Macroeconomics
Topic 1: "Define and calculate GDP. Understand the difference between real and nominal variables (e.g., GDP, wages, interest rates) and know how to construct a price index."

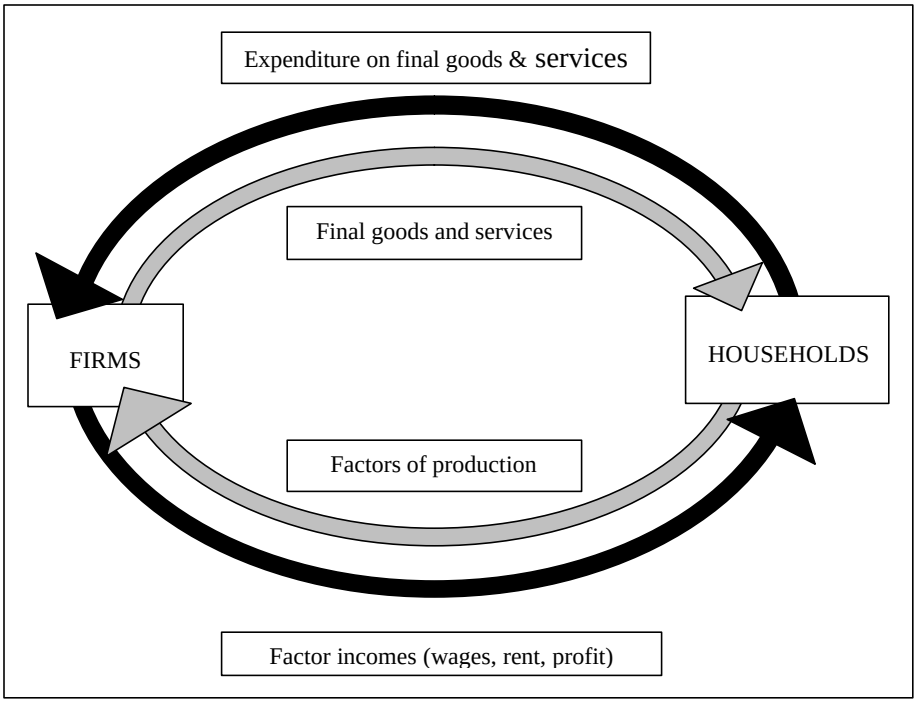
Reference: Gregory Mankiw's *Principles of Macroeconomics*, 2nd edition, Chapters 10 and 11.

Gross Domestic Product

In any study of the aggregate economy, one of the key elements is the aggregate amount of goods and services produced over a certain period of time. The measure most often used in the United States is called the nominal gross domestic product (the GDP). This is the market value of the total quantity of final goods and services produced over the specified time period. The GDP is actually measured quarterly, but the number is then multiplied by four, so that the amount is in annual terms.

In order to understand this measure, it is necessary first to understand the concept of a final product. The GDP does not measure the market value of everything that is produced, because this would entail double counting. Each final product includes intermediate goods whose value is included in the value of the final product. Take, for example, a simple loaf of bread: the loaf is made from flour (and other ingredients), the flour is made from (say) wheat, and the wheat is grown from seeds. The value of the bread (the final product) includes the value of the flour, which includes the value of the wheat, which includes the value of the seeds. The GDP includes the market value of the bread — it does not then add the value of the flour, the value of the wheat and the value of the seeds. The value of a final product is also the value of the incomes of everyone involved in the production of both the final product and the intermediate goods that went into its production.

Let us continue with the example of the bread. Let's say that the baker produces $1000 worth of bread, using $700 worth of flour. The miller, who sold the $700 worth of flour used $500 worth of wheat, which the farmer grew from $10 worth of seeds. The difference between the $1000 and the $700 is the $300 of income generated by the baker. The difference between the $700 and the $500 is the $200 of income generated by the miller. The difference between the $500 and the $10 is the $490 of income generated by the farmer. If we assume for simplicity that the seed producer started from nothing, the $10 of seeds represents the income generated by the seed producer. The sum of these incomes ($300+$200+$490+$10) is equal to the market value of the bread ($1000). Each of the producers will distribute this income to the factors of production (wages, rent and profit). As all the money is distributed or kept by the producer as profit, the market value of the final product is equal to the incomes of all the factors of production. This is usually shown as a "Flow of Income" chart:



The light arrows going in a clockwise direction show that the households supply the factors of production to the firms, and the firms produce goods and services for the households. The dark arrows going in a counter-clockwise directions show the money values of the households' expenditures on the final goods and services, which supplies exactly the required amount for the firms to pay the factor incomes (wages, rent, profit) to the household suppliers of those factors (labor, land, capital).

The government agency charged with calculating the GDP each year (the Department of Commerce) measures it in two different ways: they add up the money values of the final products, and they add up all of the incomes of the factors of production. Theoretically, these two operations should give them the same result. They never do because of their measuring errors (their published results always include a "statistical discrepancy"). The primary method of measurement is, however, the measurement of the money values of the final products. Basically, they measure expenditure on final goods and services, and then make adjustments for (a) the goods that are produced this period but not sold, and (b) the goods that are sold this period but were produced earlier.

The components of this measure of GDP (Y) are: —

Consumption (C) — All household purchases of goods and services

Investment (I) — All purchases by businesses of buildings, machinery and tools, plus purchases of new housing, plus the market value of changes in inventory. It is the last part of this measure that changes the measure of expenditure into a measure of production. If inventories increase during a particular period, then production is more than sales during that period—the increase in inventory is then added to the expenditures to show production. If inventories decrease during a particular period, then sales are greater than production — the reduction in inventory is then subtracted from expenditure to show current production.

Government expenditure (G) — All purchases of goods and services by local, state and federal governments. This includes the "purchase" of the services of all government employees (including the military), but it does not include transfer payments like Social Security benefits. Transfer payments are not included because they do not represent income from current production.

Net exports (NX) — This amount represents the money value of domestically produced goods that are sold outside the United States (i.e., our exports) minus the purchase of goods and services produced in other countries (i.e., our imports). Our exports are part of our domestic production, so obviously must be included. Our imports are subtracted here because they are goods and services produced by foreign countries, but they have already been included in our consumption, investment and government expenditures. If imports increase, but all other parts of the GDP remain the same, the GDP will not change, because the imports are first included in the calculation of C + I + G, and then they are subtracted out.

Thus,

$$\mathbf{Y = C + I + G + NX}.$$

Other Aggregate Measures

It is important to understand that the GDP only measures the output that is produced within the country. If someone living in Canada commutes into the United States to work, what that person produces is part of the US GDP, not Canada's GDP. Similarly, if a US resident owns a company abroad, the production of that company is part of the GDP of the foreign country where the company is located rather than being part of US GDP. There is, however, another statistic that is used to measure the output of the country's permanent residents. This is the gross national product (or the GNP). The Canadian resident who works in the US is adding to Canadian GNP, and the US resident who owns a company abroad is adding to the US GNP. The GNP thus includes the incomes of US residents wherever they earn it.

The US also measures what is called the net domestic product and the net national product. These two measures are derived from the GDP and the GNP respectively by subtracting what is called depreciation or the consumption of fixed capital. This subtracted amount represents the wear and tear on the country's capital equipment of buildings, machinery, and tools.

Real versus Nominal GDP

If the GDP changes, either the actual output of goods and services has changed, or the prices at which they are selling has changed, or both. Economists must separate the changes in output from the changes in prices. To do this they use the concept of real output. The real output of the economy (i.e., the real GDP) is measured by looking at current outputs and pricing them at the prices that existed at some time in the past.

Currently the prices of 1996 are used. Thus nominal GDP for this year is this year's output priced at this year's prices, and real GDP for this year is this year's output priced at 1996 prices. 1996 is known as the base year. Because real GDP is not affected by price changes (only 1996 prices are used), any change in the real GDP figure reflects only a change in the actual amounts of goods and services produced.

From the nominal GDP and the real GDP, however, we can derive a statistic that is used for measuring the rate of inflation. This is called the GDP Deflator. Prices obviously affect the nominal GDP but not the real GDP, so dividing nominal GDP by real GDP gives an indication of the prices. The Deflator is the nominal GDP multiplied by a hundred and divided by the real GDP. As nominal and real GDP are the same in the base year, the deflator is always 100 in the base year. For any other year, the deflator states the price level for that year as a percentage of the prices in the base year. The percentage change in the GDP deflator from year to year is published as the rate of inflation.
The real GDP is used as an indicator of economic growth and as an indicator of recessions. The rate of growth of the economy is given as the annual rate of change of real GDP. The economy is officially considered to be in a recession if the real GDP has declined over at least two successive quarters. A recession is usually accompanied by other indicators of weakness in the economy: rising unemployment, falling profits, increased bankruptcies, etc., but the primary indicator in the official statistics is a two-quarter downturn in the real GDP.

Although we tend to use real GDP as a measure of our general welfare (i.e., we consider ourselves better off when the economy is growing in real terms — particularly if real per capita output is increasing), it should not be thought that it is a good indicator of our over-all well being. There are many aspects of our lives that we consider important that are not included in the measure at all. The amount of leisure we have is not included, nor is the effect of production on the quality of the environment. Although GDP does include a rental value of owner occupied housing and the value of the food consumed by farmers out of their own produce, the GDP ignores most transactions that do not take place in legal markets. It also excludes such things as life expectancy and levels of literacy.

Price Indices

Although inflation may be measured using the GDP deflator (see above), this is not considered to be a good measure of what we call "the cost of living." The GDP deflator is calculated from the GDP which includes all final goods and services, but the average consumer doesn't consume a little bit of everything produced. To measure what our money wages are worth, we look at the prices of only the kinds of consumer goods and services that the average wage earner buys, and we weight the prices according to the proportion the goods and services have in our total purchases.. This index is called the consumer price index (CPI). The CPI is calculated by the Bureau of Labor Statistics (part of the Department of Labor).

The Bureau of Labor Statistics takes periodic surveys to determine what is considered to be the typical "basket of goods" that the average consumer buys: i.e., not just the items

purchased, but what quantities of these items are purchased. The prices are then weighted according to the quantities. The bureau then collects the prices of each of the items. The basket (whose quantities remain unchanged) can thus be valued in accordance with the prices that exist for each time period. The Bureau then compares the cost of the basket with the prices that existed in a chosen base year. The price of the basket each year is then divided by the price of the basket in the base year, and then multiplied by 100. The CPI is this number, and it is, of course, always 100 in the base year. The value of the index is at any point in time shows current prices as a percentage of base year prices. If the index is 100 in the base year (as it always is), 103 the following year, and 107 the following year, then the index shows that the cost of living rose by 3% in the first year, and then by a further 4% the following year. Measuring inflation by the percentage change in the index from one year to the next, shows the inflation rate in the first year is 3% (i.e., (103-100)/100 = 3/100 = 0.03 or 3%). However, the inflation rate in the second year is not 4%. The index has risen by 4% of the original 100, from 103 to 107, so the inflation rate is 3.88% (i.e., (107-103)/103 = 4/103 = 0.0388 or 3.88% as the increase has to be calculated as a percentage of 103, not 100). Inflation rates are always expressed as a percentage of what the index was in the previous period. These figures mean that as far as the typical consumer is concerned, the cost of living rose by 3% in the first year, and by 3.88% in the second year.

The accuracy of the CPI (and any other index for that matter) depends on how typical the contents of the chosen basket of goods and services are. The basket currently in use is: 41% housing (including utilities and furnishings), 17% food and beverages, 17% transportation, 8% other goods and services, 7% medical care, 6% apparel and upkeep, and 4% entertainment. Once the basket has been chosen, there are still problems that cause a bias in the statistics. The three main problems are:

1) the substitution bias;
2) the introduction of new products; and
3) the problem of quality changes in the products.

The substitution bias comes from the fact that not all prices change in the same proportion. Consumers will make substitutions towards goods whose prices have risen less (i.e., have become relatively less expensive). A fixed basket of goods will miss these changes in quantities purchased. By keeping the quantity of the now more expensive good the same, the index overstates the effect of the price change on the cost of living. The fixed basket will also, of course, not take new products into consideration at all—until they change the basket (which they tend to do about once every ten years). Quality changes are hard to measure, but the quality of some goods does improve (cars get more miles to the gallon, or have more horsepower). If the quality of any good in the basket improves, the value of the dollar rises. The Bureau of Labor Statistics does try to adjust for such changes, but it is not always easy to do.

Other Price Indexes

Apart from the CPI, the Bureau of Labor statistics calculates several other price indexes. The CPI is an attempt to measure the cost of living by looking only at the prices that consumers pay for consumer goods and services. The Bureau also makes calculations that refer to specific geographical areas (there's a CPI for the Los Angeles area), and indexes for certain categories of goods like food, clothing, and energy. In addition the Bureau calculates what is called the Producer Price Index, which is a price index for a basket of goods and services bought by business firms. When prices rise in the economy, it is often the case that the producer price index starts to rise before the consumer price index, so it is often used as a predictor of inflation in the cost of living.

Using Price Indexes

All price indexes show a ratio. The ratio of a particular year's prices to the prices in a base year. The base year is always given as 100 (meaning a hundred percent of base year prices), and the index in other years shows the ratio as a percentage of base year prices. If the price index is currently, say, 110, it means that prices have rise by ten percent since the base year. As prices generally rise over time, it is almost always the case that the price level before the base year is shown by the index being a number less than a 100. If, say, the index five years before the base year is 85, then it means that the prices in that year were 85% of what they were in the base year.

Dollar Figures from Different Times

Price indexes can be used to compare amounts through time. Mankiw's book uses Babe Ruth's salary in 1931 as an example. Ruth earned $80,000 that year. The CPI (based on 1992 prices) was 8.7 in 1931, and 107.6 in 1995. I.e., 1931 consumer prices were on average 8.7% of 1992 prices, and 1995 prices were 107.6% of 1992 prices. If we divide Ruth's salary by the 1931 index, and then multiply by the 1995 index, we get Ruth's 1931 salary in 1995 dollars. $80,000 x (107.6)/(8.7) = $989,425. This is considerably less than the highest paid baseball players were paid in 1995, showing that baseball players' salaries have risen relative to the CPI — meaning that today's players are better paid in real terms than was Ruth in 1931.

Price indexes are usually used to convert nominal (or money) amounts to base year prices. This is, in other words, how nominal statistics are converted to real statistics. The nominal GDP is divided by the GDP Deflator to give the real GDP: — The nominal GDP this year is this year's quantities of output multiplied by this year's prices. The GDP deflator is the ratio of this year's prices to base year prices. Thus, if we divide the nominal GDP by the deflator, we get this year's output valued at base year prices.

Real GDP in 2002 =

$$\frac{output_{2002} \cdot prices_{2002}}{prices_{2002} / prices_{1996}} = \left(output_{2002} \cdot prices_{2002}\right)\left(prices_{1996} / prices_{2002} \right) = output_{2002} \cdot prices_{1996}$$

Nominal (or money) wages are usually deflated by the CPI to give real wages. This means that the money amount of wages is divided by the CPI. The base year for the CPI is currently 1992, so if the CPI in 1995 was 107.6 (i.e., 107.6% of 1992 prices), then the real wage for 1995 is given as the money wage in 1995 divided by 1.076. Although the index is expressed as a percentage (i.e., 107.6), calculations use it as a decimal (i.e., 1.076). If prices are 107.6 percent of base year prices, then current prices are 1.076 times base year prices.

Real and Nominal Interest Rates

Nominal amounts are converted to real amounts by dividing them by the relevant price index, but there is an exception to this method of calculation that you must be aware of. Nominal amounts are divided by the relevant index, but numbers that are ratios cannot be treated this way. The real rate of interest is NOT the nominal rate of interest divided by the price index. If you put $1,000 in the bank in a savings deposit that pays, say, 10% per annum, then in a year you will have $1,100. But if prices have risen in the meantime, we have to allow for this. If prices have risen by 4%, then the $1,100 will by less than $1,100 would have bought at the outset. In real terms the rate of return is only 6%. The $1,100 will buy 6% more than the original $1,000 would have bought. Thus

The Real interest rate = the nominal interest rate – the inflation rate

The changes in the price index are used to find the rates of inflation, but the rates of inflation are then subtracted from the nominal interest rates.