Macroeconomic Data

Seek truth from facts. – a Chinese idiom [1]

1 Introduction

We know about our economy through the measurement of some key macroeconomic variables such as gross domestic product (GDP), consumer price index (CPI), unemployment rate, and so on. Each of these variables measures one dimension of the economy. For example, GDP measures the total size of the economy, CPI measures the overall price level, and the unemployment rate measures the extent of labor utilization.

On each dimension of our economy, there may be more than one relevant variable. For example, gross national income (GNI) 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 boundaries of output, while GNI emphasizes national claim of income. Looking at both GDP and GNI may give us a clearer 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. The variation of a macroeconomic variable on the time dimension characterizes the dynamics of the economy. For example, the percentage change in GDP characterizes the speed at which the economy grows in size. For another example, the 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 national income accounting, which is to measure the economic activity of a nation using a consistent system of accounting techniques. From 1952 to 1992, China used the Material Product System (MPS), which was the prevalent system in socialist countries back then. In 1992, China formally adopted the System of National Accounting (SNA) which was the system used in Western countries. There are two major differences between MPS and SNA. First, as the name suggests, MPS counts only goods, exclusive of service, while SNA counts both goods and services. Second, SNA uses market prices in the valuation of goods and services, while MPS has to rely on administered prices.

Macroeconomic data can be very general in scope. Any data that help us gauge the state of the economy can be called macroeconomic data. In addition to data from government agencies, macroeconomic data can also include market quotes for interest rates, exchange rates, and so on. Indexes that are 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 of the state of the economy. For example, in China, electricity consumption, volume of rail cargo, and total bank loans are well-known indicators of the economy.

In this chapter, we focus on the principles and rules for computing four of the most important macroeconomic variables: GDP, CPI, unemployment rate, and money supply.

2 National Income Accounting

National income accounting is a set of principles and procedures for the measurement of total income and output in an economy. GDP and its components are arguably the most important statistics in national income accounting. The national income accounting also produces flow-of-funds and balance-of-payments tables. Here we focus on GDP and its components.

2.1 Nominal GDP

GDP is a measure of the size of the economy. There are three ways to view and calculate GDP:

(i) The production view: the total market value of final goods and services produced in the economy.

(ii) The income view: the total income generated from all transactions involving final goods and services produced in the economy.

(iii) The expenditure view: the total expenditure on the economy's output of final goods and services.

Note that, in theory, GDP calculated from each of the preceding views (namely, production-based GDP, income-based GDP, and expenditure-based GDP) should be equal to each other. In practice, however, they are different from each other since they use different data sources and statistical procedures. Their differences are called *statistical discrepancies*.[2] Generally speaking, GDP based on production and expenditure is more reliable and timely.

Using the production approach, we formally define (nominal) GDP as the market value of all final goods and services produced within an economy in a given period (e.g., a quarter). Mathematically, we have

$$\text{GDP}_t = \sum_{i=1}^{M} q_{it} p_{it}, \tag{1}$$

where q_{it} and p_{it} are quantity and price, respectively, of the i-th item produced in period t. Note that p_{it} in (1) are current prices that change with time. We call the GDP calculated as in (1) the *nominal* GDP, in contrast to the *real* GDP that we will introduce later.

Example: An Economy of Two Trees

Consider an economy of two trees, an apple tree and an orange tree. If the apple tree produces 20 apples and the orange tree produces 10 oranges in 2020, with their market prices 0.5 and 1.0 CNY (Chinese Yuan[3]), respectively, then the GDP of the twin-tree economy is

$$20 \times 0.5 + 10 \times 1.0 = 20 \text{ CNY}.$$

Note that (1) only counts final goods and services. Intermediate goods, which are parts of final goods, are not individually counted, to avoid double accounting. It is clear that

$$\begin{aligned} \text{GDP} &= \text{value of final goods and services produced} \\ &= \text{sum of value added at all stages of production.} \end{aligned}$$

To avoid repeated accounting, transactions of used goods are also not counted in GDP, and sales of goods in inventory do not add to GDP. To understand the latter point, suppose that Shanghai Motors produces a car in China but does not manage to sell it this year. Instead, Shanghai Motors puts the car into inventory and plans to sell it next year. The national accounting considers the unsold car as an "investment" in this year. When Shanghai Motors sells the car next year, the sale will not add to next year's GDP.

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 law enforcement and firefighting, also requires imputation. Typically, the national accounts value these government services in GDP by the wages paid to the public servants.

What GDP Does Not Include

One may argue that "services" of durable goods, such as cars and refrigerators, should also be valued in GDP, but these are omitted for convenience. There are also good reasons to include the value of domestic work performed by housewives and

househusbands, such as cooking and washing, into GDP. Typically, however, these are 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 housekeeping, the tax administration has little incentive to enforce taxation.

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

2.2 Real GDP

Recall that in (1), we calculate GDP using current prices and obtain a nominal GDP. The nominal GDP changes over time because either there are changes 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 (or constant-price GDP) measures the value of final goods and services at constant prices,

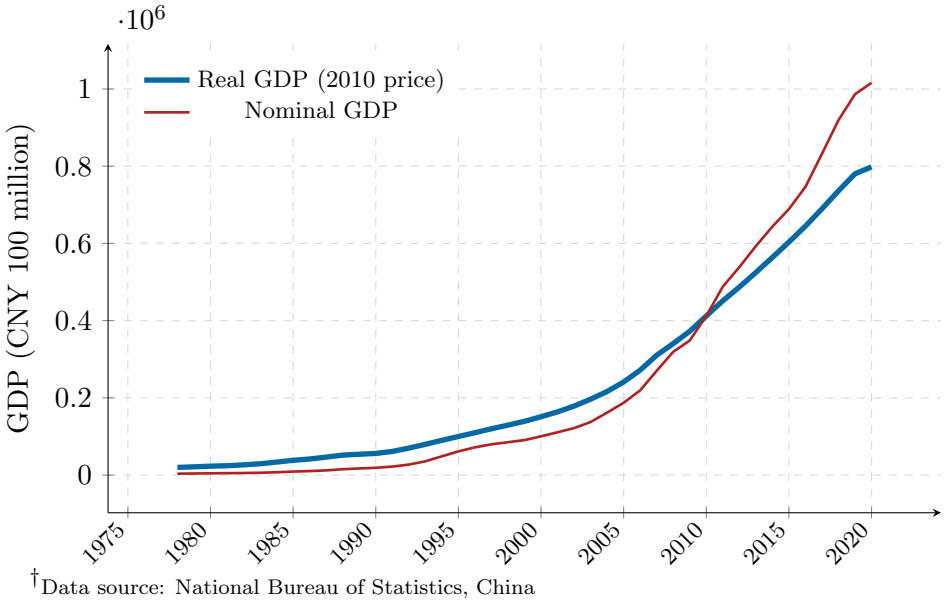
$$\text{RGDP}_t = \sum_{i=1}^{M} q_{it} p_{i,t_0} \ , \tag{2}$$

where t_0 stands for the *base year* and p_{i,t_0} is a constant for each i. Taking real measurements is essential for gauging the growth or improvement in living quality (e.g., real wage). And using nominal and real GDP, we can define the GDP deflator (or implicit price deflator for GDP) as follows: $P_t \equiv \text{GDP}_t \ / \ \text{RGDP}_t$. As we will see later in the chapter, the GDP deflator is a measure of the general price level.

One principle of calculating real GDP is that the base year should not be too distant, ensuring that prices are not too out of date. For example, the cell phone was a rare product 30 years ago and was very expensive. It would be absurd to use the price of cell phones 30 years ago to calculate the value of cell-phone output in today's GDP. In China, the National Bureau of Statistics changes base-year every five years for the calculation of real GDP.

Since 1995, the US has been using chain-weighted measures of real GDP growth. For each year, the chain-weighted GDP growth rate is the average of two real GDP growth rates. For example, in 2020, there are two real GDP growth rates: the growth rate using 2019 prices and the growth rate using 2020 prices.

Figure 1: China's real and nominal GDP.



†Data source: National Bureau of Statistics, China

Figure 1 shows the real and nominal GDP of China from 1978 to 2020. Since the base year of real GDP is 2010, the lines of real and nominal GDPs cross in the 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 2020. GDP is typically reported every quarter. The quarterly YoY growth rate is calculated as

$$R_t = \log\left(\frac{\text{RGDP}_t}{\text{RGDP}_{t-4}}\right),$$

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

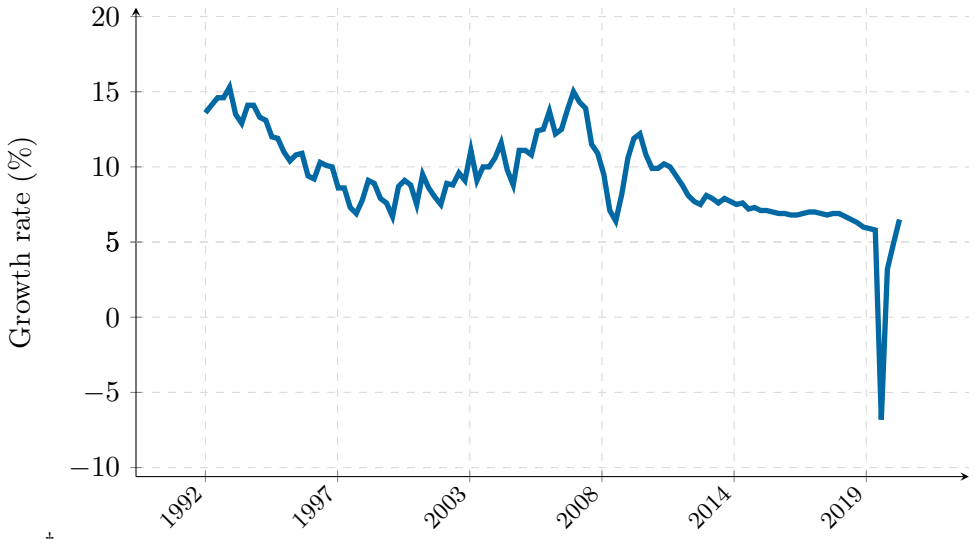
Table 1 shows the GDP and GDP per capita of the largest 10 economies in the world. Note that although China has become the second largest economy, it still lags far behind high-income countries such as the USA and Japan in terms of GDP per capita. And note that GDP per capita is a measure of average income (since GDP is total income) or the standard of living for average citizens.

2.3 Components of GDP

From the expenditure view, we may roughly decompose GDP into four components: consumption (C), investment (I), government spending (G), and net export (X). Let Y denote GDP. By definition we have

$$Y = C + I + G + X. \tag{3}$$

Figure 2: Real GDP growth of China (quarterly).



†Data source: National Bureau of Statistics, China.

Table 1: The largest economies in 2020

Country	GDP (trillion USD)	GDP per capita (USD)
United States of America	21,040.0	63,000.0
China	14,736.2	10,238.3
Japan	4,985.8	39,420.4
Germany	3,790.2	45,237.9
United Kingdom	2,706.2	39,711.9
India	2,679.6	1,941.7
France	2,605.2	38,564.6
Italy	1,885.2	31,179.9
Canada	1,643.4	43,542.4
Korea, Republic of	1,630.3	31,798.9

†Data source: United Nations Conference of Trade and Development (UNCTAD) Statistics.

We call this equation the national income accounts identity.

Consumption Expenditure (C)

The consumption component measures the value of all goods and services bought by households. It includes the value of durable goods, nondurable goods, and 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. Service refers to the work done for consumers by individuals and firms, such as housing, dry cleaning, air travel, and so on.

Investment Expenditure (I)

The investment component measures the value of total spending on goods bought for future use. There are two types of investment: one is the 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 and services. The fixed investment conducted by individuals and families is called residential fixed investment, which mainly consists of spending on apartments and houses.

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

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

Concepts: Stock and Flow

In economics and accounting, it is important to distinguish the *stock* variables and the *flow* variables. The stock variable measures the quantity at particular time points, while the flow variable measures the change in a given period. We also call stock variables *level* variables.

In business accounting, the balance sheet tabulates stock variables such as debt, equity, and so on. And both the income statement and the cash flow statement tabulate flow variables such as revenue, profit, cash inflow, wage layout, and so on.

In national accounting, GDP is a flow variable, since it measures the domestic output in a given period. The unit of annual GDP is CNY/year. In contrast, the capital stock in a country is a stock variable with the unit CNY.

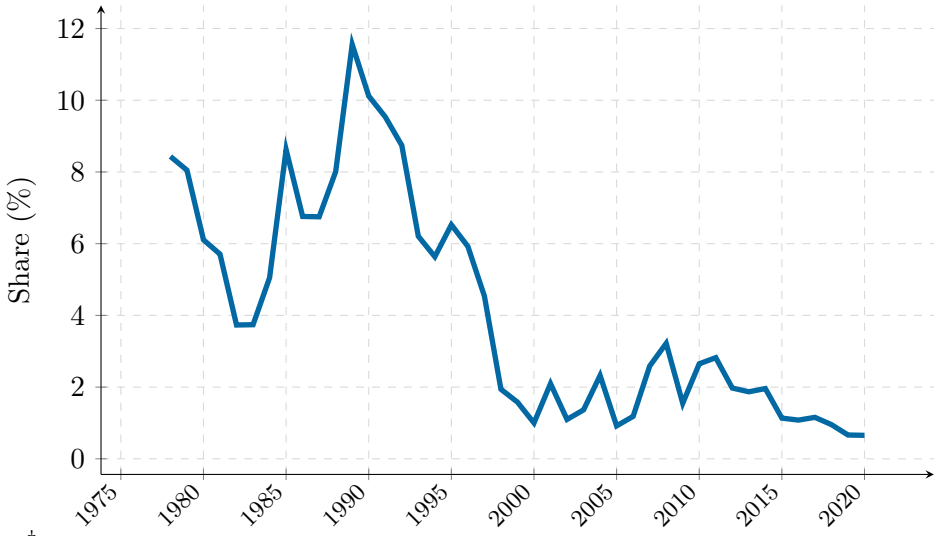
We can meaningfully compare a stock variable with another stock variable, and a flow variable with another flow variable. However, it would be meaningless to compare a stock variable with a flow variable, since the stock variable and the flow variable have different units. Nonetheless, it sometimes makes sense to calculate the ratio of a stock variable to a flow variable. For example, we often compare the ratio of total national debt to GDP. 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. We purchase houses for future consumption of *housing service*. Spending on new houses is thus investment, not consumption. The housing service the house provides, however, is consumption. Note that it is not "repeated accounting" that we count both the spending on new houses and rents. All fixed investments are supposed to generate future returns. Business fixed investments generate future profits, and residential fixed investments generate rent incomes.

The inventory investment component measures the change in the value of unsold outputs (if not spoilable, such as vegetables) that are placed into inventory, whether or not the inventory buildup is intentional. Note that when a good in inventory (produced last year) is sold this year, the component of inventory investment declines by the value of the good. At the same time, if the good is purchased by households as consumption, then the consumption component of this year increases by the same amount, so that the sale of the good in inventory does not add to this year's GDP.

And note that inventory investment can be negative, which means that the inventory falls over the year. For example, if the inventory is worth 12 billion CNY

Figure 3: Share of inventory investment in GDP.



†Data source: National Bureau of Statistics, China.

at the beginning of the year, and 10 billion CNY at the end, then the inventory investment equals −2 billion CNY for the year.

Figure 3 shows the ratio of inventory investment to GDP in China. In the 1980s and the early 1990s, the share of inventory investment was high, implying that a substantial amount of factory output ended up unsold. We may understand this phenomenon by noting that China was in transition from a planned economy to a market economy in the 1980s and 1990s. In the 1980s and the early 1990s, the economy was still dominated by state-owned enterprises (SOEs), which would produce to fulfill *plans*. They were largely guided by the visible hands of the government rather than the invisible hands of the market. As a result, there were big mismatches between production and demand in the economy. In the latter half of the 1990s, however, China made great progress in reforming its SOEs. The government privatized many small SOEs and reformed large SOEs into modern corporations. As a result, the managerial efficiency of corporate China improved dramatically. Even the remaining SOEs started to behave like business enterprises, constantly adjusting production according to market demand. Thus the share of inventory investment in GDP declined sharply to a healthy level.

Government Expenditure (G)

Government expenditure includes all government spending on goods and services. To avoid double accounting, G excludes "transfer payments" such as unemployment insurance payments. Transfer payments are, however, included in "government outlays" in the government budget.

Net Export (X)

Net export (X), or balance of trade, equals the total value of export minus that of import in a given period. Let EX denote the value of export and IM the value of import. Then $X = EX - IM$. Net export represents the net foreign expenditures on goods and services produced in our country. If it is positive, we say that the country has a *trade surplus*. Otherwise, we say that the country has a *trade deficit*.

Generally speaking, a trade surplus implies that the tradable sector of the country is competitive in the world. A moderate trade deficit, however, is not necessarily uncompetitive. The United States, for example, enjoys a special privilege in that other countries want to hold dollar-denominated financial assets. The US treasury bonds, in particular, are the dominant reserve assets held by other central banks. As a result, the USA persistently runs a trade deficit with the rest of the world. However, if the trade deficit becomes excessive and persistent, then some adjustment would have to occur, for example, the exchange rate would tend to depreciate.

A More Detailed Decomposition

Let C^d be the consumption of domestic goods and services, and let C^f be the consumption of imported goods and services. We have $C = C^d + C^f$. Similarly, we define I^d, I^f, G^d, and G^f, and we have $I = I^d + I^f$ and $G = G^d + G^f$. Note that $IM = C^f + I^f + G^f$. Now we have a more detailed decomposition of the total expenditure:

$$\begin{aligned} Y &= C + I + G + (EX - IM) \\ &= (C^d + C^f) + (I^d + I^f) + (G^d + G^f) + EX - (C^f + I^f + G^f). \end{aligned}$$

Note that C, I, and G include the value of both imported and domestically produced goods and services. For example, if I buy an imported car, then this purchase should be included in the calculation of C. However, this purchase does not affect GDP since the calculation of X removes the value of the imported car.

Table 2 shows China's decomposition of GDP on the expenditure side in 2020. The share of household consumption in GDP (C/Y) is 37.7% and the share of investment (I/Y) is 43.1%. In comparison, the US consumption and investment shares of 2020 are 67.2% and 17.4%, respectively. To understand the contrast between China and the US, note that it is typical for fast-growing economies to have high share of investment in GDP. But there is a caveat about Chinese investment data. While the investment component commonly refers to investment expenditure by private businesses and households, the investment component in China also includes investment expenditure made by the state sector (the government and the state-owned enterprises). As a result, the metric I/Y tends to make Chinese investment share higher than other countries.

Chinese data may also underestimate share of consumption. First, the consumption of "housing service" is measured in China by multiplying the building cost by a

Table 2: Expenditure components of China's GDP in 2020 (CNY trillion).

Total Expenditure	102.59
Consumption	55.70
Household consumption	38.72
Government consumption	16.98
Investment	44.24
Fixed asset formation	43.57
Inventory investment	0.67
Net export	2.65

†Data source: National Bureau of Statistics, China.

depreciation rate (2% for urban houses and 3% for rural houses). This method underestimates the consumption of housing since the building cost is sometimes only a fraction of market value. Second, the official statistics do not account for household purchases that are paid for by company accounts and treated as investment.

2.4 Income Measures

Gross domestic income (GDI) is an alternative measure of the size of the economy. Since it is obtained by counting the incomes earned and costs incurred in production, we may call it income-based GDP. In theory, GDI should equal GDP, but they usually differ by a small *statistical discrepancy*,

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

As an income measure, GDI is not satisfactory because it does not count income earned from employment or investment in foreign countries. A better measure is GNI. The relationship between GNI and GDP is as follows:

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

For large countries with diversified industries, GDP and GNI should be similar. In small countries with one or two dominant industries (e.g., oil), GDP and GNI can differ substantially from each other. Note that GNI is conceptually the same as gross national product (GNP). In international statistics, GNI has gradually replaced GNP.

Another measure of aggregate income is national income (NI), which is defined by

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

Furthermore, personal income is defined as the income received by all individuals or households from all sources (e.g., wage, dividend, interest, etc.) in a given period (e.g., a year). Disposable personable income (or simply, disposable income) is defined as the personal income minus personal tax and nontax payments.

3 Price and Inflation

In macroeconomics, price is often shorthand for the *general price level* in an economy. And inflation is a sustained increase in the general price level of goods and services over a time interval, such as a year. In this section, we discuss two popular measures of the general price level, consumer price index (CPI) and GDP deflator.

3.1 CPI

CPI is an index that measures the overall level of prices for consumers. A government agency (the National Bureau of Statistics in China, the Bureau of Labor Statistics in the US) first determines a basket of goods and services consumed by a typical or average household. Using the basket, the agency then computes an index,

$$\text{CPI}_t = c_0 \frac{\sum_i q_{i,t_0} p_{it}}{\sum_i q_{i,t_0} p_{i,t_0}}, \tag{4}$$

where p_{it} is the price of the $i-$th item at time t, p_{i,t_0} is the price of the $i-$th item at some base time t_0, q_{i,t_0} is the quantity of the $i-$th item in the consumption basket at t_0, and c_0 is a constant. For example, we may choose $c_0 = 100$, implying that the level of CPI at time t_0 is 100.

Note that we may define the weight of expenditure on the i-th item in the consumption basket as

$$w_i = \frac{q_{i,t_0} p_{i,t_0}}{\sum_i q_{i,t_0} p_{i,t_0}}.$$

The weight changes as the base year t_0 changes. But we omit the dependence of w_i on t_0 for the simplicity of notation. Then (4) can be written as

$$\text{CPI}_t = c_0 \sum_i w_i \frac{p_{it}}{p_{i,t_0}}. \tag{5}$$

That is, CPI is a *weighted average* of price ratios.

For example, the twin-tree economy produces and consumes all fruits of the apple tree and the orange tree. The following table shows the quantities and prices of the economy:

Year	Apple		Orange	
	Price	Quantity	Price	Quantity
2016	0.6	25	1.1	15
2015	0.5	20	1	10

Now we calculate the CPI of 2016 using the 2015 prices. That is, we use 2015 as the base year. According to the consumption of 2015, the weights in the consumption basket are:

$$w_{apple} = \frac{0.5 \times 20}{0.5 \times 20 + 1 \times 10} = \frac{1}{2}, \quad w_{orange} = \frac{1 \times 10}{0.5 \times 20 + 1 \times 10} = \frac{1}{2}.$$

If $c_0 = 100$, which means $\text{CPI}_{2015} = 100$, then the CPI for 2016 is

$$\text{CPI}_{2016} = 100 \cdot \left(w_{apple} \cdot \frac{0.6}{0.5} + w_{orange} \cdot \frac{1.1}{1} \right) = 115.$$

Then the inflation in 2016 is $(115/100 - 1) \times 100\% = 15\%$.

The government typically reports inflation data every month. Within each year, inflation may exhibit seasonality. In China, for example, the price level typically reaches the high point during the Spring Festival every year. As a result, seasonal adjustment is often necessary before any analysis of inflation based on CPI.

To deal with the seasonality, China's National Bureau of Statistics (NBS) reports the following monthly CPI:

$$\text{CPI}_t = \sum_i w_i \left(\frac{p_{it}}{p_{i,t-12}} \right) \times 100. \tag{6}$$

Here the subscript t represents the month. The preceding statistic assigns 100 to the CPI of the same month in the previous year. It is straightforward to infer from the statistic the YoY inflation rate, the percentage change in CPI compared with the same month last year. If $\text{CPI}_{2020.9} = 103$, then we know that the YoY inflation rate for September 2020 is 3%. The YoY inflation rate does not eradicate the seasonality problem, because the Spring Festival may fall in different months (January or February). Furthermore, it loses information on month-to-month variation in CPI.

The statistics bureau determines the composition of the consumption basket and the weights assigned to each item by conducting household surveys. The composition of the basket has to change over time, as consumer behavior changes over time. For example, as income per capita increases, the proportion of income spent on food would fall (Engel's law). As a result, the share of food in the basket should decrease during economic growth. Even within the category of food, the share of grain would decrease, and that of meat would increase, as people's lives improve.

There are eight major categories of consumption expenditure in China's CPI basket: (1) food and beverages, (2) housing, (3) transportation and communications, (4) educational, cultural, and entertainment goods/services, (5) household goods/services, (6) health care, (7) apparel, and (8) other goods/services. For each of these eight major categories, there is a sub-CPI. From these sub-CPIs and the CPI for the entire basket, we can infer the CPI basket weights (or relative importance) for the eight categories, which China's NBS does not disclose. Table 3 shows

Table 3: China's CPI basket weights (estimated, using $2016-2020$ data)

Category	Weight (%)
Food and beverages	30.15
Housing	20.57
Transportation and communication	11.81
Educational, cultural, entertainment goods/services	11.36
Household goods/services	10.83
Health care	8.27
Apparel	3.83
Other goods/services	3.16

†Source: Author's own calculation.

Table 4: The US CPI basket weights (city average, $2017-2018$ weights)

Category	Weight (%)
Food and beverages	15.157
Housing	42.385
Transportation	15.16
Recreation	5.797
Education and communication	6.810
Medical care	8.870
Apparel	2.663
Other goods/services	3.159

†Data source: U.S. Bureau of Labor Statistics.

the estimated basket weights using $2016-2020$ data (NBS adjusts weights every five years).

For comparison, Table 4 shows the weights for eight major categories of US consumption. It is notable that the US weight for *food and beverages* is much lower than the Chinese counterpart, consistent with what Engel's law predicts.

3.1.1 Why CPI Often Draws Criticism

The fact that a country calculates its CPI using one basket implies that the CPI reflects the price level facing the *average consumer* in the country. For a diverse country such as China or the US, this average consumer is elusive. Naturally, many people would feel that the CPI gives a biased measure of the living cost. In most cases, since price increases are more infuriating and news worthy, people would feel that the CPI understates inflation systematically.

There are, however, good reasons to argue that CPI tends to overstate inflation.

First, there is the so-called *substitution bias*. Since the CPI uses fixed weights, it cannot reflect consumers' ability to substitute with goods whose relative prices have fallen. In other words, when one item in the consumption basket becomes more expensive, the weight of this item should decrease. But the CPI calculation ignores this possibility.

Second, the introduction of new goods makes consumers better off and, in effect, increases the value of the money. But this does not reduce the CPI, also due to the fixed weights.

Third, quality improvements increase the value of the money, but they are also conveniently ignored.

3.1.2 Core CPI

A special and important sub-CPI is called *core* CPI, which is a price index for a consumer basket that excludes food and energy. The inflation of the core CPI is called *core inflation*. The rationale for using core inflation is that inflation is supposed to be *sustained* increase in the price level. But food and energy prices are largely dependent on some key commodities (e.g., corn, oil, etc.), the price of which may be volatile and transitory. Core inflation has become the preferred measure of inflation by major central banks. China's NBS does not report core inflation.

The US Federal Reserve prefers to use core personal consumption expenditures (PCE) price index. There are two main differences between the PCE price index and CPI. First, the CPI weight is based on a survey of what households are buying, while the PCE is based on surveys of what businesses are selling. For example, medical services paid for by employer-provided insurance are in PCE but not CPI. Second, the PCE attempts to account for substitution effects. When one good becomes more expensive and consumers buy less, its weight in PCE may decline, while the CPI weights remain fixed. As a result, the PCE inflation is in general lower than the CPI inflation. The core PCE, like core CPI, strips out food and energy components in the PCE basket.

3.2 GDP Deflator

There is another statistic that can be used to measure inflation, the GDP deflator. Recall that we define GDP deflator by

$$P_t = \frac{Y_t}{y_t} = \frac{\sum_i q_{it} p_{it}}{\sum_i q_{it} p_{i,t_0}}, \tag{7}$$

where Y_t is the nominal GDP and y_t is the real GDP with base year t_0. If we define

$$w_{it} = \frac{q_{it} p_{i,t_0}}{\sum_i q_{it} p_{i,t_0}},$$

then we obtain

$$P_t = \sum_i w_{it} \cdot \left(\frac{p_{it}}{p_{i,t_0}} \right),$$

which is also a weighted average of price ratios just like CPI.

However, there are three major differences between CPI and the GDP deflator. First, the baskets of goods and services are different. The basket for the GDP deflator contains all final goods and services produced domestically. The weight of each item is proportional to the total output of each item. But the CPI basket contains only those goods and services consumed by an *average consumer*. The weight of each item is proportional to the consumption of the item by the average consumer. For example, an increase in the price of goods bought only by firms or the government will show up in the GDP deflator, but not in the CPI. For another example, imported consumer goods are not a part of GDP and therefore don't show up in the GDP deflator, but they are in the CPI basket. Second, the GDP deflator is available at the frequency as GDP, which is typically quarterly data, but CPI is typically monthly data. Third, the weight for the GDP deflator changes every quarter since the composition of output changes every time, while that for CPI changes much more slowly (roughly every five years in China).

Given a measure of the general price level, say P_t, we may calculate inflation by taking percentage change of P_t,

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

Or, we may take logarithm difference of P_t,

$$\pi'_t = \log\left(P_t / P_{t-1}\right),$$

where $\log(\cdot)$ is natural logarithm. Note that π is an approximation of π'_t since

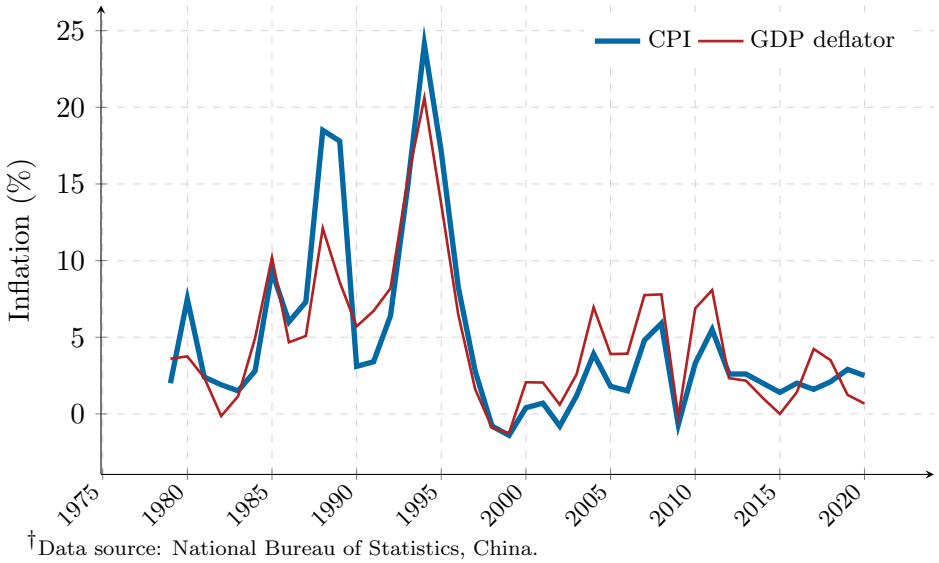
$$\log\left(P_t / P_{t-1}\right) = \log\left(1 + \frac{P_t - P_{t-1}}{P_{t-1}}\right) \approx \frac{P_t - P_{t-1}}{P_{t-1}}.$$

Figure 4 shows the annual inflation in CPI and the GDP deflator. From 1979 to 2020, there are about eight cycles of inflation. The four inflation cycles before the mid-1990s are more volatile, while those after the mid-1990s are moderate. While CPI inflation and GDP deflator inflation generally move together in each cycle, there are substantial quantitative differences.

3.3 PPI

Pproducer price index (PPI) measures the (weighted) average changes of the prices received by domestic producers. In contrast to CPI, the PPI basket generally does not have full coverage of services. In China, the PPI basket includes industrial

Figure 4: China's annual inflation in CPI and the GDP deflator.



†Data source: National Bureau of Statistics, China.

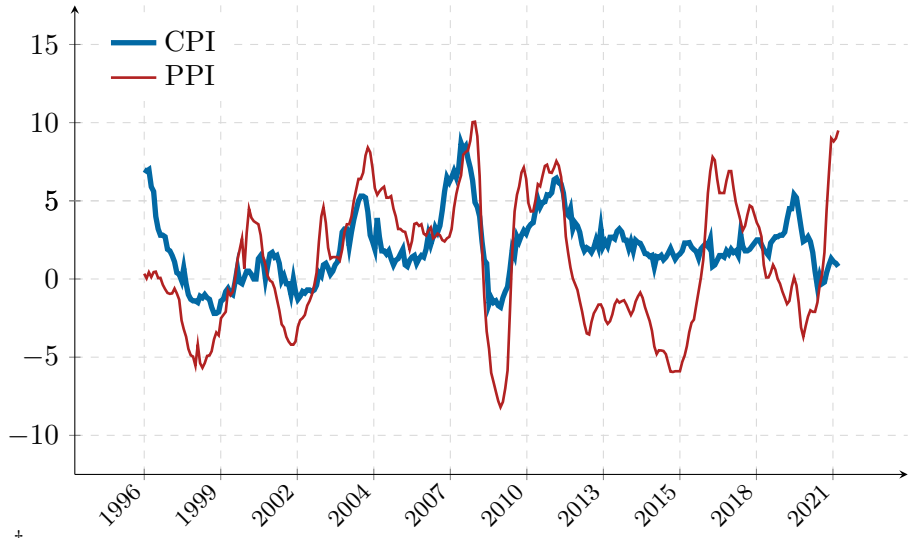
goods only. The full name of China's PPI is the Producer Price Index for Industrial Products. Additional to the treatment of services, there are also several other major differences between PPI and CPI. First, the CPI basket includes imports, while the PPI basket does not (similar to the GDP deflator). Second, the PPI basket includes exports, while the CPI basket does not. Third, the PPI basket includes government purchases, while the CPI basket does not. Fourth, the PPI basket includes intermediate inputs to production, including fixed-asset investment, while the CPI basket does not. Finally, similar to the GDP deflator, the PPI weights change every month.

PPI is available at a monthly frequency. Because many industrial goods are inputs to the production of consumption goods, PPI is widely believed to be a leading indicator for CPI. In practice, however, this lead-lag relationship is not entirely obvious. And thanks to the differences in the coverage of goods and services, PPI and CPI can sometimes diverge (Figure 5).

4 Employment

In macroeconomics, employment is shorthand for total employment, which is the number of employees in the economy. The measure of employment typically excludes business owners, household employees, unpaid volunteers, and the unincorporated self-employed. Total employment is a measure of the utilization of human resources.

Figure 5: China's monthly inflation in CPI and PPI.



†Data source: National Bureau of Statistics, China.

4.1 Nonfarm Employment

Sometimes it is helpful to focus on nonfarm employment, the measure of employment that excludes farmers and farm employees. Changes in nonfarm employment give us valuable information on business cycles. For example, the monthly total nonfarm employment data of the US is a popular indicator of the US business cycles. The ADP national employment report of the US, which tracks the US nonfarm private-sector employment, is also closely scrutinized by the capital market.

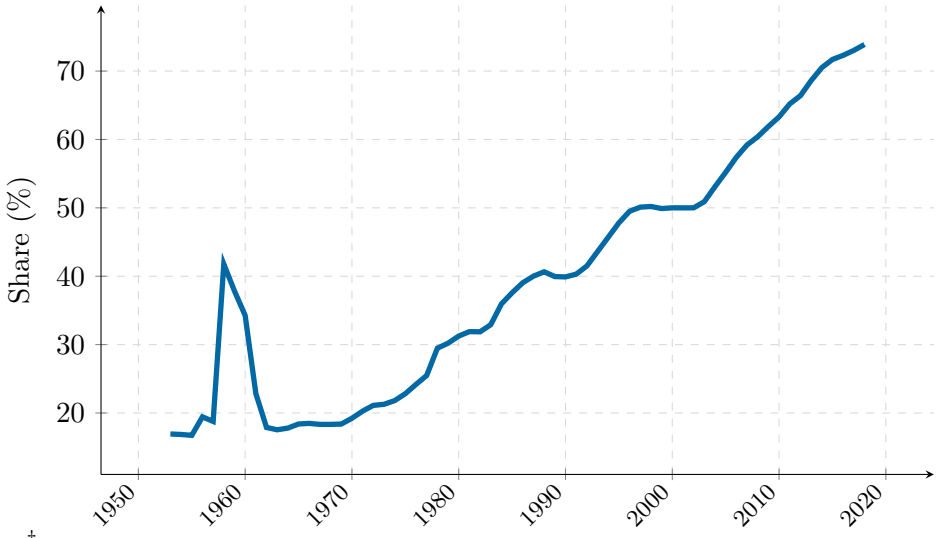
For developing countries such as China, changes in the share of nonfarm employment in total employment also reflect the pace of economic development. Economic development is almost synonymous with industrialization. As an agricultural economy develops, more and more people would leave the agricultural sector for the industrial or service sector. Consequently, the share of nonfarm employment may exhibit a secular upward trend, as we can see in Chinese data since the 1970s (Figure 6).

4.2 Unemployment Rate

We may define unemployment as the situation of someone above a specified age (say, fifteen) who wants to work but cannot find a job. If someone neither has a job nor is looking for one, then the person is not considered unemployed. Instead, we say that the individual has withdrawn from the labor force. We define the unemployment rate as the percentage of the labor force that is unemployed:

$$\text{Unemployment rate} = \frac{\text{Number of the unemployed}}{\text{Labor force}}, \tag{8}$$

Figure 6: Share of nonfarm employment in China.



†Data source: National Bureau of Statistics, China.

where the *labor force* is the sum of the employed and the unemployed. The unemployment rate is a measure of how difficult it is to find a job. It is also a measure of how *tight* the labor market is. A high unemployment rate means that it is difficult for an unemployed worker to find a job. But it also means that it is easy for employers to find workers.

In China, there are two unemployment statistics. One is called the registered urban unemployment rate,[4] the other is the surveyed urban unemployment rate.[5] The former is known to be prone to under-report the unemployment rate, reflecting the fact that the unemployment insurance program is under-developed in China. The latter, which is based on monthly surveys, is more promising. But it is available only from 2018.

4.3 Labor-Force Participation Rate

A related ratio is the labor-force participation (LFP) rate, which is the percentage of the adult population who are in the labor force:

$$\text{Labor force participation rate} = \frac{\text{Labor force}}{\text{Adult population}}. \tag{9}$$

China's Population and Labor Statistics

In 2019, China's population and labor statistics are as follows (unit: million):

$$\begin{aligned} 1410.1 \text{ (population)} &= 236.6 \text{ (children, age } 0-14) + 1173.5 \text{ (adults)} \\ 811.0 \text{ (labor force)} &= 774.7 \text{ (employed)} + 36.3 \text{ (unemployed)} \end{aligned}$$

Then,

$$\begin{aligned} \text{Unemployment rate} &= \frac{36.3}{811.0} = 4.5\% \\ \text{Labor-force participation rate} &= \frac{811.0}{1173.5} = 69.1\% \end{aligned}$$

†Data source: National Bureau of Statistics, China.

5 Money Supply

Traditionally, money includes physical cash (cash in short), central bank reserves (reserves in short), and bank deposits. Reserves are a central bank's liabilities held only by commerical banks. And bank deposits are commercial banks' liabilities held by individual or corporate savers. The supply of cash and reserves is controlled by the monetary authority (the central bank), which also records and publishes money supply data.

Different types of money differ mainly in liquidity. Cash is the most liquid money, while time deposits (or term deposits) are much less liquid. The fact that there are different types of money poses a problem for the measurement of the total money supply in the economy. Central banks use several measures (M0, M1, M2, etc.), classified from the narrowest to the broadest measurements. Narrow measures include the most liquid types of money, while broad measures include illiquid money.

Typically, the definitions of narrow money supply are similar in different countries. For example, M0 typically measures all physical currency. For another example, the base money (MB) is the value of all physical currency plus reserves (including required reserve and excess reserve). However, each central bank may use different names. For example, the Bank of England's "narrow money (M0)" roughly corresponds to MB in the US and China.

However, the definitions of broad money may differ substantially in each country. We can see this in Table 5, which tabulates the definitions of M0, M1, and M2 in the US and China. As a result of different definitions, it may be misleading to compare the supply of broad money across countries.

Table 5: The definitions of money supply and data (December 2020)

	China	US
M0	Physical currency	Physical currency
	(9.3 trillion CNY)	(2.0 trillion USD)
M1	M0 + demand deposits	M0 + demand deposits + travelers checks + other checkable deposits
	(54.6 trillion CNY)	(17.8 trillion USD)
M2	M1 + saving deposits	M1 + Saving deposits (including money market deposits) + retail money market mutual fund balances + small time deposits
	(202.3 trillion CNY)	(19.3 trillion USD)

[†]Data source: Wind Data Service.

6 Concluding Remarks

Macroeconomic data are important for the functioning of an economy. First, the availability of high-quality data helps firms and individuals to make decisions with more confidence. Among all decisions, the decision to invest is particularly fragile. It takes great courage to overcome the "fear of unknown" to invest. High-quality data, however, help investors to evaluate risk, and reduce overall uncertainty in the economy.

Second, high-quality data are a necessary condition for successful policy making. Without high-quality data, it is impossible for policymakers to identify adverse trends in a timely manner and take appropriate measures. The effectiveness of macroeconomic management itself is an important piece of data for investors. The lack of high-quality data is an indicator for poor economic management, which discourages investment, especially foreign direct investment (FDI).

Third, high-quality data attract high-quality research. Effective policy making relies on the understanding of an economy, which further relies on economic research. High-quality data not only help *in-house* research in the central bank or other government agencies but also attract academic economists around the world to study the economy. The US, for example, receives dividends for its high-quality economic data.

For serious students of macroeconomics, familiarity with data is a prerequisite for understanding the economy. Keynes once said, "Good economists are scarce because the gift for using 'vigilant observation' to choose good models, although it does not require a highly specialized intellectual technique, appears to be a very rare one." The "vigilant observation" obviously refers to the familiarity with data.

Notes

[1]实事求是

[2]In China's Statistical Year Book, GDP calculated from the production view is listed in Table 3-1 (Gross Domestic Product, 国内生产总值), GDP calculated from the expenditure view is listed in Table 3-11 (Gross Domestic Product by Expenditure Approach, 支出法国内生产总值). The National Bureau of Statistics does not directly report income-based GDP. But there three ways to calculate it from other data: (i) aggregation of province data; (ii) the non-financial flow-of-funds table (非金融资金流量表); (iii) the input-output table (intermediate use) (投入产出基本流量表, 中间使用部分). The quality of province data is poor. The quality of the other two is good, but they are available only with a significant delay.

[3]In foreign exchange markets, CNY represents the *onshore* Chinese Yuan and CNH represents the *offshore* Chinese Yuan, which is traded mostly in Hong Kong and Singapore

[4]城镇登记失业率

[5]城镇调查失业率

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[1] Bureau of Economic Analysis, 2015, Measuring the Economy: A Primer on GDP and the National Income and Product Accounts. Available online at `https://www.bea.gov/resources/methodologies/measuring-the-economy`.

[2] Landefeld, J. Steven, Eugene P. Seskin, and Barbara M. Fraumeni, 2008, Taking the Pulse of the Economy: Measuring GDP. Journal of Economic Perspectives 22(2), 193–216.