Part IIA

Supervision 10 - Revision

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This Class

- Beware own suggested solutions, which may contain typos.
- Sample Exam Paper 2020-2021.
- Past Paper Questions.
- Other Questions (Read over at home).
- Some Revision Tips.

Short Questions

Question A1 - Set Up

- *A1. Suppose an economic agent faces the following optimisation problem:*

$$U = \max_{c,L} \left\{ \ln c + \ln(1 - L) \right\}$$
$$\text{s.t.} \quad c = wL - T$$

where c denotes consumption, L labour supply, $1 - L$ leisure, w the real wage, and T lump-sum taxes.

Question A1 - (a) Static Choice

- *(a) Derive the optimal choice of consumption, c, and labour supply, L.*

- Rewrite the problem, using the **binding** budget constraint:

$$U = \max_{c,L} \left\{ \ln c + \ln(1-L) \right\} = \max_{L} \left\{ \ln(wL - T) + \ln(1-L) \right\}$$

- To find optimal labour supply take FOC:

$$\text{FOC:} \quad \frac{w}{wL-T} - \frac{1}{1-L} = 0 \quad \Rightarrow \quad L = \frac{1}{2} + \frac{T}{2w}.$$

- The SOC proves this is an optimal solution:

$$\text{SOC:} \quad -\frac{w^2}{(wL-T)^2} - \frac{1}{(1-L)^2} < 0.$$

Question A1 - (a) Static Choice (Calibration)

- *(a ctd) Compute c, L and total utility U, with* $w = 1$, $T = 0$.

- Plug result for L into budget constraint to find c:

$$c = wL - T \quad \Rightarrow \quad c = w\left(\frac{1}{2} + \frac{T}{2w}\right) - T = \frac{w}{2} - \frac{T}{2}.$$

- Hence find utility:

$$U = \ln\left(\frac{w}{2} - \frac{T}{2}\right) + \ln\left(\frac{1}{2} - \frac{T}{2w}\right).$$

- Plug in $w = 1$ and $T = 0$ to show:

$$L = \frac{1}{2}, \quad c = \frac{1}{2}, \quad U = -\ln 4 < 0.$$

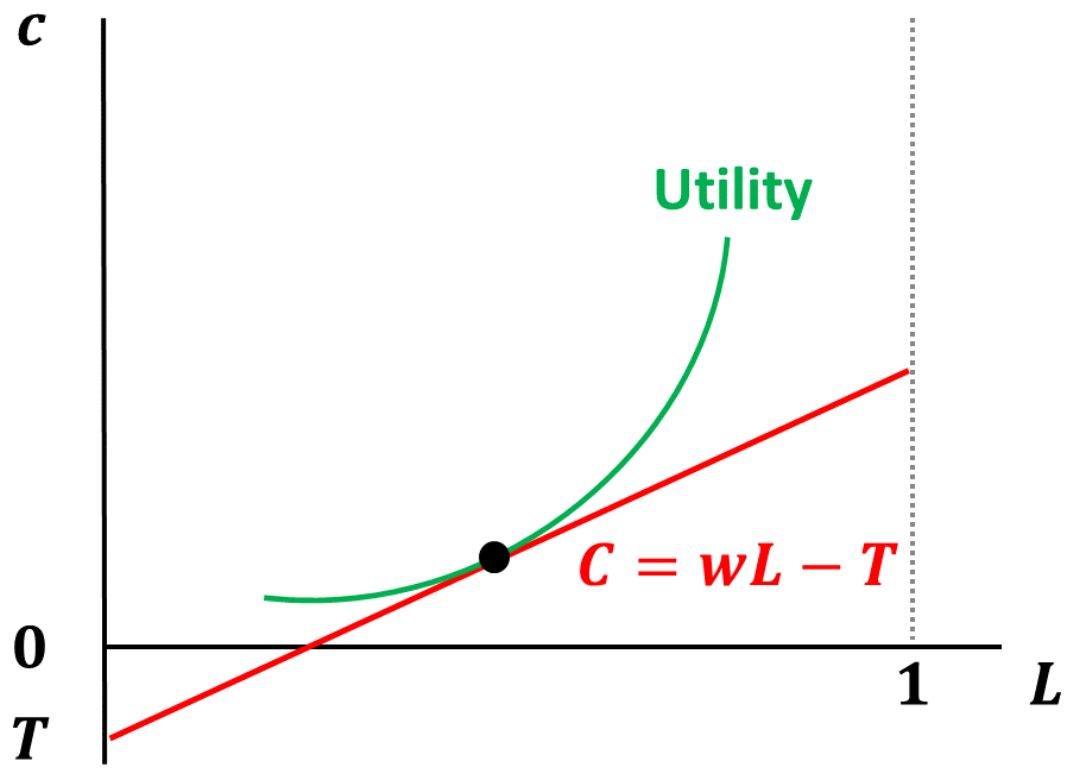
Question A1 - (b) Substitution Effect

- *(b) Suppose there is an increase in the wage from* $w = 1$ *to* $w = 4$*. Explain only the substitution effect of this wage increase and illustrate it using a diagram with leisure on the horizontal axis and consumption on the vertical axis.*

Question A1 - (b) Graphical I

- Initial position. Utility from consumption and leisure.

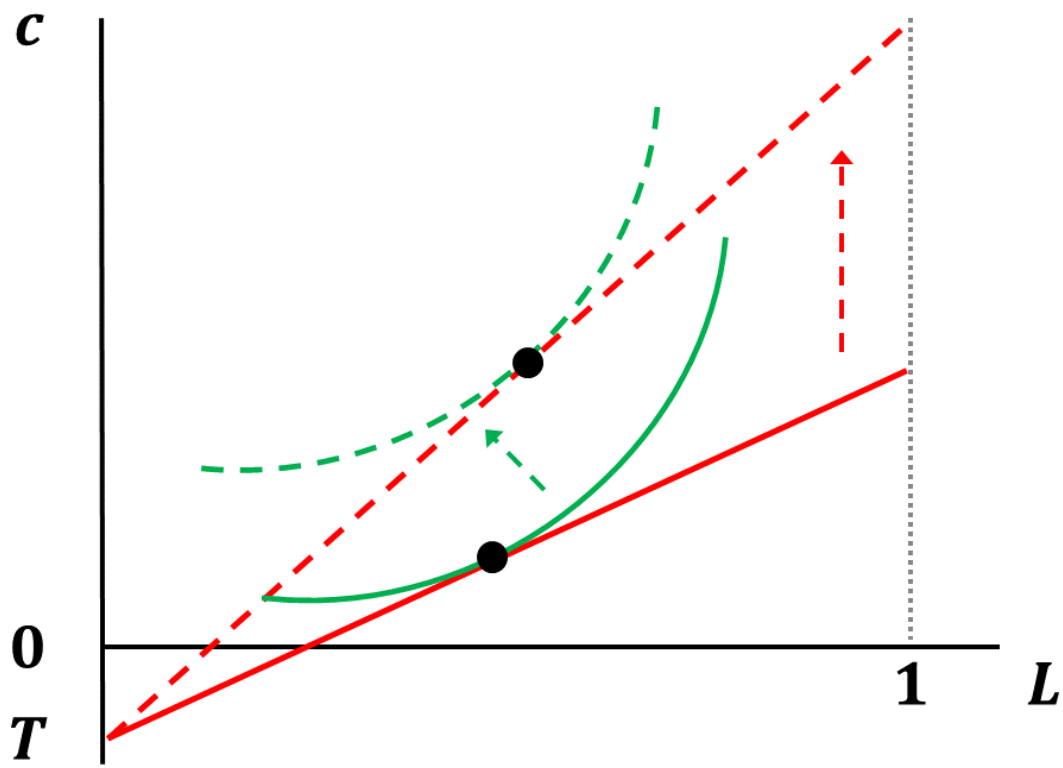
Consumption-Leisure Trade-off



Question A1 - (b) Graphical II

- Real wage increases, **unambiguously** improving welfare.

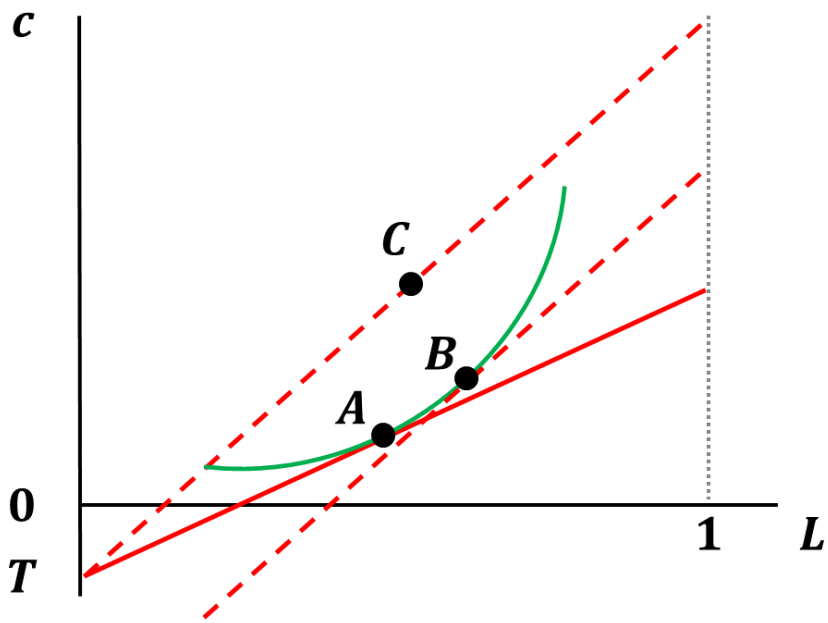
Consumption-Leisure Trade-off



Question A1 - (b) Graphical III

- Two decomposition methods due to **Hicks** and **Slutsky**.
- **Hicksian** SE is the movement between points A and B below.
- Difference between original bundle and a new bundle arising with higher wages but on the **original** indifference curve.

Consumption-Leisure Trade-off



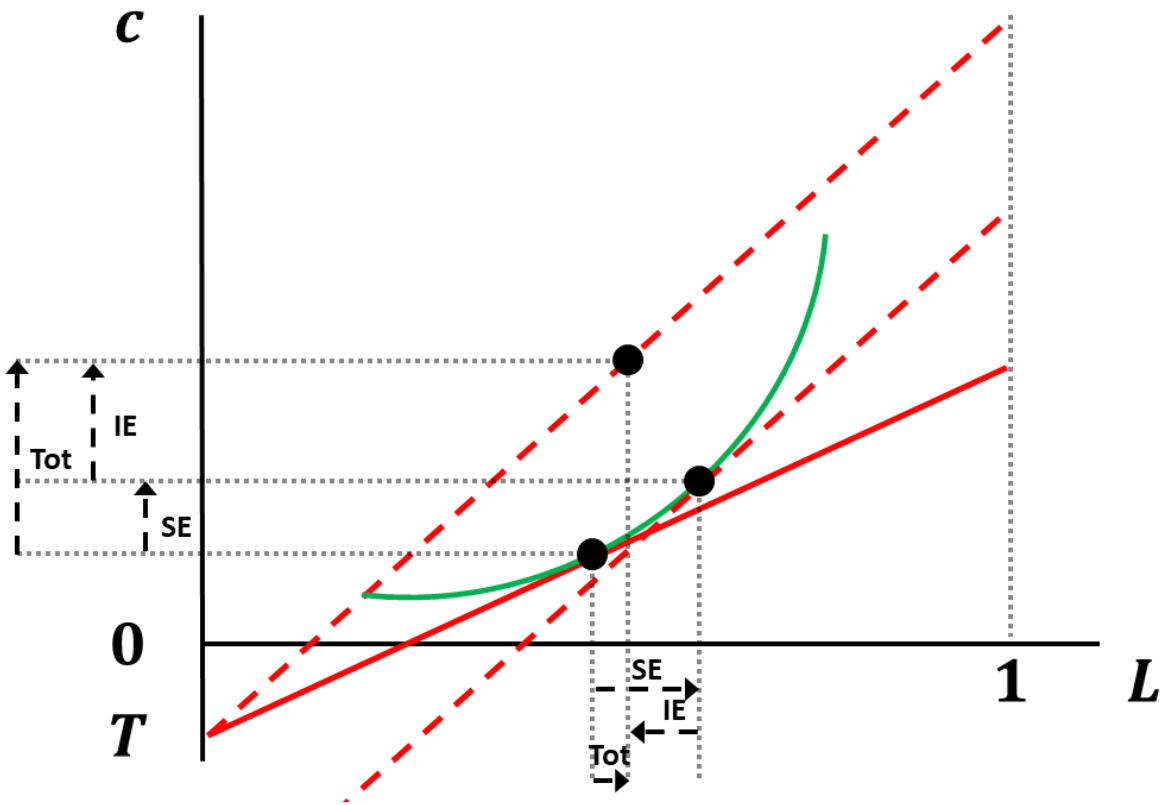
Question A1 - (b) Substitution Effect

- As $w \uparrow$, the **relative price** of leisure has risen.
- Thus SE results in **lower** leisure (as the opportunity has risen) and **higher** consumption (which is now more affordable).

Question A1 - (b) Total Effect

- Could then mention the total effect as both SE and IE.

Consumption-Leisure Trade-off



Question A1 - (c) Substitution Effect (Maths)

- *(c) Show mathematically that increasing the wage from* $w = 1$ *to* $w = 4$ *and simultaneously increasing taxes from* $T = 0$ *to* $T = 2$ *leaves the agent indifferent. Use this result to compute the substitution effect of the wage increase on both consumption* c *and labour* L*.*

Question A1 - (c) Substitution Effect (Maths)

- Plug in new values using analytical results:

$$c = \frac{w}{2} - \frac{T}{2}, \quad L = \frac{1}{2} + \frac{T}{2w}, \quad U = \ln\left(\frac{w}{2} - \frac{T}{2}\right) + \ln\left(\frac{1}{2} - \frac{T}{2w}\right).$$

- Hence the calibration results in:

	Initial (A)	SE (B)	Final (C)
w	1	4	4
T	0	2	0
c	$\frac{1}{2}$	1	2
L	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$
U	$-\ln 4$	$-\ln 4$	0

- The SE is $+\frac{1}{4}$ for L and $+\frac{1}{2}$ for c.

Question A2 - Set Up

- *Consider the following McCall search model in which the reservation wage, w_r, is determined by:*

$$w_r - b = \underbrace{\frac{\beta}{1-\beta} \sum_{w \in W} \max\{w - w_r, 0\} Pr(w)}_{h(w_r)}$$

where β is the intertemporal discount factor, b denotes unemployment benefits, $W = \{w_1, w_2, w_3\}$ denotes the set containing the possible wage offers, and $Pr(w)$ denotes the probability of wage offer w.

- *Suppose that $\beta = \frac{5}{6}$, $W = \{2, 4, 6\}$, and $Pr(w_1) = \frac{1}{5}$, $Pr(w_2) = \frac{3}{5}$, and $Pr(w_3) = \frac{1}{5}$.*

Question A2 - (a) $h(w_r)$

- *(a) Carefully draw the function $h(w_r)$ with w_r on the horizontal axis and $h(\cdot)$ on the vertical axis.*

- Using calibrated values, the functional form becomes:

  $$h(w_r) = \max\{2 - w_r, 0\} + 3\max\{4 - w_r, 0\} + \max\{6 - w_r, 0\}$$

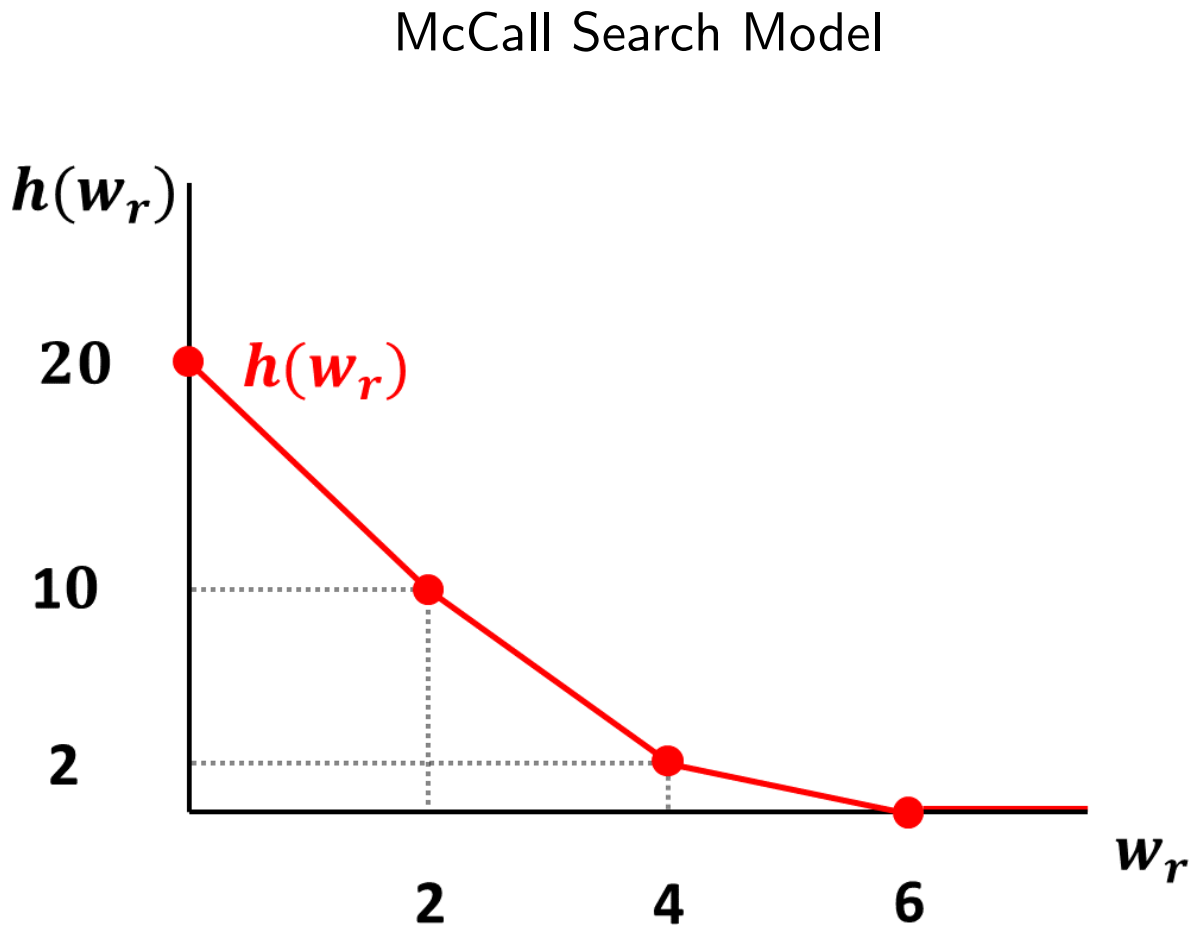
  which is **continuous**, **decreasing** and **piecewise linear**.

- Four regions of interest:

$$h(w_r) = \begin{cases} 20 - 5w_r & \text{if } \ 0 \leq w_r \leq 2, \\ 18 - 4w_r & \text{if } \ 2 \leq w_r \leq 4, \\ 6 - w_r & \text{if } \ 4 \leq w_r \leq 6, \\ 0 & \text{if } \ 6 \leq w_r. \end{cases}$$

Question A2 - (a) Graphical

- Find nodes and carefully draw the $h(w_r)$.

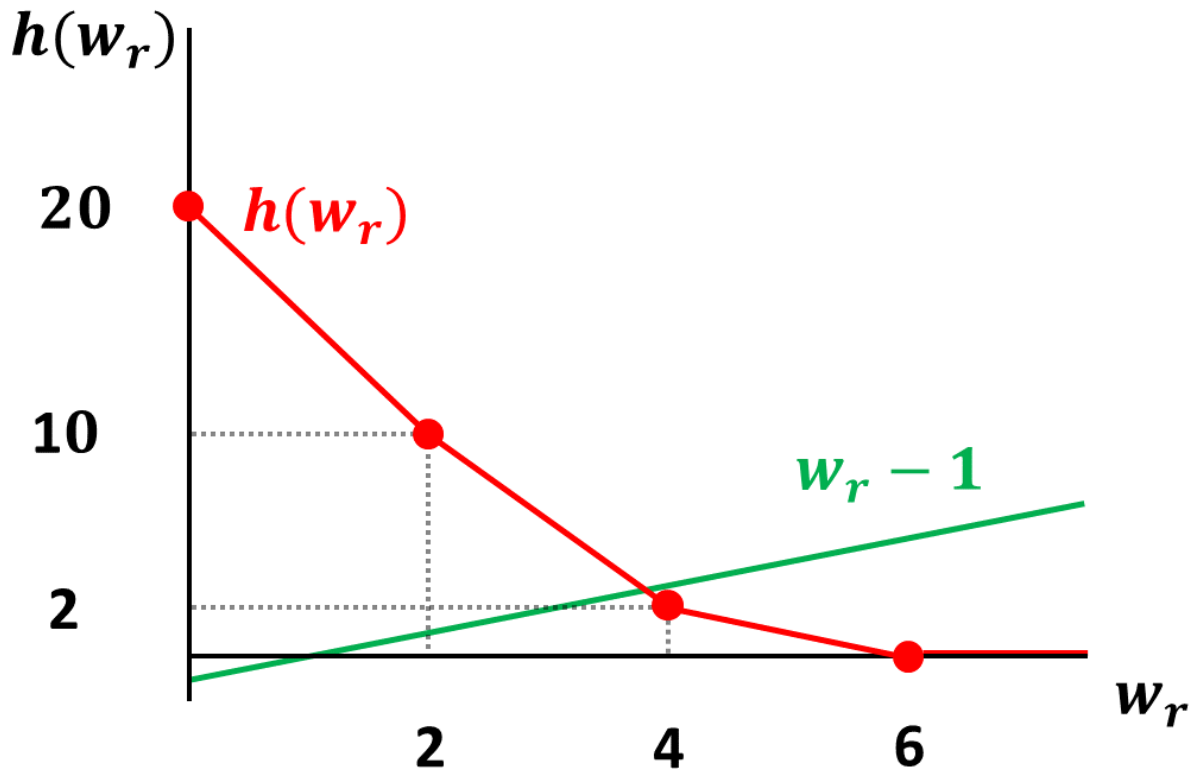


Question A2 - (b) Graphical

- *(b) Suppose that $b = 1$. Compute the reservation wage w_r.*

- Plot $w_r - 1$ on the graph: **likely** intersection $2 \leq w_r \leq 4$.

McCall Search Model



Question A2 - (b) Maths

- Conjecture:

$$\begin{aligned} w_r - 1 = h(w_r) &= 18 - 4w_r, \\ 5w_r &= 19, \\ w_r &= \frac{19}{5} = 3.8. \end{aligned}$$

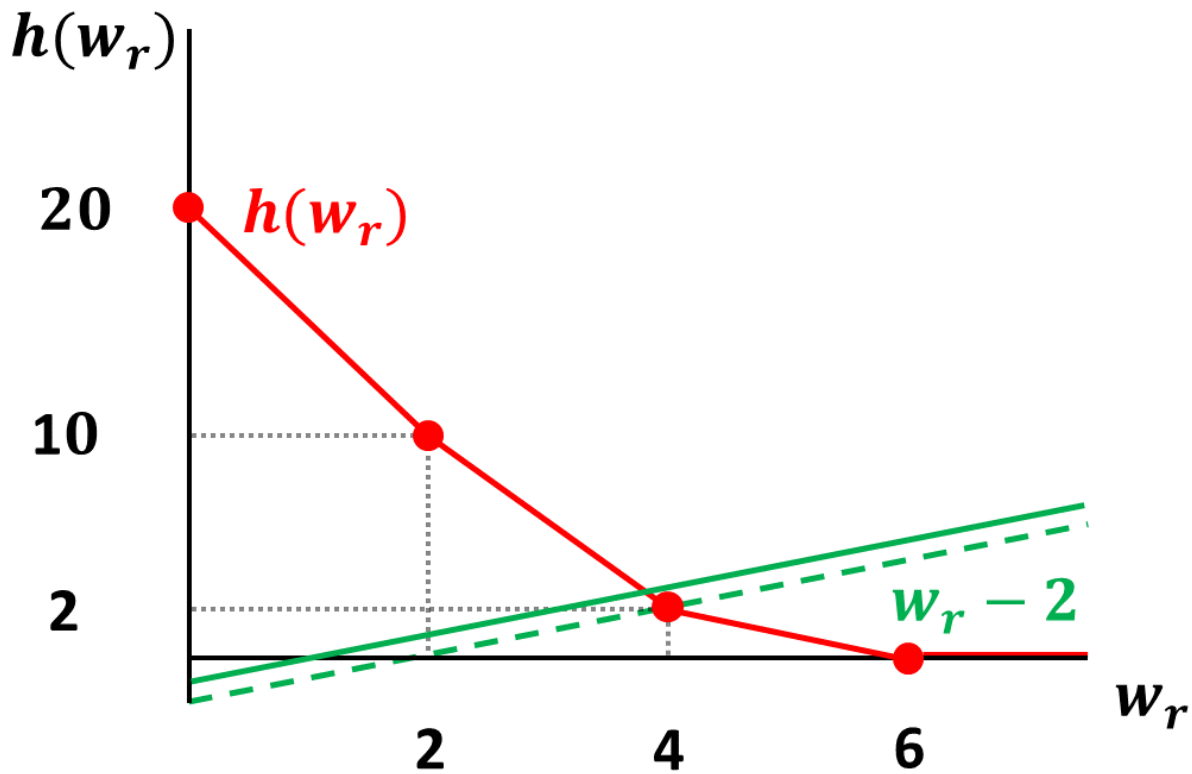
- Since $2 \leq 3.8 \leq 4$, we verify our conjecture correct.
- Note: all other initial guesses lead to **contradictions**.
- Alternative method uses a proof by contradiction.

Question A2 - (c) Graphical

- *(c) Now suppose that unemployment benefits rise to $b = 2$. Explain how that affects the reservation wage w_r.*

- $w_r - b$ line **shifts down**, leading to an **increase** in w_r.

McCall Search Model



Question A2 - (c) Maths & Intuition

- By inspection, or reusing contradiction method, now $w_r = 4$.
- Higher unemployment benefits increase the value of the **outside option**. (Higher value to not working).
- Workers are **willing to wait** longer for a higher wage offer.
- Workers must therefore be compensated at a higher wage level to make the **indifferent** between accepting the job or not.
- The reservation wage, w_r, **rises**.

Question A3 - Set Up

- *A3. Last autumn, the United States experienced severe strain in the repo market and interbank market for reserves, such that the overnight repo rate jumped to 10% and the federal funds rate reached the 2.25% ceiling of its target range on 17 September 2019. Against this background, show and briefly explain the effects on the Federal Reserve's balance sheet of each of the following changes (ceteris paribus):*

- *(a) US Treasury issues $55bn in USTs to US private sector.*

- *(b) US companies pay $30bn in tax to US Treasury.*

- *(c) Federal Reserve enacts open market purchase of $75bn of USTs in secondary market.*

- *Explain how these changes affect the federal funds rate.*

Question A3 - Stylised Federal Reserve Balance Sheet

- Recall from lecture notes:

Assets ($bn)	Liabilities ($bn)
Domestic securities (A)	Currency (C)
Foreign securities (F)	Bank's reserves (R)
Loans to banks and gov't (L_{CB})	Government deposits (D_G)

- Largest **asset** component is typically domestic securities, (A).

- Largest **liability** component is typically bank's reserves, (R).

Question A3 - (a) Private Sector Issuance

- *(a) US Treasury issues $55bn in USTs to US private sector.*
- US Treasury deposits increase by $+\$55bn$.
- Private sector balances (held as excess bank reserves) falls $-\$55bn$.
- No change to asset side of balance sheet.

Assets ($bn)	Liabilities ($bn)
Domestic (A)	Currency (C)
Foreign (F)	Bank's reserves ($\Delta R = -\$55bn$)
Loans (L_{CB})	Government deposits ($\Delta D_G = +\$55bn$)

Question A3 - (b) Tax Payments

- *(b) US companies pay $30 billion in taxes to the US Treasury by bank transfer.*

- US Treasury deposits increase by $+\$30bn$.

- Private sector balances (held as excess bank reserves) fall $-\$30bn$.

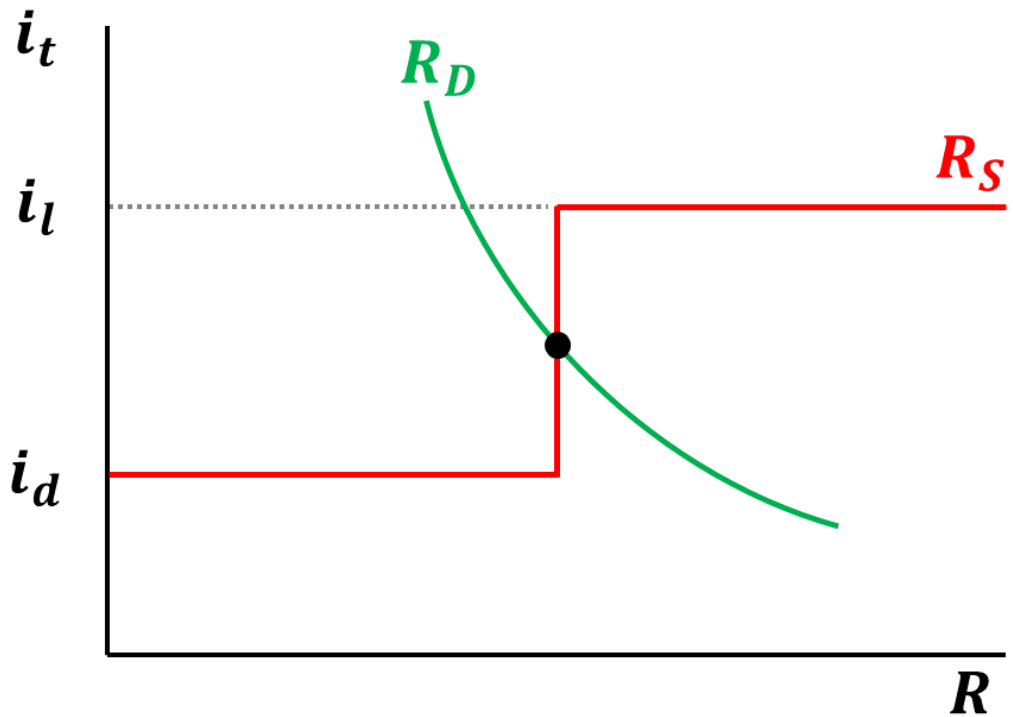
- Again, no change to asset side of balance sheet.

Assets ($bn)	Liabilities ($bn)
Domestic (A)	Currency (C)
Foreign (F)	Bank's reserves ($\Delta R = -\$30bn$)
Loans (L_{CB})	Government deposits ($\Delta D_G = +\$30bn$)

Question A3 - (a & b) Graphical I

- Interbank demand for reserves, $R_D = R_{min} + R_e(\underline{i})$,
- Interbank supply of reserves, $R_S = R_n + R_b - R_d$

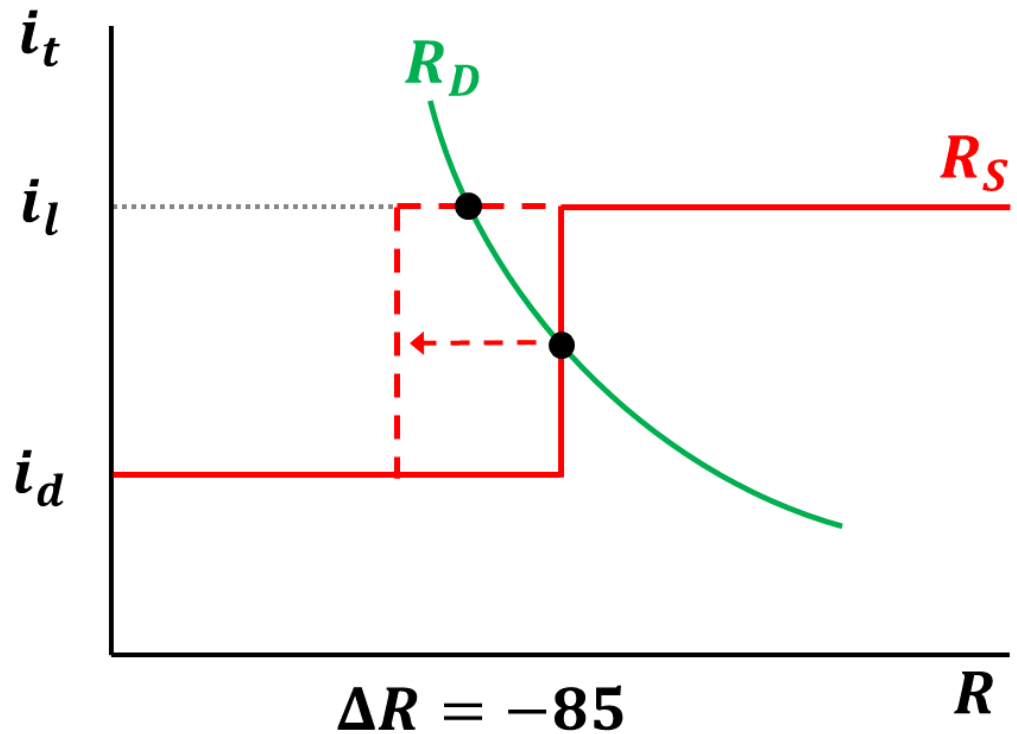
Interbank Reserves Market



Question A3 - (a & b) Graphical II

- Fewer (non-borrowed) reserves, R_n, in interbank market.
- FFR increases until it intersects the discount rate, $i_l = 2.25\%$.

Interbank Reserves Market



Question A3 - (a & b) Discount Loans

- The Fed's discount window **may** be required.
- E.g. as above and the question suggested on 17/09/2019.
- Then the fall in non-borrowed reserves is **partially offset** by a rise in borrowed reserves R_b.

Assets (\$bn)	Liabilities (\$bn)
Domestic (A)	Currency (C)
Foreign (F)	Bank's reserves ($\Delta R = -\$85bn + R_b$)
Loans ($\Delta L_{CB} = +R_b$)	Government deposits ($\Delta D_G = +\$85bn$)

Question A3 - (c) Open Market Operations

- *(c) Federal Reserve enacts open market purchase of \$75bn of USTs in secondary market.*
- Fed's domestic asset holdings increase by $+\$75bn$.
- Banks receive this, so reserves also increase by $+\$75bn$.
- Additional reserves partially offset need for adjustment of borrowed reserves (as overall $\Delta R = -\$10bn$).
- May lead to **fall** in i if discount window no longer required.

Assets (\$bn)	Liabilities (\$bn)
Domestic ($\Delta A + \$75bn$)	Currency (C)
Foreign (F)	Bank's reserves ($\Delta R = \$75bn$)
Loans (L_{CB})	Government deposits (D_G)

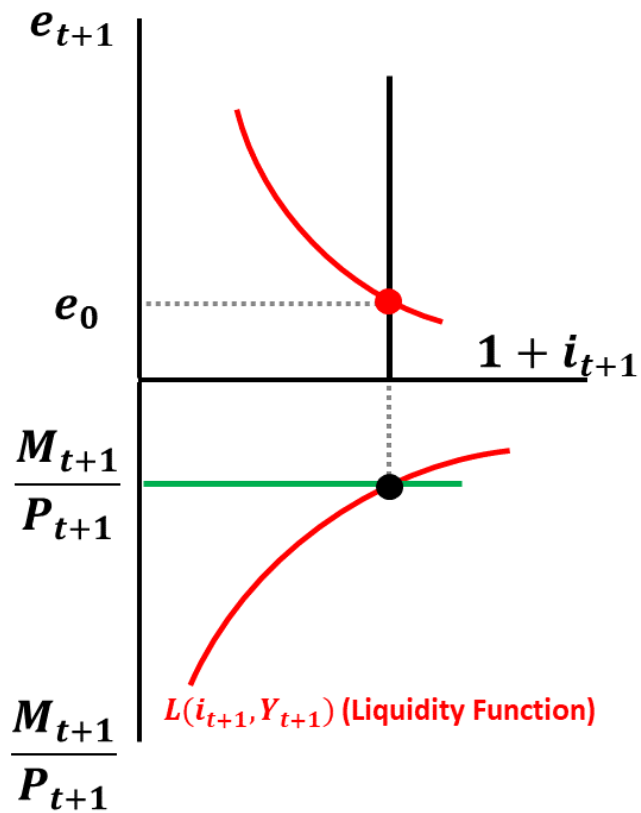
Question A4 - Set Up

- *A4. On 30 January 2020 the Monetary Policy Committee of the Bank of England announced that it had decided to keep Bank Rate at 0.75% and maintain its stock of asset purchases, while significantly reducing its output growth forecasts. In response, the British pound appreciated by 0.4% against the US dollar. Explain whether this could be consistent with the asset market model of the exchange rate.*

Question A4 - Future Period I

- Money and foreign exchange markets jointly determine i_{t+1} and e_{t+1}.
- First assume news about lower future output is **unexpected**.

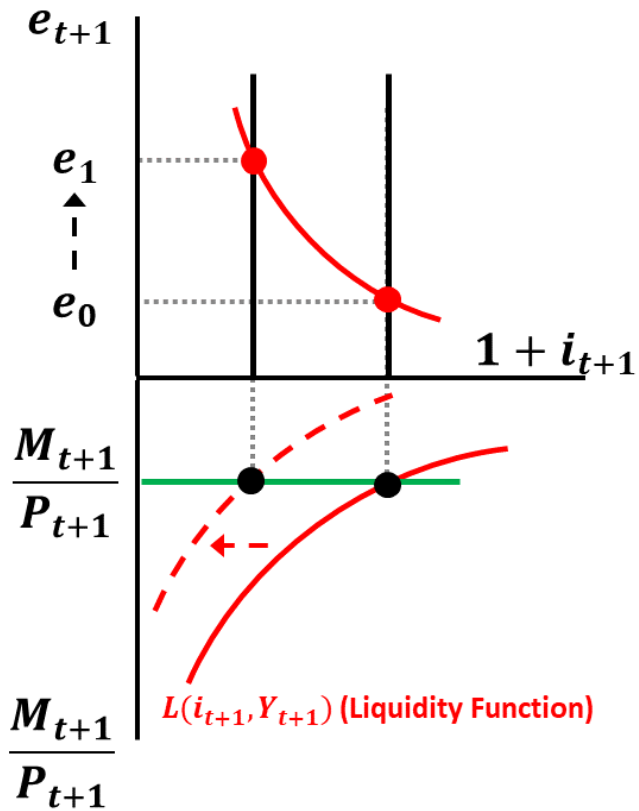
Money and FX Equilibrium.



Question A4 - Future Period II

- Lower **transactions demand** for money reduces future nominal interest rate.
- Anticipate future **depreciation** of the exchange rate (as lower return on domestic currency).

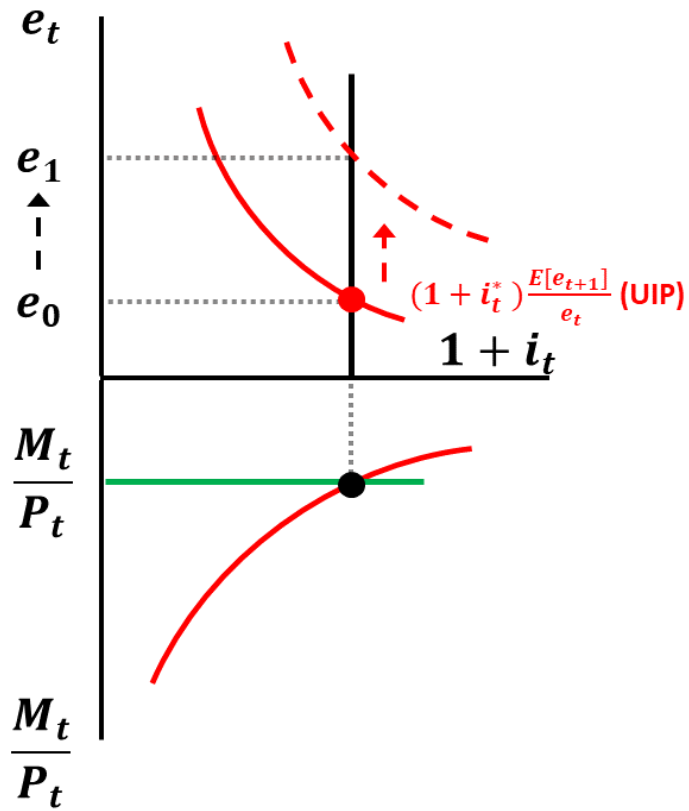
Money and FX Equilibrium.



Question A4 - Current Period

- Anticipation of future **depreciation** leads to current **depreciation**, as lower expected return on domestic vs. foreign currency deposits.

Money and FX Equilibrium.



Question A4 - Reconciliation

- To rationalise the currency **appreciation** we therefore need to appeal to prior beliefs.
- Option 1: Financial markets expected **larger** growth revisions.
- Option 2: Financial market expected **monetary stimulus**.
- Go over each in some detail.

Long Questions

Question B1 - Set Up

- *B1. Suppose that a representative, price-taking firm faces the following optimisation problem:*

$$\max_{k_t, l_t} \{y_t - w_t l_t - (r_t + \delta) k_t\}$$
$$\text{s.t. } y_t = A_t k_t^{\alpha} l_t^{1-\alpha}.$$

where y_t denotes output, A_t productivity, k_t capital, l_t labour, w_t the real wage, r_t the real interest rate, and the subscript t refers to the time period. The depreciation rate satisfies $\delta \in [0, 1]$ and the production technology parameter $\alpha \in (0, 1)$.

Question B1 - (a) Firm's Problem

- *(a) Derive the firm's first order conditions, and use these to find expressions for the factor prices r_t and w_t. Provide an economic interpretation of the results.*

- Substitute in a **binding** production function:

$$\max_{k_t, l_t} \{A_t k_t^{\alpha} l_t^{1-\alpha} - w_t l_t - (r_t + \delta) k_t\}$$

- Differentiate to show:

$$\begin{aligned} \text{FOC, } k_t \quad & \alpha A_t k_t^{\alpha-1} l_t^{1-\alpha} - (r_t + \delta), \\ \text{FOC, } l_t \quad & (1-\alpha) A_t k_t^{\alpha} l_t^{-\alpha} - w_t. \end{aligned}$$

- Set to 0 and rearrange as:

$$\begin{aligned} \text{Real cost of capital } &= \delta + r_t = \alpha A_t k_t^{\alpha-1} l_t^{\alpha} = MP_K, \\ \text{Real wage } &= w_t = (1-\alpha) A_t k_t^{\alpha} l_t^{-\alpha} = MP_L. \end{aligned}$$

Question B1 - More Set-Up

- *Assume for the remainder of this question that* $l_t = 1$ *and* $\delta = 1$*. The representative household's optimisation problem is given by:*

$$\begin{aligned} &\max_{c_0, c_1, b_1} \{\ln c_0 + \beta \ln c_1\}, \\ &\text{s.t. } w_0 + (1 + r_0) b_0 = c_0 + b_1, \\ &\qquad w_1 + (1 + r_1) b_1 = c_1. \end{aligned}$$

where c_t denotes consumption, b_t bond holdings, with $b_0 > 0$ given, and $\beta \in (0, 1)$ the intertemporal discount factor.

Question B1 - (b) Household's Problem

- *(b) Derive the Euler equation for the household's optimisation problem. Provide an intuitive explanation of the result.*

- Transform into easier problem using **binding** BCs:

$$\max_{c_0,c_1,b_1} \{\ln c_0+\beta \ln c_1\} \Rightarrow \max_{b_1}\{\ln[w_0+(1+r_0)b_0-b_1]+\beta \ln[w_1+(1+r_1)b_1]\}$$

- Differentiate with respect to b_1:

$$-\frac{1}{w_0+(1+r_0)b_0-b_1}+\frac{\beta(1+r_1)}{w_1+(1+r_1)b_1}=-\frac{1}{c_0}+\frac{\beta(1+r_1)}{c_1}$$

- Set to 0 and rearrange to give intertermporal Euler equation for consumption:

$$\frac{1}{c_0}=\beta(1+r_1)\frac{1}{c_1}$$

- Intuition: equal marginal utility of extra consumption unit in each period.

Question B1 - (c) General Equilibrium I

- *(c) Market clearing implies that $b_t = k_t$ for $t = 0, 1$. Using the expressions for r_t and w_t in part (a), show that the representative household's constraints yield $y_0 = c_0 + I_0$ and $y_1 = c_1$ in equilibrium, where $I_0 = k_1$ denotes investment. In addition, derive the optimal equilibrium outcomes of c_0 and k_1 as a function of k_0.*
- Use equilibrium conditions, $b_0 = k_0$ and $b_1 = k_1$, in HH BCs:

$$w_0 + (1 + r_0)k_0 = c_0 + k_1,$$
$$w_1 + (1 + r_1)k_1 = c_1.$$

- Use Firm's FOCs with $(\delta = I_t = 1)$:

$$1 + r_t = \alpha A_t k_t^{\alpha - 1} \qquad \text{and} \qquad w_t = (1 - \alpha) A_t k_t^{\alpha}.$$

- Hence:

$$(1 + r_t)k_t + w_t = A_t k_t^{\alpha} = y_t.$$

Question B1 - (c) General Equilibrium II

- From previous in terms of k_1:

$$\begin{aligned} y_0 = c_0 + I_0, \quad &\Rightarrow \quad A_0 k_0^{\alpha} - k_1 = c_0, \\ y_1 = c_1, \quad &\Rightarrow \quad A_1 k_1^{\alpha} = c_1. \end{aligned}$$

- Combine with Euler condition, in terms of k:

$$\begin{aligned} c_1 &= \beta(1 + r_1)c_0, \\ c_1 &= \beta(\alpha A_1 k_1^{\alpha-1})c_0, \\ A_1 k_1^{\alpha} &= \beta(\alpha A_1 k_1^{\alpha-1})(A_0 k_0^{\alpha} - k_1), \\ \Rightarrow k_1 &= \frac{\alpha\beta}{1 + \alpha\beta} A_0 k_0^{\alpha}. \end{aligned}$$

- Use this to find show:

$$c_0 = \frac{1}{1 + \alpha\beta} A_0 k_0^{\alpha}.$$

Question B1 - (d) Anticipated Productivity Shock

- *(d) Suppose that agents know that there will be an increase in A_1. Explain how that affects consumption c_0 and investment I_0. Provide an intuitive explanation and illustrate the effects on equilibrium outcomes in a diagram with output y_0 on the horizontal axis and the real interest rate r_1 on the vertical axis.*

- A_1 has no impact on c_0 or I_0.

- Investment demand and consumption demand curve both shift outwards.

- Higher real interest rate **perfectly offsets** desire to smooth income through time.

Question B2 - Set Up

- *B2. Consider the following Bernanke-Blinder model. Banks are assumed to hold bonds, B, loans, L, and reserves, R as assets, and have deposits, D as liabilities, so that the representative bank's balance sheet is:*

$$B + L + R = D.$$

Reserves are equal to the minimum reserve requirement $R = \tau D$ with required reserve ratio $\tau = \frac{1}{2}$. The demand for deposits is given by:

$$D^d = Y - \frac{1}{3} i_B,$$

where Y is real aggregate output and i_B the bond interest rate. The demand for loans is described by:

$$L^d = \frac{1}{2} Y - i_L + i_B,$$

where i_L is the loan interest rate. The supply of loans is given by:

$$L^s = \frac{1}{2}(D - R).$$

Goods market equilibrium is described by:

$$Y = 75 - i_L - i_B.$$

Question B2 - (a) Money Market Equilibrium

- *(a) Derive the equilibrium bond interest rate, i_B in the money market in terms of output, Y and reserves R; and derive the equilibrium loan interest rate, i_L, in the loan market in terms of Y, R and i_B. Explain intuitively how i_B and i_L are affected by Y and R.*
- In equilibrium, the demand and supply of **deposits** are equal:

$$\frac{R}{\tau} = D^s = D^d = Y - \frac{1}{3} i_B. \quad \Rightarrow \quad i_B = 3Y - \frac{3}{\tau} R. \quad \text{(LM)}$$

- **Higher** output **increases** money demand (transactions motive), lowering demand for bonds. Bond price falls; $i_B \uparrow$:

$$\frac{\partial i_B}{\partial Y} = 3 > 0.$$

- **Higher** reserves **increase** money supply, via money multiplier, increasing demand for bonds. Bond price increases; $i_B \downarrow$:

$$\frac{\partial i_B}{\partial R} = -\frac{3}{\tau} < 0.$$

Question B2 - (a) Loan Market Equilibrium

- In equilibrium, the demand and supply of **loans** are equal:

$$\frac{1}{2}(D-R) = L^s = L^d = \frac{1}{2}Y - i_L + i_B,$$

$$\Rightarrow \quad i_L = \frac{1}{2}Y + i_B - \frac{1}{2}\frac{(1-\tau)}{\tau}R. \qquad (*)$$

- **Imperfect** substitutes as $i_L \neq i_B$.

- **Higher** output **increases** loan demand (transactions motive), hence increasing loan interest rates; $i_L \uparrow$:

$$\frac{\partial i_L}{\partial Y} = \frac{1}{2} > 0.$$

- **Higher** reserves **increase** loan supply, via money multiplier. Loan interest rates fall; $i_L \downarrow$:

$$\frac{\partial i_L}{\partial R} = -\frac{1}{2}\frac{(1-\tau)}{\tau} < 0.$$

Question B2 - (b) Goods and Loan Market Equilibrium

- *(b) Derive the level of output, Y, in terms of R and i_B, such that there is equilibrium in both goods market and loan market. Explain how this level of Y depends on i_B and R.*
- Simultaneous equilibrium in goods **and** loan markets requires:

$$Y = 75 - \underbrace{\left[\frac{1}{2}Y + i_B - \frac{1}{2}\frac{(1-\tau)}{\tau}R\right]}_{i_L} - i_B,$$

$$\Rightarrow Y = 50 + \frac{1}{3}\frac{(1-\tau)}{\tau}R - \frac{4}{3}i_B. \qquad \text{(CC)}$$

- **Higher** i_B **reduces** output (typically investment). (1) directly via i_B and (2) indirectly through i_L:

$$\frac{\partial Y}{\partial i_B} = -\frac{4}{3} < 0.$$

- **Higher** reserves **increase** output (I), by indirectly reducing i_L:

$$\frac{\partial Y}{\partial R} = \frac{1}{3}\frac{(1-\tau)}{\tau} > 0.$$

Question B2 - (c) Overall Equilibrium

- *(c) Assume that "quantitative easing" by the central bank leads to an increase in reserves from $R = 15$ to $R' = 30$. Compute the initial and new equilibrium levels of output, Y, the bond interest rate i_B and the loan interest rate i_L. Give an intuitive explanation of the effects.*

- Equilibrium in **all** markets when "Liquidity-Money" (LM) and "Commodities and Credit" (CC) curves intersect:

$$Y = 50 + \frac{1}{3}\frac{(1-\tau)}{\tau}R - \frac{4}{3}\underbrace{\left[3Y - \frac{3}{\tau}R\right]}_{i_B},$$

$$\Rightarrow Y = 10 + \frac{13-\tau}{15\tau}R.$$

Question B2 - (c) Analytical Results

- Then, using (LM):

$$i_B = 3\underbrace{\left[10 + \frac{13-\tau}{15\tau}R\right]}_{Y} - \frac{3}{\tau}R,$$

$$\Rightarrow i_B = 30 - \frac{2+\tau}{5\tau}R.$$

- Finally, using $(*)$:

$$i_L = \frac{1}{2}\underbrace{\left[10 + \frac{13-\tau}{15\tau}R\right]}_{Y} + \underbrace{\left[30 - \frac{2+\tau}{5\tau}R\right]}_{i_B} - \frac{1}{2}\frac{(1-\tau)}{\tau}R,$$

$$\Rightarrow i_L = 35 + \frac{4\tau-7}{15\tau}R.$$

Question B2 - (c) Calibration & Intuition

1. Use $\tau = \frac{1}{2}$. Gives the (LM) and (CC) curves as:

$$i_B = 3Y - 6R, \tag{LM}$$

$$i_B = \frac{75}{2} + \frac{1}{4}R - \frac{3}{4}Y. \tag{CC}$$

2. Use $R = 15$ & $\tau = \frac{1}{2}$.

3. Use $R' = 30$ & $\tau = \frac{1}{2}$.

	Analytical	(1)	(2)	(3)
Y	$10 + \frac{13-\tau}{15\tau}R$	$10 + \frac{5}{3}R$	35	60
i_B	$30 - \frac{2+\tau}{5\tau}R$	$30 - R$	15	0
i_L	$35 + \frac{4\tau-7}{15\tau}R$	$35 - \frac{2}{3}R$	25	15

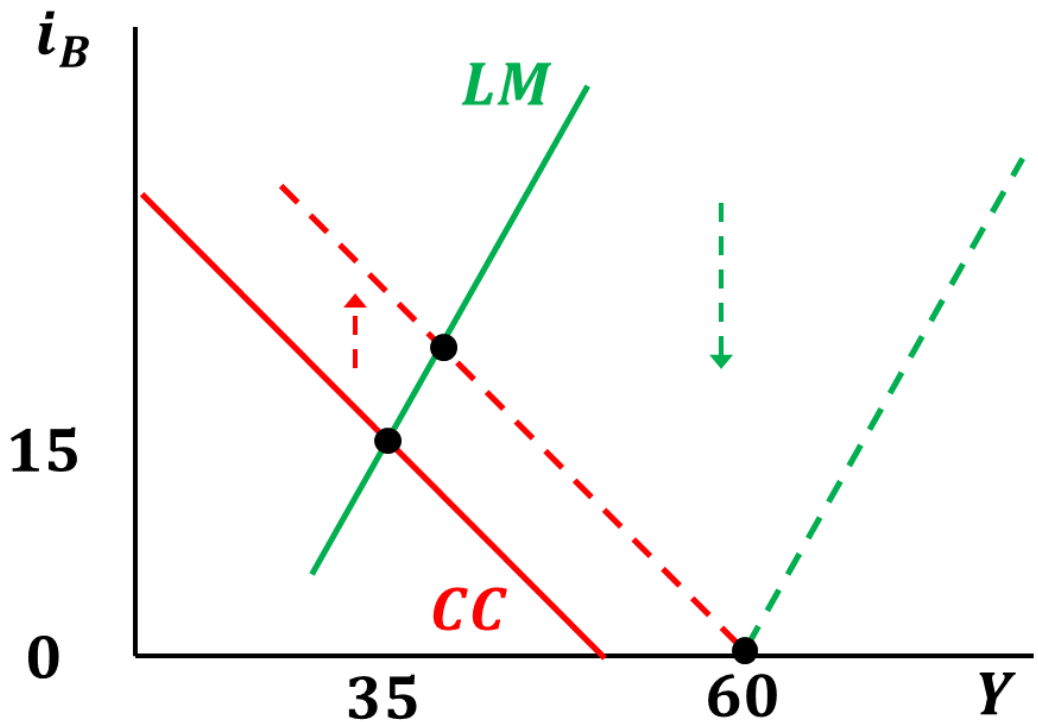
- "QE", through higher bank reserves, **causes higher output**.
- As, overall, $i_B \downarrow$ Keynesian interest rate channel dominates.

Question B2 - (c) Graphically

- **Keynesian** interest rate channel: greater money supply shifts (LM) down ($Y \uparrow$ and $i_B \downarrow$).

- **Bank lending** channel: higher loan supply, reduces i_L and shifts the CC curve up (further $Y \uparrow$ but $i_B \uparrow$).

Bernanke-Blinder



Question B2 - (d) Higher Reserves

- *(d) Suppose CB wants to raise the required reserve ratio, τ, to improve financial stability in the banking system. Analyze how a higher required reserve ratio, τ, would affect the equilibrium levels of output, Y, and the bond interest rate i_B, and the effectiveness of "quantitative easing" in this model.*

- Consider the impact of changing τ on (LM) and (CC):

$$i_B = 3Y - \frac{3}{\tau}R, \quad \Rightarrow \quad \frac{\partial i_B}{\partial \tau} = \frac{3R}{\tau^2} > 0, \quad \text{(LM)}$$

$$i_B = \frac{75}{2} + \frac{(1-\tau)}{4\tau}R - \frac{3}{4}Y, \quad \Rightarrow \quad \frac{\partial i_B}{\partial \tau} = -\frac{R}{4\tau^2} < 0. \quad \text{(CC)}$$

- Thus (LM) shifts **upwards**, while (CC) shifts **downwards**.

Question B2 - (d) Endogenous Variables

- Now consider the impact in **general equilibrium**.
- **Unambiguously** this leads to lower output:

$$Y = 10 + \frac{13 - \tau}{15\tau} R, \quad \Rightarrow \quad \frac{dY}{d\tau} = -\frac{13}{15}\frac{R}{\tau^2} < 0.$$

- In this particular case, the change always leads to **higher** i_B:

$$i_B = 30 - \frac{2 + \tau}{5\tau} R, \quad \Rightarrow \quad \frac{di_B}{d\tau} = \frac{2}{5}\frac{R}{\tau^2} > 0.$$

Question B2 - (d) QE Effectiveness

- Let us **define** the effectiveness of QE as the ability of the central bank to change Y and i_B by shifting R.
- Then QE would be **less** effective if a **given** shift in R leads to a smaller change in Y and i_B.
- Seen using the cross-derivatives (either on results or curves):

$$\frac{\partial^2 i_B}{\partial \tau \partial R} = \frac{3}{\tau^2} > 0, \tag{LM}$$

$$\frac{\partial^2 i_B}{\partial \tau \partial R} = -\frac{1}{4\tau^2} < 0. \tag{CC}$$

- A higher τ:
  1. **Reduces** the **downward** shift in (LM) (as smaller money multiplier).
  2. **Reduces** the **upwards** shift in the (CC) (due to smaller rise in loan supply and thus smaller decline in i_L).

Essays

Question C1 - Set Up

- *C1. In the early 1980's both Europe and the United States experienced a marked decline in inflation and a pronounced increase in unemployment. The unemployment rate in the United States subsequently fell back towards its long-run average, while the European unemployment rate remained high. To which extent is this pattern consistent with the NAIRU theory, and which other explanations may contribute to our understanding of this period?*

- What is the NAIRU theory?

- Does NAIRU explain these facts?

- Any other explanations?

Question C1 - What is the NAIRU Theory?

- The Non-Accelerating Inflation Rate of Unemployment (NAIRU) describes the **negative relationship**:

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n).$$

where u_n is the **structural** or **natural** rate of unemployment.

- Whenever $u_t < u_n$, this implies $\pi_t > \pi_{t-1}$ (*accelerating*).

- An ad hoc relationship, with few micro foundations.

- Nonetheless empirically relevant and a useful **rule of thumb**.

Question C1 - Does NAIRU Explain These Facts?

- **Yes**. The 1980's provide evidence of a **negative** relationship.
- US and Europe experienced a **fall** in inflation ($\pi_t < \pi_{t-1}$) alongside an **higher** unemployment ($u_t > u_n$).
- Subsequent pattern in the US (stabilising inflation and falling unemployment) is also consistent with NAIRU.
- **Problem**: persistently high European unemployment.

Question C1 - Any Other Explanations

- Adapt the theory to explain the facts. Allow time-varying $u_{t,n}$
- Labour market **hysteresis**.
- **Institutional** differences between US and Europe (e.g. unions, welfare provision).
- If expectations matter... perhaps anything goes!

Question C2 - Set Up

- *C2. A dollar spent by the government is a dollar taxed, either in the present or in the future. How can then government spending stimulate the economy, let alone private demand? Discuss to what extent this argument is correct, and to what extent it is not.*
- Temporary \$1 increase in government spending must be taxed by an equal amount. **True**.
- But the reduction in **permanent income** of \$1 increase in taxes is extremely small.
- Hence private demand is only crowed out by a small amount, and this may stimulate the economy.
- Also refer to **Ricardian equivalence** and it's failures (particularly due to credit constraints).

Question C3 - Set Up

- *C3. The outbreak of the new coronavirus during the first few months of 2020 had sizeable effects on financial markets, including: (a) Sharp drops in equity prices (e.g. more than 10% in late February). (b) Government bond yields hitting record lows and the global amount of negative-yielding debt rising significantly (e.g. to more than $14 trillion in early March). (c) A significant depreciation of Asia-Pacific currencies (e.g. the Australian dollar and Thai baht depreciated around 4.5% during the first six weeks of 2020). Use economic theory to analyze the short-run impact of bad news about the coronavirus outbreak on equity prices, bond prices and exchange rates, and explain the three empirical facts above.*

- Extremely clear 3-part structure.

Question C3 - (a) Equity Prices

Dividend Discount Models

Simple	Generalised	Gordon Growth
$p_t = \frac{D^e_{t+1}+p^e_{t+1}}{1+\tilde{i}}$	$p_t = \sum_{n=1}^{\infty} \frac{D^e_{t+n}}{(1+\tilde{i})^n}$	$p_t = \frac{D^e_{t+1}}{\tilde{i}-g}$

- Lower production reduces expected future dividends, $D^e_{t+1} \downarrow$.
- Potentially persistent impact, $D^e_{t+n} \downarrow$ and hence $g \downarrow$.
- Heightened uncertainty increases the risk-adjusted interest rate, $\tilde{i} \uparrow$.

Question C3 - (b) Government Bond Yields

- Bond market model may be summarised using:

$$B^d\begin{pmatrix} p_t; & p^e_{t+1}, & RR^e_{t,o}, & \sigma_B/\sigma_O, & liq_B/liq_O, & W_t \\ - & + & - & - & + & + \end{pmatrix} = B^s\begin{pmatrix} p_t; & \pi^e_t, & \Pi^e_t, & G_t - T_t \\ + & + & + & + \end{pmatrix},$$

- Already discussed falling equity prices. As **relative riskiness**, $\sigma_B/\sigma_O \downarrow$, of bonds falls, "safe haven" demand for government bonds increases.

- Bond prices increase, and their yield to maturity falls.

- QE anticipation, $p^e_{t+1} \uparrow$?

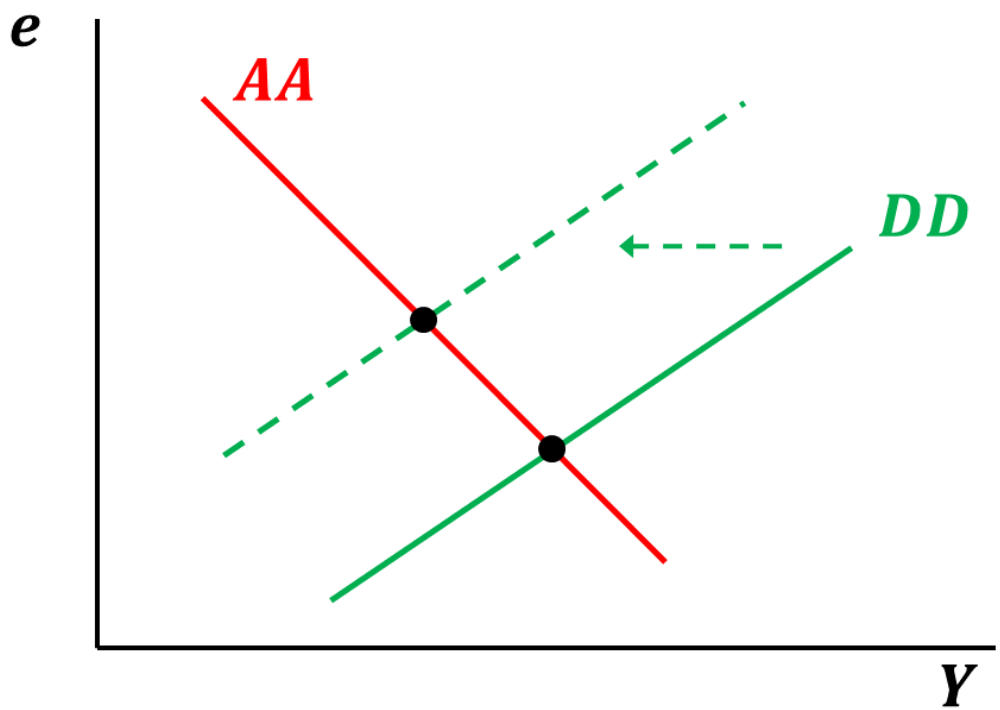
- If effects are strong enough, yields actually turn negative!

- Note: supply may be **fixed** in the short-run.

Question C3 - (c) Depreciation of Asia-Pacific Currencies

- Lower global activity reduces Asia-Pacific export demand (given e). DD curve **shifts inwards**.
- Then, movement **along** AA curve as lower transactions demand for money $L(i, Y \downarrow) \downarrow$, causing interest rates to fall, $i \downarrow$, and an exchange rate **depreciation**, $e \uparrow$.

DD AA Model



Question C4 - Set Up

- *C4. After the exit of the United Kingdom (UK) from the European Union (EU) on 31 January 2020, the UK government has stated that the UK will no longer be able to engage in frictionless trade with the EU after the transition period that lasts until the end of 2020. Analyze the short-run effects that this is likely to have on the UK economy in 2021, including aggregate output, consumption, investment, the current account, the nominal interest rate and the nominal exchange rate. In addition, analyze the likely short-run effects on the EU economy in 2021, taking into account international macroeconomic interdependence. Carefully explain the effects, specifying and discussing the assumptions you make for your analysis.*

- A tricky question!

- Use IS-LM-UIP, as AA-DD assumes exogenous investment.

Question C4 - IS-LM-UIP Recap

- IS curve (goods market equilibrium):

$$Y = C(\underset{+}{Y} - \bar{T}) + I(\underset{-}{r}) + G + CA(\underset{+}{eP^*/P}, \underset{-}{Y} - \bar{T}).$$

- LM curve (money market equilibrium):

$$\frac{\bar{M}}{P} = L(\underset{-}{i}, \underset{+}{Y}).$$

- UIP curve (FX market equilibrium):

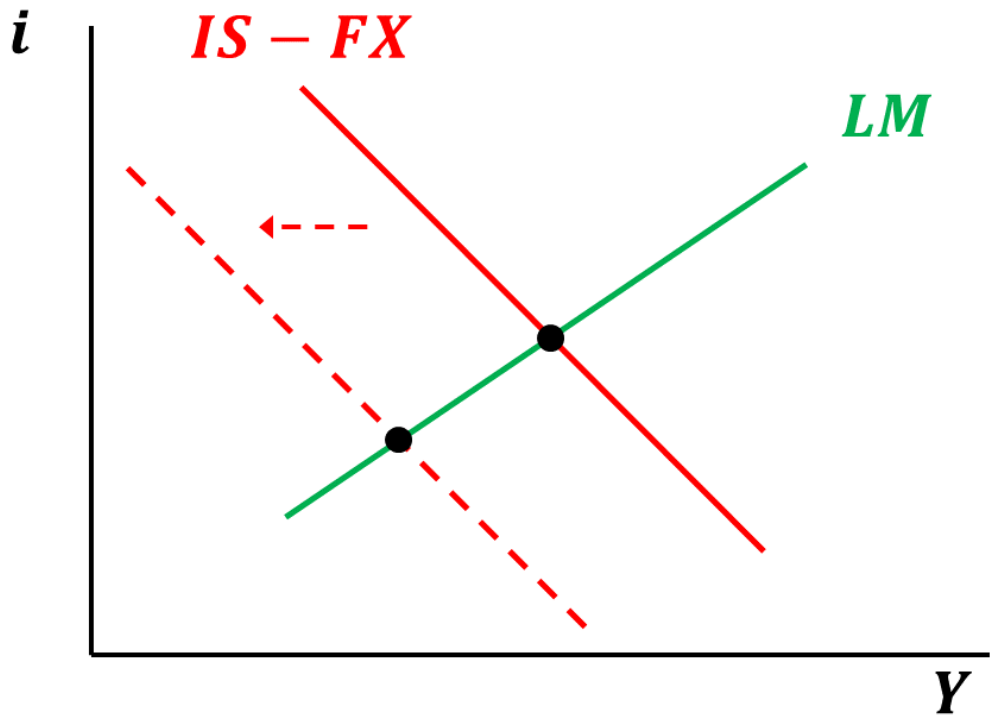
$$(1 + i) = (1 + i^*)\frac{E[e]}{e}.$$

- SR sticky prices, $P = \bar{P}$. LR flexibility ensures $Y = \bar{Y}$.

Question C4 - UK Economy I

- Higher trade barriers / frictions cause net exports to fall in UK (at given sticky prices).
- IS-FX shifts left.

DD AA Model



Question C4 - UK Economy II

- No **expectations effect** as the change was announced.
- Output falls, as NX $\downarrow$, and hence consumption falls too:

$$\Delta Y < \Delta C < 0, \text{as } 0 < mpc < 1.$$

- Transactions demand for money $\downarrow$, causing interest rates (i and r) to fall.
- $I(r) \uparrow$ ($\Delta I > 0$, assuming no direct impact from barriers).
- Lower return on £ deposits causes £ depreciation, and CA improvement (assuming ML condition), compounded by imports $\downarrow$ due to income $\downarrow$. But **net negative** effect on CA as:

$$\Delta CA = \Delta Y - \Delta C - \Delta I = (1 - mpc)\Delta Y - \Delta I < 0$$

Question C4 - EU Economy

- Similar NX $\downarrow$, but **smaller** as UK trade is smaller share of EU economy than EU trade for UK.
- € **appreciation** reinforces initial impact on CA.

Past Paper Questions.

Intertemporal - 2012 B1 (b) - Set Up

- Consider the following dynamic optimization problem:

$$\max_{c_1,c_2,\ell_1,\ell_2} u(c_1) + v(\ell_1) + \beta[u(c_2) + v(\ell_2)],$$

$$\text{s.t.} \quad (1-\ell_1)w_1 + (1-\ell_2)\frac{w_2}{1+r} = c_1 + \frac{c_2}{1+r}.$$

  where β is the subjective intertemporal discount factor ($0 < \beta < 1$) and r the real interest rate.

- Solution using Lagrangian:

$$u'(c_1) = \lambda, \qquad \beta u'(c_2) = \frac{\lambda}{1+r},$$

$$v'(\ell_1) = \lambda w_1, \qquad \beta v'(\ell_2) = \frac{\lambda w_2}{1+r},$$

- We have 5 equations (4 FOCs + IBC) in 5 unknowns (c_1, c_2, ℓ_1, ℓ_2 and λ). Hence we can solve.

Intertemporal - 2012 B1 (b) - Euler

- (i) Derive the Euler equation for consumption, and the Euler equation for labour supply.

- Do this by combining FOCs to eliminate λ.

$$u'(c_1) = \lambda, \quad \beta u'(c_2) = \frac{\lambda}{1+r}, \quad \rightarrow \quad u'(c_1) = \beta(1+r)u'(c_2),$$

$$v'(\ell_1) = \lambda w_1, \quad \beta v'(\ell_2) = \frac{\lambda w_2}{1+r}, \quad \rightarrow \quad v'(\ell_1) = \beta(1+r)\frac{w_1}{w_2}v'(\ell_2)$$

- Don't forget these **will not solve the system on their own**, as 2 equations in 4 unknowns! We also require a intratemporal condition involving c and ℓ but not λ. Convenient to choose:

$$v'(\ell_1) = u'(c_1)w_1.$$

- New system of 4 unknowns is now solved by EEs in c and ℓ, the IBC, and the intratemporal condition.

Intertemporal - 2012 B1 (b) - Calibration

- (ii) Suppose again that $u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}$ with $\sigma > 0$, but for simplicity assume that $v(\ell_t) = \ln(\ell_t)$, $\beta = 1$, and $r = 0$. Solve for leisure in period one, ℓ_1, as a function of the relative wage w_1/w_2. How does labour supply in period one, $1 - \ell_1$, relate to the relative wage w_1/w_2? In what way is this relationship affected by the value of σ?

- Use all these restrictions in previous system:

$$\begin{aligned} u'(c_1) = \beta(1+r)u'(c_2), \quad &\rightarrow \quad c_1 = c_2, \\ v'(\ell_1) = \beta(1+r)\frac{w_1}{w_2}v'(\ell_2), \quad &\rightarrow \quad \frac{1}{\ell_1} = \frac{w_1}{w_2}\frac{1}{\ell_2}, \\ v'(\ell_1) = u'(c_1)w_1, \quad &\rightarrow \quad \frac{1}{\ell_1} = w_1 c_1^{-\sigma}. \end{aligned}$$

- Including in the IBC (using $r = 0$):

$$(1-\ell_1)w_1 + (1-\ell_2)w_2 = c_1 + c_2.$$

Intertemporal - 2012 B1 (b) - General Equilibrium I

- Finally, combine all equations to find ℓ_1:

$$(1-\ell_1)w_1 + (1-\ell_2)w_2 = c_1 + c_2, \quad \text{(Start with IBC)}$$
$$(1-\ell_1)w_1 + (1-\ell_2)w_2 = 2c_1, \quad \text{(Use EE C)}$$
$$(1-\ell_1)w_1 + (1-\ell_2)w_2 = 2(w_1\ell_1)^{\frac{1}{\sigma}}, \quad \text{(Use Intratemporal)}$$
$$(1-\ell_1)w_1 + \left(1 - \frac{w_1}{w_2}\ell_1\right)w_2 = 2(w_1\ell_1)^{\frac{1}{\sigma}}. \quad \text{(Use EE } \ell\text{)}$$

- Tricky to proceed from here. Assuming $\sigma = 1$, rearrange to:

$$\ell_1 = \frac{1}{4}\left(1 + \frac{w_2}{w_1}\right),$$
$$1 - \ell_1 = \frac{3}{4} - \frac{1}{4}\frac{w_2}{w_1},$$

- Higher w_2/w_1 encourages leisure in period 1 (and discourages work).

Intertemporal - 2012 B1 (b) - General Equilibrium II

- Next try for $\sigma \to \infty$, rearrange to:

$$\ell_1 = \frac{1}{2}\left(1 + \frac{w_2}{w_1}\right) + \frac{1}{w_1}$$
$$1 - \ell_1 = \frac{1}{2} - \frac{1}{2}\frac{w_2}{w_1} - \frac{1}{w_1},$$

- So larger value of σ makes labour supply more responsive to changes in the relative wage. For $\sigma > 1$.

- Greater curvature of marginal utility in consumption, than in leisure.

Labour - 2015 B1 - Set Up

- 2015 B.1 *The reservation wage, w_r, in McCall's search model is characterised by the equation:*

$$w_r - b = \frac{\beta}{1-\beta}\Big(\int_{w_r}^{\infty}(w - w_r)dF(w)\Big),$$

where b denotes unemployment benefits, $\beta \in (0,1)$ the discount factor, w wages, and and $F(w)$ denotes the cumulative distribution function (CDF) for wage offers.

Labour - 2015 B1 (a) - Intuition

- (a) Intuitively explain how the reservation wage depends on both b and β.

- An increase in b shifts the $(w_r - b)$ line **downwards**, and hence results in a higher reservation wage. Higher unemployment benefits increase the utility from rejecting a job offer.

- An increase in β shifts the $h(w)$ curve (define this) **upwards** since:

$$\frac{d}{d\beta}\frac{\beta}{1-\beta} = \frac{1}{(1-\beta)^2} > 0$$

- A higher level of patience encourages workers to reject current low offers and wait for a better search outcome. The value of rejecting increases.

Labour - 2015 B1 (b) - Higher Unemployment Benefits

- (b) Suppose that b increases. What happens to the job finding rate, and what is the implication for the unemployment rate? What are the possible effects on output/welfare?

- As above, $b \uparrow$ causes $w_r \uparrow$.

- Hence the job finding rates, $[1 - F(w_r)]$, will fall. Unemployment rate therefore rises.

- Impact on welfare is **ambiguous**. More unemployed workers, but employed workers have higher average salary.

Labour - 2015 B1 (c) - Value Functions

- *Let $V(w)$, denote the value of having a job paying a perpetual wage w:*

$$V(w) = \frac{w}{1-\beta}.$$

Let U denote the value of not having a job:

$$U = b + \beta E[\max\{V(w), U\}].$$

where E denotes the expectations operator associated with the CDF above.

- (c) For a given value of U, graphically illustrate the value:

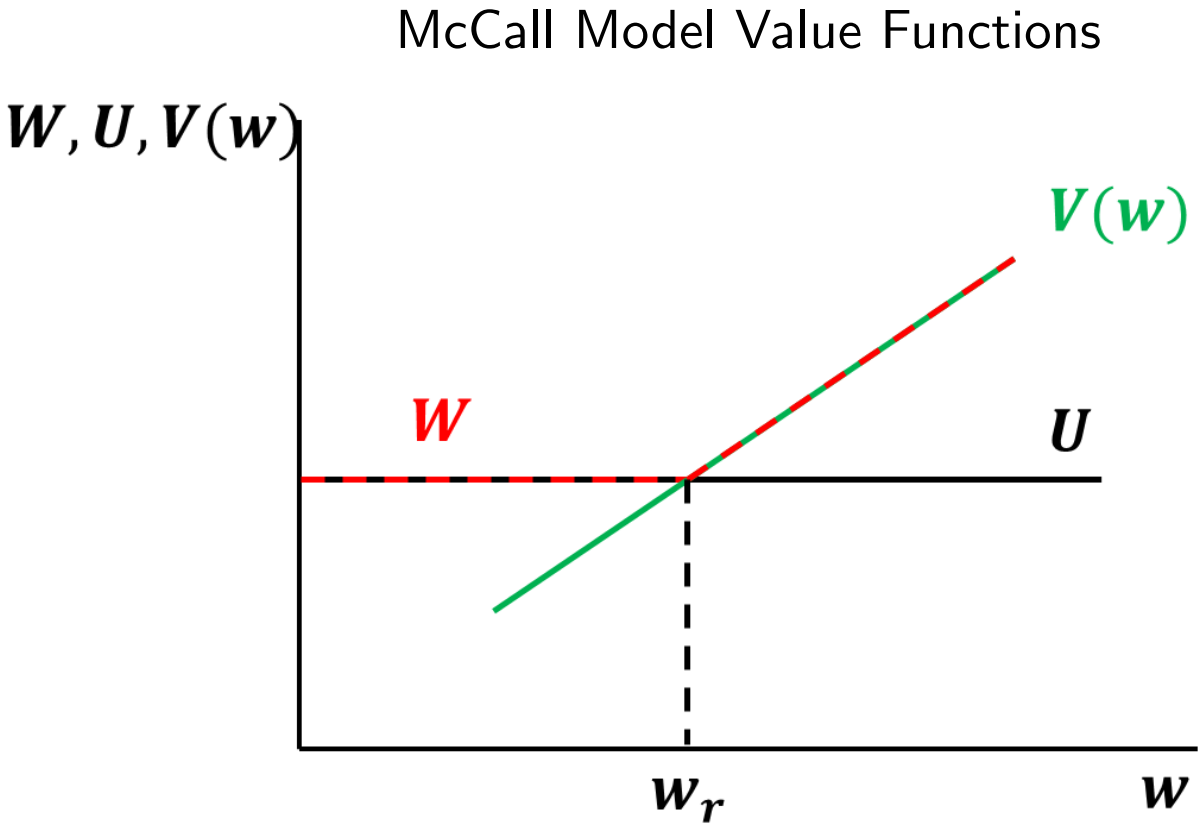
$$W = \max\{V(w), U\}.$$

with w on the x-axis, and with W on the y-axis. Carefully mark out the reservation wage, w_r, in your graph, and explain.

- $V(w)$ is an increasing line in w. Hence W easier to plot.

Labour - 2015 B1 (c) - Graph

- Reservation wage, w_r makes household indifferent between accepting, utility $V(w)$, and rejecting offer, utility U.



Labour - 2015 B1 (d) - Functional Form

- (d) Suppose w has a uniform distribution with CDF:

$$F(w) = \frac{w - \underline{w}}{\bar{w} - \underline{w}}, \qquad w \in \{\underline{w}, \bar{w}\},$$

where the mean, μ_w, and variance, σ_w^2, are given by

$$\mu_w = \frac{1}{2}(\bar{w} + \underline{w}), \qquad \sigma_w^2 = \frac{1}{12}(\bar{w} - \underline{w})^2.$$

Suppose now that $\bar{w}$ and $\underline{w}$ changes to $\bar{w}_{\text{new}} = \bar{w} + \varepsilon$ and $\underline{w}_{\text{new}} = \underline{w} - \varepsilon$, respectively, with $\varepsilon > 0$. What is the effect on the mean and the variance of the wage offer? How do you think this change of the wage offer distribution will affect the reservation wage? Explain intuitively why.

- No impact on mean (Mean preserving spread).

- But variance increases.

Labour - 2015 B1 (d) - Reservation Wage I

- Let's begin to calculate w_r:

$$w_r - b = \frac{\beta}{1-\beta}\Big(\int_{w_r}^{\infty}(w - w_r)dF(w)\Big),$$

- Using the fact that $\frac{dF(w)}{dw} = \frac{1}{\bar{w}-\underline{w}}$: generates.

$$\begin{aligned}
h(w) &= \frac{\beta}{(1-\beta)(\bar{w}-\underline{w})}\Big(\int_{w_r}^{\infty}(w - w_r)\Big), \\
&= \frac{\beta}{(1-\beta)(\bar{w}-\underline{w})}\Big(\int_{w_r}^{\bar{w}+\varepsilon}(w - w_r)\Big), \\
&= \frac{\beta}{(1-\beta)(\bar{w}-\underline{w})}\Big[\frac{w^2}{2} - w_r w\Big]_{w_r}^{\bar{w}+\varepsilon}, \\
&= \frac{\beta}{(1-\beta)(\bar{w}-\underline{w})}\Big[\frac{(\bar{w}+\varepsilon)^2}{2} + \frac{w_r^2}{2} - w_r(\bar{w}+\varepsilon)\Big].
\end{aligned}$$

Labour - 2015 B1 (d) - Reservation Wage II

- Now differentiate $h(w)$: generates.

$$\frac{\partial h(w)}{\partial \varepsilon} = \frac{\beta(\bar{w} + \varepsilon - w_r)}{(1-\beta)(\bar{w} - \underline{w})} > 0.$$

- Hence a mean preserving spread increases reservation wages.

- Under a more spread out wage distribution unemployed workers wait longer as more higher paying jobs will be available (and more low paying jobs, but they will be rejected anyhow).

Other Questions.

International - 2014 A4 - Monetary Transmission

- EA banks make unexpected early repayments of large 3-year loans made by the ECB **during the sovereign debt crisis**. Analyse the short-run effect of this on the money supply, nominal interest rate, nominal exchange rate and aggregate output in the euro area using the DD-AA model.

- Q. As debts repaid early, why is money supply falling and not lower government spending? Is it permanent?

- Here loans to commercial banks (not sovereign) are repaid. Repayment reason not given! (1) Any creditors (not just domestic sovereign) repay early. (2) Higher earnings from other assets. (3) Lower value of other liabilities.

- Unless CB looks to offset this, it is a permanent change.

- Even **if** sovereign, why? (1) spending $\downarrow$; (2) GDP (& taxes) $\uparrow$.

International - 2016 A4 - Monetary Transmission

- The ECB announced a deposit rate cut of 10bps, and an extension of its LSAPs by EUR60bn per month for 2 years. In response, the euro experienced an appreciation. Explain whether this **could** be consistent with the asset market model of the exchange rate.

- Q. Looking for a hint on the transmission mechanism.

- Yes. Though ECB deposit rate reduction makes investment in euro deposits less attractive, this LE effect was offset by an EE as ECB monetary stimulus (esp wrt QE) **less than anticipated**, so E[e] $\downarrow$. Thus, asset market model of FX yields euro appreciation if expectations effect outweighs liquidity effect.

- Best solutions would also include graphical analysis.

International - 2018 C4 - Trump Policies

- Analyse the SR effects of large tax cuts and protectionist trade policies on the economy, including on i, e, Y, C, I, and CA. Discuss your assumptions.
- Q. Should protectionist trade policies be treated as temporary/permanent increase in G? Would large tax cuts be unliked to income so that it is like a transfer? Would I treat the effect of a large tax cut as an increase in consumption and net exports?
- Choose to use IS-LM-UIP model (since asked about I).
- Large tax cut $T \downarrow$ (must be temporary due to fiscal deficit) shifts IS-FX out, so $Y \uparrow$, $i \uparrow$ and $e \downarrow$ (appreciation), worsening current account deficit as $CA(\underset{+}{eP^*/P}, \underset{-}{Y - T})$. Corporate tax cut may increase investment.
- Protectionist trade policies (e.g. import tariffs/quotas) improve current account ($CA \uparrow$), shifting IS-FX out. But if permanent, increased relative demand for home goods results in long run real appreciation, so $\mathbb{E}[e] \downarrow$, shifting IS-FX and UIP in, leading to $\Delta Y = 0$ in short run, while $e \downarrow$ (appreciation), completely crowding out $CA0 \uparrow$, ($\Delta CA = 0$). Also, threat of trade war.

International - 2019 A4 - Exchange Rate Overshooting

- In line with prior announcement, the Fed is reducing its UST holdings, accumulated through LSAPs. Analyse the SR effects of this reduction on the e and Y in the US and the RoW using the DD-AA model. Provide intuition.

- Q. Is this asking for a temporary $M \downarrow$ because it is pre-announced? I.e. no EE so the analysis won't be like an unanticipated permanent decrease in the money supply.

- A. Unanticipated - yes, but temporary, no! Permanent just one off LE, no EE.

Question 1 - Exchange Rate Overshooting

- Q. Intuition for SR FX overshooting where the SR FX equals the LR FX level? Is that economy in a liquidity trap?
- No. Firstly, overshooting requires SR FX $\neq$ LR FX.
- Secondly, answer is entirely model dependant (say AA-DD).
- In a liquidity trap as nobody wants to hold bonds and a strict preference for money, hence, combining with the UIP condition, the AA curve will be **horizontal**. In a similar fashion to the horizontal LM curve of ISLM. Note: Also arises as in problem set with the output sensitivity of money demand is zero.
- But, in AA-DD model overshooting also requires EE and LE switched on – and may be guaranteed with 0 exchange rate sensitivity of the current account (vertical DD).

Question 2 - IS-LM-UIP Model

- Q. In the IS-LM-UIP model with a permanent monetary expansion and exchange rate overshooting (large liquidity effect), is the reason why there is a lower nominal interest rate because the effect of a large liquidity effect on the nominal interest rate outweighs the effect of a higher level of output on the nominal interest rate?

- A. Yes.

Question 3 - Ricardian Equivalence

- Q. As in the case for a permanent fiscal expansion, for a permanent fiscal contraction will there still be no short run effect on output?

- A. Correct, this is Ricardian Equivalence and it is symmetric.

Question 4 - AS relationship with labour

- AS slopes upwards, as higher r, encourages labour substitution to P1 where returns on earnings are greater.
- Permanent TFP $\downarrow$. AS shifts left through large **direct** effect.
- Labour substitution is the **indirect** effect on AS:
  - K_1 is fixed. When permanent TFP $\downarrow$ workers are worse-off. But they are **relatively** better-off in P1 than P2. In a model w/o $I(r)$ this doesn't arise since K_2 not adjusted down in P2. Firms previous decisions are now seen as overinvestment at current TFP level – there is relatively abundant K_1 and MPL is relatively high in P1 (compared to P2). More willing to employ workers in P1.
  - $w_1 > w_2$ expected, inducing workers to supply relatively more labour in P1, than P2.
  - Cause rightwards AS shift, reducing overall (leftwards) shift.
  - Likely small, but utility function required to know precise size.

Revision: Some Guidance.

Revision: Ahead of Time

- Create document (practise method for diagrams).
- Know your literature references (group by topic).
- Organise work material and workspace.
- Practise open book essays using previous exams (it's not an easy option).

Revision: During the Exam

- Give all questions a chance.
- Determine if questions are on **multiple** topics or **just one**.
- Determine your answer approach:
  - Build a model.
  - Graphical explanation.
  - Critical essay.
- You **must** plan essays (start with base essay, add detail).
- You **must** read over and check your full answer.

Revision: What to Avoid

- Factual mistakes (including in literature).
- Not understanding the **main** point of question.
- Extensive use of lecture material (a false friend).
- Long derivations that go nowhere.

Revision: Keep in Mind

- Like regular exam answers, essays should be self-contained.
- Sufficient detail should be provided to understand your points.
- The more precise and informative the essay is in addressing the question, the higher the mark.

Final Thoughts

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- How to prepare for open book exams.
- Good luck!