Chapter 1 – Problem 1 – Calculating Growth Rates Data:

Year	Real Per Capita GNP
1950	$11,745
1960	$13,951
1970	$18,561
1980	$22,784
1990	$28,598
1995	$30,525
1996	$31,396
1997	$32,520
1998	$33,544
1999	$34,367
2000	$35,265
2001	$35,165
2002	$35,368
2003	$35,895
2004	$36,939
2005	$37,773

(a) Calculate the percentage growth rates in real GDP per capita per each of the years 1996 through 2005 from the previous year.

(b) Now, instead of calculating the annual percentage growth rates in the years 1996 through 2005 directly, use as an approximation $100 \times (\ln y_t - \ln y_{t-1})$ where y_t is real per capita GDP in year *t*. How close does this approximation come to the actual growth rates you calculated in part (a)?

(c) Repeat parts (a) and (b), but now calculate the percentage rates of growth in real per capita GDP from 1950 to 1960, from 1960 to 1970, from 1970 to 1980, 1980 to 1990 and 1990 to 2000. In this case, how large an error do you make by approximating the growth rate by the change in natural log? Why is there a difference here relative to parts (a) and (b)?

(d) During what decade from 1950 to 2000 was growth in real per capita GDP the highest? What was it the lowest?

(a) Actual Percentage Growth Rates, 1996–2005.

The “actual” percentage growth rate is calculated by:

$$g_t = 100 \times \frac{y_t - y_{t-1}}{y_{t-1}}$$

where y_t is the real per capita GNP. Note that we multiply by 100 to obtain a growth rate in “percentage” terms. Also see p.6 in the textbook.

(a) Actual Percentage Growth Rates, 1996–2005.

Year	Real Per Capita GNP	%Growth
1995	$30,525	
1996	$31,396	2.85
1997	$32,520	3.58
1998	$33,544	3.15
1999	$34,367	2.45
2000	$35,265	2.61
2001	$35,165	–0.28
2002	$35,368	0.58
2003	$35,895	1.49
2004	$36,939	2.91
2005	$37,773	2.26

(b) Approximate Percentage Growth Rates, 1996–2005.

The "approximate" percentage growth rate is calculated by:

$$g_t \approx 100 \times \ln\left(\frac{y_t}{y_{t-1}}\right) = 100 \times \left(\ln y_t - \ln y_{t-1}\right)$$

where "ln" is the natural log operator. Note that we multiply by 100 to obtain a growth rate in "percentage" terms. Also see p.6 in the textbook.

(b) Approximate Percentage Growth Rates, 1996–2005.

Year	Real Per Capita GNP	%Growth
1995	$30,525	
1996	$31,396	2.81
1997	$32,520	3.52
1998	$33,544	3.10
1999	$34,367	2.42
2000	$35,265	2.58
2001	$35,165	–0.28
2002	$35,368	0.58
2003	$35,895	1.48
2004	$36,939	2.87
2005	$37,773	2.23

COMPARISON of Growth Calculation Methods

Year	Actual %Growth	Approximate %Growth
1995		
1996	2.85	2.81
1997	3.58	3.52
1998	3.15	3.10
1999	2.45	2.42
2000	2.61	2.58
2001	–0.28	–0.28
2002	0.58	0.58
2003	1.49	1.48
2004	2.91	2.87
2005	2.26	2.23

The approximation is extremely close. The approximation works well for small percentage changes.

(c) Actual Percentage Growth Rates for Decades, 1950–2000.

Year	Real Per Capita GNP	%Growth
1950	$11,745	
1960	$13,951	18.78
1970	$18,561	33.04
1980	$22,784	22.75
1990	$28,598	25.52
2000	$35,265	23.31

Approximate Percentage Growth Rates.

Year	**Real Per Capita GNP**	**%Growth**
1950	$11,745	
1960	$13,951	17.21
1970	$18,561	28.55
1980	$22,784	20.50
1990	$28,598	22.73
2000	$35,265	20.96

COMPARISON of Growth Calculation Methods

Year	Actual %Growth	Approximate %Growth
1950		
1960	18.78	17.21
1970	33.04	28.55
1980	22.75	20.50
1990	25.52	22.73
2000	23.31	20.96

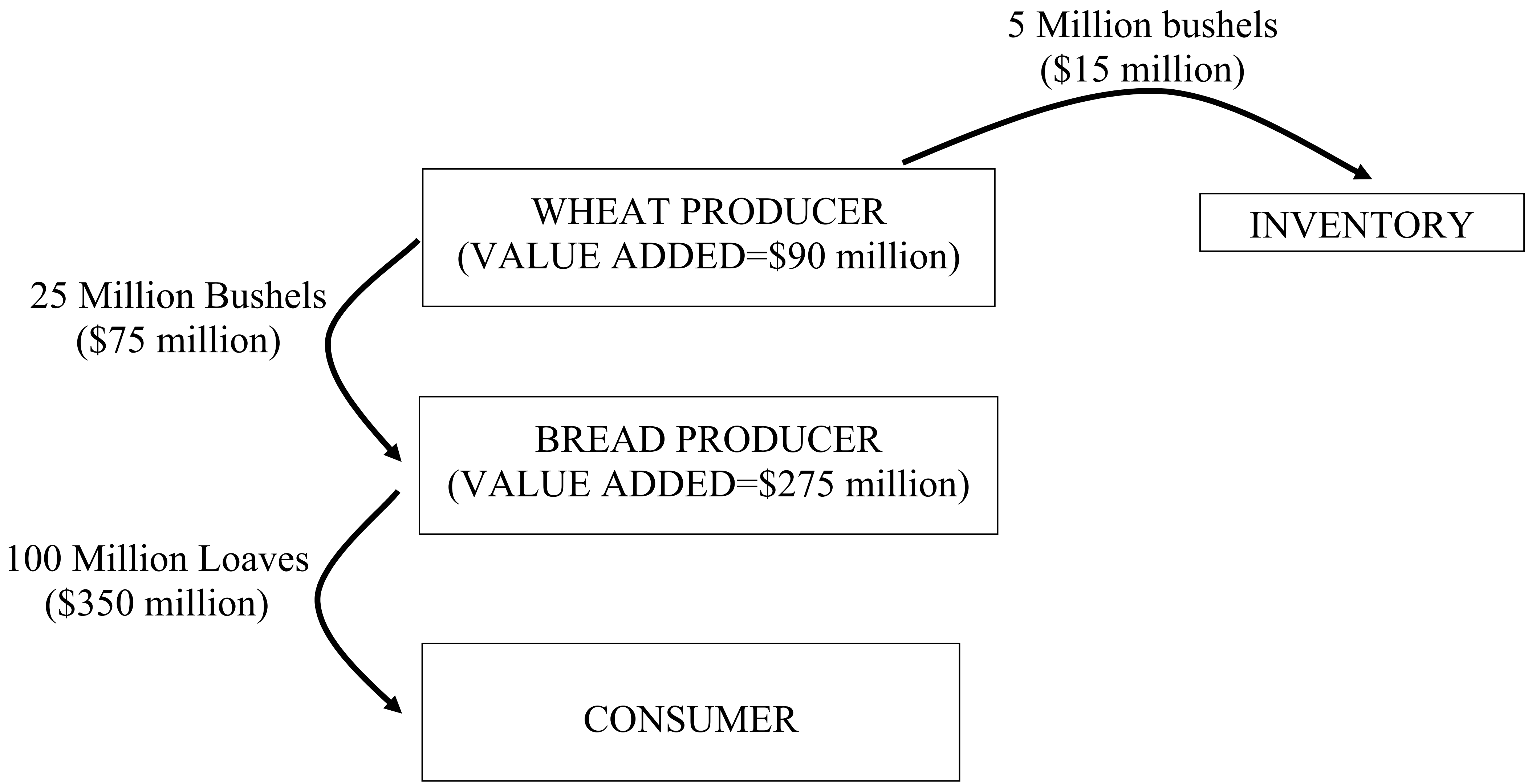
The approximation is still relatively close, but the approximation errors are larger because the growth rates are larger. Because, remember that approximation works better for low growth rates.

(d) Growth is fastest in the 1960s. Growth is slowest in the 1950s.

Chapter 2 – Problem 1

Assume an economy where there are two producers: a wheat producer and a bread producer. In a given year, the wheat producer grows 30 million bushels of wheat of which 25 million bushels are sold to the bread producer at $3 per bushel, and 5 million bushels are stored by the wheat producer to use as seed for next year's crop. The bread producer produces and sells 100 million loaves of bread to consumers for $3.50 per loaf. Determine GDP in this economy during this year using the product and expenditure approaches.

Related Diagram:



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.

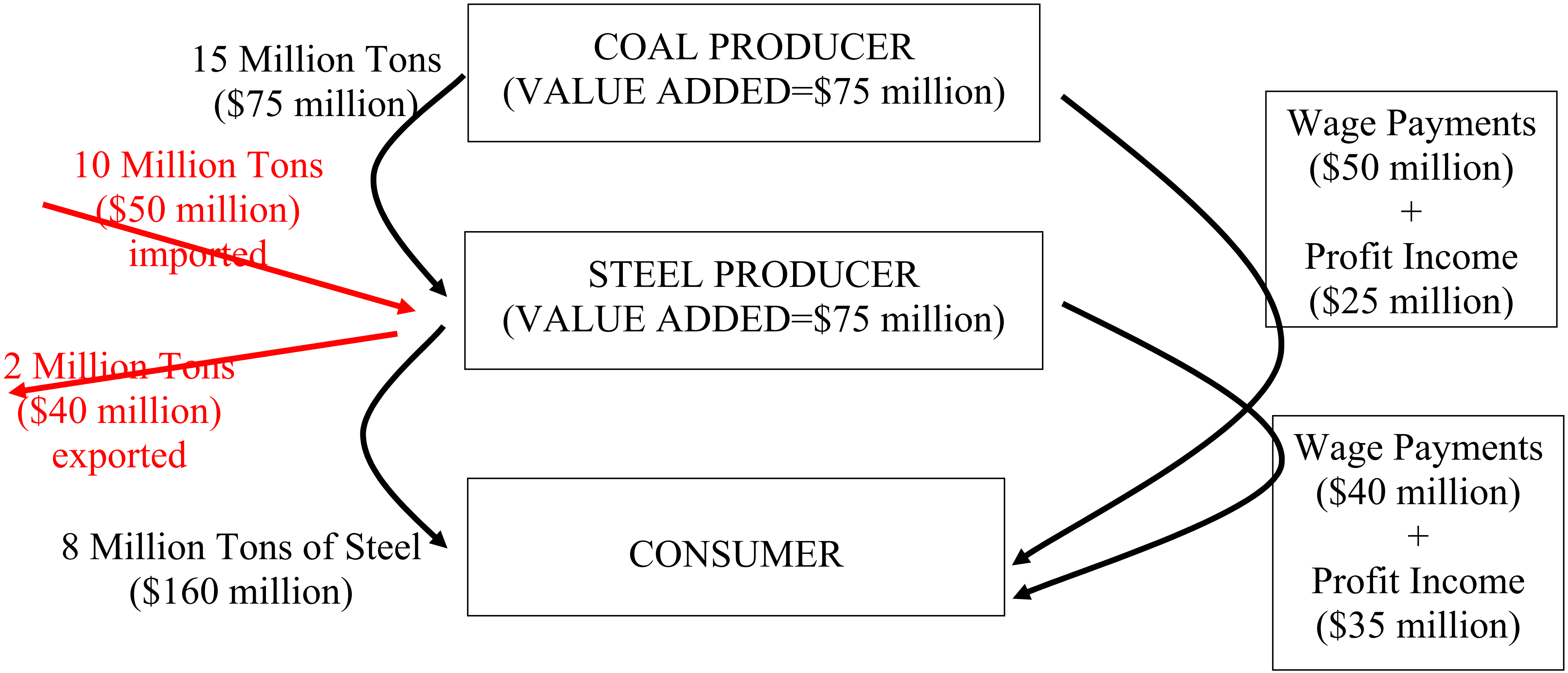
2. Assume and economy with a coal producer, a steel producer, and some consumers (there is no government). In a given year, the coal producer produces 15 million tons of coal and sells it for $5 per ton. The coal producer pays $50 million in wages to consumers. The steel producer uses 25 million tons 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.

Related Diagram:



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.