ECN 106 Macroeconomics 1

Lecture 2

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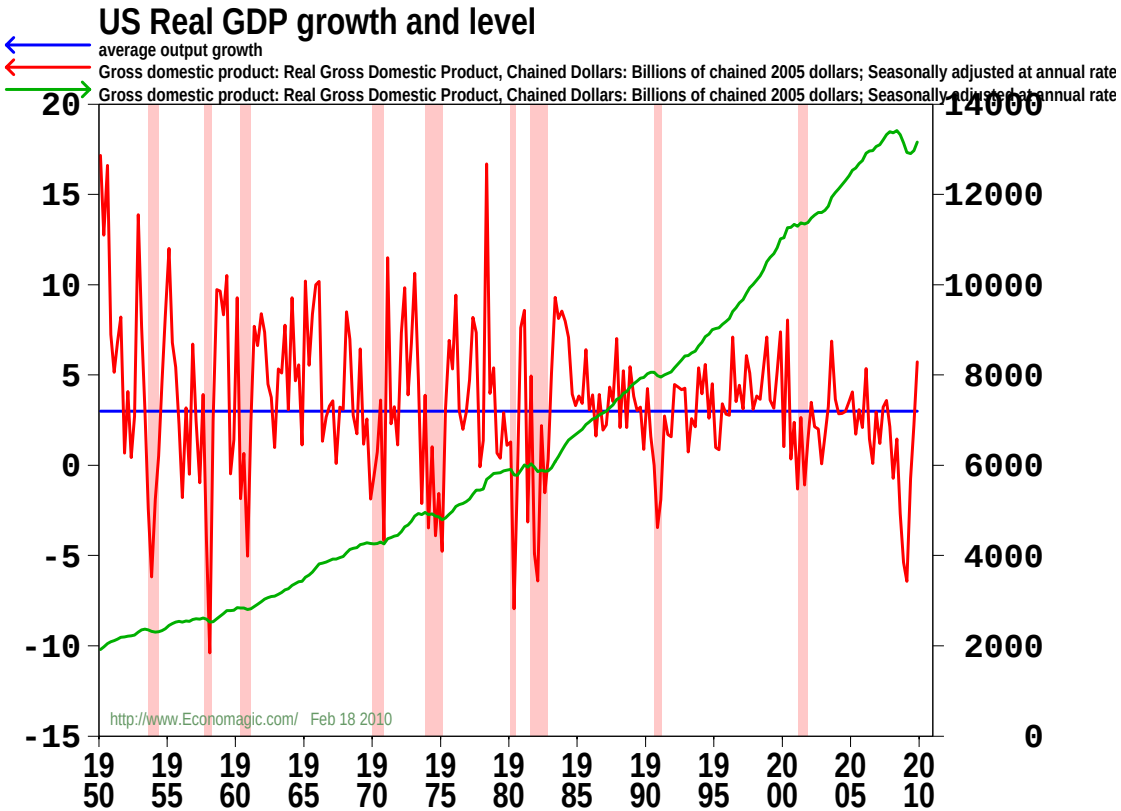
Roadmap for this lecture

- How can we explain fluctuations in output/income?
- A simple model of output determination: the Keynesian cross.
  - The composition of aggregate expenditure and its determinants
  - Output response to shocks
  - Adjustment from one equilibrium to another.
- The relationship between equilibrium output and the interest rate: the IS curve
- Mankiw: Chs. 3-3, 10-1

What we want to explain

Output fluctuations



Green line: GDP level

Red line: GDP % growth rate

Blue line: average GDP % growth rate

Shaded regions: recessions

The circular flow identity

- Over any period of time the flow of income equals the flow of production which equals the flow of actual expenditure.
- Aggregate output or expenditure coincides with the value of domestic final goods and services produced in the given period.
- Too difficult to keep track of all individual goods: aggregation.

Composition of actual expenditure

Closed economy.

1. Goods and services demanded by the private sector
   i) Consumption: C. Roughly 65% of GDP.
      - Non-durables: benefits accrue within the period; e.g. food, movies, etc.
      - Durables: cars, appliances, health, education, etc.
   ii) Investment: I. Roughly 15% of GDP.
      - housing, plants, equipment, etc.
2. Goods and services demanded by the government: G.
   - Defense equipment, public infrastructure, salaries of public employees, etc.
3. Undesired accumulation of inventories of storable goods: I_s.

Output ≡ Expenditure identity

Assume just one good (e.g. wheat) $\Longrightarrow$ We can sum.

$$Y \equiv \underbrace{C + I + G}_{Z} + I_s \tag{1}$$

$$Y \equiv Z + I_s \tag{2}$$

Production ≡ Actual expenditure ≡ Demand (aka desired expenditure) + undesired inventory accumulation

This is an identity (always true).

Determinants of expenditure: consumption

- In this course we assume a very simple story of consumer behaviour.
- Consumption is an increasing function of disposable income $Y - T$, where T is net taxes (taxes - minus government transfers).

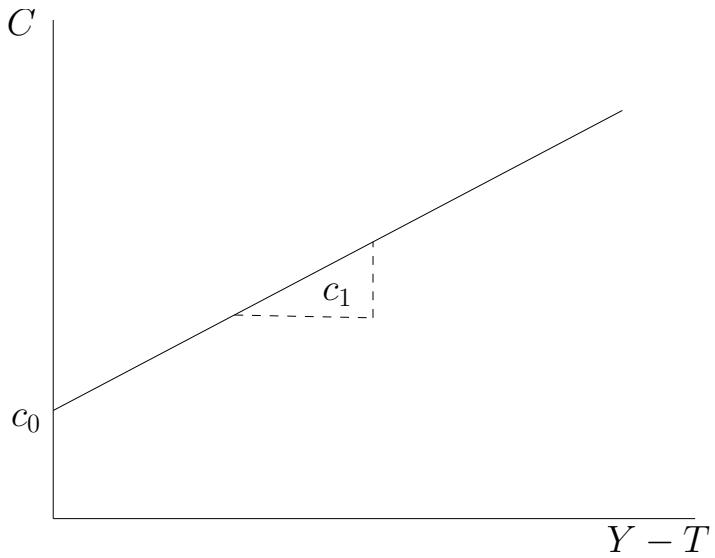
$$C = C(Y - T)$$

- For simplicity, we assume a linear function

$$C(Y - T) = \bar{C} + c(Y - T).$$

- The **marginal propensity to consume (MPC)** c is between 0 and 1.

Determinants of expenditure: consumption (II)



If $c = 0.7$ an increase in $Y - T$ by 1£ increases consumption by 70p.

Determinants of expenditure: investment

Both households and firms purchase investment goods.

- Households: mainly new houses.
- Firms:
  - new equipment, plants, office buildings;
  - *desired* (i.e. chosen) inventories: works in progress, buffer stocks.
    Note that these differ from *undesired* inventory accumulation.

Determinants of expenditure: investment (II)

- Firms invest on the basis of the expected costs and benefits of their investment.
- Suppose the cost of buying a given machine today is £X.
- Suppose also that the machine gives a yearly stream of returns equal to £y for t years.
- If the interest rate is i, the value V of the machine (the value today of its lifetime benefits) is

$$V = £y + \frac{£y}{1+i} + \frac{£y}{(1+i)^2} + \frac{£y}{(1+i)^3} + ... + \frac{£y}{(1+i)^t} \quad (3)$$

- A higher interest rate reduces V because it increases the opportunity cost of buying the machine (you could have bought bonds that yield i).

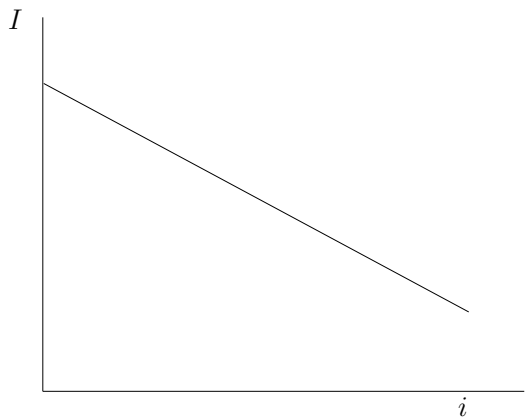
Determinants of expenditure: investment function

- It is optimal to invest (benefits exceed the cost) as long as

$$V \geq X. \tag{4}$$

- As i increases, V falls and investment projects which were profitable become unprofitable $\rightarrow$ investment falls.
- So investment is a decreasing function of the interest rate (again, we assume linear for simplicity)

$$I = I(i) = a - bi. \tag{5}$$



Investment: what is the relevant interest rate?

There are many interest rates in the economy:

- Nominal interest rate: how many extra £ tomorrow for 1£ today.
- Real interest rate: how many extra units of output tomorrow for one unit today (nominal rate adjusted for inflation).
- *Risky* interest rate: if investors dislike risk they demand an extra risk premium ρ over the risk-free rate for each unit of output invested in a risky project.

If r denotes the real risk-free rate, then the real *risky* rate equals

$$i = r + \rho.$$

Investment: what is the relevant interest rate? (II)

- Cash flows from investment projects (i.e. profits, rental) are usually indexed to inflation *and* risky (they may fluctuate both because of shocks to the firm and shocks to the economy as a whole.)
- So, the relevant interest rate is the *real, risky* one $i = r + \rho$

$$I = a - b(r + \rho)$$

- In most of this course we abstract from ρ and set it equal to zero $\rightarrow$ $I = a - br$.
- We will relax the assumption $\rho = 0$ only to talk about the current recession.

Government expenditure and revenues

- We do not model the political process that leads to a particular choice of fiscal variables (fiscal policy).
- We take both government purchases and net taxes as exogenous*

$$G = \bar{G}$$

$$T = \bar{T}$$

- The government budget deficit is the difference between government expenditure and its revenue (net taxes); i.e.

$$BD = \bar{G} - \bar{T}.$$

* The bar on top emphasizes that a variable is exogenous.

A simple model of income determination

The Keynesian cross

- Simplest interpretation of how national income is determined and building block towards the more realistic IS-LM model.
- Insight:
  - in the short run output/income is largely determined by the spending decisions of households, firms and the government;
  - the more agents spend, the more firms can sell and the more output they will choose to produce.
- Remember that total desired expenditure $Z = C + I + G$.
- Income is endogenous. The model aims at explaining how it is determined.

The model environment

Assumptions:

1. $G = \bar{G}$ and $T = \bar{T}$ are exogenous.
2. The real interest rate $r = \bar{r}$ is exogenous $\rightarrow$ investment $I = \bar{I} = I(\bar{r})$ is also exogenous.
3. $C = C\left(Y - \bar{T}\right) = \bar{C} + c(Y - \bar{T})$ with $0 < c < 1$
   Consumption is endogenous being a function of income.
4. Equilibrium: production adjusts to demand until the goods market clears: i.e. production (supply of goods) = demand

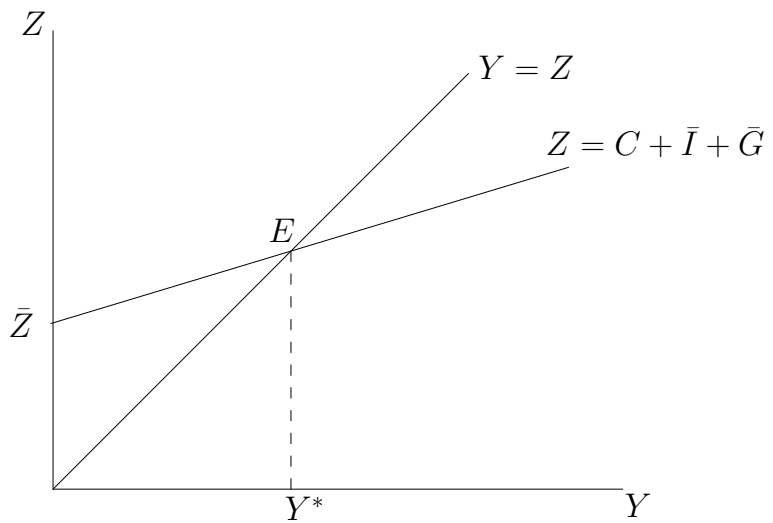
$$Y = Z. \tag{6}$$

Different from the identity $Y \equiv Z + I_s$.

The model equilibrium: graphical solution

Pair of values for the two endogenous variables $[Y, C]$ such that the goods market clears (output equals desired expenditure).

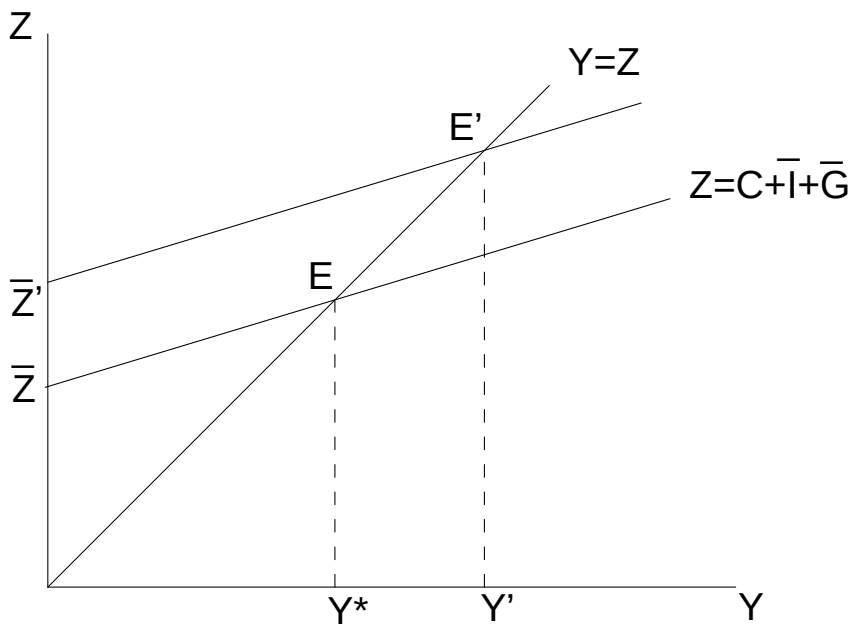
$$\begin{cases} Z = \overbrace{\bar{C} + c(Y - \bar{T})}^{C} + I(\bar{r}) + \bar{G} \\ Y = Z \end{cases} \tag{7}$$



$\bar{Z} = \bar{C} - c\bar{T} + \bar{I} + \bar{G}$ is autonomous (i.e. exogenous) expenditure.

Output response to a shock: graphical solution

Equilibrium output increases in response to an increase in the exogenous components of expenditure.



The model equilibrium: analytical solution

$$\begin{cases} Z = \bar{C} + c(Y - \bar{T}) + I(\bar{r}) + \bar{G} \\ Y = Z \end{cases} \tag{8}$$

$$Y = \bar{C} + c(Y - \bar{T}) + I(\bar{r}) + \bar{G} \tag{9}$$

$$Y(1 - c) = \bar{C} - c\bar{T} + I(\bar{r}) + \bar{G} \tag{10}$$

$$Y = \frac{1}{1 - c}\left(\bar{C} - c\bar{T} + I(\bar{r}) + \bar{G}\right) = \frac{1}{1 - c}\bar{Z} \tag{11}$$

$$c > 0 \Longrightarrow \frac{1}{1 - c} > 1$$

The term $\frac{1}{1-c}$ is called the *Keynesian multiplier.*

Output response to a shock: analytical solution

Equilibrium output:

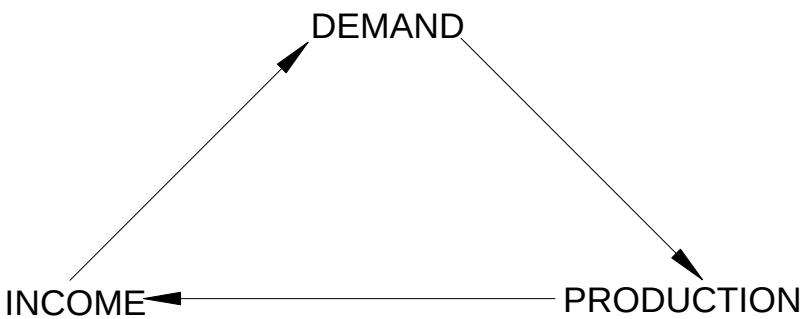
$$Y = \frac{1}{1-c}\bar{Z}$$

Response of equilibrium output to a shock $\Delta\bar{Z}$:

$$\Delta Y = \frac{1}{1-c}\Delta\bar{Z}$$

Main message

- Output fluctuations are driven by demand shocks: i.e. fluctuations in consumption, investment, fiscal policy
- Output increases more than the increase in the autonomous components of expenditure because desired expenditure increases further due to the endogenous increase in consumption.



Intuition: why the multiplier is > 1? (II)

$$
\begin{array}{lcr}
\text{Initial change in } \bar{Z} & = & \Delta\bar{Z} \\
\text{First change in consumption} & = & c\Delta\bar{Z} \\
\text{Second change in consumption} & = & c_1^2\Delta\bar{Z} \\
\text{Third change in consumption} & = & c_1^3\Delta\bar{Z} \\
\vdots & & \vdots \\
\hline
\Delta Y = (1 + c + c_1^2 + c_1^3 + \ldots)\Delta\bar{Z} & &
\end{array}
$$

In the limit

$$\Delta Y = \frac{1}{1-c}\Delta\bar{Z}.$$

The effect of (debt-financed) fiscal policy

The government budget deficit is given by $BD = \bar{G} - \bar{T}$.

1. Output effect of gvt. expenditure with unchanged taxes

$$\Delta Y = \frac{1}{1-c}\Delta\bar{G}, \qquad \Delta BD = \Delta\bar{G}$$

2. Output effect of taxes with unchanged expenditure

$$\Delta Y = -\frac{c}{1-c}\Delta\bar{T}, \qquad \Delta BD = -\Delta\bar{T}.$$

Debt-financed government expenditure has more bang for the buck than tax cuts of equal size.

The effect of tax-financed fiscal policy

Government expenditure increase financed by a tax increase: $\Delta\bar{T} = \Delta\bar{G}$.

- Budget deficit is unchanged:

$$\Delta BD = \Delta\bar{G} - \Delta\bar{T} = 0$$

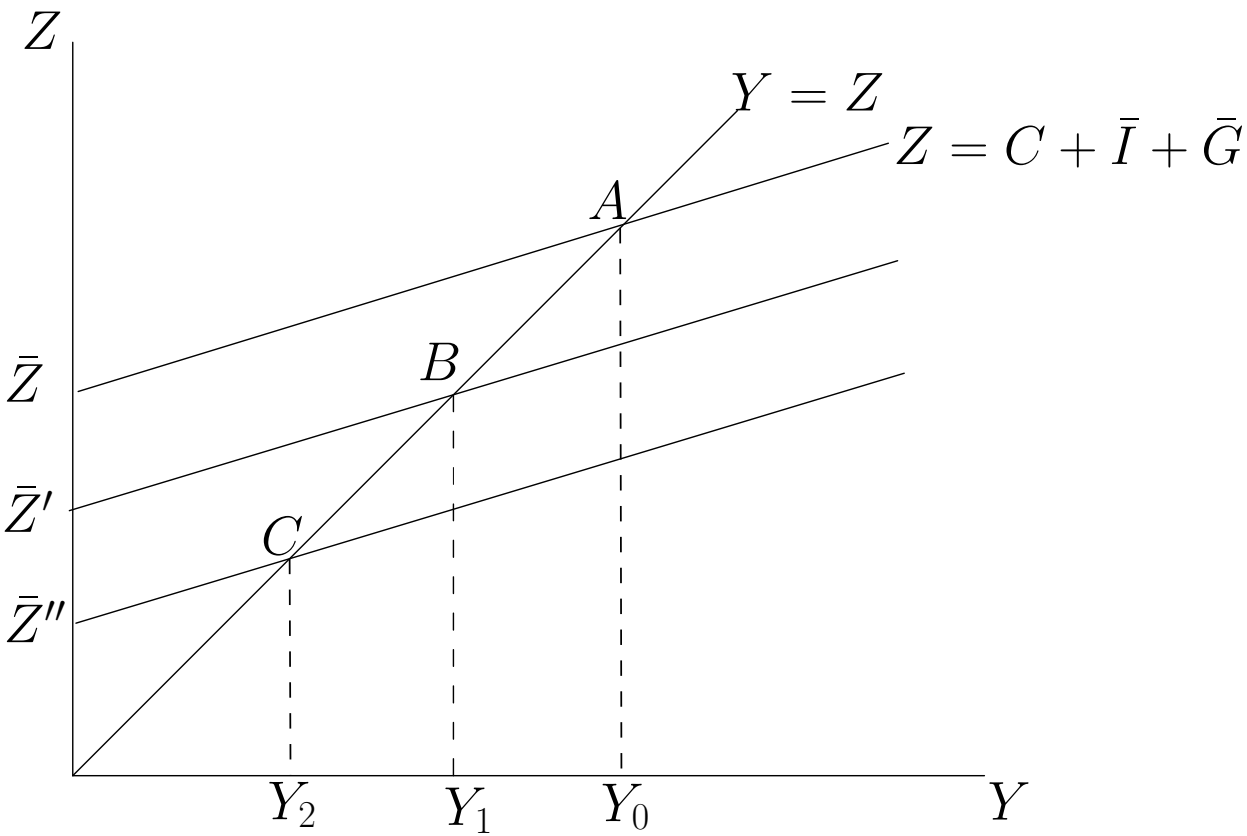
- Total output effect is the sum of the two effects

$$\begin{aligned}\Delta Y &= -\frac{c}{1-c}\Delta\bar{T} + \frac{1}{1-c}\Delta\bar{G} \\ &= -\frac{c}{1-c}\Delta\bar{G} + \frac{1}{1-c}\Delta\bar{G} \\ &= \Delta\bar{G}\end{aligned}$$

- Tax-financed expenditure increases are expansionary.

Explaining the current "Great Recession" (UK version)

- Burst of US housing bubble and banking crisis: fall in $\bar{C}$ and $\bar{I} \rightarrow$ from A to B
- Fiscal austerity: fall in $\bar{G}$ and increase in $\bar{T} \rightarrow$ from B to C



Adjustment process

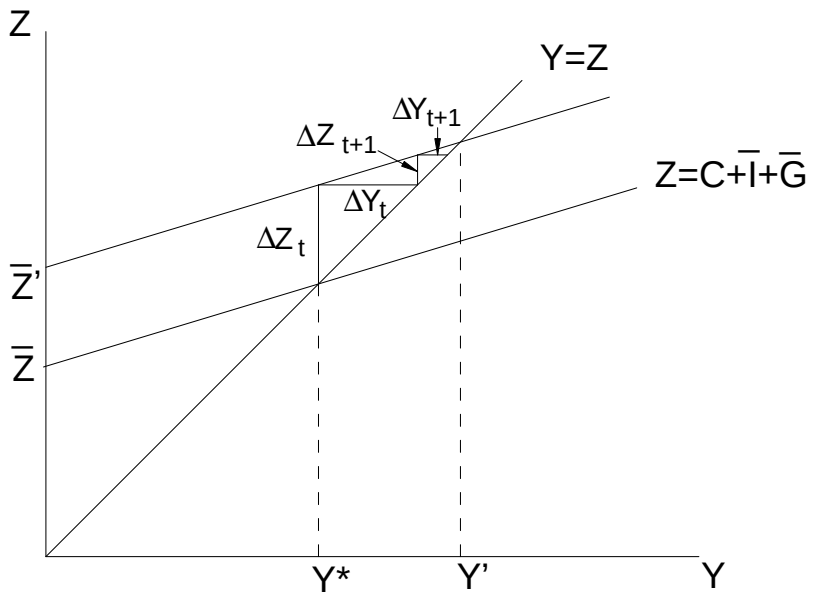
- If desired expenditure is out of line with production, the goods market is not in equilibrium.
- Some adjustment either in output, or desired expenditure, or both is needed for equilibrium to be reestablished.
- How does the economy react to a disequilibrium on the goods market?
- Which signals induce agents to change their choices so that equilibrium is reestablished?

Output adjustment to disequilibrium

1. Assumption: output reacts to a disequilibrium in the goods market (firms need to be able to expand production)$\Longrightarrow$

   (Assumption) There are unemployed resources and it is profitable for firms to expand production.
2. (Assumption) The signal that induces firms to respond is the difference between the demand for their product and production; i.e. the undesired change in inventories I_t^s.
3. More precisely, Output cannot adjust to demand within the period. So $I_t^s = Y_t - Z_t$. Firms, though, adjust output to desired expenditure in the previous period; i.e. $Y_{t+1} = Z_t$.

The dynamics of adjustment



Of course equilibrium is achieved when

$$Y_T = Z_T$$

i.e. output equals desired expenditure in the same period.

The impact of the interest rate on equilibrium output

Remember the composition of desired expenditure

$$Z = \bar{C} + c(Y - \bar{T}) + I(\bar{r}) + \bar{G} \tag{12}$$

Replace for the investment function $I(\bar{r}) = a - b\bar{r}$

$$Z = \underbrace{\bar{C} - c\bar{T} + a + \bar{G}}_{\bar{Z}_0} - b\bar{r} + cY. \tag{13}$$

Equilibrium output is the solution to the system

$$\begin{cases} Z = \underbrace{\bar{Z}_0 - b\bar{r}}_{\bar{Z}(\bar{r})} + cY \\ Y = Z \end{cases}. \tag{14}$$

The IS curve

- Solving formally

$$Y = \bar{Z}_0 - b\bar{r} + cY \tag{15}$$

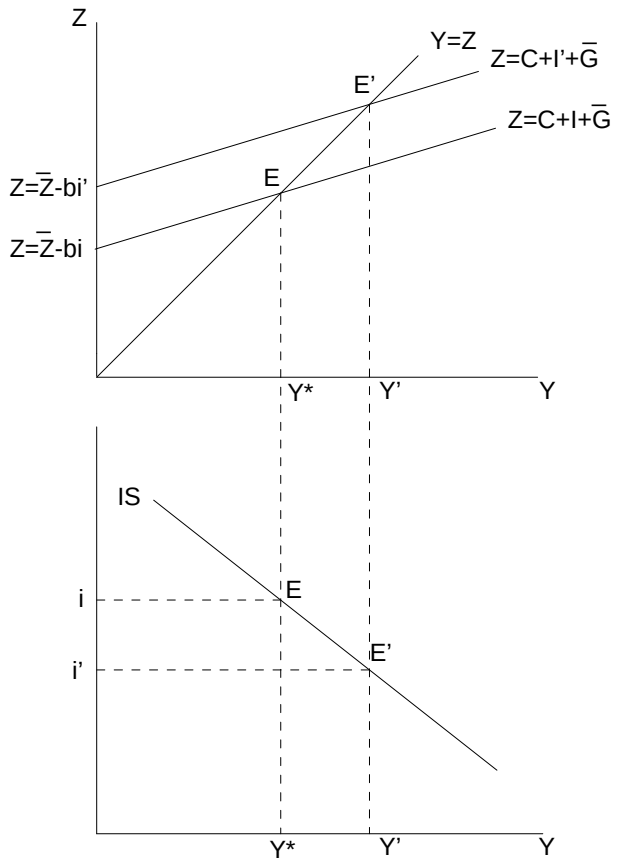
which can be rewritten as

$$Y = \frac{1}{1-c}\left(\bar{Z}_0 - b\bar{r}\right). \tag{16}$$

- Equilibrium output is now a decreasing function of the interest rate.
- Equation 16 is the IS curve. The set of (Y, r) pairs for which the goods or output market is in equilibrium.

Intuition

Consider a fall in the interest rate from r to r'. Investment increases and so do expenditure and equilibrium output.



The IS curve (II)

$$Y = \frac{1}{1-c}\left(\bar{Z}_0 - b\bar{r}\right).$$

- The Keynesian multiplier now gives the horizontal shift in the IS curve in response to a change in $\bar{Z}_0$.
- Slope of the IS curve is decreasing in b and c (in absolute value).