

INTRODUCTION

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Outline

- 1 What's Macro?
- 2 Models

Outline

- 3 Functions and basic math
 - 3.1 Functions
 - 3.2 How to calculate a percentage change
 - 3.3 Exponents
 - 3.4 Solving systems of equations
 - 3.5 Derivatives:
 - Basic derivatives
 - Partial derivatives

What's Macro?

- **Macroeconomics** is the study of the economy as a whole
- **Microeconomics** is the study of individual behavior
- **Economy** is the mechanism by which a society decides what, how and for whom to produce.

Models

- **Models** are simplified versions of reality.
- Models have:
 1. **assumptions**: propositions
 2. **implications**: results from the assumptions through logic

Models

- Mathematical models have two kinds of variables:
 1. **exogenous** (generated outside the model): givens
 2. **endogenous** (generated inside): unknowns

Functions and basic math

Functions

- Functions express relations among variables

$$Q_d = D(P_b, Y)$$

- Q_d = quantity demanded = dependent variable
- P_b = price of bread = independent variable
- Y = income = independent variable
- $D(\cdot)$ = function

Functions and basic math

- Functional form: $Q_d = c - a \cdot P_b + b \cdot Y$
- a , b and c = parameters

Use econometrics to know functional forms and values of parameters:

$$Q_d = D(P_b, Y) = c - a \cdot P_b + b \cdot Y = 60 - 10P_b + 2Y$$

Functions and basic math

How to calculate a percentage change

$$Q_1 = \text{GDP}_{91} = 180$$

$$Q_0 = \text{GDP}_{90} = 160$$

Percentage change?

Functions and basic math

$$\frac{\Delta Q}{Q_0} \cdot 100 = \frac{Q_1 - Q_0}{Q_0} \cdot 100 = \left[\frac{20}{160} = 12.5\% \right]$$

Functions and basic math

Exponents

- $X^a \cdot X^b = X^{a+b}$
- $X^a / X^b = X^{a-b}$
- $X^{-a} = 1/X^a$
- $X^0 = 1$

Functions and basic math

- Solving systems of equations

Try to solve the equilibrium price of bread:

$$Q = 8 - 2P \quad (1)$$

$$Q = 3 + P/2 \quad (2)$$

Which one represents the demand?

The supply?

Functions and basic math

- Solve for one of the variables in one of the equations
- Substitute into other equation: you have one less equation and one less unknown.
- Repeat until down to 1 equation and 1 unknown,
- Solve for this unknown
- Move backwards.

Do it!!

Functions and basic math

Solve for Q in (1) and substitute into (2),

$$8 - 2P = 3 + P/2$$

$$P = 2.$$

Substituting into (1)

$$Q = 4.$$

Functions and basic math

Derivatives

1. Basic derivatives

Derivative: what happens to the dependent variable when the independent variable changes.

$$y = f(x)$$

Functions and basic math

$$\frac{dy}{dx} = \lim_{\Delta x \rightarrow 0} \frac{\Delta y}{\Delta x}$$

- $dy/dx = f'(x) = y'$

Functions and basic math

Rules

1. If $y = f(x) = x^a$, then

$$dy/dx = f'(x) = y' = a \cdot x^{a-1}$$

Calculate

1. $y = x^2$
2. $y = 1/x$

Functions and basic math

2. If $y = c \cdot f(x)$, then $dy/dx = y' = c \cdot f'(x)$

Calculate

1. $y = a \cdot x^2$
2. $y = a$

Functions and basic math

3. If $y = c \cdot f(x) + d \cdot g(x)$,
then $dy/dx = y' = c \cdot f'(x) + d \cdot g'(x)$

Calculate

1. $y = a \cdot x^\alpha + b \cdot x^\beta$

Functions and basic math

2. Partial derivative

$$y = F(x, z)$$

Partial derivative of y respect to x : what happens to y (the dependent variable) if x (one of the independent variables) changes, assuming that the other independent variable z stays constant.

Functions and basic math

$$\frac{\delta y}{\delta x} = F_x(x, z) = F_1(x, z) = y_x$$

Functions and basic math

Example: Aggregate production function:

$$Y = F(K, L)$$

- Y = output
- K = capital
- L = labour

Marginal Product of Labour (MPL)?

Functions and basic math

- Marginal product of labour (MPL): increase in output when labour increases by one unit keeping capital constant.

$$MPL = \frac{\delta Y}{\delta L} = F_L(K, L) = F_2(K, L) = Y_L$$

Functions and basic math

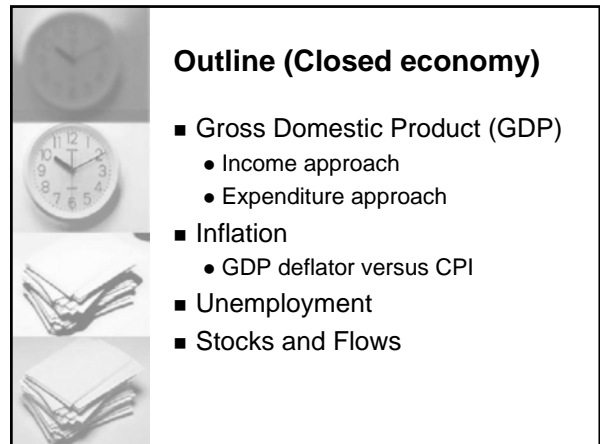
$$Y = A \cdot K^\alpha \cdot L^\beta$$

Calculate MPL



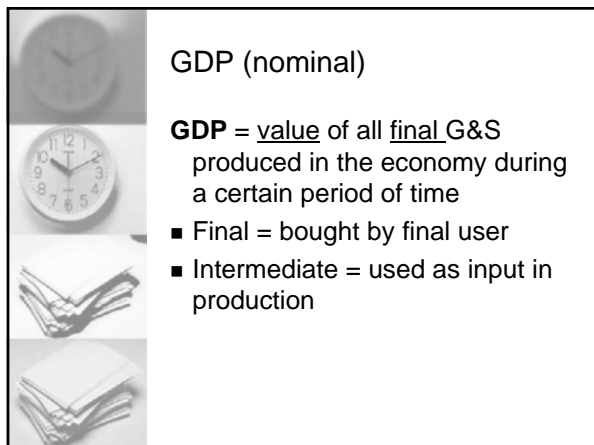
2. The data

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Outline (Closed economy)

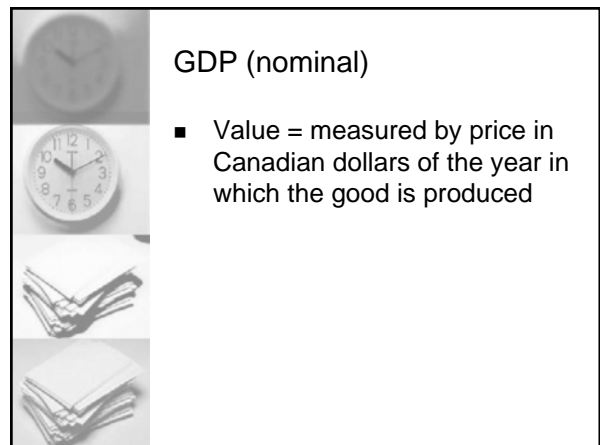
- Gross Domestic Product (GDP)
 - Income approach
 - Expenditure approach
- Inflation
 - GDP deflator versus CPI
- Unemployment
- Stocks and Flows



GDP (nominal)

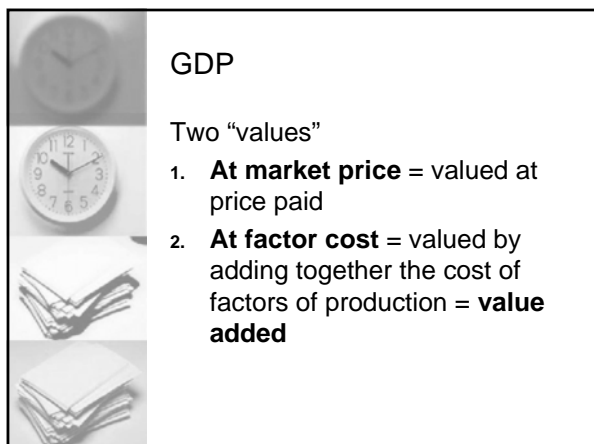
GDP = value of all final G&S produced in the economy during a certain period of time

- Final = bought by final user
- Intermediate = used as input in production



GDP (nominal)

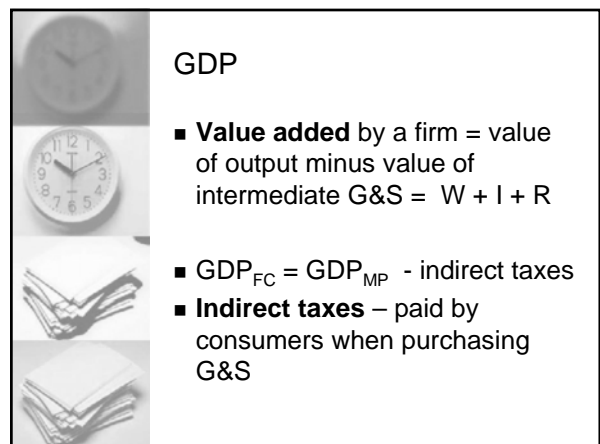
- Value = measured by price in Canadian dollars of the year in which the good is produced



GDP


Two “values”

1. **At market price** = valued at price paid
2. **At factor cost** = valued by adding together the cost of factors of production = **value added**



GDP

- **Value added** by a firm = value of output minus value of intermediate G&S = $W + I + R$
- $GDP_{FC} = GDP_{MP} - \text{indirect taxes}$
- **Indirect taxes** – paid by consumers when purchasing G&S



GDP


- **Gross** – includes depreciation
- **Net** – does not
- **Depreciation** – decrease in value of a capital (investment) good due to the passing of time (called *capital consumption allowances* in the national accounts)



GDP


NDP = GDP – depreciation

(net) Domestic income (at factor cost) = NDP_{FC}



GDP


Income approach

$$Y = W + R + I$$


GDP

In the national accounts:

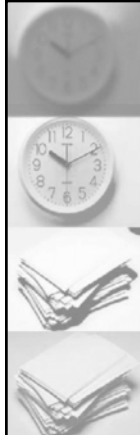
- Compensation of employees = W
- Corporate profits = $R + I$
- Non-incorporated business income = $W + I + R$
- Net interest = $I + R$ = paid by firms to households



GDP

Disposable income = income – personal (direct) taxes


PROBLEM 2



GDP

Expenditure approach





- **Consumption (C)**: G&S bought by households
- **Government purchases or expenditure (G)**: G&S bought by federal, provincial or municipal governments



GDP





3. **Investment (I)**: goods bought by firms for future production

- future: key to differentiate between investment and intermediate goods.





GDP

- Only goods bought by firms (exception: houses).
- Only new goods
- Need to differentiate between savings and investment (used differently in daily life)





GDP

- No Government: $S = I$
 - $Y = C + S$
 - $Y = C + I$
- Government: $S + T = I + G$
 - $Y = C + S + T$
 - $Y = C + I + G$




GDP

- $S + (T - G) = I$
 - S = private (household) saving
 - $(T - G)$ = public (government) saving
 - $S + (T - G)$ = national saving = private + public saving

Inflation

Nominal GDP measures the value of final goods and services using current prices.

$$\sum_i p_{i2006} \cdot q_{i2007}$$





Inflation


Real GDP measures the value of final goods and services using prices of a given year (called the base year).

$$\sum_i p_{i2000} \cdot q_{i2007}$$

GDP deflator =
nominal GDP/real GDP








Inflation

Consumer Price Index (CPI) =
 average level of prices of goods and services consumed by a typical urban Canadian family




Inflation

CPI versus GDP deflator

1. GDP deflator – G&S produced; CPI – G&S consumed
2. GDP deflator – domestic G&S; CPI – both domestic and imported G&S
3. CPI – fixed weights; GDP deflator – changing weights

PROBLEMS 3 AND 4




Unemployment Rate

Labour force = employed + unemployed

Unemployment rate = $100 \times \text{unemployed} / \text{labour force}$

Labour-Force Participation Rate
 = $100 \times \text{labour force} / \text{adult population (15+)}$


PROBLEM 1



Stocks and Flows

Stock = variable measured at a given point in time

Flow = variable that needs to be measured per unit of time.



TRY PROBLEM 5 ON YOUR OWN