Exam name: Macroeconomics (BPOLO1290E)

**Final Exam 2021 – Macroeconomics (BPOLO1290E) - Home assignment (UC)**

Home assignment (UC)

BSc in International Business and Politics

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## Question 1

a)

Deriving the per-capita production function is done by dividing the production function by N:

$$f(K,N) = Y = K^{\frac{1}{4}}N^{\frac{3}{4}}$$

$$\frac{Y}{N} = \frac{K^{\frac{1}{4}}N^{\frac{3}{4}}}{N} \rightarrow \frac{Y}{N} = \frac{K^{\frac{1}{4}}N^{\frac{3}{4}}}{N^{\frac{1}{4}}N^{\frac{3}{4}}} \rightarrow \frac{Y}{N} = \left(\frac{K}{N}\right)^{\frac{1}{4}}$$

Thus, the per-capita production function is $\frac{Y}{N} = \left(\frac{K}{N}\right)^{\frac{1}{4}}$.

b)

Capital per worker in the steady state is found via the law of motion of capital, and since in the steady state, capital per worker is constant, the law of motion becomes:

$$\frac{K_{t+1}}{N} - \frac{K_t}{N} = sf\left(\frac{K_t}{N}\right) - \delta\frac{K_t}{N} \rightarrow 0 = sf\left(\frac{K_t}{N}\right) - \delta\frac{K_t}{N} \rightarrow sf\left(\frac{K^*}{N}\right) = \delta\frac{K^*}{N}$$

Which we then use to find the steady state capital per worker:

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

$$s * \left(\frac{K^*}{N}\right)^{\frac{1}{4}} = \delta \frac{K^*}{N}$$

$$s\left(\frac{K^*}{N}\right)^{\frac{1}{4}} * \frac{1}{\left(\frac{K^*}{N}\right)^{\frac{1}{4}}} = \delta \frac{K_t}{N} * \frac{1}{\left(\frac{K^*}{N}\right)^{\frac{1}{4}}}$$

$$s\left(\frac{K^*}{N}\right) * \frac{1}{\left(\frac{K^*}{N}\right)^{\frac{1}{4}}} = \delta \frac{K_t}{N} * \left(\frac{K^*}{N}\right)^{-\frac{1}{4}}$$

$$\frac{s}{\delta} = \left(\frac{K^*}{N}\right)^{\frac{3}{4}}$$

$$\left(\frac{s}{\delta}\right)^{\frac{4}{3}} = \frac{K^*}{N}$$

Inserting the numbers:

$$\frac{K^*}{N} = \left(\frac{0.3}{0.15}\right)^{\frac{4}{3}} = 2.52$$

Thus, the steady state level of capital per worker is **2.52**.

Capital stock will not evolve over time, if it is at this level - the steady state level - as the condition for the steady state level is that capital stock is constant.

Steady state value of output per worker:

$$\frac{Y^*}{N} = f\left(\frac{K^*}{N}\right) = \left(\frac{K^*}{N}\right)^{\frac{1}{4}} = \left(\left(\frac{s}{\delta}\right)^{\frac{4}{3}}\right)^{\frac{1}{4}} = \left(\frac{s}{\delta}\right)^{\frac{1}{3}} = \left(\frac{0.3}{0.15}\right)^{\frac{1}{3}} = 1.26$$

Thus, steady state value of output per worker is **1.26**.

Steady state value of consumption per worker:

$$\frac{C^*}{N} = \frac{Y^*}{N} - \delta\frac{K^*}{N} = 1.26 - (0.15 * 2.52) = 0.882$$

Thus, the steady state value of consumption per worker is **0.882**.

c)

Lower education can lead to lower output and lower economic growth because lower education means that technological progress is slowing down or not happening at all.

As the population, N, is growing by 2.7% a year (twice the pace of Asia), the output/GDP growth should also be growing in order for the economy to grow at the same pace as other parts of the world or grow at all (Y should also grow, in order for $\frac{Y}{N}$ to stay the same or increase). This GDP growth could come via technological progress, but if education is hit hard because of the pandemic, then this growth will not be there. Thus, the African lack of education can lead to lower output and also lower economic growth.

The effect on economic growth in the Solow model would be permanent, as a decrease in technological growth in the Solow model means changing the production function, which shifts both the output curve and the investment curve. This shifts the new steady state to a lower capital stock per worker and output per worker. d)

The new steady state level of output per capita, if the educational deficits affect the production function:

Firstly, I find the new per capita production function:

$$\frac{Y}{N} = \frac{0.8K^{\frac{1}{4}}N^{\frac{3}{4}}}{N} \Rightarrow \frac{Y}{N} = 0.8\frac{K^{\frac{1}{4}}N^{\frac{3}{4}}}{N^{\frac{1}{4}}N^{\frac{3}{4}}} \Rightarrow \frac{Y}{N} = 0.8\left(\frac{K}{N}\right)^{\frac{1}{4}}$$

Then, I find the new steady state capital per capita:

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

$$s * 0.8\left(\frac{K^*}{N}\right)^{\frac{1}{4}} = \delta\frac{K^*}{N}$$

$$s0.8\left(\frac{K^*}{N}\right)^{\frac{1}{4}} * \frac{1}{\ \ } = \delta\frac{K_t}{\ \ }\ 1$$

$$N \quad \left(\frac{K^*}{N}\right)^{\frac{1}{4}} \quad \frac{}{N} * \frac{}{\left(\frac{K^*}{N}\right)^{\frac{1}{4}}}$$

$$\frac{0.8s}{\delta} = \left(\frac{K^*}{N}\right)^{\frac{3}{4}}$$

$$\left(\frac{0.8s}{\delta}\right)^{\frac{4}{3}} = \frac{K^*}{N}$$

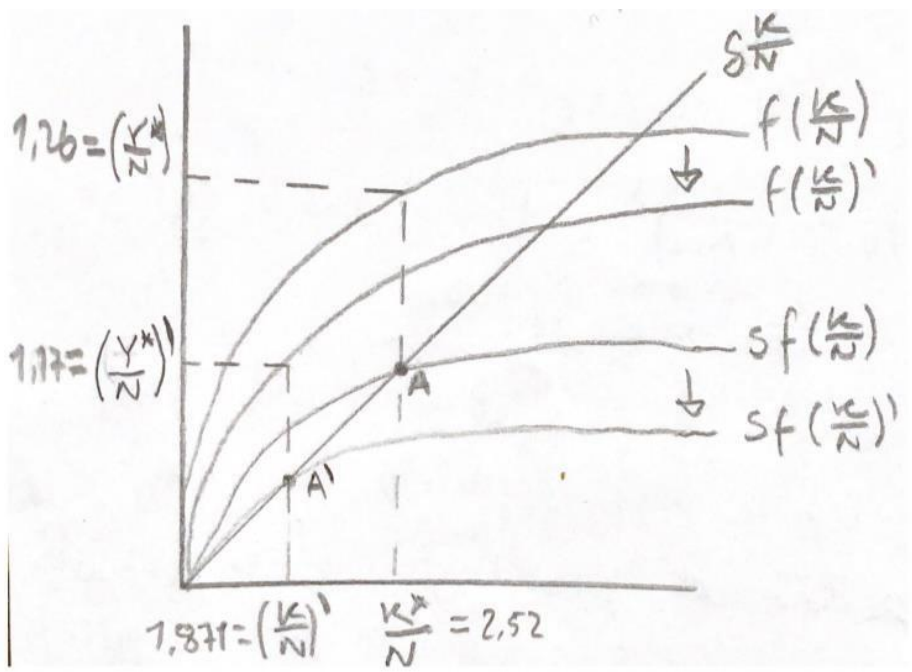
With the provided numbers: $\frac{K^*}{N} = \left(\frac{0.8*0.3}{0.15}\right)^{\frac{4}{3}} = 1.871$.

Then, I find the new state value of output per capita:

$$\frac{Y^*}{N} = f\left(\frac{K^*}{N}\right) = \left(\frac{K^*}{N}\right)^{\frac{1}{4}} = \left(\left(\frac{0.8s}{\delta}\right)^{\frac{4}{3}}\right)^{\frac{1}{4}} = \left(\frac{0.8s}{\delta}\right)^{\frac{1}{3}} = \left(\frac{0.8 * 0.3}{0.15}\right)^{\frac{1}{3}} = 1.17$$

Thus, the new steady state level of output per capita is **1.17**.

e)
Graphically showing the effect of lower education in the Solow model:




As said in c), the effect of lower education means changing the production function, as seen in d).

Graphically, this shifts down the output curve (from $f(\frac{K}{N})$ to $f(\frac{K}{N})'$) and it shifts down the investment curve ($sf(\frac{K}{N})$ to $sf(\frac{K}{N})'$), as they both depend on the production function.

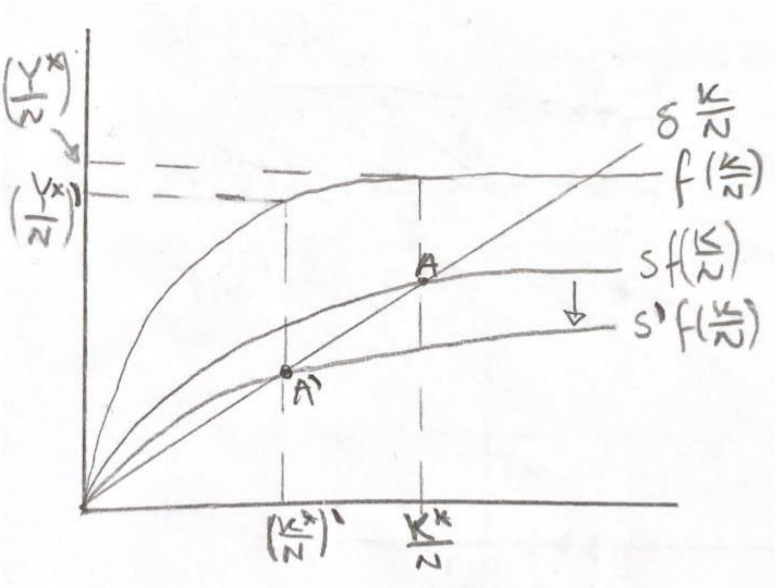
These shifts cause the steady state/long run equilibrium to shift from A to A', where both output per worker and capital per worker is lower.

f)

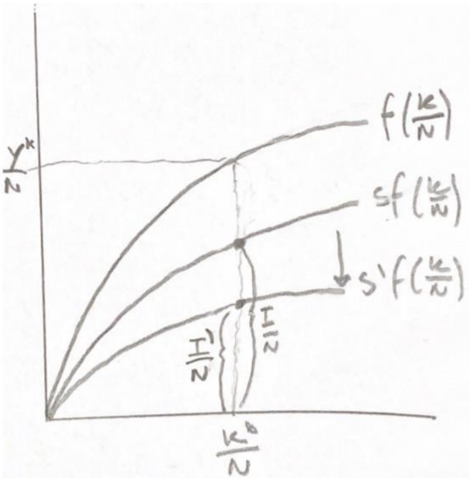
Lower government spending can have negative effects on economic growth and output because this results in lower investment.

To model this change in the Solow model, we would have to decrease the savings rate, as the amount people save is what gets invested. Thus, a decrease in investment must mean a decrease in the savings rate.

When moving from A to A' (see below), we would experience negative economic growth and the new steady state results in a negative effect on output, aka a lower output per worker in the steady state.



When drawing investment within the graph, we see that the change in the investment curve (the savings rate curve) causes investment to lower, and thus, a decrease in government spending would have to be modelled as a decrease in the savings rate, s:



Question 2 a)
QE became necessary after the Covid-19 shock, because when the economy is hit by a crisis like the pandemic, people worry about losing their jobs, and thus they spend less and save more. This causes less consumption, which hurts businesses, who thus have to lay off workers (continues like a spiral from here). And if interest rates are close to zero/zero/or below zero, there cannot be big cuts in the interest rates, which would cause consumption and investment to increase. Thus, unconventional monetary policy measures like QE is necessary to bring back the economy and to encourage borrowing money and spending.
When the central bank buys government bonds, corporate bonds and mortgages, etc, this pushes the price up, which affects the interest rates on loans, and thus these interest rates will go down and borrowing becomes easier, and thus consumption and investment increases. Likewise, commercial banks end up holding more deposit funds, which makes consumption possible.

Thereby, QE helps economic growth, creates inflation, keeps wages at the same level, and thereby also avoids increases in the unemployment rate. This was necessary after the Covid-19 shock.

b)
Lowering the risk premium: Lowering the risk premium means lowering the borrowing rate (r+x), which makes borrowing less expensive, which means that investment increases, since investment negatively depends on the risk premium: $I = b_0 + b_1 Y - b_2(r + x)$. When investment increases, this increases demand, and thereby output, as $Z = Y$. When output increases, consumption increases, as consumption positively depends on output: $C = c_0 + c_1(Y - T)$. Thus, demand increases again and thereby also output - this continues because of the multiplier until we reach a new equilibrium with a higher output level, thus stimulating the economy. This is expansionary fiscal policy.

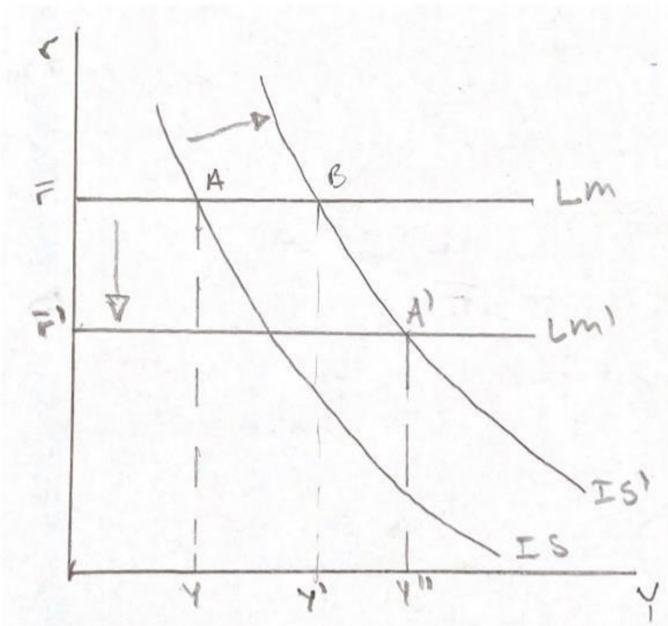
Increasing inflation: When the central bank is increasing the money supply, the money demand increases, and interest rates go down. This again encourages investment and consumption and like above this increases the demand and thereby output through the multiplier. We end up with an equilibrium with higher output and thus the economy is stimulated. This is expansionary monetary policy.

Conducting expansionary fiscal policy causes the IS curve to shift rightwards (shifting the equilibrium from A to B, IS to IS', and increasing output from Y to Y'). When conducting expansionary monetary policy at the same time, the LM curve shifts downwards (from LM to LM'), further increasing the output (from Y' to Y'').

It is important to consider the zero lower bound, because if the nominal interest rate is at the zero-lower bound, then the possible real interest rate is equal to the negative of inflation:$r = \bar{r} = i - \pi^e$. Thus, if i is 0 and inflation is negative, then the real interest rate can also only be positive, which may mean that the LM curve cannot shift downwards or that it maybe even have to shift upwards (which would decrease output).

c)
Deriving the IS curve means isolating Y on one side and only having the interest rate, r, as a variable on the right side (since we are looking at the extended IS-LM model):

$$Y = C + I + G$$



$$Y = 20 + 0.3 * (Y - T) + 0.2Y - 100(r + x) + G$$

$$Y = 20 + 0.3Y - 0.3T + 0.2Y - 100r - 100x + G$$

$$Y - 0.3Y - 0.2Y = 20 - 0.3T - 100r - 100x + G$$

$$0.5Y = 20 - 0.3 * 100 - 100r - 100 * 0.1 + 110$$

$$0.5Y = 90 - 100r$$

$$Y = 180 - 200r$$

Thus, the IS curve is $\boldsymbol{Y = 180 - 200r}$.

The LM curve in the extended IS-LM model is the real interest rate:

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

And since we know the economy is operating at the zero lower bound, then $i = 0$:

$$r = 0 - 0.01 = -0.01$$

Thus, the LM curve is $\boldsymbol{r = -0.01}$.

d)
Equilibrium output:

$$Y = 180 - 200r = 180 - 200 * (-0.01) = 182$$

Thus, equilibrium output is **182**.

Equilibrium consumption:

$$C = 20 + 0.3 * (Y - T) = 20 + 0.3(182 - 100) = 44.6$$

Thus, equilibrium consumption is **44.6**.

Equilibrium investment:

$$I = 0.2Y - 100(r + x) = 0.2 * 182 - 100(-0.01 + 0.1) = 27.4$$

Thus, equilibrium investment is **27.4**.

e)
If the expected inflation rate increases to 1.5%, then the real interest rate, r, changes to:

$$r = i - \pi^e = 0 - 0.015 = -0.015$$

If the risk premium decreases to 0.05, the IS curve becomes (equation taken from the calculations made in c)):

$$0.5Y = 20 - 0.3 * 100 - 100r - 100 * 0.05 + 110$$

$$0.5Y = 95 - 100r$$

$$Y = 190 - 200r$$

Thus, the effect on output, investment and consumption will be the following:

$$Y = 190 - 200r = 190 - 200 * (-0.015) = 193$$

Thus, the new equilibrium output is 193 and the effect of the changes in the risk premium and the expected inflation on output is an increase of **11**

$(193 - 182 = 11)$

Consumption:

$$C = 20 + 0.3 * (Y - T) = 20 + 0.3(193 - 100) = 47.9$$

Thus, the new equilibrium consumption is 47.9, and the effect of the changes in the risk premium and the expected inflation on consumption is thus an increase of **3.3**
$(47.9 - 44.6 = 3.3)$

Investment:

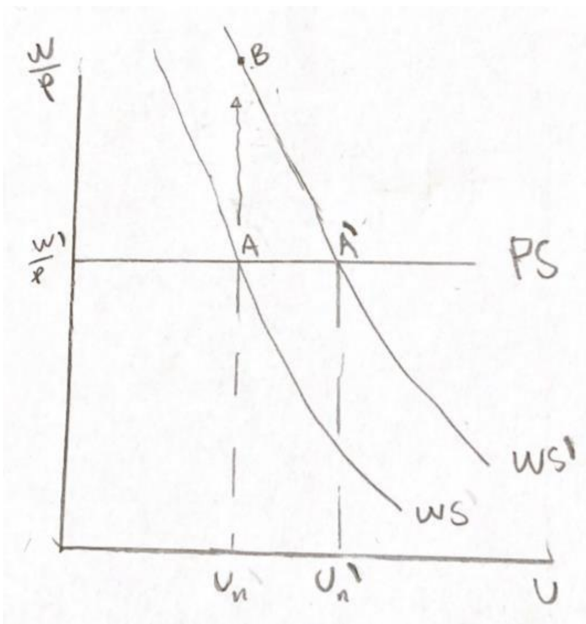
$$I = 0.2Y - 100(r + x) = 0.2 * 193 - 100(-0.015 + 0.05) = 35.1$$

Thus, the new equilibrium investment is 35.1, and the effect of the changes in the risk premium and the expected inflation on investment is thus an increase of **7.7**
$(35.1 - 27.4 = 7.7)$

## Question 3

a)

An increase in the minimum wage means that workers get more bargaining power (the catch all variable z increases, which shifts the WS curve to the right to WS', as the WS curve positively depends on z). This means that the nominal wages increase (W increases), which means that the real wage the workers are requesting are above the level, the employers want to pay (we move from A to B). Since the real wage the firms want to pay does not change (PS curve does not shift), some workers will not accept this lower real wage, and thus they would rather be unemployed than agreeing to this wage, and thus the natural rate of unemployment increases. This decreases the bargaining power of the workers and they accept this lower real wage, and thus the new equilibrium in the labour market represents the same real wage but higher natural rate of unemployment (we move from B to A').



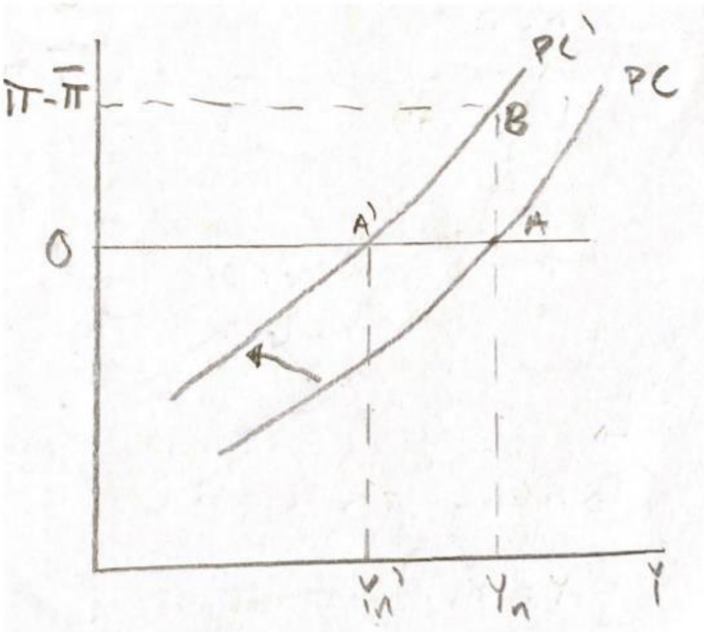

b)

The increase in the natural rate of unemployment causes a leftwards shift of the PC curve, because the Phillips curve positively depends on output, but negatively on unemployment. As $u_n' > u_n$ because of the increased minimum wage, then $Y_n' < Y_n$ meaning that the change in the natural level of output, $Y_n$, is negative: $\Delta Y_n < 0$, and that the change in output becomes: $\Delta(Y - Y_n) = 0 - \Delta Y_n = -\Delta Y_n$ and thus $\Delta(Y - Y_n) > 0$.

Inserting this in the Phillips Curve equation $\pi - \bar{\pi} = ({}^{\alpha}{}_{L})(Y - Y_n)$, for the PC relation to hold, the change in inflation also needs to be positive: $\Delta(\pi - \bar{\pi}) > 0$.

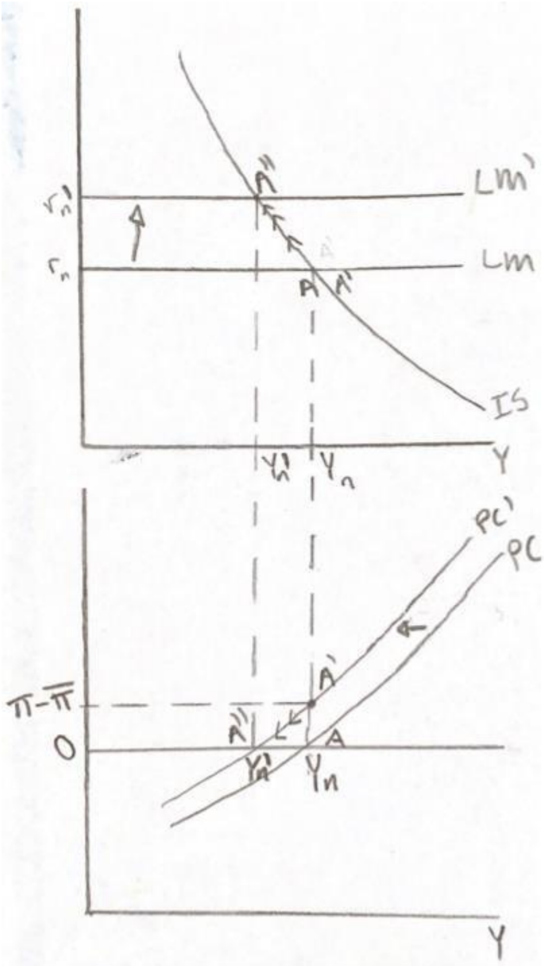
Thus, when the natural rate of unemployment increases, the natural level of output will decrease, which causes the PC curve to shift to the left (from PC to PC') and causes inflation to rise in the short run.

We shift the PC curve leftwards from PC to PC', and the short run equilibrium thus becomes B (moving from A to B as the minimum wage is increased), and the inflation increases above target level:




c)

The central bank will react to this change in inflationbecause they want to bring down the inflation to target level.
The central bank reacts this way, because the main job of the central bank today is to maintain the inflation rate at target level (often 2%). They do this by decreasing/increasing the policy rate via monetary policy.
The central bank's monetary policy in this case, where minimum wage increases, will thus be an increase in the interest rate in order to discourage investment and thereby decrease demand and output, which brings output and inflation down to their new natural level and rate, and thus the central bank causes the economy to reach a medium run equilibrium, where $Y_t = Y_n$ and $u_t = u_n$ and $\pi_t = \bar{\pi}$.
The increase in the interest rate causes the LM curve to shift upwards (from LM to LM') and the medium run equilibrium becomes A''.
In the medium run, $Y_n$ will thus decrease, since $u_n$ is higher, meaning we move along the new PC curve and along the IS curve to point A''




In the short run, neither the IS or LM curve shifts, which is why A and A' is the same point on the graph.

d)
This statement is true, as we consider the short run as the demand side, and the medium as the supply side. As stated in c), neihter the IS or LM curve shift in the short run, and thus the increase in minimum wage does not have any direct effects on the demand for goods.
As we increase the minimum wage, we see a shift in the PC curve and thereby also in the LM curve in the medium run, which is the supply side.
This also makes sense, when we think of the medium run as the labour market reactions, and thus an increase in the minimum wage will have direct effects on the labor market and thus also on the supply of goods.

## Essay Question 1

This question relates to the IS-LM-PC model, the idea of the natural level of output, and the medium run equilibrium, where output is determined by the natural rate of unemployment ($Y_n = L(1 - u_n)$ determined in the labour market.
The output gap is the difference between the natural and actual output: $Y_t - Y_n$ and only exists in the short run, where output can differ from the natural level of output (compared to the medium run, where $Y_t = Y_n$).

The main difference between these two statements/opinions is the view of the pandemic as a short run or medium run crisis. Thus, if one argues that the natural level of output has stayed the same, but the output gap has risen, one sees the Covid-19 shock as a short run effect on the economy, where demand is affected (a leftwards shift of the IS curve met by a downwards shift in the LM curve, thus keeping the natural level of output the same: changes in the goods market but not in the labour market). Since the pandemic up until now "only" have existed for around a year, then this view can be argued to be correct, as the medium run is said to be a couple of years.

In contrast to this view, one might also argue that since the pandemic crisis has affected the natural rate of unemployment, like the discussion in question 2.a) on why QE is necessary because unemployment would increase during the pandemic. Thus, it is possible to argue that the Covid-19 shock has increased the natural rate of unemployment, which decreases the natural level of output (a medium run change).

## Essay Question 2

During recessions, governments should run deficits in order to stimulate the economy, and this makes debt. Governments use expansionary fiscal policy, when running deficits.

The circumstance that determines future generations transfer wealth to current generations depend on, when the government decides to pay back their debt. If the government decides to pay back its debt, as soon as the Covid-19 crisis is over, then the tax increase will be smaller (because of the interest rates on the debt), and the wealth that is needed to pay back this debt will come from the generations living now instead of the future generations. If the government repays their increased debt caused by the Covid-19 crisis in the first boom period possible, the future generations will not have to pay. However, if this is not the case, future generations will be the ones to pay.

Another relevant circumstance is how the increased government spending is used today. If investment is targeted at education, digitalisation, and environmental protection (important factors for future generations and their working and life conditions), then the future generations will be in a good position to pay back this debt and not be significantly affected by the increased taxes. This is because if firms are kept going via these increased deficits, then unemployment might be kept low both during and after the Covid-19 shock. However, if this is not the case, then the future generations will be in a bad position to repay this debt and they would have to transfer wealth to current generations.