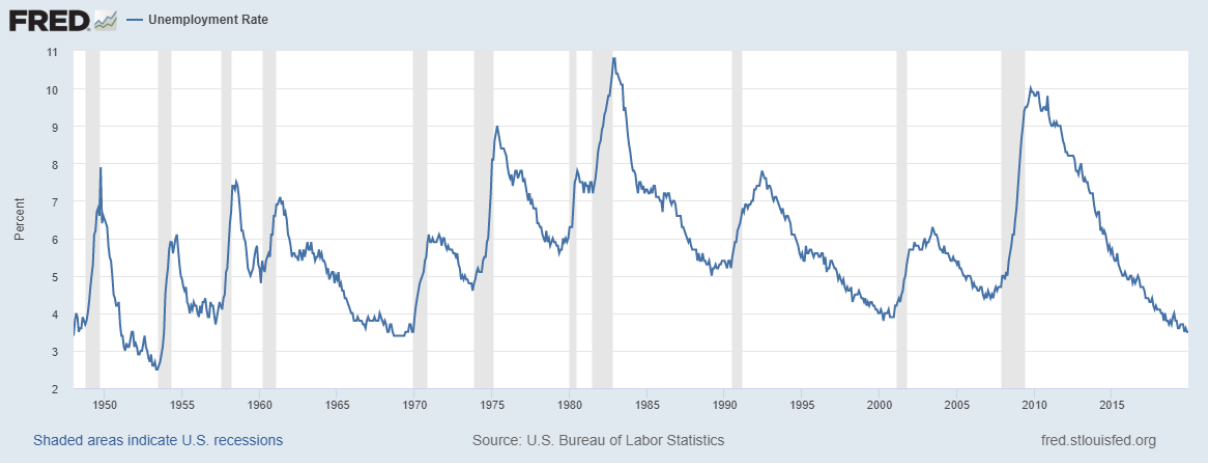
The AS/AD Model

We now turn our attention to explaining one of the central questions of macroeconomics: why are there business cycles? Business cycles refer to short-term fluctuations in macroeconomic performance. One part of the business cycle is a *recession*, which is defined as a period of declining economic activity. For many years, a recession was defined as two consecutive quarters of shrinking GDP. Now, however, the most popular dating method for the U.S. is a more subjective approach taken by the National Bureau of Economic Research (NBER). The NBER looks for a variety of signs that the economy is slumping including stagnant or shrinking output and high or rising unemployment. Figure 1 plots the U.S. civilian unemployment rate with recessions in grey.

Figure 1: U.S. U-3 Unemployment Rate



An *economic expansion* is the period of time between recessions where economic activity is increasing. As of January 2020, the U.S. is in the longest expansion in its history. Recessions may be becoming less frequent. And despite the severity of the Great Recession, they may also be becoming less severe, certainly compared to the nineteenth century.

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. These specific notes set up the basics of the model and we will next look at how fiscal policy (taxes and government spending) and monetary policy impact the model.

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

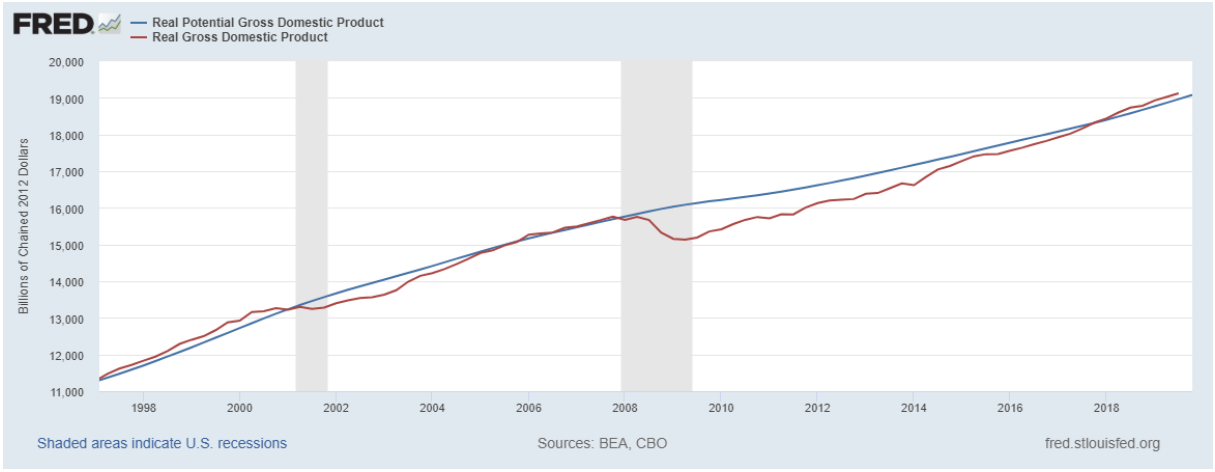
1. $\tilde{Y}$, the output gap. This is not real aggregate output. Rather, it is actual real output minus its natural rate. The natural rate of output is the level of output that the economy would produce, if unemployment equaled its natural rate (about 4-5% in the United States).

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.

Figure 2 shows an estimate of the natural rate of output along with actual GDP. Because the natural rate of GDP is not an actual variable, it must be estimated using statistical techniques and there is thus more potential measurement error than for actual GDP. The gap between these lines is the estimated output gap.

Figure 2: U.S. U-3 Potential GDP (blue) and actual GDP (red)



Importantly, we are not explaining where the natural rate of output comes from. Here, it is an *exogenous* variable that comes from outside the model. This does not mean it is unimportant.

The natural rate of output may be thought of as output's long-run level. Later in the course, we will examine what affects its value.

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. Other major Central Banks, including the European Central Bank, Bank of England, and the Bank of Japan use the same 2% 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.

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:

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

where C represents households' consumption of final goods and services, and I, investment, refers to firm's purchases of capital. New housing, whether it is purchased by firms or households is also included in investment. Housing has features of both consumption and investment. While it provides utility like most consumption goods, it is also used to create other goods

and services like a capital good. Including it in investment is more of an accounting than economic choice. G refers to government purchases of both capital and consumption goods. M are imports, purchases of capital and consumption goods made in other countries. These are also including in C, I, or G. By subtracting M, they do not affect GDP. X are exports, capital and consumption goods sold to other countries. They do count in aggregate output.

Conceptually, deriving aggregate demand is asking the question, "if prices go up or down, how does this 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:

There are many reasons why higher inflation could affect these components of GDP. Our aggregate demand curve is therefore a product of the specific assumptions we make. The following analysis does not consider every possible explanation. Instead, we will focus on the most plausible reasons.

Interest Rates

Interest rates are the price that borrowers pay to lenders on a loan. Suppose that I borrow \$100 and agree to pay you back \$105 in one year. The interest rate is then 5%. Because it is measured in a currency (dollars), we call this a *nominal interest rate*.

There are several reasons why lenders demand interest. These include the risk of default (and not getting fully paid back) and the time value of money which reflects that most people prefer \$1 today to \$1 tomorrow. Another factor, however, is inflation. If inflation is 5% then the purchasing power of \$100 today is the same as \$105 next year.

Real interest rates are calculated by subtracting inflation from nominal interest rates. But because lenders and borrowers do not know what inflation will be when a loan is made, they must rely on expected inflation: π^e.

$$r_t = i_t - \pi^e \tag{2}$$

For most loans (*e.g* student loans, mortgages), quoted interest rates are nominal and not real. But most economic behavior depends on the real rate, not the nominal rate. Paying 20% interest may seem excessive, but if you also expect inflation to be 20%, then it is not in real terms.

Why Aggregate Demand is Downward Sloping?

We now consider a few reasons why higher than expected inflation leads to higher demand:

i. Money demand. To understand the relationship between inflation and output, we need to consider the market for money. The nominal interest rate may be regarded as the price of money. If I hold \$100 for one year and the interest rate is 3%, then the opportunity cost of holding money for a year is 3%. I will choose to do so, however, if the convenience of holding money (it is easier to buy stuff) outweighs this cost.

Later in the course, we will discuss what constitutes money. For now, think of it as currency and checking accounts. For our simple model of supply and demand, we will use real money, $\frac{M}{P}$ instead of nominal money, M. Real money accounts for the purchasing power of money. Suppose, for example, that all prices double. The purchasing power of any amount of money has now been cut in half. Real money accounts for this.

Now suppose that prices increase. The real money supply decreases. Basic supply and demand suggest that interest rates, the price of money, rise.

Graph: Money Market

Higher interest rates discourage both investment and consumption. Many firms borrow in order to purchase new capital, and higher interest rates discourage them from doing so. Households are also discouraged from purchasing housing, considered part of investment, and durable consumption goods which require financing, such as cars.

2. Wealth effects. When inflation is higher than expected, those with positive wealth are made worse off because any amount of wealth now has less purchasing power. This may result in lower consumption.

Importantly, higher than expected inflation, reduces the real value of debts. This may spur increased consumption, offsetting some of the effect discussed in the previous paragraph.

3. International effects. Exchange rates represent the prices of different currencies. If one U.S. dollar may be exchanged for 2 Canadian dollars, then the USD/CAD exchange rate is 0.5. Equivalently, the CAD/USD exchange rate is 2.

Suppose that prices in the U.S. double so that any dollar now can only buy half as many goods and services. If Canadian prices stay the same, then we might expect the USD/CAD exchange rate to rise from 0.5 to 1 so one U.S. dollar also can only purchase $\frac{1}{2}$ as many Canadian dollars as before. But this is not always the case. If the exchange rate does not adjust, then Canadian fgoods and services become cheaper relative to American ones. Americans will likely export less and import more. Because net exports are part of aggregate output, $\tilde{Y}$ falls.
These factors cause a downward sloping AD curve. As P goes up, $\tilde{\pi}$ increases, and $\tilde{Y}$ declines.

Graph: AS/AD

Note that the AD curve is not downward sloping for the same reasons as ordinary market demand curves typically are. The former slopes downward partly 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.

There is one other factor that we consider:

4. Multiplier effects. Suppose that higher prices have already led to lower output. Household consumption is closely tied to households' after tax income (Y-T). As average income falls, households respond by lowering their consumption. This amplifies (makes worse) the initial decline in output. This is not a cause of a downward sloping AD curve. But it does make it flatter because any drop in prices now leads to an even bigger change in output.

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 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

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. We will instead save this question for later in the semester.

The supply of labor comes from household preferences. We assume that as real wages go up, households choose to work more. This is not obvious. It is also possible that some households will choose to work less- in essence buying more leisure time with their increased wages.

Labor demand is related to the marginal product of labor- how much additional output a worker produces. Suppose that an additional worker will produce $30 of extra output per hour. Then firms will be willing to pay up to this wage.

1. If the nominal wage, W can adjust quickly, then changes to prices should have no effects on labor and output. We begin with simple graph of the labor market. Employment is on the horizontal axis and the real wage (W/P) is on the vertical. We once again use the real wage instead of the nominal wage (W) because workers care about how much their wages can purchase.

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.[1]

[1]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 technological innovation allows workers to be more productive so that the same wage and employment results in more output. AS shifts to the right.

Graph: AS/AD

Other factors that make it costlier to produce output, excluding the wage, can shift AS to the left. Suppose, for example, that trade is eliminated. This would prevent firms from specializing and cause AS to shift to the left. For oil importing nations, higher oil prices cause AS to shift to the left.

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 raises interest rates rise by 0.25%. This 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 lowered interest rates, 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.

It is worth noting that as the United States has become less dependent on imported energy, the effect of higher energy prices on the economy is less important than it used to be. For energy exporters, higher prices may be a net benefit.

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 want a model designed for long-term analysis. We will address this when we develop the Solow model later in the semester.

Long Term AS

Our assumption that wages are sticky is only true in the short-run. In the long run, a period we may think of as a few years, wages will adjust and the world goes back to our basic model of supply and demand where equilibrium occurs where the two curves intersect. We can call this point, long term aggregate supply, and it is simply a vertical line at $\tilde{Y} = 0$.

So how does the economy go from the short run to the long run. Suppose that the wage is initially stuck at a high level. We thus have a negative output gap, $\tilde{Y} < 0$. In the long-run, wages will become unstuck and fall. But this means that production is cheaper. AS thus shifts to the right so that $\tilde{Y} = 0$.

Graph: AS/AD