**Some Answers**

_You must show your work for credit and answer in complete sentences when appropriate (such as when the question asks you to “describe” or “explain”)._

**Comparing GDP Using Purchasing Power Parity**

1) Consider two economies, Richania and Pooristan, which produce and consume only bread and buildings. The table contains price and production data for each country:

<table>
<thead>
<tr>
<th>Country</th>
<th>Bread Produced per Capita</th>
<th>Buildings Produced per Capita</th>
<th>Price of Bread in Local Currency</th>
<th>Price of Buildings in Local Currency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richania</td>
<td>150</td>
<td>30</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Pooristan</td>
<td>25</td>
<td>5</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

a. Calculate the level of GDP per capita in each country, measured in its own currency.

*Richania:* $150 \times 4 + 4 \times 100 = 3600$ Richanian dollars (R$)

*Pooristan:* $25 \times 2 + 5 \times 10 = 100$ Pooristanian dollars (P$)

b. Calculate the market exchange rate between the currencies of the two countries.

$2$ R$/1$ P$ (look at traded good prices for this rate)

c. What is the ratio of GDP per capita in Richania to GDP per capita in Pooristan, using the market exchange rate?

$100$ P$ \times (2$ R}$/1$ P$) = 200$ R$. This calculation implies that Richania is (3600 R$/200$ P$) = 18$ times wealthier than Pooristan. This however is misleading – Richania does not produce 18 times more stuff as Pooristan.

d. Calculate the purchasing power parity (PPP) exchange rate between the two currencies.

_The basket of goods should be 5 units of bread and one building._

*Richania:* $5 \times 4$ R$ + 1 \times 100$ R$ = 120$ R$

*Pooristan:* $5 \times 2$ P$ + 1 \times 10$ P$ = 20$ P$
Thus the PPP exchange rate is $120 \text{ R$}/20 \text{ P$} = 6 \text{ R$}/1 \text{ P$}

\[ \text{e. What is the ratio of GDP per capita in Richania to GDP in Pooristan, using the PPP exchange rate?} \]

\[ 100 \text{ P$} \times (6 \text{ R$/1 P$}) = 600 \text{ R$}. \text{ This calculation implies that Richania is} \]

\[ (3600 \text{ R$/600 P$}) = 6 \text{ times wealthier than Pooristan. Indeed, this is reality!} \]

**Computing Growth Rates**

2) Suppose \( x \) grows at 5% per time period (that is, \( x_{t+1}/x_t = 1.05 \)), and \( y \) grows at 2% per time period (that is, \( y_{t+1}/y_t = 1.02 \)). Calculate the per period growth rate of \( z \) in each of the following cases:

\[ \begin{align*}
\text{a. } z &= xy \quad 0.05 + 0.02 = 0.07 \\
\text{b. } z &= x/y \quad 0.05 - 0.02 = 0.03 \\
\text{c. } z &= y/x \quad 0.02 - 0.05 = -0.03 \\
\text{d. } z &= x^{1/2}y^{1/2} \quad (0.5*0.05) + (0.5*0.02) = 0.035 \\
\text{e. } z &= (x/y)^2 \quad (2*0.05) - (2*0.02) = 0.06 \\
\text{f. } z &= x^{-1/3}y^{2/3} \quad (-0.33*0.05) + (0.67*0.02) = -0.33
\end{align*} \]

**How Do We Know Growth Over the Very Long Run?**

3) The poorest countries in the world have a per capita income of about $600 today. As suggested by Pritchett in “Divergence, Big Time,” we can reasonably assume that it is nearly impossible to live on an income below half this level (below $300). Per capita income in the United States in 2000 was about $33,000. With this information in mind, consider the following questions.

a. For how long is it possible that per capita income in the United States has been growing at an average annual rate of 2% per year?

\[ 300 \times (1.02)^t = 33,000. \text{ Solve for } t \text{ to get } t = \ln(110)/\ln(1.02) = 237.4 \text{ years} \]

b. Some economists have argued that growth rates are mis-measured. For example, it may be difficult to compare per capita income today with per capita income a century ago when so many of the goods we can buy today were not available at any price then. Suppose the true growth rate in the last century was 3% per year
rather than 2%. What would the level of per capita income in 1800 have been in this case? Is this answer plausible?

For the twentieth century: \( x \times (1.03)^{100} = 33,000 \)

For the nineteenth century: \( y \times (1.02)^{100} = x \)

So, first solve for \( x \) (the implied income for 1900), and then use this to solve for \( y \) (the implied income for 1800). You should get \( y = 237 \) bucks. The answer is thus implausible if we believe mankind cannot survive on less than 300 dollars (valued today). In other words, twentieth century growth could not have been that rapid.

More Growth Rate Calculations

4) In 1900 GDP per capita in Japan (measured in year 2000 dollars) was $1433. In 2000 it was $26,375. Calculate the growth rate of income per capita in Japan over this period. Now suppose that Japan grows at the same rate for the century following 2000. What will Japanese GDP per capita be in the year 2100?

We can solve for the average annual growth rate, \( g \), by substituting the appropriate values into the equation: \( (Y_{1900}) \times (1 + g)^{100} = Y_{2000} \).

Letting \( Y_{1900} = $1,617 \), \( Y_{2000} = $23,639 \), and rearranging to solve for \( g \), we get:

\[
g = \frac{Y_{2000}}{Y_{1900}}^{1/100} - 1,
\]

\( g \approx 0.0272 \).

Converting \( g \) into a percent, we conclude that the growth rate of income per capita in Japan over this period was approximately 2.72 percent per year.

To find the income per capita of Japan 100 years from now, in 2100, we solve

\( (Y_{2000}) \times (1 + g)^{100} = Y_{2100} \).

Letting \( Y_{2000} = $23,639 \) and \( g = 0.0272 \),

\[
(23,971) \times (1 + 0.0272)^{100} = Y_{2100},
\]

\( Y_{2100} = $346,043.09 \).

That is, if Japan grew at the average growth rate of 2.72 percent per year, we would find the income per capita of Japan in 2100 to be about $346,043.09.

Why Do We Care About GDP?

5) In a speech Senator Robert Kennedy gave when he was running for president in 1968, he said the following about GDP:
[It] does not allow for the health of our children, the quality of their education, or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It measures neither our courage, nor our wisdom, nor our devotion to our country. It measures everything, in short, except that which makes life worthwhile, and it can tell us everything about America except why we are proud that we are Americans.

Wow. Was Kennedy right? If so, should we just end this class right now? [Um, that was rhetorical] But why should we care about GDP?

As Senator Robert Kennedy pointed out, GDP is an imperfect measure of economic performance or well-being. In addition to the left-out items that Kennedy cited, GDP also ignores the imputed rent on durable goods such as cars, refrigerators, and lawnmowers; many services and products produced as part of household activity, such as cooking and cleaning; and the value of goods produced and sold in illegal activities, such as the drug trade. These imperfections in the measurement of GDP do not necessarily reduce its usefulness. As long as these measurement problems stay constant over time, then GDP is useful in comparing economic activity from year to year. Moreover, a large GDP allows us to afford better medical care for our children, newer books for their education, and more toys for their play. Finally, countries with higher levels of GDP tend to have higher levels of life expectancy, better access to clean water and sanitation, and higher levels of education. GDP is therefore a useful measure for comparing the level of growth and development across countries.