Output, Prices and Inflation

These notes introduce important macroeconomic variables and discuss how they are measured. We start with aggregate output and national income. Aggregate output is the market value of all final goods and services produced within an economy in a certain time period. For example, as of the fourth quarter of 2021, U.S. gross domestic product (GDP) was $24.0 trillion. GDP is currently the most popular measure of aggregate output and is probably the most commonly used metric to judge the health of an economy. As we will see, however, it is a highly imperfect measure for doing so.

National income is simply the sum of all income received in an economy over a certain period of time. The biggest component (about $\frac{2}{3}$) is the wages paid to workers. It also includes the profits made by firms and rents received by the owners of capital, land, etc.

It turns out that national income and aggregate output are necessarily equal to each other. This point is illustrated with a simple chart known as the circular flow. This version applies to a simple economy consisting only of households and firms.[1]

Firms and households meet in two distinct markets. In the market for goods and services (represented by our example of soda when we developed supply and demand), households purchase the products produced by the firms. In factor markets, firms purchase inputs of production from households (or other firms). Households, as an example, supply labor to firms in exchange for wages. They may also rent capital or land, or buy energy.

Suppose a firm sells it product to households. All of the sales price is somebody's income. Part of the sales price becomes profit, income to the firm (which is then passed onto the households that own the firm). The rest of it goes to cover costs. Labor costs becomes income to workers, capital costs become income to capital owners, etc. Because all production is income, aggregate output and national income must be equal.

[1] More complex versions can add additional agents such as government and financial institutions.

Figure 1: Circular Flow

We now turn to measuring aggregate output. The most common measure is GDP. The key component here is geography, instead of ownership. A good or service counts in GDP if it is produced within the borders of the economy, regardless of who owns the production. An alternate measure, Gross National Product (GNP) is defined by ownership. U.S. GNP includes things produced by Americans, regardless of where the product was physically produced. GNP used to be more popular. But for the U.S., the two are similar.

Table 1 provides an example economy:

It is easier to think about what is not included in GDP:

1. Used goods (that were not produced in the relevant year) do not count. This is to avoid counting the same production twice. If a car was produced in 2010, it is counted in that year's GDP. It does not meet the definition of something produced in 2021 and is thus not included in 2021 GDP.

Suppose I sold you a used car for $10 and then you sold it right back to me for the same amount. The final outcome is the same as if neither transaction had occurred. But including these sales in

Table 1: Goods and Services Purchased in 2021

Good or Service	Quantity	Price ($)
Snow Plowing	10	5
New Cars	2	30
Used Cars	2	10
Murder for Hire	1	50
Imported Beer	10	1
K-Mart Stock	10	10
Car Engines (Used in the New Cars)	2	10

GDP would increase in by $20 which does not reflect any actual economic production.

2. Imported goods are those used in the domestic economy, but produced in a foreign economy. They thus do not meet the definition of a good or service produced within the economy. The imported beer thus does not count.

3. Activities in the shadow economy do not count. Illegal activities do not count. But the shadow economy includes other components as well. It includes informal activities such as paying a babysitter in cash. It also includes non-market activities such as cleaning your own house (but it would count if you hired someone else to do it). GDP is thus often said to include market activity only and it does not catch all economic behavior. During the pandemic, fewer people have hired others to do work in their home. This reduced GDP.

4. Intermediate goods do not count. In this example, car engines are new, but are used to produce new cars. The value of the car engines in thus included in the price of of the new cars. In order to avoid double counting, we thus only include the final good (new cars).

5. Financial transactions do not count. Buying stock in a firm is not buying any production. Instead it is buying the right to a share of that firm's profits. It thus does not count.

In this example, only new cars (a good) and snow plowing (a service) meet the criteria. We

then calculate the market value of each product: $10 * 5 = \$50$ and $2 * 30 = \$60$ for plowing and cars respectively. Summing these, GDP equals \$110.

It is often useful to break GDP down into several different components using the *national income accounting identity*:

$$Y \equiv C + I + G + X - M \tag{1}$$

The symbol $\equiv$ means that this equation is always true (known as an *identity*). It is always true because all it does is classify all production (Y) into these categories:

C is consumption. Consumption includes goods and services that are used to provide utility to households. Because imported goods provide utility, we include these as well. In our example, both snow plowing and cars count as consumption.

I is investment. Capital goods are those used in the productive process as opposed to providing utility. Examples include business equipment and software. Investment refers to purchases of new capital. Note that this is a somewhat different definition than what you might encounter in common English. Purchasing stock is often called investment in casual conversation. Confusing these definitions is a common mistake that students make. In macroeconomics, this is saving, not investment. Investment includes only the purchase of new capital.

Some goods are in a gray area between consumption and investment. New housing is the best example. It provides utility but also is part of the productive process. It is included in investment even though it includes some features of a consumption good..

G is government services. These are consumption or capital goods purchased by all levels of government.

X is exports, production sold to other economies. M is imports, goods and services used in the domestic economy but produced outside of it. We subtract off imports to offset their inclusion in

consumption[2] so that they do not affect Y. If I drink a bottle of Scotch, it counts in consumption and imports. Because one is added to GDP and the other is subtracted from it, it has no effect on GDP.

Figure 2 compares GDP in the United States and the Eurozone, the group of countries which have adopted the Euro as their common currency.

Figure 2 break down U.S. and Eurozone GDP by type:[3]

Figure 2: GDP by Component, 2011

% Nominal GDP	2011 e	
	US	Eurozone
Consumer	71%	58%
Govt	20%	22%
Capex	10%	14%
Housing	2%	5%
Inventories Ch	0%	1%
Net Trade	-4%	0%
Exports	14%	24%
Imports	18%	24%

In both economies, consumption is by far the largest component. This chart breaks investment down into different categories. These include changes to inventories which are firms' stockpiles of their product. Because these are produced by firms, but not yet counted in consumption, they are counted as part of investment. Capital expenditures and housing are two other types of investment. Note that net exports may be negative, this is known as a trade deficit. Government spending is much higher in the Eurozone than in the United States.

[2]Imports may also appear in I and G

[3]Source: http://www.ritholtz.com

GDP Growth, and Real vs.Nominal GDP

Economists pay careful attention to GDP growth. For developed economies, 2-3% GDP growth is about average. Negative growth is a characteristic of a recession. Table 2 compares 2014 to 2015 for our sample economy:

Table 2: Good and Services Purchased in 2019-20

Good or Service	Quantity (19)	Price (19) ($)	Quantity (20)	Price (20) ($)
Snow Plowing	12	3	10	5
New Cars	2	20	2	30

For 2014, GDP equals $12 * 3 + 2 * 20\$76$. As before, 2020 GDP equals $10 * 5 + 2 * 30 = \$110$. GDP growth is the percentage change in GDP:

$$GDP_{growth} = \frac{GDP_{20} - GDP_{19}}{GDP_{19}} = \frac{110 - 76}{76} = 44.7\% \tag{2}$$

So GDP growth is astronomical. But something is wrong, the number of new cars is the same and the number of snow plows has actually fallen between 2019 and 2020. So there is clearly less output in 2020 than in 2019. The problem is that we have calculated *nominal GDP*. Nominal GDP can increase either because output has increased or because prices have gone up. Note that both snow plows and cars are more expensive in 2020.

Real GDP corrects for changes in prices to isolate the effects of changes in quantities. The trick is to first choose a base year, and then fix prices at their base year levels.

We are free to choose either year as the base year. Let's start by choosing 2019. So we always use 2019 prices when calculating GDP and GDP growth. For 2019, real GDP equals $12*3+2*20 = \$76$. Note that real and nominal GDP are the same for the base year. But we now multiply 2020 quantities by 2019 prices to calculate real GDP for 2020. It equals $10 * 3 + 2 * 20 = \$70$. So real GDP growth now equals:

$$GDP_{growth} = \frac{GDP_{20} - GDP_{19}}{GDP_{19}} = \frac{70 - 76}{76} = -7.9\% \tag{3}$$

Real GDP has actually declined, which suggests that the economy is actually doing poorly.

Now let's instead use 2020 as the base year. This means that we always use 2020 prices when calculating GDP. For 2019, it equals $12*5+2*30 = \$120$. For 2020, it equals $10*5+2*30 = \$110$, the same as nominal GDP (because 2020 is now the base year). So real GDP growth now equals:

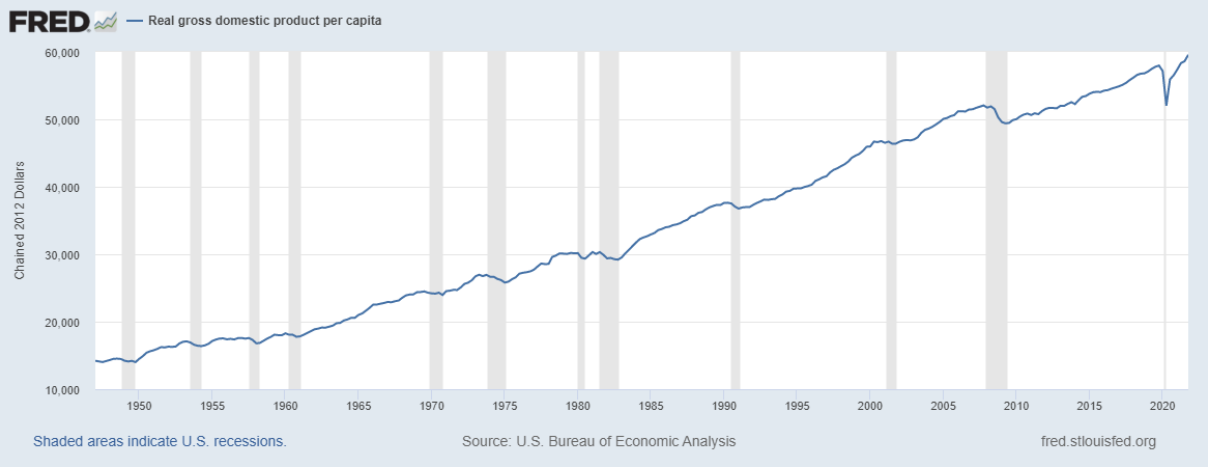
$$GDP_{growth} = \frac{GDP_{20} - GDP_{19}}{GDP_{19}} = \frac{70 - 76}{76} = -8.3\% \tag{4}$$

The Bureau of Economic Analysis does not use such a simple method. They use a chain weighted approach that is similar to taking an average of base years.

Note that the the denominator from (4) always includes the earlier year's value, not always the base year.

When comparing living standards over time or across areas, we typically divide by the population to get per-capita real GDP. Figure 3 shows U.S. per capita GDP:

Figure 3: U.S. Real Per Capita GDP



The shaded regions of the graph are recessions, periods of depressed macroeconomic activity. Notice that the last two recessions have been especially severe.

Sustained periods of positive growth are known as *economic expansions*. As of February 2020, the United States was enjoying the longest expansion in its history. That was ended by covid-19.

Another feature of Figure 3 is that the average rate of GDP growth appears to be slowing. The reasons for this decline have been the subject of much recent research. Possible explanations include an older population, which means more retirees compared to workers), fewer prime-age people choosing to work, and the possibility that technological advances are having less of an impact on productivity.

Price Levels and Inflation

We now consider how to construct a price level, a measure of overall prices. While there are many different price levels, they are all defined by a basket of goods and services. This is just the set of prices that we are including in our measure. One simple price level is the GDP deflator. This is a price level where the basket of goods is just whatever is included in GDP.

When calculating real GDP, we vary quantities and fix prices at their base year levels. When calculating a price level, we instead allow prices to vary and fix quantities at their base year levels. We will use 2019 as the base year.

The price level for 2019 is $12 * 3 + 2 * 20 = \$76$, the GDP deflator is again nominal GDP for the base year. For 2015, the price level is $12 * 5 + 2 * 30 = \$120$. Inflation ($\pi$) is the percentage change in the price level:

$$\pi_{2020} = \frac{P_{20} - P_{19}}{P_{19}} = \frac{120 - 176}{76} = 57.9\% \tag{5}$$

This is a very high level of inflation, the long run target in the U.S. is 2%. Were the U.S. to actually experience such a high rate of inflation, it would be regarded as an economic calamity.

There are quite a few other prices indices, each of which uses a different basket of goods. A popular one is the Consumer Price Index or CPI (there are actually many different versions of the CPI). It constructs a basket of goods that a representative consumer might purchase. A Producer

Price Index (PPI) constructs a basket that producers might purchase. Different indices fit best under different contexts.

In November 2019, the U.S. Consumer Price Index was 257.9. This figure should mean nothing to you. As a result, we almost always discuss aggregate prices in the context of inflation (the rate of change), and not the level of the price index itself.

There are a pair of issues with price indices that merit further discussion:

1. It is hard for them to capture changes in quality. A television or doctor's visit in 2021 is not really the same product as they were in 1950. The quality has improved enormously and prices indices struggle to account for this. As a result, they might overstate inflation. To see this, imagine that TV prices are unchanged since 1950. This suggests zero inflation. But for such a better TV to cost the same today as in 1950, suggests that the real price of TVs has fallen (think of it as the price per pixels).

2. Regular measures of price indices might also overstate inflation due to substitution effects. Consider a stupid example, the soda price index:

Table 3: Soda Purchased in 2015

Good or Service	Quantity (19)	Price (19) ($)	Quantity (20)	Price (20) ($)
Sprite	1	1	2	1
7-Up	1	1	0	1,000,000

Using 2019 as the base, year, the price index is 2. In 2020, the price of 7-Up goes up to $1 million for a 2 liter. The price index, rises to 1,000,001, inflation is extreme.

The problem is that no consumer would ever endure this price change. Instead, we see that they substitute away from Sprite toward 7-Up. But the price index does not capture this. Inflation is overstated. The chain weighted approach tries to fix this.

Social security recipients receive annual benefits increases known as COLAs (Cost of Living Allowances) that are based on non-chain weighted inflation calculated using a CPI. Because this

tends to overstate inflation, it has been proposed that benefits be linked to chain weighted CPI instead. This would reduce their future benefit and reduce the U.S. Federal budget deficit. The proposal has met with fierce resistance.

The Costs of Inflation

Macroeconomists pay a great deal of attention to inflation, the percentage change in the price level. **Important:** Inflation is not costly because it makes goods and services more expensive and allows people to buy fewer of them. Such an effect is, by definition, a decline in output. The question is why is inflation costly, even if output is unchanged. The answer is far less intuitive than why more unemployment or less output is undesirable.

We begin with a hypothetical. Suppose we all know that inflation will be 10% next year. I can design a solution so that this high rate of inflation poses few problems:

-wages rise by 10%. Workers' wages now have the same purchasing power as before and they are no worse off.

-Interest rates rise by 10%. So at the end of the year, peoples' assets have the same purchasing power as before.

- Because prices rise by 10%, and labor costs rise by 10% too, firm profits also rise by 10%. these profits then have the same purchasing power as before so business owners are neither better nor worse off.

In this example, the inflation rate does not matter because it is evenly distributed across all types of prices. This included not only prices for goods and services, but other prices, like those for labor, which are known as wages.

In reality, when inflation is high, it rarely is evenly distributed across all types of prices. As a result, it tends to create winners and losers while re-distributing wealth within the economy. Consider some examples.

. 1. There is evidence that wages move slower than prices for goods and services. If so, then real wages (wages divided by the price level) will fall when inflation is high. In this case workers lose and firms win, and inflation is redistributionary.

2. Interest rates are the cost of borrowing. If I borrow $1000 from you for one year, and the interest rate is 5%, then I must pay you back $1050 in one year. If inflation is high, however, then my money will not purchase as many goods and services in one-year compared to now. If lenders expect inflation, then they charge higher interest rates to compensate them for inflation.

But if high inflation is unexpected then lenders will not charge high enough interest rates. If you borrow (*e.g.* a mortgage or student loan) the debt you owe at the end of the year will be worth less in terms of goods and services than before. Borrowers thus benefit from unexpectedly high inflation while lenders lose. Unexpectedly low inflation has the opposite effect; borrowers lose and lenders win. Unexpected inflation is thus redistributionary.

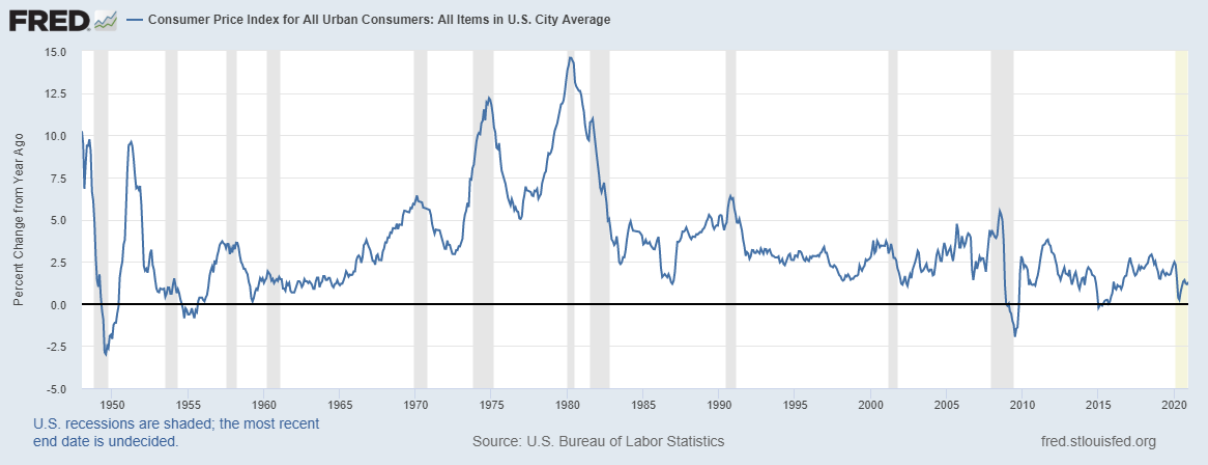
3. Because people are risk averse, they do not like the redistributionary potential of inflation. One way to reduce risk, is to reduce your economic activity: work less, produce less, etc. It is thus possible that inflation might cause lower output. In extreme case, known as hyperinflations, economic activity can become so risky due to inflation that the economy collapses.

Figure 4 shows the U.S. inflation rate in recent decades:

In the 1970s, the United States underwent a period of high inflation, known as the *Great Inflation*. Notice that in the early 1980s, we observe a major reduction in inflation rates. This is known as *disinflation*, and for reasons we may discuss later, probably caused a major recession that until recently was considered the worst since the Great Depression.

Also note that inflation may be negative, known as *deflation*. For reasons we will discuss later, deflation is as bad, or worse, than an equivalent inflation. The deflationary period near 1930 remains the most likely culprit behind the catastrophic Great Depression of the 1930s where unemployment neared 25%.

Figure 4: U.S. Inflation Using the Consumer Price Index



You may hear people argue that deflation is a good thing because it makes goods and services cheaper, allowing households to buy more of them. Once again, this confuses inflation/deflation with output.

Core vs. Overall Inflation

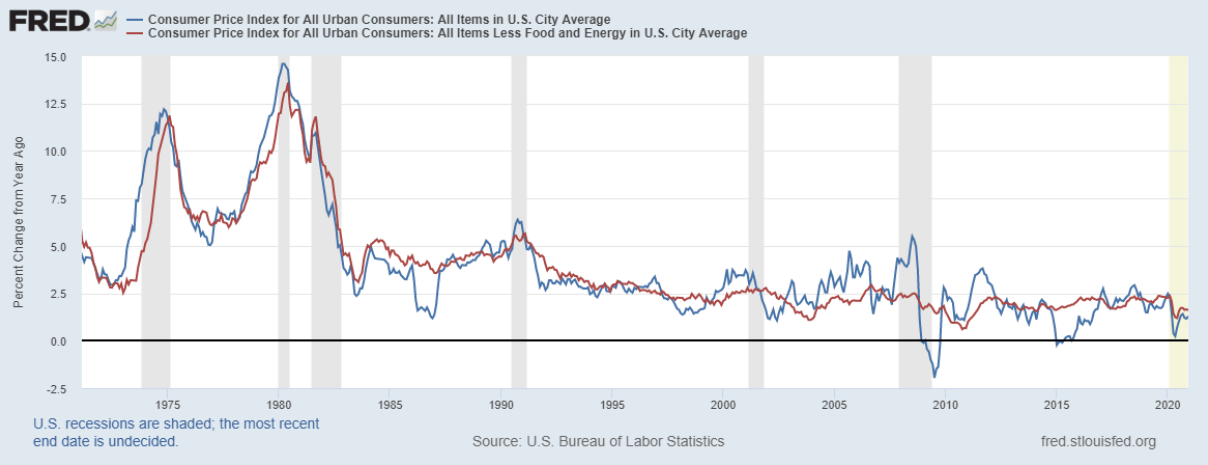
All price indices are defined by the basket of goods which is used to compute them. The Consumer Price Index, for example, consists of a bundle of goods which a typical household might purchase each month. This includes food and energy.

An alternate measure of inflation, known as core inflation excludes food and energy. in Europe, core inflation also excludes alcohol and tobacco products. Many policy makers, such as the Federal Reserve, care more about core inflation than overall inflation. This is not because food and energy prices are unimportant. Rather, these prices are volatile and largely determined in global markets which domestic policy makers have little ability to influence. Furthermore, core inflation may be a better predictor of upcoming overall inflation than overall inflation itself.

Figure 5 compares U.S. overall and core CPI inflation

Notice that core-CPI (the red line) is more stable than overall inflation (the blue line). The Federal Reserve hopes to avoid overreacting to short-term swings in energy prices in particular by

Figure 5: U.S. Inflation Using the Consumer Price Index



relying mostly on core inflation. The Federal Reserve itself, prefers a slightly different price index known as PCE (Personal Consumption Expenditures) inflation.