ECO402: Intermediate Macroeconomics

Output, Unemployment, and Inflation

Short Run, Medium Run, and Long Run

Monika Islam Khan

Department of Economics

University of Kentucky

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1 Output

Economists had no way to measure aggregate output until the end of World War II when the national income and product accounts were created. The national income accounts measure aggregate output as the gross domestic product (GDP). The national income accounts define what GDP and are components are and ways to measure them. To illustrate GDP consider an economy with only two firms:

- Firm 1 sells steel, they employ workers and pay them $80 in wages to operate machinery to produce steel that they sell to firm 2 for $100.
- Firm 2 buys the steel and hires workers to operate machines for $70 and produce cars. The revenue from car sales is $200.

Table 1: Toy Economy

	Steel Company	Car Company
Revenues from Sales	$100	$200
Wages/Machines	$80	$70
Raw Steel		$100
Expenses	$80	$170
Profit	$20	$30

What is the value of GDP in this economy? Is it the sum of the sales of the cars and steel? But the steel was used to make the cars. Here is one definition of GDP that might help answer this question.

Gross Domestic Product: The value of the final goods and services produced in the Economy during a given period.

By that definition it seems obvious that we shouldn't count the steel since it was used in the production of a final good, it is part of the car that is sold which the car's price should reflect. This can illuminated by supposing the steel and car companies merged and now the

car company produced the steel in house. The new conglomerate would still sell cars at $200 and now it would have to hire both sets of workers at $150, leaving $50 in profit.

Gross Domestic Product: The sum of value added in the economy during a given period.

Value added is the value of what is produced by a firm less the value of intermediate goods used in production. With this definition in mind we look at the revenue generated by the firm less the intermediate goods used in production. In our example the steel company does not buy any intermediate goods, so their value added is $100. The car company however buys the steel for $100, so their value added is $200-$100=$100. So GDP would be $200.

Gross Domestic Product: The sum of incomes in the economy during a given period.

The previous definitions were focused on the value of the goods that were produced, this one however focuses on income. Income could be wages or it could be profits. If we return to the previous example and add up wages and profits we get that GDP is $200 again. These three definitions are all **equivalent**.

1.1 Nominal VS Real GDP

Nominal GDP (NGDP): The sum of quantities of final goods produced times the current price.

Based on this definition we know that nominal GDP can increase for two reasons:

- The production of most goods increasing.
- The price of most goods increasing.

One can see that if we are only concerned with measuring output and its growth rate over time that NGDP will not be able to reliably give us that information as some of its growth is due to inflation. How can we compare output today to output in 1960? That is where **real GDP** comes in.

Real GDP: The sum of the quantities of final goods times constant prices.

To illustrate this difference lets suppose that our economy only produces one good - calzones.

Table 2: Calzone Economy

Year	Quantity of Calzones	Price of Calzones	Nominal GDP	Real GDP (In 2015 Dollars)
2014	300	\$6	\$1,800	\$2,100
2015	400	\$7	\$2,800	\$2,800
2016	450	\$10	\$4,500	\$3,150

We construct real GDP first in 2015 prices. That means that in each year we calculate GDP by multiplying the real quantities by the price of \$7. If instead we chose 2014 as the base year real GDP would be \$1,800, \$2,400, and \$ 2,700 would be the values of real GDP. Similarly choosing 2016 as the base year would give us \$3,000, \$4,000, and \$4,500.

The problem with constructing real GDP in practice however is that there are multiple goods sold at different prices. Now let's suppose that our economy only produces calzones and board games.

Table 3: Calzone and Board Game Economy

		Year 0	
	Quantity	\$ Price	\$ Value
Calzones	10	\$5	\$50
Board Games	5	\$10	\$50
Nominal GDP			\$100

		Year 1	
	Quantity	\$ Price	\$ Value
Calzones	15	\$5	\$75
Board Games	5	\$6	\$30
Nominal GDP			\$105

So real GDP in Year 0 at Year 1 prices is \$80. Real GDP in Year 1 at Year 0 prices is \$125.

1.2 A Detour to some Definitions

GDP Per Capita: This is the ratio of real GDP in a country to its population.

GDP Growth: Let Y_t be real GDP in time t, and let ΔY_t be GDP growth in time t.

$$\Delta Y_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}}$$

Periods of positive GDP growth are called expansions, while periods of negative GDP growth are called recessions.

1.3 Back to Nominal vs Real GDP

In our previous example Nominal GDP grew at a rate of 5% ($\frac{105-100}{100} = 5\%$). What is the rate of change of real GDP? First let us use the prices in period zero as our **base year**. That means that in year zero dollars GDP is still \$100 in year zero, but in year zero dollars GDP in year one is \$125, so the rate of growth of real GDP is 25%.

Let us suppose instead that we use year one as the base year, then in year one dollars the year one GDP is unchanged, but year zero GDP is now \$80, which implies a real GDP growth rate of $\frac{105-80}{80} = 31.2\%$. As you can see the base year affects constructed percentage of real GDP growth. Starting in 1995 the Bureau of Economic Analysis (BEA) started calculating real GDP using chained dollars. This is a process where real GDP is calculated using the following steps:

1. Choose a base year, this year will have its NGDP equal its real GDP.

2. Calculate the real GDP growth rate from year t and year $t-1$ using the prices in both year t and year $t-1$ and average them.

3. Real GDP in in chained dollars in time $t+1$ is the calculated as:

$$(1 + \Delta_C) * Y_{C,t} \tag{1}$$

Where Δ_C is the averaged real growth rate from period t to $t+1$ and $Y_{C,t}$ is the chained real GDP at time period t.

As an example let's return to the calzone and board game economy. We set year 0 as a base year, then to calculate real GDP in year 1 we first calculate that the growth rate from year 0 to year 1 at year 0 prices is 25% and at year 1 prices is 31.25% which averages to 28.125%. Thus real chained GDP is \$128.125.

2 Unemployment

Employment: The number of people who have a job.

Unemployment: The number of people who do not have a job but are looking for one.

Labor Force: The sum of employment and unemployment.

Unemployment Rate: the ratio of the number of people who are unemployed to the number of people in the labor force:

$$u = \frac{U}{L}$$

Example (p 26 in B&J): In 2010 estimates from the Current Population Survey (CPS) showed that roughly 139 million people were employed while roughly 14.8 million people were unemployed, this gives us a labor force of 153.8 million, and an unemployment rate of $\frac{14.8}{139+14.8} = 9.6\%$.

Discouraged Workers: Unemployed workers who give up looking for a job after searching for a job, usually during times of hihg unemployment. These workers are not counted as part of unemployment.

Labor Force Participation Rate: The ratio of the labor force to the total population of working age.

In general periods of high unemployment are associated with periods of lower labor force participation due to the discouraged worker effect.

So why care about unemployment? First unemployment has negative effects on the well-being of the unemployed. Even with unemployment benefits there is usually a financial and psychological cost to being unemployed. This cost depends on the duration of unemployment. During normal times most people do not remain unemployed very long, however when unemployment increases the duration can last much longer. For example the average duration of unemployment during 2000-2007 was only 9 weeks, while during 2010 it was 33 weeks.

The other reason for interest is that unemployment is a barometer for how well the economy is performing. When unemployment is high it is a signal that the economy is not allocating human resources efficiently if there are people looking for work that cannot find it. When unemployment is "too low" the economy may be over-utilizing resources and suffer from labor shortages.

3 Inflation

Inflation a sustained rise in the general level of prices. The inflation rate is the rate at which the price level increases.

Deflation a sustained decline in the price level, it corresponds to a negative inflation rate.

GDP Deflator a measure of the price level, known as a *price index*. Numerically it is defined as the ratio of nominal GDP to real GDP, where P_t is the GDP deflator:

$$P_t = \frac{NGDP_t}{RGDP_t}$$

The GDP deflator also has an intuitive interpretation - if you multiply real GDP by the GDP deflator you get back nominal GDP:

$$NGDP_t = P_t \times RGDP_t$$

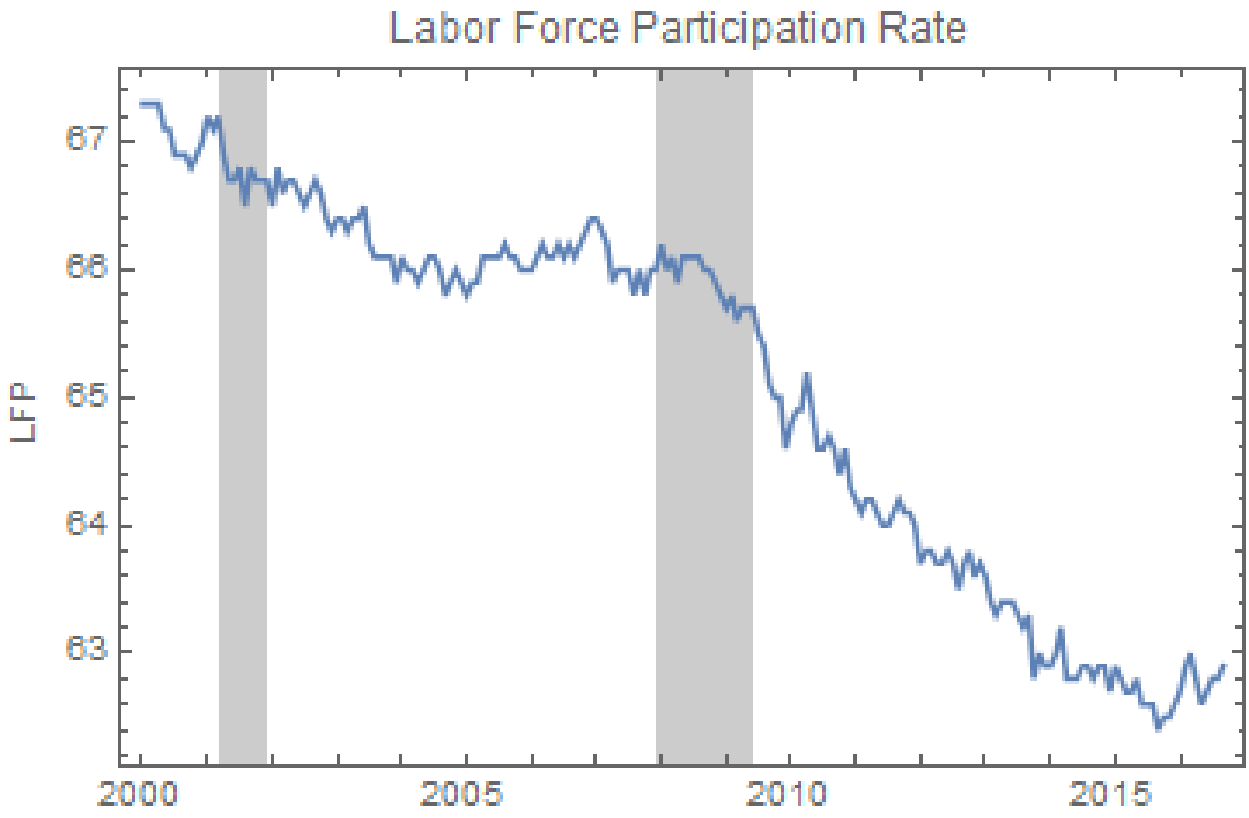

Figure 1: United States labor force participation rate 2000-2016.
Source: Federal Reserve Economic Data

Additionally the rate of growth in nominal GDP is approximately equal to the rate of inflation plus the rate of growth of real GDP.

The GDP deflator may not be the best way to assess the price level and its fluctuations. The GDP deflator gives the average price of all goods. Consumers however, care more about the average price of the goods they actually consume.

Consumer Price Index (CPI): measures the cost (in dollars) of a specific list of goods and services over time. The list of goods is updated once every 10 years and represents the typical consumption basket of an urban consumer. Obviously, the basket of goods and services is different for different countries. It is an index, meaning that it is set equal to 100 in the period chosen as the **base** period, thus the level itself has no significance. However, it can be used to compare standard of living. For example, if the CPI this year is **300**, then we can say that it costs **thrice** as much today (in dollars) to purchase the same consumption basket than in the **base** year.

CPI and GDP deflator move together most of the time, and differ by less than 1%. Some exceptions would be 1979 and 1980 when the price of oil doubled, and since oil was predominantly imported at the time it had a much larger effect on CPI.

So why care about inflation? Hypothetically if all prices rose at the same rate, then inflation would be only a minor inconvenience. If the prices of goods rose by 10% but wages also increased by 10%, individuals would still be able to afford the same basket of goods and services were purchasing before. This is what is sometimes called "pure inflation". However, it doesn't actually exist!

Sticky Prices: Some prices (like wages) are **sticky**! Therefore, not all prices and wages rise proportionally and inflation ends up affecting standard of living and income distribution. For example, in the 1990s, Russian retirement pensions did not keep up with inflation, and as a result, many retirees were pushed to the brink of starvation.

Expectations and Distortions: Variations in relative prices can lead to more uncertainty in

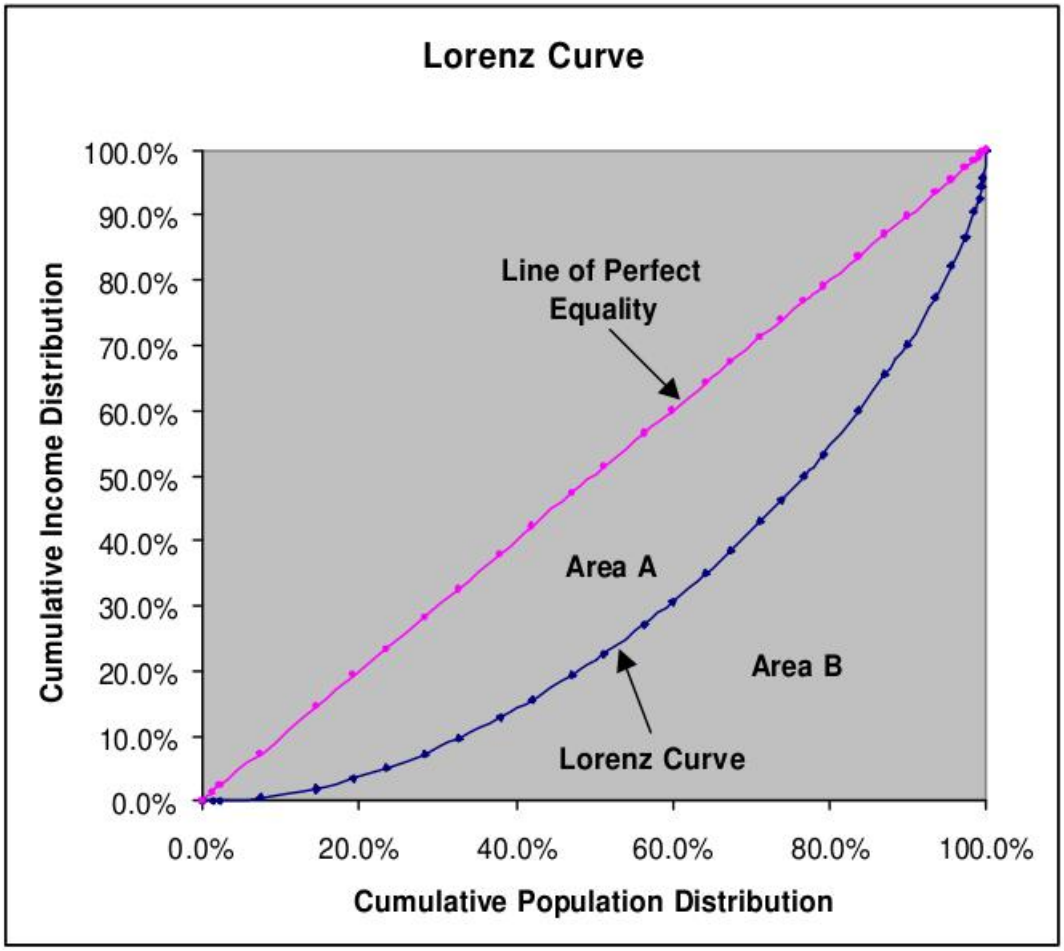

Figure 2: An example of a Lorenz curve made with randomly generated data. The Gini Coefficient is the area of A divided by the area of A plus B.

the economy making it harder for firms to make decisions about the future.

Discussion If inflation can be bad, does that mean deflation is good?

3.1 Inequality

The aggregate measures we have discussed so far are a good guide for the economy well-being of a nation, but they lack information on how the economic wealth of that nation is distributed.

Lorenz Curve: A graphical representation of the income or wealth distribution of a country. Figure 2 shows what proportion of wealth is held by what proportion of the population.

Line of Perfect Equality: The 45-degree line on the graph that represents equal distribu-

tion of wealth across a country.

Gini Coefficient: A way to measure inequality. Mathematically, it is the ratio of the area between the Lorenz curve and the 45-degree line (Area A) and the area of the triangle formed by the 45-degree line and the horizontal axis from zero to one on each axis (Area A+Area B).

As a result when the Lorenz curve moves closer to the 45-degree line it would mean that society is getting more equal. This coincides with an economy where each individual had the same income. In this situation the Gini coefficient is equal to zero. On the other hand as wealth gets more and more concentrated in the hands of one individual the Lorenz curve moves closer and closer to being near vertical at the end of the income distribution. This coincides with a Gini coefficient of one.

How might one practically calculate a Gini coefficient? One equation is:

$$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - xj|}{2n^2 \bar{x}} \tag{2}$$

where x_i is the income (wealth) of person i, n is the size of the population, and $\bar{x}$ is average income. To implement this we first add up the distance of each person's income from the first person in our list. Then we add to that the distance of each person's income from the second person on in our list etc. Once all of these distances are added up we divide by $2n^n\bar{x}$. One can also obtain the same result by the following:

$$G = \frac{n+1}{n} - \frac{2\sum_{i=1}^{n}(1+n-i)x_i}{n\sum_{i=1}^{n} x_i}. \tag{3}$$

If using this method then the x_i's must be in ascending order. For this method we divide the sum of each person i's income times one plus n minus i by n times the total of all incomes and subtract it from the ration of $n+1$ and n.

On your homework expect to be asked to calculate a Gini coefficient for a given set of incomes. You can do this any way you please, it would be very easy to do using something

like Matlab, Python, Julia, or Mathematica if you are comfortable with them. It can be done with Excel however (2) will be somewhat more difficult in Excel than (3). Finally it can be done by hand with a calculator as well, it will just be a bit tedious. If you need help with any of these methods come by during office hours or schedule an appointment.

4 Relationships Between Output, Unemployment, and Inflation Rate

4.1 Okun's Law: Output and Unemployment

If output growth is high, unemployment will decrease. The relationship is roughly that a one percent increase in the growth rate will lead to roughly a .4% decrease in unemployment. It also takes a growth rate of roughly 3% to keep unemployment constant.

Okun's law is an approximate relationship that seems to always hold. And it makes sense that we would observe a relationship like this - if we produce more then firms should be hiring more workers to do the production.

4.2 The Phillips Curve: Unemployment and Inflation Rate

The relationship between inflation and unemployment (or output). Generally thought to be negative with unemployment and positive with output.

Intuitively when unemployment is very low the economy will likely "overheat" which will put upward pressure on prices. In 1958 New Zealand economist A.W. Phillips plotted the relationship between inflation and unemployment. It has also been defined as the relationship between unemployment and the change in the rate of inflation. The relationship is a negative one although this isn't always the case, as there have been some times when high unemployment and high inflation coincided.

5 Short, Medium, and Long Run

Macroeconomic variables may have different relationships over different time horizons. This has implications for policy. We will talk about all three time horizons over the course of this class, they are:

- In the **short run**, say one or two years it is largely fluctuations in aggregate demand that determine total output.
- In the **medium run**, think about a decade it is the economy's productive capacity that determines output.
- In the **long run** it is innovation that determines what productive capacity can be.