GDP: Definition and Calculations

Gross Domestic Product (GDP) is the market value of all goods and services produced within a country over a given time period, typically a year.

- GDP is measured in market value, not quantities
- GDP includes on final goods, not intermediate goods
  - A *final good* is purchased by the final user and is not used in the production of any other good or service
  - An *intermediate good* is used as an input for another good or service
- GDP only includes production in the current time period/year

Calculating GDP: The Price-Quantity Method

In this method we take the market value of all final goods and services produced in an economy and multiply them by their market value. This formula can be represented by the following:

$$GDP = \sum_{i=1}^{n} P_i Q_i$$

Example 1: Suppose that in a year an economy produces 100 golf balls that sell for $3 each and 75 pizzas that sell for $8 each. What is the GDP in this economy?

Calculating GDP: The Expenditures Approach

In this method we calculate GDP by summing the expenditures on final goods and services in an economy. The formula used here is:

$$Y = C + I + G + NX$$

- C = Consumption Spending
- I = Investment Spending. Includes purchase of durable/capital goods by firms, purchase of new homes, and changes in inventory over a year
- G = Government Spending. Only includes purchases of goods and services by the government, and not transfers of wealth
- NX = Net Exports = Exports – Imports

Example 2: In 2011, consumption spending is $7000, government purchasing is $2,000, and investment spending is $1,500. If GDP for 2011 is $10,300, then what are net export in the economy?

Calculating GDP: The Value Added Approach

In this approach you add the *value added* by each good in the economy

$$Value\ Added = Price\ of\ final\ good - Price\ of\ intermediate\ goods$$

Example 3: Suppose that a pizza maker sells their product for $20. To do so a company uses $5 worth of bread, $2 worth of cheese, $3 worth of sauce, and $3 worth of pepperoni. What is the value added of each good?

Calculating GDP: The Income Approach

In this method we add up the income paid to all the factors of production

$$GDP = Wages + Interest + Rent + Profit$$

- Note that these approaches should all yield the *same* value of GDP

Real vs. Nominal GDP

Nominal GDP is defined as GDP that has not been adjusted for prices and has been calculated using the prices in the year in which the output is produced.

Real GDP is GDP calculated as if prices had remained at the level of some given *base year*

There are two methods to solve problems involving real/nominal GDP. One involves using the price-quantity method and the other involves a new formula comparing real/nominal GDP

Revisiting the Quantity Method

$$Nominal\ GDP = \sum_{i=1}^{n} P_i^{current\ year} Q_i$$

$$Real\ GDP = \sum_{i=1}^{n} P_i^{base\ year} Q_i$$

Example 4: Suppose that in year 1 an economy produces 100 golf balls that sell for $3 each and 75 pizzas that sell for $8 each. The next year the economy produces 110 golf balls that sell for $3.25 each and 80 pizzas that sell for $9 each. What is the real GDP in year 2 using year 1 as the base year?

The GDP Deflator Method

$$GDP\ Deflator = \frac{Nominal\ GDP}{Real\ GDP} \cdot Scale\ Factor$$

The GDP Deflator is an *index number*. It is a data point reflecting the price level compared to some base level, which is determined by the *scale factor*

Example 5: Using the information from question 4, and assuming that year 1 is the base year, calculate the GDP Deflator in years 1 and 2 with a scale factor of 100

Tutorial: using scale factors to convert exam scores

When given scores for multiple exams/assignments, the scores can be converted to a common scale by following two steps:

Step 1: Determine the scale factor for each score

The scale factor for each score can be found using the following formula:

$$Scale\ Factor = \frac{Desired\ Scale}{Max\ Score\ on\ Assignment}$$

Step 2: Multiply each score by the scale factor

Example 6: Given the following scores, convert them to a 100 point scale

- 19 out of 20
- 150 out of 200
- 24 out of 30

The Unemployment Rate

In order to calculate the unemployment rate, we must first define some terms regarding how we think about employment and unemployment.

Employment is the total number of people currently employed, either full time or part time

Unemployment is the total number of people who are actively looking for work but aren't currently employed

From here, we can define the *labor force, labor force participation rate,* and *unemployment rate* mathematically

$$Labor\ Force = Employment + Unemployment$$

$$Labor\ Force\ Participation\ Rate = \frac{Labor\ Force}{Population\ age\ 16\ and\ older} \times 100$$

$$Unemployment\ Rate = \frac{Unemployment}{Labor\ Force} \times 100$$

Example 7

	Country A	Country B
Population over 16 years old	1,000,000	2,000,000
Employed	600,000	1,300,000
Unemployed	60,000	200,000

What is the labor force participation rate in country A? Country B? What is the unemployment rate in country A? Country B?

Discouraged workers are non-working people who are capable of work but have given up looking for work given the state of the job market

Marginally attached workers would like to be employed and have looked for a job in the recent past but are not currently looking for work

- Discouraged workers are a part of the marginally attached workers category

Underemployment is the number of people who work part time because they cannot find full-time work

- Note that the underemployed and marginally attached are not considered unemployed

The Natural Rate of Unemployment

Frictional unemployment is unemployment due to the time workers spend in the job search

Structural unemployment is the unemployment rate that results when there are more people seeking jobs in a particular labor market than there are jobs available at the current wage rate

The *natural rate of unemployment* is the unemployment rate that arises from the effects of frictional plus structural unemployment

$$Natural\ Rate\ of\ Unemployment = Frictional + Structural$$

Cyclical unemployment is the deviation of the actual rate of unemployment from the natural rate

$$Actual\ Unemployment = Natural\ Rate\ of\ Unemployment + Cyclical$$

Market Baskets and the CPI

A *price index* is a single number used to summarize the prices of all goods and services in an economy

The most widely used price index is the *Consumer Price Index (CPI)*

The CPI, as with many price indexes, is calculated through the use of a *market basket*, which is a hypothetical bundle of goods thought to represent the consumption of a typical household

$$CPI = \frac{Cost\ of\ market\ basket\ in\ a\ given\ year}{Cost\ of\ market\ basket\ in\ base\ year} \times Scale\ Factor$$

Example 8

Year	Price of Apple	Price of Orange
2013	5	10
2014	6	12

Suppose that a typical market basket consists of 6 apples and 4 oranges. If the base year is 2013, and the scale factor is 100, what is the CPI in 2013? 2014?

Price indexes are also the basis for measuring inflation. The *inflation rate* is the percent change in price over time

$$Inflation\ Rate = \frac{Price\ index\ in\ year\ 2 - Price\ index\ in\ year\ 1}{Price\ index\ in\ year\ 1} \times 100$$

Example 9

Using the information from example 8, calculate the inflation rate from 2013 to 2014

If the inflation rate is positive from one year to another, we claim there was *inflation* during that time period. If the inflation rate is negative from one year to another, we claim that there was *deflation*.

Inflation has several impacts on the economy at large. The first is its impact on *real wages*, which are nominal wages divided by the price level. While real wages typically adjust with the price level, unexpected inflation (or deflation) will cause real wages to be lower (or higher) than expected, harming households (or firms). *Shoe-leather costs* and *menu costs* refer to the impact that inflation has on everyday economic activities, such as the rate at which transactions take place or on how often firms change the prices of their goods.

Most notably, inflation has an impact in lending markets. When there is inflation, borrowers who have borrowed money pay their debtors back with money which is less value than that they borrowed To adjust, lenders set the *nominal interest rate* such that after inflation the real return determined by the *real interest rate* is acceptable.

$$Real\ interest\ rate = Nominal\ interest\ rate - Expected\ inflation$$

However when there are unexpected changes in the price level, this impacts the actors in the lending market. When there is unexpected inflation, the real interest rate falls, hurting lenders. In contrast, when there is unexpected deflation, this increases the real interest rate, hurting borrowers.

Practice Questions

1. Choose the true statement:
a) If nominal GDP in an economy is growing over time this implies that over time real GDP in this economy may be increasing, decreasing or remaining constant.
b) GDP per capita is a measure that can be used to assess how unequal the income distribution is.

2. If in 2015 the unemployment rate is higher than in 2014 and the total population stays the same, fewer people have jobs.
a) This statement must be true.
b) This statement may not be true.

3. The difference in the definition between Real and Nominal GDP is
a) that Real GDP is measured by excluding some of the sectors.
b) that Real GDP is always smaller than Nominal GDP.
c) that the price level is changed from the base year to the current year.
d) Answers (a), (b), and (c) are all true
e) Answers (a), (b) and (c) are all false

4. Consider the hypothetical economy consisting of three firms in the table below. In this economy, Steel, Inc buys intermediate goods from Ore, Inc. Motors, Inc buys its intermediate goods from Steel, Inc. Choose the true statement from the following choices.

	Ore, Inc.	Steel, Inc.	Motors, Inc.
Intermediate Goods	0	4,200	9,000
Wages	2,000	3,700	10,000
Interest Payments	1,000	600	1,000
Rent	200	300	500
Profit	1,000	200	1,000
Value of Sales	4,200	9,000	21,500

a) The total payments to factors are equal to the total value added. So the GDP in this economy is $21,500.
b) Summing the total value of sales of each of the three companies we can compute the GDP of this economy, which equals $34,700.
c) The value added by the firm Motors, Inc. is $12,500
d) Alternatives a) and b) are correct.
e) Alternatives a) and c) are correct.

5. Teddy's Creations (located in Duluth, MN, USA) manufactures bathmats that they sell for $20 each on the web. In 2013 Teddy's Creations manufactured 1,000 of these bathmats and sold 600 of them. Teddy, the owner of Teddy's Creations during 2013 also purchased a number of items to use at home: he bought $400 worth of Italian shoes, $300 worth of California wine, and $250 worth of Wisconsin cheese. In 2014 Teddy bought the same dollar value of Italian shoes, the same dollar value of California wine, but decreased his purchases of Wisconsin cheese by $100. In 2014 Teddy's Creations produced 1,000 bathmats and sold 1200 bathmats at a price of $20 per bathmat. Given this information, which of the following statements is true about Teddy and Teddy's Creations contribution to GDP?
a) The effect of these activities on GDP in 2013 is to increase GDP by $20,550 while the effect of these activities on GDP in 2014 is an increase of $20,450.
b) The effect of these activities on GDP in 2013 is to increase GDP by $20,150 while the effect of these activities on GDP in 2014 is an increase of $24,050.
c) The effect of these activities on GDP in 2013 is to increase GDP by $20,950 while the effect of these activities on GDP in 2014 is an increase of $24,850.
d) The effect of these activities on GDP in 2013 is to increase GDP by $12,950 while the effect of these activities on GDP in 2014 is an increase of $24,450.
e) The effect of these activities on GDP in 2013 is to increase GDP by $12, 950 while the effect of these activities on GDP in 2014 is an increase of $24,850

6. Consider the following information about an economy in 2012:
• There are 150,000 people age 16 and older in this economy in 2012
• There are 40,000 people who are retired (they are all over 65 years old) in this economy in 2012
• There are 5,000 full-time students that are age 16 and older in this economy in 2012
• There are 80,000 people age 16 and older who are working for pay full-time in this economy in 2012 in jobs they really like
• There are 4,000 people age 16 and older who are working half-time in this economy in 2012 even though they would prefer to work full-time

• There are 4,000 people age 16 and older who are working half-time in this economy in 2012 in jobs for which they are over qualified
• There are 2,000 people age 16 and older who are working for pay full-time in this economy in 2012 in jobs they really dislike
• There are 5,000 people age 16 and older who are currently not working, are available for work but who have not made a job application in the past month
• There are 10,000 people age 16 and older who are currently not working, are available for work and are actively filling out job applications
Given the above information and holding everything else constant, the unemployment rate in this economy for 2012 is equal to
a) 5%
b) 10%
c) 15%
d) 20%
e) The unemployment rate in this economy cannot be calculated given the above information.

	Country A	Country B
Employed	500,000	590,000
Frictionally Unemployed	20,000	10,000
Structurally Unemployed	20,000	40,000
Cyclically Unemployed	60,000	110,000

7. *Use the above table.* What is the cyclical rate of unemployment in Country A?
   a) 3.3%
   b) 4.0%
   c) 10.0%
   d) 12.0%

8. *Use the above table.* What is the natural rate of unemployment in Country B?
   a) 5.0%
   b) 6.7%
   c) 8.5%
   d) 14.7%

8. Use the following information about production in a small economy to answer this set of questions. Assume that this economy only produces bikes, books, and tables from its available resources.

	2010	2011	2012
Price of a Bike	$500	$500	$600
Quantity of Bikes Produced	20	25	30
Price of a Book	$10	$15	$10
Quantity of Books Produced	10	20	20
Price of a Table	$100	$80	$100
Quantity of Tables Produced	5	8	8

a. Calculate the value of nominal GDP for 2010, 2011, and 2012 for the small economy described in the above table. Explicitly provide the formula you use to find nominal GDP and make sure your answer is clear, logical and easy to follow in its presentation. Summarize your final calculations in the table provided.

Year	Nominal GDP
2010	
2011	
2012	

b. Using 2010 as your base year, calculate the value of real GDP for 2010, 2011, and 2012 for the small economy described in the above table. Explicitly provide any formula you use to find real GDP and make sure your answer is clear, logical and easy to follow in its presentation. Summarize your final calculations in the table provided.

Year	Real GDP
2010	
2011	
2012	

c. Using 2010 as your base year, and 100 as a scale factor calculate the value of the GDP Deflator for 2010, 2011, and 2012 for the small economy described in the above table. Explicitly provide any formula you use to find real GDP and make sure your answer is clear, logical and easy to follow in its presentation. Summarize your final calculations in the table provided.

Year	GDP Deflator
2010	
2011	
2012	

10. Consider the following information about an economy in 2012:
• George a realtor sells 10 houses built between 1990 and 2009 for $1,000,000 and collects 10% of this amount as a commission on his efforts
• Harry runs a gambling operation where customers can place bets on the outcomes of different athletic events: he makes $50,000 in 2012 and does not report any of this income to government authorities
• Susie exchanges babysitting services with Stan: since they both provide services to each other they do not pay for these services: the value of these services is $30,000 for 2012
• Ace Car Manufacturing manufactures 4000 cars in 2012 and sells 3500 of these cars: the price of each car is $20,000
• Swift Tires manufactures 20,000 tires and provides Ace Car Manufacturing with 16,000 tires for the new

cars; the rest of the tires are sold as replacement tires and each tire is sold for $100

GDP in 2012 in this economy given the above information would equal
a. $82,680,000
b. $82,100,000
c. $82,600,000
d. $80,500,000

11. Wormwood currently does not include discouraged workers as part of the unemployed when it computes its unemployment rate. This decision not to include discouraged workers results in
a. The unemployment rate in Wormwood being higher than it would be if the discouraged workers were included.
b. The employment rate in Wormwood being lower than it would be if the discouraged workers were included.
c. No impact on the unemployment rate.
d. The unemployment rate in Wormwood being lower than it would be if the discouraged workers were included.

12. Investment spending is spending on productive physical capital. According to the national accounts system the construction of a new house
a) would be included as a part of investment spending.
b) would not be included as a part of investment spending.

13. Michael has three job offers for next year with the following salaries: 1) $80,000 in New York City; 2) $50,000 in Madison; and 3) $60,000 in St. Louis. Michael knows that the cost of living in New York is twice the cost of living in Madison and the cost of living in St. Louis is 75% of the cost of living in New York. Assume all three jobs are equivalent and Michael only cares about his real salary for the coming year. What do you recommend?
a. Michael should take the job in Madison.
b. Michael should take the job in New York.
c. Michael should take the job in St. Louis.
d. Michael should continue searching for a job

14. Which of the following statements is true?

I. The construction of the CPI uses a fixed market basket.
II. In the base year the nominal value of a variable is equal to its real value.
III. If the CPI increases over time this implies that the real value of a variable must also increase.

a. Statements I, II and III are all true statements.
b. Statements I and II are true statements.
c. Statements I and III are true statements.
d. Statement I is a true statement.
e. Statement II is a true statement.

	2010	2011	2012
Price of a Bike	$500	$500	$600
Price of a Book	$10	$15	$10
Price of a Table	$100	$80	$160

For purposes of constructing the CPI for this economy the market basket is defined as 1 Bike, 4 Books, and 1 Table.

15. a) What is the cost of the market basket in each of the three years? Summarize your calculations in the provided table.

Year	Cost of Market Basket
2010	
2011	
2012	

b) Provide CPI index numbers on a 100 point scale for 2010, 2011, and 2012 using 2010 as your base year. Summarize your calculations in the provided table.

Year	CPI with base year 2010
2010	
2011	
2012	

c) Suppose the base year is changed to 2012. Provide the CPI index numbers for 2010, 2011, and 2012 on a 100 point scale using 2012 as your base year. Summarize your calculations in the provided table.

Year	CPI with base year 2012
2010	
2011	
2012	

d. Calculate the rate of inflation from 2011 to 2012. Do this twice: once with 2010 as the base year and again with 2012 as the base year