

## Problem Set 1 Solution

**1) Consider the following estimates for an iPad sold in Canada in 2010: retail price \$550 (say at Best Buy), Apple (a U.S. corporation) wholesale price \$475, Apple intermediate costs \$385. Of Apple's intermediate costs, \$100 was wholly produced by U.S. manufacturers, and \$285 from other foreign producers. Suppose the production chain was as follows: China sells \$145 of domestic parts to the Japan, who adds domestic parts and ships to the U.S. for \$285. (For simplicity, assume all figures are already in Canadian Dollars and provide your answers in CAD)**

**(a) What is Apple's value added per iPad?**

\$90 (\$475 wholesale price – \$385 intermediate costs).

**(b) How much value added is in Canadian retail trade?**

\$75 (\$550 retail price – \$475 wholesale price).

**(c) How much of the iPad's retail value shows up in Canadian GDP in the production approach?**

\$75 (That is the value added of the retail trade sector, as in (b)).

**(d) How much of the iPad's retail value shows up in U.S., China, and Japan's GDP in the production approach?**

**U.S.: \$190** (\$90 Apple's value added as it is a U.S corporation + \$100 of other U.S. suppliers); **China: \$145**; **Japan: \$140** (\$285 sold to the U.S - \$145 purchased from China)

**(e) Where does the iPad show up in the expenditure components of Canada's GDP?**

+\$550 in C and (-\$475) in NX, summing to the same \$75 contribution as in (c).

**(f) How does the iPad show up in Canada's bilateral trade deficits with Japan, China, and the U.S. respectively?**

Not at all with Japan and the China, -\$475 with the U.S. (the recorded transaction is buying a good from the U.S.; we do not account for the entire chain. U.S. bilateral deficit with Japan would include the amount spent on purchasing the intermediate goods from Japan)

2) Consider an economy that produces three products: blueberries, blackberries (the fruit, not the phone), and machines. Production and price data are:

	Year	Quantity	Price
Blueberries	2008	8,000 baskets	\$2 per basket
	2009	10,000 baskets	\$3 per basket
Blackberries	2008	3,000	\$4 per basket
	2009	6,000	\$2 per basket
Machines	2008	100	\$200 each
	2009	110	\$250 each

- (a) What is the growth rate of nominal GDP from 2008 to 2009?  
 (b) What is the growth rate of real GDP at 2008 prices?  
 (c) What is the growth rate of real GDP at 2009 prices?  
 (d) What is the growth rate of chain-weight real GDP? You may use either the exact or approximate formula.  
 (e) Let's say you had to guess to answer to (d) based on the results in (c), (d) without actually using the chain-weighted formula. How can you approximate?

(a) Nominal GDP in 2008 =  $8000 \times 2 + 3000 \times 4 + 100 \times 200 = \$48,000$ .  
 Nominal GDP in 2009 =  $10000 \times 3 + 6000 \times 2 + 110 \times 250 = \$69,500$ .

→ Growth rate =  $69,500/48,000 - 1 = 0.448$ , or 44.8%

(b) GDP in 2008 at 2008 prices = \$48,000  
 GDP in 2009 at 2008 prices =  $10000 \times 2 + 6000 \times 4 + 110 \times 200 = \$66,000$ .

→ Growth =  $66/48 - 1 = 0.375$ , or 37.5%

(c) GDP in 2008 at 2009 prices =  $8000 \times 3 + 3000 \times 2 + 100 \times 250 = \$55,000$ .  
 GDP in 2009 at 2009 prices = \$69,500

→ Growth =  $69,500/55,000 - 1 \approx 0.264$ , or 26.4%

(d) Chain weight real GDP growth (see formula in lecture slides):

$$\left( \frac{66,000}{48,000} \right)^{0.5} \left( \frac{69,500}{55,000} \right)^{0.5} - 1 \approx 1.318 - 1 = 0.318, \text{ or } 31.8\%$$

(e) You can approximate it by  $0.5 \times 0.264 + 0.5 \times 0.375 = 0.319$ , or 31.9% (Note that it is the approximation is not always that close).

**3) Continue with the same data as in question #2. Now let's calculate GDP deflator and inflation in the economy.**

**(a) What is the GDP deflator in 2008 and 2009 if you calculate real GDP based on 2008 prices?**

**(b) What is the GDP deflator in 2008 and 2009 if you calculate real GDP based on 2009 prices?**

**(c) What is the GDP deflator in 2008 and 2009 if you use the chain-weighted growth rate? (assume 2008 to be the base year)**

**(d) What is the inflation rate (based on GDP deflator) in associated with the price levels of (a), (b), and (c)**

We saw in class that GDP deflator is the ratio  $\frac{\text{Nominal GDP}}{\text{Real GDP}}$ . Using the results in question #2:

$$(a) \quad \begin{aligned} P_{2008} &= 1 \\ P_{2009} &= \frac{69,500}{66,000} = 1.053 \end{aligned}$$

$$(b) \quad \begin{aligned} P_{2009} &= 1 \\ P_{2008} &= \frac{48,000}{55,000} = 0.873 \end{aligned}$$

(c) Here we have to first calculate the value of Real GDP in 2009. Since we assumed 2008 to be the base year, we have  $P_{2008} = 1$ , and  $Y_{real,2008} = Y_{nom,2008} = 48,000$ .

We also have the real, chain-weighted, growth rate (31.8%), hence

$$Y_{real,2009} = (1 + g_{Y,2009})Y_{real,2008} = (1 + 0.318) \times 48,000 = 63,264$$

With that, we can calculate the GDP deflator

$$\begin{aligned} P_{2008} &= 1 \\ P_{2009} &= \frac{69,500}{63,264} = 1.098 \end{aligned}$$

(d) We know that  $\pi = \frac{P_{2009} - P_{2008}}{P_{2008}}$ , therefore the inflation rates are 5.3%, 14.5%, and 9.8% in parts (a), (b), and (c), respectively.

**4) Continue with the same data as in question #2. Now let's calculate Consumer Price Index inflation in the economy. Assume that there are 1,000 households identical households in the economy, and each of them consumes the same basket of consumption goods (i.e only the fruit, not the machines, enter the CPI calculations).**

**(a) Assume that the “representative consumption basket” is the one reflected by the quantities of 2008. What is the price of this basket in 2008? 2009?**

In this case, the representative consumption basket is 8 baskets of blueberries and 3 baskets of blackberries. The cost of this basket in 2008 is  $8 \times 2 + 3 \times 4 = \$28$ . The cost of the same basket in 2009 is  $8 \times 3 + 3 \times 2 = \$30$ .

**(b) Assume that the “representative consumption basket” is the one reflected by the quantities of 2009. What is the price of this basket in 2008? 2009?**

In this case, the representative consumption basket is 10 baskets of blueberries and 6 baskets of blackberries. The cost of this basket in 2008 is  $10 \times 2 + 6 \times 4 = \$44$ . The cost of the same basket in 2009 is  $10 \times 3 + 6 \times 2 = \$42$ .

**(c) What is the inflation rate associated with the prices in (a), (b) ?**

The inflation rate is  $30/28 - 1 = 0.0714$ , or 7.14% if the assumptions of (a) hold.  
The inflation rate is  $42/40 - 1 = -0.0454$  or -4.54% if the assumptions of (b) hold.

**(d) Why are the inflation rates different?**

Because in when we fix quantities, we don't take into account the fact that the representative basket may change as well (due to tastes, new products, etc.).

**(e) What is the reason for the different inflation rates in this question relative to the inflation rates based on GDP deflator?**

As we discussed in class, the CPI includes *consumer goods* only. Therefore, the CPI does not account for price changes of machines that have been significant in our data.

**5) Assume that in 2009 China's GDP per capita was 8,000 yuan, and that the market exchange rate between the yuan and the U.S. dollar was 8 yuans per dollar. Also assume that a representative product costs \$1 in the US, and 4 yuans in China.**

**(a) What is the market value of China's GDP in U.S. dollars?**

China's nominal GDP is its value in yuan divided by the market exchange rate

$$GDP_{CH,nom\$} = \frac{GDP_{CH,yuan}}{e^{nom}} = \frac{8,000}{8} = \$1,000$$

**(b) What is the "purchasing power exchange rate" between the yuan and U.S. dollar?**

The "purchasing power exchange rate" is the price ratio (in local currency) in the two

countries. Under our assumptions:  $e^{PP} = \frac{P_{yuan}}{P_{\$}} = \frac{4}{1} = 4$

**(c) What is the China's PPP GDP per capita?**

China's nominal GDP is its value in yuan divided by the market exchange rate

$$GDP_{CH,PPP} = \frac{GDP_{CH,yuan}}{e^{PP}} = \frac{8,000}{4} = \$2,000$$

**(d) Is the Chinese yuan overvalued or undervalued relative to the U.S. dollar?**

For that we have to calculate the real exchange rate between the two currencies.

$$e^{real} = \frac{e^{nom}}{e^{PP}} = \frac{8}{4} = 2$$

Since it is larger than 1, we say that the Chinese yuan is undervalued (or the U.S. dollar is overvalued). [Intuition: let's say you own one good in the U.S., you sell it for \$1, convert it to 8 yuan, and travel to China. Since you can buy more than one unit of the same good, the dollar is overvalued]

**(e) Many people argue that the Chinese yuan is undervalued relative to the U.S. dollar, and that the yuan should appreciate to 4 yuans per dollar. Assume that the yuan appreciates. How would that change your answer in (a)? How would it change your answer in (b) (assume the nominal exchange rate is the only thing changing)?**

Market value GDP would double.

Nothing happens to PPP GDP as local prices remain the unchanged in both countries.

**(f) If the data in this question is true, why do you think the yuan should appreciate to exactly 4 yuans per dollar?**

Setting the market exchange rate to 4 yuans per dollar implies that the real exchange rate is exactly one (given local prices), so that Purchasing Power Parity holds.

- 6) The British government has issued inflation-indexed bonds for many years.**
- (a) Explain briefly how you can form expectations about inflation using the rates on the non-indexed and the inflation-indexed bonds.**
- (b) Can the *ex ante* real interest rate be negative on non-indexed government bonds in Britain?**
- (c) Can the *ex post* real interest rate be negative on non-indexed government bonds in Britain? Explain your answers.**

(a) We saw in class that  $E(r) \approx i - \pi^e$ . Here we have a guaranteed  $r$  if we buy the indexed bond (this is an asset that is immune to any inflationary fluctuations). The non-indexed bond offers some nominal return  $i$ . Therefore, (assuming that financial markets are doing their job correctly), the difference  $i - r$  is a way to form expectations about inflation.

(b) No. The inflation-indexed bonds offer a nonnegative real interest rate which is guaranteed because it is indexed for inflation. So anyone who expected a negative real interest rate on the nominal bonds would buy the inflation-indexed bonds instead.

(c) Yes. If inflation turns out to be higher than expected, then the ex post real interest rate on nominal bonds can be negative despite their nonnegative ex ante real interest rate.

[Aside: Because a positive ex post real interest rate is guaranteed on the indexed bonds, holders of nominal bonds must be compensated for the “inflation risk” they bear, as shown in this answer. Thus the spread between nominal bonds and indexed bonds contains an inflation risk premium along with the expected inflation rate.]

**(7) (From a past midterm) *The Economist* publishes the “big mac index” in order to determine whether currencies are over or under valued relative to the US dollar. The procedure is simple: use the local price of big mac to determine epp, and use market data to find enom.**

**In 2004 *the Economist* compared the results of the “big mac index” with the results based on the same procedure using Starbucks “tall-latte index”.**

**Simple results suggest that: (1) the Canadian Dollar was under valued by 16% according to both indexes; (2) Singapore Dollar was over-valued by 2% according to the Starbucks index, but under-valued by 31% according to the big mac index.**

**(a) State and explain the conditions required for a currency to be undervalued relative to the US dollar.**

**(b) Assume that the results above provide a good account for the real exchange rate for Canada. Suppose you wish to convert the value of Canadian GDP to US dollars. Does Canada look richer when its nominal GDP is converted using the market (nominal) exchange rate or the purchasing power exchange rate?**

**(c) Which of the findings (1) and (2) above do you find more surprising? Explain.**

(a) For a currency to be undervalued, it must be that the real exchange rate of that currency relative to the US dollar is greater than 1. Intuitively, this happens if I have a unit of the representative good in the US, and I can sell it, convert it to another currency, and buy more than one unit of the same good in the other country.

(b) In order for the real exchange rate to be greater than one, it must be that the nominal exchange rate is greater than the “pp” exchange rate. Therefore:

$$\frac{\text{Nominal CAN GDP}}{e^{nom}} < \frac{\text{Nominal CAN GDP}}{e^{pp}}$$

Therefore Canada looks richer under purchasing power exchange rate.

(c) The results for Canada are somewhat surprising. Note that the real exchange rate in this index is measured based on a single good (in each case). Since it is hard to believe that either a big mac or a tall latte are a “representative good”, the fact that they result in the same degree of undervaluation looks very coincidental.

The Singapore example illustrates how hard it is to account for heterogeneity and the fact that the representative basket is a mix of many goods.