ECO 120-04
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Assignment 8 Solutions

Part A: Aggregate accounting

Suppose Wisconsin has a two-good economy with the following historical data for 2019 and 2020:

	Wisconsin, 2019		Wisconsin, 2020	
Good	Price ($/pound)	Output (billion pounds)	Price ($/pound)	Output (billion pounds)
Cow beverage	1.50	10	1.00	20
Soy beverage	2.00	25	3.00	20

1. What was the nominal GDP of the Wisconsin two-good economy in 2019?

$$\begin{aligned}\text{nom. gdp}_{2019} &= p_{2019}^{\text{cow bev.}} \times y_{2019}^{\text{cow bev.}} + p_{2019}^{\text{soy bev.}} \times y_{2019}^{\text{soy bev.}} \\ &= \frac{\$1.50}{\text{lb. cow bev.}} \times 10 \text{ B lbs. cow bev.} + \frac{\$2.00}{\text{lb. soy bev.}} \times 25 \text{ B lbs. soy bev.} = \$65 \text{ B}\end{aligned}$$

2. What was the nominal GDP of the Wisconsin two-good economy in 2020?

$$\begin{aligned}\text{nom. gdp}_{2020} &= p_{2020}^{\text{cow bev.}} \times y_{2020}^{\text{cow bev.}} + p_{2020}^{\text{soy bev.}} \times y_{2020}^{\text{soy bev.}} \\ &= \frac{\$1.00}{\text{lb. cow bev.}} \times 20 \text{ B lbs. cow bev.} + \frac{\$3.00}{\text{lb. soy bev.}} \times 20 \text{ B lbs. soy bev.} = \$80 \text{ B}\end{aligned}$$

3. What was the percent change in nominal GDP from 2019 to 2020?

$$\begin{aligned}\%\,\Delta \text{ = percent change} &= \frac{x_{\text{final}} - x_{\text{initial}}}{x_{\text{initial}}} \\ \%\,\Delta\,(\text{nom. gdp}) = \%\text{ change in nom. gdp} &= \frac{\text{nom. gdp}_{2020} - \text{nom. gdp}_{2019}}{\text{nom. gdp}_{2019}} \\ &= \frac{\$80 \text{ B} - \$65 \text{ B}}{\$65 \text{ B}} = 0.2308 = 0.2308 \times 100\% = 23.08\%\end{aligned}$$

4. For the following questions, please use 2019 as the base year.

a) What was the real GDP of the Wisconsin two-good economy in 2019?

Complete answer: \$65 B.

To find real GDP, we use prices from the base year and output from the year of interest. After all, we're trying to measure of output for the year of interest by controlling for prices.

$$\begin{aligned}\text{real gdp}_{2019} &= p^{\text{cow bev.}}_{\textbf{base year}} \times y^{\text{cow bev.}}_{2019} + p^{\text{soy bev.}}_{\textbf{base year}} \times y^{\text{soy bev.}}_{2019} \\ &= p^{\text{cow bev.}}_{\textbf{2019}} \times y^{\text{cow bev.}}_{2019} + p^{\text{soy bev.}}_{\textbf{2019}} \times y^{\text{soy bev.}}_{2019} \\ &= \frac{\$1.50}{\text{lb. cow bev.}} \times 10 \text{ B lbs. cow bev.} + \frac{\$2.00}{\text{lb. soy bev.}} \times 25 \text{ B lbs. soy bev.} = \$65 \text{ B}\end{aligned}$$

Real GDP for the base year is always the same as nominal GDP for the base year.

b) What was the real GDP of the Wisconsin two-good economy in 2020?

Complete answer: \$49.

$$\begin{aligned}\text{real gdp}_{2020} &= p^{\text{cow bev.}}_{\textbf{base year}} \times y^{\text{cow bev.}}_{2020} + p^{\text{soy bev.}}_{\textbf{base year}} \times y^{\text{soy bev.}}_{2020} \\ &= p^{\text{cow bev.}}_{\textbf{2019}} \times y^{\text{cow bev.}}_{2020} + p^{\text{soy bev.}}_{\textbf{2019}} \times y^{\text{soy bev.}}_{2020} \\ &= \frac{\$1.50}{\text{lb. cow bev.}} \times 20 \text{ B lbs. cow bev.} + \frac{\$2.00}{\text{lb. soy bev.}} \times 20 \text{ B lbs. soy bev.} = \$70 \text{ B}\end{aligned}$$

c) What was the percent change in real GDP from 2019 to 2020?

Complete answer: −24.61%

$$\begin{aligned}\%\,\Delta\,(\text{real gdp}) &= \frac{\text{real gdp}_{2020} - \text{real gdp}_{2019}}{\text{real gdp}_{2019}} \\ &= \frac{\$70 \text{ B} - \$65 \text{ B}}{\$65 \text{ B}} = 0.0769 = 0.0769 \times 100\% = 7.69\%\end{aligned}$$

d) Using your calculation of nominal GDP above and your calculation of real GDP (with a 2019 base year), how much of the percentage change in nominal GDP is due to inflation?

Complete answer: 15.39%.

To estimate inflation in this manner, we always subtract $\%\,\Delta\,(\text{real gdp})$ *from* $\%\,\Delta\,(\text{nom. gdp})$:

$$\%\,\Delta\,(\text{nom. gdp}) - \%\,\Delta\,(\text{real gdp}) = 23.08\% - 7.69\% = 15.39 \text{ p.p.}$$

We use this percentage point difference in these output measures as an estimate of the inflation rate. Here, they suggest an inflation rate of 15.39%. (In this case, percentage points

> serve as an estimate of a percentage.)

5. For the following questions, please use 2020 as the base year.

a) What was real GDP of the Wisconsin two-good economy in 2019?

> $85 B.

b) What was real GDP of the Wisconsin two-good economy in 2020?

> $80 B.

c) What was the percent change in real GDP from 2019 to 2020?

> −5.88%.

d) Using your calculation of nominal GDP above and your calculation of real GDP (with a 2020 base year), how much of the percentage change in nominal GDP is due to inflation?

> $$\%\,\Delta\,(\text{nom. gdp}) - \%\,\Delta\,(\text{real gdp}) = 23.08\% - (-5.88\%) = 28.96 \text{ p.p.}$$
>
> This suggests an inflation rate of 28.96%.

6. For the following questions, please use 2019 as the base year.

a) Calculate a consumer price index for 2019.

> *Complete answer:* 100.
>
> To find a CPI, we use output from the base year and prices from the year of interest. After all, we're trying to construct an index of prices for the year of interest by controlling for output. Notice that this is the opposite of what we do with real GDP.
>
> $$\begin{aligned}
> \widetilde{\text{CPI}}_{2019} &= p_{2019}^{\text{cow bev.}} \times y_{\textbf{base year}}^{\text{cow bev.}} + p_{2019}^{\text{soy bev.}} \times y_{\textbf{base year}}^{\text{soy bev.}} \\
> &= p_{2019}^{\text{cow bev.}} \times y_{\textbf{2019}}^{\text{cow bev.}} + p_{2019}^{\text{soy bev.}} \times y_{\textbf{2019}}^{\text{soy bev.}} \\
> &= \frac{\$1.50}{\text{lb. cow bev.}} \times 10 \text{ B lb. cow bev.} + \frac{\$2.00}{\text{lb. soy bev.}} \times 25 \text{ B lb. soy bev.} \\
> &= \$15 \text{ B} + \$50 \text{ B} \\
> &= \$65 \text{ B}
> \end{aligned}$$
>
> But this is not quite the CPI, because a true CPI is normalized to 100 in the base year. This CPI should then be 100. So we must use a normalization factor of (100 / $65 B) for *all* of our

CPI calculations, including this one. The normalization is *always* $(100/\text{nom. gdp}_{\textbf{base year}})$.

$$\begin{aligned}
\text{CPI}_{2019} &= \left(p_{2019}^{\text{cow bev.}} \times y_{\textbf{base year}}^{\text{cow bev.}} + p_{2019}^{\text{soy bev.}} \times y_{\textbf{base year}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{\textbf{base year}}} \\
&= \left(p_{2019}^{\text{cow bev.}} \times y_{\textbf{2019}}^{\text{cow bev.}} + p_{2019}^{\text{soy bev.}} \times y_{\textbf{2019}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{\textbf{2019}}} \\
&= \left(\frac{\$1.50}{\text{lb. cow bev.}} \times 10 \text{ B lb. cow bev.} + \frac{\$2.00}{\text{lb. soy bev.}} \times 25 \text{ B lb. soy bev.}\right) \times \frac{100}{\$65 \text{ B}} \\
&= (\$15 \text{ B} + \$50 \text{ B}) \times \frac{100}{\$65 \text{ B}} \\
&= 100
\end{aligned}$$

The CPI in the base year is always 100.

b) Calculate a consumer price index for 2020.

Complete answer: 125.81.

We can use the normalization factor we found when we calculated the CPI for the base year. Or we can use $(100/\text{nom. gdp}_{\textbf{base year}})$.

$$\begin{aligned}
\text{CPI}_{2020} &= \left(p_{2020}^{\text{cow bev.}} \times y_{\textbf{base year}}^{\text{cow bev.}} + p_{2020}^{\text{soy bev.}} \times y_{\textbf{base year}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{\textbf{base year}}} \\
&= \left(p_{2020}^{\text{cow bev.}} \times y_{\textbf{2019}}^{\text{cow bev.}} + p_{2020}^{\text{soy bev.}} \times y_{\textbf{2019}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{\textbf{2019}}} \\
&= \left(\frac{\$1.00}{\text{lb. cow bev.}} \times 10 \text{ B lb. cow bev.} + \frac{\$3.00}{\text{lb. soy bev.}} \times 25 \text{ B lb. soy bev.}\right) \times \frac{100}{\$65 \text{ B}} \\
&= (\$10 \text{ B} + \$75 \text{ B}) \times \frac{100}{\$65 \text{ B}} \\
&= 130.77
\end{aligned}$$

All CPIs should be unitless.

c) Calculate the percentage change in your index from 2019 to 2020.

Complete answer: 30.77%.

$$\%\,\Delta\,(\text{CPI}) = \frac{\text{CPI}_{2020} - \text{CPI}_{2019}}{\text{CPI}_{2019}} = \frac{130.77 - 100}{100} = \frac{30.77}{100} = 30.77\%.$$

This nicely illustrates the appeal of normalizing the CPI to 100 in the base year—it facilitates comparison against the base year.

d) Please interpret your last result with a sentence.

> Using 2019 output as the basket of goods, inflation from 2019 to 2020 was 30.77%.

7. For the following questions, please use 2020 as the base year.

a) Calculate a consumer price index for 2019.

> *Complete answer:* 87.50.
>
> $$\begin{aligned}
> \text{CPI}_{2019} &= \left(p_{2019}^{\text{cow bev.}} \times y_{\textbf{base year}}^{\text{cow bev.}} + p_{2019}^{\text{soy bev.}} \times y_{\textbf{base year}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{\textbf{base year}}} \\
> &= \left(p_{2019}^{\text{cow bev.}} \times y_{\textbf{2020}}^{\text{cow bev.}} + p_{2019}^{\text{soy bev.}} \times y_{\textbf{2020}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{2020}} \\
> &= \left(\frac{\$1.50}{\text{lb. cow bev.}} \times 20 \text{ B lb. cow bev.} + \frac{\$2.00}{\text{lb. soy bev.}} \times 20 \text{ B lb. soy bev.}\right) \times \frac{100}{\$80 \text{ B}} \\
> &= (\$30 \text{ B} + \$40 \text{ B}) \times \frac{100}{\$80 \text{ B}} \\
> &= 87.50
> \end{aligned}$$

b) Calculate a consumer price index for 2020.

> *Complete answer:* 100.
>
> $$\begin{aligned}
> \text{CPI}_{2019} &= \left(p_{2020}^{\text{cow bev.}} \times y_{\textbf{base year}}^{\text{cow bev.}} + p_{2020}^{\text{soy bev.}} \times y_{\textbf{base year}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{\textbf{base year}}} \\
> &= \left(p_{2020}^{\text{cow bev.}} \times y_{\textbf{2020}}^{\text{cow bev.}} + p_{2020}^{\text{soy bev.}} \times y_{\textbf{2020}}^{\text{soy bev.}}\right) \times \frac{100}{\text{nom. gdp}_{2020}} \\
> &= \left(\text{nom. gdp}_{2020}\right) \times \frac{100}{\text{nom. gdp}_{2020}} \\
> &= 100.
> \end{aligned}$$

c) Calculate the percentage change in your index from 2019 to 2020.

> *Complete answer:* 14.29%.
>
> $$\%\,\Delta\,(\text{CPI}) = \frac{\text{CPI}_{2020} - \text{CPI}_{2019}}{\text{CPI}_{2019}} = \frac{100 - 87.5}{87.5} = 0.1429 = 0.1429 \times 100\% = 14.29\%.$$

d) Please interpret your last result with a sentence.

Using 2020 output as the basket of goods, inflation from 2019 to 2020 was 14.29%.

Part B: The La Crosse-Onalaska, WI-MN metropolitan statistical area

Consider these actual labor force data from the Bureau of Labor Statistics:

Labor force data for the La Crosse-Onalaska, WI-MN MSA					
	Number of persons, in thousands				
	Oct. 2021	Nov. 2021	Dec. 2021	Jan. 2022	Feb. 2022
Civilian Labor Force	78.2	78.6	78.3	77.5	78.6
Employment	76.6	77.1	76.8	75.4	76.5
Unemployment	1.6	1.5	1.4	2.1	2.2

Unfortunately the BLS does not provide data on the labor force participation rate for MSAs. So let's try to estimate one ourselves using national data.

In the US during Nov 2021, the working-age population was 205,225,809; the total population was 332,598,000. The population of the La Crosse MSA was 139,211. Assume that the La Crosse MSA has the same age distribution as the entire US.

1. Calculate an estimate of the working-age population for the La Crosse MSA. Assume that this population was constant across all the months listed above.

$$139211 \text{ people} \times \frac{205225809 \text{ people}}{332598000 \text{ people}} = 85899 \text{ people}$$

2. Consider the fall quarter of 2021 (Q4) by comparing Oct. 2021 and Jan. 2022.

   a) What was the labor participation rate in Oct. 2021?

$$\frac{78.2 \text{ k people}}{85899 \text{ people}} = 91.04\%$$

   b) What was the unemployment rate in Oct. 2021?

$$\frac{1.6 \text{ k people}}{78.2 \text{ k people}} = 2.05\%$$

   c) What was the labor participation rate in Jan. 2022?

$$\frac{77.5 \text{ k people}}{85899 \text{ people}} = 90.22\%$$

d) What was the unemployment rate in Jan. 2022?

$$\frac{2.1 \text{ k people}}{77.5 \text{ k people}} = 2.71\%$$

e) What was the change in labor participation rate during 2021 Q4?

$$90.22\% - 91.04\% = -0.82 \text{ p.p.}$$

f) What was the change in the unemployment rate during 2021 Q4?

$$2.71\% - 2.05\% = 0.66 \text{ p.p.}$$

g) By how many people did the labor force change over this period?

$$-0.82 \text{ p.p.} \times 85899 \text{ people} = -704 \text{ people}$$

h) By how many people did unemployment change over this period?

$$2.1 \text{ k people} - 1.6 \text{ k people} = 500 \text{ people}$$

3. Suppose that those people who left the labor force over the course of 2021 Q4 had been unemployed and gave up on their job search. What if they had instead continued their job search? In this part, consider a scenario in which these people kept searching for a job. That is, count the people from question 2g as being unemployed (and thus also part of the labor force) in Jan. 2022.

a) How many unemployed people would have been counted for Jan. 2022?

$$2.1 \text{ k people} + 704 \text{ people} = 2804 \text{ people}$$

b) The labor force in Jan. 2022 would have totaled what value?

$$77.5 \text{ k people} + 704 \text{ people} = 78204 \text{ people}$$

c) What would the labor participation rate have been for Jan. 2022?

$$\frac{78204 \text{ people}}{85899 \text{ people}} = 91.04\%$$

d) What would the unemployment rate have been for Jan. 2022?

$$\frac{2.1 \text{ k people} + 704 \text{ people}}{78204 \text{ people}} = 3.59\%$$

e) What would the change in labor participation rate have been for 2021 Q4?

$$91.04\% - 91.04\% = 0 \text{ p.p.}$$

f) What would the change in the unemployment rate have been for 2021 Q4?

$$3.59\% - 2.05\% = 1.54 \text{ p.p.}$$