National Income (Mankiw, chapter 3)

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Past lecture

Definition of macroeconomic variables

- GDP (or output)
  - value of all final goods produced during a period
  - recall that output = income
- inflation rate
  - growth rate of general price level
- unemployment rate
  - proportion of potential workers (willing and looking for work) without a job

Today

Data by itself is not enough - we want a theory that can answer questions such as:

- what determines the level of GDP?
- how is output divided between consumption, investment and government expenditures?
- how is income divided between workers and capital owners?
- what equilibriates production and demand?

Classical model

This chapter presents a *classical* model - very simple (and unrealistic in some ways).

Why study it?

- useful benchmark and starting point
- this is the model Keynes had in mind when criticizing "classical" economics in his General Theory

Overview:

- one period
- households supply labor and capital to firms
- firms produce final good
- part of output is consumed by households or government
- part is used for investment

Circular flow diagram

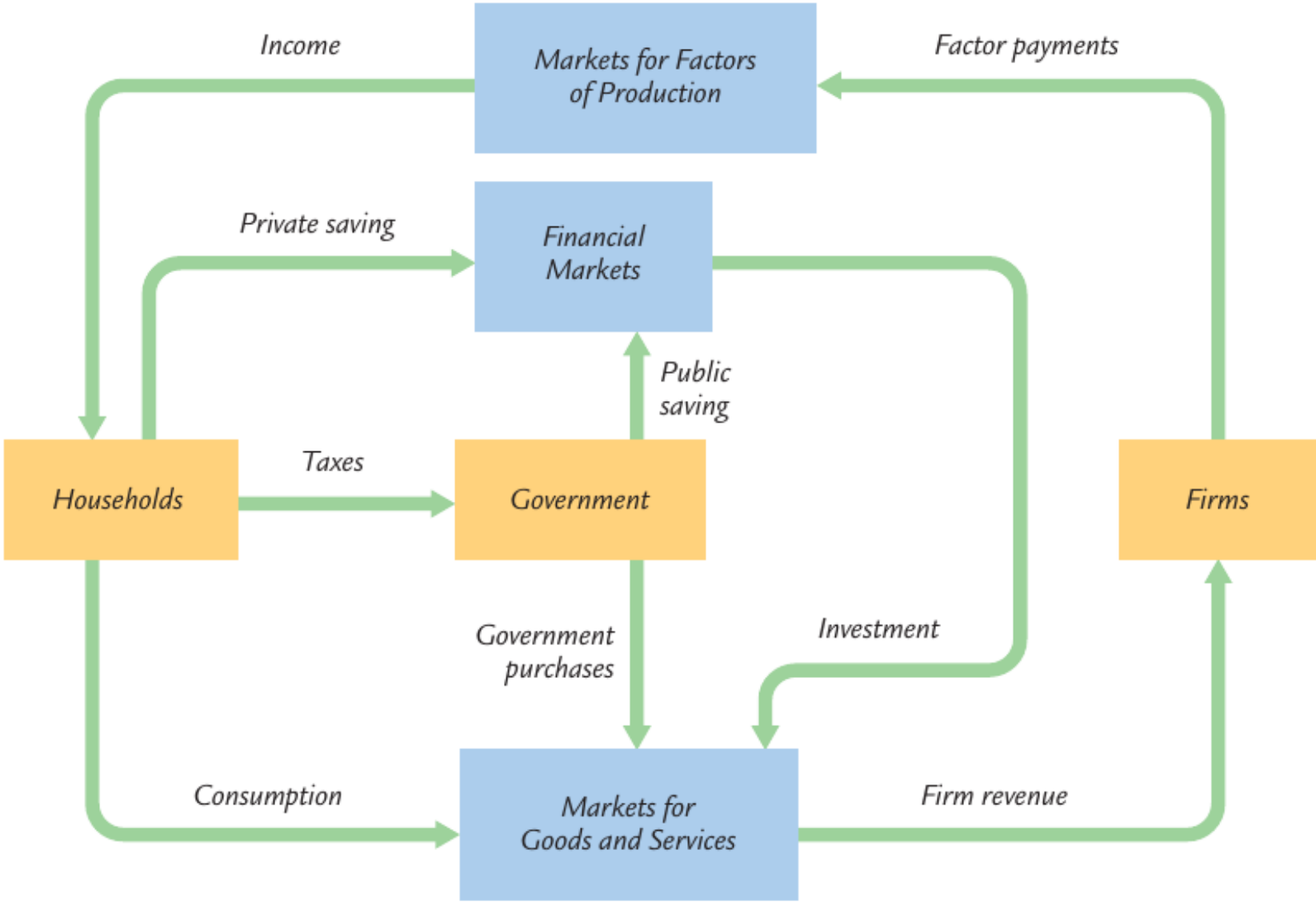

Figure : Circular flow diagram for classical model (figure 3.1 in Mankiw)

Supply side

Production function:

$$Y \leq F(K, L)$$

- Y: output (units of final good)
- K: capital (physical units)
- L: labor (hours worked)

Example - Cobb-Douglas production function

$$F(K, L) = AK^{\alpha}L^{1-\alpha}$$

Returns to scale

What happens if we doubled inputs?

$$F(2K, 2L) = A(2K)^{\alpha}(2L)^{1-\alpha} = A2^{\alpha+1-\alpha}K^{\alpha}L^{1-\alpha} = 2F(K, L)$$

Cobb-Douglas, as written above, has *constant returns to scale*:

$$\forall b > 0 : F(bK, bL) = bF(K, L)$$

We could also have

- decreasing returns: $F(bK, bL) \leq bF(K, L)$ if $b > 1$ (and vice-versa)
  - can always scale down, but maybe not up
- increasing returns: $F(bK, bL) \geq bF(K, L)$ if $b > 1$ (and vice-versa)
  - can always scale up, but maybe not down

Economists often like CRS (will see why).

Exercise

Consider more general version of Cobb-Douglas:

$$F(K, L) = AK^{\alpha}L^{\beta}, \alpha > 0, \beta > 0$$

How do returns to scale depend on parameters?

Supply side

Assume that

1. amount of labor and capital (and thus output) is exogenous

$$K = \bar{K}$$
$$L = \bar{L}$$

2. all factors are fully utilized

$$Y = F(\bar{K}, \bar{L})$$

Thus output is entirely determined by supply-side factors.

Distribution of income

Firms sell the output. How are revenues distributed?

Depends on prices.

- price of final good - normalize to 1
- wage - W
- rent for capital - R

Thus value of output can be divided:

$$Y = \underbrace{\Pi}_{\text{profit}} + \underbrace{W \times L}_{\text{payment to labor}} + \underbrace{R \times K}_{\text{payment to capital}}$$

Income distribution depends on prices.

- classical model - marginal theory of value
- prices are determined by competitive market

Competitive prices

- firms take prices R, W *as given*
- they choose optimal demand for labor $L_d(R, W)$ and capital $K_d(R, W)$
- "the market" chooses the price so that demand equals supply:

$$L_d(R, W) = \bar{L}$$
$$K_d(R, W) = \bar{K}$$

  - recal perfect competition from your micro class
- thus we need to study the firm's problem

Profit maximization

The firm wants to maximize profit:

$$\max_{L_d, K_d} F(K_d, L_d) - WL_d - RK_d$$

First order conditions:

$$\frac{\partial}{\partial K} F(K_d, L_d) = R$$
$$\frac{\partial}{\partial L} F(K_d, L_d) = W$$

Intuition:

- cost of additional worker equal to its marginal product
- if not, firm could increase/decrease profit by hiring more or less
- same for capital

Exercise

Solve for factor demand with Cobb-Douglas.

Distribution of income

- distribution of income depends on marginal products
- with CRS, firm profits are zero
  - math works out that way (Euler theorem)
  - intuition: if firms made positive profits, and could scale production up arbitrarily, they could in fact make infinite profits - cannot happen in equilibrium
  - what we usually mean by profit is "hidden" in payments to capital
- in case of CD technology, share α of income goes to capital, $1 - \alpha$ to labor
  - empirically, labor share is quite stable over time

Exercise

Say some catastrophe (e.g. plague) has exogenously decreased the labor force. How will prices change?

Demand side

Assume closed economy.

All output must be used either for

- consumption
- investment
- or bought by government.

Aggregate demand:

$$Y = C + I + G$$

What determines these elements?

Consumption

- define disposable income as $Y - T$, T: taxes
- assume consumption depends on current disposable income
- consumption function:

$$C = \mathcal{C}(Y - T)$$

- example: $C = a(Y - T)$, $0 < a < 1$
  - a: marginal propensity to consume

Investment

- investment: demand for investment by firms depends on the *real interest rate r*

$$I = \mathcal{I}(r)$$

  - real rate = nominal rate - inflation
  - don't worry about inflation yet
- intuition: interest rate is a cost of funds for the firm
  - lower interest rate - cheaper loans - more investment

Government

- government: we will just assume that government expenditures and taxes are set exogenously:

$$G = \bar{G}$$
$$T = \bar{T}$$

- budget is not necessarily balanced

Equilibrium

Aggreggate supply:

$$Y = F(\bar{K}, \bar{L})$$

Aggregate demand:

$$Y = C + I + G$$

These two things should be equal. If not, we're in trouble.

- this property is sometimes called Say's law

In classical model, equilibrium happens through *loanable fund* market.

Loanable funds

- to invest, firms must obtain funds through financial markets
- demand for savings is the investment function
- supply of savings: unconsumed part of output

$$S = \underbrace{(Y - T) - C}_{\text{private savings}} + \underbrace{(T - G)}_{\text{government saving}}$$

  - if $G > T$, government savings are negative
- real interest rate adjusts so that $\mathcal{I}(r) = S$
  - if interest rate entered consumption function, supply of savings would depend on r too
- in equilibrium, investment demand by firms is just equal to saving by households and government

Whole model

Supply block:

$$Y = F(\bar{K}, \bar{L})$$
$$W = \frac{\partial}{\partial L} F(\bar{K}, \bar{L})$$
$$R = \frac{\partial}{\partial K} F(\bar{K}, \bar{L})$$

Demand block:

$$Y = C + I + \bar{G}$$
$$C = \mathcal{C}(Y - \bar{T})$$
$$I = \mathcal{I}(r)$$

This is system of 6 equations in six variables (Y, C, I, R, W, r), given four exogenous parameters $(\bar{K}, \bar{L}, \bar{G}, \bar{T})$.

Comparative statics

What happens when $\bar{G}$ increases?

- capital and labor unchanged - output stays the same
- disposable income of households unchanged - consumption stays the same
- government saving decreases
- supply of savings lower - interest rate must increase, so that investment goes down
- end result: increase in G was exactly offset by decrease in private investment - "crowding out"

Exercise

What will change if consumption depends on r?

Exercise

What happens when G and T increase by the same amount? (balanced budget fiscal expansion)

Exercise

$$
\begin{aligned}
Y &= C + I + G \\
C &= 250 + 0.75(Y - T) \\
I &= 1000 - 50r
\end{aligned}
$$

and

$$Y = 5000, G = 1000, T = 1000$$

- compute private/public/total saving
- compute equilibrium interest rate
- repeat if $G = 1250$

Where's money?

What about money, inflation, etc.?

- remember, all quantities above were real and all prices relative to the price of the consumption good
- model doesn't say anything about price level, money supply, central bank,. . .
- given our assumptions - that relative prices freely adjust to equilibriate the market, we could solve for all real quantities without saying anything about monetary side of the economy
- *classical dichotomy*
- this might hold in the long run; short run - not so much
  - "In the long run, we are all dead"