

Econ 102
Measuring National Income and Prices
Solutions

1. Measurement of National Income and Decomposing GDP

This question is designed to see if you understand how Gross Domestic Product (GDP) is measured. For each transaction answer the following questions:

- How is the GDP of the countries mentioned affected?
- In which component of each country's GDP (C, I, G, or NX) will the transaction appear?

Before you begin, you should define exactly what GDP is. This definition should help you answer the question. Each one of your answers should be able to satisfy this definition.

Definition of GDP: the market value of all final goods and services produced in an economy in a given period of time. $Y=C+I+G+(EX-IM)$, where $EX-IM=NX$ or net exports...

- i. Households in the U.S. go on a binge of buying and eating U.S.-produced popcorn.

There will be an increase in US consumption (C), which will raise US GDP (Y).

- ii. J.B., who is a Canadian citizen living in Canada, buys a new car in Ann Arbor which was built by a firm based in Michigan.

J.B.'s purchase increases U.S. exports and thus increases U.S. GDP. His purchase has no effect on Canadian GDP because it increases Canadian consumption (C) and reduces Canadian imports (NX) by the same amount..

- iii. US Steel Corporation purchases a new \$10 million steel rolling machine for its factory. Assume the steel-rolling machine was produced in Japan.

US GDP is not affected, since nothing was produced in the US. Investment increases but imports increases by exactly the same amount, so there is no overall direct effect on US GDP. In Japan, GDP will increase because of increased exports.

- iv. The city of Ann Arbor purchases a new, German-made bus for \$150,000.

The purchase made by the City of Ann Arbor shows up as a Government purchase but it is also counted as imports from Germany. GDP in the US is then left unaffected. In Germany GDP will increase because of increased exports.

- v. The University of Michigan, a public school, builds a new library for \$20 million.

Since the U of M is a public school, its spending counts as a government purchase. Therefore, US Government purchases increase by \$20 million, and because all the goods

and services that go into the construction of the library add to the value of US output, Y also increases by \$20 million.

- vi. Aunt Jane buys a new home in Ann Arbor, MI in 2003 for \$600,000. The home has been built in 2003 from \$40,000 worth of bricks produced in Canada in the same year.

Total world output has increased by \$600,000, since this is a new home that was produced. \$40,000 of it was produced in Canada, therefore, Canadian GDP increases by \$40,000. The remaining \$560,000 were produced in the US, which raises US GDP by that amount.

The bricks were exported from Canada to the US, which increases Canada's NX by \$40,000. US imports mirror Canadian exports, thus US IM increase by \$40,000. The tricky part is that a new residential building counts as investment in GDP accounting, not consumption: US I increases by \$600,000.

- vii. A TV assembly plant in Mexico buys \$100 worth of components from US factories, assembles a TV, and sells it to the Ann Arbor Best Buy store for \$350. A Canadian buys it in Ann Arbor for \$400 while on his vacation.

The US sells \$100 in exports to Mexico (+100 NX), buys \$350 TV from Mexico (+350 I, due to the increase in inventory of TVs, and -350 IM), and sells it to a Canadian (+400 EX and -350 I, due to the fall in inventory). The total change in US GDP would be +\$150 dollars. You could also calculate this by using a value added technique.

For Mexico, the \$100 in components (-100 IM and +100 I) causes no change in GDP, but the export of the finished TV causes an increase in Mexican GDP (+350 EX and -100 I).

Lastly, for Canada, we have an increase in consumption and an increase in imports, which does not change Canadian GDP (+400 C and -400 NX)

- viii. Due to the current favorable exchange rate, EU citizens start purchasing shares on the US stock market.

Remember here that buying shares of stock or any other financial asset is not considered "investment" in the sense of the value of "I" in the measurement of GDP. The reason is that such purchases do not represent anything that is produced.

This, then, will certainly not affect the EU GDP, since there is no increase in the market value of goods and services produced in the EU.

In US, there will not be an increase either, since buying stocks does not increase the capital stock in the US.

- ix. You sell your copy of Mankiw's "Brief Principles of Macroeconomics back to Ulrich's for \$15 after a very successful semester.

There will be no change in US GDP, seeing that it was counted when it was first sold/produced.

- x. Your GSI spends 5 hours fixing the broken wheel on his car; a job that would have cost him \$300 at the local service station.

There will be no change in GDP, because there was no market transaction. Had your GSI taken his car to the shop, then we would have a service rendered, adding to GDP. You should see a drawback in GDP accounting here, for we do not include activities such as housework or yard work if no individual gets paid through an organized market. GDP therefore understates actual production in this case.

2. The GDP Deflator and the Consumer Price Index

Price indices are very important in macroeconomics. We use them to measure inflation and adjust for its effects. This problem is designed to help us calculate and understand price indices.

There are many price indices. One is the **Consumer Price Index (CPI)**, commonly reported in the news. The CPI calculates the cost of a certain basket of consumer goods and services each month. The change in the cost of this basket is the basis for computing the increase in the cost of living.

Another price index of interest in macroeconomics is the **GDP Deflator**, which is used to calculate real (i.e. deflated) GDP. While a fixed basket of goods and services is used in calculating the CPI, the GDP deflator is measured using the set of final goods and services that is actually produced in the economy in a given time period.

Suppose the economy of Ann Arbor produces 4 goods, but only strawberries, ice cream, and sushi are consumer goods. Coolers are also final goods, but are not bought by consumers. The total production of all goods is given in the following table followed by their prices:

Quantities				
Item	2000	2001	2002	2003
Strawberries	8	9	9	10
Ice cream	10	14	18	20
Sushi	12	12	12	15
Coolers	-	-	2	8
Prices				
Item	2000	2001	2002	2003
Strawberries	\$4	\$5	\$5	\$6
Ice cream	\$2	\$2	\$3	\$5
Sushi	\$3	\$3	\$4	\$5
Coolers	-	-	\$8	\$4

Using these data, answer the following questions:

- a) Step 1: Take 2000 as the base year, and take consumption in 2000 as the basket for constructing the CPI. Calculate the cost of the consumption basket for years 2000 through 2003.

$$\text{Cost of basket of goods in 2000: } 8 \times 4 + 10 \times 2 + 12 \times 3 = \$88$$

$$\text{Cost of basket of goods in 2001: } 8 \times 5 + 10 \times 2 + 12 \times 3 = \$96$$

Cost of basket of goods in 2002: $8 \times 5 + 10 \times 3 + 12 \times 4 = \118

Cost of basket of goods in 2003: $8 \times 6 + 10 \times 5 + 12 \times 5 = \158

Step 2: Calculate the CPI for each year.

$$CPI_{2000} = 100$$

$$CPI_{2001} = (96/88) \times 100 = 109.1$$

$$CPI_{2002} = (118/88) \times 100 = 134.1$$

$$CPI_{2003} = (158/88) \times 100 = 179.5$$

Step 3: Calculate the rate of inflation based on the CPI for all years (i.e. between 2000 and 2001, 2001 and 2002, 2002 and 2003).

$$\text{Inflation rate 2000-2001} = (CPI_{2001} - CPI_{2000}) / CPI_{2000} = (109.1 - 100.0) / 100.0 = 9.1\%$$

$$\text{Inflation rate 2001-2002} = (CPI_{2002} - CPI_{2001}) / CPI_{2001} = (134.1 - 109.1) / 109.1 = 22.9\%$$

$$\text{Inflation rate 2002-2003} = (CPI_{2003} - CPI_{2002}) / CPI_{2002} = (179.5 - 134.1) / 134.1 = 33.9\%$$

b) Step 1: Compute the nominal GDP for each year.

$$\text{Nominal GDP}_{2000} = 8 \times 4 + 10 \times 2 + 12 \times 3 = \$ 88$$

$$\text{Nominal GDP}_{2001} = 9 \times 5 + 14 \times 2 + 12 \times 3 = \$109$$

$$\text{Nominal GDP}_{2002} = 9 \times 5 + 18 \times 3 + 12 \times 4 + 2 \times 8 = \$163$$

$$\text{Nominal GDP}_{2003} = 10 \times 6 + 20 \times 5 + 12 \times 5 + 8 \times 4 = \$267$$

Step 2: Compute the real GDP for each year using 2000 prices. For coolers, take the price in 2002 as its base year price.

$$\text{Real GDP}_{2000} = 8 \times 4 + 10 \times 2 + 12 \times 3 = \$ 88$$

$$\text{Real GDP}_{2001} = 9 \times 4 + 14 \times 2 + 12 \times 3 = \$100$$

$$\text{Real GDP}_{2002} = 9 \times 4 + 18 \times 2 + 12 \times 3 + 2 \times 8 = \$124$$

$$\text{Real GDP}_{2003} = 10 \times 4 + 20 \times 2 + 12 \times 3 + 8 \times 8 = \$189$$

Step 3: Compute GDP deflators for all years.

$$\text{GDP deflator 2000} = (\text{Nominal GDP}_{2000} / \text{Real GDP}_{2000}) \times 100 = 100$$

$$\text{GDP deflator 2001} = (\text{Nominal GDP}_{2001} / \text{Real GDP}_{2001}) \times 100 = 109 / 100 \times 100 = 109.0$$

$$\text{GDP deflator 2002} = (\text{Nominal GDP}_{2002} / \text{Real GDP}_{2002}) \times 100 = 163 / 124 \times 100 = 131.5$$

$$\text{GDP deflator 2003} = (\text{Nominal GDP}_{2003} / \text{Real GDP}_{2003}) \times 100 = 267 / 189 \times 100 = 141.3$$

Step 4: Calculate the rate of inflation based on the GDP deflator for all years.

$$\text{Inflation rate 2000-2001} = (\text{GDPdeflator}_{2001} - \text{GDPdeflator}_{2000}) / \text{GDPdeflator}_{2000} = (109.0 - 100.0) / 100.0 = 9.0\%$$

$$\text{Inflation rate 2001-2002} = (\text{GDPdeflator}_{2002} - \text{GDPdeflator}_{2001}) / \text{GDPdeflator}_{2001} = (131.5 - 109.0) / 109.0 = 20.6\%$$

$$\text{Inflation rate 2002-2003} = (\text{GDPdeflator}_{2003} - \text{GDPdeflator}_{2002}) / \text{GDPdeflator}_{2002} = (141.3 - 131.5) / 131.5 = 7.5\%$$

c) Compare the inflation rates you've calculated based on the CPI and the GDP deflator. How do you explain the differences? Hint: the availability of coolers

improves the quality of ice cream. In this example, can you detect other reasons as to why the CPI overstates inflation?

All Inflation rates measured by the percentage change in the GDP deflator are smaller than the inflation rates measured by the percentage change in the CPI. This is primarily because the CPI assumes a fixed basket.

From 2000 to 2001, there is an increase in the price of strawberries, but the prices of the other consumption goods remain the same, which makes strawberries relatively more expensive. As a result, we observe substitution away from strawberries. In other words, consumption of strawberries would have increased even more, had its price not increased. Instead, consumers switched into other goods, in this example into ice cream. The GDP deflator takes this into account, but not the CPI.

From 2001 to 2002, the quality of ice cream has increased due to the availability of coolers. The increase in price of ice cream is not just due to inflation, but it also reflects this increase in quality. The CPI fails to take this into account, as it measures the old quantity and quality of ice cream, whereas the GDP deflator accounts for the new units of ice cream in 2002.

From 2002 to 2003, the price of coolers, the new good, has dropped dramatically, and its share in GDP has increased a lot. The CPI does not capture this decrease in price, as it does not include coolers for two reasons: coolers were not available in the base year of the CPI and coolers are not a consumption good.

This exercise demonstrates that the CPI does tend to overstate inflation in practice, yet it is a better measure of the cost of living than the GDP deflator.

- d) The following table gives the aggregate nominal income of middle class citizens in this country. In which year did they have the highest well-being?

2000	2001	2002	2003
\$110	\$115	\$145	\$190

In order to find well being we need to convert all income levels to some year's constant dollars. Below we are converting nominal incomes to real income based on year 2000 prices.

2000 dollar value of 2000 income = \$110

2000 dollar value of 2001 income = 2001 income \times $CPI_{2000} / CPI_{2001} = 115 \times 100 / 109.1 = \105.4

2000 dollar value of 2002 income = 2002 income \times $CPI_{2000} / CPI_{2002} = 145 \times 100 / 134.1 = \108.1

2000 dollar value of 2003 income = 2003 income \times $CPI_{2003} / CPI_{2000} = 190 \times 100 / 179.5 = \105.8

Middle class citizens' well being was the highest in 2000.

Alternatively, you can calculate how many consumption good baskets a middle class citizen could afford in each year.

2000 income/2000 cost of consumption basket = \$110 / \$88 = 1.25

2001 income/2001 cost of consumption basket = \$115 / \$96 = 1.20

2002 income/2002 cost of consumption basket = \$145 / \$118 = 1.23

2003 income/2003 cost of consumption basket = \$190 / \$158 = 1.20

A middle class citizen could afford to consume most in the year 2000.

3. Using the CPI

- a) Find a particular price or wage from the past, from at least 10 years ago and no more than 50 years ago. It may be easiest to ask one of your parents for this, or someone else you know who is old enough to remember what they paid for something, or were paid, in the past. For example, ask what their wage or salary was in their first job, or what they paid in their youth for a beer, a pizza, or a house. Be sure to get the year of this transaction. (This will be easiest if you can get the price or wage from the United States. If that is not possible, try to get some idea of what the price would have been, at the time, in U.S. dollars.)

I can't ask my parents, but then I don't need to. I can remember, for example, that when I was a kid in, say, 1956 (to keep it not much more than 50 years ago), it cost three cents to mail a letter.

- b) Calculate what this price or wage would be today if it had risen at the same rate as U.S. consumer prices. For this you will need to look up the CPI by going to a Bureau of Labor Statistics publication, presumably on the web (see <http://data.bls.gov/cgi-bin/surveymost>). Report exactly what version of the CPI you use and how you calculate your answer.

From the BLS web site, I looked up the CPI for all urban consumers, with base year 1967. The CPI it reports for 1956 was 81.4. It reports the CPI for 2005 as 585.0. So if US postage had risen at the same rate as US consumer prices, it would now cost $\$0.03(585.0/81.4) = \0.216 . Actual postage recently rose to \$0.39, so the real cost of postage has gone up from 22¢ to 39¢.

4. Nominal and Real Rates of Interest.

Imagine an economy in which only one good – Tasty Ice Cream – is produced and consumed. Each 1/2 gallon carton of ice cream costs \$5. Your last job paid you \$200. Now you want to reap the benefits of your hard labor.

You have two options: you can either indulge in ice cream right away, and because you are an ice cream fanatic you can't stop before you've used up all your money. Or you can just hold off with the purchases for one more year and receive 12% interest on your bank deposits in the meantime.

- a) The nominal return on your saving in this example is 12%: you get 12% more money back than what you deposited originally. How many extra dollars will you have available to spend after one year? Also, calculate the number of extra cartons of ice cream you will be able to buy if the price remains constant at \$5 per carton. What is the percentage increase in the number of gallons of ice cream you are able to consume (real rate of return)?

If you consume now you can have 40 cartons of ice cream ($\$200/\5), or equivalently 20 gallons. If you put your money in the bank you will have \$224 ($\200×1.12) at the end of a year, i.e. you'll receive \$24 for waiting for one year. This means that you could buy 44.8 cartons of ice cream ($\$224/\5) if their price remained at \$5 a carton, which is means you can consume 2.4 more gallons ($4.8/2$) compared to indulging today. So your return in terms of ice cream gallons (real return) is equal to 12% ($(22.4 - 20)/20$).

Now suppose that global warming increases the cost of refrigeration, so over the course of the year Tasty Ice Cream becomes more expensive: The price per carton rises to a whopping \$5.60.

- b) Now what is your nominal return from saving your money for one year rather than consuming it right away? How many extra gallons of ice cream do you get to purchase after one year of waiting? What, in this case, is the percentage increase in the number of gallons of ice cream you will be able to consume?

Since the nominal interest rate is unchanged, your nominal return from saving your money for one year is still 12%. However, the \$224 that you can withdraw from your bank account after one year cannot buy as much ice cream as before, because ice cream has become more expensive. You can only buy 40 cartons of ice cream ($\$224/\5.6), equivalently 20 gallons, at the price of \$5.60 per carton. This is the same amount of ice cream you could have bought without saving. So your real return in terms of ice cream is equal to 0 % ($(20-20)/20$). Because prices have risen, your real return is now less than your nominal return.

The above calculations show that the real rate of return (r) on your savings (i.e. the real rate of interest) is just the nominal rate (i) adjusted for changes in price (i.e. inflation, π).

- c) Use your calculations to verify the following approximation of the real rate of interest: $r \approx i - \pi$. This equation is called the Fisher equation. (Caveat: this approximation works only when both the inflation rate and the nominal interest rate are small.)

The nominal rate of interest, i , is just the percentage return you get from the bank, $12\% = 0.12$. The rate of inflation is the percentage by which prices rise in one year, in this case the price only of Tasty Ice Cream, since it is the only good: $(\$5.60 - \$5.00)/\$5.00 = 0.12 = 12\%$. The formula therefore gives:

$$r = 0.12 - 0.12 = 0$$

This turns out to be exactly equal to the value of 0% found above using the actual price of ice cream.

- d) Which interest rate – nominal or real – matters for your decision whether to consume today or tomorrow? Give a brief explanation. In your own case, would you rather consume now or wait?

What matters for your decision whether to consume today or in a year is obviously the real interest rate, as it tells you how much you'll really get in return for your patience. However, some of us may prefer to consume their ice cream today, and some of us prefer to wait for another year. That depends on our personal preferences. More generally, the higher the real interest rate, the more you are rewarded for saving, which means that saving will be increasing in the real interest rate. In other words, The higher the real interest rate, the more costly it is to consume today, since you will have to forego more consumption later – therefore, consumption is decreasing in the real interest rate. When the real interest rate is zero, there is no incentive to defer consumption, and hence no reason to save.