5 From Nominal to Real: GDP, Wage, and Interest Rate

This tutorial covers **how to**:

- compute nominal GDP
- compute real GDP by holding prices fixed at base year's values
- convert a nominal wage into a real wage
- convert a nominal interest rate into a real interest rate

1 Nominal GDP

Gross Domestic Product (GDP) measures the total output of an economy. A country's GDP is the market value of all final goods and services produced in that country during a time period.

TABLE 2

Real and Nominal GDP
This table shows how to calculate real GDP, nominal GDP, and the GDP deflator for a hypothetical economy that produces only hot dogs and hamburgers.

Prices and Quantities

Year	Price of Hot Dogs	Quantity of Hot Dogs	Price of Hamburgers	Quantity of Hamburgers
2013	$1	100	$2	50
2014	$2	150	$3	100
2015	$3	200	$4	150

Calculating Nominal GDP

2013	($1 per hot dog × 100 hot dogs) + ($2 per hamburger × 50 hamburgers) = $200
2014	($2 per hot dog × 150 hot dogs) + ($3 per hamburger × 100 hamburgers) = $600
2015	($3 per hot dog × 200 hot dogs) + ($4 per hamburger × 150 hamburgers) = $1,200

Calculating Real GDP (base year 2013)

2013	($1 per hot dog × 100 hot dogs) + ($2 per hamburger × 50 hamburgers) = $200
2014	($1 per hot dog × 150 hot dogs) + ($2 per hamburger × 100 hamburgers) = $350
2015	($1 per hot dog × 200 hot dogs) + ($2 per hamburger × 150 hamburgers) = $500

Calculating the GDP Deflator

2013	($200 / $200) × 100 = 100
2014	($600 / $350) × 100 = 171
2015	($1,200 / $500) × 100 = 240

Mankiw's (2018) Table 2 summarizes a simple economy with only two goods: hot dogs and hamburgers. The data are annual from 2013 to 2015. The top panel displays the prices and

quantities of hot dogs and hamburgers in each year.

To compute nominal GDP, we sum expenditures on hot dogs and hamburgers. The second panel shows the calculations. For instance, people spent $100 on hot dogs and $100 on hamburgers in 2013. In 2015, they spent $600 on each good. So nominal GDP was $200 in 2013 and $1,200 in 2015.

2 Real GDP

A quick scan of the top panel of Table 2 reveals that prices of hot dogs and hamburgers rose sharply each year. So a lot of the increase in nominal GDP from 2013 to 2015 is likely due to rising prices rather than rising output. Let's isolate the changes in **real GDP** by sweeping out the effect of rising prices.

To compute real GDP, we use prices in one year, the base year. Since our new calculations use the same prices in each year (e.g., prices from 2013), any change in the resulting GDP measure must be due to a change in real output rather than a changes in prices.

With 2013 as the base year, we compute expenditures in 2014 using 2013 prices and expenditures in 2015 using 2013 prices. (See the third panel of Table 2.) For instance, expenditures in 2015 would have summed to $500 (rather than $1,200) if prices in 2015 were the prices from 2013. The result ($500) is real GDP in 2015.

The $1,000 increase in nominal GDP from 2013 to 2015 has two parts. Real GDP rose from $200 to $500. Rising prices caused the remaining $700 increase in nominal GDP.

Practice Question

This question is from Table 4.3 in Parkin's *Macroeconomics*, 10th ed.

TABLE 4.3 Calculating Nominal GDP and Real GDP

	Item	Quantity (millions)	Price (dollars)	Expenditure (millions of dollars)
(a) In 2005				
C	T-shirts	10	5	50
I	Computer chips	3	10	30
G	Security services	1	20	20
Y	Real and Nominal GDP in 2005			100
(b) In 2010				
C	T-shirts	4	5	20
I	Computer chips	2	20	40
G	Security services	6	40	240
Y	Nominal GDP in 2010			300

What was real GDP in 2010?

3 Real Wage

Table 1.3 in McLaughlin's *Labor Economics: Principles in Practice*, 2/e displays the minimum wage and Consumer Price Index (CPI) in 1938, 1976, and 2017. The 25-cent minimum wage in 1938 was much lower than the $7.25 minimum wage in 2017, but prices were much lower in 1938, too. How much stuff would that minimum wage in 1938 buy? And how does that compare to the stuff a minimum-wage worker could buy in 2017?

Table 1.3

Year	Minimum Wage ($/hour)	Consumer Price Index (P_t)	Scale Factor (P_{2017}/P_t)	Real Minimum Wage (2017 $/hour)
1938	0.25	14.00	17.6	4.40
1976	2.30	58.20	___	___
2017	7.25	246.52	1.0	7.25

To compare buying power of a wage across two periods with different prices, we adjust the wage in one of the two periods for inflation. Let's measure the real minimum wage in 2017 dollars, dollars that we're all familiar with.

We see in the third column that the CPI rose from 14.00 in 1938 to 246.52 in 2017. That means that prices in 2017 were 17.6 times prices in 2013. Goods and services in 2017 tended to cost

what they cost in 1938 plus 16.6 times more. That also means that \$1 in 1938 was worth \$17.60 in 2017.

How much was the \$0.25 minimum wage in 1938 worth in 2017 dollars? \$4.40. We simply multiply \$0.25 by 17.6 to express the 1938 minimum wage in 2017 dollars.

$$\begin{aligned}\text{real minimum wage}_{1938} &= \text{minimum wage}_{1938} \times \frac{P_{2017}}{P_{1938}} \\ &= \$0.25 \times \frac{246.52}{14.00} \\ &= \$4.40\end{aligned}$$

Thus we say that the real minimum wage in 1938 as \$4.40 in 2017 dollars.

What about the real minimum wage in 1976? Was it also lower than that in 2014?

$$\begin{aligned}\text{Real minimum wage in 1976} &= 2.30 \times \frac{\text{2014 CPI}}{\text{1976 CPI}} \\ &= 2.30 \times \frac{236.74}{56.90} \\ &= 2.30 \times 4.16 \\ &= 9.57.\end{aligned}$$

The real minimum wage in 1976 was actually higher than that in 2014!

Notice that the real minimum wage equals the nominal minimum wage in 2014, because 2014 is chosen as the base year in this example.

Practice Question

Compute the scale factor (P_{2017}/P_t) for $t = 1976$. What was the real minimum wage in 1976 (in 2017 dollars)? Was the real minimum wage in 1976 greater than or less than the minimum wage in 2017?

4 Real Interest Rate

When you deposit money in a bank, in the future the bank gives the money back to you plus some interest. When you borrow money from a bank, in the future you return the money as well as some interest to the bank.

You deposit 100 dollars in a bank today; the balance in your bank account will be \$110 one year from today. The extra \$10 is the interest on your \$100 bank balance because the annual interest rate is 10%

Will you be able to buy more goods and services with \$110 next year than you can buy with \$100 this year? To answer this question, we need to adjust the 10% interest rate for the change

in prices from this year to next year. That is, we generate the **real interest rate** by adjusting the nominal interest rate for inflation.

The real interest rate is (approximately) the nominal interest rate minus the inflation rate. Suppose price rise 4% percent over the next year. Since the nominal interest rate is 10%, the

$$\begin{aligned}\text{real interest rate} &= \text{nominal interest rate} - \text{inflation rate} \\ &= 10\% - 4\% = 6\%\end{aligned}$$

Since prices are 4% higher, it takes \$104 next year to buy what \$100 buy this year. The extra \$6 measures additional buying power, which is why the real interest rate is 6%.

Practice Question

You deposit \$500 in your bank account on January 1, 2020. The bank pays a 4% annual interest rate on your deposit. If the annual inflation rate is 3%, what is the real interest rate?

References

Mankiw, N. Gregory. *Principles of Economics*, 8/e. Cengage Learning, 2018.

McLaughlin, Kenneth J. *Labor Economics: Principles in Practice*, 2/e. Oxford University Press, 2018.

Parkin, Michael. *Macroeconomics*, 10/e. Pearson Education, 2011.

Additional Resources

For questions about this topic, see an **Algebra** tutor at the Dolciani Mathematics Learning Center (Hunter East, 7th floor) or any tutor in the Economics Tutoring Center (Hunter West, 15th floor).

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