The Digital Economist

Lecture 8 -- Aggregate Supply and Price Level Determination

LONG RUN AGGREGATE SUPPLY

Aggregate Supply represents the *ability of an economy to produce goods and services*. In the **Long Run** this ability to produce is based on the level of production technology and the availability of factor inputs. This relationship can be written as follows:

$$\mathbf{Y}^*_t = f(L_t, K_t, M_t)$$

where **Y*** is an aggregate measure of **potential output** in a given economy.

In the aggregate,

- L_t represents the quantity and ability of labor input available to the production process,
- K_t represents capital, machinery, transportation equipment, and infrastructure, and
- M_t represents the availability of natural resources and materials for production.

Over time with growth in the availability of factor inputs or technological improvement, the level of potential output is expected to increase. Thus in the Long Run we define the Aggregate Supply (AS_{LR}) function as being influenced by those elements included in the production function defining the level of potential output but independent of the price level.

Figure 1 -- Aggregate Production

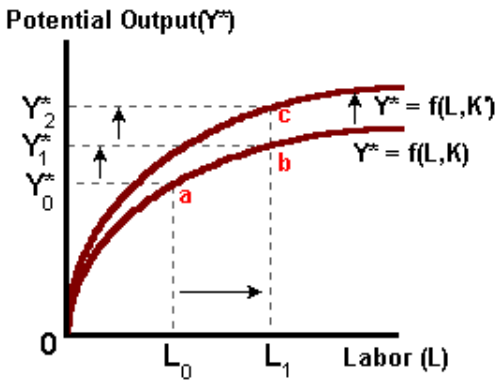
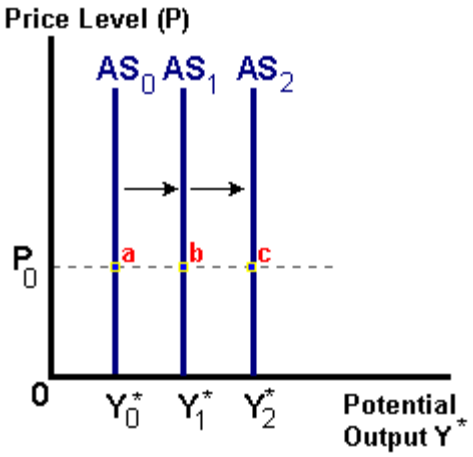


Figure 2 -- Aggregate Supply



In the above diagrams we find that in time period '1' the economy is capable of producing a level of output equal to $\mathbf{Y}^*_0$. Growth in the amount of labor ('a' to 'b') available allows for the production of more output with existing levels of technology ($\mathbf{Y}^*_0$ to $\mathbf{Y}^*_1$). More

capital (*or materials*) or improvements in productivity will lead to an even greater potential to produce ($\mathbf{Y^*_1}$ to $\mathbf{Y^*_2}$) at each-and-every price level (i.e., 'b' to 'c').

PRICE LEVEL DETERMINATION

In the aggregate economy the price level is determined by the balance (or imbalance) between the *ability to produce* goods and services and the ability to spend to acquire those same goods (see Figure 3). The ability to produce is summarized by the long run Aggregate Supply ($\mathbf{AS_{LR}}$) function based on the level of technology and availability of factor inputs. The *ability to spend* is summarized by the Aggregate Demand (**AD**) relationship which represents combinations of prices and output levels for a given level of Nominal GDP. As prices rise, purchasing power falls, and thus the quantity of goods and services that can be acquired with a given nominal income declines. Aggregate Demand represents this inverse relationship between the price level and purchasing power.

$$\mathbf{AD} = \mathbf{Y^R} = NGDP/P_t$$
$$\mathbf{AS} = Y^* = f(L_t, K_t, M_t)$$

A supply-side shock, such as an increase in labor productivity, would shift $\mathbf{AS_{LR}}$ outward demonstrating a greater potential to produce at each and every price level. We can see this change in figure 4. This shock, over a sufficient period of time, creates an excess supply of goods ($\mathbf{Y^* > Y^R}$) and puts downward pressure on the price level. As prices fall, purchasing power increase reflecting an increase in the ability to spend (i.e., a movement from **A** to **B**). The net result is an increase in output and spending and a lower price level.

Figure 3
Aggregate Supply and Aggregate Demand

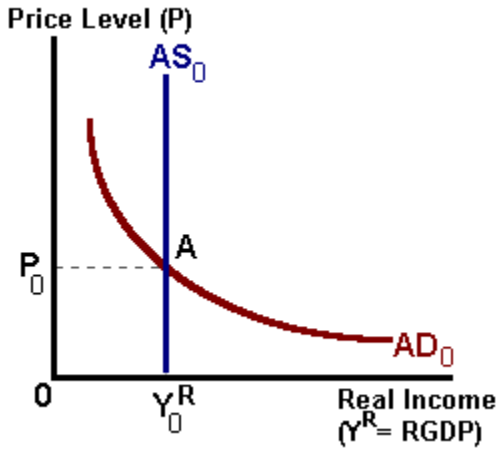
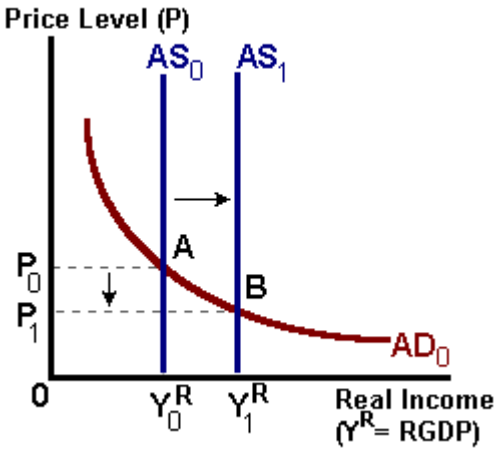


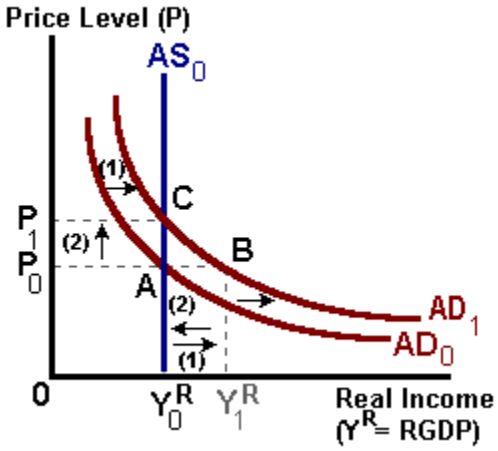
Figure 4
A Supply-side Shock



In figure 5, we have a demand-side shock perhaps the result of an increase in government spending (*expansionary fiscal policy*). This shock shifts the **AD** relation outward. Initially there is an excess demand for goods (**A** to **B**) evidenced by a depletion of inventories.

Given that potential output has not changed, in time this excess demand will cause the price level to increase. As prices increase, purchasing power falls and the ability to spend decreases (**B** to **C**). The net result of this shock is an increase in the price level with no change in output or real spending.

Figure 5, A Demand-side Shock



Graphically the reaction of the price level to demand-side or supply-side shocks is easy to model. However the actual process of adjustment is a bit more complicated. In cases where the *ability to spend* exceeds the *ability of the economy to produce goods*, depleted inventories are only replenished through the acquisition of scarce factor inputs -- factor inputs that are fully employed elsewhere in the economy. Attempts to replenish these inventories will require attracting resources from alternative uses by bidding up wages and factor prices. It is this process of bidding for resources and the impact on the price level that requires additional discussion.

LABOR MARKETS and the PRICE LEVEL

In 1958 A.W. Phillips established an empirical relationship between wage inflation and the gap between the actual level of unemployment 'u' and the natural rate of unemployment 'u*' – a relationship known as the **Phillips Curve**. The **natural rate of unemployment** is defined as that rate where there is no upward nor downward pressure on wage rates. A rate of unemployment 'u_{high}' above this natural rate would imply slack in labor markets such that wages would be expected to fall or, at least, not rise. A rate of unemployment 'u_{low}' below the natural rate would signal tight labor markets such that wages are being bid upwards as employers attempt to fill out the ranks of their required labor force. The parameter 'β' represents that rate at which wages adjust to tightness or slack in labor markets.

$$\%\Delta w = -\beta(u-u^*)$$

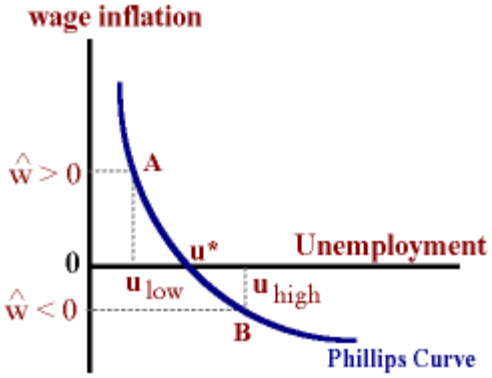
if $u > u^*$ then

$$\%\Delta w < 0$$

and wage deflation exists.
Otherwise if $u < u^*$,

$$\%\Delta w > 0,$$

we have wage inflation.



Given that labor costs are a significant proportion of production costs, increases in the wage rate will put upward pressure on costs. Depending on the degree of competition in different industries, business firms will attempt to pass these higher costs of production on to their customers in the form of higher prices. To summarize, as 'u' the actual rate of unemployment 'u' approaches or falls below the natural rate of unemployment 'u*', economic agents will begin to expect to observe an increasing price level.

MONEY and the PRICE LEVEL

A popular identity defined by Irving Fisher is the **quantity equation** commonly used to describe the relationship between the money stock and aggregate expenditure:

$$\mathbf{MV \equiv PY}$$

An "identity" is an expression that is is true by definition such as the following:

a triangle = a three sided geometric figure

There is no debate about this equality, its truth comes from the nature of the definitions used.

The terms on the right-hand side represent the price level (**P**) and Real GDP (**Y**). Taken together these two terms represent Nominal GDP or a measure of the total spending that takes place in an economy in a given time period.

On the left-hand side, **M** represents some measure of the money supply, perhaps $\mathbf{M_1}$, and '**V**' represents the velocity of this monetary measure. Velocity represents the number of times money changes hands in support of the total spending in an aggregate economy.

We might more accurately state the equation as follows:

$$\mathbf{M_1V_1 = PY^R}$$

denoting the use of $\mathbf{M_1}$, its corresponding velocity $\mathbf{V_1}$ and Real GPD '$\mathbf{Y^R}$'.

For example, in 2001, Nominal GPD (PY) was equal to roughly $10 trillion. In that same year, $\mathbf{M_1}$ was measures at roughly $2.2 trillion with a corresponding velocity of 4.5. or

$$\$2.2(4.5) = \$10.0$$

The $2.2 trillion of money was used in support of $10 trillion of expenditure.

If we chose to use $\mathbf{M_2}$ as our monetary measure then the expression would be:

$$\mathbf{M_2V_2 = PY^R}$$

The truth of the expression does not change. Even though, we find ourselves using a broader definition of money, and corresponding velocity measure will be smaller.

Through a simple transformation and, the quantity equation can be transformed into the following:

$$\%\Delta M + \%\Delta V = \%\Delta P + \%\Delta Y^R$$

where each term represents growth in the money stock, growth in velocity, the rate of inflation, and the rate of Real economic growth respectively. If we are able to assume that velocity is a numerical constant (its value determined by institutions and habits that see little change over time), this expression can be written as follows:

$$\%\Delta P = \%\Delta M - \%\Delta Y^R$$

The implications of this expression are that if growth rates in the money stock exceed the rate of real economic growth, inflation will be the result. The money stock growing by a smaller amount as compared to the rate of economic growth will lead to deflationary pressures in the aggregate economy. And, of course, price stability implies that growth in the money stock should match the [expected] rate of growth in a particular economy.

Be sure that you understand the following concepts:

- The Aggregate Production Function
- Factor Inputs
- Aggregate Output
- Potential Output
- Long Run Aggregate Supply
- Real GDP
- Aggregate Demand
- Inventory Depletions / Accumulation
- Output Gap
- the Price Level
- Supply-side Shocks
- Demand-side Shocks
- the Markup
- the Rate of Unemployment
- the Natural Rate of Unemployment
- The Phillips Curve
- Okun's Law