# Macroeconomic Data

We know about our economy through measurement of some key macroeconomic variables such as GDP (Gross Domestic Product), CPI (Consumer Price Index), unemployment rate, and so on. Macroeconomic data is the "realization" of these variables. Each variable measures one dimension of the economy. For example, GDP measures the total size of the economy, CPI measures the overall price level, and unemployment rate measures the extent of labor underuse.

On each dimension of our economy, there may be more than one variable that are relevant. For example, GNP (Gross National Product) is also a good measurement of the total size of the economy. Often these variables complement each other in describing a certain dimension of the economy. For example, GDP emphasizes geographic boundary while GNP emphasizes national ownership. Output of foreign enterprises located inside the country is counted in GDP, but not in GNP. Looking at both GDP and GNP (or equivalently, GNI (Gross National Income)) may give us a better picture of the size of the economy.

To each variable there is also a time dimension. So macroeconomic data are invariably time series, or "realizations" of stochastic processes. Variation of a macroeconomic variable on the time dimension characterizes the dynamics of the economy. For example, percentage change in GDP characterizes the speed at which the economy grows. For another example, percentage change in CPI characterizes inflation, or the speed at which money loses purchasing power.

Macroeconomic data are often systematically collected and compiled by national statistical bureaus, central banks, and other government agencies. In particular, GDP is a direct product of the *national accounting*, which is to measure economic activity of a nation using a consistent system of accounting technique. From 1952 to 1992, China used the Material Product System (MPS) that was prevailing in socialist countries back then. In 1992 China formally adopted the SNA (System of National Accounting) that was prevailing in western countries. There are two major differences between MPS and SNA. First, as the name suggests, MPS counts only goods output, exclusive of service. Second, SNA uses market prices in valuation of goods and services, while MPS has to rely on administered prices.

Macroeconomic data can be very general in scope. Basically any data that help us gauge the state of the economy can be called macroeconomic data. In addition to data from government agencies, market prices for interest rates, exchange rates, stock market valuations, and so on, are of course macroeconomic data. Indices based on surveys, such as Purchasing Managers' Indexes (PMI), are also macroeconomic data. It is also well known that output data from key industries can be reliable indicators for the state of the economy. In China, electricity consumption, volume of rail cargo, and total bank loan, are widely recognized as reliable indicators for the economy.

In this course, we focus on the principles and rules for computing three of most important macroeconomic variables: GDP, CPI, and unemployment rate. We also show time series dynamics and cross-country comparisons of these data. This would help us to gain some basic knowledge

of the economy of our country and the world.

**National Accounts**

National accounts include three parts: (1) GDP (Gross Domestic Product) and its components; (2) flow of funds table; (3) balance of payments table.

GDP (Gross Domestic Product) is essentially the total value of all transactions in the economy within a time interval (say, a quarter). There are two ways to view and calculate GDP: (i) the total income generated in the economy; (ii) the total expenditure on the economy's output of goods and services. Of course, total income must equal total expenditure, because every transaction generates an income to the seller and an equal amount of expenditure to the buyer.

More precisely, GDP is the *market value* of all *final* goods and services produced within an economy in a given period of time. Mathematically, we have

$$GDP_t = \sum_{i=1}^{M} q_{it} p_{it}, \tag{1}$$

where $q_{it}$ and $p_{it}$ are quantity and price, respectively, of $i$-th item produced period $t$. For example, if we have an economy of two trees, one apple tree and the other orange tree. If the apple tree produces 20 apples and the orange tree produces 10 oranges, with their market prices 0.5 and 1.0 RMB, respectively, then the GDP of the twin-tree economy is

20*0.5 + 10*1.0 = 20 RMB.

Note that only final goods are counted in GDP. Intermediate goods, which are parts and parcels of final goods, are not individually counted. This is to avoid double accounting. It is clear that

GDP = value of final goods produced

= sum of *value added* at all stages of production.

To avoid double accounting, transactions of used goods are also not counted in GDP. Note that the "used" goods can be new to consumers. For example, suppose that GM produces a car in China but does not manage to sell it this year. Instead, GM puts the car into inventory and plans to sell it next year. In national accounting, the value of the car is counted in this year's GDP as inventory investment. When the car is finally sold next year, it would be treated as "used" and not counted in next year's GDP. If, however, it is a spoilable good (e.g., vegetables) that is produced but not sold, then it is not counted in GDP at all.

Note also that in computing GDP, we use market prices, when available, to calculate the value of goods and services. When market prices are not available, we use imputed prices, which are estimates of market prices. For example, to calculate the value of housing service, it is common to impute the rent people have to pay to their landlords, who may be themselves if they own their homes. The value of government services, such as police and firefighting, also needs imputation. Typically, the national accounts value these government services in GDP by the wages paid to the public servants.

**What GDP Does NOT Include**

It may be argued that "services" of durable goods, such as cars and refrigerators, should also be valued in GDP. But these are omitted for convenience. There is also good reason to include the value of domestic work performed by house-wives and husbands, such as cooking and washing, into GDP. Typically, however, this is also omitted in practice.

GDP calculation also omits goods and services in the underground economy. The underground economic activity can be substantial. People have incentives to "hide" transactions either because these transactions are illegal, or for tax-avoidance purposes. Illegal transactions include illegal drug trade, human trafficking, and so on. For minor services such as babysitting, the tax administration has little incentive to enforce taxation.

As can be seen, GDP is an inaccurate measure of the size of the economy. In addition, although the general framework for GDP computation is the same across countries, substantial differences exist in details. As a consequence, comparing GDP across countries can be misleading. However, if the rules do not change over time, comparisons along the time dimension are meaningful.

**Nominal and Real GDP**

Note that in equation (1), we calculate GDP using current prices. We call the value of such calculation *nominal GDP*. The nominal GDP changes over time either because there is a change in the amount (real value) of goods and services or there are changes in the prices of those goods and services.

In contrast, *real GDP* measures the value of final goods and services at *constant prices*,

$$RGDP_t = \sum_{i=1}^{M} q_{it} p_{it_0}, \tag{2}$$

where $t_0$ stands for the *base year* and $p_{it_0}$ is a constant for each $i$. The relationship between nominal and real GDP can be characterized by

$$GDP_t = P_t \cdot RGDP_t,$$

where $P_t$ is called *GDP deflator,* or *implicit price deflator for GDP*. Taking *real* measurements is essential for gauging growth or improvement (e.g., real wage) in living quality.

One principle of calculating RGDP is that the base year should not be too far, so that prices will not be too out of date. For example, cell phone was a rare product 20 years ago. It would be absurd to use the price of cell phone 20 years ago to calculate today's GDP.

Since 1995, the US has been using chain-weighted measures of real GDP in the calculation of real GDP growth. The chain weight works as follows: Average prices in 2009 and 2010 are used to measure real growth from 2009 to 2010. Average prices in 2010 and 2011 are used to measure real growth from 2010 to 2011, and so on. In China, we change base-year every five years.

Figure 1 shows the real and nominal GDP of China from 1978 to 2012. Since the base year of real GDP is 2010, the lines of real and nominal GDP's cross at year 2010. We can see in the graph that

China experiences rapid growth during the over 30-year period. The growth of nominal GDP is of course higher than that of real GDP, reflecting a rising price level. Figure 2 shows the quarterly year-over-year (YoY) growth rate of real GDP from 1992 to 2015. GDP is typically reported every quarter. The quarterly YoY growth rate is calculated as

$$R_t = \ln\left(\frac{RGDP_t}{RGDP_{t-4}}\right),$$

where $t$ denotes quarter. The YoY growth rate naturally filters out seasonality.

**Figure 1: The Real and Nominal GDP of China (Unit: RMB 100mil)**

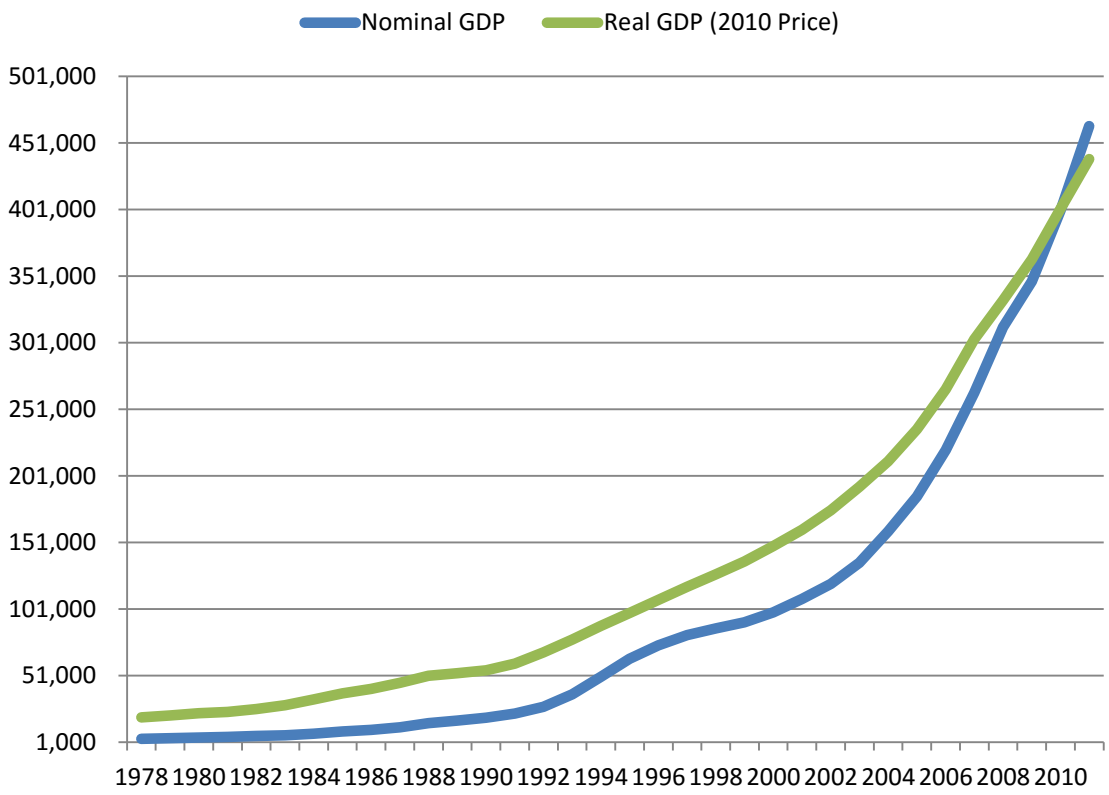
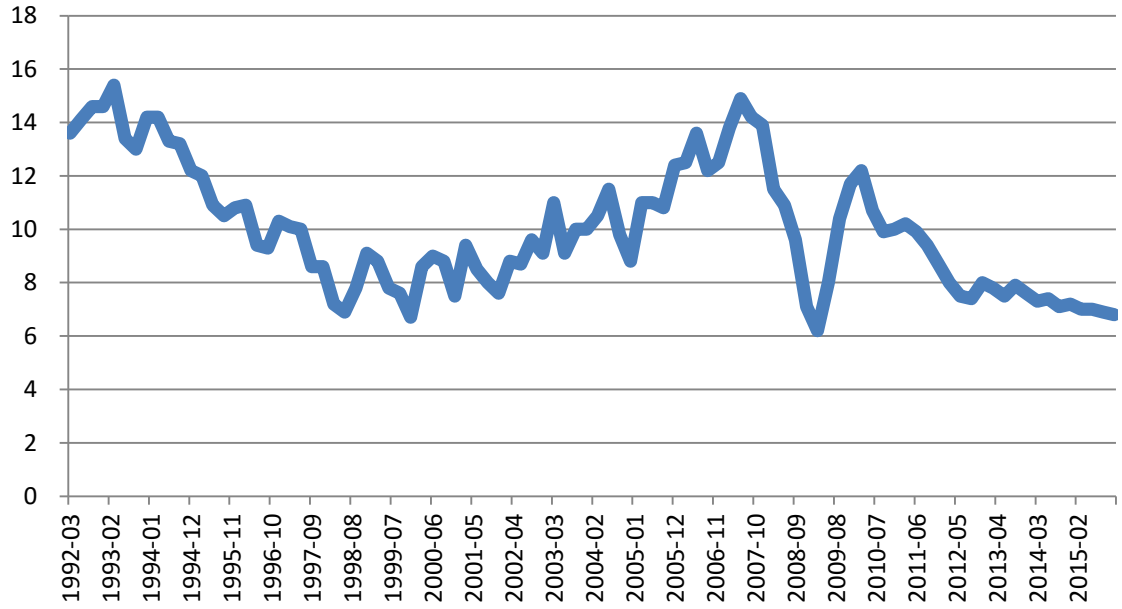



**Figure 2: Real GDP Growth of China (Quarterly, 1992-2015)**




**Components of GDP (The Expenditure Side)**

From the perspective of expenditure, GDP can be decomposed into four components:
(1) Consumption spending by households (C)
(2) Investment spending by businesses and households (I)
(3) Government spending of goods and services (G)
(4) Net exports (or net foreign spending on domestically produced goods) (NX)
Let $Y$ denote GDP. By definition we have

$$Y = C + I + G + NX. \quad (3)$$

We call this equation the *national income accounts identity*. In the following we go into details of these four components.

**Consumption (C)**

The consumption component measures the value of all goods and services bought by households. It includes the value of durable goods, non-durable goods, and consumer service. Durable goods are those that last a long time, such as cars, refrigerators, and so on. Non-durable goods last a relatively short time, e.g., food and clothing. Consumer service refers to the work done for consumers by individuals and firms, such as dry cleaning, air travel, and so on.

**Investment (I)**

The investment component measures the value of total spending on goods bought for future use. There are two types of investment: one is fixed investment, which adds to the capital stock; the other is inventory investment, which adds to the inventory. The fixed investment conducted by firms is called business fixed investment, which is spending on plants and equipment that firms will use to produce goods & services. The fixed investment conducted by individuals and families

is called residential fixed investment, which mainly consists of spending on apartments and houses. The inventory investment measures the change in the value of all firms' inventories

Fixed investment increases capital. For firms, capital is one of the most important factors of production. The more capital a firm has, the higher capacity the firm has for future production. In aggregate is also true. The more capital we have in the country, the higher potential we have for future production and consumption. Capital, however, depreciates. For example, machines wear and break down eventually. So investment on new capital is essential for maintaining and increasing the stock of capital.

For example, suppose that on 1/1/2016, an economy has a capital stock worth 500. During 2016, there is fixed investment worth 100 with depreciation worth 20. Then at the end of 2016, the economy has a capital stock worth: 500+100-20=580.

Stock and Flow

In economics and accounting, it is important to distinguish the "stock" variable and the "flow" variable. The stock variable measures the quantity at particular time points, while the flow variable measures the change in a given time period. It is in this sense that stock can also be called "level" and that flow can be called "rate".

In business accounting, the balance sheet (资产负债表) tabulates stock variables such as debt, equity, and so on. And both the income statement (利润表) and the cash flow statement (现金流量表) tabulate flow variables such as revenue, profit, cash inflow, wage layout, and so on. In national accounting, GDP is obviously a flow variable, since it measures the domestic output in a given time period. The unit of annual GDP is Yuan/Year. In contrast, the capital stock in a country is a stock variable with the unit Yuan.

We can meaningfully compare a stock variable with another stock variable, a flow variable with another flow variable. However, it would be meaningless to compare a stock variable with a flow variable, since they have different units. Nonetheless, it is sometimes meaningful to calculate the ratio of a stock variable to a flow variable. For example, the ratio of total national debt to GDP is often compared. Since the unit of the ratio is "Year", the ratio can be understood as the number of years the country would take to pay off the debt, if all income (GDP) is devoted to debt payoff.

An apartment or house is a special piece of capital. It is used to produce consumer service which we may call "housing service". Spending on new houses is counted under investment, not consumption. But the housing service the house provides is counted under consumption. Note that it is not double accounting that both the spending on new houses and on rents are counted in GDP. All fixed investment will help produce goods or services in the future that will be counted in the future GDP.

Unsold output goes into inventory, and is counted as "inventory investment", whether the

inventory buildup was intentional or not. If total inventories are 10 at the beginning of the year, and 12 at the end, then inventory investment equals 2 for the year. Note that inventory investment can be negative, which means that inventories fall over the year.

**Figure 3: Inventory Investment/GDP of China (1992-2015)**

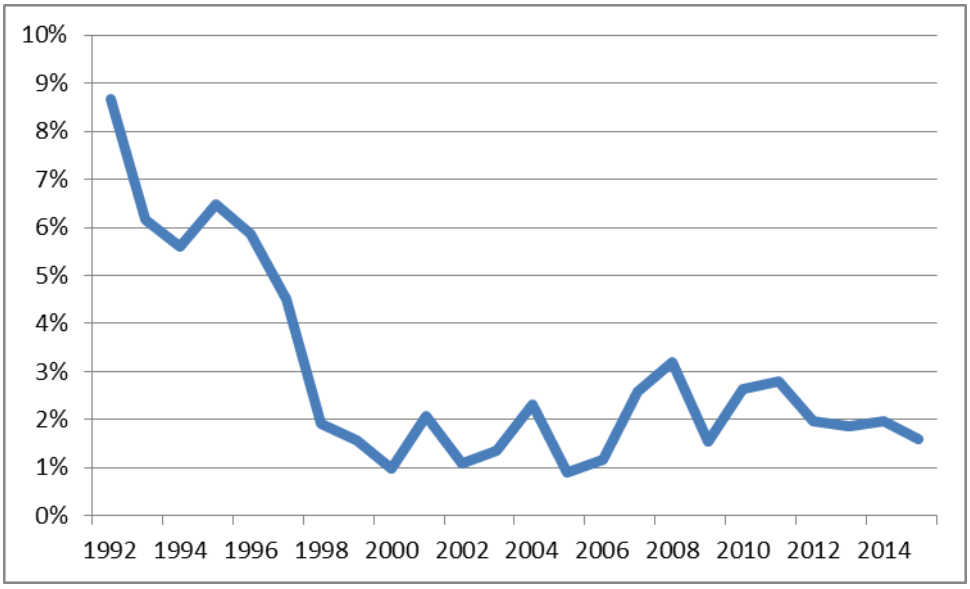



Figure 3 shows the ratio of inventory investment to GDP in China. In the early 1990s, the ratio of inventory investment was abnormally high, implying that a substantial amount of factory output ended up unsold. During the planed-economy era, this phenomenon was not uncommon. Since the economy was dominated by the state-owned enterprises (SOEs), which produced goods not to satisfy consumer demand, but to fulfill "plans", large-scale mismatch between production and demand persisted in the economy. Then the inventory ratio declined sharply at the end of 1990s. To explain the dramatic turn around, note that China reformed its state-owned enterprises (SOEs) at the end of 1990s. During the reform, many small SOE's was sold to the private sector, and large SOE's was reformed and consolidated into modern corporations. As a result, the managerial efficiency of the corporate China improved dramatically. The sharp decline of inventory is one indicator of the success of the SOE reform in 1990s.

**Government Spending (G)**

Government spending includes all government spending on goods and services. To avoid double-counting, G excludes transfer payments (转移支付) such as unemployment insurance payments. Transfer payments are, however, included in "government outlays" in national budgetary process.

**Net Export (NX)**

Net export, or balance of trade, equals the total value of export minus that of import in a given period of time. It represents the net foreign expenditures on goods and services produced in our country. If the net export is positive, we say that the country has a *trade surplus*. Otherwise we

say that the country has a *trade deficit*.

Generally speaking, trade surplus is good, implying that the tradable sector of the country is competitive. A moderate trade deficit, however, is not necessarily bad. It may be caused by the competitiveness of the financial products offered by the country. If the trade deficit becomes excessive (say 5% of GDP) and persistent, then some adjustment has to occur, say, the exchange rate has to depreciate.

**The Income Side of the National Accounts**

GDP can also be calculated by summing up the income distributed by domestic producers to households. GDP calculated this way is also called gross domestic income (GDI). In principle, GDI should be equal to GDP (sum of expenditures). In practice, however, these two numbers differ by a small measurement error called *statistical discrepancy*,

$$\text{Statistical discrepancy} = \text{GDP} - \text{GDI}.$$

A more important measure of aggregate income is the gross national income (GNI), which is the sum of household income in a given period. The relationship between GNI and GDP is as follows,

$$\text{GNI} = \text{GDP} + \text{net factor payment from abroad}.$$

GNI is conceptually the same as the gross national output (GNP). In international statistics, GNI has gradually replaced GNP.

The national income (NI) is defined as

$$\begin{aligned}\text{NI} &= \text{GDI} + \text{net factor payment from abroad} - \text{depreciation} \\ &= \text{GNI} - \text{depreciation} - \text{statistical discrepancy}.\end{aligned}$$

(To be continued…)