FINAL EXAM
14.02 Principles of Macroeconomics
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PART I: *True, False, Uncertain. (40 points)*

Please answer all eight questions. Your score will be based on the quality of your brief explanation in supporting your answers.

1. According to the LM relation, the demand for bonds depends negatively on nominal income.

   True: $B^d = \$W - M^d = \$W - \$Y*L(i)$. *Since an increase in income will lead to higher money demand, keeping the wealth fixed, then bond demand will be lower. Thus, according to our simple LM relation, the demand for bond depends negatively on nominal income.*

2. The fact that the European unemployment rate is much higher than the US unemployment rate indicates a breakdown of the Phillips curve.

   False: The original Phillips curve broke down because inflation expectations were not accounted for. Current levels of unemployment usually are different from the natural rate of unemployment, which does not need to be equal across countries. Natural rates of unemployment are different in Europe from that in the US because of, among other factors, labor market rigidity.

   Note: If what you had in mind was the augmented Phillips curve you must make a consistent argument. There might be a breakdown if unemployment rate is below the natural rate and inflation is not accelerating, or in the case when unemployment rate is above the natural rate and inflation is not decelerating.

3. Asian countries are considering the introduction of unemployment benefit programs. This is likely to result in a higher rate of natural unemployment.

   True: Higher unemployment benefits will increase workers' reservation wage. Thus, for any present level of unemployment rate, workers will demand higher wages. As a result, the WS curve shifts up, leading to a higher natural rate of unemployment.

4. Currency devaluations are completely useless since they cannot affect the level of output or its composition in the long run.

   False: Though it is true that devaluations are neutral in the long run, i.e. it cannot affect the level of output, nor its composition in the long run, it is still useful tool in the short run. For example, if the currency is overvalued and the economy is in

recession, currency devaluation may be used to stimulate the export, thus accelerating the adjustment process out of recession. Devalutions also can be used in combination with fiscal policy to correct trade imbalance without affecting the level of output.

5. Monetary policy is most effective under fixed exchange regime.

   False: Country with a fixed exchange rate regime does not have an independent monetary policy since the central bank will always have to keep its domestic interest rate to the world interest rate level.

6. The traditional Phillips curve implies that the natural rate of unemployment in the US is 7%.

   False: The traditional Phillips curve implies that there is no natural rate of unemployment. The government can simply choose any combination of unemployment and inflation rate along the downward sloping Phillips curve without affecting the rate of growth of inflation. For the period since 1970's up until couple of years ago, most economists agreed that the U.S. natural rate of unemployment was around 6%. However, the recent combination of historically low unemployment rate without any sign of accelerating inflation in the U.S. economy has caused some to revise downward the natural rate, and to some extent, question the validity of the natural rate concept altogether.

7. A new policy by the government to force people to save for retirement will certainly increase the country's economic growth rate forever.

   False: An increase in the saving rate cannot affect the long run rate of growth of the economy; it will only increase the growth rate only during the transition period. Decreasing returns to capital will eventually reduce the rate of growth until the new steady state is achieved. However, it will produce a higher output per capita in the new long run equilibrium.

8. An announcement of a deficit-reduction plan will produce a recession this period for sure.

   Uncertain/ False: There are number of issues here. First, if the plan is implemented either by lowering G, increasing T, or combination of both, it will lower output and interest rate in this period. (you can think of this as a result of downward shift of the IS curve.) However, looking in the future period, both consumers and firms will anticipate lower expected future interest rate, and thus this might dampen the contractionary effect in this period. Moreover, if the Fed views the plan as credible, thus willing to soften the output loss in this period, it may accommodate the government by adopting a relatively loose monetary policy. This will further help reduce potential of output loss due to fiscal contraction. Therefore, the net effect on

output of the deficit reduction plan will depend on a number of factors as described here.

You may add additional assumptions about the package, but still you should explain clearly what the effects of the announcement itself are.

PART II: *AS/AD Model and the Exchange Rate (30 points)*

Scenario 1: Devaluation in a standard AS/AD model

Let the aggregate demand schedule be given by:

$$Y_t = Y\left(\frac{\overline{E}P^*}{P}, G, T\right),$$

where $\overline{E}$ is the nominal exchange rate, under a fixed exchange rate regime, P is the domestic price level, P^e is the expected domestic price level, and P^* is the foreign price level. Assume that the aggregate supply is

$$P_t = P_t^e(1+\mu)F\left(1-\frac{Y_t}{L}, z\right),$$

where

$$P_t^e = P_{t-1}$$

Suppose that starting from an initial equilibrium at the natural level of output, a country devalues its currency.

1. **(3 points)** Draw an AS/AD diagram illustrating the short run impact of this policy.

Short run impact of the policy: assuming that Marshall Lerner condition holds (and this is what we have been doing so far, so why would you assume otherwise in the final exam?) a devaluation will improve the current account. Then if net exports increase, the AD curve will shift to the right, increasing the equilibrium level of output.

2. **(3 points)** In the short run, what happens to the real exchange rate, net exports, and output?

In the short run the real exchange rate will go up. Even though prices increase when the AD curve shifts to the right, the increase in the nominal exchange rate is higher and the net effect on the real exchange rate is positive. Net exports and output will also increase.

3. **(3 points)** After all the adjustments have taken place, indicate the long run equilibrium of the economy in your diagram.

In the short run output increases above its natural level. This will cause prices to go up and then the expected price increases. If the expected price is higher than before then the AS curve will shift upwards. In the end (long run) the equilibrium is at the intersection of the new AS with the AD, at the same level of output as the original but at a higher price level.

4. **(4 points)** In the long run, what happens to the real exchange rate, net exports, and output (compared to the initial equilibrium)?

In the long run, everything goes back to the original levels. Output goes down to its natural level and both exchange rate and net exports go back to the value where they started.

5. **(4 points)** Suppose that a country's initial equilibrium level of output is higher than the natural level. Suggest two possible policy alternatives to bring the output level back to its natural level. What happens to net exports in each case?

There are different options here: (i) do nothing; the economy will move back to the natural level of output and a higher price level. This happens through a shift of AS upwards. At the new equilibrium the price level is higher, which means that the real exchange rate is lower, so net exports are lower. (ii) revalue the currency. A revaluation will reduce net exports and then reduce the equilibrium level of output. (iii) contractionary fiscal policy. Reducing government spending or increasing taxes will shift AD to the left, thus reducing output until it gets back to its natural level. In doing so, the price level is lower which means that the real exchange rate is higher, which means that net exports are higher. Note that monetary policy cannot be applied in this setting because the (nominal) exchange rate is fixed.

Scenario 2: Consumer price index and nominal exchange rate

Assume now that the aggregate supply schedule is the same as that in scenario 1:

$$P_t = P_t^e (1+\mu) F\left(1 - \frac{Y_t}{L}, z\right),$$

but now the expected price is given by

$$P_t^e = \frac{1}{2} P_{t-1} + \frac{1}{2} \overline{E} P_{t-1}^*$$

1. **(3 Points)** How could you justify the new equation for P_t^e?

In this case the expected price depends on both past domestic and past foreign price levels. The rationale behind this is quite simple: when individuals consume not only domestic but foreign goods, it makes sense that they base their expectations not only on what the price of domestic goods is but also on the price of imports, which in this case is the foreign price times the exchange rate.

2. **(4 points)** Draw an AS/AD diagram illustrating the short run impact of a devaluation.

As opposed to scenario 1, question 1, a devaluation now will affect both the AS and AD curves. The AD will move as before, upwards. But this time AS will move upwards too, even in the short run. This is because a devaluation will increase the nominal exchange rate, which will change the expected price.

Note that in this part we did not give much partial credit, because part of the question involved reproducing the setting of part 1 in scenario 1.

3. **(3points)** What is the long run effect of a nominal devaluation on output?

The long run effect of a nominal devaluation is the same in this scenario as in the previous one, i.e. none. All the variables return to their original levels.

4. **(3 points)** Is the exchange rate neutral in this case?

The exchange rate is neutral in this case (as it was in the previous one). This means that an increase in the nominal exchange rate is matched by an increase in the price level, so the exchange rate does not have an effect on real variables.

PART 3: *Growth (30 points)*

In this problem we are going to study the effects of growth in a closed economy. Assume that the aggregate production function is given by:

$$Y = \sqrt{K}\sqrt{NA},$$

where Y is aggregate output, K is capital, N is the number of workers in the economy and A is the state of technology. You can think of NA as the amount of *effective labor* in the economy. If the state of technology doubles, it is as if the economy had twice as many workers. Further assume that capital depreciates at a rate δ, the rate of technological progress is g_A, the population is growing at rate g_N (and so does the number of workers, N), and the saving rate is s.

(a) **(4 points)** Does the aggregate production function satisfy constant returns to scale? Explain.

Yes. Doubling both inputs (capital and effective labor) simultaneously doubles output.

$$2Y = \sqrt{2K}\sqrt{2NA} = 2\sqrt{K}\sqrt{NA},$$

or more generally, $\lambda Y = \sqrt{\lambda K}\sqrt{\lambda NA} = \lambda\sqrt{K}\sqrt{NA}$

(b) (**4 points)** Suppose you were to quadruple capital, keeping effective labor constant. What would be the effect on output? What does this imply about returns to capital?

Output would only double, which implies that our production function exhibits decreasing returns to capital.

$$2Y = \sqrt{4K}\sqrt{NA} = 2\sqrt{K}\sqrt{NA}$$

(c) **(4 points)** Rewrite the production function, so that you have output *per effective worker* on the left-hand side. What is actual investment *per effective worker* in this economy?

$$\frac{Y}{NA} = \frac{\sqrt{K}\sqrt{NA}}{NA} = \sqrt{\frac{K}{NA}}$$

Since economy is closed, actual investment, $I_a = S = sY$.

Actual investment per effective worker is therefore, $\frac{I_a}{NA} = s\sqrt{\frac{K}{NA}}$.

(d) **(4 points)** What is the level of investment *per effective worker* needed to maintain a constant level of capital per effective worker?

Desired investment per effective worker is investment needed to maintain a constant level of capital per effective worker, i.e., the amount necessary to offset the effects of capital depreciation and growth.

$$\frac{I_d}{NA} = (\delta + g_A + g_N)\frac{K}{NA}$$

You can also get this result by looking at capital accumulation:

$$\frac{K_{t+1}}{NA} - \frac{K_t}{NA} = s\sqrt{\frac{K_t}{NA}} - (\delta + g_A + g_N)\frac{K_t}{NA}$$

In the steady state the level of capital per effective worker is not changing. Therefore, LHS is equal to zero, and actual investment per effective worker is equal to the desired investment per effective worker.

(e) **(5 points)** Solve for the steady state levels of capital *per effective worker* and output *per effective worker*. What is the growth rate of capital *per effective worker* and output *per effective worker* in the steady state?

In the steady state,

$$\frac{K_{t+1}}{NA} - \frac{K_t}{NA} = 0 = s\sqrt{\frac{K_t}{NA}} - (\delta + g_A + g_N)\frac{K_t}{NA}$$

Therefore,

$$s\sqrt{\frac{K_t}{NA}} = (\delta + g_A + g_N)\frac{K_t}{NA}$$

Square both sides to get:

$$s^2\frac{K}{NA} = (\delta + g_A + g_N)^2\left(\frac{K}{NA}\right)^2$$

$$\left(\frac{K}{NA}\right)^{ss} = \frac{s^2}{(\delta + g_A + g_N)^2}$$

$$\left(\frac{Y}{NA}\right)^{ss} = \frac{s}{\delta + g_A + g_N}$$

In the steady state, both capital and output per effective worker are constant, and therefore, their growth rates are equal to zero.

Consider two countries described by the model above: Country *X* is a developing country with a very high population growth rate and a very low rate of technological progress. Country *Z* is a developed country with a very low population growth rate and a very high rate of technological progress. To make life even simpler, let's assume that $g_N^X = g_A^Z = \beta > 0$ and $g_A^X = g_N^Z = 0$. Also assume that the savings rates are the same in both countries.

(f) **(3 points)** What is the steady state growth rate of output in Country *X*? What is the steady state growth rate of output *per worker* in Country *X*?

In the steady state, $\frac{Y}{NA}$ *is not changing. NA grows at the rate* $g_N^X = \beta$. *Therefore, Y must be growing at the rate* $g_N^X = \beta$ *as well. Output per worker is constant and thus has a zero growth rate.*

(g) **(3 points)** What is the steady state growth rate of output in Country *Z*? What is the steady state growth rate of output *per worker* in Country *Z*?

In the steady state, $\frac{Y}{NA}$ *is not changing. NA grows at the rate* $g_A^Z = \beta$. *Therefore, Y grows at the rate* $g_A^Z = \beta$ *as well, and so does* $\frac{Y}{N}$.

(h) **(3 points)** If two countries initially have the same output per worker, which country will end up having a higher standard of living?

Country Z will have a higher standard of living, as measured by output per worker. This is because output per worker is not growing in the steady state in Country X, while it is growing at a positive rate in country Z. The intuition is that all growth in output in X comes from population growth, and therefore, per capita quantities don't change. In Z, population size is unchanged, so there is more output for everybody due to technological progress.

PART IV: *Japan Revisited (Long Question)*

In the first quiz we used our understanding of a closed economy to examine the current situation in Japan. Since then, the Japanese government has passed a fiscal stimulus package. In this question, we will use all the tools we have developed in 14.02 to re-examine the situation.

Instructions:
The question has three sections. Each part is designed so that most of it can be completed independently of the other two. Once an assumption has been stated it remains true for the remainder of that section.

* Do NOT use a calculator.
* SHOW ALL YOUR WORK, including each algebraic step.
* NO CREDIT will be given to correct answers that have not been explicitly developed.

Section 1: *Goods Market*

Consider the following model of the goods market:

$$C = 300 + \frac{5}{20}Y$$

$$I = 60 + \frac{6}{20}Y - 500i$$

and assume that the interest rate is fixed,

$i=1\%$.

(1.a) (2 points) Solve for the goods market equilibrium level of output as a function of government spending, G. *(Algebraic hint: express your answer in terms of the fraction* $\frac{9}{20}$ *without simplifying any further.)*

Answer: Y=C+I+G => Y = $\frac{20}{9}$(355+G)

(1.b) (1 point) (From this point on all the answers are in terms of integers.) Suppose that $G=50$. What is the equilibrium level of output?

Answer: Plug in to find: Y = **900**

(1.c) (2 points) The Japanese government views the equilibrium level of output as too low and wants to increase it to **Y=1000**. What is the required increase in government spending?

Answer: From 1a: Y = $\frac{20}{9}$(355+G) => 1000 = $\frac{20}{9}$(355+G) =>

G=90 => ΔG=45

Section 2: *Goods & Financial Markets*

Consider the following model of the goods market:

$$C = 300 + \frac{5}{20}Y$$

$$I = 60 + \frac{6}{20}Y - 500i$$

and assume that the financial market equilibrium is given by:

$$M - P = -80 + .1Y - 1000i$$

(No, this is not a typo. The real money stock is written as (**M - P**) rather than $\frac{M}{P}$ for simplicity.)

(2.a) (4 points) Solve for the IS curve by expressing the equilibrium level of output as a function of government spending, **G**, and the interest rate **i**. *(Algebraic hint: express your answer in terms of the fraction* $\frac{9}{20}$ *without simplifying any further.)*

Answer: Y=C+I+G => $Y = \frac{20}{9}(360 - 500i + G)$

(2.b) (4 points) *(From this point on all the answers are in terms of integers.)* Solve for the aggregate demand relationship between output, government spending, the level of the money stock, and the level of prices.

Answer: From 2a: $Y = \frac{20}{9}(360 - 500i + G)$ **(IS)**

given: M - P = -80 + .1Y - 1000i (LM)

solve for i from the LM and substitute into the IS:
Y = 800 + 2G + M - P (AD)

Grading Note: If contrary to the instructions, you used (M/P) rather than (M-P) then you only lost one point for the whole section and none for the next one. HOWEVER, the answers were much more involved and you lost further points if you did not solve the model with (M/P) correctly.

(2.c) (4 points) *IS-LM* Assume that prices are fixed, **P=100**, that **M=100**, and that **G=50**. Solve for the equilibrium level of output and the interest rate. What can you tell about the potential usefulness of expansionary monetary policy?

Answer: From the AD relationship in 2b, plug in to find: **Y = 900.**
Then, plug in to the LM relation to find i=1% --> The interest rate is already so low that monetary policy is not likely to be of much use.

(2.d) (4 points) The Japanese government is unhappy with the equilibrium level of output and wants to increase it to **Y=1000** using *monetary policy*. What is the required change in the level of the money stock **M**? Why is such a policy is unfeasible? *(Hint: look at the LM curve.)*

Answer: From the AD relationship in 2b, plug in to find Δ**M = 100.** Its unfeasible because it requires a *negative nominal* interest rate, **i=-8%**, which you can find by plugging into the LM relation.

Grading Note: you CANNOT plug Y=1000 into the IS curve and assume that the interest rate is 1% as you found in 2c. This is exactly the point of the IS-LM model: you determine both the interest rate and the level of output.

(2.e) (4 points) The Japanese government is unhappy with the equilibrium level of output and wants to increase it to **Y=1000** using *fiscal policy*. What is the required change in the level of government spending **G**?

Answer: From the AD relationship in 2b, plug in to find Δ**G = 50.**

Grading Note: you CANNOT plug Y=1000 into the IS curve and assume that the interest rate is 1% as you found in 2c. This is exactly the point of the IS-LM model: you determine both the interest rate and the level of output.

(2.f) (4 points) *(This is the only question in this part that requires having solved Part 1.)* Compare your answer to (2.e) with your answer to (1.c) and explain.

Answer: When the interest rate is fixed as in Section 1, a smaller increase in government spending (45 vs. 50) is required for the same increase in output. The reason is that in the IS-LM model where the interest rate is determined within the model, the increase in the

demand for goods leads to an increase in money demand, too. In equilibrium, the interest rate has to increase somewhat to maintain money demand equal to the fixed money supply. This lowers investment and thus a higher increase in government spending is required in order to achieve the same increase in output.

Section 3: *Flexible Prices*

(General hint: although you are asked to provide mostly algebraic answers, you may find that it helps to think in terms of the graphs we have used in class before you solve the questions. However, you do not have to show any graphs.)

Consider the following model of aggregate demand and aggregate supply:

$$Y = 800 + 2G + M - P$$

$$P = P^e - 1000 + Y$$

Also, let the financial market equilibrium be given by:

$$M - P = -80 + .1Y - 1000i$$

(3.a) (3 points) What is the natural level of output?

Answer: By definition the natural level is when $P=P^e$, so $Y = 1000$.

(3.b) (3 points) Suppose that $P^e=200$. Solve for equilibrium output as a function of G and M only.

Answer: Plug $P^e=200$ in to the AS curve: $P = P^e - 1000 + Y$ and solve for P.
Then take the expression for P and plug into the
AD curve: $Y = 800 + 2G + M - P$ to get
$Y = 800 + G + 0.5M$

(3.c) (3 points) Suppose also that $G=50$ and that $M=100$. Solve for equilibrium output, prices, and the interest rate.

Answer: Plug into the expression from 3b to get $Y=900$.
Then use the AS relation to get $P=100$,
and the LM relation to get $i=1\%$.

(3.d) (3 points) Explain in three short sentences (or less) the evolution of the economy if the government does nothing. You may assume that expected prices are last period's prices. Make sure to address the following questions: Which curve shifts and why? When

does the process end and what is the end result on output and prices? *(Only the first three sentences will be graded.)*

Answer: The aggregate supply curve will start shifting down because prices are below expected prices. Output increases and the price level decreases until the natural level of output has been reached.

(3.e) (3 points) In one or two short sentences explain why the government may choose to use policy rather than let the economy evolve by itself.

Answer: Because the above process takes a long time and in the mean time the economy is in a recession (output is below its natural level).

Grading note: Some of you noted (without being asked) that the AD relationship implied that if there was no policy change the natural level of output is associated with P=0 and negative interest rate. While this maybe true algebraically, negative nominal interest rates are not possible, and the economy would never get below i=0 (this is admittedly a sick case... who told you to go solve for P and i in this case???). So that avoiding the situation of P=0 and negative interest rate is not a valid explanation about why the government would want to use policy, since it would never happen.

(3.f) (3 points) The government has decided to use fiscal policy to return output to its natural level. What is the exact change in government spending required, and what are the equilibrium levels of output, prices and the interest rate?

Answer: The natural level is **Y=1000**.Use your answer in 3b to find that Δ**G=100.**
Since we are at the natural level, you should be able to tell without looking at any equations that $P=P^e=200$. The LM relation then implies that i=12%.

(3.g) (3 points) *(This is the only question in this part that requires having solved Part 2.)* Compare your answer to (3.f) with your answer to (2.e) and explain.

Answer: When prices are flexible, a larger increase in government spending (100 vs. 50) is required for the same increase in output. The reason is that prices are allowed to increase and the price increase has a negative effect on demand. This is because an increase in prices leads to a lower real money stock, which shifts the LM curve in.