total wealth. $C_t = C(W_t)$.

Wealth consists of:

1) Human capital (expected present discounted value of lifetime after tax labour income).
2) Nonhuman capital (financial assets, physical assets).

Note
In reality, $C_t = C(W_t, Y_t - T_t)$.

Market Failure
Cannot use future assets as collateral!

Note
Sometimes, with higher income, one enjoys life more. $C_t = C(Y_t, Y^e, r_t, r^e, T_t, T^e)$.