1. A glimpse of the real sector: GDP, inflation rate, macroeconomic identities

1. Real sector and financial sector

Macroeconomics studies the aggregate effects of what people do. Most of what people do has to do with:

(i) the production and use (allocation) of goods (goods means "goods and services");

(ii) the issuance and allocation (resale, trading, exchange) of financial assets (financial assets are a sort of substitutes for money).

The activities related to (i) give rise to the real sector (or real side) of an economy. Those related to (ii) give rise to the financial sector.

2. (Economic) Wealth and money

Wealth refers to, and is measured in terms of, goods. More wealth means having a higher amount of goods (to consume or to produce more goods). Therefore, wealth is generated in the real sector.

Money maybe synonymous with wealth for an individual but, for the economy as a whole, money is different from wealth (this is an example of the fallacy of composition). Money is an instrument for generating or transferring wealth, but (in general) is not wealth itself. The activities in the financial sector of an economy are essentially concerned with the creation and transfer of money.

3. Measuring (economic) wealth

Aggregate production generated in economy during a given period t of time can be used to measure the aggregate wealth created in the economy during t. Aggregate production itself could be seen as an indicator of the level of economic activity that takes place in the real sector.

4. Gross domestic product (GDP)

Definition 4.1. Gross domestic product (GDP). Market value of all the final goods (= not used to produce other goods) produced in an economy in a given period of time.

GDP is the most common measure of aggregate production and also a crude estimator of how rich and how big an economy is. It excludes black market activities (underground, hidden, or shadow economy = economic activity that is not taxed or which is not reported), second-hand sales (production already counted), and does not value goods that are not exchanged in markets (quality of education, life expectancy, income inequalities, pollution, social and political institutions, leisure time, moral values, loss of natural resources, environmental damage…). So, strictly speaking, GDP is not a measure of social welfare.

5. Nominal GDP and real GDP

Definition 5.1. Nominal GDP (GDP^n). Nominal GDP values production at current prices.

Changes in nominal GDP are misleading: they may reflect changes in production and prices.

Definition 5.2. Real GDP (GDP^r). Real GDP (GDP at constant prices or GDP adjusted for inflation) values production each period using the prices of one fixed period (called "base period").

6. Nominal GDP and real GDP: an example

It is practically impossible to compute GDP according to the definition because of the complexity involved in collecting all the necessary information (in a modern economy millions of goods are produced) and because prices of the same good may differ across regions of an economy (a solution would be to consider the same good produced in two regions a different good). In practice, then, GDP is an estimated value itself. The following example illustrates how GDP would be computed in an ideal situation.

time t	p_1^t	q_1^t	p_2^t	q_2^t
1	4	6	2	8
2	9	5	3	5

Example 6.1. The table just above presumes that there are only two goods (good 1 and good 2) and lists, for two periods, the amount produced of each good and the corresponding price.

- Nominal GDP in $t = 1$. $\text{GDP}_1^n = p_1^1 \cdot q_1^1 + p_2^1 \cdot q_2^1 = 4 \cdot 6 + 2 \cdot 8 = 40$ (monetary units of $t = 1$).
- Nominal GDP in $t = 2$. $\text{GDP}_2^n = p_1^2 \cdot q_1^2 + p_2^2 \cdot q_2^2 = 9 \cdot 5 + 3 \cdot 5 = 60$ (monetary units of $t = 2$).

From $t = 1$ to $t = 2$, GDP^n has increased a 50%: $\widehat{\text{GDP}^n} = \frac{60-40}{40} = \frac{1}{2} = 0.5 = 50\%$.

- Real GDP in $t = 1$ at constant prices of period $t = 1$. $\text{GDP}_1^{r,t=1} = p_1^1 \cdot q_1^1 + p_2^1 \cdot q_2^1 = 4 \cdot 6 + 2 \cdot 8 = 40$ (monetary units of $t = 1$). So $\text{GDP}^r = \text{GDP}^n$ at the base period (this always happens).
- Real GDP in $t = 2$ at constant prices of period $t = 1$. $\text{GDP}_2^{r,t=1} = p_1^1 \cdot q_1^2 + p_2^1 \cdot q_2^1 = 4 \cdot 5 + 2 \cdot 5 = 30$ (monetary units of $t = 1$).

From $t = 1$ to $t = 2$, GDP^r has fallen a 25%: $\widehat{\text{GDP}^r} = \frac{30-40}{40} = \frac{1}{4} = 0.25 = 25\%$. What if the base period is $t = 2$?

- Real GDP in $t = 1$ at constant prices of $t = 2$. $\text{GDP}_1^{r,t=2} = p_1^2 \cdot q_1^1 + p_2^2 \cdot q_2^1 = 9 \cdot 6 + 3 \cdot 8 = 78$.
- Real GDP in $t = 2$ at constant prices of $t = 2$. $\text{GDP}_2^{r,t=2} = p_1^2 \cdot q_1^2 + p_2^2 \cdot q_2^2 = 9 \cdot 5 + 3 \cdot 5 = 60$.

Hence, by taking the base period to be $t = 2$, GDP^r has fallen a 23%.

7. Interpretation and strategic use of data

Example 6.1 suggests two thoughts. First, what is "actually" the change in real GDP? There is no answer for this question. Real GDP solves the problem of the dependence of nominal GDP on the change of prices but real GDP has the shortcoming of depending on the base period chosen.

The second consideration is that the impossibility of telling the "actual" change in real GDP opens the room for manipulation to people whose interests are affected by economic information, as this people may have an incentive to disclose information selectively. In the context of Example 6.1, a government will be probably interested in informing citizens of only the increase in nominal GDP. The leading party of the opposition would instead like to point to the fall in real GDP. And if forced to mention real GDP changes, the government would prefer to take period 2 as the base period (due to the smaller reduction in real GDP in comparison with choosing 1 as the base).

8. Nominal variable and real variable

Definition 8.1. A nominal variable is a variable measured in terms of current prices.

Changes in current prices may affect a nominal variable. The typical nominal variable is measured in (current) monetary units.

Example 8.2. Typical nominal variables are GDP at current prices, money stock, (nominal) interest rate, (nominal) exchange rate, and consumer price index (see 16).

Definition 8.3. A real variable is a variable measured in physical quantities (or that measure physical quantities).

Real variables are not affected by current prices.

Remark 8.4. Some real variables, like total employment or the unemployment rate, need no price to be defined. Others are defined by fixing prices, like GDP at constant prices, which measures production using the prices of a base period. Still others come from nominal variables by removing the effects of prices, like the real interest rate.

Warning 8.5. Economic variables are meaningless without specifying its units of measurement (if any). For instance, nominal GDP is measured in monetary units of the current period and employment is measured in number of persons (also possibly in hours of work).

9. Stock variable and flow variable

Definition 9.1. A stock variable is measured in levels rather than rates of change or measured at a given point in time.

Definition 9.2. A flow variable is measured in rates per unit of time rather than levels.

Example 9.3. GDP is a flow variable, as it measures production during a period of time (so GDP is production per unit of time). Population at a given moment of time is a stock variable. Wealth is also a stock variable.

10. Meanings of the term "rate"

Remark 10.1. Rate as relative change. The term "rate" in "GDP growth rate" refers to a relative (in percentage terms) change in GDP.

$$\text{GDP growth rate (from period } t-1 \text{ to period } t) = \frac{\text{GDP}_t - \text{GDP}_{t-1}}{\text{GDP}_{t-1}}$$

The formula above gives the rate of change per one. To get a percentage, multiply by 100. If $\text{GDP}_{t-1} = 40$ and $\text{GDP}_t = 50$, the rate of change is $\frac{50-40}{40} = \frac{10}{40} = \frac{1}{4} = 0.25$ (per one); that is, 25%.

Remark 10.2. Rate as relative price. "Rate" in "exchange rate" means "ratio" or relative price.

Remark 10.3. Rate as amount. "Rate" in "interest (or wage) rate" means "amount".

11. Potential GDP and output gap

Definition 11.1. Potential (sometimes also called "natural") GDP refers to the maximum GDP level that an economy can sustain over time.

Definition 11.2. The output gap is the difference between potential GDP and actual GDP.

The output gap could be viewed as a measure of the degree to which an economy is performing well. When GDP is below potential, some production inputs must lie idle (remain unused). The more it is below, the higher unemployment is expected to be.

12. Real GDP per capita

Definition 12.1. Real GDP per capita is the ratio of real GDP to the population of the economy.

Real GDP per capita can be regarded as an indicator of the development or prosperity of an economy. It is usually taken as a measure of the average standard of living in the economy.

Real GDP per capita seems positively correlated with many indicadors of economic development and the quality of life: life expectancy, subjective well-being, education, health care expenditure… It appears to be positively correlated with the Human Development Index.
http://hdr.undp.org/en/2014-report

13. Short run and long run

Definition 13.1. "Short run" refers to a relative short period of time (a few months to a couple of years). In that period it is presumed that some factors or variables (technology, population) are essentially constant.

Short-run macroeconomics focuses on explaining the oscillations of real GDP (the business cycle).

Definition 13.2. "Long run" refers to a sufficiently long period of time in which (almost) everything may change.

Long-run macroeconomics tries to explain the dynamics of real GDP per capita (long-run economic growth). From a historical point of view, one of the most important events in the evolution of real GDP per capita is the so-called "Rise of the West". This expression refers to the fact that it was in Western Europe that the modern regime of sustained growth in real GDP per capita started. Related to the Rise of the West is the "Great Divergence", namely, the increase in the prosperity gap between Western Europe (and the Western offshoots: Australia, Canada, New Zealand, and the United States) and most of the rest of the world. Another related question is "The Needham puzzle": why was modern science invested in Western Europe when, for centuries, Chinese science and technology appeared far more advanced than European science?

14. Price indices

Definition 14.1. A price index is a measure of the general price level of an economy. This level can be thought of as a weighted average of the prices of all the goods.

By assuming the fiction that there is a unique good in the economy (the domestic product), if GDP measures the quantity of the good, then the price level would represent the price of the good.

As distinguished from GDP, price indices have no units and the value by itself means nothing. It is the rate of change of the index that is informative.

15. The GDP (implicit price) deflator

Definition 15.1. The GDP deflator is a price index defined as

$$\text{GDP deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}}.$$

The GDP deflator measures the changes in prices in all the goods produced in an economy between the base period used to calculate the real GDP and the current period.

Example 15.2. If $\text{GDP}^n_{2013} = 100$, $\text{GDP}^r_{2013} = 80$, $\text{GDP}^n_{2014} = 135$, and $\text{GDP}^r_{2014} = 90$, then GDP_{2013} deflator $= 100/80 = 1.25$ and GDP_{2014} deflator $= 135/90 = 1.5$. Having GDP_{2014} deflator $>$ GDP_{2013} deflator indicates a general price increase between 2013 and 2014.

16. The consumer price index (CPI)

Definition 16.1. The CPI is a measure of the cost of purchasing a fixed basket of goods of a consumer considered representative. The CPI_t in period t is defined as

$$\text{CPI}_t = \frac{\text{value of the basket at prices of period } t}{\text{value of the basket at prices of the base period}}.$$

For the index to have base 100, just multiply the right-hand side by 100.

Example 16.2. To illustrate the construction of the CPI, suppose the basket of goods is given by $(x, y, z) = (3, 2, 1)$, where the numbers represent the amounts of each of three goods. The following table shows the prices of the goods in four periods and the value of the basket in each period.

period	p_x	p_y	p_z	$V_t = basket\ value\ in\ period\ t$	CPI_t
1	1	4	5	$3 \cdot 1 + 2 \cdot 4 + 1 \cdot 5 = 16$	1
2	2	1	8	$3 \cdot 2 + 2 \cdot 1 + 1 \cdot 8 = 16$	1
3	3	1	1	$3 \cdot 3 + 2 \cdot 1 + 1 \cdot 1 = 12$	0.75
4	2	5	4	$3 \cdot 2 + 2 \cdot 5 + 1 \cdot 4 = 20$	1.25

Taking $t = 1$ as the base period, $\text{CPI}_1 = \frac{V_1}{V_1} = 1$; $\text{CPI}_2 = \frac{V_2}{V_1} = \frac{16}{16} = 1$; $\text{CPI}_3 = \frac{V_3}{V_1} = \frac{12}{16} = 0.75$; and $\text{CPI}_4 = \frac{V_4}{V_1} = \frac{20}{16} = 1.25$.

17. Inflation rate

Definition 17.1. The inflation rate π associated with the price index P is the rate of change of the price index P :

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

where π_t is the inflation rate from period $t-1$ to period t, P_t is the price index in the current period t and P_{t-1} is the price index in the immediately preceding period $t-1$. To express the inflation rate as a percentage, multiply by 100 the right-hand side.

Example 17.2. If $P_t = 50$ and $P_{t-1} = 40$, then $\pi_t = \frac{50-40}{40} = \frac{1}{4} = 0.25$ $(= 25\%)$: the price index has been pushed up a 25%.

Example 17.3. Consider Example 6.2 and let π_t be the inflation rate from $t-1$ to t. In this case:

- π_1 is not defined (since there is no CPI_0);
- $\pi_2 = \frac{\text{CPI}_2 - \text{CPI}_1}{\text{CPI}_1} = \frac{1-1}{1} = 0$;
- $\pi_3 = \frac{\text{CPI}_3 - \text{CPI}_2}{\text{CPI}_2} = \frac{0.75-1}{1} = -0.25$ (or -25%);
- $\pi_4 = \frac{\text{CPI}_4 - \text{CPI}_3}{\text{CPI}_3} = \frac{1.25-0.75}{0.75} = \frac{2}{3}$ (or 66.6%).

If π is calculated, for instance, from $t = 1$ to $t = 4$, then $\pi_{1\to4} = \frac{\text{CPI}_4 - \text{CPI}_1}{\text{CPI}_1} = \frac{1.25-1}{1} = 0.25$ (25%).

17. Differences between CPI and deflator

The CPI generally includes imported goods. The GDP deflator does not: it only includes the goods produced in the economy, not abroad.

The basket of goods in the GDP deflator may vary from period to period. The basket in the CPI generally does not.

Despite all that, the empirical evidence suggests that both indices are strongly correlated and tend to move in parallel.

18. Inflation concepts

Definition 18.1. As an economic phenomenon (not as a number), inflation refers to the sustained increase of the CPI. It occurs for periods during which the inflation rate is positive.

Definition 18.2. Deflation is the phenomenon opposite to inflation: it is a sustained decrease of the CPI (negative inflation rates, not negative CPI values).

Definition 18.3. Disinflation takes place when, during inflation, the inflation rate diminishes (but remains positive).

Definition 18.4. Hyperinflation occurs with astronomical inflation rates (montly inflation rates of at least 50%). Under a hyperinflation, inflation is out of control.

Definition 18.5. Core inflation rate is computed by excluding the prices of food and energy prices, which tend to be very volatile.

The core inflation rate (as opposed to headline inflation rate) is a measure of underlying long-term inflation and can also be used as an indicator of future inflation.

19. Expenditure categories

National income accounting assigns each good produced to one of four categories (all of them nominal or all of them real variables) according to the type of agent that has received the good.

- Personal consumption expenditures or, for short, consumption (**C**).
- Gross private domestic investment or investment (**I**).
- Government consumption and gross investment or government purchases (**G**).
- Exports of goods/services (**EX**) minus imports of goods/services (**IM**) or net exports (**NX**).

Definition 19.1. Consumption C. Value of the purchases of new goods (durable and non-durable) and services by households (no matter where the goods have been produced).

Definition 19.2. Investment I. Consists of the value of:

- fixed investment (on new factories, office buildings, and machinery to produce goods);
- residential investment (spending by households or firms on new homes); and
- changes in the firms' inventories (goods that have been produced but not sold yet).

Definition 19.3. Government purchases G. Spending by all levels of government (local, regional, national) on newly produced goods and services. Includes consumption (salaries to civil servants) and investment spendings (university buildings, new submarines).

Definition 19.4. Transfer payments (**TR**). These are payments by the government without receiving anything in return.

Typical transfer payments are Social Security payments to retired and disabled people and unemployment insurance to unemployed people. Transfer payments are excluded from government purchases.

Definition 19.5. Net exports $\mathbf{NX} = \mathbf{EX} - \mathbf{IM}$. Value of the exports of goods and services minus the value of the imports of goods and services (those imports have been already included in **C**, **I**, or **G**).

20. Trade balance

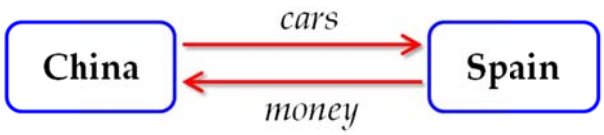
Definition 20.1. A trade surplus occurs when exports are greater than imports (net exports are positive: $\mathbf{NX} > 0$).

Definition 20.2. A trade deficit is run when imports are greater than exports ($\mathbf{NX} < 0$).

When exports equal imports, the trade deficit (or surplus) is zero. The difference "exports minus imports" is also known as "trade balance".

21. Why IM–EX (or –NX) represents foreign saving

Imagine that China exports only cars to Spain and that China imports nothing from Spain. This situation can be represented as follows.



China runs a trade surplus (with Spain) and Spain a trade deficit (with China). China delivers goods and receives in exchange money. Thus, China is saving and has lending capacity: has money (in general, financial assets) to lend. Trade surplus implies lending capacity. Trade deficit implies financial need.

22. How production is used

Definition 22.1. The fundamental macroeconomic identity is given by (1).

$$\underbrace{\mathbf{C} + \mathbf{I} + \mathbf{G} + \mathbf{NX}}_{\text{ex-post demand for output}} \equiv \underbrace{\mathbf{Y}}_{\text{ex-post supply of output = GDP}} \qquad (1)$$

Expression (1) is an identity (it is always true), as the values of the variables are established ex-post (once all spending decisions have been made). The supply and demand model provides an analogy: quantity demanded may be different quantity supplied, but quantity sold is always equal to quantity bought (someone sells because someone buys and vice versa).

(1) is true when the variables are nominal (nominal consumption, nominal GDP…) and also when the variables are real (real consumption, real GDP…).

One way to guarantee that (1) always holds is to define one of the variables in terms of the rest: if a discrepancy existed between $\mathbf{C} + \mathbf{I} + \mathbf{G} + \mathbf{NX}$ and $\mathbf{Y}$, then the discrepancy would be declared to be part of $\mathbf{I}$ (for instance, as involuntary investment). (1) can equivalently expressed as (2).

$$\mathbf{C} + \mathbf{I} + \mathbf{G} + \mathbf{EX} \equiv \mathbf{Y} + \mathbf{IM} \qquad (2)$$

Example 22.2. Suppose that a new car is available in the economy. If the car has been produced within the economy, the value of the car is included in **Y**; if the car has been produced abroad, then its value added to **IM**. On the other hand, who gets the car determines in which category on the left-hand side of (2) the value of the car must be placed.

- If a household purchases the car, its value appears in **C**.

• If a firm buys the car to use it in production activities (a leasing car company, for instance), then the value of the car is in **I**.

• If some public organization gets the car, then its value is included in **G**.

• If someone from another economy obtains the car, then its value counts as **EX**.

• If the car has been produced domestically and no one purchases it, then its value lies in **I** (the firm that produced the car is attributed involuntary investment).

23. Government budget

Definition 23.1. Designating by **T** the taxes paid by households and firms to the government, the government budget (or government saving) is defined as (2).

$$\mathbf{GB} \equiv \mathbf{T} - \mathbf{G} - \mathbf{TR} \tag{2}$$

The government budget equals the government's tax receipts minus its spending on goods and services minus transfer payments.

Definition 23.2. A budget deficit occurs if $\mathbf{GB} < 0$ (spending larger than receipts).

Definition 23.3. A budget surplus occurs if $\mathbf{GB} > 0$.

Definition 23.4. Public debt is the accumulation of past deficits.

24. How income is used

Definition 24.1. The income accounting identity is given by (3).

$$\mathbf{Y} \equiv \mathbf{C} + \mathbf{S} + (\mathbf{T} - \mathbf{TR}) \tag{3}$$

Interpreting GDP (**Y**) as aggregate income (GDP as net incomes earned by factors of production), then (3) says that income can be used to consume, to save, and to pay taxes (taxes net of transfers).

Definition 24.2. Disposable income $\mathbf{Y_d}$ is defined as (4).

$$\mathbf{Y_d} \equiv \mathbf{Y} - \mathbf{T} + \mathbf{TR} \tag{4}$$

By combining (3) and (4),

$$\mathbf{Y_d} \equiv \mathbf{C} + \mathbf{S}.$$

25. Where do savings go?

Definition 25.1. The savings accounting identity is given by (5).

$$\mathbf{S} \equiv \mathbf{I} + (\mathbf{G} + \mathbf{TR} - \mathbf{T}) + \mathbf{NX} \tag{5}$$

Identity (5) can be obtained as follows. Using the fundamental accounting identity (1),

$$\mathbf{Y} - \mathbf{C} \equiv \mathbf{I} + \mathbf{G} + \mathbf{NX}$$

From the income accounting identity (3),

$$\mathbf{Y} - \mathbf{C} \equiv \mathbf{S} + \mathbf{T} - \mathbf{TR}$$

By inserting the latter into the former identity, $\mathbf{I} + \mathbf{G} + \mathbf{NX} = \mathbf{S} + \mathbf{T} - \mathbf{TR}$. Rearranging,

$$\underbrace{\mathbf{S}}_{\text{private saving}} \equiv \underbrace{\mathbf{I}}_{\text{investment}} + \underbrace{(\mathbf{G} + \mathbf{TR} - \mathbf{T})}_{\text{government budget deficit}} + \underbrace{\mathbf{NX}}_{\text{trade balance}}.$$

Identity (5) tells that there are three ways of disposing of the savings of an economy. Each part of savings can go to

- firms to finance investment,
- the government to finance a budget deficit, or
- foreigners, when they buy more from the economy than the economy buys from them (the economy runs a trade surplus, so the rest of the world runs a trade deficit with the economy).

26. How is investment financed?

Definition 26.1. Solving for **I** in (5), the investment accounting identity is defined by (6).

$$\underbrace{\mathbf{I}}_{\text{investment}} \equiv \underbrace{\mathbf{S}}_{\text{private saving}} + \underbrace{(\mathbf{T} - \mathbf{G} - \mathbf{TR})}_{\text{government saving}} + \underbrace{(-\mathbf{NX})}_{\text{foreign saving}} \qquad (6)$$

According to (6), domestic investment is financed by private saving **S**, public saving $\mathbf{T} - \mathbf{G} - \mathbf{TR}$, or foreign saving $-\mathbf{NX}$.

27. Twin (or double) deficits

Suppose investment equals savings; that is, $\mathbf{I} = \mathbf{S}$. In this case, the savings identity (5) implies that the government budget deficit $\mathbf{G} + \mathbf{TR} - \mathbf{T}$ equals the trade balance **NX**.

This means that if the government runs a budget deficit, then it must be financed by foreigners: if $\mathbf{I} = \mathbf{S}$, then $\mathbf{G} + \mathbf{TR} - \mathbf{T} > 0$ implies $\mathbf{NX} < 0$. In sum, there is government and trade deficits.

As a result, the government spends more without having to increase taxes, and households and firms buy from abroad more goods than they sell. Are all of them living beyond their possibilities?

28. Identities versus theories

Identities do not establish causal connections between variables. To establish causal connections a theory is needed (a theory consists of proposing causal relationships). Identities are not theories, but mere descriptions of what is necessarily true: identities are tautologies. Theories, on the other hand, may be false. The attempt to identify causality from identities is an instance of the *cum hoc* fallacy.

Example 28.1. From $\mathbf{S}-\mathbf{I}\equiv(\mathbf{G}+\mathbf{TR}-\mathbf{T})+\mathbf{NX}$ and a rise in $(\mathbf{G}+\mathbf{TR}-\mathbf{T})$, it cannot be concluded that **NX** falls: may be **NX** declines because $\mathbf{S}-\mathbf{I}$ diminishes.