HE1002 Macroeconomics I

Problem Sheet 2 – Problems & Solutions

Academic Year 2025/2026, Semester 1

Quantitative Research Society @NTU

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Problem 2-1

Subscribing to the theory that life is indeed a beach, the residents of La Playa spend all of their money on three things: Every year, they collectively buy 250 bathing suits, 600 tubes of sunscreen, and 400 beach towels. Using the data in Table 8P-1, calculate the following.

Table 8P-1

Item (amount purchased)	Price 2021 ($)	Price 2022 ($)	Price 2023 ($)	Price 2024 ($)
Bathing suits (250)	10.00	12.00	15.00	18.00
Sunscreen (600)	4.00	5.00	5.00	6.00
Beach towels (400)	5.00	5.50	7.00	9.00

(a) The total cost of this basket each year from 2021 through 2024.

Solution:

Year	Total Cost of Basket
2021	$(250 \times 10) + (600 \times 4) + (400 \times 5) = \$6,900$
2022	$(250 \times 12) + (600 \times 5) + (400 \times 5.5) = \$8,200$
2023	$(250 \times 15) + (600 \times 5) + (400 \times 7) = \$9,550$
2024	$(250 \times 18) + (600 \times 6) + (400 \times 9) = \$11,700$

(b) How much the price of this basket has changed from year to year in percentage terms?

Solution:

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$$\text{2021 to 2022:} \quad \frac{8,200 - 6,900}{6,900} = 0.188 \text{ or } \mathbf{18.8\%}$$

$$\text{2022 to 2023:} \quad \frac{9,550 - 8,200}{8,200} = 0.164 \text{ or } \mathbf{16.4\%}$$

$$\text{2023 to 2024:} \quad \frac{11,700 - 9,550}{9,550} = 0.225 \text{ or } \mathbf{22.5\%}$$

Problem 2-2

Suppose a typical American consumer purchases three goods, creatively named good A, good B, and good C. The prices of these goods are listed in Table 8P-2.

Table 8P-2

Good	Price in 2023 ($)	Price in 2024 ($)
A	10	15
B	6	5
C	2	3

(a) If the typical consumer purchases two units of each good, what was the percentage increase in the price paid by the consumer for this basket between 2023 and 2024?

Solution:

Cost of basket in 2023: $2(\$10) + 2(\$6) + 2(\$2) = \$36$

Cost of basket in 2024: $2(\$15) + 2(\$5) + 2(\$3) = \$46$

Percentage increase: $\frac{\$46-\$36}{\$36} = 0.2777$ or **27.77%**

(b) If the typical consumer purchases 10 units of good B and 2 units of both good A and good C, what was the percentage increase in the price paid by the consumer for this basket?

Solution:

Cost of basket in 2023: $2(\$10) + 10(\$6) + 2(\$2) = \$84$

Cost of basket in 2024: $2(\$15) + 10(\$5) + 2(\$3) = \$86$

Percentage increase: $\frac{\$86-\$84}{\$84} = 0.0238$ or **2.38%**

(c) Given your answers to parts (a) and (b), what is the relationship between the market basket and the percentage price change?

Solution:

The overall change in the cost of the market basket is affected by how many units of each good one purchases. If two goods are rising in price at different rates, but the market basket contains more of good X than good Y, then the rate of increase of the overall market basket will be closer to the rate of increase of X rather than Y.

Problem 2-3

Using the data in Table 8P-3, calculate the CPI in each year, using 2019 as a base year.

Table 8P-3

Year	Cost of Basket ($)
2019	20,000
2020	21,400
2021	22,800
2022	26,150
2023	28,840
2024	32,600

Solution:
Formula: CPI in year $X = \frac{\text{Cost of basket in year } X}{\text{Cost of basket in base year}} \times 100$
Inflation rate: Inflation rate $= \frac{\text{CPI}_t - \text{CPI}_{t-1}}{\text{CPI}_{t-1}} \times 100$

Year	Cost of Basket ($)	CPI	Inflation Rate
2019	20,000	100	—
2020	21,400	$\frac{21,400}{20,000} \times 100 = 107.0$	$\frac{107.0-100}{100} = 7.0\%$
2021	22,800	$\frac{22,800}{20,000} \times 100 = 114.0$	$\frac{114.0-107.0}{107.0} = 6.5\%$
2022	26,150	$\frac{26,150}{20,000} \times 100 = 130.8$	$\frac{130.8-114.0}{114.0} = 14.7\%$
2023	28,840	$\frac{28,840}{20,000} \times 100 = 144.2$	$\frac{144.2-130.8}{130.8} = 10.3\%$
2024	32,600	$\frac{32,600}{20,000} \times 100 = 163.0$	$\frac{163.0-144.2}{144.2} = 13.0\%$

Problem 2-4

Table 8P-4 lists the prices and quantities consumed of three different goods from 2022–2024.

Table 8P-4

	2022		2023		2024	
Good	**Price**	**Quantity**	**Price**	**Quantity**	**Price**	**Quantity**
X	\$10	10	\$16	8	\$18	5
Y	\$5	18	\$3	30	\$4	25
Z	\$1	10	\$2	5	\$5	10

(a) For 2022, 2023, and 2024, determine the amount that a typical consumer pays each year to purchase the quantities listed in the table.

Solution:

$$\begin{aligned} 2022: &\quad \$10(10) + \$5(18) + \$1(10) = \$200 \\ 2023: &\quad \$16(8) + \$3(30) + \$2(5) = \$228 \\ 2024: &\quad \$18(5) + \$4(25) + \$5(10) = \$240 \end{aligned}$$

(b) Using the amounts you found in part (a), calculate the percentage change in the amount the consumer paid from 2022 to 2023, and from 2023 to 2024.

Solution:

$$\begin{aligned} \text{2022 to 2023:} &\quad \frac{\$228 - \$200}{\$200} = 0.14 \text{ or } \mathbf{14\%} \\ \text{2023 to 2024:} &\quad \frac{\$240 - \$228}{\$228} = 0.053 \text{ or } \mathbf{5.3\%} \end{aligned}$$

(c) Why is it problematic to use your answers to part (b) as a measure of inflation?

Solution:

The growth found in part (b) includes both price changes as well as consumption changes. A proper measure of inflation should hold quantities constant to measure only the effect of price changes.

(d) Suppose we take 2022 as the base year, which implies that the market basket is fixed at the 2022 consumption levels. Using 2022 consumption levels, now find the rate of inflation from 2022 to 2023 and from 2023 to 2024.

Solution:

Using 2022 quantities (10, 18, 10):

Year	**Cost of 2022 Basket**	**% Change**
2022	\$10(10) + \$5(18) + \$1(10) = \$200	—
2023	\$16(10) + \$3(18) + \$2(10) = \$234	$\frac{\$234-\$200}{\$200} = 17\%$
2024	\$18(10) + \$4(18) + \$5(10) = \$302	$\frac{\$302-\$234}{\$234} = 29\%$

(e) Repeat the exercise from part (d), now assuming that the base year is 2023.

Solution:

Using 2023 quantities (8, 30, 5):

Year	Cost of 2023 Basket	% Change
2022	\$10(8) + \$5(30) + \$1(5) = \$235	—
2023	\$16(8) + \$3(30) + \$2(5) = \$228	$\frac{\$228-\$235}{\$235} = -3.0\%$
2024	\$18(8) + \$4(30) + \$5(5) = \$289	$\frac{\$289-\$228}{\$228} = 26.8\%$

(f) Why were your answers from parts (d) and (e) different?

Solution:

Using 2022 and 2023 as base years puts different weights on the goods in the basket. The choice of base year affects the measured inflation rate because different consumption patterns weight price changes differently.

Problem 2-5

Which of the following goods have likely required hedonic quality adjustment over time if they were included in the Consumer Price Index (CPI)?

Solution:

A hedonic quality adjustment is required when the features of the good being measured change over time. The hedonic quality adjustment method removes any price differential attributed to a change in quality by adding or subtracting the estimated value of that change from the price of the old item.

(a) Laptop computers.

Yes. Laptop computers have changed significantly over time. Older models were larger, heavier, and slower to operate.

(b) Cellphones.

Yes. More and better features have been added to cellphones over time.

(c) Salt.

No. Salt is always the same chemical formula.

(d) Televisions.

Yes. The televisions of today are far more complex and offer a far more vivid display than the TVs of just a decade ago.

(e) Housing.

No. In general, housing in terms of shelter doesn't need any sort of adjustment. Over time, the quality of the goods within the house changes, but the housing itself doesn't change very much.

(f) Tennis rackets.

Yes. Today's tennis rackets use materials like carbon fiber and titanium, while the rackets of yesteryear were made of wood.

Problem 2-6

Use Table 8P-5 to calculate core and headline inflation in each time frame relative to the base year, assuming that each category is weighted equally in the calculation of headline inflation.

Table 8P-5

Year	Core CPI	Food & Energy CPI
2020	102	116
2024	107	105

Note: Headline inflation includes food and energy whereas core inflation does not. Since food and energy prices are much more volatile than the prices of other goods and services, these items are removed to get a better measure of what is happening to the prices of other goods and services.

(a) 2020 to a base year.

Solution:

Core inflation: $\frac{102-100}{100} = 0.02$ or $\mathbf{2\%}$

Percentage change in food and energy: $\frac{116-100}{100} = 0.16$ or $\mathbf{16\%}$

Since overall CPI is equally weighted between the two:

Headline inflation: $\frac{16\%+2\%}{2} = \mathbf{9\%}$

(b) 2024 to a base year.

Solution:

Core inflation: $\frac{107-100}{100} = 0.07$ or $\mathbf{7\%}$

Percentage change in food and energy: $\frac{105-100}{100} = 0.05$ or $\mathbf{5\%}$

Headline inflation: $\frac{7\%+5\%}{2} = \mathbf{6\%}$

(c) 2020 to 2024.

Solution:

Core inflation: $\frac{107-102}{102} = 0.049$ or **4.9%**

Percentage change in food and energy: $\frac{105-116}{116} = -0.0948$ or **-9.48%**

Headline inflation: $\frac{4.9\%+(-9.48\%)}{2}$ = **-2.3%**

Problem 2-7

Table 8P-6 shows the GDP deflator and CPI over five recent years for Vortexia. How much did prices change between years in each measure? By what percent did prices change between years for each measure? Calculate the annual inflation rate and then the inflation rate across the entire time period.

Table 8P-6

Year	GDP Deflator	CPI
2020	100	100
2021	105	104
2022	112	110
2023	123	113
2024	127	120

Solution:

Formula: Percent change in PI = $\frac{\text{PI}_t - \text{PI}_{t-1}}{\text{PI}_{t-1}}$

Year	GDP Deflator	Change in GDP Deflator	CPI	Change in CPI
2020	100	—	100	—
2021	105	$\frac{105-100}{100} = 5\%$	104	$\frac{104-100}{100} = 4\%$
2022	112	$\frac{112-105}{105} = 6.7\%$	110	$\frac{110-104}{104} = 5.7\%$
2023	123	$\frac{123-112}{112} = 9.8\%$	113	$\frac{113-110}{110} = 2.7\%$
2024	127	$\frac{127-123}{123} = 3.3\%$	120	$\frac{120-113}{113} = 6.2\%$
2020–2024	—	$\frac{127-100}{100} = 27\%$	—	$\frac{120-100}{100} = 20\%$

Problem 2-8

The median American household earned $12,051 in 1973 and $88,590 in 2021. During that time, though, the CPI rose from 44.4 to 271.

(a) Calculate the total growth rate in nominal median household income from 1973 to 2021.

Solution:

$$\text{Nominal growth rate} = \frac{88,590 - 12,051}{12,051} = 6.351 \text{ or } \mathbf{635.1\%}$$

(b) Calculate the total growth rate in real median household income from 1973 to 2021.

Solution:

Real income in 1973 in 2021 dollars:

$$\text{Income}_{2021} = \text{Income}_{1973} \times \frac{\text{CPI}_{2021}}{\text{CPI}_{1973}} = 12,051 \times \frac{271}{44.4} = 73,555$$

Real income in 2021 in 2021 dollars: $88,590 (same as nominal income)

Growth rate in real median income:

$$\frac{88,590 - 73,555}{73,555} = 0.204 \text{ or } \mathbf{20.4\%}$$

Problem 2-9

Using Table 8P-7, find the real value of a $1,200 payment to be received each year given the following CPI values. Next, find the amount that this $1,200 should be adjusted to, in order to keep its real value at $1,200.

Table 8P-7

Year	CPI	Real value of $1,200 (in $2021)	Cost of living adjusted payment
2021	100	1,200	1,200
2022	103		
2023	105		
2024	110		

Solution:
Formula: Real value$_Y$ = Nominal value$_X$ $\times \frac{\text{CPI}_Y}{\text{CPI}_X}$
To keep the real value at $1,200, we need to index the payment according to inflation:
Nominal payment in t = $1,200 $\times$ (1 + inflation rate) = $1,200 $\times \frac{\text{CPI}_t}{\text{CPI}_{t-1}}$

Year	CPI	Real value of \$1,200 (in \$2021)	Cost of living adjusted payment
2021	100	\$1,200	\$1,200
2022	103	$1,200 \times \frac{100}{103} = \$1,165.05$	$1,200 \times \frac{103}{100} = \$1,236$
2023	105	$1,200 \times \frac{100}{105} = \$1,142.86$	$1,200 \times \frac{105}{100} = \$1,260$
2024	110	$1,200 \times \frac{100}{110} = \$1,090.91$	$1,200 \times \frac{110}{100} = \$1,320$

Problem 2-10

Suppose General Electric paid its line workers \$10 per hour in 2023 when the Consumer Price Index was 100. Suppose that deflation occurred and the aggregate price level fell to 80 in 2024.

(a) What must GE pay its workers in 2024 in order to keep the real wage fixed?

Solution:

The real hourly wage in 2024 measured in 2023 dollars has to be equal to \$10.

In 2024: $\text{Wage}_{2023} = \text{Wage}_{2024} \times \frac{\text{CPI}_{2023}}{\text{CPI}_{2024}} = \$10$

Solve for Wage_{2024}: $\$10 = \text{Wage}_{2024} \times \frac{100}{80}$

$\text{Wage}_{2024} =$ **\$8**

(b) What did GE need to pay its workers in 2024 if it wanted to increase the real wage by 10 percent?

Solution:

GE needed to pay its workers 10 percent more than the answer in part (a):

$\$8 \times 1.1 =$ **\$8.80** per hour

(c) If GE kept the wage fixed at \$10 per hour in 2024, in real terms, what percentage increase in real wages did its workers get?

Solution:

The real wage in 2024 in 2023 dollars:

$$\text{Wage}_{2023} = \text{Wage}_{2024} \times \frac{\text{CPI}_{2023}}{\text{CPI}_{2024}} = \$10 \times \frac{100}{80} = \$12.50$$

The real wage in 2023 measured in 2023 dollars is \$10 (same as the nominal wage by definition).

Increase in real wages:

$$\text{Real growth rate} = \frac{\$12.50 - \$10}{\$10} = 0.25 \text{ or } \mathbf{25\%}$$

Problem 2-11

Table 8P-8 shows the prices of a tall Starbucks latte in countries around the world. Using the data, and the fact that a latte costs $3 in the United States, calculate how much a country's currency is under- or overvalued according to purchasing power. First, calculate the implied exchange rate for each country. Next, calculate the "latte index" for each country using the Big Mac index formula from the chapter.

Table 8P-8

Country	Price	Official exchange rate
Thailand	60 baht	30 baht/$
Argentina	15 pesos	6 pesos/$
U.K.	2 pounds	0.5 pounds/$
Japan	450 yen	80 yen/$

Solution:

If PPP holds, purchasing power would be the same everywhere when stated in a common currency.

Implied exchange rate $= \frac{\text{Foreign currency price of latte}}{\text{Domestic currency price (\$3)}}$

Currency valuation $= \frac{\text{Implied exchange rate} - \text{Official exchange rate}}{\text{Official exchange rate}} \times 100$

If the implied exchange rate is greater than the actual exchange rate (+ve), the currency is overvalued against the US$. If the implied exchange rate is less than the actual exchange rate (-ve), then the currency is undervalued against the US$.

Country	Price	Official rate	Implied rate	Valuation
Thailand	60 baht	30 baht/$	$\frac{60}{3} = 20$ baht/$	$\frac{20-30}{30} \times 100 = -33.3\%$
Argentina	15 pesos	6 pesos/$	$\frac{15}{3} = 5$ pesos/$	$\frac{5-6}{6} \times 100 = -16.7\%$
U.K.	2 pounds	0.5 pounds/$	$\frac{2}{3} = 0.67$ pounds/$	$\frac{0.67-0.5}{0.5} \times 100 = 34.0\%$
Japan	450 yen	80 yen/$	$\frac{450}{3} = 150$ yen/$	$\frac{150-80}{80} \times 100 = 87.5\%$

Problem 2-12

An employee asks her boss whether she can transfer offices so that she can work in a different part of the country. The boss responds positively and says that the employee can choose to work in Cleveland, Miami, or New York City. The boss then hands the employee a list, as shown in Table 8P-9, of the salaries that she would earn in the different cities and the average price levels in those same cities.

Table 8P-9

City	Salary ($)	Price Level (CPI)
Cleveland	85,000	100
Miami	125,000	160
New York City	165,000	205

(a) From a standpoint of maximizing the employee's consumption possibilities, which office should she choose?

Solution:

We need to calculate the real salary in each location by adjusting all salaries to Cleveland dollars.

$$\begin{aligned} \text{Cleveland:} \quad & 85,000 \times \frac{100}{100} = \$85,000 \\ \text{Miami:} \quad & 125,000 \times \frac{100}{160} = \$78,125 \\ \text{New York City:} \quad & 165,000 \times \frac{100}{205} = \$80,488 \end{aligned}$$

The employee makes the most money in **Cleveland** after adjusting for the cost of living.

(b) What would be the minimum salary in New York City the boss could offer the employee to make the employee indifferent between moving to Cleveland and to New York City?

Solution:

The manager needs to offer a nominal salary in New York City such that the real salary in "Cleveland dollars" is at least $85,000.

$$\text{NYC}_{\text{real, Cleveland}} = \text{NYC}_{\text{nominal}} \times \frac{\text{CPI}_{\text{Cleveland}}}{\text{CPI}_{\text{NYC}}}$$

Substitute in $85,000 for $\text{NYC}_{\text{real, Cleveland}}$ and solve for $\text{NYC}_{\text{nominal}}$:

$$\$85,000 = \text{NYC}_{\text{nominal}} \times \frac{100}{205}$$

$$\text{NYC}_{\text{nominal}} = \mathbf{\$174{,}250}$$

$174,250 in NYC would have the same purchasing power as $85,000 in Cleveland.

Problem 2-13

Calculate the PPP-adjusted GDP for each of four countries, using the information found in Table 8P-10.

Table 8P-10

Country	GDP ($)	Price-level adjustment
Ona	10,000	-0.06
Rye	12,700	0.27
Zolfo	14,100	0.10
Avon	23,400	-0.20

Solution:
Formula: PPP-adjusted GDP $= \text{GDP}_{\text{nominal}} \times \left[\frac{1}{1-\text{price-level adjustment}}\right]$

Country	GDP ($)	Price-level adjustment	PPP-adjusted GDP
Ona	10,000	-0.06	$10,000 \times \frac{1}{1+0.06} = \frac{10,000}{1.06} =$ **$9,434**
Rye	12,700	0.27	$12,700 \times \frac{1}{1-0.27} = \frac{12,700}{0.73} =$ **$17,397**
Zolfo	14,100	0.10	$14,100 \times \frac{1}{1-0.10} = \frac{14,100}{0.9} =$ **$15,667**
Avon	23,400	-0.20	$23,400 \times \frac{1}{1+0.20} = \frac{23,400}{1.20} =$ **$19,500**

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