1) When Father Theodore Hesburgh became president of Notre Dame in 1952, the endowment was $7M. In 2008, it had a value of $6.5B. Calculate the total return on the endowment from 1952 to 2008. Calculate the annualized return.

This is tricky…we could calculate this using the usual percentage change formula

1952: $7M
2008: $6,500M

\[ \frac{(6,500 - 7)}{7} \times 100 = 92,757\% \] (Wow! That’s a BIG number).

Or, we could take the difference in natural logs

\[ \ln(6,500) - \ln(7) \times 100 = 683\% \]

This is a big difference!

\[ \left( \frac{6500}{7} \right)^{\frac{1}{56}} - 1 \times 100 = 13\% \]

Or,

\[ \frac{\ln(6,500) - \ln(7)}{56} \times 100 = 12.2\% \]

• What is the difference between a nominal variable and a real variable?

Real variables remove the effect of inflation (price changes)

• The CPI in 1952 was 26.5 while the CPI in 2008 was 211 (1983 = 100).

So, let’s calculate average annual inflation.

\[ \left( \frac{211}{26.5} \right)^{\frac{1}{56}} - 1 \times 100 = 3.8\% \]
Or,

\[
\frac{\ln(211) - \ln(26.5)}{56} \times 100 = 3.7\%
\]

Now, subtract inflation from the growth in the endowment to get real growth:

\[
12.2\% - 3.7\% = 8.5\% \text{ per year!}
\]

2) Suppose that the US and Mexico produce manufactured goods and services. Manufactured goods are traded internationally, but services aren’t. We have the following local prices in Mexico and the US (US prices are in dollars, Mexican prices are in Pesos).

<table>
<thead>
<tr>
<th>Country</th>
<th>Manufactured Goods</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>$4</td>
<td>$8</td>
</tr>
<tr>
<td>Mexico</td>
<td>P8</td>
<td>P4</td>
</tr>
</tbody>
</table>

Further, we have the following production numbers for the US and Mexico for 2016 and 2017.

**United States**

<table>
<thead>
<tr>
<th></th>
<th>Manufactured Goods</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2017</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Mexico**

<table>
<thead>
<tr>
<th></th>
<th>Manufactured Goods</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2017</td>
<td>50</td>
<td>150</td>
</tr>
</tbody>
</table>

a) Calculate GDP in the US (in dollars) and Mexico (in Pesos) for 2016 and 2017.

*So, this is just price times quantity for each good and then add up across goods.*

**United States:**

\[
GDP_{2016} = 4(100) + 8(100) = 1,200
\]

\[
GDP_{2017} = 1,200
\]
Mexico:

\[ GDP^{2016} = P8(100) + P4(100) = P1,200 \]
\[ GDP^{2017} = P8(50) + P4(150) = P1,000 \]

b) Calculate a price index for the US (in dollars) and Mexico (in Pesos) for each year as a weighted average of the individual prices where the weights are expenditure shares of each good.

*Expenditure shares are just the percent of total expenditures on each good.*

\[ P_{2016} = \left( \frac{400}{1,200} \right) (4) + \left( \frac{800}{1,200} \right) (8) = 6.67 \]
\[ P_{2017} = 6.67 \]
\[ P^{*}_{2016} = \left( \frac{800}{1,200} \right) (8) + \left( \frac{400}{1,200} \right) (4) = 6.67 \]
\[ P^{*}_{2017} = \left( \frac{400}{1,000} \right) (8) + \left( \frac{600}{1,000} \right) (4) = 5.60 \]

c) Assuming PPP holds for traded goods, what is the exchange rate between the US and Mexico?

*Given that manufactured goods cost $4 each and the same manufactured good costs 8 Pesos, the exchange rate should be:*  
\[ e = \frac{P^{*}}{p} = \frac{P8}{P4} = 2 \text{ (Pesos per dollar)} \]

\[ e = \frac{P^{*}}{p} = \frac{8}{4} = 2 \] (Pesos per dollar)


d) Given the calculate price indices above, does the Mexican dollar appear undervalued or overvalued? Explain.

*If we calculate the ratio of prices,*

\[ \frac{P^{*}_{2016}}{P_{2016}} = \frac{6.67}{6.67} = 1 \text{ (Pesos per dollar)} \]
\[ \frac{P^{*}_{2017}}{P_{2017}} = \frac{5.60}{6.67} = .84 \text{ (Pesos per dollar)} \]

*The peso appears undervalued in 2016 and even more undervalued in 2017.*
e) Assuming the PPP exchange rate from (c), convert the Mexican GDP figures to dollars using the PPP approach and using the exchange rate approach.

**Exchange Rate Approach (divide by the pesos per dollar exchange rate):**

\[
\begin{align*}
GDP^{*}_{2016} &= \frac{P(100) + P(100)}{2} = 600 \\
GDP^{*}_{2017} &= \frac{P(50) + P(150)}{2} = 500
\end{align*}
\]

**PPP Approach (divide GDP by the ratio of price indices):**

\[
\begin{align*}
GDP^{*}_{2016} &= \frac{P(100) + P(100)}{1} = 1200 \\
GDP^{*}_{2017} &= \frac{P(50) + P(150)}{.84} = 1190
\end{align*}
\]

3) What is the Gini coefficient? If the Gini coefficient is increasing, what does this tell you about an economy? How might you explain the change in the Gini coefficient in the US over the past 50 years?

*The Gini coefficient is a measure of income inequality. An increase in the Gini coefficient indicates that the distribution of income is becoming more uneven.*

4) In 1980, the price level was 78 while in 2014 it was 235. Calculate the average annual inflation rate in the US over the past between 1980 and 2014.

\[
\left[ \frac{235}{78} \right]^{\frac{1}{34}} - 1 \times 100 = 3.24%
\]

Or,

\[
\left[ \frac{\ln(235) - \ln(78)}{34} \right] \times 100 = 3.24%
\]

5) The consumer price index in January of 2015 was 234.67 while in February is 235.18. Calculate the annualized inflation rate for the month of January 2015.
Again, there are a couple ways to do this…we can do this with logs or without logs.

**With Natural Logs**

First, the monthly percentage change:

$$\left[ \ln(235.18) - \ln(234.67) \right] * 100 = 0.21\%$$

No, to annualize, multiply by 12 (12 months in a year)

$$0.21\% * 12 = 2.52\%$$

**Without Natural Logs**

$$\left( \frac{235.18 - 234.67}{234.67} \right) * 100 = 0.215\%$$

Now, to annualize it:

$$\left[ (1.00215)^{12} - 1 \right] * 100 = 2.61\%$$

6) Real GDP in the first quarter of 2014 was $15,831 (in billions) while in the second quarter of 2014 it was $16,010 (in billions). Calculate the annualized rate of real GDP growth:

**With Natural Logs**

First, the quarterly percentage change:

$$\left[ \ln(16,010) - \ln(15,831) \right] * 100 = 1.12\%$$

Then to annualize it, multiply by 4 (4 quarters in a year)

$$1.12 * 4 = 4.48\%$$

**Without Natural Logs**

$$\left( \frac{16,010 - 15,831}{15,831} \right) * 100 = 1.13\%$$

Now, to annualize it:

$$\left[ (1.0113)^{4} - 1 \right] * 100 = 4.59\%$$