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MACROECONOMIC PRINCIPLES

LENT TERM

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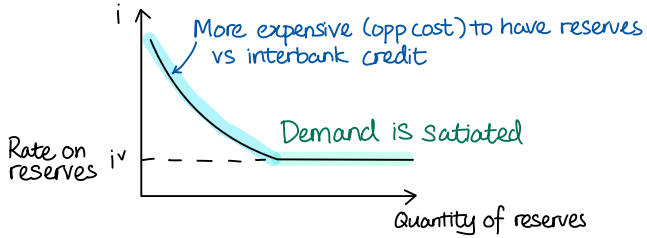
MONPOL BASICS

INFLATION $\pi_t = \frac{P_t}{P_{t-1}} \approx \Delta \log(P_t)$

- Change in price level
- Loss of real value of the unit of account

RESERVE Deposit of banks at CB

- Can only be held at banks recognised by CB
- Can only be issued by CB
- Short term (overnight) as it's just used by banks to settle claims
- Free of default (CB can issue more)



Demand for reserves

Interbank credit (pays i) is imperfect sub for reserves

FRIEDMAN RULE $i - i^v = 0$ is optimal (opp cost of reserves)

- Since CB issues reserves at 0 MC, private opp cost of reserves $i - i^v = 0$ too
- In reality, gov may tax reserves: $i = i^v + t$

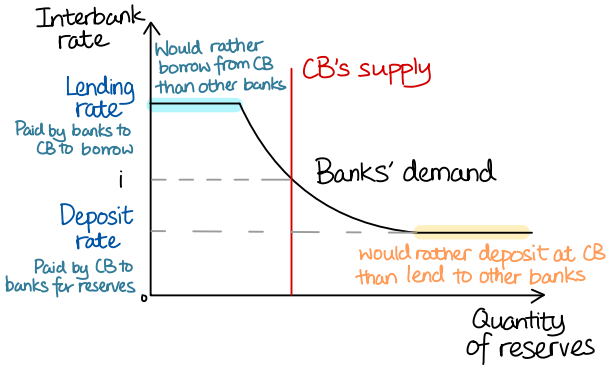
INTERBANK MARKET

bank rate, Federal Funds rate, EONIA

Interbank rate i (assume overnight, safe, nominal)

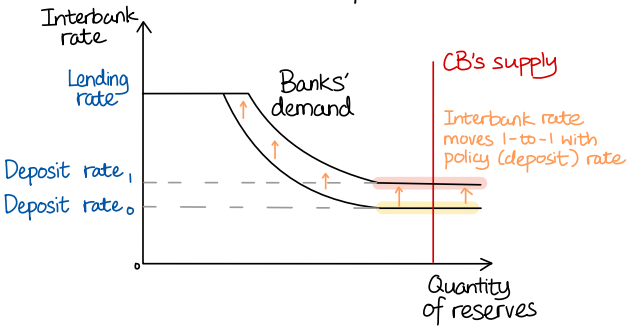
$\uparrow i \Rightarrow \downarrow$ deposit at CB (should lend for profit instead!)

Banks choose reserves supply and lending/deposit rate

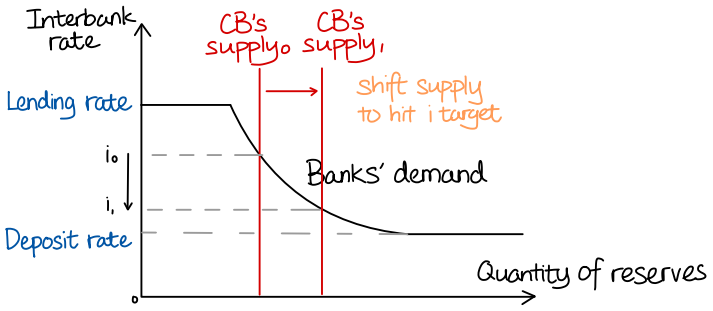


FLOOR SYSTEM Reserve satiation $i = i^v$,

- deposit rate is policy rate
- Current system
- More stable but lose info on banks' demand (but is the info useful?)



CORRIDOR SYSTEM Open-market operation (pre-2009)



Pros and cons of floor vs corridor: PS1

NOMINAL RETURN Nominal net RoI, $i = \frac{y}{x} - 1$ (get next year / give today)

REAL RETURN $ret = \frac{y/P_{t+1}}{x/P_t} - 1$ (get next yr (in units of goods!) / give today)

A nominal bond (give 1 today, get $1+i$ next year) will get, in real terms, $1+ret$ next year

	Simple/Nominal bond	Real bond
Give	1	1
Receive (nominal)	$1+i$	$(1+r)(1+\pi)$
Receive (Real)	$1+ret = (1+i)\left(\frac{1}{1+\pi}\right)$	$1+r$

$$1+ret = \left(\frac{y}{x}\right)\left(\frac{P_t}{P_{t+1}}\right) = (1+i)\left(\frac{P_t}{P_{t+1}}\right) = (1+i)\left(\frac{1}{1+\pi}\right)$$

NO ARBITRAGE

Expected real returns of real and nominal bonds must be equal. $1+r = 1+ret^e = (1+i)\left(\frac{1}{1+\pi^e}\right)$

- If $ret^e > r$, $dd_{nom\ bond} = \infty$, $dd_{real\ bond} = 0$
- $1+r = \frac{1+i}{1+\pi^e}$ —take logs, assume small→ $\pi^e = i - r$ (you can use differentiation to find exact rel too!)
- Nominal rate (i) = Real rate (r) + Expected inflation (π^e) (Fisher equation) ✱ relationships linearised due to approximation formula

LONG RUN MONPOL

Long run: $\pi^e = \bar{\pi}$ (LR inflation)

can't fool people all the time!

We know $\bar{r} = MPK$, so LR inflation $\bar{\pi}$ is determined (perfectly) by LR nominal interest rate CB sets

$\bar{\pi} = \bar{i} - \bar{r}$

2% 4% 2%

but MPK has been falling lately...

SHORT TERM MONPOL

TAYLOR RULE $i = \bar{r} + \bar{\pi} + \chi(\pi - \bar{\pi}) + \hat{i}$

(LR setting: $\bar{r} + \bar{\pi}$; deg of response to SR π: χ; i response to $\pi - \bar{\pi}$ (CB chooses))

- $\uparrow i$ when inflation above target $(\pi - \bar{\pi})$
  - So this differs from LR interest rate
- $\hat{i}$: Discretionary policy "shock" (LR $E(\hat{i}) = 0$)

EXPECTED INFLATION $\pi^e = \bar{\pi} + \pi^{as}$ (π^{as}: deviation due to animal spirits)

- SR expectations may deviate from target
  - In LR, $\pi^e = \bar{\pi}$.

PHILIPS CURVE $r = \bar{r} - \alpha(\pi - \pi^e) + \hat{r}$ (α: strength of)

Higher $i \rightarrow \downarrow C$ and I today $\rightarrow \downarrow$ firms' prices $\rightarrow \downarrow \pi$

$$\bar{r} + \bar{\pi} + \chi(\pi - \bar{\pi}) + \hat{i} = i = r + \pi^e = \bar{r} - \alpha(\pi - \pi^e) + \hat{r} + \bar{\pi} + \pi^{as}$$

(Taylor = Fisher = Philips)

$$\chi(\pi - \bar{\pi}) + \hat{i} = -\alpha(\pi - \bar{\pi} - \pi^{as}) + \hat{r} + \pi^{as}$$

$$(\chi + \alpha)(\pi - \bar{\pi}) = \hat{r} - \hat{i} + (1 + \alpha)\pi^{as}$$

$$\pi = \bar{\pi} + \frac{\hat{r} - \hat{i}}{\chi + \alpha} + \left(\frac{1 + \alpha}{\chi + \alpha}\right)\pi^{as}$$

- Consistent with $\pi = \bar{\pi}$ in LR ($\hat{i} = \hat{r} = \pi^{as} = 0$)
- A policy tightening $\uparrow \hat{i}$, in the sense of discretionary deviation from the rule, $\downarrow \pi$ in SR
- CB doesn't know and need to forecast $\hat{r}$, then use $\hat{i}$ to offset
- CB chooses $\chi > 1$ s.t. animal spirits get attenuated and $\pi \rightarrow \bar{\pi}$ (Taylor principle)
  - Otherwise spirits will be enhanced by policy, justifying them, causing instability

YIELD CURVE

BONDS

Focus on government (no default) zero-coupon (no intermed. payment) n-year bonds

Pay $q_t^{(n)}$ today, get £1 in n years

Return: $\frac{1}{q_t^{(n)}}$

YIELD TO MATURITY

Constant annual interest rate that equals return on the bond

$1 + i_t = \frac{1}{q_t^{(1)}}$, so $(1 + i_t^{(n)})^n = \frac{1}{q_t^{(n)}}$

Assume investors are risk-neutral, care only about expected returns

So by the no-arbitrage condition,

Expected return on a long sequence of 1-year bonds = Expected return on n-year bond

($i_t^{(N)}$: yield on N-year bond; $i_{t+1}^{(1)e}$: expected yield on 1-year bond in year $t+1$)

$$(1 + i_t^{(N)})^N = (1 + i_t^{(1)})(1 + i_{t+1}^{(1)e}) \ldots (1 + i_{t+N-1}^{(1)e})$$

$$i_t^{(N)} \approx \frac{(i_t^{(1)} + i_{t+1}^{(1)e} + \ldots + i_{t+N-1}^{(1)e})}{N}$$

CB sets only short-term rates.

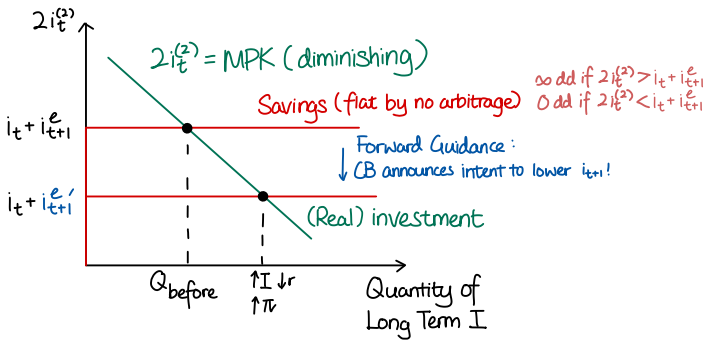
But by controlling the forward curve $\{i_t^{(1)}, i_{t+1}^{(1)e}, \ldots, i_{t+N-1}^{(1)e}\}$,

it influences (but not "control" - expectations still may differ) the entire yield curve $\{i_t^{(1)}, i_t^{(2)}, \ldots, i_t^{(N)}\}$

TERM SPREAD is difference between long and short rate

- Reveals market expected path for short rate
- Slope of yield curve $2i_t^{(2)} = i_t^{(1)} + i_{t+1}^{(1)e} \Rightarrow 2(i_t^{(2)} - i_t^{(1)}) = i_{t+1}^{(1)e} - i_t^{(1)}$
- Positive spread: long rates > short rates
  market expects short-term rates to rise

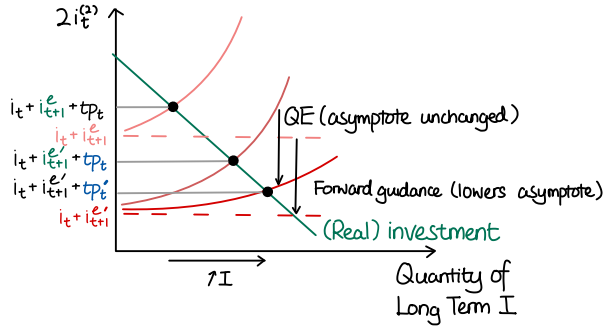
FORWARD GUIDANCE



CB can announce future short-term interest rate plans
controls forward curve $\{ i_t^{(1)}, i_{t+1}^{(1)e}, .., i_{t+N-1}^{(1)e} \}$
thus influences the entire yield curve $\{ i_t^{(1)}, i_t^{(2)}, ..., i_t^{(N)} \}$

QUANTITATIVE EASING

Issue reserves to buy gov bonds of longer maturities
↑dd for/↑P of longer maturity bonds
↓compensation for liquidity/risk (tp_t)



CB BALANCE SHEET

	Pre-QE/2008	Post-QE/2008
Assets	Mostly short-term gov bonds	Long-term gov bonds
Liabilities	Reserves and currency	Sated (bigger) reserves and currency
Size of balance sheet	Small	Very large

By definition, Assets = Currency + Reserves

NET INCOME (BEFORE)

$= i^{assets}_{\text{short term}} \text{Assets} - i^{r}_{\text{dep rate}} \text{Reserves} - 0 \times \text{Currency}$

$= i_{\text{interbank}} (\text{Assets} - \text{Reserves})$

$= i \times \text{Currency}$ Small but positive and stable

($i^{assets} = i^r = i$ when assets are short-term bonds)

NET INCOME (AFTER)

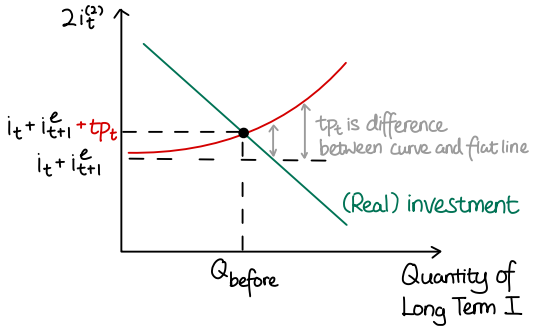
$= i^{(2)}_{\text{long term}} \text{Assets} - i^{r}_{\text{dep rate}} \text{Reserves} - 0 \times \text{Currency}$

$= \text{Assets} \underbrace{(i^{(2)} - i)}_{\substack{\text{term spread} \\ \text{buying short} \\ \text{selling long}}} + i \times \text{Currency}$

- Term spread gives extra positive (usually) or negative income to CB
- CB can make losses! Need fiscal backing
- If not, will have to print more currency to make income nonnegative. May cause hyperinflation

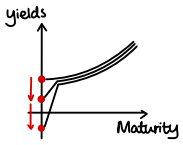
IMPERFECT FINANCIAL MARKETS

Risk-averse investors want term premium tp_t
to compensate for risk of holding 2-year bonds

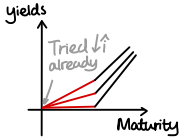


SUMMARY: MONPOL

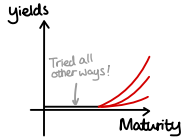
Raising $i_t^{(1)}$



Forward guidance
Intention to raise $i_{t+1}^{(1)}, ...$



QE



(Effective for ~2 years)

CURRENCY

PROPERTIES

- Physical
- Unit of account (exchanges 1-1 with reserves)
- We pay 0 interest from holding it (sets zero lower bound on interest rates)
- Exchanges are anonymous
- Monopoly issuance by the State
- Widely accepted as medium of exchange (avoid double coincidence of wants) and store of value into the future
- If issue too much (e.g. to cover CB income losses when there's no fiscal backing) will cause hyperinflation!

NEW CURRENCIES

- Abolish high denomination bills (often used by criminals)
- Cryptocurrencies: anonymous, decentralised creation, blockchain database, digital (like CB database; like banks depositing; like reserves)
- CB digital currencies (e.g. E-Krona)
  - currently net income ≈ 0 since $i=0$
  - Banks are resisting — "disintermediation!"
    - People can just deposit at CB and hold CB debit card
    - But unlikely – retail banking still very convenient

QUANTITY THEORY

$$M \times V(i) = \underbrace{P \times Y}_{\text{Nominal GDP}}$$

(P: Price; Y: All o/p)

M: Currency in circulation

V: Velocity; no. of times it changes hands

- Increasing fn of nominal interest rate
- $\uparrow i \Rightarrow \uparrow$ opp cost of cash (can lend!) $\Rightarrow \uparrow V$
- CB sets i; $i = r + \pi^e$ by Fisher

SEMI-ELASTICITY OF VELOCITY

$$\xi = \frac{\Delta V}{V \Delta \pi^e}$$

% change in velocity in response to change in expected inflation

Lin approx of quantity theory: $\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$

$$\Rightarrow \mu + \xi \Delta \pi^e = \pi + g$$

(μ: change in currency in circulation)

$\uparrow \mu$ (maybe to finance fiscal deficit) $\Rightarrow \uparrow \pi \Rightarrow \uparrow i$

LONG-RUN INFLATION

$$\mu = \bar{\pi} + \bar{g} = \bar{i} - \bar{r} + \bar{g}$$

- Assumes expectations are stable ($\Delta \pi^e = 0$)
- Inflation and money growth positively correlated

SEIGNIORAGE

$\frac{\Delta M}{P}$

- Equal to CB's Net Income $= i\frac{M}{P} = (\mu + r - g)\frac{M}{P} \approx \mu \frac{M}{P} = \frac{\Delta M}{P}$
- Easy to raise in SR

HYPERINFLATION

Begins when fiscal debt forces CB to print currency

Exogenous $\uparrow \mu \Rightarrow \uparrow \Delta \pi e \Rightarrow \frac{\uparrow \Delta V}{V} \Rightarrow \uparrow \pi \Rightarrow \uparrow i \Rightarrow \uparrow \mu$

ENDING IT

$\downarrow \mu$ now is not enough because people expect you to print even more in future $\rightarrow \uparrow \Delta \pi^e$

Need fiscal reform to credibly signal you won't print more in future

EXCHANGE RATE

E: nominal e/r $\left(\frac{\text{Foreign currency}}{\text{Domestic currency}}\right)$ $\uparrow E \Rightarrow \uparrow$ Appreciation

Real e/r, $\mathcal{E} = \frac{E \times P_{dom}}{P_{for}} = \frac{EP}{P^*}$ (Price of a basket)

LAW OF ONE PRICE

$\mathcal{E} = 1 \Rightarrow E = \frac{P_i^*}{P}$

Absent transporting costs, the same individual good must sell for the same price everywhere (purchasing power parity)

- Violated (diff baskets, non-traded goods, trade barriers, transport costs)
- So instead, we make the weaker assumption: $\frac{\Delta \mathcal{E}}{\mathcal{E}} = 0$

WHAT PINS DOWN E?

$E = \frac{\mathcal{E}P^*}{P} \Rightarrow \frac{\Delta E}{E} = \frac{\Delta \mathcal{E}}{\mathcal{E}} + \frac{\Delta P^*}{P^*} - \frac{\Delta P}{P} = \pi - \pi^*$ ($=0$ if PPP)

Appreciation when dom. inflation relatively higher!

Not applicable recently since $\mathcal{E}$ tends to change in SR

FREE CAPITAL FLOWS

- Enables carry-trade: If $i_t^* > i_t$ (foreign i/r, local i/r), borrow local and invest foreign
- Instead of holding dom currency and getting $1+i_t$ next year, convert to E_t foreign currency, get $\frac{E_t(1+i_t^*)}{E_{t+1}^e}$ dom currency

	Year t	Year t+1
Domestic bonds	£1 → (invest domestically)	£$(1+i_t)$
	£1 → ¥E_t → (if $i_t^* > i_t$, may invest abroad)	£$\frac{E_t}{E_{t+1}^e}(1+i_t^*)$
Foreign bonds		¥$E_t(1+i_t^*)$

NO ARBITRAGE

$1+i_t = (1+i_t^*)\frac{E_t}{E_{t+1}^e}$ (Interest parity)

For foreign & domestic markets to clear, ROI must be same

- $i_t \approx i_t^* - \frac{E_{t+1}^e - E_t}{E_t} \Rightarrow \left(\frac{\Delta E}{E}\right) = i_t^* - i_t$
- So investor buys foreign currency if it is expected to appreciate:

Theory of exchange rates

$$\left(\frac{\Delta E}{E}\right)^e = \frac{E_{t+1}^e - E_t}{E_t} = i_t^* - i_t > 0$$

EXCHANGE RATE VOLATILITY

$\uparrow i_t^e \Rightarrow \uparrow \pi^e \Rightarrow \downarrow E_t$

$\uparrow i \Rightarrow \uparrow E_t$ today $\Rightarrow \downarrow E_t^e$ tmr

$$1+i_t = (1+i_t^*)\frac{E_t}{E_{t+1}^e} \Rightarrow E_t = \left(\frac{1+i_t}{1+i_t^*}\right)E_{t+1}^e$$

$$= \left(\frac{1+i_t}{1+i_t^*}\right)\left(\frac{1+i_{t+1}^e}{1+i_{t+1}^*}\right)E_{t+2}^e$$

$$= \left(\frac{1+i_t}{1+i_t^*}\right)\cdots\left(\frac{1+i_{t+N}^e}{1+i_{t+N}^*}\right)E_{t+N+1}^e$$

Current exchange rate E_t varies with

- Both countries' expected interest rates at far-away horizons
- Expected future E and $\mathcal{E}$

Very volatile!

FIX EXCHANGE RATES

ADVANTAGE

Promote trade by removing exchange rate variability
Commit publicly to an inflation target equal to the other countries' inflation

IMPLEMENTATION

To force depreciation: print money and buy foreign currency with it, and lower interest rates (China)

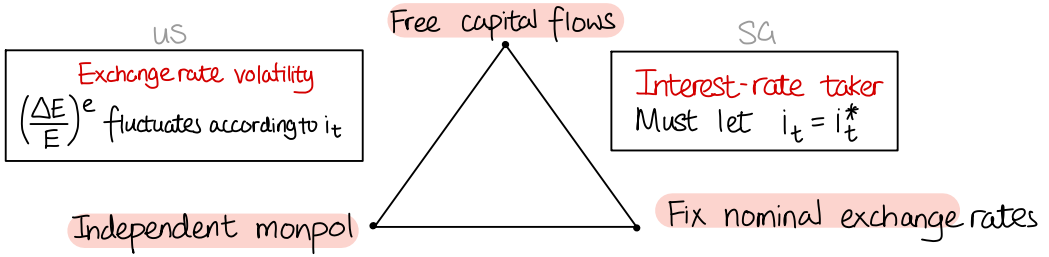
Costly (like an insurance premium) since you'll be holding lots of very liquid foreign assets that are easy to convert back (but also gives low returns)

To force appreciation: sell own foreign reserves to push down exchange rate, and raise interest rates

But if you run out of foreign reserves or can't afford to raise interest rates (e,g, in response to an increase in interest rates in the country you're pegged against) you have no choice but to float (e.g. UK leaves ERM).

To avoid this, you can use the same currency and same central bank as the country you're pegged against (i.e. the Euro). Independence is sacrificed.

TRILEMMA



Pros and cons: 2020 Q3

of capital inflows

MISALLOCATION BETWEEN SECTORS

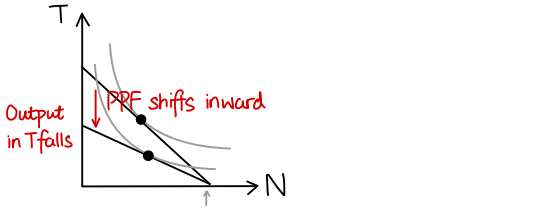
Given lack of international competition, firms in non trade sectors can form local cartels and pressure politicians and banks. Favouring non tradable sectors creates rents. Resources and effort diverted to capture these rents, resulting in lower resources for the economy.
Note: if we are talking about capital controls then it's the opposite: politicians favour tradable sectors relative to non tradable sectors.

Politicians favour sector N and tax T

assume tax revenue is just out of the system not subsidise N

$\frac{MPK_{(T)}}{MPK_{(N)}}$ falls. I, K flows from T to N

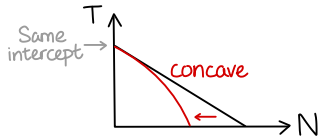
PPF flatter since diverting 1 unit of K from N to T gives lower return



Total output and welfare fall
Ratio of output in T falls relative to N
Economy worse off

MISALLOCATION WITHIN SECTORS

Politicians impose firm-size limits on N
Instead of a few large efficient firms
we have many small efficient + inefficient firms
- "Dispersion of TFP across firms" rises



N now has diminishing MPK
More output in T is sacrificed for an extra unit of N
Economy worse off

Politicians see small firms as "entrepreneurship" or income mobility, small firms also employ a large % of population. Banks in underdeveloped financial markets lack managerial resources to diversify portfolio, and may be wary of giving large loans to a few large firms.

EURO CRISIS

Domestic bond may default with probability d_t

Interest parity becomes

$$d_t \times 0 + (1-d_t)(1+i_t) = (1+i_t^*)\frac{E_t}{E_{t+1}^e}$$

linear approx $\Rightarrow$

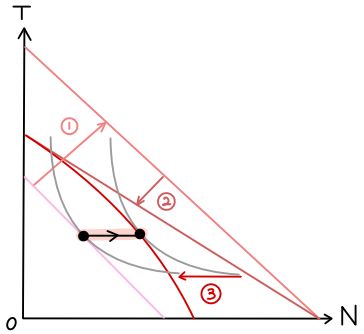
$$\left(\frac{\Delta E}{E}\right)^e - d_t \approx i_t^* - i_t$$

$i_t = \frac{i_t^*}{1-d_t} > i_t^*$

Interest rate spread depends on not just e/r risk but also default risk

After the adoption of the Euro, poor countries' sovereign yields converged to that of rich countries, suggesting investors perceive the default risk to be 0 (or that they expect bailouts)

A lot of capital flowed from core (richer) countries to the peripheral, poorer countries like Greece and Spain.



Assume efficient economy at the start

① Capital inflow boom
② Misallocation between sectors
Less pressure on politicians for structural reforms + abundant credit lowers threshold for project quality
Funds get diverted to assets which are inelastically supplied, creating capital gains, augments future expectations and fuels asset bubbles which further
③ injects credit into inefficient sectors
Misallocation within sectors

Economy grows, but no trade sector grows at the expense of trade sector. TFP falls on aggregate. Furthermore, debt must eventually be repaid.
Allocation is crucial. More credit and capital is not always good.

ROLES OF BANKS

1. Participate in payment system
2. Maturity transformation (liquidity insurance) Diamond-Dybvig
3. Monitor loans

② DIAMOND-DYBVIG MODEL

1. Three period model, t=0,1,2
2. N people in the economy each with 1 unit of good in t=0.
3. Investment project such that if you invest 1 at t=0, get 1+r at t=2. If pull out at t=1, get only 1 at t=1 and 0 at t=2.
4. People are identical in period 0, in period 1 can become one of two types (private information-even depositors don't know)
   Probability θ that want to consume at date 1
   Probability $1-\theta$ that want to consume at date 2
5. Maximise expected utility function

$$\theta u(c_1) + (1-\theta)u(c_2) = \theta\left(1-\frac{1}{c_1}\right) + (1-\theta)\left(1-\frac{1}{c_2}\right)$$

increasing in c, concave (risk-averse)

6. Banks are perfectly competitive and make zero profits

WORLD WITHOUT BANKS

N investors

- Terminate investment at t=1, get $c_1 = 1$ if liquidity shock ($pr=\theta$)
- Otherwise, get $c_2 = 1+r$ at $t=2$ ($Pr = 1-\theta$)

$$U^{nobank} = (1-\theta)\frac{r}{1+r}$$

- No secondary market: early type only sell for $p>1$
  late type only buy at $p<1$

MATURITY TRANSFORMATION

Banks offer deposit contract:

$t=0$: N depositors each give 1 unit
$t=1$: Bank gives y_1 to anyone withdrawing (θN). Sequential service.
$t=2$: Bank gives y_2 to anyone withdrawing ($(1-\theta)N$)

Banks make 0 profits in perfect comp and choose y_1, y_2 to maximise consumers' expected utility (First Welfare Theorem)

LIQUIDITY INSURANCE

If only people with liquidity shock withdraw at t=1

no. of early ppl; no. of projects liquidated

At $t=1$, $N\theta y_1 = Nx$
At $t=2$, $N(1-\theta)y_2 = (1+r)N(1-x)$

Intertemporal budget constraint: $y_2 = \frac{(1-\theta y_1)(1+r)}{1-\theta}$

Max expected utility (FOCs, substitute) with budget constraint to get

$$\frac{y_2}{y_1} = \sqrt{1+r} < 1+r \Rightarrow 1 < y_1 < y_2 < 1+r$$

$\uparrow c_1, \downarrow c_2$. $\uparrow U$ because risk-averse
Happy to pay insurance premium to $\downarrow$ uncertainty

But this mechanism may fail when...

BANK RUN

- If I think everyone else will withdraw in $t=1$, bank cannot satisfy all customers since
  $(N-1)y_1 > N$ for large N ($y_1 > 1$)
- By sequential service, only first $\frac{N}{y_1}$ ppl in line will get paid; the rest gets 0. So run
- Self-fulfilling. Can happen out of nowhere

SOLUTION: SUSPEND CONVERTIBILITY

announce!: Only $N\theta$ will be paid at $t=1$

To a late consumer:
At $t=1$, withdraw to get $\leq y_1$
At $t=2$, withdraw to get $y_2 > y_1$
$\Rightarrow$ will wait!

Issue: We don't know θ. If set θ too low, some people hurt by liquidity shock can't withdraw at $t=1$

SOLUTION: DEPOSIT INSURANCE

You get y_2 even if there's a run at $t=1$

Off-equilibrium threat: gov bailout will never happen

- Must be credible
  1. Able to do it (have enough tax revenue)
  2. Willing to do it if it happens
     - × "better use of tax money than bail-out"
     - × "why bail out banks but not firms..."

SOLUTION: LENDER OF LAST RESORT

If θ too high, CB lend reserves to banks (bailout)

Issues

- How come no interbank mkt? Moral hazard
- May bail out failing businesses
- Bagehot doctrine: Lend safely at penalty (higher than usual) interest to good (illiquid but solvent) banks with good collateral
  - But how to distinguish?
  - Depositors may still doubt bank's ability to repay $\Rightarrow$ run

LINK TO 2008

No deposit insurance for "shadow banks"

Money market funds: Invests deposits in short-term liquid assets (~90 day loans)

- Lehman run

Repo market: i.e. pawn shop
Banks sell assets & promise to buy it back at a higher price tmr

- Fails when value of bank's mortgage is doubted
- Bear Sterns, Northern Rocks run

- Fed had to be LOLR

WHY BANKS?

Banks transform liquid, short-term liabilities into illiquid, long-term assets (maturity mismatch)

- "illiquid": if you terminate the project early, you get very little ($y_1 \ll y_2$)
- Mutual funds' assets are liquid

Banks do not add value, only provides collection services

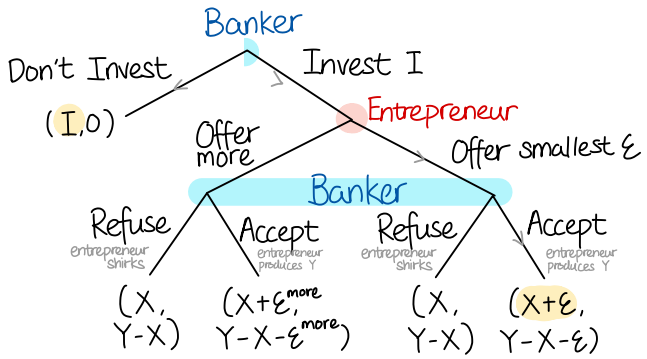
- VCs add managerial value; not simple intermediaries

③ BANKS AS MONITORS

SPECIFIC SKILLS

- "Capital" others can't seize/replicate
- Banker can monitor project
  - provide collection services we don't have
- Entrepreneur has skills

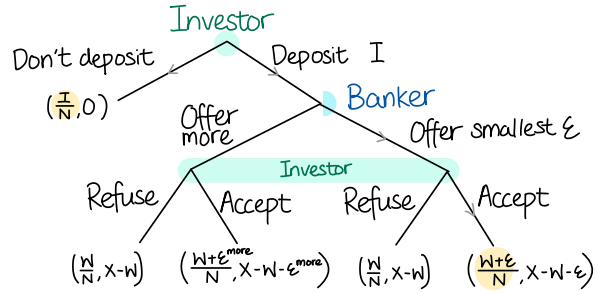
ENTREPRENEUR'S RENT



- Banker invests I, entrepreneur can make Y>I with skills
- After investment, entrepreneur makes take-it-or-leave-it offer
- If banker accepts, get X+ε; if refuse, entrepreneur shirks. Banker can seize depreciated assets X<Y
- Banker compares X, I in investment decision
  larger if banker has better monitoring skills

X<I: No project. Inefficient to society (Y>I)
X>I: Entrepreneur keeps Y-X-ε • return to specificity capital/hold-up rent

BANKER'S RENT



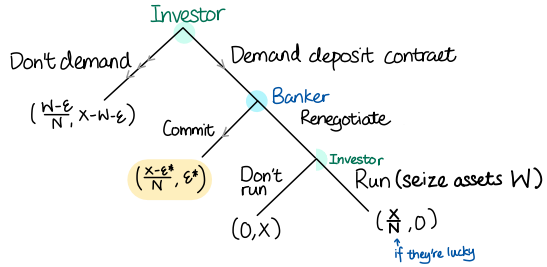
- Each investor deposits $\frac{I}{N}$
- After deposit: banker offers $\frac{W+\varepsilon}{N}$.
  - If investor refuses, can seize assets and recover W
  - W<X since investor has no skills
- Investor compares I, W larger if investor more skilled

W<I: No project. Inefficient to society (Y>I)
W>I: Banker keeps X-W-ε • return to specificity capital/hold-up rent

Implication: entrepreneur can only borrow up to W

BANK RUN THREAT

- Investors demand deposit contract: invest $\frac{I}{N}$, must get $\frac{X-\varepsilon^*}{N}$ back
- If banker tries to renegotiate, seize assets to get mkt value W
  - $\frac{W}{X}$<100% of them get paid, so run
- If banker commits to effort, investor gets $\frac{X}{N}$



Threat of bank run disintermediates banker

- Not inefficient; only shifts rents from banker to depositors
- Rents minimised even though banker has skills
- Banker lost bargaining power
- Banks don't add value, just collect
- Banks can now raise up to X>W; more credit makes society better off
- Threat of bank runs disciplines banks
- Entrepreneur can borrow up to X

W, X, Y is assumed to be independent of I. The investment doesn't go into capital or machinery that scales up production, but rather helps to sustain the cash flow and keep the firm liquid (see page 7 of Diamond Rajan paper)

MODERN FINACIAL CRISIS

MODERN DEVELOPMENTS

SECURITISATION

- Pool (e.g. housing) loans to remove idiosyncratic risk
- Sell revenue stream from future payments/for $$ today
  - i.e. gimme £100 today and I'll pay you back over next 10 years
- These securities often backed by mortgages/other assets
- Securities traded at value marked to market
- Adds tradable assets (e.g. housing) to banks' balance sheet

WHOLESALE FUNDING

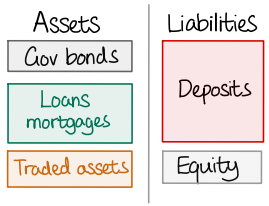
① Borrow from other banks instead of attracting depositors
- Short-term, uninsured, unsecured
- Effective seniority over deposits – other banks are well-informed, quick to run, not inert

② Repo (pawn my security at other banks)
- Haircuts – sell for < market value so lender has cushion for changes in collateral's value
- Senior claims over interbank loans and depositors
- Very short duration. Rolled over frequently (gets repaid before)

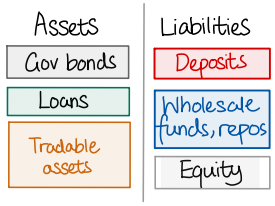
Borrower finds it easier than attracting depositors
Lender can exit quickly if something is wrong
Wholesale markets are international, hard to regulate

⇒ Grow quickly!

TRADITIONAL BANK



MODERN BANK



RISKS

DANGERS TO BANK

Securitisation
- Large share of assets marked to market
- Can make losses quickly; must be able to sell assets

Wholesale funding
- Creditors well-informed and run swiftly
- Repos may not be rolled over

DANGERS TO FINANCIAL SYSTEM

Weakens incentives for prudence
- Bank grows $\Rightarrow \downarrow \frac{\text{equity}}{\text{liability}} \Rightarrow \uparrow$ leverage $\Rightarrow \uparrow$ Banker's share (return to equity)
  $\Rightarrow \downarrow$ incentive to monitor loans

Funding liquidity risk (risk of run)
- Wholesale creditors more well informed and alert; quick to exit
- Shadow banks not regulated/insured

Amplify asset-price cycles

↑asset prices ⇒ banks borrow more ⇒ banks lend more

EUROPEAN BANKS

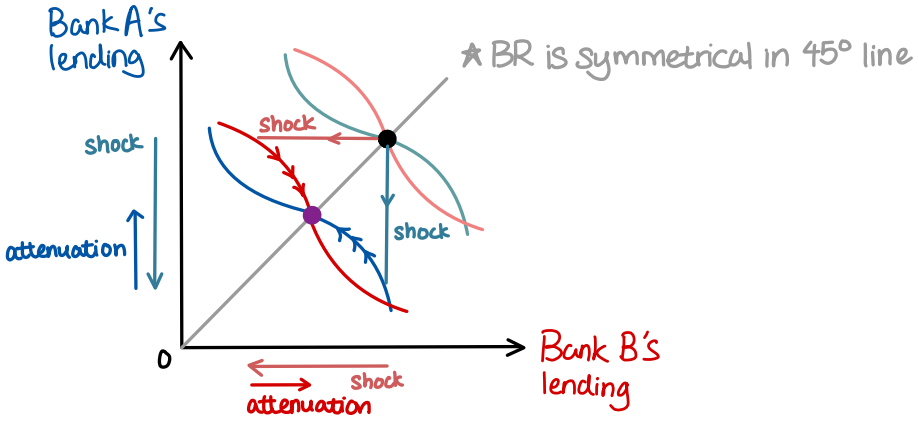
Got too large for individual countries to bail out
- Financed mostly by uninsured interbank lending
- Banking sector highly concentrated (assets > GDP)

LENDING

PRE-CRISIS

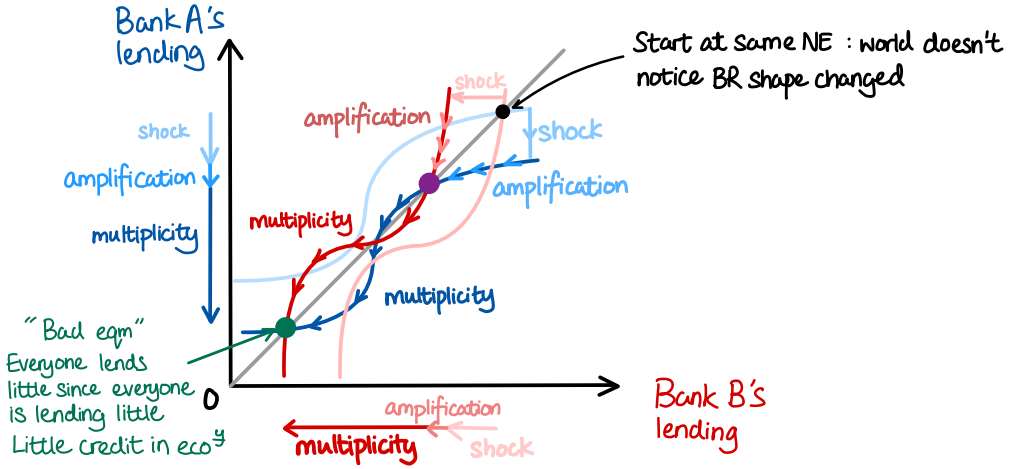
If all other banks lend more,
Lend less since all other banks captured the high MPK projects
If all other banks lend less,
Lend more to capture high MPK projects

- Downward sloping BR curve
- Converge to unique intersection (NE)
- If exogenous shocks push down BR, can be attenuated



CRISIS

If all other banks lend more, Lend more (asset-price cycle)
If all other banks lend less, Lend less
↓house prices ⇒ ↓ securitised assets ⇒ losses (↓equity)
⇒ make up by selling assets ⇒ (everyone selling) less mkt liquidity ⇒ … fire sales amplification
⇒ less repo collateral ⇒ losses spiral ⇒ margins spiral
⇒ less funding liquidity (↑ about liability) ⇒ lend less
(↑ haircuts !!!)
Might even cause multiplicity (like a bank run)



SYSTEMIC RISK

Banks selling assets ↓asset prices (pecuniary externality)
other banks & whole financial system make losses as assets are used as collateral (due to the existence of market frictions)

INSOLVENCY & ILLIQUIDITY

Whether debtor has revenues in the present and the future (i.e. total discounted revenue) to repay debt

↑interest rate ⇒ ↓discounted future cash flows ⇒ ↑Pr(insolvent)

With perfect, complete markets,
∃ a unique interest rate as insolvency threshold
With frictions,
∃ multiple interest rates used to assess solvency

- Can be solvent but illiquid

SIMPLE MODEL

No debt contract

Institution needs q to finance a project with uncertain return $z \in [0,1]$ uniform dist

Net return: $\frac{z}{q} - 1$ (e.g., 5%)

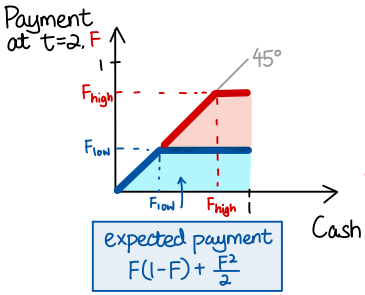
Expected return: $\frac{1}{2q} - 1$ ∵ $E(z) = \frac{1}{2}$

In perfect market, $i < \frac{1}{2q} - 1 \Leftrightarrow$ solvent

DEBT CONTRACT

Lend q at t=1, get F at t=2

FRICTIONLESS MARKET



↑ face value of debt to F_{high}
➔ ↑payment but ↑Pr(default)
➔ ↑expected payment
➔ can borrow more (↑q)

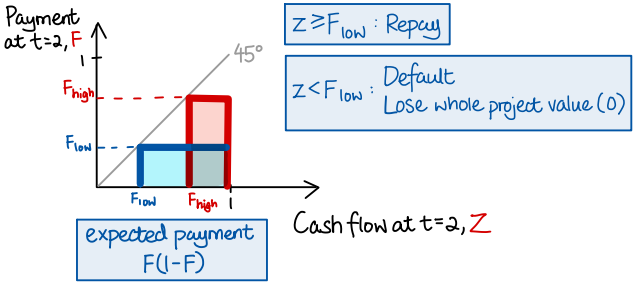
$z \geq F_{low}$: Repay (payoff is horizontal line)
$z < F_{low}$: Default; pay residual value of project (diagonal line)

F=1 : Max expected payment, always default
debtor is effectively equity holder (keeps whole value of project)

MARKET FRICTION

Value is lost when firm defaults (↓payoff)

- Creditor seizing the asset cannot generate as much cash flow as entrepreneur
- Insolvency is costly: Lawyers, bankruptcy court fees

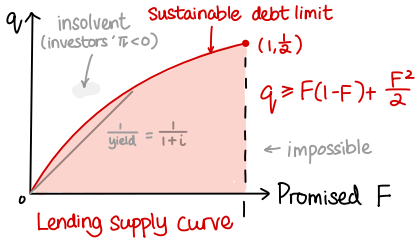


F_{low} and F_{high} make same expected return (rectangle)!
F=1 now worthless (just like F=0)

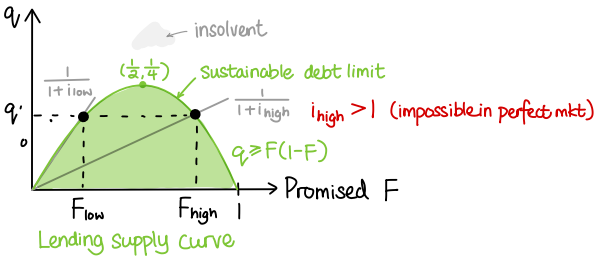
SOLVENCY

E(payoff) > amt borrowed, q
☆ Assume future not discounted

$F \leq 1 \Leftrightarrow q \leq \frac{1}{2}$ $(i \leq 1)$ if markets perfect



$F \leq 1 \Leftrightarrow q \leq \frac{1}{4}$ if friction (i can → ∞)



Higher solvency risk if graph moves inward ☆ more frictions

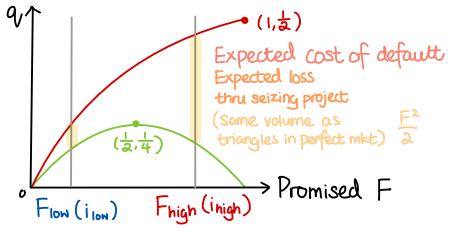
LIQUIDITY CRISIS

Being at "bad eqᵐ", i_{high}, high % defaults "default based on belief"

self-fulfilling equilibrium at i_{high}

Perceived ↑ default risk ⇒ investor ↑i (debtor promise ↑F) ⇒ ↑% defaults

INSOLVENCY LOSSES



- ↑F/i ⇒ ↑Expected Social costs of default ⇒ ↓societal welfare
- Liquidity crisis at F_{high} is a worse equilibrium since it raises same q as F_{low} but ↑default costs
- May start at F_{low}, but any shock that makes investors doubt solvency can push to F_{high}, stuck there multiplicity

SOVEREIGNS

- Hard to tell if solvent since z (budget surpluses) dep on politics
- Prone to liquidity crises
  - Small shock can push country to insolvency (↓green curve) and justify ↑i, but shifts in mkt beliefs can also force economy to move to i_{high} and ↑Pr(default)
  - Creditors can't "seize assets" if sovereigns default. ↑mkt frictions

IMF Funded by countries; lends at fixed i, $i_{low} < i < i_{high}$

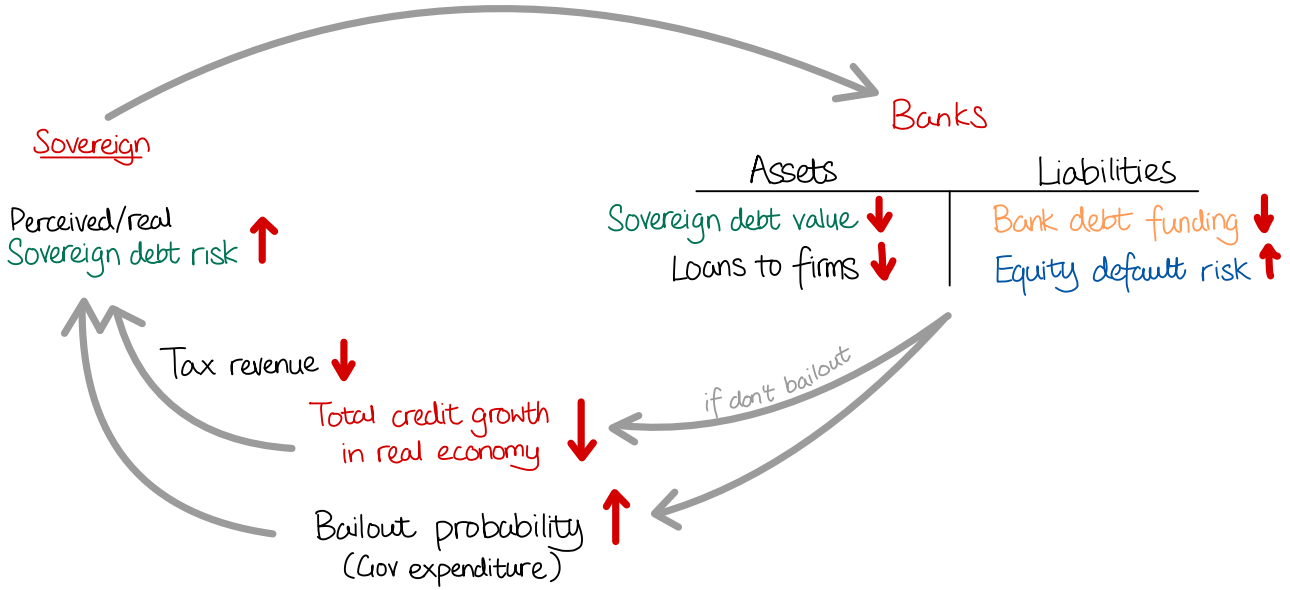
Illiquid: Can eliminate liquidity crisis
- country can prove it's solvent and repay loan
- No value transfer

Insolvent: Country will default. Expected net return < 0
- Value transfer from foreign countries (bailout)

No country (IMF) wants to lend at a loss

- Can't discern in real time... can lend with strings attached (austerity) to push out green curve but of course unpopular

DIABOLIC LOOP



WHY BANKS HOLD A LOT OF BONDS

① Financial regulations force bonds to hold some safe liquid assets and banks usually think gov bonds are "safe"
② Need to keep some bonds to sell to CB for reserves (monpol)
③ Banks are primary dealers of bonds (sell "on behalf" of gov)
④ Moral suasion by govs in trouble ("pls buy our bonds. We need ££!")
- Technically illegal

⑤ Implicit (bailout) or explicit (deposit insurance) State guarantees

BREAK THE DIABOLIC LOOP

- Banks shouldn't hold too many of own sovereign's bonds (e.g. US)
- Have a Eurobond that pools sovereigns' risks
  - Currently, Italian banks hold risky Italian bonds; can't hold safer German bonds since 1. Germany doesn't issue that many bonds 2. Will cause capital outflow

BUSINESS CYCLES

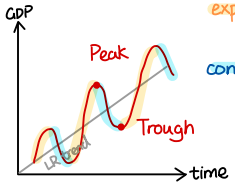
The short-run fluctuations of output and employment around a (long run) trend

- If Y is log output, then $Y = Y^{trend} + Y^{cycle}$

PROPERTIES

- Small relative to trend but not "minor"
  - Great Depression was "just" 10-15% ↓, but still serious
- Recurrent but non-predictable
- Can be regarded as a succession of peaks and troughs
- Helpful to identify peaks/troughs, contraction/expansion
  - Hard! Need fancy algorithms;
  - may also be judged by NBER (US)/CEPR (UK)

TERMS



expansion: When cyclical output is rising
Starts with trough, ends with peak

contraction: When cyclical output is falling
Starts with peak, ends with trough
media's rule of thumb:
2 successive Qs of ↓ GDP

boom: When output above trend or cyclical output >0

recession: When output below trend or cyclical output <0

LINKS ACROSS INDUSTRIES ★ co-movement

- Defining feature of the business cycle: all industries' value added increase tgt
- All industries seem to share a common factor that explains half of overall industry op shifts

ACROSS COMPONENTS OF OUTPUT

Procyclical: Positive corr with Y^{cycle}
C, I, M, inflation (Philips Curve: inf - corr un^n + Okun's law)

Countercyclical: Negative corr with Y^{cycle}
Unemployment (Okun's law)

Acyclical: ≈ 0 corr with Y^{cycle}
real wages (offset by inflation)
gov spending

IMPULSE AND PROPAGATION

Theory: the economy gets hit by a shock macroecon vars respond by generating business cycles

- Impulse: source of shock (i/r, tech, energy price)
- Propagation: Channel through which shocks transmit to macroecon vars over time (modelled)

AUTOREGRESSION MODEL

a model, not a regression

$$y_t = \gamma y_{t-1} + \sigma \varepsilon_t$$

y_t: economic variable

ε_t: economic shock (exogenous)

σ: economic model of transmission
- mechanism by which ε_t impacts y_t

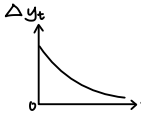
γ: economic model of propagation
- mechanism by which y_{t-1} impacts y_t

$$y_{t+2} = \gamma\Big(\underbrace{\gamma(\gamma y_{t-1} + \sigma\varepsilon_t)}_{y_t} + \sigma\varepsilon_{t+1}\Big) + \sigma\varepsilon_{t+2}$$

$$y_{t+T} = \sigma\varepsilon_{t+T} + \gamma\sigma\varepsilon_{t+T-1} + \gamma^2\sigma\varepsilon_{t+T-2} + \dots + \gamma^T\sigma\varepsilon_t + \gamma^{T+1}y_{t-1}$$

The impulse response is thus $\{\sigma, \gamma\sigma, \gamma^2\sigma, \dots, \gamma^T\sigma\}$

$$y_{t+T} = \sigma\varepsilon_{t+T} + \gamma\sigma\varepsilon_{t+T-1} + \gamma^2\sigma\varepsilon_{t+T-2} + \dots + \gamma^T\sigma\varepsilon_t + \gamma^{T+1}y_{t-1}$$



y_t in response to a single positive shock at $t=0$

COMOVEMENT

2 econ vars, 2 econ shocks, interlinked!!

$$y_t^a = \theta_a y_t^b + \gamma_{aa} y_{t-1}^a + \gamma_{ab} y_{t-1}^b + \sigma^a \varepsilon_t^a$$
$$y_t^b = \theta_b y_t^a + \gamma_{ba} y_{t-1}^a + \gamma_{bb} y_{t-1}^b + \sigma^b \varepsilon_t^b$$

$$\Leftrightarrow \begin{pmatrix} 1 & -\theta_b \\ \theta_a & 1 \end{pmatrix}\begin{pmatrix} y_t^a \\ y_t^b \end{pmatrix} = \begin{pmatrix} \gamma_{aa} & \gamma_{ab} \\ \gamma_{ba} & \gamma_{bb} \end{pmatrix}\begin{pmatrix} y_{t-1}^a \\ y_{t-1}^b \end{pmatrix} + \begin{pmatrix} \sigma^a & 0 \\ 0 & \sigma^b \end{pmatrix}\begin{pmatrix} \varepsilon_t^a \\ \varepsilon_t^b \end{pmatrix}$$

comovement

$$\Leftrightarrow \Theta Y_t = \Gamma Y_{t-1} + \Sigma \varepsilon_t$$

propagation, transmission

$$\Theta Y_t = \Theta^{-1}\Gamma Y_{t-1} + \Theta^{-1}\Sigma\varepsilon_t$$

if Θ^{-1} doesn't exist, can have multiple equilibria

The impulse response is thus $\{\Theta, \Gamma, \Sigma\}$

The theorists essentially specify their own versions of Θ, Γ, Σ and the empiricists verify them with data

VECTOR AUTOREGRESSION VAR

Empirically estimate $\Theta^{-1}\Gamma$ and $\Theta^{-1}\Sigma$ to verify theory

TRENDS

- "Great moderation" maybe not true – we had great recessions too!
- Recovery after recessions slower, maybe due to productivity puzzle

COVID-19

- Industry usually more procyclical than services
  - Opposite for COVID-19
- ↑ women unemployment than men
  - More in services: but issue persists within sector

KEYNESIAN

Fixes P and π instead of the usual Y and r (by pdn fn)

- Models very short run

IS: INVESTMENT=SAVINGS

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

$Y=C+I+G$

① $C=\underset{\text{shocks/"autonomous spending"}}{c}+\gamma(\overset{\text{disposable income}}{Y-T})$ $\quad \Delta C=\gamma\Delta Y$

② $I=\underset{\text{"autonomous I"}}{a}-\delta r$ $\quad \uparrow r \overset{\text{borrowing cost}}{\Rightarrow}\downarrow I$ — related to animal spirits

③ $T=t$ $\quad G=g$ both exogenous

Assume linearity, γ, δ constant

MULTIPLIER

$Y=c+\gamma(Y-T)+a-\delta r+g$

GOV-PURCHASES MULTIPLIER

$\Delta Y=\gamma\Delta Y+\Delta g$ $\quad \uparrow g \Rightarrow \uparrow Y \underset{\times\infty}{\Rightarrow} \uparrow C$

$\frac{\Delta Y}{\Delta g}=\frac{1}{1-\gamma}$ ← marginal propensity to consume

TAX MULTIPLIER

$\Delta Y=\gamma(\Delta Y-\Delta t)$ $\quad \uparrow t \Rightarrow \downarrow C \underset{\times\infty\ (P\ \text{fixed})}{\Rightarrow} \downarrow Y$

$\frac{\Delta Y}{\Delta t}=-\frac{\gamma}{1-\gamma}$

BALANCED-BUDGET MULTIPLIER

If g and t rise by same amt

$\Delta Y=\Delta g\left(\frac{1}{1-\gamma}\right)-\Delta t\left(\frac{\gamma}{1-\gamma}\right)=\Delta \overset{\Delta t=\Delta g}{}$

$\frac{\Delta Y}{\Delta}=1$

Private output C+I constant but

Total output C+I+G rises

- Dep on which you think measures welfare

IS CURVE

$r=\frac{1}{\delta}(a+c-(1-\gamma)Y+g-\gamma t)$

$\uparrow r \Rightarrow \downarrow I \Rightarrow \downarrow Y$

$\uparrow Y \Rightarrow \uparrow$ savings $\Rightarrow \uparrow$ supply of loanable funds $\Rightarrow \downarrow r$

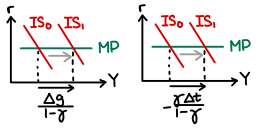
Slope $-\frac{1-\gamma}{\delta}<0$ is steeper if

I is interest-rate inelastic ($\downarrow\delta$) / $\downarrow$MPC(γ)

$\uparrow G \Rightarrow \overrightarrow{IS}$ by $\frac{1}{1-\gamma}\Delta G$

$\uparrow T \Rightarrow \overleftarrow{IS}$ by $-\frac{\gamma}{1-\gamma}\Delta T$

↑G ↓T

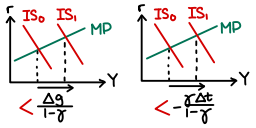


Unresponsive MP ($\eta=0$)

e.g. liquidity trap

interest rates too close to ELB

"FP should recharge MP!"

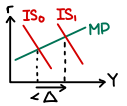


Crowding out of investments

↑Y from ↑G is offset by ↑r and ↓I

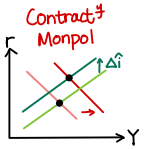
- If η is high, ↑Y may be low, then ↑G is offset by ↓I.
- Private output C+I may even fall!
- Crowding out increases with slope

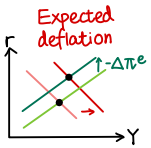
BALANCED BUDGET $\Delta\uparrow G=\Delta\uparrow T$



☆ feasibility affected by long and variable time lags

SITUATION





Expected deflation (nominal i, Y, π etc constant) increases r $\Rightarrow \downarrow I \downarrow Y \underset{\text{multiplier}}{\downarrow C \downarrow Y}$...

MP CURVE

$r=i-\pi^e=\bar{r}+\bar{\pi}+\chi(\pi-\bar{\pi})+\hat{i}+\eta Y-\pi^e$

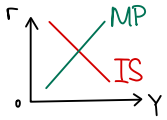
response to output

Assume $\bar{\pi}=\bar{r}=0$ (i.e. drop constants)

$r=\eta Y+\chi\pi+\hat{i}-\pi^e$

Steeper if MP responds more to O/P

- Curve shifts up (left) with tighter MP ($\hat{\uparrow}\uparrow$) or $\downarrow\pi^e$



AUTOMATIC STABILISER

PROPORTIONAL INCOME TAX

instead of $c+\gamma(Y-T)$

Makes disposable income $c+\gamma(1-\tau)Y$

Similar to a smaller γ – IS steeper, shifts by less after shock

Does not rely on identifying shocks/implementing policy on time

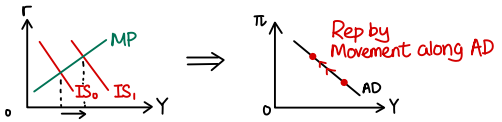
AD-AS

AGGREGATE DEMAND

DERIVATION

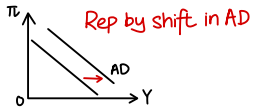
Eliminate r in IS-MP & combine to get AD eqn in terms of Y, π
Not an actual "dd curve", but eqm relations

$\uparrow\pi \rightarrow \uparrow i = X\pi \uparrow r \rightarrow \downarrow I \downarrow Y \downarrow C \downarrow Y \ldots \rightarrow \downarrow Y$
MP; IS-MP interactions



$\Rightarrow$

$\downarrow\hat{i} / \uparrow\pi^e \uparrow G/Y \ldots \rightarrow \uparrow Y$



SHORT RUN π constant. AS vertical. Classical (W1)

LONG RUN Y unchanged. AS horizontal. Keynes (W7)

AGGREGATE SUPPLY

$\pi = \pi^e + \alpha(Y - \bar{Y}) + \varepsilon$ (o/p gap; shocks)

- Upward-sloping due to nominal rigidities

DERIVATION

(Assume they can set prices) firms' desired prices

$p^* = P + a(Y - \bar{Y}) + \tilde{\varepsilon}$ ← shock to mkt power
(P: price level; $(Y-\bar{Y})$: output gap — more pdn ⇒ ↑MC, w OR more dd ⇒ ↑mkt power)

Some firms adjust prices flexibly

① $p = P + a(Y - \bar{Y}) + \tilde{\varepsilon}$ (menu costs, sticky prices; ↳ inattention, sticky info)

Some firms dk current price level, form forecast (sticky)

② $p = E(P + a(Y-\bar{Y}) + \tilde{\varepsilon}) = P^e$ ($a(Y-\bar{Y}) = 0$; $\tilde{\varepsilon} = 0$)

On aggregate, general price level

$P = sP^e + (1-s)[P + a(Y-\bar{Y})] + (1-s)\tilde{\varepsilon}$ (s: % sticky firms)

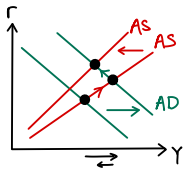
★ Must assume $\pi = P_t - P_{t-1}$, $\pi^e = P^e - P_{t-1}$
possible if prices are logged values, or if $P_{t-1} = 1$

$$\pi = \pi^e + \left(\frac{a(1-s)}{s}\right)(Y - \bar{Y}) + \left(\frac{1-s}{s}\right)\tilde{\varepsilon}$$
$\left(\frac{a(1-s)}{s}\right) = \alpha$; $\left(\frac{1-s}{s}\right) = \varepsilon$

① If average inflation high &/ volatile, firms update prices more often
↓s ↑α steeper AS curve

② Prices are sticky in general
- Main reason is Sticky info (distracted)
- most ppl dk/dc what inflation will be

LR MONPOL NEUTRAL



① Monpol ↓$\hat{i}$ ↑AD ↑Y
SR monpol effective

② In LR, everyone knows, "people catch up" SWW
LR monpol neutral

PHILLIPS CURVE

OKUN'S LAW

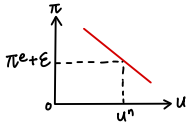
$Y - \bar{Y} = -\eta(u - u^n)$ (u^n: Natural rate of unemployment)

- Useful as u^n is easier to measure than $\bar{Y}$
- Sub into AS to get ...

PHILLIPS CURVE

(the MONIAC guy)

$\pi = \pi^e - \alpha\eta(u - u^n) + \varepsilon$



Stickier prices ⇒ flatter
Firms respond to stimulus by ΔY rather than ΔP

Data on (π, Y) traces out Phillips Curve (AS)

- Supports theory that business cycles are driven by AD (dd-driven cycles)
- If economists can control AD, Phillips Curve maps out set of achievable eqm pts
  - "dismal science of picking a tradeoff btwn π and u" in 1960s
  - But difficult to control π^e esp when big AD/AS shocks happen

SACRIFICE RATIO

How much extra unemployment $(u - u^n)$ to tolerate to lower inflation by 1%

e.g. $\pi = \pi^e = 4$, $\alpha\eta = 0.5$, no ε
π^e calculated by average of last two years
Monpol lowers π immediately to $\pi = 2$

$t=0$: $u - u^n = (4-2) \div 0.5 = 4$
$t=1$: $u - u^n = (3-2) \div 0.5 = 2$
$t=2$ (LR) → π^e fully adjusted: $u - u^n = (2-2) \div 0.5 = 0$
(take Sum of u gap arising from change in π)

$$\text{Sacrifice ratio} = \frac{4+2}{2} = 3$$
(↳ divide by $\Delta\pi$)

- Sacrifice ratio = 0 in LR
- Dep on $\alpha\eta$ and how long π^e adjusts
- ratio = 0 if policy is credible (anticipated by everyone) since PC shifts to neutralise policy
  - CB makes announcements — "disinflate w/o cost" ↑transparency to ↓expectations error

INFLATION EXPECTATIONS

"ADAPTIVE" $\pi_t^e = \pi_{t-1}$

Then $\pi_t = \pi_{t-1} - \alpha\eta(u-u^n) + \varepsilon$ (demand-pull; cost-push)

u^n : NAIRU. If $u = u^n$ inflation is not accelerating

Inflation inertia : $\uparrow\pi_1 \Rightarrow \uparrow\pi_2^e \Rightarrow \uparrow\pi_2 \Rightarrow \dots$

Unrealistic – if not, hyperinflation never ends

"OPTIMAL": RATIONAL

- Optimally use avail info to make best forecast possible
- Controversial: model-consistent expectations
  - People have same info as govts, are macro model experts, not locked into old contracts

POLICY INEFFECTIVENESS PROPOSITION

i.e. "The LR is here, always"

- Using FP/MP to exploit PC will cause ppl to realise, $\Delta\pi^e$ and neutralise it
- Only unanticipated policy can have effects has to be random, can't stabilise business cycle
- Difficult issue is time horizon

POLICY RULE

Avoid mis-directing agents/mistakes/confusion

GOODHART'S LAW/LUCAS CRITIQUE

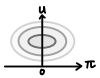
As soon as we try to exploit a macro relation (PC), it causes Δexpectations that causes that relation to break down (shift)

CB'S TEMPTATION

GAME SETUP dynamic Stackelberg game

1. Public π^e is rational. Enter contracts based on them. $\pi^e = E(\pi)$
2. Shocks (e.g. to supply) to economy are realised $\varepsilon \sim (0, \sigma^2)$
3. CB chooses π optimally to min loss fn $L = 0.5\pi^2 + 0.5\lambda(u-u^T)^2$ (just scaling; dislike both)
4. Outcomes realised in economy by Phillips Curve eqn $u = u^N - (\pi - \pi^e) - \varepsilon$

Lagrangean not needed for EC210



NO SHOCK

BACKWARD INDUCTION follows Kydland-Prescott-Barro-Gordon

③ CB $\min_{\pi} 0.5\pi^2 + 0.5\lambda(u-u^T)^2$ assume no ε

Subject to constraints $\begin{cases} u = u^N - (\pi - \pi^e) & \text{(PC with } \beta=1, \varepsilon=0) \\ u^T = u^N - k & \text{(u target)} \end{cases}$

Sub in constraints: $\min_{\pi} 0.5\pi^2 + 0.5\lambda(k-(\pi-\pi^e))^2$

FOC: $\pi = \lambda[k-(\pi-\pi^e)] = \lambda(u-u^T)$

Tradeoff between π and u

So if $u > u^T$, $\pi > 0$

① Public solves $\pi^e = E(\pi) = \lambda k > 0$

Outcome: $\pi = \lambda k > 0$ but $u = u^N$ ← u not at u^T!

COMPARE

If commit to $\pi = 0$: $\pi = 0$, $u = u^N$, $L^C = 0.5\lambda k^2$

If discretion: $\pi = \lambda k$, $u = u^N$, $L^D = 0.5(\lambda^2+\lambda)k^2 > L^C$ oh no!

- Under discretion, if CB pursues $u^T < u^N$, it's tempted to mechanically $\uparrow\pi$ to min L
- Policy is biased toward higher π
- But public rationally expects this, raise π^e (thus PC) up to where MB of $\downarrow u$ = MC of $\uparrow\pi$ Higher π, unchanged u!
- Commitment better than discretion

WITH SHOCK CB can react to ε but public cannot. Discretion can stabilise economy

BACKWARD INDUCTION follows Kydland-Prescott-Barro-Gordon

③ CB $\min_{\pi} 0.5\pi^2 + 0.5\lambda(u-u^T)^2$ assume no ε

Subject to constraints $\begin{cases} u = u^N - (\pi - \pi^e) + \varepsilon & \text{(PC with } \beta=1) \\ u^T = u^N - k & \text{(u target)} \end{cases}$

Sub in constraints: $\min_{\pi} 0.5\pi^2 + 0.5\lambda(k-(\pi-\pi^e)+\varepsilon)^2$

FOC: $\pi = \lambda[k-(\pi-\pi^e)+\varepsilon] = \lambda(u-u^T)$

So if $u > u^T$, $\pi > 0$

① Public solves $\pi^e = E(\pi) = \lambda k > 0$

COMPARE

If commit to $\pi = 0$: $\pi = 0$ $u = u^N + \varepsilon$

expected loss → $L^C = 0.5E[0^2 + \lambda(k+\varepsilon)^2] = 0.5\lambda(k^2+\sigma^2)$

If discretion: $\pi = \lambda k + \left(\frac{\lambda}{1+\lambda}\right)\varepsilon$

$u = u^N + \left(\frac{1}{1+\lambda}\right)\varepsilon$

$L^D = 0.5E\left\{\left[\lambda k + \left(\frac{\lambda}{1+\lambda}\right)\varepsilon\right]^2 + \lambda\left[\left(\frac{1}{1+\lambda}\right)\varepsilon + k\right]^2\right\}$

$= 0.5\lambda\left[(1+\lambda)k^2 + \frac{\sigma^2}{1+\lambda}\right]$

Rules ↓average π but ↑u volatility

Rules preferred to discretion when

$L^C < L^D \Leftrightarrow (1+\lambda)k^2 > \sigma^2$

↑k, larger temptation

↑λ, more tempted by temptation

↓σ, little scope for stabilisation

Rules vs Discretion

Rules

- Avoid temptations
- Discretion may introduce variability
- Stability (π=0) supports role of money in facilitating transactions

Discretion

- Time inconsistency problem too exaggerated Institutional design can address it! (Next page)
- Discretion allows for response to shocks (Covid)
- "With great power comes great responsibility (to use it!)"

INSTITUTIONAL DESIGN ↓ inflation bias

CB INDEPENDENCE

- Politicians care a lot about u; high k and λ
- Independence (appt/dismissal process; policymaking) ↓λ,k
- But risks technocracy

APPOINT A HAWK

- Make CB chairman dislike inflation more than society $\lambda^* < \lambda$
- ↓π but ↑u variability
- Optimal to do so a little at the margin
- Distorts response

$L^{hawk} = 0.5\pi^2 + 0.5\lambda^*(u-u^T)^2$

CONTRACT W PENALTY ON π

e.g. NZland

↑π ⇒ ↓wage of CB chair

$L^{CB\ chair} = 0.5(\pi^2 + \lambda(u-u^T)^2 + 2\omega\pi)$

$\pi = \lambda k - \omega + \left(\frac{\lambda}{1+\lambda}\right)\varepsilon$

$u = u^N + \left(\frac{1}{1+\lambda}\right)\varepsilon$ unchanged!

- Linear penalty only affects mean inflation, not variable response
- Can reach optimum by setting $\omega = \lambda k$
- But can always excuse high inflation with an EC
  + CB chair may care more about reputation than pay
    - "Even if wage is low, I can yeet to politics!"
- Hard to set contract

INFLATION TARGETING

Set a π^* (usually 0.02)

$L^{CB\ chair} = 0.5((\pi-\pi^*)^2 + \lambda(u-u^T)^2)$

$= 0.5[\pi^2 + \lambda(u-u^T)^2 - 2\pi^*\pi + \pi^{*2}]$ ignore this constant

Pick $\pi^* = -\omega = -\lambda k$ to get optimal solution

- Failing to meet π^* punishes reputation — more effective than ££
- V successful at getting stable (& low) π
- Can flexibly deviate from π^* in SR to respond to business cycle

CAN CB DO MORE?

- Address happiness/climate change/inequality
- Criticism: lack of clarity on goals
  - It's a trend, not a gap
  - How to measure progress
  - Is it even feasible
  - Should probably let elected gov do it?

OPTIMAL DEBT MANAGEMENT

MT'S CONSUMPTION PROBLEM

$$\max_{c_1,c_2,c_3} u(c_1)+\beta u(c_2)+\beta^2 u(c_3)$$
(β: impatience)

$$\text{s.t.} \begin{cases} c_1+s_1=y_1 \\ c_2+s_2=y_2+s_1(1+r) \\ c_3=y_3+s_2(1+r) \end{cases}$$

or just $c_1+\frac{c_2}{1+r}+\frac{c_3}{(1+r)^2}=W$,
$W=y_1+\frac{y_2}{1+r}+\frac{y_3}{(1+r)^2}$

CN SMOOTHING

Ricardo's simplification: $\beta=0, r=0, u(\cdot)=\log(\cdot)$
Solve to get $c_1=c_2=c_3=\frac{W}{3}$

- So only W/permanent income matters
- Time profile of income $\{y_1,y_2,y_3\}$ doesn't
- People borrow/save to smooth consumption

RICARDIAN EQUIVALENCE

Gov's intertemp budget with lump-sum taxes
$g_1+g_2+g_3=t_1+t_2+t_3$

Assuming taxes don't affect willingness to earn income (t not a function of y)

$W=y_1-t_1+y_2-t_2+y_3-t_3$
$=y_1+y_2+y_3-(g_1+g_2+g_3)$

Only W matters for c.
Time profile of $\{g_1,g_2,g_3\}$ and lump sum tax $\{t_1,t_2,t_3\}$ don't matter

DISTORTIONARY TAX

Consumer's budget: $\sum_{i=1}^{3}(1+\tau_i)c_i=W$

Gov's budget: $\sum_{i=1}^{3}\tau_i c_i=g$ (g: total spending)

...FOC: $\frac{c_3}{c_2}=\frac{1+\tau_2}{1+\tau_3}$

$\frac{c_3}{c_1}=\frac{1+\tau_1}{1+\tau_3}$

Consumption taxes change relative price of consumption/ relative return to saving in each period (not first-best)

OPTIMAL DEBT

If gov wants to $\max_{\tau_1,\tau_2,\tau_3}\sum_{i=1}^{3}\log(c_i)$ s.t. $\sum_{i=1}^{3}c_i=W-g$ (combined)
Solution: $c_1^*=c_2^*=c_3^*$, achieved by $\tau_1=\tau_2=\tau_3$

- Tax smoothing (using deficits/surpluses)
- Optimal debt management is to keep τ constant and use deficits/surpluses when spending/revenue deviates from average (similar to consumers use saving/borrowing)
  - e.g. war vs peace
  - ↑ recessions/booms
- Countercyclical stabilisation policy and optimal public debt management are two standard arguments for deficits in recessions

FIRST BEST

A tax plan is first best when it solves the benevolent social planner's problem
max $\Sigma \ln c_i$ st $\Sigma c_i=\Sigma y_i-\Sigma t_i$

- Lump-sum tax is first-best, distortionary taxes aren't

DYNAMIC INCONSISTENCY

SALIENCE OF THE PRESENT

Extra weight of present relative to future

At $t=1$, $U=\delta\log(c_1)+\log(c_2)+\log(c_3)$ $\delta>1$
$c_1+c_2+c_3=1$
Self-1 $\max_{c_1,c_2} U$ to get $\frac{\delta}{c_1}=\frac{1}{c_2}=\frac{1}{c_3}\Rightarrow c_1>c_2=c_3$

At $t=2$, $U=\delta\log(c_2)+\log(c_3)$, $c_2+c_3=1-c_1$
Self-2 $\max_{c_2} U$ to get $\frac{\delta}{c_2}=\frac{1}{c_3}\Rightarrow c_2>c_3$

- Procrastination: planned to consume (tax) same at 2 and 3 but actually consumes more (taxes less) at 2
- Very low c_3 when retired
- Dynamic inconsistency: early selves disagree with later selves
  - e.g. Gym memberships, deficits (delay ↓g/↑t)

SOLUTIONS

no. of countries with fiscal rules ↑↑↑ from 1990-2010
maybe bc welfare state ideas ↑↑ temptations

① Tie to the mast
Self-1 can enforce $\frac{\delta}{c_1}=\frac{1}{c_2}=\frac{1}{c_3}$ by making some savings illiquid & only available at $t=3$ (e.g. buying a house)
e.g. balanced budget rules – can't run deficit/surplus

② Raise borrowing/consumption costs
Make c_2 33% more expensive and c_3 33% cheaper
Self 2 $\max_{c_2} 2\ln(c_2)+\ln(c_3)$ s.t. $\frac{4}{3}c_2+\frac{2}{3}c_3=1-c_1\Rightarrow c_2=c_3$
e.g. constraints on bond issuance; debt limits
play sequential game against yourself, solve with BI

③ Nudge (paternalism)
Auto enroll in tax-advantaged (lucrative) savings plan by default on opt-out basis
e.g. Join the EU and blame Brussels for ↑t