HE1002 Macroeconomics I

Problem Sheet 1 – Problems & Solutions

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Problem 1-1

Suppose a gold miner finds a gold nugget and sells the nugget to a mining company for $500. The mining company melts down the gold, purifies it, and sells it to a jewelry maker for $1,000. The jewelry maker fashions the gold into a necklace that it sells to a department store for $1,500. Finally, the department store sells the necklace to a customer for $2,000. How much has GDP increased as a result of these transactions?

Solution:

GDP has increased by **$2,000**, which is the price of the final necklace produced. This represents the value of the final good sold to the end consumer.

Value-added method verification:

Company	Revenues	Cost of Purchased Inputs	Value Added
Gold miner	$500	$0	$500
Mining Co.	$1,000	$500	$500
Jewelry maker	$1,500	$1,000	$500
Department store	$2,000	$1,500	$500
Total			**$2,000**

The value-added method gives the same answer: $2,000.

Problem 1-2

Table 7P-1 shows the price of inputs and the price of outputs at each step in the production process of making a shirt. Assume that each of these steps takes place within the country.

Table 7P-1

	Cotton Farmer	Fabric Maker	Sewing and Printing
Price of inputs	—	\$1.10	\$3.50
Price of output	\$1.10	\$3.50	\$18.00

(a) What is the total contribution of this shirt to GDP, using the standard expenditure method?

Solution:

Using the expenditure method, the contribution to GDP is **\$18.00**, which is the final selling price of the shirt.

(b) If we use a value-added method (i.e., summing the value added by producers at each step of the production process, equal to the value of outputs minus the price of inputs), what is the contribution of this shirt to GDP?

Solution:

	Cotton Farmer	Fabric Maker	Sewing/Printing	Total
Value of inputs	\$0	\$1.10	\$3.50	
Value of output	\$1.10	\$3.50	\$18.00	
Value added	\$1.10	\$2.40	\$14.50	**\$18.00**

Using the value-added method: \$1.10 + \$2.40 + \$14.50 = **\$18.00**

(c) If we mistakenly added the price of both intermediate and final outputs without adjusting for value added, what would we find that this shirt contributes to GDP? By how much does this overestimate the true contribution?

Solution:

If we incorrectly sum all outputs: \$1.10 + \$3.50 + \$18.00 = \$22.60

This overestimates the true contribution by \$22.60 - \$18.00 = **\$4.60**.

Problem 1-3

The U.S. government gives income support to many families living in poverty. How does each of the following aspects of this policy contribute to GDP?

(a) Does this government's expenditure on income support count as part of GDP? If so, in which category of expenditure does it fall?

Solution:

No, transfer payments do not count as part of G (government purchases). Transfer payments are not payments for goods or services produced; they are simply redistributions of income.

(b) When the families buy groceries with the money they've received, does this expenditure count as part of GDP? If so, in which category does it fall?

Solution:

Yes, this counts as part of GDP in the **consumption** category (C).

(c) If the families buy new houses with the money they've received, does this count as part of GDP? If so, in which category does it fall?

Solution:

Yes, this counts as part of GDP in the **investment** category (I). Residential construction is classified as investment.

Problem 1-4

Given the following information about each economy, either calculate the missing variable or determine that it cannot be calculated.

(a) If $C = \$20.1$ billion, $I = \$3.5$ billion, $G = \$5.2$ billion, and $NX = -\$1$ billion, what is total income?

Solution:

Using the GDP identity:

$$\text{Total income} = C + I + G + NX = 20.1 + 3.5 + 5.2 + (-1) = \mathbf{\$27.8 \quad billion}$$

(b) If total income is \$1 trillion, $G = \$0.3$ trillion, and $C = \$0.5$ trillion, what is I?

Solution:

We have: Total income $= C + I + G + NX$

Substituting known values: $1 = 0.5 + I + 0.3 + NX$

This equation has two unknowns (I and NX), so **neither can be determined without additional information**.

(c) If total expenditure is \$675 billion, $C = \$433$ billion, $I = \$105$ billion, and $G = \$75$ billion, what is NX? How much are exports? How much are imports?

Solution:

Using the GDP identity:

$$NX = \text{Total expenditure} - C - I - G = 675 - 433 - 105 - 75 = \mathbf{\$62 \quad billion}$$

Exports and imports cannot be determined individually since $NX = \text{Exports} - \text{Imports}$ and we only know the net value.

Problem 1-5

Using Table 7P-3, calculate the following.

Table 7P-3

Activity	Total value (thousands of $)
Families buy groceries	600
Electronics company sells HD projectors to households	100
Personal trainer gives Zumba class	5
Custard stand sells pistachio ice cream	2
Police department buys new cars	500
Mayor leads creation of new education budget	300
Elevator construction company builds new factory	600
Local businessperson purchases corn from Mexico	400
Sports-gear company sells hockey gloves to Canadian team	200
Bike store sells used carbon-fiber bikes	200
Local stockbroker executes trades for clients	2,000

(a) Consumption = $707,000

(b) Investment = $600,000

(c) Government purchases = $800,000

(d) Net exports = -$200,000

(e) GDP = $1,907,000

Problem 1-6

Determine which category each of the following economic activities falls under: consumption (C), investment (I), government purchases (G), net exports (NX), or not included in GDP.

Solution:

Transaction	Category
(a) The mayor of Chicago authorizes the construction of a new stadium using public funds.	G
(b) A student pays rent on her apartment.	C
(c) Parents pay college tuition for their son.	C
(d) Someone buys a new Hyundai car produced in South Korea.	$-NX$
(e) Someone buys a used Hyundai car.	Not included
(f) Someone buys a new General Motors car produced in the United States.	C
(g) A family buys a house in a newly-constructed housing development.	I
(h) The U.S. Army pays its soldiers.	G
(i) A Brazilian driver buys a Ford car produced in the United States.	X
(j) The Department of Motor Vehicles buys a new machine for printing drivers' licenses.	G
(k) An apple picked in Washington in October is bought at a grocery store in Mississippi in December.	C
(l) Hewlett-Packard produces a computer and sends it to a warehouse in another state for sale next year.	I

Problem 1-7

Table 7P-3 shows economic activity for a very tiny country. Using the expenditure approach, determine the following.

Table 7P-3

Economic Activity	Dollar Value
Consumers spend	\$200,000
Businesses invest	\$50,000
Government purchases	\$75,000
Consumers buy imported goods	\$20,000
Foreigners buy domestic goods	\$45,000

(a) Consumption.

Solution:

Consumption = **\$200,000**

(b) Investment.

Solution:

Investment = **\$50,000**

(c) Government purchases.

Solution:

Government purchases = **$75,000**

(d) Net exports.

Solution:

Net exports = Exports - Imports = $45,000 - $20,000 = **$25,000**

(e) GDP.

Solution:

$$\text{GDP} = C + I + G + NX = 200{,}000 + 50{,}000 + 75{,}000 + 25{,}000 = \textbf{\$350,000}$$

Problem 1-8

During the 2008 recession sparked by financial crisis, the U.S. economy suffered tremendously. Suppose that, due to the recession, the U.S. GDP dropped from $14 trillion to $12.5 trillion. This decline in GDP was due to a drop in consumption of $1 trillion and a drop in investment of $500 billion. The U.S. government, under the current president, responded to this recession by increasing government purchases.

(a) Suppose that government spending had no impact on consumption, investment, or net exports. If the current presidential administration wanted to bring GDP back up to $14 trillion, how much would government spending have to rise?

Solution:

The total decline in GDP is $14 trillion - $12.5 trillion = $1.5 trillion.

To counteract a $1.5 trillion drop in expenditure, government spending (G) would need to rise by **$1.5 trillion**.

(b) Many economists believe that an increase in government spending doesn't just directly increase GDP, but that it also leads to an increase in consumption. If government spending rises by $1 trillion, how much would consumption have to rise in order to bring GDP back to $14 trillion?

Solution:

If government spending rises by $1 trillion, then to reach $14 trillion GDP, consumption would have to rise by **$0.5 trillion**.

Economic explanation: Consumption is a function of income. As income increases, consumption increases. Government spending injects money into the economy through infrastructure projects, public services, social programs, etc. This spending becomes income for workers, suppliers, and contractors, which in turn increases their consumption.

Problem 1-9

Assume Table 7P-4 summarizes the income of Paraguay.

Table 7P-4

Wages paid to labor	\$8.3 billion
Interest paid to capital	\$0.7 billion
Rental income	\$9.0 billion
Total business revenues	\$36.0 billion
Total business expenditures	\$27.0 billion

(a) Calculate profits.

Solution:

Profits = Total business revenues - Total business expenditures = \$36.0 - \$27.0 = **\$9.0 billion**

(b) Calculate the GDP of Paraguay using the income approach.

Solution:

Using the income approach:

$$\text{GDP} = \text{Wages} + \text{Interest} + \text{Rental income} + \text{Profits} = 8.3 + 0.7 + 9.0 = \textbf{\$18.0} \text{ billion}$$

(c) What would GDP be if you were to use the value-added approach?

Solution:

Using the value-added approach: **\$18.0 billion**

(d) What would GDP be if you were to use the expenditure approach?

Solution:

Using the expenditure approach: **\$18.0 billion**

All three approaches must yield the same GDP value.

Problem 1-10

Table 7P-5 provides information about the cost of inputs and the value of output for the production of a road bike. Note there are four different stages of production.

Table 7P-5

	Raw Mat.	**Tires**	**Frame/Comp.**	**Mech.**
Cost of inputs	—	\$20/tire	\$80+\$70	\$250+\$30/tire
Value out	\$20/tire+\$80+\$70	\$30/tire	\$250	\$350
Sale price				\$500

(a) What value is added by the supplier of the raw materials?

Solution:

Value added by raw materials supplier:

$$\$190 = (2 \times \$20) + \$80 + \$70$$

(b) What value is added by the tire maker?

Solution:

Value added by tire maker:

$$\$20 = (\$30 - \$20) \times 2$$

(c) What value is added by the maker of the frame and components?

Solution:

Value added by frame and components maker:

$$\$100 = \$250 - (\$80 + \$70)$$

(d) What value is added by the bike mechanic?

Solution:

Value added by bike mechanic:

$$\$40 = \$350 - [\$250 + (2 \times \$30)]$$

(e) What value is added by the bike store?

Solution:

Value added by bike store:

$$\$150 = \$500 - \$350$$

(f) What is the total contribution of the bike to GDP?

Solution:

Total contribution to GDP:

\$500 = Value of final good = Sum of value added = $\$190 + \$20 + \$100 + \$40 + \$150$

Problem 1-11

Imagine that the United States produces only three goods: apples, bananas, and carrots. The quantities produced and the prices of the three goods are listed in Table 7P-6.

Table 7P-6

Good	Quantity	Price
Apples	5	\$2.00
Bananas	10	\$1.00
Carrots	20	\$1.50

(a) Calculate the GDP of the United States in this three-goods version of its economy.

Solution:

$$\text{GDP} = (\$2 \times 5) + (\$1 \times 10) + (\$1.50 \times 20) = \$10 + \$10 + \$30 = \mathbf{\$50}$$

(b) Suppose that a drought hits the state of Washington. This drought causes the quantity of apples produced to fall to 2. Assuming that all prices remain constant, calculate the new U.S. GDP.

Solution:

With apple quantity falling to 2:

$$\text{New GDP} = (\$2 \times 2) + (\$1 \times 10) + (\$1.50 \times 20) = \$4 + \$10 + \$30 = \mathbf{\$44}$$

(c) Assume, once again, that the quantities produced and the prices of the three goods are as listed in Table 7P-6. Now, given this situation, carrot sellers decide that the price of carrots is too low, so they agree to raise the price. What must be the new price of carrots if the U.S. GDP is \$60?

Solution:

Let P be the new price of carrots. The equation becomes:

$$(\$2 \times 5) + (\$1 \times 10) + (P \times 20) = \$60$$

$$\$10 + \$10 + 20P = \$60$$

$$20P = \$40 \implies P = \mathbf{\$2}$$

The new price of carrots must be \$2.

Problem 1-12

Suppose that the British economy produces two goods: laptops and books. The quantity produced and the prices of these items for 2023 and 2024 are shown in Table 7P-7.

Table 7P-7

	2023		2024	
Good	**Quantity**	**Price**	**Quantity**	**Price**
Laptops	50	\$200	100	\$150
Books	1,000	?	?	\$10

(a) Let's assume that the base year was 2023 so that real GDP in 2023 equals nominal GDP in 2023. If the real GDP in Britain was \$15,000 in 2023, what was the price of books?

Solution:

In the base year, real GDP = nominal GDP.

For 2023:

$$\$15{,}000 = 50(\$200) + 1{,}000(P)$$

where P is the price of books.

$$\$15{,}000 = \$10{,}000 + 1{,}000P$$

$$1{,}000P = \$5{,}000 \implies P = \mathbf{\$5}$$

The price per book in 2023 is \$5.

(b) Using your answer from part (a), if the growth rate in nominal GDP was 10 percent, how many books must have been produced in 2024?

Solution:

If nominal GDP grew by 10%:

$$\text{Nominal GDP in 2024} = \$15{,}000 \times 1.1 = \$16{,}500$$

In 2024:

$$\$16{,}500 = 100(\$150) + Q(\$10)$$

where Q is the quantity of books.

$$\$16{,}500 = \$15{,}000 + 10Q$$

$$10Q = \$1{,}500 \implies Q = \mathbf{150}$$

150 books must have been produced.

(c) Using your answers from parts (a) and (b), what is the real GDP in 2024? What was the growth rate in real GDP between 2023 and 2024?

Solution:

To find real GDP in 2024, use 2024 quantities with 2023 prices:

$$\text{Real GDP in 2024} = 100(\$200) + 150(\$5) = \$20{,}000 + \$750 = \mathbf{\$20{,}750}$$

Growth rate in real GDP:

$$\frac{\$20{,}750 - \$15{,}000}{\$15{,}000} = \frac{\$5{,}750}{\$15{,}000} = 0.383 = \mathbf{38.3\%}$$

Problem 1-13

Based on Table 7P-8, calculate nominal GDP, real GDP, the GDP deflator, and the inflation rate in each year, and fill in the missing parts of the table. Use 2022 as the base year.

Table 7P-8

	Oranges		Beach Balls					
Year	**Q**	**P**	**Q**	**P**	**Nominal GDP**	**Real GDP**	**GDP Deflator**	**Inflation Rate**
2022	500	\$1.00	850	\$5.00				
2023	600	\$1.50	900	\$7.50				
2024	750	\$1.65	1,000	\$8.25				

Solution:

	Oranges		Beach Balls					
Year	**Q**	**P**	**Q**	**P**	**Nominal GDP**	**Real GDP**	**GDP Deflator**	**Inflation Rate**
2022	500	\$1.00	850	\$5.00	\$4,750.00	\$4,750.00	100	—
2023	600	\$1.50	900	\$7.50	\$7,650.00	\$5,100.00	150	50%
2024	750	\$1.65	1,000	\$8.25	\$9,487.50	\$5,750.00	165	10%

Formulas used:
Nominal GDP = (Q oranges × P orange) + (Q beach balls × P beach ball)
Real GDP (using 2022 as base year) = (Q oranges × \$1.00) + (Q beach balls × \$5.00)
GDP deflator = (Nominal GDP / Real GDP) × 100
Inflation rate = [(New deflator - Old deflator) / Old deflator] × 100%

Problem 1-14

Based on Table 7P-9, calculate nominal GDP per capita in 2021 and 2022, and the real GDP growth rate between the two years. Which countries look like they experienced recession in 2021-2022?

Table 7P-9

	2021			2022		
Country	**Pop. (millions)**	**Nominal GDP**	**Real GDP**	**Pop. (millions)**	**Nominal GDP**	**Real GDP**
Artemis	81	$1,019	$821	81	$1,139	$801
Gaia	10	$34	$28	9	$23	$30
Hermes	12	$505	$410	11	$559	$416
Pan	207	$304	$310	208	—	$329
Zeus	32	$1,833	$1,468	32	$1,997	$1,511

Solution:

Country	Nominal GDP/capita (2021)	Nominal GDP/capita (2022)	Real GDP growth rate
Artemis	$12,580	$14,067	-2.4%
Gaia	$3,400	$2,556	7.1%
Hermes	$42,083	$50,818	1.5%
Pan	$1,469	—	6.1%
Zeus	$57,281	$62,406	2.9%

Countries experiencing recession: Artemis experienced a recession (real GDP declined by 2.4%).

Formulas used:

Nominal GDP per capita = Nominal GDP / Population

Real GDP growth rate = [(Real GDP_{2022} - Real GDP_{2021}) / Real GDP_{2021}] $\times$ 100%

Problem 1-15

Table 7P-10 describes the real GDP and population of a fictional country in 2023 and 2024.

Table 7P-10

	2023	**2024**
Real GDP	$10 billion	$12 billion
Population	1.0 million	1.1 million

(a) What is the real GDP per capita in 2023 and 2024?

Solution:

$$\text{Real GDP per capita in 2023} = \frac{\$10 \text{ billion}}{1.0 \text{ million}} = \mathbf{\$10{,}000}$$

$$\text{Real GDP per capita in 2024} = \frac{\$12 \text{ billion}}{1.1 \text{ million}} = \mathbf{\$10{,}909}$$

(b) What is the growth rate in real GDP?

Solution:

Growth rate of GDP:

$$\frac{\$12 \text{ billion} - \$10 \text{ billion}}{\$10 \text{ billion}} \times 100\% = \mathbf{20\%}$$

(c) What is the growth rate in population?

Solution:

Growth rate in population:

$$\frac{1.1 \text{ million} - 1.0 \text{ million}}{1.0 \text{ million}} \times 100\% = \mathbf{10\%}$$

(d) What is the growth rate in real GDP per capita?

Solution:

Growth rate in real GDP per capita:

$$\frac{\$10{,}909 - \$10{,}000}{\$10{,}000} \times 100\% = \mathbf{9.09\%}$$

Problem 1-16

Table 7P-11 shows data on population and expenditures in five countries, as well as the value of home production, the underground economy, and environmental externalities in each.

Table 7P-11

Country	Pop.	C	I	G	NX	Home Prod.	Underground	Env. Ext.
Bohemia	8	$60	$20	$50	-$10	$8	$10	-$6
Silesia	10	$10	$3	$4	$0	$4	$5	-$1
Bavaria	15	$30	$10	$8	$2	$6	$8	-$3
Saxony	12	$25	$8	$6	$1	$5	$6	-$2
Ottoman Empire	9	$70	$25	$20	-$5	$10	$12	-$7

(a) Calculate GDP and GDP per capita in each country.

Solution:

Country	GDP	GDP per capita
Bohemia	$120	$15.00
Silesia	$17	$1.70
Bavaria	$50	$3.33
Saxony	$40	$3.33
Ottoman Empire	$110	$12.22

(b) Calculate the size of home production, the underground economy, and environmental externalities in each country as a percentage of GDP.

Solution:

Country	GDP	Home Prod. %	Underground %	Env. Ext. %
Bohemia	\$120	6.7%	8.3%	-5.0%
Silesia	\$17	23.5%	29.4%	-5.9%
Bavaria	\$50	12.0%	16.0%	-6.0%
Saxony	\$40	12.5%	15.0%	-5.0%
Ottoman Empire	\$110	9.1%	10.9%	-6.4%

(c) Calculate total and per capita "GDP-plus" in each country by including the value of home production, the underground economy, and environmental externalities.

Solution:

Country	GDP-plus (total)	GDP-plus per capita
Bohemia	\$132	\$16.50
Silesia	\$25	\$2.50
Bavaria	\$61	\$4.07
Saxony	\$49	\$4.08
Ottoman Empire	\$125	\$13.89

(d) Rank countries by total and per capita GDP, and again by total and per capita "GDP-plus." Compare the two lists. Are the biggest and the smallest economies the same or different?

Solution:

Country	GDP Rank	GDP per capita Rank	GDP-plus Rank	GDP-plus per capita Rank
Bohemia	1	1	1	1
Silesia	5	5	5	5
Bavaria	3	3	3	3
Saxony	4	3	4	2
Ottoman Empire	2	2	2	4

The rankings change slightly when including home production, underground economy, and environmental externalities in "GDP-plus," showing that conventional GDP may not fully capture economic welfare and activity.

Problem 1-17

Suppose a parent was earning $20,000 per year working at a local firm. The parent then decides to quit his job in order to care for his child, who was being watched by a babysitter for $10,000 per year. Does GDP rise, fall, or stay constant with this action, and how much does GDP change (if at all)?

Solution:

GDP **falls** by **$30,000**.

Explanation: Previously, GDP generated by the parent and the babysitter would have been $20,000 + $10,000 = $30,000 (using the income method).

After the change, the GDP generated is $0 since the parent watching his/her own child is not a market transaction and therefore not counted in GDP.

Thus, GDP falls by $30,000, even though the same childcare service is still being provided. This illustrates one limitation of GDP as a measure of economic welfare—it does not capture non-market productive activities such as home production.