Econ 302 - Handout 1
January 29, 2016

General Concepts

1. **Model** - A model is a simplified represntation of reality used to discipline thinking and test assumptions.

2. **Exogenous and Endogenous Variables** - An **exogenous** variable is taken as given in a model. An **endogenous** variable is explained by the model.

3. **Equilibrium** - A condition in which supply equals demand. We have reasons to think that an economy will tend towards equilibrium, so we study what happens at an equilibrium. Think of this as an "if-then" statement: "if we are at equilibrium, then this is what it will look like."

4. **Macroeconomics is applied microeconomics!** - Do not forget your tools from micro. When trying to figure out how a change in interest rates will affect GDP, think of a representative consumer or firm: how will lower interest rates affect the decision to buy a car or build a factory? Tell yourself a microeconomic story.

Gross Domestic Product (GDP)

1. **Definition** - Gross domestic product (GDP) is the market value of all final goods and services produced within an economy in a given period of time (Mankiw 21).

   (a) Final vs. Intermediate Goods - A final good is purchased by the final user and is not used in the production of any other good or service.

   An intermediate good is used as an input for another good or service.

   Example: The steel used in producing a truck is an intermediate good and thus not included in GDP. The truck is included in GDP.

   (b) Domestic Production - Only goods produced in the economy (in this case the United States) are counted in GDP. If you buy a GM car, it is counted in US GDP. If you buy a BMW, it is not.

   (c) Given Period of Time - If a car is produced in 2014, sits on a lot, and then is sold in 2015, it is counted in GDP for 2014, NOT for 2015.

2. **Calculating GDP** - Recall that your consumption is someone else's income, thus it must be that total expenditure equals total income. Therefore, we can measure GDP by looking at either income or expenditure. The following will all yield the *same value* of GDP.

(a) Price - Quantity Approach

$$GDP = \sum_{i=1}^{n} P_i Q_i$$

Note this is probably infeasible.

(b) Value Added Approach

$$\text{Value Added} = \text{Final Price - Cost of Intermediate Goods}$$

GDP calculated by adding up total value added of all firms.

(c) Income Approach

$$\text{GDP} = \text{Wages} + \text{Interest} + \text{Rent} + \text{Profit}$$

(d) Expenditure Approach

$$\text{GDP} = \text{C} + \text{I} + \text{G} + \text{NX}$$

This is referred to as the *national income accounts identity.* We will usually use this approach to calculating GDP.

$$\begin{aligned} \text{C} &= \text{Consumption} \\ \text{I} &= \text{Investment} \\ \text{G} &= \text{Government Purchases} \\ \text{NX} &= \text{Exports - Imports} \end{aligned}$$

Note on Inventories: Recall that a car produced in 2014 but sold in 2015 is counted in GDP for 2014. But if we measure GDP based on expenditure, won't the car show up in "C" for 2015? The answer is yes. However, we treat unsold goods produced in 2014 as investment spending by the firm. Think of a car going on the lot: the firm is investing in future sales. Let the price of the car be X. So "I" increases by X, as the firm "spends" X to invest in future sales. Thus 2014 GDP increases by X. Say the car is sold in 2015, then clearly "C" increases by X. But also "I" falls by X as the inventory is drawn down. Thus the net effect of the transaction on 2015 GDP is X-X=0.

3. **Real vs. Nominal GDP** - The above is *nominal GDP*, and as is clearly seen from the price-quantity approach, an increase in prices will cause GDP to increase. This might not be what we want if we are considering the productive capacity of the economy.

   Another measure is *real GDP*, which is the value of all goods and services using a fixed set of prices (i.e. we choose a "base year" and use the prices for that year). This allows us to compare the productive capacity of the economy across years even if prices change.

$$GDP_{real} = \sum_{i=1}^{n} P_i^{base} Q_i$$

Note that if we are using 2015 as a base year, real GDP and nominal GDP for 2015 *are the same*. This can clearly be seen from the definitions above.

Price Levels

1. **Inflation** - Inflation is an increase in the overall level of prices. The inflation rate is the percentage change in the price level between two points in time.

2. **GDP Deflator** - As mentioned above, changes in prices can cause nominal GDP to change *even if the quantities produced did not change*. Thus, we can construct a measure of the price of output relative to prices in a base year in the following manner:

$$\text{GDP Deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}}$$

   Usually we multiply this by 100 to get nice numbers, and notice that if we use 2015 as the base year, the GDP deflator for 2015 is 100.

3. **Consumer Price Index** - The CPI, as with many price indexes, is calculated through the use of a market basket, which is a hypothetical bundle of goods thought to represent the consumption of a typical household:

$$\text{CPI} = \frac{\text{Cost of market basket in a given year}}{\text{Cost of market basket in base year}}$$

   Again, we usually multiply by 100 for convenience.

4. **Personal Consumption Expenditures Deflator** - The PCE is calculated in the same way as the GDP Deflator, but only personal consumption goods (the "C") are included.

5. **Inflation Rate** - Given one of these indexes, the inflation rate is calculated as:

$$\text{Inflation Rate} = \frac{\text{Price index in year 2 - Price index in year 1}}{\text{Price index in year 1}}$$

Unemployment

1. **Current Population Survey** - Survey of households from which the unemployment rate is calculated. Each adult over the age of 16 is categorized as one of the following:

   (a) Employed - Working either full time or part time

   (b) Unemployed - Not employed but have tried to find work in the last four weeks

(c) Not in labor force - Those neither employed nor unemployed

2. **Labor Force** -

$$\text{Labor Force} = \text{Employed} + \text{Unemployed}$$

3. **Unemployment Rate** -

$$\text{Unemployment Rate} = \frac{\text{Unemployed}}{\text{Labor Force}} \times 100$$

4. **Labor Force Participation Rate** -

$$\text{Labor Force Participation Rate} = \frac{\text{Labor Force}}{\text{Adult Population}} \times 100$$

Production, Distribution, and Allocation

Here we develop a theory of how much an economy produces and how these resources are distributed. This requires a model, so let us lay out the assumptions we use towards this end.

1. **Factors of Production** - We abstract away from particular inputs (i.e. the leather, steel, marketing, etc that go into making a car) and assume that output is produced with labor, L, and capital, K. We assume that these factors are *fixed*.

2. **The Production Function** - We abstract away from the fact that there are many different firms that combine capital and labor in many different ways, and we think of a single firm that uses K and L to create output. We call the particular way in which the firm combines capital and labor *the production function*:

$$Y = F(K, L)$$

Further, we assume that the production function has *constant returns to scale* (homogeneous of degree one):

$$zY = F(zK, zL)$$

Put simply, doubling the inputs will double the output. This feature makes our assumption of a single firm rather innocuous: a single firm doubling inputs to double output is equivalent to a new firm being formed in the economy.

3. **The Theory of the Firm** - Having described how resources are produced in our model, we need to consider distribution. Put simply, what does labor get paid in wages and what does an owner of capital get paid in rent? The prices of capital and labor are set in a competitive market, and since we have assumed that the supply of capital and labor is fixed, we just need to consider demand. The demand for capital and labor is determined by the choices that firms make.

   A crucial assumption is that firms are *competitive*: each individual firm is too small to affect prices by itself. Denote by W and R the wages paid to labor and the rent paid to capital. Firm's make profit:

$$\begin{aligned} \text{Profit} &= \text{Revenue - Labor Cost - Capital Cost} \\ &= PF(K,L) - WL - RK \end{aligned}$$

   We assume that firms aim to maximize profit. Thus the question is *what quantity of labor and capital will firms hire to do this?*

   Each additional unit of labor and capital hired produces some extra output. We call this the *marginal product of labor (MPL)* and the *marginal product of capital (MPK)*. Below we define MPL, but it should be clear that MPK is defined analogously:

$$MPL = F(K, L+1) - F(K, L)$$

   or using calculus:

$$MPL = \frac{\partial F(K,L)}{\partial L}$$

   In general we assume *diminishing marginal product*: as you hire more and more labor (capital), the MPL (MPK) falls.

   The *marginal cost of labor* is clearly the wage, W.

   The *marginal cost of capital* is clearly the rental rate, R.

   Now a profit maximizing firm will hire labor and capital as long as the marginal revenue the additional unit yields is greater than the marginal cost. Given diminishing marginal product, the firm will hire labor and capital until:

$$\begin{aligned} P \times MPL &= W \\ P \times MPK &= R \end{aligned}$$

   thus

$$\begin{aligned} MPL &= W/P \\ MPK &= R/P \end{aligned}$$

So the profit maximizing firm hires factors until real wage equals the MPL and real return to capital equals MPK.

4. **Profits Competed to Zero** - By Euler's Theorem, the fact that the production function has CRS gives us:

$$Y = MPL \times L + MPK \times K$$

So output is completely exhausted by payments to labor and capital, thus profits are zero! If this seems odd, consider what happens if profits are not zero: another firm can come in and charge slightly less than the firms currently in the market. This happens until profits end up at zero.

5. **Cobb-Douglas Production Function** - We will often use the following production function:

$$Y = F(K, L) = AK^{\alpha}L^{1-\alpha}$$

Although this seems arbitrary, note that the share of income paid to labor and the share of income paid to capital have been close to constant over time. The production function that leads to this is Cobb-Douglas.

To see that the Cobb-Douglas function leads to constant shares of national income, notice that

$$MPL = A(1-\alpha)K^{\alpha}L^{-\alpha} = \frac{(1-\alpha)Y}{L}$$
$$MPK = A\alpha K^{\alpha-1}L^{1-\alpha} = \frac{\alpha Y}{K}$$

thus

$$MPL \times L = (1-\alpha)Y$$
$$MPK \times K = \alpha Y$$

Demand for Goods and Services

1. **Closed Economy** - Recall that

$$GDP = C + I + G + NX$$

This equation represents the four aspects of *expenditure* that constitute GDP. Here we ask ourselves what determines the levels of expenditure.

We will proceed assuming a *closed economy*. Thus

$$NX = 0$$

2. **Consumption** - We assume that household consumption is a linear function of disposable income

$$C = C(Y - T)$$
$$C = \alpha + MPC * (Y - T)$$

where T is taxes and MPC is the *marginal propensity to consume*, or the amount of every additional dollar of disposable income that a household consumes.

3. **Investment** - Investment spending depends on the interest rate, as the interest rate is the cost of money. Thus

$$I = I(r)$$

If the interest rate falls, then investment spending increases. To see this, imagine a consumer that wants to finance a new car. At four percent interest, they might think borrowing the money is too expensive. If the interest rate falls to three percent, they are more likely to make the purchase.

Notice that this holds even if the consumer does not borrow money to buy the car! The consumer is deciding whether to use cash to buy a new car or to save the money by investing. If the return to investing falls (the interest rate falls), then the opportunity cost of buying the car falls, and thus the consumer is more likely to buy the car.

Now as an exercise, tell yourself an analogous story about a brewery in Madison deciding whether to open a new factory. How will interest rate changes alter the brewery's decision?

4. **Government Purchases** - Here we assume government purchases and taxes are exogenous:

$$G = \overline{G}$$
$$T = \overline{T}$$

5. **Equilibrium** - Since we assume capital and labor are fixed, the supply of goods and services is fixed. Thus the above gives us

$$\overline{Y} = C(\overline{Y} - \overline{T}) + I(r) + \overline{G}$$

The only variable is the interest rate, so that must change to yield equality and thus equilibrium.

Notice that

$$\overline{Y} - C(\overline{Y} - \overline{T}) - \overline{G} = I(r)$$

The left hand side of the equation is all income minus all consumption (both private and public). Then the right hand side is *savings*, or income minus consumption. So we have

$$\overline{S} = I(r)$$

Thus the equilibrium interest rate is determined by *saving in the economy equaling desired investment.*

Exercises

1. Mankiw 3.4 - Suppose that an economy's production function is Cobb-Douglas with parameter $\alpha = 0.3$.
   (a) What fractions of income do capital and labor receive?
   (b) Suppose immigration increases to labor force by 10 percent. What happens to total output (in percent)? The rental price of capital? The real wage?
   (c) Suppose that a gift of capital from abroad raises the capital stock by 10 percent. What happens to total output (in percent)? The rental price of capital? The real wage?
   (d) Suppose that a technology advance raises the value of the parameter A by 10 percent. What happens to total output (in percent)? The rental price of capital? The real wage?
2. Mankiw 3.5 - Labor's share of total income is approximately a constant over time. The trend in the real wage closely tracks the trend in labor productivity. How are these facts related? Could the first be true without the second also being true? Use the mathematical expression for labor's share to justify your answer.
3. Mankiw 3.9 - Suppose that an increase in consumer confidence raises consumers' expectations about their future income and thus increases the amount they want to consume today. This might be interpreted as an upward shift in the consumption function. How does this shift affect investment and the interest rate?