

National Income and Product Accounts (NIPA)¹

Our first goal is to come up with a notion of the economy’s “output” or productive capacity of the economy. The U.S. produces a variety of goods and services, and we cannot just add up quantities of apples, cars, haircuts... The solution is to add the monetary value (in dollars) of goods and services. The most important measure of aggregate output is the GDP.

Gross Domestic Product (GDP) – the market value of the final goods and services produced by labor and property located in the United States during a year.

Let’s discuss this definition. First, GDP measures the value of goods and services traded in legal **markets**. Economic activity that does not take place in official markets is not counted in the GDP. For example, if you make a cup of coffee at your home, this production will not be counted in the GDP. If, on the other hand, Starbucks produces and sells a cup of coffee, then the value of that cup of coffee will be counted as part of GDP.

Final goods are goods that sold to their end users, as opposed to **intermediate goods**, which are used as inputs in order to produce other goods. For example, when a consumer buys sugar from a supermarket for his own use, then this purchase is considered a final good that will be counted in the GDP. When a bakery buys sugar and uses it as an input in the production of cakes, then sugar is an intermediate good and is *not* counted in the GDP. The next example illustrates this idea.

Suppose that the production of bread consists of 4 stages: (1) farming the wheat, (2) converting the wheat to grain, (3) baking the bread, and (4) selling the bread. The next table shows the transactions and the value added at each stage.

Value Added in Bread Production

				Sell	Value Added
Farmer	\$0.80			\$0.80	\$0.80
Miller	\$0.80	\$1.00		\$1.80	\$1.00
Baker	\$0.80	\$1.00	\$0.70	\$2.50	\$0.70
Retailer	\$0.80	\$1.00	\$0.70	\$2.75	\$0.25

In the first stage the farmer grows the wheat and sells it to the Miller for the price of \$0.80. We say that the value added by the farmer is \$0.80. The value added is defined as

$$\text{Value added} = \text{sales} - \text{purchases from other firms} + \text{change in inventories}$$

In the second stage of production, the miller grinds the wheat into flour and sells the flour to the baker for \$1.80. We say that the value added by the baker is \$1. In the third stage the baker bakes the bread and sells it to the retailer for \$2.50. We say that the value added

¹ The main source for definitions and methodologies is “Bureau of Economic Analysis”. This is a government agency responsible for collecting data for the National Income and Product Accounts. Visit <http://www.bea.doc.gov/> for “A Guide to the NIPA’S”.

by the bakery is \$0.70. In the last stage the retailer sells the bread to the consumer for \$2.75, so the value added by the retailer is \$0.25. Notice that although the retailer did not do anything to the product, it provided retail services to the consumer. The retail services include convenience of buying everything at one place, storage, etc.

If we added the value of all the transactions that took place, the contribution of one loaf of bread to the GDP would have been

$$0.8 + 1.8 + 2.5 + 2.75 = \$7.85$$

This would have been a biased value because the value added by the farmer would be included 4 times, the value added by the miller is included 3 times, and the value added by the bakery is included twice. We want the GDP to properly reflect the value of goods and services produced within the economy, without multiple counting of the same production.

Finally notice that the GDP counts goods and services that were produced during given time period. For example, the GDP of 2006 will count the value of goods and services produced in the year 2006. Goods that were produced before the year 2006 are not counted in the GDP of 2006.

A related measure to GDP is GNP, which measure the aggregate output of the country's residents.

Gross National Product (GNP) – the market value of the (final) goods and services produced by labor and property supplied by U.S residents during a year.

$$(1) \text{GNP} = \text{GDP} + \text{NFP}$$

- *NFP* – Net Factor Payments from abroad to domestic residents, i.e. $\text{NFP} = (\text{payments to domestic residents from abroad}) - (\text{payments to foreign factors in the U.S.})$.

The GNP measures what the U.S. residents produced, whether within the U.S. or abroad, while the GDP measures what was produced within the U.S., either by residents or foreigners. In the U.S. the difference between GDP and GNP is small (i.e. *NFP* is small). For the purpose of this course we will ignore this difference.

Measuring Nominal GDP

We now show two ways of measuring the nominal GDP. By nominal we mean that the value of all the goods and services is computed using the current prices.

I. Expenditure approach

$$(2) \text{GDP} = C + I + G + NX$$

- Personal Consumption Expenditures (*C*) – Goods and services purchased by persons resident in the United States, except new housing.
- Gross Investment (*I*) – Private and Government investment. Private investment is the spending of firms on plant, equipment and inventories, and the spending of households on new houses. Government investment is net purchases of fixed assets by the general government.
- Government Consumption Expenditures (*G*) – net purchases of goods, services, from business and from the rest of the world by general government; payments by general government to households in the form of compensation of employees; the

consumption of general government fixed capital; inventory change of government enterprises.

- Net Exports of goods and services (NX) – exports less imports of goods and services ($NX = X - IM$). Receipts and payments of factor income and transfer payments to the rest of the world (net) are excluded.

II. Income Approach

$$(3) NI = W + Int + rent + \pi_p + \pi_B$$

- National Income (NI) – the total payment to the factors of production.
- Compensation of employees (W) – wages, salaries and fringe benefits earned by workers.
- Net interest (Int) – interest paid by domestic businesses plus interest earned from the rest of the world.
- Rental income ($rent$) – income that landlords receive from renting, including the “imputed” rent that homeowners pay themselves, less expenses on the house such as depreciation.
- Proprietors’ income (π_p) – income of non-corporate business, such as small farms and law partnerships.
- Corporate profits (π_B) – income of corporations after payments to their workers and creditors.

$$(4) \pi_B = T_B + Div + S_B$$

- Profits tax liability (T_B) – the sum of Federal, State and local income subject to taxes.
- Dividends (Div).
- Undistributed profits (S_B) – business saving.

Formula (3) gives the National Income. We now show how the National Income is related to the GDP.

$$(5) GDP = NI + Ti + Dep$$

- Indirect business tax net of subsidies (Ti). These are tax liabilities that are chargeable to business expense in the calculation of profit-type incomes and sales taxes
- Consumption of fixed capital or Depreciation (Dep) – a charge for using up of private and government fixed capital located in the United States.

This formula makes intuitive sense. From it we see that after subtracting from GDP the expenses on maintaining the current level of capital stock (Dep), and the sales taxes, what remains is the National Income, i.e., the income of the factors of production that were used to produce the GDP .

Remark: Since the spending and income sides are estimated independently and using imperfect data, the BEA adds a number to the income side, called “statistical discrepancy” to reconcile the income and product sides. Let denote the GDP estimated by the expenditure approach in formula (2) by GDP^{EXP} and the GDP estimated by the income approach in formula (5) by GDP^{INC} . Then the two are related as follows:

$$GDP^{INC} + \text{statistical discrepancy} = GDP^{EXP}$$

Review question.

To make sure that you understand the above definitions, answer the following question.

1. How will the following transactions be recorded in the NIPA of the current year:
 - a. A person buys a new car made in the U.S.
 - b. A person buys a new foreign made car
 - c. A person buys an old car
 - d. A person buys a new house
 - e. A person buys an old house
 - f. A firm buys a new machine

What the GDP Does Not Capture

We needed a measure of the productive capacity in the economy, and the most important measure is the GDP. However, there are certain production activities that are not captured by the GDP. Recall that the GDP records only transactions that take place in legal markets. Thus, the GDP does not record illegal activities (sales of forbidden drugs for example), and home production. In the home production the household combines his time and purchased goods in order to produce other goods. For example, you combine your time with teabags and sugar to make a cup of tea. This production is not recorded in the economy. The problem is not severe if in all the countries the size of the home sector is the same as a fraction of the total output. In this case comparisons across countries will not be biased. The problem is that in some underdeveloped countries the home sector is quite large, and thus the GDP of these countries underestimates the level of overall production in those countries.

Measuring Real GDP and Inflation

Our next goal is to decompose the change in the nominal GDP into: (1) change in prices, and (2) change in output. In other words, we want to be able to express the nominal GDP as follows:

$$GDP_t = Q_t \cdot P_t$$

Q is called the real output or real GDP and P is called the price level or GDP deflator.

The reason why economists want to decompose the nominal GDP into real GDP and price level is for comparisons of GDP across time. Suppose that the nominal GDP increased by 5% in the last year. Is this an increase in production or simply an increase in prices? Notice that if the economy does not change the production of any good, and the prices of all goods go up by 5%, then the nominal GDP will increase by 5%. In this case the increase in nominal GDP does not reflect an increase in the productive capacity of the economy, but simply a result of increasing prices. It is of crucial importance to be able to tell how much of the change in the nominal GDP is due to changes in prices and how much is due to changes in production. The growth rate of the price level is called *inflation*.

I. Base Year Approach (used before 1996)

Notations:

P_t^i – price of good i in year t

Q_t^i – quantity of good i in year t

According to the base year approach we fix the prices of all goods at their level in some base year, and use those fixed prices to compute the real GDP in any other year. The formula for real GDP at time t and base year b is given by:

$$RGDP_b^t = \sum_i P_b^i Q_t^i.$$

Notice that in the base year, the real GDP is equal to the nominal GDP.

The price level is then obtained by dividing the nominal GDP by the real:

$$P_t = \frac{GDP_t}{RGDP_b^t}$$

This accomplishes the task that we set to ourselves, namely decomposing the nominal GDP into real GDP and a price level:

$$GDP_t = Q_t \cdot P_t = RGDP_b^t \cdot P_t$$

The level of the real GDP and the price level are of very little interest to economists. More important are the *growth rate* of real GDP and the *growth rate* of the price level. The later is called *inflation*. **The problem however is that different choices of the base year give different results about the growth rate of real GDP and inflation.** The next example illustrates this point.

Suppose that the economy produces two goods, 1 and 2. The prices and quantities for several years are given in the table below. The table also shows the decomposition of GDP into real GDP and prices, using the base year approach. The yellow part uses 2000 as the base year, while the blue part uses 2005 as the base year.

Year	P1	Q1	P2	Q2	GDP	Base year = 2000				Base year = 2005			
						Q	P	g_Q	g_P	Q	P	g_Q	g_P
2000	1	100	10	2	120	120	1.00			630.00	0.19		
2001	2	101	11	3	235	131	1.79	1.09	1.79	651.00	0.36	1.03	1.90
2002	3	102	12	4	354	142	2.49	1.08	1.39	672.00	0.53	1.03	1.46
2003	4	103	13	5	477	153	3.12	1.08	1.25	693.00	0.69	1.03	1.31
2004	5	104	14	6	604	164	3.68	1.07	1.18	714.00	0.85	1.03	1.23
2005	6	105	15	7	735	175	4.20	1.07	1.14	735.00	1.00	1.03	1.18

First, let's make sure that we know how the real GDP and price level were computed. For example, to compute the real GDP in 2003 using 2000 as the base year we fix the prices at 2000 level and multiply them by the quantities in 2003:

$$RGDP_{2000}^{2003} = 1 \cdot 103 + 10 \cdot 5 = 153$$

As another example, let's compute the real GDP in 2003 using 2005 as the base year:

$$RGDP_{2005}^{2003} = 6 \cdot 103 + 15 \cdot 5 = 693$$

Notice that the real GDP in the base year is always equal to the nominal GDP in the base year.

The price deflator is the nominal GDP divided by the real GDP. For example, the price deflator in 2003 when the base year is 2000 is:

$$P_{2003} = \frac{GDP_{2003}}{RGDP_{2000}^{2003}} = \frac{477}{153} = 3.12$$

The columns labeled g_Q and g_P show the growth rate of real GDP and the growth rate² of the price level (inflation).

Now that we know how the entries were computed, observe the growth rates of real GDP and price level between the years 2004 and 2005. When the base year is 2000, the measured inflation was 14% and when the base year is 2005 the inflation measured inflation is 18%. Similarly, when the base year is 2005 the measured growth in real GDP is 3%, while with 2000 as the base year the measured growth rate of real GDP is 7% (more than twice as high!). After 1996 many countries switched to an alternative method, called the Chain-Weighting method, which does not use any fixed base year.

II. Chain-Weighting Approach

According to this approach we let the growth rate of the **real GDP** between two adjacent years ($t - 1$ and t) be³

$$g_c^Q = \sqrt{g_{t-1}^Q \cdot g_t^Q}$$

Where g_{t-1}^Q is the growth rate of real GDP between time $t - 1$ and t using $t - 1$ as the base, and g_t^Q is the growth rate of real GDP between time $t - 1$ and t using t as the base.

In other words, each year we compute two different real GDP's: one using last year as the base and the other uses current year as the base. So there is no fixed year which serves as the base. For example, in 2005 we compute real GDP using 2004 as the base and another real GDP using 2005 as the base. Then we simply average them (geometrically).

Similarly, we let the growth rate of the prices be

² The table shows the gross growth rate, defined as y_t / y_{t-1} while the net growth rate is defined as $y_t / y_{t-1} - 1$. It is clear from the context which one I am talking about.

³ This is a geometric average of g_{t-1}^Q and g_t^Q . The subscript c indicates the "chain" weighting approach.

$$g_c^P = \sqrt{g_{t-1}^P \cdot g_t^P}$$

These growth rates can be used to construct real GDP series and GDP deflator. Choose any base year. In the base year the real GDP is set to be the same as the nominal. Then use the above growth rate to construct the series of the real GDP. Suppose that the base year is $t - 1$. Then the real GDP in $t - 1$ is the same as the nominal GDP in $t - 1$. The real GDP in year t is

$$RGDP_c^t = GDP^{t-1} \cdot g_c^Q.$$

Suppose that instead we choose the year t to be the base year. Then real GDP in year t is the same as the nominal GDP and

$$RGDP_c^{t-1} = GDP^t / g_c^Q.$$

In both cases, the growth rate of the **real GDP** is the same (since we set it to be the same and $= g_c^Q$).

The construction of the GDP deflator is similar. In the base year GDP deflator is 1. Then use the above growth rate to construct the GDP deflator in other years. The name “chain” comes from the fact that we use the growth rates to construct the next year’s GDP by “chaining” it to the current year.

Answer to the review question.

2. How will the following transactions be recorded in the NIPA of the current year:
 - a. A person buys a new car made in the U.S.

As part of C, the personal consumption expenditures.

- b. A person buys a new foreign made car

As part of C, and IM, so that the purchase does not affect the U.S. GDP.

- c. A person buys an old car

It is not recorded in the NIPA. If the car was purchased from a car salesman, then part of the payment goes to the agency for its services. The income of the agency is a service that was produced in the current year, so it is recorded in C.

- d. A person buys a new house

As part of I. Remember that purchases of new houses by persons is part of investment and not consumption.

- e. A person buys an old house

This transaction is not recorded in the NIPA, same as old car. Again, if a real-estate agent was involved, then his fee is recorded in C as consumption of services.

- f. A firm buys a new machine

As part of I if the machine is made in the U.S., and if it is imported, then both I and IM.