ECON 352 Final Review

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This is the notes packet for the final exam review session on April 11th, 2023 for the Macroeconomics - Honours class (ECON 352, McGill University) given by Francisco Alvarez-Cuadrado. The topics covered in this class is basic macroeconomic theory, and its applications to modern economic issues.

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2 Measurement

There are 3 ways to measure GDP which give the same value:

1. **Production (value-added) measure of GDP**

   Add the market value of final goods and services produced in the economy.

   - Intermediate goods and services are excluded.
   - Unsold goods are considered "purchased" by producing firm.
   - Only current-year production of goods and services is counted.
   - For items with no market, we value it at cost of production.

2. **Income measure of GDP**

   Add all income generated in production processes in the economy.

- Transfer payments (income reallocation) are excluded.
- Rents of owner-occupied housing are included.

3. **Expenditure measure of GDP**

   Add the value of total purchases of final goods and services.

$$Y = C + I + G + NX$$

- C, consumption, is final goods purchased by households.
- I, investment is final goods purchased by firms. It includes increase in inventories and depreciation.
- G, government spending, is final goods purchased by the government.
- NX, net exports, is $(X - M)$, where X, exports, is final goods sold abroad and M, imports, is final goods purchased abroad.

Example 1. Consider an economy that produces steel, cars, and has a delivery company. This year domestic steel production generates revenues of $100. Of this $100 worth of steel, $60 were purchased by the car producer and $40 were sold abroad to a foreign company. The steel producer paid $30 worth of wages and $10 worth of taxes. The car producer combines the services of the delivery company, the steel it purchased from the steel producer, and $20 worth of labor (wages) to produce $140 worth of cars. Its total sales this year were $130 and the remaining $10 worth of cars is kept as an inventory for the following year. The $130 worth of cars were purchased by domestic families. The car company pays $20 worth of taxes. The delivery company, whose sole client is the car company, generates a revenue of $30 which is enough to cover its labor costs of $30. This company pays no taxes.

The government in this economy uses the $30 worth of taxes and builds a school. The cost of building the school is $40, which are paid to workers as wages. This school is partially financed by an international loan of $10.

a) Summarise this information in a table similar to the one used in the lecture notes.

Firms	Steel Co.	Car Co.	Delivery Co.
Revenue	**100**	**140**	**30**
Domestic Sales	60	130	30
Exports	40		
Change in inventories		+10	
Cost	**30**	**110**	**30**
Wages	30	20	30
Intermediate inputs		90	
Taxes	**10**	**20**	
Profit (after tax)	**60**	**10**	
Government			
Spending	40		
Tax revenue	30		
Wages	40		
Consumers			
Wage income	120		
Profits distributed by firms	70		

b) Calculate GDP using the three alternative approaches. Show your derivations.

Value-added approach:

$$\begin{aligned} Y &= \text{VA steel} + \text{VA cars} + \text{VA delivery} + \text{School} \\ &= 100 + (140 - 90) + 30 + 40 = 220 \end{aligned}$$

Income approach:

$$\begin{aligned} Y &= \text{Wages} + \text{Profit (before tax)} \\ &= (30 + 20 + 30 + 40) + (70 + 30) = 220 \end{aligned}$$

Expenditure approach:

$$\begin{aligned} Y &= C + I + G + NX \\ &= 130 + 10 + 40 + 40 = 220 \end{aligned}$$

4 *Growth*

Example 2. A version of the Solow model with subsistence needs. Consider an economy with the following aggregate production function, $Y(t) = K(t)^{\alpha}(N(t))^{1-\alpha}$. The labor force grows at the exogenous rate, n. If income per capita is low, particularly if $Y_1 \leq \bar{Y}_i$, per capita saving is 0, since all income is devoted to satisfy subsistence needs. Once income per capita crosses that threshold, households save a constant fraction, s, of the excess, i.e. the level of saving per capita is given by $s(Y_i - \bar{Y}_i)$ for values of income per capita capital above $\bar{Y}_i$.

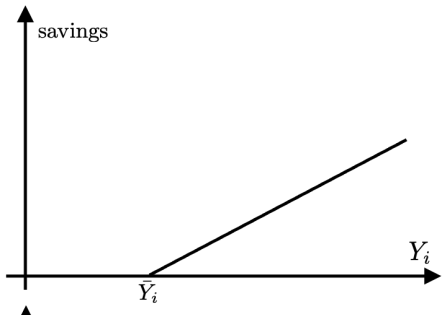
(a) Write the saving function for this economy and graph saving against income per capita.

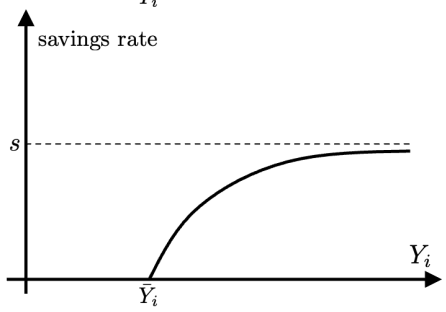
The saving function $\tilde{s}$ for the economy is

$$\text{savings} = \begin{cases} 0 & \text{when } Y_i \leq \bar{Y}_i \\ s(Y_i - \bar{Y}_i) & \text{when } Y_i > \bar{Y}_i \end{cases}$$

and the savings rate is given by

$$\tilde{s} = \begin{cases} 0 & \text{when } Y_i \leq \bar{Y}_i \\ s\left(1 - \frac{\bar{Y}_i}{Y_i}\right) & \text{when } Y_i > \bar{Y}_i. \end{cases}$$





(b) Assuming capital depreciates at a constant rate δ draw the Solow diagram for this model under the assumption that there is a value of output per capita such that actual investment per capita exceeds replacement investment per capita. How many steady states does this economy have (including the one where capital is zero)? Explore the stability of each of these steady states. It is enough to do it graphically but you need to briefly explain your result.

By our standard Solow derivations, we have that

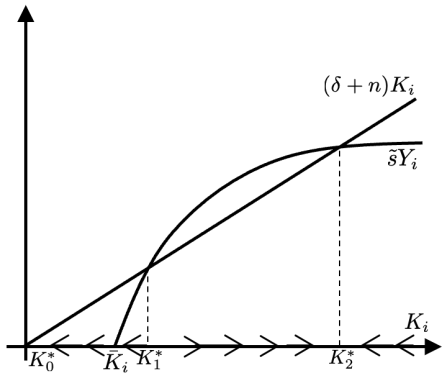
$$\dot{K}_i = \tilde{s}Y_i - \delta K_i \quad \text{and} \quad Y_i = K_i^{\alpha}.$$

Combined with our saving function, and defining $\bar{K}_i = \bar{Y}_i^{1/\alpha}$, we get

$$\dot{K}_i = \begin{cases} -(\delta + n)K_i & \text{when } K_i \leq \bar{K}_i \\ s(K_i^{\alpha} - \bar{K}_i^{\alpha}) - (\delta + n)K_i & \text{when } K_i > \bar{K}_i. \end{cases}$$

Then, since there is a value of output per capita such that actual investment per capita exceeds replacement investment per capita, we get 3 steady states, K_0^*, K_1^* and K_2^*.

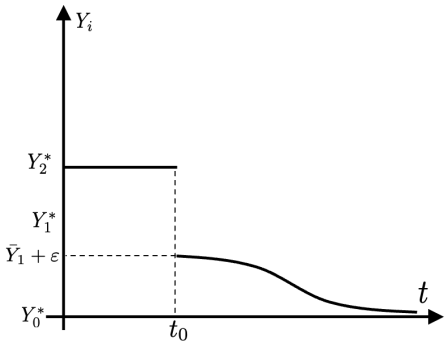
When $0 < K_i < \bar{K}_i$, or $K_i > K_2$, replacement investment exceeds actual investment, so capital is falling. When $K_1^* < K_i < K_2^*$, actual investment exceeds replacement investment, so capital is rising. So our stable steady states are K_0^* and K_2^*, while K_1^* is unstable.



(c) The basic Solow model presented in class suggests there is a tendency for countries to converge, with economies with low initial levels of capital (or income) growing faster than economies with high initial levels of capital (or income). Does this model exhibit convergence? Explain why?

This model does not exhibit convergence. Suppose there are two countries, A and B, where the initial level of capital per capita in country A, K_i^A, is such that $K_i^A < K_1^*$, while initial level of capital per capita in country B, K_i^B, is such that $K_i^B > K_1^*$. Then, country A will move towards K_0^* while country B will move towards K_2^*.

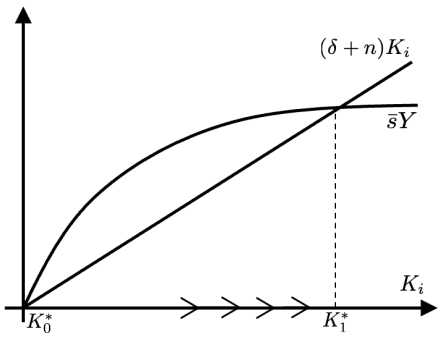
(d) Imagine an economy in the highest steady state that you had identified in b). Now, assume there is a natural disaster that reduces output per capita. After this disaster output per capita is at a level, $\bar{Y}_i + \varepsilon$ where ε is a very small number. Notice that at that level of income per capita savings is still (but barely) positive. Sketch the evolution of income per capita against time (make sure to include in your timeline the period before the shock, the shock and the transition after the shock). Can a temporary flow of foreign aid have permanent effects on the level of income per capita? Explain your answer.



We let Y_0^*, Y_1^*, and Y_2^* be the level of output for steady states K_0^*, K_1^*, and K_2^* respectively. When the output per capita is at level $\bar{Y}_i + \varepsilon$ at time t_0, the per capita investment is slightly above $\bar{K}_i^{\alpha}$. Since this economy is near subsistence, it is not saving much, so replacement investment exceeds actual investment, and capital and output begin to fall. This process continues until the economy reaches K_0^*.

A temporary flow of foreign aid can have permanent effects on the level of income per capita if it brings the income level at t_0 above Y_1^*. With this higher level of income, the country will save enough such that actual investment is greater than replacement investment, and they will experience capital accumulation until they reach the initial steady state K_2^*, permanently.

(e) Contrast the results of d) with those obtained in the standard version of the Solow model. Can a temporary flow of foreign aid have permanent effects on the level of income per capita? Explain.



In the standard version of the Solow model, the economy would have returned to the highest steady state K_1^* regardless, since savings behaviour is such that actual investment is always greater than replacement investment when $0 < K_i < K_1^*$. So the temporary flow of foreign aid will have no permanent effects on the level of income per capita.

5 *One-Period Model of Consumption and Leisure*

Example 3. Consider an individual with the following preferences, $U(c, l) = \theta \ln l + (1 - \theta) \ln c$, where c is consumption, l is leisure and θ is the parameter that shows relative importance of consumption and leisure. They receive labour income equal to their real wage, times the fraction of the day they work, n. They also receive a lump-sum transfer, $T > 0$ from the government, financed from abroad (so taxation and government expenditure remain the same).

(a) Write the individual's budget constraint.

The individual's budget constraint is

$$wn + T = C.$$

(b) Derive the consumer's optimal work choices and interpret.

$$\begin{aligned} U(n) &= \theta \ln(1-n) + (1-\theta)\ln(wn+T) \\ U_n &= -\frac{\theta}{1-n} + \frac{w(1-\theta)}{wn+T} = 0 \\ \Rightarrow \frac{\theta}{1-n} &= \frac{w(1-\theta)}{wn+T} \\ \theta wn + \theta T &= w - w\theta - nw + \theta wn \\ n &= (1-\theta) - \frac{\theta T}{w} \end{aligned}$$

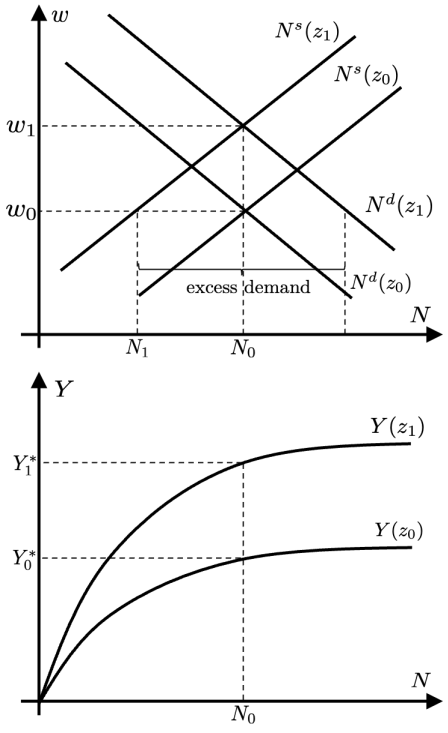
This implies that work effort decreases as transfers increase.

(c) Assume that the economy is at equilibrium in the standard one-period model of consumption. There is an increase in total factor of productivity due to the invention of computers. Discuss the effects of this increase in total factor productivity.

With increased total factor productivity, there is an increase in marginal product of labour for any level of employment, and since the firm solves $MPN = w$, this leads to a shift to the right in labour demand. Additionally, the representative consumer shifts their labour supply to the left, due to the income effect.

At the initial wage w_0, there is excess demand in the labour market, which induces an increase in wages. As the wage increases, quantity of labour supplied increases as more consumers are induced to work, and quantity of labour demanded decreases, as producers want to employ less of the more expensive labour. This process continues until the wage reaches w_1, where the amount of labour supplied by our representative consumer coincides with the amount of labour demanded by firms. In the new equilibrium, both wages and output are higher. This increase in output all goes towards increase in consumption of the consumer.

The effect on employment is ambiguous, because it depends on the relative size of the shift of labour demand and supply.



6 *Two-Period Model of Consumption and Leisure*

Example 4. Consider the following two-period economy where individual preferences are given by $U(c, c') = \ln(c) + \ln(c')$, where c and c' are current and future consumption respectively. Each household

receives an endowment today, y and tomorrow, y', and is taxed at a rate of t today and t' tomorrow. There is a financial market in which households can borrow and lend at a rate r. The government uses its taxed income to fund government spending today, G and tomorrow, G'.

(a) Derive the direction and magnitude of change in current consumption with respect to current income, and explain the cause for this response. What does this imply for saving?

We can derive the consumer's lifetime budget constraint in current terms, which is

$$y - t + \frac{y' - t'}{1+r} = c + \frac{c'}{1+r}$$

Since $U(c, c') = \ln(c) + \ln(c')$, we have that:

$$\begin{aligned} MRS_{c,c'} &= \frac{c'}{c} = 1 + r \\ \Rightarrow c' &= c(1+r) \\ c' &= -(1+r)(c) + (1+r)\left(y - t + \frac{y' - t'}{1+r}\right) \\ 2(1+r)c &= (1+r)\left(y - t + \frac{y' - t'}{1+r}\right) \\ c &= \frac{1}{2}\left(y - t + \frac{y' - t'}{1+r}\right) \\ \Rightarrow \frac{\partial c}{\partial y} &= \frac{1}{2} \end{aligned}$$

As income increases, half of this increase goes towards current consumption, and the rest towards future consumption. This is because the consumer has a preference for variety, which makes them smooth their consumption over the 2 time periods.

Since in the first period, $y - t = c + s$, if $\Delta c = \frac{1}{2}\Delta y$, then $\Delta s = \frac{1}{2}\Delta y$ as well. This implies that timing of income is the main determinant of fraction of resources saved.

(b) Prove Ricardian Equivalence in this setting, and briefly discuss its implications.

The household budget constraint gives us that

$$C + \frac{C'}{1+r} = \left(Y + \frac{Y'}{1+r}\right) - \left(T + \frac{T'}{1+r}\right).$$

Then, by the government's lifetime budget constraint, we get

$$C + \frac{C'}{1+r} = \left(Y + \frac{Y'}{1+r}\right) - \left(G + \frac{G'}{1+r}\right).$$

This implies that the timing of the taxation does not impact consumption, but rather the total amount of government spending.

7 *Real Business Cycle Model*

Example 5. Take the Real Business Cycle model presented in class (with all its auxiliary assumptions). The basic equations of this model are given by:

$$\begin{aligned} N^S\left(\underset{+}{w},\underset{+}{r},\underset{+}{T},\underset{+}{T'}\right) \\ N^D\left(\underset{-}{w},\underset{+}{z},\underset{+}{K}\right) \\ Y^S\left(\underset{+}{r},\underset{+}{z},\underset{+}{K},\underset{+}{T},\underset{+}{T'}\right) \\ Y^D\left(\underset{-}{r},\underset{-}{T},\underset{-}{T'},\underset{-}{K},\underset{+}{z'},\underset{+}{G}\right) \end{aligned}$$

Assume the government receives a transfer from the rest of the world, and uses it to subsidise consumer work effort in the current period. Since the transfer is financed with a transfer from abroad, it leaves unchanged the initial levels of government expenditure and taxes for the first and second periods of the model. Specifically, for each additional hour worked by the consumer in the current period, the government rebates to the consumer $s > 0$ in the same period. We restrict our analysis to the current period.

(a) Derive the new optimal consumption and leisure choice of the consumer. Explain the effects of the subsidy on labour supply and demand, and modify accordingly the labour supply and demand curves.

Our new lifetime budget constraint is:

$$(w+s)(h-l)+\pi-T+\frac{w'(h-l')+\pi'-T'}{1+r}=C+\frac{C'}{1+r}.$$

Then, if the representative consumer maximises their preferences subject to the Lagrangian, we get that

$$\mathcal{L}=U(C,C',l,l')+\lambda\left((w+s)(h-l)+\pi-T+\frac{w'(h-l')+\pi'-T'}{1+r}-C-\frac{C'}{1+r}\right).$$

Our first order conditions give us that

$$\begin{aligned} U_C &= \lambda \\ U_{C'} &= \frac{\lambda}{1+r} \\ U_l &= \lambda w+s \\ U_{l'} &= \frac{\lambda w'}{1+r} \end{aligned}$$

So our new optimal consumption and leisure choices are such that

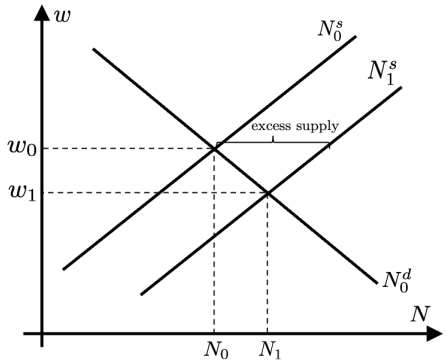
$$MRS_{l,C} = \frac{U_l}{U_C} = w + h$$
$$MRS_{l',C'} = \frac{U_{l'}}{U_{C'}} = w'$$
$$MRS_{C,C'} = \frac{U_C}{U_{C'}} = 1 + r$$

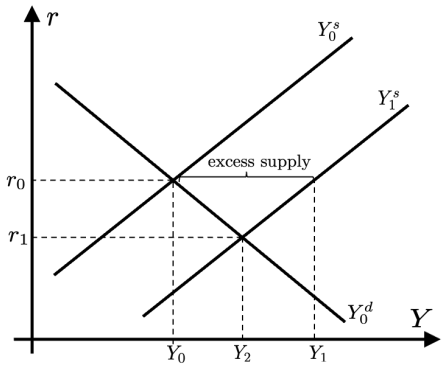
With the subsidy on work effort, the marginal benefit of current leisure relative to future leisure increases, and it pays off to reduce leisure today, increasing the current labour supply. So

$$N^S \left(\underset{+}{w}, \underset{+}{h}, \underset{+}{r}, \underset{+}{T}, \underset{+}{T'} \right)$$

At the same time, firms still only have to pay workers the original wage w, so the firm problem remains unchanged, and the firm will hire current labour until $MPN = w$. The firm's current labour demand curve remains unchanged.

(b) Trace the macroeconomic response of the economy after the introduction of the subsidy using the graphs for the labor market and the goods market. Discuss the adjustment of the economy. Specifically, what are the effects on output, employment, wages and the interest rate?





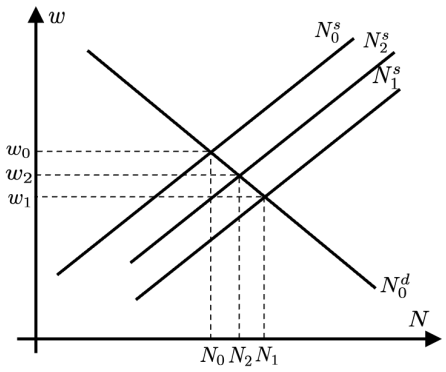
The introduction of the subsidy induces a decrease in leisure, which is an increase in labour supply, so the labour supply curve shifts to the right. At the initial wage w_0, there is an excess supply in the labour market. As a result, wages begin to fall until w_1, and firms find it optimal to hire additional workers until N_1.

This increase in employment associated with the subsidy leads to an expansion of output supply, a shift outwards in the output supply curve, with production increasing to Y_1 at the initial interest rate r_0. The shift outwards in the output supply curve creates excess supply in the goods market at the initial interest rate r_0, so the interest rate starts to fall towards r_1.

As the interest rate decreases, working today and saving becomes less attractive so labour supply decreases, which creates excess demand in the labour market that pushes wages up to w_2, decreasing employment until N_2.

The decrease in employment associated with this shift in labour supply from lower interest rates induces an increases in quantity of output supplied, a movement along the output supply curve from Y_1 to Y_2, beginning to close the excess demand in the goods market. The decrease in interest rates also induces consumption

and investment to increase, a downward movement along the output demand curve. These two forces contribute to close the excess demand in the goods market.



(c) What are the effects on consumption and investment?

Both consumption and investment increase, due to the decrease in interest rates.

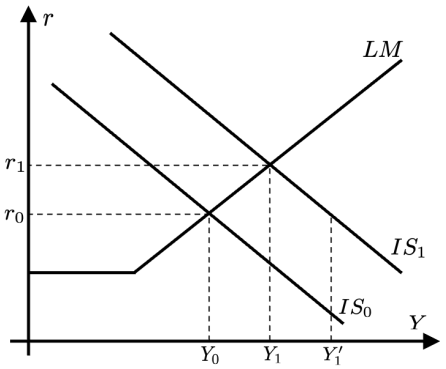
8 *Short-Run Model*

Example 6. Consider a standard version of the closed economy IS-LM model given by the following equations:

Consumption:	$C = c_0 + c_1(Y - T)$
Investment:	$I = b_0 - b_1 r$
IS curve:	$Y = C + I + G$
LM curve:	$M/P = d_1 Y - d_2(r + \pi^e)$

where all the parameters $c_0, c_1, b_0, b_1, d_1, d_2$ are positive and $c_1 < 1$.

(a) Use the IS-LM diagram to determine the effects of an increase in base rate of investment, b_0, on output and interest rate. Explain your result.



The increase in base rate of investment b_0 shifts the IS curve to the right. At the original interest rate r_0, the unchanged initial level of output Y_0 falls short of planned expenditure Y_1'. Firms begin to deplete inventories, and they increase production and employment. Output increases.

As income increases so does the demand for money for transaction purposes. For the money market to remain in equilibrium, the interest rate needs to increase. At this point, there are two forces reducing the initial excess of planned expenditure over output. First, output is increasing. Second, the increase in the real interest rate decreases investment and therefore planned expenditure. As a result, the economy moves along the LM curve with both output and real interest rate increasing until the new equilibrium (r_1, Y_1) is reached.

(b) Analytically determine the effects of the increase in base rate of investment on output and interest rate.

Differentiating the IS curve with respect to b_0, we get

$$\begin{aligned} dY &= db_0 + c_1 dY - b_1 dr \\ \Rightarrow (1 - c_1) dY &= db_0 - b_1 dr. \end{aligned}$$

Differentiating the LM curve with respect to b_0, we get

$$0 = d_1 dY - d_2 dr.$$

Then, solving simultaneously, we get

$$\begin{aligned} dY &= \frac{d_2}{d_1} dr \\ (1-c_1)\frac{d_2}{d_1} dr &= db_0 - b_1 dr \\ \frac{dr}{db_0} &= \frac{d_1}{(1-c_1)d_2 + b_1 d_1} > 0 \\ \frac{dY}{db_0} &= \frac{d_2}{(1-c_1)d_2 + b_1 d_1} > 0. \end{aligned}$$

9 *Open Economy*

Example 7. Consider the following version of the open economy IS-LM model,

IS curve: $Y = E^p = c_0 + c_1(Y - T) + I(r) + G + NX\left(e\frac{P^*}{P}\right)$

LM curve: $M/P = YL(r + \pi^e)$

Interest rate parity: $r + \pi^e = r^* + \pi^{e*} + E\left(\frac{\dot{e}}{e}\right)$

(a) Derive analytically the effect of a change in nominal exchange rate e on income Y, and explain this effect.

$$\begin{aligned} (1-c_1)dY &= \frac{\partial NX(e\frac{P^*}{P})}{\partial e} de \\ \frac{\partial e}{\partial Y} &= \frac{1-c_1}{\partial NX(e\frac{P^*}{P})/\partial e} > 0 \end{aligned}$$

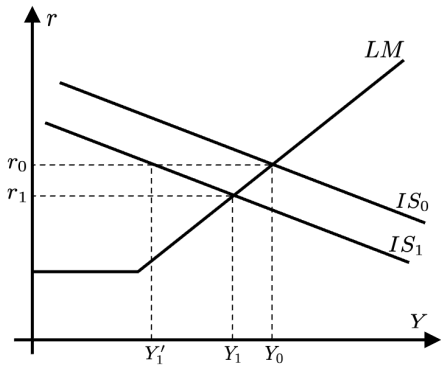
As e increases, which is a nominal depreciation of the domestic currency, with fixed prices, this corresponds to a real depreciation. This depreciation makes domestic goods cheaper than foreign goods, which increases net exports. This leads to planned expenditure exceeding output, so firms begin to deplete their inventories, increasing employment and production. This increases output.

(b) Compare the effects of a decrease in government expenditure on an open economy with imperfect capital flows versus an open economy with perfect capital flow and flexible exchange rate. Here, recall that $CF(r + \pi^e - r^* + \pi^{e*}) + NX(e\frac{P^*}{P}) = 0$.

For the case with imperfect capital mobility, our new IS curve is

$$Y = c_0 + c_1(Y - T) + I(r) + G - CF(r + \pi^e - r^* + \pi^{e*}).$$

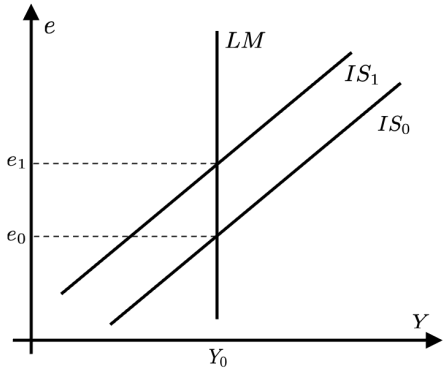
Since capital inflow increases as domestic interest rate increases, the IS curve remains downwards sloping in the $Y - r$ space.



Then, as government expenditure decreases, we have a leftward shift in the IS curve, so at the original interest rate r_0, the unchanged initial level of output Y_0 is greater than planned expenditure Y_1', Firms begin to accumulate unplanned inventories, and they decrease production and employment. Output decreases.

As income decreases, so does the demand for money for transaction purposes. For the money market to remain in equilibrium, the interest rate needs to decrease. At this point, there are two forces reducing the initial excess of output over planned expenditure. First, output is decreasing. Second, the decrease in interest rates increases investment and decreases capital flows, thereby increasing planned expenditure. As a result, the economy moves along the LM curve with both output and real interest rate increasing until the new equilibrium (r_1, Y_1) is reached.

For the case with perfect capital mobility and a flexible exchange rate, we notice that since the domestic interest rate must coincide with the world exchange rate, there is only one level of output Y that is consistent with equilibrium in the money market, so the LM curve is a vertical line in the $Y - e$ space. As we have derived above, we know that the IS curve is upwards sloping in the $Y - e$ space.



So, a decrease in government expenditure results in a leftward shift in the IS curve, which results in a decrease in interest rates in the same manner as the analysis above. However, in the open economy with perfect capital mobility, the downward pressure on domestic interest rate generates a capital outflow that causes the domestic currency to depreciate. This depreciation continues until the increase in net exports exactly offsets the initial decrease in government expenditure.

Here, notice that there is no negative output shock from doing contractionary fiscal policy in the perfect capital mobility case, but there are negative output shocks in the imperfect mobility case.

(c) How does level of capital mobility impact the effectiveness of monetary and fiscal policy?

As seen above, with completely free capital mobility, fiscal policy is rendered ineffective in stimulating the output of the economy, since the change in interest rates and the resulting change in capital flows will change the exchange rate of the economy, causing net exports to exactly offset the initial change in government expenditure. However, in this scenario, monetary policy is the most

effective tool to stimulate the economy, since changes in interest rate will not only change investment, but also change capital flows, which influence net exports.

With imperfect capital mobility, fiscal policy is still useful, albeit less effective than in a closed economy, due to the presence of capital flows making the IS curve flatter than in a closed economy. Monetary policy is also useful here, since the changes in interest rates will not only change investment, but also change capital flows, but to a smaller extent than in a completely open economy.

10 Medium-Run Model

Example 8. Consider the following version of the IS-LM-PC model presented in class,

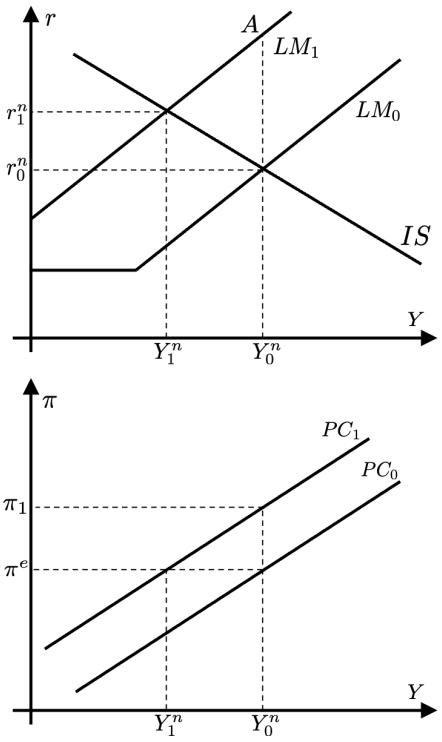
$$\begin{aligned} &\text{IS curve:} && Y = c_0 + c_1(Y_t - T_t) + I(r_t) + G_t \\ &\text{LM curve:} && M/P = YL(r + \pi^e) \\ &\text{Phillips curve:} && \pi_t = \pi^e - \sigma(Y_t - Y^n) \end{aligned}$$

where inflation expectations π^e are not adaptive.

(a) Assume the economy, previously at equilibrium, went through a natural disaster which destroyed some of their capital stock. This decreased the natural level of output Y^n, while all other factors stay the same. Use the IS-LM-PC diagram to show what happens to the economy in the new equilibrium.

When the natural level of output Y^n decreases, we have that the PC curve shifts inwards. In the short run, the economy remains at equilibrium. However, with output above potential, unemployment is below its natural rate, and the economy is not in medium-run equilibrium. The low unemployment rate requires increases in nominal wages to ensure that workers exert the appropriate level of effort. This increase in nominal wage induces firms to set higher prices, and inflation turns out to exceed expectations $\pi_1 > \pi^e$.

This increase in prices reduces the supply of real money balances M/P, which shifts the LM curve to the left. This leads to an immediate increase in the interest rate (point A). At the higher interest rate, output exceeds planned expenditure and firms begin to accumulate inventories. As a result, they decrease employment and production. So output decreases. With output decreasing, the interest rate must be decreasing for the money market to remain in equilibrium, a movement along the LM curve. Both the decrease in output and the increase in interest rate decreasing planned expenditure contribute to close the gap between output and planned



expenditure. The new short run equilibrium is now (r_1^n, Y_1^n) and inflation expectations are back at π^e.

(b) Why would the natural unemployment rate r_t^n be above zero?

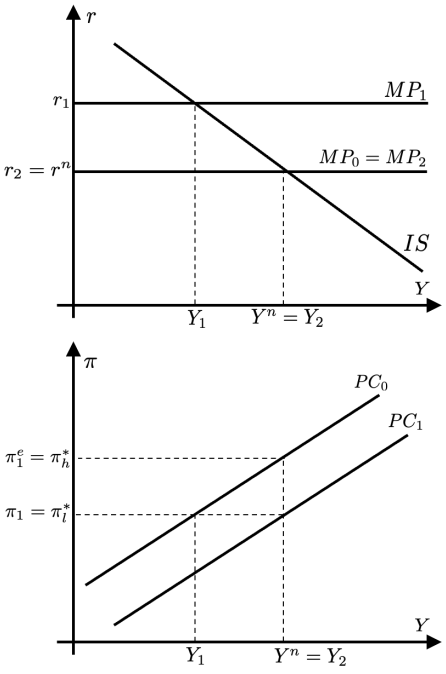
Frictional and structural unemployment are not eliminated in the medium run. Frictional unemployment is when some proportion of the labour force is unemployed as they are briefly in between jobs, and this is an unavoidable part of a dynamic economy. Structural employment is when some proportion of the labour force is unemployed as there is a fundamental mismatch between their skills and the requirements of jobs available. These two types of unemployment contribute to there being a base rate of unemployment throughout the business cycle.

11 Monetary Policy

Example 9. Consider the following version of the IS-MP-PC model presented in class,

$$\begin{aligned}
&\text{IS curve:} && Y = c_0 + c_1(Y_t - T_t) + I(r_t) + G_t \\
&\text{MP curve:} && r_t = r_t^n - \beta(\pi_t - \pi^*) \\
&\text{Phillips curve:} && \pi_t = \pi^e - \sigma(Y_t - Y^n)
\end{aligned}$$

(a) Use the IS-MP-PC model to show what happens to the economy when the Central Bank attempts to conduct disinflation by reducing its inflation target.



When the central bank decreases its inflation target from π_h^* to π_l^*, inflation is above its target, so the central bank increases the policy rate by $\beta(\pi_h^* - \pi_l^*)$, and the MP curve shifts up from MP_0 to MP_1. At this policy rate, output exceeds planned expenditure, so firms begin to accumulate unwanted inventories, reducing production and employment. Output falls to Y_1, and the economy enters a recession.

But with output below potential Y^n, unemployment exceeds its natural rate, so the economy is not in medium-run equilibrium. The high unemployment rate induces reductions in nominal wages, and the decrease in nominal wages induces firms to set lower prices, so inflation falls to π_l^*.

With inflation at the new lower target, the central bank and the public will adjust their behaviour, so both the monetary rule and the Phillips curve will shift. The central bank reduces its policy rate back to its natural level r^n, which represents a downwards shift in the MP curve back to MP_0. The decrease in policy rate increases planned expenditure above output, and firms begin to

deplete their inventories, increasing production and employment. Output rises back to Y^n

Under adaptive expectations, since $\pi_1^e = \pi_h^* > \pi_1 = \pi_l^*$, wage setters expecting lower prices decrease proportionally nominal wages. As a result, the Phillips curve shifts down. With output at full employment, actual inflation coincides with expected inflation and the economy returns to the medium-run equilibrium.

(b) Briefly explain what a deflationary spiral is, and how it can occur.

A deflationary spiral is when the economy's natural level of interest at time t , r_t^n falls below the zero lower bound of $-\pi_t^e$. Then, although the central bank wants to set the policy rate below r_n^t, they are unable to, resulting in prices and production declining in period after period.