

# Chapter 7

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A proximate determinant  
of long-run growth:  
Productivity

# Introduction: Proximate determinants

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- ✓ Physical capital
- ✓ Population growth
- ✓ Human Capital
  - ✓ Health
  - ✓ Education
- Productivity
  - Technology
  - Efficiency
- International trade

# Introduction: Productivity

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- We saw how factor accumulation can explain income level differences but
  1. It did not explain all the differences;
  2. It did not explain economic growth in the long run (sustained growth).
- We will see that long-run economic growth is due to growth in productivity and that
  1. Long run productivity growth is due mainly to technological progress;
  2. Country differences in productivity are mainly due to differences in efficiency.

# A cautionary note on terminology

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- One should make clear the difference between
  1. Labor productivity
  2. Total Factor Productivity (TFP)
- Labor productivity:
  - Output per worker
  - Depends on technology, capital, efficiency, ...
- Total Factor Productivity (TFP):
  - The “ability” with which all factors are combined to produce outputs.
  - Does not depend on capital.
  - Also called “multifactor productivity”.

# A cautionary note on terminology

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- ❑ Weil does not make this distinction as he uses the term productivity to refer to TFP only.
- ❑ He uses “output per worker” instead of “labor productivity”.
- ❑ In the literature, the term productivity may mean one or the other.
- ❑ To avoid confusion, if you use the term “productivity”, I recommend you specify “labor productivity” or “TFP”.
- ❑ In this course, unless otherwise noted:  
$$\text{Productivity} = \text{TFP}$$

# What is productivity (TFP)

- ❑ The “effectiveness” or “ability” with which production factors are used to produce outputs.
- ❑ Determined by
  - Technology
  - Efficiency
- ❑ Technology: The knowledge about how to combine inputs in order to produce outputs.
- ❑ Efficiency: Differences in productivity that are not explained by differences in technology.
- ❑ Examples later. For now, let us study how we can measure productivity.

# Outlook for this chapter

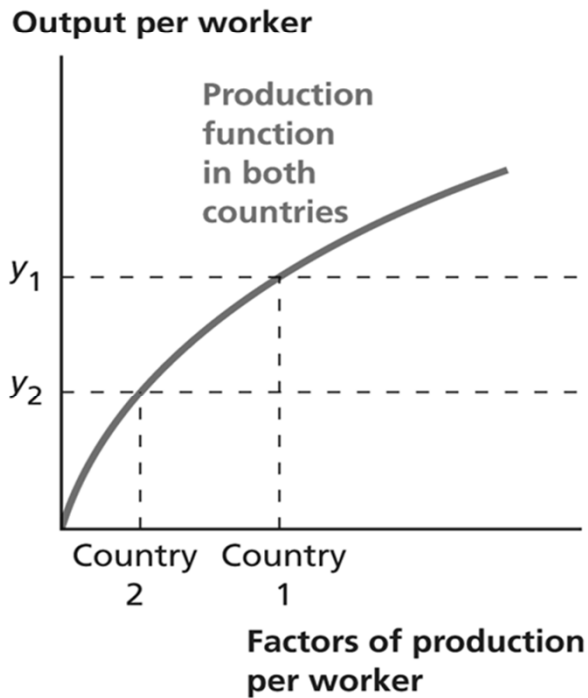
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1. What is productivity and how to measure it.
2. How it differs between countries.
3. Importance in explaining income level differences between countries.
4. Measure how productivity growth differs between countries.
5. Measure relative contributions of productivity growth and factor accumulation in countries' total growth.

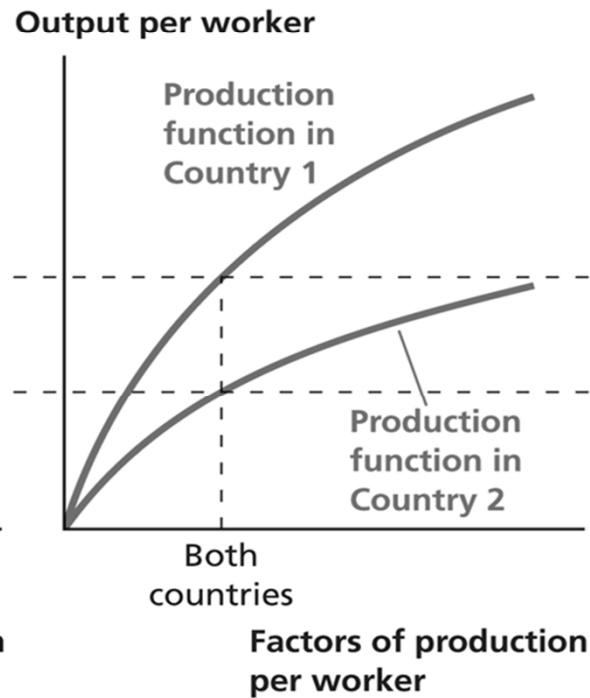
# Theoretical framework

**FIGURE 7.1**  
Possible Sources of Differences in Output per Worker

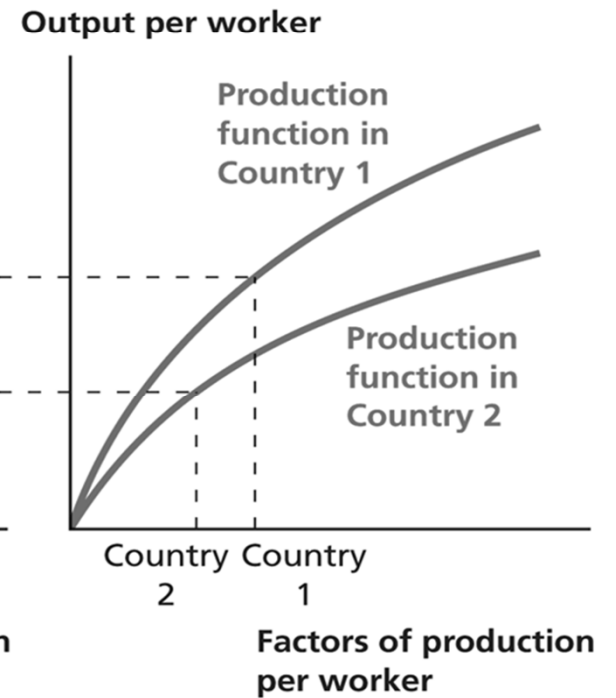
(a) Differences in output due to factor accumulation



(b) Differences in output due to productivity



(c) Differences in output due to both productivity and factor accumulation





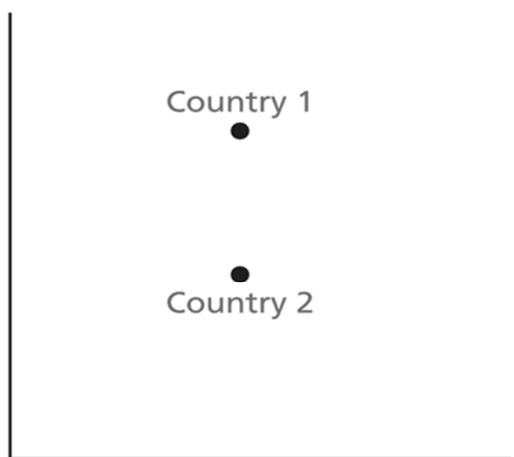
# Problem with observations

**FIGURE 7.2**

**Inferring Productivity from Data on Output and Factor Accumulation**

**(a) The countries have equal factor accumulation, but Country 1 has higher output.**

Output per worker



**Factors of production per worker**

**(b) The countries have equal output, but Country 1 has higher factor accumulation.**

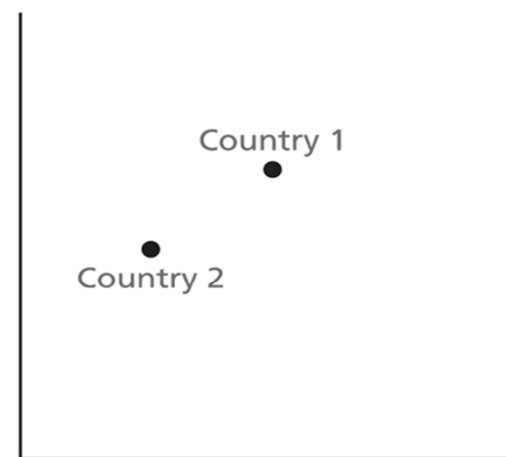
Output per worker



**Factors of production per worker**

**(c) Country 1 has higher output and higher factor accumulation**

Output per worker



**Factors of production per worker**

# Development Accounting

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(Take note.)

# Productivity differences across the world are substantial

Country	Output per Worker, $y$	Physical Capital per Worker, $k$	Human Capital per Worker, $h$	Factors of Production, $k^{1/3}h^{2/3}$	Productivity, $A$
United States	1.00	1.00	1.00	1.00	1.00
Norway	1.12	1.32	0.98	1.08	1.04
United Kingdom	0.82	0.68	0.87	0.80	1.03
Canada	0.80	0.81	0.96	0.91	0.88
Japan	0.73	1.16	0.98	1.04	0.70
South Korea	0.62	0.92	0.98	0.96	0.64
Turkey	0.37	0.28	0.78	0.55	0.68
Mexico	0.35	0.33	0.84	0.61	0.56
Brazil	0.20	0.19	0.78	0.48	0.42
India	0.10	0.089	0.66	0.34	0.31
Kenya	0.032	0.022	0.73	0.23	0.14
Malawi	0.018	0.029	0.57	0.21	0.087

*Sources:* Output per worker: Heston, Summers, and Aten (2011); physical capital: author's calculations; human capital: Barro and Lee (2010). The data set used here and in Section 7.3 is composed of data for 90 countries for which consistent data are available for 1975 and 2009.

# TFP differences across the world

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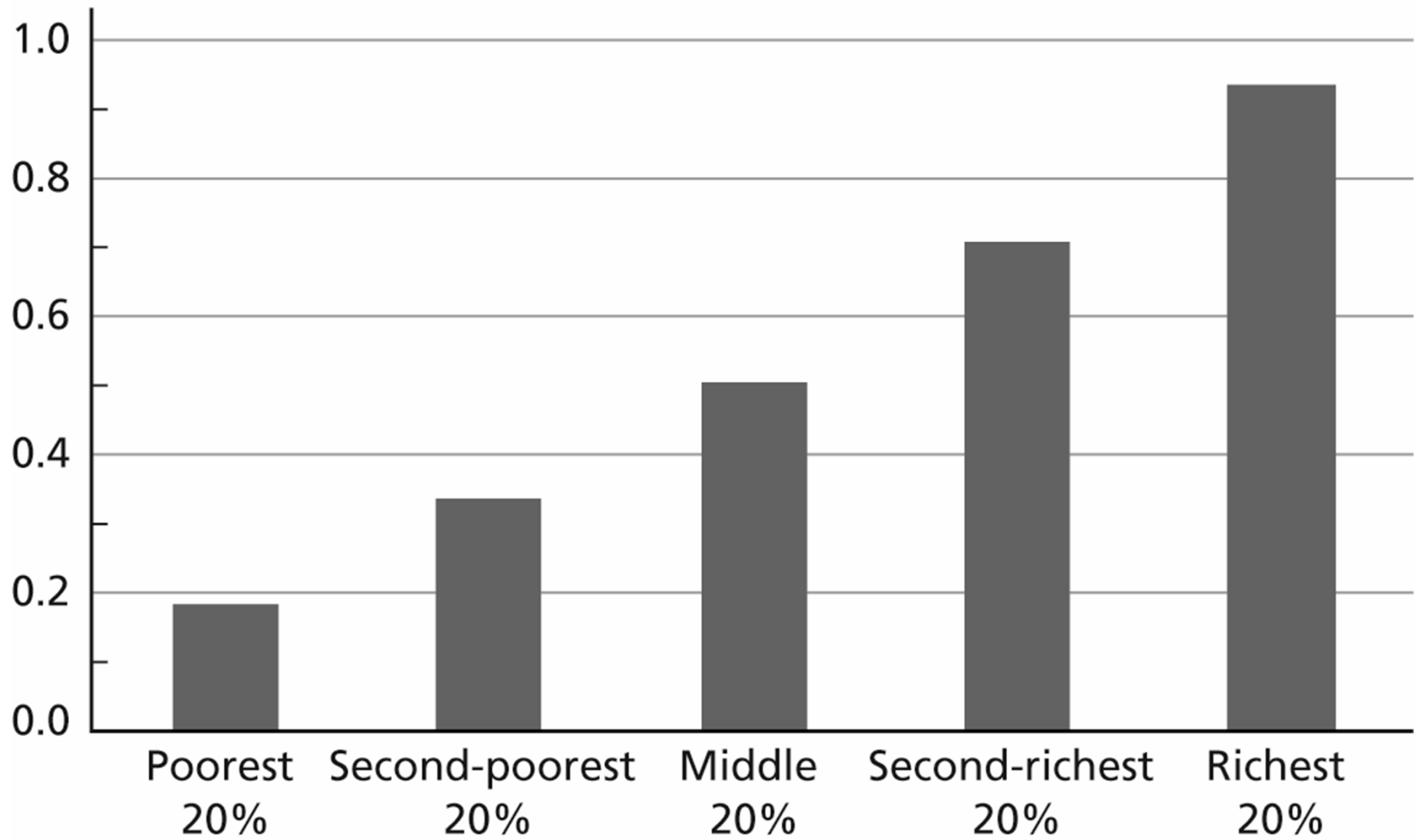
1. Lower income in Canada (compared to USA) is mainly due to lower productivity.
2. Even if South Korea had the same quantity of factors, its income would be 64% that of the USA.
3. Canada and the UK have similar income levels. But Canada has more factors. The UK is thus more productive.

# Explaining world income differences

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- What is more important to explain income differences:
  - Capital accumulation?
  - Productivity?

## Factors of production per worker relative to U.S.

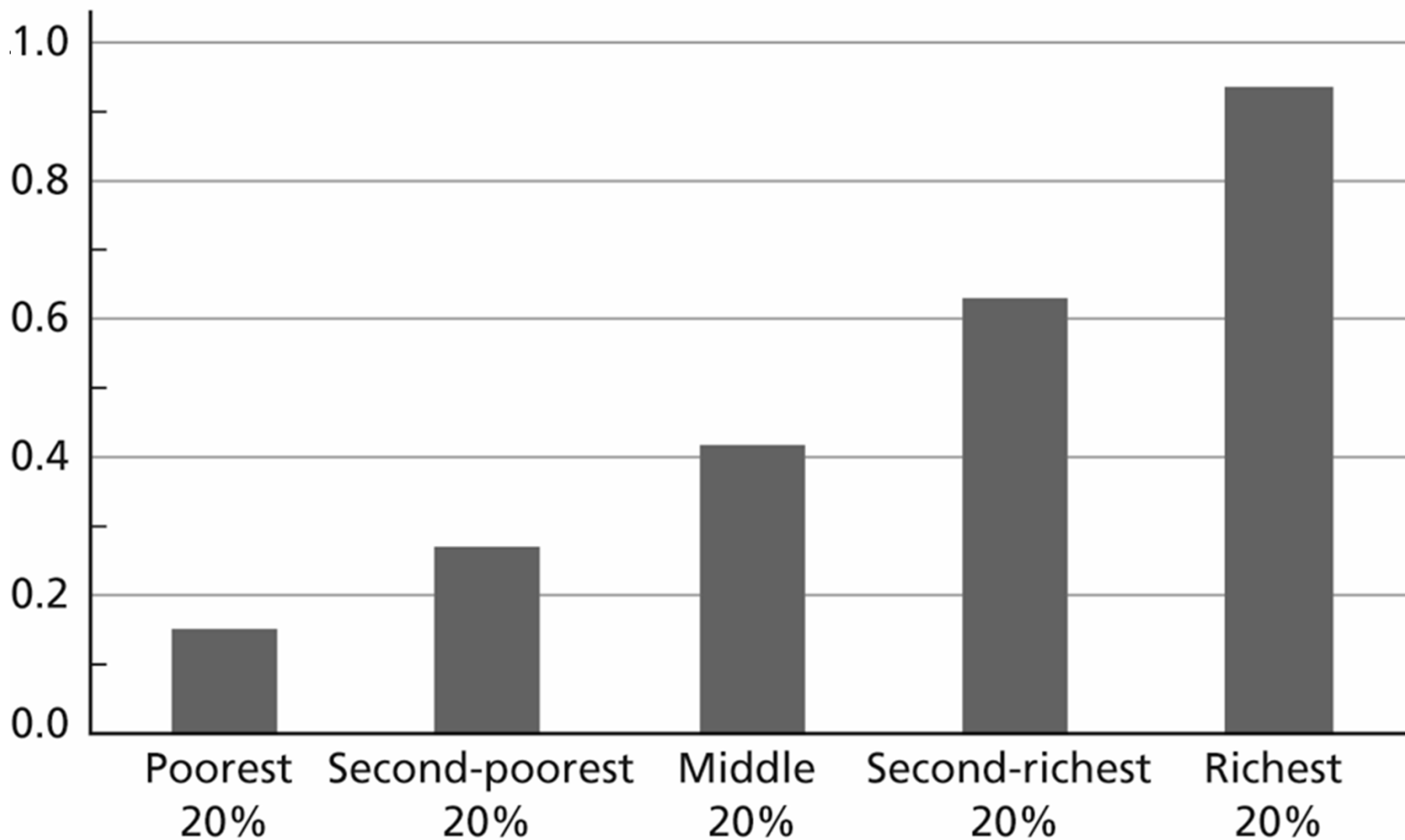


# Explaining income differences thru factor accumulation

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- The richest quintile has 94% of the USA level on average.
  - If productivities were the same, richest quintile's per capita income would be 94% that of the USA.
- The lowest quintile has 19%.
  - If productivities were the same, poorest quintile's per capita income would be 19% that of the USA.

## Productivity relative to U.S.





# Explaining income differences thru productivity

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- The richest quintile has 94% of the USA level on average.
  - If factor accumulations were the same, richest quintile's per capita income would be 94% that of the USA.
- The lowest quintile has 15%.
  - If factor accumulations were the same, poorest quintile's per capita income would be 15% that of the USA.
- Note how similar the numbers are per group between both productivity and factor accumulation.

# Explaining world income differences among middle-income countries

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- A typical mid-income country:
  - Factor accumulation: 51% wrt USA
  - TFP: 41% wrt USA
  - $51\% \times 41\% = 21\%$  of USA income
- For mid-income countries, factor accumulation and productivity both play important roles in explaining why they are poorer.

# Explaining world income differences

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- Both figures yield a similar picture: Both factor accumulation and TFP increase at similar rates when going from poorest to richest countries.
- More sophisticated analysis suggests that
  - 47% of overall world income differences are due to factor accumulation differences.
  - 53% are due to TFP differences.

# Accounting

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- With development accounting, we were able to separate the contributions of productivity and factor accumulation in explaining income level differences. (X-section)
- But present levels are the result of past growth.
- It is equally important to determine what part of a country's total growth is due to
  1. Productivity growth
  2. Factor accumulation

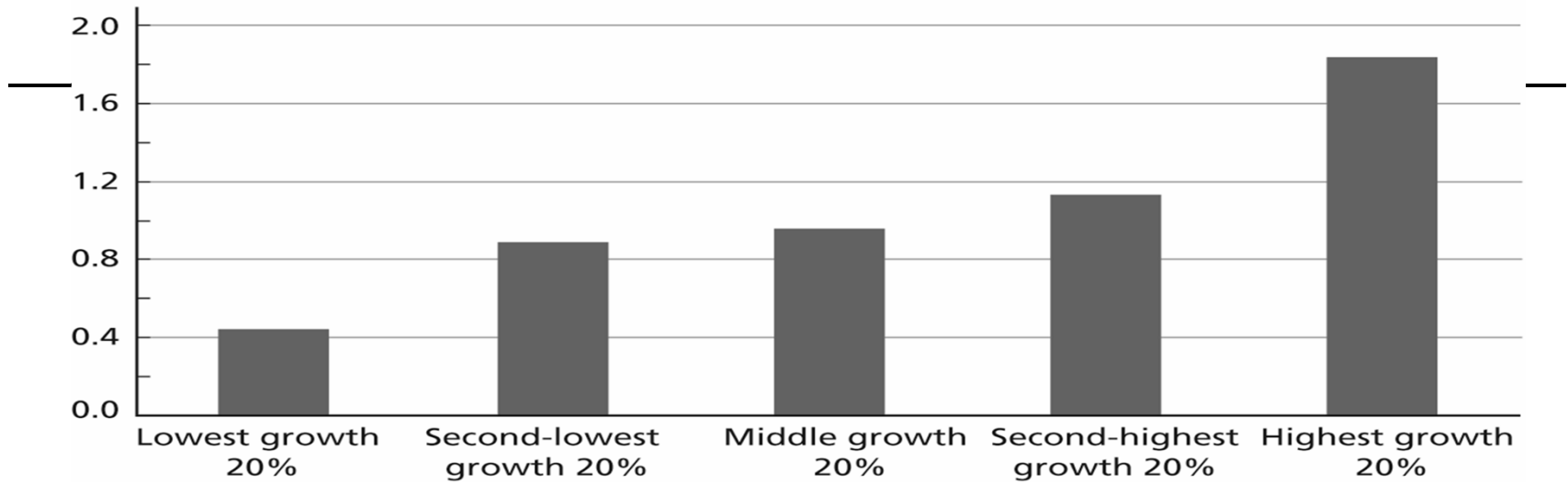
# Growth Accounting

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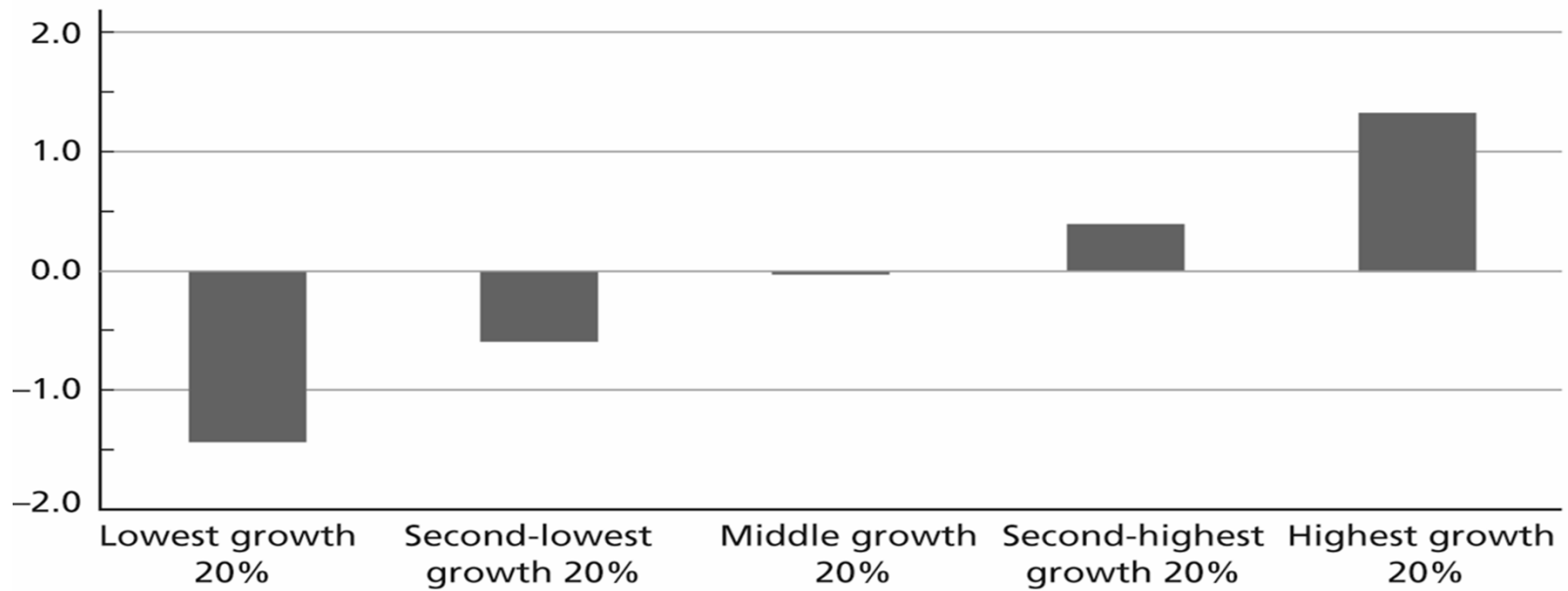
(Take note.)

# 1975-2009

**Growth rate of factors of production (% per year)**



**Growth rate of productivity (% per year)**



# Growth Accounting

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- The positive correlation suggests that both elements are important in explaining economic growth.
- Note the negative productivity growth for the 2 lowest income growth group.
- For highest growth countries, factor-based growth equals 1.83% per year on average.
- For lowest growth countries, factor-based growth equals 0.43% per year on average.
- The factor-based growth gap between lowest and highest growth countries is 1.4% per year.
- The productivity based gap is much higher at 2.75%

# Growth accounting

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- Eye inspection suggests that both elements are important to explain economic growth, just as found with development accounting.
- Productivity growth is a more important source of differences in output growth rates.
- According to more sophisticated estimations:
  - 68% of world differences in per capita income growth are due to differences in productivity growth.
  - Leaving 32% caused by factor accumulation.



# Case Study: Singapore v. Hong Kong

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- ❑ From 1960 to 1996, both cities had high growth of per capita income of 6 to 7%.
- ❑ Due to their similarity, one is tempted to conclude that those high growth rates have the same origins.
- ❑ Young (1995) estimated productivity growth through growth accounting:
  - HK: 2.3%
  - Singapore: 0.2%
- ❑ Singapore's growth would be based almost entirely on capital accumulation. Solely in physical capital, investment rate reached up to 40% of GDP at some point.
- ❑ It suggests that growth will slow down sharply due to diminishing returns to capital.

# Conclusion

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- We have seen
  - How productivity can differ between countries in both levels and growth.
  - Up to what point those differences explain differences in income levels and total income growth.
- We have argued that productivity can only be measured as a  
residual
- i.e. what is left after accounting for factor accumulation. Hence, in the 50s, it has been termed  
the measure of our ignorance

# Conclusion

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We now would like to explain why productivity differs:

- ❑ What determines technological progress?
- ❑ What affects production efficiency?
- ❑ Which is most important in explaining productivity differences between countries?