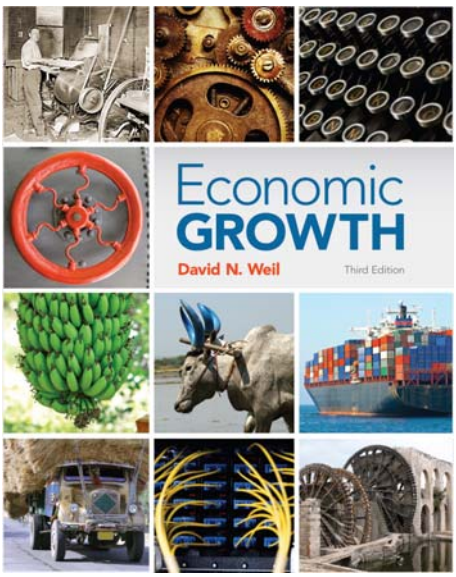
Chapter 7

MEASURING PRODUCTIVITY



Groups for presentations

13 dec
Laszlo, Paulina, Kinga, Giulia
Public Administration

19
Jole , Matteo and Tim
Green economy

18
Valentina, Riccardo, Pawel, Davide, Byliana
Labor market and skills

19
Alessandro, Paola, Pauline and Mateusz
Social protection and cohesion.

Figure 7.1 Possible Sources of Differences in Output per Worker

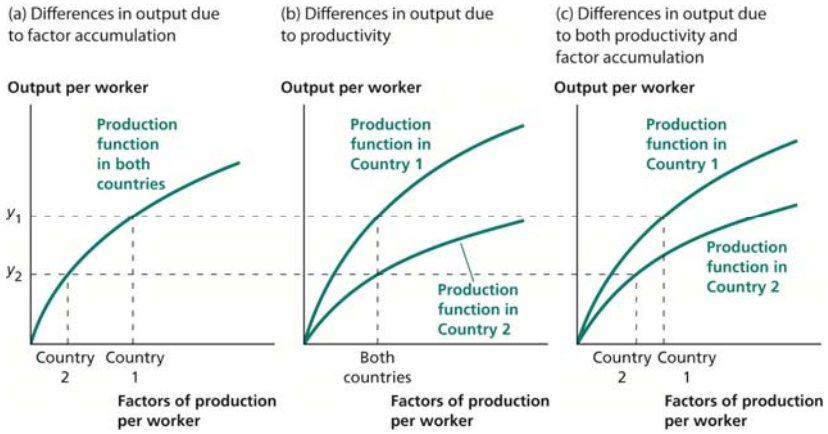
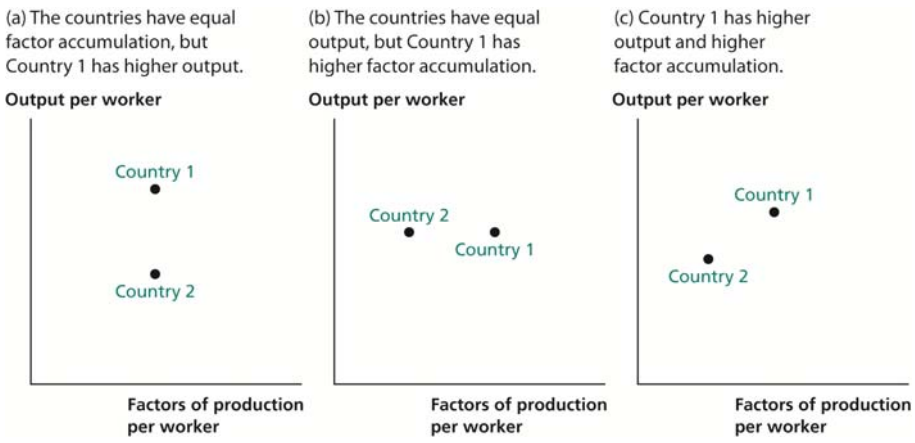


Figure 7.2 Inferring Productivity from Data on Output and Factor Accumulation



productivity accounting

Ratio of output=

Ratio of productivity * Ratio of factors of production

Ratio of productivity=

Ratio of income/Ratio of factors of production

Table 7.1 Data Used to Analyze Productivity in Country 1 and Country 2

	Output per Worker, *y*	Physical Capital per Worker, *k*	Human Capital per Worker, *h*
Country 1	24	27	8
Country 2	1	1	1

Table 7.2 Development Accounting

Country	Output per Worker, y	Physical Capital per Worker, k	Human Capital per Worker, h	Factors of Production, $k^{\alpha}h^{\alpha}$	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	0.86	0.87	0.80	1.03
Canada	0.80	0.91	0.96	0.91	0.88
Japan	0.73	1.15	0.98	1.04	0.70
South Korea	0.62	0.92	0.98	0.96	0.64
Turkey	0.37	0.26	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.

Problems with measuring capital and implications

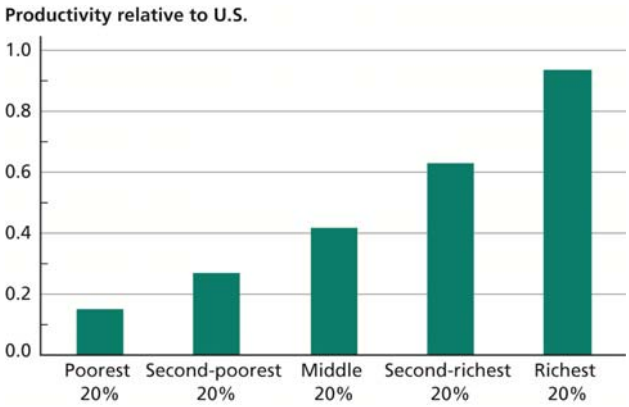
- Waste of investment
- Quality of investment

- There are estimate according to which the actual level of the capital stock is in between 60% to 75% of the official statistics…

Figure 7.3 Role of Factors of Production in Determining Output per Worker, 2009

For sources, see Table 7.2.

Figure 7.4 Role of Productivity in Determining Output per Worker, 2009



For sources, see Table 7.2.

Growth accounting

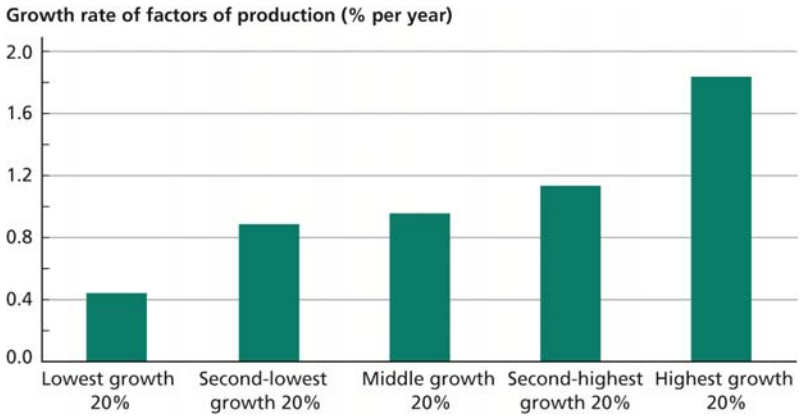
Output =productivity*factors of production

Output growth rate =
Productivity growth rate + growth rate of factors of production

The growth rate of factors of productions has to be weighted with respect to their share on output

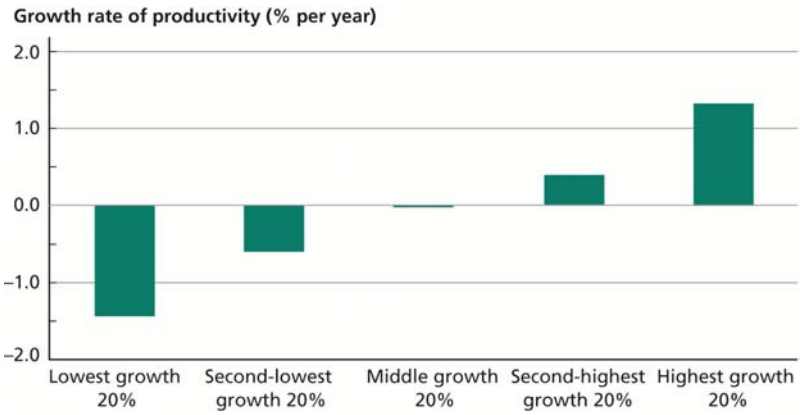
Productivity growth rate=
Output growth rate – growth rate of factors of production

Figure 7.5 Role of Factors of Production in Determining Growth, 1975–2009



For sources, see Table 7.2.

Figure 7.6 Role of Productivity in Determining Growth, 1975–2009



For sources, see Table 7.2.

Chapter 8

THE ROLE OF TECHNOLOGY IN GROWTH

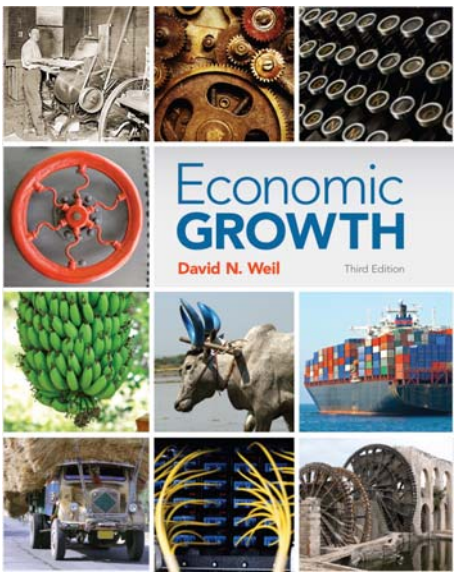
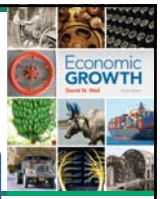


Table 8.1 Researchers and Research Spending, 2009

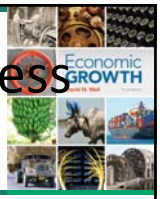


And Italy?

Country	Number of Researchers	Researchers as a Percentage of the Labor Force	Research Spending ($ billions)	Research Spending as a Percentage of GDP
United States	1,412,639	0.89%	398.2	2.8%
Japan	655,530	1.00%	137.9	3.4%
Germany	311,519	0.74%	82.7	2.8%
France	229,130	0.80%	48	2.2%
Korea	236,137	0.96%	43.9	3.3%
OECD Total	4,199,512	0.70%	965.6	2.4%

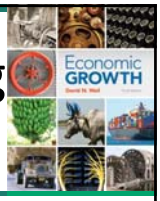
Source: OECD Main Science and Technology Indicators database.

The nature of technological progress



- Technology creation
- Technology transfer or diffusion
  - Non rivarly
  - Non excludability

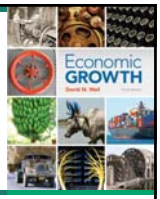
Determinants of R&D spending



- Profit considerations
  - How much advantage with respect to followers
  - Size of the market
  - How long does the advantage last
  - Uncertainty

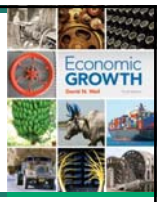
Concept of creative distruction

One country model



- Labour is the only factor
- Which can be used either in production or in the R&D
- $L = (L_Y + L_A)$
- γ_A is the quota of labour used in R&D…
- Its function is similar to the saving rate in the Solow model

Production function

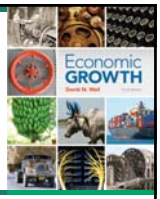


- Production function
- $Y=A(1-\gamma_A)L$

or in per worker terms

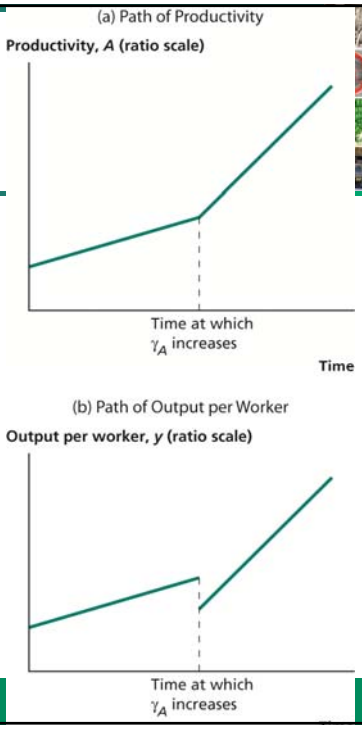
- $y=A(1-\gamma_A)$

Process of productivity growth



- Growth of $A = L_A/\mu$
- where μ represents the price/cost of the new invention
- The growth rate of A represents the growth rate of y

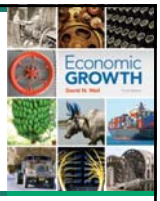
Figure 8.1 Effect of Shifting Labor into R&D



Two country model/1

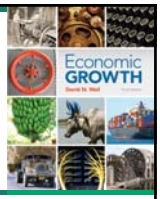
- γ and μ are now different among countries
- One country invests more in R&D and it is the leader (country 1) the other one is the follower (country 2)
- $Y_1=A_1(1-\gamma_{A1})L_1$ …. $y_1=A_1(1-\gamma_{A1})$
- $Y_2=A_2(1-\gamma_{A2})L_2$ …. $y_2=A_2(1-\gamma_{A2})$
- where $\gamma_{A1} > \gamma_{A2}$

Two country model/2



- Country 1 invents and innovates
- Country 2 imitates and/or does incremental innovation
- $\hat{A}_1 = (\gamma_{A1}/\mu_i)L$ where μ_i is the cost of invention
- μ_c is the cost of copying for country 2 and it is given by a function of A_1/A_2
- $\mu_c = c(A_1/A_2)$ and $\hat{A}_2 = (\gamma_{A2}/\mu_c)L_2$

Figure 8.2 Cost of Copying for the Follower Country



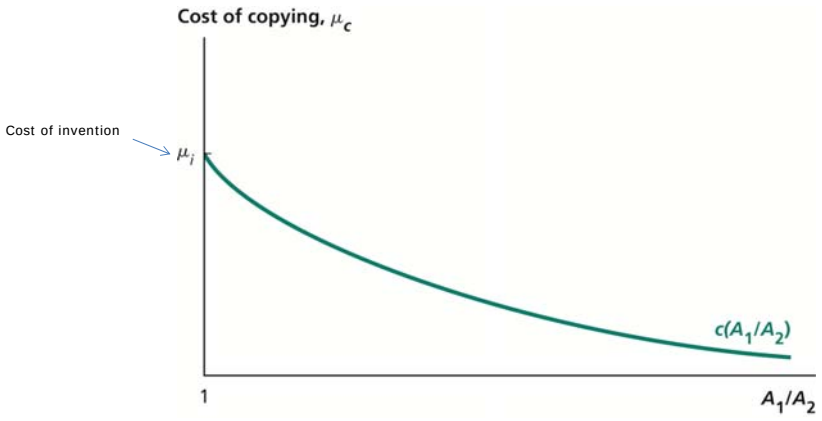
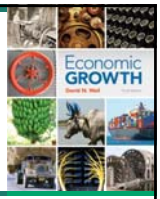
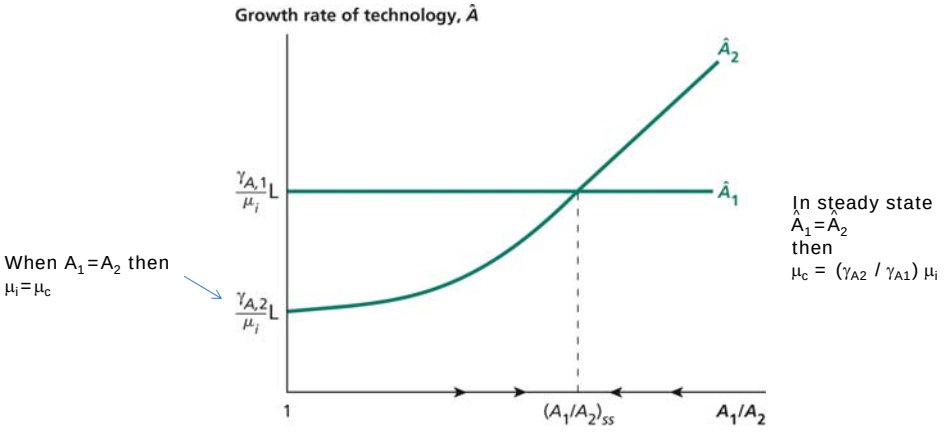


Figure 8.3 Steady State in the Two-Country Model

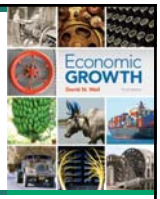




When $A_1 = A_2$ then $\mu_i = \mu_c$

In steady state $\hat{A}_1 = \hat{A}_2$ then $\mu_c = (\gamma_{A2} / \gamma_{A1})\, \mu_i$

Figure 8.4 Effect of an Increase in R&D in the Follower Country on the Steady State



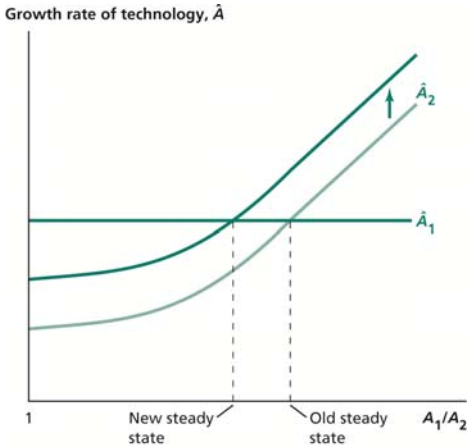
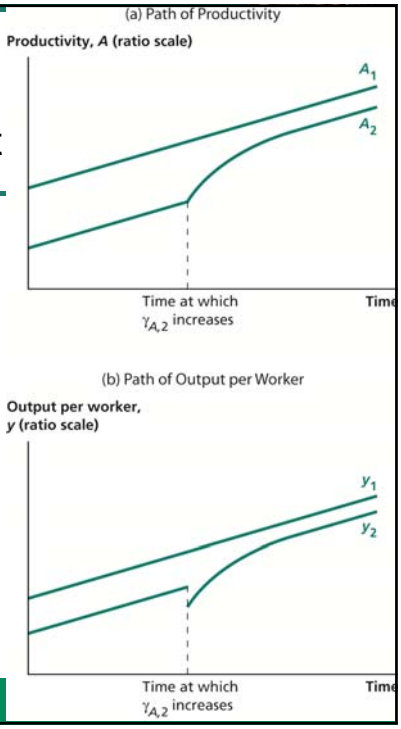
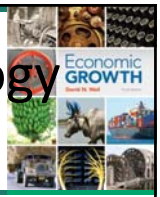


Figure 8.5 Effect of an Increase in $\gamma_{A,2}$ on Productivity and Output

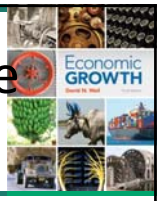


Barriers to international technology transfer



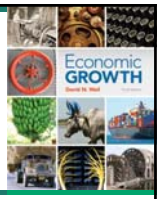
- Appropriate technology
- Tacit knowledge
- Patents and other tools to appropriate R&D returns

Increasing returns to knowledge accumulation



- Let us take the example of tacit knowledge and of local public good
- …then there might be increasing returns at the local level
- ..and the world (made of rich and poor countries) would be diverging rather than moving at the same speed

Figure 8.6 Neutral Technological Change



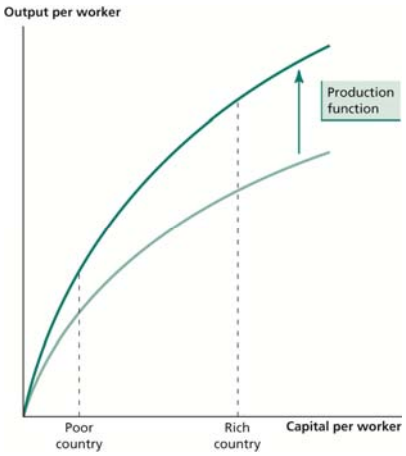
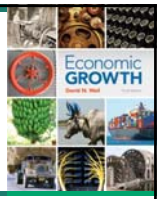
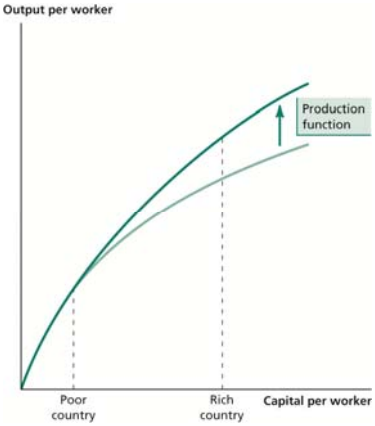


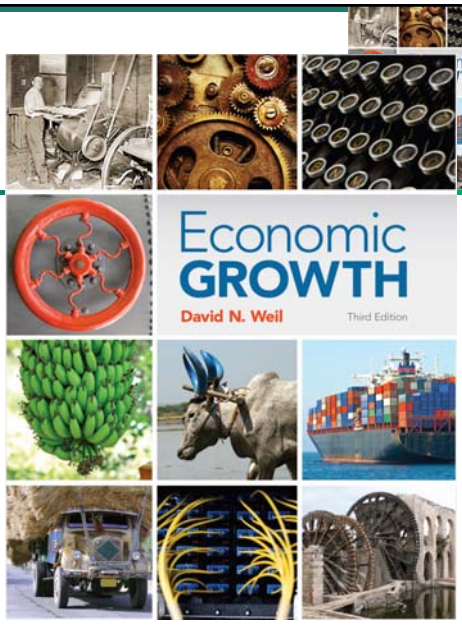
Figure 8.7 Capital-Biased Technological Change





Chapter 9

THE CUTTING EDGE OF TECHNOLOGY



Chapter 10

EFFICIENCY

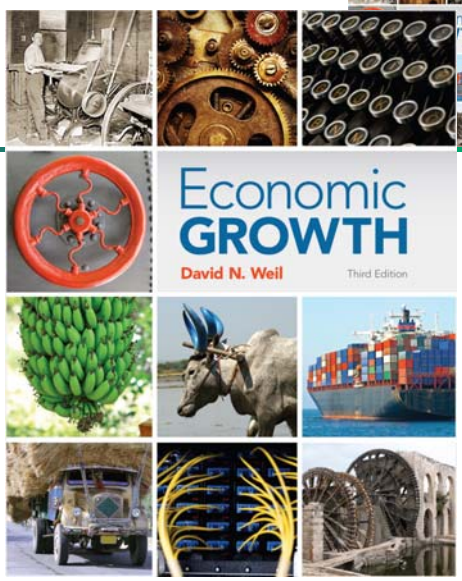
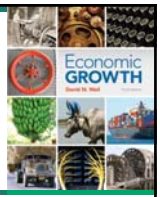


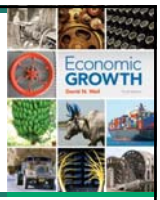
Table 10.1 Decomposition of Productivity Gap Between India and the United States

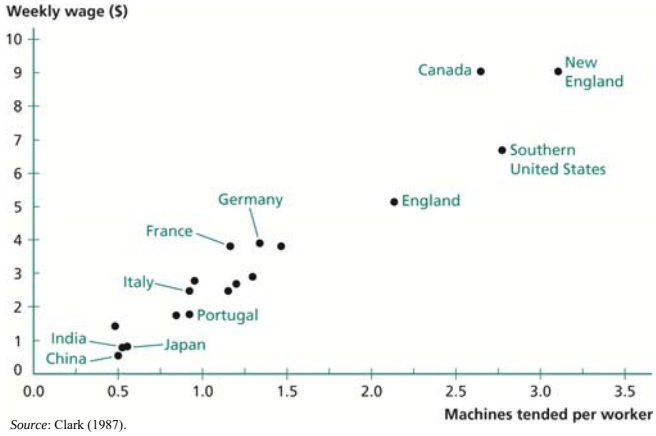
$A = T * E, \qquad A_{india}/A_{usa} = 0.35$



Years India Lags United States in Technology (*G*)	Level of Technology in India Relative to United States (*T*)	Level of Efficiency in India Relative to United States (*E*)
10	0.95	0.33
20	0.90	0.35
30	0.85	0.36
40	0.81	0.38
50	0.76	0.41
75	0.67	0.46
100	0.58	0.53
125	0.51	0.61

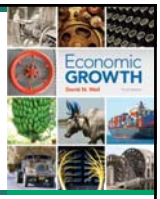
Figure 10.1 Wages and Machines in the Textile Industry, 1910





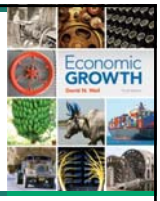
Source: Clark (1987).

Table 10.2 Productivity in Selected Industries in the Early 1990s



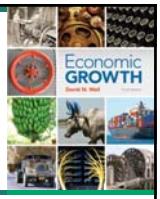
	United States	Japan	Germany
Automobiles	100	127	84
Steel	100	110	100
Food Processing	100	42	84
Telecommunications	100	51	42
Aggregate Productivity	100	67	89

Types of inefficiencies



- Unproductive activities
  - Rent seeking phenomena (licences)
- Idle resources
  - Unemployment
  - Under participation to labour force
- Misallocation of factors among sectors and firms
  - Barriers to mobility
  - Wages not equal to marginal product

Figure 10.3 Efficient Allocation of Labor between Sectors



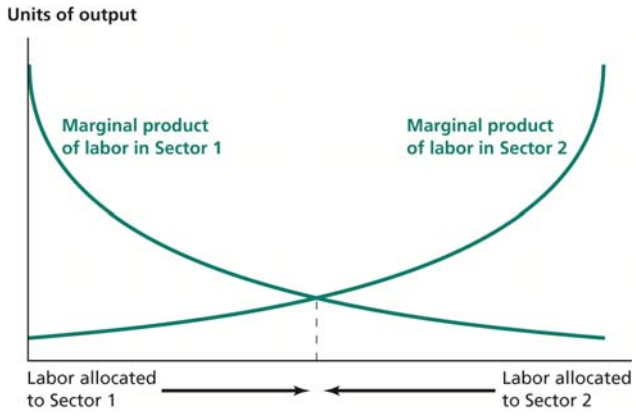


Figure 10.4 Overallocation of Labor to Sector 1

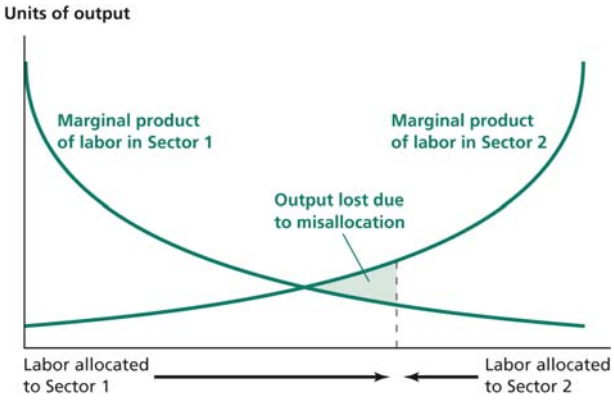
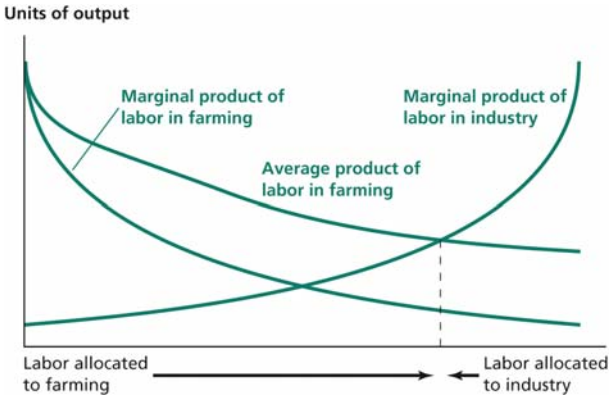


Figure 10.5 Overallocation of Labor to Farming When Farmworkers Are Paid Their Average Product



Chapter 11

GROWTH IN THE OPEN ECONOMY

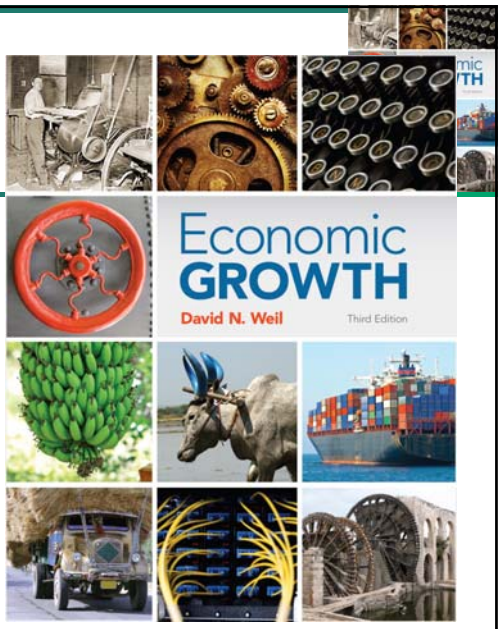
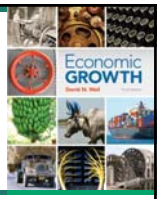
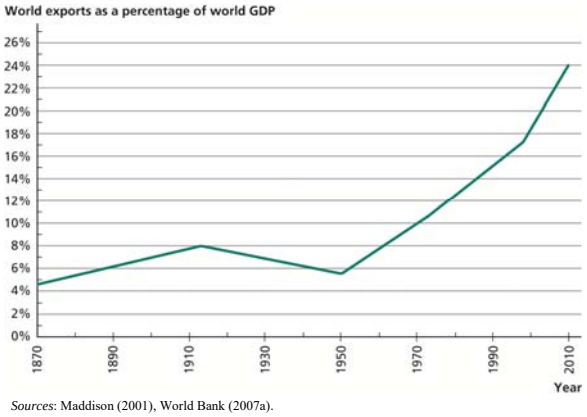


Figure 11.1 Growth of World Trade, 1870–2010

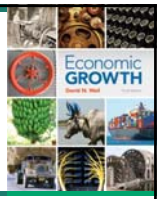


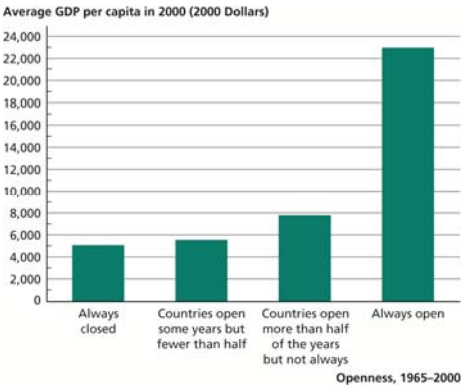
Thanks to:
- Decreasing transport costs
- Easier diffusion of information
- Trade policy



Sources: Maddison (2001), World Bank (2007a).

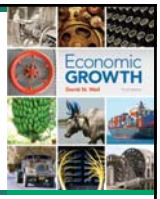
Figure 11.2 Relationship between Economic Openness and GDP per Capita

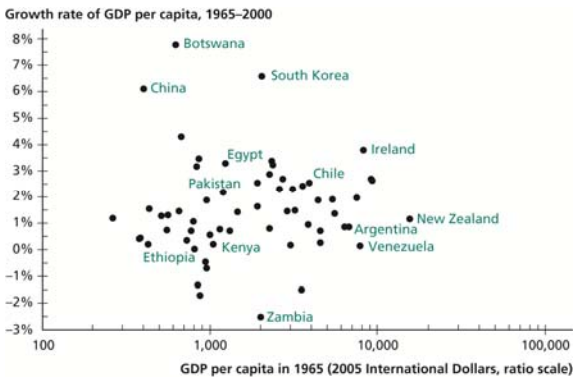




Sources: Sachs and Warner (1995), Wacziarg and Welch (2008).

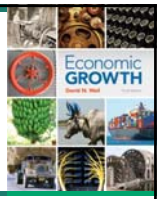
Figure 11.3 Growth in Closed Economies

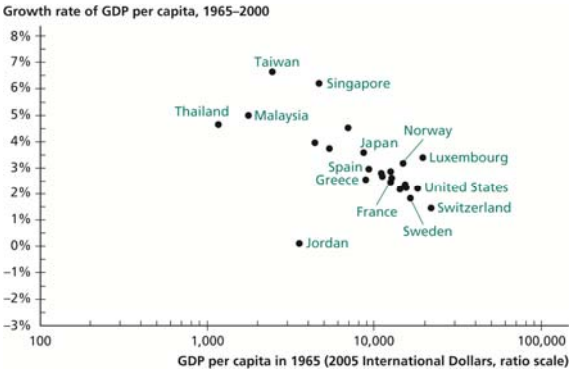




Sources: Sachs and Warner (1995), Wacziarg and Welch (2008), Heston et al. (2011).

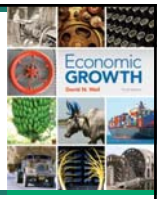
Figure 11.4 Growth in Open Economies





Sources: Sachs and Warner (1995), Wacziarg and Welch (2008), Heston et al. (2011).

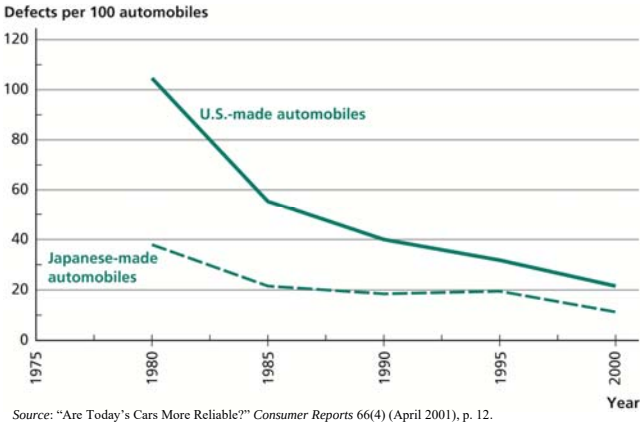
Table 11.1 Prices in Japan before and after Opening to Trade



	Price Before Opening (U.S. cents per pound)	Price After Opening (U.S. cents per pound)
Tea	19.7	28.2
Sugar	22.7	11.2

Source: Bhuber (1971).

Figure 11.6 Quality of U.S.- and Japanese-made Automobiles



Source: "Are Today's Cars More Reliable?" *Consumer Reports* 66(4) (April 2001), p. 12.

Effects of openess

- Specialisation
- More competition
- Better allocation of factors across countries
- …