

## Macroeconomic Measurement I: Output and Production

Chapter 5 (p. 101-119)

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## Measuring Material Well-Being

- To measure the material well-being of a country, economists use the concept of **Gross Domestic Product**

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## Definition of Gross Domestic Product

- GDP is the total value of all final goods and services produced for the marketplace during a given period, within the nation's borders

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## Breaking Down Definition of GDP

- GDP is the total value of all final goods and services produced for the marketplace during a given period, within the nation's borders

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## "...the total value..."

- The economy produces many different goods and services
- We aggregate them all together into one number by adding up their dollar value (price x quantity)

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## Algebraically

$$\text{GDP in year } t = P_{\text{good 1}}^t Q_{\text{good 1}}^t + P_{\text{good 2}}^t Q_{\text{good 2}}^t + \dots$$

where:

$P$  – price in year  $t$

$Q$  – quantity produced in year  $t$

good 1, good 2,... are all final goods and services produced for the market place in year  $t$ , within nation's borders

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## Breaking Down Definition of GDP

- GDP is
  - the total value
  - of all final goods and services
  - produced
  - for the marketplace
  - during a given period
  - within the nation's borders

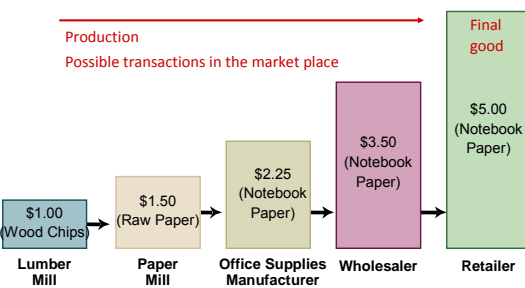
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## "...of all final..."

- Some goods are not sold to the final user
  - Instead, they are purchased by other firms and further processed
  - We call them **intermediate goods**
- Intermediate goods are not included in the formula for GDP
  - Including them would make us count things twice

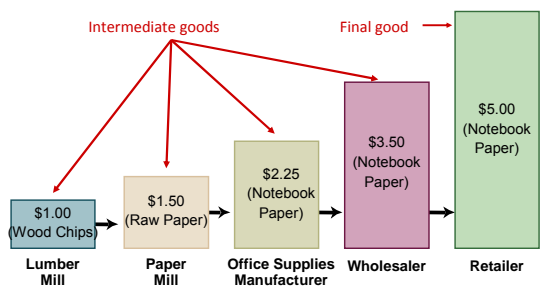
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## Example: Production of a Notebook



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## Example: Production of a Notebook



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## Example: Production of a Notebook

- Value of intermediate goods is embedded in the value of the final good
  - Value worth \$5 has been created in the end (=value of the final good)
  - If you count all the goods, you count some things at least twice:  
 $\$1 + \$1.5 + \$2.25 + \$3.5 + \$5 = \$13.25$

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## Breaking Down Definition of GDP

- GDP is
  - the total value
  - of all final goods and services
  - produced
  - for the marketplace
  - during a given period
  - within the nation's borders

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### “...produced...”

- People purchase many other things in the marketplace that have not been produced: *stocks, bonds or land*
- Bonds and stocks are included in GDP only as far as the value of the paper they are printed on is concerned (if any)
  - Their value as financial assets is irrelevant – it represents the value of a claim against future goods that has not yet been produced

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### Breaking Down Definition of GDP

- GDP is the total value of all final goods and services produced **for the marketplace** during a given period, within the nation’s borders

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### “...for the marketplace...”

- Need prices for aggregation to work
  - Some goods are not sold in the market place, e.g. apples you pick in your garden
- Since we do not know prices of some goods, we can not include them in GDP
  - A limitation of GDP as an accurate measure of material well-being of a country

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### “...for the marketplace...”

- To avoid mismeasurement from this source, whenever possible the true value of some goods is imputed to still include them in GDP
- Two important categories are:
  - Services and goods produced by public institutions
  - Inventories of unsold products

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### Services Provided by Public Institutions

- Public institutions provide many services for free or below the market price: education, health services, etc...
- To address mismeasurement from this source: **GDP includes them at the cost of providing these services (e.g. cost of running the public school/hospital)**

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### Inventories of Unsold Products

- Inventories are considered as goods that a firm sells to itself
  - They are included in GDP with imputed value
- Getting data on their value is not a problem – firms keep track of the value of their inventories in the books

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## Breaking Down Definition of GDP

- GDP is the total value of all final goods and services produced for the marketplace **during a given period** within the nation's borders

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## "...during a given period..."

- GDP is a **flow** of new final goods and services produced for the marketplace during a given period of time, within nation's borders

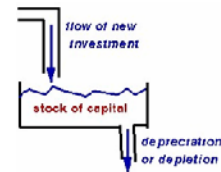
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## "...during a given period..."

- **Flow** – characterizes the change of a system occurring over an interval of time
  - Example: how much water flows into the lake *in a given interval of time*
- **Stock** – characterizes the state of a system at a given point in time
  - Example: how much water there is in the lake *at a given point in time*

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## Example: Flow versus Stock



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## Breaking Down Definition of GDP

- GDP is the total value of all final goods and services produced for the marketplace **during a given period, within the nation's borders**

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## "...within nation's borders"

- A matter of definition: in GDP we include the output produced within the nation's borders
- **Gross National Product (GNP)** looks at it differently

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## GNP Versus GDP

- GNP = GDP + **net** income received by residents from non-resident sources

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## GNP Versus GDP

- GNP = GDP + **net** income received by residents from non-resident sources
- GNP additionally **includes**:
  - Profits that GM makes in Germany and sends to US
  - The money a US nurse who works in Ethiopia sends back to her family in the US

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## GNP Versus GDP

- GNP = GDP + **net** income received by residents from non-resident sources
- GNP additionally **excludes**:
  - The money a Canadian student who works in the US sends back to his girlfriend in Canada
  - Profits that VW make in US and sends back to Germany

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## Definition of GDP: Recap

$$\text{GDP in year } t = P_{\text{good 1}}^t Q_{\text{good 1}}^t + P_{\text{good 2}}^t Q_{\text{good 2}}^t + \dots$$

–imported intermediate inputs

where:

$P$  – price in year  $t$

$Q$  – quantity produced in year  $t$

good 1, good 2 are all final goods and services

produced for the market place in year  $t$ ,

within nation's borders

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## GDP in Constant Prices as a measure of real GDP

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## Problem With Dollar's Changing Value

- Changing purchasing power of the dollar (e.g. inflation) is a problem to compare GDP over time
- **Key Issue**: GDP may grow, even though physically the economy has not produced more goods

$$\text{GDP in year } t = \overset{\uparrow}{P}_{\text{good 1}}^t \overset{\uparrow}{Q}_{\text{good 1}}^t + \overset{-}{P}_{\text{good 2}}^t \overset{\uparrow}{Q}_{\text{good 2}}^t + \dots$$

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## Remedy: GDP at Constant Prices

- Remedy: Use base period prices and apply them instead of period  $t$  prices to obtain a **GDP at constant (base period) prices**:

GDP in year  $t$  at constant prices from year 0 =

$$= P_{\text{good 1}}^0 Q_{\text{good 1}}^t + P_{\text{good 2}}^0 Q_{\text{good 2}}^t + \dots$$

where:

$P$  – price of the good in year 0 (base period price)

$Q$  – quantity of the good produced in year  $t$

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## Real and Nominal Variables in Macro

- GDP in constant prices is called **real GDP** (this method is one of many ways of obtaining real GDP)
- In general, any macroeconomic variable measured in dollars
  - When **adjusted for the dollar's changing purchasing power**, it is called **real**
  - When measured with **no adjustment for the dollar's changing purchasing power**, it is called **nominal**

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## Real GDP versus Nominal GDP

- Real GDP is useful for intertemporal comparisons of improvements of material well-being over time (growth measurement)
  - Nominal GDP is ill-suited for this purpose

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## Numerical Example

- Poland produces only 3 goods: *apples, cars and books*. They are all final goods, produced for the marketplace.
- Quantities Produced:
  - year 1990: 1 apples, 5 cars, 5 books
  - year 1991: 2 apples, 4 cars, 5 books
  - year 1992: 3 apples, 5 cars, 6 books
- Market Prices:
  - year 1990: \$5 for an apple, \$1 for a car, \$5 for a book
  - year 1991: \$6 for an apple, \$2 for a car, \$10 for a book
  - year 1992: \$6 for an apple, \$3 for a car, \$15 for a book

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## Numerical Example Cont'd

- Compute nominal GDP for each year:  
**Answer:**  
nGDP in 1990 =  $5 \times 1 + 1 \times 5 + 5 \times 5 = \$35$   
nGDP in 1991 =  $6 \times 2 + 2 \times 4 + 10 \times 5 = \$70$   
nGDP in 1992 = \$123
- What was the growth rate of nominal GDP in year 1991?  
**Answer:**  $= (70 - 35) / 35 * 100\% = 100\%$  (it doubled)
- Explain why the growth rate of nominal GDP is not a good measure of improvement in material well-being in Poland during this time period.

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## Numerical Example Cont'd

- Calculate real GDP in 1990 and 1991 measured by GDP in constant prices from year 1990.  
**Answer:**  
Clearly: rGDP 1990 = nGDP in 1990  
rGDP in 1991 =  $5 \times 2 + 1 \times 4 + 5 \times 5 = 39$
- What was the growth rate of real GDP in year 1991 (between 1991-90)?  
**Answer:**  $= (39 - 35) / 35 * 100\% = 11.4\%$
- Explain why the growth rate of real GDP is a better measure of improvement in material well-being in Poland during this time period.

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## Numerical Example Cont'd

- Calculate real GDP in 1990 and 1991 measured by GDP in constant prices from year 1992.  
Answer:  
 $rGDP\ 1990 = 6 \times 1 + 3 \times 5 + 15 \times 5 = 96$   
 $rGDP\ in\ 1991 = 6 \times 2 + 3 \times 4 + 15 \times 5 = 99$
- What was the growth rate of real GDP in 1991 when measured by GDP at constant prices from year 1992?  
Answer:  $= (99 - 96) / 96 * 100\% = 3.1\%$
- Explain why it is different from the answer you gave previously?  
Answer: The relative prices have changed – relative to apples, cars and books are cheaper in 1992 than they were in 1990. There was fast growth in production of apples (physical quantity doubles), and no growth in production of cars and books. So, by using 1990 prices we put more weight on high growth sector (apples), and using 1992 we shift weight towards stagnant sectors. This is a general property of this kind of real GDP. Measurement in past prices will tend to inflate figures and measurement in current prices will tend to downgrade them. Neither method is superior. The problem is called *substitution bias*.

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## Calculation of GDP in Practice

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## Calculation of GDP in Practice

- Calculating GDP directly from definition is difficult to implement in practice
  - It is difficult to tell whether a good is intermediate or final from its physical properties
    - Tires may be a final good, but also intermediate good sold to car manufacturers
  - Imported intermediate contents needs to be subtracted from value of final goods

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## Calculation of GDP in Practice

- So, in practice, Commerce Department's Bureau of Economic Analysis (BEA) looks at expenditures of final users rather than goods per se
  - Expenditures by all final users (exhaustive list) = value of all final goods produced
- The method is called **expenditure approach**

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## The Expenditure Approach

- Start with exhaustive list of final users: households, businesses, government agencies, foreigners
  - Exhaustive list guarantees that every final good is reflected in someone's expenditures
  - Measure their expenditures by combining several databases: retail sales of goods and services, government expenditures data, manufacturing shipments of machinery and equipment, data on inventories, exports and imports, etc...

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## Expenditure Approach to GDP

- $GDP = C + I + G + NX$ 
  - Add up the value of the goods and services purchased by each type of final user
    - $C$  = Consumption spending by households
    - $I$  = Private investment by firms
    - $G$  = Government purchases by government agencies
    - $NX$  = Exports - Imports = Net exports by foreigners

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## Consumption Spending $C$

- The part of GDP purchased by households as final users
- Largest component of GDP (70%)
  - Includes estimations for
    - Food - self-produced and consumed
    - Rent - owner-occupied homes
- Excludes
  - Used goods, Assets (stocks, bonds, land), newly constructed homes (part of investment)

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## Private Investment $I$

- The part of GDP purchased by business as final users
  - Business purchases of plant, equipment, and software
  - New-home construction
  - Changes in the stock of inventories of final and intermediate goods
    - Inventories: goods that have been produced, but not yet sold

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## Government Purchases $G$

- Spending by federal, state, and local governments on goods and services
- Excludes
  - Transfer payments as they are not expenditures on purchases of goods and services
    - Transfer payments - money redistributed from one group of citizens (taxpayers) to another (the poor, the unemployed, the elderly)

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## Net Exports $NX$

- Net Exports = Total exports *minus* total imports
  - **Total exports:** U.S. production purchased by foreigners
  - **Total imports:** U.S. purchases of goods produced outside of the United States
- Why do we need it?
  - $C+I+G$  includes imported goods that aren't part of our GDP, and excludes exported goods which are part of our GDP – need to correct it by subtracting imports and adding exports

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## Other Approaches to GDP

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## Other Approaches to GDP

- Expenditure Approach is not the only method to calculate GDP
- BEA also uses
  - Value Added Approach
  - Factor Payments Approach
- In theory, they all should be equal
  - In practice, there are small discrepancies due to measurement error

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## Value Added Approach to GDP

- Value added of a firm = revenue from sales – cost of intermediate good purchases
- Total value added in the economy = sum of value added of all firms in the economy

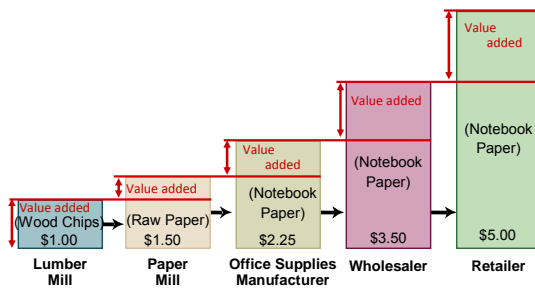
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## Value Added Approach to GDP

- CLAIM:
  - Total value added in the economy = value of all final goods

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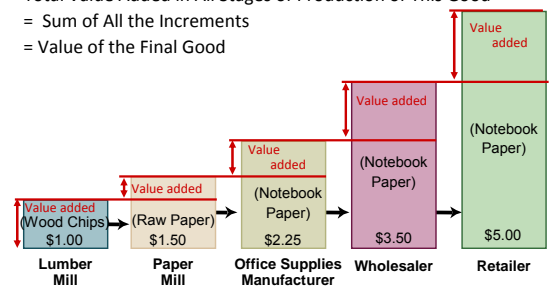
## Total Value Added = Value of the Good



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## Total Value Added = Value of the Good

For each final good we have:  
 Total Value Added in All Stages of Production of This Good  
 = Sum of All the Increments  
 = Value of the Final Good



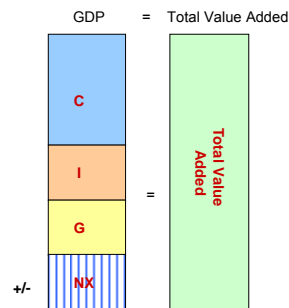
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## Value Added Approach to GDP

- GDP = total value added in the economy
- Total value added in the economy (by the previous diagram) = total value of all final goods = GDP

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## Value Added Approach to GDP



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## Factor Payments Approach to GDP

- $GDP \approx$  Total factor payments by all firms
- Value added of a firm  $\approx$  total factor payments to workers and capital owners made by this firm (wages + rents + net interest payments + profits)
  - Total factor payments of all firms  $\approx$  total value added by all firms = GDP

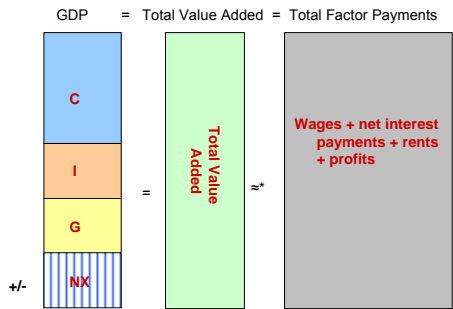
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## (\* Technical Caveat

- Read footnote 2 (page 113) in the textbook:
  - $GDP = \text{total factor payments}$  is just an approximation
    - The true relationship is that  $GDP = \text{total factor payments} + \text{excise and sales taxes} + \text{depreciation of its plant and equipment}$
    - Only these items are paid out as total factor payments
    - We ignore this difference in this course!

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## Factor Payments Approach to GDP



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## Illustrating 3 Methods of Calculating GDP Using a Circular Flow Diagram

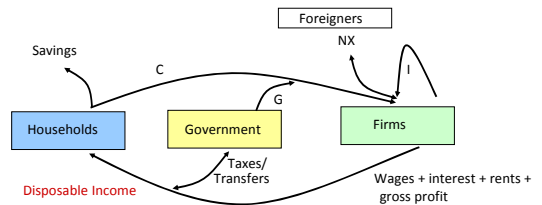
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## Circular Flow Diagram

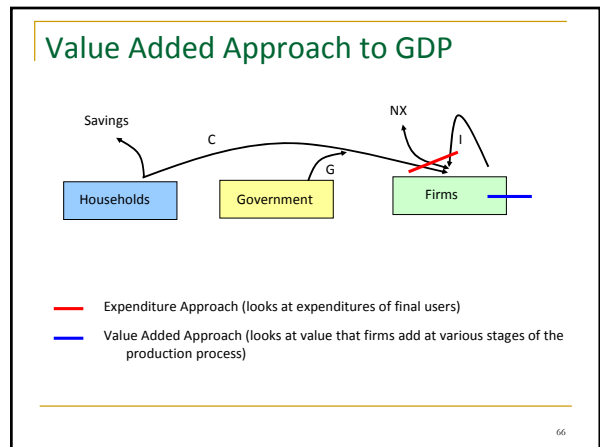
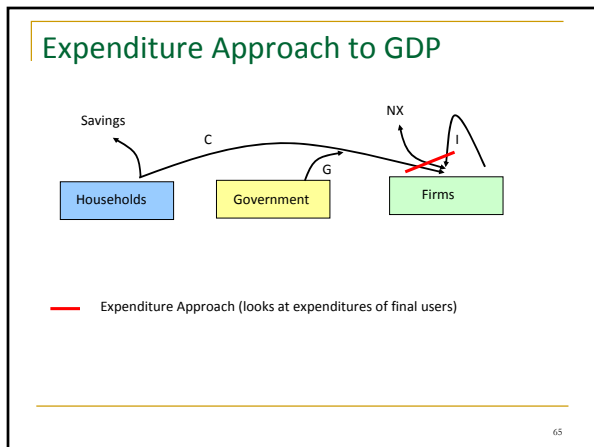
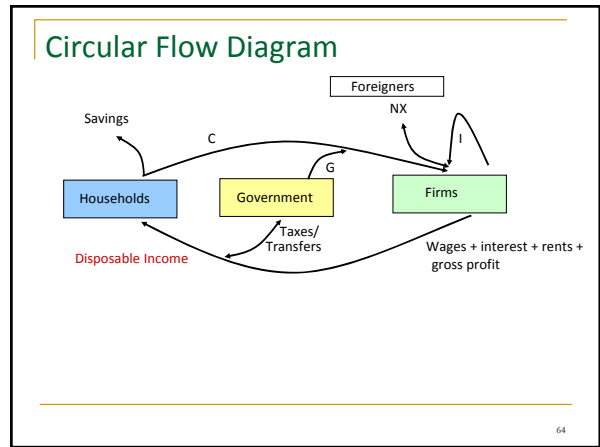
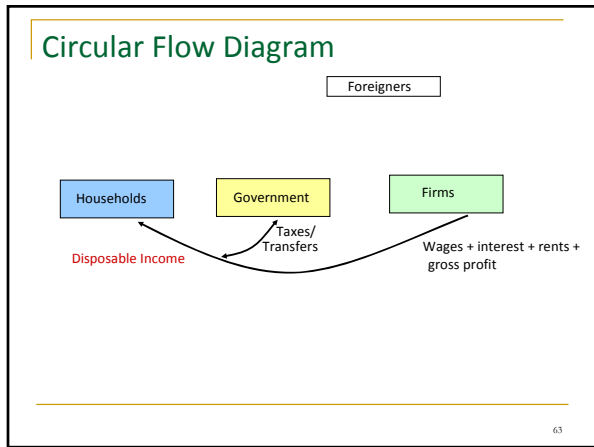
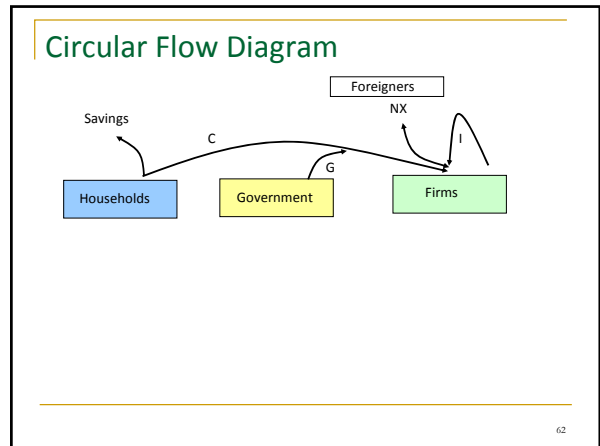
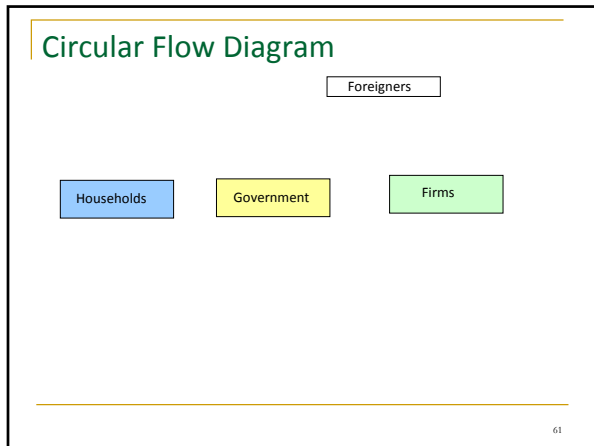
- Three different methods of calculating GDP are a consequence of circular flows between final users: households, firms, government, foreigners
  - Income  $\rightarrow$  Expenditures  $\rightarrow$  Revenue from sales of final goods  $\rightarrow$  Total value added  $\rightarrow$  factor payments as source of income for expenditures
- We can use a diagram to illustrate these flows, and the three methods of calculating GDP

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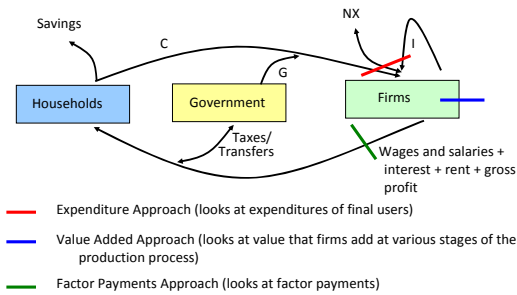
## Circular Flow Diagram



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## Factor Payments Approach to GDP



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## Exercise

- Wonderland is a closed economy (imports=exports=0) and produces 2 goods: *cotton and T-shirts*.
  - T-shirts are sold as final good
  - Cotton is sold both as final and intermediate good
- In 2008, the complete account of all transactions made by all businesses residing in Wonderland is:

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## Exercise Cont'd

- **Cotton Farmers**
  - *Payments:*
    - (1) Wages and Salaries: \$1000
    - (2) Profits \$500
    - (3) Rent and Interest payments \$500
  - *Receipts:*
    - (4) Revenue from sales \$1500
    - (5) Change in inventories: +\$500

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## Exercise Cont'd

- **Shirt Manufacturers (purchase cotton from Cotton Farmers)**
  - *Payments:*
    - (6) Wages and Salaries: \$1000
    - (7) Profits \$500
    - (8) Purchases of cotton for production: \$500
  - *Receipts*
    - (9) Revenue from sales \$1500
    - (10) Change in inventories: +\$500

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## Exercise Cont'd

- How much cotton is sold as final good and how much as intermediate good?
  - *Answer: Sold as final good:  $(4)+(5)-(8)=1500+500-500=1500$ ; sold as intermediate good:  $(8) = 500$ .*
- Calculate GDP directly from the definition (value of all final goods and services produced...)
  - *Answer: From the above: value of cotton sold as final good = 1500. All T-shirts are sold as final good, so value of T-shirts produced =  $1500+500$  (inventories)=2000. Thus,  $GDP=2000+1500=3500$ .*

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## Exercise Cont'd

- Calculate GDP using value added approach
  - *Answer: Need to sum up value added of all firms in the economy. Value added is revenue from sales (including inventories) – cost of intermediate inputs. For farmers, we have:  $(4)+(5)=2000$ . For T-shirt manufacturers, we have:  $(9)+(10)-(8)=1500$ . Thus, total value added is:  $3500=GDP$ .*

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### Exercise Cont'd

- Calculate GDP using factor payments approach
  - Answer:  $(1)+(2)+(3)+(6)+(7)=3500$ .
- We know that  $NX=0$ . Suppose in addition that  $G=100$ . Calculate  $C+I$  using national income accounting identities.
  - Answer:  $3500=GDP=C+I+G+NX$ . Thus,  
 $C+I=3500-100=3400$ .