

A person is running away from the camera on a paved road that curves through a dry, hilly landscape. The runner is wearing a bright yellow-green long-sleeved shirt and black leggings. To the right of the road, there is a green mile marker sign that reads 'MILE 36.5'. The background shows rolling hills with sparse vegetation and some trees in the distance under a clear sky.

Long Run Macroeconomics

EC1101E Macro Lecture 2

Agenda

1. Growth rates, economic history and institutions

- Growth rate math
- Institutional conditions for growth

2. The aggregate production function and the ingredients for growth

3. Productivity growth

4. The Classical Model

Growth rate math

Suppose real GDP of a country in 2009 is \$100 billion

Suppose **growth rate** of real GDP is 7 percent per year

In one (**1**) year,

$$\begin{aligned}\text{RGDP} &= \$100\text{bn} \times (1.07)^{\mathbf{1}} \\ &= \$107\text{bn}\end{aligned}$$

In ten (**10**) years,

$$\begin{aligned}\text{RGDP} &= \$100\text{bn} \times (1.07)^{\mathbf{10}} \\ &= \$196.7\text{bn} \\ &\approx 2 \times \$100\text{bn}\end{aligned}$$

The Rule of 70 approximation for doubling time

The **Rule of 70** approximation:

Time to double $\approx 70 / \text{growth rate percentage point}$

E.g.: Growth rate is 7% per year, so time to double is...

Rule of 70 approximation: $70/7 =$ **10 years**

Precise calculation: **10.24 years**

Another approximation for growth rates

Let g_A denote the growth rate of variable A

Growth rate approximations for products and quotients:

If $C = A \times B$, then $g_C \approx g_A + g_B$

If $C = A / B$, then $g_C \approx g_A - g_B$

E.g. Real wage (base year dollars) = Nominal Wage \times 100/CPI

If nominal wage grows at 10% per year

And CPI inflation rate (i.e. growth rate of CPI) is 4% per year

Then real wage grows at approximately $10 + 0 - 4 = 6\%$ per year

Precise calculation:

5.76% per year

Application: the Growth Equation

$$\begin{aligned}\text{RGDP per capita} &\equiv \frac{\text{RGDP}}{\text{Population}} \\ &= \frac{\text{RGDP}}{\text{Employed}} \times \frac{\text{Employed}}{\text{Population}} \\ &= \frac{\text{RGDP}}{\text{Hrs worked}} \times \frac{\text{Hrs worked}}{\text{Employed}} \times \frac{\text{Employed}}{\text{Population}} \\ &= \text{Productivity} \times \text{Average Hours} \times \text{Employment to Population Ratio (EPR)}\end{aligned}$$

Thus, one can write the Growth Equation:

$$g_{\text{RGDP per capita}} \approx g_{\text{Productivity}} + g_{\text{Avg. Hrs.}} + g_{\text{EPR}}$$

Active Learning: The Growth Equation

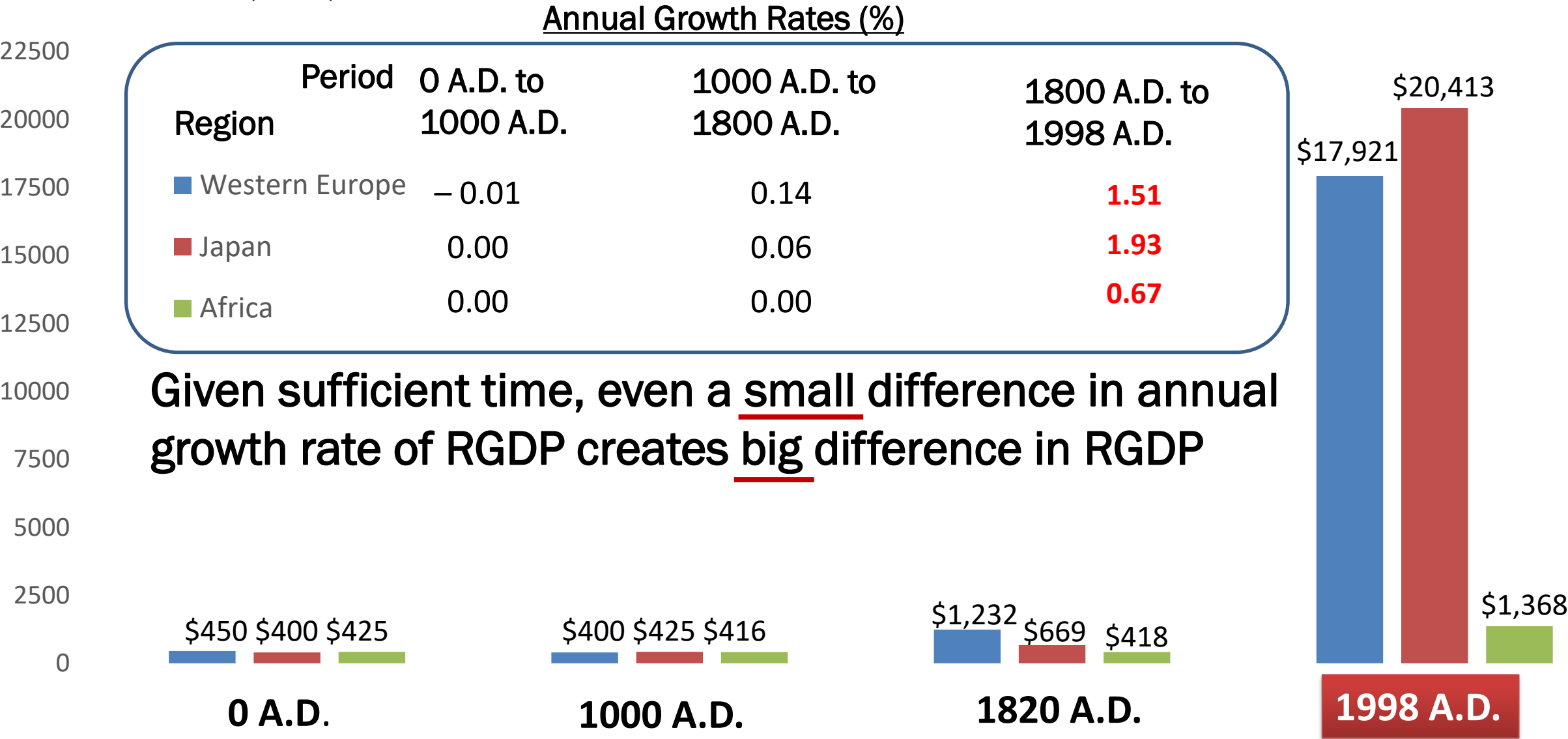
$$g_{\text{RGDP per capita}} \approx g_{\text{Productivity}} + g_{\text{Avg. Hrs.}} + g_{\text{EPR}}$$

	2016	2017	Growth Rate
Productivity	\$10/hour	\$10.20/hour	2%
Average Hours	2,000	2,080	4%
EPR	0.5	0.515	3%
GDP per capita			

Using the Growth Equation, RGDP per capita grew approximately
__% + __% + __% = __% in 2017

Estd. RGDP per capita, selected regions, 0-1998 A.D.

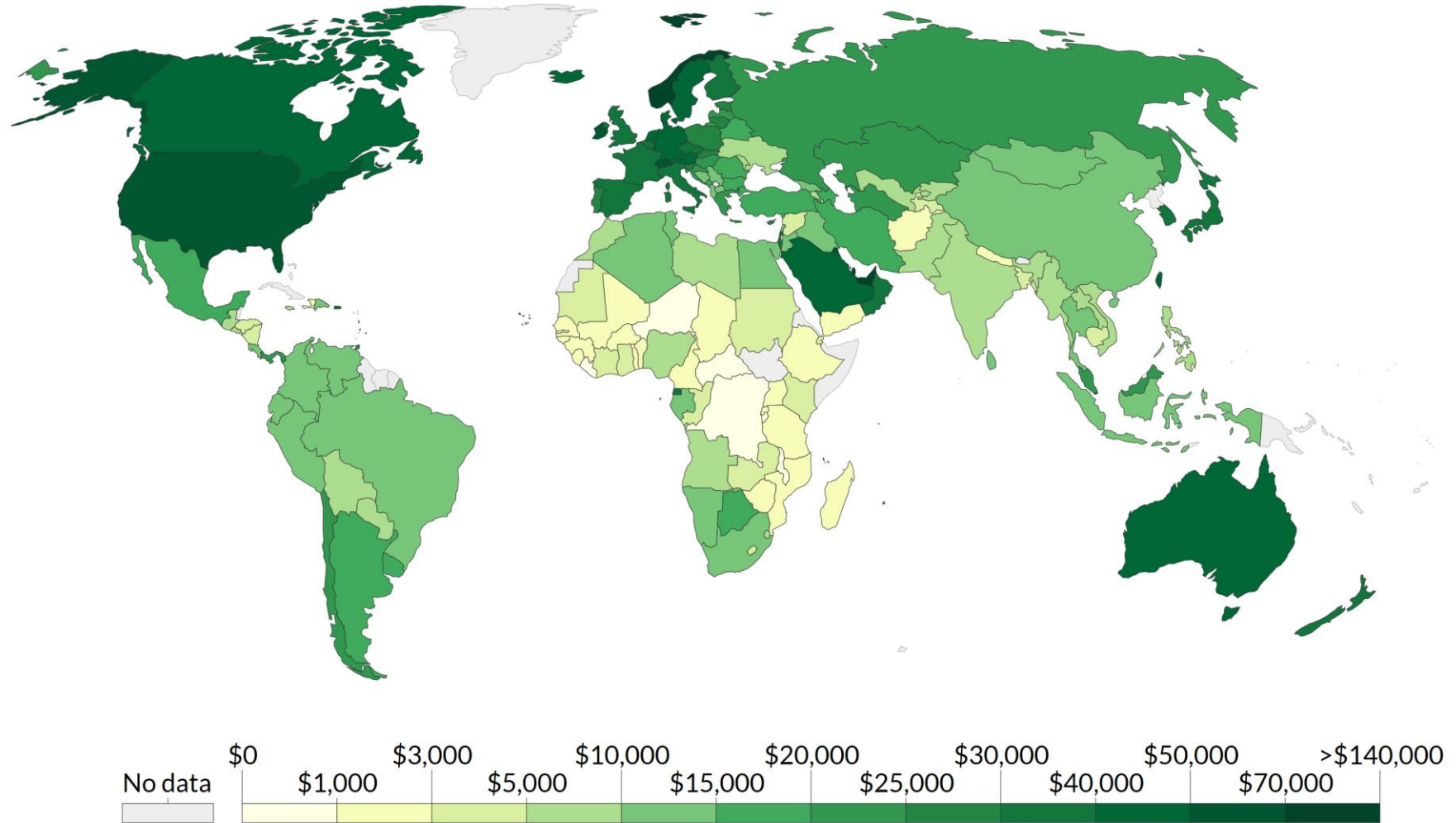
Source: Maddison (2001)



GDP per capita, 2016

GDP per capita adjusted for price changes over time (inflation) and price differences between countries – it is measured in international-\$ in 2011 prices.

**Economic
growth
has been
uneven**



Source: Maddison Project Database (2018)

OurWorldInData.org/economic-growth • CC BY

Note: These series are adjusted for price differences between countries using multiple benchmark years, and are therefore suitable for cross-country comparisons of income levels at different points in time.

Institutional conditions for growth

Questions arising in **economic history**

EC4377 Global Economic History

- Why did growth accelerate in 1800s Western Europe?
- Why and how did countries like Japan catch up?
- Why have some countries failed to catch up?

Short answer: **Institutions** needed for **markets** to thrive must be developed for growth

- E.g. rule of law, market orientation, openness, stability

Rule of Law

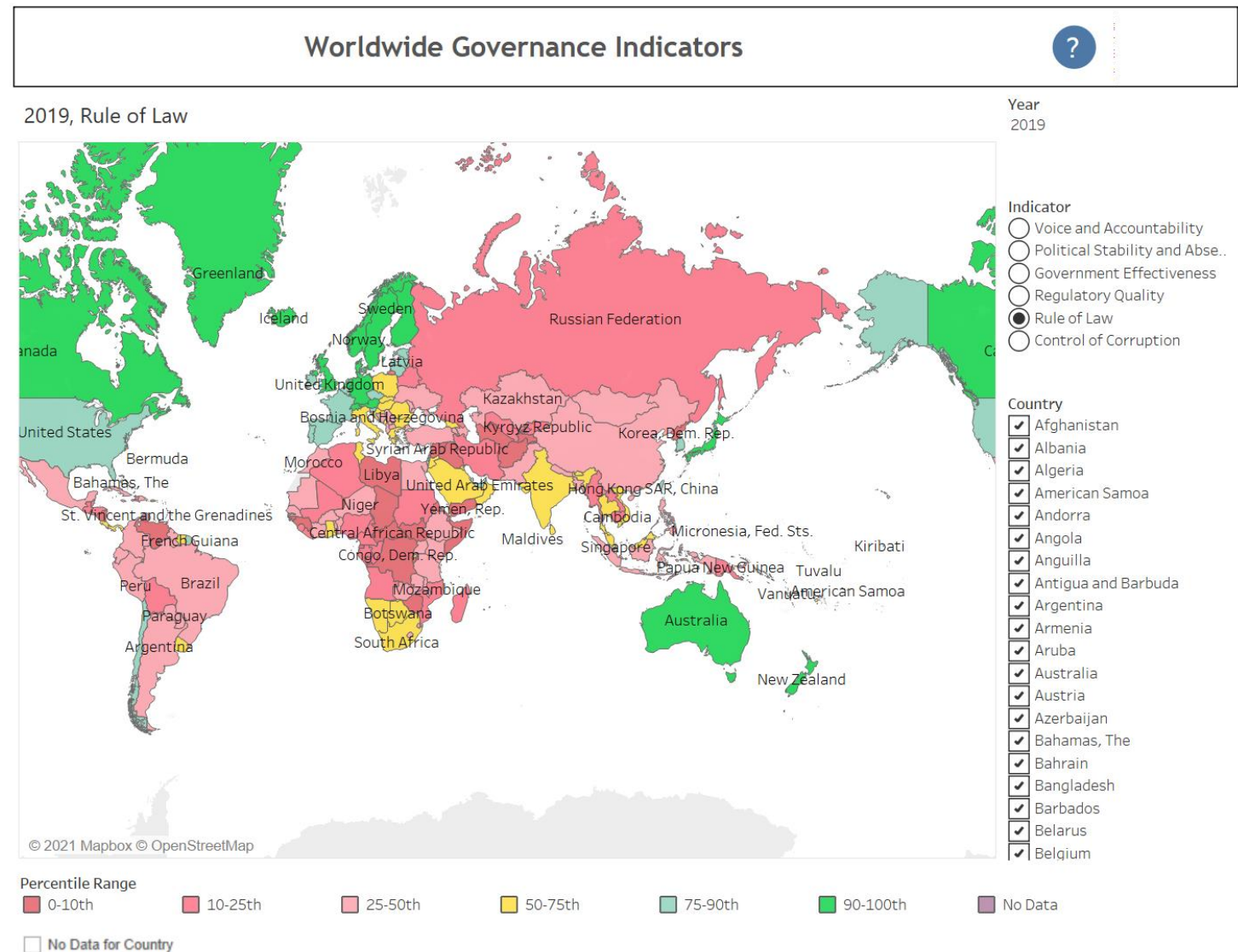
Private property rights

- Right to the proceeds of your effort and investment must be secure against **criminal appropriation** and **govt appropriation(!)**

Enforcement of contracts

- Private enforcement is expensive, inefficient and uncertain
- Much better to rely on a trustable **legal system**

Rule of Law Measurement by the World Bank



Source: Kaufmann D., A. Kraay, and M. Mastruzzi (2010), *The Worldwide Governance Indicators: Methodology and Analytical Issues* - https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130

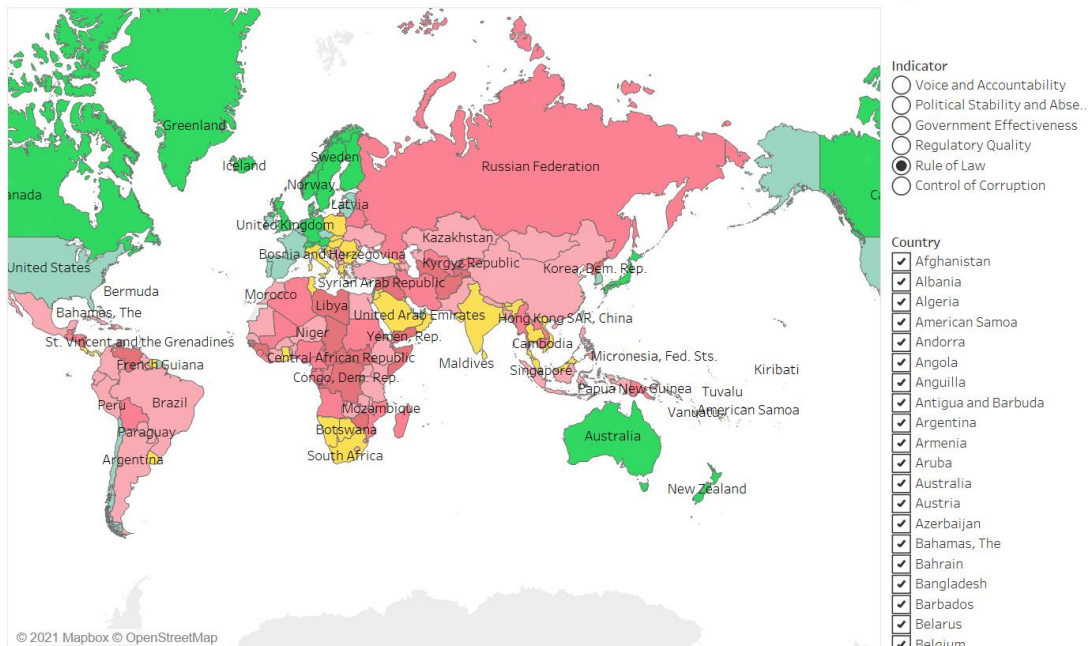
The Worldwide Governance Indicators are available at: <http://info.worldbank.org/governance/wgi/index.aspx#home>
Note: The Worldwide Governance Indicators (WGI) are a research dataset summarizing the views on the quality of governance provided by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries. These data are gathered from a number of survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms. The WGI do not reflect the official views of the World Bank, its Executive Directors, or the countries they represent. The WGI are not used by the World Bank Group to allocate resources.

Worldwide Governance Indicators



2019, Rule of Law

Year
2019



Percentile Range

- 0-10th
- 10-25th
- 25-50th
- 50-75th
- 75-90th
- 90-100th
- No Data

☐ No Data for Country

Source: Kaufmann D., A. Kraay, and M. Mastruzzi (2010), *The Worldwide Governance Indicators: Methodology and Analytical Issues* - https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130

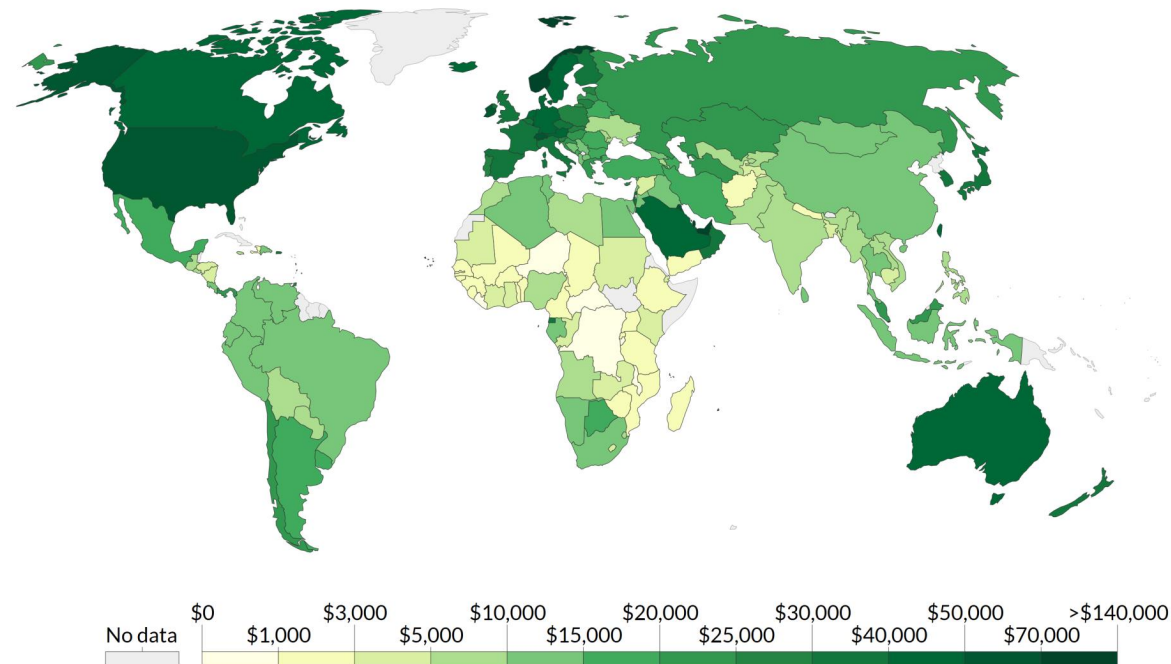
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GDP per capita, 2016

GDP per capita adjusted for price changes over time (inflation) and price differences between countries – it is measured in international-\$ in 2011 prices.

Our World
in Data



Source: Maddison Project Database (2018)

Note: These series are adjusted for price differences between countries using multiple benchmark years, and are therefore suitable for cross-country comparisons of income levels at different points in time.

OurWorldInData.org/economic-growth • CC BY

Market Orientation (I)

Central Planning can mobilize resources on massive scale, and is capable of great technological leaps

But central planning has often led to serious **resource misallocation** and **mal-investment**



Market Orientation (II)

Market-based economies are faster in **generating and processing information** about needs and constraints (via **prices**)

Economies that harness markets are consequently far more **adaptive to changes** in the economic environment

See Tim Harford's "How China grew rich"



Market Orientation (III)

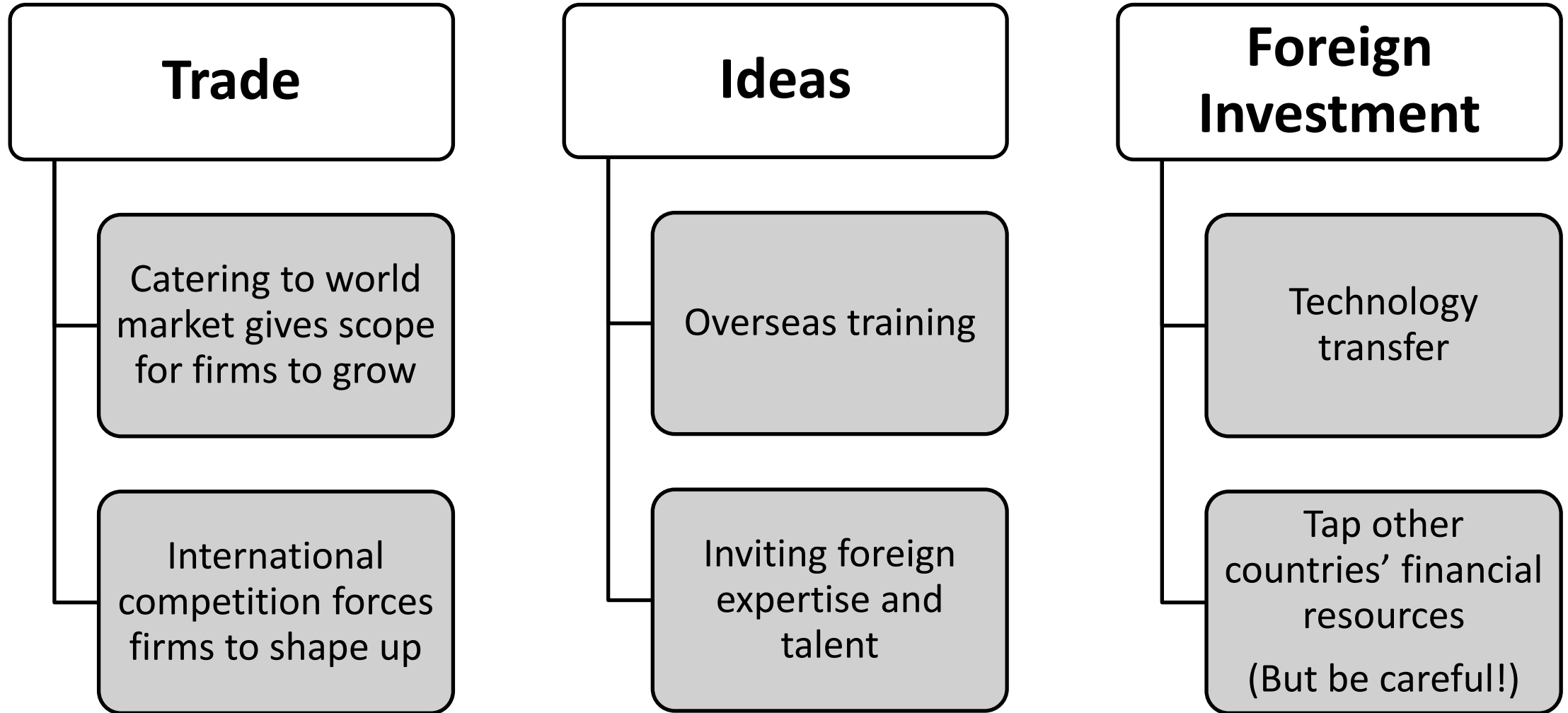
Industrial policy (govt-directed attempts to grow specific targeted industries) has a **mixed record**

Some successful examples (e.g. shipbuilding in South Korea), but also many failures (e.g. Malaysia National Car project)



‘National champion’ industries based on protectionism tend to be inefficient

Openness: exploit the world economy





A Natural Experiment

Stability

Stability provides basis for making long-term investment decisions

Macroeconomic stability

Low, predictable inflation

Stable exchange rate

Avoid economic crises

Political stability

Orderly changes of government

Avoid sectarian conflicts and wars

For foreign investors in Myanmar, coup adds new uncertainties

The possibility of Western sanctions leaves foreign entrepreneurs in Myanmar worried about their future prospects.



Al Jazeera
2021 Feb 18

Ongoing street protests against the February 1 military coup in Myanmar have added to fears among foreign investors of a return to the instability of the country's pre-democracy era [Sai Aung Main/AFP]

Agenda

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2. The aggregate production function and the ingredients for growth

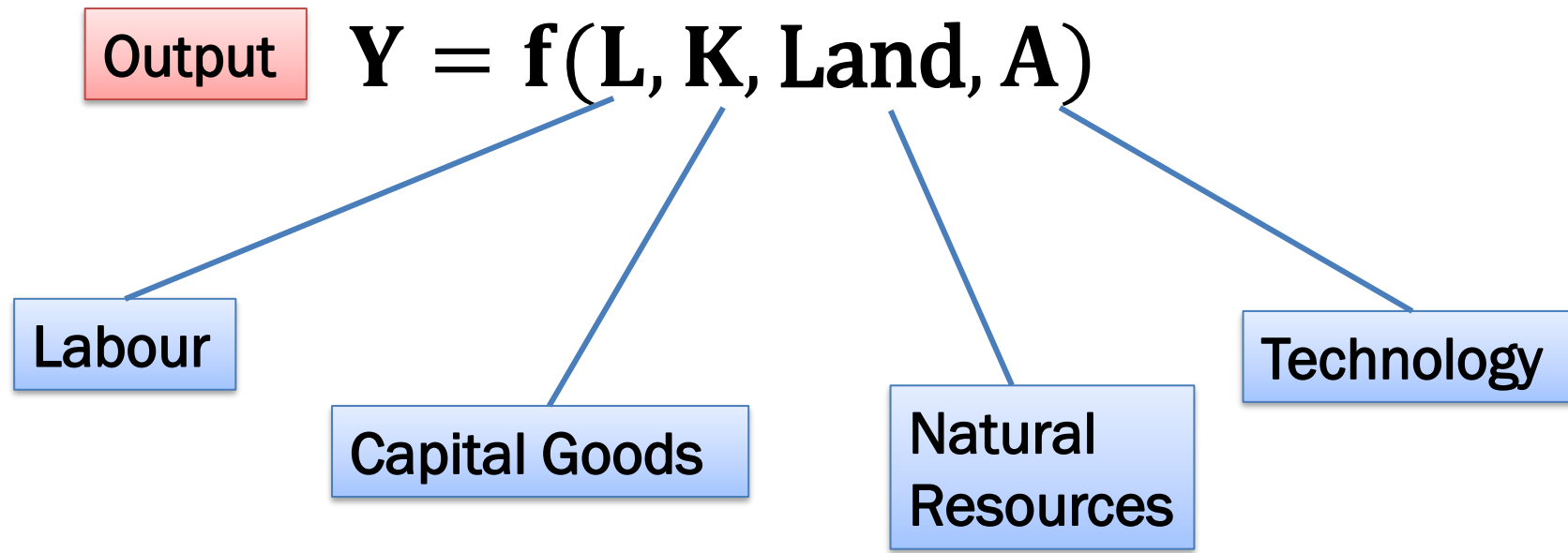
- The aggregate production function
- Natural resources and growth
- Growth by increasing labour supply?

3. Productivity growth

4. The Classical Model

The Aggregate Production Function

The **Aggregate production function** summarizes the relationship between an economy's output (Y) and its **resources** and **technology**

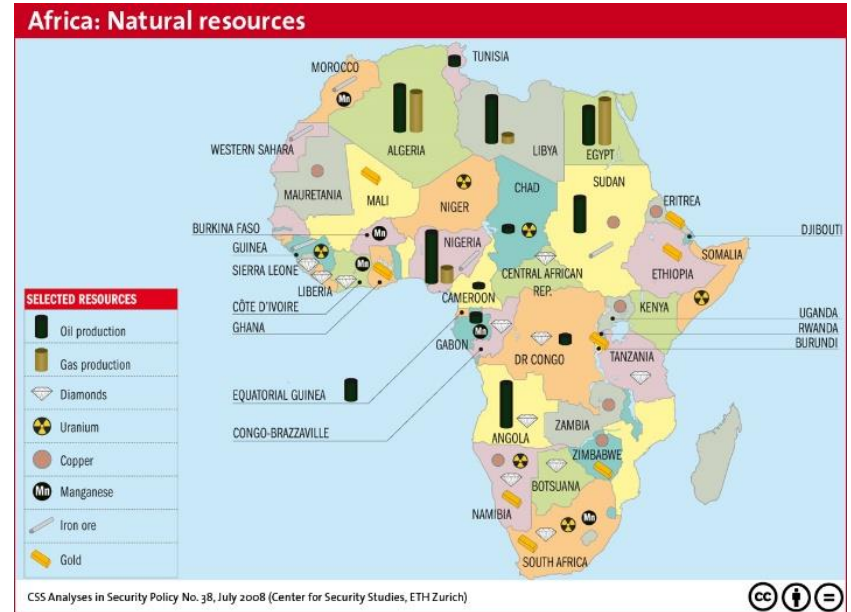


Natural resources and Growth



Lack of natural resources has not been a constraint for growth in many countries

Production function without “land”:



Resource abundance has not helped many countries grow quickly

$$Y = f(L, K, A)$$

A famous bet on natural resource sustainability

Simon-Ehrlich wager: **Would raw commodity prices rise over time?**

- Yes implies resource constraints are becoming binding

The economist won the wager!



Population ecologist

Economist

Global warming looms as the ultimate natural resource constraint

Global Agenda | Future of Energy | International Trade and Investment
Long-Term Investing, Infrastructure and Development

EC2383 Environmental Economics

Competition is driving down the cost of renewables. That's good news for the planet



Renewables are now cost-competitive with fossil fuels in many parts of the world.

Image: REUTERS/Phil Noble

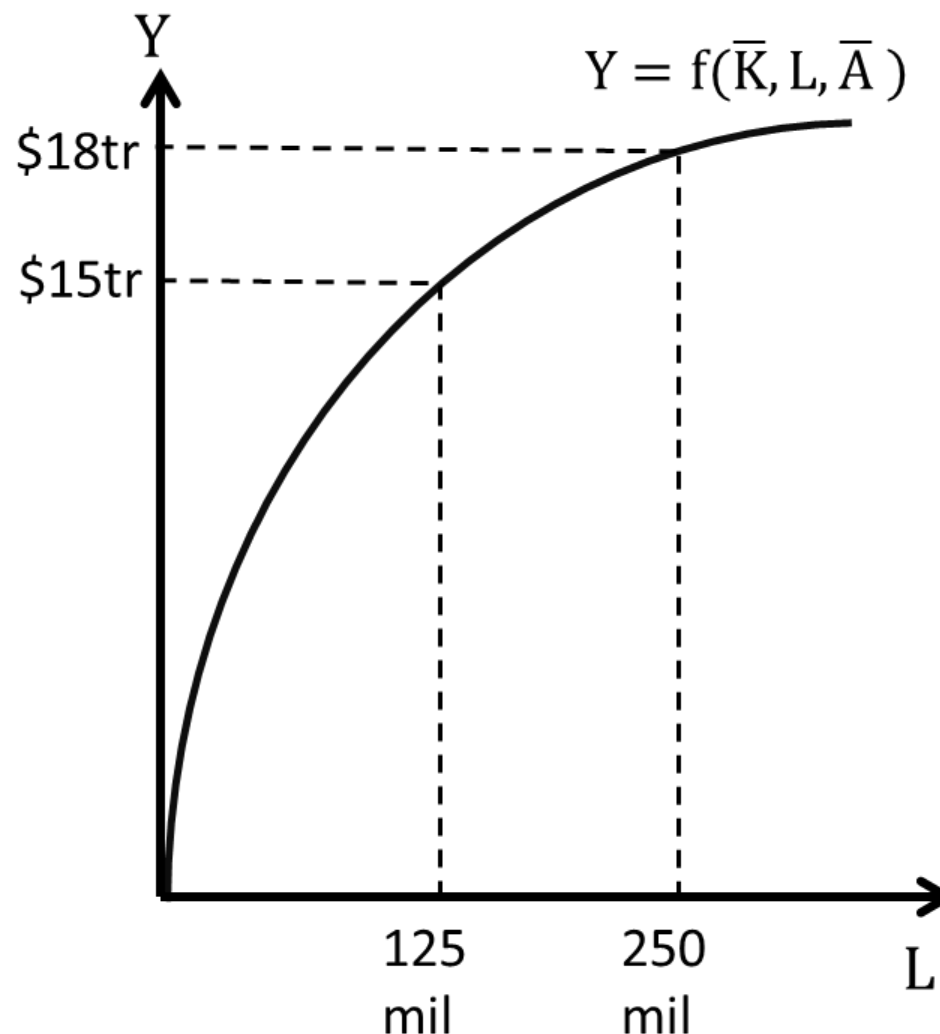
<https://www.weforum.org/agenda/2018/11/renewable-energy-auctions-bidding-our-way-to-a-greener-future/>

Output when labour is increased

For a given amount of capital (represented by \bar{K}) and technology (\bar{A}), what happens to Y as L is increased?

Ans:

- Each additional unit of L increases Y , but by smaller and smaller extent
- Doubling $L \rightarrow$ Less than doubling Y
- Economists call this **diminishing returns to labour**



A simple model of the Labour Market

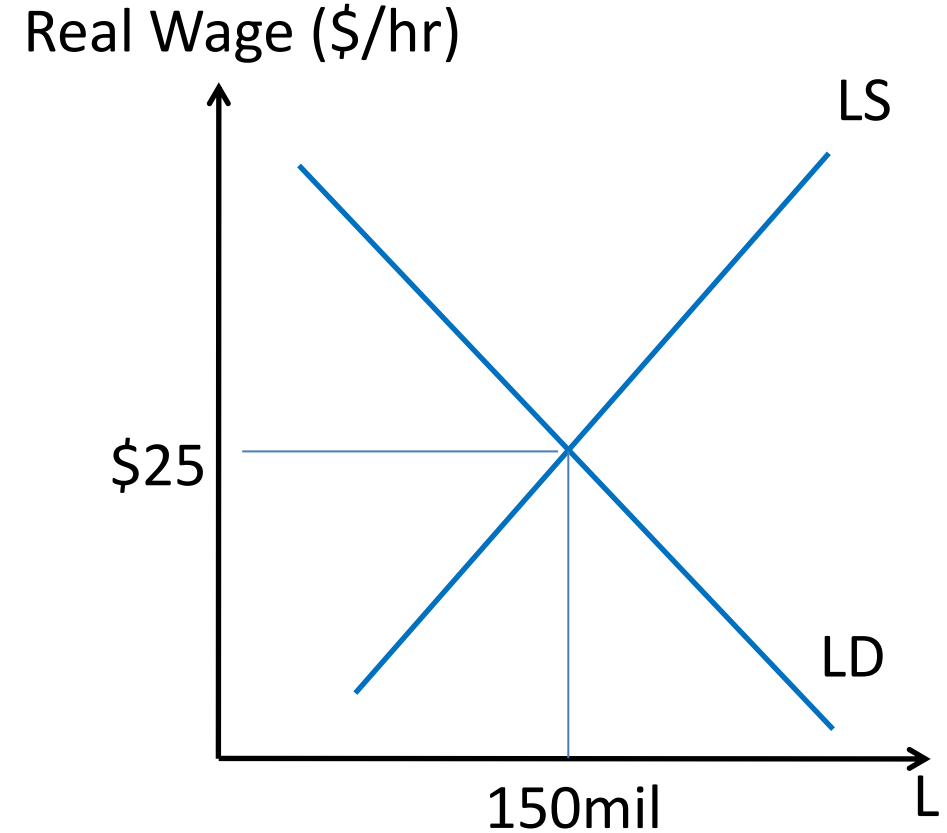
Labour demand from firms

- Downward sloping, because of diminishing returns

Labour supply from households

- Upward sloping

This labour market **clears** (i.e. **reaches equilibrium**) at real wage of \$25/hr and employment of 150mil



Growth by increasing labour supply?

Recall the growth equation:

$$g_{\text{RGDP per capita}} \approx g_{\text{Productivity}} + g_{\text{Avg. Hrs.}} + g_{\text{EPR}}$$

Growth can be achieved by growing average hours and EPR

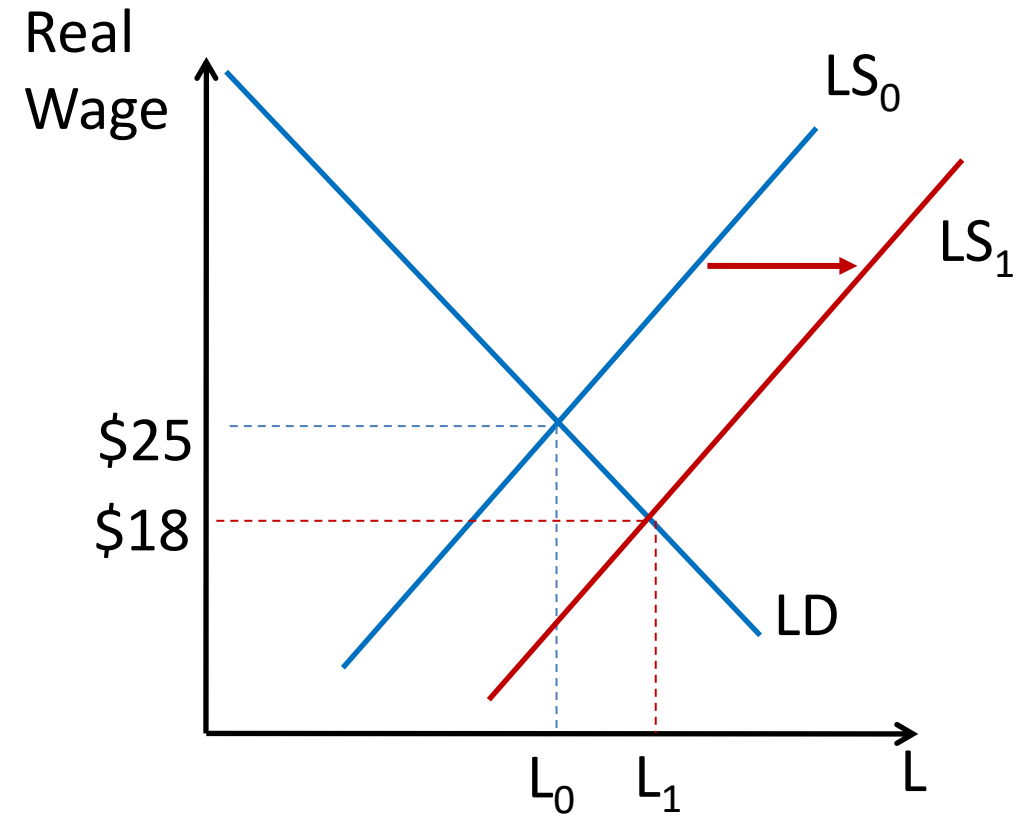
But these pathways are not sustainable (recall: **diminishing returns**), nor are they necessarily desirable

Problems with increasing labour supply for growth (I)

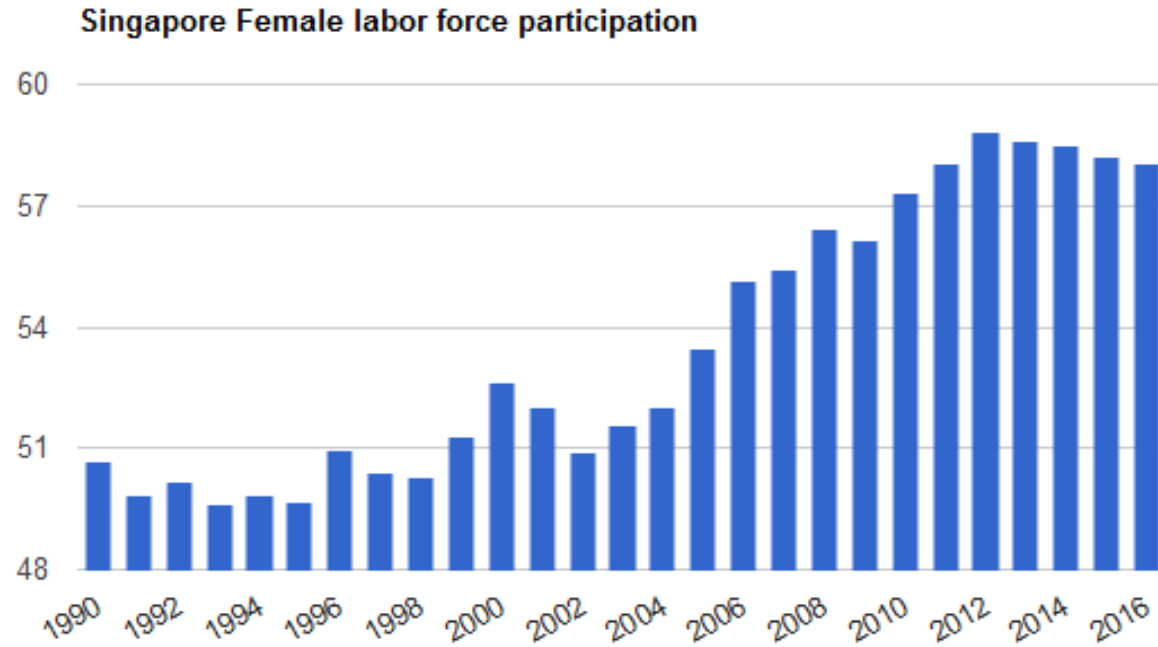
Increasing labour supply, other things equal, results in **falling real wage**

Most households obtain much of their incomes from work

Growth by increasing labour supply may not benefit them



Problems with increasing labour supply for growth (II)



Encourage homemakers to work?

Import foreign workers?



Problems with increasing labour supply for growth (III)



Encourage elderly to work?



Get children to work?

KAR●SHI 過勞死
death by overwork

Lengthen work hours?

Productivity Growth

$$g_{\text{RGDP per capita}} \approx g_{\text{Productivity}} + \cancel{g_{\text{Avg. Hrs.}}} + \cancel{g_{\text{PR}}}$$

“Higher productivity is the only sustainable way to raise incomes for ordinary Singaporeans ...”

(Then) DPM Tharman Shanmugaratnam,
Singapore Budget 2013



“**Per unit labour**” version of
production function
focuses on productivity:

$$\frac{Y}{L} = f\left(\frac{K}{L}, A\right)$$

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1. Growth rates, economic history and institutions

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- Capital deepening
- Technological change

4. The Classical Model

Capital deepening

Raising K/L is called **Capital Deepening**

For simplicity, assume L is fixed, so $\uparrow K$ means $\uparrow K/L$

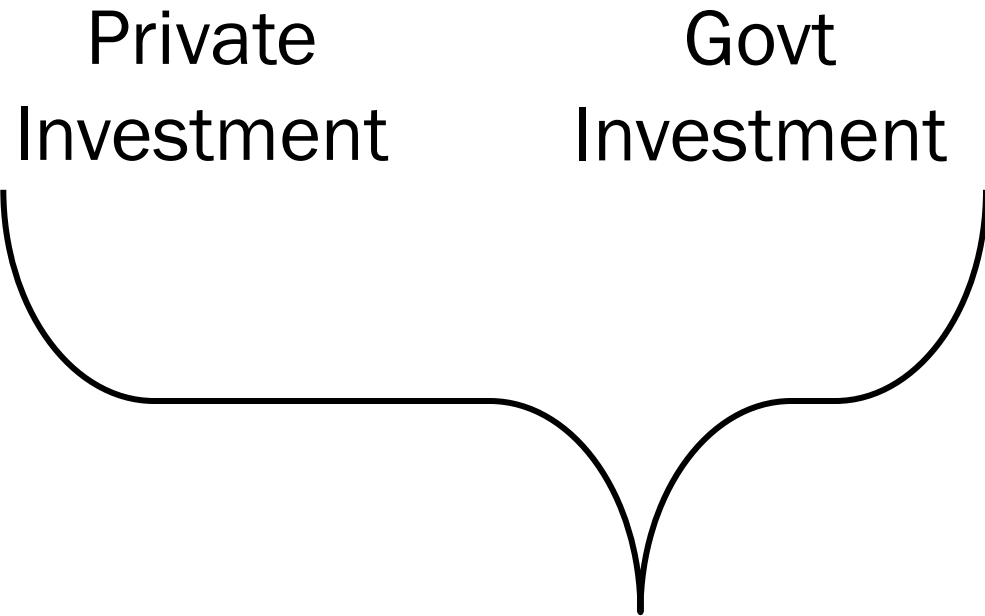
Let K_t = **capital stock** at end of time t

$K_t - K_{t-1}$ = increase in capital stock in the period $t-1$ to t

$K_t - K_{t-1}$ is a **flow**

Net versus Gross Investment

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



Depreciation = loss
due to wear and tear,
obsolescence

Assumed for simplicity to be
a constant fraction δ of the
existing capital stock K_{t-1}

$$\text{Net Investment} = \text{Gross}^* \text{Investment} - \text{Depreciation}$$

*This is where the "Gross" in GDP comes from

Active Learning: depreciation and net investment

Suppose the depreciation rate (i.e. fraction δ expressed as a percentage) is 10 percent per year. End-2019 capital stock is \$1 billion. How much gross investment in 2020 is needed for End-2020 capital stock to reach \$1.2 billion?

- A. \$100 million
- B. \$200 million
- C. \$300 million
- D. \$400 million

Policies for Capital Deepening

Change
incentives
to promote
investment

Reduce **corporate tax** (tax on firm' profits), though evidence of effectiveness is mixed

Grant **Investment Tax Credit** = tax reduction for firms that invest in new capital

Change
incentives
to promote
saving

Shift from taxing income to **taxing consumption**

Reduce transfers to elderly, unemployed

Mandatory saving (e.g. Singapore's Central Provident Fund)

Fiscal policy for long-run economic growth

Fiscal policy = government's use of **taxes, transfers and expenditures** to influence the macroeconomy

Fiscal policy can be used to **foster long-run economic growth**

Fiscal policy can also be used for **short-run economic stabilization**
(Macro 3)

Human Capital and labour quality

Workers' knowledge, skills, discipline, and health are part of what economists call **human capital***

- Spending on human capital increases productivity much like spending on physical capital, though such spending is not included under “investment” in GDP accounting

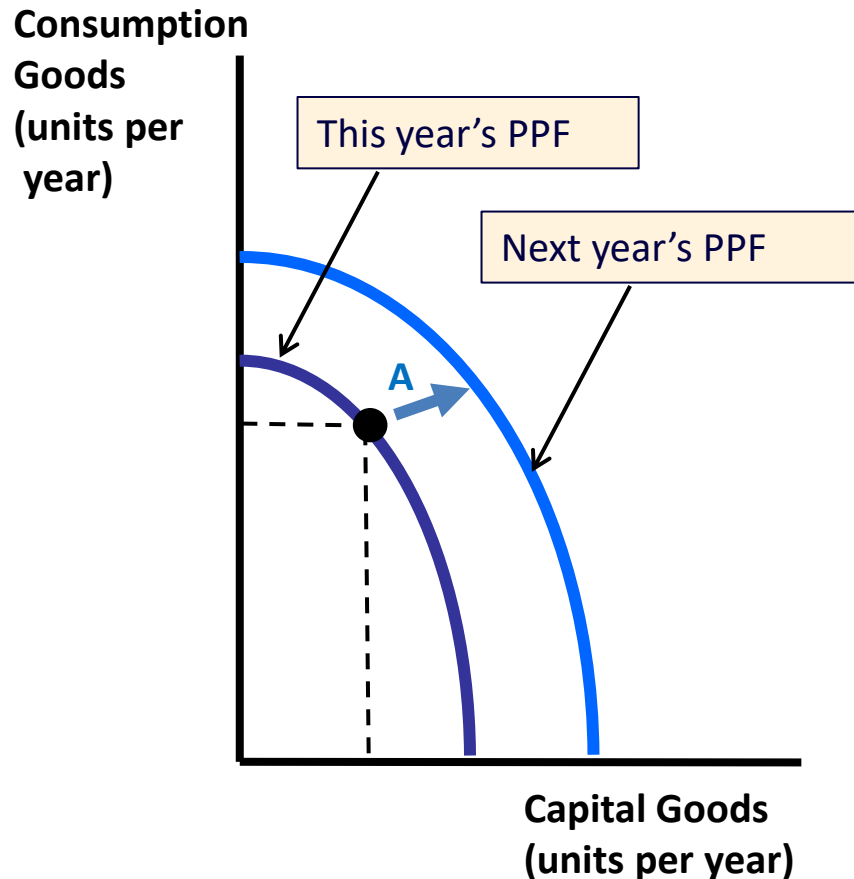
Production function can be modified by adding a measure of human capital per unit of labour H/L (e.g. average years of schooling)

$$\frac{Y}{L} = f\left(\frac{K}{L}, \frac{H}{L}, A\right)$$

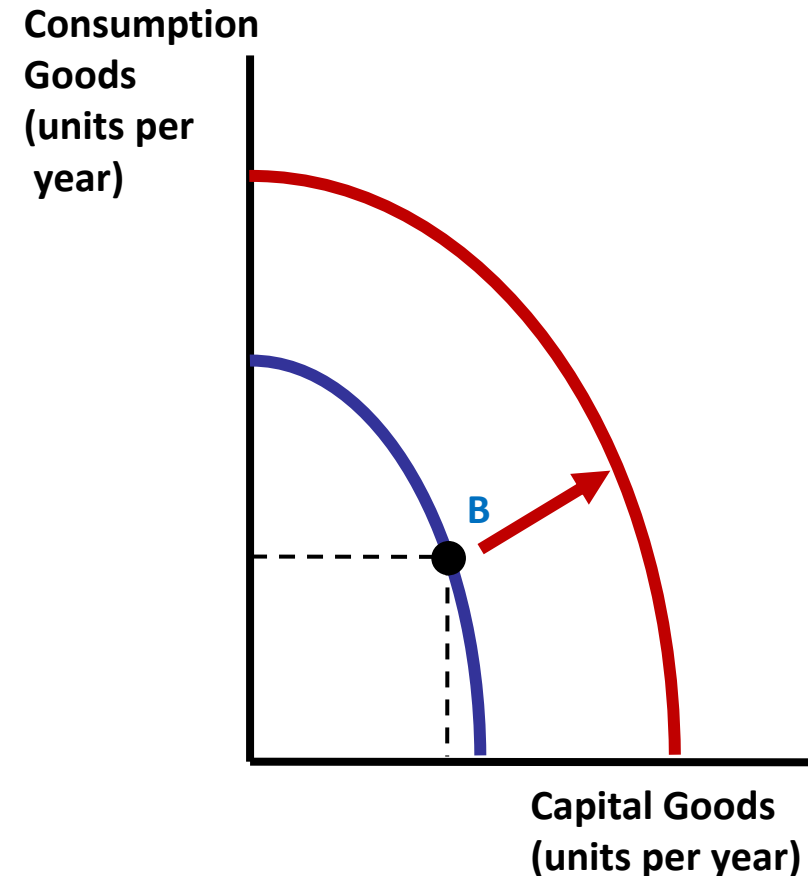
*Enrichment reading: *The Economist* (2017) [Gary Becker's Concept of Human Capital](#)

Cost of Capital Deepening: foregone consumption

More consumption,
Less Investment,
Lower Growth



Less consumption,
More investment,
Higher Growth



Capital deepening and catch-up growth

Poor countries with solid institutional conditions can grow rapidly and catch up to rich countries

Prominent examples:

- Post-WWII Japan and Germany
- **Four Asian “Tigers”**
- China, Southeast Asia, India

Elements of **catch-up growth**:

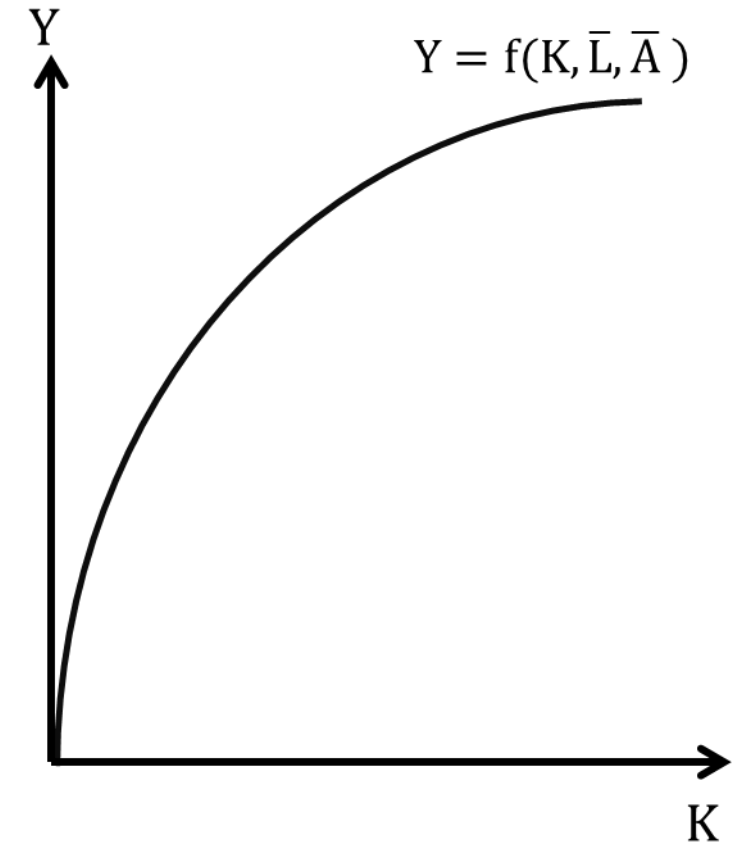
1. **Reduce consumption** , to boost investment
2. **Invest in health and education** to improve human capital
3. **Adopt and adapt technology** from rest of world

Limits to Capital Deepening: diminishing returns

For a given amount of labour (represented by \bar{L}) and technology (\bar{A}) ...

Ans:

- **Diminishing returns to capital!**
- Productivity growth from capital deepening eventually slows



Limits to Capital Deepening: rising depreciation

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

Net Investment = Gross Investment – Depreciation

As capital increases, depreciation also increases

Thus, more gross investment is needed to replace depreciated capital, leaving less for net investment

Technological Change

Productivity growth can also come from **technological change**: invention and application of new inputs, new products, or new production methods

Rich, high capital-per-worker countries rely on **discovery-based growth**: growth based on pushing the technological frontier by creating and using new ideas

Knowledge and ideas as sources of economic growth

Knowledge and ideas...

...are not subject to diminishing returns, ...

... do not depreciate ...

... and are **non-rival**: can be used by one without destroying its availability for use by others

$$\frac{Y}{L} = f\left(\frac{K}{L}, \frac{H}{L}, A\right)$$

Note that “A” isn’t divided by L in the per-unit labour production function

Intellectual property rights for Discovery based Growth (I)

Establish and protect **intellectual property rights** via patents, copyrights, etc.

Patent = right to exclude others from, or charge others for, the use of one's invention, valid for a set period (e.g. 5 years, 20 years)

Copyright = right to exclude others from, or charge others for, reproducing one's work, valid for a set period (e.g. 50 years, 100 years)

Intellectual property rights for Discovery based Growth (II)

Intellectual property rights are needed to incentivize commercial R&D

- Otherwise, copycats will reap gains without paying R&D costs

But intellectual property rights should not be too strong

- Otherwise, people will be discouraged from using discoveries

Amazon's '1-Click' patent expires today, and soon you'll be able to accidentally order stuff across the entire internet

BY MONICA NICKELSBURG on September 11, 2017 at 10:03 am

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Amazon CEO Jeff Bezos is listed as one of the inventors on the patent. (GeekWire File Photo)

From outdated party decorations to that iTunes single you didn't really mean to buy, Amazon has been behind every unintentional, one-click purchase on the internet. Until now.

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Geekwire (2017 September 11)

Other policies for Discovery based Growth

Promoting entrepreneurship

- Startup culture, seed financing



Government funding for R&D

- Subsidies for private R&D
- Government direct funding of R&D
 - Especially for basic research



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- The Loanable Funds market
- The Classical Model and Say's Law

The Loanable Funds Market

The **Loanable funds market** is a highly simplified, demand-supply model of the **financial system**

- Used to explain how **saving** is channeled towards financing **investment**, and how **govt budget decisions** affect investment, in the long run
- In lecture we will look at a closed economy
- Chapter 20 Appendix covers open economy

Households and saving

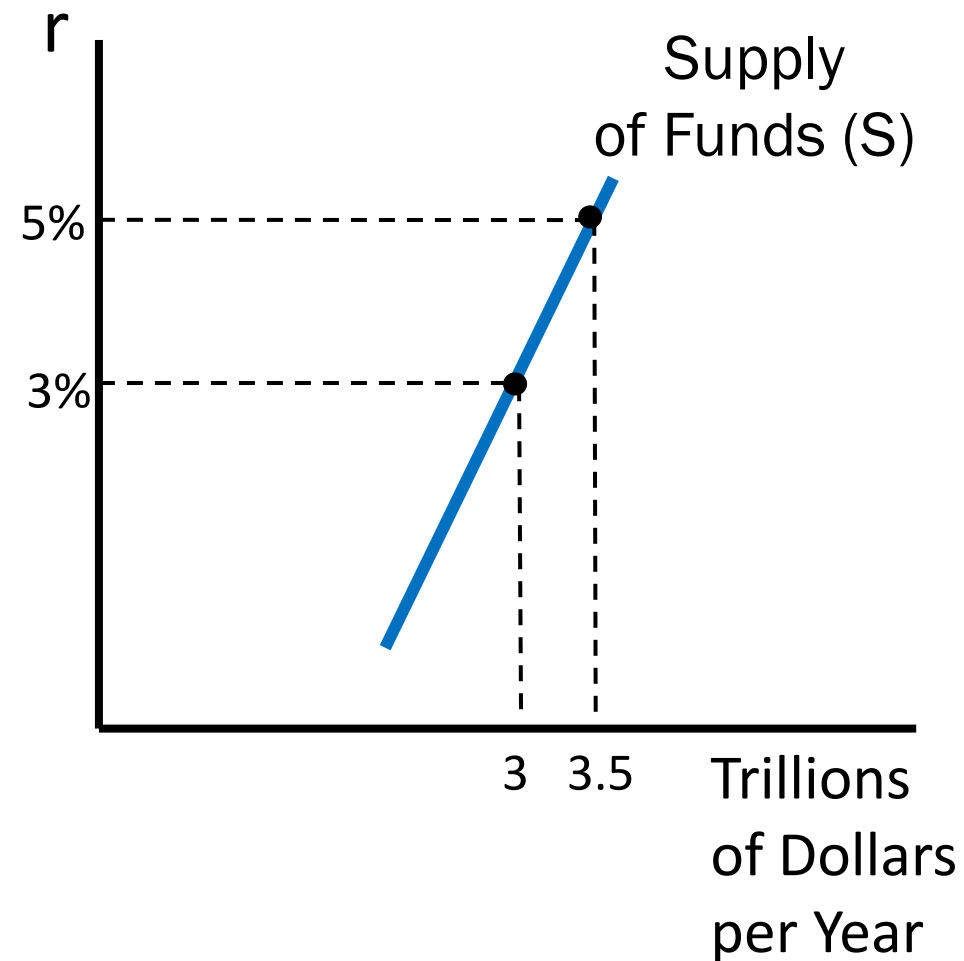
Households

- Are paid **income Y** as factor owners
- Pay **net taxes T** (taxes paid to govt – transfers from govt)
- Remainder **$Y - T$** is called **disposable income**
- From $Y - T$, spends a portion as **consumption C**
- Thus, **saving $S = Y - T - C$**
- Households supply S to the loanable funds market, earning a **real interest rate, r**

Supply of Loanable Funds

Determinants of S:

- **Real interest rate, r**
 - If r rises, saving is more lucrative
 - Thus, S rises
 - Thus, supply curve **slopes upward**
- **Other determinants**
 - If **expected future income rises**, less need to save → supply curve **shifts left**
 - Similarly, if households' **wealth falls** → supply curve **shifts right**



Firms and planned investment

Firms (a.k.a. businesses)

- Produce **output Y**
- Pay factor owners **income Y**
- Borrow in loanable funds market to finance spending on their **planned (private) investment I^P**

Why **planned investment I^P** instead of **actual investment I**?

Because there could be **unplanned change in inventories**

- E.g. if firms sell fewer goods than expected, there is an unplanned **increase** in inventories

For simplicity let all changes in inventories be unplanned

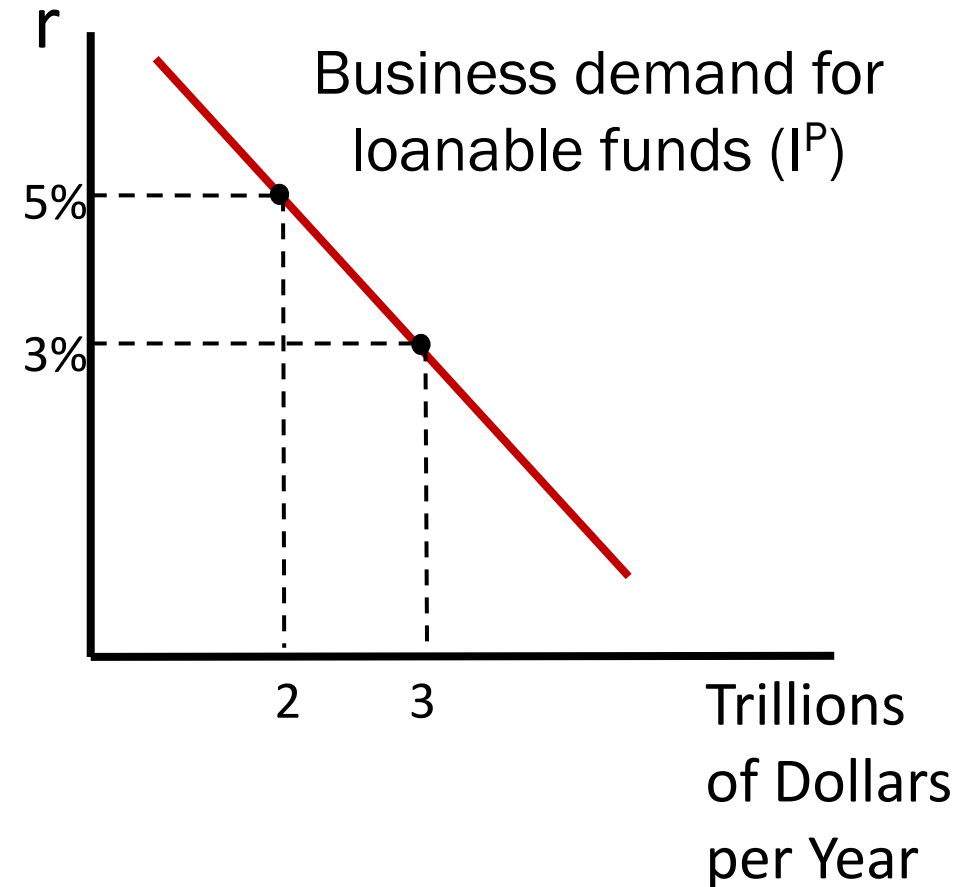
Let Δ = “Change in”

We can then write **$I = I^P + \Delta \text{inventories}$**

Business demand for Loanable Funds

Determinants of I^P

- **Real interest rate, r**
 - If r rises, I^P is more costly
 - Thus, I^P falls
 - Thus, business demand curve **slopes downward**
- **Expected future profits from new capital**
 - **Increased optimism** about future profits → business demand curve **shifts right**



Government

Govt buys goods and services, i.e. **govt purchases G**

Govt collects taxes and gives out transfers, i.e. collects **net taxes T**

If $G > T$

- Govt has **budget deficit** of size $G - T$
- Govt will demand funds
- $G - T = \text{govt demand}$

If $T > G$

- Govt has **budget surplus** of size $T - G$
- Govt will supply funds
- $T - G = \text{govt supply}$

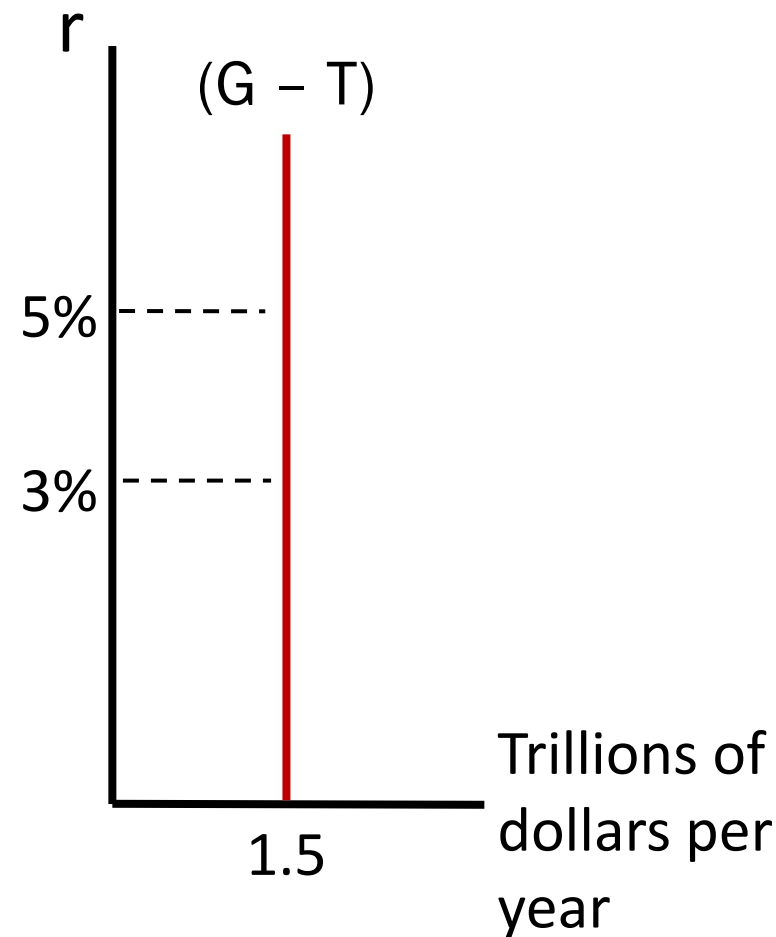
Govt demand for loanable funds

We will assume that the govt runs a budget deficit

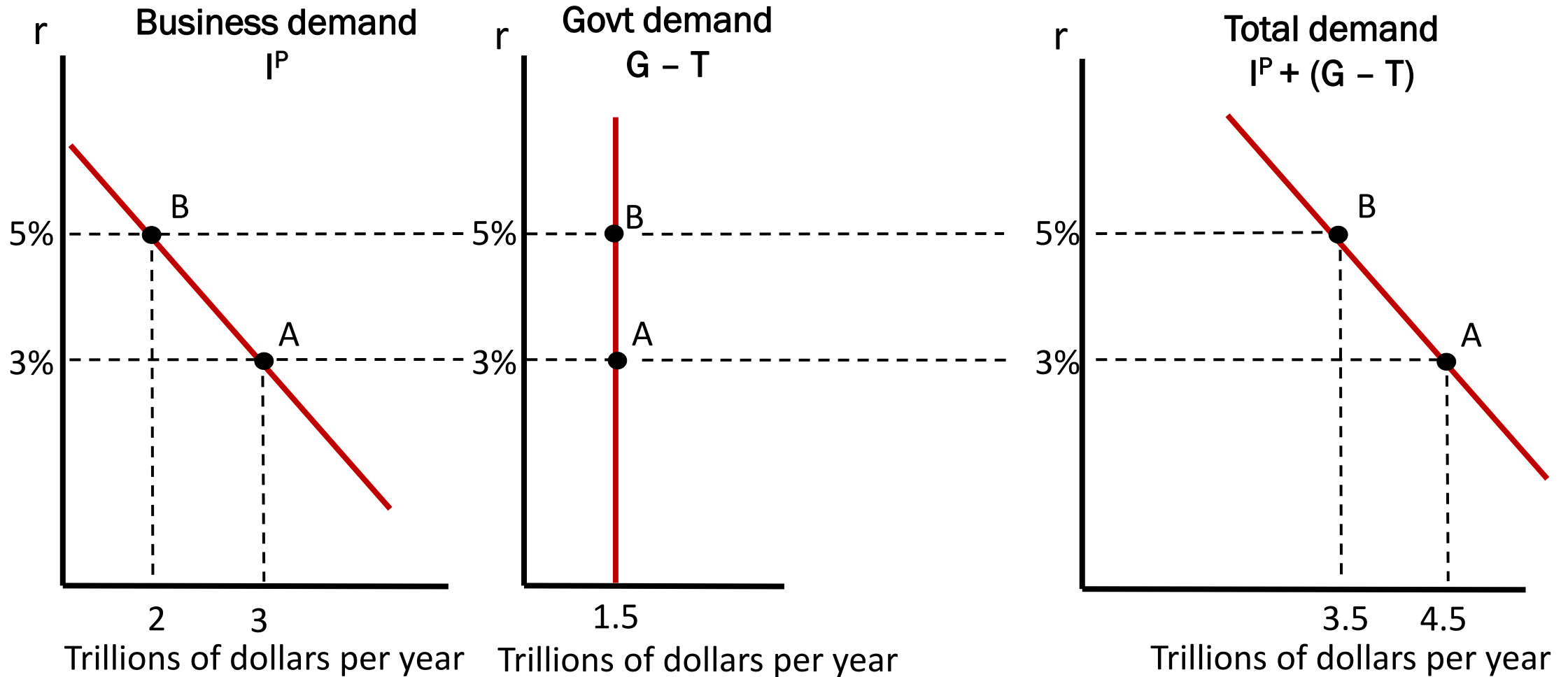
- $G - T = \text{govt demand}$

Government decisions on G and T are generally **insensitive** to changes in r

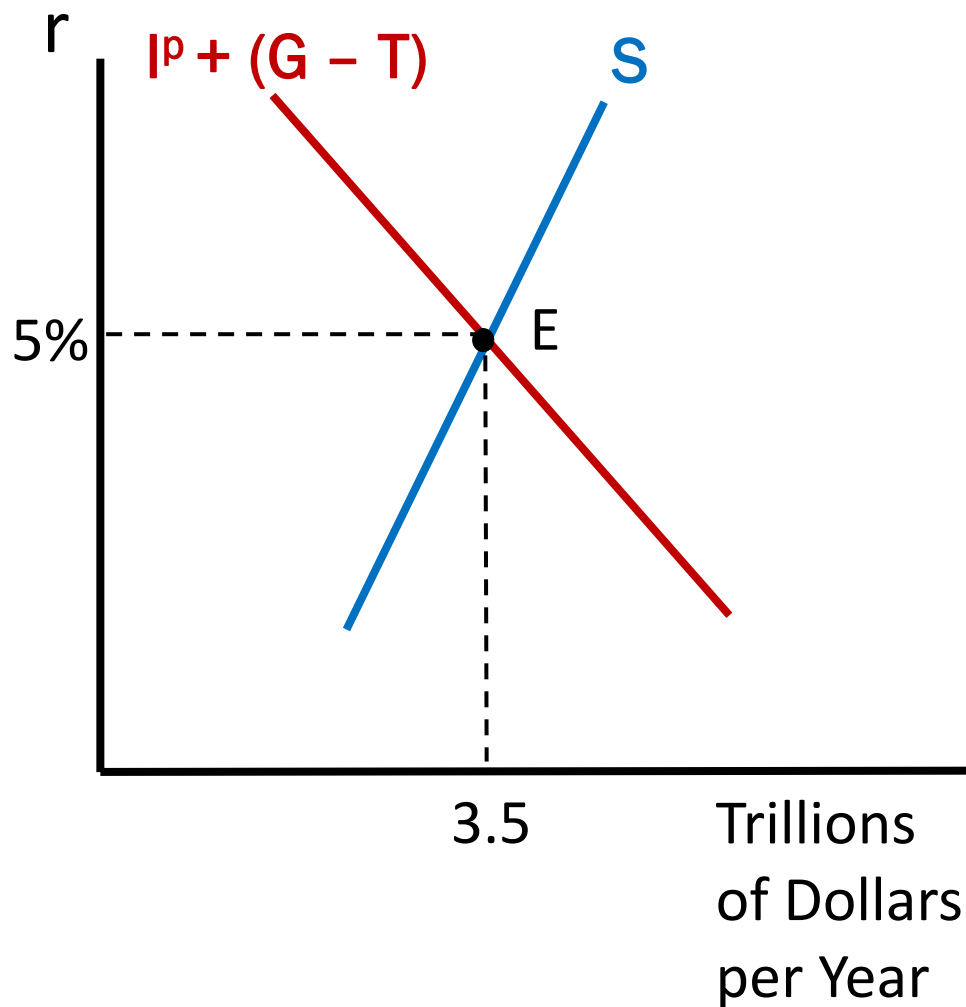
We simplify by assuming $G - T$ does not respond to changes in r



Total Demand for Loanable Funds



Demand, Supply, Equilibrium



r adjusts until loanable funds market is in **equilibrium**:

$$S = I^P + (G - T)$$

Implication:

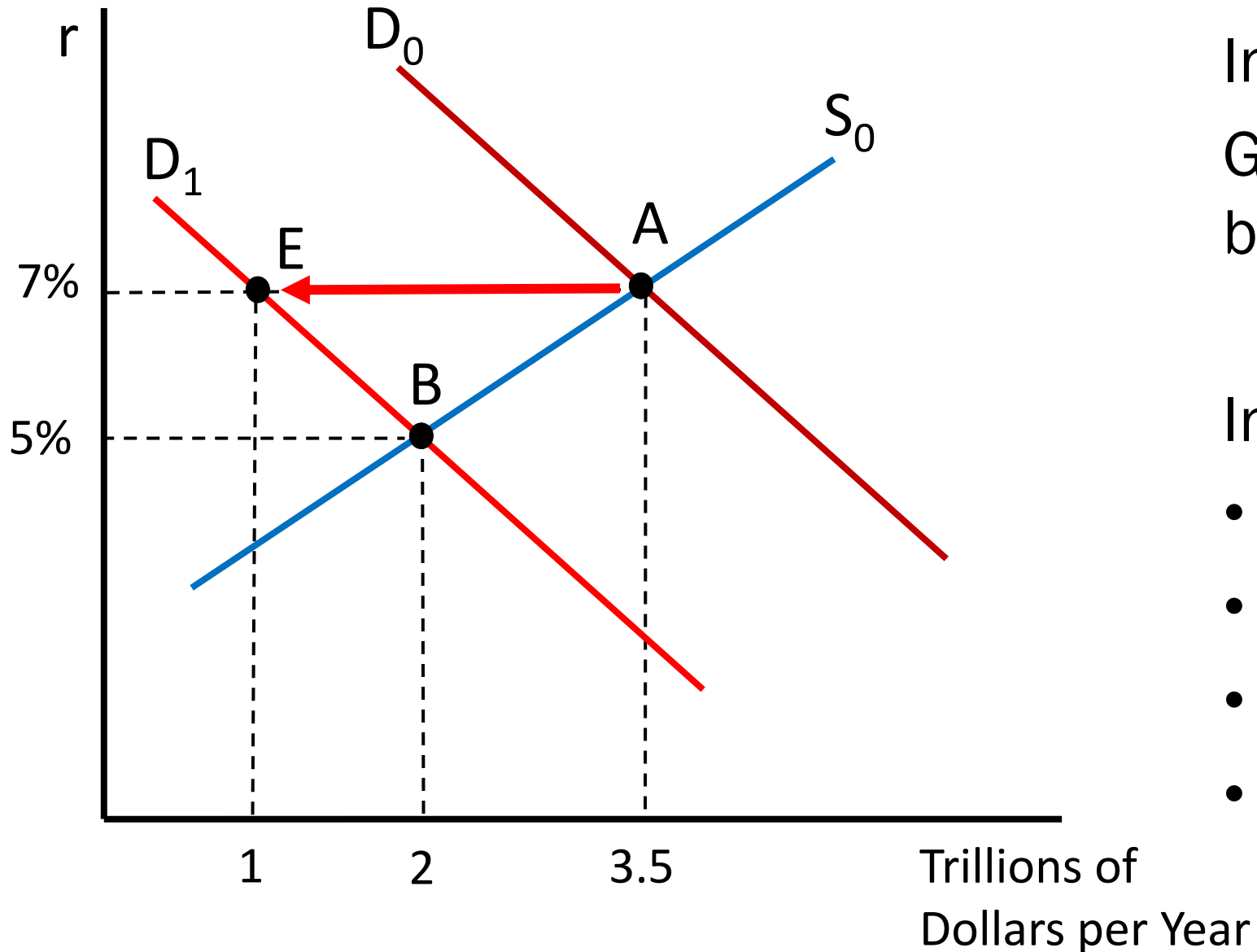
$$(Y - T) - C = I^P + (G - T)$$

$$Y - C = I^P + G$$

$$Y = C + I^P + G$$

Output = Planned Spending
Equilibrium in g&s market

Active Learning: Deficit reduction by cutting G



Initially at A

Govt decides to let G fall by \$2.5tr

In the new equilibrium:

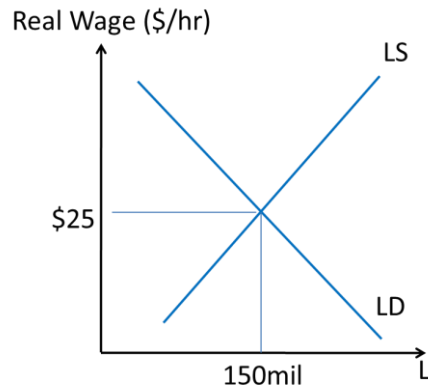
- Interest rate falls to ___%
- I^P rises | falls by \$___tr
- S rises | falls by \$___tr
- C rises | falls by \$___tr

The Classical Model and Say's Law

The **Classical (Long Run) Model** focuses on resource markets and technology as determinants of an economy's **potential output**

Classical model's key components:

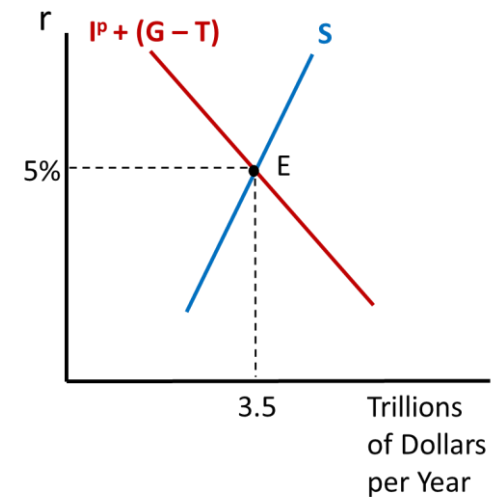
Labour market
that clears



Aggregate
Production
Function

$$Y = f(L, K, A)$$

Loanable Funds
market that clears



Classical Model's crucial assumption: markets clear

Say's Law and 100% Crowding Out

The Classical Model provides justification for an old idea called **Say's Law**: Spending adjusts to equal output (and not the other way around)

Say's Law is often written as “Supply creates its own demand”

If one spending component increases (falls), output does not change. Instead the other spending components fall (increase) by *the same extent*. This is called **100% crowding out**



Jean-Baptiste Say,
1767-1832
French economist and
businessman

Say's Law and crowding out in an open economy?

We have, so far, been looking at a **closed economy**

What about in an **open economy** context?

- Can a country's loanable funds market be in equilibrium while its spending $>$ its output?
- If so, how is the additional spending financed?
- Can the entire world's spending $>$ its output?