Practice Problem Set #4 – Solutions
EC202C1, Spring 2012, Jeremy Smith

Chapter 7

3. This is the same as the discussion of an oil price shock in the textbook, except that the supply shock is caused by a change in the wage-setting relation rather than in the mark-up. (Remember that an increase in the generosity of unemployment benefits will increase the catch-all variable *z*, pushing up the wage-setting relation and hence the aggregate supply curve.)

   a. *SR*: short run *WS*: wage-setting relation
   MR: medium run *PS*: price-setting relation

	WS	PS	AS	AD	IS	LM
SR	up	no change	up	no change	no change	up
MR	same as SR	no change	up further	no change	no change	up further

   b.

	Y	i	P
SR	falls	rises	rises
MR	falls further	rises further	rises further

Note that the *LM* curve shifts ONLY because the price level changes, not because there is any direct shock in the financial market. Also, note that the actual real wage is not affected by the shock to unemployment benefits (whereas aggregate supply shocks caused by an increase in the mark-up lead to a lower actual real wage).

You might be wondering why additional unemployment benefits do not affect the aggregate demand curve. To be absolutely complete in our treatment of this case, we should allow for that possibility. The payment of benefits does not show up as an increase in government expenditure (because the government is not buying some physical goods or services) but rather as a decrease in taxes (which should technically be defined as net taxes, i.e. total taxes collected minus pure transfers paid out, where unemployment benefits are a pure transfer). So the initial supply shift should perhaps be accompanied by a small rightward shift in aggregate demand. In the medium run, this would only result in a slightly higher price level than otherwise. However, the intent of the problem was to focus purely on a supply shock emanating from the wage-setting relation. To keep things clear, we will never consider shocks that affect aggregate supply and aggregate demand *simultaneously*. (On the other hand, the next two problems focus on a situation in which a supply shock is *followed by* a simple demand-side policy response in the form of a change in the nominal money supply or the level of government expenditure.)

9. a. The *AS* curve shifts up in the short run due to the immediate impact of the shock, then shifts up further over the medium run as price expectations adjust. Output falls in the short run and falls further in the medium run (to its new, lower natural level). The price level rises in the short run and rises further in the medium run. (See Figure 13 in the text.)

b. The unemployment rate rises in the short run (corresponding with the fall in output) and rises further in the medium run to the new, higher natural rate (corresponding with the further fall in output).

c. (Note that there is a typo in this part of the question in the textbook. The phrase "decline in business confidence" should be replaced with "increase in the price of oil". I alerted you to this in the e-mail I sent when the practice problems were first posted, and it would be worth revisiting what I wrote then. The oil price shock does not affect business confidence or otherwise directly affect demand. The only reason the *AD* curve shifts in this entire problem is due to the monetary policy response being contemplated in this part.) The Fed could increase the money supply in the short run, thus shifting the *AD* curve to the right, immediately following the initial upward shift in the *AS* curve. The *AS* curve would shift up further over time as per the usual medium run adjustment of price expectations, with the economy converging to the natural level of output (which is now lower than the original natural level). This convergence is now happening along the new, higher aggregate demand curve.

d. Output and the price level are higher in the short run in part c) than in part a) without a policy response. Output is the same in the medium run in parts a) and c) (at the new natural level), but the price level is higher in part c).

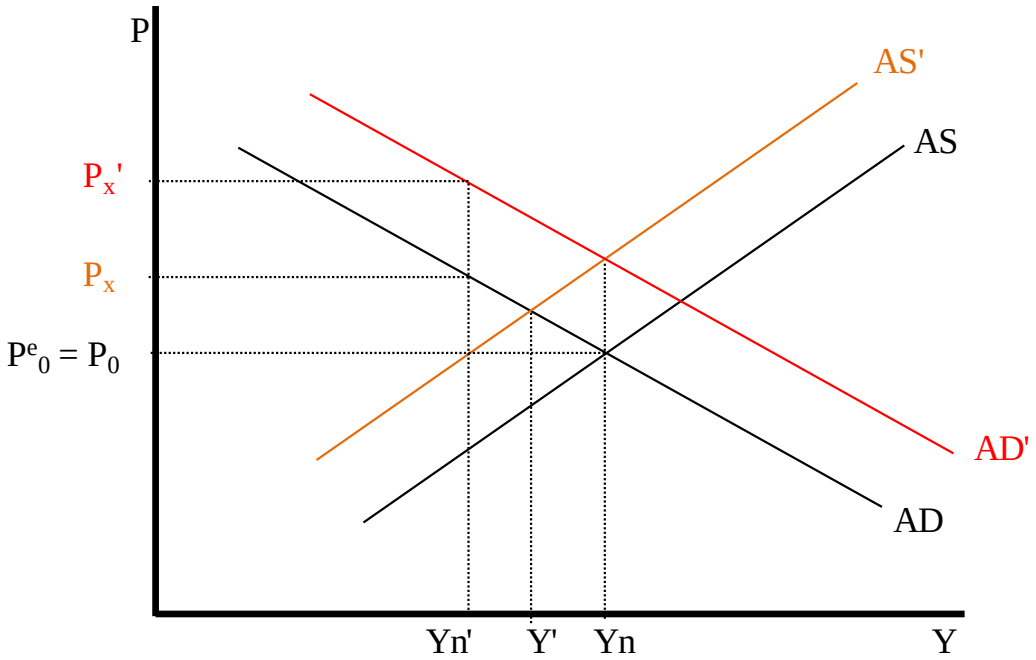
e. The unemployment rate in the short run is lower in part c) than in part b) without a policy response, but the same in the medium run in parts b) and c) (at the new natural rate).

See the graph on the next page for an illustration. In the short run, the aggregate supply curve shifts up to AS' and output falls to Y'. (The corresponding price level P' is not labeled on the graph, but would be where AS' intersects *AD*.) If there is no policy response, the cycle of price expectation adjustment and consequent convergence to the new natural level of output will begin. It will end when the aggregate supply curve has shifted all the way to the intersection with *AD* at the new natural level of output and price level P_x (and, by definition, an expected price level equal to this actual price level). (The final aggregate supply curve is not shown in order to keep the graph tidy.)

If instead there is a policy response – specifically in this case, the Fed increases the money supply by exactly enough to shift aggregate demand to AD' immediately after the supply shock and thus achieve the original output level – the short run equilibrium will jump from Y' back up to the original level of output but at a higher price level. (This higher price level P'' is not labeled on the graph, but would be at the intersection of AS' with AD'.) Then the usual cycle of price expectation adjustment will ensue, but this time the economy will travel along the higher AD' rather than the original *AD*. The medium run adjustment will continue until the economy has converged to the new natural level of

output, but this now occurs at the higher price P_x' (and, by definition, an expected price level equal to this actual price level). (Again, the final aggregate supply curve is not shown in order to keep the graph tidy. Obviously, this will be a different final aggregate supply curve than the one when there is no policy response.)

The new natural level of output is Y_n' in BOTH cases. Remember that simple changes in the nominal money supply (or government expenditure for that matter) do not change the natural rate of unemployment (and so also do not change the natural level of output). This point was discussed in problem 4. of Chapter 7, which was assigned in the third set of practice problems. In the present problem, the oil price shock (manifesting itself as an increase in the mark-up in the price-setting relation) immediately causes a drop in the natural level of output to Y_n' and a shift in the aggregate supply curve up to AS': this has nothing to do with fiscal or monetary policy, and the natural level of output will thereafter stay permanently fixed at Y_n' in the absence of any further supply-side shocks; and any subsequent changes in the nominal money supply or government expenditure will merely affect how long it takes for the economy to converge to this new and permanent natural level of output as price expectations adjust over the medium run. (On the other hand, as was alluded to in the solution to part c) of problem 4. in Chapter 7, government policies that go beyond simple changes in expenditure can indeed affect the natural level of output. An example of such a policy was explored in problem 3. above. Another example would be patent law reforms aimed at fostering greater innovation, which could be modeled as inducing a drop in the mark-up and thus raising the natural level of output and shifting the aggregate supply curve down. Such qualitative government policies causing changes in the labor market relations shift the aggregate supply curve and change the natural level of output, but simple changes in government expenditure or the nominal money supply do NOT.)



Extra Question

Consider an economy characterized by the following Aggregate Demand and Aggregate Supply relations:

$P = P^e(0.5 + 0.0005Y)$ [*AS*]
$P = 10 - 0.008Y + 0.01G$ [*AD*].

a) Confirm that the natural level of output is 1000. If the economy starts in medium run equilibrium with government expenditure of $G = 200$, find: the level of output; the actual price level; and the expected price level.

answer:

When the economy is in its natural state, the expected price level is equal to the actual price level. Substitute this condition into the *AS* curve:

$P = P^e(0.5 + 0.0005Y)$
$P = P(0.5 + 0.0005Y)$
$1 = 0.5 + 0.0005Y$
$0.0005Y = 1 - 0.5$
$Y_n = 0.5/0.0005 = 1000.$

In medium run equilibrium, output will be equal to the natural level, and the price level (which will, by definition, be equal to the expected price level) will be determined by the height of the *AD* curve:

$P = 10 - 0.008Y + 0.01G$
$P_0 = 10 - 0.008(1000) + 0.01(200) = 10 - 8 + 2 = 4 = P^e_0.$

b) Now suppose that there is a sharp increase in the price of oil, which causes the Aggregate Supply curve to shift to $P = P^e(0.5875 + 0.0005Y)$ [*AS'*]. Continue to assume that $G = 200$.

i. Find the new natural level of output.

answer:

Again, impose equality between the actual and expected price level, and this time substitute into *AS'*:

$P = P^e(0.5875 + 0.0005Y)$
$P = P(0.5875 + 0.0005Y)$
$1 = 0.5875 + 0.0005Y$
$0.0005Y = 1 - 0.5875$
$Y_n' = 0.4125/0.0005 = 825.$

ii. Find the short run equilibrium output and price level (accounting for adjustment in all markets, but no immediate adjustment in price expectations) directly caused by the supply shift.

answer:

Find the intersection of AS' and AD, with price expectations remaining at $P^e_0 = 4$ (i.e. where they were in the initial medium run equilibrium):

$AS' = AD$
$P^e(0.5875 + 0.0005Y) = 10 - 0.008Y + 0.01G$
$4(0.5875 + 0.0005Y) = 10 - 0.008Y + 0.01(200)$
$0.002Y + 0.008Y = 10 + 2 - 2.35$
$0.01Y = 9.65$
$Y' = 9.65/0.01 = 965.$

Plug this into either supply or demand to find the corresponding price level:

$P = 10 - 0.008Y + 0.01G$
$P = 10 - 0.008(965) + 0.01(200)$
$P' = 10 - 7.72 + 2 = 4.28.$

iii. Find the level of output and the price level that will arise once the economy has converged to its new medium run equilibrium.

answer:

Price expectations will adjust upwards, which will push actual prices yet higher, and so on. This adjustment all happens along the AD curve, and as always, the economy converges to its natural level of output over the medium run, which is now 825, as we found above. The price level will be determined by the height of the aggregate demand curve, since the aggregate supply curve will keep shifting up (due to increasing price expectations) until it intersects aggregate demand at the natural level of output.

$P = 10 - 0.008Y + 0.01G$
$P_x = 10 - 0.008(825) + 0.01(200) = 10 - 6.6 + 2 = 5.4.$

(And, by definition, price expectations have converged to the actual price level for the economy to be in its natural state, so $P^e_x = 5.4$ also.)

c) Continue to assume that the Aggregate Supply curve is $P = P^e(0.5875 + 0.0005Y)$. Government expenditure is initially at $G = 200$. Suppose that, immediately after the supply shift, the government decides to adjust its expenditure to move the economy back to the previous output level (i.e. the initial natural level of output, 1000).

i. Find the new level of government expenditure that is necessary to achieve the government's goal.

answer:

We want to find AD' corresponding to some new level of government expenditure G' such that AD' intersects AS' at the desired output level, which is 1000 in this case. Since government expenditure is going to change immediately after the supply shock, price expectations will still remain at the initial price level of 4 for now.

$AS' = AD'$
$P^e(0.5875 + 0.0005Y) = 10 - 0.008Y + 0.01G'$
$4(0.5875 + 0.0005(1000)) = 10 - 0.008(1000) + 0.01G'$
$0.01G' = 4.35 - 10 + 8$
$G' = 2.35/0.01 = 235.$

This is higher than the original level of government expenditure. This should make sense: a *rightward* shift in aggregate demand (which an *increase* in government expenditure accomplishes) is necessary to offset the immediate drop in the actual output level due to the upward shift in aggregate supply.

ii. Find the level of output and the price level that will arise once the economy has converged to its new medium run equilibrium. (Assume that government expenditure stays fixed at the new level you just found.)

answer:

As always, the economy will converge to its natural level of output over the medium run. We have already found this to be 825. In this case, the adjustment to this output level will happen along the new, higher aggregate demand curve. In the short run equilibrium that will be reached directly following the increase in government expenditure, the actual price level (called P'' and found by plugging output of 1000 either into AD' – which is the aggregate demand curve evaluated at government expenditure of 235 – or into AS') is much higher than the expected price level (which is still $P^e_0 = 4$). So expectations will adjust upwards, which will cause actual prices to be pushed yet higher, and so on. The price level that will eventually be reached once this medium run convergence is complete will be determined by the height of the new aggregate demand curve, since the aggregate supply curve will keep shifting up (due to increasing price expectations) until it intersects aggregate demand at the natural level of output.

$P = 10 - 0.008Y + 0.01G'$
$P_x' = 10 - 0.008(825) + 0.01(235) = 10 - 6.6 + 2.35 = 5.75.$

(And, by definition, price expectations have converged to the actual price level for the economy to be in its natural state, so $P^e_x' = 5.75$ also.)

It makes sense that this is higher than the 5.4 we found previously for the case in which there is no policy response to the supply shift, because the supply response pushes the economy onto a new, higher, aggregate demand curve. The policy response manages to briefly keep output at

1000, but only ends up making the price level higher than it otherwise would be in the medium run and delaying the adjustment process.

Up to this point, this problem mirrors problem 9. in Chapter 7 of the textbook. (The source of the demand-side policy response is fiscal here rather than monetary there, but this makes no difference to the broader argument.) The notation I have used in these solutions is the same as the notation I used in the graph and the concluding discussion for the textbook problem above. Make sure you can see how these numerical results fit with that graph and discussion.

d) Continue to assume that the Aggregate Supply curve is $P = P^e(0.5875 + 0.0005Y)$. Forget about part c), and assume once again that government expenditure is initially at $G = 200$. Suppose that, immediately after the supply shift, the government decides to adjust its expenditure to move the economy directly to the new natural level of output.

i. Find the new level of government expenditure that is necessary to achieve the government's goal.

answer:

We want to find AD'' corresponding to some new level of government expenditure G'' such that AD'' intersects AS' at the desired output level, which is 825 in this case. Since government expenditure is going to change immediately after the supply shock, price expectations will still remain at the initial price level of 4.

$AS' = AD''$
$P^e(0.5875 + 0.0005Y) = 10 - 0.008Y + 0.01G''$
$4(0.5875 + 0.0005(825)) = 10 - 0.008(825) + 0.01G''$
$0.01G'' = 4 - 10 + 6.6$
$G'' = 0.6/0.01 = 60.$

This is lower than the original level of government expenditure. This should make sense: a *leftward* shift in aggregate demand (which a *decrease* in government expenditure accomplishes) is necessary to push output down from its level directly following the supply shock all the way to the new natural level of output.

(I want to point out a small mechanical feature of this problem and stress that it is NOT a general result in these kinds of problems. You may have noticed that changes in government expenditure feed through one-for-one into changes in short-run equilibrium output levels in this specific example. In the case of the expansionary policy of the previous part, an increase in government expenditure of 35 units – from 200 to 235 – led to an increase in output of 35 units – from 965 to 1000. And in the case of the contractionary policy of this part, a decrease in government expenditure of 140 units – from 200 to 60 – led to a decrease in output of 140 units – from 965 to 825. In other words, the multiplier for the full *AS-AD* model at this particular starting point – the change in short run equilibrium output accounting for adjustment in all three markets due to a change in exogenous expenditure by one unit for an expected price level of 4 – is exactly one. This is very specific to the exact parameter values and starting point of this

problem, and is not at all a general result. Correct solutions to problems like these MUST correctly proceed as above by imposing the correct equilibrium condition and solving, NOT by just assuming that changes in government expenditure will feed through one-for-one to changes in output. If you understand that, you don't need to pay attention to anything else in this parenthetical comment. The rest of this comment is not required at all, and you shouldn't bother with it unless you're really interested. Speaking of multipliers, we can actually back out the implied value of the *IS-LM* multiplier – the change in equilibrium output accounting for adjustment in the goods and financial markets only due to a change in exogenous expenditure of one unit, which was derived symbolically in part c) of problem 2. in Chapter 5 on the second set of practice problems and was asked about on the first mid-term – even though we have no explicit information on the goods and financial market relations. To do that, we need to know how output changes holding the actual price level – and thus everything in the labor market – fixed. We have already indirectly done that in this problem. From part a), we saw that output is 1000 when the price level is 4 and government expenditure is 200. From part d), we saw that output is 825 when the price level is 4 and government expenditure is 60. So, holding the price constant, a change in government expenditure of 140 leads to a change in output of 175. Dividing the latter by the former gives the value of the *IS-LM* multiplier as 1.25 in this specific example.)

ii. Find the level of output and the price level that will arise in the new medium run equilibrium. (Assume that government expenditure stays fixed at the new level you just found.)

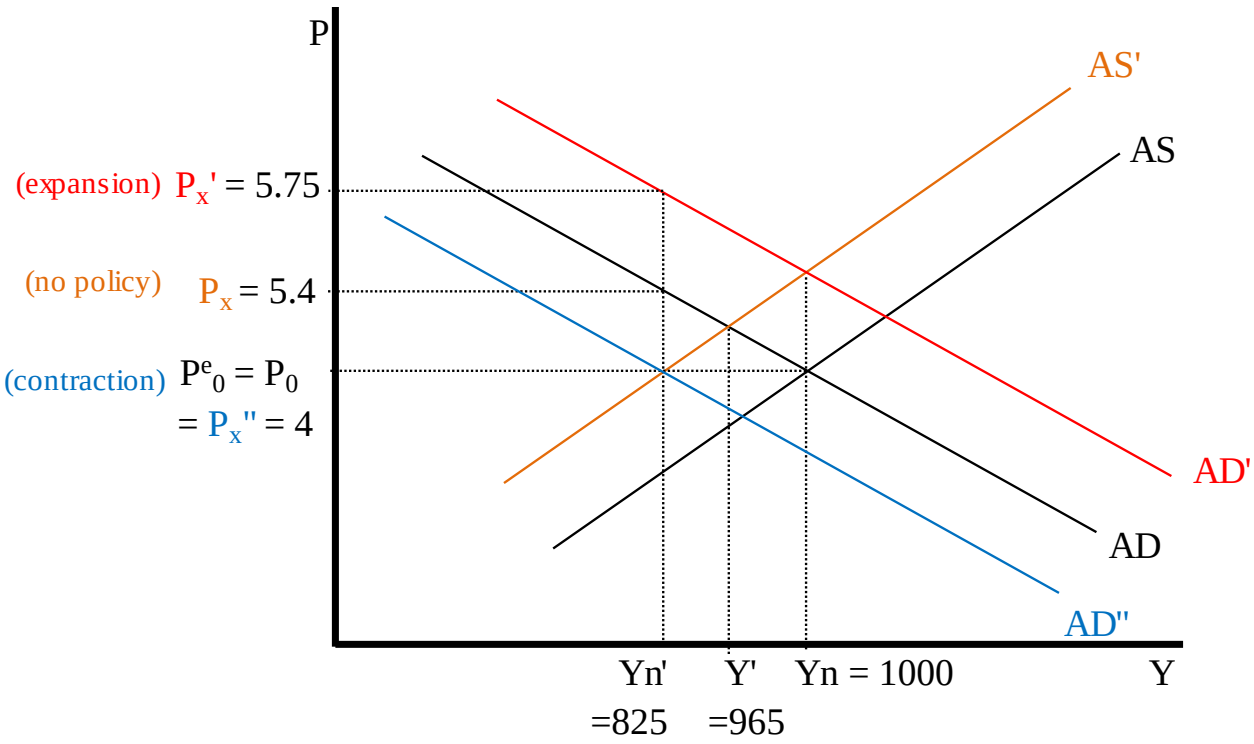
answer:

$P = 10 - 0.008Y + 0.01G''$
$P_x'' = 10 - 0.008(825) + 0.01(60) = 10 - 6.6 + 0.6 = 4.$

The policy achieves output of 825 by construction. If it didn't, we know that the economy would converge there over the medium run in any case, but here, no convergence is necessary. The actual price level is equal to the expected price level (which we have assumed has stayed fixed at 4 in the short run, during which the expenditure change was executed directly after the supply shock). Therefore, there will be no further adjustment.

This policy saves the economy the inflation of the price level through medium run adjustment that would have happened without any policy or to an even larger degree with expansionary policy. It is the "correct" option in the sense that the economy is going to end up at an output level of 825 regardless, and this is accomplished without any price increase or lengthy adjustment process in this case. (We haven't talked about the potential pernicious consequences of inflation yet, so it may not be so clear why the higher price level is such a bad thing. We'll return to this later in the semester.)

There is a graph on the next page that augments the graph from the previous problem and tries to put all three cases together. It would be useful practice to draw a detailed graph for each case individually as well.



To conclude, we can think about some practical issues of macroeconomic policy making in light of what we have learned from the *AS-AD* model. This was discussed here and there in class and is also the subject of problem 10. in Chapter 7 (which was not assigned but might be worth thinking about now that we've been through the whole chapter). You can imagine the difficulty of arguing for massive cuts in government expenditure during a recession, even though we have just argued here that this would be the "correct" policy in the present case. Even if we knew with certainty that the natural level of output had fallen, we would probably want to believe that we could use expansionary policy and live with some inflation while waiting for a beneficial supply shock to come along and undo the adverse supply shock – though this might end up taking a long time, and so lead to a large degree of inflation in the meantime. The larger problem, of course, is identifying whether a drop in output has been caused by a negative demand shock or an adverse supply shock. If there has been a negative demand shock, the appropriate response is expansionary policy to hasten the return to the natural level of output (as in problem 8. in Chapter 7 on the third set of practice problems); contractionary policy would push the economy further away from its natural state, deepening the recession and prolonging the return to the natural state. If, on the other hand, there has been an adverse supply shock, the appropriate response is contractionary policy to hasten convergence to the new, lower natural output level while avoiding inflation (as has been argued above); expansionary policy will serve only to exacerbate inflation while at best keeping output higher very temporarily. So, if we find ourselves in a recession, should we increase government expenditure or decrease it? We have opposite prescriptions depending on what caused the recession, so we need to first diagnose the underlying causes of the recession, which is often a very difficult task. And, as always, we're leaving aside the budgetary and procedural issues that actual governments need to worry about, which would complicate the decision over a policy response even further.