Applications of the Classical Model

Chapter 8 (p. 198-217)

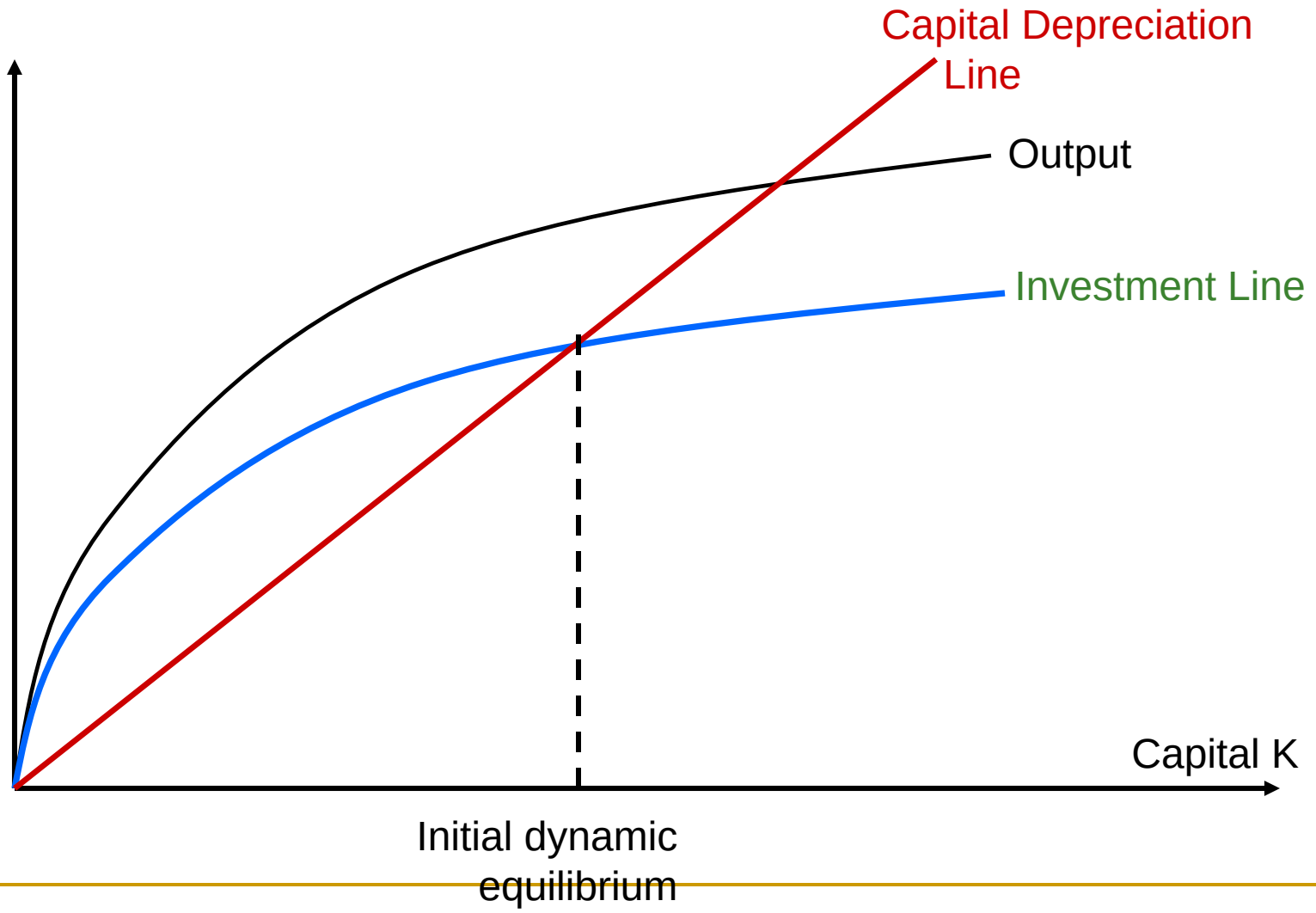
Chapter 15

Part I:
Understanding the Sources of Growth

Role of Capital Accumulation

- Conventional wisdom about development is that the economy must save and invest in capital
  - This was the basis for many policies implemented in the former Soviet block
- Our model says that accumulation of capital can *not* be the engine of growth

Effect of Higher Saving Rate



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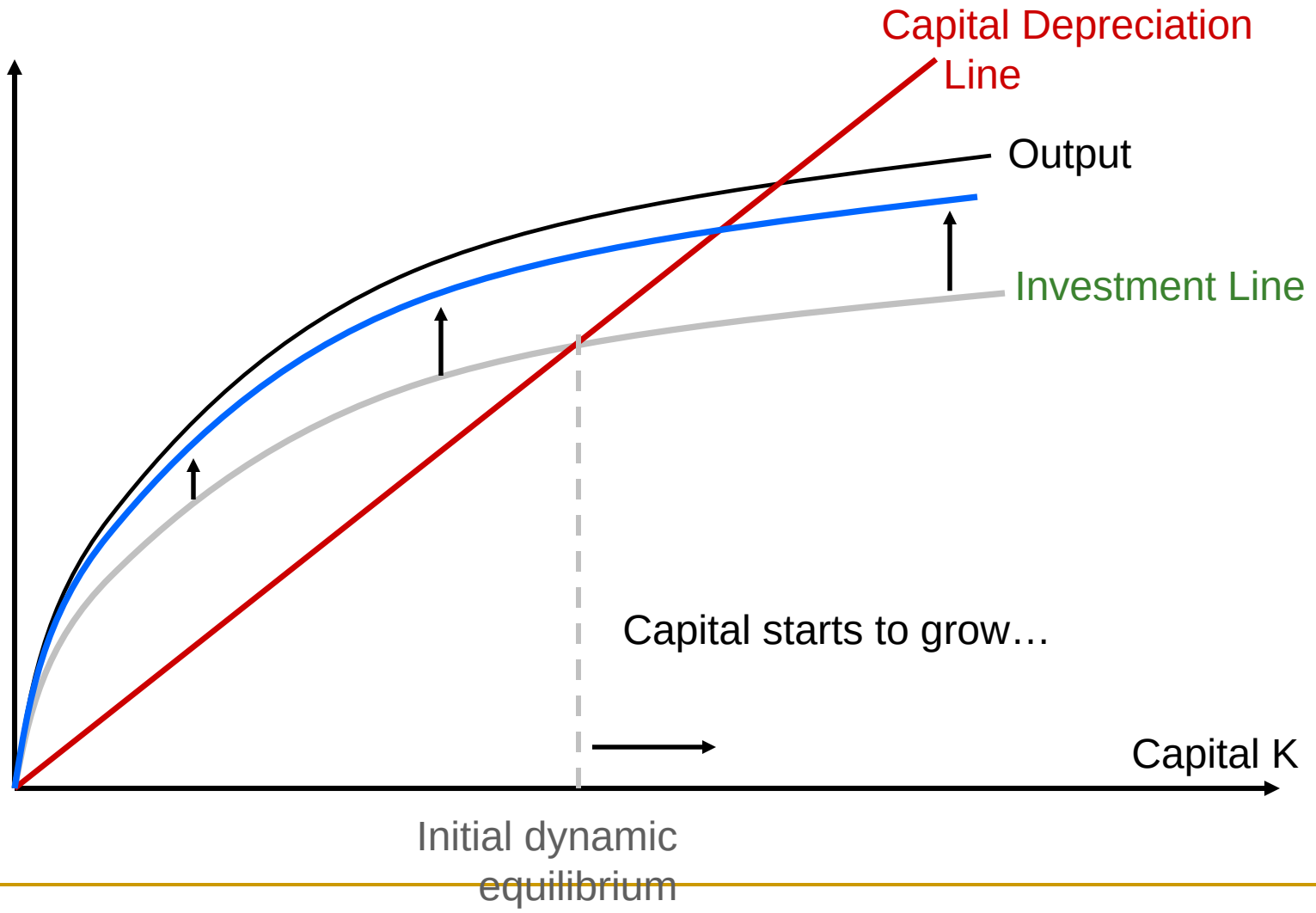

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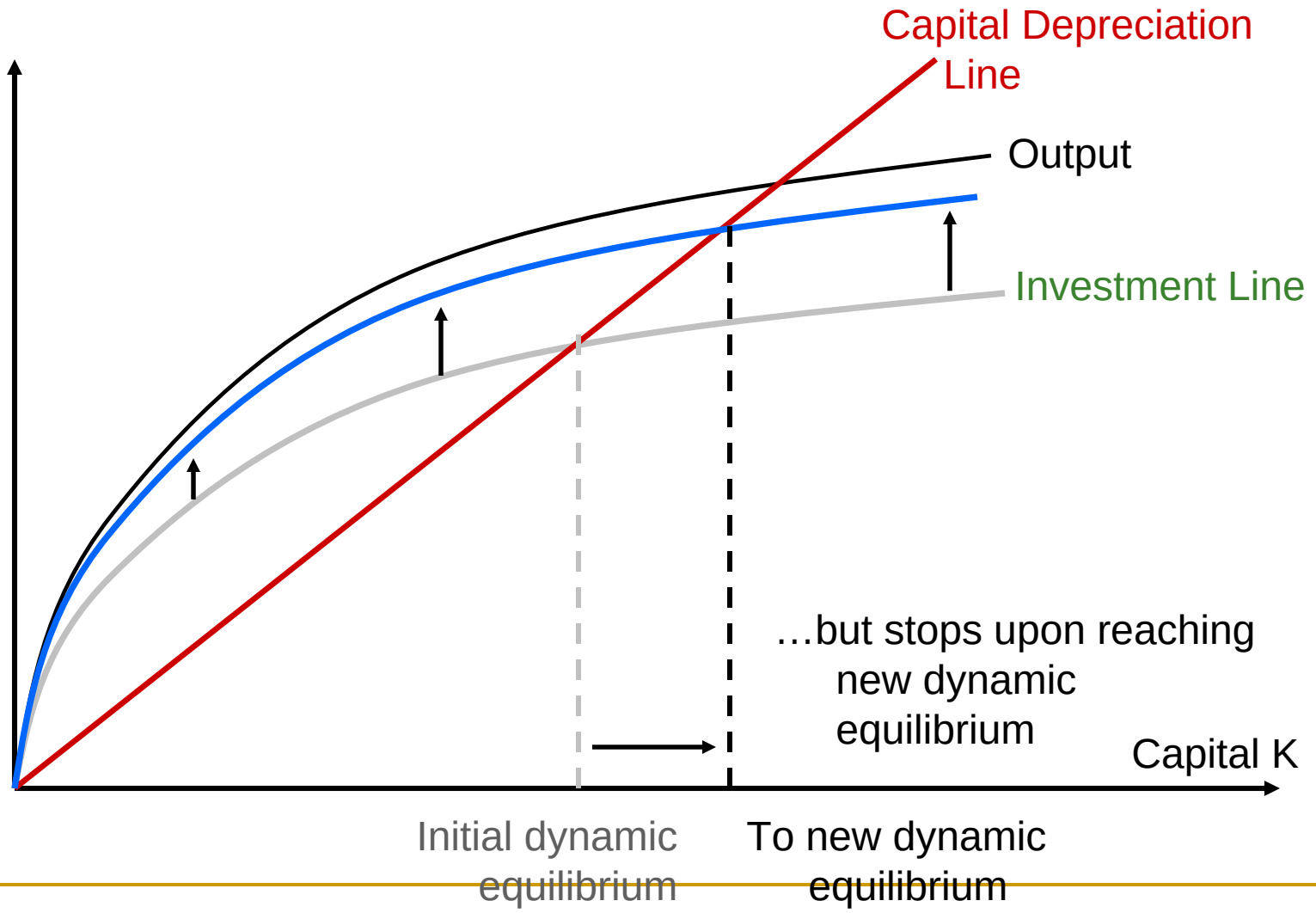
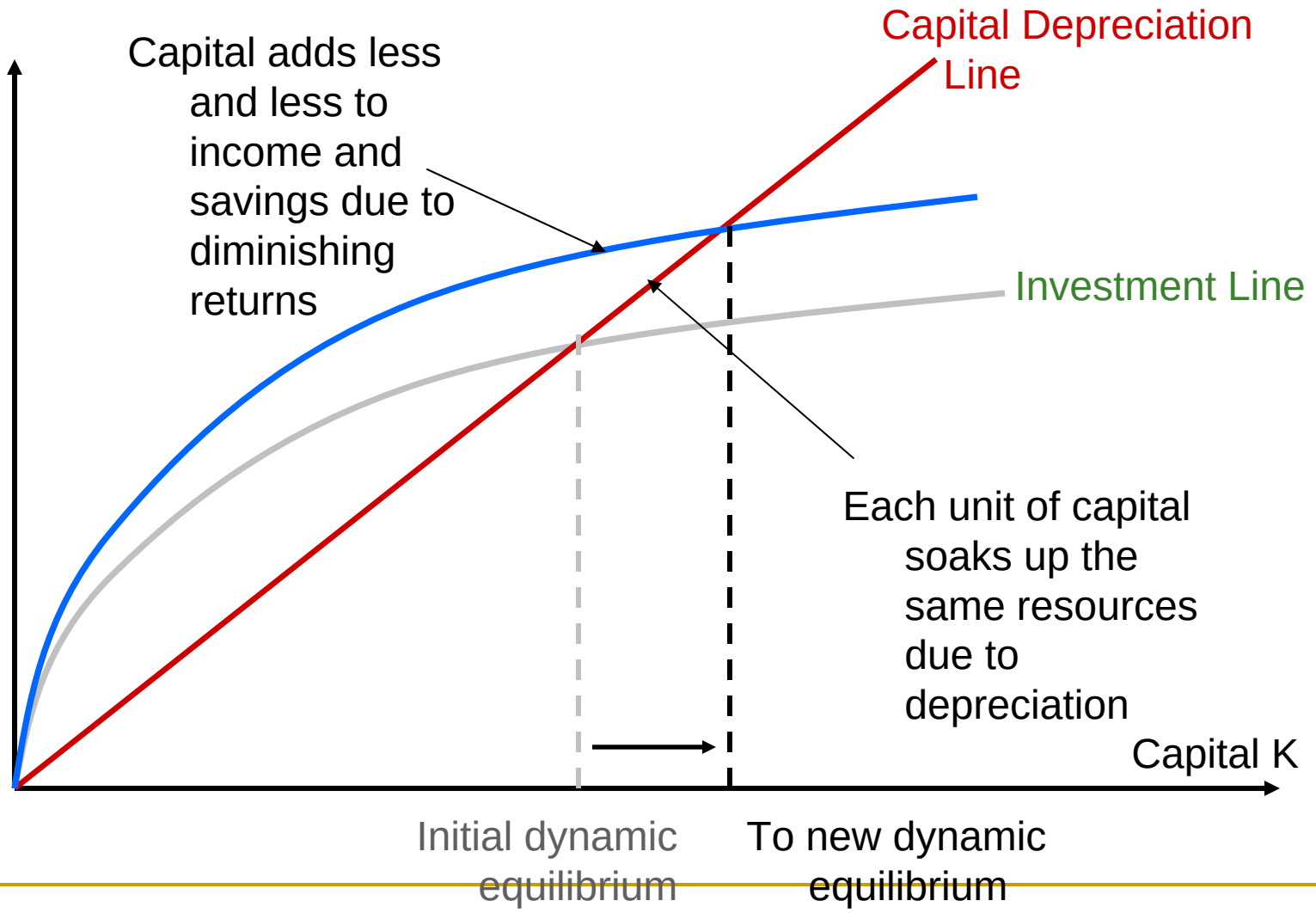


Why No Permanent Growth?



Key Lessons from Theory

- High saving rate leads to a higher level of output in the long-run, but not higher growth of output
- Can't indefinitely fuel capital accumulation by encouraging savings → it is not possible to save more than income
  - Accumulation of physical capital can not be the source of steady long-run growth (engine of growth)

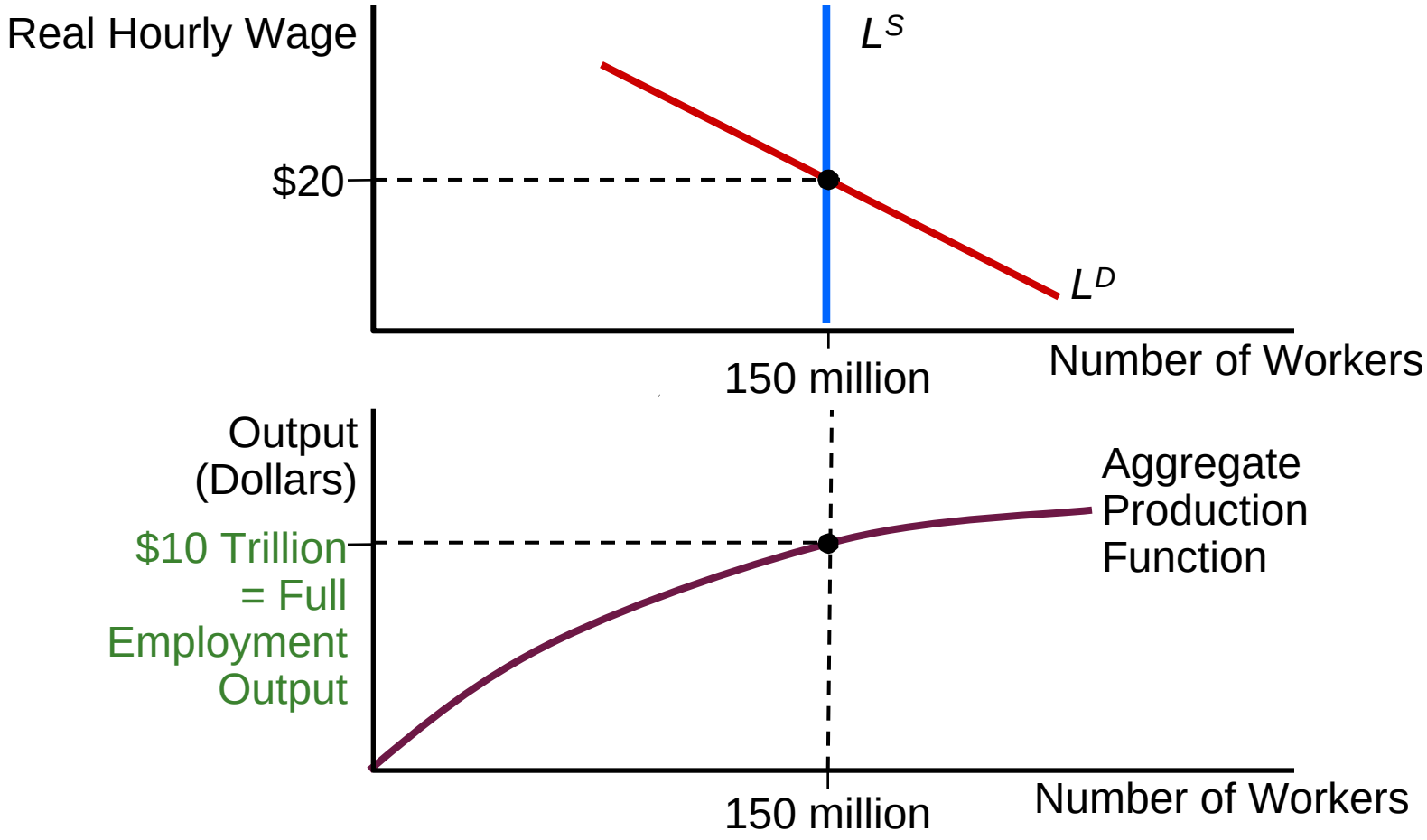
Role of Technological Progress

- Technological progress shifts production function upwards (more output from same factor inputs)
  - Unlike capital, technological progress can be the engine of growth (fuel growth indefinitely)
    - In principle, there are no bounds for new ideas!

Example: IT Revolution

- What is the likely effect of the technological progress driven by growing use and availability of PCs on the economy?

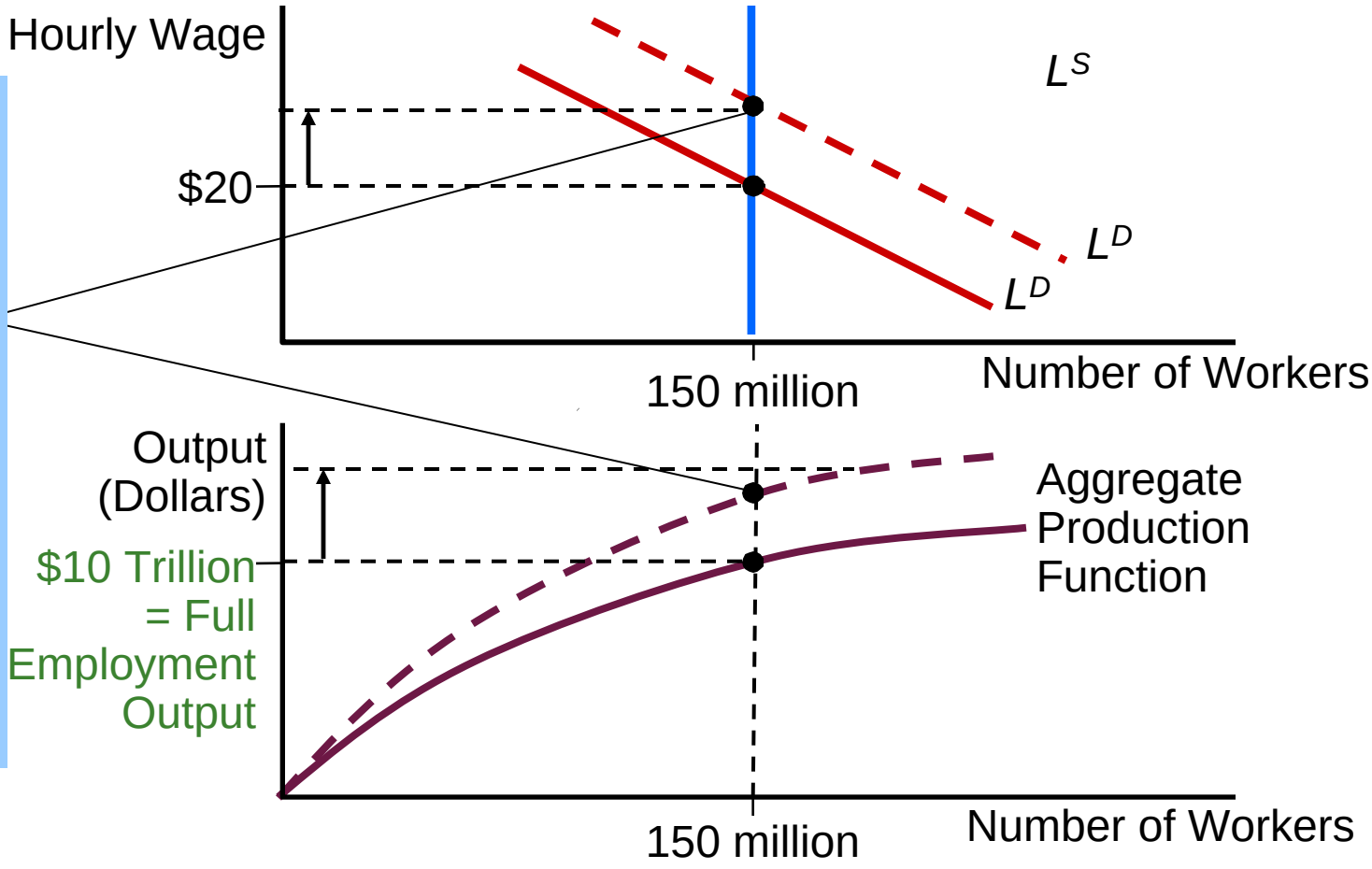
Effect on Output and Employment



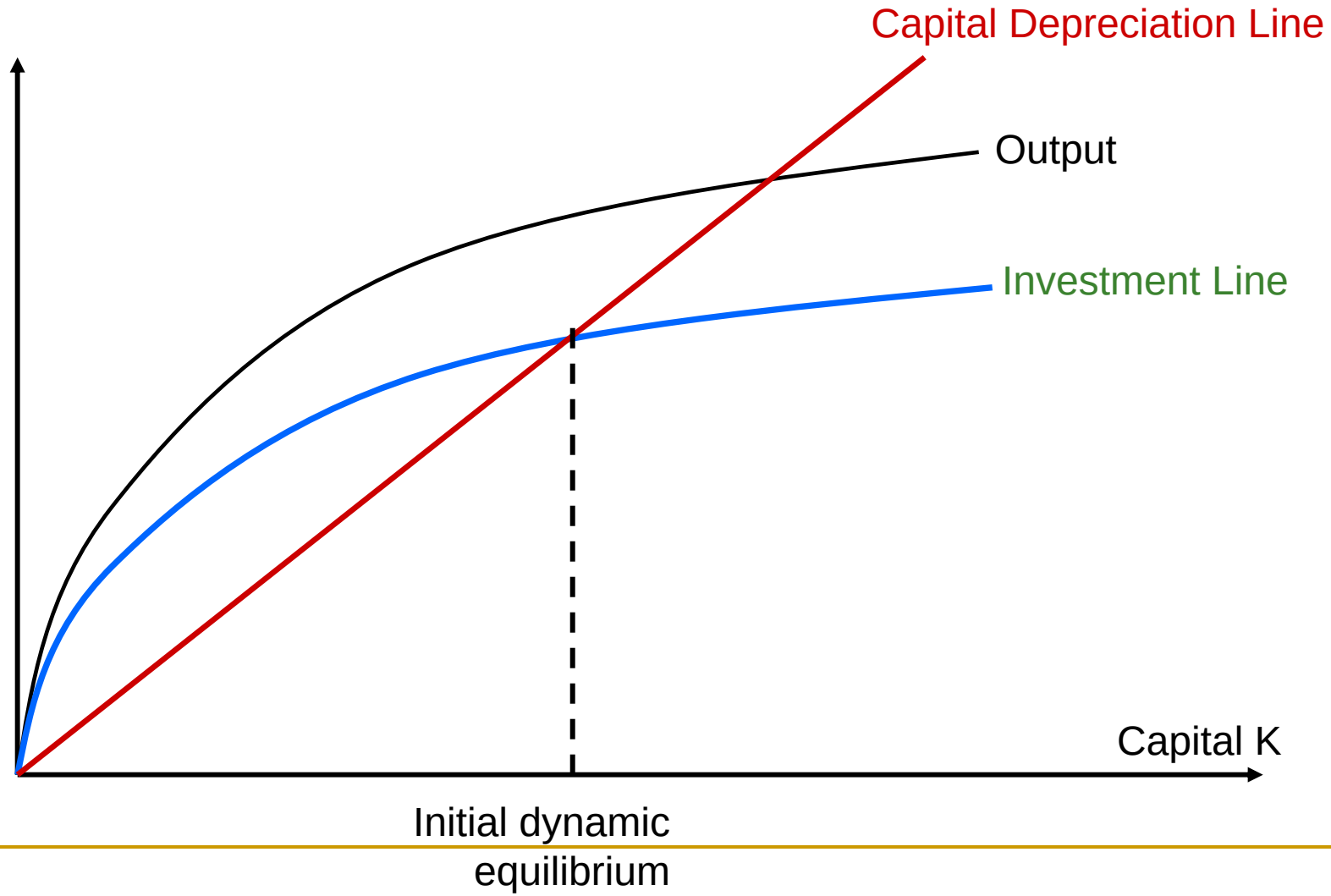
Effect on Output and Employment

Output goes up

Workers more productive – increased demand for labor leads to higher real wage and real income



Effect on Capital and Output



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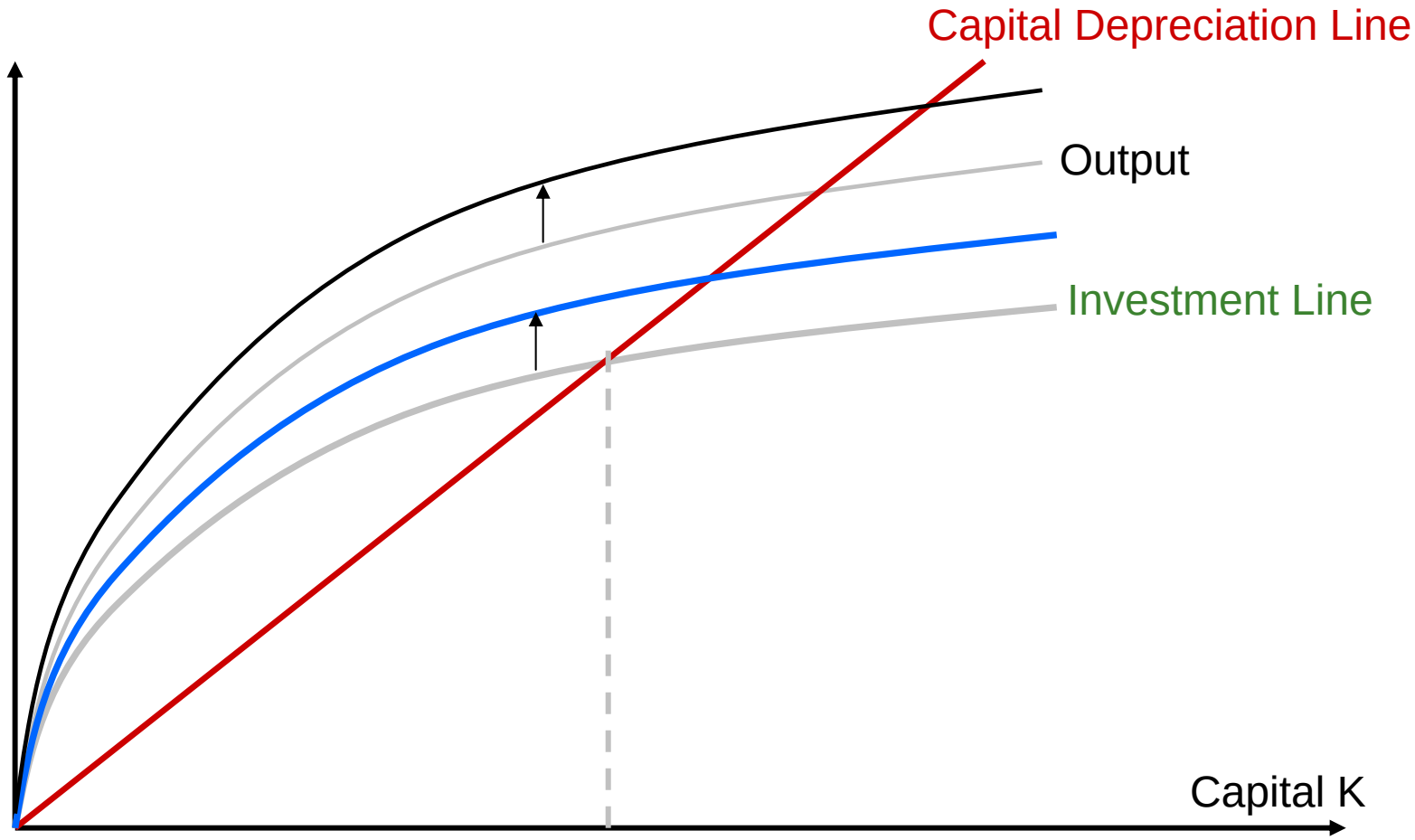

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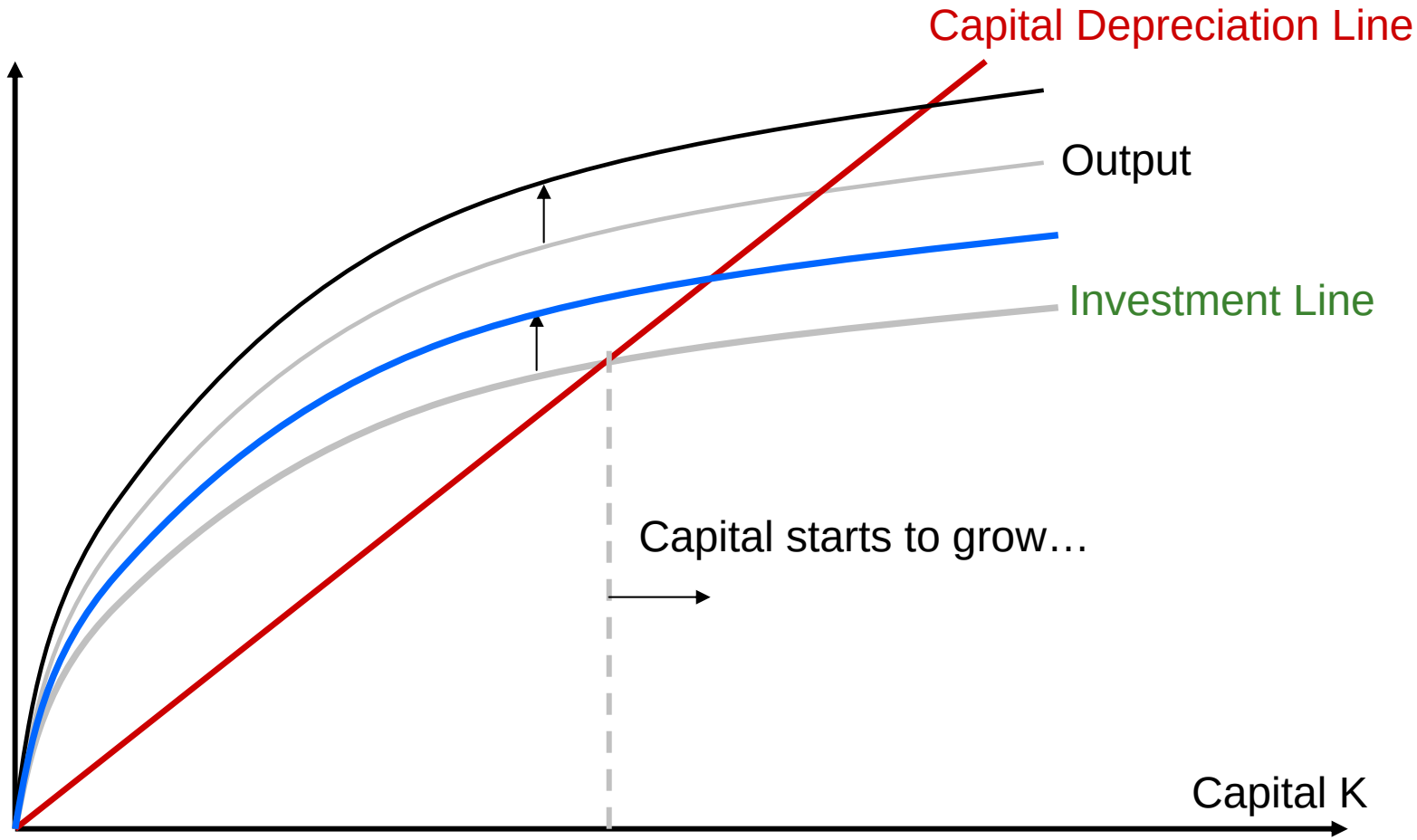

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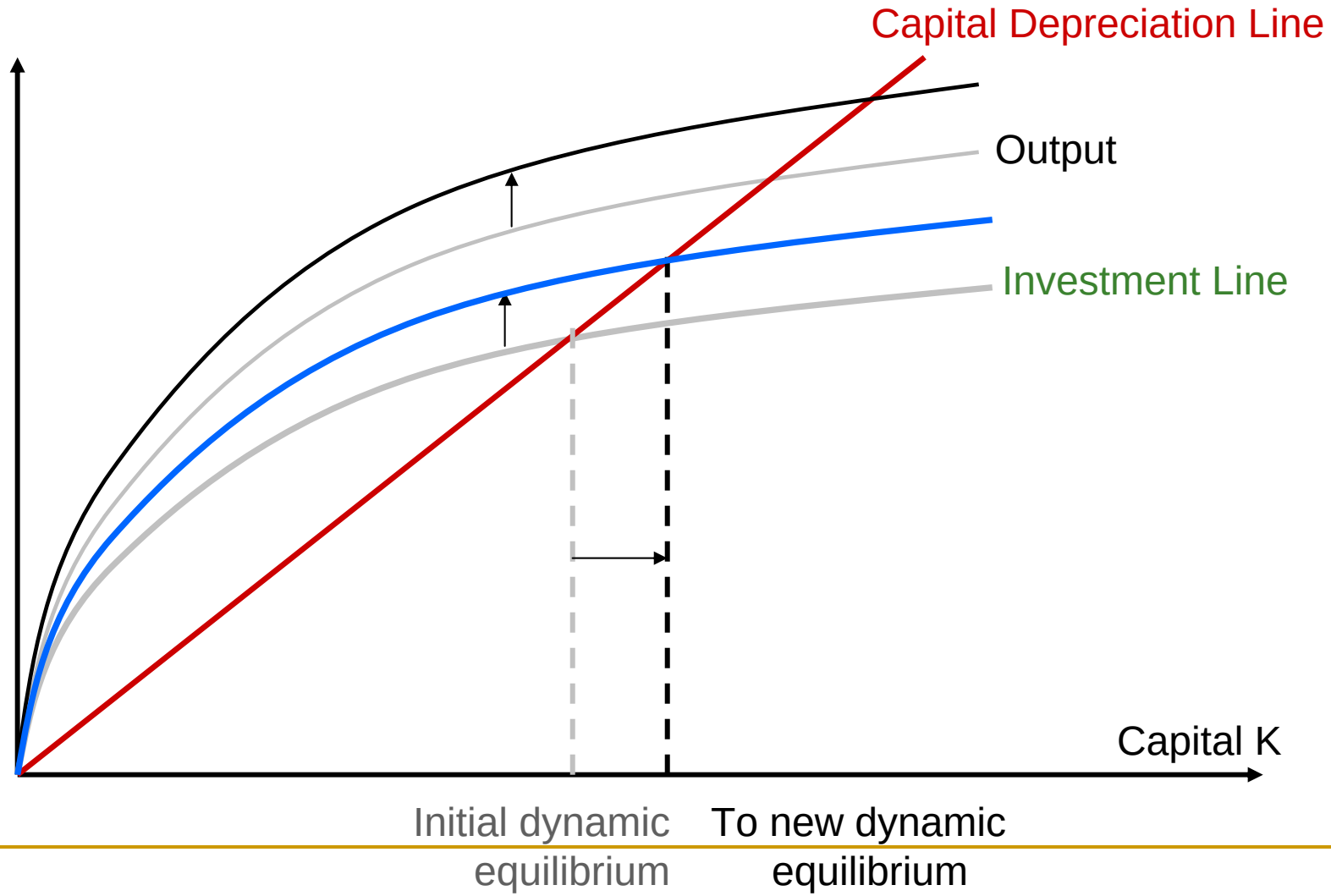
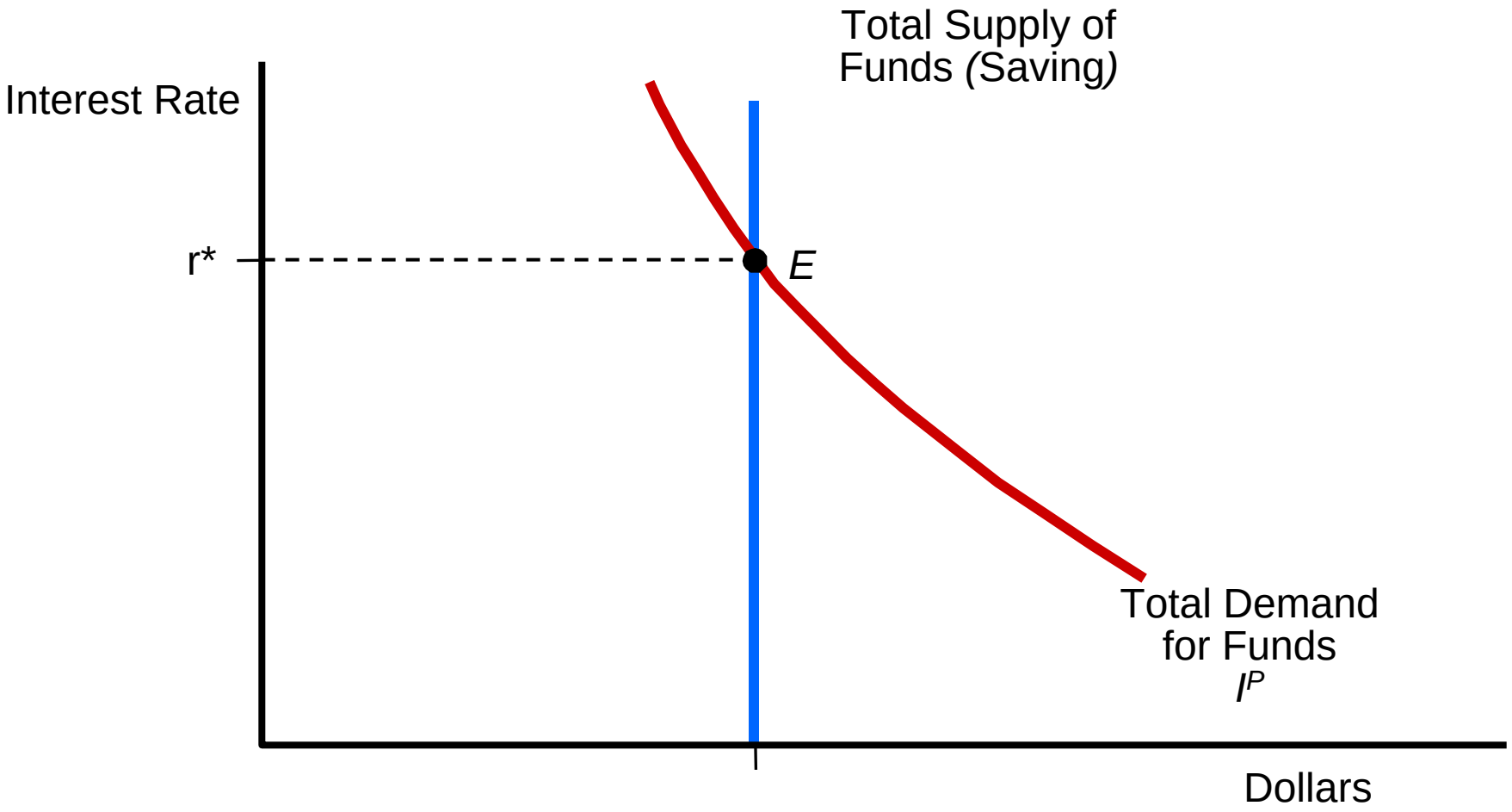


Behind the Scene

- Higher output leads to higher savings (as savings are a constant fraction of output)
  - Supply of funds goes up
- New and better technology likely to open up high return investment opportunities
  - demand for funds likely to go up
- Is it consistent with falling interest rates over the 90s?

Effect on Loanable Funds Market



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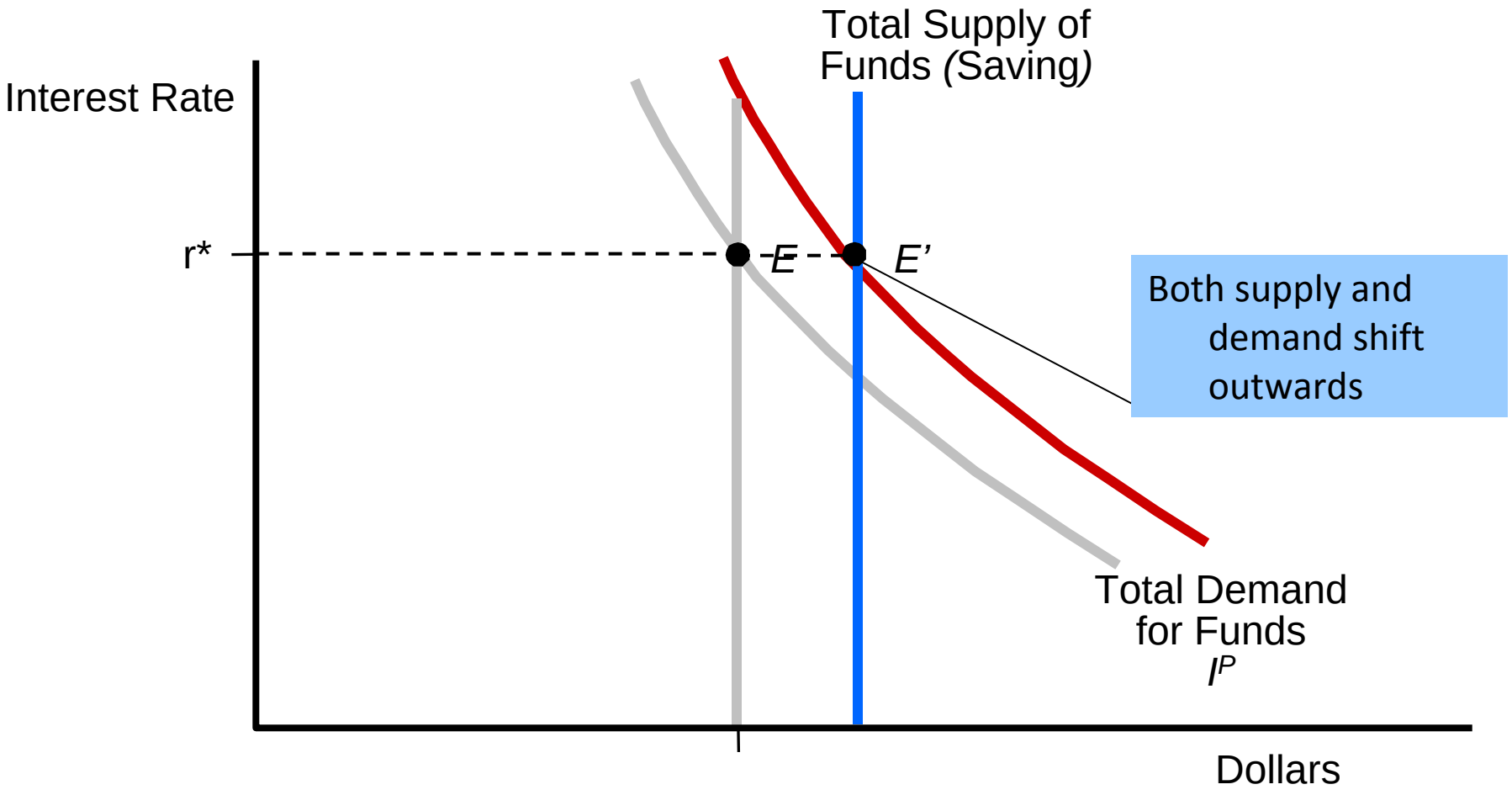

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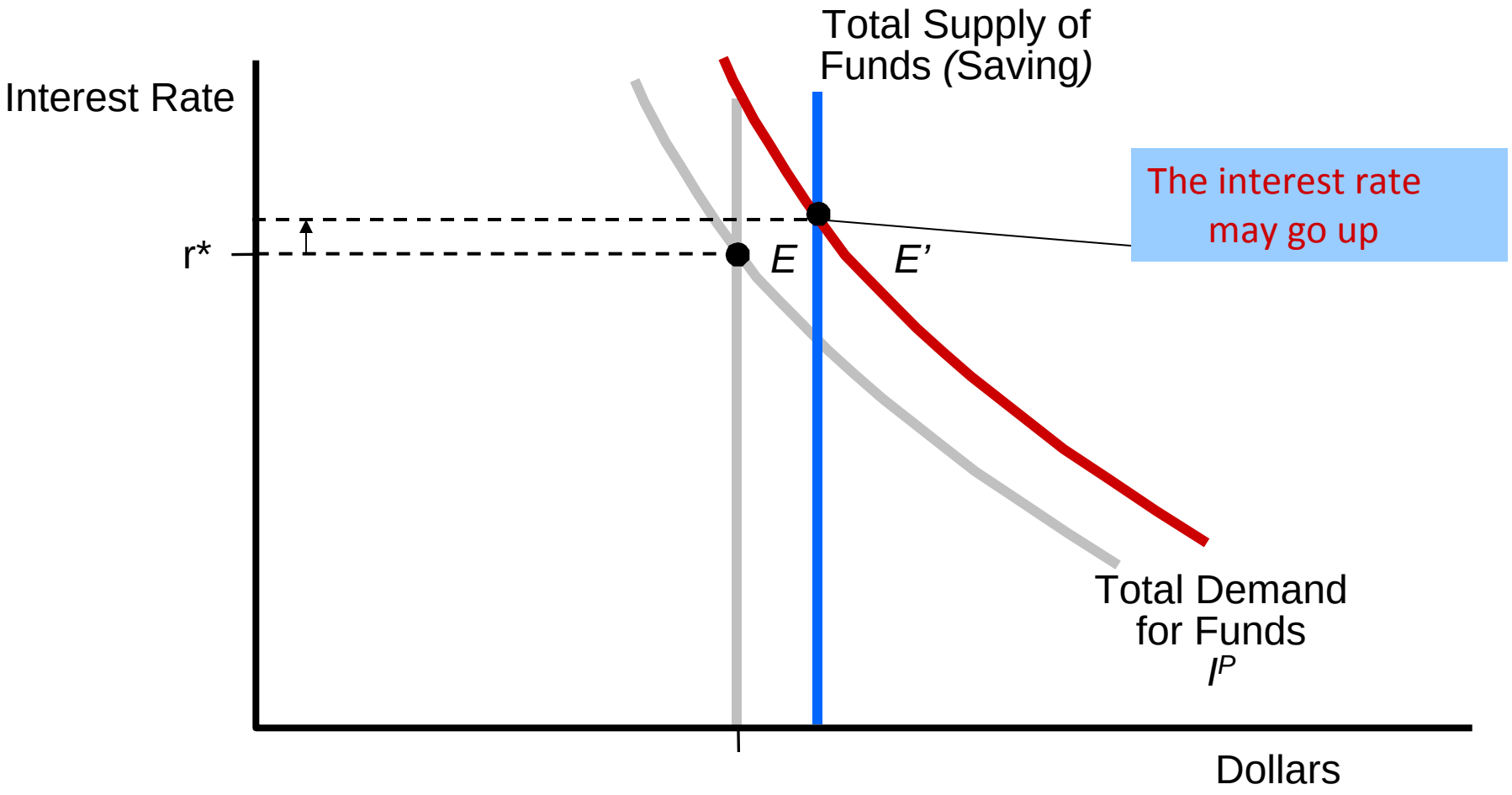

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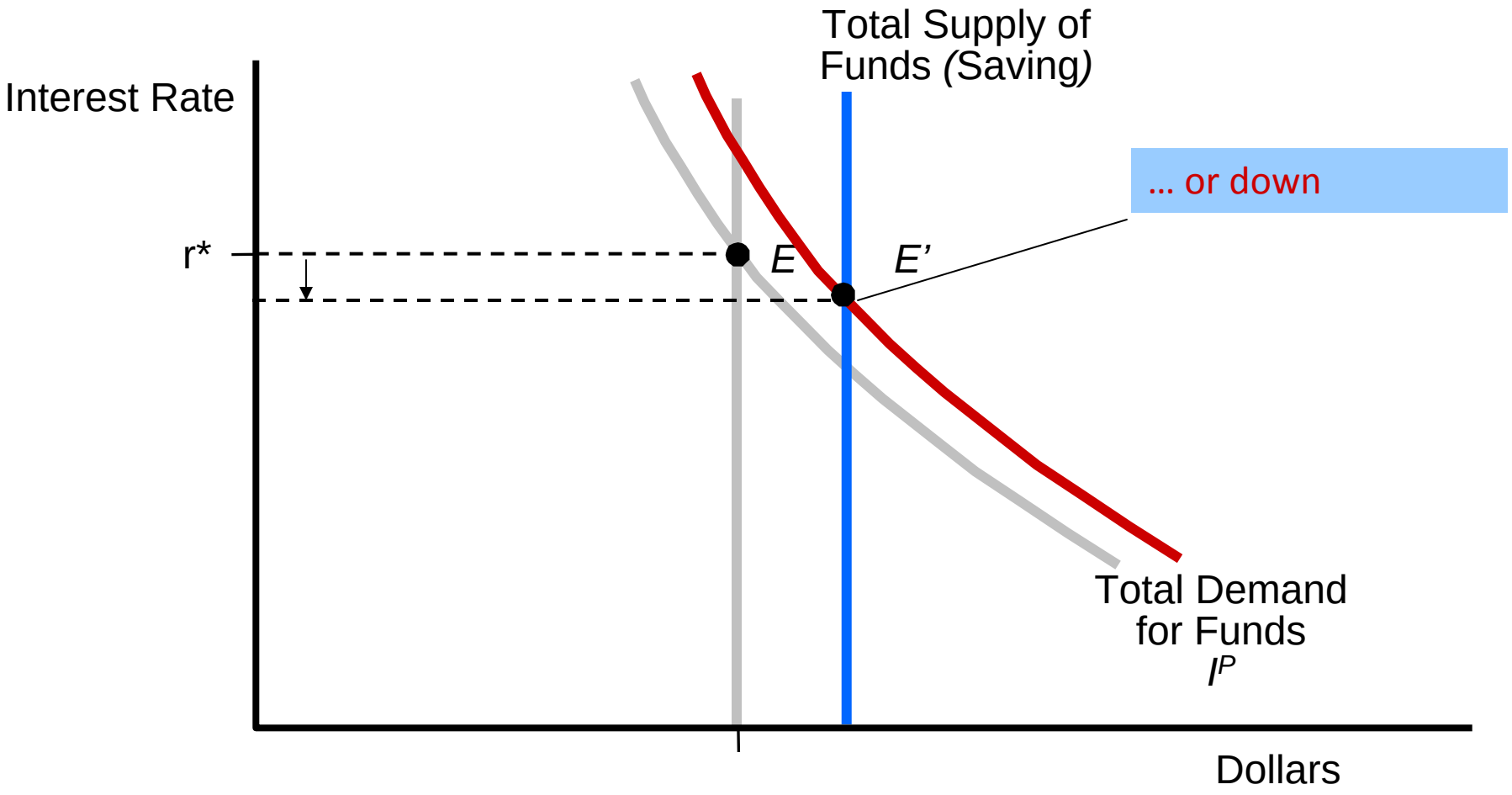


Role of Technological Progress

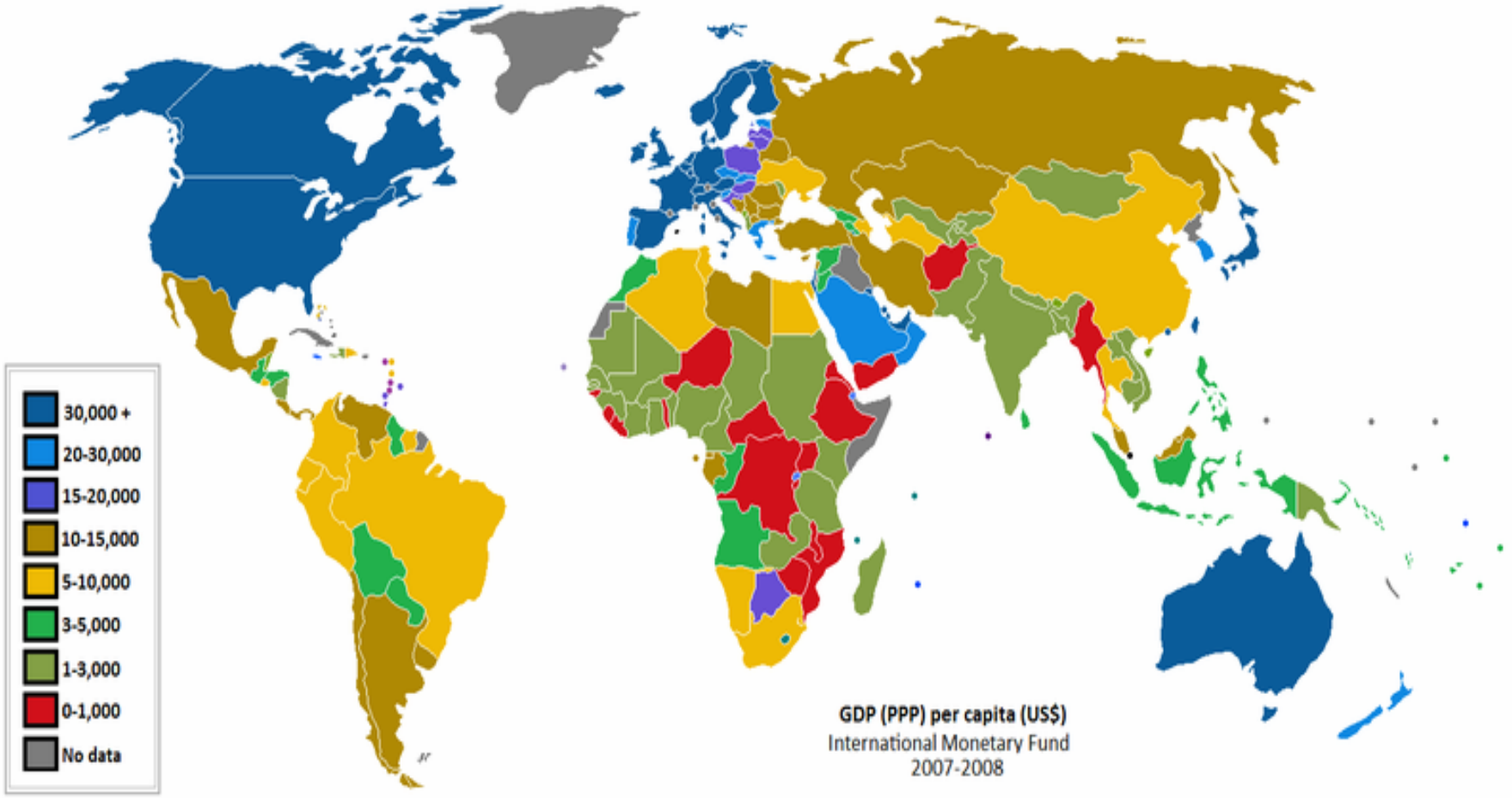
- The level of output, national savings, capital, and employment all increase
  - The effect on the equilibrium interest rate is ambiguous – depends on the relative magnitude of the shifts in the demand for funds and the supply of funds
- Sustained technological progress can fuel growth indefinitely – in principle, there are no bounds for new ideas

Part II:
Accounting for Income Differences in the World

Income Differences in the World

- Income differences between countries are enormous
  - In 1998, average US worker produced in 10 days as much as an average worker in Niger produces in the entire year

Income Differences in the World



Income Differences in the World

- What are the sources of such enormous income differences between countries?
  - Can our model help us understand part of it?

Sources of Income Differences

- In the classical model, the source of income difference are factor inputs and the production function
  - General formulation of production function

$$Y = AK^{\alpha}L^{1-\alpha}$$

  - Dividing both sides by L, we have

$$y = Ak^{\alpha}$$

  - where y=Y/L (output per worker) and k=K/L (capital per worker)

Growth Accounting

$$y = Ak^{\alpha} \qquad (*)$$

- Growth accounting asks the question which part accounts for *y* predominantly
  - Is it capital per worker *k?*
  - Is it A?

Growth Accounting

$$y = Ak^{\alpha} \qquad (*)$$

- Growth accounting asks the question which part accounts for *y* predominantly
  - Is it capital per worker *k*? → Calculated from data
  - Is it A? → Given k, calculated by making the above equation (*) hold, i.e.

$$A = y / k^{\alpha}$$

What Is "A"?

- "A" is calculated as a residual, and so it is:
  - Everything that aggregate production function does not measure explicitly
- Examples
  - Other production factors (e.g. human capital)
  - Technology
  - Social infrastructure (e.g. law enforcement)
  - Number of hours worked by each worker

How Does It Work?

$$y = Ak^{\alpha}$$

- Suppose we have 2 countries and $\alpha = 1/3$
  - We observe in the data:
    - In country 1 (US): $k_{US} = 3$, and $y_{US} = 6$
    - In country 2 (EU): $k_{EU} = 2$ and $y_{EU} = 5$
  - We calculate:
    - In country 1 (US): $A_{US}=y_{US}/k_{US}^{\alpha} =6/1.44=4.16$
    - In country 2 (EU): $A_{EU}=5/1.26=3.96$

How Does It Work?

By definition of A, we have:

$$y_{US} = A_{US} k_{US}^{\alpha} \text{ and } y_{EU} = A_{EU} k_{EU}^{\alpha}$$

- Dividing each side of these equations, we can obtain a decomposition of the income gap

$$\frac{y_{US}}{y_{EU}} = \frac{A_{US}}{A_{EU}} \times \left(\frac{k_{US}}{k_{EU}}\right)^{\frac{1}{3}}$$

$$\frac{6}{5} = \frac{4.16}{3.96} \times \left(\frac{3}{2}\right)^{\frac{1}{3}}$$

$$1.2 = 1.05 \times 1.14$$

How Does It Work?

$$\frac{y_{US}}{y_{EU}} = \frac{A_{US}}{A_{EU}} \times \left(\frac{k_{US}}{k_{EU}}\right)^{\frac{1}{3}}$$

$$1.2 = 1.05 \times 1.14$$

- So, output gap of 20% is attributable to:
  - Residual A: accounts for 5 percentage points
  - Capital k: accounts for 14 percentage points
  - Compounding: accounts for the rest, i.e. 20-14-5=1 percentage point*

*Note 14+5 does not add up to 20. The source of this is compounding of the two effects together. But, it still means that if we increase A by 5% and $k^{1/3}$ by 14%, EU is going to catch up with US. Compounding of the two effects together will do the rest of the job.

Applying Growth Accounting to Data

- Will apply this method to actual data for 127 countries for year 1998
  - Capital per worker from investment series going back to 1960 and law of motion

$$K_{tomorrow} = (1-\delta)K_{today} + I$$

  - Value of α consistent with estimates looking at share of labor income in total income – turns out around 1/3 for almost all countries

Results: Selected Countries vs. US

$$\frac{y_{US}}{y_{Country}} = \frac{A_{US}}{A_{Country}} \times \left(\frac{k_{US}}{k_{Country}}\right)^{\frac{1}{3}}$$

column 2 column 3 column 4

Country	Gap in y	Fraction acocunted for by A	k	Compounding
Canada	6%	4%	2%	0%
Germany,	22%	23%	-1%	0%
France	22%	21%	1%	0%
U.K.	38%	15%	20%	3%
Taiwan	125%	50%	49%	25%
Mexico	131%	59%	45%	27%
Argentina	139%	73%	38%	28%
U.S.S.R.	140%	106%	17%	17%
Brazil	213%	96%	60%	58%
Ecuador	322%	163%	60%	98%
Kenya	1686%	462%	217%	1006%
Niger	3348%	719%	321%	2308%

Source: Authors' calculation based on the data appendix to the paper by R. Hall and C. Jones, "Why Do Some Countries Produce So Much More Output Per Worker than Others", Quarterly Journal of Economics, Feb, 1999.

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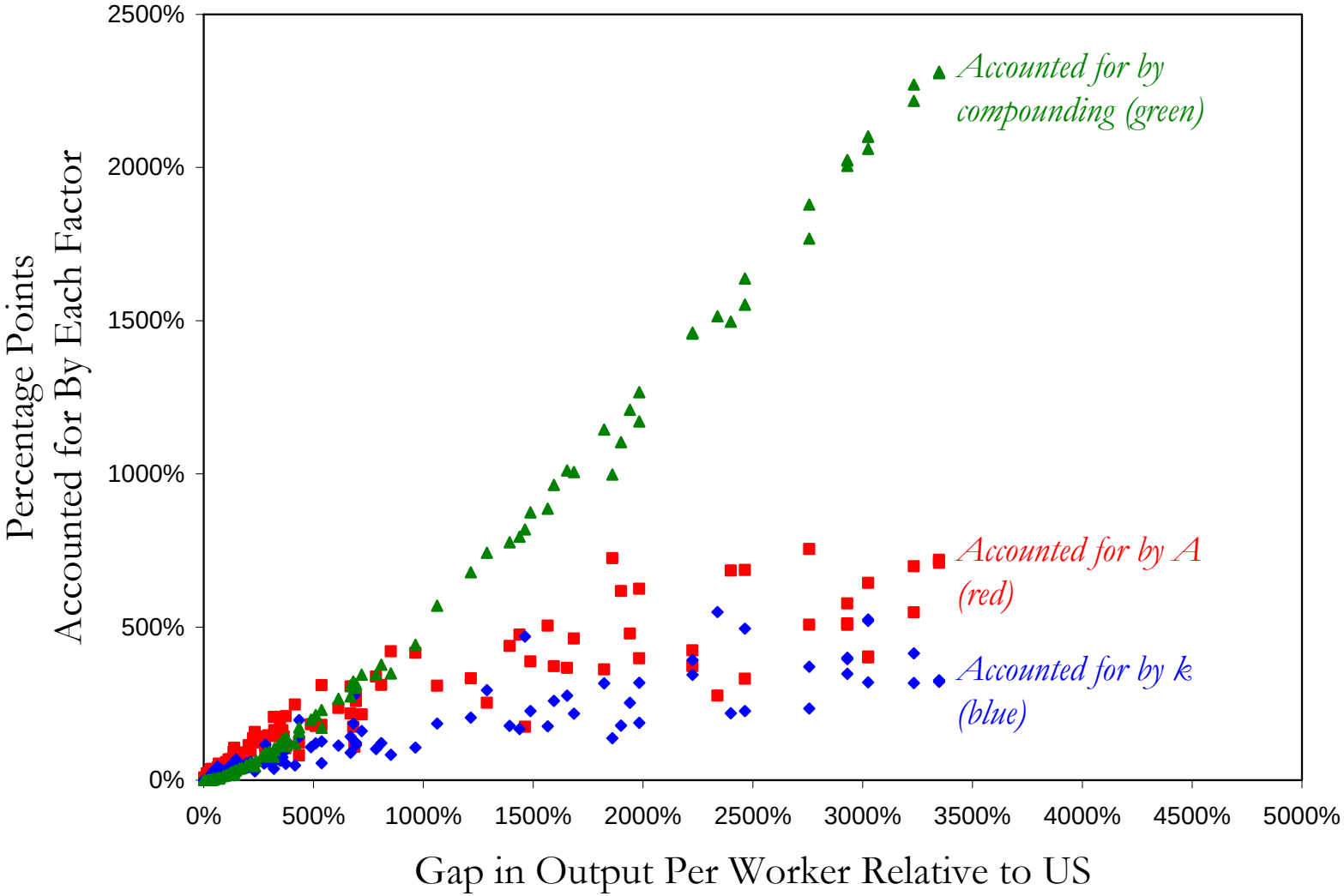
Contribution of Each Factor



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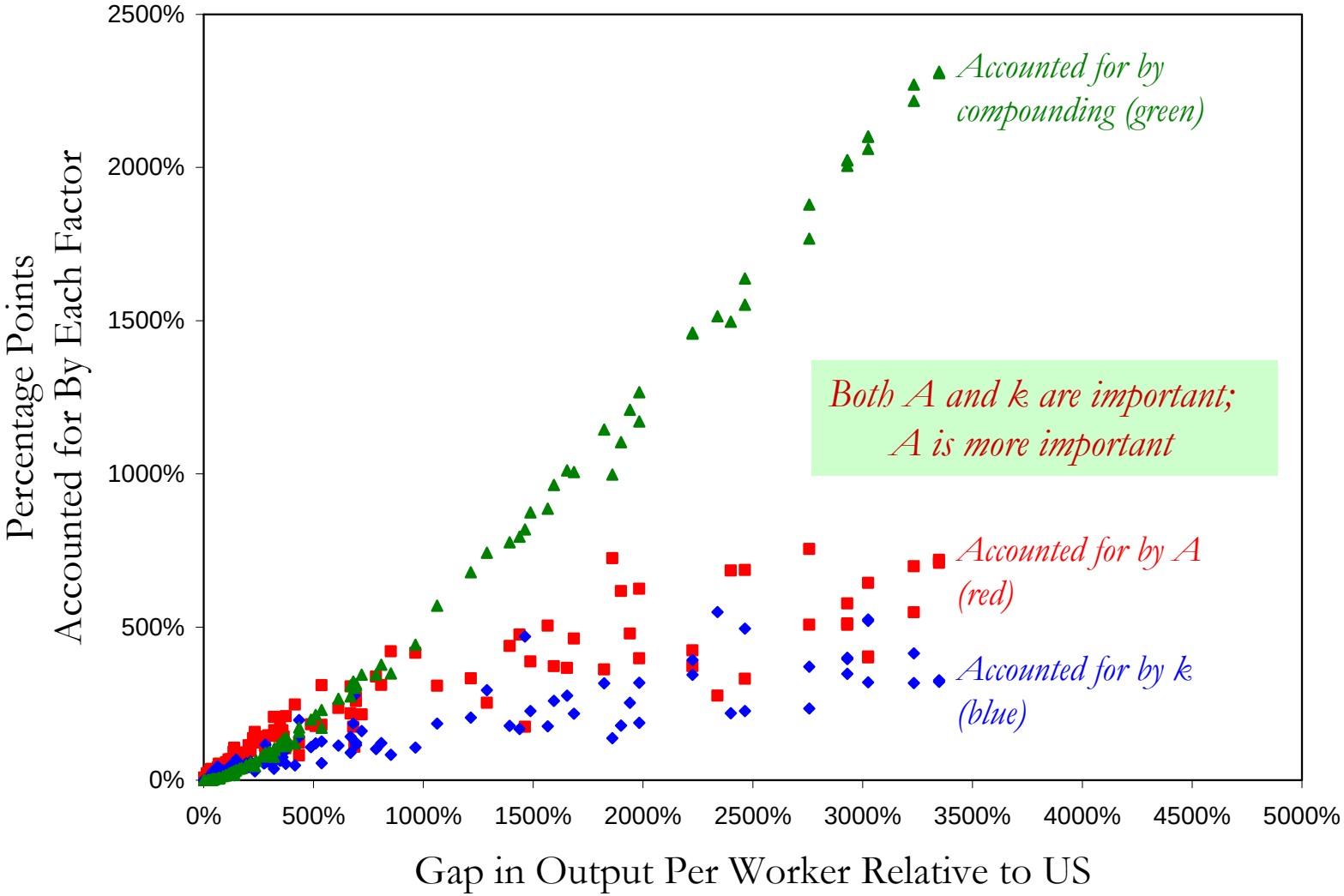
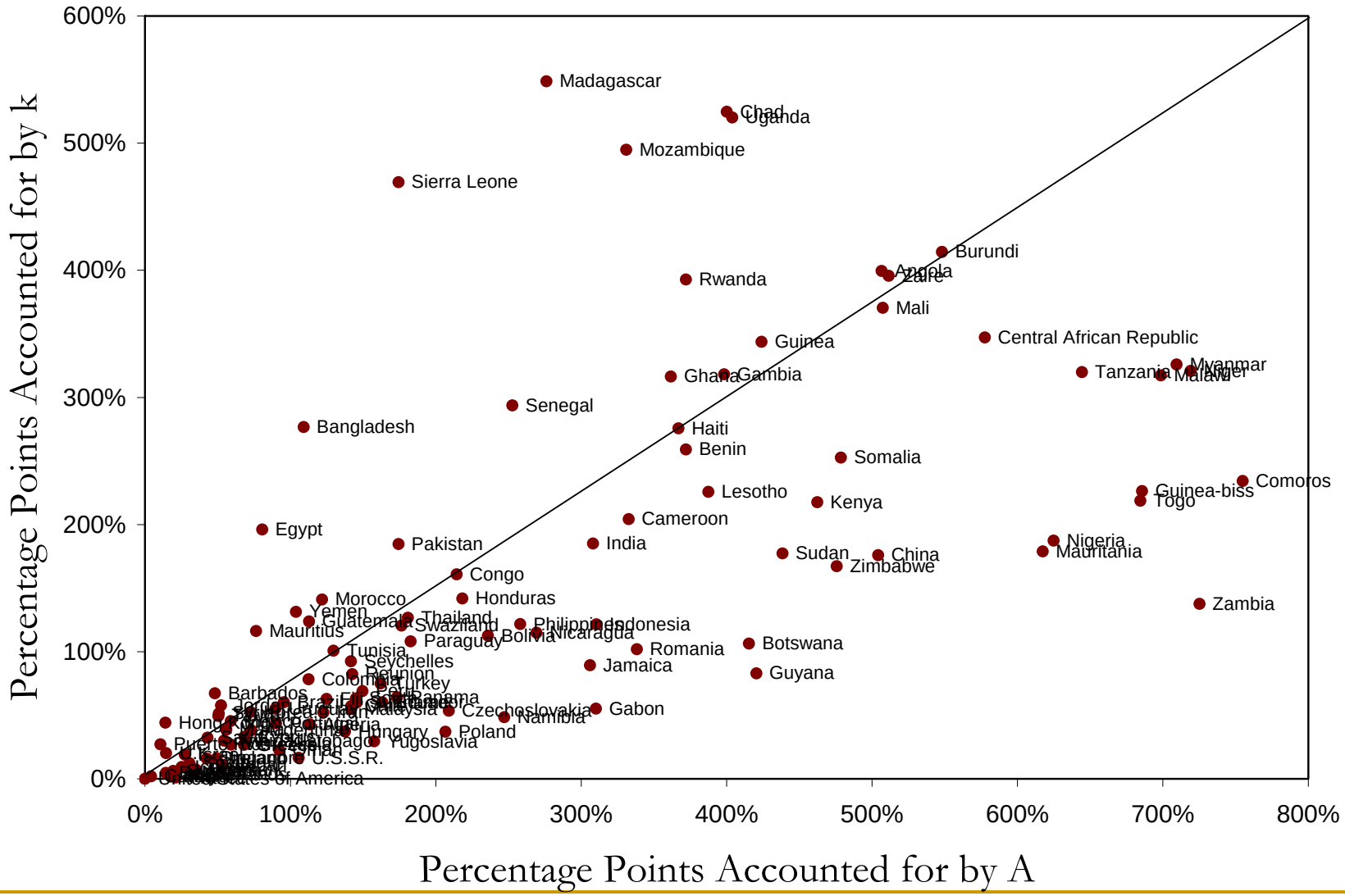
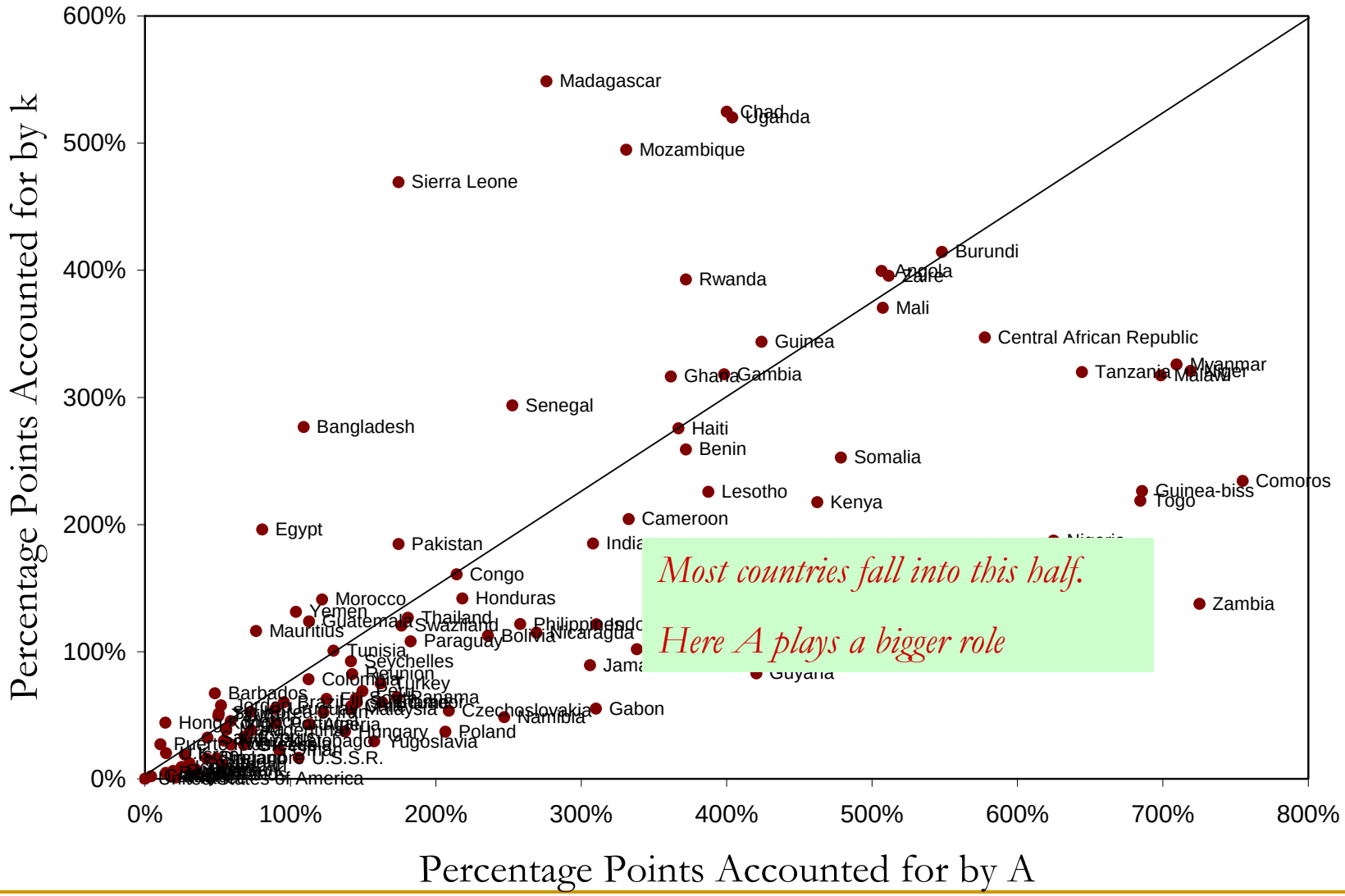


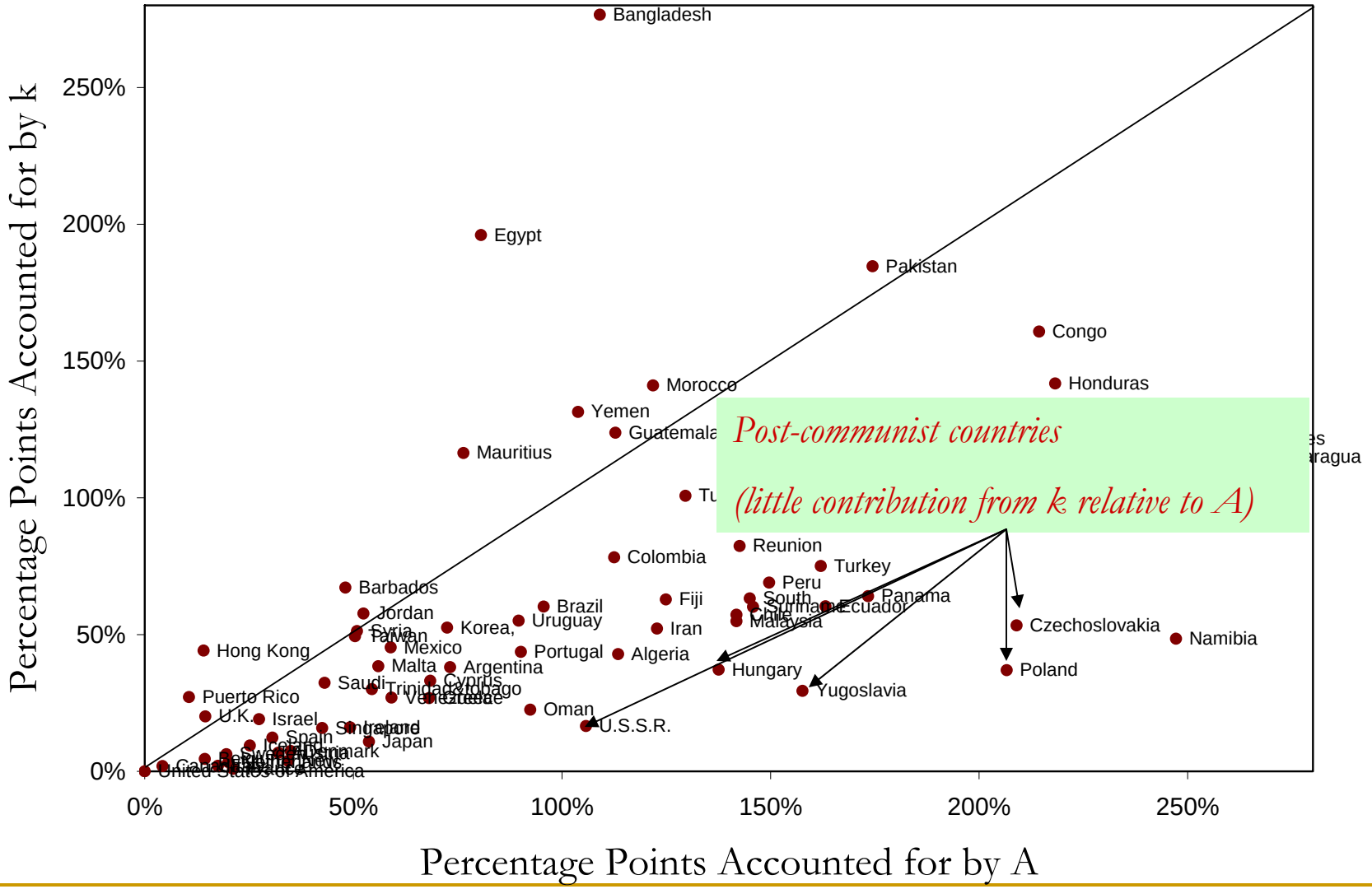
Contribution of A versus k



Contribution of A versus k



Contribution of A versus k (Zoomed in)



Conclusions

- Both A and K play a role in accounting for output gap; A has more explanatory power than k
  - Rich countries have both more k and more A → compounding kicks in as an important factor
- Interestingly, largest rich European countries (France, Germany) seem to fall behind the US due to A
- Post-communist countries are abundant in capital, but lack A → consistent with the Soviet doctrine of forced capital accumulation

Puzzle: Why Europe Has Lower A?

$$\frac{y_{US}}{y_{Country}} = \frac{A_{US}}{A_{Country}} \times \left(\frac{k_{US}}{k_{Country}}\right)^{\frac{1}{3}}$$

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Why Europe Has Lower A?

- Europeans work much less than Americans
  - Europeans produce 40% less than US per person, but almost all of the gap is accounted for by labor force participation and less hours worked per person in the labor force
- We measure output per worker, and so a lower number of hours each worker works in our accounting is automatically attributed to A

Why Europe Has Lower A?

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  - Is it enough to account for the entire gap between Germany/France and the US?

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  - Is it enough to account for the entire gap between Germany/France and the US? YES

Labor Supply, Productivity, and GDP

Major Advanced Countries: 1993–96

Country	Hours per week per person 15-64	GDP per hour U.S.=100	GDP[a] per person 15-64; U.S.=100
Germany	19.3	99	74
France	17.5	110	74
Italy	16.5	90	57
Canada	22.9	89	79
United Kingdom	22.8	76	67
Japan	27.0	74	78
United States	25.9	100	100

[a] OECD purchasing power parity GDP numbers

Source: E.C. Prescott, "Why Do Americans Work So Much More than Europeans", Minneapolis FED Staff Report 321, Nov 2003

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Why Europeans Work So Much Less?

- Edward Prescott (Nobel Laureate) argues that most of the effect is accounted for by higher taxes in Europe:
  - "In these countries if someone works more and produces 100 additional euros of output, that individual gets to consume only 40 euros of additional consumption and pays directly or indirectly 60 euros in taxes" (in the US the corresponding number would be 40 euros)

Evidence Supporting Prescott's Claim

- In the 70s taxes in Europe were similar to US
  - If Prescott's hypothesis is right, it should be that Europeans worked just as much as Americans in the 70s
  - It is true?

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Europe versus US in the 70s

Labor Supply, Productivity, and GDP

Major Advanced Countries: 1970–74

Country	Hours per week per person 15-64	GDP per hour U.S.=100	GDP[a] per person 15-64; U.S.=100
Germany	24.6	72	75
France	24.4	74	77
Italy	19.2	65	53
Canada	22.2	91	86
United Kingdom	25.9	62	68
Japan	29.8	49	62
United States	23.5	100	100

[a] OECD purchasing power parity GDP numbers

Part III:
Aggregate Consequences of Fiscal Policy

Government and the Economy

- Government is an important player in the economy
  - US government collects in taxes and spends around $2trillion → about 18% of GDP
- Using these resources, the government can influence the economy, which is referred to as fiscal policy

Government and the Economy

- Using our model, we will study the effects of fiscal policy on output, employment, investment, capital accumulation, and future output

Important Caveats to Our Analysis

- The only variables we have in our model are: net taxes T and total spending G
- In particular,
  - Our model ignores how taxes are collected or how G is spent
  - Our model ignores the social benefits from G
- Just need to be aware of these limitations when we interpret the results

Government Budget

- As any economic entity, government has a budget
- Budget is determined by G-T
  - When G-T>0 government has deficit and needs to borrow
  - When G-T<0 government has a surplus and saves
- G-T results determines evolution of public debt D

$$D_{tomorrow} - D_{today} = G_{today} - T_{today} + (\text{Interest on } D_{today})$$

Data for US

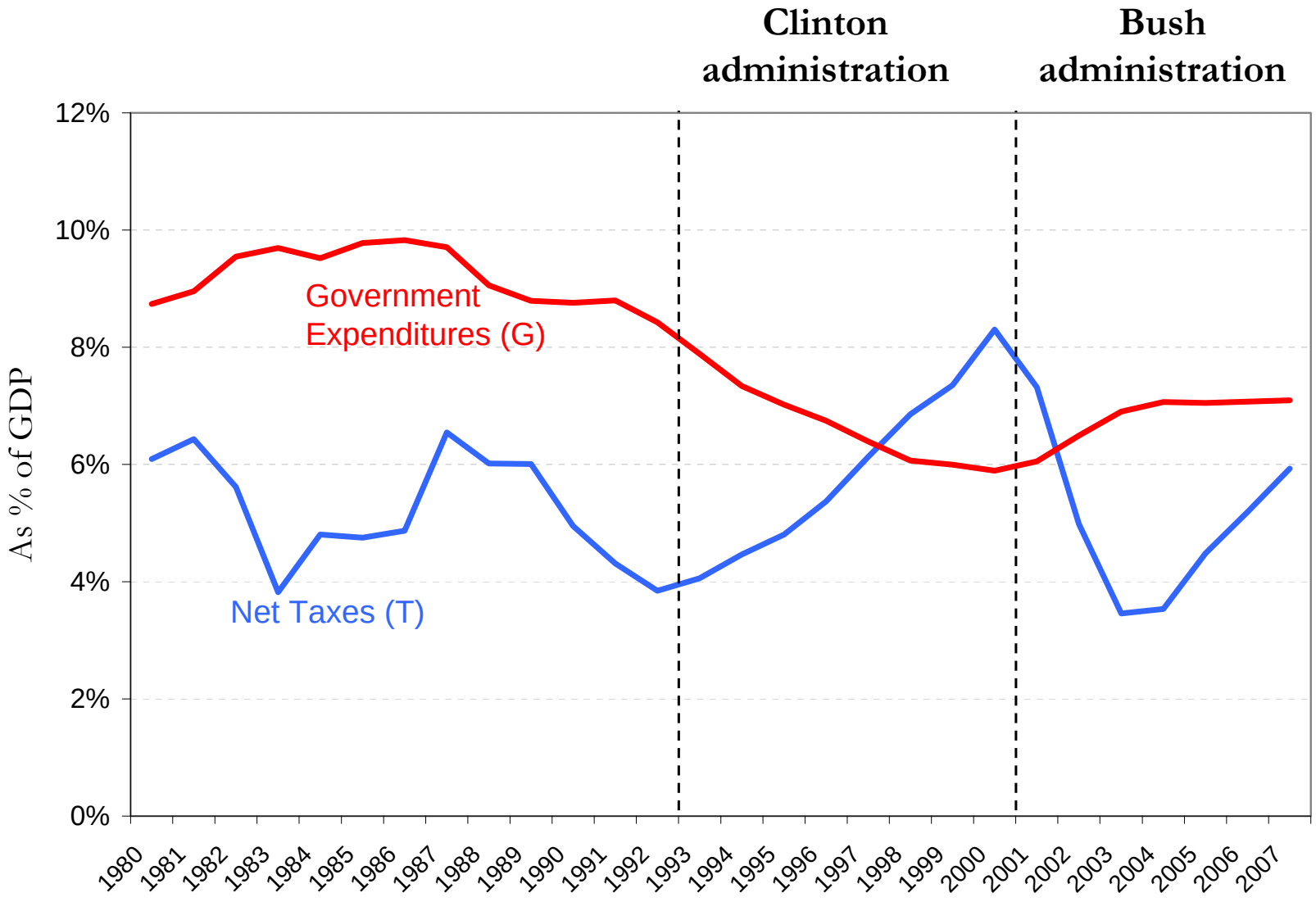
- Can learn about G and T (federal) in US by combining data from Congressional Budgetary Office (CBO) and National Income and Product Accounts*
  - Link to CBO: http://www.cbo.gov/
  - Link to NIPA: http://www.bea.gov/national/nipaweb/index.asp
- *Here we talk about federal portion of G and T, technically our G and T should also include state governments. Given our focus on fiscal policy this is a fair assumption.

Data for US

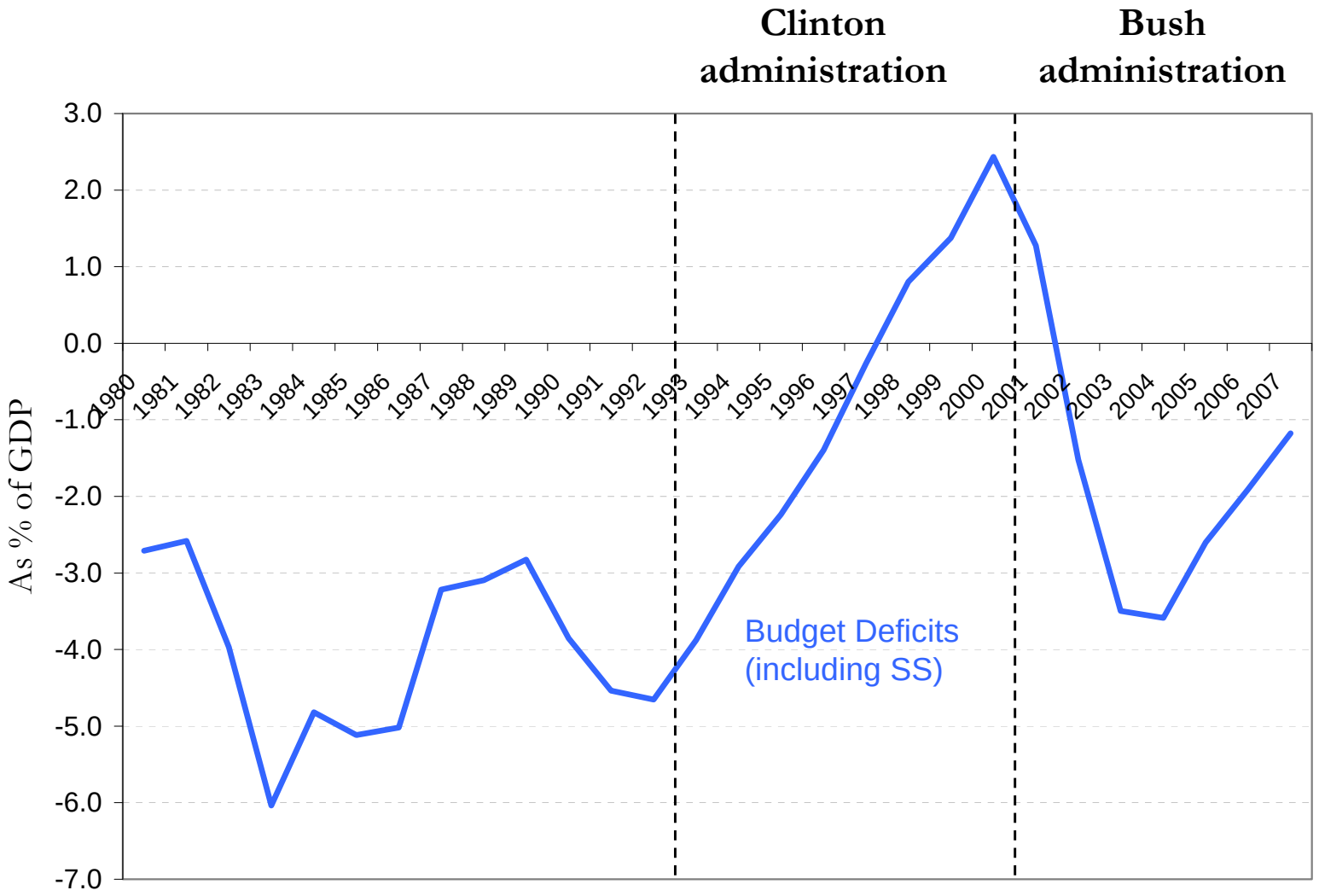
- CBO data tells us about outlays (government spending on goods and services G + transfers) and gross tax revenues of the government
- NIPA give us information on government spending on goods and services G
- Combining the two, we can back out net taxes T
  - T=gross tax revenues – (outlays – G)

TRANSFERS: E.g. social security payments, disability or unemployment insurance, etc…

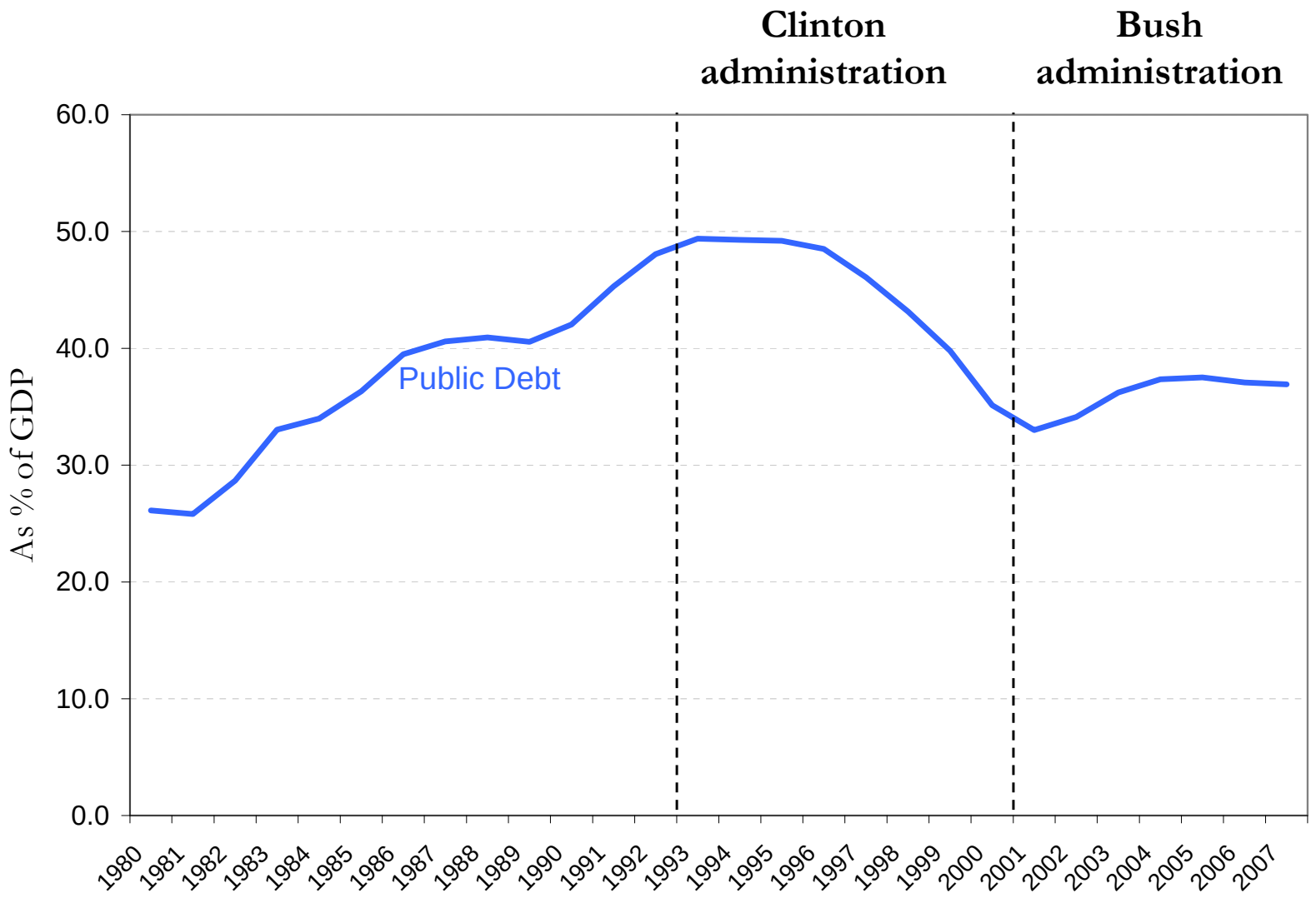
G and T in the US, 1980-2007



Budget Deficits in the US, 1980-2007



Public Debt in the US, 1980-2007



Fiscal Policy in the Classical Model

- How does fiscal policy affect the economy according to the classical model?
- Will use a two step analysis:
  - STEP 1: Impact on the static equilibrium: output, employment, investment
  - STEP 2: Impact on dynamic equilibrium: future capital, and future output

STEP 1: Employment and Output

- In static equilibrium, capital K is predetermined
- Employment is equal to population size L
- Thus, output (today) is independent from G and T, as it is determined by K and L through the production function
  - Neither of them depends on G and T

STEP 1: Investment

- Investment is determined by equilibrium of the loanable funds market
- With government it says:
  - Investment I = private savings S + government savings (T-G), which we can write by plugging in for S as

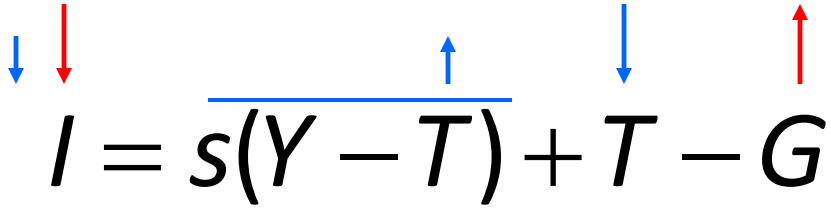
$$I = s(Y - T) + T - G$$

STEP 1: Investment

$$I = s(Y - T) + T - G$$

- When T goes down or G up
  - Investment falls
  - Government deficit increases
    - Effect through G stronger than through T

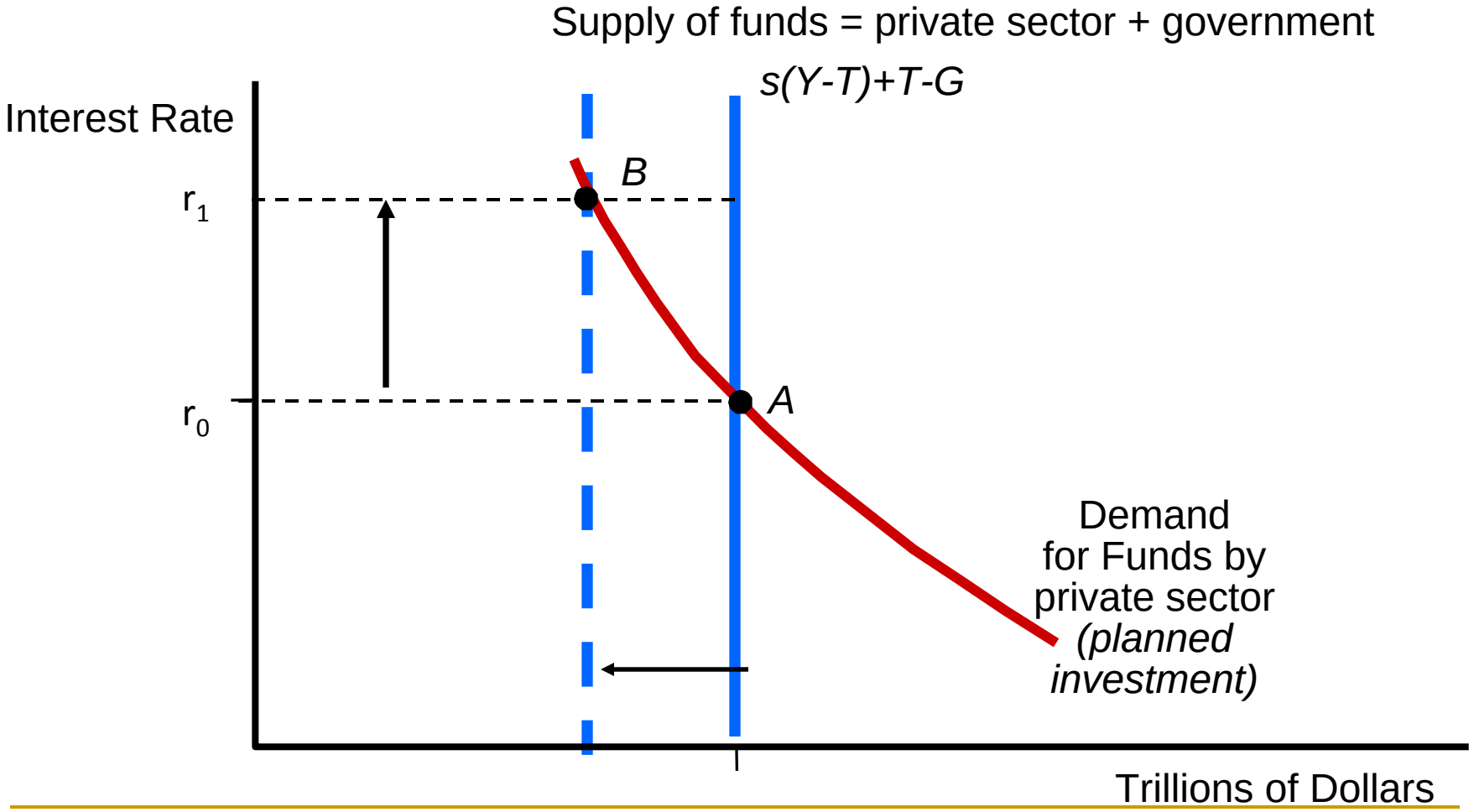
STEP 1: Investment



- When T goes down or G up
  - Investment falls
  - Government deficit increases (G-T up)
    - Effect through G stronger than through T
- Will refer to this policy as *fiscal expansion*

STEP 1: Interest Rates

- Fiscal expansion



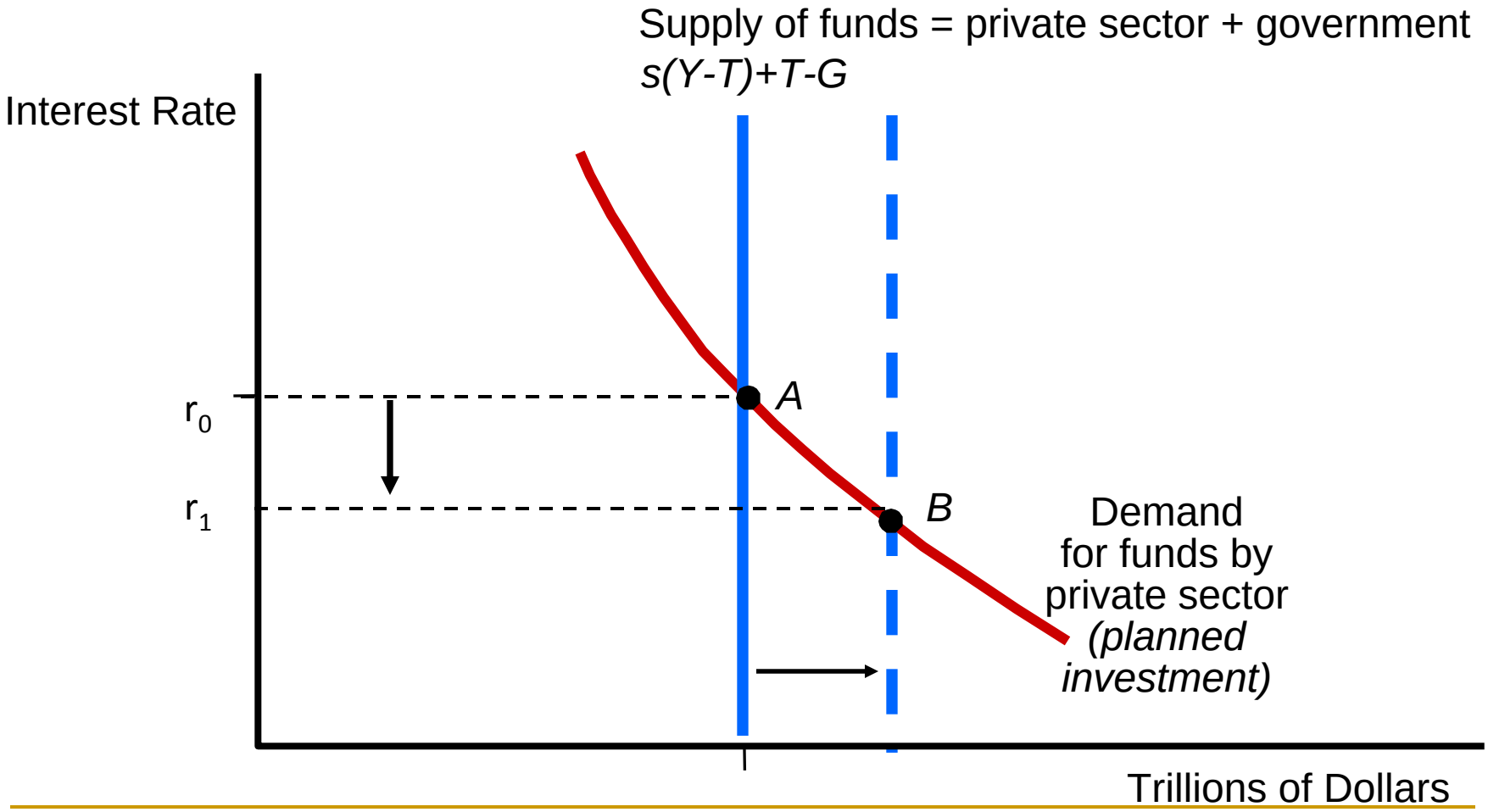
STEP 1: Investment

$$I = s(Y - T) + T - G$$

- The opposite policy (T up or G down) will be referred to as fiscal contraction
- It has exactly the opposite effect

STEP 1: Interest Rates

- Fiscal contraction



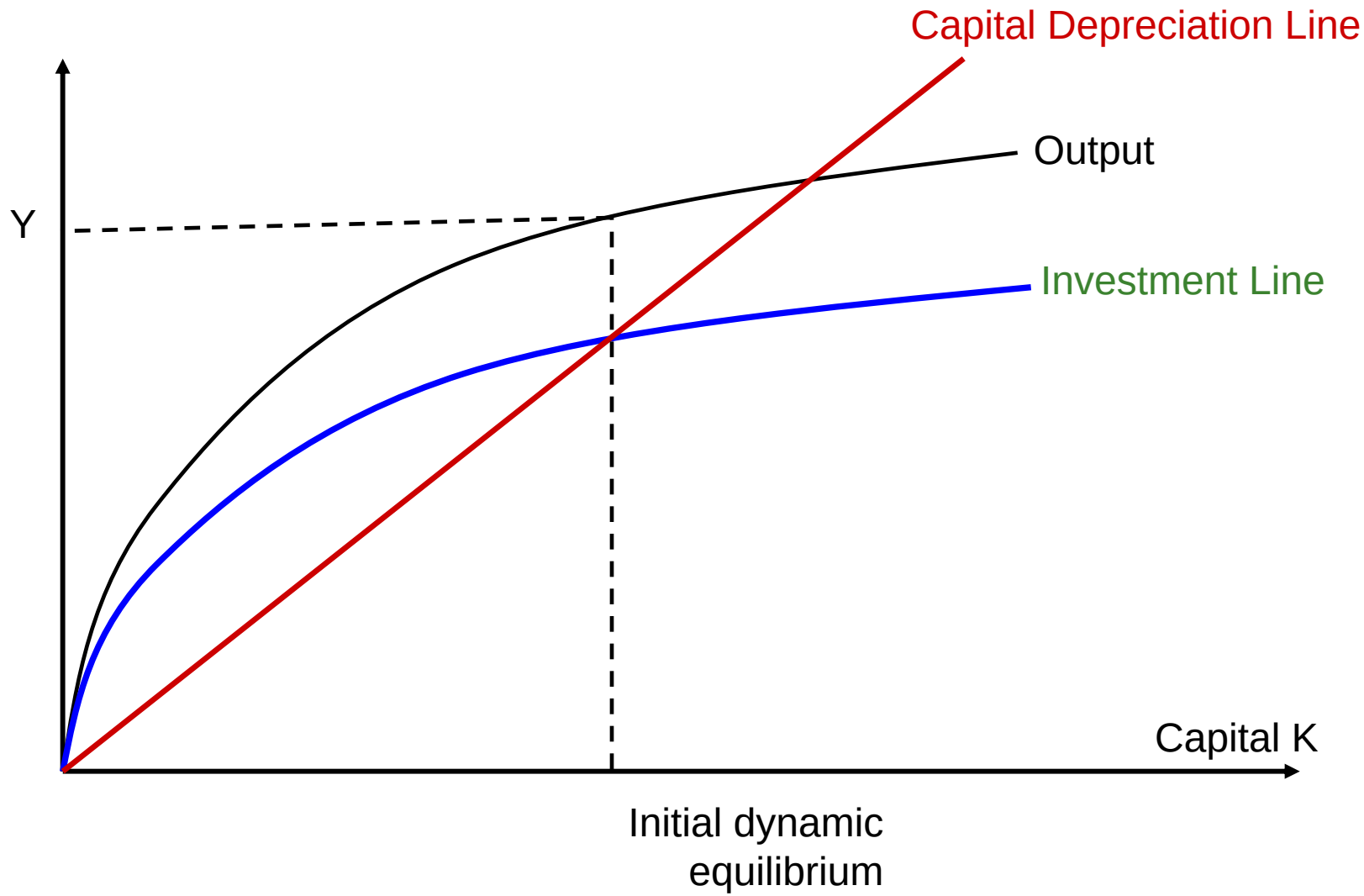
Conclusions from Step 1

- Fiscal expansion
  - Supply of funds falls as government soaks up part of it
  - Interest rates go up, investment falls
- Fiscal contraction
  - Supply of funds goes up as government soaks up less (or even saves)
  - Interest rates go down, investment increases

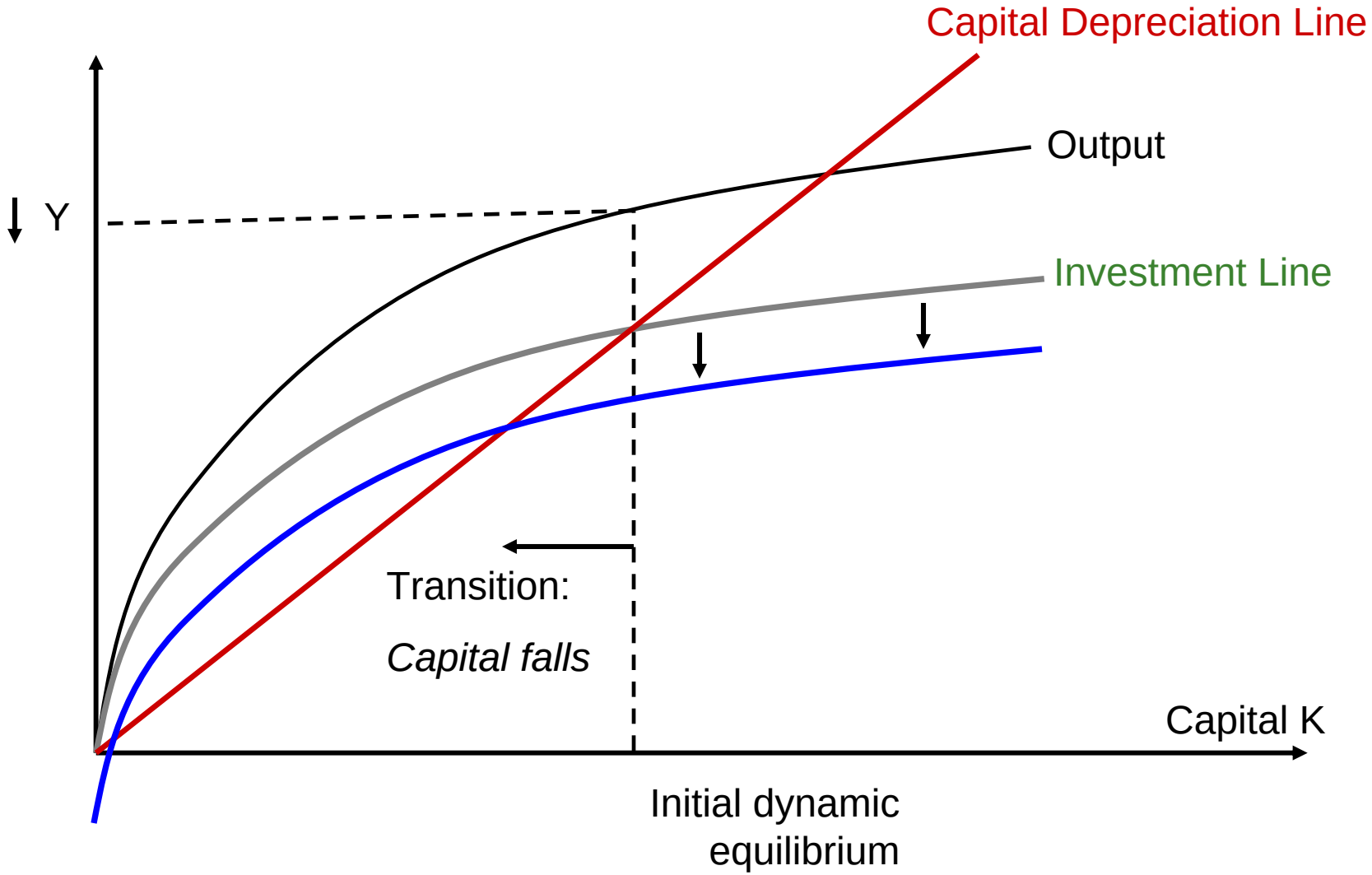
STEP 2: Long-Run Effect of Fiscal Policy

- Because investment changes, fiscal policy affects future capital and future output
  - Fiscal expansion: capital falls to a lower level, thus future output goes down
  - Fiscal contraction: capital increases to a higher level, thus future output goes up

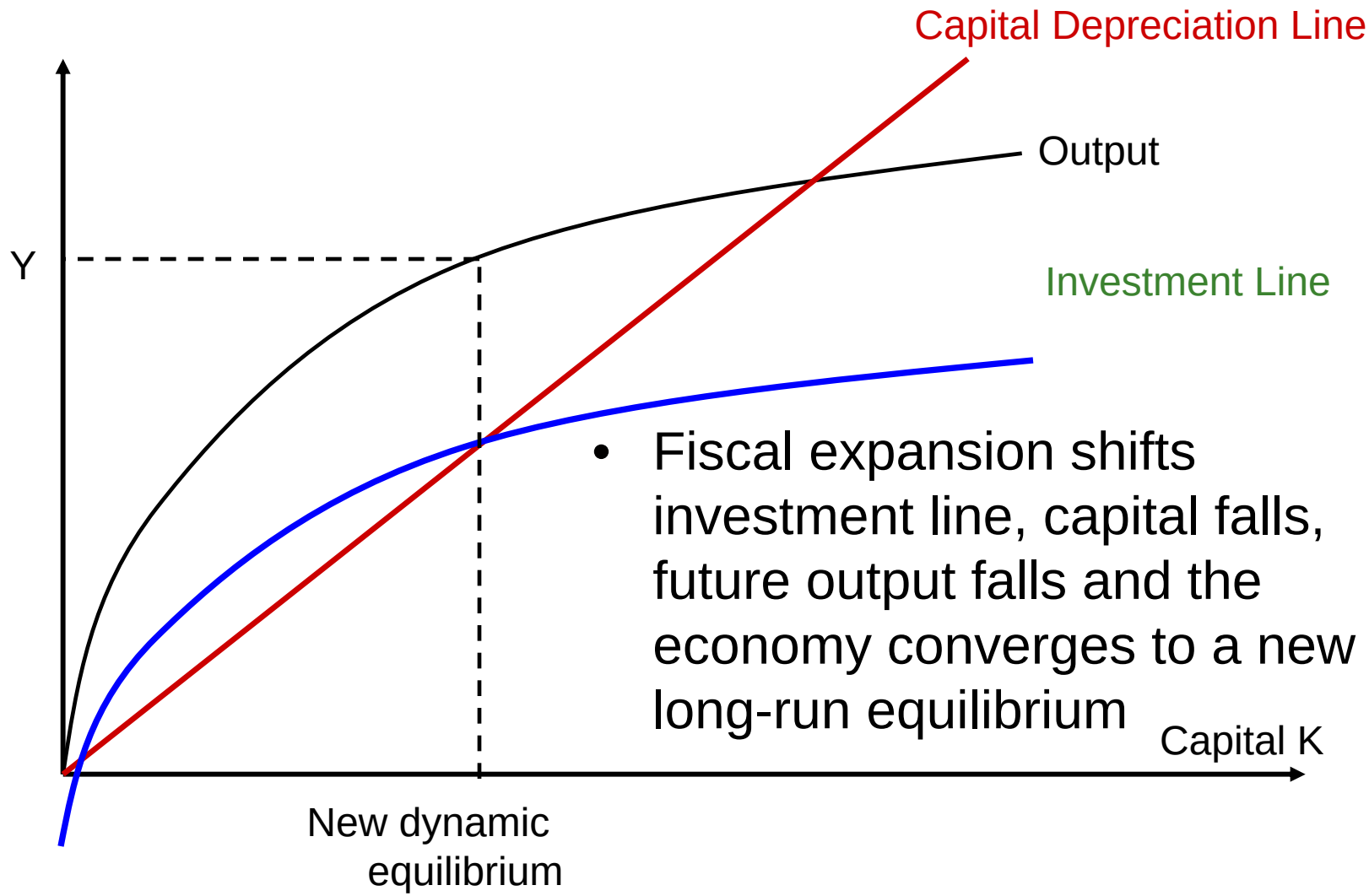
Effect of Fiscal Policy on Future Output



Effect of Fiscal Policy on Future Output



Effect of Fiscal Policy on Future Output



- Fiscal expansion shifts investment line, capital falls, future output falls and the economy converges to a new long-run equilibrium

Evidence on Crowding Out Effect?

- The crowding out effect of private investment is consistent with the US evidence regarding the hike of government spending during the World War II

Caveats

- According to our model Bush's policy would lead in the long-run to lower output, investment and capital, and Clinton's to higher
- However, there are several caveats to this finding
  - Lower income taxes and dividend taxes may encourage economic activity because additional $1 income/profit is going to be taxed less (we don't have this effect in the model)
  - In an open economy crowding out effect may be much weaker due to supply of foreign funds

Caveats

- Ricardian equivalence
  - Higher budget deficits = higher future taxes to repay public debt
  - Households must save more to sustain the same level of consumption in the future
    - *s* may go up, and partially compensate the fall in the supply of the loanable funds

Key Take Away

- To unambiguously stimulate output in the long-run, need both lower taxes and lower spending
  - Classical model says: Under some conditions, lower taxes without any reduction of spending may lead to an offsetting effect of a fall of aggregate supply of funds, and thus crowding out of private investment