1. Chapter 2. Problems and Applications 2,6,9:

1.2. $6 has been added to GDP in this example. We don’t want to double-count the value of the wheat and flour, since they show up in the price of the bread. Thus, we measure GDP by counting final goods only (here the bread) or equivalently by adding up the value added for all goods (in this case $1 + $2 + $3 = $6).

1.6. We have the following information on purchases and prices in the two years:

<table>
<thead>
<tr>
<th>Year</th>
<th>P_{autos}</th>
<th>Q_{autos}</th>
<th>P_{bread}</th>
<th>Q_{bread}</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>$50,000</td>
<td>100</td>
<td>$10</td>
<td>500,000</td>
</tr>
<tr>
<td>2010</td>
<td>$60,000</td>
<td>120</td>
<td>$20</td>
<td>400,000</td>
</tr>
</tbody>
</table>

1.6.a. With base year 2000, we have:

<table>
<thead>
<tr>
<th>Year 2000</th>
<th>Year 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal GDP</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>Real GDP</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>GDP Deflator</td>
<td>100</td>
</tr>
<tr>
<td>CPI</td>
<td>100</td>
</tr>
</tbody>
</table>

Here is how I calculated these numbers.

\[
\text{Nominal GDP}_t = \sum_i (P_t \times Q_t)_i
\]

where \( t \) indicates year (either 2000 or 2010) and \( i \) indicates good (here autos or bread). So

\[
\text{Nominal GDP}_{2000} = 50,000 \times 100 + 10 \times 500,000 = 10,000,000
\]

\[
\text{Nominal GDP}_{2010} = 60,000 \times 120 + 20 \times 400,000 = 15,200,000
\]

Nominal GDP rose over the course of the decade. However, prices of both autos and bread rose, so at least some of the increase in Nominal GDP is due to rising prices, rather than rising output. Output of autos rose while output of bread fell. By valuing these quantities at base year prices, Real GDP gives us a measure of overall output.

\[
\text{Real GDP}_t = \sum_i (P_0 \times Q_t)_i
\]

So with the base year the year 2000:

\[
\text{Real GDP}_{2000} = 10,000,000
\]

\[
\text{Real GDP}_{2010} = 50,000 \times 120 + 10 \times 400,000 = 10,000,000
\]

With the base year the year 2000, Real GDP is unchanged between 2000 and 2010. Thus, all of the increase in Nominal GDP is attributed to price increases, and none to overall quantity increases.
It is worth noting, however, that Real GDP is sensitive to the choice of base year. Real GDP measured with base year 2010 falls from $16 million in the year 2000 to $15.2 million in the year 2010. Neither measure is intrinsically better, and so there is a certain amount of arbitrariness in any Real GDP figures.\(^1\)

\[
\text{GDP Deflator}_t = \frac{\text{Nominal GDP}_t}{\text{Real GDP}_t} \times 100 = \frac{\sum_i (P_t \times Q_t)_i}{\sum_i (P_0 \times Q_t)_i} \times 100
\]

So with the base year the year 2000:

\[
\text{GDP Deflator}_{2000} = 100
\]

\[
\text{GDP Deflator}_{2010} = \frac{15,200,000}{10,000,000} \times 100 = 152
\]

This says that on average, prices rose 52% over the course of the decade.\(^2\)

Again, this measure of inflation is somewhat arbitrary. Any price index averages over the various prices in the economy using some particular set of weights. Changing the base year, or switching to the CPI, changes the weights used to calculate the average price, and so changes measured inflation. Consider the CPI:

\[
\text{CPI}_t = \frac{\sum_i (P_t \times Q_0)_i}{\sum_i (P_0 \times Q_0)_i} \times 100
\]

So with the base year the year 2000:

\[
\text{CPI}_{2000} = 100
\]

\[
\text{CPI}_{2010} = \frac{60,000 \times 100 + 20 \times 500,000}{10,000,000} \times 100 = 160
\]

Thus, according to the CPI, on average, prices rose 60% over the course of the decade, whereas, according to the GDP Deflator, prices only rose 52% over that period.

1.6.b. The CPI gives a higher measure of inflation in this example because it weighs price increases on each good by the good’s share in spending in 2000 (the base year), rather than in 2010 (the current year) as does the GDP Deflator. Notice that the price of bread rose by 100%, whereas the price of autos rose by only 20%. Consumers appear to have reacted by reducing their purchases of bread, while raising their purchases of autos. Therefore, the GDP Deflator places less weight on bread than does the CPI in calculating average price increases.

Specifically, the shares of autos and bread in base year spending were each 0.5 (half of the $10 million dollars spent in the year 2000 was spent on each good). So overall inflation measured by the CPI is 0.5 \(\times 20\% + 0.5 \cdot 100\% = 60\%\). The shares of autos and bread in real GDP in 2010 were 0.6 and 0.4 respectively.

\(^1\) In practice, the problem tends not to be this severe. Further, in the U.S. the Commerce Department now moderates this problem by “chaining” (updating the base year each year).

\(^2\) Note that, due to compounding, this implies an average annual inflation rate of somewhat less than 5% (about 4.3%).
(i.e., 60% of spending on real GDP was made up by automobiles, and 40% on bread). So overall inflation measured by the GDP Deflator is $0.6 \times 20\% + 0.4 \cdot 100\% = 52\%$.\(^3\)

Both indexes provide information about how rapidly the cost of living is increasing. However, the information is somewhat different. The GDP Deflator shows how fast prices have risen for what you are purchasing today. The CPI shows how fast prices have risen for what you purchased in the base year. However, since you didn’t purchase the same things in the two years, neither is clearly better than the other. The CPI ignores the fact that if something gets very expensive, we will probably buy less of it and more of other things (i.e., we substitute away from the goods with the greatest inflation rate). On the other hand, the GDP Deflator underestimates the increase in the cost of our original (base year) standard of living.

1.6.c. As we saw above, the measured change in the cost of living will often be higher if you use a Laspeyres than if you use a Paasche index. Which one you will want to use depends on how you want to interpret the term “cost of living” given that the composition of consumer purchases changes over time. However, one reason for using the CPI to index government transfer payments like Social Security and pensions is that the CPI measures the cost of goods and services that consumers purchase (and so includes imports of consumer goods that do not show up in GDP and excludes things like nuclear submarines and industrial lathes which are included in GDP). Other issues to consider are whether the cost of living for the elderly is rising faster or slower than the cost of living for all consumers and how good a job the BLS is doing adjusting for improvements in product quality when it constructs the CPI.\(^4\)

1.6.d. Any price index can be written as a weighted average of \((P_t/P_0)_i\) for each good \(i\):

\[
\text{Index Value}_t = \sum_i w_{i,t} \left( \frac{P_t}{P_0} \right)_i \times 100
\]

where \(w_{i,t}\) is the weight given to good \(i\) in the average in year \(t\).\(^5\) Consequently, if the rate of inflation on each good \(i\) is the same, then all price indexes will measure this as the general inflation rate.

In this example (part d), prices on autos and bread both increased by 20 percent. Consequently both the GDP Deflator and the CPI will indicate that the general price level rose 20 percent over the decade.

Notice that \((P_t/P_0)_i = 1.2\) for both goods and so the value of the GDP Deflator and CPI will both be 120 for the year 2010.

<table>
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</table>

2. We can compare the real purchasing power of the minimum wage in the two years (1970 and 2014) by using the CPI.

\[
\begin{array}{ll}
\text{Nominal Wage} & \$1.60 \\
\text{CPI} & 38.8 \quad 238.0
\end{array}
\]

For the purchasing power of the nominal minimum wage to be the same in 2014 as it was in 1970, it would have to be \(\$1.60 \times (238.0/38.8) = \$9.81\) per hour. I.e., the nominal wage would have to keep up with the general price level which is 6.134 times higher than it was in 1970.\(^6\)

---

\(^3\) Similarly, the the CPI in 2010 is \((0.5 \times 1.2 + 0.5 \times 2.0) = 160\), and the GDP Deflator is \((0.6 \times 1.2 + 0.4 \times 2.0) = 152\).

\(^4\) The effect of indexing on the U.S. federal budget is quite substantial, causing the construction of the CPI by the BLS to become a political issue in recent years.

\(^5\) For the GDP Deflator, the weights reflect the importance of each good in current year \((t)\) purchases (current year real GDP), while the weights for the CPI reflect the importance of each good in base year purchases.

\(^6\) The Federal minimum wage in the U.S. is currently (September 2014) \$7.25. The NY State minimum wage recently increased to \$8.00 (Jan 1, 2014) and is scheduled to increase to \$8.75 in January 2015 and \$9.00 in January 2016.
An equivalent way of doing this is to calculate the nominal minimum wage in 2014 that would make the “real” minimum wage the same in both years:

\[
\text{Real Wage}_t = \frac{\text{Nominal Wage}_t}{\text{CPI}_t} \times 100
\]

The real minimum wage in 1970 is $4.12 (this is sometimes called the 1970 minimum wage “in 1983 dollars”). A nominal minimum wage of $9.81 would give the same real minimum wage in 2014.

To have the minimum wage keep up with both inflation and productivity growth, it would have had to grow 6.134 times to keep up with inflation (i.e., to preserve the same real purchasing power) and then another \(2.390 = 1.02^{14}\) times to keep up with productivity growth. This minimum wage would be $23.46.

4. Chapter 3: 8,9,10,11,13. These problems refer to the basic model of saving and investment in the long run. Output is held fixed, so policy changes affect the composition of output, but not its level.

4.8. An increase in taxes (of $100 billion) will reduce disposable income and consequently cause consumers to reduce their consumption expenditures. If the MPC is .6, consumers reduce their consumption by 60 billion and their saving by 40 billion. National saving \(S = Y - C - G\), the income left over after consumption and government spending, increases by 60 billion, driving the interest rate down by just enough to drive investment spending up by the equivalent 60 billion. The composition of output has changed, with consumption falling and investment rising by equal amounts.

Note the chain of causality here. The tax increase raises national saving \(S\), creating a surplus of loanable funds which causes the interest rate \(r\) to fall. This reduction in the interest rate in turn causes investment spending \(I\) to increase. So the chain of causality is \(\uparrow S \rightarrow \downarrow r \rightarrow \uparrow I\).

4.8.a. Public saving is the government budget surplus \(T - G\) (which has been negative in the US for most of the past 30 years). Since tax revenues have risen by 100 billion and government spending has remained unchanged, public saving has risen by 100 billion.

4.8.b. Private saving is disposable income minus consumption \((Y - T - C)\). This has decreased by 40 billion as indicated above.

4.8.c. National saving has risen by 60 billion. We can see this easily by looking at our definition: \(S = Y - C - G\). Consumption has fallen by 60 billion, while \(Y\) and \(G\) are unchanged. We could also note that national saving is private plus public saving, and use the answers to parts a and b.

4.8.d. Investment must increase by the same amount as national saving, since by national income accounting: \(S = I + NX\), and in this problem \(NX = 0\).

4
4.9. National saving falls, and so interest rates rise, causing investment to fall. In equilibrium we have a change in the composition of GDP, with consumption rising and investment falling by equal amounts. Consumption spending is said to *crowd out* investment spending (whereas in 8, $I$ was *crowded in*).

4.10.a. Plugging in the values for $Y$ and $T$, we can see that $C = 3250$. Consequently, Private Saving $= Y - T - C = 750$, Public Saving $= T - G = 0$, and National Saving $S = Y - C - G = 750$.

4.10.b. In equilibrium, we have

\[
Y = C + I + G + NX
\]

\[
= 3250 + (1000 - 50r) + 1000 + 0
\]

\[
r = 5
\]

4.10.c. An increase in $G$ by 250 lowers both Public and National Saving by 250 and leaves Private Saving unchanged.

4.10.d. The fall in National Saving by 250 will cause interest rates to rise, subsequently causing $I$ to fall by exactly 250 in equilibrium. Repeating the steps in part b we can calculate that the new equilibrium interest rate is $r = 10$. 
4.11. Use the example in 8. Now consumption falls by 60 billion as in 8, but government spending rises by 100 billion. National saving, the income left over after $C$ and $G$, falls by 40 billion. Interest rates rise and investment spending is crowded out by 40 billion. Notice, however, that higher MPCs lead to smaller decreases in national saving. The government is taxing away and spending income from consumers, some of which the consumers were saving. With a higher MPC, less of that income had been saved, so more of the 100 billion of income that the government is taxing away is just being transferred from $C$ to $G$.

4.13. Consider 8 again. National saving increases by 60 billion due to an increase in taxes. This drives down the interest rate. However, if consumers respond to the fall in the interest rate by consuming more of their income and saving less of it (e.g., racking up credit card purchases, buying new cars, etc.), then national saving will fall back down somewhat. The interest rate will fall by less in equilibrium than in 8 and the equilibrium increase in saving and investment will be smaller than 100 billion.

The general effect of interest sensitive saving in the model is to mitigate the crowding out/in mechanism. For example, increases in $G$ and $C$ will lead to less crowding out of investment, and autonomous increases in investment will actually cause investment to rise in equilibrium (i.e., not crowd itself out completely).