Introducing the IS-MP-PC Model

As this is the second module in a two-module sequence, following Intermediate Macroeconomics, I am assuming that everyone in this class has seen the IS-LM and AS-AD models. In the first part of this course, we are going to revisit some of the ideas from those models and expand on them in a number of ways:

- Rather than the traditional LM curve, we will describe monetary policy in a way that is more consistent with how it is now implemented, i.e. we will assume the central bank follows a rule that dictates how it sets nominal interest rates. We will focus on how the properties of the monetary policy rule influence the behaviour of the economy.
- We will have a more careful treatment of the roles played by real interest rates.
- We will focus more on the role of the public's inflation expectations.
- We will model the zero lower bound on interest rates and discuss its implications for policy.

Our model is going to have three elements to it:

- **A Phillips Curve** describing how inflation depends on output.
- **An IS Curve** describing how output depends upon interest rates.
- **A Monetary Policy Rule** describing how the central bank sets interest rates depending on inflation and/or output.

Putting these three elements together, I will call it the IS-MP-PC model (i.e. The Income-Spending/Monetary Policy/Phillips Curve model). I will describe the model with equations.

I will also merge together the second two elements (the IS curve and the monetary policy rule) to give a new IS-MP curve that can be combined with the Phillips curve to use graphs to illustrate the model's properties.[1]

Model Element One: The Phillips Curve

Perhaps the most common theme in economics is that you can't have everything you want. Life is full of trade-offs, so that if you get more of one thing, you have to have less of another thing. In macroeconomics, there are important trade-offs facing governments when they implement policy. One of these relates to a trade-off between desired outcomes for inflation and output.

What form does this relationship take? Back when macroeconomics was a relatively young discipline, in 1958, a study by the LSE's A.W. Phillips seemed to provide the answer. Phillips documented a strong negative relationship between wage inflation and unemployment: Low unemployment was associated with high inflation, presumably because tight labour markets stimulated wage inflation. Figure 1 shows one of the graphs from Phillips's paper illustrating the kind of relationship he found.

In 1960, a paper by MIT economists Robert Solow and Paul Samuelson (both of whom would go on to win the Nobel prize in economics for other work) replicated these findings for the US and emphasised that the relationship also worked for price inflation. Figure 2 reproduces the graph in their paper describing the relationship they found. The Phillips curve

[1] Though the particular model that will be presented in these lectures can't be found in any specific article or book, models that are very similar have been presented by a number of economists. In particular, the article linked to on the website by Walsh (2002) presents a similar model. I have provided a links to Walsh's paper on the website but only for those interested in seeing a versions of our model that consider some more advanced issues such as optimal monetary policy rules.

quickly became the basis for the discussion of macroeconomic policy decisions. Economists advised that governments faced a tradeoff: Lower unemployment could be achieved, but only at the cost of higher inflation.

However, Milton Friedman's 1968 presidential address to the American Economic Association produced a well-timed and influential critique of the thinking underlying the Phillips curve. Friedman pointed out that it was expected real wages that affected wage bargaining. If low unemployment means workers have a strong bargaining position, then high nominal wage inflation on its own is not good enough: They want nominal wage inflation greater than price inflation.

Friedman argued that if policy-makers tried to exploit an apparent Phillips curve tradeoff, then the public would get used to high inflation and come to expect it. Inflation expectations would move up and the previously-existing tradeoff between inflation and output would disappear. In particular, he put forward the idea that there was a "natural" rate of unemployment and that attempts to keep unemployment below this level could not work in the long run.

Evidence on the Phillips Curve

Monetary and fiscal policies in the 1960s were very expansionary around the world, partly because governments following Phillips curve "recipes" chose booming economies with low unemployment at the expense of somewhat higher inflation.

At first, the Phillips curve seemed to work: Inflation rose and unemployment fell. However, as the public got used to high inflation, the Phillips tradeoff got worse. By the late 1960s inflation was rising even though unemployment had moved up. Figure 3 shows the US time series for inflation and unemployment. This *stagflation* combination of high inflation and high unemployment got even worse in the 1970s. This was exactly what Friedman had predicted.

Today, the data no longer show any sign of a negative relationship between inflation and unemployment. If fact, if you look at the scatter plot of US inflation and unemployment data shown in Figure 4, the correlation is positive: The original formulation of the Phillips curve is widely agreed to be wrong.

Figure 1: One of A. W. Phillips's Graphs

Figure 2: Solow and Samuelson's Description of the Phillips Curve

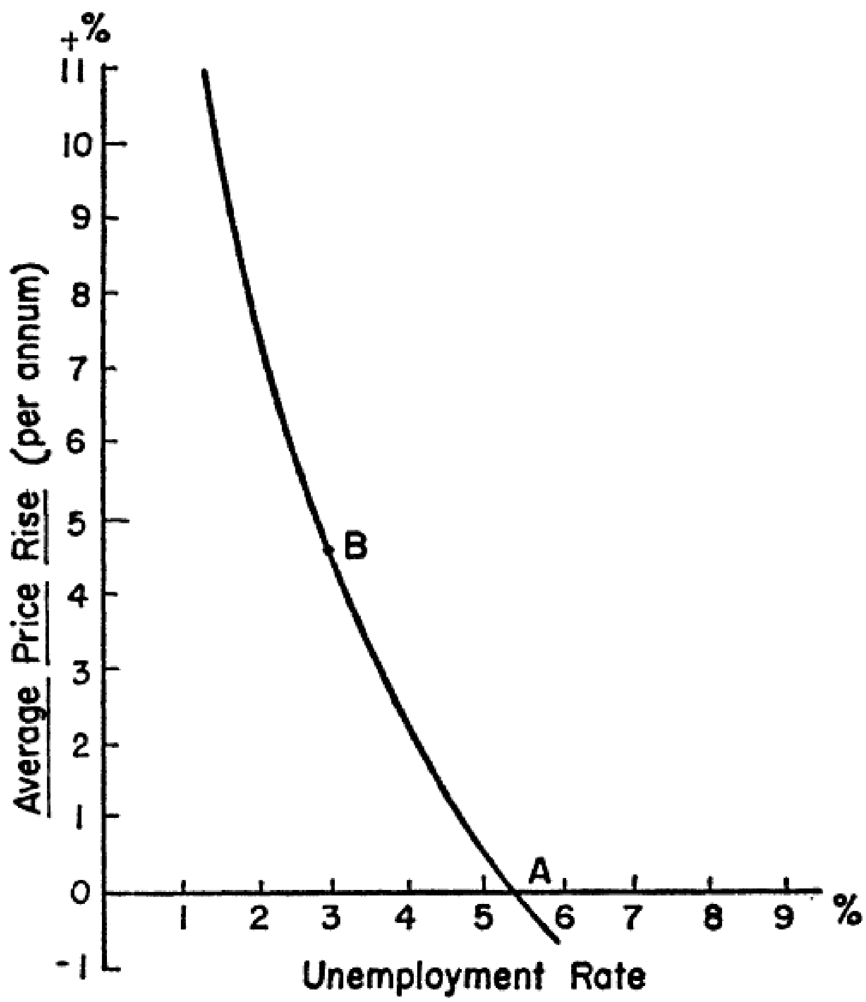


FIGURE 2

MODIFIED PHILLIPS CURVE FOR U.S.
This shows the menu of choice between different degrees of unemployment and price stability, as roughly estimated from last twenty-five years of American data.

Figure 3: The Evolution of US Inflation and Unemployment

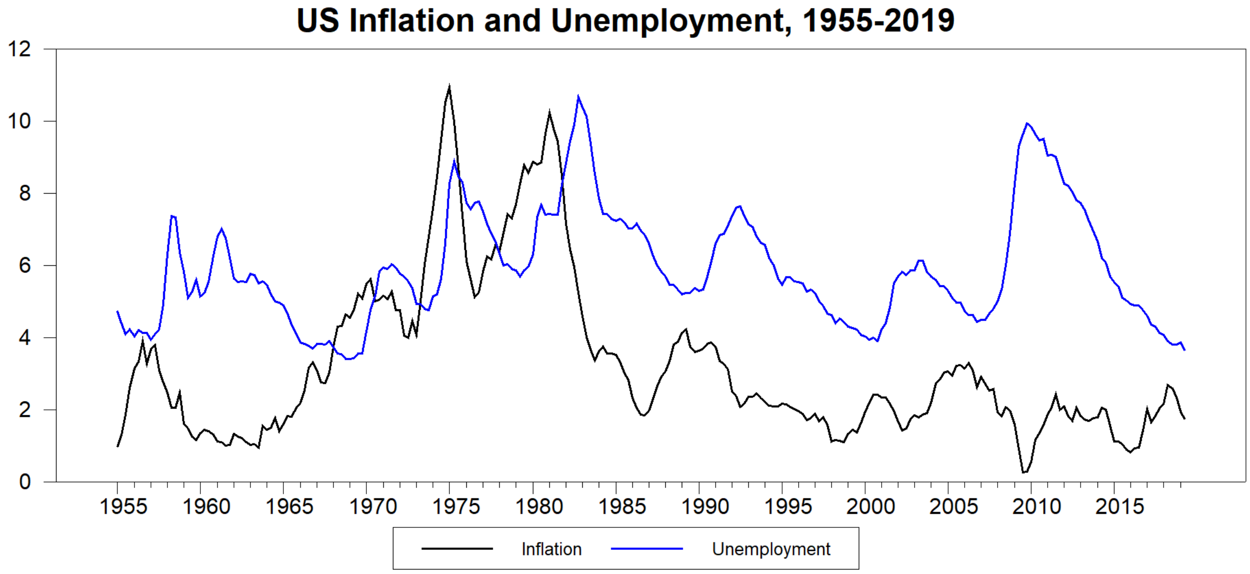
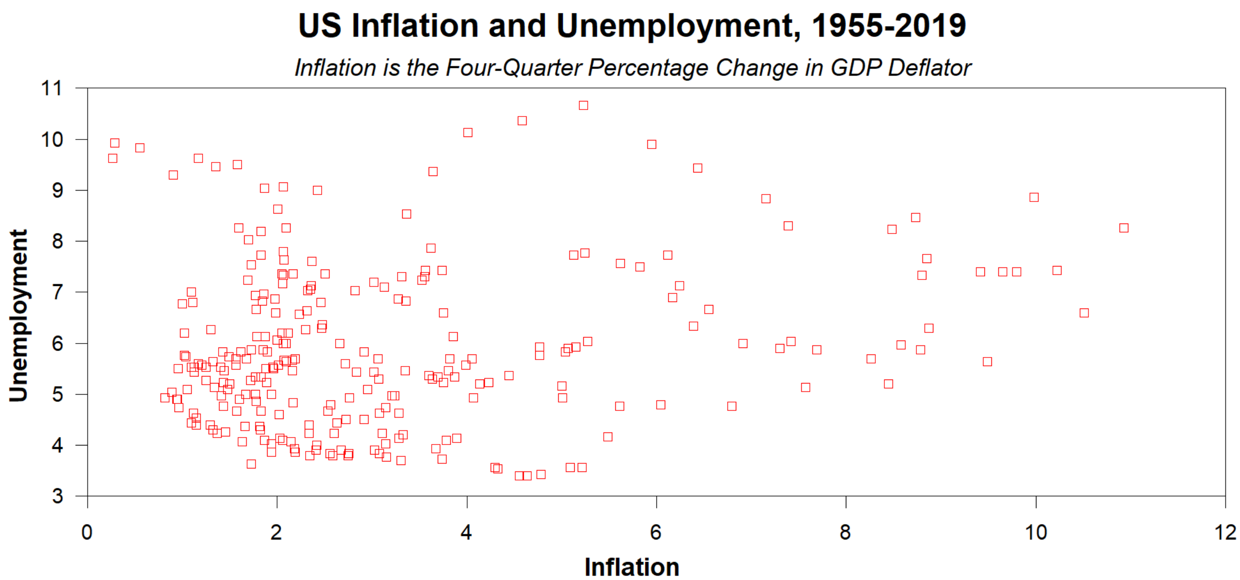


Figure 4: The Failure of the Original Phillips Curve



Equations: Variables, Parameters and All That

We will use both graphs and equations to describe the models in this class. Now I know many students don't like equations and believe they are best studiously avoided. However, that won't be a good strategy for doing well in this course, so I strongly encourage you to engage with the technical material in this class. It isn't as hard is it might look to start with.

Variables and Coefficients: The equations in this class will generally have a certain format. They will often look a bit like this.

$$y_t = \alpha + \beta x_t \tag{1}$$

There are two types of objects in this equation. First, there are the *variables*, y_t and x_t. These will correspond to economic variables that we are interested in (inflation or GDP for example). We interpret y_t as meaning "the value that the variable y takes during the time period t"). For most models in this course, we will treat time as marching forward in discrete intervals, i.e. period 1 is followed by period 2, period t is followed by period $t+1$ and so on.

Second, there are the parameters or *coefficients*. In this example, these are given by α and β. These are assumed to stay fixed over time. There are usually two types of coefficients: Intercept terms like α that describe the value that series like y_t will take when other variables all equal zero and coefficients like β that describe the impact that one variable has on another. In this case, if β is a big number, then a change in the variable x_t has a big impact on y_t while if β is small, it will have a small impact.

Some of you are probably asking what those squiggly shapes — α and β — are. They are Greek letters. While it's not strictly necessary to use these shapes to represent model parameters, it's pretty common in economics. So let me introduce them: α is alpha (Al-Fa), β is beta (Bay-ta), γ is gamma, δ is delta, θ is theta (Thay-ta) and π naturally enough is pi.

Dynamics: One of the things we will be interested in is how the variables we are looking at will change over time. For example, we will have equations along the lines of

$$y_t = \beta y_{t-1} + \gamma x_t \tag{2}$$

Reading this equation, it says that the value of y at time t will depend on the value of x at time t and also on the value that y took in the previous period i.e. $t-1$. By this, we mean that this equation holds in every period. In other words, in period 2, y depends on the value that x takes in period 2 and also on the value that y took in period 1. Similarly, in period 3, y depends on the value that x takes in period 3 and also on the value that y took in period 2. And so on.

Subscripts and Superscripts: When we write y_t, we mean the value that the variable y takes at time t. Note that the t here is a *subscript* – it goes at the bottom of the y. Some students don't realise this is a subscript and will just write yt but this is incorrect (it reads as though the value t is multiplying y which is not what's going on).

We will also sometimes put indicators above certain variables to indicate that they are special variables. For example, in the model we present now, you will see a variable written as π_t^e which will represent the public's expectation of inflation. In the model, π_t is inflation at time t and the e above the π in π_t^e is there to signify that this is not inflation itself but rather it is the public's expectation of it.

Our Version of the Phillips Curve

We will use both graphs and equations to describe the various elements of our model. One convention that I want to flag here is that all of the parameters in our model will be assumed to be positive. If a right-hand-side variable has a negative effect on the left-hand-side variable, we will put a minus sign in front of the parameter.

The first element of the model is an expectations-augmented Phillips curve which we will formulate as a relationship in which inflation depends on inflation expectations, the gap between output and its "natural" level and a temporary inflationary shock. Our equation for this is the following:

$$\pi_t = \pi_t^e + \gamma \left(y_t - y_t^* \right) + \epsilon_t^\pi \tag{3}$$

In this equation π represents inflation and by π_t we mean inflation at time t. The equation states that inflation at time t depends on three factors:

1. **Inflation Expectations,** π_t^e: This term—which puts an e superscript above the π_t—represents the public's inflation expectations at time t. We have put a time subscript on this variable because the public's expectations may change over time. Note that a 1 point increase in inflation expectations raises inflation by exactly 1 point. This is because we are assuming that people bargain over real wages and higher expected inflation translates one-for-one into their wage bargaining, which in turn is passed into price inflation.

2. **The Output Gap,** $(y_t - y_t^*)$: This is the gap between GDP at time t, as represented by y_t, and what we will term the "natural" level of output, which we term y_t^*. This is the level of output at time t that would be consistent with unemployment equalling its natural rate. (Note we are describing inflation as being dependent on the output

gap rather than the gap between unemployment and its natural rate because this would require adding an extra element to the model, i.e. the link between unemployment and output). We would expect this natural level of output to gradually increase over time as productivity levels improve. The coefficient γ (pronounced "gamma") describes exactly how much inflation is generated by a 1 percent increase in the gap between output and its natural rate.

3. **Temporary Inflationary Shocks,** ϵ_t^π: No model in economics is perfect. So while inflation expectations and the output gap may be key drivers of inflation, they won't capture all the factors that influence inflation at any time. For example, "supply shocks" like a temporary increase in the price of imported oil can drive up inflation for a while. To capture these kinds of temporary factors, we include an inflationary "shock" term, ϵ_t^π. (ϵ is a Greek letter pronounced "epsilon"). The superscript π indicates that this is the inflationary shock (this will distinguish it from the output shock that we will also add to the model) and the t subscript indicates that these shocks change over time.

The Phillips Curve Graph

Figure 5 shows how to describe our Phillips curve equation in a graph. The graph shows a positive relationship between inflation and output. The key points to notice are the markings on the two axes indicating what happens when output is at its natural rate. This graph illustrates the case when there are no temporary inflationary shocks so $\epsilon_t^\pi = 0$. In this case, the Phillips curve is just

$$\pi_t = \pi_t^e + \gamma \left(y_t - y_t^* \right) \tag{4}$$

So when $y_t = y_t^*$ we get $\pi_t = \pi_t^e$. This is a key aspect of this graph. If you are asked to draw this graph in the final exam and you just draw an upward-sloping curve without describing the key points on the inflation and output axes, you won't score many points.

The curve can move up or down depending on what happens to the inflationary shocks, ϵ_t^{π}, and with inflation expectations. Figure 6 illustrates what happens when there is a positive inflationary shock so that ϵ_t^{π} goes from being zero to being positive. In this case, even when output equals its natural level (i.e. $y_t = y_t^*$) we still get inflation being above its expected level. Figure 7 illustrates how the curve changes when expected inflation rises from π_1 to π_2. The whole curve shifts upwards because of the increase in expected inflation.

Figure 5: The Phillips Curve with $\epsilon_t^{\pi} = 0$

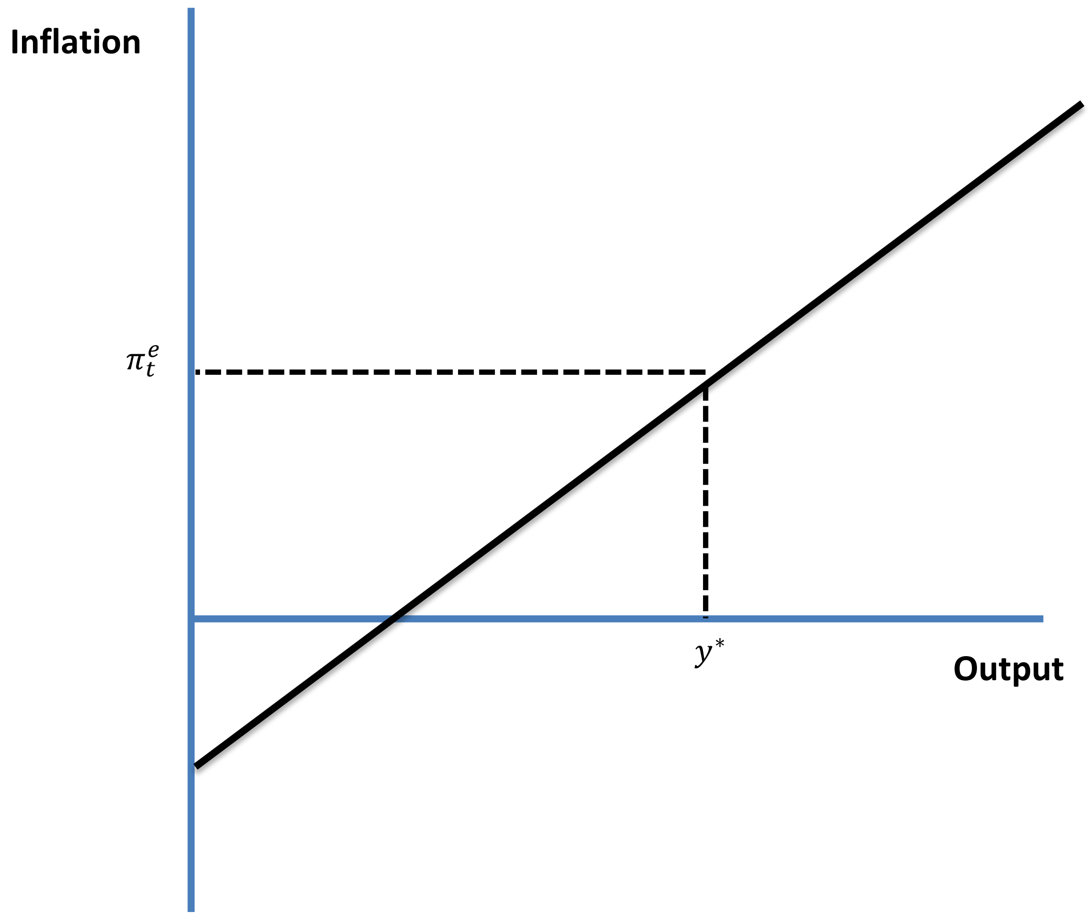


Figure 6: The Phillips Curve as we move from $\epsilon_t^\pi = 0$ to $\epsilon_t^\pi > 0$ (An Aggregate Supply Shock)

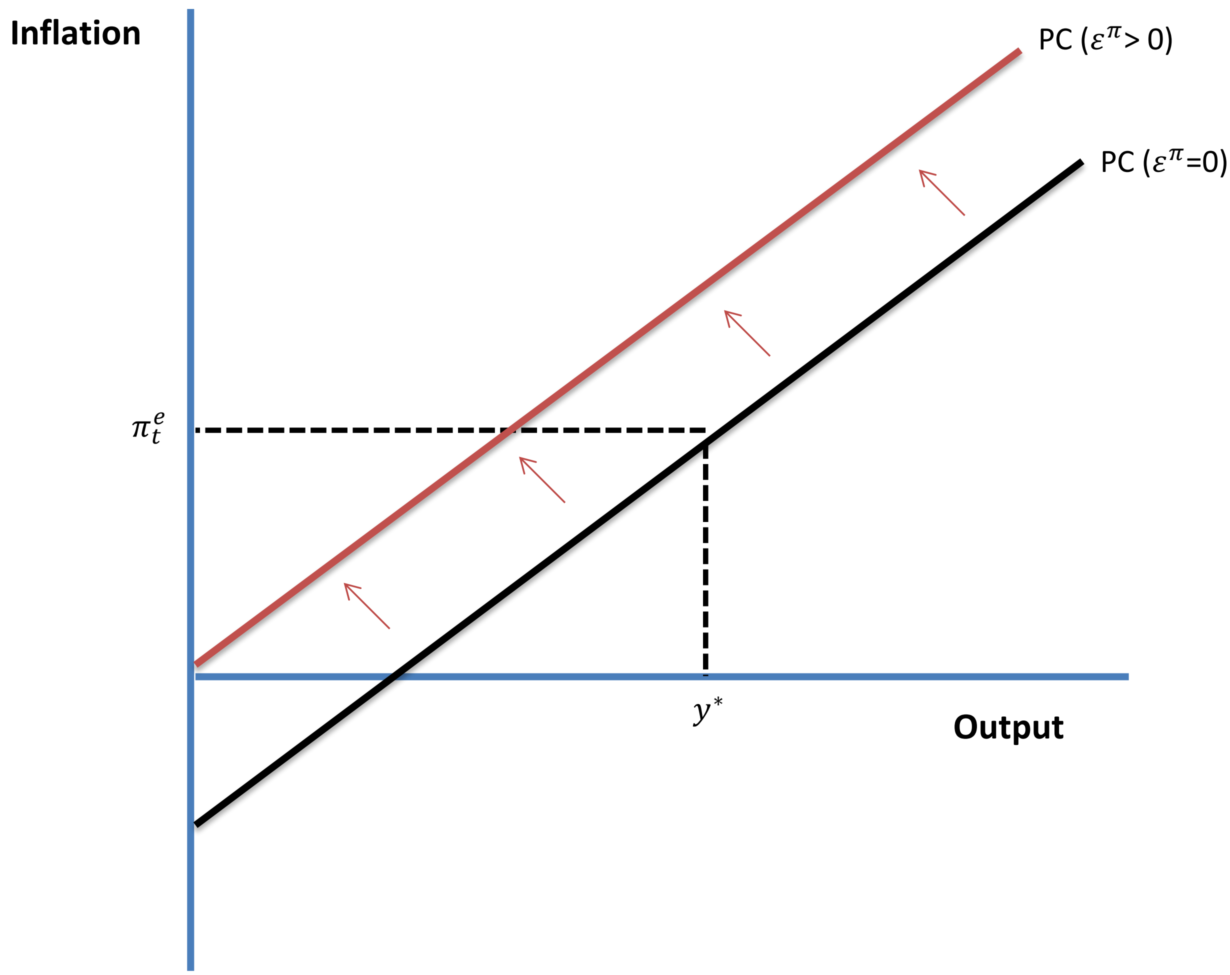
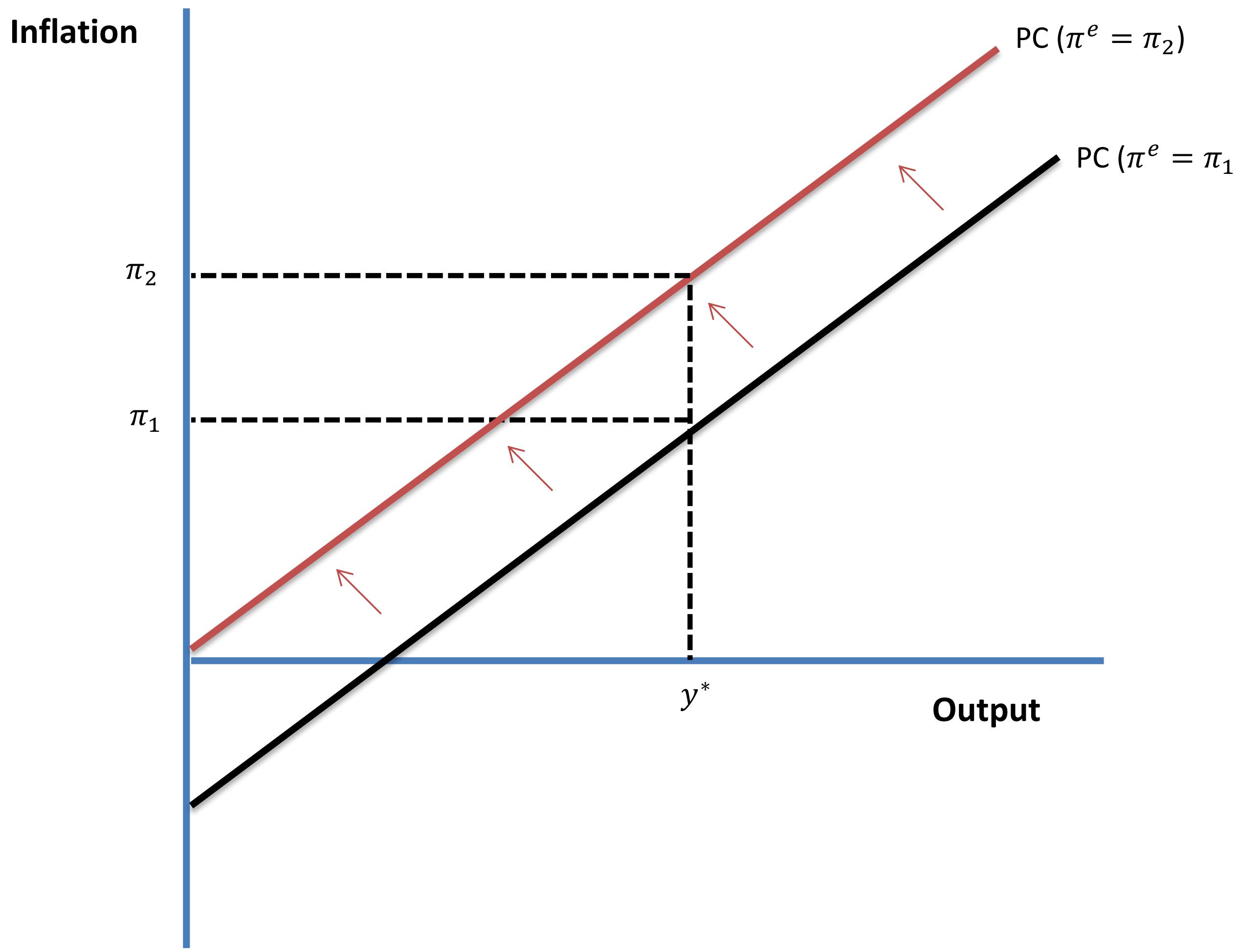


Figure 7: The Phillips Curve as we move from $\pi_t^e = \pi_1$ to $\pi_t^e = \pi_2$



Model Element Two: The IS Curve

The second element of the model is one that should be familiar to you: An IS curve relating output to interest rates. The higher interest rates are, the lower output is. However, I want to stress something here that is often not emphasised in introductory treatments of the IS curve. The IS relationship is between output and *real* interest rates, not nominal rates. Real interest rates adjust the headline (nominal) interest rate by subtracting off inflation.

Think for a second about why it is that real interest rates are what matters. You know already that high interest rates discourage aggregate demand by reducing consumption and investment spending. But what is a high interest rate? Suppose I told you the interest rate was 10 percent. Is this a high interest rate?

You might be inclined to say, "Yes, this is a high interest rate" but the answer is that it really depends on inflation. Consider the decision to save for tomorrow or spend today. The argument for saving is that it can allow you to consume more tomorrow. If the real interest rate is positive, then this means that you will be able to purchase more goods and services tomorrow with the money that you set aside. For instance, if the interest rate if 5% but inflation is 2%, then you'll be able to buy 3% more stuff next year because you saved. In constrast, if the interest rate if 5% but inflation is 8%, then you'll be able to buy 3% less stuff next year even though you have saved your money and earned interest. For these reasons, it is the real interest rate that determines whether consumers think saving is attractive relative to spending.

The same logic applies to firms thinking about borrowing to make investment purchases. If inflation is 10%, then a firm can expect that its prices (and profits) will be increasing by that much over the next year and a 10% interest rate won't seem so high. But if prices are falling, then a 10% interest rate on borrowings will seem very high.

With these ideas in mind, our version of the IS curve will be the following:

$$y_t = y_t^* - \alpha \left(i_t - \pi_t - r^* \right) + \epsilon_t^y \tag{5}$$

Expressed in words, this equation states that the gap between output and its natural rate $(y_t - y_t^*)$ depends on two factors:

1. **The Real Interest Rate**: The nominal interest rate at time t is represented by i_t, so the real interest rate is $i_t - \pi_t$. The coefficient α (pronounced "alpha") describes the effect of a one point increase in the real interest rate on output. As noted above, all of our parameters are assumed to be positive, so $\alpha > 0$. Note, though, there is a negative sign in front of it. This means increases in the real interest rate have a negative effect on output. The equation has been constructed in a particular way so that it explicitly defines the real interest rate at which output will, on average, equal its natural rate. This rate can be termed the "'natural rate of interest" a term first used by early 20th century Swedish economist Knut Wicksell. Specifically, we can see from the equation that if $\epsilon_t^y = 0$ then a real interest rate of r^* will imply $y_t = y_t^*$.

2. **Aggregate Demand Shocks,** ϵ_t^y: The IS curve is an even more threadbare model of output than the Phillips curve model is of inflation. Many other factors beyond the real interest rate influence aggregate spending decisions. These include fiscal policy, asset prices and consumer and business sentiment. We will model all of these factors as temporary deviations from zero of an aggregate demand "shock", ϵ_t^y. Note that this shock has a superscript y to distinguish it from the "aggregate supply" shock ϵ_t^π that moves the Phillips curve up and down.

Model Element Three: A Monetary Policy Rule

Thus far, our model has described how inflation depends on output and how output depends on interest rates. We can complete the model by describing how interest rates are determined.

Traditionally, in the IS-LM model, this is where the LM curve is introduced. The LM curve links the demand for the real money stock with nominal interest rates and output, with a relationship of the form

$$\frac{m_t}{p_t} = \delta - \mu i_t + \theta y_t \tag{6}$$

For a given stock of money (m_t) and a given level of prices (p_t), this relationship can be re-arranged to give a positive relationship between output and interest rates of the form

$$y_t = \frac{1}{\theta}\left(\frac{m_t}{p_t} - \delta + \mu i_t\right) \tag{7}$$

This positive relationship between output and interest rates is combined with the negative relationship between these variables in the IS curve to determine unique values for output and interest rates, something that can be illustrated in a graph with an upward-sloping LM curve and a downward-sloping IS curve. Monetary policy is then described as taking the form of the central bank adjusting the money supply m_t in a way that sets the position of the LM curve. The determination of prices is usually described separately in an AS-AD model.

We will not be using the LM curve, for three reasons.

1. **Realism 1**: In practice, no modern central bank implements its monetary policy by setting a specified level of the monetary base. Instead, they use their power to supply potentially unlimited amounts of liquidity to set short-term interest rates to equal a target level. The supply of base money ends up being whatever emerges from enforcing the interest rate target. This approach — which has been the practice at all the major

central banks for at least 30 years — makes the LM curve (and the money supply) of secondary interest when thinking about core macroeconomic issues. Our approach will be to describe how the central bank sets interest rates and we won't focus on the money supply.

2. **Realism 2**: The traditional approach is for IS-LM to describe the determination of output and interest rates. Then a separate AS-AD model is used to describe the determination of prices (and thus, implicitly, inflation). However, the reality is that rather than being determined independently of inflation, most modern central banks set interest rates with a very close eye on inflationary developments. A model that integrates the determination of inflation with the setting of monetary policy is thus more realistic.

3. **Simplicity**: In simplifying the determination of output, inflation and interest rates down to a single model, this approach is also simpler than one that requires two different sets of graphs.

We will consider two different types of monetary policy rules that may be followed by the central bank in our model. The first one is a simple one in which the central bank adjusts its interest rate in line with inflation with the goal of meeting an inflation target. Specifically, the first rule we will consider is the following one:

$$i_t = r^* + \pi^* + \beta_\pi \left(\pi_t - \pi^*\right) \tag{8}$$

In English, the rule can be intepreted as follows: The central bank adjusts the nominal interest rate, i_t, upwards when inflation, π_t, goes up and downwards when inflation goes down (we are assuming that $\beta_\pi > 0$) and it does so in a way that means when inflation equals a target level, π^*, chosen by the central bank, real interest rates will be equal to their natural level.

That's a bit of a mouthful, so let's see that this is the case and then try to understand why the monetary policy rule would take this form. First, note what the nominal interest rate will be if inflation equals its target level (i.e. $\pi_t = \pi^*$). The term after the final plus sign in equation (8) will equal zero and the nominal interest rate will be

$$i_t = r^* + \pi^* \tag{9}$$

In this case, because $\pi_t = \pi^*$, we can also write this as

$$i_t = r^* + \pi_t \tag{10}$$

So the real interest rate will be

$$i_t - \pi_t = r^* \tag{11}$$

Now think about why a rule of this form might be a good idea. Suppose the central bank has a target inflation rate of π^* that it wants to achieve. Ideally, it would like the public to understand that this is the likely inflation rate that will occur, so that $\pi_t^e = \pi^*$. If that can be achieved, then the Phillips curve (equation 3) tells us that, on average, inflation will equal π^* provided we have $y_t = y_t^*$. And the IS curve tells us that, on average, we will have $y_t = y_t^*$ when $i_t - \pi_t = r^*$. So this is a policy that can help to enforce an average inflation rate equal to the central bank's desired target, provided the public adjusts its inflationary expectations accordingly.

The IS-MP Curve

That's the model. It consists of three equations. Let's pull them together in one place. They are the Phillips curve:

$$\pi_t = \pi_t^e + \gamma\left(y_t - y_t^*\right) + \epsilon_t^\pi \tag{12}$$

The IS curve:

$$y_t = y_t^* - \alpha\left(i_t - \pi_t - r^*\right) + \epsilon_t^y \tag{13}$$

And the monetary policy rule:

$$i_t = r^* + \pi^* + \beta_\pi\left(\pi_t - \pi^*\right) \tag{14}$$

Now you may recall that I had promised a graphical representation of this model. However, this is a system of three variables which makes it hard to express on a graph with two axes. To make the model easier to analyse using graphs, we are going to reduce it down to a system with two main variables (inflation and output). We can do this because the monetary policy rule makes interest rates are a function of inflation, so we can substitute this rule into the IS curve to get a new relationship between output and inflation that we will call the IS-MP curve.

We do this as follows. Replace the term i_t in equation (13) with the right-hand-side of equation (14) to get

$$y_t = y_t^* - \alpha\left[r^* + \pi^* + \beta_\pi\left(\pi_t - \pi^*\right)\right] + \alpha\left(\pi_t + r^*\right) + \epsilon_t^y \tag{15}$$

Now multiply out the terms in this equation to get

$$y_t = y_t^* - \alpha r^* - \alpha\pi^* - \alpha\beta_\pi\left(\pi_t - \pi^*\right) + \alpha\pi_t + \alpha r^* + \epsilon_t^y \tag{16}$$

We can bring together the two terms being multiplied by α on its own, and cancel out the terms in αr^* to get

$$y_t = y_t^* - \alpha\beta_\pi \left(\pi_t - \pi^*\right) + \alpha \left(\pi_t - \pi^*\right) + \epsilon_t^y \tag{17}$$

which simplifies to

$$y_t = y_t^* - \alpha \left(\beta_\pi - 1\right) \left(\pi_t - \pi^*\right) + \epsilon_t^y \tag{18}$$

This is the IS-MP curve. It combines the information in the IS curve and the MP curve into one relationship.

The IS-MP Curve Graph

What would this curve look like on a graph? It turns out it depends especially on the value of β_π, the parameter that describes how the central bank reacts to inflation. The IS-MP curve says that an extra unit of inflation implies a change of $-\alpha\left(\beta_\pi - 1\right)$ in output. Is this positive or negative? Well we are assuming that $\alpha > 0$ (we put a negative sign in front of this when determining the effect of real interest rates on output) so this combined coefficient will be negative if $\beta_\pi - 1 > 0$.

In other words, the IS-MP curve will have a negative slope (slope downwards) provided the central bank reacts to inflation so that $\beta_\pi > 1$. The explanation for this is as follows. An increase in inflation of x will lead to an increase in nominal interest rates of $\beta_\pi x$ so real interest rates change by $\left(\beta_\pi - 1\right) x$. This means that if $\beta_\pi > 1$ an increase in inflation leads to higher real interest rates and, via the IS curve relation, to lower output. So if $\beta_\pi > 1$ then the IS-MP curve can be depicted as a downward-sloping curve. In contrast, if $\beta_\pi < 1$, then an increase in inflation leads to lower real interest rates and higher output, implying an upward-sloping IS-MP curve.

For now, we will assume that $\beta_\pi > 1$ so that we have a downward-sloping IS-MP curve but we will revisit this issue after a few more lectures. Figure 8 thus shows what the IS-MP curve looks like when the aggregate demand shock $\epsilon_t^y = 0$. Again, the key thing to notice is the value of inflation that occurs when output equals its natural rate. When $y_t = y_t^*$ we get $\pi_t = \pi^*$. As with the Phillips curve, if you are asked to draw this graph in the final exam and you just draw an downward-sloping curve without describing the key points on the inflation and output axes, you won't score many points. Figure 9 shows how the IS-MP curve shifts to the right if there is a positive value of ϵ_t^y corresponding to a positive shock to aggregate demand.

Figure 8: The IS-MP Curve with $\epsilon_t^y = 0$

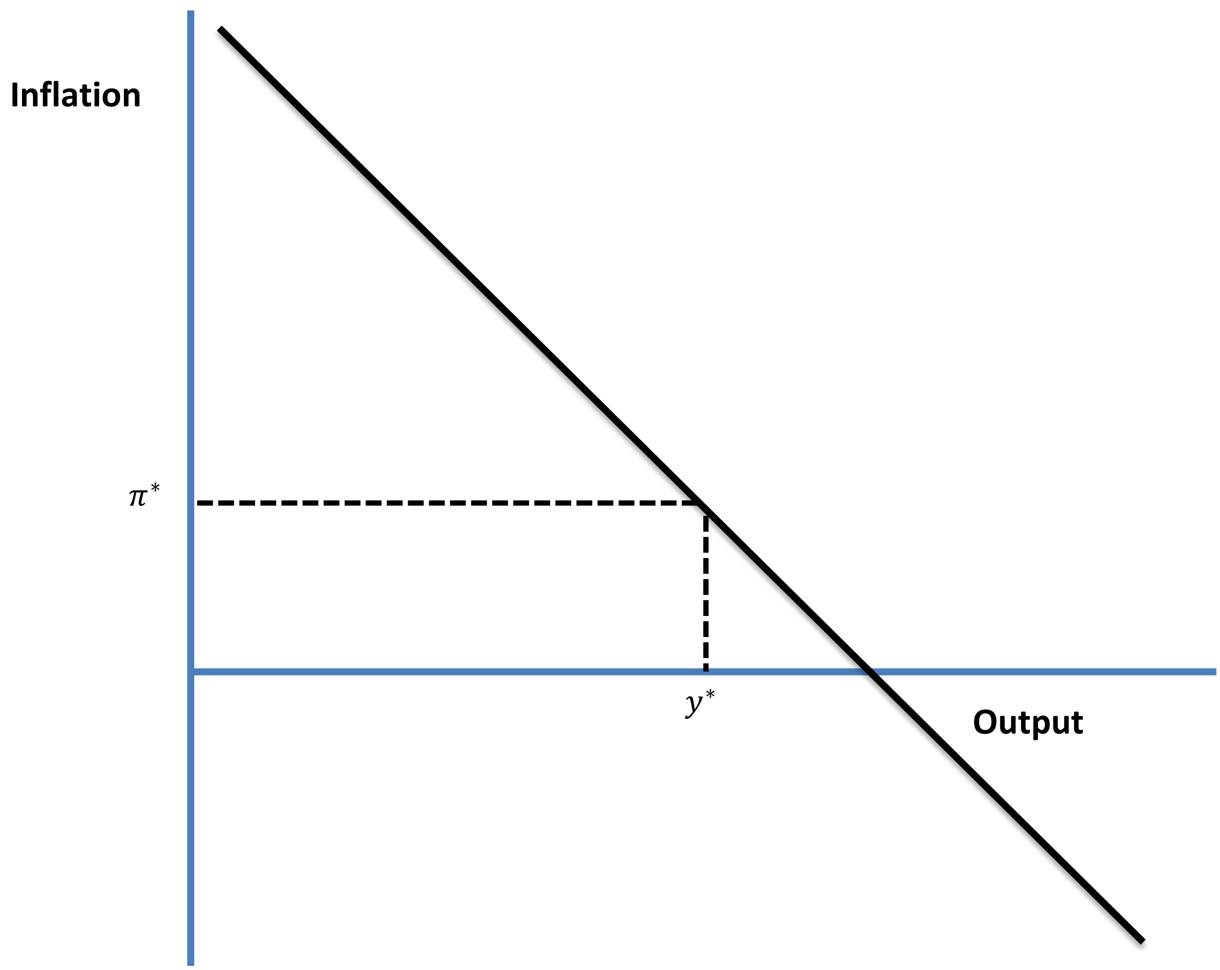
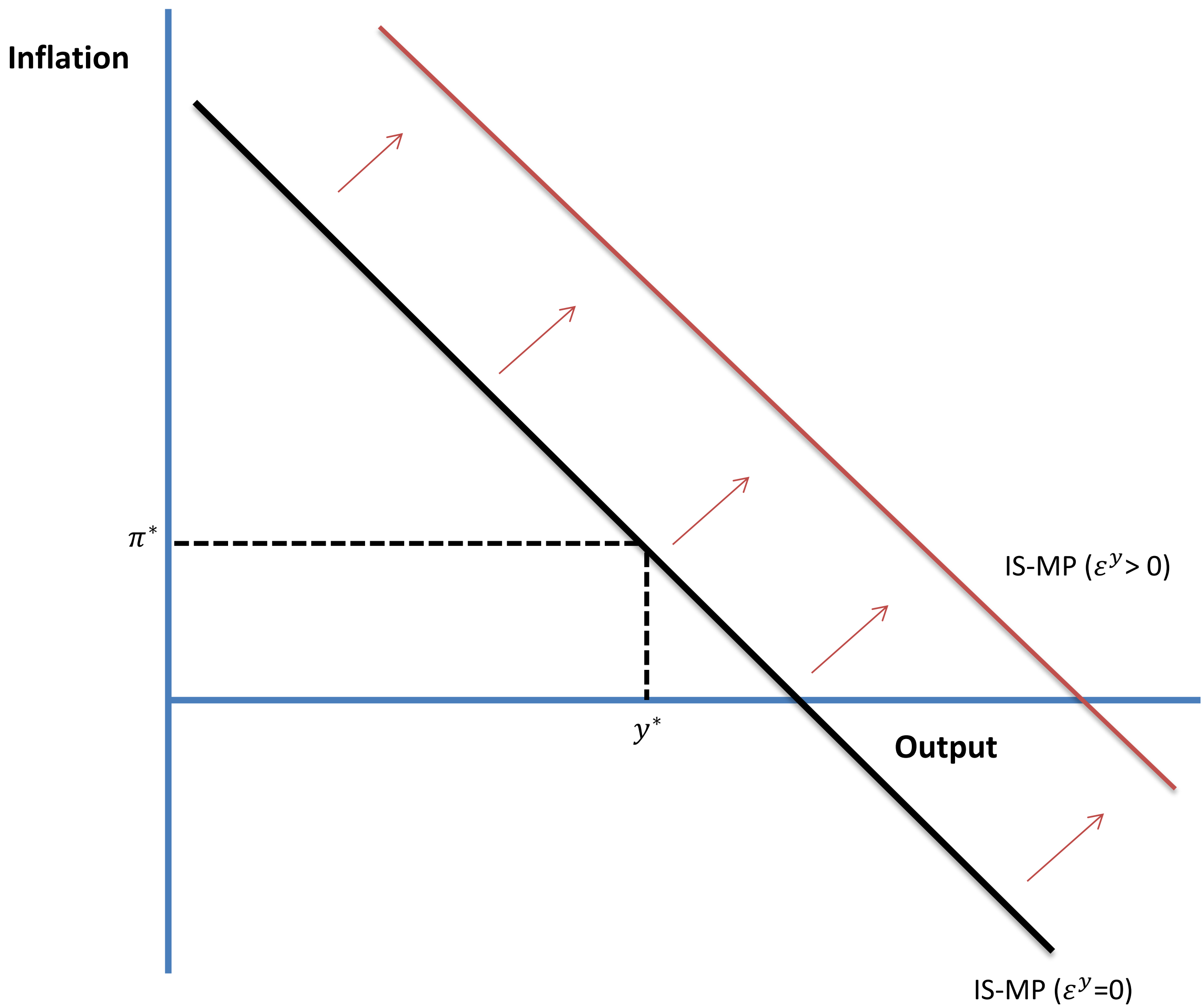


Figure 9: The IS-MP curve as we move from $\epsilon_t^y = 0$ to $\epsilon_t^y > 0$ (An Aggregate Demand Shock)

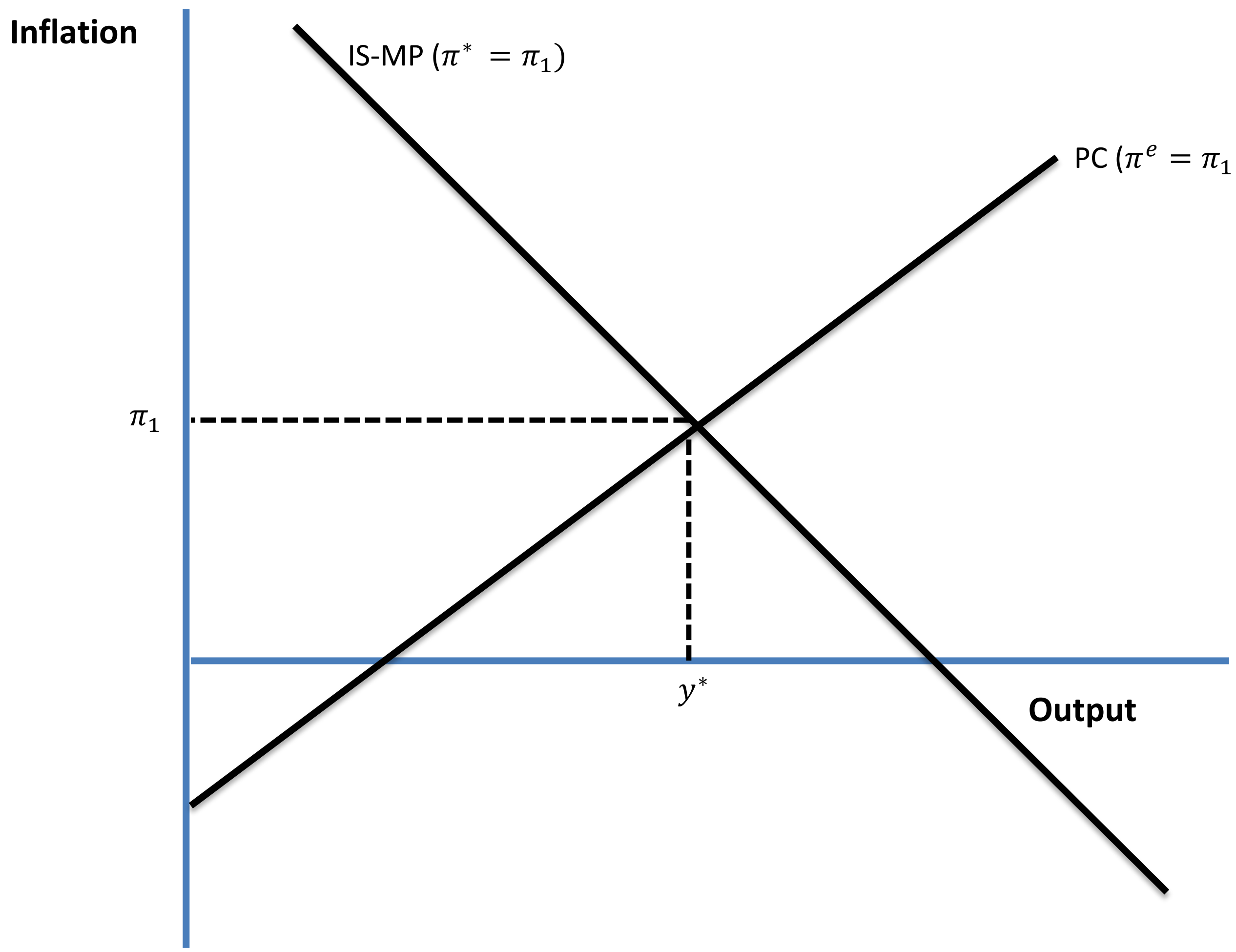


The Full Model

The full IS-MP-PC model can be illustrated in the traditional fashion as a graph with one curve that slopes upwards (the Phillips curve) and one that slopes downwards (the IS-MP curve provided we assume that $\beta_\pi > 1$.) Figure 10 provides the simplest possible example of the graph. This is the case where both the temporary shocks, ϵ_t^π and ϵ_t^y equal zero and the public's expectation of inflation is equal to the central bank's inflation target. Note that I have labelled the PC and IS-MP curves to explicitly indicate what the expected and target rates of inflation are and it will be a good idea for you to do the same when answering questions about this model.

In the next set of notes, we will analyse this model in depth, examining what happens when various types of events occur and focusing carefully on how inflation expectations change over time.

Figure 10: The IS-MP-PC Model When Expected Inflation Equals the Inflation Target



A More Complicated Monetary Policy Rule: The Taylor Rule

Before moving on to analyse the model in more depth, I want to describe the more complex version of the monetary policy rule that I alluded to earlier. This rule takes a form that is associated with Stanford economist John Taylor. In a famous paper published in 1993 called "Discretion Versus Policy Rules in Practice" (you will find a link on the class webpage) Taylor noted that Federal Reserve policy in the few years before his paper was published seemed to be characterised by a rule in which interest rates were adjusted in response to both inflation and the gap between output and an estimated trend.

Within our model structure, we can amend our monetary policy rule to be more like this "Taylor rule" if we make it take the following form:

$$i_t = r^* + \pi^* + \beta_\pi \left(\pi_t - \pi^*\right) + \beta_y \left(y_t - y_t^*\right) \tag{19}$$

It turns out that the properties of the IS-MP-PC model don't really change if we adopt this more complicated monetary policy rule. If we substitute the expression for the nominal interest rate in (19) into the IS curve equation (5), we get

$$y_t = y_t^* - \alpha \left[r^* + \pi^* + \beta_\pi \left(\pi_t - \pi^*\right) + \beta_y \left(y_t - y_t^*\right)\right] + \alpha \left(\pi_t + r^*\right) + \epsilon_t^y \tag{20}$$

This can be re-arranged as follows (canceling out the terms involving r^*):

$$y_t - y_t^* = -\alpha\beta_y \left(y_t - y_t^*\right) - \alpha\beta_\pi \left(\pi_t - \pi^*\right) - \alpha\pi^* + \alpha\pi_t + \epsilon_t^y \tag{21}$$

Bringing together all the terms involving the output gap $y_t - y_t^*$, we get

$$\left(1 + \alpha\beta_y\right)\left(y_t - y_t^*\right) = -\alpha\beta_\pi \left(\pi_t - \pi^*\right) + \alpha \left(\pi_t - \pi^*\right) + \epsilon_t^y \tag{22}$$

Which can be expressed as

$$y_t - y_t^* = -\frac{\alpha\left(\beta_\pi - 1\right)}{1 + \alpha\beta_y}\left(\pi_t - \pi^*\right) + \frac{1}{1 + \alpha\beta_y}\epsilon_t^y \tag{23}$$

This equation shows us that broadening the monetary policy rule to incorporate interest rates responding to the output gap doesn't change the essential form of the IS-MP curve. As long as $\beta_\pi > 1$, the curve will slope downwards and will feature $\pi_t = \pi^*$ when $y_t = y_t^*$ and there are no inflationary shocks. So while the addition of an output gap response to the monetary policy rule changes the coefficients of the IS-MP model a bit, it doesn't change the underlying economics. In the analysis in the next sets of notes, we will stick with the model that uses the basic "inflation targeting" monetary policy rule.

Things to Understand from these Notes

Here's a brief summary of the things that you need to understand from these notes.

1. The evidence on the Phillips curve.
2. The Phillips curve that features in our model and how to draw it.
3. Why real interest rates are what matters for aggregate demand.
4. The IS curve that features in our model.
5. The monetary policy that features in our model.
6. How to derive the IS-MP curve.
7. What determines the slope of the IS-MP curve.
8. How the IS-MP curve changes when the monetary policy rule takes the form of a "Taylor rule".