

Directions:

- The homework will be collected in a box **before** the large lecture.
- Please place your name, TA name, and section number on the top of the homework (legibly). Make sure you write your name as it appears on your ID so that you can receive the correct grade.
- Late homework will not be accepted so make plans ahead of time. **Please show your work.** Good luck!

Please realize that you are essentially creating “your brand” when you submit this homework. Do you want your homework to convey that you are competent, careful, professional? Or, do you want to convey the image that you are careless, sloppy, and less than professional. For the rest of your life you will be creating your brand: please think about what you are saying about yourself when you do any work for someone else!

1) Aggregate Consumption and Expenditure – The Keynesian Cross

The following table gives some information regarding GDP, Consumption (C), Taxes (T), Transfers (TR), and Investment (I) in the autarkic (no imports or exports) nation of Haagland.

Year	GDP or Y	C	T	TR	G	I
2014	\$350	\$200	\$100	\$50	\$75	\$200
2015	\$450	\$250	\$100	\$50	\$75	\$200

a) Given the above information, assuming that autonomous consumption and the marginal propensity to consume are constant, find an equation for consumption as a function of disposable income (Disposable Income = $Y_d = Y - (T - TR)$).

The fact that autonomous consumption and MPC are constant tells us that the consumption function is linear; thus, we need only identify two points that lie on the consumption function line to solve for the line.

For 2014, we have $Y_d = 350 - 100 + 50 = 300$, and $C = 200$. For 2015, $Y_d = 450 - 100 + 50 = 400$, and $C = 250$. Using these two points and standard algebra, we can find the equation for consumption as a function of disposable income:

$$C = 50 + (1/2)Y_d$$

b) Now, write the equation for consumption as a function of total income (GDP or Y).

To write consumption as a function of total income, we must pull out the tax and transfer term from Y_d as follows:

$$C = 50 + (1/2)Y_d = 50 + (1/2)*(Y-100+50) = 50 - 25 + (1/2)Y$$

$$\text{Thus, } C = 25 + (1/2)Y$$

c) Finally write the private savings functions: first, as a function of disposable income, and then as a function of total income.

First, to get private savings as a function of disposable income, we need only switch the sign on autonomous consumption and replace the slope (MPC) with the MPS = (1-MPC):

$$S = -50 + (1/2)Y_d$$

To get savings as a function of total income, we need to pull out the tax and transfer terms as we did in the previous part:

$$S = -50 + (1/2)*(Y-100+50)$$

$$S = -75 + (1/2)Y$$

d) Give the equation for Aggregate Expenditure (that is, find $AE = C + I + G$). What is the equilibrium level of GDP in this economy? Given this information, what was the change in inventories in 2014?

Using the result from part (b) we have

$$AE = C + I + G = 25 + (1/2)Y + I + G$$

Now plugging in the values for I and G from the table we have:

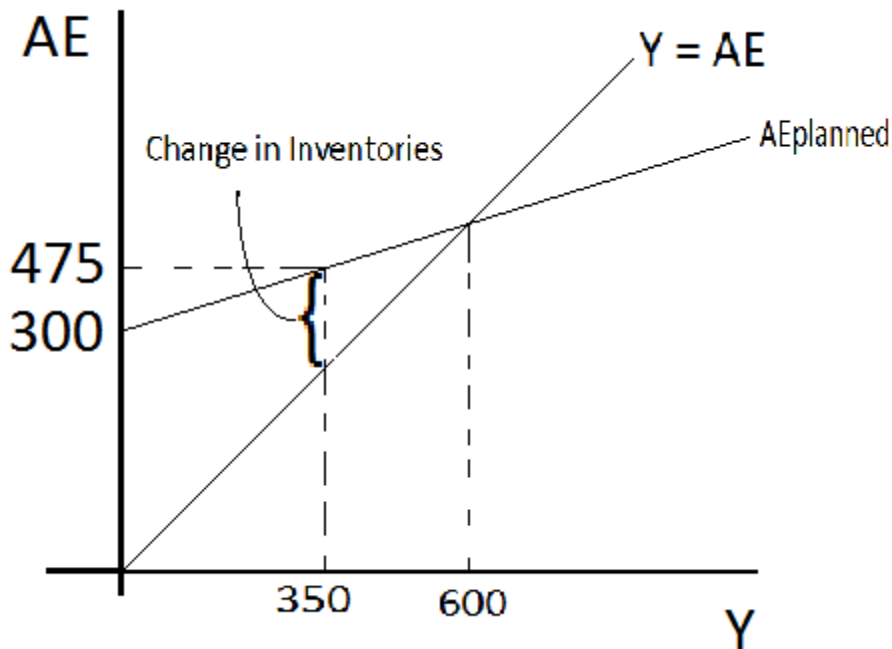
$$AE = 300 + (1/2)Y$$

The equilibrium level of output is where $AE_{\text{planned}} = Y$ (so there is no accumulation or draw down on inventories). Thus, we solve:

$$Y = 300 + (1/2)Y$$

And with some algebra, we find $Y^* = \$600$.

The difference between planned aggregate expenditure and actual production must be due to a change in inventories. In both years, planned aggregate expenditure was less than the equilibrium level of production. This implies the planned aggregate expenditure must have been above output at the level of production, thus producers must have been drawing down their inventories to meet demand. To determine how much inventories were drawn down, we must determine the difference between the AE curve and the 45° line (the $Y = AE$ curve) as shown below.



To solve for this algebraically, we use the following method inspired by the above diagram

$$AE = Y + \text{inventory}$$

$$200 + 75 + 200 = 350 + \text{inventory}$$

Solving through, we find that \$125 worth of inventory was sold in 2014 to make up for the difference between AE and output.

e) Suppose now that you are an economist working for the government of Haagland. In 2016, the government wants to balance its budget. The two options are to either (1) reduce the amount of transfers to 25, or (2) reduce government spending to \$50. All else being equal and assuming that aggregate expenditure is in equilibrium, which policy would you recommend as having the higher resulting GDP (according to the standard Keynesian analysis)? Plot the change in the aggregate expenditure curve for both. Assume that investment spending does not change.

To determine which policy has a smaller downward effect on equilibrium output, it suffices to see which policy results in a smaller vertical shift of the aggregate expenditure curve.

Recall from the previous part that before the policy change we have:

$$AE = 300 + (1/2)Y$$

After the policy lowering the level of transfers we have:

$$AE = 50 + (1/2)*(Y-100+25) + 75 + 200 = 325 - (1/2)*(75) + (1/2)Y$$

$$AE = 287.5 + (1/2)Y$$

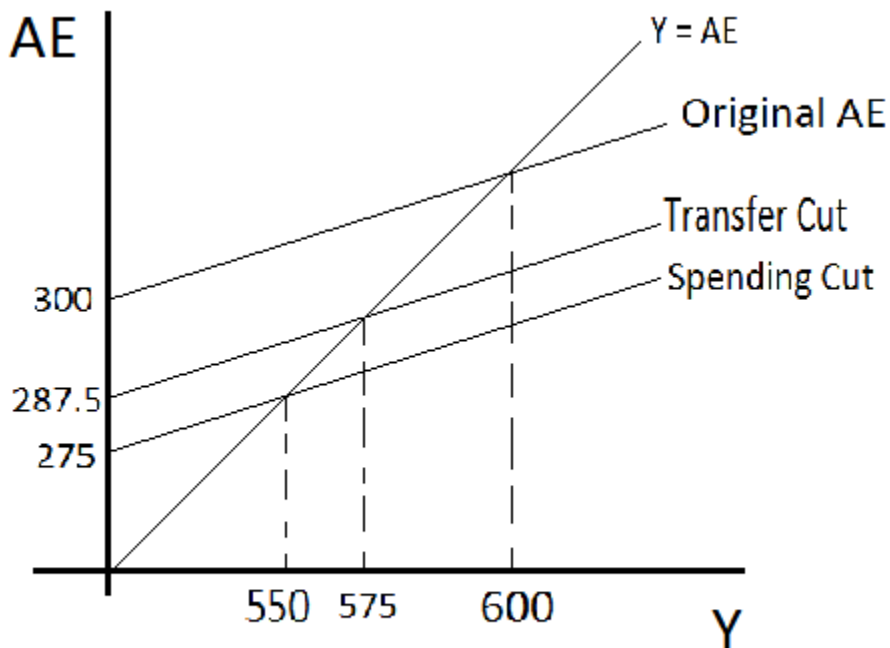
But, if we reduce government spending we get an AE curve as follows:

$$AE = 25 + (1/2)Y + 50 + 200$$

$$AE = 275 + (1/2)Y$$

Notice the spending reduction had a bigger negative shift on the AE curve than the transfer cut, thus the transfer cut will have a smaller negative effect on GDP than the spending cut, and thus would be the policy recommendation implied by this model.

To follow this fully through, solving for the equilibrium output level after both policies you should find $Y^* = \$575$ for the transfer cut, and $Y^* = \$550$ for the spending cut.



f) The solution to part (e) depends on the difference between the government spending multiplier and the tax multiplier. Using your computations from the previous part what is the government spending multiplier and the tax/transfer multiplier? Why are they different? (Hint: think of how each dollar of additional spending flows through the economy and write out the first few terms of the sum). What does this imply about the government's ability to stimulate the economy while running a balanced budget according to the Keynesian model?

Using the result from the previous part, we have that a \$25 reduction in spending resulted in a \$50 reduction in GDP thus the government spending multiplier must be 2.

On the other hand, a \$25 reduction in transfers resulted in a \$25 fall in output, so the tax/transfer multiplier must be 1.

To see the intuition for why the tax/transfer multiplier is less than the spending multiplier, consider how \$1 of government spending flows through the economy vs \$1 paid as a transfer.

The \$1 of government spending counts immediately towards GDP, while a part of the \$1 transfer payment is saved by the recipient of the transfer payment. Thus, the government spending multiplier will always be 1 more than the tax/transfer multiplier in the simple Keynesian model developed in class.

Thus, according to the model, the government would be able to stimulate the economy through spending even if it runs a balanced budget because every dollar of spending increases GDP by more than the dollar paid in taxes reduces the level of spending.

g) *Challenge question:* Page 347 of your textbook gives one way to derive an expression for the multiplier as a function of the MPC. Let's consider another way to derive it using the story you learned in lecture.

Consider how one additional dollar flows through the economy: the dollar is spent by the first person (the government suppose) contributing one dollar to GDP; that dollar is income for another individual who spends $1 \cdot \text{MPC}$ of it; that $1 \cdot \text{MPC}$ dollars now becomes income for a third person who spends $(1 \cdot \text{MPC}) \cdot \text{MPC} = \text{MPC}^2$ of it.

Repeat this process to express the total change in GDP as a sum of terms involving the MPC. To what does this sum converge? (Hint: look up "geometric series.")

Using the story given above we can write the contribution of \$1 of additional spending to GDP (let's call this "J") as an infinite sum as follows:

$$J = 1 + \text{MPC} + \text{MPC}^2 + \text{MPC}^3 + \text{MPC}^4 + \dots$$

Using the hint, you would have seen that this is what is known as a geometric series which converges to $1/(1-\text{MPC})$ provided MPC is less than 1.

A simple way to see this without appealing to any calculus would be as follows:

Assuming the sum is finite, we have

$$J = 1 + \text{MPC} + \text{MPC}^2 + \dots$$

$$J - 1 = \text{MPC} + \text{MPC}^2 + \dots$$

$$(J / \text{MPC}) - (1/\text{MPC}) = 1 + \text{MPC}^2 + \dots \text{ (Which is our original sum)}$$

$$J \cdot (1/\text{MPC}) - (1/\text{MPC}) = J$$

$$J \cdot ((1/\text{MPC}) - 1) = (1/\text{MPC})$$

$$J = \{(1/\text{MPC}) / [(1/\text{MPC}) - 1]\}$$

$$J = (1/\text{MPC}) / [(1 - \text{MPC})/\text{MPC}]$$

$$J = (1/\text{MPC}) [\text{MPC} / (1 - \text{MPC})]$$

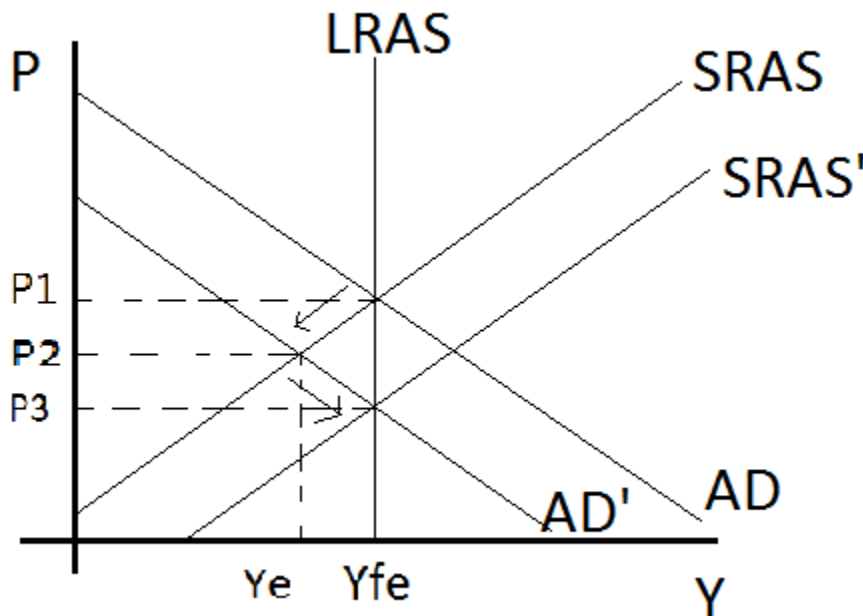
$$J = 1/(1-\text{MPC})$$

2) Aggregate Supply and Demand

Plot each of the following scenarios on a qualitative graph with aggregate demand, short-run aggregate supply, and long-run aggregate supply. Measure the aggregate price level (P) on the vertical axis in your graphs and measure real GDP (Y) on the horizontal axis in your graphs. Then describe the way in which the economy will return to the long-run equilibrium if there is no fiscal or monetary policy intervention and include this long run adjustment in the same graph. Describe verbally what happens to output and prices in the short run and then the long run. For each scenario, assume that the economy starts in long run equilibrium, then moves to a short run equilibrium before returning to a long run equilibrium.

a) A stock market panic results in many bank closures causing many people to lose their savings.

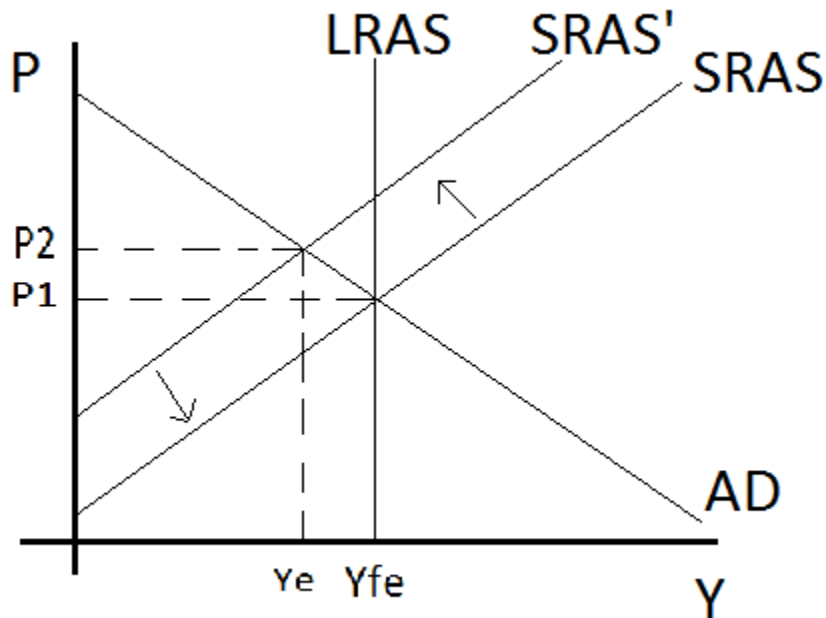
The sharp reduction in household wealth would cause a leftward shift in the AD curve resulting in the short run level of real GDP being lower than the full employment level of real GDP. In the short run, both real GDP and the aggregate price level will fall from their initial levels (Y_{fe} falls to Y_e and P_1 falls to P_2). In the long run nominal wages will decrease due to the high unemployment rates ($Y_e < Y_{fe}$). As these wages fall the SRAS curve will shift to the right from SRAS to SRAS' returning this economy in the long run to Y_{fe} but with a lower aggregate price level (P_3) than the initial aggregate price level (P_1).



b) Oil prices unexpectedly increase sharply and this causes an increase in production costs for many producers in the economy.

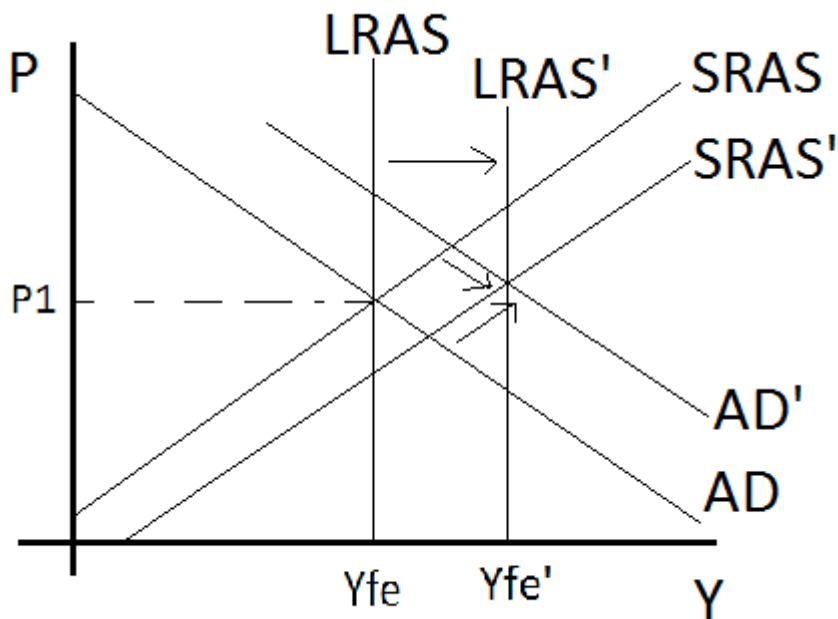
The increase in costs results in producers being willing to produce less at a given price level, thus the SRAS supply curve shifts to the left from SRAS to SRAS'. In the short run this results in output decreasing from Y_{fe} to Y_e while the aggregate price level rises from P_1 to P_2 . This is an

example of stagflation: a stagnant economy with rising prices. In the long run nominal wages will fall due to the conditions in the labor market (higher levels of unemployment than the natural rate of unemployment since $Y_e < Y_{fe}$). This will cause the SRAS' to shift back to the right returning this economy to its initial Y_{fe} and P_1 .



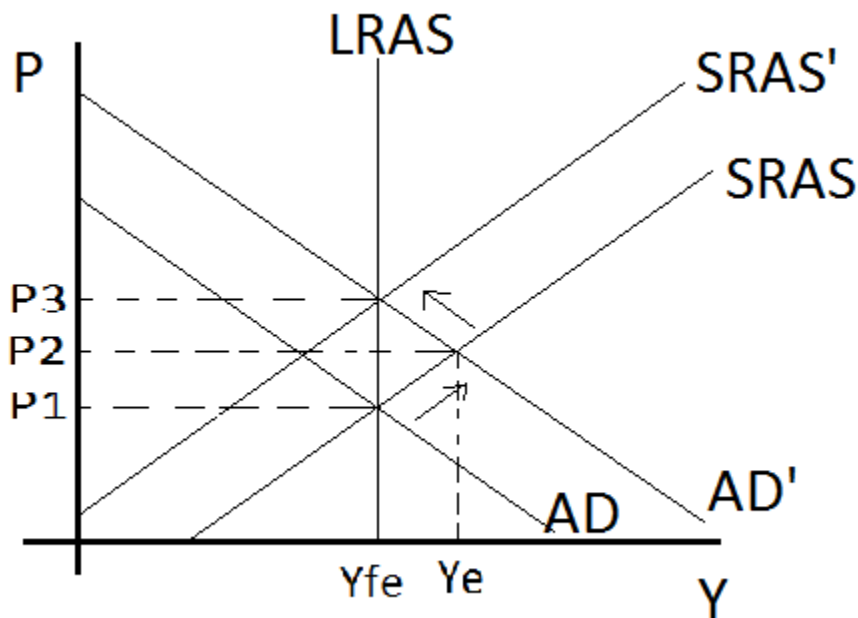
c) A new computer technology improves the productive capacity of the economy.

The new technology shifts the long-run AS curve out. In the short run, the equilibrium will remain at the old, lower, long-run output level (Y_{fe} and not the new Y_{fe}'). In the long run, the SRAS curve will shift out (from SRAS to SRAS') due to the reduction in production costs that firms experience due to this increase in productive capacity by firms, while the AD curve will shift out (from AD to AD') as increased worker productivity results in higher wages. Eventually, output reaches the new, higher long-run level. The effect of the aggregate price level is ambiguous depending on which (the AD or SRAS curve) shifts relatively more.



d) The government announces a higher than expected increase in GDP for last year, resulting in increased consumer confidence.

In the short run increased consumer confidence would likely lead to a rightward shift of the AD curve (from AD to AD') resulting in higher output (Y_{fe} to Y_{fe}') and an increase in the aggregate price level (from P_1 to P_2). In the long-run, as nominal wages adjust upward to the higher aggregate price level, the SRAS curve shifts left (from SRAS to SRAS'), returning output to the long-run level (Y_{fe}) and leading to a further increase in the aggregate price level (from P_2 to P_3).



3) More Aggregate Supply and Demand

For most of this problem you are not *required* to graph anything, but it is strongly advisable in order to inform your algebra.

Suppose the small autarkic nation of Guam has the following equations describing certain aggregate economic quantities:

$$C = 300 - P + (1/4)Y$$

$$I = 200 - 20r$$

$$G = 50$$

$$M_d = 1000 - 100r$$

$$M_s = 500$$

$$\text{SRAS: } Y = P - 100$$

Where C is consumption, P is the aggregate price level (scale = 100), Y is GDP, I is investment, r is the interest rate (in percent), G is government spending, M_d is money demand, M_s is supply, and SRAS is the short run aggregate supply curve.

a) Solve for the money market equilibrium. Using this interest rate, solve for the equilibrium level of investment.

Setting money supply equal to money demand in the usual fashion we have:

$$1000 - 100r = 500$$

$$r^* = 5$$

Plugging r^* into the investment equation, we have that the equilibrium level of investment is \$100.

b) What is the equation for aggregate expenditure as a function of P and Y? Find the equilibrium level of output as a function of prices (i.e. the aggregate demand equation).

Using the result from the part (a) and our knowledge of aggregate expenditure, we have:

$$AE = C + I + G + NX \quad (NX = \text{net exports} = (X - IM) = 0 \text{ because of autarky})$$

$$AE = 300 - P + (1/4)Y + 100 + 50$$

$$AE = 450 - P + (1/4)Y$$

Now solving for the equilibrium output by setting $AE = Y$ we have

$$Y = 450 - P + (1/4)Y$$

$$(3/4)Y = 450 - P$$

$$Y = 600 - (4/3)P$$

This is our AD curve.

c) Using your solution from part (b), solve for the equilibrium level of output (Y^*) and aggregate price level (P^*). Assume that the current equilibrium output is also the long run output.

Setting $AD = SRAS$ we have

$$600 - (4/3)P^* = P^* - 100$$

And solving for P^* we find $P^* = 300$, resulting in $Y^* = \$200$. Thus, long-run aggregate supply is also \$200.

d) Suppose now a major typhoon sinks a large oil tanker resulting in higher costs for producers leading the SRAS curve to shift to the left by 70 units of output at all prices. Solve for the new equilibrium output ($Y^{*'}$) and aggregate price level ($P^{*'}$).

Given this horizontal leftward shift of 70, the new SRAS curve is $Y^{*'} = P^{*'} - 170$. Setting this equal to AD we have

$$P^{*'} - 170 = 600 - (4/3)P^{*'}$$

Giving us $P^{*'} = 330$ and $Y^{*'} = \$160$.

e) To speed recovery from this typhoon, the government decides to increase spending. By how much must the government increase spending to return the economy to the long run full employment output you found in (c)? Be careful here: you need an increase that is greater than our simple Keynesian model would predict given that the aggregate supply curve is upward sloping. Before you do your calculations you might want to draw a sketch of the problem. What effect will the disaster and following government policy have on the price level?

Given the inward shift of the SRAS curve, we want some increase in government spending that results in a level of output equal to the long-run value of \$200. By plugging this into our SRAS curve, we know that we need the price level to be 370 to achieve this level of production. Let d be the increase in the constant term of aggregate demand. We wish to solve for

$$600 + d - (4/3)P = Y \quad \text{where } P = 370 \text{ and } Y = 200$$

$$600 + d - (4/3)(370) = 200$$

$$d = (4/3) \cdot 370 - 400 = (280/3) \approx \$93.33$$

Now, we wish to find the change in government spending that will result in a \$93.33 change in the constant term of the AD curve. For this, we must examine our original AE curve. Let g be the change in government spending.

$$AE = 450 + g - P + (1/4)Y$$

Solving for $AE = Y$, we have

$$Y = (4/3)*(450 + g) - (4/3)P$$

Where $(4/3)*g = 93.33$. This gives us $g = \$70$, as required.

f) Now, return to the scenario of part (d). Suppose the citizens of Guam oppose the original government spending recovery policy proposal. As a substitute policy, the Central Bank of Guam decides to conduct open market operations to manipulate the interest rate. In order to return the economy to its long run output, should the Central Bank buy or sell assets, and how much? What will be the resulting interest rate and price level? (You may need a calculator for parts of this problem.)

The Central Bank's goal is to return output to \$200. To do this, it must incentivize an increase in investment (of \$70 as we found in the previous part), which it can accomplish by *lowering* the interest rate. To lower the interest rate, the Central Bank must *increase* the money supply, which means it must *buy* assets with open market operations.

From the previous part, we know we need investment to increase by \$70, so the total investment after the money supply change must be \$170.

$$\text{Thus } 200 - 20r = 170$$

Which implies $r^* = 3/2$

So now we need to find the increase in the money supply (call it m) that will result in an interest rate of 1.5%.

Returning to our money market we have

$$1000 - 100r = 500 + m \text{ where } r = 3/2$$

$$m = 500 - 150 = \$350$$

This change in the money supply will give exactly the same result in the AD-AS diagram as the previous part.

4) The Central Bank and the Money Multiplier

The small country of Emamade has a Central Bank, which manages the money supply, and a single depository institution, the Emamade Credit Union. Alice and Bob are the only two residents of Emamade and both use the Emamade Credit Union for their deposits. The initial T-Accounts for each of these institutions are given below:

<u>Central Bank of Emamade</u>			
Assets		Liabilities	
T-Bills	\$200,000	Reserves	\$200,000

<u>Emamade Credit Union</u>			
Assets		Liabilities	
Reserves	\$200,000	Alice's Deposits	\$500,000
T-Bills and other earning assets	\$800,000	Bob's Deposits	\$500,000

All transactions in Emamade occur through checks so there is no currency ever in circulation. Additionally, the Credit Union never holds excess or insufficient reserves.

a) Given the information above, what is the monetary base (the monetary base is defined as the amount of reserves held by banks in this example) in this economy? What is the money supply, M2, where M2 consists of all currency in circulation plus demand deposits? Given this, what is the money multiplier for this economy?

The monetary base is the total amount of currency (which is all held as reserves by the Credit Union), so $MB = \$200,000$. The (M2) money supply is total deposits plus currency in circulation (equal to zero in this economy), thus $M2 = \$1,000,000$.

The money multiplier is the ratio of M2 to MB so $MM = 1,000,000/200,000 = 5$. Equivalently, the money multiplier is equal to $(1/\text{required reserve ratio})$; since there are no excess reserves we can see that the required reserve ratio is 20% and that implies that the money multiplier is equal to $1/.2 = 5$.

b) Given the information above, what is the Credit Union's reserve requirement?

Given that the Credit Union holds exactly its reserve requirement, we have that the reserve requirement must be 20% since the Credit Union has \$1,000,000 in deposits and keeps \$200,000 of it in reserve.

c) Suppose that Alice decides to purchase a car from Bob's car dealership for \$50,000 (using a check). Write the new T-account for the Credit Union given this change. How does this change affect the Credit Unions assets? Does it now hold insufficient or excess reserves?

This change simply lowers Alice's deposits to \$450,000 and increases Bob's to \$550,000. There is no change on the liabilities side, so the Credit Union still holds precisely its reserve requirement.

<u>Emamade Credit Union</u>			
Assets		Liabilities	
Reserves	\$200,000	Alice's Deposits	\$500,000 \$450,000
T-Bills and other earning assets	\$800,000	Bob's Deposits	\$500,000 \$550,000

d) Return to the original scenario (before Alice purchased her car in part (c)). The Credit Union of Emamade is an especially responsible depository institution, and its depositors have a great deal of faith in its solvency. In light of this, the Central Bank decides to cut the Credit Union's reserve requirement in half. Write the new T-account for the Credit Union assuming that Alice and Bob both benefit equally from the new loans the Credit Union provides. What is the new level of the money supply (M2)? What is the new money multiplier?

Because the reserve requirement is now only 10%, the Credit Union can create more money in the form of loans increasing the deposits of Alice and Bob. Since the monetary base has not been changed, the end result should be to have the same amount of reserves, but now because the reserve requirement is only 10%, this reserve can support \$2,000,000 in deposits.

Since Alice and Bob both benefit equally from this, their deposits must both double. M2 is thus now \$2,000,000. Finally, this results in a money multiplier of 10.

<u>Emamade Credit Union</u>			
Assets		Liabilities	
Reserves	\$200,000	Alice's Deposits	\$500,000 \$1,000,000
T-Bills and other earning assets	\$800,000 \$1,800,000	Bob's Deposits	\$500,000 \$1,000,000

e) Given the change in part (d), how might you expect the aggregate demand curve of Emamade to react? What might you expect to happen in the short and long runs to prices and output?

In the short run, this increase in wealth would shift out the AD curve, increasing prices and output. In the long-run, wages will adjust upward to account for the price level change, shifting the SRAS curve to the left and returning total output to its long-run equilibrium (Y_f) with a higher price level.

This should make sense intuitively since the lowering of the reserve requirement led to an increase in the money supply, which should lead to inflation.

f) Let's again return to the original scenario (before the reserve requirement change). The Central Bank is now concerned that Emamade's economy is performing below the long-run trend, and thus decides to increase Emamade's monetary base to \$400,000. What policy must the Central

Bank undertake to get this new currency to the Credit Union? After undertaking such a policy, does the Credit Union hold insufficient or excess reserves? Write the new T-accounts for both the Central Bank and Credit Union based solely on the Central Bank's activity.

In order to increase the monetary base, the Central Bank must *buy* assets (the Central Bank purchases T-bills from the Credit Union) from the Credit Union. After this purchase of T-bills the Credit Union holds *excess* reserves and will proceed to loan out those reserves (see next part).

Central Bank of Emamade

Assets			Liabilities		
T-Bills	\$200,000	\$400,000	Currency	\$200,000	\$400,000

Emamade Credit Union

Assets			Liabilities		
Reserves	\$200,000	\$400,000	Alice's Deposits	\$500,000	
T-Bills and other earning assets	\$800,000	\$600,000	Bob's Deposits	\$500,000	

g) Given the result from (f), what will the Credit Union do to eliminate any insufficient or excess reserves? Write the new T-account for the Credit Union assuming again that the deposits of Alice and Bob are both adjusted equally.

The reserve requirement is still 20%, so the Credit Union can now create an additional \$1,000,000 in deposits, again doubling Alice and Bob's deposits.

Emamade Credit Union

Assets			Liabilities		
Reserves	\$400,000		Alice's Deposits	\$500,000	\$1,000,000
T-Bills and other earning assets	\$600,000	\$1,600,000	Bob's Deposits	\$500,000	\$1,000,000