Class Outlines
November 6 and November 8, 2001

November 6, 2001

I. Handed back exam 2, problem set 2a, and problem set 2b. Went over exam 2. Please see special note attached to the website.

November 8, 2001

I. Review

a. Okun's Law- the negative relationship between output growth above the normal growth rate of output and the change in the unemployment rate: Given by the following equation:
   i. $u_t-u_{t-1}=-\beta(\Delta Y_t-\Delta Y^*)$, where ΔY^* denotes the *normal growth rate of output,* the growth rate in output necessary to keep the unemployment rate from increasing.

b. Phillip's curve- again there are several versions of the Phillips curve that we could employ. We choose the following version:
   i. $\pi_t-\pi_{t-1}= -\alpha(u_t-u_N)$.

c. The aggregate demand relationship – this provides the relationship between money growth and output growth. The equation is given as follows:
   i. $\Delta Y_t=\Delta M_t-\pi_t$

II. A return to the medium run.

a. We have defined the medium run as the time period necessary to allow the economy to adjust to any change in economic variables. More importantly, we have concentrated on the role of economic policy. We are primarily concerned with monetary policy in this chapter. Thus in the medium run, all economic variables have responded to all policy change. This must mean that policy is not changing in the medium run. Thus, money growth is a constant number in the medium run.
   i. In the medium run money growth is constant. In these notes, I will use a star (*) without a subscript t to denote that the series is constant. (In class, I have placed a bar over the term I mean to keep constant). We thus have the following for money growth in the medium run:
      1. $\Delta M_t=\Delta M^*$
   ii. In the medium run, the economy always returns to full employment. This implies that the economy is operating at the

natural rate of unemployment. Thus in the medium run, we have the following:

1. $u_t=u_N$

iii. When the economy returns to full employment, there is some growth in output necessary to keep unemployment from growing above the natural rate. We have defined this output rate as the natural growth rate of output. This yields the following for the change in output growth in the medium run:

1. $\Delta Y_t=\Delta Y^*$

iv. We can use these relationships to say something specific about the inflation rate. Although the growth rate in the money supply is constant in the medium run, it is not constant in the same way the other variables are constant. The natural rate of unemployment, for example, is a number that we have taken as a constant that policy can not change. Technically speaking, we have assumed that the natural rate of unemployment is exogenous. We can however, choose different policies that allow for different constant money growth rates in the medium run. For example, we can choose a policy such that in the medium run, the money growth rate is constant at 5% or we could choose a policy such that in the medium run, the money growth rate is constant at 10%. Hopefully, this will become clear in future lectures. Given these facts, however, we can rewrite the aggregate demand relationship as follows:

1. $\pi_t=\Delta M^*-\Delta Y^*$.
    a. The *adjusted nominal growth rate of money* is given by the right hand side of the above equation. In other words, the inflation rate is equal to the difference between the nominal growth rate in the money supply and the normal growth rate of output. Since output grows at a constant rate, to account for additional transactions, money must also grow. If money grows at a rate higher than necessary (to cover transactions) then the impact is higher inflation. We say that in the medium run, inflation is equal to the adjusted nominal growth rate of money.
        i. Example: Suppose the normal growth of output is 3%. If a policy is selected that leads to a medium run growth rate of the money supply of 5%, then inflation is 2%. Consider an alternative policy that leads to a medium growth rate in the

money supply equal to 10%. The inflation rate is then 7%.

ii. These equations imply that, in the medium run, monetary policy does not impact unemployment (which is constant and equal to the NAIRU) and does not impact the growth rate of output (which is constant and simply equal to the normal growth rate of output). The only effect of a higher growth rate in the money supply is a higher inflation rate.

iii. We plotted the "long-run Phillips curve" with the unemployment rate on the x-axis and the inflation rate on the y-axis. The unemployment rate is constant in the medium run and is thus represented by a vertical line at the natural rate of unemployment (implying that no matter what the inflation rate is, the natural rate of unemployment always prevails). The inflation rate was represented by a horizontal line, and is equal to the adjusted nominal growth rate in the money supply.

III. Dynamics

a. The above indicates where an economy will eventually return following a change in policy. Now, we want to look at the interim period. In other words, we want to track the variables in the above relationships to determine the necessary policies aimed at decreasing inflation.

b. Recall our goal to reduce inflation is based on the Phillips curve relationship. In order to bring about a decrease in the growth rate of inflation, we must be willing to endure some unemployment above the natural rate. The key questions are how much unemployment must be endure and for how long? Directly related to these questions are two terms, *point years of excess unemployment, and the sacrifice ratio.*

i. A single *point year of excess unemployment* is an increase in the unemployment rate above the natural rate by 1% for one year.

1. Example. Suppose that the unemployment rate is held above the natural rate by 5% next year, 2% the following year, and 3% the year after. In the first year,

there are 5 point years of excess unemployment, 2 in the year after, and 3 in the final year. In other words there is a total of 10 point years of excess unemployment. Suppose instead that the unemployment rate was held above the natural rate by 10% this year. This would also correspond to 10 point years of excess unemployment.

2. Let's consider a specific example related to the following Phillips curve:
    a. $\pi_t-\pi_{t-1}=-.5(u_t-u_N)$.
3. Suppose the current inflation rate is 15% and monetary authorities want to decrease inflation to 10%. Suppose that in year t+1 they increase unemployment by 10% over the natural rate. Thus,
    a. $\pi_{t+1}-15\%=-.5(10\%) \Rightarrow \pi_{t+1}=10\%$.
    b. We have accomplished our goal by increasing the unemployment rate above the natural rate by 10% for one year. Thus, if we are willing to cut inflation in one year, we need 10 point years of excess unemployment.
    c. Suppose instead that we decide to increase unemployment above the natural rate by 5% in year t+1, and by 5% in year t+2.
        i. $\pi_{t+1}-15\%=-.5(5\%) \Rightarrow \pi_{t+1}=12.5\%$.
        ii. $\pi_{t+2}-12.5\%=-.5(5\%) \Rightarrow \pi_{t+2}=10\%$.
        iii. Here, we have accomplished our goal by holding the unemployment rate above the natural rate of unemployment by 5% for two years. Notice, that in terms of point years of excess unemployment, the results are the same under both scenarios. The point is this: the duration of unemployment does not affect the amount of total unemployment that must endured. In other words, we can bring about a desired decrease in inflation in 1 year, 2 years, or 10 years. However, we can not vary the duration length in an attempt to decrease (or increase) the point years of excess unemployment needed.

ii. The sacrifice ratio. *The sacrifice ratio* is the number of point years of excess unemployment needed to decrease the inflation rate by 1%. Mathematically it is equal to $1/\alpha$. In the previous example, α was equal to .5. Thus the sacrifice ratio was 2. For

each percentage point reduction in inflation, we had to endure 2 point years of excess unemployment.

c. An example. In class, we began working though an example based on the following relationships:
   i. $u_t - u_{t-1} = -.4(\Delta Y_t - 3\%)$ (Okun's Law)
   ii. $\pi_t - \pi_{t-1} = -(u_t - u_N)$ (Phillip's curve)
   iii. $\Delta Y_t = \Delta M_t - \pi_t$ (aggregate demand relationship)

d. We will resume with this example next Tuesday.