The AS/AD Model[1]

These notes develop a formal model of the business cycle. Our goal is a simple and comprehensible model that allows us to examine the effects of some of the most important components of short term volatility. We are not trying to include everything that might affect output and inflation. We are also focusing on the short run, leaving long run analysis to the Solow Model. I am trying to rely more on intuition in deriving the model and I am less concerned with mathematical rigor.

This model includes two major endogenous variables, those that the model is trying to explain. They are:

1. $\tilde{Y}$, the output gap. This is not real aggregate output. Rather, it is actual real output minus its natural rate. The natural rate of output is the level of output that the economy would produce, if unemployment equaled its natural rate (about 5% in the United States).

For example, suppose that unemployment is 7% and $\tilde{Y} = -4\%$. This suggests that output is 4% lower than what it would be were unemployment to equal its natural rate instead of 7%. Likewise, if $\tilde{Y} = 2\%$, then output is higher than it would be if unemployment were to equal its natural rate. Most likely, unemployment is less than 5% in this case.

The output gap may be negative. Negative values do not imply that output is negative (which would make no sense). It just means that output is probably less than policy makers would like it to be.

2. $\tilde{\pi}$. This is the difference between inflation and the targeted inflation rate. In the United States, the Federal Reserve has chosen a 2% inflation target. So $\tilde{\pi} = 5\%$ would imply that actual inflation is 7%, 5% above its target. But our model is general enough to allow for different target inflation rates.

Throughout, the analysis will be done with simple graphs. The AS/AD space has the inflation gap on the vertical axis, and the output gap on the horizontal.

[1]These are undergraduate lecture notes. They do not represent academic work. Expect typos, sloppy formatting, and occasional (possibly stupefying) errors.

Graph: AS/AD

Aggregate Demand

We define aggregate demand as all combinations of $\tilde{Y}$ and $\tilde{\pi}$ where markets for goods and services are in equilibrium. The components of goods and services may be found on the right hand side of the national income accounting identity:

$$Y \equiv C + I + G + X - M \tag{1}$$

Conceptually, deriving aggregate demand is asking the question, "if prices go up or down, how does that affect C, I, G, X, and M, based on the assumption we are making?" If higher prices imply that these components collectively increase, then aggregate demand is upward sloping. If higher prices imply that these components decrease, then aggregate demand is downward sloping:

We now derive aggregate demand in steps:

1. Suppose that, for some reason, prices go up. Because inflation and the inflation gap are both functions of prices, they also increase. So far, we have not made any assumptions.

2. Recall our model of supply and demand for money. The interest rate was on the vertical axis. Real money M/P was on the horizontal axis. So when P goes up, M/P goes down. The real money supply goes down. When money supply shifts to the left, interest rates go up.

Graph: Money Market

When we discussed money, we made numerous assumptions. Notably, we assumed that the money demand curve was downward sloping. These assumptions are thus part of our AS/AD model. If you think they are bad assumptions, then you should be skeptical of this model and the results that follow.

3. When interest rates increase, investment and consumption decline. This results from the assumptions we made when discussing how monetary policy works. These assumptions, that firms and homebuilders invest more as the interest rate declines, and the households consume more too, are also part of our model.

4. We have thus derived a downward sloping AD curve. As P goes up, $\tilde{\pi}$ increases, and $\tilde{Y}$ declines. As always, this result just follows from the assumptions we have made about the market for money and how consumption and investment depend on interest rates.

Other factors, separate from P can also affect aggregate demand. If they change $\tilde{Y}$ without affecting P, they shift the aggregate demand curve whereas changing P causes the model to move along it. The following factors have this effect:

1. Suppose that the government decides to increase its spending so that G goes up. Any value of $\tilde{\pi}$ now results in more output in the markets for goods and services. So the AD curve shifts to the right. Had G decreased, AD would have shifted to the left.

Graph: AS/AD

2. We now assume that consumption is increasing in households', *after tax* income. So if the government raises taxes, households will have less after tax income and will consume less. AD thus shifts to the left.

3. Suppose that foreigners acquire an increased taste for American bourbon. America's net exports ($X - M$ will thus increase. Any event that increases net exports will thus shift the AD curve to the right.

4. Suppose that the Central Bank does something to increase the nominal money supply (M), such as lowering its target interest rate. The real money supply M/P also increases for any price level. Interest rates fall, consumption and investment increase, and AD shifts to the right.

Table 1 summarizes these events and how they affect AD.

Table 1: Events that Impact Aggregate Demand

Event	Shift to AD	Comment
M ↑	AD →	Expansionary Monetary Policy
G ↑	AD →	Expansionary Fiscal Policy
T ↑	AD ←	Contractionary Fiscal Policy
X-M ↑	AD →	
P ↑	**NONE**	This is how we derived AD, we move along it

Note that the AD curve is not downward sloping for the same reasons as ordinary market demand curves typically are. The former slopes downward because higher prices reduce the real money supply, which increases interest rates, which reduces investment and consumption. The

latter slope downward because we typically assume decreasing marginal utility. The reasoning is very different and you should not think of the aggregate demand curve as the sum of ordinary demand curves.

Aggregate Supply

Aggregate supply (AS) refers to all combinations of output and prices where factor markets are in equilibrium. We will focus on one factor market, the labor market, although AS more generally incorporates other factor markets, such as capital, as well. We will derive this relationship only through intuition.

To simplify the analysis, we will treat all other inputs except labor (capital, land, energy) as exogenous. We are thus not trying to explain, for example, how the capital stock has reached a certain level.

1. If the nominal wage, W can adjust quickly, then changes to prices should have no effects on labor and output. Recall our simple graph of the labor market. Employment is on the horizontal axis and the real wage (W/P) is on the vertical.

Graph: Labor Market

Suppose that we are happily at equilibrium and prices double. If wages are flexible (as we typically assume prices are in microeconomics), then W can just double so that labor is unchanged. If labor is unchanged, then any price results in the same level of employment, and thus output. If labor and other inputs do not change, then neither does output.

Graphically, the AS curve is thus vertical:

Graph: AS/AD

2. Macroeconomics emerged in the 1930s with the publication of John Maynard Keynes's "The General Theory of Employment, Interest and Money." Keynes argued that there is something fundamentally different about the aggregate economy as compared to individual markets. One common approach to modeling this difference is to assume *sticky prices*. Sticky prices, which include the potential for sticky wages (a wage is just a price for labor), are when prices are slow to adjust to changes in economic conditions. Keynes himself suggested that contracts (possibly through collective bargaining) were a plausible source of this stickiness. Other explanations, however, have also been offered.

We now assume that nominal wages (W) are sticky. We could get similar results if we instead assumed that goods and services prices (P) are sticky. Consider an employee with a set wage. Every day, small factors affect both the productivity of that employee and her willingness to supply labor. Yet wages rarely adjust on a daily basis to such changes. This is some casual evidence for wage stickiness.

The assumption of price stickiness has long been controversial. Many macroeconomists still find it dubious. In my judgment, there is persuasive empirical evidence in defense of this approach.

Now suppose that P goes up. If W is sticky, then W/P goes down. The real wage is lower. This provides firms with an incentive to hire more workers. As employment goes up, so does output.[2]

[2]This approach also assumes that labor demand is more important than supply. Labor demand thus drives the results.

There is thus a positive relationship between inflation and output. The AS curve is thus upward sloping.

3. There is, however, a finite amount of labor and other inputs. No matter how high inflation might go, output cannot double in the short run. We thus assume that as the output gap becomes significantly positive, the AS curve becomes very steep so that additional inflation does not have large effects on output.

#2 and #3 may be reconciled. Perhaps when unemployment is relatively high (and the output gap is relatively low), nominal wages are sticky. Here, workers might lack the leverage to negotiate higher nominal wages as output becomes higher. But when unemployment is low, workers have more leverage, and they are able to "unstick" the nominal wage. Hence, AS starts fairly flat, but becomes steep as Y gets larger.

Graph: AS/AD

The AD curve can also shift if something other than P temporarily affects how much output a given amount of labor produces. The best example would be a change to another input. Suppose, for example, that energy prices fall. Moore affordable energy allows workers to be more productive o that the same wage and employment results in more output. AS shifts to the right.

Graph: AS/AD

Analyzing the Effects of Macroeconomic Events and Policies in the Model

We now consider some representative examples using the model:

#1: Contractionary Monetary Policy. Suppose that the FOMC is worried that inflation is going to exceed its target. It knows that more money causes higher prices (more inflation). So it instructs the New York Fed's trading desk to sell Treasuries until interest rates rise by 0.25%.

The Fed acquires money in exchange for the bonds. The reduction in the nominal money supply (M) causes the aggregate demand curve to shift to the left. The policy is successful in the short run in that inflation is reduced. The FOMC, however, faces a tradeoff. The output gap decreases. In the short run, monetary policy faces a tradeoff between lower inflation and higher output.

Graph: AS/AD

This example formalizes the intuition from the previous discussion of monetary policy. By lowering the money supply, the Fed raises interest rates (from the graph of the money market), discouraging investment and consumption. Because this policy reduces output, it is called *contractionary*. Had the Fed instead increased the money supply, both output and inflation would have increased. Such a policy is called *expansionary*.

#2: Expansionary fiscal policy. It is early 2009 and Congress was worried about rising unemployment and falling output. It thus passed what is known as *fiscal stimulus*, which includes tax cuts and increases to government spending. Both policies shift the aggregate demand curve to the right.

Graph: AS/AD

The fiscal stimulus increases output. Note that the effect is bigger when the output gap is highly negative. Were it highly positive, the effect would be small. In contrast, the effect on inflation becomes larger as $\tilde{Y}$ gets larger. Also, because higher prices reduce real wages, firms hire more labor which reduces unemployment.

This policy was in fact enacted as the American Recovery and Reinvestment Act (ARRA) of 2009. Although professional macroeconomists use much larger and sophisticated models, the basic intuition of our simple version was arguably the main motivation behind the policy.

#3: Rising energy prices. Here, higher energy prices reduce the productivity of labor, shifting the AS curve to the left.

Graph: AS/AD

This event (which is not a policy as in the previous two examples) causes both higher inflation and less output. Both of these changes are usually considered to be adverse (although higher inflation can be good if deflation is a concern). This combination is called *stagflation*. This term was coined during the 1970s when high unemployment and high inflation were observed simultaneously. This occurred because that economic downturn was caused by a reduction in aggregate supply instead of aggregate demand. Higher energy prices were in fact, a significant part of the story.

The Long Run AS Curve

All of the arguments that prices and wages are sticky apply only to the short run. After several years, macroeconomists agree that prices are flexible. In the long run (and we do not agree on how long the long run is), the AS curve is thus vertical in this model.

Consider any policy that increases aggregate demand. When the AD curve shifts to the right, inflation increases, but output does not change.

Graph: AS/AD

One final caution. We should not take this last result to imply that nothing the government does regarding taxes or spending affects long term macroeconomic output. Rather, these policies have no such effects in this model. But this is not a good model for long run macroeconomic analysis, its strength is the short run. If we seriously wanted to examine, for example, how a large government sector affected growth, we would be better off appending something like the Solow Model to include government spending.