

### Aggregate Demand – Aggregate Supply

This handout presents a model wherein the price level is allowed to change in response to output, the expected price level, and supply shocks (such as changes in the price of inputs). This material is also covered in Chapter 26 of the textbook. To simplify the analysis, the BP=0 condition is omitted from the analysis.

#### 1. Basics

Consider the solution to the IS-LM model, but including time subscripts.

$$(1) \quad Y_t = \hat{\alpha} \left[ \bar{A}_t + \overline{EXP}_t - \overline{IMP}_t + (n + v)q_t + \left(\frac{b}{h}\right) \left(\frac{\bar{M}_t}{P_t}\right) \right]$$

Where the price level  $P$  is now *allowed to vary*. This means that there are different levels of aggregate demand for different price levels. This relationship is graphed in Figure 26.1 (page 554) in the textbook.

What is the corresponding aggregate supply curve? Let  $Y^{FE}$  be “full-employment” output. Then aggregate supply is given by:

$$(2) \quad \left(\frac{Y_t^{AS}}{Y^{FE}}\right) = \left(w \frac{P_t}{\bar{W}_t}\right)^\sigma \quad (26.2) \text{ Short Run Aggregate Supply, AS}_{SR}$$

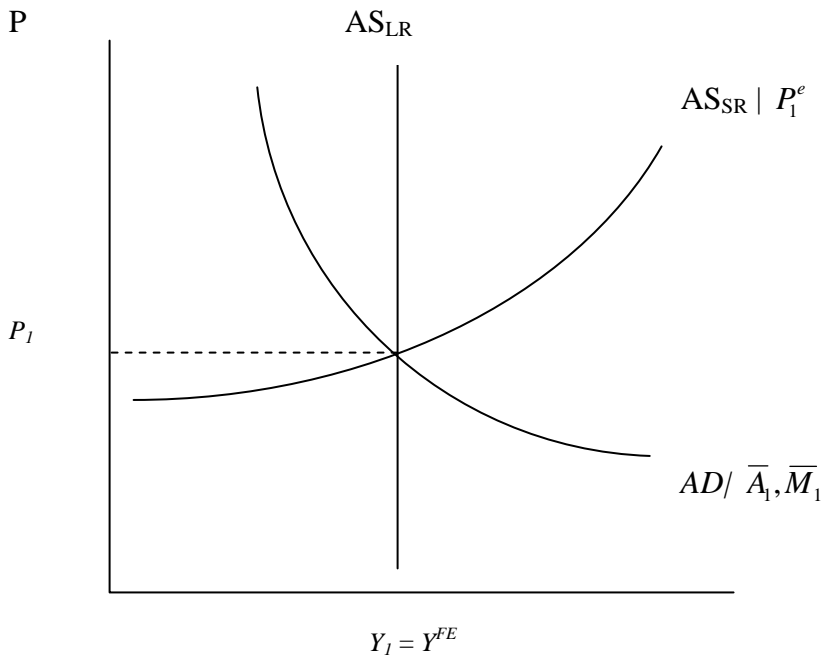
Where  $\bar{W}_t = wP_t^e$ ,  $w$  is the real wage rate that equilibrates the labor market in a neoclassical sense, and  $P_t^e$  is the period  $t$  price level expected based upon time  $t-1$  information. Notice (2) is equivalent to:

$$(2') \quad \left(\frac{Y_t^{AS}}{Y^{FE}}\right) = \left(\frac{P_t}{P_t^e}\right)^\sigma \quad (26.3) \text{ Short Run Aggregate Supply, AS}_{SR}$$

This means that when the price level equals the expected price level, aggregate supply equals full employment (that is why the  $AS_{SR}$  curve cuts the  $AS_{LR}$  line at  $P_1$ , when the  $AS_{SR}$  line is drawn conditional on the expected price level).

In order to make the model workable, we have to take a stand on how price expectations are formed. I’m going to assume that people use a very simple rule to generate their price forecasts – namely that people expect this period’s price level to equal last period’s actual price level. This approach to modeling behavior is called adaptive expectations.

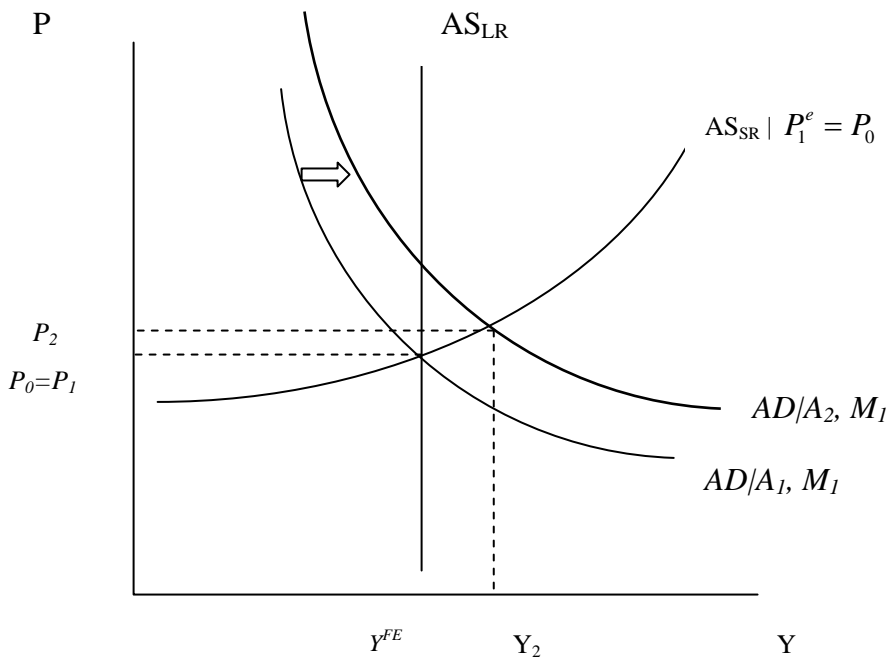
$$(4) \quad P_t^e = P_{t-1} \quad \text{Price expectations formation}$$



**Figure 1:** Output, price level in period 1, with expected price level  $P_1^e = P_1 = P_0$

**2. Demand shocks in the AD-AS framework**

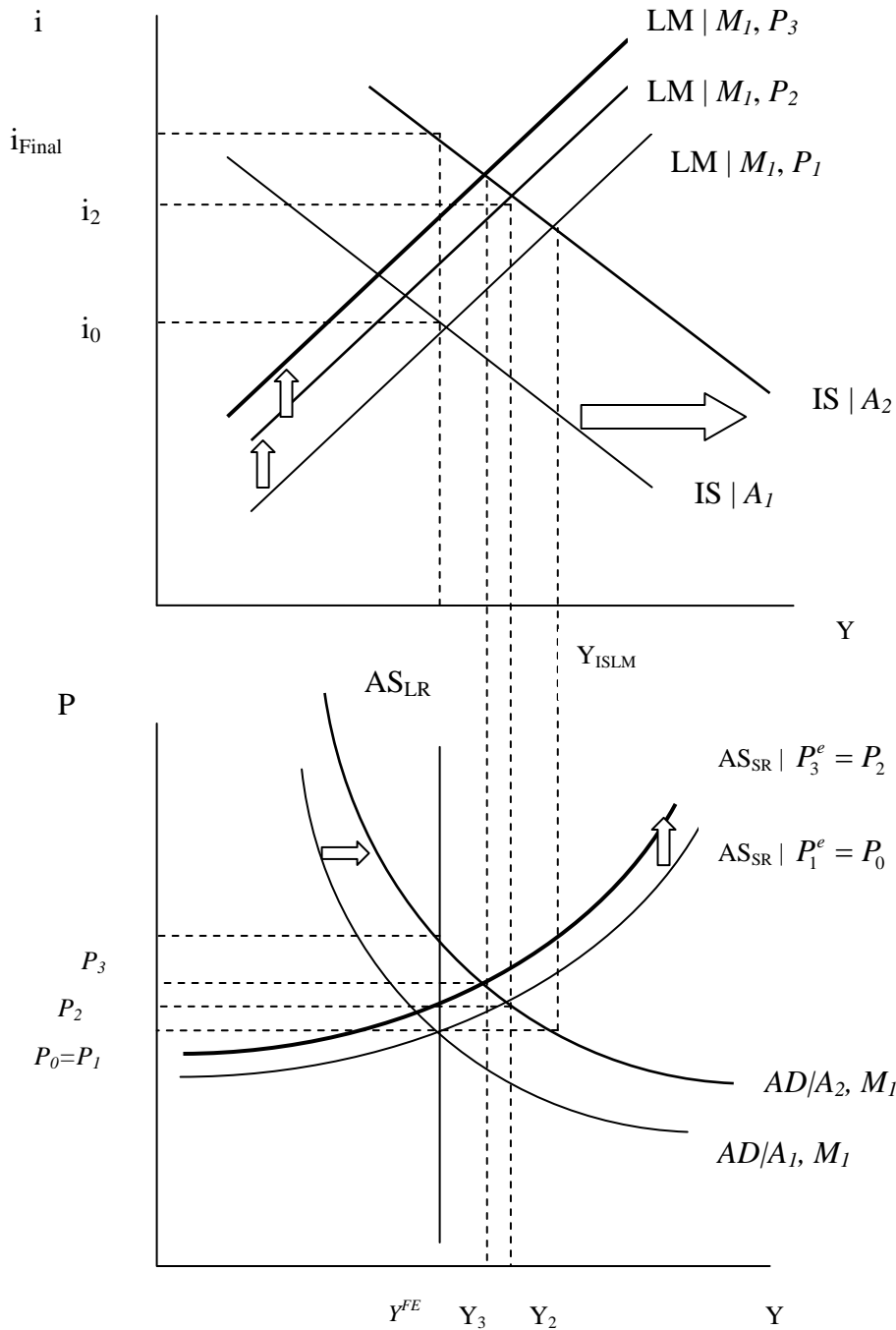
Now consider what would happen starting from a position of initial rest. Assume to begin with in periods 0 and 1  $Y_t = Y^{FE}$ , and  $A_t = A_1$ ,  $M_t = M_1$ . Then suppose in period 2, autonomous spending increases to  $A_2$  (perhaps because of an increase in government spending). Then output rises in period 2 to  $Y_2$ , as does the price level. That is because as the price level rises relative to expected price level, that is the same as the price level rising relative to the nominal wage rate – hence the real wage rate declines. Consequently output rises (since the marginal product of labor is set equal to the real wage rate).



**Figure 2:** Expansionary fiscal policy. Note  $A_2 > A_1$

How does this AD-AS diagram relate to the IS-LM diagram we used before? One way to think about the diagram is that movements along the predetermined price line were consistent with the solution of the IS-LM diagram. To see what happens in the process of adjustment to lower income as the price level rises, consider this pairing of diagrams.

In Figure 3 below, one sees that since the price level rises, the increase in output in period 2 is not equal to that in the standard answer to the IS-LM model, indicated as  $Y_{ISLM}$  below (where the price level is held constant).



**Figure 3:** Price adjustment over time. Note  $P_3 > P_2$

Instead, the price level is  $P_2$ , so the LM curve is shifted back in period 2. In period 3, the price level rises as the  $AS_{SR}$  curve shift (because the period 3 expected price level is modeled as equaling the actual price level observed in period 2). As this occurs, the LM shifts back and output falls to  $Y_3$ .

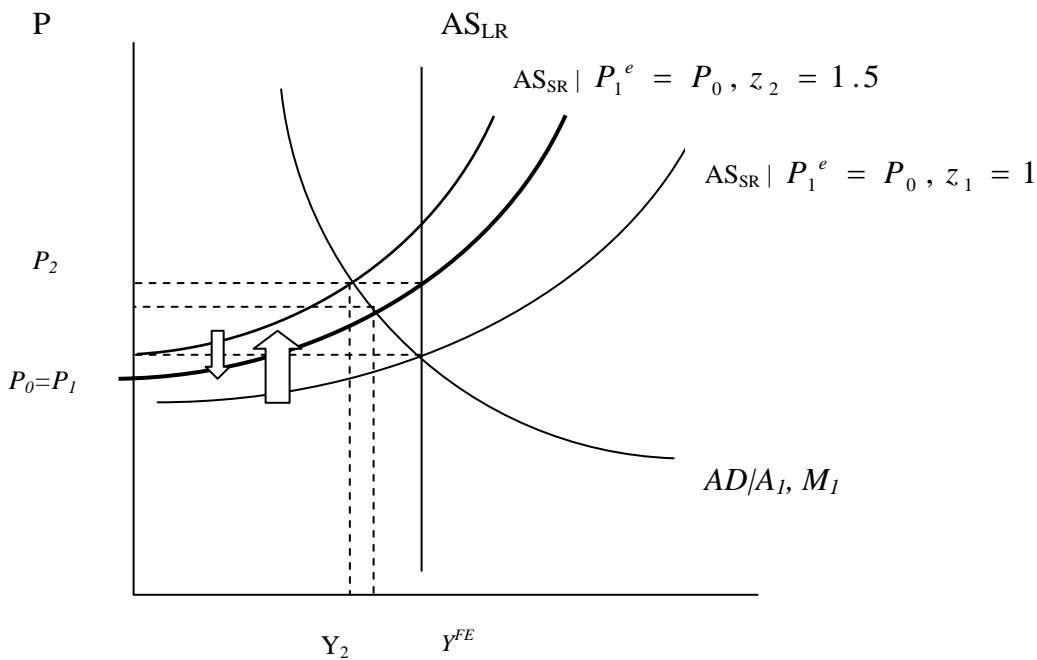
Notice that over the longer term, the price level keeps on rising (as long as output exceeds full-employment GDP), the real money stock keeps on falling, shifting back the LM curve, until finally output equals full-employment GDP, the price level equals  $P_{Final}$ , the interest rate equals  $i_{Final}$ .

### 3. Supply shocks

Now suppose the price level is a function of the nominal wage rate ( $W$ ) and the price of inputs ( $z$ ); such inputs would include oil. The aggregate supply function would then be:

$$\left( \frac{Y_t^{AS}}{Y^{FE}} \right) = \left( \frac{w_t}{z_t} \frac{P_t}{w_t P_t^e} \right)^\sigma \quad (26.3) \text{ Augmented Short Run Aggregate Supply}$$

When  $z$  rises, that pushes up the short run AS curve.



**Figure 4:** Supply Shock w/o offsetting government policy

Output falls to  $Y_2$ . Over time, output recovers as the price level falls. (In the background, the real wage falls). In the end, output returns to full-employment, but in the meantime, the economy experiences a period of reduced output and elevated prices. Consider what happens if the policy authorities (monetary or fiscal) attempt to maintain output at potential. In this economy, the economy would then end up at a permanently higher level.

### 4. Adaptive inflationary expectations

Now consider the outcome if instead of (4), the price expectations mechanism looked like this:

$$(5) \quad P_t^e = P_{t-1} + P_{t-1} \left( \frac{P_{t-1} - P_{t-2}}{P_{t-2}} \right) \quad \text{Inflation expectations formation, adaptive}$$

Which is a rewrite of:

$$(6) \quad \pi_t^e = \pi_{t-1} \quad \text{Inflation expectations formation, adaptive}$$

Then if the government shifted out the AD curve (as in Figure 3), inertia would get built into expected prices and the AS<sub>SR</sub> curve would overshoot P<sub>Final</sub>. A recession would occur, until prices started falling. In the end the economy would end up at P<sub>Final</sub>.

If the government tried to keep output at Y<sub>2</sub>, this would require continuous outward shifts of either the IS or LM curves. This in turn would mean accelerating inflation over time.

Now consider the effect of a supply shock in the context of this inflationary mechanism. It would induce an even deeper recession and more rapid inflation. Eventually, the economy would settle back in where it began.

If the government attempted to get output back to full-employment GDP in period 2, this would build in permanently positive inflation.