Intermediate Macroeconomics Cheat Sheet

Credit 经12-计18 褚诗颖 2021011056

1 Introduction to Macroeconomics

- Growth Theory: determinants of long-run growth
- Monetary Theory: nomial prices and inflation
- Business-cycle Theory: short-run flunctuations
- International Macroeconomics: a country's international transactions

---

1. exogenous (外生): taken ✓, explained x, assumed ✓
   endogenous (内生): taken x, explained ✓, assumed x
2. short run: fixed capital/prices/technology, market in process of clearing
   long run: prices adjust, markets clear, capital accumulates, tech improves
3. stocks 存量: "wealth" at a date
   flows 流量: "income" within a year

---

4. GDP (Gross Domestic Product):
   某一既定时期一个国家内生产的所有最终物品和服务的市场价值.
   (the market value of all final goods and services newly produced within a fixed period of time in domestic soil)
   - ways of measurement
     - total sales to consumers / spending
     - sum of value added in the production
     - total income to everyone in the economy
   - $GDP_t = \sum_{i=1}^{N} P_t^i Q_t^i$
     impute 估算 price ✓, used goods x, inventory ✓
   - problems: underground economy x
     non-market activities x
     income but not wealth (flows)
     income is not welfare
   - financing doesn't matter
     GDP measures value created. Distribution comes later.
5. GNP (Gross National Product)
6. GDP per capita: Singapore > US > Australia > HK > Germany > UK > France > Taiwan > Japan >> China (~\$12,970, 2021).
   (~\$79,426)
7. Nomial GDP: $NGDP_t = \sum_{i=1}^{N} P_t^i Q_t^i$
   Real GDP: $RGDP_t = \sum_{i=1}^{N} P_b^i Q_t^i$ (based period)
   $NGDP_{Japan}^{dollar} = NGDP_{Japan}^{Yen} / E$ E: nomial exchange rate 单位: yen/dollar
   E ≠ purchasing power exchange rate
   - Purchasing-power parity (PPP) exchange rate
     $E^{PPP} = \frac{P_{Japan}}{P_{US}} \Rightarrow NGDP_{Japan}^{PPP} = NGDP_{Japan}^{yen} / E^{PPP}$
     衡量一国的生活成本

---

8 measure of inflation:
   - GDP deflator: $P_t = \frac{NGDP_t}{RGDP_t}$
   - consumer price index $(CPI_t) = \frac{\sum_{i=1}^{N} P_t^i Q_t^i}{\sum_{i=1}^{N} P_b^i Q_t^i}$
     x: sampling, substitution bias, new goods, quality adjust

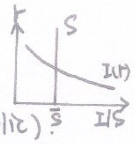
Taxes on consumption: $\begin{cases}(1+\tau_1)c_1 + s = y_1 \\ (1+\tau_2)c_2 = y_2 + (1+r)s\end{cases} \Rightarrow (1+\tau_1)c_1 + \frac{(1+\tau_2)c_2}{(1+r)} = w$ (B,C)

consumer problem: $\max_{c_1,c_2} \{\ln(c_1) + \beta \ln[(\frac{1+r}{1+\tau_2})(w-(1+\tau_1)c_1)]\}$

(FOC) $\frac{c_2}{c_1} = \beta(1+r)(\frac{1+\tau_1}{1+\tau_2})$ tax smoothing: $\tau_1 = \tau_2$ raise revenue without distorting timepath of consumption

2 GDP and Production Function

1. Breakdown of GDP
   - breakdown by sectors and value added (VA)
     agriculture ↘: industrialization
     manufacture ↗, service ↗↗: weightless economy
     GDP = VA agriculture, mining (primary)
     + VA manufacturing, construction (secondary)
     + VA services (tertiary).
     $Y = Y_{ag} + Y_{mfg} + Y_{ser}$
   - breakdown by income (poverty) (inequality)
     GDP = income to everyone in the economy
     GDP = capital income + labor income
   - breakdown by expenditure
     $Y = C + I + G + (X - M)$ X: export M: import
     $I = \underbrace{\underset{\text{private saving}}{(Y-C-T)} + \underset{\text{public saving}}{(T-G)}}_{\text{savings by domestic agents}} + \underbrace{\underset{\text{trade deficit}}{(M-X)}}_{\text{savings by foreigners}}$
2. Interest Rate Model
   asy1. closed economy: $Y = C+G+I$
   asy2. C = C(disposable income): $C = \bar{a} + \bar{b}(Y-T)$
   asy3. $I = I(r)$: $I = \bar{c} - \bar{d}r$
   asy4. Government exogenous. $G = \bar{G}$, $T = \bar{T}$
   asy5. fixed output: $Y = \bar{Y}$.
   $\Rightarrow \bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}$: $\bar{G}\uparrow \Rightarrow r\uparrow$
   $\bar{S} = (\bar{Y} - \bar{T} - \bar{C}) + (\bar{T} - \bar{G})$: $\bar{G}\uparrow \Rightarrow \bar{S}\downarrow$ (public)



   - Twin deficit (gov. budget deficit + trade deficit)

---

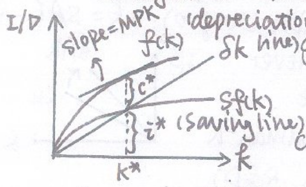
3. Production
   production function: $Y = AF(K,L)$ {asy1. seperated K, L; asy2. tech linear A}
   Cobb-Douglas constraints: $Y = AK^{\alpha}L^{1-\alpha}$ (constant RTS)
   profit-function: profit $= pY - wL - rK$
   Equilibrium: $(MPL = \frac{\partial Y}{\partial L}) = \frac{w}{p}$ (real wage).
   $(MPK = \frac{\partial Y}{\partial K}) = \frac{r}{p}$ (real rent).
   $Y = MPL \times L + MPK \times K$ + Economic Profit
   $= (1-\alpha)Y + \alpha Y$ + Economic Profit
   ⇒ labor income share = constant
   ⇒ no economic shares

3 Solow-Swan Growth Model (exogenous)

- Neoclassical production function
  1. constant RTS: $AF(\lambda K, \lambda L) = \lambda AF(K,L)$
  2. increasing and concave: $\frac{\partial F}{\partial K} > 0$, $\frac{\partial^2 F}{\partial K^2} < 0$; $\frac{\partial F}{\partial L} > 0$, $\frac{\partial^2 F}{\partial L^2} < 0$.
     (positive and diminishing return)
  3. Inada condition: $\lim_{K,L\to 0} \frac{\partial F}{\partial K} = \frac{\partial F}{\partial L} = \infty$, $\lim_{K,L\to\infty} \frac{\partial F}{\partial K} = \frac{\partial F}{\partial L} = 0$
  4. essentiality: $F(0,L) = F(K,0) = 0$
- Solow-Swan Model
  1. neoclassical production function: $y = f(k)$
  2. closed economy, no government: $y = c + i$
  3. capital stock accounting: $I = \Delta K + \delta K$, $i = \Delta k + \delta k$
  4. consumption function: $i = sy$, $c = (1-s)y$

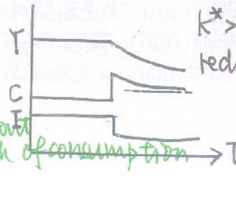
Fundamental Equation: $\Delta k = sf(k) - \delta k$

steady state: $\Delta k = 0 \Rightarrow k^* = (\frac{As}{\delta})^{\frac{1}{1-\alpha}}$ $(y = Ak^{\alpha})$.

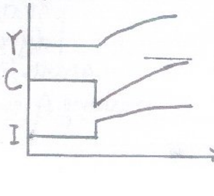


growth rate $\frac{\Delta k}{k} = sAk^{\alpha-1} - \delta$
(smaller k, larger growth)
⇒ unconditional convergence
conditional convergence:
控制其它变量, 同类型国家同k*

k_{gold}: the Golden Rule level of capital maximizing c
$c^* = f(k^*) - \delta k^*$ (steady state economy).
$\Leftrightarrow MPK = \delta \Leftrightarrow k_{gold}^*$



$k^* > k^*_{gold}$
reduce s

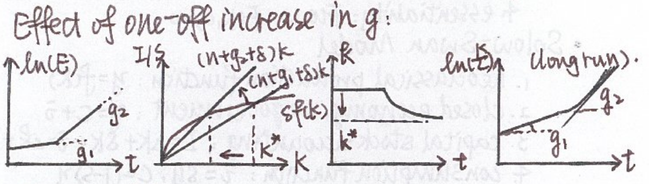


$k^* < k^*_{gold}$
increase s

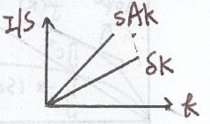
- foreign aid
  "one-off": k↑, no effect in the long run
  "sustained": s↑, convergence to higher steady state
- add population growth ($\frac{\Delta L}{L}=n$)
  Fundamental Equation : $\Delta k = sf(k)-(\delta+n)k$
  (proof): $\frac{dk}{k}=d(\ln k)=d(\ln\frac{K}{L})=d\ln K - d\ln L=\frac{dK}{K}-\frac{dL}{L}$
  $\therefore dk=\frac{dK}{K/k}-\frac{dL}{L}\cdot k=\frac{dK}{L}-nk=\frac{I-\delta K}{L}-nk=i-(\delta+n)k$
  Equilibrium : $i^*=\delta k^*+nk^*$ (*) n↑ → y↓ ?
  Golden Rule : $MPK=\delta+n$ · causality ? · no long run effect (A)
- Growth Accounting
  $Y=AK^{\alpha}L^{1-\alpha} \Rightarrow \frac{\Delta Y}{Y}=\frac{\Delta A}{A}+\alpha\frac{\Delta K}{K}+(1-\alpha)\frac{\Delta L}{L}$ (primal)
  output growth, solow residual, Capital, Labor
  TFP / Total Factor Productivity
  考虑 $Y=AK^{\alpha_K}L^{\alpha_L}$
  primal: $\frac{dY}{Y}=\alpha_K\frac{dK}{K}+\alpha_L\frac{dL}{L}+\frac{dA}{A}$
  - Growth 'Miracle' of Asian Tigers
    主要由其它因素趋动. TFP unremarkable
    Krugman : not sustainable
    Hsieh: mismeasurement in national account
    $\Rightarrow Y=rK+wL$
    $dY=d(rK)+d(wL)$
    $=rdK+Kdr+wdL+Ldw$
    $=rK\frac{dK}{K}+rK\frac{dr}{r}+wL\frac{dL}{L}+wL\frac{dw}{w}$
    $\therefore \frac{dY}{Y}=\frac{rK}{Y}(\frac{dK}{K}+\frac{dr}{r})+\frac{wL}{Y}(\frac{dL}{L}+\frac{dw}{w})$
    $\frac{\Delta Y}{Y}=\alpha(\frac{dK}{K}+\frac{dr}{r})+(1-\alpha)(\frac{dL}{L}+\frac{dw}{w})$
    $\therefore \frac{\Delta A}{A}=\frac{\Delta Y}{Y}-\alpha\frac{\Delta K}{K}-(1-\alpha)\frac{\Delta L}{L}$
    $=\alpha\frac{\Delta r}{r}+(1-\alpha)\frac{\Delta w}{w}$ (dual approach)
    (dual TFP is higher for them than primal TFP).
    dual : $Y=rK+wL+\Pi$
    $\frac{dY}{Y}=\alpha_K(\frac{dK}{K}+\frac{dr}{r})+\alpha_L(\frac{dL}{L}+\frac{dw}{w})+\frac{d\Pi}{\Pi}\cdot\Pi(1-\alpha_K-\alpha_L)$

4 Endogenous Growth Model

1. Labor-augmenting Extension of Solow-Swan Model
   $Y=AF(K,L)=F(K,EL)$.
   $=AK^{\alpha}L^{1-\alpha}=K^{\alpha}(EL)^{1-\alpha}$, where $A=E^{1-\alpha}$
   E: efficiency of labor
   $\begin{cases} g=\frac{\Delta E}{E}, \text{ where } (1-\alpha)\frac{\Delta E}{E}=\frac{\Delta A}{A} \\ n=\frac{\Delta L}{L},\ y=\frac{Y}{EL},\ k=\frac{K}{EL},\ y=f(k)=Ak^{\alpha}=E^{1-\alpha}k^{\alpha}\end{cases}$
   Fundamental Equation: $\Delta k=sf(k)-(\delta+n+g)k$
   Steady state : $\frac{K}{EL}, \frac{Y}{EL}$ = constant
   $\frac{K}{L}, \frac{Y}{L}$: grow at rate g
   K, Y : grow at rate (g+n)
   Effect of one-off increase in g:

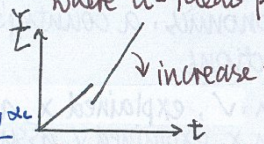


2. AK model
   production function (α=1) : $Y=AK$
   Fundamental Equation (n=g=0): $\Delta k=sAk-\delta k$
   · $sA>\delta$: growth forever
   · no steady state
   · interpret L as human-K



   A = h(ideas, patents, R&D)
   ↳ non-rival, excludable, fixed costs
   small MC, high FC, excludability ⇒ 垄断
   ↳ patents pitfall :
   { static inefficiency 消费者福利↓
   { dynamic inefficiency 其它人创新↓
   grants / prizes, altruism, 先发者优势…?
   … making A endogenous

3. Two-sector model
   production of goods : $Y=K^{\alpha}[(1-u)EL]^{1-\alpha}$
   accumulation of ideas : $\Delta E=g(u)E$
   accumulation of capital : $\Delta K=sY-\delta K$
   Fundamental Equation :
   $\frac{\Delta k}{k}=sk^{\alpha-1}(1-u)^{1-\alpha}-\delta-g(u)$, where $k=\frac{K}{EL}$
   (proof) : $\frac{\Delta k}{k}=\frac{\Delta K}{K}-\frac{\Delta E}{E}-\frac{\Delta L}{L}=\frac{sY-\delta K}{K}-g(u)$
   where u = ideas production, 1-u = goods production



   A = h(… , institutions)
   (1) luck / multiple equilibria
   chaos (蝴蝶效应) ; coordination failure (协同时开始?) ; great man (leader) ; poverty trap
   (2) culture and growth
   individualist > collectivist culture
   (3) geography and growth
   disease burden ; landlocked, natural resources
   (4) institutions and growth
   property rights, legal system, corruption, entry barriers, democracy, electoral rules.
   - Colonization : natural experiment
     - reversal of fortune
       higher urbanization ⇒ worse institution (property protection)
       ⇒ lower growth rate

5. Unemployment

H: total hours worked
E: number of people employed
U: number of people unemployed
L: people in the labor force (L=E+U)
N: population

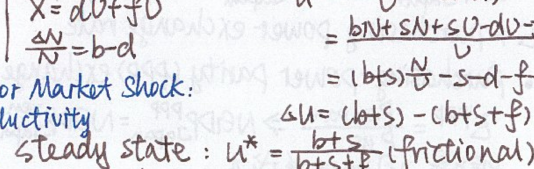
$\frac{H}{N}=(\frac{H}{E})\times(1-\frac{U}{L})\times(\frac{L}{N})$

hours worked per capita, hours worked per workers, unemployment rate (i.e. u), participation rate ↓ { incarceration ↑, demographics 老龄, longer education

$U=(U-U^N)+U^F+U^S$ { minimum wage, union, efficiency wage.

frictional + structural = U^N (cyclical).

- Job Search Model



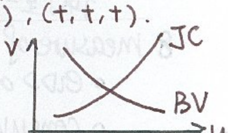
I: entry
X: exit
$u=\frac{U}{N}$

(1/f : expected duration of unemployment).

$\begin{cases}\Delta U=I-X \\ I=bN+S(N-U) \\ X=dU+fU \\ \frac{\Delta N}{N}=b-d\end{cases} \Rightarrow \frac{\Delta u}{u}:=\frac{\Delta U}{U}-\frac{\Delta N}{N}$ (definition)

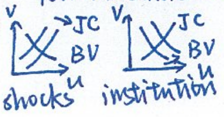
$\frac{\Delta u}{u}=\frac{I-X}{U}-(b-d)$
$=\frac{bN+SN+SU-dU-fU}{U}-b+d$
$=(b+s)\frac{N}{U}-s-d-f-b+d$
$\Delta u=(b+s)-(b+s+f)u$

steady state : $u^*=\frac{b+s}{b+s+f}$ (frictional).
cyclical changes : $f=f(v,i,m)$, (+, +, +).
{ v: vacancies
{ i: intensity of search
{ m: ease of matching



BV: Beveridge Curve (v越大u越小).
JC: Job Creation Curve (u越大v越大).
u↑ → w↓ → 增加v (return to firm f).
shift to the right : productivity↓, union power↑

European Labor Market Shock:
1. Fall in productivity
   lower MPL
   ⇒ JC right
2. institutions :
   generous unemployment insurance :
   BV right
   employment protection : s↓, f↓
   lower vacancies : JC right

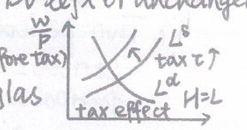


⇒ JC back
⇒ BV back

- Recent U.S. looks like Europe

share of long-term unemployment ↑ ⇒ $i\downarrow, m\downarrow$ ⇒ BV right
efficiency of matching (across industry + migration) ↓ ⇒ $m\downarrow$
participation margin ↓↑ ⇒ $d\uparrow$ $(b\downarrow)$ ⇒ BV left or unchanged
part-time jobs ↑↓

- Hours worked versus output (don't consider unemployment)



Asy.1. neoclassical firms with Cobb-Douglas production functions:
(labor demand) $MPL=\frac{w}{p} \Leftrightarrow (1-\alpha)\frac{Y}{L}=\frac{w}{p}$

tax rate τ
Labor: L
Y: output per person
H: hours worked

Asy.2. representative household choosing hours:
100 hours every week, H for work
$\max_{C,H} U(C,100-H)$ s.t. $pC=(1-\tau)wH$

Asy 3. particular utility function: $U(C,100-H)=\ln C+\theta\ln(100-H)$

Asy4. in equilibrium: $L=H$ hours (total endowment)
output per hour worked
(FOC) $\frac{\theta C}{(1-\tau)(100-H)}=\frac{w}{p}=(1-\alpha)\frac{Y}{H}$, thus $H=\frac{100(1-\alpha)}{1-\alpha+(\frac{C}{Y})(\frac{\theta}{1-\tau})}$

(counter example: Scandinavians: tax used for employment)

6 Money and Inflation

1. Money: unit of account, medium of exchange, store of value
(stage): barter ⇒ commodity money ⇒ fiat money
composition: currency (C) + demand deposits (M_1) checkable deposits
+ savings deposits (M_2) money market / time deposits

$$1+\mu_t=\frac{M_t}{M_{t-1}} \leftarrow \text{nomial money supply}$$

μ_t: growth rate of money

2. Inflation

$$1+\pi_t=\frac{P_t}{P_{t-1}}$$

π_t: net inflation, P_t: price level

- cost of expected inflation (4): shoe leather cost, menu cost, inefficient relative-price variability, harder finance plan
- cost of unexpected inflation (2): arbitrary redistribution (debtors / lendors) hurts people on fixed nomial pensions

3. Fundamental Model

Identity: $M_tV_t=P_tT_t$ (V_t: velocity, T_t: transaction)
$\Rightarrow M_tV_t=P_tY_t$ (asy.1 $T_t=Y_t$: ignore 2nd hand sales)
Quantity theory of money: $(\frac{M_t}{P_t})^d=kY_t$ (asy.2 $V_t=\frac{1}{k}=const$)
Money Supply. $M_t^s \xrightarrow{Equ.} M_t^s=M_t^D \Rightarrow P_t=\frac{M_t^s}{kY_t}$ (money neutrality)
(Y_t determined by C, L, productivity) ↖ M_t^s 只影响 P_t
$\Rightarrow MV=PV \Rightarrow \frac{\Delta M}{M}+\frac{\Delta V}{V}=\frac{\Delta P}{P}+\frac{\Delta Y}{Y} \Rightarrow \mu=\pi+g$ (asy.3 g independent of μ; V stable)
(when $g=0$ ⇒ money super-neutrality)

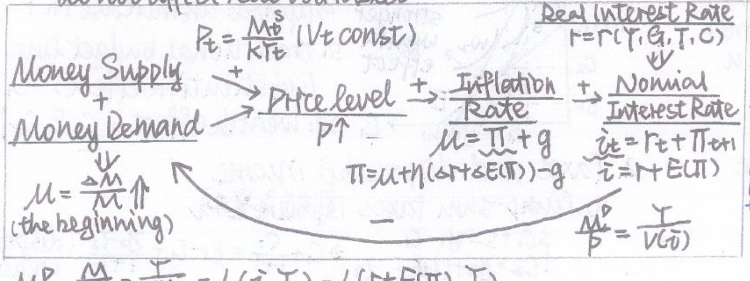
4. unstable velocity

$V=V(i)$ i: nomial interest rate
⇒ $MV(i)=PY$, where $i\uparrow \Rightarrow V(i)\uparrow$

$i=\frac{y}{x}-1$
$r=(\frac{y}{P_{t+1}})/(\frac{x}{P_t})-1$
r: real interest rate

Fisher equation: $1+i_t=(1+r_t)(1+\pi_{t+1}) \Rightarrow i_t\approx r_t+\pi_{t+1}$

古典二分法 (*) classical dichotomy: Separate matters. Nomial changes do not affect real variables



M^D: $\frac{M}{P}=\frac{Y}{V(\underset{+}{i})}=L(\underset{-}{i},\underset{+}{Y})=L(\underset{-}{r+E(\pi)},\underset{+}{Y})$

if expected money growth $\mu\uparrow \Rightarrow E(\pi)\uparrow \Rightarrow i\uparrow \Rightarrow P\uparrow, \pi\uparrow$

higher Y, need more money for transactions
higher i, opportunity cost for holding money ↑, $V(i)\uparrow$
higher $V(i)$, less demand for Money ($M^D\downarrow$)

5. Hyper inflation

interest rate semi-elasticity of money demand:

$\eta=\frac{\Delta V}{V\Delta i} \Rightarrow \frac{\Delta V}{V}=\eta(\Delta r+\Delta E(\pi))$
because: $\frac{\Delta M}{M}+\frac{\Delta V}{V}=\frac{\Delta P}{P}+\frac{\Delta Y}{Y}$
we have: $\mu+\eta(\Delta r+\Delta E(\pi))=\pi+g$
$\therefore \pi=\mu+\eta(\Delta r+\Delta E(\pi))-g$

To end it: (1) cut money growth (μ) (2) lower $E(\pi)$
Reasons: (fiscal causes) $G=T+\Delta D+\Delta M$
⇒ taxes, raise debt, print money
seigniorage (inflation tax)

6. Money (deeper)

$M=C+D$ (checking deposits)
Banks: { 100-percent-reserve
fractional-reserve
(leverage $=\frac{asset}{capital}=\frac{A}{E}$)

A (R)	L+E
Reserves	Deposits (D)
Loans	Debt
Securities	Capital (E)

Money base: $B=C+R$ (central bank)
Reserve-deposit ratio: $rr=\frac{R}{D}$ (regulations & policy)
Currency-deposit ratio: $cr=\frac{C}{D}$ (household preference)
$M=C+D=\frac{C+D}{B}\times B=m\times B$
where money multiplier $m=\frac{C+D}{B}=\frac{C+D}{C+R}=\frac{C/D+1}{C/D+R/D}=\frac{cr+1}{cr+rr}$
(if $rr<1 \Rightarrow m>1$, $\Delta M=m\times\Delta B$)

Monetary Policy

- (open market operations)

1. buy government bonds ⇒ B↑
2. lower discount rate ⇒ bank borrow reserves
3. reserve requirement ↓ ⇒ rr↓ (✗ when excess reserve)

repo: lower r
reverse repo: r↑

interest on reserves (Fed pays to banks) ↓ ⇒ rr↓

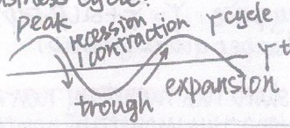
(*) 银行在Fed存款的利率 i^r < 联邦基金利率 $\bar{i}$ Federal fund rate < Fed对银行放贷利率
(Fed通过调节前后两者，来控制联邦基金利率 (r)).
(2008: $\bar{i}=i^r$)

QE (Quantitative Easing)
- Fed buy long-term gov. bonds ⇒ long-term rate ↓
- Fed buy MBS ⇒ help housing market

(*) pin down π by setting $\bar{i}$ ($\bar{i}=r+E(\pi)$).

7 Short Run Aggregate Demand (IS-LM) ← static model

Business Cycle:



Okun's law:
$\%\Delta RGDP=3.5\%-2\times\Delta u$
co-movement factor: consumption, investment

1. The IS-LM Model

animal spirit / mpc (marginal propensity to consume)

→ IS curve: $Y=C+I+G=\underline{a}+b(Y-T)+\underline{c}-dr+G$

Goods market (fiscal expansion)

Assumptions: 1. closed economy
2. consumption depends on disposable income
3. investment depends on interest rate
4. government exogenous: $\bar{G}, \bar{T}$

government-purchase multiplier: $\Delta Y=\frac{1}{1-b}\Delta G$
tax multiplier: $\Delta Y=-\frac{b}{1-b}\Delta T$
budget-balencing multiplier: $\Delta G=\Delta T \Rightarrow \Delta Y=\Delta G$

balance-budget multiplier = 1

interpretation: $r\uparrow \Rightarrow I\downarrow, Y\downarrow$
or: $r=-\frac{1-b}{d}Y+\frac{1}{d}(a+c+G-bT)$

steeper:
$d\downarrow$: I(r) inelastic
$b\downarrow$: MPC↓

thus, Y↑ ⇒ more savings, fund supply ↑ ⇒ r↓

LM curve: $\frac{M}{P}=L(Y,r+E(\pi))=Y-k(r+E(\pi))$.

money market (monetary expansion)

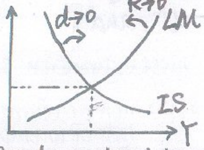
Assumptions: 1. Quantity Theory: $MV=PY$
2. Velocity increases with i: $V=V(\overset{+}{i})$
3. money supply exogenous: $M=\bar{M}$
4. Fisher equation, constant π: $i=r+E(\pi)$

interpretation: $\Delta r=-\frac{1}{k}\frac{\Delta M}{P}$, M↑ ⇒ supply↑, demand↑ ⇒ r↓
or: $r=\frac{1}{k}Y-E(\pi)-\frac{1}{k}\frac{M}{P}$

flatter:
k↑: money demand very sensitive to interest rates, not very to income

thus, Y↑ ⇒ money demand↑ ⇒ r↑ (demand-fixed)

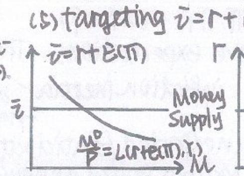
2. IS-LM Anaylisis



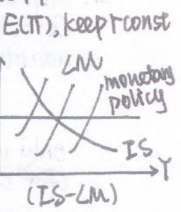
(1) G↑, IS→, crowding out, $\Delta Y=\frac{\Delta G}{1-MPC}$
(2) T↓, IS→, $\Delta Y=\Delta T\times\frac{MPC}{1-MPC}$
(3) $\Delta G=\Delta T$: IS→, $\Delta Y=\Delta G$
(4) M↑, LM→, r↓ and Y↑
(5) targeting $\bar{i}=r+E(\pi)$, keep r const

(6) fiscal-monetary interaction (T↑, shift IS left)
- contract M^s ⇒ LM left ⇒ keep r constant
- expand M^s ⇒ LM right ⇒ keep Y constant

(7) animal spirit
$a\downarrow, c\downarrow \Rightarrow IS\downarrow \Rightarrow r\downarrow, Y\downarrow$



(Money Market)



(IS-LM)

(*) $\frac{\Delta Y/\Delta G}{\Delta Y/\Delta M}=\frac{Pk}{d}$ (k>d: fiscal powerful; k<d: monetary powerful)

3. Mathmatic Analysis

$$Y=\frac{1}{1-\bar{b}+\bar{d}/\bar{k}}[G-\bar{b}T+\frac{\bar{d}}{\bar{k}}\frac{M}{P}+a+c+\bar{d}E(\bar{\pi})]$$

fluctuation ⇒ $\Delta Y=\frac{1}{1-\bar{b}+\bar{d}/\bar{k}}\Delta G$, $\Delta Y=\frac{\bar{d}/\bar{k}}{1-\bar{b}+\bar{d}/\bar{k}}\frac{\Delta M}{P}$

fluctuation due to animal spirit (a, c)
fluctuation due to ΔM

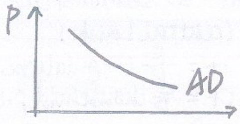
Fiscalists (Keynes, Krugman)	v.s. Monetarists (Friedman)
(1) k is high (liquidity trap) LM flat, ΔM no use	(1) k→0 (M^D inelastic of r) LM vertical, fiscal no use, ΔM++
(2) d→0, I(r) not sensitive IS vertical, ΔM no use	(2) d is high (durables depends negatively on r), IS horizontal

4. Aggregate Demand

IS-LM: two equations with 3 variables (Y, r, P)

$\Rightarrow$ eliminate r and get $P=P(Y)$, the demand curve

$P\uparrow \Rightarrow LM\leftarrow \Rightarrow Y\downarrow$, thus $P=P(\underline{Y})$



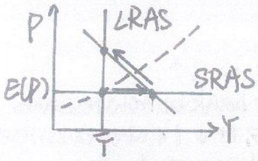
* the AD curve is mainly derived from LM curve

1928/29: fall in a, c, fall in M
(reversal of optimism) (Fed's tightening)

worsen: $G\downarrow, T\uparrow, E(\pi)\downarrow, M\downarrow$

recover: $G\uparrow, M\uparrow$

8 Aggregate Supply, Phillips Curve



short run: $M\uparrow \Rightarrow \bar{P}, Y\uparrow$

long run: $M\uparrow \Rightarrow P\uparrow, \bar{Y}$

compromised model: $\Rightarrow Y=\bar{Y}+\alpha(P-E(P)), \alpha>0$

observing higher price of goods, firm does not know if higher relative price or not

- Nominal Rigidity { menu costs, long-term relations / costs of searching suppliers, imperfect

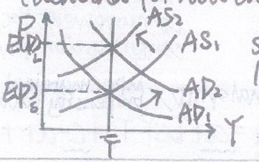
{ (fraction s) sticky price firm: $P_1 = Ep^* = E(p)$
(fraction 1-s) flexible price firm: $P_2 = p^* = p+\bar{z}(Y-\bar{Y})$
, where p^* = desired price

Adding up, $P = sE(p)+(1-s)[p+\bar{z}(\bar{Y}-Y)]$
$= E(p)+[\frac{1-s}{s}\bar{z}](\bar{Y}-Y)$

solve for Y: $Y=\bar{Y}+[\frac{s}{(1-s)\bar{z}}](P-E(P))$.

interpretation: higher $\pi \Rightarrow s\downarrow \Rightarrow$ steeper AS → LARS

- Consequence of sticky price: output $Y\uparrow$
(demand for now cheaper goods goes up)



short-run monetary non-neutrality
long-run monetary neutrality

optimal public debt management:
1. constant tax rate
2. use surpluses and deficits to smooth out shocks

application:
- financing a war
- over the business cycle (有价值资料)

× balanced budget!

⇓

① countercyclical stabilization policy ② optimal public debt management

---

1. Phillips curve: re-express AS in terms of π, u

u^n: natural rate of unemployment

$Y=\bar{Y}+\alpha(P-E(P))$

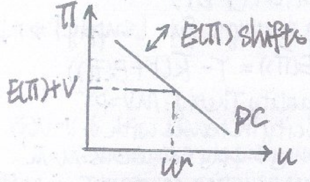
step1. $Y=\bar{Y}+\alpha P_{-1}(\frac{P-P_{-1}}{P_{-1}}-\frac{E(P)-P_{-1}}{P_{-1}})$, $\pi=\frac{P-P_{-1}}{P_{-1}}$, $E(\pi)=\frac{E(P)-P_{-1}}{P_{-1}}$

step2. $Y-\bar{Y}=\alpha P_{-1}(\pi-E(\pi)-v)$, v: supply shock

step3. $-r(u-u^n)=\alpha P_{-1}(\pi-E(\pi)-v)$, Okun's law: $Y-\bar{Y}=-r(u+u^n)$

$\Rightarrow \pi = E(\pi)-\beta(u-u^n)+v$, define $\beta=\frac{r}{\alpha P_{-1}}$

expected inflation cyclical unemployment supply shock



E(π) shifts PC

- AD recession shock
⇒ move along PC
(demand-driven business cycle)
- if policymakers perfectly controls
PC: tradeoff between π and u

In reality: no Phillips Curve!
(both high u and π: stagflation)

- Sacrifice ratio: extra unemployment needed to be tolerated to lower inflation by 1%.
⇒ calc each period's $u-u^n$, and add them up
$=\frac{1}{\Delta\pi}\sum_{t=1}^{T}(u_t-u_t^n)$ most estimation 2.5 (but 1.64...)

2. Expectation matters

NAIRU: non-accelerating inflation rate of unemployment

$Corr(\pi, \pi_{-1}) \sim (0.7, 0.9)$

adaptive expectations: $\pi=\pi_{-1}-\beta(u-u^n)+v$

inflation inertia demand-push inflation NAIRU cost-push inflation

only unexpected/anticipated policy takes effect
(for credible policy announcement, sacrifice ratio = 0)

{ announcements: managing expectations
policy rules: avoid mis-directing agents

- The Taylor Rule: $i_t = 2\% + \pi_t + 0.5(\pi_t - 2\%) + 0.5(Y_t - \bar{Y}_t)$

nominal interest rate, set by central bank natural real interest rate central bank's inflation target

on the FIRST PAGE!!!

Suppose private consumption: $C=a+b(Y-T)$, a = autonomous consumption, holding fixed real interest rate: $\Delta Y=\Delta a+b(\Delta Y)$ (recall: $\Delta Y=\Delta C=\Delta a+b\Delta Y$)
$\Rightarrow \Delta Y=\frac{\Delta a}{1-b}$, $S=Y-C-T=Y-a-b(Y-T)-T=(1-b)(Y-T)-a$. thus $\Delta S=0$.
equilibrium income↓ and Saving — when a↓ (Y−T↓ disposable income, a↓ animal spirit).

9 Fiscal Policy and Consumption

consumption model so far: (Keynesian consumption f)

{ $C=(1-s)Y$, Solow-Swan Model
$C=a+b(Y-T)$, IS-LM Model

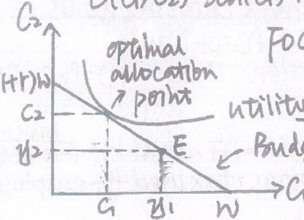
1. Two-period Consumption decision

period 1: $C_1+S=y_1$
period 2: $C_2=y_2+(1+r)S$ $\Rightarrow C_1+\frac{C_2}{1+r}=y_1+\frac{y_2}{1+r}=w$ (wealth)
(Budget Constraint)

utility function:

$U(C_1,C_2)=\ln(C_1)+\beta\ln(C_2)$, $0\le\beta\le1$: impatience

FOC: $\frac{C_2}{\beta C_1}=1+r$, or $\frac{C_2}{C_1}=\beta(1+r)$ (Euler Equation)



utility indifference curve

Budget Constraint: slop = −(1+r)

mathmatically solve:

$\max_{C_1,C_2} U(C_1,C_2)=\ln(C_1)+\beta\ln(C_2)$. s.t. $C_1+\frac{C_2}{1+r}=w$

FOC (Euler equation): $\frac{C_2}{C_1}=\beta(1+r)$

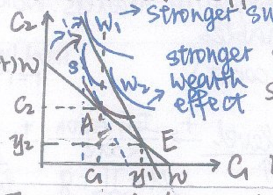
Solution: $\begin{cases} C_1=\frac{w}{1+\beta} \\ C_2=\frac{\beta(1+r)w}{(1+\beta)} \end{cases}$

- Friedman's permanent income hypothesis:
consumption each period is a fraction of wealth

1. consumption at each period depends on current income ONLY when it affects wealth
(small MPC for temporary bonus, large MPC for permanent wage increase)
2. life-cycle hypothesis: consumers smooth consumption relative to their life-time income path
3. Ricardian Equivalence: changing only the path of taxes without a spending change should not affect consumption (0 MPC for tax cuts without current or expected future spending cuts).

- Lessons from the solution
1. Wealth, not income, determines consumption
2. patience and interest rates, not income or wealth, determine consumption growth $(\frac{C_2}{C_1})$.

- Substitution Effect and Wealth Effect



suppose an increase in r (saver)

S: transitional budget line (substitution effect) $C_1\downarrow C_2\uparrow$

W: wealth effect: $C_1 ? C_2\uparrow$

---

2. Taxes and disposable income

(1) lump-sum taxes 固额总量税.

{ $C_1+S=y_1-T_1$
$C_2=y_2+(1+r)S-T_2$ $\Rightarrow C_1+\frac{C_2}{1+r}=y_1-T_1+\frac{y_2-T_2}{1+r}$ (disposable wealth)

Ricardian: the path of T_1 and T_2 is irrelevant

(2) Government (b = borrowing, g_t = government spending)

{ $g_1=T_1+b$
$g_2+(1+r)b=T_2$ $\Rightarrow T_1+\frac{T_2}{1+r}=g_1+\frac{g_2}{1+r}$

⇒ tax changes, deficits and debt issues are neutral

⇒ Government bonds are NOT net wealth

(3) controversial:

① 后代高税跟我没关 ② can't borrow today following tax increase against tax cut tomorrow
③ taxes 扭曲工作激励 (distort) ④ uncertainty of future

— in reality: bad prediction

(*) borrowing constraint (S<0?)
slavery is banned! individual bankruptcy!.

3. Financing War $\boxed{\text{public deficit}}$ = Total spending − tax revenues

Total government spending = (C+I) + social transfers + Interest

$\boxed{\text{public debt}}$ = debt last period + deficit; $\boxed{\text{primary deficit}}$ = deficit − interest pmt