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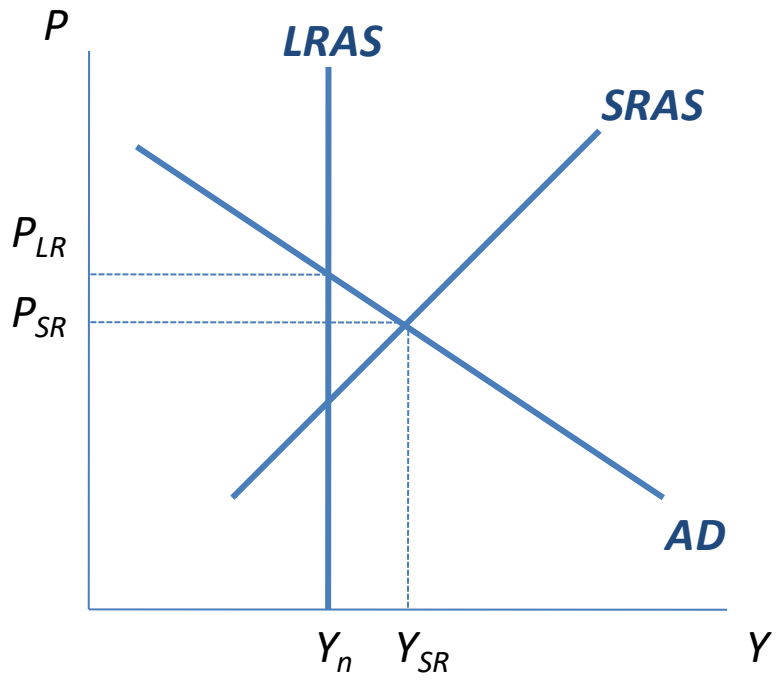
# Putting Aggregate Supply and Aggregate Demand Together: AS-AD Model

Now that we've developed both the aggregate supply and aggregate demand blocks of the model, we're ready to bring them together to complete the model. The primary goal of these notes will be to cover the dynamic movements of the economy from short-run to long-run equilibrium, as well as to discuss comparative static exercises in the AS-AD model.

## Equilibrium in the AS-AD Model

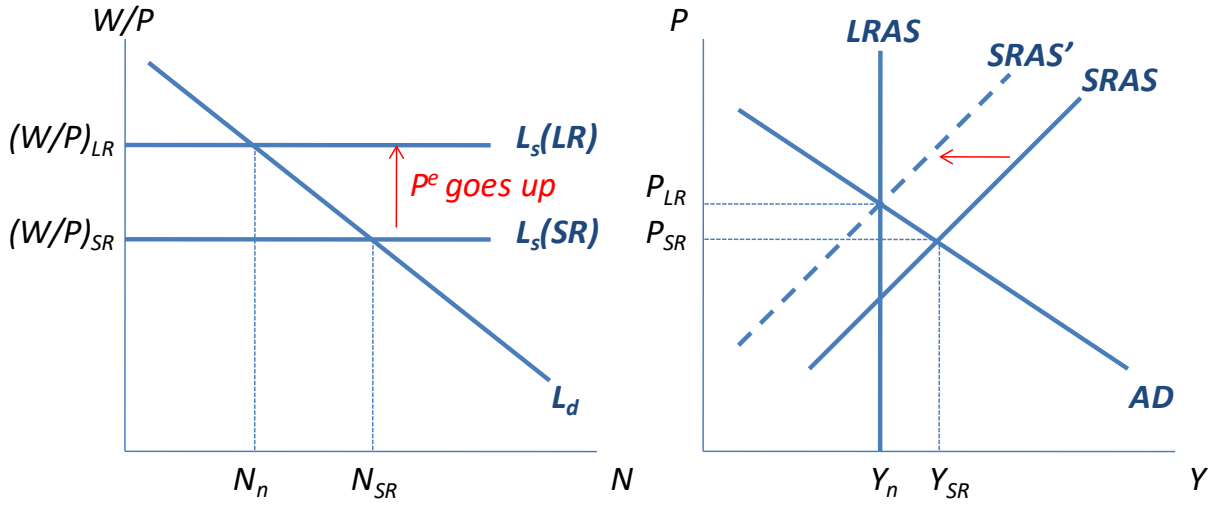
The equilibrium in the AS-AD model is a combination of a price level and output level such that aggregate supply and aggregate demand are equal. This is illustrated in the graph below. The aggregate supply and demand curves are based on previous sets of notes.




In the graph, the short-run equilibrium is given by $(P_{SR}, Y_{SR})$ while the long-run equilibrium is given by $(P_{LR}, Y_n)$. In general, given that short-run and aggregate supply curves are different, the short-run and long-run equilibrium outcomes can be different, as is the case in the graph. Given equilibrium values of $P$ and $Y$, one can then work backwards and use IS-LM to find equilibrium interest rates, consumption, investment and savings, while the labor market diagram can be used to solve for equilibrium real wages and employment.

Going from Short-Run Equilibrium to Long-Run Equilibrium

The first issue to address is how the economy moves from the short-run equilibrium to the long-run equilibrium. Here, the key lies in the labor market and the adjustment of price expectations $P^e$. Recall that the long-run aggregate supply curve is such that $P^e=P$, in other words the expected price level is equal to the actual price level. In the short-run, if expectations adjust slowly, the expectation of the price level can differ from actual price level, but over time, agents will realize that their expectations are off and correct them. Consider a situation like the one depicted above, where the long-run price level is higher than the current price level and short-run output is greater than long-run output. This situation is illustrated in the labor market diagram below.

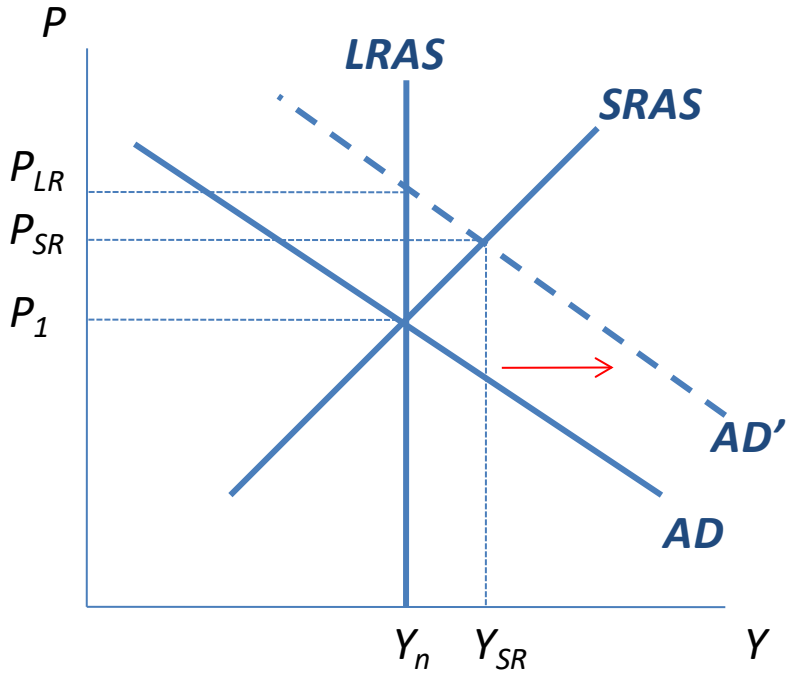



Because the future price level is higher, expectations of future prices will rise over time. This will cause workers to demand higher real wages, shifting the labor supply curve up. As this occurs, equilibrium employment in the labor market for any given price level falls, shifting the aggregate supply curve to the left. This shift will continue to occur until $P^e=P$, i.e. until expectations have fully adjusted. ***The adjustment from the short-run to the long-run always occurs through shifts in the SRAS curve due to the adjustment of price expectations.***

Comparative Statics

a) An increase in the money supply.

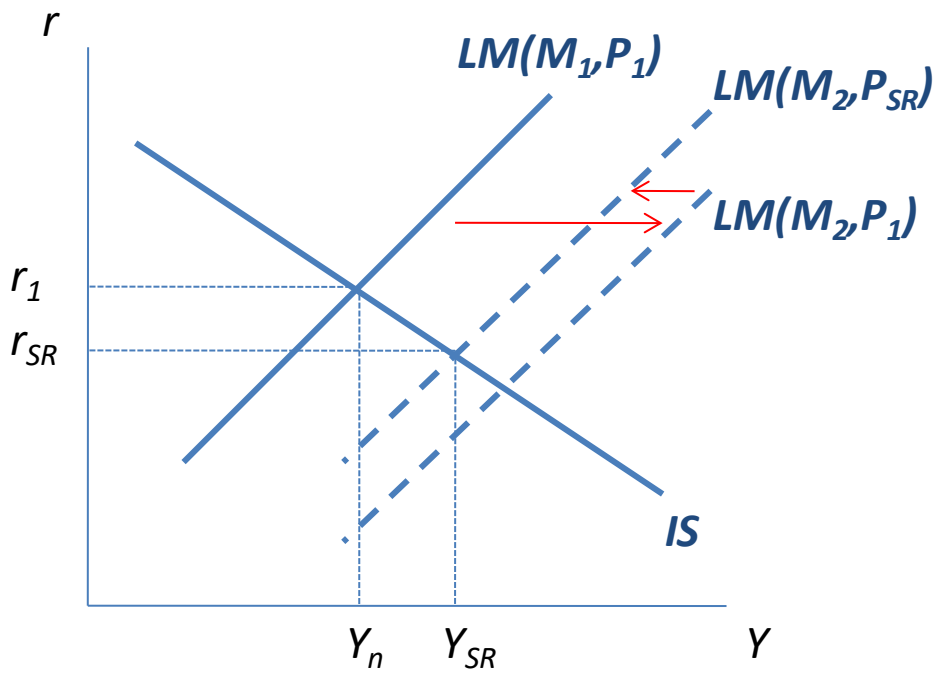
An increase in the money supply raises real money balances and tends to push the interest rate down, holding all else constant, in the money market. This shifts the LM curve to the right, which in turn shifts aggregate demand to the right. The implications for AS-AD are illustrated below, based on the assumption that the economy began at its long-run equilibrium.




In the short-run, prices must rise (to $P_{SR}$) and output must also rise (to $Y_{SR}$). In the long-run, the level of output is unchanged and remains at its natural level while the price level rises even more than in the short-run (to $P_{LR}$).

Let's figure out what happens to interest rates, consumption and investment. First, let's turn to the IS-LM diagram. The first effect is the shift in the LM curve, which caused aggregate demand to shift right. In the short-run, we see an increase in the price level, which causes the LM curve to shift back a little (we know it cannot shift back too much since output has to go up in the short-run. This is illustrated in the figure below. In the long-run, prices go up even more, causing the LM curve to shift back further. From AS-AD, we know that in the long-run, output

is unchanged, so the LM curve must keep shifting back until it reaches its original level once again.



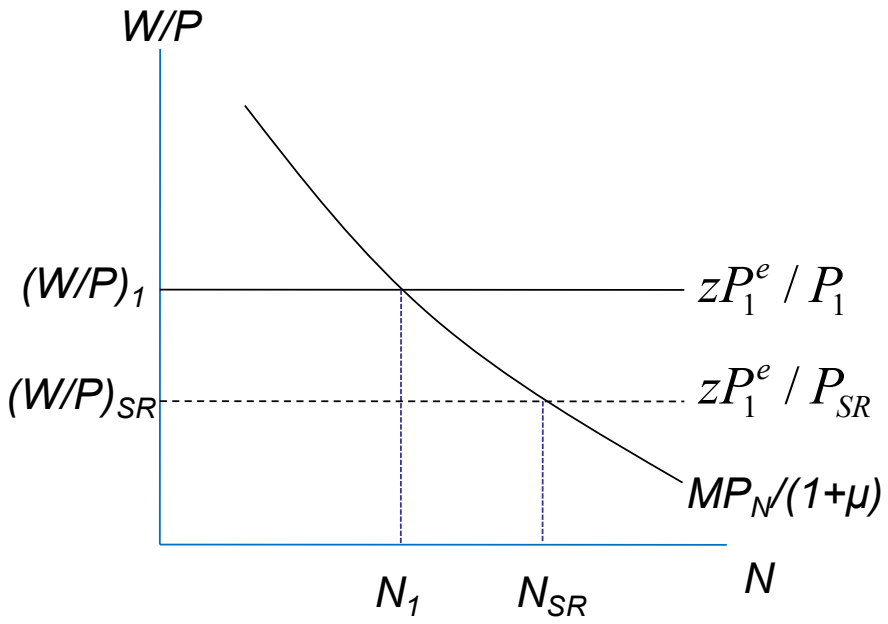

In other words, $LM(M_2,P_{LR}) = LM(M_1,P_1)$. Thus, in the long run, the interest rate goes back to $r_1$, the original level of the interest rate, so $r_{LR}=r_1$.

Now, let's figure out what happens to consumption and investment. For investment, note first that "animal spirits" *SP* is unchanged in both the short and long run. Recall the investment function: $I = I\left(\overset{+}{\widetilde{SP}}, \overset{-}{\widetilde{r}}\right)$. Since SP is unchanged, changes in investment are solely determined by the change in the interest rate. In the short run, the interest rate falls (from $r_1$ to $r_{SR}$ in the graph above) so investment must rise. In the long-run, the interest rate is unchanged relative to the original level of $r_1$, thus investment in the long-run must be unchanged.

For consumption, recall the consumption function: $C = C\left(\overset{+}{\widetilde{CS}}, \overset{+}{\widetilde{Y-T}}, \overset{-}{\widetilde{r}}\right)$. Note first that consumer sentiment is unchanged in both the short and long run. In the long-run, the level of output is unchanged, so the change in consumption depends only on the change in interest rates.

Since the interest rate is also unchanged in the long-run, consumption must be unchanged. In the short-run, output goes up and interest rates fall. Both tend to raise consumption, hence consumption must rise in the short-run.

We can also consider what happens to supply-side variables. What's happening in the labor market? Short-run and long-run changes in the labor market are illustrated in the graph below:




In the short-run, we saw in the AS-AD model that the price level had to rise, from $P_1$ to $P_{SR}$. In the labor market diagram, this rise in the price level is expressed as a fall in the labor supply curve, causing the real wage to fall and employment to rise. This increase in employment, in the short-run, is the source of the increase in output observed in the AS-AD diagram. In the long-run, expectations of prices must adjust. Thus, $P^e=P$, forcing the labor supply curve to move back up to its original position. This causes both employment and real wages to return to their original levels. We can summarize our results for the effects of an increase in M in the following way:

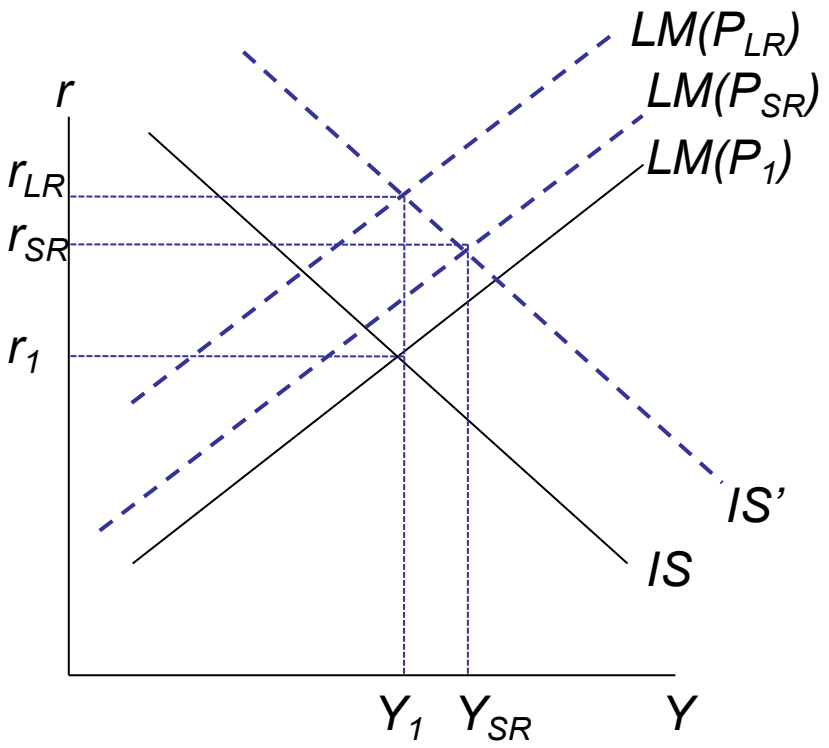
| | P | Y | r | I | C | N | W/P |
|---|---|---|---|---|---|---|---|
| Short-run | + | + | - | + | + | + | - |
| Long-run | + | 0 | 0 | 0 | 0 | 0 | 0 |

This feature of the model, that a change in money supply has no effect on output in the long-run, is known as **monetary neutrality**. In the long-run, increases in the money supply have no effect on real variables (measured in goods) but simply cause nominal variables (measured in $) to rise by the same proportion. In other words, suppose the money supply went up 10%, in the long run, this just causes the price level (and nominal wages W) to rise 10%, leaving real variables unchanged.

b) An increase in government spending:

Consider now the effects of an increase in *G*. In the AS-AD model, this causes aggregate demand to shift right, just like an increase in money supply did. Thus, the short and long-run changes in prices and output are the same as in the previous case. In the short-run, prices and output both rise. In the long-run, prices rise but output stays at the original level.

Once we know what happens in the AS-AD diagram, we turn to the IS-LM graph. An increase in government spending shifts the IS curve to the right. Because the price level also rises in the short-run, this induces a small leftward-shift of the LM curve (we know it can't be too big because we know that output in the short-run must rise). Thus, the short-run equilibrium is at $r_{SR}$ and $Y_{SR}$.




In the long-run, we know from the AS-AD diagram that prices must continue to rise and output must return to its original level. This increase in prices shows up as a leftward shift of the LM curve from LM($P_{SR}$) to LM($P_{LR}$). The LM curve keeps shifting left until the equilibrium level of output returns to $Y_1$. Thus, in the long-run, the interest rate rises, and even higher than in the short-run.

Given the responses of output and interest rates, we can now turn to consumption and investment. For investment, again note that because "animal spirits" *SP* did not change, only interest rate changes affect investment. Because interest rates rise in both the short and long-run, investment falls at both horizons, and by more in the long-run than the short run. This decrease in investment caused by rising government spending is the ***crowding out*** effect discussed in earlier notes.

For consumption, consider first the long-run. Output is unchanged in the long-run, and so is consumer sentiment (*CS*). Thus, because interest rates rise in the long-run, consumption must fall in the long-run. In the short-run, the answer is less clear since output also rises. The

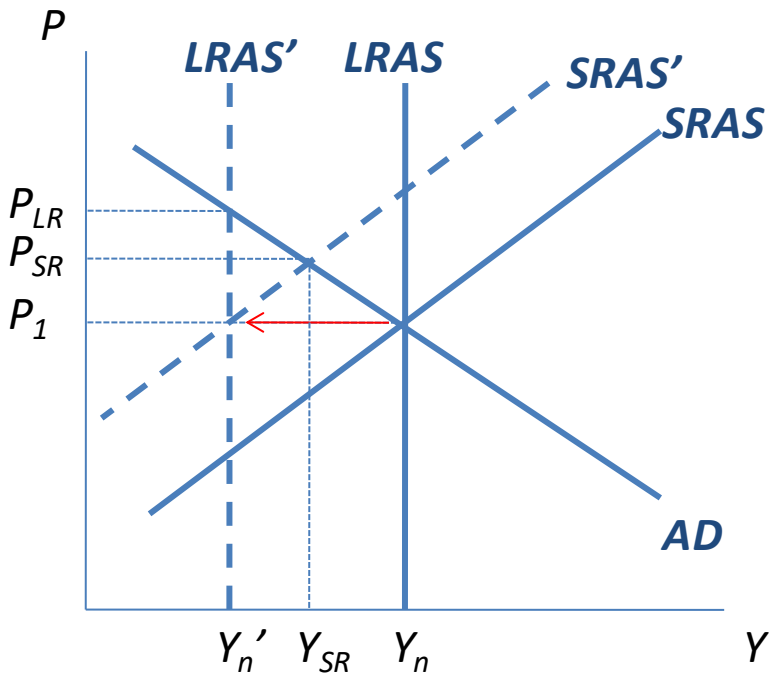
increase in output tends to raise consumption, whereas the increase in interest rates tends to lower consumption. Hence, the net effect on consumption is ambiguous in the short run. The labor market dynamics are identical to those for an increase in money supply.

Hence, we can summarize the results for the effects of an increase in government spending as

| | P | Y | r | I | C | N | W/P |
|---|---|---|---|---|---|---|---|
| Short-run | + | + | + | - | ? | + | - |
| Long-run | + | 0 | + | - | - | 0 | 0 |

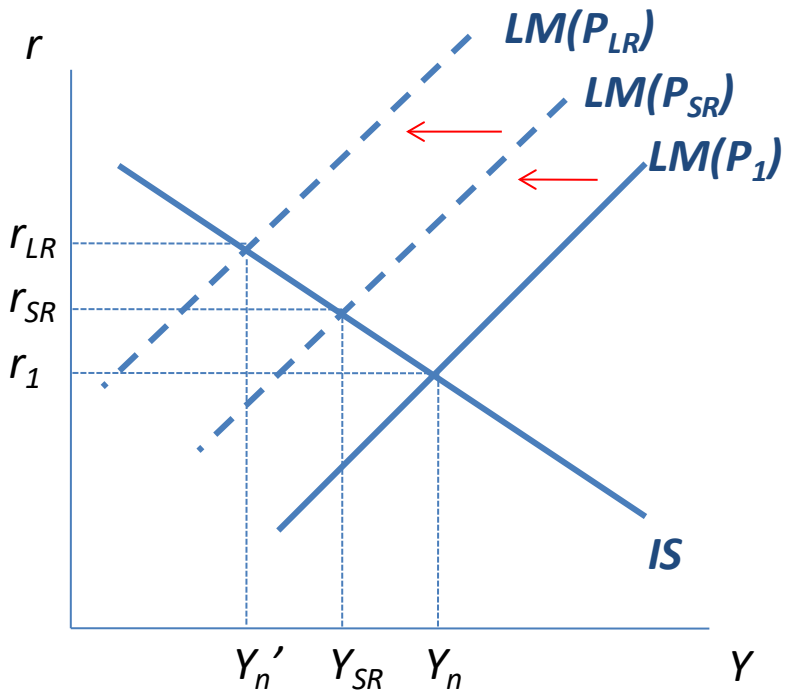
c) An increase in markups ($\mu$)

Consider now a supply-side shock: an increase in $\mu$, the degree of monopoly power of firms. From our work on aggregate supply, we know that this shifts the aggregate supply curves to the left. This is illustrated in the graph below:



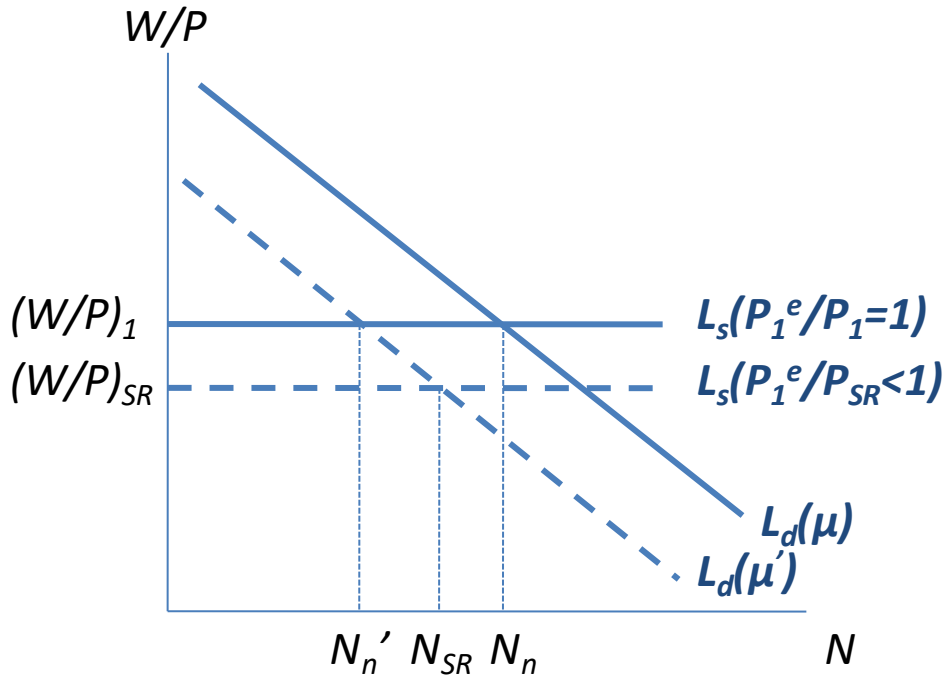
The economy starts at $(P_1, Y_n)$. The increase in μ shifts both aggregate supply curves to the left, as illustrated by the red arrow. This yields two new equilibria: the short-run equilibrium $(P_{SR}, Y_{SR})$ and the long-run equilibrium $(P_{LR}, Y_n')$. In both cases, prices are higher and output is lower than at the original equilibrium, but the changes are bigger in the long-run than short-run: $P_{LR}>P_{SR}>P_1$ and $Y_N'<Y_{SR}<Y_N$.

Once we know what happens to output and prices, we turn to the IS-LM model to understand what's happening to interest rates. Here, the only exogenous (from the point of view of IS-LM) variable changing is the price level. As prices rise, the LM curve shifts left. This is illustrated in the graph below:




The economy starts out at $r_1$ and $Y_N$, given $P_1$. The increase in $\mu$, which has no direct effect on the IS-LM diagram, pushes up the price level in the short-run and long-run. As this shifts the LM curve left, we see output falling (as in the AS-AD diagram) and the interest rate rising. The higher the price level, the higher the interest rate. Since the price level is higher in the long-run than the short-run, we have $r_{LR}>r_{SR}$.

Having determined changes in $P$, $Y$, and $r$ in the short and long-run, let's now turn to the effects on consumption and investment. First, investment is determined by the investment function. Since animal spirits ($SP$) is unchanged, changes in investment are determined entirely by the change in interest rates. Since interest rates are rising, investment must be falling. With interest rates higher in the long-run than short-run, investment falls to an even lower level in the long run than in the short run. For consumption, we use the consumption function which depends on $CS$, $Y$-$T$, and $r$. Consumer sentiment ($CS$) is unchanged. In both the short and long-run, output $Y$ falls and taxes are unchanged, so this tends to lower consumption. In both the short and long run, the interest rate is rising, which also tends to lower consumption. Thus, consumption must fall in both the short and long run, and must be even lower in the long run than in the short run (since $Y$ is lower in the long run than short run and r is higher in the long run than short run). Now, let's turn to the labor market and changes in real wages and employment. The economy starts off with labor demand as a function of the original level of $\mu$ and labor supply with the original price level and expectations ($P_1^e=P_1$), as illustrated in the graph below. With these curves, the real wage is originally $(W/P)_1$ and employment is $N_N$.




The increase in $\mu$, the degree of monopoly power, means that firms seek to reduce their production to raise prices. This lowers the demand to labor to $L_d(\mu')$. This is what caused

aggregate supply to shift left in the AS-AD diagram. However, from the AS-AD, we know that in the short-run, this causes prices to rise to $P_{SR}>P_1$. This increase in prices means that $Pe_1/P$ must fall, causing the labor supply curve to shift down. This yields the short-run equilibrium in the labor market: $(W/P)_{SR}$ and $N_{SR}$. Note that employment falls in the short-run, which explains why output falls in the short-run in AS-AD. In the long-run, $Pe=P$, so the labor supply curve goes back to its original position, and the real wage in the long-run is equal to the original real wage $(W/P)_1$. Employment falls further, to $N_N'$, which is lower still than $N_{SR}$. We can summarize our findings as to how the economy responds to an increase in $\mu$ as:

| | P | Y | r | I | C | N | W/P |
|---|---|---|---|---|---|---|---|
| Short-run | + | - | + | - | - | - | - |
| Long-run | + | - | + | - | - | - | 0 |