

Comparing GDP Across Countries

In these notes we discuss the comparison of GDP across countries. Recall that the GDP is the market value of the final goods and services produced by labor and property located in the country during one year. Thus the U.S. GDP is measured in dollars while India's GDP is measured in Indian Rupee. It seems reasonable that in order to compare the U.S. GDP with India's GDP we need to convert them into a common currency. For example, we can convert India's GDP into dollars or the U.S. GDP into Indian Rupee. The straight forward way of converting one currency into another is using the market exchange rate. We will show that using the market exchange rates tends to undervalue the GDP of developing countries. We will demonstrate that using an alternative exchange rate, the so called Purchasing Power Parity (PPP) exchange rate eliminates some of that bias.

Using Market Exchange Rates

Suppose that the exchange rate between the dollar (\$) and the Indian Rupee (INR) is 40 Indian Rupees per 1 dollar. This means that the price of one dollar is 40 Indian Rupees. We denote the above exchange rate by

$$e = 40 \frac{INR}{\$}$$

Example 1: Suppose that I have \$100, and I want to know how many INR I can get for that. The exchange rate tells me that each dollar is worth 40 INR, so \$100 is worth 4000 INR. That is,

$$100\$ \cdot 40 \frac{INR}{\$} = 4000 \text{ INR}$$

To make sure that we did not make a mistake, and multiplied by the exchange rate instead of dividing, notice that the \$ "cancels out" and we are left with INR

$$100\$ \cdot 40 \frac{INR}{\$} = 4000 \text{ INR}$$

Example 2: Now suppose that I have 80 INR, and I want to see how many dollars I can get for that at the foreign exchange. If 40 INR are traded for 1 dollar, then 80 INR will give me 2 dollars. That is,

$$80INR \cdot \frac{1 \text{ \$}}{40 \text{ INR}} = \$2$$

Now we had to divide by the exchange rate, so that INR will "cancel out" and we are remained with dollars.

### The Law of One Price

Example 3: Suppose that televisions are traded good and the price of a TV set in U.S. is \$100 while the price of the same TV set in India is 8000 INR. What should be the exchange rate between the \$ and INR? Since the TV's are traded, the price of a TV, when converted to the same currency, must be the same. Therefore,

$$100\$ \cdot e \frac{INR}{\$} = 8000INR$$

Here  $e$  is the exchange rate, i.e., the price of 1 dollar in Indian Rupees. The exchange rate has to be such that when the price of the U.S. TV is converted to Indian currency, we get the same price at which this TV is traded in India. If the above inequality did not hold, there was a possibility for arbitrage (either buy TV's in India and sell in the U.S., or the other way around). The above equality is called the "**Law of One Price**", that is, the price of **traded goods** has to be the same in two countries when converted into a common currency. From the above equation we see that  $e = 80 INR/\$$ .

### Comparing GDP in Two Countries Using Market Exchange Rate

Suppose that two countries, the U.S. and India, can produce two goods: TV's that are traded, and restaurant meals that are not traded internationally. The following table contains data on quantities produced and local prices of both goods in the two countries. The quantities produced are per capita.

	TV's produced	Meals produced	Price of TV	Price of meal	GDP in local currency
U.S.	4	12	4 \$	2 \$	$4 \cdot 4 + 12 \cdot 2 = 40 \$$
India	1	3	40 INR	1 INR	$1 \cdot 40 + 3 \cdot 1 = 43 INR$

Of course we cannot compare 40\$ with 43INR unless we convert them to a common currency. What should be the market exchange rate under the assumption of the law of one price? The price of the traded good (TV's) has to be the same when converted to common currency. The law of one price requires that

$$4\$ \cdot e \frac{INR}{\$} = 40INR$$

Which implies that the exchange rate is

$$e = 10 \frac{INR}{\$}$$

Now let's convert the U.S. GDP into Indian currency and compare the two.

$$GDP_{U.S.} = 40\$ \cdot 10 \frac{INR}{\$} = 400INR$$

Now comparing the GDP in the two countries gives:

$$\frac{GDP_{U.S.}}{GDP_{IND}} = \frac{400}{43} = 9.3$$

Which means that the U.S. GDP is more than 9 times larger than the Indian GDP. A closer look however reveals that U.S. produces 4 times as much as India of both goods,

so it seems that the right ratio of U.S. GDP over Indian GDP should be 4:1. Why did we get such a big difference in GDP of two countries when we used the market exchange rate? Notice that the price of meals is much lower in India than in the U.S.: 2\$ is equivalent to 20INR using the market exchange rate. But meals are not traded, so the law of one price does not force the exchange rate to adjust.

### Comparing GDP in Two Countries Using PPP Exchange Rate

Suppose that you live in the U.S. and you have 4\$. You can buy 1 TV or 2 meals. Now suppose that you trade your 4\$ for 40INR (the market exchange rate is 10 INR/\$) and move to India. In India you are able to buy 1 TV or 40 meals. This means that the purchasing power of 4\$ is much greater in India than in the U.S. The “regular” market exchange rate does not take into account that meals are so much cheaper in India than in the U.S. The PPP exchange rate attempts to account for the **much cheaper non-traded goods** in India. When we construct the PPP exchange rate, we pretend that all goods are traded. We choose a common consumption bundle that will include traded and non-traded goods and the PPP exchange rate is set such that this bundle costs the same in both countries, when converted into a common currency. What bundle should we choose for our example? It seems reasonable to choose 1 TV and 3 meals because this is the ratio at which those goods are produced in both countries.

The price of the bundle in U.S.:  $1 \cdot 4 + 3 \cdot 2 = 10\$$

The price of the bundle in India:  $1 \cdot 40 + 3 \cdot 1 = 43\text{INR}$

Equating the two:

$$10\$ \cdot e_{PPP} \frac{\text{INR}}{\$} = 43\text{INR}$$

This gives us that the PPP exchange rate is  $e_{PPP} = 4.3 \frac{\text{INR}}{\$}$ . Notice that when we take into account the cheaper meals in India, the value of the Indian currency goes up relative to the dollar. Using PPP exchange rate, let’s convert the U.S. GDP into Indian currency and compare:

$$GDP_{U.S.} = 40\$ \cdot 4.3 \frac{\text{INR}}{\$} = 172\text{INR}$$

Now comparing the two:

$$\frac{GDP_{U.S.}}{GDP_{IND}} = \frac{172}{43} = 4$$

Thus, the PPP exchange rate gives us a more correct measure of the relative GDP in both countries.

**Summary:** Our goal was to compare standard of living in the two countries. When we neglect to take into account the cheap meals in India, we undervalue India’s standard of living. Comparing bundles which include both traded and non-traded goods, gives us a better estimate of the relative differences in the standard of living.