SOLUTIONS MANUAL

Macroeconomics

Third Edition

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Chapter 2
Measurement

■ Teaching Goals

Students must understand the importance of measuring aggregate economic activity. Macroeconomics hopes to produce theories that provide useful insights and policy conclusions. To be credible, such theories must produce hypotheses that evidence could possibly refute. Macroeconomic measurement provides such evidence. Without macroeconomic measurements, macroeconomics could not be a social **science,** and would rather consist of philosophizing and pontificating. Market transactions provide the most simple and direct measurements. Macroeconomists' most basic measurement is Gross Domestic Product (GDP), the value of final, domestically market output produced during a given period of time.

In the United States, the Commerce Department's National Income and Product Accounts provide official estimates of GDP. These accounts employ their own set of accounting rules to ensure internal consistency and to provide several separate estimates of GDP. These separate estimates are provided by the product accounts, the expenditure accounts, and the income accounts. The various accounting conventions may, at first glance, be rather dry and complicated. However, students can only easily digest the material in later chapters if they have a good grounding in the fundamentals.

GDP changes through time because different amounts of goods and services are produced, and such goods and services are sold at different prices. Standards of living are determined by the amounts of goods and services produced, not by the prices they command in the market. While GDP is relatively easy to measure, the decomposition of changes in real GDP into quantity and price components is much more difficult. This kind of problem is less pressing for microeconomists. It is easy to separately measure the number of apples sold and the price of each apple. Because macroeconomics deals with aggregate output, the differentiation of price and quantity is much less easily apparent. It is important to emphasize that while there may be more or less reasonable approaches to this problem, there is no unambiguous best approach. Since many important policy discussions involve debates about output and price measurements, it is very important to understand exactly how such measurements are produced.

■ Classroom Discussion Topics

As the author demonstrates in presenting this chapter's material, much of this material is best learned by example. Rather than simply working through the examples from the text or making up your own, the material may resonate better if the students come up with their own examples. They can start by picking a single good, and by the choice of their numbers they provide their own implied decomposition of output into wage and profit income. Later on, encourage them to suggest intermediate input production, inventory adjustments, international transactions, a government sector, and so on. Such an exercise may help assure them that the identities presented in the text are more than simply abstract constructions.

If many of your students are familiar with accounting principles, it may also be useful to present the National Income and Product Account with the "T" accounts. Highlighting how every income is an expense elsewhere. Make one account for each of the firms, one for the household and one for the government. Add another account for the rest of the world when discussing the example with international trade. This procedure can highlight how some entities can be inferred from others because accounting

identities must hold. It makes it also easier to determine consumption for some student Social Security benefits are indexed to the Consumer Price Index. Explain with an example exactly how these adjustments are made. Ask the students if they think that this procedure is "fair." Another topic for concern is the stagnation in the growth of measured real wages. Real wages are measured by dividing (for example) average hourly wages paid in manufacturing by the consumer price index. Ask students if measured changes in real wages confirm or conflict with their general beliefs about whether the typical worker is better or worse off than 10 or 20 years ago. How does possible mis-measurement of prices reconcile any apparent differences between casual impressions and statistical evidence?

The text discusses why unemployment may or may not be a good measure of labor market tightness. Another interpretation of the unemployment rate is as a(n inverse) measure of economic welfare. Ask the students if they agree with this interpretation. Does the unemployment rate help factor in considerations like equal distribution of income? How can the unemployment rate factor in considerations like higher income per employed worker? Discuss possible pros and cons of using unemployment rather than per capita real GDP as a measure of well-being. Can unemployment be too low? Why or why not?

■ Outline

I. Measuring GDP: The National Income and Product Accounts

A. What Is GDP and How Do We Measure It?
   1. GDP: Value of Domestically Produced Output
   2. Commerce Department's National Income and Product Accounts
   3. Business, Consumer, and Government Accounting

B. The Product Approach
   1. Value Added
   2. Intermediate Good Inputs

C. The Expenditure Approach
   1. Consumption
   2. Investment
   3. Government Spending
   4. Net Exports

D. The Income Approach
   1. Wage Income
   2. After-Tax Profits
   3. Interest Income
   4. Taxes
   5. The Income-Expenditure Identity

E. Gross National Product (GNP)
   1. Treatment of Foreign Income
   2. GNP = GDP + Net Foreign Income

F. What Does GDP Leave Out?
   1. GDP and Welfare
      a. Income Distribution
      b. Non-Market Production
   2. Measuring Market Production
      a. The Underground Economy
      b. Valuing Government Production

G. Expenditure Components
   1. Consumption
      a. Durable Goods
      b. Non-Durable Goods
      c. Services
   2. Investment
      a. Fixed Investment: Nonresidential and Residential
      b. Inventory Investment
   3. Net Exports
      a. Exports
      b. Imports
   4. Government Expenditures
      a. Federal Defense
      b. Federal Non-Defense
      c. State and Local
      d. Treatment of Transfer Payments

II. Nominal and Real GDP and Price Indices

A. Real GDP
   1. Output Valued at Base Year Prices
   2 Chain Weighted Real GDP

B. Measures of the Price Level
   1. Implicit GDP Price Deflator
   2. Consumer Price Index (CPI)

C. Problems Measuring Real GDP and Prices
   1. Substitution Biases
   2. Accounting for Quality Changes
   3. Treatment of Newly Introduced Goods

III. Savings, Wealth, and Capital

A. Stocks and Flows

B. Private Disposable Income and Private Sector Saving
   1. $Y^d = Y + NFP + TR + INT - T$
   2. $S^p = Y^d - C$

C. Government Surpluses, Deficits, and Government Saving
   1. $S^g = T - TR - INT - G$
   2. $D = -S^g$

D. National Saving: $S = S^p + S^g = Y + NFP - C - G$

E. Saving, Investment, and the Current Account
   1. $S = I + NX + NFP$
   2. $CA = NX + NFP \Rightarrow S = I + CA$

F. The Stock of Capital
   1. S $\Rightarrow \Delta$ Wealth
   2. $I \Rightarrow \Delta K$
   3. $CA \Rightarrow$ Claims on Foreigners

IV. Labor Market Measurement

A. BLS Categories

1. Employed
2. Unemployed
3. Not in the Labor Force

B. The Unemployment Rate

$$\text{Unemployment Rate} = \frac{\text{Number unemployed}}{\text{Labor force}}$$

C. The Participation Rate

$$\text{Participation Rate} = \frac{\text{Labor force}}{\text{Total working age population}}$$

D. Unemployment and Labor Force Tightness

1. Discouraged Workers
2. Job Search Intensity

■ Textbook Question Solutions

Questions for Review

1. Product, income, and expenditure approaches.

2. For each producer, value added is equal to the value of total production minus the cost of intermediate inputs.

3. This identity emphasizes the point that all sales of output provide income somewhere in the economy. The identity also provides two separate ways of measuring total output in the economy.

4. GNP is equal to GDP (domestic production) plus net factor payments from abroad. Net factor payments represent income for domestic residents that are earned from production that takes place in foreign countries.

5. GDP provides a reasonable approximation of economic welfare. However, GDP ignores the value of nonmarket economic activity. GDP also measures only total income without reference to how that income is distributed.

6. Measured GDP does not include production in the underground economy, which is difficult to estimate. GDP also measures the value of government spending at its cost of production, which may be greater or less than its true value.

7. The largest component is consumption, which represents about 2/3 of GDP.

8. Investment is equal to private, domestic expenditure on goods and services ($Y - G - NX$) minus consumption. Investment includes residential investment, nonresidential investment, and inventory investment.

9. National defense spending represents about 5% of GDP.

10. GDP values production at market prices. Real GDP compares different years' production at a specific set of prices. These prices are those that prevailed in the base year. Real GDP is therefore a weighted average of individual production levels. The weights are determined according to prevailing relative prices in the base year. Because relative prices change over time, comparisons of real GDP across time can differ according to the chosen base year.

11. Chain weighting directly compares production levels only in adjacent years. The price weights are determined by averaging the prices of the individual goods and services over the two adjacent years.

12. Real GDP is difficult to measure due to changes over time in relative prices, difficulties in estimating the extent of quality changes, and how one estimates the value of newly introduced goods.

13. Private saving measures additions to private sector wealth. Government saving measures reductions in government debt (increases in government wealth). National saving measures additions to national wealth. National saving is equal to private saving plus government saving.

14. National wealth is accumulated as increases in the domestic stock of capital (domestic investment) and increases in claims against foreigners (the current account surplus).

15. Measured unemployment excludes discouraged workers. Measured unemployment only accounts for the number of individuals unemployed, without reference to how intensively they search for new jobs.

Problems

1. Product accounting adds up value added by all producers. The wheat producer has no intermediate inputs and produces 30 million bushels at \$3/bu. for \$90 million. The bread producer produces 100 million loaves at \$3.50/loaf for \$350 million. The bread producer uses \$75 million worth of wheat as an input. Therefore, the bread producer's value added is \$275 million. Total GDP is therefore \$90 million + \$275 million = \$365 million.

   Expenditure accounting adds up the value of expenditures on final output. Consumers buy 100 million loaves at \$3.50/loaf for \$350 million. The wheat producer adds 5 million bushels of wheat to inventory. Therefore, investment spending is equal to 5 million bushels of wheat valued at \$3/bu., which costs \$15 million. Total GDP is therefore \$350 million + \$15 million = \$365 million.

2. Coal producer, steel producer, and consumers.

   (a) (i) Product approach: Coal producer produces 15 million tons of coal at \$5/ton, which adds \$75 million to GDP. The steel producer produces 10 million tons of steel at \$20/ton, which is worth \$200 million. The steel producer pays \$125 million for 25 million tons of coal at \$5/ton. The steel producer's value added is therefore \$75 million. GDP is equal to \$75 million + \$75 million = \$150 million.

   (ii) Expenditure approach: Consumers buy 8 million tons of steel at \$20/ton, so consumption is \$160 million. There is no investment and no government spending. Exports are 2 million tons of steel at \$20/ton, which is worth \$40 million. Imports are 10 million tons of coal at \$5/ton, which is worth \$50 million. Net exports are therefore equal to \$40 million − \$50 million = −\$10 million. GDP is therefore equal to \$160 million + (−\$10 million) = \$150 million.

(iii) Income approach: The coal producer pays $50 million in wages and the steel producer pays $40 million in wages, so total wages in the economy equal $90 million. The coal producer receives $75 million in revenue for selling 15 million tons at $15/ton. The coal producer pays $50 million in wages, so the coal producer's profits are $25 million. The steel producer receives $200 million in revenue for selling 10 million tons of steel at $20/ton. The steel producer pays $40 million in wages and pays $125 million for the 25 million tons of coal that it needs to produce steel. The steel producer's profits are therefore equal to $200 million − $40 million − $125 million = $35 million. Total profit income in the economy is therefore $25 million + $35 million = $60 million. GDP therefore is equal to wage income ($90 million) plus profit income ($60 million). GDP is therefore $150 million.

(b) There are no net factor payments from abroad in this example. Therefore, the current account surplus is equal to net exports, which is equal to (−$10 million).

(c) As originally formulated, GNP is equal to GDP, which is equal to $150 million. Alternatively, if foreigners receive $25 million in coal industry profits as income, then net factor payments from abroad are (−$25 million), so GNP is equal to $125 million.

3. Wheat and Bread

(a) Product approach: Firm A produces 50,000 bushels of wheat, with no intermediate goods inputs. At $3/bu., the value of Firm A's production is equal to $150,000. Firm B produces 50,000 loaves of bread at $2/loaf, which is valued at $100,000. Firm B pays $60,000 to firm A for 20,000 bushels of wheat, which is an intermediate input. Firm B's value added is therefore $40,000. GDP is therefore equal to $190,000.

(b) Expenditure approach: Consumers buy 50,000 loaves of domestically produced bread at $2/loaf and 15,000 loaves of imported bread at $1/loaf. Consumption spending is therefore equal to $100,000 + $15,000 = $115,000. Firm A adds 5,000 bushels of wheat to inventory. Wheat is worth $3/bu., so investment is equal to $15,000. Firm A exports 25,000 bushels of wheat for $3/bu. Exports are $75,000. Consumers import 15,000 loaves of bread at $1/loaf. Imports are $15,000. Net exports are equal to $75,000 − $15,000 = $60,000. There is no government spending. GDP is equal to consumption ($115,000) plus investment ($15,000) plus net exports ($60,000). GDP is therefore equal to $190,000.

(c) Income approach: Firm A pays $50,000 in wages. Firm B pays $20,000 in wages. Total wages are therefore $70,000. Firm A produces $150,000 worth of wheat and pays $50,000 in wages. Firm A's profits are $100,000. Firm B produces $100,000 worth of bread. Firm B pays $20,000 in wages and pays $60,000 to Firm A for wheat. Firm B's profits are $100,000 − $20,000 − $60,000 = $20,000. Total profit income in the economy equals $100,000 + $20, 000 = $120,000. Total wage income ($70,000) plus profit income ($120,000) equals $190,000. GDP is therefore $190,000.

4. Price and quantity data are given as the following.

Year 1

Good	Quantity	Price
Computers	20	\$1,000
Bread	10,000	\$1.00

Year 2

Good	Quantity	Price
Computers	25	\$1,500
Bread	12,000	\$1.10

(a) Year 1 nominal GDP $= 20 \times \$1{,}000 + 10{,}000 \times \$1.00 = \$30{,}000$.

Year 2 nominal GDP $= 25 \times \$1{,}500 + 12{,}000 \times \$1.10 = \$50{,}700$.

With year 1 as the base year, we need to value both years' production at year 1 prices. In the base year, year 1, real GDP equals nominal GDP equals \$30,000. In year 2, we need to value year 2's output at year 1 prices. Year 2 real GDP $= 25 \times \$1{,}000 + 12{,}000 \times \$1.00 = \$37{,}000$. The percentage change in real GDP equals (\$37,000 − \$30,000)/\$30,000 = 23.33%.

We next calculate chain-weighted real GDP. At year 1 prices, the ratio of year 2 real GDP to year 1 real GDP equals g_1 = (\$37,000/\$30,000) = 1.2333. We must next compute real GDP using year 2 prices. Year 2 GDP valued at year 2 prices equals year 2 nominal GDP = \$50,700. Year 1 GDP valued at year 2 prices equals (20 × \$1,500 + 10,000 × \$1.10) = \$41,000. The ratio of year 2 GDP at year 2 prices to year 1 GDP at year 2 prices equals g_2 = (\$50,700/\$41,000) = 1.2367. The chain-weighted ratio of real GDP in the two years therefore is equal to $g_c = \sqrt{g_1 g_2} = 1.23496$. The percentage change chain-weighted real GDP from year 1 to year 2 is therefore approximately 23.5%.

If we (arbitrarily) designate year 1 as the base year, then year 1 chain-weighted GDP equals nominal GDP equals \$30,000. Year 2 chain-weighted real GDP is equal to (1.23496 × \$30,000) = \$37,048.75.

(b) To calculate the implicit GDP deflator, we divide nominal GDP by real GDP, and then multiply by 100 to express as an index number. With year 1 as the base year, base year nominal GDP equals base year real GDP, so the base year implicit GDP deflator is 100. For the year 2, the implicit GDP deflator is (\$50,700/\$37,000) × 100 = 137.0. The percentage change in the deflator is equal to 37.0%.

With chain weighting, and the base year set at year 1, the year 1 GDP deflator equals (\$30,000/\$30,000) × 100 = 100. The chain-weighted deflator for year 2 is now equal to (\$50,700/\$37,048.75) × 100 = 136.85. The percentage change in the chain-weighted deflator equals 36.85%.

(c) We next consider the possibility that year 2 computers are twice as productive as year 1 computers. As one possibility, let us define a "computer" as a year 1 computer. In this case, the 25 computers produced in year 2 are the equivalent of 50 year 1 computers. Each year 1 computer now sells for \$750 in year 2. We now revise the original data as:

Year 1

Good	Quantity	Price
Year 1 Computers	20	\$1,000
Bread	10,000	\$1.00

Year 2

Good	Quantity	Price
Year 1 Computers	50	\$750
Bread	12,000	\$1.10

First, note that the change in the definition of a "computer" does not affect the calculations of nominal GDP. We next compute real GDP with year 1 as the base year. Year 2 real GDP in year 1 prices is now $50 \times \$1{,}000 + 12{,}000 \times \$1.00 = \$62{,}000$. The percentage change in real GDP is equal to (\$62,000 − \$30,000)/\$30,000 = 106.7%.

We next revise the calculation of chain-weighted real GDP. From above, g_1 equals (\$62,000/\$30,000) = 206.67. The value of year 1 GDP at year 2 prices equals \$26,000. Therefore, g_2 equals (\$50,700/\$26,000) = 1.95. 200.75. The percentage change chain-weighted real GDP from year 1 to year 2 is therefore 100.75%.

If we (arbitrarily) designate year 1 as the base year, then year 1 chain-weighted GDP equals nominal GDP equals \$30,000. Year 2 chain-weighted real GDP is equal to (2.0075 × \$30,000) = \$60,225. The chain-weighted deflator for year 1 is automatically 100. The chain-weighted deflator for year 2 equals (\$50,700/\$60,225) × 100 = 84.18. The percentage rate of change of the chain-weighted deflator equals −15.8%.

When there is no quality change, the difference between using year 1 as the base year and using chain weighting is relatively small. Factoring in the increased performance of year 2 computers, the production of computers rises dramatically while its relative price falls. Compared with earlier practices, chain weighting provides a smaller estimate of the increase in production and a smaller estimate of the reduction in prices. This difference is due to the fact that the relative price of the good that increases most in quantity (computers) is much higher in year 1. Therefore, the use of historical prices puts more weight on the increase in quality-adjusted computer output.

5. Price and quantity data are given as the following:

Year 1

Good	Quantity (million lbs.)	Price (per lb.)
Broccoli	1,500	\$0.50
Cauliflower	300	\$0.80

Year 2

Good	Quantity (million lbs.)	Price (per lb.)
Broccoli	2,400	\$0.60
Cauliflower	350	\$0.85

(a) Year 1 nominal GDP = Year 1 real GDP $= 1{,}500 \text{ million} \times \$0.50 + 300 \text{ million} \times \$0.80 =$ \$990 million.

Year 2 nominal GDP $= 2{,}400 \text{ million} \times \$0.60 + 350 \text{ million} \times \$0.85 = \$1{,}730.5 \text{ million}$

Year 2 real GDP $= 2{,}400 \text{ million} \times \$0.50 + 350 \text{ million} \times \$0.80 = \$1{,}450 \text{ million}.$

Year 1 GDP deflator equals 100.

Year 2 GDP deflator equals (\$1,730.5/\$1,450) × 100 = 119.3.
The percentage change in the deflator equals 19.3%.

(b) Year 1 production (market basket) at year 1 prices equals year 1 nominal GDP = \$990 million. The value of the market basket at year 2 prices is equal to $1{,}500 \text{ million} \times \$0.60 + 300 \text{ million} \times \$0.85 = \$1{,}050 \text{ million}.$

Year 1 CPI equals 100.

Year 2 CPI equals (\$1,050/\$990) × 100 = 106.1.
The percentage change in the CPI equals 6.1%.

The relative price of broccoli has gone up. The relative quantity of broccoli has also gone up. The CPI attaches a smaller weight to the price of broccoli, and so the CPI shows less inflation.

6. Corn producer, consumers, and government.

(a) (i) Product approach: There are no intermediate goods inputs. The corn producer grows 30 million bushels of corn. Each bushel of corn is worth \$5. Therefore, GDP equals \$150 million.

(ii) Expenditure approach: Consumers buy 20 million bushels of corn, so consumption equals \$100 million. The corn producer adds 5 million bushels to inventory, so investment equals \$25 million. The government buys 5 million bushels of corn, so government spending equals \$25 million. GDP equals \$150 million.

(iii) Income approach: Wage income is \$60 million, paid by the corn producer. The corn producer's revenue equals \$150 million, including the value of its addition to inventory. Additions to inventory are treated as purchasing one owns output. The corn producer's costs include wages of \$60 million and taxes of \$20 million. Therefore, profit income equals \$150 million − \$60 million − \$20 million = \$70 million. Government income equals taxes paid by the corn producer, which equals \$20 million. Therefore, GDP by income equals \$60 million + \$70 million + \$20 million = \$150 million.

(b) Private disposable income equals GDP (\$150 million) plus net factor payments (0) plus government transfers (\$5 million is Social Security benefits) plus interest on the government debt (\$10 million) minus total taxes (\$30 million), which equals \$135 million. Private saving equals private disposable income (\$135 million) minus consumption (\$100 million), which equals \$35 million. Government saving equals government tax income (\$30 million) minus transfer payments (\$5 million) minus interest on the government debt (\$10 million) minus government spending (\$5 million), which equals \$10 million. National saving equals private saving (\$35 million) plus government saving (\$10 million), which equals \$45 million. The government budget surplus equals government savings (\$10 million). Since the budget surplus is positive, the government budget is in surplus. The government deficit is therefore equal to (−\$10 million).

7. Price controls.

   Nominal GDP is calculated by measuring output at market prices. In the event of effective price controls, measured prices equal the controlled prices. However, controlled prices reflect an inaccurate measure of scarcity values. Nominal GDP is therefore distorted. In addition to distortions in nominal GDP measures, price controls also inject an inaccuracy in attempts to decompose changes in nominal GDP into movements in real GDP and movements in prices. With price controls, there is typically little or no change in white market prices over time. Alternatively, black market or scarcity value prices typically increase, perhaps dramatically. Measures of prices (in terms of scarcity values) understate inflation. Whenever inflation measures are too low, changes in real GDP overstate the extent of increases in actual production.

8. Underground economy.

   Transactions in underground economy are performed with cash exclusively, to exploit the anonymous nature of currency. Thus, once we have established the amount of currency held abroad, we know the portion of $2,474 that is held domestically. Remove from it what is used for recorded transactions, say by using some estimate of the proportion of transactions using cash and applying this to observed GDP. Finally apply a concept of velocity of money to the remaining amount of cash to obtain the size of the underground economy.

9. $S^p - 1 = CA + D$

   (a) By definition:

$$S^p = Y^d - C = Y + NFP + TR + INT - T - C$$

   Next, recall that $Y = C + I + G + NX$. Substitute into the equation above and subtract I to obtain:

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

   (b) Private saving, which is not used to finance domestic investment, is either lent to the domestic government to finance its deficit (D), or is lent to foreigners (CA).

10. Computing capital with the perpetual inventory method.

   (a) First, use the formula recursively for each year:

$K_0 = 80$

$K_1 = 0.9 \times 80 + 10 = 82$

$K_2 = 0.9 \times 82 + 10 = 83.8$

$K_3 = 0.9 \times 83.8 + 10 = 85.42$

$K_4 = 0.9 \times 85.42 + 10 = 86.88$

$K_5 = 0.9 \times 86.88 + 10 = 88.19$

$K_6 = 0.9 \times 88.19 + 10 = 89.37$

$K_7 = 0.9 \times 89.37 + 10 = 90.43$

$K_8 = 0.9 \times 90.43 + 10 = 91.39$

$K_9 = 0.9 \times 91.39 + 10 = 92.25$

$K_{10} = 0.9 \times 92.25 + 10 = 93.03$

   (b) This time, capital stays constant at 100, as the yearly investment corresponds exactly to the amount of capital that is depreciated every year. In (a), we started with a lower level of capital, thus less depreciated than what was invested, as capital kept rising (until it would reach 100).

11. Assume the following:

$$\begin{aligned} D &= 10 \\ INT &= 5 \\ T &= 40 \\ G &= 30 \\ C &= 80 \\ NFP &= 10 \\ CA &= -5 \\ S &= 20 \end{aligned}$$

(a)

$$\begin{aligned} Y^d &= S^p + C \\ &= S + D + C \\ &= 20 + 10 + 80 = 110 \end{aligned}$$

(b)

$$\begin{aligned} D &= G + TR + INT - T \\ TR &= D - G - INT + T = 10 - 30 - 5 + 40 = 15 \end{aligned}$$

(c)

$$\begin{aligned} S &= GNP - C - G \\ GNP &= S + C + G = 20 + 80 + 30 = 130 \end{aligned}$$

(d)

$$GDP = GNP - NFP = 130 - 10 = 120$$

(e)

$$\text{Government Surplus} = S^g = -D = -10$$

(f)

$$\begin{aligned} CA &= NX + NFP \\ NX &= CA - NFP = -5 - 10 = -15 \end{aligned}$$

(g)

$$\begin{aligned} GDP &= C + I + G + NX \\ I &= GDP - C - G - NX = 120 - 80 - 30 + 15 = 25 \end{aligned}$$