

Multiple Choice Questions

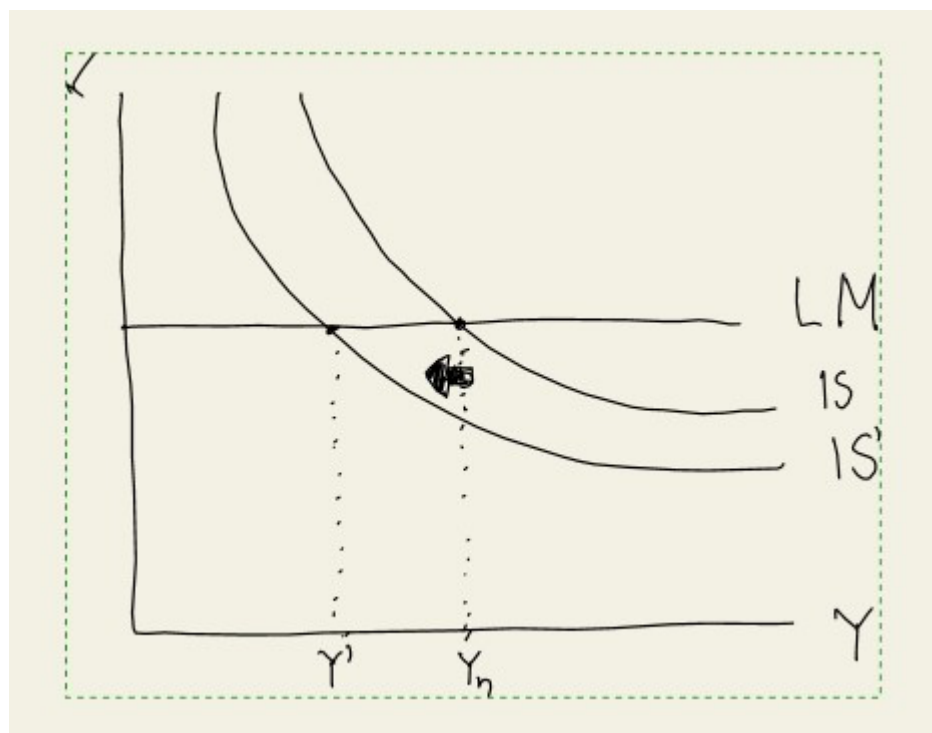
1	B
2	B
3	A
4	B
5	B

Exercise 1 – War and the medium-run equilibrium

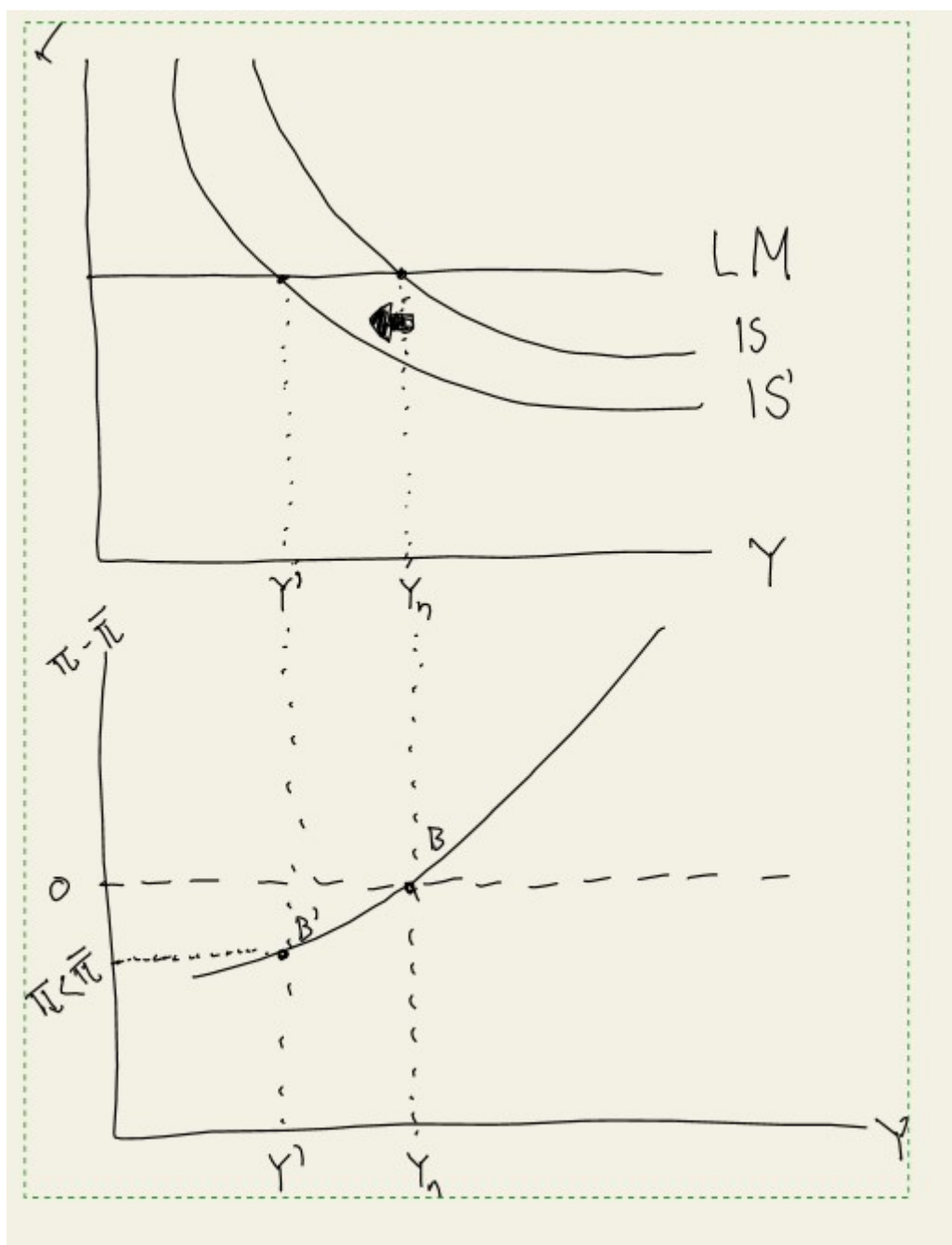
a.

Judging from the graph, there is no doubt that consumer confidence has decreased throughout the Eurozone. Every country in graph has a substantial negative change in consumer confidence, and the average change in the Eurozone is approximately - 9.5%.

In the IS-LM-PC model, this will decrease consumption which will, through the multiplier effect, decrease investment and further decrease consumption. This will push output below its natural level. Thus, this change in c_0 will decrease output for any given real interest rate. Visually, the IS curve shifts to the left:



Because of the lower output less labor will be needed, which will increase the unemployment rate above its natural level. This will result in an inflation rate below target level. Visualized in an IS-LM-PC diagram:

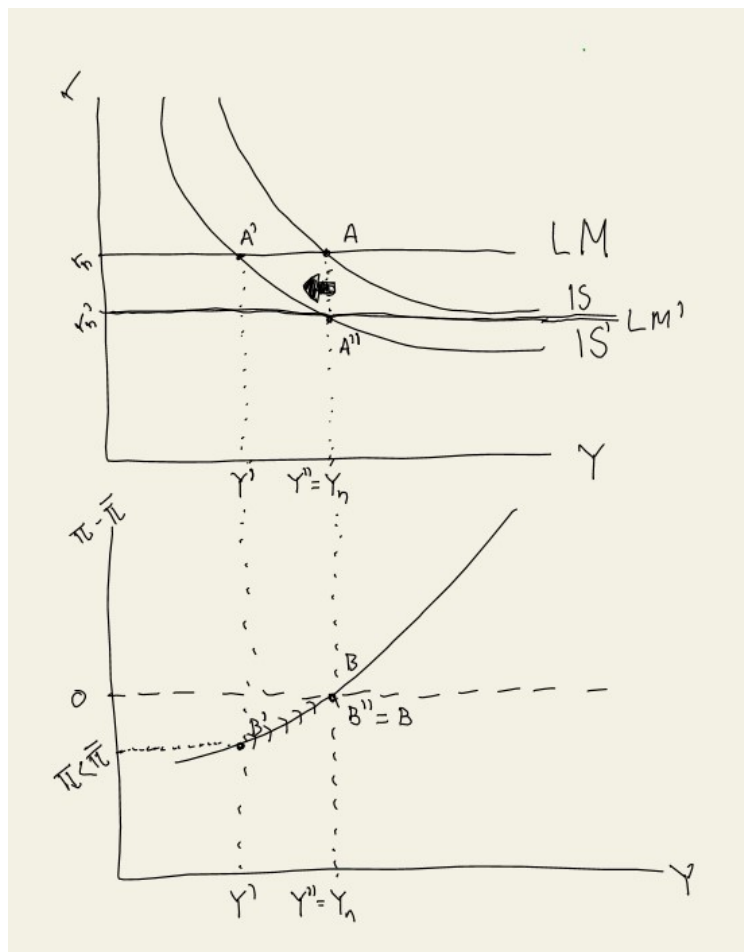


This happens because output is determined by demand in the short run, whereas the medium run equilibrium (which is characterized by an inflation equal to target) remains unchanged. Thus, the lowered consumer confidence leads to lower production by firms. The lower production means that they will need fewer workers, which increases unemployment. This gives workers less bargaining power in wage negotiations, which leads to lower nominal wages. Because the real wages paid by firms remain constant, this implies a decrease in the price level as well. Thus, inflation decreases.

b.

The central bank should pursue an expansionary monetary policy. More precisely, they should decrease the policy rate by purchasing bonds in open market operations and thereby increasing the money supply. The aim of this would be to decrease the borrowing rate faced by firms. This will make it cheaper for firms to invest, which will make them invest more and thereby increase

output. This will, through the multiplier effect, increase consumption and further increase investment. This, the expansionary monetary policy will increase output. The central bank should aim for the natural interest rate, r_n' , which yields the natural level of output. Visualized in an IS-LM-PC diagram:



The central bank decreases the policy rate such that $r = r_n'$. This moves the short-run equilibrium from point A' to point A'' . This will increase output to Y'' , which is equal to the natural output, Y_n . When at the natural output, the economy will also be at its medium-run equilibrium, which is represented by $B = B''$ in the PC-diagram. Therefore, this policy will stabilize inflation at $\bar{\pi}$.

c.

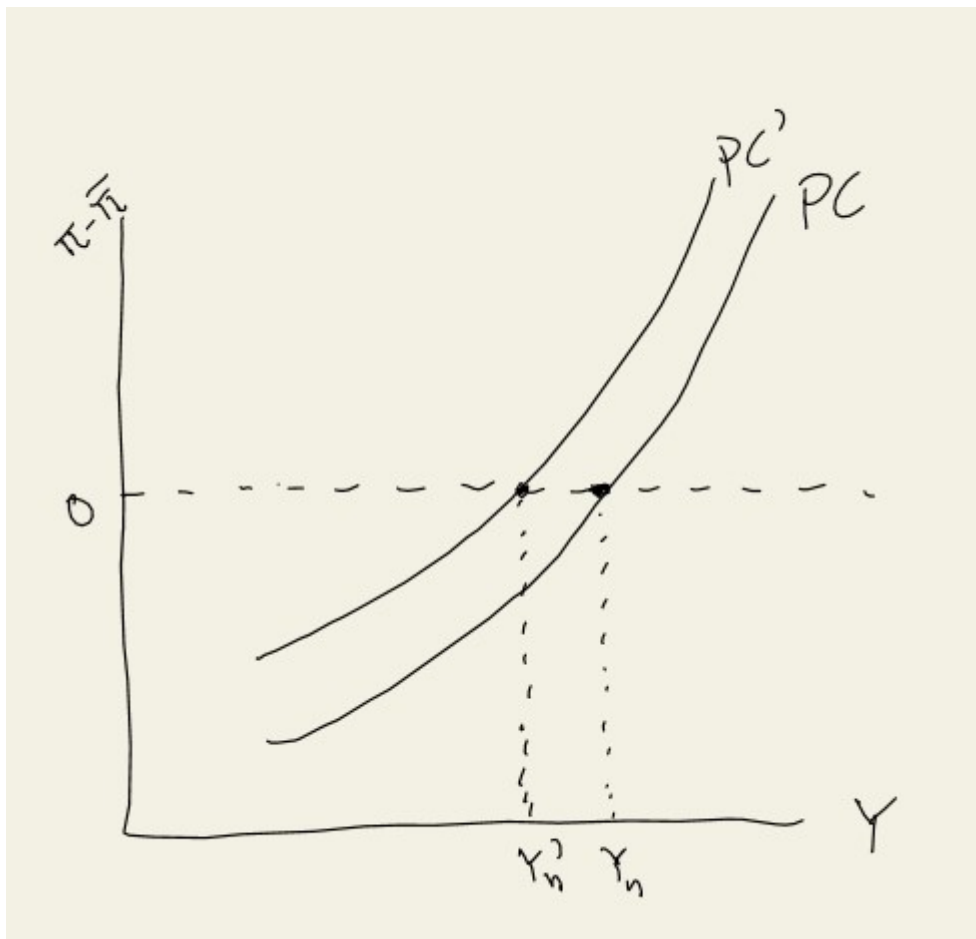
c_0 is still at the level shown by the graph in question a), so consumption will be lower than before. Since the real interest rate has decreased, investment will be higher. Therefore, the composition of output has changed: In the second equilibrium, Consumption is lower than in the initial equilibrium and Investment is higher than in the initial equilibrium. Judging from the information given, government spending remains constant.

d.

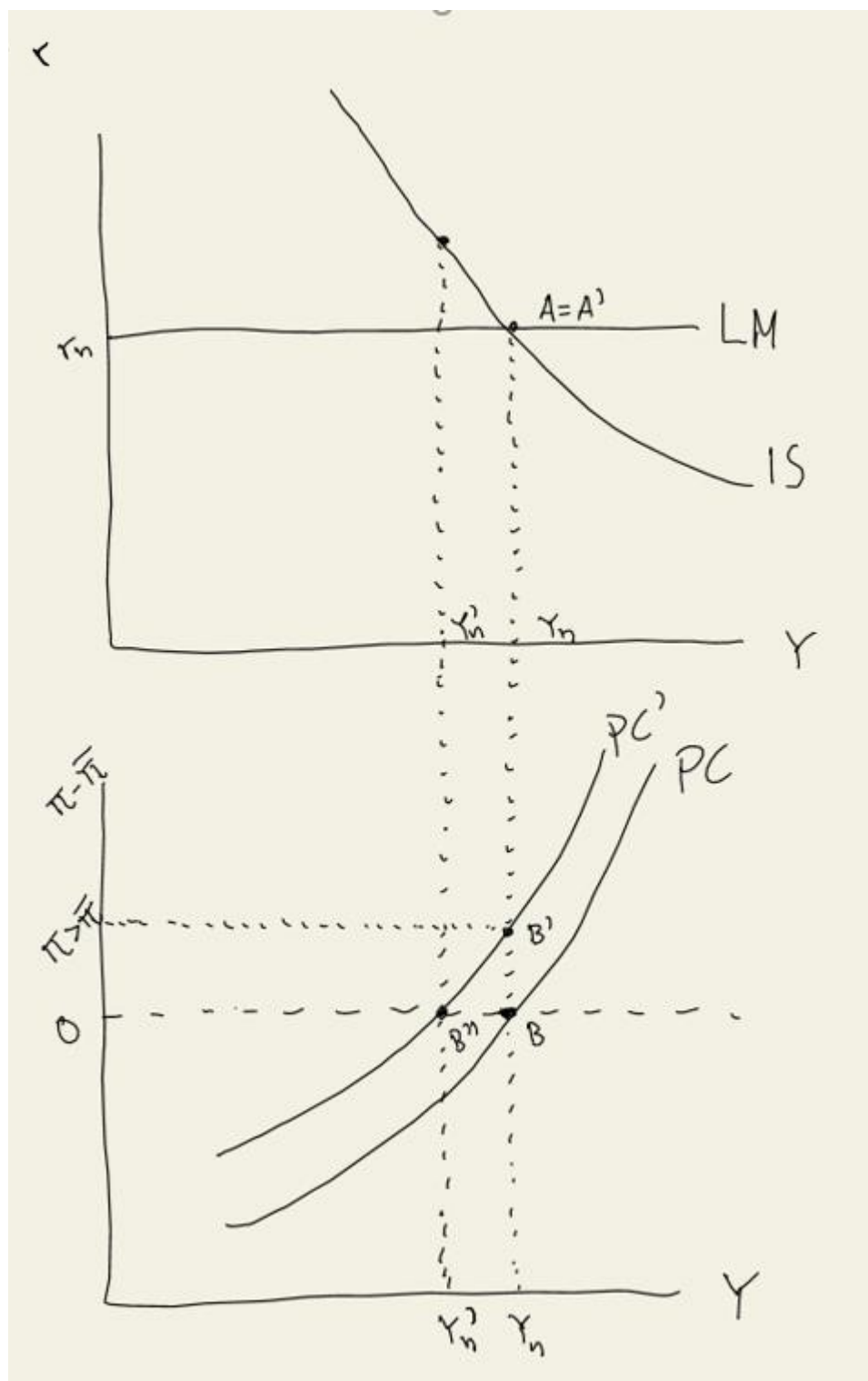
Initially, firms will produce the same output, as output is determined by demand in the short run. However, they will now charge a higher price because of the increase in m . Because firms now spend more money on energy, they raise their prices. Since the overall price level

increases, real wages decrease for any given nominal wage. Therefore, fewer workers can have their reservation wage satisfied in real terms, even though their nominal wage remains unchanged. This leads to a higher natural rate of unemployment. However, firms do not adjust their employment immediately, because short-run output is determined by demand. Thus, output remains at the initial level in the short run.

Since the Philips curve can be written as $\pi - \bar{\pi} = (m + z) - \alpha u_n$ and u_n and Y_n are inversely related, the increase in m leads to a leftward shift of the Philips curve from PC to PC' :



However, the short-run equilibrium remains the same (before any intervention by the central bank), which means that the output gap is positive, which increases inflation. Inflation is now above target because the economy is now in point B' instead of the new medium-run equilibrium, B'' . Visualized:

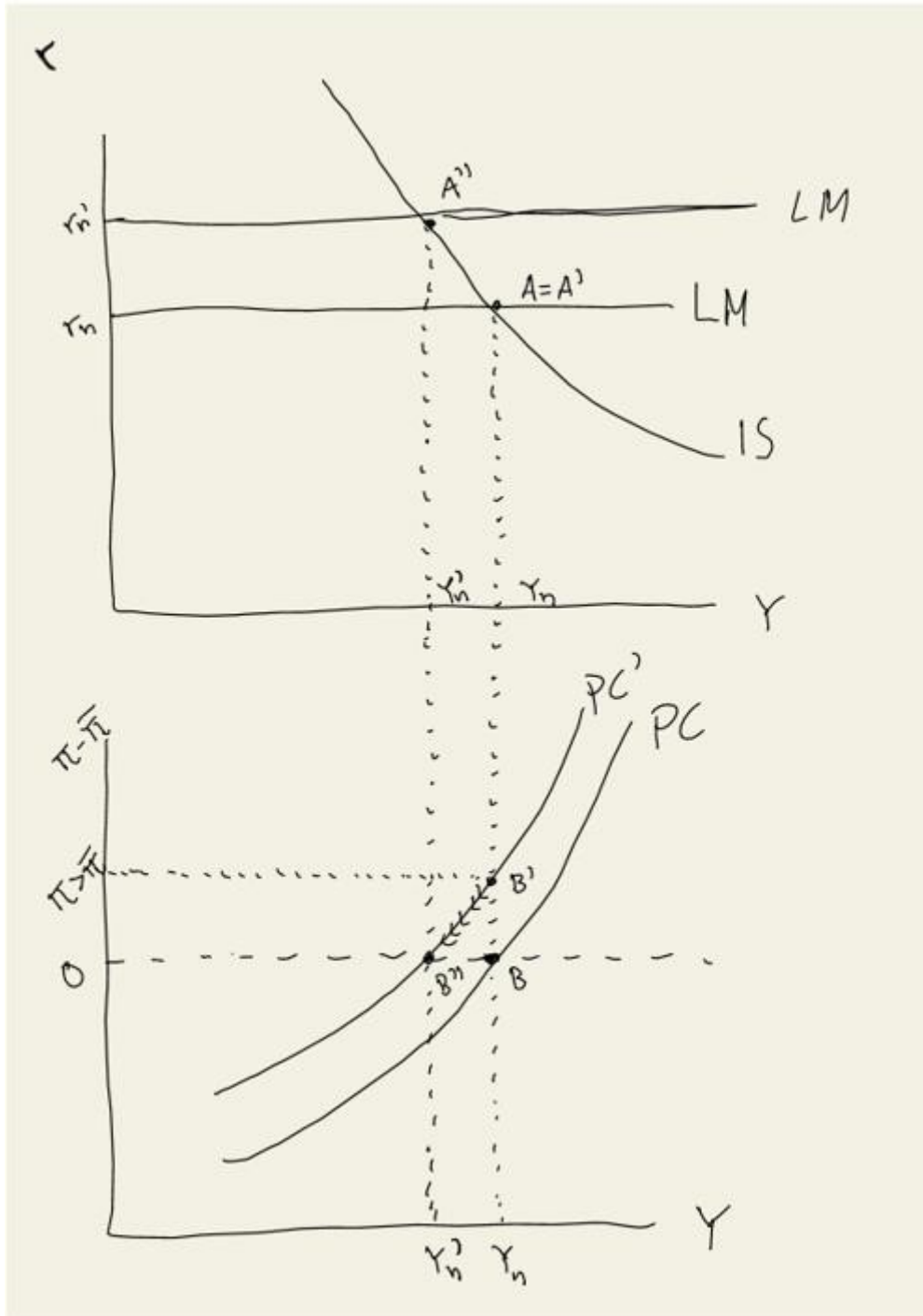


The answer differs because the increase in energy prices affect m , and therefore the labor market and not the demand. Shock to the labor market changes the natural output and unemployment rate, and thereby the medium run equilibrium. Shocks to demand changes the short-run equilibrium.

Therefore, question d) changes the medium-run equilibrium that the central bank should aim for with the short run equilibrium, whereas the short-run equilibrium remains constant in question a). However, the scenario in question a) requires the central bank to steer the economy back to a short-run equilibrium that has the same output as the initial level.

e.

The central bank should aim to decrease output to the new natural level, Y' . They can do this by pursuing a contractionary monetary policy, that is increasing the policy rate in order to increase the borrowing rate faced by firms. This will make it more expensive for firms to invest, which will decrease output. This will, through the multiplier effect, decrease consumption as well as enhance the decrease in investment. The central bank should aim for the new natural interest rate, r_n' , in order to reach the short run equilibrium A'' .



This will bring the economy to the new medium-run equilibrium, B'' .

This situation is tricky for the European central bank because they are trying to deal with both effects (questions a), and d)) at once. On one hand, the natural level of output has almost certainly decreased (this is impossible to measure). This means that the central bank has to decrease output significantly to reach the new natural level (as described in questions d) and e)), in order to avoid inflation. It is reasonable to fear that this will cause a recession, which would be enhanced by the decrease in consumer confidence. If consumer confidence continues to be low, this recession can become hard to recover from.

One could say that the ECB have to choose between creating inflation in the short run or securing output, and thereby wealth and happiness, in the medium-run.

Exercise 2 – Monetary policy in the short run

a.

Generally speaking, the short-run equilibrium is given by the equation:

$$Y = C + I + G \rightarrow Y = c_0 + c_1Y - c_1T + I_0 + d_1Y - d_2r - d_2x$$
 Which can

also be written as:

$$Y = \frac{1}{1 - c_1 - d_1} (c_0 - c_1T + I_0 - d_2r - d_2x + G)$$

Substituting all exact values except r gives the IS-equation:

$$Y = \frac{1}{1 - 0.6 - 0.15} (200 - 0.6 * 500 + 100 - 2500r - 2500 * 0 + 550)$$
$$\rightarrow Y = \frac{1}{0.25} (550 - 2500r) \rightarrow Y = 2200 - 10000r$$

Generally speaking, the LM equation is given by:

$$r = i - \pi^e$$

In this case,

$$r = 0.04 - 0.02$$

Thus, the IS and LM curves are:

LM: $r = 0.02$

IS: $Y = 2200 - 10000r$

Substituting the real interest rate into the IS-equation gives the equilibrium output:

$$Y = 2200 - 10000 * 0.02 = 2000$$

Which gives the disposable income:

$$Y^D = Y - T = 2000 - 500 = 1500$$

Thus, consumption is:

$$C = c_0 + c_1(Y - T) \rightarrow = 200 + 0.6(2000 - 500) = 1100$$

Which gives the investment:

$$I = I_0 + d_1Y - d_2(r + x) \rightarrow I = 100 + 0.15 * 2000 - 2500 * (0.02 + 0) = 350$$

In conclusion:

$$Y = 2000; Y^D = 1500; C = 1100; I = 350 \text{ b.}$$

Because the fiscal multiplier is 4, we know that this will have a four-fold effect on overall output. Thus, output decreases by 200 to $Y' = 1800$.

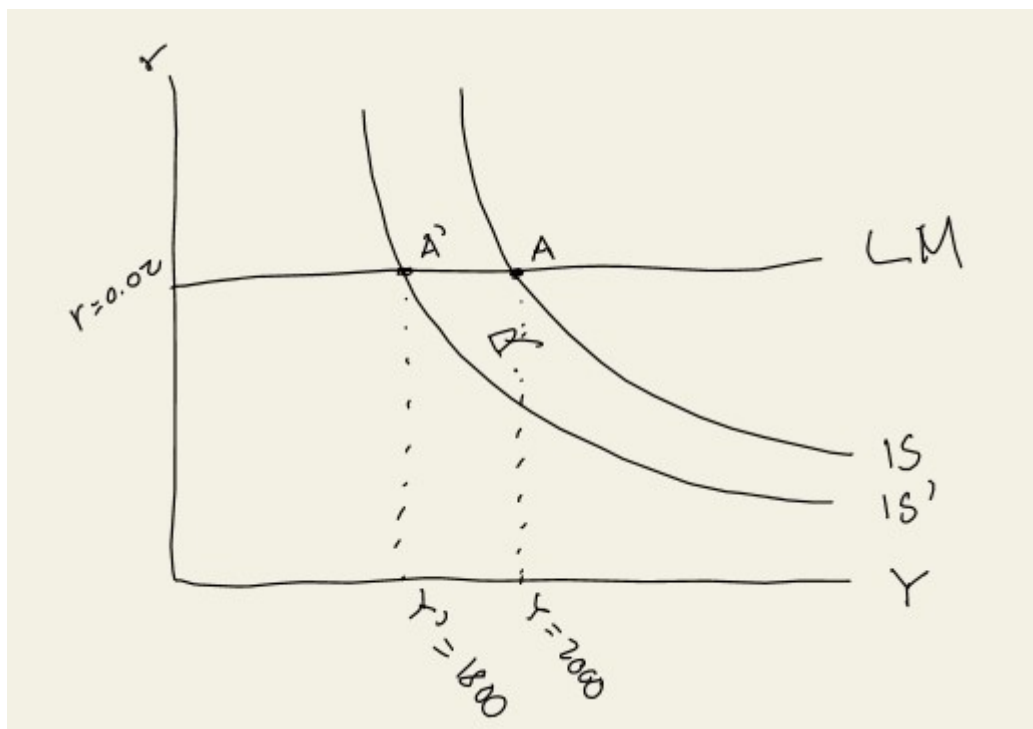
Thus consumption is now:

$$C = c_0 + c_1(Y - T) \rightarrow = 200 + 0.6(1800 - 500) = \mathbf{980}$$

While investment is:

$$I = I_0 + d_1Y - d_2(r + x) \rightarrow I = 50 + 0.15 * 1800 - 2500 * (0.02 + 0) = \mathbf{270}$$

Intuitively speaking, output is now lower for any given real interest rate. Thus, the IS curve shifts to the left:



The reason that the change in output is larger than 50 is the multiplier effect. Both consumption and investment depends on output itself. Therefore, a decrease in output resulting from a decrease in investment will both decrease consumption (because of a decrease in disposable income) and investment, because they now have less capital to invest from.

It is also evident from the fact that output decreased by 200, while consumption decreased by 120 and investment decreased by 80.

c.

Yes it can. It can decrease the policy rate by purchasing bonds in open market operations, which will decrease the real interest rate. The real interest rate that they should aim for can be found by setting the new output equation, $Y = \frac{1}{1-0.6-0.15} (200 - 0.6 * 500 + 50 - 2500r - 2500 * 0 + 550)$, equal to 2000:

$$2000 = 4(200 - 0.6 * 500 + 50 - 2500r - 2500 * 0 + 550) \rightarrow 2000 = 2000 - 10000r$$

Solving for r:

$$2000 = 2000 - 10000r \rightarrow 0 = -10000r \rightarrow r = 0$$

They should aim for a real interest rate of 0. While doing this, they should consider expected inflation, which is assumed to remain at 0.02. Thus, the central bank should set the policy rate at $i = r + \pi = 0.02$.

In this equilibrium, consumption is now:

$$C = c_0 + c_1(Y - T) \rightarrow = 200 + 0.6(2000 - 500) = \mathbf{1100}$$

While investment is:

$$I = I_0 + d_1Y - d_2(r + x) \rightarrow I = 50 + 0.15 * 2000 - 2500 * (0 + 0) = \mathbf{350}$$

To sum up, the equilibrium values are now:

$$i = 0.02; r = 0; Y = 2000; Y^D = 1500; C = 1100; I = 350; G = 550$$

d.

Yes, they can. They will have to decrease the policy rate to 0, in order to keep the real interest rate constant. ($r = i - \pi \rightarrow 0 = i - 0 \rightarrow i = 0$)

The equilibrium will be the same as in question c), with exception of the policy rate, because the real interest rate is kept constant:

$$i = 0; r = 0; Y = 2000; Y^D = 1500; C = 1100; I = 350; G = 550$$

e.

No, the central bank cannot get output back to the initial level if constrained by the zero lower bound.

The change in output caused by the change in the risk premium is given by:

$$\Delta Y = \frac{1}{0.25} (-2500 * \Delta x)$$

In this case:

$$\Delta Y = \frac{1}{0.25} (-2500 * 0.01) = -100$$

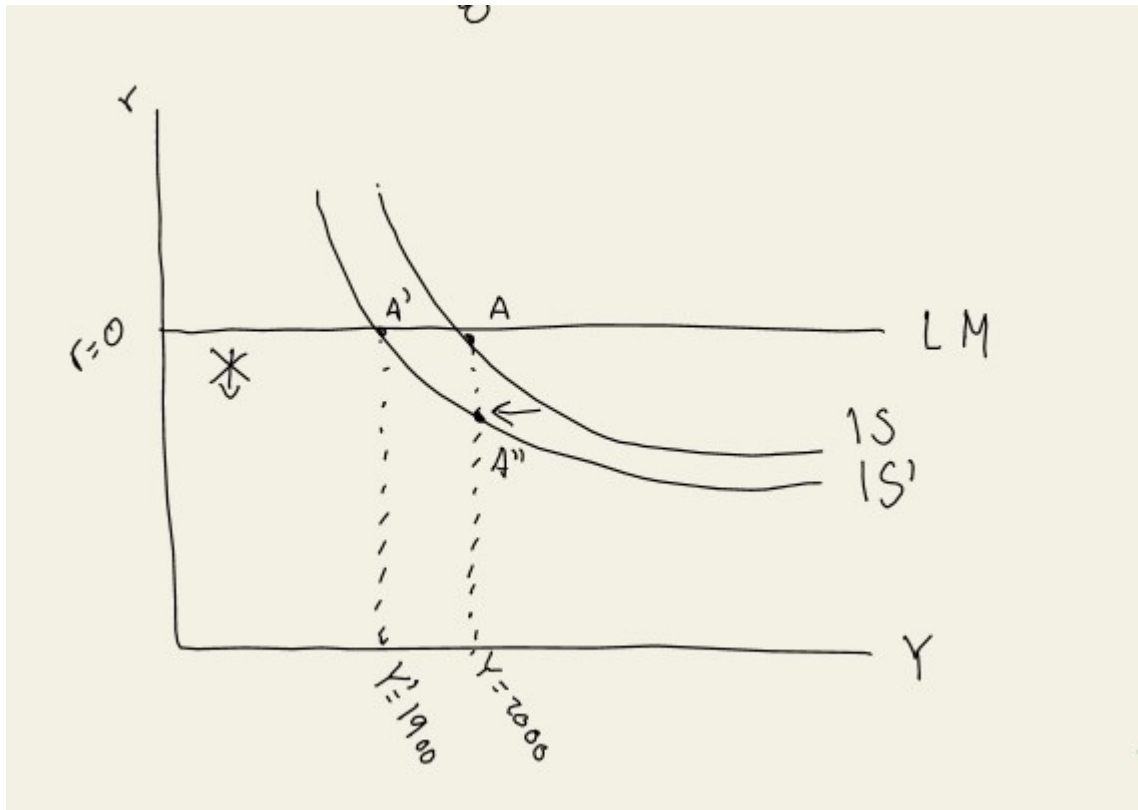
This means that output will be 100 lower for any given real interest rate. In other words, the IS curve is now given by:

$$Y = 1900 - 10000r$$

Assuming that expected inflation is still 0, the lowest rate that the central bank can achieve is 0. This will yield the output.

$$Y = 1900 - 10000 * 0 = 1900$$

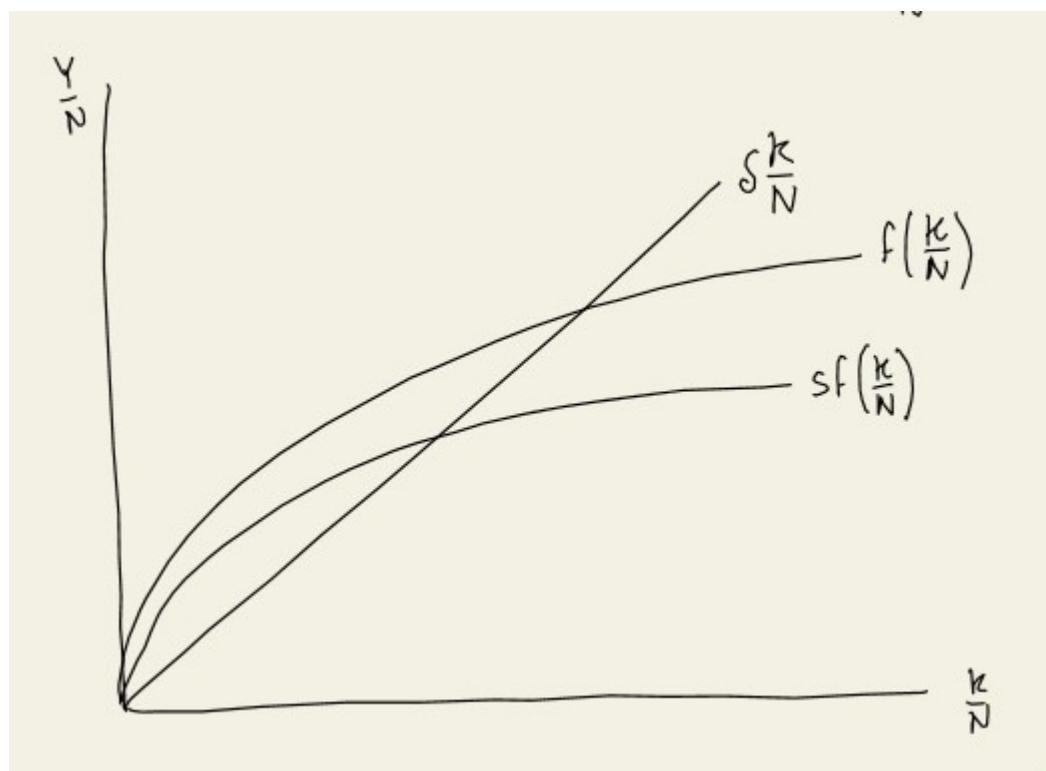
Thus, the maximum output that the central bank can achieve under these circumstances is 1900. Visualized:



The economy is initially in point A, where $Y=2000$. The change in the risk premium shifts the IS curve to IS' . Therefore, the short run equilibrium is now in point A' , where $Y=1900$. In order to reach the initial output level of 2000, the central bank should aim for point A'' , where output is once again 2000. They cannot do this because of the zero lower bound, which implies that they cannot decrease i , which in this case is equal to r , any further.

Exercise 3 – Solow model

a.



Depreciation per worker is denoted by $\frac{\delta K}{N}$, and is measured as a proportion of output per worker on the Y axis. Depreciation per worker is the amount of capital that depreciates during a given period. The rate at which it depreciates is constant no matter the level of capital per worker, which makes it a proportional relationship. Thus, the graph is linear.

Output per worker is denoted by $f\left(\frac{K}{N}\right)$. The shape of this curve is concave, because the function has decreasing marginal returns to capital. Intuitively, this means that subsequent added units of capital yields smaller and smaller increases in $\frac{Y}{N}$ (holding N constant).

In this model, we assume that all savings are invested, thus the investment curve is given and denoted by $sf\left(\frac{K}{N}\right)$. Because this is simply a proportion, s, of the output function $f\left(\frac{K}{N}\right)$, it has the same shape (concave). Intuitively, this means that subsequent added units of capital yields smaller and smaller increases in investment (holding N constant).

b.

In the steady state, the capital stock remains unchanged. This will only be the case if investment equals depreciation. Thus, the condition for the steady state can be written as:

$$sf\left(\frac{K^*}{N^*}\right) = \frac{\delta K^*}{N^*}$$

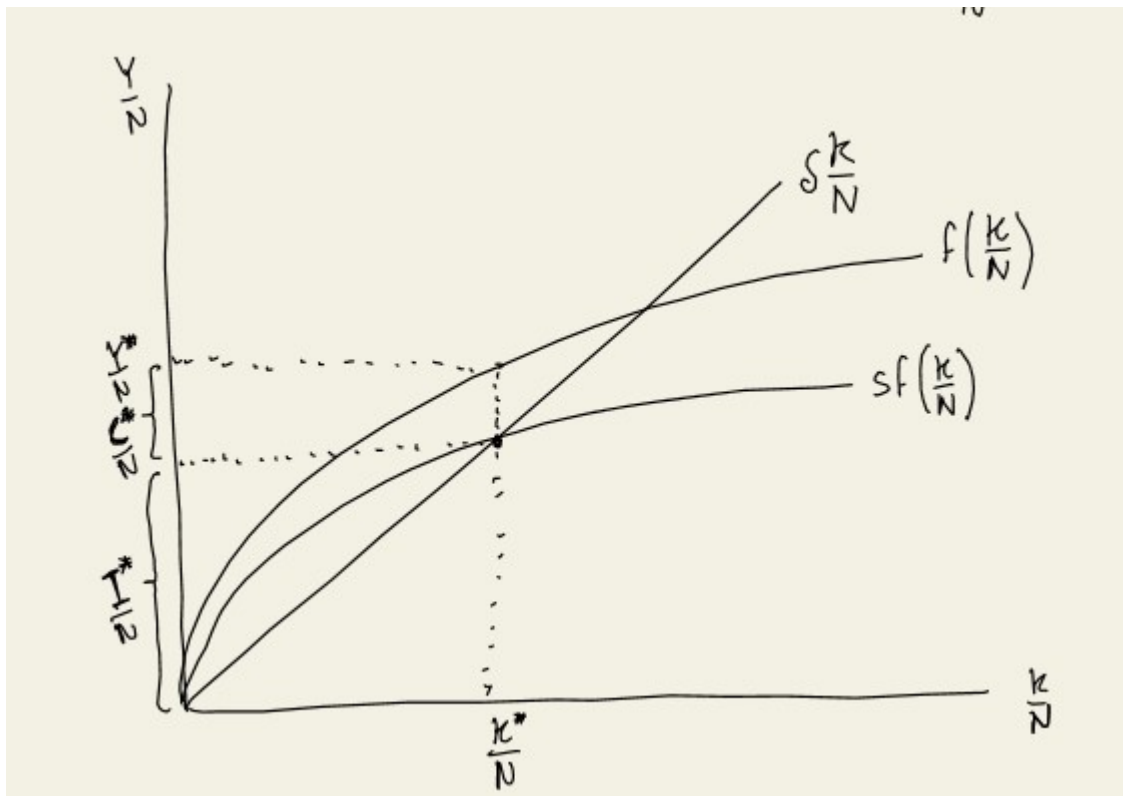
Solving for $\frac{K^*}{N}$:

$$sf\left(\frac{K}{N}\right) = \frac{\delta K}{N} \rightarrow s^* \left(\frac{K}{N}\right)^{\frac{1}{3}} = \frac{\delta K}{N} \rightarrow \frac{s^*}{\delta} \left(\frac{K}{N}\right)^{\frac{1}{3}} = \frac{K}{N} \rightarrow \frac{s^*}{\delta} = \left(\frac{K}{N}\right)^{\frac{2}{3}} \rightarrow \left(\frac{K}{N}\right)^{\frac{3}{2}} = \frac{s^*}{\delta} K$$

Substituting values for δ and s to get steady state capital per worker:

$$\frac{s^{\frac{3}{2}} K^*}{\delta} = \frac{0.2^{\frac{3}{2}} K^*}{0.05} \rightarrow (4)^2 = \frac{K^*}{N} \rightarrow \frac{K^*}{N} = 8$$

Visualization of the steady state:

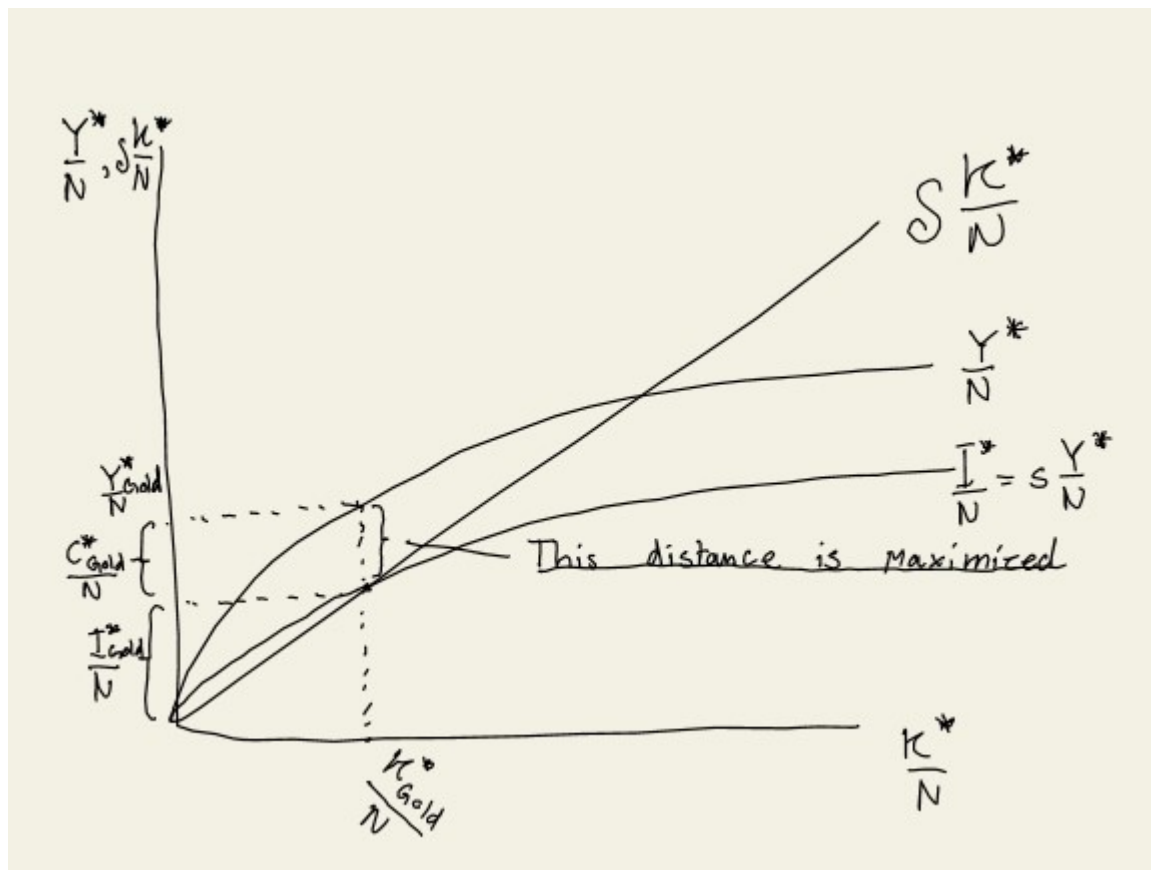


Steady state capital per worker is at the intersection between the investment curve and depreciation curve. Consumption per worker is given by the difference between output per worker and investment per worker.

c.

The Golden rule level of savings is the savings rate where consumption is maximized. This must be between 0 and 1, because. A savings rate of 0 would yield no capital and therefore no output at

the steady state. A savings rate of 1 would imply that all income is saved, and therefore not consumed.



This golden rate of savings will maximize the distance between the depreciation curve and the output curve, which is consumption per worker. This is what makes it desirable. d.

This can be derived from the steady state condition:

$$sf\left(\frac{K^*}{N}\right) = \delta \frac{K^*}{N}$$

Solving for s:

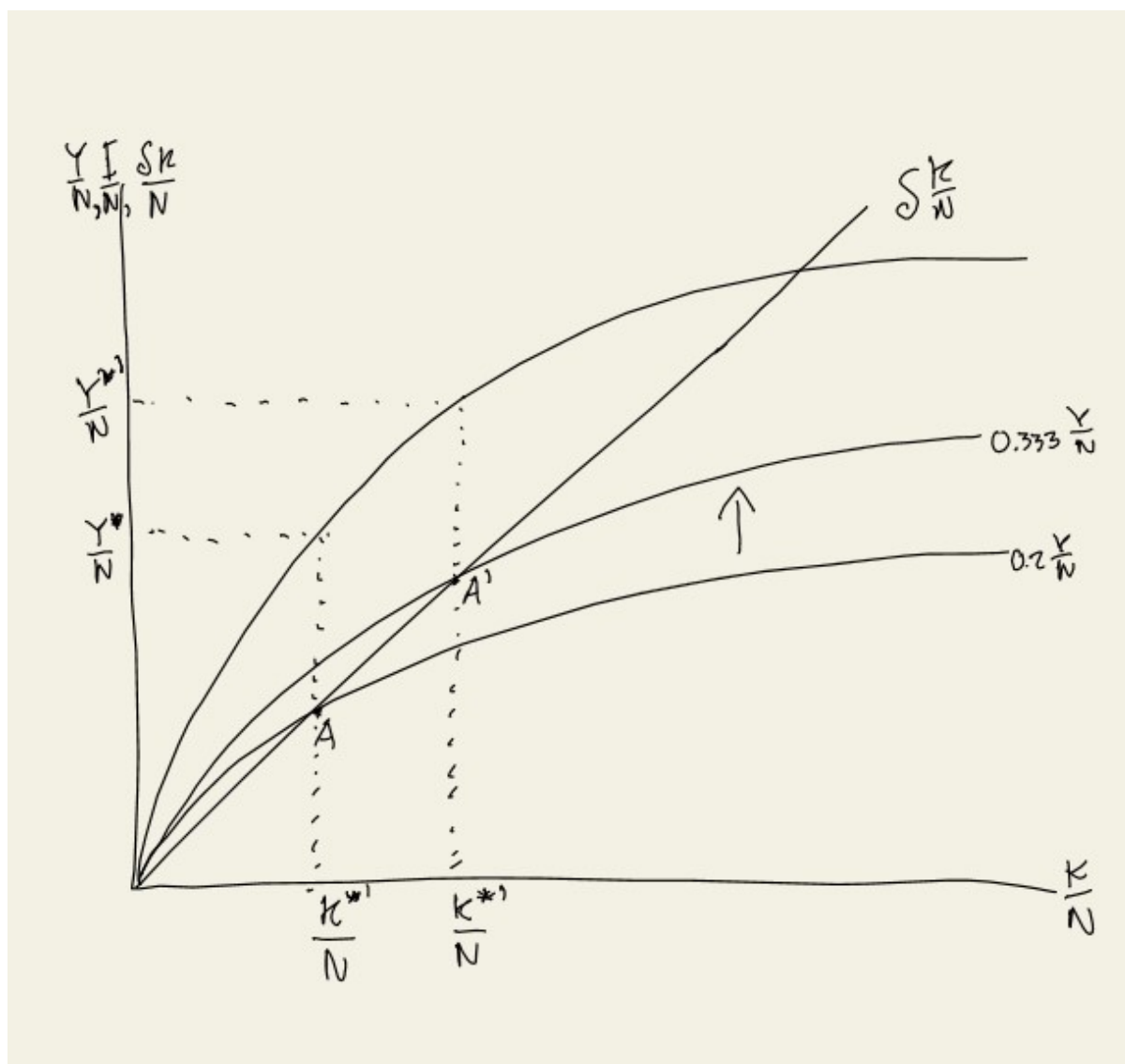
$$s = \delta \left(\frac{K^*}{N}\right)^{\frac{2}{3}}$$

Substituting concrete values:

$$s = 0.05(17.21)^{\frac{2}{3}} = 0.333$$

In order to golden rule level of capital per worker, they must impose a savings rate of 0.333 e.

Savings now constitute a larger fraction of the income per worker, which means that the curve pivots upwards. This leads to a new steady state in point A'



Because the savings rate is now higher, the savings curve pivots upwards. The economy can now replace a larger amount of capital per period, which means that it can offset a larger amount of depreciation and thereby sustain a larger capital stock. This means that output per worker will be higher in the steady state, as well output. Because it is the golden rule level of savings, we know that consumption is also higher (maximized).

f.

Initially, the economy will be growing, however at a decreasing rate, until it reaches the new steady state with a growth rate of 0.

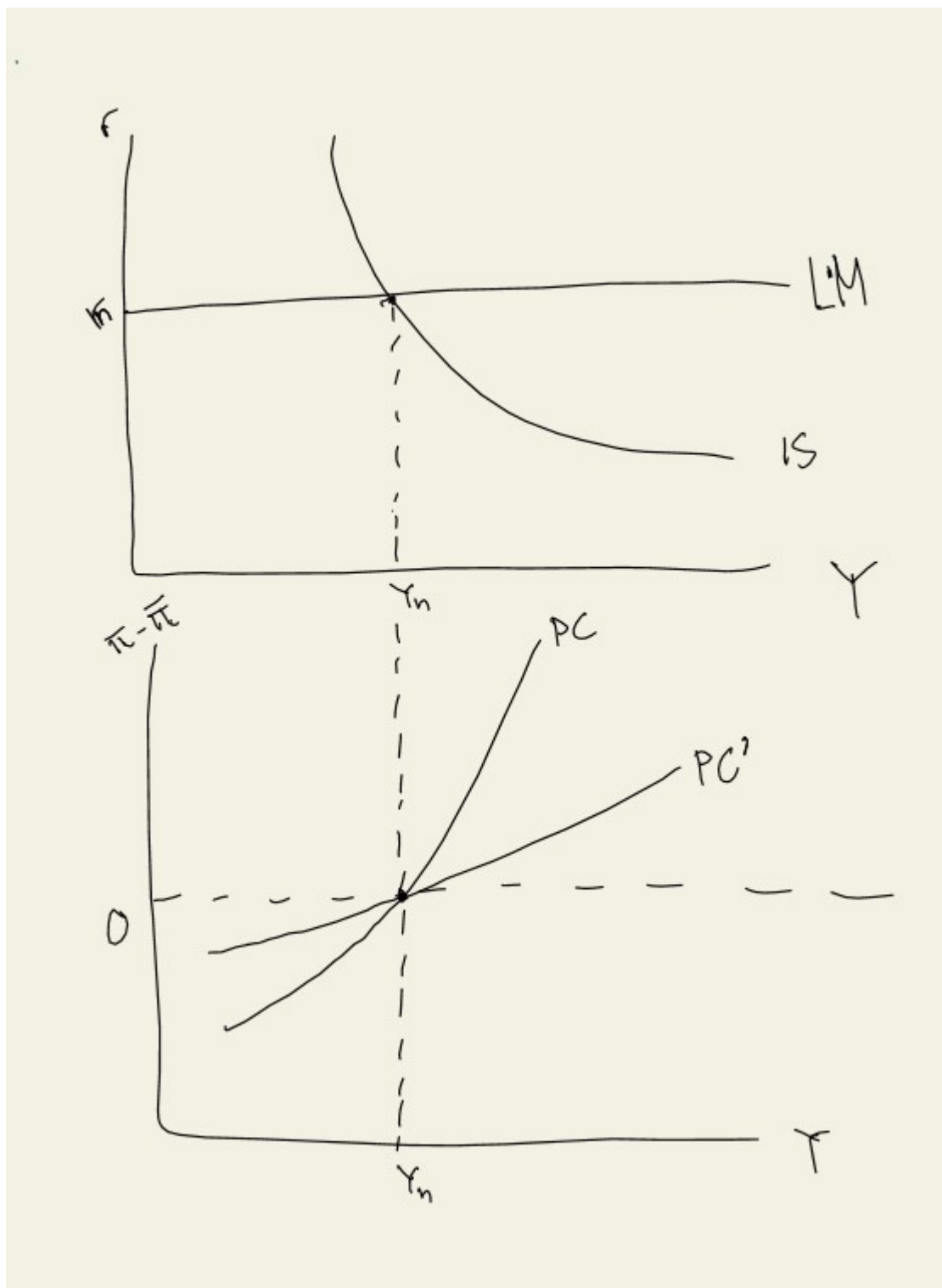
This happens because the investment given by the new investment curve exceeds the $\frac{\delta K}{N}$ depreciation of the existing capital stock ($s f(k) > \frac{\delta K}{N}$). This means that the capital stock will be

growing. The depreciation of capital per worker will be increasing at a constant rate, while investment per worker will increase at a decreasing rate. Thus, the gap between investment and depreciation becomes smaller and smaller until it reaches 0. Thus, the economy is not growing faster once the steady state is reached, but only on the way there.

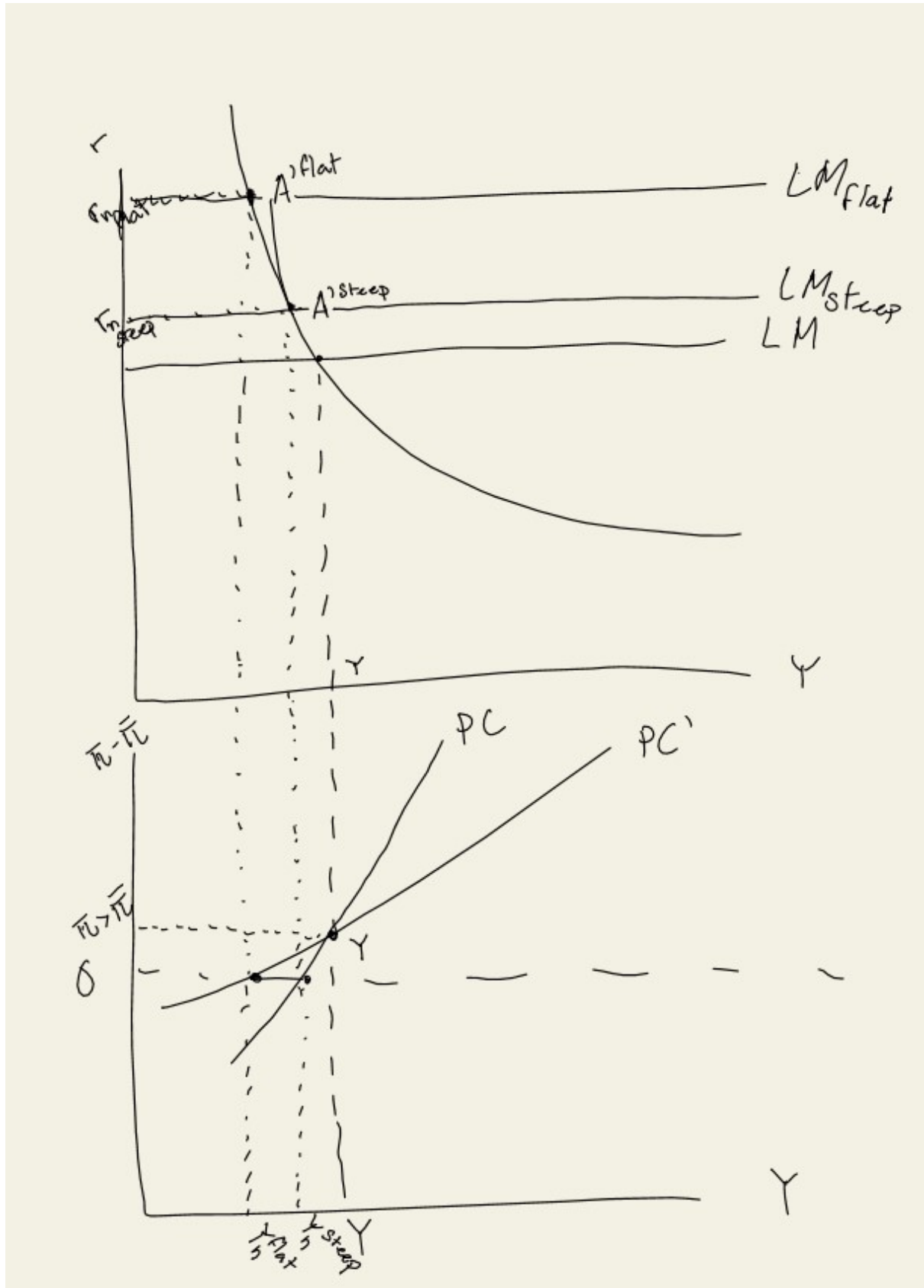
Generally speaking, it is not always desirable to increase the savings rate. In the extreme case of a savings rate of 1 or 100%, nothing is consumed, which undoubtedly would lead to quite low life satisfaction. People need to consume in order to be happy, and therefore consumption per worker is a reasonable proxy for life quality in this model. As discussed in questions c) and e), an increase in the savings rate from a point below the golden rule level would increase consumption per worker. However, if one is above the golden rule, this would decrease consumption per worker, because the difference between output and investment becomes smaller. Thus, increasing the savings rate is only desirable if it is initially below the golden rule level.

Open Question – The Philips Curve in the Euro Zone

The flattening of the Philips curve implies that the sensitivity of inflation to unemployment, and thereby output, has fallen. This can be captured as a decrease in α in the formula: $\pi - \bar{\pi} = \alpha$
 $-\lambda (Y - Y_n)$. Visualized in the IS-LM-PC model in equilibrium:



For a central bank that i) needs to assess the output gap, they run the risk x if they fail to notice this change. If the central bank does not recognize this change, it might think that their output gap is more significant than it really is, because they can only observe $\pi - \bar{\pi}$. If this happens, a central bank that ii) aims to stabilize inflation will adjust the interest rate by too small of a margin. Say for example that inflation is above target. The central bank fails to notice that α has changed, and thinks that the output gap is smaller than it really is. Therefore they increase the interest rate too little, and end with an output that is still above the natural level. Visualized in an IS-LM-PC diagram:



The central bank thinks that the natural level of output is Y_{nsteep} , but it is actually Y_{nflat} .

Therefore, they only increase the interest rate to LM_{steep} instead of LM_{flat} , where the natural interest rate is.

For the central bank to notice this change in the Philips curve, they need to compare two different levels of output. In the short run, looking at past years might not be very useful (because these are affected by several other factors). Therefore, they will have to observe $\pi - \bar{\pi}$ before and after a change in the interest rate. However, it might be too late for them to achieve the desired output after their first try at changing the interest rate. Therefore, they have to assess the magnitude in the change of α before they can observe it through inflation, which makes them rely on other sources such as labor market reports. This will, all else equal, make their predictions more challenging to make and less precise, resulting in worse monetary policy.