

Problem Set I - Solutions

Question 1

Decide whether each of the following transactions is included in the GDP. If the transaction is included, determine which component of final expenditure it represents. If the transaction is excluded for GDP, explain why.

- a. Your local ice cream maker buys peaches to make peach ice cream.
- b. Your local ice cream maker buys a new and improved ice cream machine.
- c. You buy peach ice cream from your local ice cream maker.
- d. Your local ice cream maker sells peach ice cream to a local restaurant that serves peach smoothies.
- e. Your cousin from Germany buys peach ice cream from your local ice cream maker while she visits you from Germany.
- f. You buy a used book to learn how to make ice cream.
- g. You buy peaches to make peach ice cream for yourself.
- h. You buy a new ice cream machine to make peach ice cream for yourself.
- i. You give some of your peach ice cream to your cousin when she visits from Germany.

Solution:

- a. Transaction is excluded, peaches are intermediate goods, not a final good.
- b. Transaction is included, it represents Investment.
- c. Transaction is included, it represents Consumption.
- d. Transaction is excluded, peach ice cream is intermediate good, not a final good.
- e. Transaction is included, it represents Consumption.
- f. Transaction is excluded because it was counted when it was new.
- g. Transaction is included, it represents Consumption.
- h. Transaction is included, it represents Consumption.
- i. Transaction is excluded because gift was not counted for GDP.

Question 2

Suppose in an economy only three goods X, Y and Z are produced and the only factor of production is labor. The wage rate is 2 TL. for each sector. The input requirements of those goods are as follows:

One unit of X: 1 unit of labor

One unit of Y: 1,5 units of labor + 0, 5 units of X + 1 unit of Z

One unit of Z: 1 unit of labor + 1 unit of X

Further suppose that in a given period 26 units of X, 12 units of Y and 20 units of Z are produced while the prices of X, Y, and Z are 2 TL., 8 TL. and 4 TL., respectively.

a. Identify the intermediate and final goods.

X is an intermediate good. All X produced is used in production of Y and Z.

Y is a final good.

Z is both an intermediate good (12 units) and a final good (8 units)

b. Calculate GDP from expenditure approach.

It is the expenditure made to purchase FINAL goods.

Expenditure made for Y + Expenditure made for Z

$$8 \cdot 12 + 8 \cdot 4 = 128$$

c. Calculate the value added generated in the production of each good and total value added.

VA = Value of output - value of purchases from other firms

$$\text{VA of X} = 26 \cdot 2 = 52$$

$$\text{VA of Y} = 12 \cdot 8 - (6 \cdot 2 + 12 \cdot 4) = 36$$

$$\text{VA of Z} = 4 \cdot 20 - (2 \cdot 20) = 40$$

$$\text{Total VA} = 52 + 36 + 40 = 128$$

d. Calculate GDP from income approach. Wage Income + Profit Income

Payments to labor used for production of X: $26 \times 2 = 52$

Payments to labor used for production of Y: $18 \times 2 = 36$

Payments to labor used for production of Z: $20 \times 2 = 40$

Total payments: $52 + 36 + 40 = 128$

Profits: 0

GDP = 128

Question 3

From the following table, calculate:

- | | | | |
|-----------|-----------------------------------|------------|----------------------------|
| a. | gross private domestic investment | e.) | net national product |
| b. | net exports | f) | national income |
| c. | gross domestic product | g) | personal income |
| d. | gross national product | h) | disposable personal income |

Transfer payments	15
Subsidies	5
Social insurance payments	35
Depreciation	50
Receipts of factor income from the rest of the world	4
Government consumption and investment	75
Imports	50
Payments of factor income to the rest of the world	5
Indirect taxes	20
Exports	60
Net private domestic investment	100
Personal taxes	60
Corporate profits	45
Personal consumption expenditures	250
Dividends	4

Solution:

+	Personal consumption expenditure (C)	250
+	Gross private domestic investment (I)	150
	Net private domestic investment	100
	Depreciation	50
+	Government consumption and investment (G)	75
+	Exports (E)	60
-	Imports (IM)	50
	Net exports = E - IM	10
=	GDP	485
+	Receipts of factor income from the rest of the world	4
-	Payments of factor income to the rest of the world	5
=	GNP	484
-	depreciation	50
=	Net national product	434
=	National income	434
-	Indirect Taxes	20
+	Subsidies	5
-	Corporate profits	45
+	dividends	4
-	Social insurance payments	35
+	Transfer payments	15
=	Personal Income	358
-	Personal taxes	60
=	Disposable personal income	298

Question 4

Assume an economy with a coal producer, a steel producer, and some consumers (there is no government). In a given year, the coal producer produces 15 million tons of coal and sells it for \$5 per ton. The coal producer pays \$50 million in wages to consumers. The steel producer uses 25 million tons of coal as an input into steel production, all purchased at \$5 per ton. Of this, 15 million tons of coal comes from the domestic coal producer and 10 million tons is imported. The steel producer produces 10 million tons of steel and sells it for \$20 per ton. Domestic consumers buy 8 million tons of steel, and 2 million tons are exported. The steel producer pays consumers \$40 million in wages. All profits made by domestic producers are distributed to domestic consumers.

- a) Determine GDP using (i) the product approach, (ii) the expenditure approach, and (iii) the income approach.
- b) Determine the current account surplus.
- c) What is GNP in this economy? Determine GNP and GDP in the case where the coal producer is owned by foreigners, so that the profits of the domestic coal producer go to foreigners and are not distributed to domestic consumers.

a. Determining GDP using three approaches:

i) Product Approach: GDP is calculated by summing the value added of each producer on intermediate good inputs. We have two types of producers: The coal producers and the steel producers.

$GDP = \text{Value added of Coal Producers} + \text{Value added of Steel Producers}$

Value added of Coal Production = Quantity of Coal Produced * Coal Price
 $= 15 \text{ million tons} * \$5/\text{ton} = \$75 \text{ million}$

Value added of Steel Production = (Quantity of Steel Produced * Steel Price) - Quantity of Intermediate Good (Coal) * Coal Price = $10 \text{ million tons} * \$20/\text{ton} - 25 \text{ million tons} * \$5/\text{ton} = \$75 \text{ million}$

(ii) Expenditure Approach: GDP is calculated as the total spending on final goods and services produced within the economy.

$GDP (\text{expenditure approach}) = \text{Consumption (C)} + \text{Investment (I)} + \text{Government Spending (G)} + (\text{Exports} - \text{Imports})$

Consumption = $8 \text{ million tons of steel} * \$20/\text{ton} = \$160 \text{ million}$

(It's the domestic consumption, foreign consumption of domestic goods is counted under exports)

Investment = 0

Government Spending = 0

Net Exports = Exports – Imports = $-\$10 \text{ million}$

Exports = $2 \text{ million tons of steel} * \$20/\text{ton} = \$40 \text{ million}$

Imports = $10 \text{ million tons of coal} * \$5/\text{ton} = \$50 \text{ million}$

$$\text{GDP} = \$160 - \$10 = \$150 \text{ million}$$

(ii) Income Approach: GDP is calculated as the total sum of income received by factors of production. In this economy, there is wage income and profit income.

$$\text{Total Income} = \text{Wage Income} + \text{Profit Income}$$

$$\begin{aligned} \text{Wage Income} &= \text{Wages paid by coal producers} + \text{Wages paid by steel producers} \\ &= \$50 \text{ million} + \$40 \text{ million} \\ &= \$90 \text{ million} \end{aligned}$$

$$\begin{aligned} \text{Profit Income} &= \text{Value added} - \text{Wages paid} \\ \text{Profits of Coal Producers} &= \$75 \text{ million} - \$50 \text{ million} \\ &= \$25 \text{ million} \end{aligned}$$

$$\begin{aligned} \text{Profits of Steel Producers} &= \$75 \text{ million} - \$40 \text{ million} \\ &= \$35 \text{ million} \end{aligned}$$

$$\text{Profit Income} = \$25 \text{ million} + \$35 \text{ million} = \$60 \text{ million}$$

$$\begin{aligned} \text{Total Income} &= \$90 \text{ million (wage income)} + \$60 \text{ million (profit income)} \\ &= \$150 \text{ million} \end{aligned}$$

$$\begin{aligned} \text{b) Current Account} &= \text{Net Exports} + \text{Net Factor Payments} \\ &= -\$10 \text{ million} + 0 \\ &= -\$10 \text{ million} \end{aligned}$$

$$\text{c) GNP} = \text{GDP} + \text{NFP}$$

Case 1:

$$\text{GNP} = \$150 \text{ million} + 0$$

Case 2:

$$\begin{aligned} \text{GNP} &= \$150 \text{ million} - \$25 \text{ million (profits of coal producers)} \\ &= \$125 \text{ million} \end{aligned}$$

Question 5

In year 1 and year 2, there are two products produced in a given economy, computers and bread. Suppose that there are no intermediate goods. In year 1, 20 computers are produced and sold at \$1,000 each, and in year 2, 25 computers are sold at \$1,500 each. In year 1, 10,000 loaves of bread are sold for \$1.00 each, and in year 2, 12,000 loaves of bread are sold for \$1.10 each.

- Calculate nominal GDP in each year.
- Calculate real GDP in each year, and the percentage increase in real GDP from year 1 to year 2 using year 1 as the base year. Next, do the same calculations using the chain-weighting method.
- Calculate the implicit GDP price deflator and the percentage inflation rate from year 1 to year 2 using year 1 as the base year. Next, do the same calculations using the chain-weighting method.
- Suppose that computers in year 2 are twice as productive as computers in year 1. That is, computers are of higher quality in year 2 in the sense that one computer in year 2 is equivalent to two computers in year 1. How does this change your calculations in parts (a) to (c)? Explain any differences.

	Year 1		Year 2	
Goods	Quantity	Price	Quantity	Price
Computer	20	\$1000	25	\$1500
Bread	10000	\$1	1200	\$1.1

a)

Year 1:

$$\text{Nominal GDP}_1 = 20 * \$1000 + 10000 * \$1 = \$30000$$

Year 2:

$$\text{Nominal GDP}_2 = 25 * \$1500 + 1200 * \$1.1 = \$50700$$

b) Take year 1 as the base year:

Year 1 (base year):

$$\text{nGDP}_1 = \text{rGDP}_1 = \$30000$$

Year 2:

$$\begin{aligned} rGDP_2^{b1} &= Q_{c2} * P_{c1} + Q_{b2} * P_{b1} \\ &= 25 * \$1000 + 12000 * \$1 \\ &= \$37000 \end{aligned}$$

% change in real GDP from year 1 to year 2:

$$\begin{aligned} &= \frac{rGDP_2^{b1} - rGDP_1^{b1}}{rGDP_1^{b1}} * 100 \\ &= \frac{\$37000 - \$30000}{\$30000} * 100 \cong \% 23.3 \end{aligned}$$

When we use traditional way of calculating real GDP growth rate as we did above that we use the prices of base year, we implicitly assume that relative prices are the same with the base year. However, the relative prices so the weights of the goods in the expenditure are changing. In order to address this problem, chain-weighting method is developed as a new method to calculate real GDP.

In this method, in order to find chain-weighting growth rate, we calculate two separate growth rates that the first one has found by using prices of the previous year and the second one has found by using prices of the current year, and then we take the geometric average of these two rates.

So, we need GDP of year 2 with the prices of year 1 and year 2 and GDP of year 1 with the prices of year 1 and year 2.

$$GDP_1 \text{ (base 1)} = nGDP_1 = \$30000$$

$$GDP_2 \text{ (base 1)} = rGDP_2^{b1} = \$37000$$

$$GDP_2 \text{ (base 2)} = nGDP_2 = \$50700$$

$$GDP_1 \text{ (base 2)} = rGDP_1^{b2} = 20 * \$1500 + 10000 * \$1.1 = \$41000$$

First growth rate will be calculated with the prices of year 1. Take GDP_1 (base 1) and GDP_2 (base 1).

$$g_1 = \frac{rGDP_2^{b1}}{nGDP_1} = \frac{\$37000}{\$30000} \cong 1.2333$$

Second growth rate will be calculated with the prices of year 2. Take GDP_1 (base 2) and GDP_2 (base 2).

$$g_2 = \frac{nGDP_2}{rGDP_1^{b2}} = \frac{\$50700}{\$41000} \cong 1.2367$$

Now, take the geometric average of the two rates.

$$g_c = \sqrt{g_1 * g_2} = \sqrt{1.2333 * 1.2367} = 1.2345$$

So, the chain-weighting real GDP in year 2 = $rGDP_2^c = 1.2345 * \$30000 = \37035

c) We first calculate the GDP deflator with traditional way that we take the prices of the base year.

$$\text{Implicit GDP price deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} * 100$$

For the base year;

$$\text{GDP price deflator} = \frac{\text{Nominal GDP}_1}{\text{Real GDP}_1} * 100 = 100$$

For year 1;

$$\text{GDP price deflator} = \frac{\text{Nominal GDP}_2}{\text{Real GDP}_2} * 100 = \frac{50700}{37000} * 100 = 137$$

We find inflation by the % change in GDP deflator (index). This is one type of inflation calculation, there's also another methods to calculate inflation like through CPI.

$$\text{Inflation} = \frac{137-100}{100} * 100 = 37\%$$

Now finding GDP deflator by using chain weighting method,

C-W GDP deflator for year 1;

$$\frac{\text{Nominal GDP}_1}{\text{Real GDP}_1^c} * 100 = \frac{\$30000}{\$30000} * 100 = 100$$

C-W GDP deflator of year 2;

$$\frac{\text{Nominal GDP}_2}{\text{Real GDP}_2^c} * 100 = \frac{\$50700}{\$37035} * 100 = 136.9$$

d)

Here we need to analyze the case where the productivity or the quality of the same product (computer) doubled respect to previous year. If one computer in year 1 is as good as two computers in year 2, then the quantity of the computers would be like doubled respect to the previous year while the price is like the half. So, we change the table as below.

	Year 1		Year 2	
Goods	Quantity	Price	Quantity	Price
Computer	20	\$1000	50	\$750
Bread	10000	\$1	1200	\$1.1

Now we do the same calculations in part (a) and (c) with our new table. Since we do not change the total expenditures on the goods, nominal GDP's will not change.

$$nGDP_1 = \$30000$$

$$nGDP_2 = \$50700$$

However, the real GDP figures calculated through both methods will change.

Let's calculate real GDP for Year 2 taking Year 1 as the base year.

$$rGDP_2^{b1} = 50 * \$1000 + 12000 * \$1 = \$62000$$

Now, calculate implicit GDP deflator and inflation:

$$\text{Implicit GDP Deflator} = \frac{nGDP_2}{rGDP_2^{b1}} * 100 = \frac{\$50700}{\$62000} * 100 \cong 81.7$$

$$\text{Inflation} = \frac{81.7 - 100}{100} = -18.3\%$$

So, in the first case GDP deflator was 137 and the inflation rate was %37, now we have GDP deflator at about 82 and negative inflation. So, we understand that if we do not consider the quality improvement of products, we may under-calculate the real GDP growth and over-calculate the inflation rate.

Now, let's find the chain weighting growth rate.

$$nGDP_1 = \$30000$$

$$nGDP_2 = \$50700$$

$$rGDP_1^{b2} = 20 * \$750 + 10000 * \$1.1 = \$26000$$

$$rGDP_2^{b1} = 50 * \$1000 + 12000 * \$1 = \$62000$$

$$g_1 = \frac{rGDP_2^{b1}}{rGDP_1^{b1}} = \frac{\$62000}{\$30000} \cong 2.07$$

$$g_2 = \frac{rGDP_2^{b2}}{rGDP_1^{b2}} = \frac{\$50700}{\$26000} \cong 1.95$$

$$g_c = \sqrt{g_1 * g_2} = \sqrt{2.07 * 1.95} \cong 2.0075$$

$$C - W \text{ Real GDP growth rate} = (g_c - 1) * 100 = (2.0075 - 1) * 100 = \%100.8$$

$$rGDP_2^c = 2.0075 * \$30000 = \$60225$$

Chain-weighted GDP deflator :

$$\text{Deflator for } GDP_2^c = \frac{\text{Nominal } GDP_2}{\text{Real } GDP_2^c} * 100 = \frac{\$50700}{\$60225} * 100 = 84.2$$

$$\text{Inflation} = \frac{84.2 - 100}{100} = -15.8\%$$

The difference between traditional method and chain-weighting method is more pronounced when the quality change is taken into computations.

In traditional method we take the quantity change (rooted on quality improvement) into account yet we do not take the price change into account, so in traditional method we over-calculate the real GDP growth and under-calculate the inflation respect to chain-weighting method.

Question 6

Consider the identity $S_p - I = CA + D$, where S_p is private sector saving, I is investment, CA is the current account surplus, and D is the government deficit.

- Show that the above identity holds.
- Explain what the above identity means.

Solution:

- Show that the above identity holds.

$$\begin{aligned} S &= S^p + S^g = (Y^d - C) + (T - TR - INT - G) \\ &= (Y + NFP + TR + INT - T - C) + (T - TR - INT - G) \\ &= Y + NFP - C - G \\ &= C + I + G + NX + NFP - C - G && \text{recall } Y = C + I + G + NX \\ &= I + NX + NFP && \text{recall } CA = NX + NFP \\ &= I + CA \end{aligned}$$

So,

$$S^p + S^g = I + CA$$

and

$$S^p - I = CA - S^g = CA + D$$

where D is budget deficit; $D = -S^g$

b) Explain what the above identity means.

Let's analyze the following identity:

$$S^p + S^g = I + CA$$

Here, we understand the total national savings (public+private) can be used to either finance domestic investment or be lent to foreigners.

We define,

$$D = -S^g$$

Then,

$$D = S^p - I - CA$$

Meaning that government deficit must be financed either through savings over domestic investment or borrowed from foreigners through giving CA deficit (-CA: current account deficit)

If the domestic savings and investment does not change while D is increasing, means that (-CA) is increasing as well. If the economy suffers both from budget deficit and current account deficit, that is called "Twin Deficit".

Section II: Chapter 3

Question 7

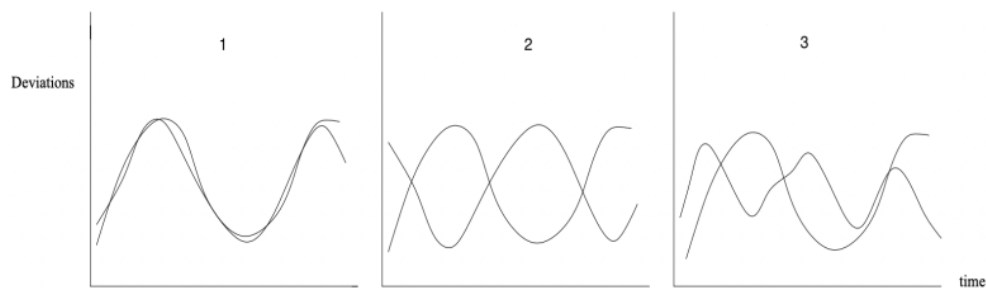
1. What is the primary defining feature of business cycles?
2. Besides persistence, what are three important features of the deviations from trend in GDP?
3. Explain why forecasting GDP over the long term is difficult.
4. Why are the co-movements in aggregate economic variables important?
5. Give a non-economic example of two variables that are positively correlated and an example of two variables that are negatively correlated.
6. What are the three features of co-movement that macro-economists are interested in?
7. Describe the key business cycle regularities in consumption and investment expenditures.
8. What are the key business cycle regularities with respect to the price level and the money supply?
9. What are the key business cycle regularities in the labor market?

Solution

1. The primary defining features of business cycles is that they are fluctuations around trend in real gross domestic product.
2. No regularity in amplitude, no regularity in the frequency of fluctuations, choppy fluctuations in real GDP.
3. It is difficult to predict long run data by merely looking at past data because there are irregularities in amplitude and frequency of fluctuation.
4. Although GDP fluctuates in irregular patterns, macroeconomic variables fluctuate together in patterns that exhibit strong regularities.
5. Positive Correlation: The number of people meeting in a confined area and the realized COVID incidence in the next three weeks for the group of people meeting. Negative Correlation: The number of days a student skipped her class and her grades.
6. We are interested principally in how a particular variable moves about trend relative to real GDP (whether it is procyclical, countercyclical, or acyclical), whether it is a leading, lagging, or coincident variable (relative to real GDP), and how variable it is relative to real GDP.
7. Consumption is procyclical, coincident, and less variable than real GDP. Investment is procyclical, coincident, and more variable than real GDP.
8. In the data set we examined in the book, the price level is a countercyclical variable, it is coincident, and it is less variable than GDP. The money supply is procyclical, leading, and about as variable as real GDP. (The fact that the money supply tends to lead real GDP was assigned much importance by Milton Friedman.)
9. In the labor market, employment is procyclical, lagging, and less variable than real GDP. The real wage, too, is procyclical. There is, however, no consensus among macroeconomists on whether the real wage is a leading or lagging variable. Average labor productivity is pro-cyclical, coincident, and less variable than real GDP.

Question 8

Within the realm of business cycles, we do not just look at GDP. Since several other series have some peculiar properties in relation with GDP, we also look at their cyclical components which tend to move in a particular fashion, loosely synchronized with GDP. These properties are called co-movements. Now consider the figure below. Classify co-movement in graphs 1, 2, 3.



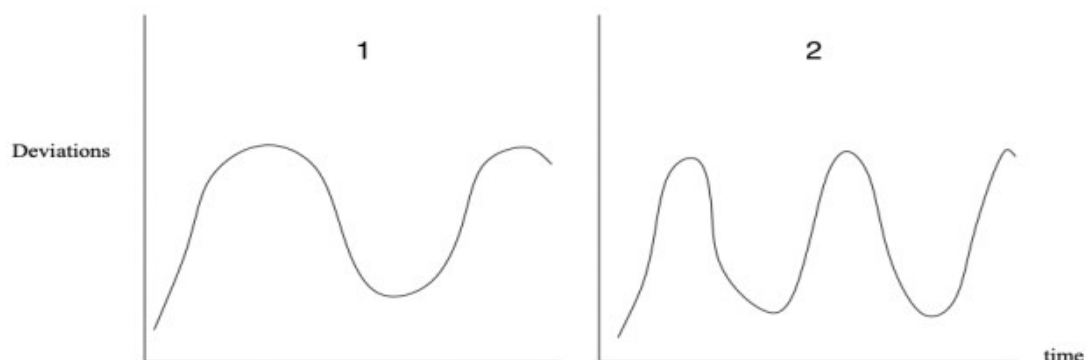
Solution Indeed, we do not just want to look at GDP. It turns out that several other series have some peculiar properties in relation with GDP: their cyclical components tend to move in a particular fashion, loosely synchronized with GDP. We call these properties comovements, and they can be classified in the following way:

procyclical comovement:(GRAPH 1) the series move in the same direction as GDP (here we abuse some language, as we really mean the cyclical components of each series);
acyclical comovement:(GRAPH 3) there is no discernible relationship between their movements;
countercyclical comovement:(GRAPH 2) the series move in opposite directions.

Usually this is done by comparing GDP with another series, i.e. we may say that consumption is procyclical, meaning that the cyclical components of consumption and GDP usually move in the same direction.

Question 9

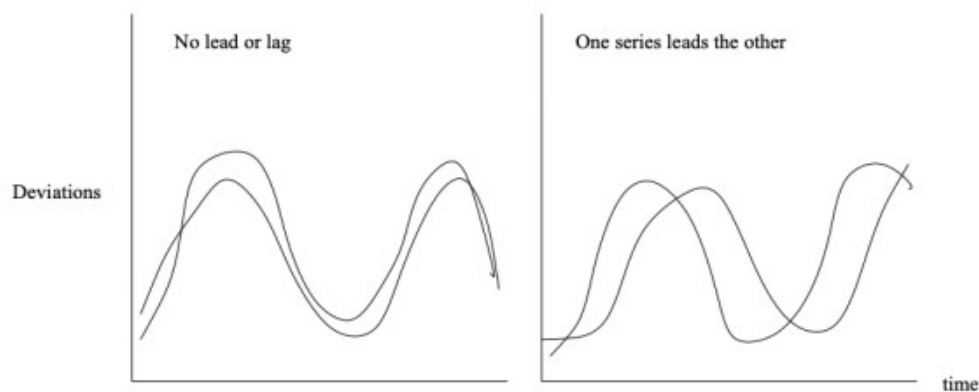
We define the length of business cycle to be between two and eight years. They can on average be close to two years or to eight years. Now, what is "frequency" and "persistence" in the context of the business cycle. Look at the graphs below, determine which one seems to have high frequency (low persistence).



Solution We define the length of the business cycle to be between two and eight years. They can on average be close to two years or close to eight years. In the second case, we say the business cycle has high frequency or low persistence. Examples are in Figure 3. Graph 1 is an example of high persistence, and Graph 1 is an example of low persistence.

Question 10

Consider the graphs below. Explain what having a series leading or lagging behind one other means within the realm of the business cycle (With example of macroeconomic variables).



Solution A lagging series is an economic statistic that tends to have a delayed reaction to a change in the economic cycle.

A leading series is an economic statistic that tends to predict future changes in the economic cycle.

Explanation in detail:

At the start of a recession, we may get a fall in share prices and fall in consumer confidence – these are leading indicators of a change in economic mood; people expect fortunes to deteriorate and start spending less.

As the economy goes into recession, GDP falls. This is the best co-incident indicator. Though we have to remember, GDP stats is initially an estimate, it may get revised up to three years later.

Unemployment is often a lagging indicator. It takes time for firms to respond to decline in output by getting rid of workers. Workers may be protected by contracts and so not lose job straight away.

When the economy recovers, we will see a rise in business and consumer confidence and GDP rises. However, it may take time for firms to have the confidence to find and employ new workers.

Question 11

Variable	SD%	Correlation of GNP with										
		x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}
GNP	1.72	.02	.16	.38	.63	.85	1.0	.85	.63	.38	.16	.02
Consumption:												
- total	1.27	.25	.42	.57	.72	.82	.83	.67	.46	.22	-.01	-.20
- non dur., serv.	0.86	.22	.40	.55	.68	.78	.77	.64	.47	.27	.06	-.11
- durables	4.96	.24	.37	.49	.65	.75	.78	.61	.38	.11	-.13	-.31
Investment												
- total	8.24	.04	.19	.38	.59	.79	.91	.76	.50	.22	-.04	-.24
- fixed	5.34	.08	.25	.43	.63	.82	.90	.81	.60	.35	.09	-.12
- non residential	5.11	-.26	-.12	.05	.30	.57	.79	.88	.83	.60	.46	.24
- residential	10.7	.42	.55	.65	.72	.74	.63	.39	.11	-.14	-.33	-.43
- ch. inventories	17.3	-.03	.07	.22	.38	.53	.67	.51	.27	.04	-.15	-.30
Govt expenses	2.04	.03	-.01	-.03	-.01	-.01	.04	.08	.11	.16	.25	.32
Exports	5.53	-.48	-.42	-.29	-.10	.15	.37	.50	.54	.54	.52	.44
Imports	4.88	.11	.19	.31	.45	.62	.72	.71	.52	.28	.04	-.18
Labor (household survey)												
- total hours	1.59	-.06	.09	.30	.53	.74	.86	.82	.69	.52	.32	.11
- average hours	0.63	.04	.16	.34	.48	.63	.62	.52	.37	.23	.09	-.05
- employment	1.14	-.10	.04	.23	.46	.69	.85	.86	.76	.59	.40	.18
- GNP/tot. hours	0.90	.06	.14	.20	.30	.33	.41	.19	.00	-.18	-.25	-.24
Labor (establishment survey)												
- total hours	1.69	-.12	.07	.38	.54	.78	.92	.90	.78	.63	.42	.21
- average hours	0.48	.14	.26	.42	.58	.68	.62	.45	.22	.05	-.15	-.30
- employment	1.41	-.19	-.01	.22	.47	.72	.89	.92	.86	.73	.55	.34
- GNP/tot. hours	0.73	.35	.44	.44	.45	.34	.34	.10	-.09	-.30	-.38	-.42
- hourly earnings	0.76	.20	.35	.47	.58	.66	.68	.59	.46	.29	.12	-.03
Hourly compens.	0.55	.24	.25	.21	.14	.09	.03	-.07	-.09	-.09	-.09	-.10
Prices												
- GNP deflator	0.88	-.52	-.63	-.69	-.70	-.65	-.57	-.44	-.31	-.17	-.04	.08
- CPI	1.43	-.57	-.66	-.71	-.72	-.65	-.52	-.35	-.17	.02	.19	.34
Money												
- M0	0.84	.22	.33	.39	.42	.37	.30	.21	.15	.07	.03	.02
- M1	1.52	.16	.24	.33	.41	.39	.33	.21	.12	.05	.03	.02
- M2	1.46	.51	.58	.62	.62	.50	.33	.10	-.08	-.21	-.29	-.37

Now, in the light of your answers please state the stylized facts:

1. Consumption is (more/less/as) volatile than/as output.
2. All other components of GNP are (more/less) volatile.
3. The labor input is(more/less/as) volatile ... (than/as) output.
4. Average hours fluctuate (more/less) than employment.

5. All components of GNP are (acyclical/procyclical/countercyclical)- except government expenses.
6. All labor aggregates are (acyclical/procyclical/countercyclical).
7. Labor productivity is (weakly/strongly) (acyclical/procyclical/countercyclical).
8. Labor earnings are (acyclical/procyclical/countercyclical).
9. Prices are (acyclical/procyclical/countercyclical).
10. Money is (weakly/strongly) (acyclical/procyclical/countercyclical).

Solution Let us first concentrate on standard deviations (the SD% column). There we want to compare GNP's standard deviation of 1.72% to the standard deviation of other aggregates. We notice that consumption is less volatile, especially the consumption of non durables and services. The standard deviation of durables is a multiple of that of GNP, in fact it is in a similar range with fixed investment. Indeed, household durables can be thought of as investment, given that they encompass cars, household appliances and similar items. Note also that all components of investment are much more volatile than GNP. Government expenses (at all levels) are roughly as variable as GNP, while exports and imports are again in the same ballpark as investment. Turning to labor, we see that whatever the source of the data, total hours are about as volatile as GNP, and this volatility is mostly attributed to employment, not average hours. Labor earnings and labor productivity (as measured by GNP over total hours) are less volatile than GNP. Prices and monetary aggregates tend to be less volatile, but this depends on the definition.

Let us now look at correlations and let us first concentrate on the middle column (" x_t "). There we see that all components of GNP are procyclical, with one exception: government expenses. Note that some of the correlations are very high, for example total investment, and consumption. Imports are much more procyclical than exports. Labor aggregates are procyclical as well, in particular total hours and employment. Labor earnings and labor productivity tend to be procyclical. Prices are countercyclical, while monetary aggregates are mildly procyclical.

The remaining columns of Table help us determine whether any aggregate leads or lags the business cycle. The columns to the left give correlations of aggregates leading the business cycle, while they lag in the right columns. Our task is now to figure out for each aggregate whether they lead or lag by looking at the highest correlation. The norm is that they do not lead or lag, they are contemporaneous. But this is no exact science, as some correlations are very close to each other. Witness consumption, that may possibly lead, as the one-period ahead correlations are essentially equivalent to the contemporaneous ones. If we had monthly data, we may have found a lead, but we cannot conclude that this is the case with quarterly data. There is certainly not a lag.

An interesting case is investment. While total or fixed investment are resolutely contemporaneous, this is not the case for the components: non residential investment is lagging the cycle while residential investment is leading the cycle (this is why economists are always so interested in housing starts as an indicator of things to come). A similar story appears with labor aggregates. Total hours are contemporaneous, but average hours lead the cycle while employment lags the cycle. It is easy to build a theory justifying this: employers can adjust the total labor hours rapidly with overtime (or undertime), but it takes some time to adjust the number of employees. A case can also be made that prices lead the cycle (in their countercyclical nature), and that some definitions of money lead the cycle, which can give some credit to theories stating that money is an important trigger of business cycles. This is unlike government expenses which do not seem to be correlated with GNP within a five quarter window (there may be a lag of more than five quarters, though).

Within this table we can measure persistence only for one aggregate, GNP, as it is the only one to feature autocorrelations. With 0.85, the autocorrelation of order one clearly indicates that a high degree of persistence is visible at quarterly frequency. Obviously, we will never be able to find in this class theories that can replicate all this facts, especially theories matching precisely the figures of Table 1. Given that we will not cover the international sector and that we will not be able to look at leads or lags in this class, let us focus on a limited number of stylized facts. The facts should guide us through the evaluation of successive theories, and we will put them to an immediate test by looking at other countries. Here are the facts:

1. Consumption is less volatile than output.
2. All other components of GNP are more volatile.
3. The labor input is as volatile as output.
4. Average hours fluctuate less than employment.
5. All components of GNP are procyclical (except government expenses).
6. All labor aggregates are procyclical. 7. Labor productivity is procyclical.
8. Labor earnings are procyclical.
9. Prices are countercyclical.
10. Money is (weakly) procyclical.

Section II: Chapter 4

Question 12

Suppose, alternatively, that leisure and consumption goods are perfect substitutes. In this case, an indifference curve is described by the equation

$$u = aL + bC$$

where a and b are positive constants, and u is the level of utility. That is, a given indifference curve has a particular value for u , with higher indifference curves having higher values for u .

- a. Show what the consumer's indifference curves look like when consumption and leisure are perfect substitutes and determine graphically and algebraically what consumption bundle the

consumer chooses. Show that the consumption bundles the consumer chooses depends on the relationship between a/b and w and explain why.

b. Do you think it likely that any consumer would treat consumption goods and leisure as perfect substitutes?

c. Given perfect substitutes, is more preferred to less? Do preferences satisfy the diminishing marginal rate of substitution property?

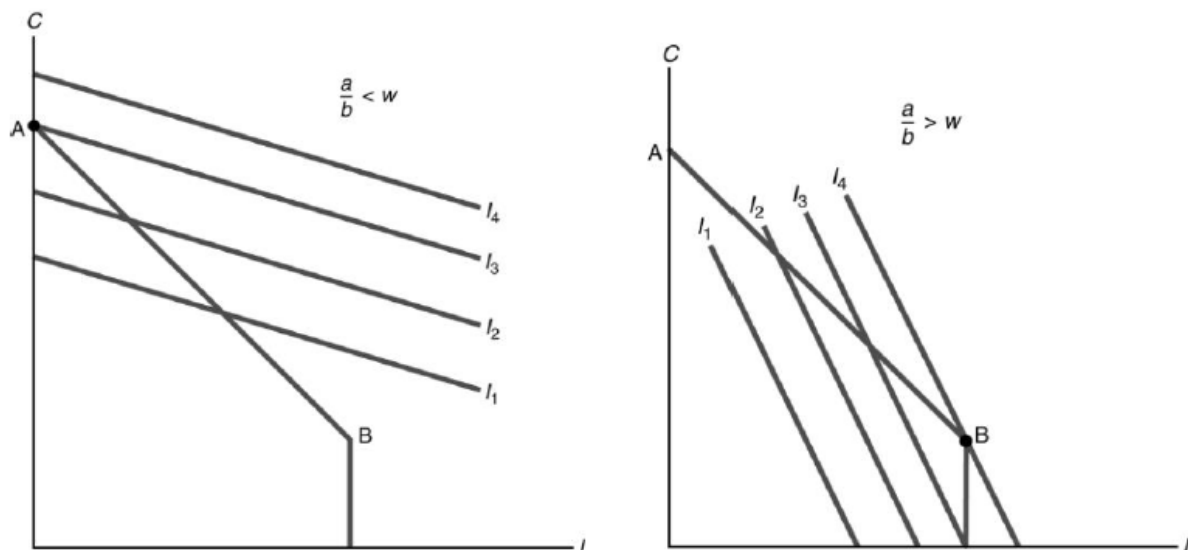
Solution:

$$u = aI + bC$$

- (a) To specify an indifference curve, we hold utility constant at u . Next rearrange in the form:

$$C = \frac{u}{b} - \frac{a}{b}I$$

Indifference curves are therefore linear with slope, $-a/b$, which represents the marginal rate of substitution. There are two main cases, according to whether $a/b > w$ or $a/b < w$. The top panel of the left figure below shows the case of $a/b < w$. In this case the indifference curves are flatter than the budget line and the consumer picks point A, at which $I = 0$ and $C = wh + \pi - T$. The right figure shows the case of $a/b > w$. In this case the indifference curves are steeper than the budget line, and the consumer picks point B, at which $I = h$ and $C = \pi - T$. In the coincidental case in which $a/b = w$, the highest attainable indifference curve coincides with the budget line, and the consumer is indifferent among all possible amounts of leisure and hours worked.



- (b) The utility function in this problem does not obey the property that the consumer prefers diversity, and is therefore not a likely possibility.
- (c) This utility function does have the property that more is preferred to less. However, the marginal rate of substitution is constant, and therefore this utility function does not satisfy the property of diminishing marginal rate of substitution.

Question 13

Suppose that the government imposes a proportional income tax on the representative consumer's wage income. That is, the consumer's wage income is $w(1 - t)(h - l)$ where t is the tax rate. What effect does the income tax have on consumption and labor supply? Explain your results in terms of income and substitution effects.

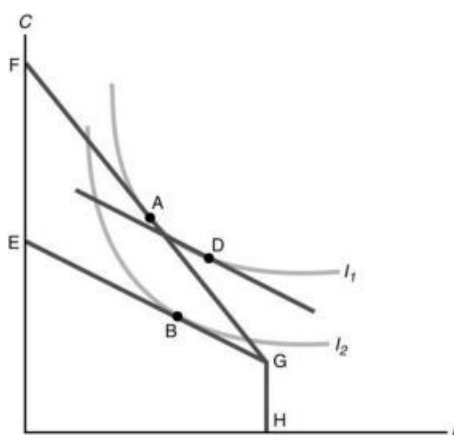
Solution:

When the government imposes a proportional tax on wage income, the consumer's budget constraint is now given by:

$$C = w(1 - t)(h - l) + \pi - T,$$

where t is the tax rate on wage income. In the figure below, the budget constraint for $t=0$, is FGH. When $t > 0$, the budget constraint is EGH. The slope of the original budget line is $-w$, while the slope of the new budget line is $-(1-t)w$. Initially the consumer picks the point A on the original budget line. After the tax has been imposed, the consumer picks point B. The substitution effect of the imposition of the tax is to move the consumer from point A to point D on the original indifference curve. The point D is at the tangent point of indifference curve, I_1 , with a line segment that is parallel to EG. The pure substitution effect induces the consumer to reduce consumption and increase leisure (work less).

The tax also makes the consumer worse off, in that he or she can no longer be on indifference curve, I_1 , but must move to the less preferred indifference curve, I_2 . This pure income effect moves the consumer to point B, which has less consumption and less leisure than point D, because both consumption and leisure are normal goods. The net effect of the tax is to reduce consumption, but the direction of the net effect on leisure is ambiguous. The figure shows the case in which the substitution effect on leisure dominates the income effect. In this case, leisure increases and hours worked fall. Although consumption must fall, hours worked may rise, fall, or remain the same.

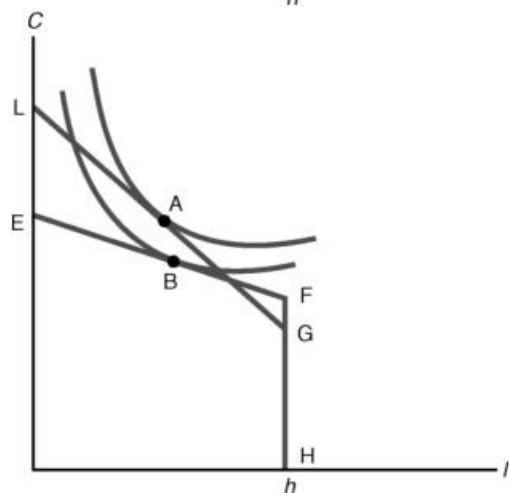
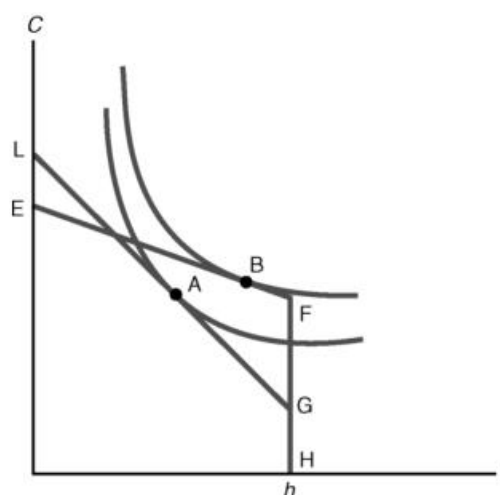
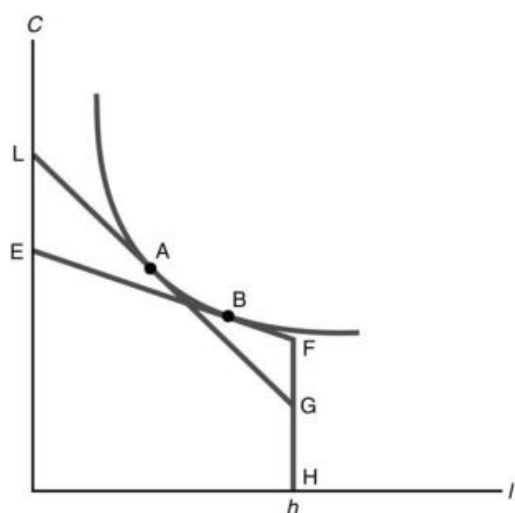


Question 14

Suppose that the representative consumer's dividend income increases, and his or her wage rate falls at the same time. Determine the effects on consumption and labor supply and explain your results in terms of income and substitution effects.

Solution:

The increase in dividend income shifts the budget line upward. The reduction in the wage rate flattens the budget line. One possibility is depicted in the figures below. The original budget constraint HGL shifts to HFE. There are two income effects in this case. The increase in dividend income is a positive income effect. The reduction in the wage rate is a negative income effect. The drawing in the top figure shows the case where these two income effects exactly cancel out. In this case we are left with a pure substitution effect that moves the consumer from point A to point B. Therefore, consumption falls and leisure increases. As leisure increases, hours of work must fall. The middle figure shows a case in which the increase in dividend income, the distance GF, is larger and so the income effect is positive. The consumer winds up on a higher indifference curve, leisure unambiguously increases, and consumption may either increase or decrease. The bottom figure shows a case in which the increase in dividend income, the distance GF, is smaller and so the income effect is negative. The consumer winds up on a lower indifference curve, consumption unambiguously decreases, and leisure may either increase or decrease.



Question 15

Suppose that the government imposes a producer tax. That is, the firm pays t units of consumption goods to the government for each unit of output it produces. Determine the effect of this tax on the firm's demand for labor.

Solution:

The firm chooses its labor input, N^d , so as to maximize profits. When there is no tax, profits for the firm are given by

$$\pi = zF(K, N^d) - wN^d.$$

That is, profits are the difference between revenue and costs. In the top figure on the following page, the revenue function is $zF(K, N^d)$ and the cost function is the straight line, wN^d . The firm maximizes profits by choosing the quantity of labor where the slope of the revenue function equals the slope of the cost function:

$$MP_N = w.$$

The firm's demand for labor curve is the marginal product of labor schedule in the bottom figure on the following page.

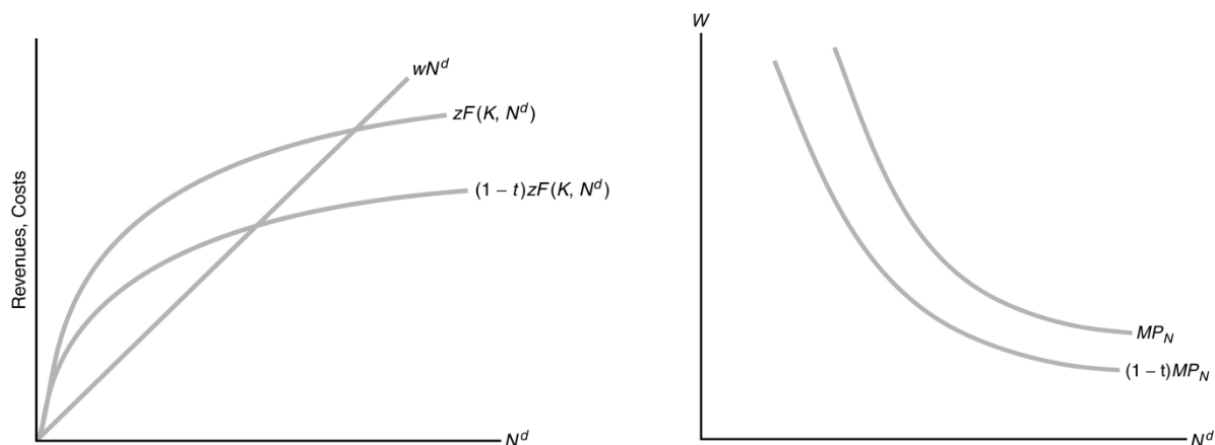
With a tax that is proportional to the firm's output, the firm's profits are given by:

$$\begin{aligned}\pi &= zF(K, N^d) - wN^d - tzF(K, N^d) \\ &= (1 - t) zF(K, N^d) - wN^d,\end{aligned}$$

where the term $(1 - t) zF(K, N^d)$ is the after-tax revenue function, and as before, wN^d is the cost function. In the top figure below, the tax acts to shift down the revenue function for the firm and reduces the slope of the revenue function. As before, the firm will maximize profits by choosing the quantity of labor input where the slope of the revenue function is equal to the slope of the cost function, but the slope of the revenue function is $(1 - t) MP_N$, so the firm chooses the quantity of labor where

$$(1 - t) MP_N = w.$$

In the bottom figure below, the labor demand curve is now $(1 - t) MP_N$, and the labor demand curve has shifted down. The tax acts to reduce the after-tax marginal product of labor, and the firm will hire less labor at any given real wage.



Question 16

Suppose that the government subsidizes employment. That is, the government pays the firm s units of consumption goods for each unit of labor that the firm hires. Determine the effect of the subsidy on the firm's demand for labor.

Solution:

The firm chooses its labor input N^d so as to maximize profits. When there is no subsidy, profits for the firm are given by

$$\pi = zF(K, N^d) - wN^d.$$

That is, profits are the difference between revenue and costs. In the top figure on the following page the revenue function is $zF(K, N^d)$ and the cost function is the straight line, wN^d . The firm maximizes profits by choosing the quantity of labor where the slope of the revenue function equals the slope of the cost function:

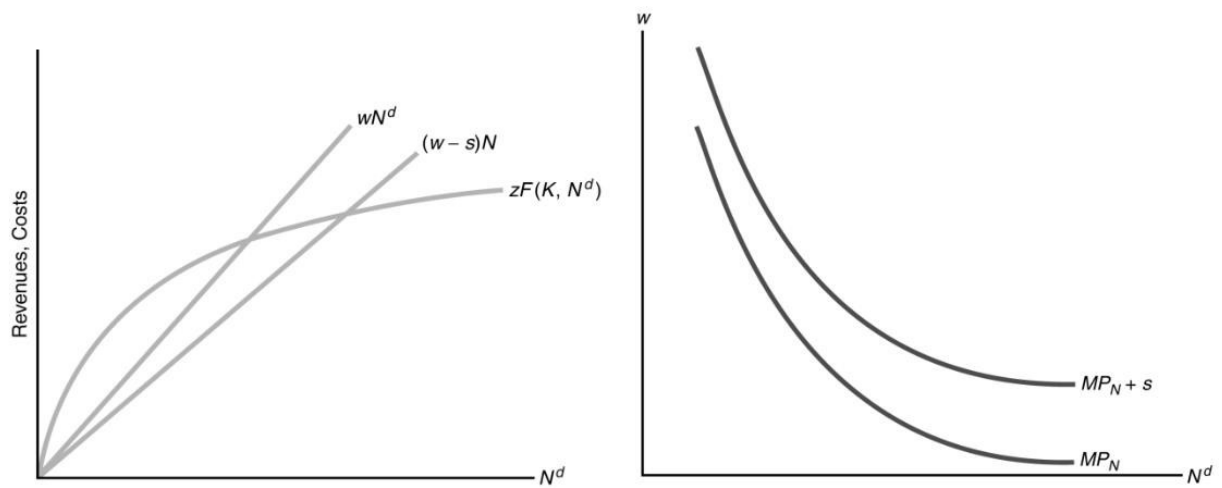
$$MP_N = w.$$

The firm's demand for labor curve is the marginal product of labor schedule in the bottom figure below.

With an employment subsidy, the firm's profits are given by:

$$\pi = zF(K, N^d) - (w - s)N^d$$

In the bottom figure below, the labor demand curve is now $MP_N + s$, and the labor demand curve has shifted up. The subsidy acts to reduce the marginal cost of labor, and the firm will hire more labor at any given real wage.



where the term $zF(K, N^d)$ is the unchanged revenue function, and $(w-s)N^d$ is the cost function. The subsidy acts to reduce the cost of each unit of labor by the amount of the subsidy, s . In the top figure below, the subsidy acts to shift down the cost function for the firm by reducing its slope. As before, the firm will maximize profits by choosing the quantity of labor input where the slope of the revenue function is equal to the slope of the cost function, $(w-s)$, so the firm chooses the quantity of labor where

$$MP_N = w - s.$$