Our Inflation Model

We are going to put together into a model the ingredients that Blanchard presents in Chapter 9 of the 5th Edition of his textbook (available on moodle).

The Phillips Curve: We summarize the supply side of the economy with the Expectations Augmented Phillips Curve in Inflation (π), Unemployment (u) Space:

(1) $\pi_t = \pi_t^e - \alpha(u_t - u_n)$

where
π_t = price inflation at time t = $(P_t - P_{t-1})/P_{t-1} = \Delta P/P$
π_t^e = expected price inflation at time t
$\alpha \approx .75$

Points to Note:

i) PC Pinning Rule: The Phillips Curve always goes through the point $\pi = \pi^e$, $u = u_n$. This is just another way of saying it obeys the Natural Rate Hypothesis, and it tells you exactly where to place the curve in the graph.

ii) The slope is $-\alpha$. This measures the degree to which tightness or looseness in the labor market affects inflation. A big α (steep PC), means that small changes in u have big effects on π.

iii) There are many ways to model inflationary expectations, any one of which is consistent with the Phillips Curve. We will use simple adaptive expectations: $\pi_t^e = \pi_{t-1}$

The AO Line: To find an equilibrium we need another line. We get this line by combining two relationships in Blanchard:

Aggregate Demand Growth (A):

(2) $g_{yt} = g_{NADt} - \pi_t$

where
g_{yt} = growth rate of real GDP= $(Y_t - Y_{t-1})/Y_{t-1} = \Delta Y/Y$
g_{NADt}= growth rate of nominal aggregate demand = $[\Delta(P\cdot Y)]/[P\cdot Y]$[1]

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[1] Blanchard simplifies the growth rate of nominal aggregate demand (g_{NADt}) to equal the growth rate of the nominal money supply ($g_{mt} = (M_t - M_{t-1})/M_{t-1}$), but we know there is more to aggregate demand than the money supply (ie. more to AD than the LM curve), so we will keep the more general formulation. Still, over

Equation (2) is just a more complicated version of the spring metaphor: if nominal aggregate demand is growing faster than inflation, then real aggregate demand is growing; and if real aggregate demand is growing, then real GDP will be growing at the same rate. Three cases:

a) $g_{NADt} > \pi_t$ implies $g_{yt} > 0$
b) $g_{NADt} = \pi_t$ implies $g_{yt} = 0$
c) $g_{NADt} < \pi_t$ implies $g_{yt} < 0$

Okun's Law (O):

(3) $\Delta u = u_t - u_{t-1} = \beta \cdot (\bar{g}_y - g_{yt})$

where
$\bar{g}_y$ is the trend growth rate of real GDP which is approx 3%
β is Okun's constant (which isn't really constant) which is approx .4

Okun's law is a complex and important relationship. I've written it to emphasize the "treadmill effect":

a) $\bar{g}_y > g_y$ implies that unemployment will rise (u_t will be greater than u_{t-1})
b) $\bar{g}_y = g_y$ implies that unemployment will remain unchanged ($u_t = u_{t-1}$)
c) $\bar{g}_y < g_y$ implies that unemployment will fall (u_t will be less than u_{t-1})

Points to Note:

i) Because $\bar{g}_y \approx 3\%$, real GDP has to grow at 3% **just** to keep the unemployment rate constant. If GDP grows slowly (let's say at 1%), the unemployment rate will **increase**. If you want to **lower** the unemployment rate, GDP has to grow faster than 3%.

ii) Because $\beta = .4$, GDP has to grow fast to significantly lower the unemployment rate. So, if you want to lower the unemployment rate by 2% in one year, GDP needs to grow by 8% (3% just to stay even, and 5% to reduce unemployment by $2\% = \beta \cdot 5\%$)

Combining the two equations gives us the AO Line (our own term)

AO Line:

(4) $u_t - u_{t-1} = \beta \cdot [\bar{g}_y - (g_{NADt} - \pi_t)]$

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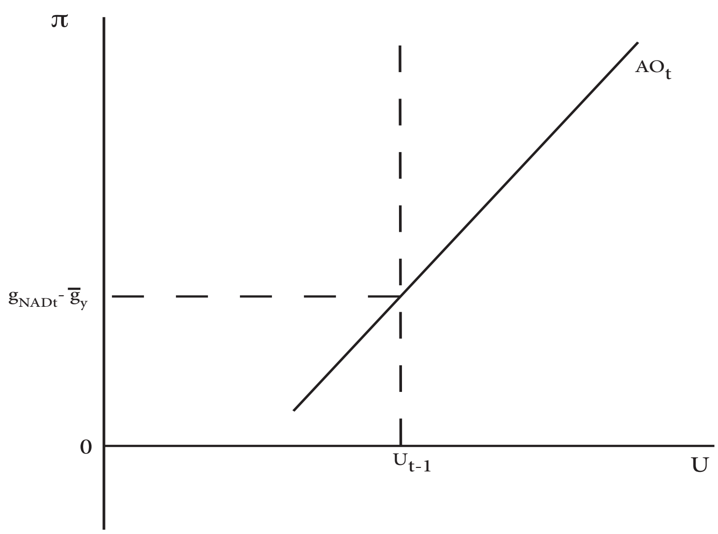
long periods of time (say 5 year periods) and for high inflation rates, (say above 15%), it is primarily the value of $g_{mt} - \bar{g}_y$ that determines the inflation rate.

Plotting the AO Line: The AO line is harder to plot and pin than the Phillips Curve. It helps to write it in the following form:

(5) $\pi_t = g_{NADt} - \overline{g}_y + (1/\beta) \cdot (u_t - u_{t-1})$

AO Pinning Rule: the AO line is pinned at the intersection of ($\pi = g_{NADt} - \overline{g}_y$ and $u = u_{t-1}$). Because u_t moves over time, u_{t-1} moves over time, so the value on the horizontal axis that determines the "longitudinal" pinning point changes over time - this makes the rule much harder to apply than the PC pinning rule. In the figure below, unemployment at **time t-1** was u_{t-1} and $g_{NADt} - \overline{g}_y$ at **time t** is show on the vertical axis, the AO line at **time t** is show at the intersection of these two values:



Properties of AO:

i) Its slope is $1/\beta$. If Okun's treadmill is steeper (a smaller β) and the economy has to run harder ($g_y >> \overline{g}_y$) in order to get unemployment to fall any given amount, then the AO line is steeper.

ii) If $g_{NADt} - \overline{g}_y$ increases, either because g_{NADt} increases or $\overline{g}_y$ decreases, then the AO line at time t shifts up by that exact amount.

The Properties of Medium Run Equilibrium: A good way to get a handle on the Inflation Model is to understand its medium run equilibrium. In the short run, the Inflation Model predicts that the economy is wherever the PC and AO lines intersect, but in the medium run:

(i) $u = u_n$ (due to the Neoclassical Synthesis)

(ii) $\pi^e = \pi$ (due to the Natural Rate Hypothesis)

(iii) $g_{yt} = \bar{g}_y$

The 3 properties above hold in the medium run regardless of the rate of growth of nominal aggregate demand, but the medium run inflation rate is dependent on g_{NADt}:

(iv) $\pi = g_{NADt} - \bar{g}_y$

So, in the medium run for a given $\bar{g}_y$, inflation increases one-for-one with g_{NADt}.

Who's Exogenous, Who's Endogenous: A second good way to get a handle on the model is to remember which variables are exogenous and can therefore shock the model, and which variables are endogenous and respond to the shocks:

Exogenous variables: u_n, g_{NADt}, and $\bar{g}_y$

Endogenous variables: u and π

Reduced Form Equations: There are two endogenous variables, so there must be two reduced form equations:

$$(6)\ \pi_t = \frac{1}{1+\alpha\beta}\left[\pi_{t-1} + \alpha(u_n - u_{t-1}) + \alpha\beta(g_{NADt} - \bar{g}_y)\right]$$

$$(7)\ u_t = \frac{1}{1+\alpha\beta}\left[\beta\{\pi_{t-1} - (g_{NADt} - \bar{g}_y)\} + u_{t-1} + \alpha\beta u_n\right]$$

These equations are difficult to use (unless you are a computer). This is because they contain the terms π_{t-1} and u_{t-1}. This does not violate our understanding of reduced form equations as having only exogenous variables on the right hand side, because at time t, period t-1's variables are exogenous (unless you have a time machine). But this does mean that you have to track the variables period after period as the system evolves through time.

The logic of the reduced form equations is as follows:

i) At any moment in time, the economy inherits an unemployment rate and an inflation rate from the past. By our assumption of adaptive expectations, π_{t-1} becomes π_t^e, which is why π_{t-1} appears in the equations (6) and (7).

ii) The exogenous variables, g_{NADt}, u_n and $\bar{g}_y$, together with the parameters α and β and the t-1 values of u and π determine the current value of u_t and π_t. Once you know g_{NADt}, and π_t, you can use equation (2) to determine g_{yt} (so g_{yt} is not a 3rd independent endogenous variable).

iii) In period t+1, the time t values of u and π become last year's values, and the whole process repeats itself.

Following the Model Over Time:

Because **both** the PC curve and the AO line are shifting every period until the economy reaches medium run equilibrium, you need to follow the model over time. There are three ways to do this:

i) You can "simply" use the reduced form equations as outlined above.

ii) You can use the Pinning Rules for the PC and AO lines and shift the curves each period.

iii) You can use the following graphical short cut:

1) The PC curve with adaptive expectations implies:

$$\Delta\pi = \pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

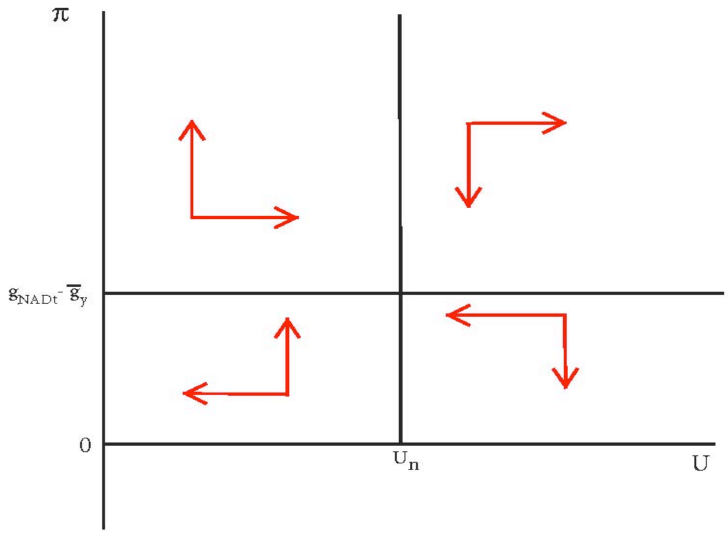
This says is that inflation is increasing whenever $u_t < u_n$ and decreasing whenever $u_t > u_n$.

2) The AO line implies:

$$\Delta u = u_t - u_{t-1} = \beta \cdot [\pi_t - (g_{NADt} - \bar{g}_y)]$$

This says is that unemployment is increasing whenever $\pi_t > (g_{NADt} - \bar{g}_y)$ and decreasing whenever $\pi_t < (g_{NADt} - \bar{g}_y)$. The reason is that $\pi_t > (g_{NADt} - \bar{g}_y)$ implies that $\bar{g}_y > (g_{NADt} - \pi_t) = g_y$, so Okun's treadmill is moving backwards faster than Okun is moving forwards and u increases. And vice versa when $\pi_t < (g_{NADt} - \bar{g}_y)$

If you divide (π, u) space into quadrants defined by $\pi = g_{NADt} - \bar{g}_y$ and $u = u_n$, the economy moves according to the "traffic" arrows in the figure below. Once you know where the economy is in this space, it will follow the "traffic" arrows until it returns to medium run equilibrium (assuming no change in the exogenous variables: g_{NADt}, u_n and $\bar{g}_y$). Note: the arrows prohibit the economy from moving directly to medium run equilibrium (try it). The economy spirals around in smaller and smaller circles until it reaches medium run equilibrium in the Zeno's Paradox sense of "reaches".



There are two ways to use this graphical analysis:

i) If you know where the economy is when it "wakes up", then you simply follow the arrows from that point.

ii) If the economy starts in medium equilibrium, then it will, of course, stay there, absent any new shocks. If, however, there is a **one time permanent exogenous shock** (though it can be for multiple exogenous variables at once), then you need to be able to use the PC and AO Pinning Rules to find out how the economy responds to the shock in Period 1. After that, you can use the traffic arrows.

When this graphical analysis is not useful:

The analysis is designed to depict the consequences of a **one time permanent shock** to one or more of the exogenous variables. The graphical analysis is not useful when one or more of the exogenous variables are changing **each** period. So, for example, you cannot use it to replicate Blanchard's disinflation example on p. 192 because he is changing g_{mt} (and therefore g_{NADt}) every period.