Paper 2: **MACRO**

SUMMARY NOTES

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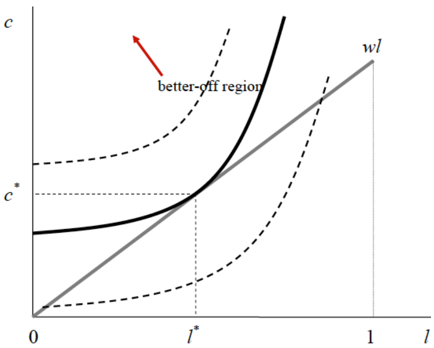
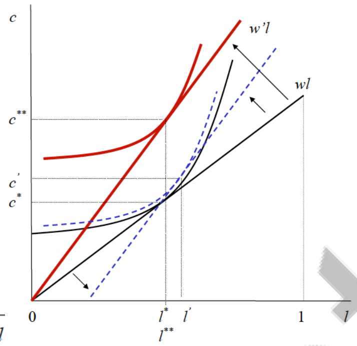
Intertemporal Macroeconomics

Static Model of Consumption and Leisure Choice

Robinson Crusoe Model

- *Set up:* Agent with non-satiated and variety (concave u-$f()$ produce convex ICs) preferences optimizes choice of c and L subject to the budget constraint.
- *Problem:* $\max_{c,L} u(c, 1-L)$ s.t. $c = wL + b$ produces $\mathcal{L} = u(c, 1-L) - \lambda[c - (wL + b)]$
- *Solution:* Standard Lagrange for c^*, L^*. $MRS = MRT$ condition gives $\frac{u_{1-L}}{u_c} = w$





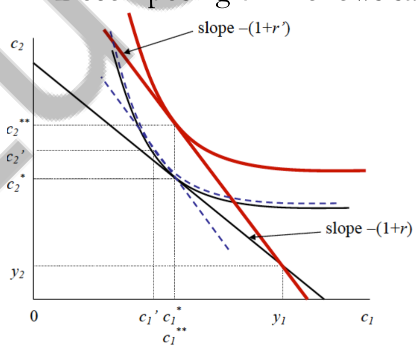
Income and Substitute Decomposition

- *Substitution Effect:* Change in the relative prices (i.e. w) assuming real income is unchanged. Modelled as a pivot of budget constraint around the endowment point (i.e. origin).
  - Overtime pay always increases labour supply
- *Income Effect:* Shift in feasibility set (i.e. Δb) assuming fixed relative prices. Modelled as a shift in budget constraint. Note that $|\Delta c| < |\Delta b|$ in all cases because variety preferences.
  - Wealth gift always decreases the labour supply
- *Decomposition of* $\uparrow w$:
  - Algebraically, Slutsky Equation states $\underset{(?)}{\frac{\Delta x_i}{\Delta p_i}} = \underset{(-)}{\frac{\Delta x_i^s}{\Delta p_i}} + (\omega_i - x_i)\underset{(?)}{\frac{\Delta x_i^m}{\Delta m}}$
  - Graphically, pivot budget constraint around IC then shift it to intersect with new optimal choice. [EE is another shift so intersects with endowment again]
  - Observe $\uparrow c$ and $\sim L$. However, empirically we have seen $\downarrow L$ since IR (60h to 44h week)

Intertemporal Consumption Choice

Saving and Borrowing

- *Budget Constraint:* $c_1 + \frac{c_2}{(1+r_1)} + \frac{c_3}{(1+r_1)(1+r_2)} \ldots = y_1 + \frac{y_2}{(1+r_1)} + \frac{y_3}{(1+r_1)(1+r_2)} \ldots$
- Agent may be saver or borrower, but aggregate economy is always at Polonius Point in equ
- Decomposing $\uparrow r$ follows same logic. Note sub effect is identical for saver and borrower.

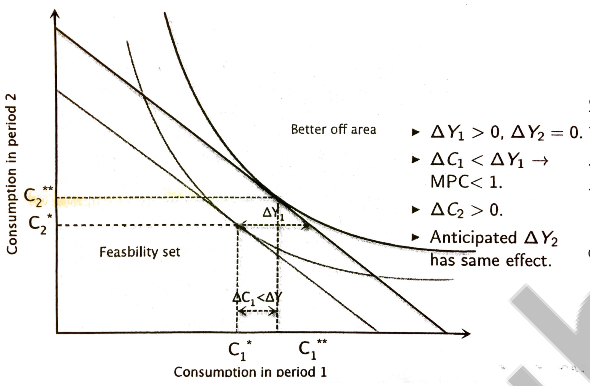


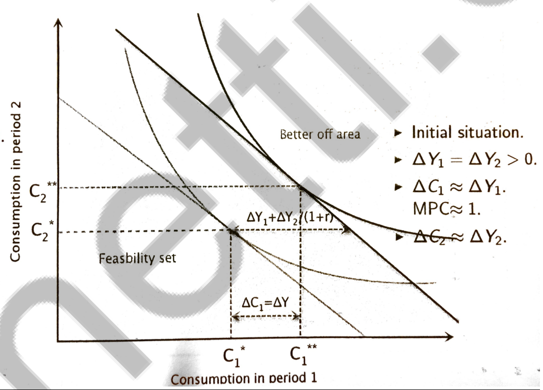
Euler Equation

- *Problem:* $\max_{c_1,c_2} u(c_1) + \beta u(c_2)$ s.t. $c_1 + \frac{c_2}{(1+r_1)} = y_1 + \frac{y_2}{(1+r_1)}$ where β is the discount factor
  - Can rewrite this as $\max_{c_1} u(c_1) + \beta u[(1+r)(y_1 - c_1) + y_2]$
  - Assume lifetime utility is additively separable (i.e. the thought of being rich tomorrow makes me no happier today) and discount factor β models degree of impatience
- *Solution:* Via FOC get condition $MB = MC$ of saving: $u'(c_1) = \beta(1+r)u'(c_2)$
  - Can rewrite this as $\beta \frac{u'(c_1)}{u'(c_2)} = 1 + r$
  - Intuitively, a rational consumer wishes to consume where the marginal returns of consumption today and the discounted marginal return in the next period are equal.

Shocks

Temporary: $\Delta y_1 > 0$ Permanent: $\Delta y_1 = \Delta y_2 > 0$



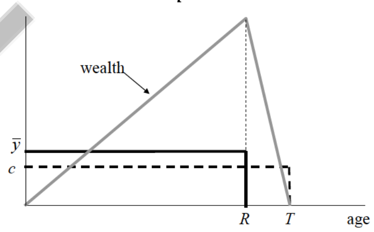


Note on Income Definitions

- NPV Income: $\bar{Y}_t = \sum_{s=t}^{\infty} \frac{Y_s}{(1+r)^{s-t}}$
- Permanent Income: Y^P s.t. $\bar{Y}_t = \sum_{s=t}^{\infty} \frac{Y^P}{(1+r)^{s-t}}$. Solving, get $Y^P = \frac{r}{1+r}\bar{Y}_t$
- Transitory Income: $\tilde{Y}_t$ s.t. NPV- and Permanent- unchanged (e.g. +£100 now, -£100 future)
- $Y = Y^P + \tilde{Y}_t$

Modigliani's Life Cycle Hypothesis (LCH)

- *Set Up:* Individuals, living for T periods and facing constraint $y + b_{t-1}(1+r) = c_t + b_t$
  - Budget constraint $c_1 + \frac{c_2}{(1+r)} + \cdots \frac{c_T}{(1+r)^{T-1}} = y_1 + \frac{y_2}{(1+r)} + \cdots \frac{y_T}{(1+r)^{T-1}} + b_0(1+r)$
  - Assume $b_T = 0$ (i.e. cannot leave behind debts and choose not leave bequests)
- *Solving:* Choose to consume constant $\bar{c}$ in every period (i.e. consumption smoothing)
  - Temporary Income Shock in period t only causes small Δc_t (although bigger for later t)
    - MPC depends on the age of the consumer (a consumption smoothing 65-year old will immediately spend much more of a windfall than a 25-year old)
    - Note, expected changes in future income immediately affect current consumption.
  - $MPC_{perm} = 1$

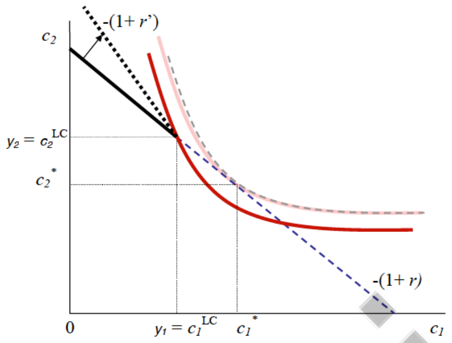


Friedman's Permanent Income Hypothesis (PIH)

- *Set Up:* Extends LCH by assuming individuals care about "next of kin". Hence agents will act as if their lives are infinitely lived: $U_1 = u(c_1) + \beta u(c_2) + \beta^2 u(c_3) \ldots$
  - Derive budget constraint $\sum_{t=1}^{\infty} \frac{c_t}{(1+r)^{t-1}} = \sum_{t=1}^{\infty} \frac{y_t}{(1+r)^{t-1}} + b_0(1+r)$
  - Assume $\lim_{t\to\infty} \frac{B_t}{(1+r)^t} \geq 0$ (i.e. debts cannot grow faster than interest, else could fund infinite consumption by borrowing increasingly more)
- *Solving:* Use $\mathcal{L}$ then $\frac{d}{dc_t}$: $\beta^{t-1}u'(c_t) = \frac{\lambda}{(1+r)^{t-1}}$ and $\frac{d}{dc_{t+1}}$: $\beta^{t-1}u'(c_{t+1}) = \frac{\lambda}{(1+r)^t}$
  - Combine to obtain Euler Equation (!): $u'(c_t) = \beta(1+r)u'(c_{t+1})$
  - In an environment with no shocks, expect c_t and y_t to be uncorrelated (only depends on y^p). Explains why groups with below average y^p save more at all level y (e.g. black USA)
  - Note than in special case $\beta(1+r) = 1$ and $y_t = y$ we get…
    - $c_t = \frac{r}{1+r}\left(\sum_{s=t}^{\infty} \frac{Y}{(1+r)^{s-t}} + b_t(1+r)\right) = \frac{r}{1+r}\left(Y_t + \frac{Y}{r} + b_t(1+r)\right) = \bar{c}$
    - Consumer discounts future utility at same rate as market. Hence no incentive to tilt
    - $MPC_{Temp} = \frac{r}{1+r}$ and $MPC_{Perm} = 1$

Liquidity Constrained Consumer

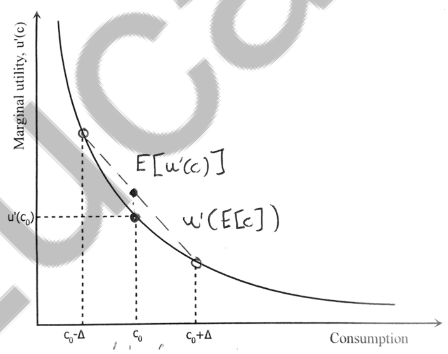
- Savers are unaffected, borrowers are (and consume on the endowment point)



- In this case even a transitory income change affects behaviour as it changes endowment
- Keynesian Link: Suppose β of population are LCC and $1-\beta$ are PIH consumers then…
  - $C = \beta c^{LCC} + (1-\beta)c^{PIH} = \beta Y + (1-\beta)c^{PIH} = \beta Y + \alpha$
  - Campbell & Mankiw estimate $\beta = 0.5$. Note that $\alpha(r)$ i.e. not a constant!

Uncertainty

- Rewrite opt. $U_t = \max E_t\{\quad\}$ and (Stochastic) Euler as $u'(c_t) = \beta(1+r)E_t\{u'(c_t+1)\}$
- Note that because the indifference curve is convex we have $E(f(x)) \geq f(E(x))$



- *Precautionary Savings:* $\uparrow \Delta$ (i.e. volatility), $\uparrow E\{u(c_t)\}, \uparrow s$ to restore Euler since risk averse
- Revisiting PIH we note $c_t = \frac{r}{1+r}E_t\{PV(Y)\}$. Assumes volatility in future income does not matter for current choices (i.e. certainty equivalence). IRL people are risk averse.

Hall's Random Walk Hypothesis

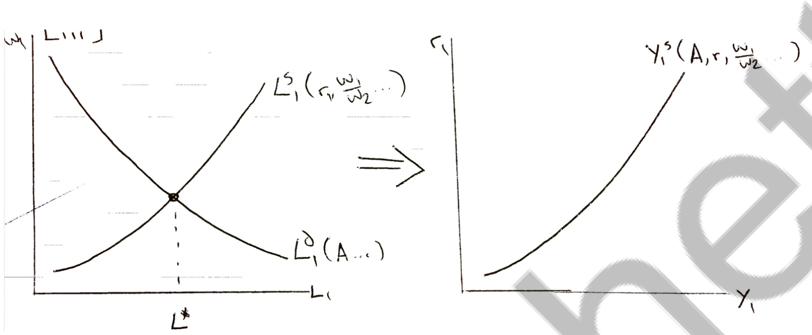
- *Strong Assumptions:* Let $\beta(1+r)=1$ and $u(c_t)=ac_t-bc_t^2$ (so do not have issue above)
- $c_t=E_t\{c_{t+1}\}$. Best estimate of c tomorrow is c today so any changes are unpredictable

Intertemporal Neoclassical Model

- Apply intertemporal model to household labour supply choice and sub into each other:
    - $\max U=u(C_1)-L_1+\beta u(C_1)-L_2$ s.t.
    - $w_1L_1+w_2L_2(1+r)=C_1+C_1(1+r)$
    - $\frac{u_\ell(1-L_1)}{u_\ell(1-L_2)}=\beta(1+r)\frac{w_1}{w_2}$

Labour Market

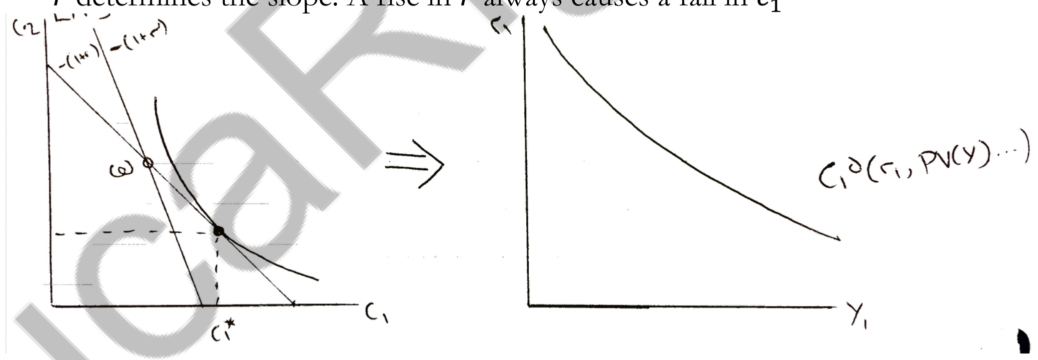
- L^* is determined by L_1^d and L_1^s.
- L^d s.t. $MPL=AF'(L)=w$
    - $\uparrow L,\downarrow MPL$ (due to DMR), $\downarrow w$
    - $\uparrow A,\uparrow MPL,\uparrow w$
- L^s s.t. Euler: $\frac{u_\ell(1-L_1)}{u_\ell(1-L_2)}=\boldsymbol{\beta(1+r)}\frac{w_1}{w_2}$.
    - $\uparrow w,\uparrow L$ (work P1 if higher w)
    - $\uparrow r,\uparrow L$ (work P1 if ↑return from s)



- Can hence rewrite as $Y_1^s=f\left(A,r,\frac{w_1}{w_2}\right)$ Note that it slopes up in r (higher r makes it more attractive to earn today, increasing L_1^s and thus Y_1^s

Goods Market

- Present Value acts as the budget constraint. At the Macro level $PV(Y)$.
- r determines the slope. A rise in r always causes a fall in c_1

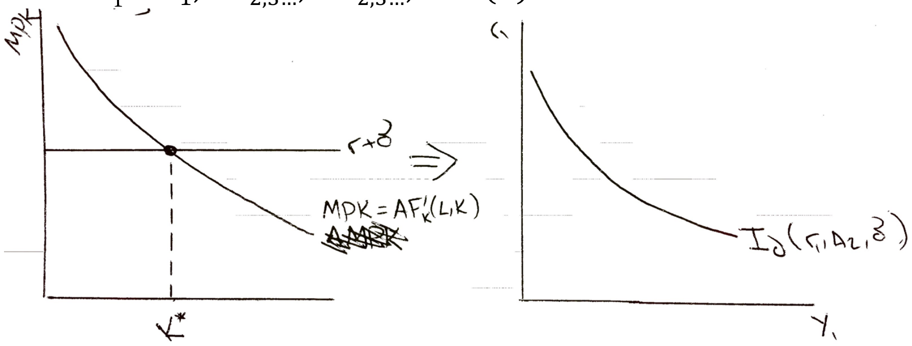


Capital Market

- IRL around 90% of output volatility is from investment. Thus critical we include this. Use 'time to build' relationship $K_2=(1-\delta)K_1+I_1\ldots$
- "User Cost of Capital": $MPK_2+(1-\delta)>(1+r)$ so $MPK_2=r+\delta$ (i.e. $MB=MC$).
    - Intuitively, RHS is MB of one unit of C at time t+1 (i.e. opportunity cost) and LHS is MB of I (actual output of investment and value of investment at t+1)
    - Tobin's q: Rearrange to $\frac{MPK_2}{r+\delta}=q$ (i.e. ratio of profit over cost). Alternatively, derive by infinity summing PV of a investment unit's returns: $q=\frac{MPK-\delta}{1+r}+\frac{MPK-\delta}{(1+r)^2}+\cdots=\frac{MPK}{r+\delta}$

- We note that $\uparrow A_2, \uparrow MPK_2, \uparrow I^d$ and $\uparrow r, \downarrow I^d$ (higher cost of borrowing means less investment). Thus $I_1^d(r, A_2, \delta) = K_2^d(r, A_2, \delta) - (1-\delta)K_1$

- Note: Including I sometimes means we dampen C via resultant Δr due to C-smoothing
- 1st Tip: $\uparrow I_1, \uparrow K_{2,3\ldots}, \uparrow w_{2,3\ldots}, \uparrow PV(Y)$



Output

- $Y_1^d = C_1^d + I_1^d = f(A_2, r, \text{PV}(Y), \ldots)$.
- $Y_1^s = f(A, K, L, \alpha) = f\left(A_1, r, \frac{w_1}{w_2}, \ldots\right)$. $\uparrow r, \uparrow L^s, \uparrow L^*, \uparrow Y$, hence upwards sloping

RBC Comparative Statistics

Shock	Direct	Indirect	Outcome
$\Delta A_1 = \Delta A_2 > 0$	$\uparrow A_1, \uparrow Y^s$ $\uparrow A_1, \uparrow MPL_1, \uparrow L^d, \uparrow L^*, \uparrow Y^s$ $\uparrow A_2, \uparrow MPL_2, \uparrow I^d, \uparrow Y^d$	$\uparrow Y^*, \uparrow PV(Y), \uparrow C^d$	$\uparrow Y^*, -r^*$ if exc. I since $1+r = \frac{1}{\beta}\left(\frac{A_1}{A_2}\right)$ $\uparrow r^*$ if inc. I (so $S = I$)
$\Delta A_1 > 0$; $\Delta A_2 = 0$	$\uparrow A_1, \uparrow MPL_1, \uparrow L^d, \uparrow L^*, \uparrow Y^s$	$\uparrow A_1, \uparrow \frac{w_1}{w_2}, \uparrow L_1^s, \uparrow L^*, \uparrow Y^s$ $\uparrow Y^*, \uparrow PV(Y), \uparrow C^d$	$\uparrow Y^*, ?r^*$
$\Delta A_1 = 0$; $\Delta A_2 > 0$	$\uparrow A_2, \uparrow MPL_2, \uparrow I^d, \uparrow Y^d$	$\uparrow A_2, \downarrow \frac{w_1}{w_2}, \downarrow L_1^s, \downarrow L^*, \downarrow Y^s$ $?Y^*, ?PV(Y), ?C^d$	$?Y^*, \uparrow r^*$

Government

Set Up

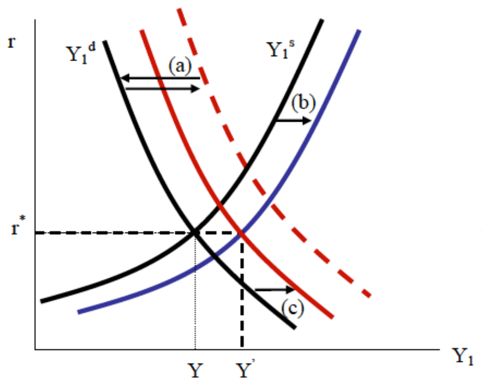
- *Comprehensive Case:* $G_t + V_t + rD_t = T_t + \frac{\Delta M_t}{P_t} + \Delta D_t$
- *Simple Case:* $G_t = T_t$ where G_t is 'useless' and T_t is lump-sum (i.e. non-distortionary)
- Hence new $Y_t^d = C_t^d(wL_t - T_t) + I_t^d + G_t$
- Note that $\Delta T = -\Delta Y$: $Y_1 - T_1 + \frac{Y_2 - T_2}{1+r} = C_1 + \frac{C_2}{1+r}$

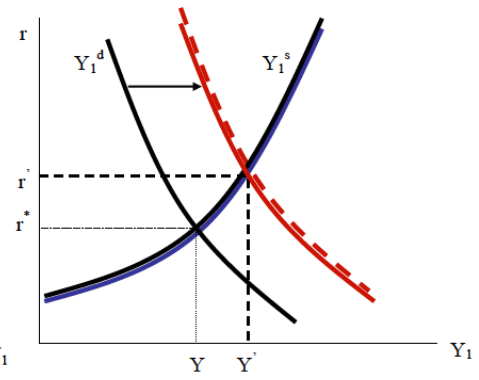
Comparative Statistics

<u>Permanent $\uparrow G$</u>

a) Crowding Out: $\uparrow G_1, \uparrow Y_1^d$ but one-for-one $\uparrow T_1, \downarrow C_1^d, \downarrow Y_1^d$
b) Wealth Effect: a) $\downarrow C_1^d, \uparrow u'(C), \uparrow u'(l)$ [via MRS=MPL $\frac{u'(C)}{u'(l)} = w$], $\uparrow L_1^s, \uparrow Y_1^s$ (thus $\downarrow C_1^d$ somewhat offset as pie grows; assumes no GHH preferences)
c) $\uparrow T_P, \downarrow$ disposable income, $\downarrow l^d, \uparrow L_s, \uparrow Y_1^s, \uparrow PV(Y), \uparrow C_1^d, \uparrow Y_1^d$ (1 for 1)

- Thus get output $\uparrow Y^*, -r^*$ (permanent so does not distort intertemporal allocations)
- Increase in GDP but less happiness (since less C and more L). But G can also have other effects IRL: infrastructure ΔMPK and public goods $u(\quad)$
- Government spending multiplier is <1. If dY/dG>1 then C would have needed to increase because we know that disposable income (i.e. C) falls





<u>Temporary $\uparrow G$</u>

Direct: increase in aggregate demand (same as for permanent)

a) $\uparrow G_1, \uparrow Y_1^d$ but one-for-one $\uparrow T_1, \downarrow C_1^d, \downarrow Y_1^d$. Note that $\downarrow C_1^d$ is small since fall in disposable income is only temporary

b) $\uparrow L_1^s, \uparrow Y_1^s$ is small since fall in $PV(Y)$ is small. Again this is small

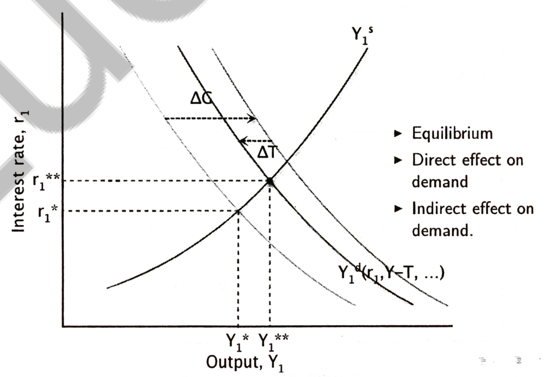
c) Note that $\frac{w_1}{w_2}$ is unchanged since we assumed lump-sum taxes

- Thus get output $\uparrow Y^*, \uparrow r^*$ (individuals borrow to smooth consumption and this drives up r)
- Higher r leads to further crowding out of C (movement along the curve)
- Neoclassical model does not predict that fiscal policy in form of G is neutral!

	Keynesian Model	Neoclassical (RBC) Model
	Ricardian Equivalence	
Conclusion	Doesn't Hold	Holds
Direct	$\beta(Y_1 - T_1)\uparrow$, so $Y^d \uparrow$	$(Y_1 - T_1)\uparrow$ offset by $\frac{Y_2 - T_2}{1+r}\downarrow$
Net Effect	$r\uparrow$, $Y^d\uparrow$, Y^s unchanged	r, Y^d, Y^s unchanged
	Permanent $G\uparrow$	
Direct	$Y^d\uparrow$, partly offset by $T^d\downarrow$	$Y^d\uparrow$, entirely offset by $T^d\downarrow$
Indirect	Y^s unchanged	$L^s\uparrow$ causes, $Y^s\uparrow$
Indirect		$L^s\uparrow$ also causes $PV(Y)\uparrow$, $Y^d\uparrow$
Net Effect	$r\uparrow$, $Y^d\uparrow$, Y^s unchanged	$Y^d\uparrow$, $Y^s\uparrow$, $L\uparrow$, $C\downarrow$, r unchanged
	Temporary $G\uparrow$	
Direct	$Y^d\uparrow$, partly offset by $T^d\downarrow$	$Y^d\uparrow$, partly offset by $T^d\downarrow$
Indirect	Y^s unchanged	$L^s\uparrow$ causes, $Y^s\uparrow$
Indirect		$L^s\uparrow$ also causes $PV(Y)\uparrow$, $Y^d\uparrow$
Net Effect	$r\uparrow$, $Y^d\uparrow$, Y^s unchanged	$Y^d\uparrow$, $Y^s\uparrow$, $L\uparrow$, $C\downarrow$, $r\uparrow$

Notes: Author's interpretation of stylised conclusions. Welfare falls as $G\uparrow$, as this is assumed to be wasteful government spending.

LCC Keynesian Model



- Recall $C_1 = \alpha + \beta(Y_1 - T_1)$ where β is proportion LCC (i.e. MPC).
- Note that individuals are not forward looking, so permanent and temporary case are identical

Ricardian Equivalence

- To isolate effect of borrowing, consider where we cut taxes today and raise them tomorrow:
  - $\Delta T_2 = (1 + r)\Delta D_1 = -(1 + r)\Delta T_1$
- PIH: Recall NPV Income is $Y_1 - T_1 + \frac{Y_2 - T_2}{1+r}$. Hence ΔT_1 only changes endowment, not opt.!
  - *Debt Neutrality Theorem*: Given G, a decline in lump-sum tax financed by deficit and future tax increases has no effect on the real economy. Intuitively, as agents envisage having to pay back deficit in future, they do not increase consumption, despite increase in income.

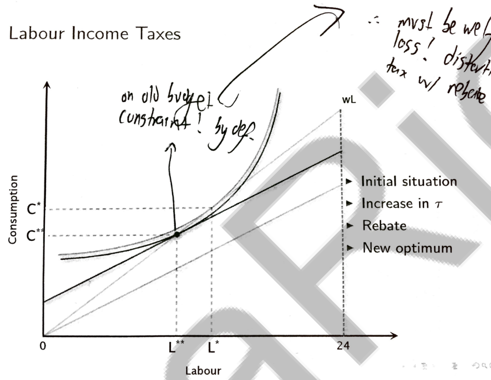
But…

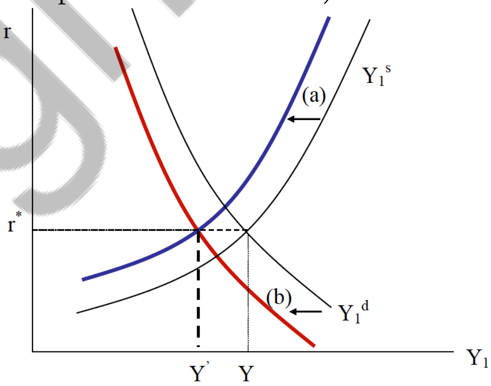
- LCH: Some will die after $t = 1$. The tax cut increases disposable income of those consumers whose horizon is shorter than the time of future tax increases (make future generations pay)
- Keynesian: LCC consume all additional disposable income in $t = 1$ so C increases by β (i.e. MPC) and L^s decreases. However, as r also increases implies less I and thus less future grow
- IRL: European Central Bank (2005) and Cuaresema (2007) find mixed evidence, with RE holding for some, but not all countries in the EU, with similar controversy in the US
  - Assumes strong REH holds, agents cannot leave debt on their death, perfect capital markets, and the tax schedule is non-distortionary.

Taxes

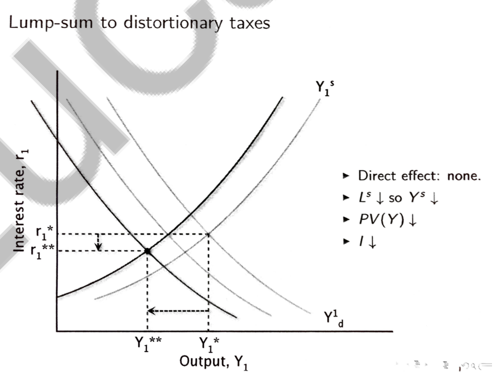
- *Income Tax:* $C = w(1 - \tau)L + b$
  - To isolate distortions consider tax rebated in lump-sum fashion: $b = w\tau L$ (rebate spread across society so not internalized by the consumer as otherwise not lump-sum)
  - Only indirect effects: (a) $\downarrow L_1^s, \downarrow Y_1^s$ (i.e. negative sub. effect) and (b) $\downarrow C_1^d, \downarrow Y_1^d$ mean we have total $\downarrow Y^*, -r^*$(since intertemporal plans are not affected)

∴ must be welfare loss! distortionary tax w/ rebate.





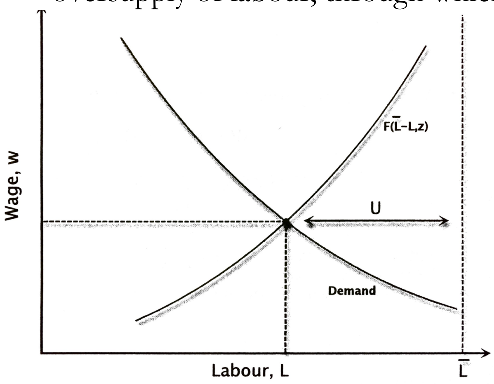
- *Capital Gains Tax:* $(1 - \tau)[A_2 MPK_2 - \delta] = r$
  - Note that $\uparrow \tau, \uparrow MPK_2, \downarrow I^d$

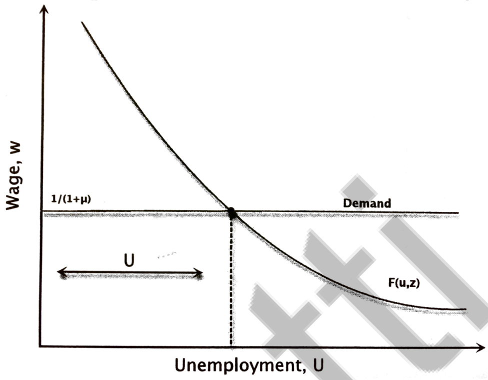


Unemployment and Labour Market

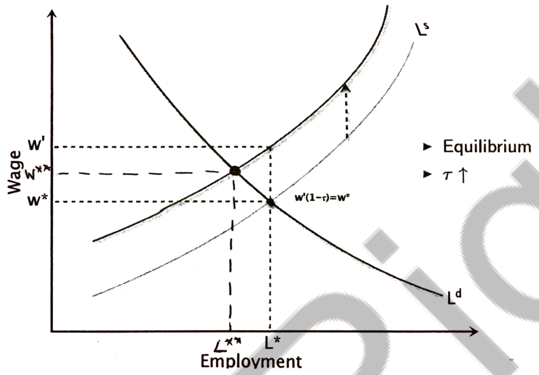
Preliminary Ideas

- Frictional Unemployment: While there may be a job for every individual (and vice versa), the matching process is imperfect. Unemployment persists as workers find the *right* job.
- Structural Unemployment: If we allow labour to be hetero, we note that a worker may be willing to work for a given wage, but could have the wrong skillset until they are retrained.
- Cyclical Unemployment: If wages are rigid, then a fall in labour demand causes an oversupply of labour, through which unemployment can occur (i.e. during downturns)

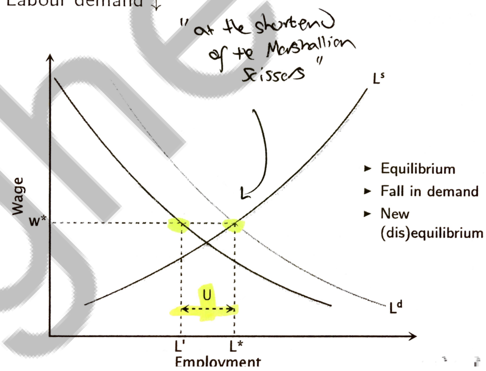




Note, as long as we are on L^s curve $u = 0$. Markets clear but people just want to work less!



Labour demand ↓



Skilled and Unskilled

- Two types of workers: L^s skilled and L^u unskilled
- Firms $\pi = \max_{L^s,L^u}\{F(L^s, L^u) - w^s L^s - w^u L^u\}$ so FOC gives $\frac{w^s}{w^u} = \frac{F_s(\bar{L}_s,\bar{L}_u)}{F_u(\bar{L}_s,\bar{L}_u)}$
- If gov. sets min. wage s.t. $\tilde{w} > w^u$ then get $F_u(\bar{L}_s, \tilde{L}_u)$ where $\tilde{L}_u < \bar{L}_u$. Unskilled u!

Basic Efficiency Wages Model

- Concern adverse selection (likely to attract better potential workers), moral hazard (employed workers feel obliged to work hard) and friction (Salop - min turnover e.g. Navy SEAL)

Basic Model: *Moral Hazard*

- Assume N identical firms that will hire L labour
- $Y = F(eL) : e = e(w, w_{other}, u)$ where $e_w, e_u > 0$ and $e_{other} < 0$ (i.e. convex)
- $\pi = \max_{w,L} F[e(w, w_{other}, u)L] - wL$
  - FOCs gives $\frac{\partial}{\partial L} : F'[e(w)L]e(w) - w = 0$ and $\frac{\partial}{\partial w} : F'[e(w)L]e'(w)L - L = 0$
  - Combining we get $e(\quad) = e'(\quad)w$, which is akin to $\max \frac{e(w)}{w}$ [i.e. max effort per dollar]
  - Solve for w^* (independent of L!) and sub back we get $F'[e(w^*)L^*]e(w^*) = w^*$ with L^*
  - Thus if $NL^* < \bar{L}$ then $u = \frac{\bar{L} - NL^*}{\bar{L}}$

Summers (1988) Interpretations

- Let $e\begin{cases}\left(\frac{w-\chi}{\chi}\right)^{\beta} & \text{if } w>\chi \\ 0 & \text{otherwise}\end{cases}$ where $\chi = (1-bu)\,w_a$. In equilibrium $w = w_a \therefore u^* = \frac{\beta}{b}$
- High β = effort is very sensitive to wages
- But Barro: "An efficiency-wage theory of weather" replaces u with t, showing miss specifics

Shapiro-Stiglitz Model

Model

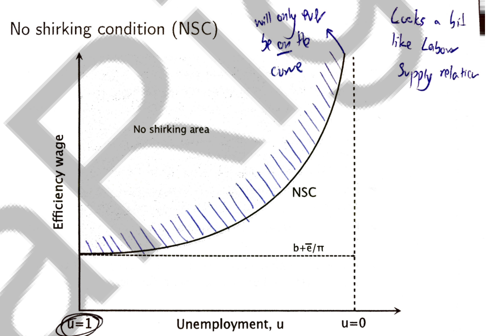
- Assume identical firms with workers moving seamlessly ($w = w_a$). Also let unemployment and probability of finding a different job be related by $u = 1 - p$ for simplicity
- Worker wants to shirk effort $\bar{e}$ but may get caught and fired (so on benefits b) with prob. π
  - $E[u(\text{shirks})] = (1-\pi)w + \pi[pw_a + ub]$ and $E[u(\text{works})] = w - \bar{e}$
  - *No Shirking Condition* (NSC): $E[u(\text{works})] \geq E[u(\text{shirks})]$ i.e. $w \geq b + \frac{\bar{e}}{\pi u}$
- Firms do not know who will shirk but determine u endogenously
  - Firms determine u endogenously $\pi = \max_L\{F(\bar{e}) - wL\}$
  - FOC gives $\bar{e}F'(\bar{e}L) = w$ and so $u(w) = \frac{\bar{L}-NL(w)}{\bar{L}}$

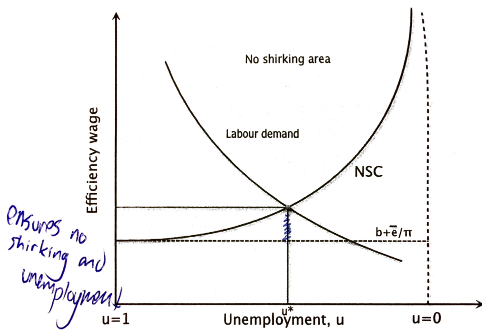
Insights

- Firms pay higher wages (i.e. create unemployment) to make shirking unattractive and ensure that IRL nobody does so
- Empirically backed by Henry Ford's Experiment: Introduction of \$5/h 8h worked day reduced absenteeism from 10% to 2.5%
- Comparative Statistics. Note $\Delta\pi$ has slope <u>and</u> shift effect with total effect $\downarrow u$

	w	u
$\downarrow b$	$\downarrow$	$\downarrow$
$\downarrow A$	$\downarrow$	$\uparrow$
$\uparrow \pi$	$\downarrow$	$\downarrow$

  - $\frac{dw}{du} = -\frac{e}{\pi u^2}$ and $\frac{d^2w}{dud\pi} = \frac{\bar{e}}{\pi^2 u^2}$. Thus $\uparrow \pi, \uparrow \frac{dw}{du}$ (i.e. fear of u affects w)
  - Intuitively, $\uparrow \pi$ must lead to $\downarrow u$ because market is less distorted as asymmetry is eliminated and thus closer the full information benchmark





McCall's Search Model

Theory

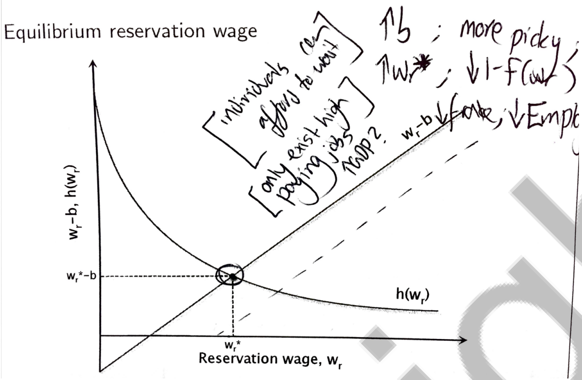
- *Motivation:* Let δ be finding rate and λ the separation rate. Hence $u^* = \frac{\lambda}{\delta+\lambda}$ and $E(\text{duration}) = \frac{1}{\delta}$. But where do these come from?
- *Set-Up:* Worker receives job offer with w drawn from CDF $F(w)$. May accept or reject this offer (instead receiving benefits and applies a new next period)
  - $u(\text{accept}) = \sum \beta^t w = \frac{w}{1-\beta}$ and $u(\text{reject}) = b + E\max\left\{U; \frac{w}{1-\beta}\right\}$
- *Calculation:* Let w_r be the reservation wage s.t. $U = \frac{w_r}{1-\beta}$. Use this to rewrite indifference:
  - $\frac{w_r}{1-\beta} = b + \beta E\max\left\{\frac{w_r}{1-\beta}; \frac{w}{1-\beta}\right\}$

- $\frac{w_r}{1-\beta} = b + \beta\left[\int_0^{w_r} \frac{w_r}{1-\beta} dF(w) + \int_{w_r}^{\infty} \frac{w}{1-\beta} dF(w)\right]$ [where $dF(w) = f(w)dw$]
- $\frac{w_r}{1-\beta} = b + \frac{\beta}{1-\beta}\left[\int_{w_r}^{\infty} (w - w_r)\, dF(w)\right]$
- $w_r - b = \frac{\beta}{1-\beta}\left[\int_{w_r}^{\infty} (w - w_r)\, dF(w)\right]$ [RHS is discounted expected improvement in U]
- $w_r - b = h(w_r)$ [i.e. opp cost of not accepting equals expected PV of waiting]
- We observe that:
  - $h(w_r) = \frac{\beta}{1-\beta}\left[\int_{w_r}^{\infty} (w - w_r)\, dF(w)\right]$ where $h(0) > 0$ and $h(\infty) = 0$
  - $h'(w_r) = -\frac{\beta}{1-\beta}[1 - F(w_r)] < 0$ using Leibnitz rule. [intuitively $1 - F(w_r)$ is probability of drawing wage higher than w_r]

- *Solution:* Infer $w_r > b$. Difference represents option value of search s.t. $w_r = b + h(w_r)$
  - Frictional unemployment is created by individuals waiting for good jobs

Comparative Statics

- $\downarrow b$, shifts up, $w_r - b$, $\downarrow w_r$. Intuitively, waiting becomes less attractive so lower wage needed to induce acceptance.
- $\uparrow \beta$, shift up $h(w_r)$ and gradient becomes steeper, $\uparrow w_r$. Intuitively, workers become more patient so more willing wait for future job so higher wage needed to induce them to accept.



$$V_u = \underbrace{b + \beta V_u}_{\text{If remain unemployed}} + \underbrace{\beta \int_{w_r}^{\infty} \Big(V_e(w) - V_u\Big) dF(w)}_{\text{Surplus if finds a job}}.$$

Essay Plan

Short Exposition of McCall

- Unemployment is the by-product of search frictions. Individuals search for one job in every period and must then decide whether to accept.
- Assumes job offered would provide wage w, which is randomly drawn from $F(w)$. Continuing to rely on benefits would provide b.
- Hence reservation wage $w_r = b + \epsilon$ since also forgo opportunity of finding a possibly higher paying job. Friction is thus the voluntary decision to wait for a better job to arrive
  - Raising b increases unemployment in SR but may raise GDP in M/LR
- Note strong assumptions: people 'stuck' in job for an infinite amount of time and workers have perfect info about the distribution of wages, workers receive a single offer each period.

Rothschild & Diamond

- *Rothschild*: (i) Criticizes assumption of non-uniform $F(w)$ if there is homo labour and also (ii) since workers always accept w_r, firms would never offer anything more [or less] than w_r.
  - McCall has no satisfying explanation of wage setting. Workers are rational but firms not
- *Diamond*: If firms do act rational, model breaks down. Once job seeker has come to a firm their search costs are sunk. Thus, perfectly informed firm $w = w_r = b$.
- Thus a forward looking agent will choose to avoid these costs entirely by not searching in the first place ("there is no option value in searching). Labour market breaks down.

- Hall and Krueger (2008): IRL observe $w > b$ and functioning labour markets even when model's assumptions are fulfflilled (firm set wages and know w_r)

Reconciliation

- Labour market institutions trivially resolve Diamond critique by forcing firms to pay higher wages (trade unions, min wage laws etc.). Yet these are weak in many functioning countries
- *Burdett & Judd (1983):* workers receive multiple offers in a single period. Competition between workers ensures $w > b$. Requires that workers already hold a potential job offer (or have a job) when bargaining with a different firm. IF this is the case, firms simply renege.
- *Mortensen (2003)*: Wages are advertised beforehand so workers direct their search to firms that at least reimburse them for their search costs. Firms do not renege due to reputation.
- Efficiency wage e.g. *Shapiro-Stiglitz*: Firms have imperfect info of workers' effort and thus need pay wages above w_r. Assume benefit of the efficiency wage is higher than search cost.
- *Poeschel (2010):* combines "advertised wages" with SS shirking model. Repeated sequential game in which firm sets wage and worker chooses effort. Advertised wages anchor workers' belief so if the firm reneges workers can credibly retaliate by shirking (white strike).

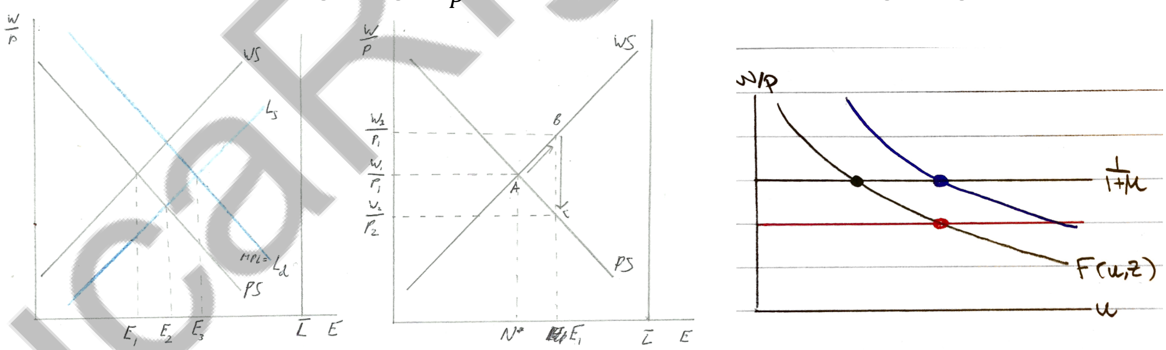
NAIRU & Phillip's Curve

Intuition

- Now consider market imperfections i.e. frictions. Losing a prospective employee/employer after being matched is costly because of search costs. Thus we have bilateral monopoly.
  - Wage setting: Union workers negotiate so $W = P^e F(u, z)$ [graphically WS above Ls]
  - Price setting: Mono-comp firms set $P = (1 + \mu)W$. [graphically PS below Ld]
- Thus obtain equilibrium involuntary unemployment. However, note that whilst WS relationship sets real wages based on price expectations, PS is based on the actual prices (since firms get to set prices).

Natural Rate of Unemployment

- Let $W = P^e F(u, z)$ & $P = (1 + \mu)W$. Now $P^e = P$ so $F(u_N, z) = \frac{1}{1+\mu}$ where NRU is u_N
  - $\uparrow b$, $\uparrow$worker bargaining, $\uparrow W$, $\frac{W}{P} > \frac{1}{1+\mu}$, $\uparrow u$, $\downarrow$worker bargaining, $\downarrow W$ [see blue]
  - $\uparrow \mu$, $\uparrow$firm bargaining, $\downarrow \frac{W}{P}$, workers reject, $\uparrow u$, $\downarrow$worker bargaining, $\downarrow W$ [see red]



- If $u < u_N$, nominal wages will increase when renegotiated next period. However, when firms agree, they bring economy to PS-curve real-wage by increasing P.
- This can only be maintained if, for each period, accelerating inflation continues. Thus equ u is also known as non-accelerating inflation rate of unemployment: NAIRU

Philips Curve

- Now also let $F = e^{z - \alpha u_t}$ and drop assumption $P^e = P$. Thus…
  - Substitution $P_t = P_t^e(1 + \mu)F(u_t, z) = P_t^e(1 + \mu)e^{z - \alpha u_t}$
  - Log Tricks: $\pi_t = \pi_t^e + (\mu + z) - \alpha u_t$
  - Rearrange as $\pi_t - \pi_t^e = (\mu + z) - \alpha u_t$. Intuitively, only surprise changes have an effect.

Fixed Expectations

- Let $\pi^e = 0$ (arbitrary), thus $\pi_t = (\mu + z) - \alpha u_t$
  - π, u are ve⁻ related. Intuitively, $\uparrow u$, $\downarrow$ worker bargaining, $\downarrow \frac{W}{P}$, $\downarrow \pi$ OR $\downarrow \pi, \uparrow \frac{W}{P}, \uparrow u$

Adaptive Expectations

- Let $\pi_t^e = \pi_{t-1}$, thus $\pi_t - \pi_{t-1} = (\mu + z) - \alpha u_t$. Now changes in rate of π matter
- Sub in NRU equation $\left[\frac{1}{1+\mu} = e^{z-\alpha u_n} \text{ thus } -\ln(1+\mu) \approx \mu = z - \alpha u_n\right]$
- Now get $\pi_t - \pi_t^e = -\alpha(u_t - u_n)$

NAIRU: If $u_t - u_n$ rate of π is decreasing. If $u_t = u_n$ then π is constant. Hence u_n is NAIRU.

Rational Expectations

- Rigidity in P^e is imperative. If $P_t^e = P_t$ fall in P is immediately met by fall in wages 1:1. Hence no impact on u. With rigidity (i.e. not 1:1) u adjusts so that $\frac{1}{1+\mu} = \frac{P^e}{P} F(u, z)$
- $\pi = pL - wL$ (i.e. firms are indifferent about how much labour to hire). Firms would hire everyone if $\frac{W}{P} = \frac{1}{1+\mu}$ but if $U = 0$ workers will bargain up $\frac{W}{P}$

Wage Indexing

- Suppose λ of pop index wages (i.e. rational expectations): $\pi_t - \pi_{t-1} = -\frac{\alpha}{1-\lambda}(u_t - u_n)$
  - Intuitively: $\downarrow u, \uparrow w, \uparrow P, \uparrow w_{index}, \uparrow\uparrow P$
  - Indexing wages can make π worse! IRL high π is strongly correlated with high var in π

Phillips Curve - Essay Plan

Intro/Conclusion

- Assume prices are determined in a bilateral monopoly between labour demanding wages [$W = P^e F(u, z)$] and monopolistic firms setting prices $P = (1 + \mu)W$:
  - $P_t = P_t^e (1 + \mu) F(u_t, z)$
  - $P_t = P_t^e (1 + \mu) e^{z - \alpha u_t}$
  - $\pi_t = \pi_t^e + (\mu + z) - \alpha u_t$
- Determinant of the relationship between π and u depends on how we model π^e.
- Model π_t^e as a weighted average between: $\pi_t^e = (1-\theta)\bar{\pi} + \theta \pi_{t-1}$ where $\theta = 0$ pre-70s. $\theta = 1$ mid-70s and $0 < \theta < 1$ today.
- Comprehensive model would endogenously determine θ (public perception of CB and its credibility). Any attempt to game the system will feedback into θ

Fixed Expectations

- <u>Theory</u>: If fixed expectations: $\pi_t = \bar{\pi} + (\mu + z) - \alpha u_t$ thus $\frac{\partial \pi_t}{\partial u_t} = -\alpha < 0$
- <u>Evidence</u>: Phillips discovered a historical negative relationship between inflation and unemployment in UK 1861-1957. Samuelson and Solow likewise for US 1900-60.
- <u>Implication:</u> Implies there is no such thing as NRU. Policymakers explicitly used this to manage the American 1961-69 expansion which saw -3.4%-points in U at expense of +4.5%-points inflation
- <u>Criticism:</u> Relationship disappeared in the 1970s with stagflation in many OECD countries. Cannot replicate Phillip's findings using more recent data sets

Adaptive Expectations

- <u>Theory</u>: Friedman and Phelps: $\bar{\pi}$ unlikely when policy makers are consistently targeting $\pi^T > \bar{\pi}$. Instead $\pi_t^e = \pi_{t-1}$ hence $\pi_t - \pi_{t-1} = \Delta\pi_t = \mu + z - \alpha u_t$ hence $\frac{\partial \Delta\pi_t}{\partial u_t} = -\alpha < 0$
- <u>Evidence:</u> Since 1970 US $\Delta\pi_t = 3.0\% - 0.5u_t$

Monetary Economics

Rational Expectations and Policy Ineffectiveness

Rational Expectations Hypothesis

- Agents optimally form expectations using all available information $x^e_{t+k|t} = E[x_{t+k}|\Omega_t]$, corresponding to optimal forecast that minimizes MSE
  - In the absence of uncertainty, implies perfect foresight $\epsilon = x - x^e$
  - Unbiased since $E[\epsilon] = E[x - x^e] = E[x - E[x|\Omega]] = E[x] - E[x] = 0$
  - Forecast error ϵ is unpredictable since $E[\epsilon|\Omega] = [x - x^e|\Omega] = E[x|\Omega] - x^e = x^e - x^e = 0$
  - Forecast errors uncorrelated $Cov\{\epsilon_t, \epsilon_{t-1}\} = 0$
- 'Model consistent' since structure of model in incorporated into optimal forecast
- May fail due to info constraints (bounded rationality) or cognitive biases (behavioural econ)

Lucas Critique

- "The way in which expectations are formed changes when the behaviour of forecasted variables change". Econ relations become unstable when policymakers attempt to exploit!
- Adaptive Expec: $x^e_{t+1|t} = x^e_{t|t-1} + \kappa(x_t - x^e_{t|t-1})$ with $0 < \kappa \le 1$ converge to rational

New Classical Ratex AS-AD Model

Assumptions

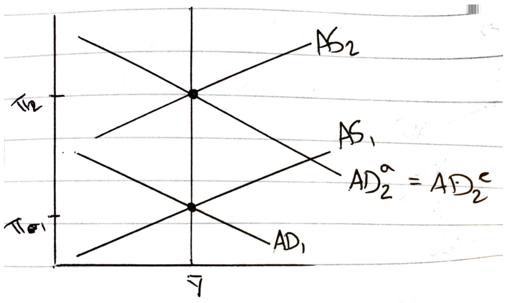
- (IS) Goods market equilibrium: $Y = \bar{Y} - \alpha(r - \bar{r}) + \eta$
- (MP) Monetary policy reaction function: $r = \bar{r} + \mu_\pi(\pi - \pi^*) + \mu_Y(Y - \bar{Y}) + v$
- (AS)/(PC) Aggregate Supply: $Y = \bar{Y} + \frac{1}{\theta}(\pi - \pi^e) + s$ or $\pi = \pi^e + \theta(Y - \bar{Y}) + s$
  - Phillips Curve View: $\uparrow Y, \downarrow U, \uparrow$ labour bargaining power, $\uparrow w, \uparrow \pi$
  - Lucas Misperception View $\uparrow \pi, \downarrow rw, \uparrow$hiring, $\downarrow U, \uparrow Y$
- (Ratex) Rational Expectations: $\pi^e = E[\pi]$ as well as Flexible Prices and Perfect Information

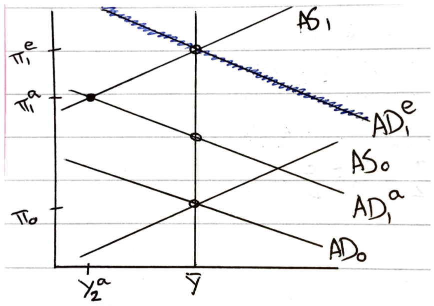
Conclusions

- To find AD sub MP into IS and rearrange
  - $Y - \bar{Y} = -\alpha[\mu_\pi(\pi - \pi^*) + \mu_Y(Y - \bar{Y}) + v] + \eta$ hence $\pi = \pi^* - \frac{1+\alpha\mu_Y}{\alpha\mu\pi_Y} - Y - \frac{1}{\mu_\pi}\ v + \frac{1}{\alpha\mu_\pi}\eta$
    - $\uparrow\pi*$, $\uparrow Y$. TR demands CB sets lower r to achieve a higher π, increasing I and thus Y
    - $\uparrow\eta$, $\uparrow Y$. An expansionary <u>unanticipated</u> shock to output increases output
- To find general equilibrium sub AD into AS and simplify.
- Phillips Curve: $\pi_t = \pi^e_t + \theta y_t + \epsilon_t$ in general case and $y_t = \frac{1}{\theta}\epsilon_t$ in special case and
  - AD Shock: $\uparrow Y$, $\uparrow\pi$. Can just move both back in tandem (divine coincidence)
  - AS Shock: $\uparrow Y$, $\downarrow\pi$. Need to make a trade off. Hence ϵ pops up in so many cases.

Policy Ineffectiveness Proposition:

- Assume flexible prices, ratex, and perfect info. If policy is expected, no effect on output gap.
- If πe=π then SRAS: Y−Y=+1$\theta\pi$−πe+s=s (vertical and anywhere depending on shock)
- MP (AD1→AD2) shifts up inflation expectations and so PC (AS1→AS2) as workers flexibly bid up wages (to protect rw) by the same amount. No effect on Y but increase in π.
  - Note: Expansionary policy leads to decline in SR Y if less than expected (AD1a<AD2e)
- Implies anticipated output gap stabilization policies ineffective and disinflation costless
- IRL evidence is weak. Disinflation lead to slow down and CB transparent makes MP more effective. Probably due to flexible price assumption failing…

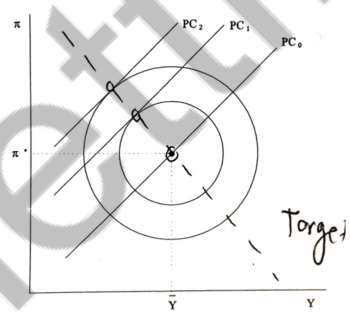




Contrast to New Keynesian

- Now assume RatEx but wages are preset each period (e.g. sticky labour contracts)
  - $\pi t = Et-1\pi t+\theta yt+\epsilon t$ where ϵt is i.i.d. so $Et-1\epsilon t=0$ and $yt=Yt-Yt$
  - Let $\xi t \equiv \pi t - Et-1[\pi t]$ (i.e. inflation forecast error)
  - Rearrange PC to $y=1\theta\xi t-1\theta\epsilon t=1\theta\xi t+s$ where $Et-1yt=0$
- yt still not affected by anticipated AD but sudden shocks will through the forecast error (graphically, AS does not move up by full amount)

Model	unanticipated	anticipated
traditional	↑Y, ↑P	↑Y, ↑π like unanticipated
new classical	" "	−Y ↑P more than unant.
new Keynesian	" "	↑Y by less ↑P by more



Optimal Monetary Policy

- CB can choose any point on PC by shifting AD (SR economic constraint faced by CB as it has to find a tradeoff between π and Y). Which one should it choose?
- $\min L = \frac{1}{2}\beta(\pi-\pi^*)^2 + \frac{1}{2}(Y-\bar{Y})^2$ (i.e. pick point tangent to loss circle via Targeting Rule)
  - Note that this has convex structure (penalizes greater deviations) and is symmetric
  - More conservative (i.e. π-variance aversion) → higher β → flatter TR
- Graphically, find the point on PC that is tangent to the loss circle (as this minimizes distance to the bliss point) and shift AD there. The target rule becomes the locus of all these points.
- Algebraically, sub in PC via π and take FOC wrt Y given π^e. Rearrange FOC to find Y and substitute into IS for r. Here $Y = \bar{Y} + \frac{\theta\beta}{1+\theta^2\beta}[\pi^* - \pi^e - \epsilon]$ and $r = \bar{r} - \frac{\theta\beta}{\alpha(1+\theta^2\beta)}[\pi^* - \pi^e - \epsilon] + \frac{1}{\alpha}$
- Ratex equilibrium is where $\pi^e = E(\pi) = \pi^*$). Here $Y = \bar{Y} - \frac{\theta\beta}{1+\theta^2\beta}\epsilon$ and $\pi = \pi^* + \frac{1}{1+\theta^2\beta}\epsilon$
- Can derive Taylor rule by taking time subscripts of $\min E_t(L_t)$, Dynamic PC, Dynamic IS. After some manipulation: $r = \bar{r} + \frac{\theta\beta}{\alpha(\theta^2\beta+1)}(\pi_t - \pi^*) + \frac{\theta^2\beta}{\alpha(\theta^2\beta+1)}(Y_t - \bar{Y})$

Inflation Bias And Solutions

Barro-Gordon Model

Assumptions

- (TR): CB minimizes loss function $L = \frac{1}{2}\beta(\pi-\pi^*)^2 + \frac{1}{2}(Y-Y^*)^2$ where $Y^* > Y$
- (PC): $\pi = \pi^e + \theta(Y-\bar{Y}) + \epsilon$
- Timing: (i) Private sector sets π^e via ratex, (ii) cost-push shock ϵ realized, (iii) CB decides Y

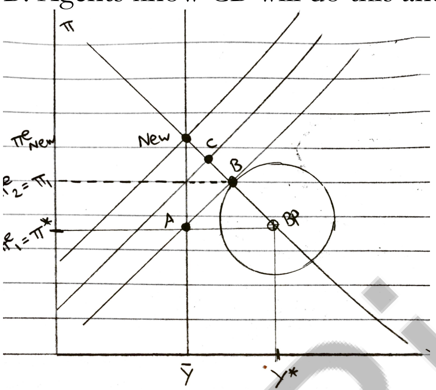
Derivations

- Sub (PC) into TR: $L = \frac{1}{2}\beta(\pi^e + \theta(Y - \bar{Y}) + \epsilon - \pi^*)^2 + \frac{1}{2}(Y - Y^*)^2$
- Take FOC wrt Y: (TR') $Y - Y^* = -\theta\beta(\pi - \pi^e)$ [Strictly convex so unique min]
- Impose ratex by taking expectations
  - (PC): $E[\pi] = \pi^e + \theta(E[Y] - \bar{Y}) + E[\epsilon]$ so $E[Y] = \bar{Y}$
  - (TR'): $E[Y] - Y^* = -\theta\beta(E[\pi] - \pi^e)$ so $E[\pi] = \pi^* + \frac{1}{\theta\beta}(Y^* - \bar{Y})$
- To solve sub $E[\quad]$ into FOC and rearrange: $\pi = \pi^* + \frac{1}{\theta\beta}(Y^* - \bar{Y}) + \frac{1}{1+\theta^2\beta}\epsilon$ and $Y = \bar{Y} - \frac{\theta\beta}{1+\theta^2\beta}\epsilon$

Conclusions

- Time inconsistency problem of discretionary MP if $Y^* > \bar{Y}$
  - Although $\pi = \pi^*$ is CB's bliss point, after π^e has been locked in, CB tries to exploit PC and use expansionary MP to boost output (Y^*) resulting in higher inflation
  - Private sector anticipates this via ratex ($\pi^e > \pi^*$) resulting in $E[Y] = \bar{Y}$ with $E[\pi] > \pi^*$
  - Optimal MP features inflation bias ($E[\pi] > \pi^*$) and not boost in output ($E[Y] = \bar{Y}$)
- MP is game between CB and private sector where $\pi = \pi^*$ is not optimal after CB has set π^e, so doing so would be subgame imperfect
- Empirically this has been a problem since the 1980s

Graphically, CB announces inflation target π^*. If $\pi_1^e = \pi^*$ locked in, CB should move from A to B. Agents know CB will do this and thus incorporate $\pi_2^e = \pi_1$. Repeat until π_{New}^e where $Y = \bar{Y}$



Solutions

Commitment

- In disgression can re-opt. every period in dynamic model. Now suppose we opt. at start then leave in dynamic model (i.e. minimize *expected* loss function)
- Timing: (i) CB commits $\pi = \pi_C$, (ii) Private sector sets π^e using RE, (iii) Cost-push realized
- Ratex implies $\pi^e = \pi_C$ so $L = \frac{1}{2}\beta(\pi_C - \pi^*)^2 + \frac{1}{2}(Y + s - Y^*)^2$. FOC gives $\pi_C = \pi^*$
- Optimal policy under commitment yields $\pi = \pi^*$ and $Y = \bar{Y} + s$.
- Commitment eliminates inflation bias but increases output volatility (cannot reoptimize and hence demand shocks cannot be corrected for). Credibility-flexibility trade off

Delegation

- "conservative CB with higher β reduces inflation bias but increases output volatility
- CB with conservative inflation target $\pi^* = \pi^* - \frac{1}{\theta\beta}(Y^* - \bar{Y})$ eliminates inflation bias without affecting stabilization
- Responsible CB with output target $Y^* = \bar{Y}$ eliminates π-bias without affecting stabilization

Incentive Contracts

- Impose inflation penalty on CB so $L = \frac{1}{2}\beta(\pi - \pi^*)^2 + \frac{1}{2}(Y - Y^*)^2 + \frac{1}{\theta}(Y^* - \bar{Y})(\pi - \pi^*)$
- Inflation penalty eliminates inflation bias without affecting stabilization

In dynamic context

- Reputation: repeated interactions make CB behave better because higher inflation raises inflation expectations which worsens inflation-output tradeoff
- Transparency: exposes inflationary MP which results in higher inflation expectations, thereby exerting a need for discipline

Additional Notes

- Cost of inflation volatility: hard disentangle changes in relative to general P, creates distortionary effects on nominally set taxes and benefits and arbitrary distribution
- Should price stability be the primary goal of the CB? In LR there is no inconsistency (NRU is not lowered by inflation) but in SR CB may need to slow down an "overheating" economy.
- Nominal Anchor: ties down to price level to achieve price stability (e.g. exchange range, M4), akin to a behavioural rule
- Time Inconsistency Problem: discretionary day-to-day MP leads to poor long run outcomes:
    - Pursue expansionary MP above what people expect
    - Boosts Y in short run but higher inflation expectations
    - Thus higher wages and prices, higher inflation with no increase in Y
- CB Independence: instrument independence (decides on adjustment in instrument e.g. BoE) and goal independence (CB specifies MP goals e.g. ECB)

Money Demand

Basic Definitions

- Money is a medium of exchange, unit of account, and store of value
- M_0: H=C+R and M_1: M=C+D
- Liquidity: ease with which a store of value can be converted into medium of exchange

QToM (Fisher): $\frac{M^d}{P} = kY$

- Assume $MV = PY$ with constant velocity $V = \bar{V}$. Rearrange to $\frac{M^d}{P} = kY$ where $k = \frac{1}{V}$
- Under classical assumption of flexible prices P and $Y = \bar{Y}$ get $\hat{M} = \hat{P} = \pi$
- Evidence IRL: Positive relation between money growth and inflation very robust for cross-section and longer run time-series data. But velocity is not constant but procyclical

Liquidity Preference Theory (Keynes): $\frac{M^d}{P} = L(i, Y)$

- Total real demand for money $L = L_T + L_P + L_S$ where
    - Transaction demand L_T for money: $\propto Y$. $\uparrow Y$, want to buy more things, $\uparrow M^d$
    - Precautionary demand L_P for money: $\propto Y$. $\uparrow Y$, want to insure more things, $\uparrow M^d$
    - Speculative demand L_S for holding money): ve^- i.
    (i) $\uparrow i$; $\downarrow p$ of bonds; capital loss (ii) people expect i gravitates back to normal value
- Thus $L_i < 0$ and $L_Y > 0$
- Evidence IRL: Speculative motive helps explain velocity fluctuations but no economic intuition for why people would act like this. Hence…

Inventory Theory (Baumol-Tobin): $\frac{M^d}{P} = L(i, Y)$ *with* $\epsilon_{L,i} = -\frac{1}{2}$ *and* $\epsilon_{L,Y} = \frac{1}{2}$

$\uparrow i$, $\downarrow$cash for transaction, $\uparrow v$. Transaction component M_D is negatively related to level of i/r

- Agents receive income Y as bonds (yielding $i > 0$) at beginning of period and spend uniformly by converting some into cash (yielding zero nominal return)
    - Average real money holdings $\frac{M}{P} = \frac{1}{n}\frac{\text{start+end}}{2} = \frac{1}{n}\frac{Y+0}{2} = \frac{1}{2}\frac{Y}{n}$

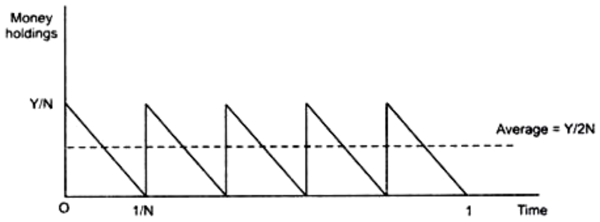


FIG. 22.3: MONEY HOLDINGS WITH "N" VISITS TO THE BANK

- Thus the total cost of holding money is given by $C = C_O + C_T = cn + i\frac{1}{2}\frac{Y}{n}$ where
  - Transaction costs $C_T = cn$ where n is number of transactions
  - Opportunity cost of holding money $C_O = i\frac{M}{P} = i\frac{1}{2}\frac{Y}{n}$
- Hence we can calculate the optimal real money demand function:
  - FOC: $\frac{\delta C}{\delta n} = c - i\frac{1}{2}\frac{Y}{n^2} = 0 \rightarrow n^* = \left(\frac{1}{2}\frac{iY}{c}\right)^{\frac{1}{2}}$ and SOC shows this is min.
  - Substituting in $\left(\frac{M}{P}\right)^* = \frac{1}{2}\frac{Y}{n^*} = \frac{1}{2}Y\left(\frac{1}{2}\frac{iY}{c}\right)^{-\frac{1}{2}}$
  - Taking ln: $\ln\left(\frac{M}{P}\right)^* = \frac{1}{2}\ln\frac{1}{2} + \frac{1}{2}\ln c + \frac{1}{2}\ln Y - \frac{1}{2}\ln i$. This gives us $\epsilon_{m,Y}$ and $\epsilon_{m,i}$
- Evidence IRL: Output sensitivity demand is higher and interest rate sensitivity is lower than assumed. Money demand function has been unstable since mid-1970s.

Money Supply

Balance Sheets

Balance sheet of Central Bank;

Assets	**Liabilities**
Domestic securities (A) – Government bonds from the treasury.	*Currency in public circulation (C)* – In past could turn in money to CB for gold.
Foreign securities (F) *Loans to banks and gov't (L_{CB})* – Like bonds, a liability to Treasury but an asset for the BoE	*Banks' reserves (R)* – Similar to above *Government deposits (D_G)* – Deposits by the treasury.

Balance sheet of Commercial Bank;

Assets	**Liabilities**
Reserves (R) – Reserves held at CB *Debt securities (B)* – Owed by other banks. *Loans (L)* – Owed by people.	*Deposits (D)* – Held by people. *Borrowings (B_B)* – Borrowed from other banks. *Bank Capital (E)* – (A-L), Borrowed from people.

Fractional Reserve Banking

- $R = \phi D$ hence $R = R_{min} + R_e$ where $R_{min} = \tau D$ and R_e is excess
- Traditional View: Banks use Deposits D to make loans L
  - Increase in reserves R to banking system allows for multiple increase in deposits D. Excess reserves are used to make loans to public. Resulting funds are deposited again
  - Money created from OMO £100 $= \Delta C + \Delta D = 0 + \Delta D = 100 + \tau 100 + \tau^2 100 = \frac{100}{1-\tau}$
- Modern View: Banks create Deposits D by making loans L
  - Deposits are used to make loans, showing banks not constrained in their lending by lack of deposits, but by limited reserves

Money Multiplier

- Assume fractional reserve banking $0 < \tau + \theta < 1$ with minimum reserve requirement $R_{min} = \tau D$ and where banks keep excess reserves $R_e = \theta D$. Public holds currency $C = \gamma D$

- Derivation:
  - Recall $M = C + D$ and $H = C + R = C + R_{min} + R_e$
  - Hence $\frac{M}{H} = \frac{C+D}{C+R_{min}+R_e} = \frac{\frac{C}{D}+1}{\frac{C}{D}+\frac{R_{min}}{D}+\frac{R_e}{D}} = \frac{\gamma+1}{\gamma+\tau+\theta}$
  - Thus $\frac{\delta M}{\delta H} = \frac{\gamma+1}{\gamma+\tau+\theta} > 1$.
  - Decreasing in required reserve ratio τ, excess reserve ratio θ,
- Comparative Statics:
  - $\uparrow \gamma$ currency ratio, public holds more currency, less money for banks to loan, $\downarrow m$
  - $\uparrow \tau$ reserve ratio OR excess rr θ, less money to loan out per £ of deposits, $\downarrow m$
- Evidence IRL: For some periods the money multiplier has been quite stable in LR, with M and H being proportional (e.g. UK 1870-1970). But… in SR often volatile, esp. in crises:
  - Crisis: (i) Increase in γ and θ because of greater uncertainty; (ii) loan defaults eroding capital and limiting lending; (iii) lack of demand for loans from private sector

Money Operating System

Money Operating Tools

- $R = R_n + R_b + R_d$ where R_n is nonborrowed reserves determined by CB OMO; R_b by standing lending facility at i_l; R_d by standing deposit facility at i_d
- Open Market Operations (OMO): Purchase/sale of securities by CB, typically ST gov bonds.
  - Outright: permanently or for indefinite period
  - Repo/reverse-repo: temporary purchase/sale of securities reversed after period
  - If large scale through outright OMO then quantitative easing, typically medium/long-term government bonds
- Standing lending facility: collateralized loan by CB to bank. Common tool for lender of last resort, often at penalty interest rate.
- Standing deposit facility: Interest rate i_d paid by central bank on funds in deposit facility or (excess) reserves. Useful tool for limiting fluctuations or controlling interbank rate
- Reserve requirements: Required rr $\tau = R_{min}/D$. Higher τ increases required reserves and thereby demand for reserves R, and could reduce money supply M through lower m.

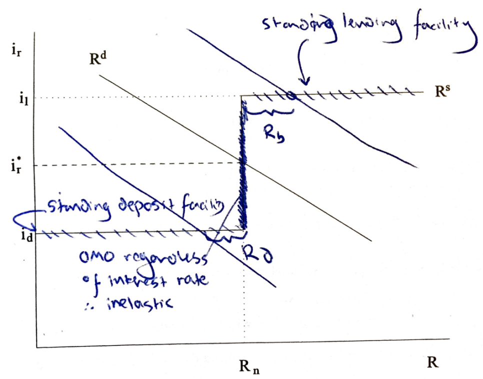
Interbank Market for Reserves

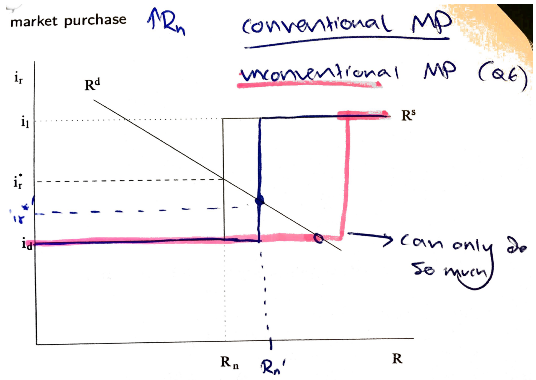
Finding Equilibrium

- We recall the components…
  - Demand for reserves $R^d = R_{min}(\text{rr}) + R_e(-i_r)$
  - Supply for reserves $R^s = R_n(\text{OMO}) + R_b(i_l) - R_d(i_d)$
- … and put it together to find equilibrium: $R^d = R^s$ determines interbank rate i_r^*, which lies somewhere in the interest rate corridor $i_d \leq i_r^* \leq i_l$

Comparative Statics

- Standard (Inelastic Supply of Reserves): i_r absorbs changes in demand and R_n stays fixed.
  - There is "pricing away" of excess demand because as i_r rises so does the opportunity cost of holding excess reserves. We move up R_d until we attain new equ.
- Special Case (Elastic Supply of Reserves): R_n absorbs changes in demand and i_r stays fixed



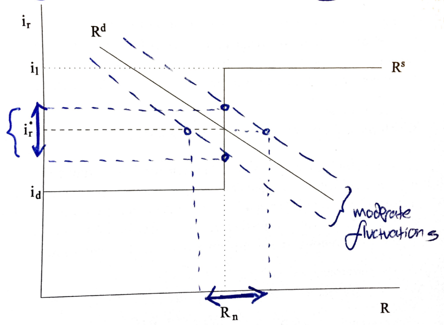


<u>Operating Instruments</u>

Tools → Policy Instruments → Intermediate Targets → Goals

- Reserve Aggregate: Quantity control allows i_r fluctuate. Used by monetary targets and QE
- Interest Rate: Fixes price but necessitates adjustment in R_n through OMO. Conventional in advanced countries and small open economies

Quantity Control – Reserve Aggregate



- Banks don't always borrow from CB because may be cheaper in private sector ($i_r^* < i_l$) or because doing so signals to the market that they are weak

Interest Rates and Bonds

Debt Instruments

- Primary Market: new issues of bonds are sold by government agency or corporation borrowing funds

	Description	Rate	Present Value	Yield to Maturity
Simple Loan	Borrowers receives principal F that must be repaid to lender at maturity date together with interest C.	$\frac{C}{F}$	$PV = \frac{CF}{(1+i)^n}$	$i = \frac{C}{F}$
Discount Bond (aka zero-coupon bond)	Borrower receives issue price of bond p and must repay lender face value F at maturity date. Discount rate equals $\frac{F-p}{F}$.	$\frac{F-p}{p}$	$PV = \frac{F}{(1+i)^N}$	$i_N = \left[\frac{F}{p}\right]^{\frac{1}{N}} - 1$
Coupon Bond	Borrower receives amount of funds p and must pay lender principal F at maturity date and also fixed interest payment C every year until maturity.	$\frac{C}{F}$	$PV = \sum_{n=1}^{N} \frac{C}{(1+i)^n} + \frac{F}{(1+i)^N}$	
Fixed-Payment Loan	Borrower receives principal that must be repaid with interest to lender by making fixed payment every period until maturity date	n/a	$PV = \sum_{n=1}^{N} \frac{C}{(1+i)^n}$	C
Perpetuity	Coupon bond without maturity date		$PV = \frac{C}{1+i} \sum_{n=0}^{\infty} \frac{1}{(1+i)^n} = \frac{C}{i}$	$i = \frac{C}{p}$

- Secondary Market: previously issued bonds are traded

Definitions

- Equity: claims to partial ownership of corporation, which entitles owner to share in profits, typically distributed as periodic payments of dividends
- Forward contract: customized agreement by two parties to buy/sell asset at pre-agreed price at specific future date
- Futures contract: standardized, negotiable forward contract. Future prices reflect expected price of asset at expiration date of futures contract.
- Swaps: Contracts that obligate two parties to exchange one set of payments for another at pre-agreed rate during specific period of time.

Important Terms

- Present Value: Value today of future cash flow payments: $PV_t = \frac{CF_{t+n}}{(1+i_{n,t})^n}$ where PV is Present Value, CF is Cash Flow, and $i_{n,t}$ opportunity cost. Use to compare debt instruments.
- Yield-To-Maturity: Constant i/r i that equates PV of all future CF with value today (price)
- Rate of Return: Gain on asset as proportion of price. $RR_t = \frac{CF_t + p_{t+1} - p_t}{p_t} = i_{c,t} + g_t$ where $g_t \equiv \frac{p_{t+1} - p_t}{p_t}$ (capital gain rate); $i_{c,t} \equiv \frac{CF_t}{p_t}$ (income yield) or $\equiv \frac{C}{p_t}$ (interest yield if coupon)
  - Bond prices do not stay constant, which limits y-t-m. Thus also use RoR.
- Note interest yield generally not equal to y-to-m except if $p = F$. RoR on bond generally not equal to yield. But y-to-m equals RoR on bond held to maturity

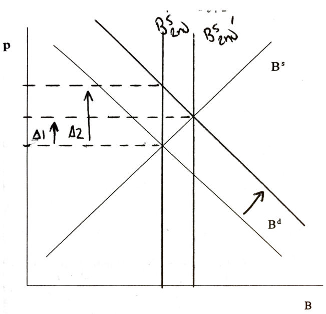
- Fisher Equation: Risk-neutral is indifferent: $(1+i)F = (1+r)(1+\pi^e)F$ so $i \approx r + \pi^e$
  - Or $(1+i_{N,t})^N F = (1+r_{N,t})^N (1+\pi^e_{N,t})^N F$ so $i \approx r + \pi^e$
  - Where Index linked bond $F' = (1+\pi)F$ where $\pi = \frac{P'-P}{P}$

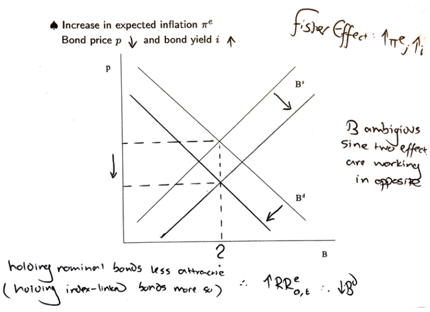
Yield and Prices Relationship

- For N-year coupon bond with coupon payment C, face value F, term-to-maturity N, price p_N, and yield-to-maturity i_N we get $p_N = \sum_{n=1}^{N} \frac{C}{(1+i_N)^n} + \frac{F}{(1+i_N)^N}$.
  - A rise in i increases denominator of all terms on RHS. Thus i and p are inverse
  - If $p > F$ implies $i < \frac{C}{F}$. If $i < 0$ then $p > NC + F$

Asset Market Model

- Analyze the primary bond market (only new issues of bonds are sold)
- Bond Demand: $B^d_t = B^d\left(p_t; p^e_{t+1};\ RR^e_{O,t}; \frac{\sigma_B}{\sigma_O}; \frac{liq_B}{liq_O}; W_t\right)$
  - $i = RR^e_t = \frac{F-p}{p}$. Thus $\downarrow p, \uparrow i, \uparrow$ return $\uparrow$ asset-demand. Hence downwards sloping
  - \+ $RR^e_t = \frac{CF_t + p^e_{t+1} - p_t}{p_t}$: Expected Rate of Return on bond. Note that this depends on p^e_{t+1}!
  - \- $RR^e_{O,t}$: Expected Rate of Return on other assets. Note that real assets depend on π^e!
  - \+ $\frac{liq_B}{liq_O}$: Liquidity of bond relative to other
  - \+ W_t: Investor's Wealth
  - \- $\frac{\sigma_B}{\sigma_O}$: Risk (i.e. volatility) of bond relative to other assets
- Bond Supply: $B^s_t = B^s(p_t; \pi^e_t; \Pi^e_t; G_t - T_t)$
  - $i = R^e = \frac{F-p}{p}$. Thus $\downarrow p, \uparrow i, \uparrow$ borrowing cost, $\downarrow$ asset-supply Hence upwards sloping
  - \+ p_t: Funds received when issuing bond
  - \+ π^e_t: Inflation lowers expected real value of future coupon and redemption payments
  - \+ Expected profitability of investment opportunities Π^e_t [for corporate bonds]
  - \+ Government budget deficit $G_t - T_t$ [for government bonds]
- Bond Equ: p_t determined by demand and supply of stock (not flow!) of bonds: $B^d_t = B^s_t$
  - Problem with this model describes primary market but in the short run bond supply is predetermined in inelastic secondary market
- Thus note that: QE announced $\rightarrow p^e_{t+1} \rightarrow B^d$





Yield Curve

Risk Structure of Interest Rates

- Variation in interest rates (yields) on bonds of same term to maturity is due to differences in default risk, liquidity, tax treatment, and/or information costs.

Term Structure of Interest Rates

- Yield curve: Plot of yield to maturity on bonds against term to maturity
  i. Yields on bonds of different maturities move together over time
  ii. When ST yield is low, yield curves tend to slope up
  iii. Yield curve tends to be upward sloping

<u>Expectations Theory</u>

- Assumes bonds of different maturities are perfect sub. Thus LT yield reflects expected ST
- $i_{n,t} = \frac{1}{n}(i_t + i^e_{t+1} + \cdots i^e_{t+n+1})$
  - Allows us to extract $i^e_{1,t+1}$ since $(1 + i_{2,t})^2 = (1 + i_{1,t})(1 + i^e_{1,t+1})$
- Explains fact i. and ii. (since people expect ir to gravitate back in future) but not iii.

<u>Segmented Markets Theory</u>

- Assumes bonds of different maturities are not sub at all but determined in separate markets
- Investors prefer ST to LT as LT are riskier due to interest rate risk
- Explains fact iii. but not i. and ii.

<u>Liquidity Premium Theory (aka Preferred habitat)</u>

- Bonds of different maturities are imperfect substitutes, with investors preferring ST bonds because of lower interest rate risk. Thus there is a "risk premium".
- $i_{n,t} = \frac{1}{n}(i_t + i^e_{t+1} + \cdots i^e_{t+n+1}) + \theta_{n,t}$
- Explains all!

Forecasting Tool (Essay)

- Slope of the yield curve—the spread between long- and short-term interest rates—is a good predictor of future economic activity.

<u>Predicting Output</u>

- Recall LPT. Since $\theta_{n,t} > 0$ and is expected to remain relatively constant, yield curve will slope upwards under normal circumstances.
- Anticipate downturn in business cycle → Anticipate lower future returns and/or countercyclical MP → Investors revise down estimates of future ir → Decline in all long-term yields → Slope down
  - LT investor expectations figure so importantly in these relationships means that the yield curve may be more forward-looking than other leading indicators.
  - But… signals are sensitive to changes in financial market conditions so may just be financial noise (thus most show persistence to be meaningful).
  - But… $\theta_{n,t}$ may not be constant. Rise in future uncertainty → Yield curve slopes upwards even though increase in the likelihood of a future recession
- <u>Dueker (1997):</u> US long-term i/r fell below short-term rates prior to recessions since 1960.

- Estrella & Mishkin (1998): term structure can forecasts US recessions up to 8q ahead.
- Haubrich & Dombrosky (1996): spread between the ten-year and three-month interest rates has substantial predictive power for real GDP growth in US for the last 30 years.

Predicting Inflation

- Recall Fisher equation $i \approx r + \pi^e$. If we assume r remains constant then any difference between the nominal interest rates (i.e. slope) must be because of different π^e.
  - $i_{2y,n+1} = \frac{1}{2}\left(i_{1y,n+1} + i_{1y,n}\right) \mid i_{2y,n+1} = r + \frac{1}{2}(\pi^e_{n+1} + \pi^e_n)$
  - $i_{2y,n+1} - i_{1,n} = r + \frac{1}{2}(\pi^e_{n+1} - \pi^e_n)$
  - $\Delta i = r + \frac{1}{2}\Delta\pi^e$
- Fama (1990) and Mishkin (1990): term spreads contain info about future inflation rates in US
- Davis & Fagan (1997): dispute general applicability as in EU only Denmark exhibits this
- Schiff (1999): notes that for NZ mid-1987 to mid-1998 the opposite is true

Financial Markets

Equity Market

- An investment fundamental value is that an asset's value is equal to the PV of its lifetime
- Simple Dividend Model: equity price equal to one-period expected PV $p_t = \frac{D^e_{t+1}}{1+i} + \frac{p^e_{t+1}}{1+i}$ where i is risk-adjusted interest rate (presumed constant)
- Generalized Dividend Model: equity price equal to PV of expected future dividends:
  - Using recursive sub we can turn simple to $p_0 = \frac{D^e_1}{1+i} + \frac{D^e_2}{(1+i)^2} + \cdots + \frac{D^e_n}{(1+i)^n} + \frac{P^e_1}{1+i}$
  - Assuming no bubbles ($\lim_{n\to\infty} \frac{p^e_n}{(1+i)^n} = 0$) we can rewrite it as $p_0 = \sum_{n=1}^{\infty} \frac{D^e_n}{(1+i)^n}$
- Gordon Growth Model:
  - Assumes constant growth rate $D^e_{t+n} = (1+g)^n D_t$ and $\frac{1+g}{1+\tilde{\imath}} < 1$
  - Thus $p_0 = \sum_{n=1}^{\infty} \frac{D^e_n}{(1+\tilde{\imath})^n} = \sum_{n=1}^{\infty} \frac{(1+g)^n D_t}{(1+\tilde{\imath})^n} = \frac{1+g}{1+\tilde{\imath}} D_t \sum_{n=1}^{\infty} \frac{(1+g)^n}{(1+\tilde{\imath})^n} = \frac{D_{t+1}}{1+\tilde{\imath}} \frac{1}{1-\frac{1+g}{1+\tilde{\imath}}} = \frac{D_{t+1}}{\tilde{\imath}-g}$
  - Foundation for equity price channel. But… $\tilde{\imath}$ and g generally are not fixed over time; if $\tilde{\imath} \approx g$, equity valuations are highly sensitive to measurement error
  - Comparative Statics:
    - Contractionary MP; ↑ bond yields ↑ $\tilde{\imath}$ to retain investment (an alt. asset); more discount future dividends; ↓PV of expected future dividends; ↓ P_t
    - Economy slows does; ↓ growth rate of firm's profits; ↓ g; ↓ P_t
    - $\tilde{\imath}$; discount future dividends more; ↓PV of expected future dividends; ↓ P_t
    - Contractionary MP; ↑ $\tilde{\imath}$; discount future dividends by more; lower PV of expected future dividends; ↓ P_t

Efficient Market Hypothesis

Assumptions

- Arbitrage: elimination of unexploited profit opportunities: $R^e = R^*$
- Rational Expectations: agents make optimal forecasts by forming expectations based on all available information: $p^e_{t+1|t} = E[p_{t+1}|\Omega_t]$
  - Note: we only need some agents to satisfy both conditions, not all.

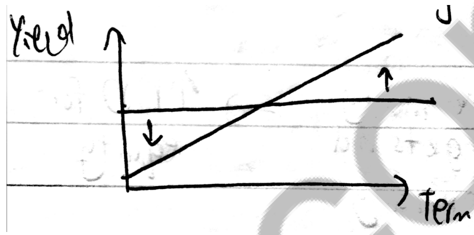
Key Implications

- Approximate random walk $p_t = p_{t-1} + v_t$ where v_t is white noise shock $E[v_t|\Omega_{t-1}] = 0$
- Best forecast of future price is current price $E[p_{t+1}|\Omega_t] = p_t$ and changes are unpredictable
- Asset prices immediately incorporate new information
- Strong form: $p_t = p^*_t = p^{TRUE}_t$ i.e. that asset prices always reflect market fundamentals

<u>IRL Evidence</u>

+ Hard to consistently outperform market as $R^e = R^*$
+ Asset prices are difficult to forecast since $E[\Delta p_t | \Omega_t] = 0$
- Weak form (Ω_t=past asset prices): Still observe mean reversion in long run
- Semi-strong form (Ω_t=all public information): Still observe pricing anomalies e.g. bubbles
- Strong form ((Ω_t=all private information): Still observe that insider trading is profitable

Monetary Transmission Mechanism



MP on Yield Curve

Standard channel: $\uparrow M, \downarrow i, \downarrow r, \uparrow I, \uparrow Y, \uparrow \pi$

- Liquidity Effect: $\uparrow M, \downarrow i_{SR}$
- Fisher Effect: $\uparrow \pi, \uparrow \pi^e, \uparrow i_{LR}$

Asset Price Channels

- <u>Keynesian ir channel:</u> $\uparrow M^s, \uparrow B^D, \uparrow p_B, \downarrow i_B, \downarrow r, \uparrow I, \uparrow Y$
  - Note that it is the real not the nominal ir that ultimately matters here. Hence must assume sticky prices (for ST) and also expectations theory (for LT)
- <u>ER channel:</u> $\uparrow M, \downarrow r, \downarrow$ return on £ assets, $\downarrow £^d$ (real deppreciation), $\uparrow NX, \uparrow Y$
- <u>Equity price channel:</u> $\uparrow M, \downarrow \tilde{\imath}, \uparrow p_E, \uparrow I, \uparrow Y$ (recall Gordon growth model $p_E = \frac{D}{\tilde{\imath} - g}$!)
  - Tobin's q: $\frac{\text{market value of firm}}{\text{replacement cost}}$. A high q means that a new plant is cheaper relative to market value of firm so the company can issue new stock to buy new K
- <u>Wealth effect channel:</u> $\uparrow M, \downarrow \tilde{\imath}, \uparrow p_{B\&E\&H}, \uparrow$ welath, $\uparrow C, \uparrow Y$
  - Lowering I raises price of assets (e.g. equity and houses). This increases financial wealth of households. PIH states thus increase in consumption but irl small

Credit Channels

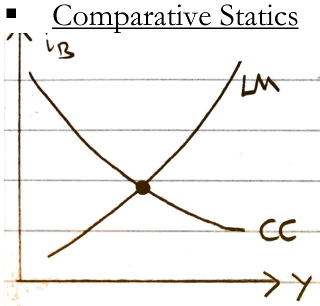
- <u>Bank lending channel:</u> $\uparrow M^s, \uparrow L^S, \downarrow i_L, , \uparrow I\&C, \uparrow Y$
  - Expansionary MP increases money supply, increasing bank deposits, lowering deposit rate. If no perfect sub of retail bank deposit for at least some agents, see rise.
  - Note that this is more relevant for small firms and durable consumption
- <u>Balance sheet channel:</u> $\uparrow M, \uparrow p_{B\&E\&H}, \uparrow$ firm networth, $\downarrow$ asymm., $\uparrow L, \uparrow I\&C, \uparrow Y$
  - Asymmetric information limits lending but less severe if firms/households have higher net worth (better balance sheets) and thus more collateral to cover losses
- <u>Cash flow channel:</u> $\uparrow M^s, \uparrow$ firm cashflow, $\downarrow$ asymm. info problems, $\uparrow L, \uparrow I\&C, \uparrow Y$
  - Interesting because it is directly nominal ST that matters
- <u>Unanticipated Price Channel:</u> $\uparrow M^s, \uparrow P, \downarrow$ firm real liabilities, $\uparrow$ firm real networth, $\downarrow$ asymm. info problems, $\uparrow L, \uparrow I\&C, \uparrow Y$
  - Fisher debt necessarily assumes net debtor economy or that borrower have a higher MPC (which makes sense since they rely on current income)

Bernanke-Blinder Model

- Extension of IS-LM that incorporated deposits, bonds, and bank loans
- <u>Assumptions</u>
  - $R + B + L = D$ (i.e. assets = liabilities)
  - Money Market: $D^d = m(-i_b, Y)$ and $D^s = \frac{1}{\tau} R$
    - $\uparrow Y$, transaction motive, $\uparrow D^d$ | $\uparrow i_b, \uparrow$ opp. cost of not investing in bonds, $\downarrow D^d$
    - In deposit supply we assume banks don't hold any excess reserves

- Credit Market: $L^d = f(-i_L, i_B, Y)$ and $L^s = \lambda(D - R)$
  - $\uparrow i_L$, more costly to take loan, $\downarrow L^d$ | $\uparrow i_B$, less costly to take loan rel. to bond, $\uparrow L^d$ | $\uparrow Y$, transaction motive, $\uparrow L^d$
  - Where $D - R$ is money banks can spend and λ is portfolio weight on loans vs bonds
- Goods Market: $Y = g(-i_B, -i_L)$
  - $\uparrow i_{BorL}$, more costly to issue Bond/Loan, $\downarrow I$ (and C for loan), $\downarrow Y$

- <u>Finding Equilibrium</u>
  - Sub in D^* into L^*-equ and solve for i_L. Sub into goods market, differentiate, rearrange
  - (LM): Money market equilibrium: $D^d = D^s$: $\frac{1}{\tau}R = m(-i_B, Y)$
  - (CC): Consumption-Credit market equilibrium: $Y = c(-i_B, R)$
- <u>Comparative Statics</u>



CC $\underbrace{\downarrow i_B \to \downarrow L^d \to \downarrow i_L}_{\text{LM equ}} \to \underbrace{\uparrow C\&I \to \uparrow Y}_{\text{CM equ}}$

$\uparrow R \to \uparrow L^s \to \downarrow i_L \to \uparrow C\&I \to \uparrow Y$

LM $\uparrow Y \to M^d \to \downarrow B^d \to \downarrow p_B \to \uparrow i_B$

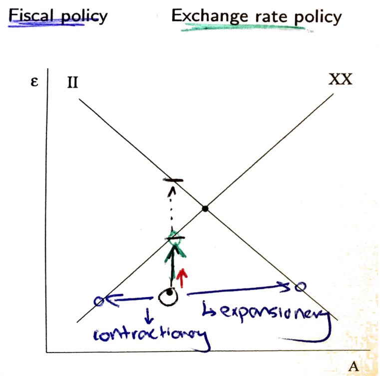
- $\uparrow \boldsymbol{R}, \uparrow \boldsymbol{M}, \uparrow$ investor wealth, $\uparrow \boldsymbol{B^d}, \uparrow \boldsymbol{p_B}, \downarrow \boldsymbol{i_B}, \uparrow \boldsymbol{I\&C}, \uparrow \boldsymbol{Y}$
- In Liquidity Trap $\boldsymbol{M_{i_B}} \to -\infty$. LM is horizontal since $\boldsymbol{i_B}$ cannot decrease any further

International Macroeconomics

Basics

Economic Discomfort Model

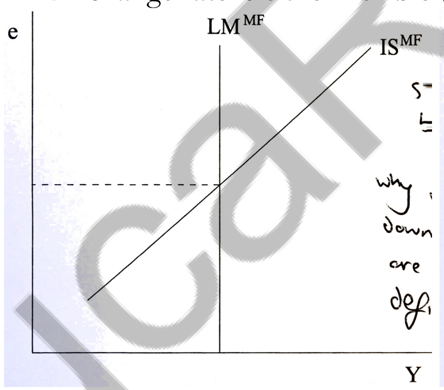
- (II) Internal Balance: $Y = A + CA\epsilon, -A$ [where $A = C + I + G$ domestic absorption]
  - $\uparrow A$, $\uparrow Y$ so to keep at Y must have $\downarrow \epsilon$, $\downarrow NX$, $\downarrow Y$. Slopes downwards.
- (XX) External Balance: $CA\epsilon, -A = X$
  - $\uparrow A$, $\uparrow M$ &$\downarrow CA$ so to keep X must have $\uparrow \epsilon$, $\uparrow NX$, $\uparrow CA$. Slopes upwards.
- Policy under fixed exchange rate:
  - Fiscal policy: G, T: affecting A: expenditure changing (move left or right)
  - Exchange rate policy: (e): affecting ϵ: expenditure switching (move up or down)
  - Automatic gradual price adjustment: (P): affecting ϵ

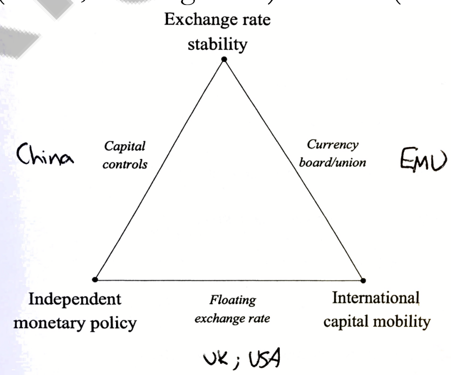


Mundell-Fleming Model:

Assumptions

- (IS) Goods Market: $Y = CY - T + I - r + G + CAeP*P, -[Y - T]$
- (LM) Money Market: $MP = L - i, Y$
- Fisher Equation: $i = r + \pi e$ and
- International Capital Mobility: $i = i*$; SR sticky prices and LR flexible prices
- Exchange rate is either flexible ($M = M$, e endogenous) or fixed ($e = e$, M endogenous)





Asset Approach to Exchange Rates

Stylized Facts:

1. Nominal exchange rate hard to predict and often seemingly unrelated to fundamentals
2. Nominal exchange rate more volatile than macro fundamentals
3. Real exchange rate exhibits long cyclical movements and sometimes long term drift
4. Nominal and real exchange rate are highly correlated

Interest Rate Parities

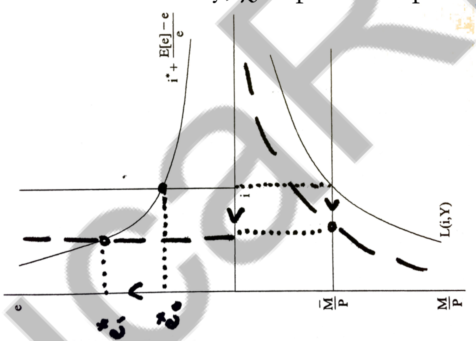
- (CIP): Covered Interest Parity: arbitrage relation between domestic and foreign currency deposits. Assumes perfect international capital mobility and substitutability
  - $1+i=1+i*fe$ so $i≈i*+f−ee$ where e is spot and f is forward ER
  - Generally holds IRL
- (UIP): Uncovered Interest Parity: CIP plus rational expectations and risk neutrality
  - $1+i=1+i*Eee$ so $i≈i*+Ee−ee=i≈i*+Ee$
  - Does not hold IRL
- (FP): Fisher Parity: arbitrage relation between nominal and real assets. Assumes perfect substitutability, rational expectations, and risk neutrality.
  - $1+i=(1+r)EPP$ so $i≈r+EP−PP=i≈r+E[\pi]$
- (UIP+FP): Real interest parity: $r≈r*+E\epsilon$

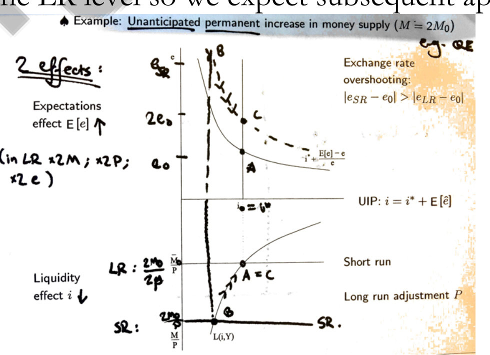
Asset Approach Model

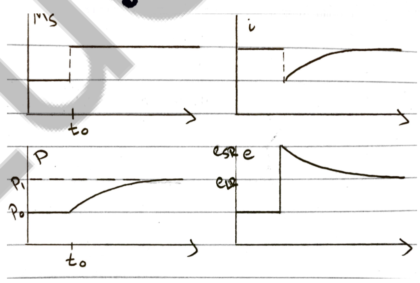
Assumptions
- UIP: $i=i*+Ee−ee$ | LM: $MP=Li,Y$ | RatEx
- SR [$P=P$ and πe given] or LR [$Y=Y$; $r=r$;$\epsilon=\epsilon$;$Ee=e$ thus $e=P=M$; $i=i*$]

Equilibrium
- LM and UIP equilibrium determine I and e (given $i*$, Ee, P, Y): $MP=Li,Y$ determines i so $i≈i*+Ee$ determines e
  - Note: change in expected future ER immediately reflected in current ER

Comparative Statics
- $\downarrow i$, ↓ relative returns on domestic currency deposits, ↓ demand for £, ↑ e (depreciates)
- $\uparrow E(e)$, ↓ relative returns on domestic currency deposits, ↓ demand for £, ↑ e (depreciates)
  - Helps explain Stylized Fact 1.
- Unanticipated Permanent ↑ M (i.e. Overshooting)
  - (i) SR Liquidity: $\uparrow \frac{M}{P_{SR}}$, $\downarrow i_{SR}$. Note in LR we are back to original $\frac{M}{P_{LR}}$ as money is neutral
  - (ii) Expectations: In LR $\hat{e}=\hat{P}=\hat{M}$ so $\uparrow E(e)$ by same proportion
  - Thus $|e_{SR}-e_0|>|e_{LR}-e_0|$. Helps explain Stylized Fact 2.
  - Intuitively, £ depreciates past the LR level so we expect subsequent appreciation to LR







Risk Premium Extension (i.e. Imperfect Asset Substitutability)

- Now $B^d\left(i-(i^*+E[\hat{e}]),-\frac{\sigma_B}{\sigma_B^*}\right)$ and $B^s=B-A$ [i.e. private sectors holdings] where risk prem. $\rho=i-(i^*+E[\hat{e}])$. Thus equilibrium: $B^d\left(\rho,-\frac{\sigma_B}{\sigma_B^*}\right)=B-A\rightarrow\rho\left(B-A,\frac{\sigma_B}{\sigma_B^*}\right)$
- This gives FX Market Equilibrium: $i=i^*+\frac{E[e]-e}{e}+\rho\left(B-A,\frac{\sigma_B}{\sigma_B^*}\right)$. UIP fails!
  - Note $\downarrow F,\uparrow A,\downarrow\rho,\downarrow e$ [appreciation]

Purchasing Power Parity

- Arbitrage relation between dom. and for. goods, assuming no barriers to international trade
  - Law Of One Price: $P_i=eP_i^*$ if not arbitrage assuming costless trade. IRL fails
  - Absolute PPP: $P=eP^*$ (i.e. $\epsilon=1$). IRL fails
  - Relative PPP: $\epsilon=e\frac{P^*}{P}$ so $\hat{e}=\pi-\pi^*$ (i.e. $\epsilon=\bar{\epsilon}$). IRL fails in SR but better in LR

Why IRL fails? Different price measures, trade barriers, imperfect competition, changes in relative demand and supply affect ϵ, non-tradeable goods etc.

- Bhagwati-Kravi-Lipsey: relative price of labour intensive non tradables is positively related to capital/labour endowment due to higher real wage
- Balassa-Samuelson Effect: aggregate price level is positively related to relative productivity of tradables vs non-tradables sector.
  - *Set-Up*:
    - Home and foreign (*) produce two goods [Tradeable T and Non-Tradeable N]
    - PPP only holds for tradables with share γ [$P_T=eP_T^*$ or $\mathrm{p}_T=e+\mathrm{p}_T^*$]
    - Linear production technology: $Y_i=A_iL_i$
    - Perfect competition $\left(\frac{W_i}{P_i}=A_i \text{ or } \mathrm{w}_i-\mathrm{p}_i=\mathrm{a}_i\right)$
    - Complete labour market ($W_T=W_N$ thus $\frac{A_T}{P_T}=\frac{A_N}{P_N}$ or $\mathrm{a}_T-p_T=\mathrm{a}_N-p_N$)
  - *Equilibrium:*
    - Aggregate Price Level: $P=P_T^\gamma P_N^{1-\gamma}\rightarrow \mathrm{p}=\gamma\mathrm{p}_T+(1-\gamma)\mathrm{p}_N$
    - Thus $\mathrm{p}=\gamma\mathrm{p}_T+(1-\gamma)(\mathrm{p}_T+\mathrm{a}_T-\mathrm{a}_N)=\mathrm{p}_T+(1-\gamma)(\mathrm{a}_T-\mathrm{a}_N)$
    - Likewise $\mathrm{p}^*=\mathrm{p}_T^*+(1-\gamma)(\mathrm{a}_T^*-\mathrm{a}_N)$
    - Thus $\mathrm{p}-\mathrm{p}^*=\mathrm{p}_T-\mathrm{p}_T^*+(1-\gamma)(\mathrm{a}_T-\mathrm{a}_T^*)=e+(1-\gamma)(\mathrm{a}_T-\mathrm{a}_T^*)$
    - Thus $e+P^*-P=-(1-\gamma)(A_T-A_T^*)$
  - *Interpretation:* Real exchange rate depends on productivity differential. Hence LT drift

Essay Plan

Introduction

- Define concepts (see above)

Empirical Evidence

- Test of Absolute PPP: Gopinath et al (2011):
  - Research compare international prices of a road basket of commodities while accounting for quality differences among supposedly identical goods
  - Find that PPP predictions are drastically wrong
  - Isard (1977): Law of One Price (which PPP builds on) also fails, with manufactured goods being sold at widely different prices in different markets since 1970
- Test of Relative PPP: Krugman, Obstfeld, Melits:

- Relative PPP predicts $e_{Y/\$}$ and $\frac{P_{Jap}}{P_{US}}$ will move in proportion but early 1980s saw steep appreciation of \$ even though $\frac{P_{Jap}}{P_{US}}$ consistently falls. Far more than PPP could predict
- Taylor & Taylor (2004): Equ ϵ may change depending on country's net wealth: ↑external debt, need ↑ trade surplus to pay off, thus ↓ ϵ (not constant as predicted by PPP)
- Note that in LR relative PPP performs better

Theoretical Justification

- Significant transport costs and restrictions on trade (e.g. tariffs)
  - Weakens law of one price, which underlies PPP, leading to a persistent price differential
  - Non-tradables (e.g. services such as haircuts) have prices not linked internationally. Solely determined by domestic dd/ss , which can cause relative price of baskets to differ
- Lack of free competition
  - Same product sold by same country is often sold at different prices in different countries. Due to different demand conditions: the more price inelastic, the higher mark up
  - E.g. VW costs \$4,000 more in Australia than Ireland
- Difference in consumption pattern and price level measurement.
  - Tests based on official price indexes more likely to fail becuase different countries use different reference baskets
  - E.g. India assigns more weight to chutney and Japan to sushi. Thus if ↑ P_{Sushi}, the price of Japan's basket increases much more than India.

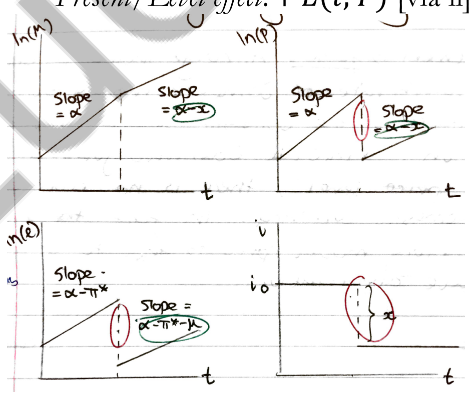
Flexible-Price Monetary Model

Assumptions

i. Relative PPP holds $\bar{\epsilon} = \frac{eP^*}{P}$ hence $\hat{e} = \pi - \pi^*$
ii. LM is given by $\frac{M}{P} = L(i, Y)$ hence $\pi = \widehat{M}$ (assuming constant i, Y)
iii. Fisher Equation with RatEX: $i = r + \pi^e$
iv. Flexible prices thus $Y = \bar{Y}$ and $r = \bar{r}$
v. We assume $\widehat{M}^* = 0$ (i.e. M is relative)

Chain of Events

- Note that $e = \bar{\epsilon}\frac{M/L(-i,Y)}{M^*/L^*(-i^*,Y^*)}$
- *Future/Growth effect*: ↓ $\widehat{M}$ by x; ↓ $\hat{\pi}$ by x [via ii]; ↓ $\hat{e}$ by x [via i]
- *Critical Link*: AND ↓ $\widehat{\pi^e}$ by x [via iii]
- *Present/Level effect*: ↑ $L(i, Y)$ [via ii]; ↓ P [via ii]; ↓ e [via i] i.e. appreciates



	Monetary policy	Exchange rate e
$i\uparrow$		
Sticky prices (short run)	contractionary $M\downarrow \to i\uparrow$ (liquidity effect)	appreciation $e\downarrow$
Flexible prices (long run)	(persistently) expansionary $\hat{M}\uparrow \to \pi^e\uparrow \to i\uparrow$ (Fisher effect)	depreciation $e\uparrow$

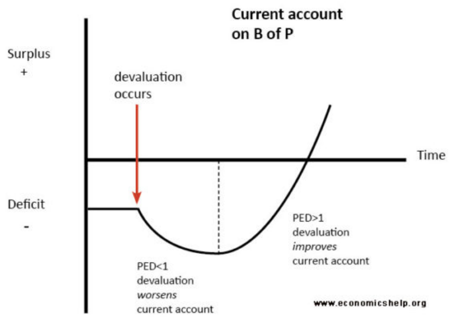
<u>Comments</u>

- Fundamental difference to previous analysis is we are looking at growth rates not level
- If we have fixed or adaptive expectations our link breaks
- Model comments on SR but better suited for LR

DD-AA Model (e,Y)

Marshall-Lerner Condition

- $\frac{\delta CA}{\delta \epsilon} > 0$ iff $\eta + \eta^* > 1$ where $\eta = \frac{\delta EX}{\delta \epsilon}\frac{\epsilon}{EX}$ and $\eta^* = -\frac{\delta EX^*}{\delta \epsilon}\frac{\epsilon}{EX^*}$ and initial balance $EX = \epsilon EX^*$
    - $CA = EX - IM = EX - \epsilon EX^*$
    - Thus $\frac{\delta CA}{\delta \epsilon} = \frac{\delta EX}{\delta \epsilon} - \epsilon\frac{\delta EX^*}{\delta \epsilon}[\text{volume effect}] - EX^*[\text{value effect}]$
    - Thus $\frac{\delta CA}{\delta \epsilon}\frac{\epsilon}{EX} = \frac{\delta EX}{\delta \epsilon}\frac{\epsilon}{EX} - \frac{\delta EX^*}{\delta \epsilon}\frac{\epsilon}{EX^*} - 1$
- Empirically, we find a J-curve effect with the initial value effect dominating the volume effect as households/firms take time to adjust volume. Hence MLC doesn't hold in very SR.



Basic Model

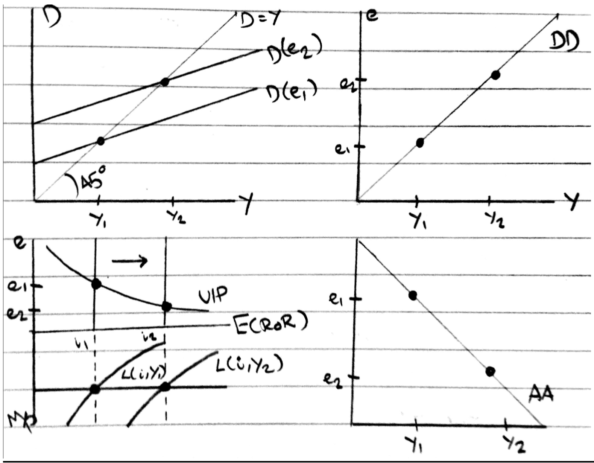
<u>Set Up</u>

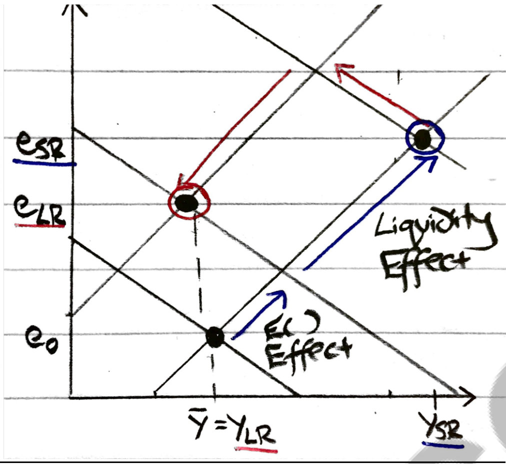
Derivation of DD Curve

- Goods market equilibrium: $Y = D = C(Y - \bar{T}) + \bar{I} + \bar{G} + CA(\epsilon, Y - T)$
    - where $\frac{\delta CA}{\delta \epsilon} > 0$, $c \equiv \frac{\delta C}{\delta(Y-T)}, m \equiv -\frac{\delta CA}{\delta(Y-T)}$, $0 < m < c < 1$
    - adjustment via firm inventories (like Keynesian Cross)
- $\uparrow e, \uparrow CA, \uparrow$demand for goods, $\uparrow$ firm production next period, $\uparrow Y$. Thus slopes up in (Y, e)

Derivation of AA Curve

- LM & UIP equilibrium: $\frac{\bar{M}}{P} = L(i^* + \frac{E[e]-e}{e}, Y)$ [see Asset Approach Model]
    - LM: Money Market: $\frac{\bar{M}}{P} = L(-i, Y)$
    - UIP: Foreign Exchange Market: $i = i^* + \frac{E[e]-e}{e}$ (ir parity condition due to arbitrage)
    - Rational Expectations $E[e]$
    - PPP in LR $e = \bar{\epsilon}\frac{P}{P^*} = \bar{\epsilon}\frac{M/L}{M^*/L^*}$. If fails, ϵ determined by rel. world dd-ss $\epsilon\left(\frac{D}{D^*}, \frac{Y}{Y^*}\right)$
- $\uparrow Y, \uparrow M^d$ (due to transaction motive) $\uparrow$ shift $L, \uparrow i$, more attractive to invest in home deposits, $\downarrow e$. Thus slopes down in (Y, e) space





Comparative Statics

- Temporary MP: $\uparrow M^s, \downarrow i, \uparrow e$ (UIP) for all Y, AA shifts out, $\uparrow e$ and $\uparrow Y$
  - Intuitively, $\uparrow e, \uparrow \epsilon, \uparrow NX, \uparrow Y$ then $\uparrow M^d, \uparrow i, \downarrow e$ somewhat (movement along)
- Permanent MP: same SR, $Y > \bar{Y}$, produce factors are working overtime, $\uparrow$ prod costs, $\uparrow P \dots$
  - AA: $\uparrow P, \downarrow \frac{M}{P}$ until back at org. (liquidity effect reverses), shifts in AA
  - DD: $\uparrow P$, domestic goods relatively more expensive, $\downarrow NX, \downarrow Y$, shift in DD
  - Thus there MAY be overshooting depending on if Liquidity > Expectation effect

Fiscal Expansion $\uparrow G, \downarrow T$

- *Temporary*: $\uparrow$ G, $\uparrow Y$ for any e, DD shifts out, $\uparrow Y$ & $\uparrow e$
  - $\uparrow G, \uparrow Y, \uparrow M^d, \uparrow i, \downarrow e, \downarrow NX, \downarrow Y$ somewhat [movement along curve]
- *Permanent*: same as *Temporary* plus expectation channel:
  - $\uparrow$ perm $G, \uparrow \frac{D}{D^*}, \downarrow \epsilon$ in LR, $\downarrow E(e), \uparrow E(\quad)$ return on domestic assets, $\downarrow e$ in SR for any Y, AA shifts in. Thus $\Delta Y = 0, \downarrow e$.
  - Intuitively, appreciation of e decreases NX, crowding out fiscal policy 1:1
  - This must be LR equ. too since $Y = Y^*$.
    - Suppose $Y > Y^*$, then must had $\uparrow M^d, \uparrow i$ so $i > i^*$ so $\frac{E(e)-e}{e} > 0$ so $E(e) > e$.
    - Expect future depreciation, $\uparrow e, \uparrow NX, \uparrow Y$. Move further away form LR equ!

IS-LM-UIP Model (r, Y)

Short-Run Extension

Derivation of IS-FX Curve

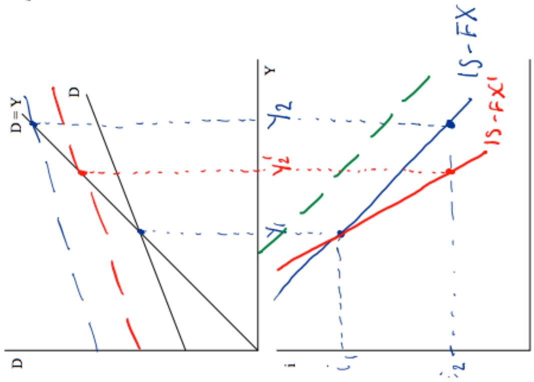
- Goods Market: I is now endog. determined by r.
  - $D = C(Y - \bar{T}) + I(-r) + \bar{G} + CA(e\frac{P^*}{P}, -[Y - \bar{T}])$
  - where $c = \frac{\delta C}{\delta(Y-T)}$, $m = -\frac{\delta CA}{\delta(Y-T)}$ with $0 < m < c < 1, \frac{\delta I}{\delta r} < 0$ and $\frac{\delta CA}{\delta \epsilon} > 0$
- ForEx: $(1 + i) = (1 + i^*)\frac{E[e]}{e}$ and Fisher: $i = r + E[\pi]$
- Thus IS-FX: $Y = C(Y - \bar{T}) + I(-[i - \pi^e]) + \bar{G} + CA\left(E[e]\frac{1+i^*}{1+i}\frac{P^*}{P}, -[Y - \bar{T}]\right)$
  - Note: If $i = i^*$ then $E[e] = e$. ER follows random walk (i.e. Mundell Fleming)

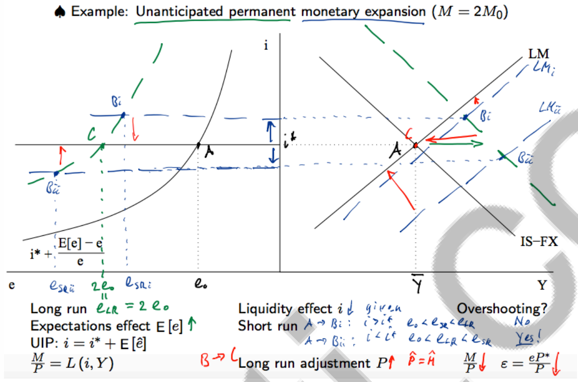
Set-Up

- (IS) Goods Market: $Y = C(Y - \bar{T}) + I(r) + \bar{G} + CA\left(e\frac{P^*}{P}, -[Y - \bar{T}]\right)$
- (LM) Money Market: $\frac{\bar{M}}{P} = L(-i, Y)$

- (UIP) Foreign Exchange Market: $(1+i) = (1+i^*)\frac{E[e]}{e}$
- Fisher: $i = r + E[\pi]$ | RatEx: $E[e]$ & $E[\pi]$ | SR sticky, LR flexible prices $\epsilon = f\left(\frac{D}{D^*}, \frac{Y}{Y^*}\right)$
  $\downarrow M_S$ has expectations and liquidity effects

DD-AA model's i-Y relationship of smaller magnitude as no I channel. Thus steeper slope





International Macroeconomic Interdependence

Balance of Payments Accounts

- $CA + KA - FA = 0$
  - Current Account (CA) = Net Exports (NX) + Net Factor Income From Abroad (NFIA) +Net Unilateral Current Transfers (NUT)
  - Capital Account (KA)
  - Financial Account Balance (-FA) = -Official reserves FA + -Non-reserve FA
- Note that (assuming KA=0): $\sum CA_t^n = 0$ | $CA_t^n = FA_t^n$ | $\sum FA_t^n = 0$
- National Income Accounting: $CA_t = S_t - I_t$
- Balance of Payments Accounting: $CA_t = FA_t = \Delta B_t$ (assuming KA=0)
  - Thus intertemp. budget $\sum_{t=1}^{T} CA_t = B_T - B_0 = 0$ (assuming $B_0 = B_T = 0$)
- Spillovers: In a closed World Economy $CA + \epsilon CA^* = 0$ where $CA(\epsilon, -[Y-T], Y^* - T^*)$ and $D = C(Y - \bar{T}) + \bar{I} + \bar{G} + CA(\epsilon, Y - \bar{T}, Y^* - \bar{T}^*)$

International Portfolio Diversification

- $U = P(s=1)u(C_1) + [1 - P(s=1)]u(C_2)$ where $s \in \{1,2\}$
- Budget: $C_s = [\alpha H_s + (1-\alpha)F_s]W$ where X_s is gross return and α is portfolio share]
- Thus can get consumption smoothing across states of nature:
  - $U = P(s=1)u([\alpha H_1 + (1-\alpha)F_1]W) + [1 - P(s=1)]u([\alpha H_2 + (1-\alpha)F_2]W)$
  - $\frac{dU}{d\alpha} = qu'(C_1)[H_1 - F_1]W + (1-q)u'(C_2)[H_2 - F_2]W = 0$
  - Rearrange to $\frac{qu'(C_1)}{(1-q)u'(C_2)} = \frac{F_2 - H_2}{H_1 - F_1}$

Currency Crisis

Recall: CB Balance Sheet	
Domestic Assets A	Currency C
Foreign Reserves F	Bank Reserves R
Loans L_{CB}	Government Deposits D_G

where $H = C + R$ and BoP$= \Delta F$

Foreign Exchange Intervention

- Open market purchase/sale of foreign assets F. Can be either
  - Non-sterilized $\Delta F = \Delta H$ (e.g. BoE sells US Treasury Bills for £100m to UK banks)
  - Sterilized by offsetting OMO so $\Delta H = 0$: $\Delta F = -\Delta A$ (e.g. BoE sells US Treasury Bills for £100m to UK banks; sterilized by buying £100m UK Gilts from UK)

<u>Non-Sterilized FX Interventions</u>

- Helps maintain fixed exchange rate: If $e > \bar{e}$, then $\downarrow F$ and $\downarrow H$, so $\downarrow M, \uparrow i$ and $\downarrow e$
  - Note: $e = \bar{e}$ and $E[\hat{e}] = 0$ thus $i = i^*$ thus $M = \bar{P}L(i^*, Y)$ (i.e. M is endogenous)

<u>Sterilized FX Interventions</u>

- How can sterilized FX interventions be effective without ΔM?
  - Signalling: if sterilized ΔF signals future ΔM, then $\Delta E[e]$ and thereby Δe
  - Imperfect International Asset Substitutability (UIP fails; see above)

1. Bad Macroeconomic Fundamentals (Krugman)

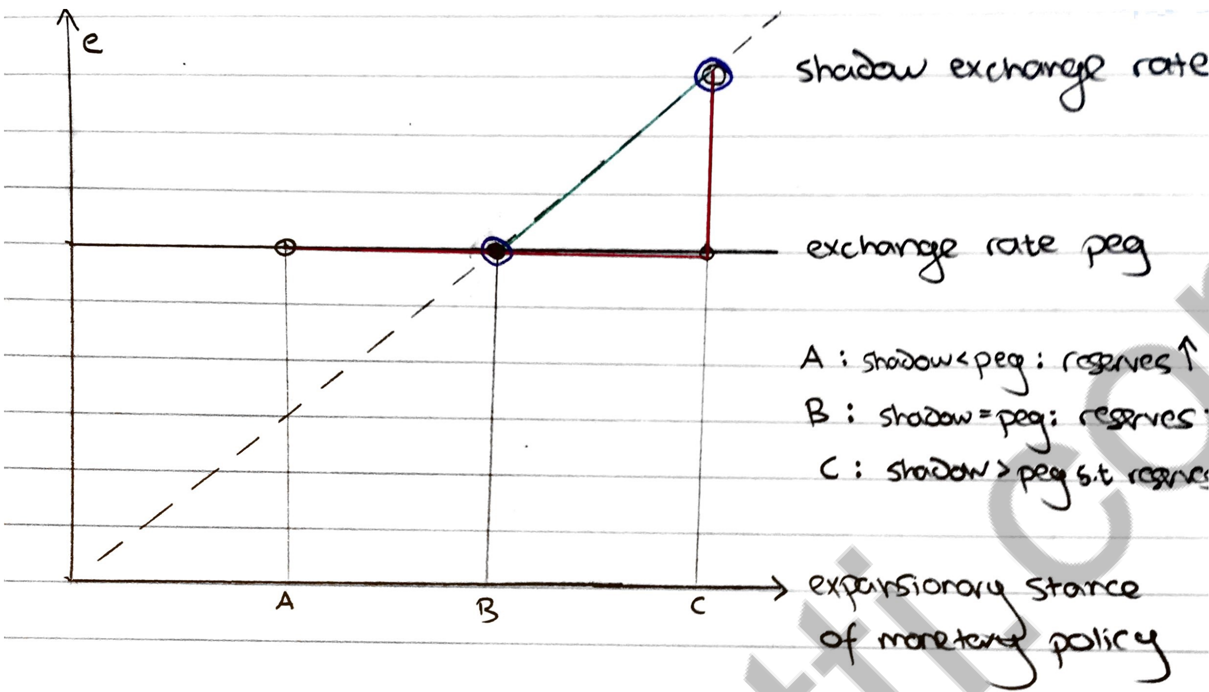
- Suppose government engages in monetary financing of debt $\hat{A} = \mu > 0$ but also tries to maintain exchange rate peg: $e = \bar{e}$
- Once foreign reserves are depleted $A = H$ and we are forced to adopt a flexible exchange rate e where $\hat{e} = \widehat{M} = \widehat{H} = \hat{A} = \mu$
  - Note that speculative attack occurs before $F = 0$! Timing T determined by $e_T^s = \bar{e}$ (where e^s is shadow ER under free float) when $\hat{e}^s = \mu > 0$

2. Self-Fulfilling Crises (Obstfeld)

- Assume UIP $i = i^* + E[\hat{e}]$ and government abandons peg $\bar{e}$ if $i > \bar{\imath}$, where threshold $\bar{\imath} > i^*$
  - If no crisis is expected $E[\hat{e}] = 0$ so $i = i^* < \bar{\imath}$ and no crisis occurs
  - If crisis is expected $E[\hat{e}] = \theta$ so $i = i^* + \theta$ and no crisis occurs if $i^* + \theta > \bar{\imath}$

3. Financial Fragility

- <u>Contagion</u>: spread of financial crisis to other countries. Transmission can be via real linkages through trade or financial linkages through international investors
  - Causes: weak banking sector, deficient financial regulation, vulnerable maturity structure of debt with short duration, foreign currency denominated debt etc.
- Let foreign currency denominated debt be eL^*. Thus economic mechanism: Negative shock, $Y \downarrow, e \uparrow, eL^* \uparrow$, worsening balance sheet, $Y \downarrow\downarrow, e \uparrow\uparrow$



Adaptive Expectations: believes $\bar{e}$ fixed forever ∴ only attack when foreign reserves = 0 i.e @ C

Krugman (1st gen): rational expectations ∴ attack as soon as currency is overappreciated i.e @ B else arbitrage

Obstfeld (2nd gen): investors are still rational but now CB has dual policy where ... multiple equilibria
- if no speculative attack @ B ∴ keep peg
- if speculative attack @ C ∴ abandon peg