Lecture 8: Borrowing and lending, and Budget Constraints

ECON-C3100 Intermediate Macroeconomics I

Meri Obstbaum

Bank of Finland

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Thinking about the future

Borrowing and lending in macroeconomics

- All economic agents (as identified in the circular flow diagram) have incentives to borrow and lend
- Households, firms, the public sector and the rest-of-the-world can by borrowing and lending shift income and spending between the present and the future
- Those who expect their incomes to grow will want to borrow and raise their standards of living now instead of waiting
- The shifting of spending over time can be seen as an **intertemporal trade**
- Because people are impatient, time has a price - the **interest rate**
- The **intertemporal budget constraint** requires that liabilities be repaid someday, while accumulated assets will eventually be spent

Thinking about the future

The future has a price

- Anything of value must have a price
- Asset markets place a value on payoffs in the future (company shares, loan repayments, steel deliveries, foreign currencies)
- Parallel between *intertemporal* consumption choices and *intratemporal* consumption choices
- Deciding whether to consume now or in the future is like deciding whether to save or borrow
- Rational households take into account their future incomes and needs, and balance these against the interest rate at which they can borrow or save

The rational expectations hypothesis

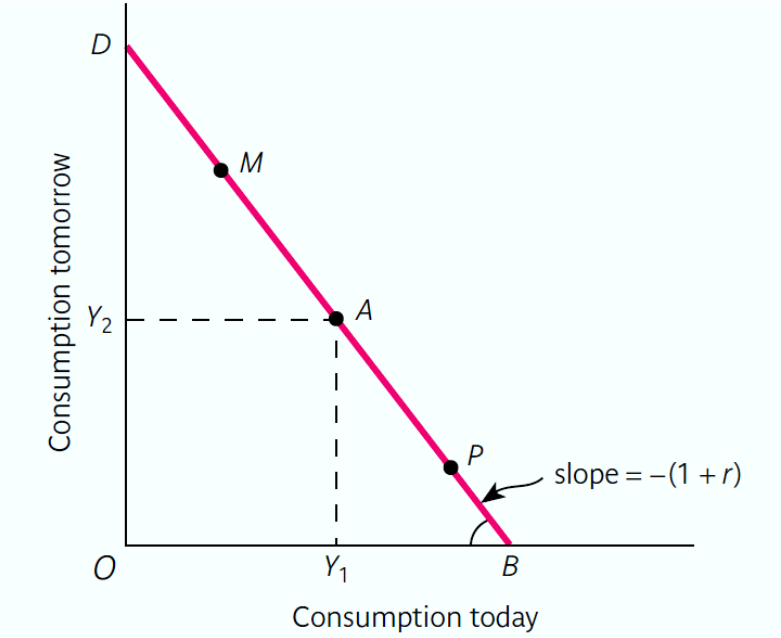
- The modern view of how firms and households form their expectations: economic agents' forecasts are right *on average*
- The rational expectations hypothesis does not mean that households and firms never make mistakes in their predictions - we just assume that they do not make *systematic* errors
- However, experiments show that we have limited ability to process all the information we have, and that humans often respond rather to emotions than to cold calculation

The rational expectations hypothesis

- How can we defend the rational expectations hypothesis?
  - There are so many ways of being irrational that there is no clear alternative
  - If agents are rational in planning their consumption, work and production, they should also be rational when thinking about the future
  - It is unlikely that people would be repeatedly and systematically wrong. If they are, they suffer losses, so they probably learn from their mistakes
  - It is often enough that a few well-informed agents behave rationally to drive the markets
- Simplified version of the rational expectations hypothesis: perfect foresight, i.e. ignore uncertainty

Endowment, wealth and consumption

The household's intertemporal budget constraint



- A is the autarky point where the household consumes its own endowment both today and tomorrow

The real interest rate

- Borrowing 100 units of the consumption good today will require paying back $100\,(1+r)$ tomorrow
- A unit of consumption tomorrow is thus worth $1/(1+r)$ consumption units today
- As the real interest rate r is positive, goods tomorrow are less valuable than goods today
- The real interest rate measures the cost of waiting
- $1/(1+r)$ is called the discount rate

The budget line

- Assume that income in each period is Y_1, Y_2 $(1 = \textit{today}, 2 = \textit{tomorrow})$
- The budget line can be represented formally as

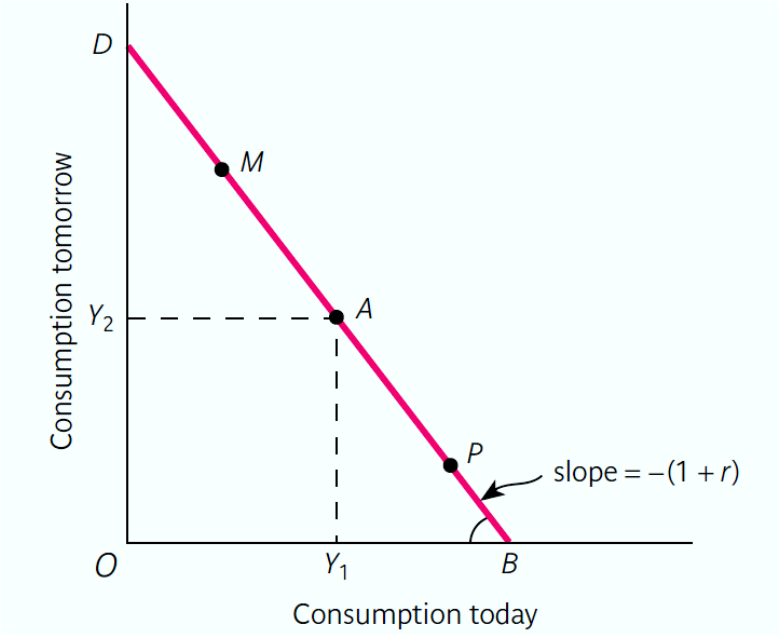
$$C_2 = Y_2 + (Y_1 - C_1)(1 + r)$$

where the last term is the interest and pricipal from savings in period 1

- Dividing both sides by $(1 + r)$ and rearranging yields

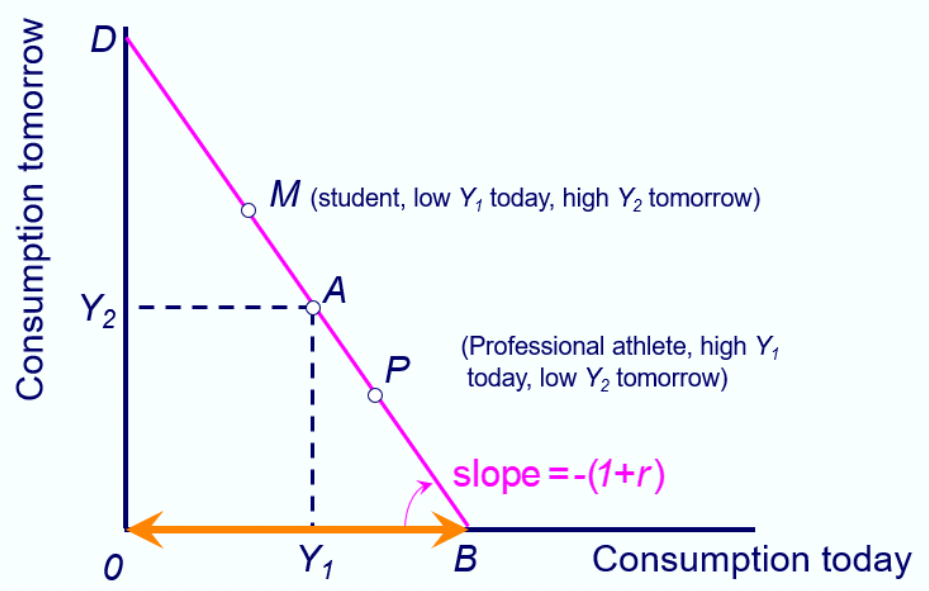
$$\underbrace{C_1 + \frac{C_2}{(1+r)}}_{\text{present value of consumption}} = \underbrace{Y_1 + \frac{Y_2}{(1+r)}}_{\text{present value of income}} = \underbrace{\Omega}_{\text{total wealth}}$$

The slope of the budget line



- The slope of the budget line is given by $-\frac{OD}{OB}$ with OB: $Y_1 + \frac{Y_2}{(1+r)}$ and OD: $Y_2 + Y_1(1+r)$

Endowment, Wealth, and Consumption



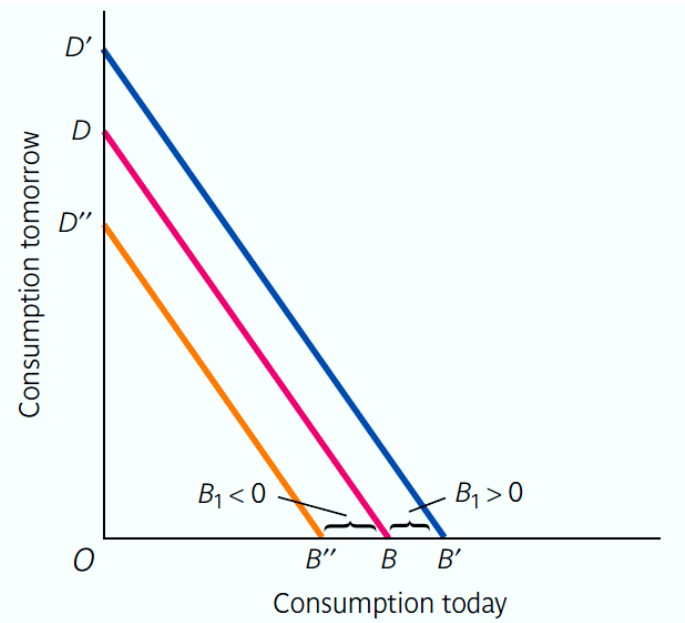
- Endowments M, A and P for interest rate r imply the identical wealth OB.
- As long as these points are on the same budget constraint, the present discounted value of income is the same
- Lending and borrowing enable individuals with same lifetime wealth but different income profiles to enjoy the same menu of possible consumption

Add initial (tradable) wealth

- Now suppose the household has initial tradable wealth B_1 and modify the budget constraint accordingly

$$\underbrace{C_1 + \frac{C_2}{(1+r)}}_{\text{present value of consumption}} = \underbrace{Y_1 + \frac{Y_2}{(1+r)} + B_1}_{\text{present value of income}} = \underbrace{\Omega}_{\text{total wealth}}$$

- If $B_1 > 0$ the household can consume more in both periods, but B_1 could be negative

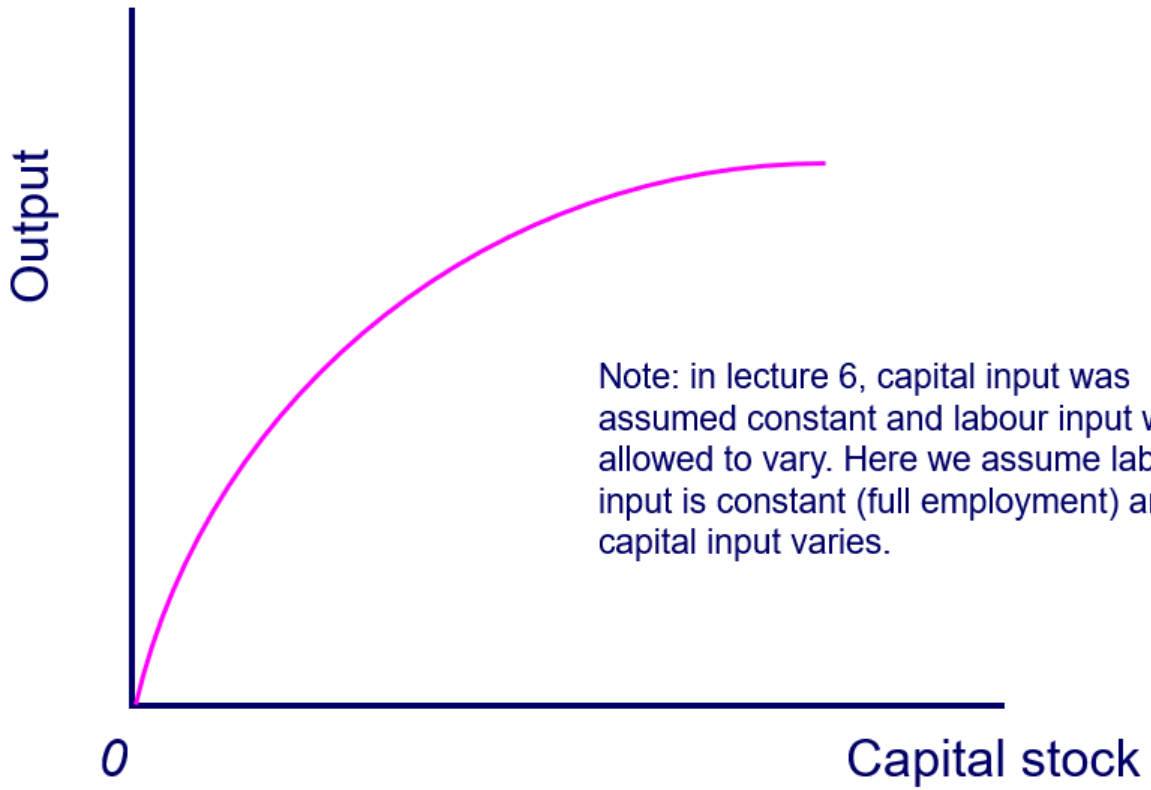


Firms and the investment decision

- Investment (fixed capital formation in the national accounts) = The use of valuable resources to produce more goods later
- The investment decision has a fundamentally intertemporal aspect
- Firms decide to accumulate capital when it is profitable
- Profitability depends on expected future outcomes

The production function

- The investment decision depends upon the amount of output that can be produced with the available equipment
- The standard assumptions about the production function imply that, as more capital is accumulated, the additional output declines (diminishing marginal productivity, $F_K > 0$, $F_{KK} < 0$)



Capital accumulation

The new capital stock in period $t+1$ (tomorrow) is equal to the capital stock today (period t) plus gross investments today minus the depreciation of capital

$$K_{t+1} = K_t + I_t - \delta K_t$$

and so the realized change in the productive capital stock is equal to the difference between gross investments and depreciation of previously accumulated capital

$$\Delta K = K_{t+1} - K_t = I_t - \delta K_t$$

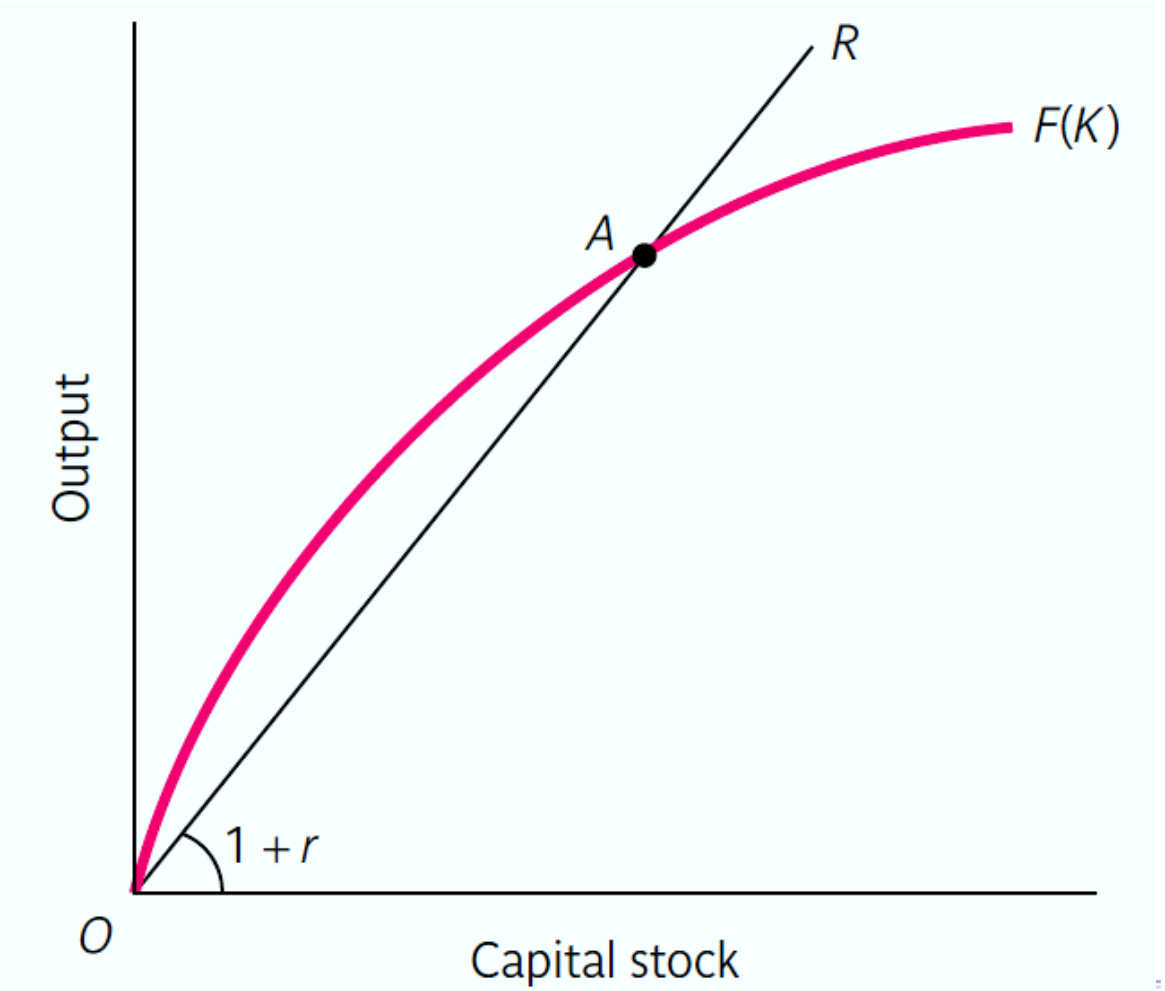
The cost of investment

- Today, the firm can either invest K in productive equipment and receive additional output tomorrow, or save K and receive $(1 + r) K$ tomorrow
- The real interest rate measures the **opportunity cost** of the resources used in investment
- The investment must therefore yield at least $1 + r$ to be worth undertaking

Productive technology

Cost of investment

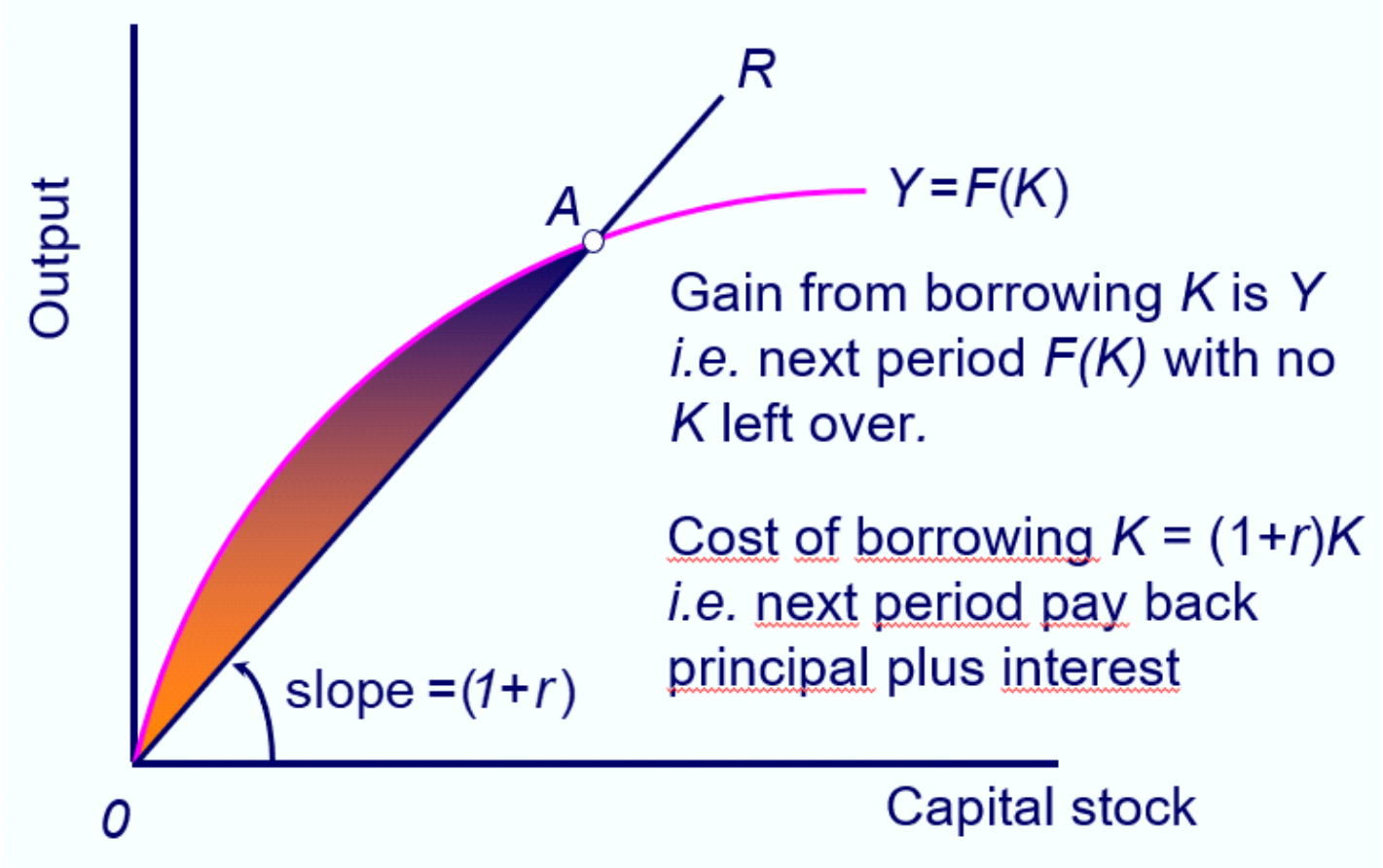
The opportunity cost of invested capital is described by the ray OR, which is given by $(1 + r) K$



Productive technology

Profit

Profit can be made as long as $F(K) > (1 + r) K$



Net return from investing

The value of the investment project is the difference between the present value of output tomorrow and investment today

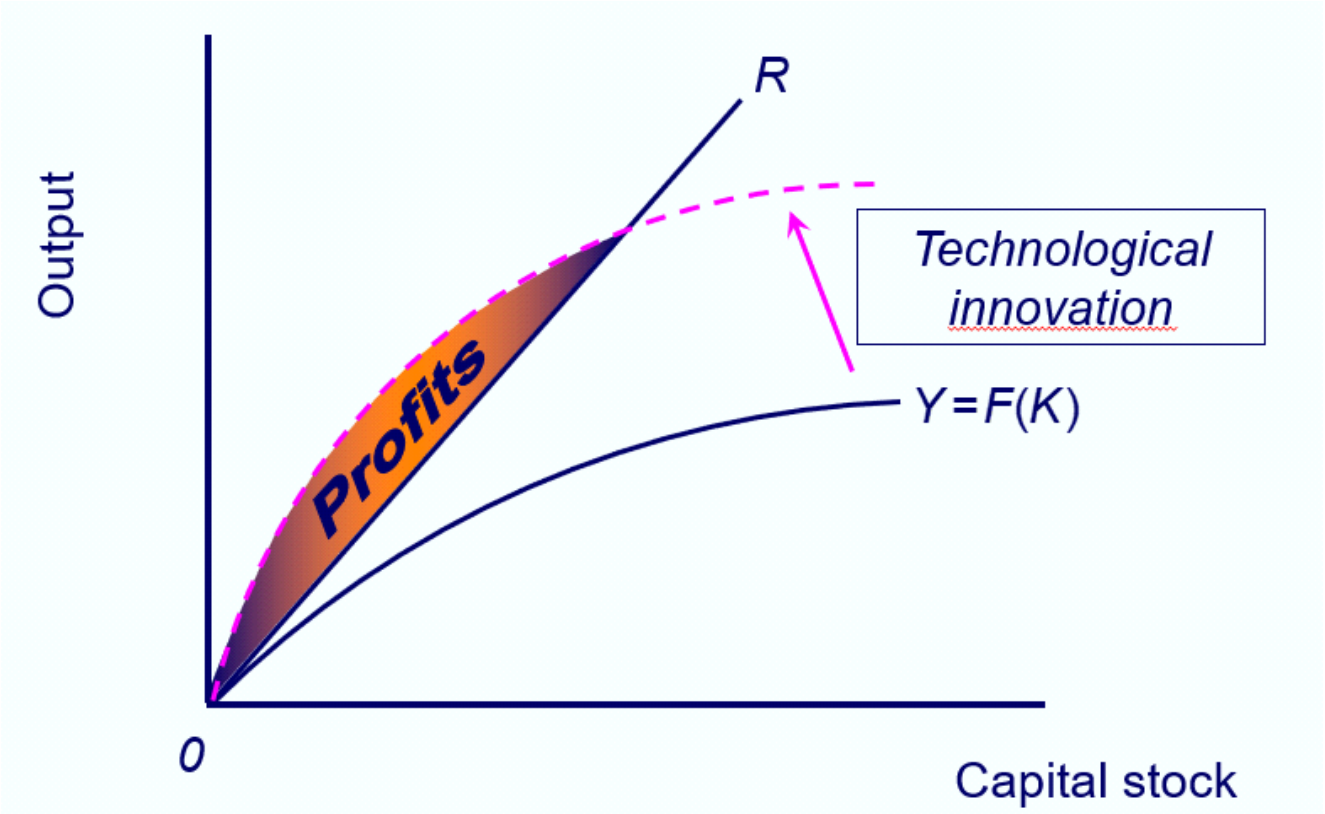
$$V = \frac{F(K)}{1+r} - K$$

An investment project is economically justifiable only if it has positive present value $V > 0$ or

$$\frac{F(K)}{1+r} > K$$

Profitability of investments

- Given the interest rate, no firm will operate with the production function $Y = F(K)$
- A technological innovation which shifts the production function upwards can make an unproductive technology productive again



The intertemporal budget constraint of the consolidated private sector

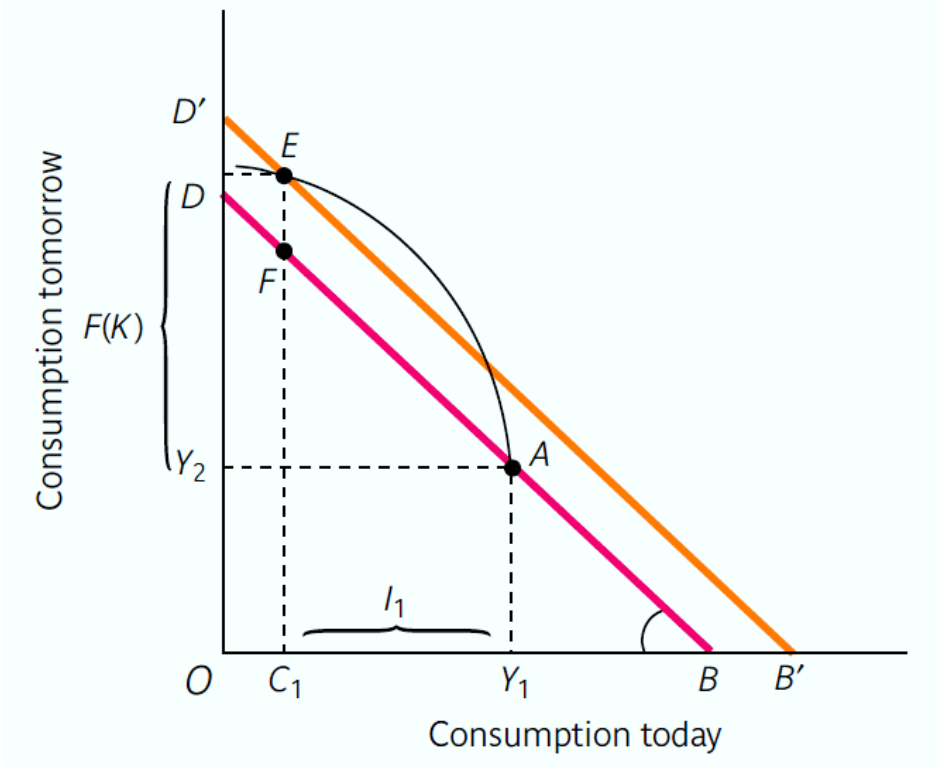
- Once investment and production are taken into account, income tomorrow is no longer simply given by nature
- The budget constraint depends also on the amount that is invested and on its profitability
- Tomorrow's capital (assuming that $K_1 = 0$)

$$K_2 = I_1 = Y_1 - C_1$$

- The more the household invests, the larger will be tomorrow's production
- Tomorrow's income - and consumption, since it is the last period - is the sum of the (natural) endowment and produced output

$$C_2 = Y_2 + F(K_2)$$

Investment increases wealth



- The distance FE represents the additional goods which become available through investment.
- Investing K increases wealth by the distance BB'.

The consolidated private sector intertemporal budget constraint

- The intertemporal budget constraint determines the present value of consumption as equal to total wealth

$$\underbrace{C_1 + \frac{C_2}{(1+r)}}_{\text{present value of consumption}} = \underbrace{\Omega}_{\text{total wealth}}$$

- Plugging in the equations for consumption today C_1 and consumption tomorrow C_2 (2 slides back), allows us to rewrite the intertemporal budget constraint as

$$\underbrace{\Omega}_{\text{total wealth}} = \underbrace{Y_1 + \frac{Y_2}{(1+r)}}_{\text{wealth from endowment}} + \underbrace{V}_{\text{value of the firm}}$$

The public budget constraint

- The government is little different from other economic agents. It can borrow, but is expected to repay its debt with interest.
- Consider a government which spends G_1 today and G_2 tomorrow, and raises net taxes T_1 and . The government also has inherited debt D_1 from the past
- D_1 already incorporates interest from the past so the government can either pay it off in its entirety, or "roll it over" into the next period
- Debt incurred must be serviced (interest must be paid) at interest rate r_G and it is carried forward into the next period
- Debt in period 2

$$D_2 = (1 + r_G)(D_1 + G_1 - T_1)$$

The public budget constraint

- If the government is solvent, all debt at the *end* of period 2 must be paid off in its entirety, i.e. $(1 + r_G)(D_2 + G_2 - T_2) = 0$
- Combine this with the equation for D_2 to get

$$D_1 = T_1 - G_1 + \frac{T_2 - G_2}{1 + r_G}$$

- A solvent government is one in which initial debt D_1 is financed by present value of current and future **primary budget surpluses**
- The primary surplus is the government balance from which interest payments or receipts have been removed

The public budget constraint

- The total borrowing requirement of a government, the headline deficit, is the sum of (1) the primary deficit, and (2) interest payments and debt repayment
- The primary surplus today is $T_1 - G_1$ and interest income is $r_G\left(D_1 + G_1 - T_1\right)$. The headline deficit is therefore (Multiply by -1 the sum of (1) and (2))

$$\text{Deficit:} \quad \underbrace{G_1 - T_1}_{\text{primary deficit}} + \underbrace{r_G\left(D_1 + G_1 - T_1\right)}_{\text{interest payment and debt repayment}}$$

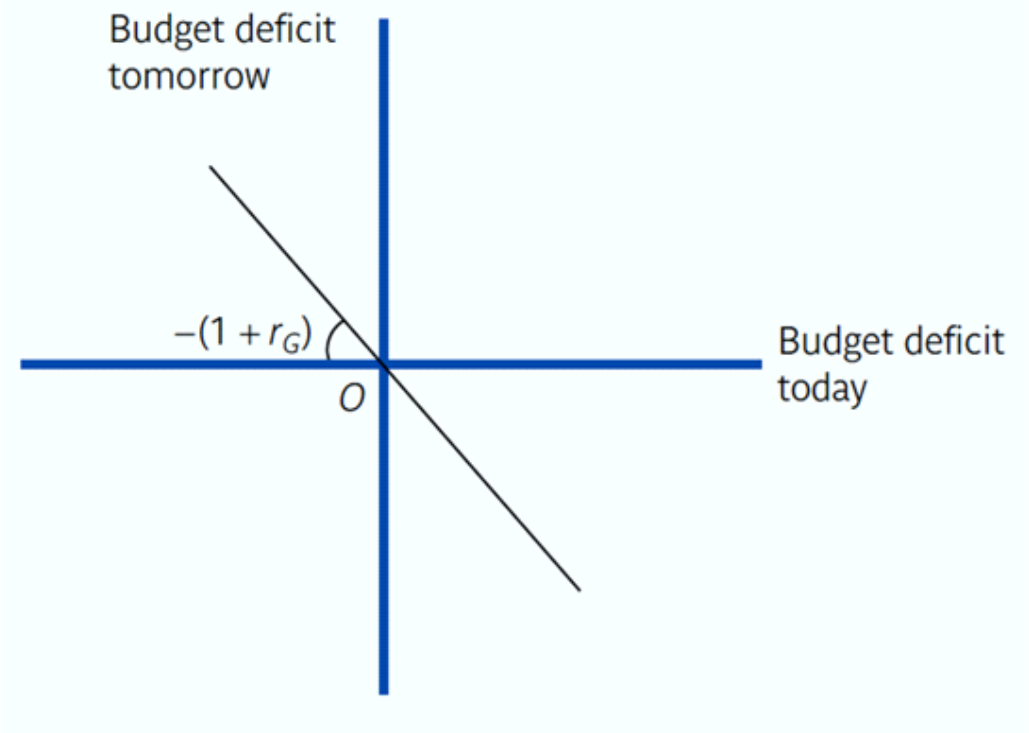
The public budget constraint

- In the simple two-period framework, the lesson from the government budget constraint is clear: in the second and last period, the government must repay its obligations in full.
- Tomorrow's primary surplus must be sufficient to repay today's deficit, the initial debt burden and the interest service on the borrowing (you can solve this from the equation for D_1 2 slides back)

$$T_2 - G_2 = r_G \left(D_1 + G_1 - T_1 \right)$$

- Tomorrow's primary surplus depends (among other things) on economic growth. When the economy grows robustly, tax revenues can be expected to grow and ease the burden on public finances. Public sector deficit and debt are usually reported relative to GDP

Budget Constraint with No Old Debt (D1=0)



$$(1+r_G)\underbrace{\left(\underbrace{D_1}_{\text{old debt}}+\underbrace{(G_1-T_1)}_{\text{this period's deficit}}\right)}_{\text{new debt}}=\underbrace{T_2-G_2}_{\text{next period's surplus}}$$

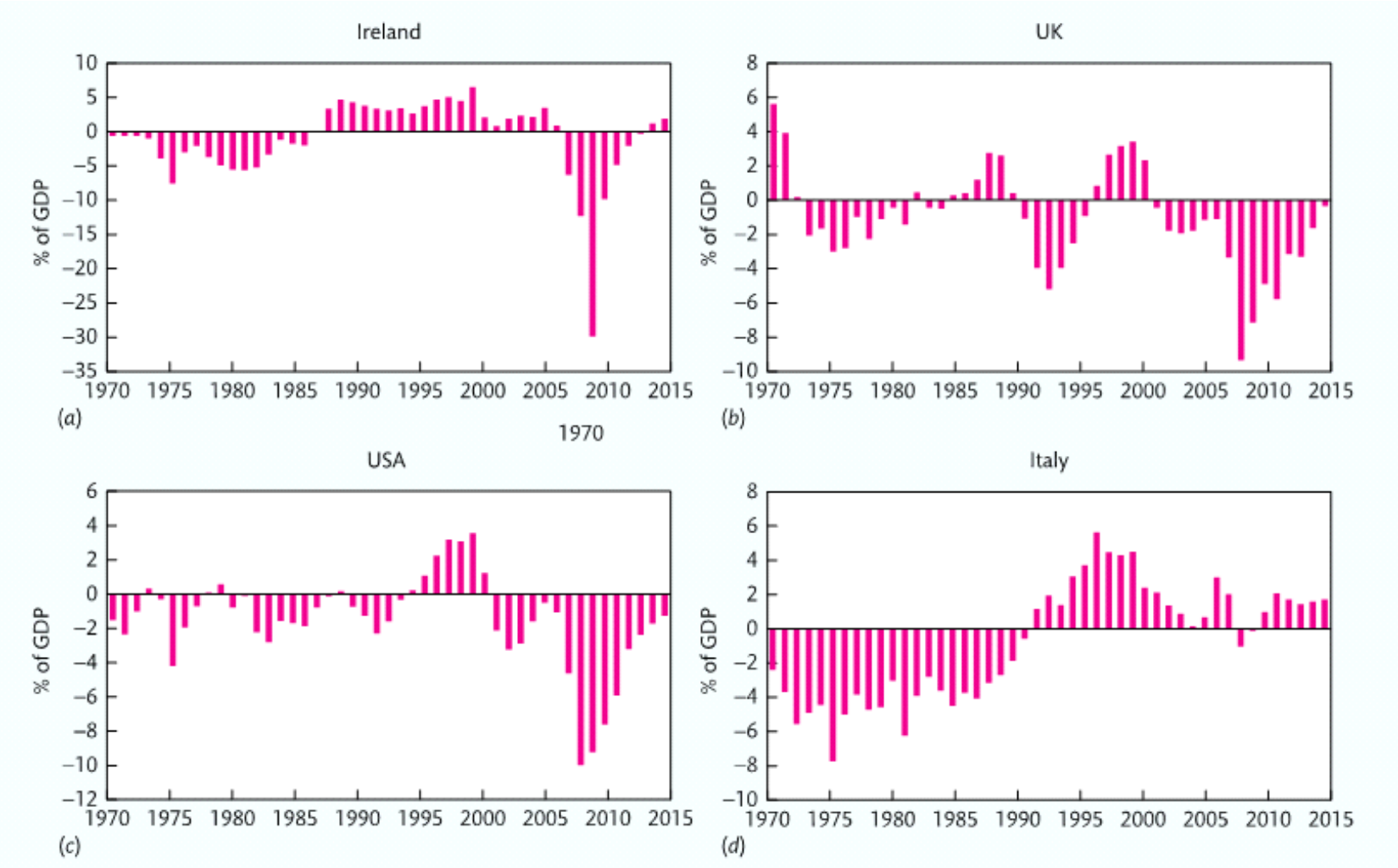
$$-(1+r_G)\underbrace{\left(\underbrace{D_1}_{\text{old debt}}+\underbrace{(G_1-T_1)}_{\text{this period's deficit}}\right)}_{\text{new debt}}=\underbrace{G_2-T_2}_{\text{next period's deficit}}$$

$$-(1+r_G)\underbrace{\left(\cancel{\underbrace{D_1}_{\text{old debt}}}+\underbrace{(G_1-T_1)}_{\text{this period's deficit}}\right)}_{\text{new debt}}=\underbrace{G_2-T_2}_{\text{next period's deficit}}$$

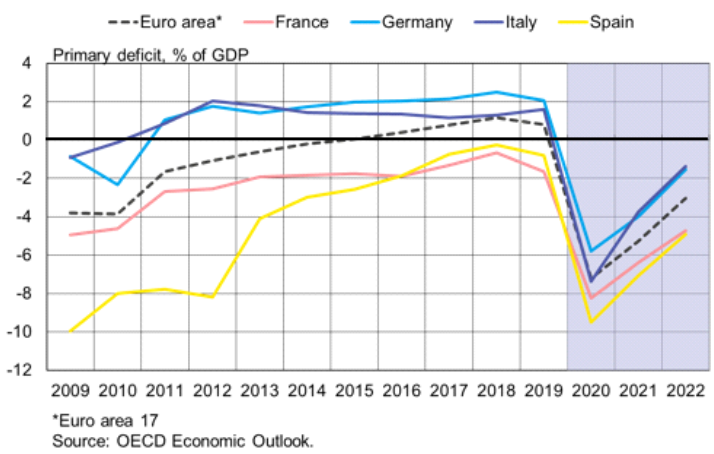
Do governments really obey their budget constraints?

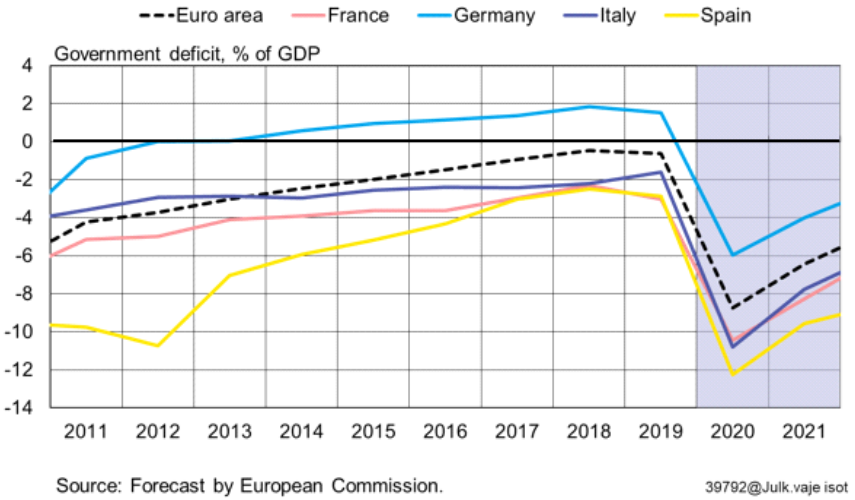
- The two-period framework contains a strong message: governments with debt and deficits *today* must run primary surpluses *tomorrow*
- Governments throughout history have been faced with budget problems, and there are several examples of government defaults
- In most cases, defaults are fust the end point of a long period of debt accumulation, reflecting persistent budget deficits which do not seem to demonstrate any budget constraint
- But what is a default? Technically, a situation where the borrowing country fails to service its debt
- In reality, the intertemporal borrowing constraint features public spending and tax revenue streams that extend into the *infinite* future

Evolution of primary budget balances in Ireland, the UK, the US and Italy, 1970-2015

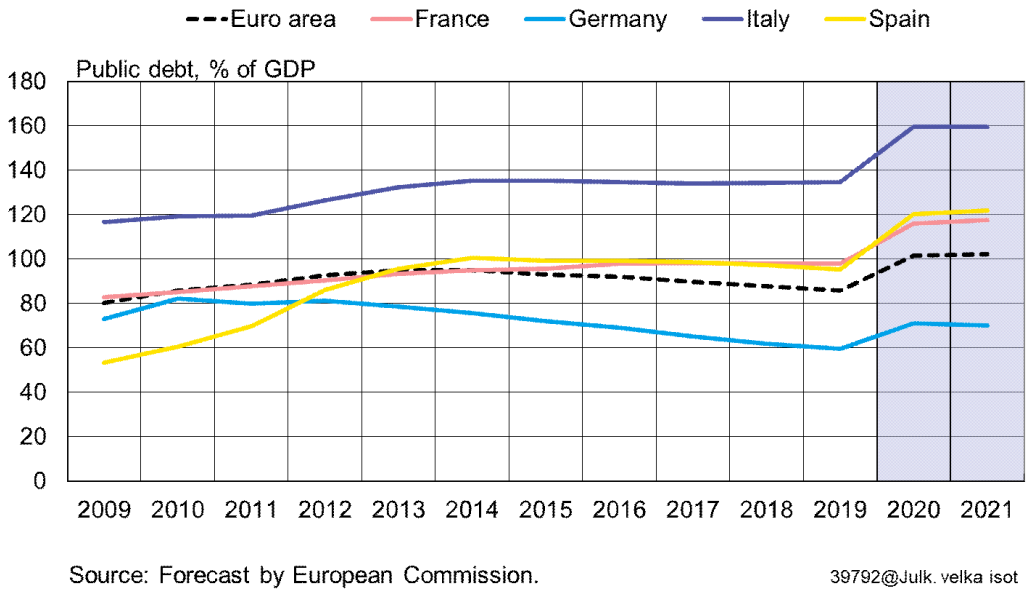


Primary and headline deficits in large euro area countries





Public debt of GDP in large euro area countries



The consolidated public and private budget constraint

- Both households and firms (which are owned by households) ultimately have to pay the taxes
- For simplicity, set initial government debt to zero
- Recall the private and public intertemporal constraints

$$C_1 + \frac{C_2}{(1+r)} = Y_1 - T_1 + \frac{Y_2 - T_2}{(1+r)}$$

$$G_1 + \frac{G_2}{1+r_G} = T_1 - + \frac{T_2}{1+r_G}$$

- According to the first contraint, the private households pay the taxes, which reduces disposable income, and according to second, the government receives them.

The consolidated public and private budget constraint

- Combining the private and public budget constraints yields the consolidated budget constraint

$$C_1 + \frac{C_2}{(1+r)} = (Y_1 - G_1) + \frac{Y_2 - G_2}{1+r} + \left(\frac{r - r_G}{1+r}\right)(G_1 - T_1)$$

- The present value of consumption (left-hand side) is equal to the sum of the present value of private resources net of government spending and the present value of the government's financing advantage.
- Usually the private sector is considered as less safe than the public sector and therefore typically $r > r_G$. This means that the last term is positive: borrowing by the government expands the consumption possibilities of households

The Ricardian Equivalence proposition

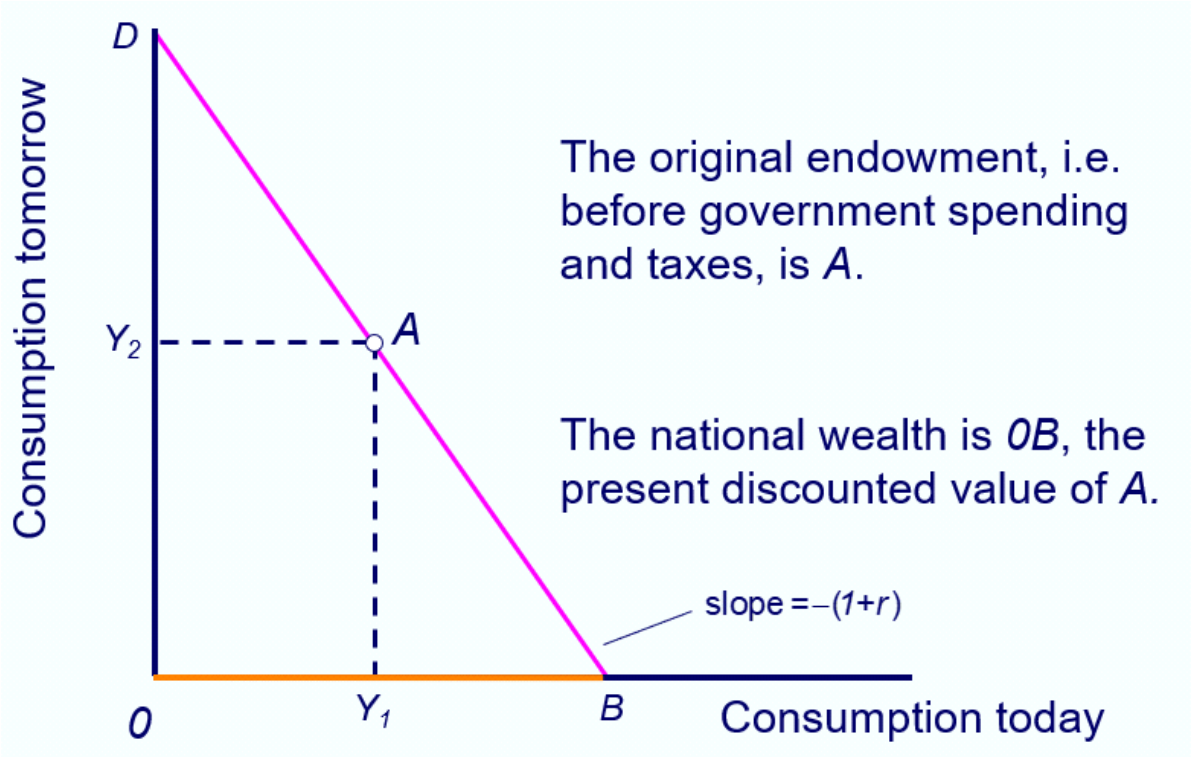
- Suppose that the interest rates of the private sector and the government are exactly equal $r = r_G$ in which case the consolidated budget constraint reduces to

$$\underbrace{C_1 + \frac{C_2}{(1+r)}}_{\text{present value of consumption}} = \underbrace{(Y_1 - G_1) + \frac{Y_2 - G_2}{1+r}}_{\text{present value of private resources net of government spending}}$$

- Taxes do not appear, meaning that it does not matter at all when taxes are levied as long as the government abides by its budget constraint
- The private sector internalizes the public sector's budget constraint. This is the **Ricardian equivalence proposition**.

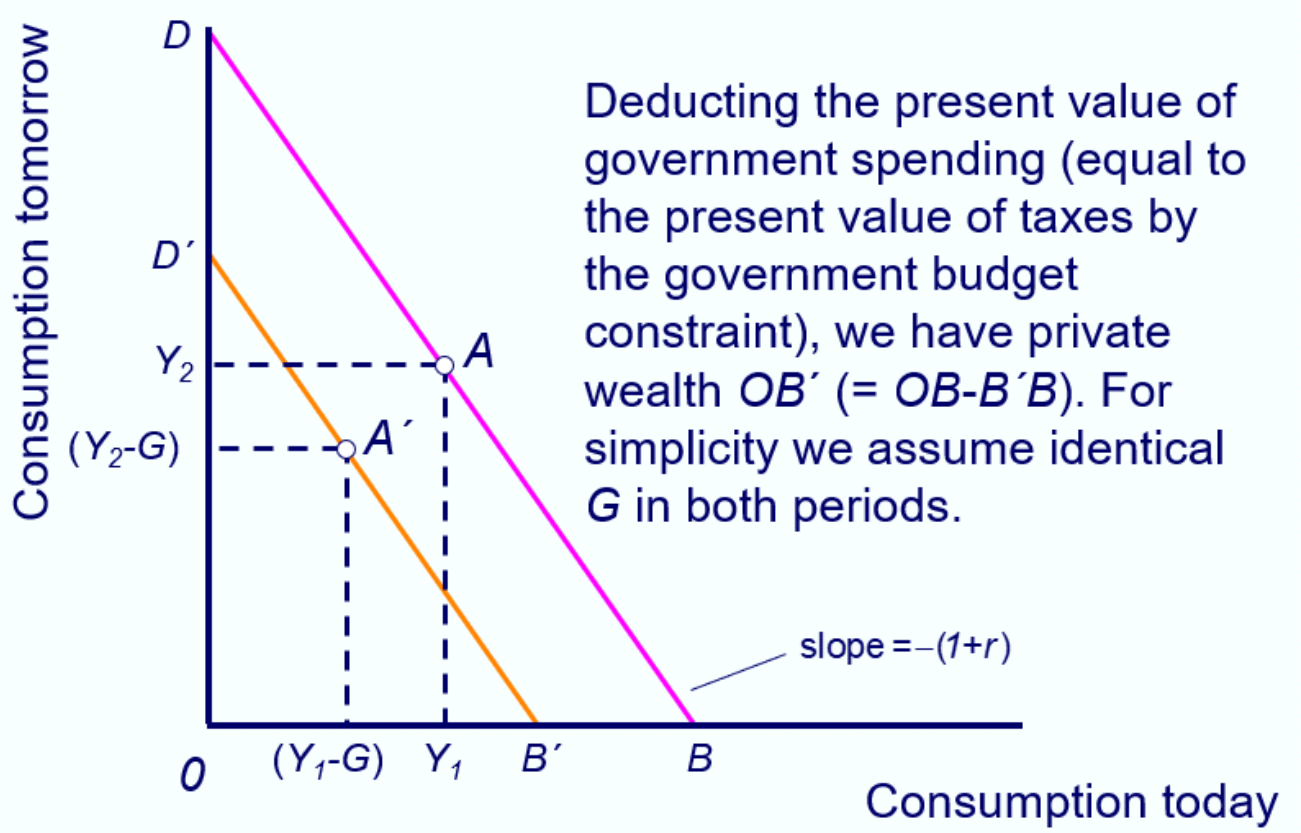
The Ricardian Equivalence proposition

Private wealth before government spending and taxes

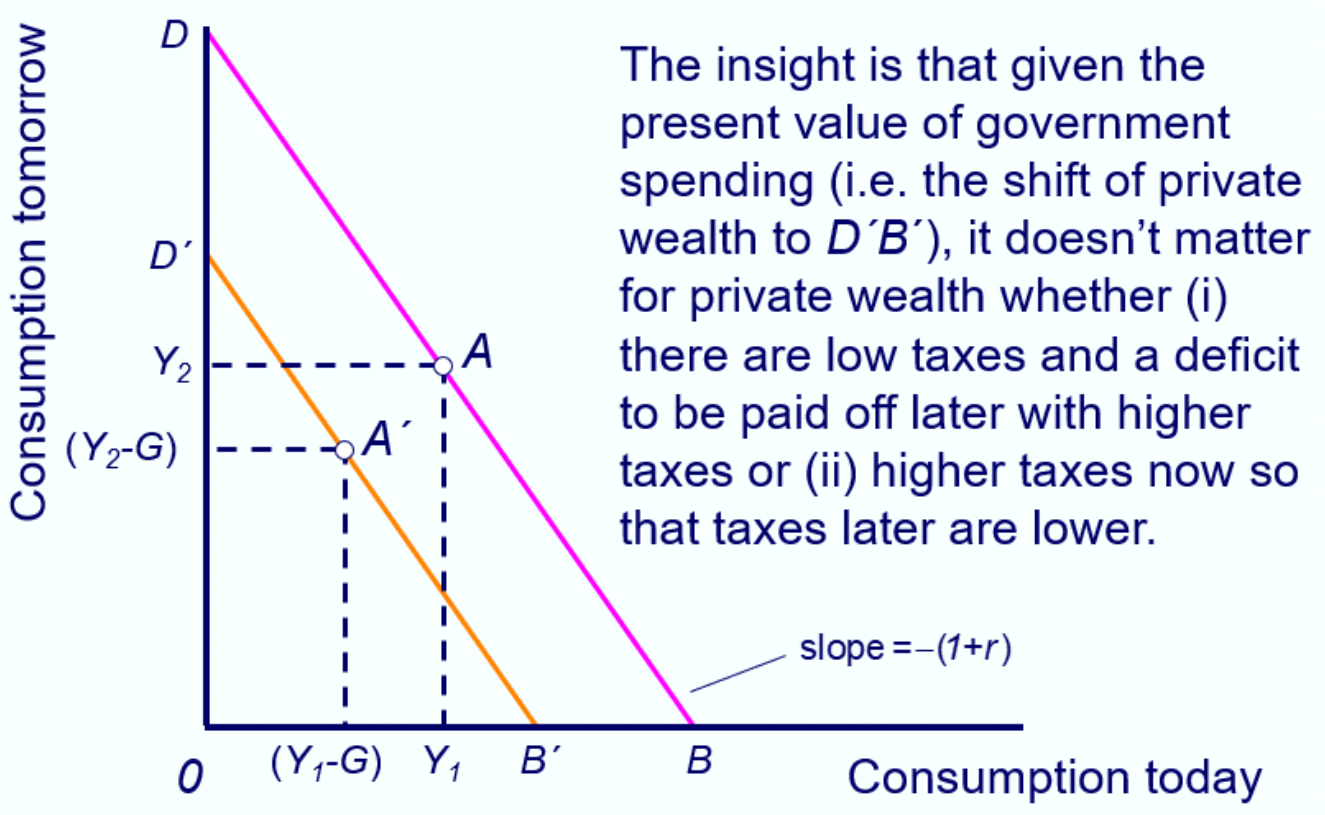


The Ricardian Equivalence proposition

Private wealth with government spending and taxes



Ricardian Equivalence



The Ricardian Equivalence proposition

Three ways of interpreting the Ricardian Equivalence proposition

- Total national spending - the sum of private and public spending on goods and services - cannot exceed the country's wealth
- Private wealth is the difference between the present value of income and public purchases of goods and services. The pattern of taxation has no effect on private wealth. What matters is public spending which represents resources taken away from the private sector.
- Citizens do not treat government debt as net wealth. The private sector sees through the veil of government. It understands that the government's promises to pay the principal and interest on public debt are matched by taxes levied to service the debt, today or tomorrow

When Ricardian Equivalence fails

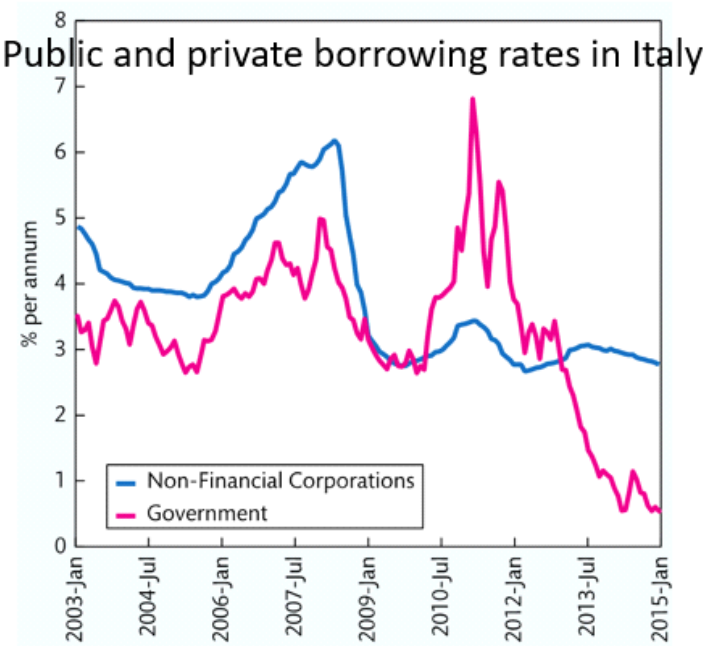
- Different interest rates
- Mortal or new citizens
- Restrictions on borrowing
- Distortionary taxes and unemployed resources

Different public and private interest rates

Interest rates for government and corporate bonds
February 2016

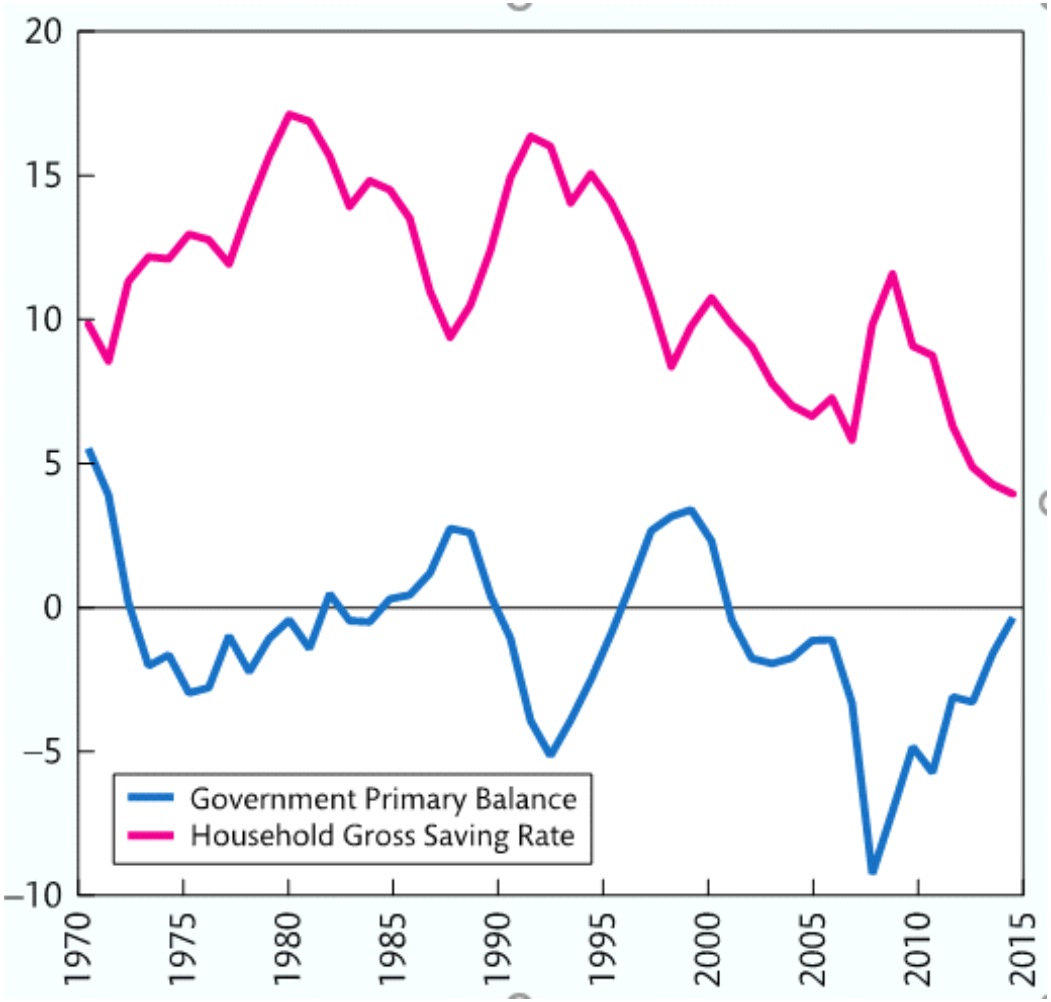
	10-Year Government Bond	10-Year Corporate Bonds	
		A-rated	BBB-rated
United Kingdom	1.32	3.46	4.25
United States	1.74	3.57	4.74
Euro Area	1.05	1.67	2.66

Source: Macrobond.



Evidence of Ricardian Equivalence?

Government balance and household saving in the UK, 1970-2015



The current account and the budget constraint of the nation

- National net saving vis-à-vis the rest of the world occurs through the current account.
- The current account can be decomposed into the **primary current account** and **net investment income**, which represents the net investment income / interest service on foreign assets and liabilities

current account surplus (CA) = primary current account surplus (PCA) + net inve

where F stands for the country's net asset position.

- Net investment income is positive when the country holds more assets than liabilities $(F > 0)$ and negative in the case of an indebted country $(F < 0)$

The current account and the budget constraint of the nation

- The budget constraint of the nation requires that the present value of a country's primary current account surpluses be no less than the value of international assets in the first period

$$\underbrace{PCA_1 + \frac{PCA_2}{1+r}}_{\text{present value of current and future primary current accounts}} \geq \underbrace{-F_1}_{\text{current net external debt}}$$

- If a country has net wealth at the beginning of period 1 $(F_1 > 0)$ it can draw on it to run future current account deficits
- If, in turn, there is external debt $(F_1 < 0)$, the present value of current accounts must be positive, by an amount sufficient to repay the external debt plus interest