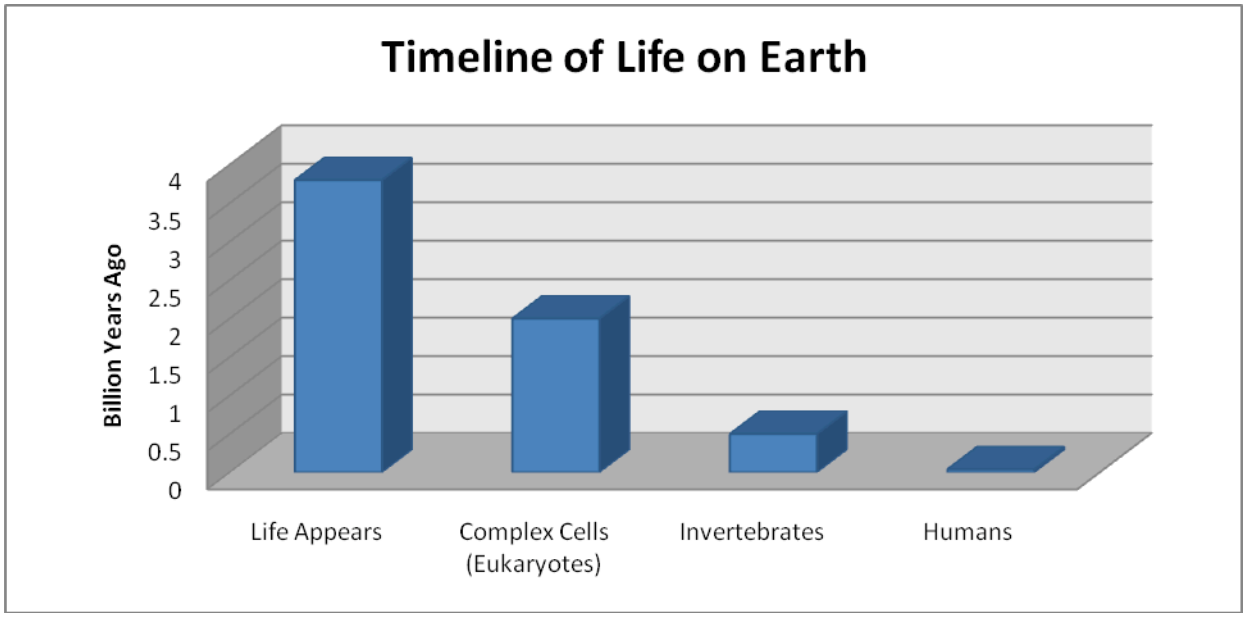
All Figures for Dr. Chichilnisky's Book:

Figure 1.1



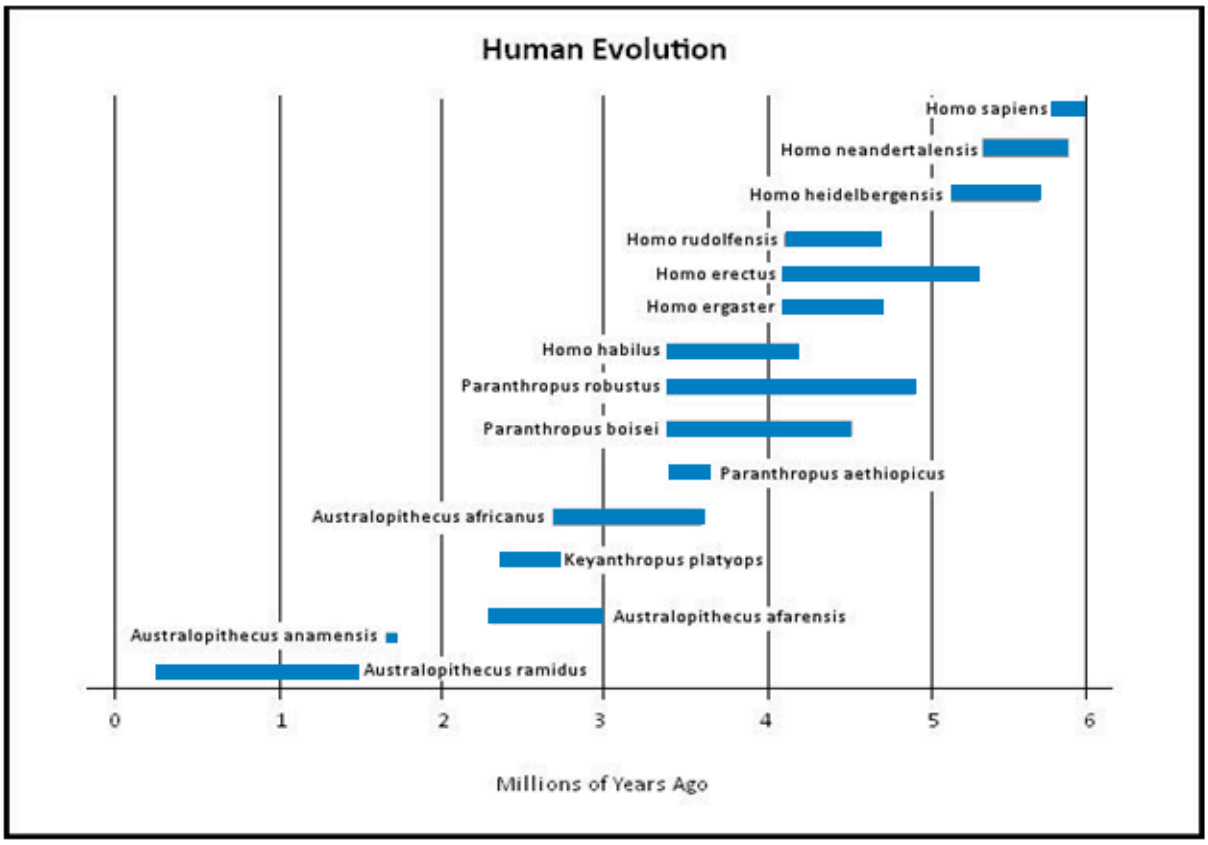


Figure 1.2a

Computer models match observed ΔT on all continents

Black lines are decadally averaged observations. Blue bands are computer models with natural forcings only. Pink bands are computer models with human + natural forcings.

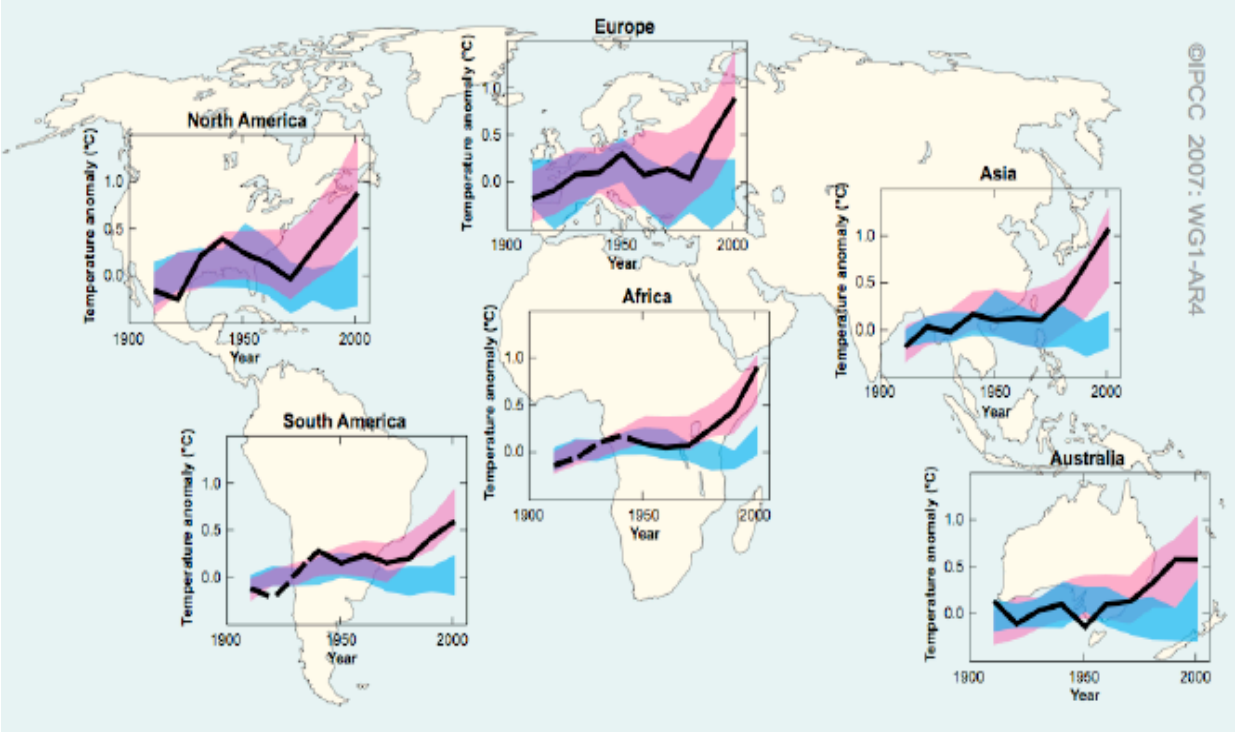
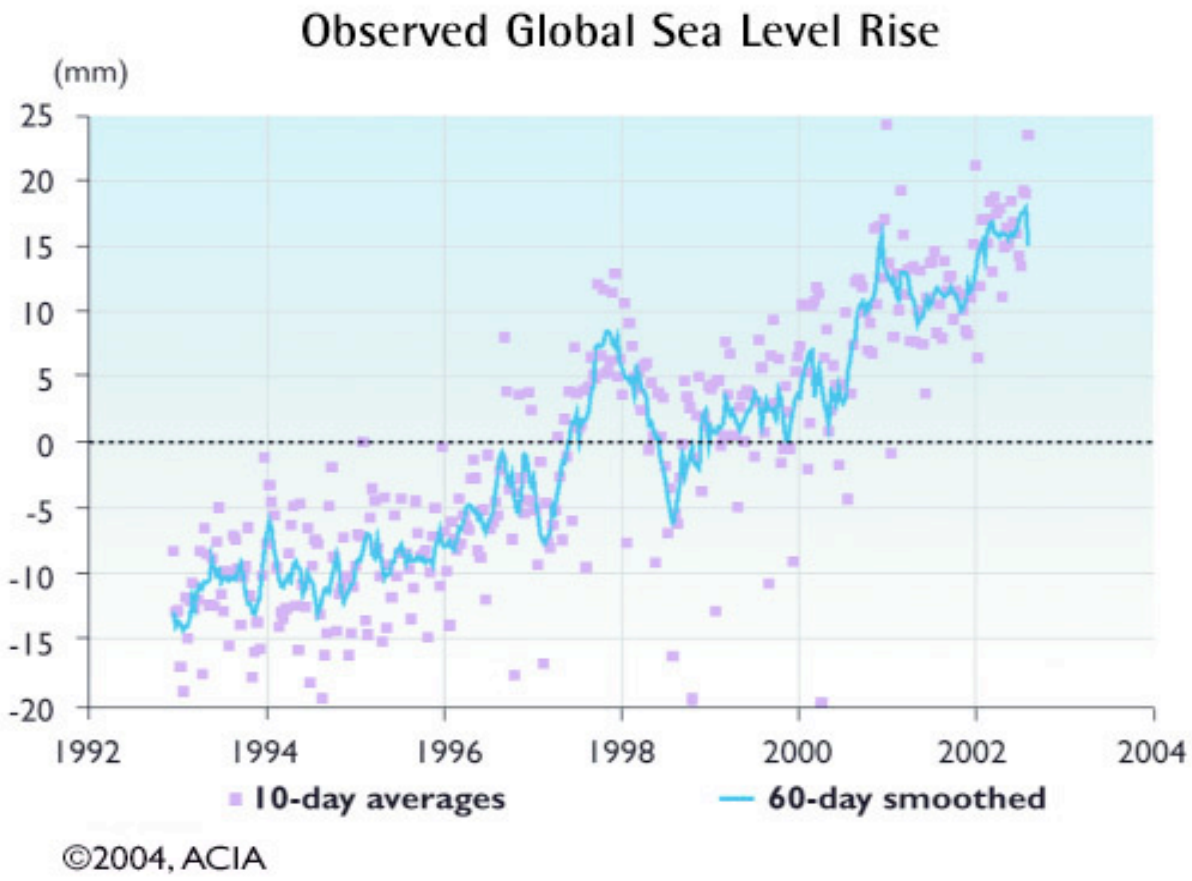


Figure 1.2b


Observed Global Sea Level Rise
(mm)
25
20
15
10
5
0
-5
-10
-15
-20
1992
1994
1996
1998
2000
2002
2004
10-day averages
60-day smoothed
©2004, ACIA

Box 1.2

SEA LEVEL RISE

A significant sea level rise is one of the major anticipated consequences of climate change (IPCC, 2007; UNEP 2007).

Global warming from increasing greenhouse gas concentrations is a significant driver of both contributions to sea-level rise. From 1955 to 1995, ocean thermal expansion is estimated to have contributed about 0.4 mm per year to sea level rise, less than 25 per cent of the observed rise over the same period. For the 1993 to 2003 decade, for which the best data are available, thermal expansion is estimated to be significantly larger, at about 1.6 mm per year for the upper 750 m of the ocean alone, about 50 per cent of the observed sea level rise of 3.1 mm per year. Scientists estimate the melting of glaciers and ice caps (excluding the glaciers covering Greenland and Antarctica) contributed to sea level rise by about 0.3 mm per year from 1961 to 1990 increasing to about 0.8 mm per year from 2001–2004.

Even for today's socio-economic conditions, both regionally and globally, large numbers of people and significant economic activity are exposed to an increase and acceleration of sea level rise. The densely populated megadeltas such as those of Ganges-Brahmaputra, Mekong and Nile are especially vulnerable to sea level rise. Some 75 per cent of the population affected live on the Asian megadeltas and deltas, with a large proportion of the remainder living on deltas in Africa. Globally, at least 150 million people live within 1 metre of high tide level, and 250 million live within 5 metres of high tide (UNEP, 2007).

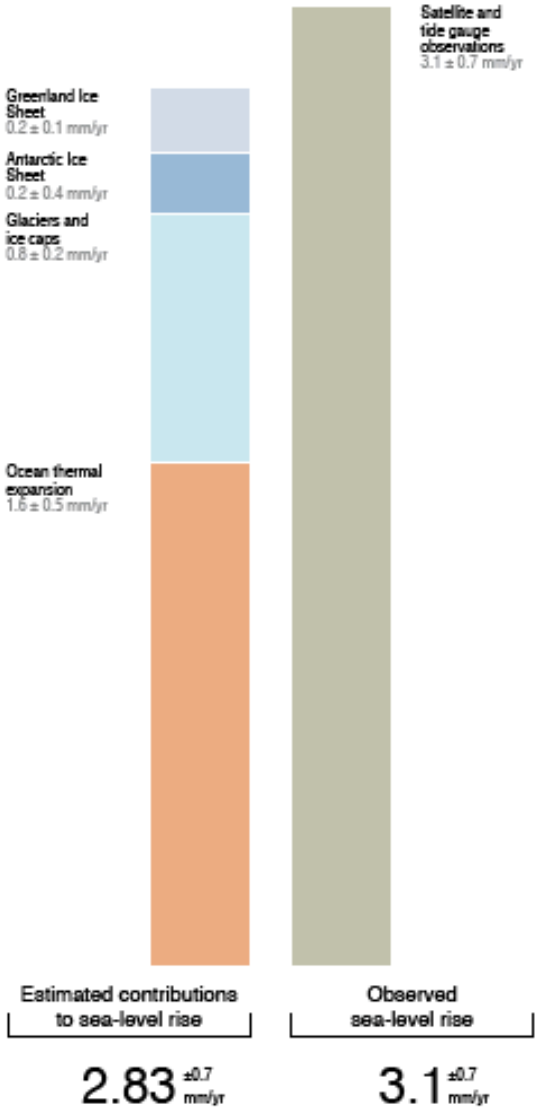


Figure 14. The projected and observed sea level rise. Observed sea level rise is currently larger than that projected by current climate models. The bar to the left also shows the contribution of different factors to sea level rise, the two most important being a) thermal expansion of ocean waters as they warm, and b) increase in the ocean mass, principally from land-based sources of ice (glaciers and ice caps, and the ice sheets of Greenland and Antarctica).

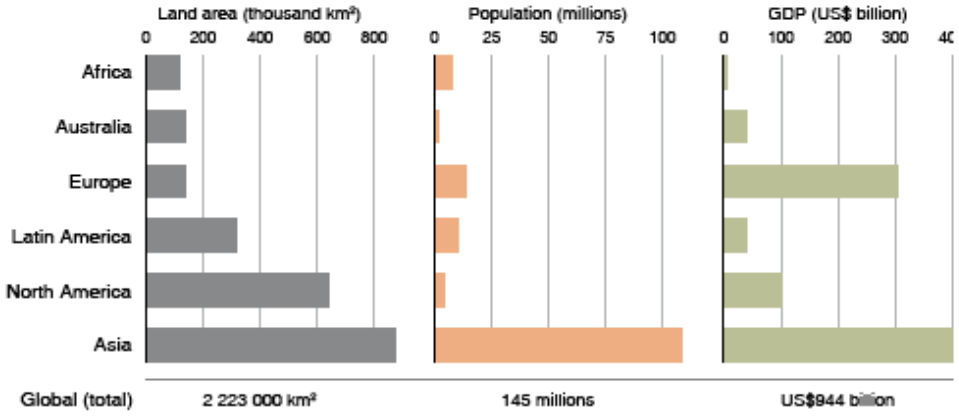


Figure 16. Land area, number of people impacted and projected economic losses from a 1 metre uniform sea level rise in different regions (Anthoff *et al.*, 2006; UNEP, 2007).

Figure 1.2c

Sea ice is receding

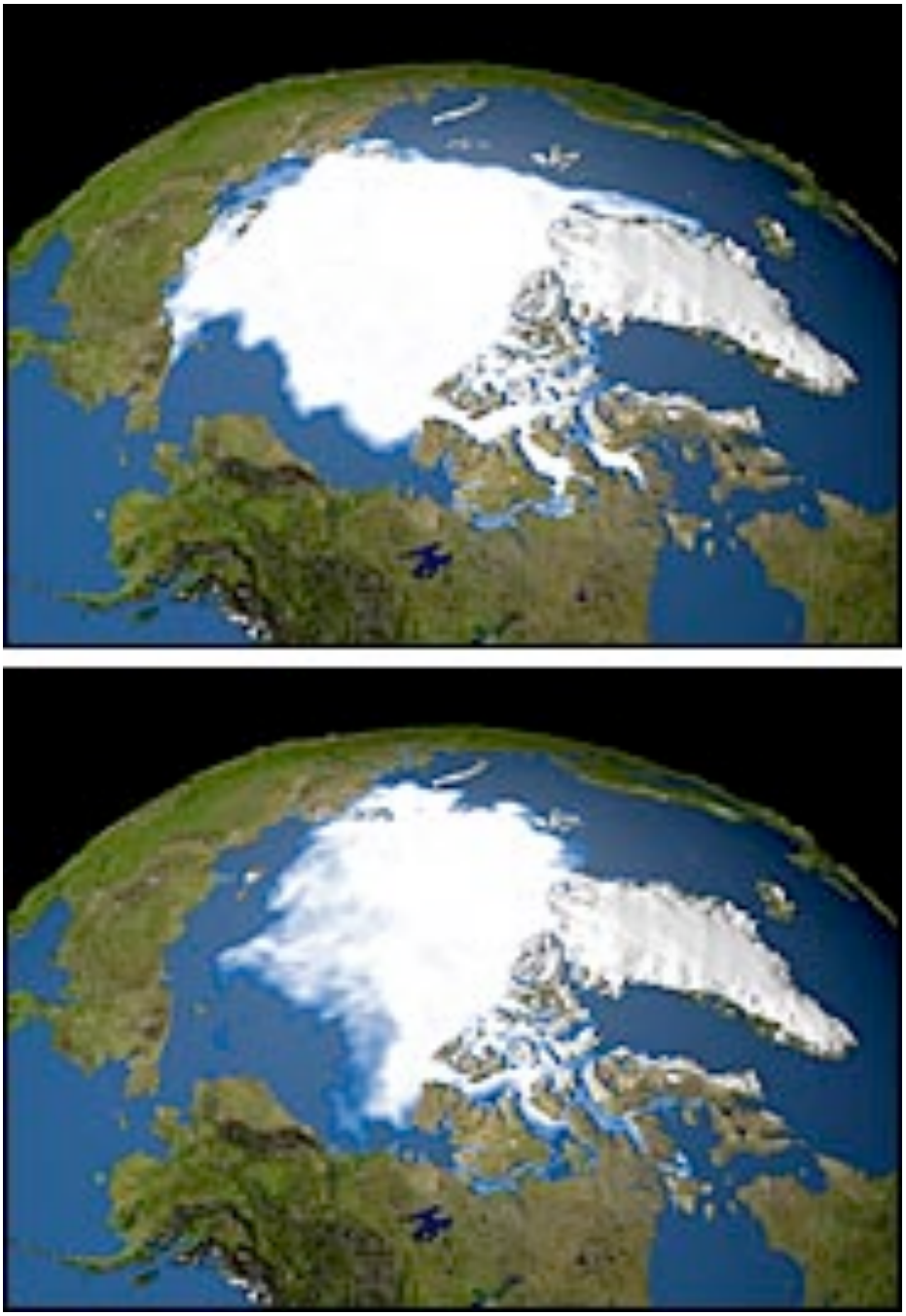


Figure 1.2d


Coastal glaciers are retreating
Muir Glacier, Alaska, 1941-2004
August 1941
August 2004

Figure 1.2e

Harm is already occurring (continued)

Total power released by tropical cyclones (green) has increased along with sea surface temperatures (blue).

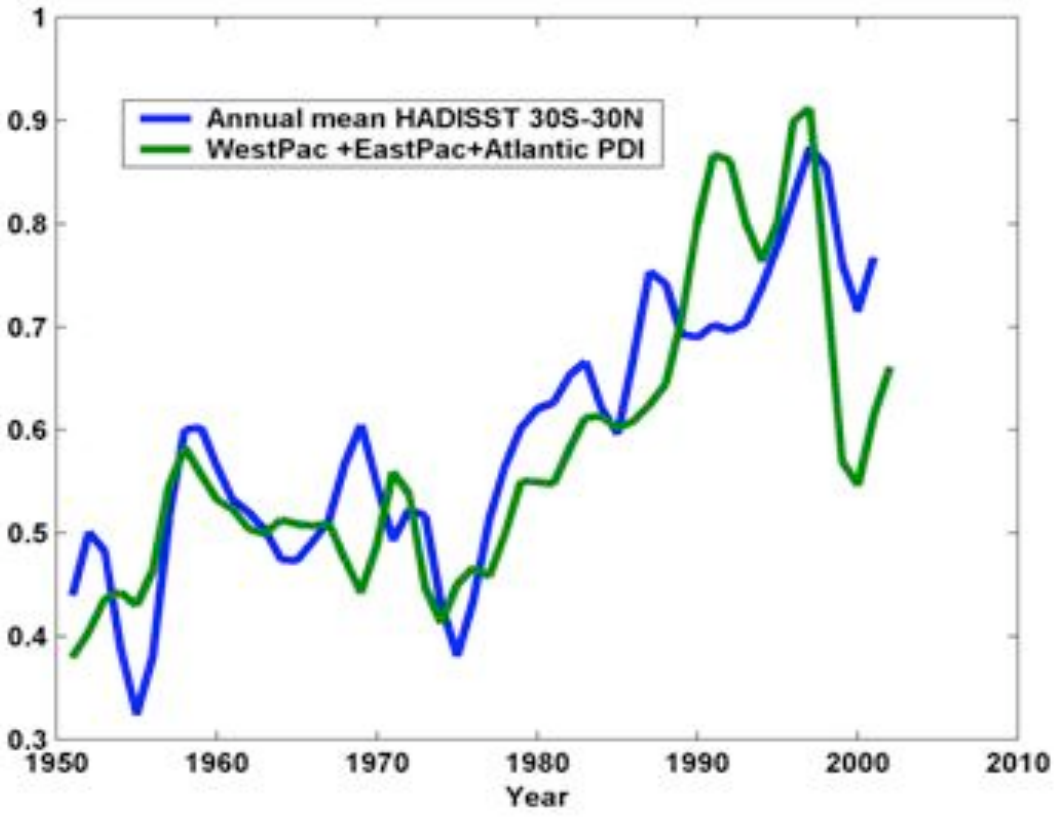


Figure 1.2f

Appendix Figure A.7. Number of Flood Events by Continent and Decade Since 1950
(C16, Fig 16.6)

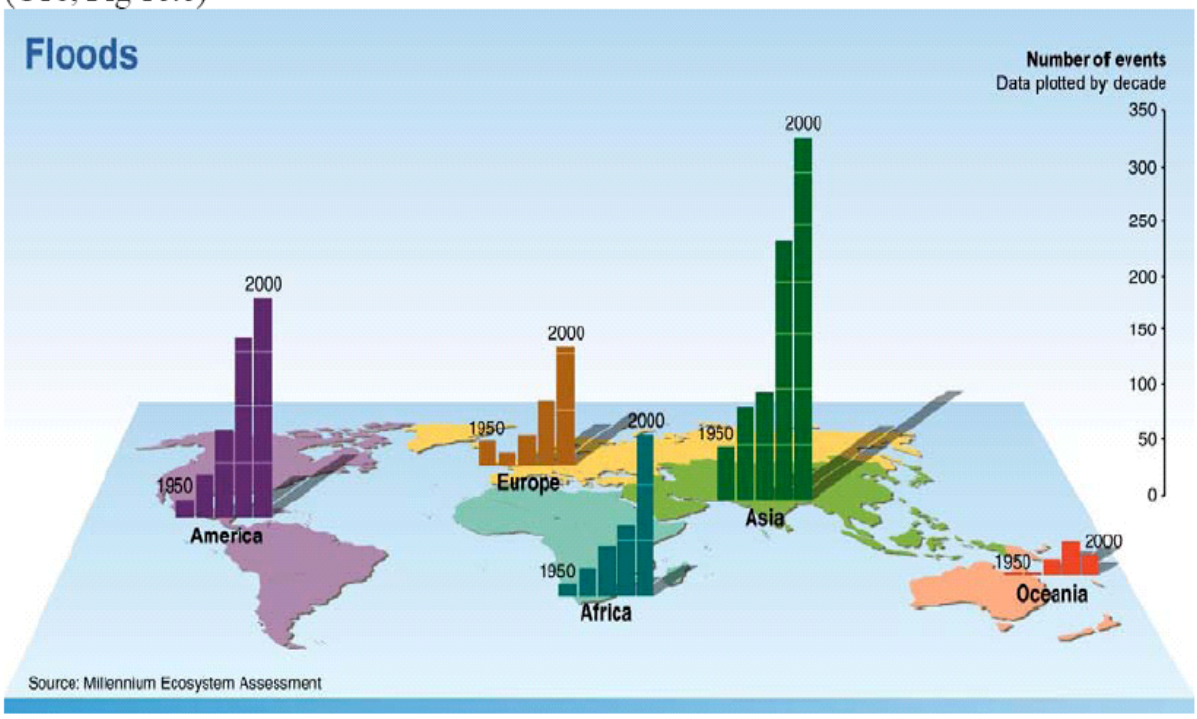


Figure 1.2g

Appendix Figure A.8. Number of Major Wild Fires by Continent and Decade Since 1950 (C16, Fig 16.9)

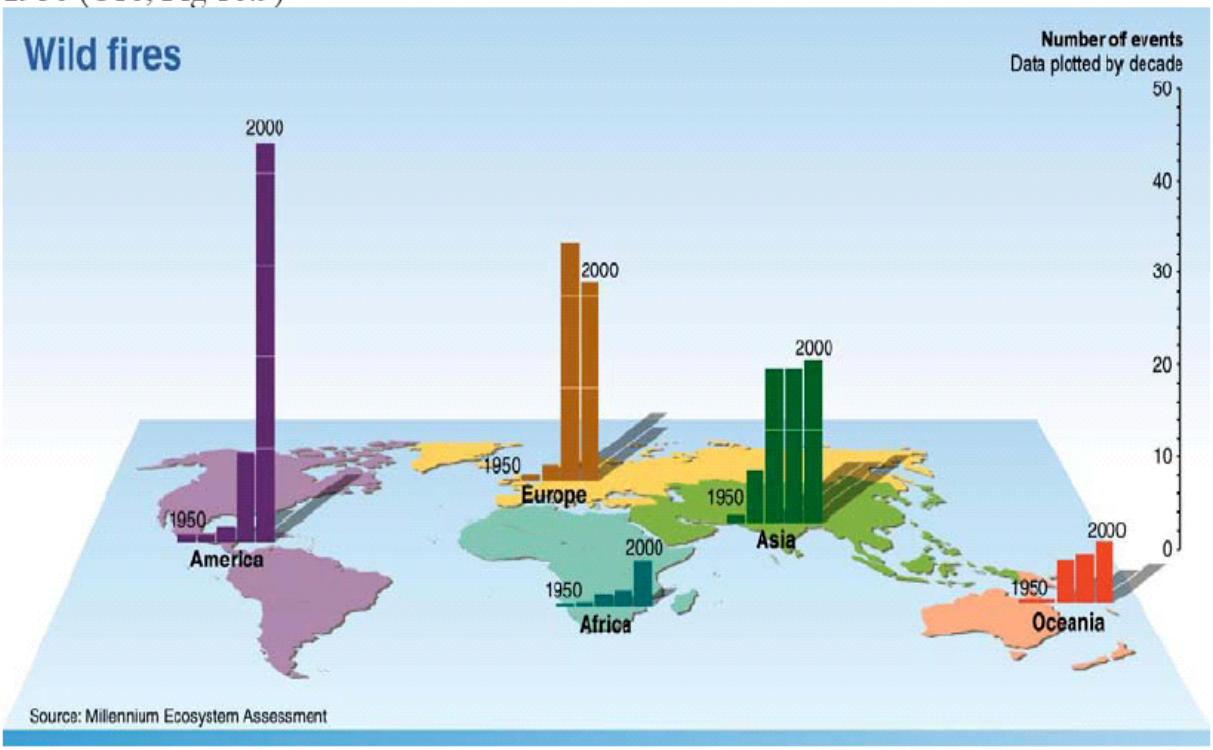


Figure 1.2h

Where we're headed: temperate-zone agriculture

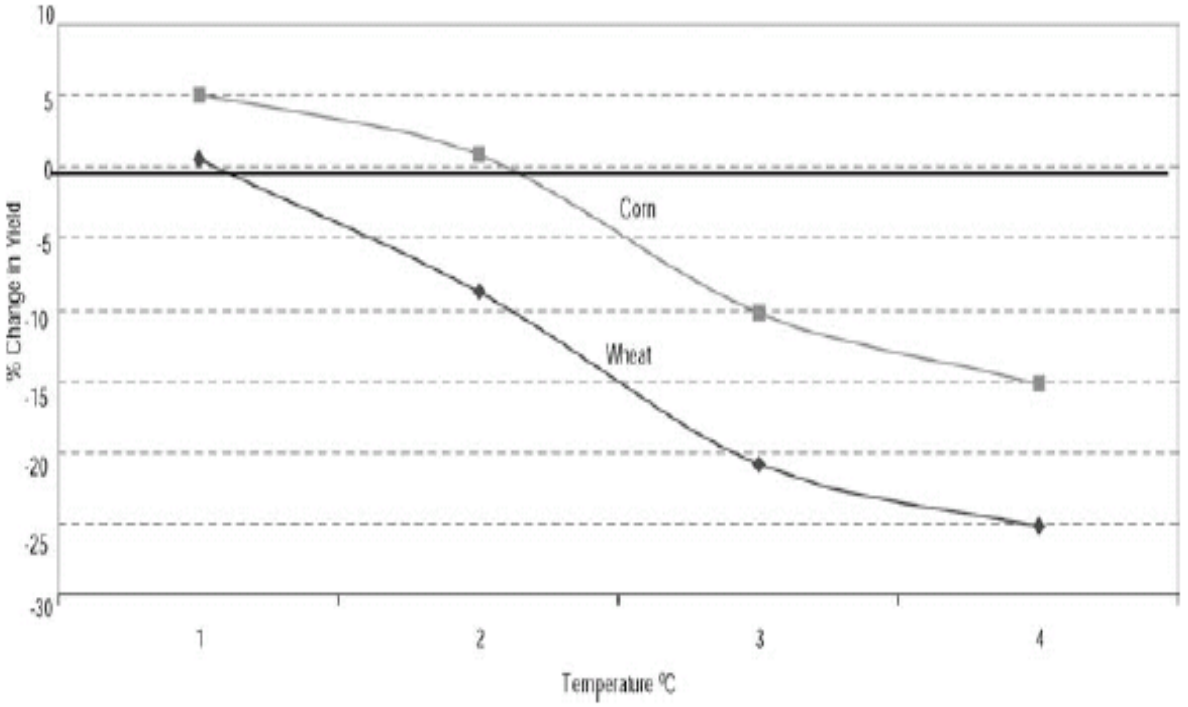


Figure 2. Corn and Wheat yields versus temperature increase in the temperate zone averaged across 30 crop modeling studies. All studies assumed a positive change in precipitation. CO_2 direct effects were included in all studies.

Figure 1.3

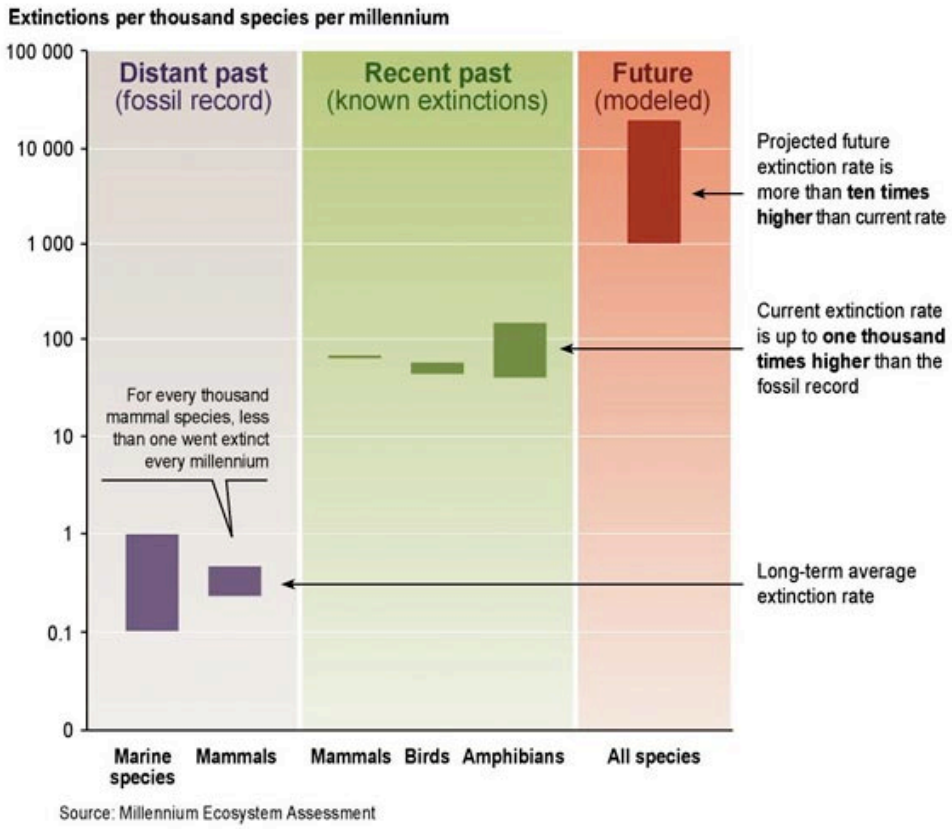

Extinctions per thousand species per millennium
100 000
10 000
1 000
100
10
1
0.1
0
Distant past
(fossil record)
Recent past
(known extinctions)
Future
(modeled)
For every thousand mammal species, less than one went extinct every millennium
Projected future extinction rate is more than ten times higher than current rate
Current extinction rate is up to one thousand times higher than the fossil record
Long-term average extinction rate
Marine species
Mammals
Mammals
Birds
Amphibians
All species
Source: Millennium Ecosystem Assessment

Figure 1.4

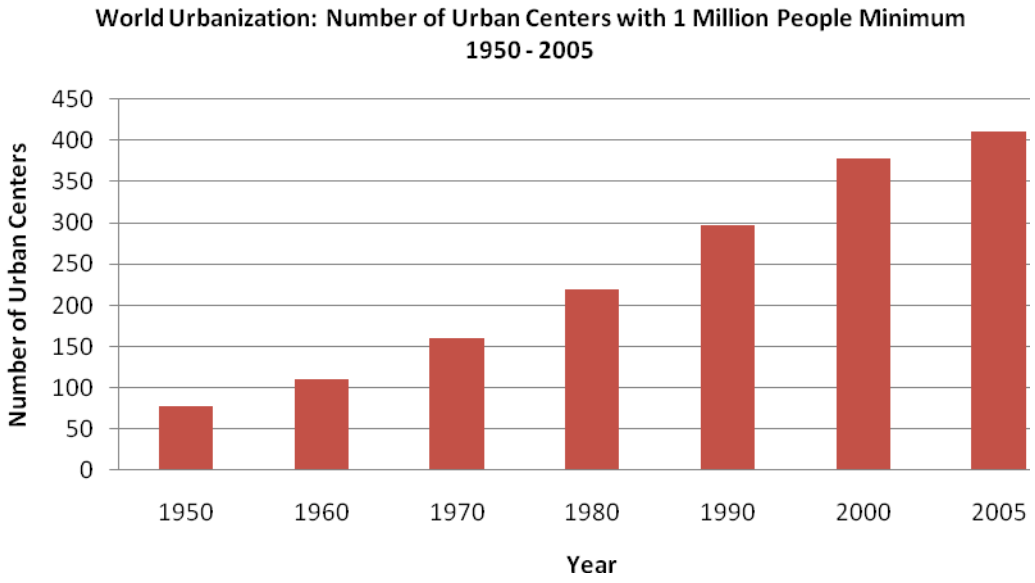
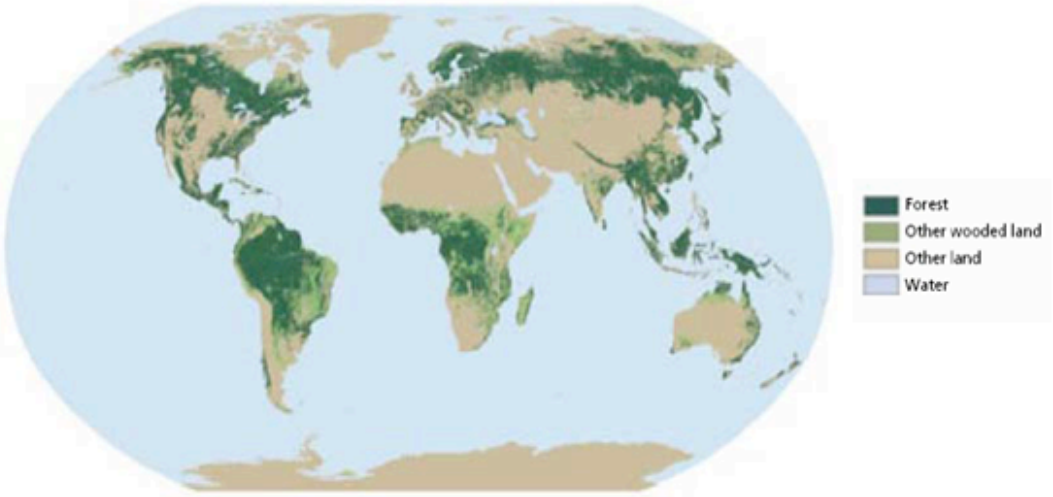

World Urbanization: Number of Urban Centers with 1 Million People Minimum
1950 - 2005
Number of Urban Centers
450
400
350
300
250
200
150
100
50
0
1950
1960
1970
1980
1990
2000
2005
Year

Figure 1.5

The world's forests



Countries with large net changes in forest area 2000–2005

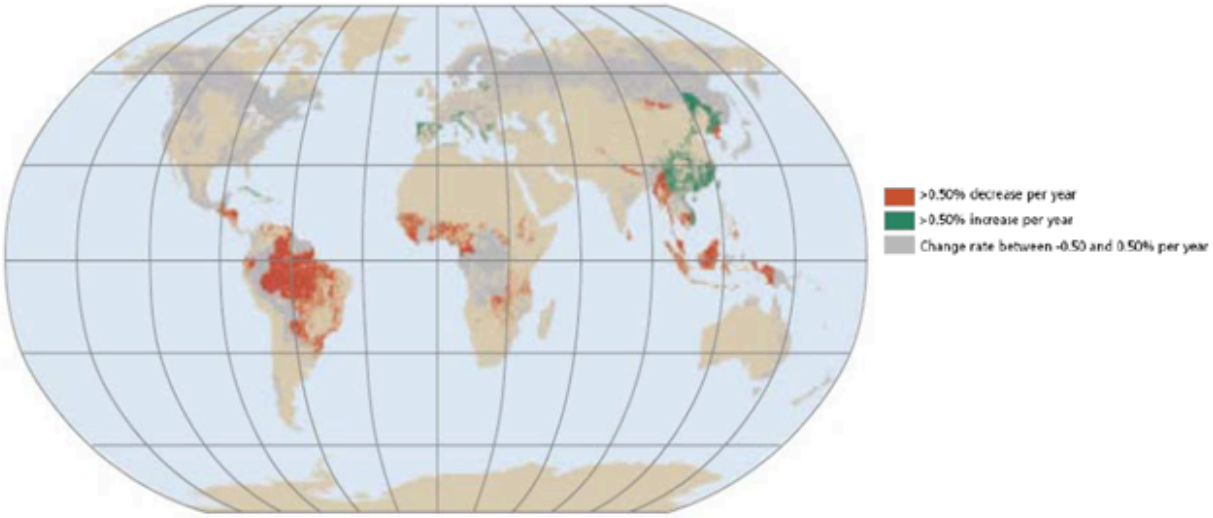
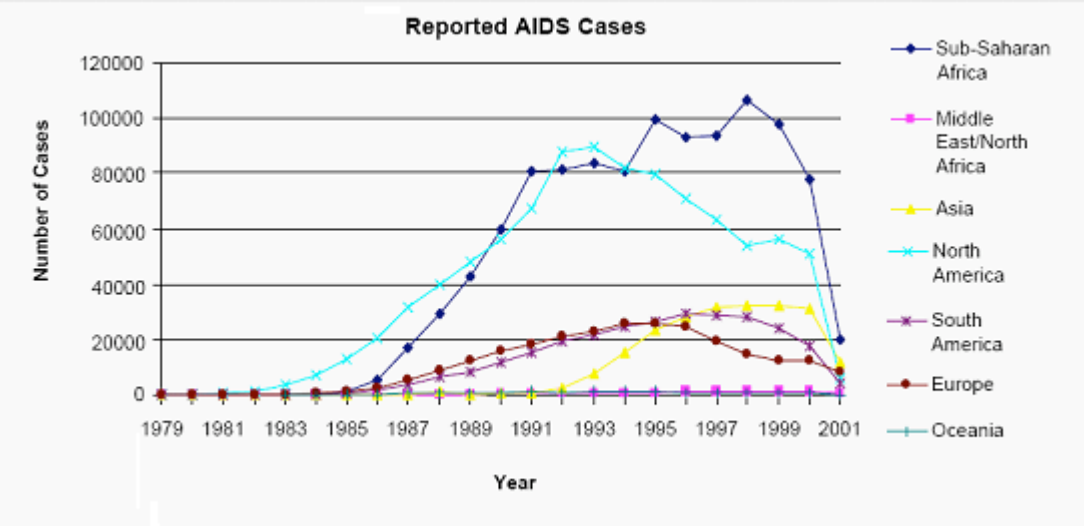


Figure 1.6


Reported AIDS Cases
Number of Cases
120000
100000
80000
60000
40000
20000
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
Year
Sub-Saharan Africa
Middle East/North Africa
Asia
North America
South America
Europe
Oceania

1.7

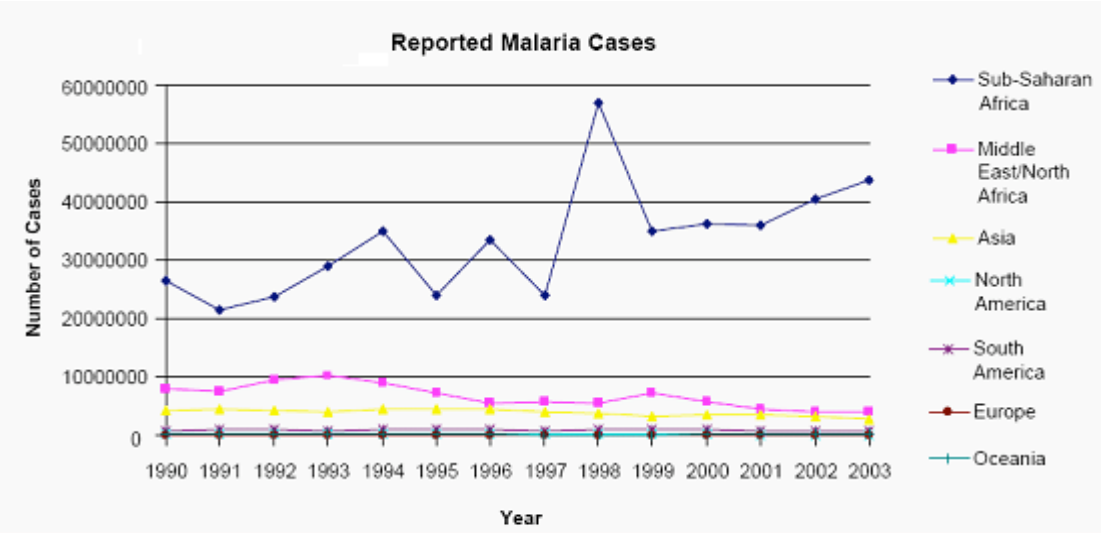

Reported Malaria Cases
Number of Cases
60000000
50000000
40000000
30000000
20000000
10000000
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
Year
Sub-Saharan Africa
Middle East/North Africa
Asia
North America
South America
Europe
Oceania

Figure 1.8

Major Previous Mass Extinctions and Resulting Climate Change		
Mass Extinction	*Time*	*Global Climate Change*
Ordovician	440 Million Years Ago	Cooling
Devonian	370 Million Years Ago	Cooling
Permian	245 Million Years Ago	Warming
Triassic	210 Million Years Ago	Warming
Cretaceous	65 Million Years Ago	Brief Cooling Followed by Warming

Figure 1.9a

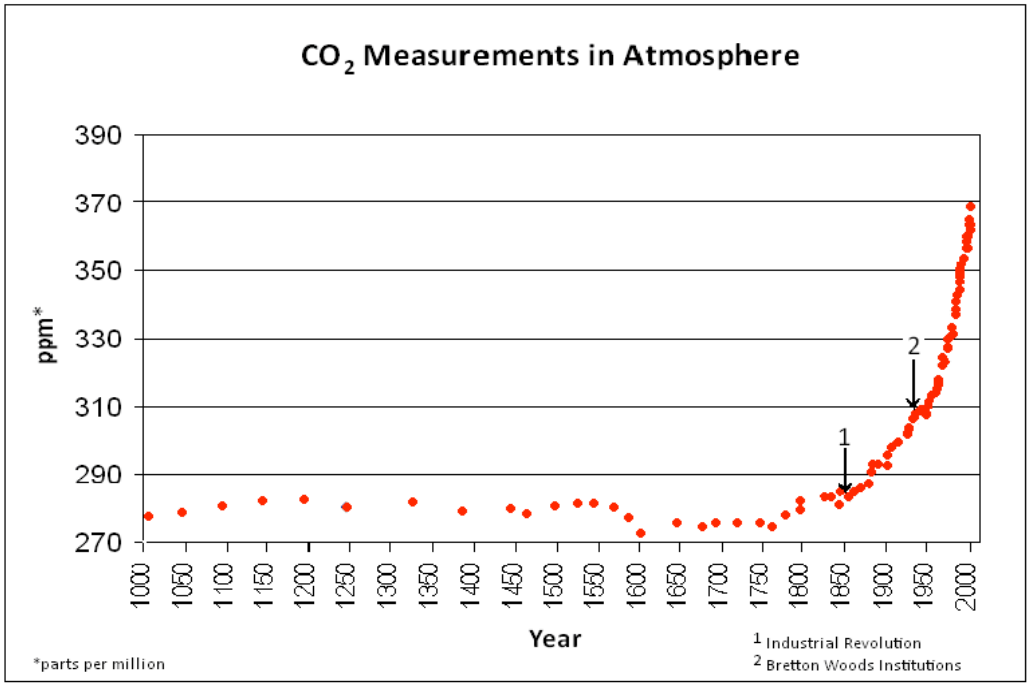
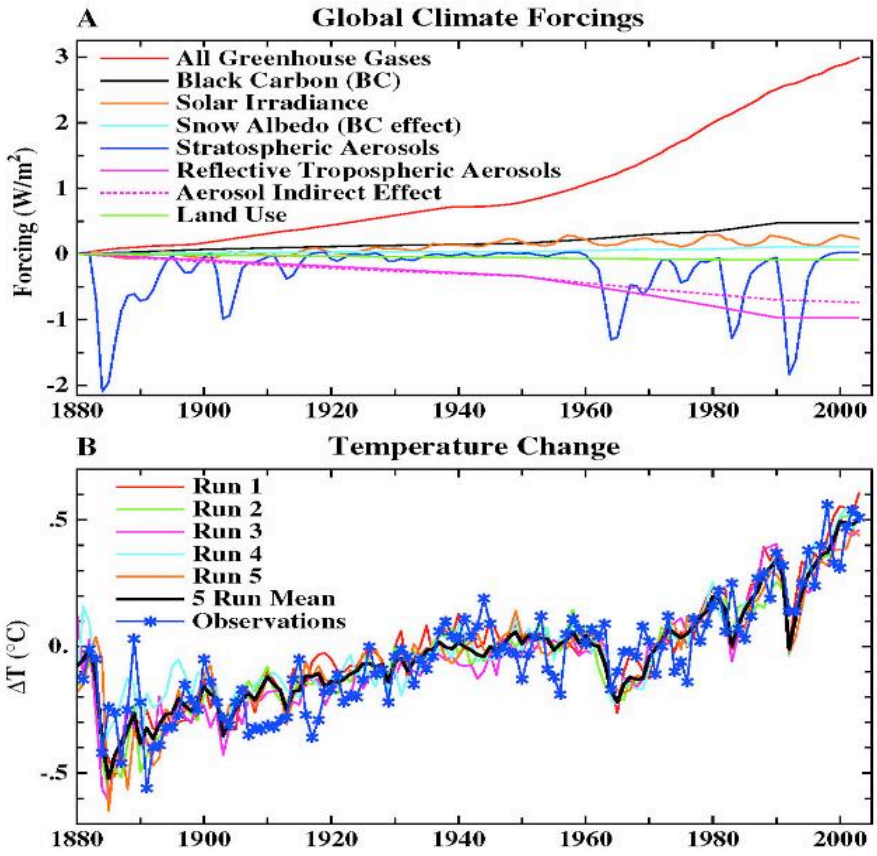

CO2 Measurements in Atmosphere
390
370
350
330
310
290
270
ppm*
1000
1050
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000
Year
1
2
*parts per million
1 Industrial Revolution
2 Bretton Woods Institutions

Figure 1.9b



The smoking gun for human influence

Top panel shows best estimates of human & natural forcings 1880-2005.

Bottom panel shows that state-of-the-art climate model, given these forcings, reproduces almost perfectly the last 125 years of observed temperatures.

Figure 1.9c

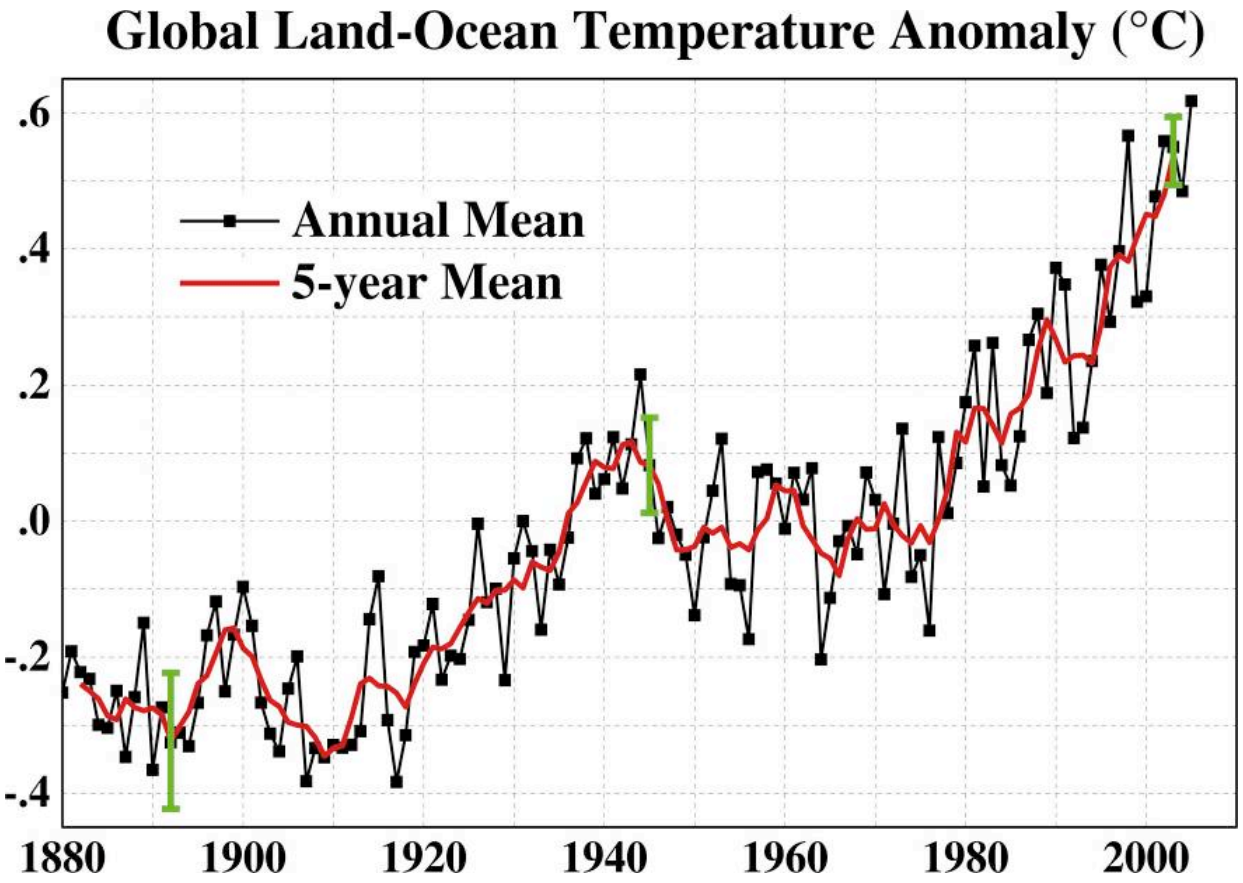

Global Land-Ocean Temperature Anomaly (°C)
.6
.4
.2
.0
-.2
-.4
Annual Mean
5-year Mean
1880
1900
1920
1940
1960
1980
2000

Figure 1.10

Rapidly Increasing Ozone Holes

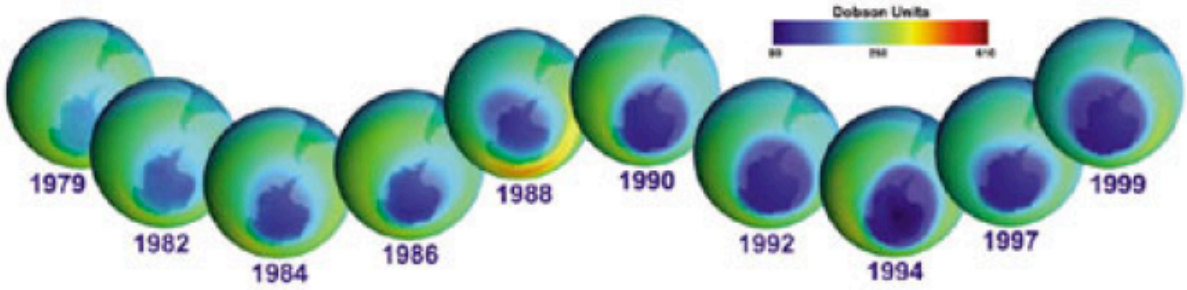


Figure 1.11

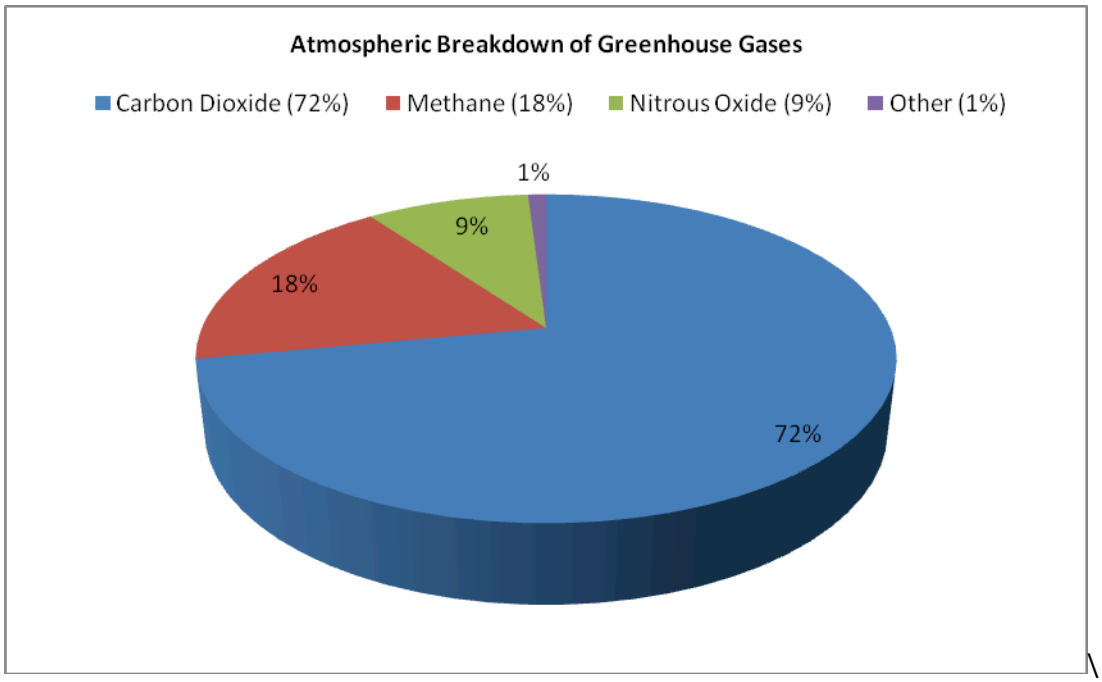

Atmospheric Breakdown of Greenhouse Gases
Carbon Dioxide (72%)
Methane (18%)
Nitrous Oxide (9%)
Other (1%)
1%
9%
18%
72%

Figure 1.12

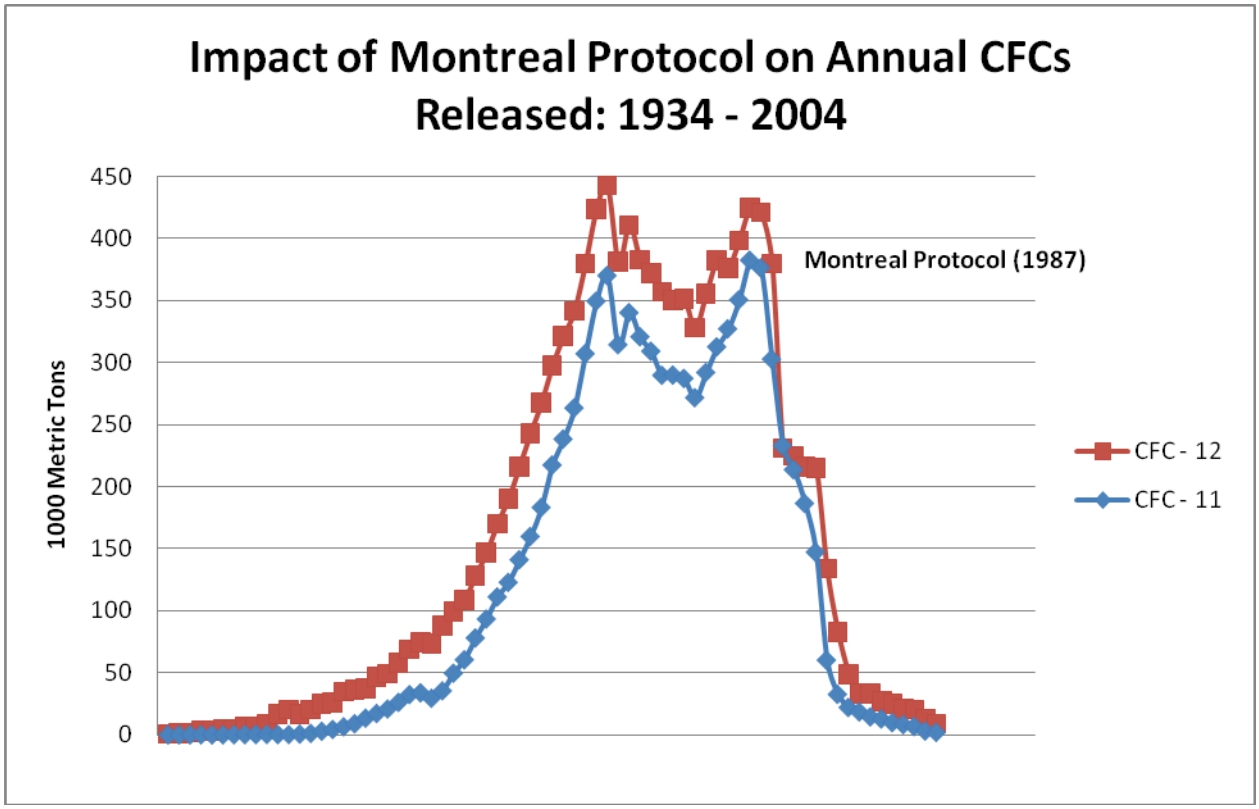

Impact of Montreal Protocol on Annual CFCs Released: 1934 - 2004
1000 Metric Tons
450
400
350
300
250
200
150
100
50
0
Montreal Protocol (1987)
CFC - 12
CFC - 11

Figure 1.13

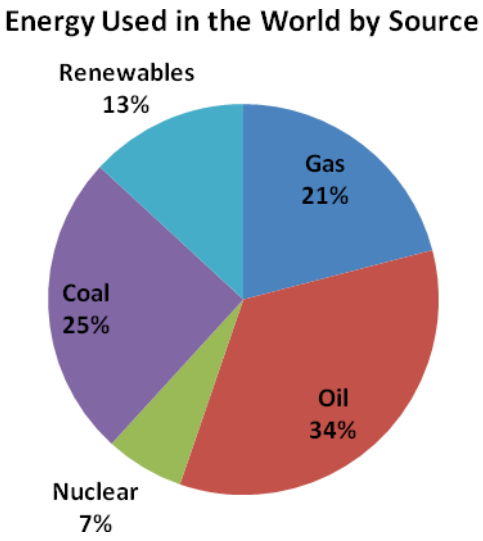
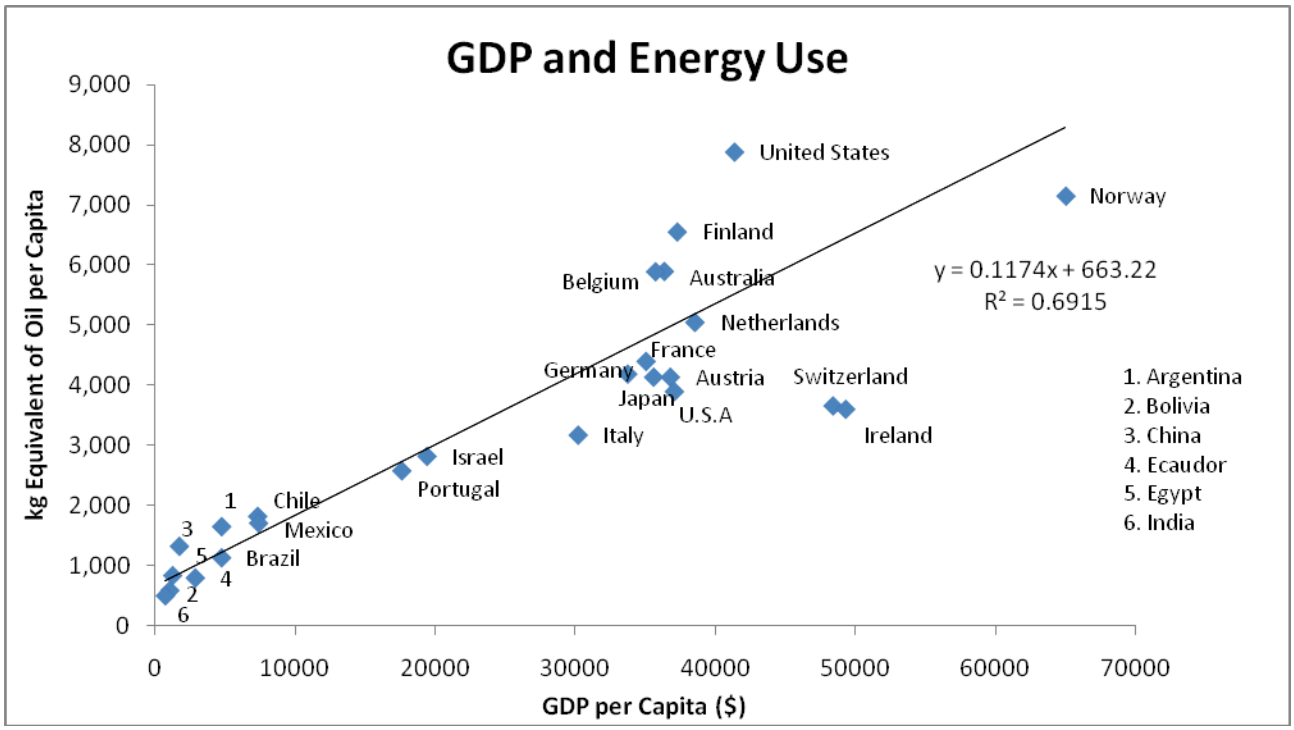


Figure 1.14


GDP and Energy Use
kg Equivalent of Oil per Capita
GDP per Capita ($)
y = 0.1174x + 663.22
R² = 0.6915
United States
Norway
Finland
Belgium
Australia
Netherlands
France
Germany
Austria
Switzerland
Japan
U.S.A
Italy
Ireland
Israel
Portugal
Chile
Mexico
Brazil
1. Argentina
2. Bolivia
3. China
4. Ecaudor
5. Egypt
6. India

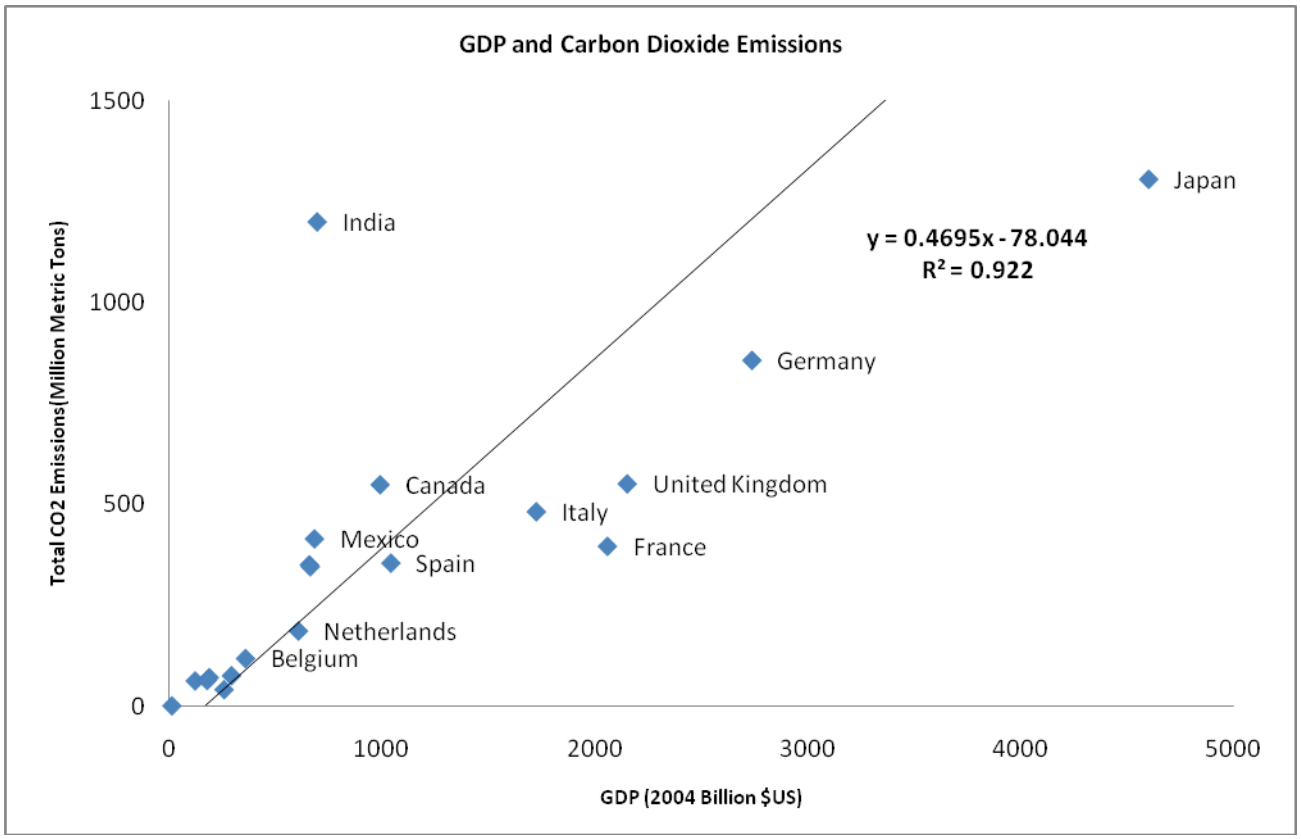

GDP and Carbon Dioxide Emissions
Total CO2 Emissions(Million Metric Tons)
GDP (2004 Billion $US)
y = 0.4695x - 78.044
R² = 0.922
Japan
India
Germany
Canada
United Kingdom
Italy
France
Mexico
Spain
Netherlands
Belgium

Table 2.1

	Cumulative CO_2 Emissions (1990 – 2002)	CO_2 Emissions 2002	Population (2002)	GDP (2002)
Developed Nations (OECD)	79.0%	60%	21.5%	**79.2%**
Developing Nations	**21.0%**	**40%**	**78.5%**	**20.8%**

Figure 2.1a

GNI per Capita vs. Carbon Emissions per Capita

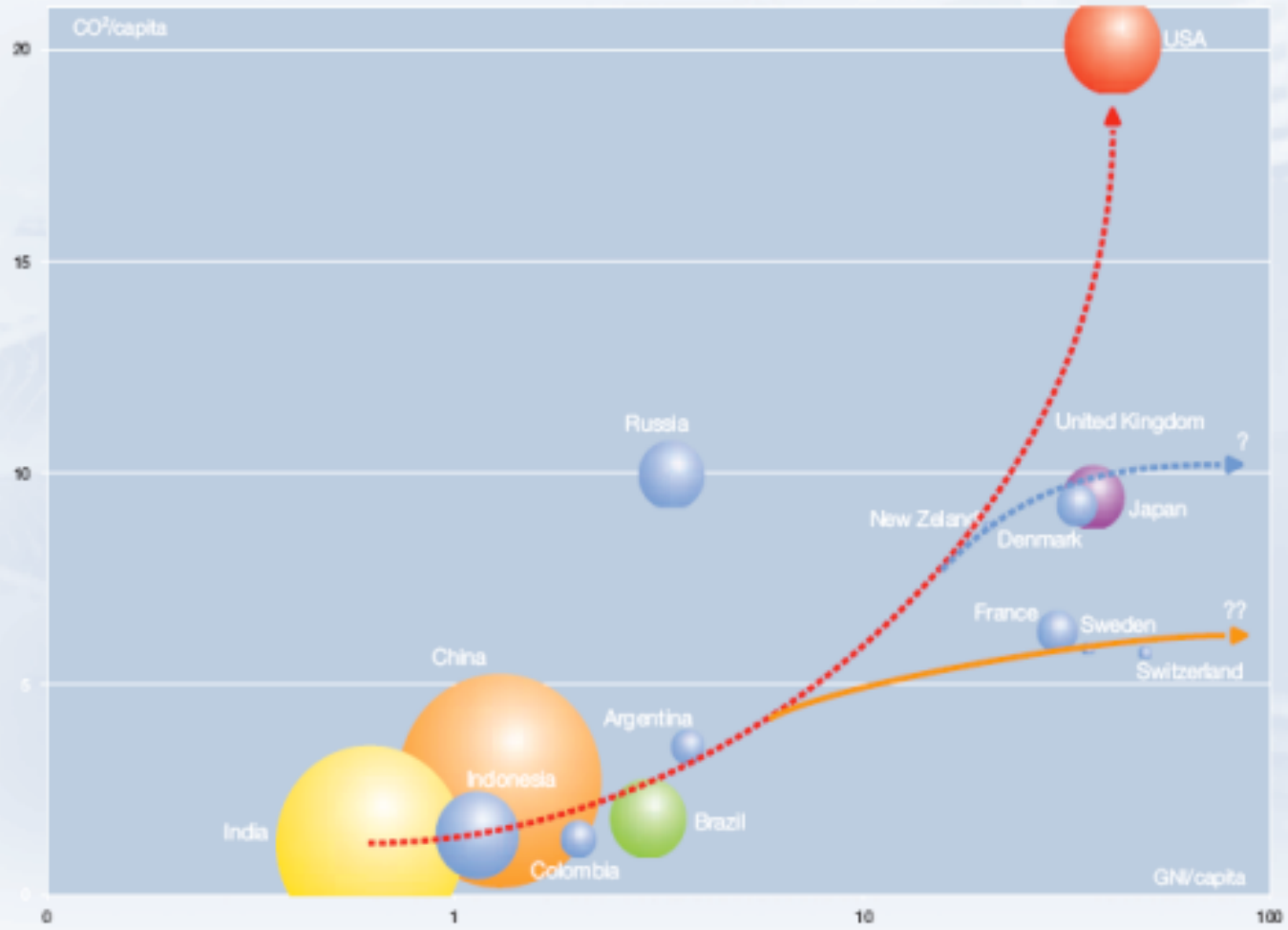


Figure 2.1b

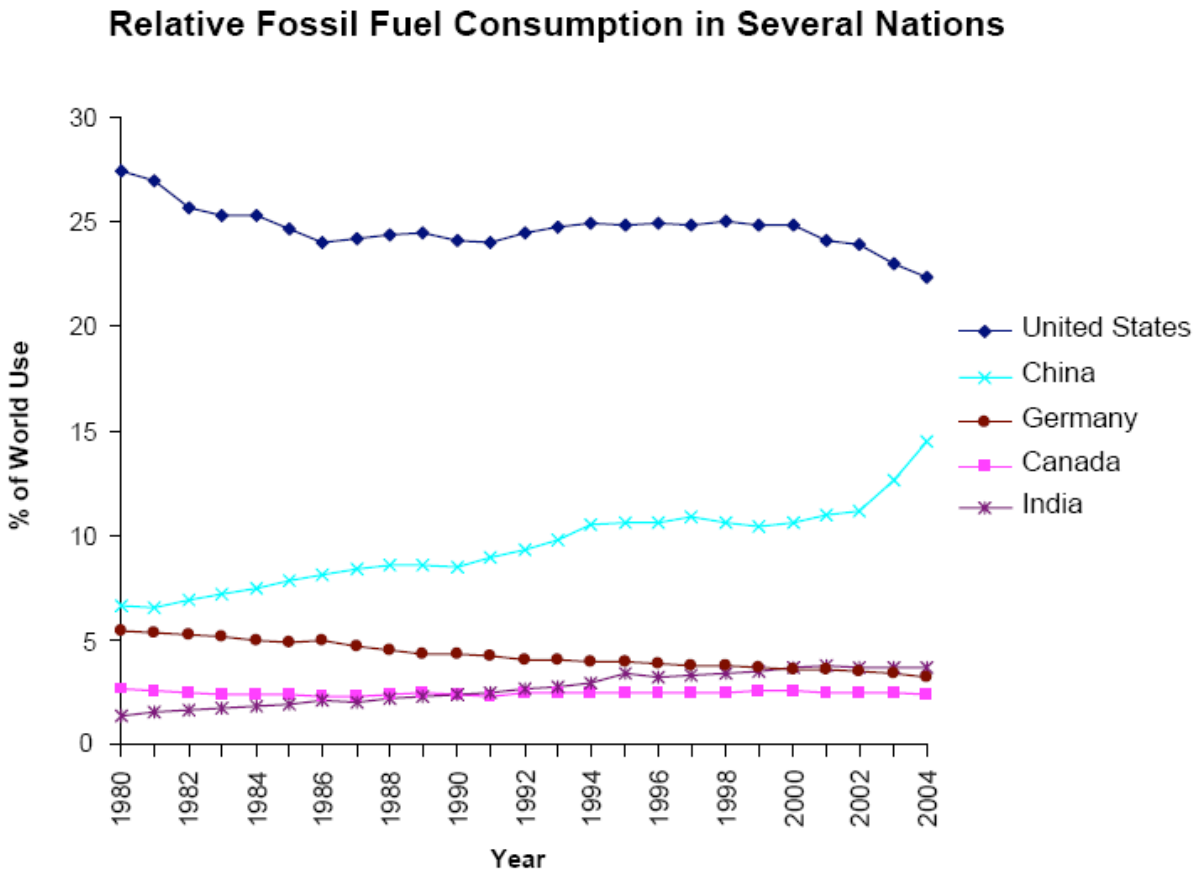

Relative Fossil Fuel Consumption in Several Nations
% of World Use
30
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year
United States
China
Germany
Canada
India

Figure 2.1c

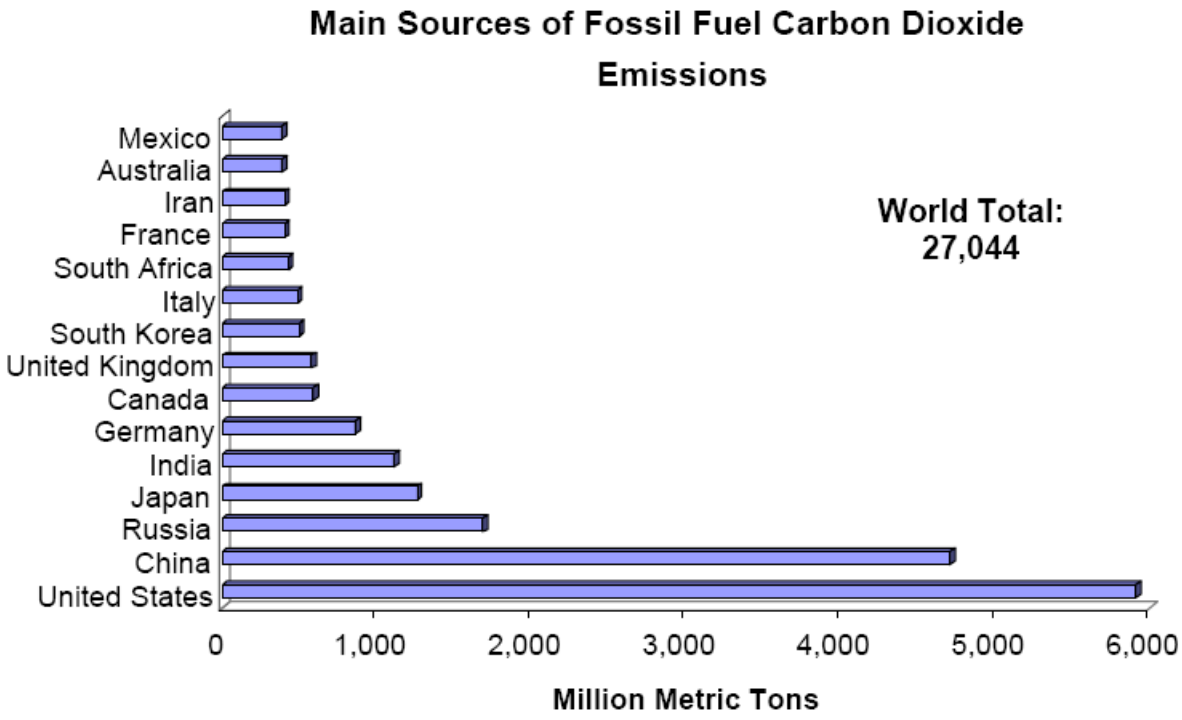

Main Sources of Fossil Fuel Carbon Dioxide Emissions
Mexico
Australia
Iran
France
South Africa
Italy
South Korea
United Kingdom
Canada
Germany
India
Japan
Russia
China
United States
World Total:
27,044
0
1,000
2,000
3,000
4,000
5,000
6,000
Million Metric Tons

Figure 2.2

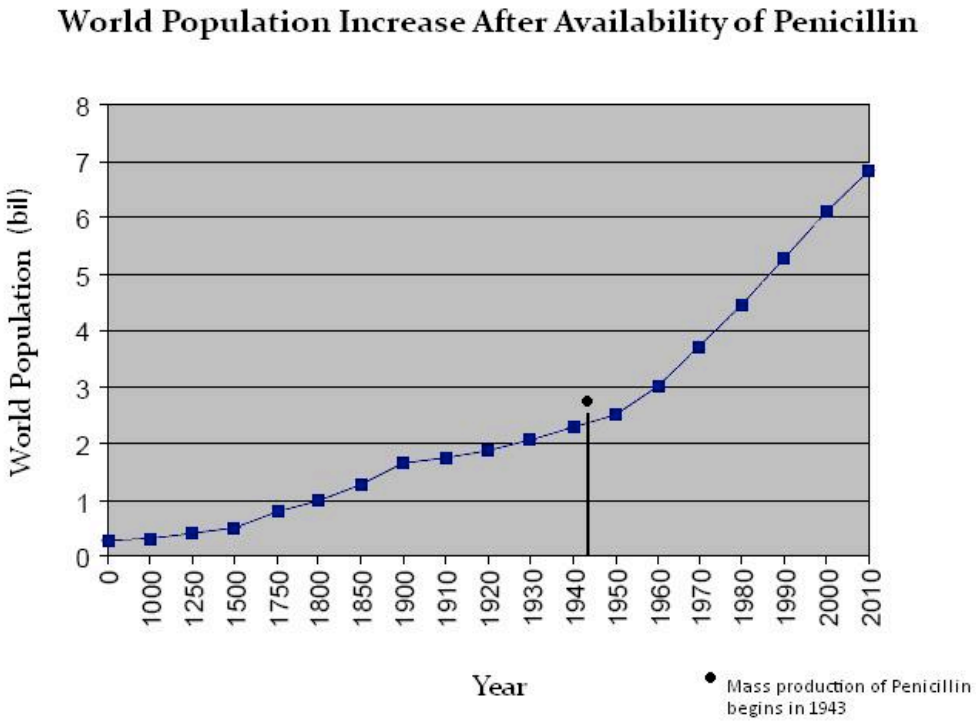

World Population Increase After Availability of Penicillin
World Population (bil)
0
1
2
3
4
5
6
7
8
0
1000
1250
1500
1750
1800
1850
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year
Mass production of Penicillin begins in 1943

Figure 2.3


Growth in Global Trade and Global Economy since 1950
Dollars (Constant 1990 Prices)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Years (1950, 1998 and 2005)
World Trade - 6.2% average growth
World GDP - 3.8% average growth

Figure 2.4

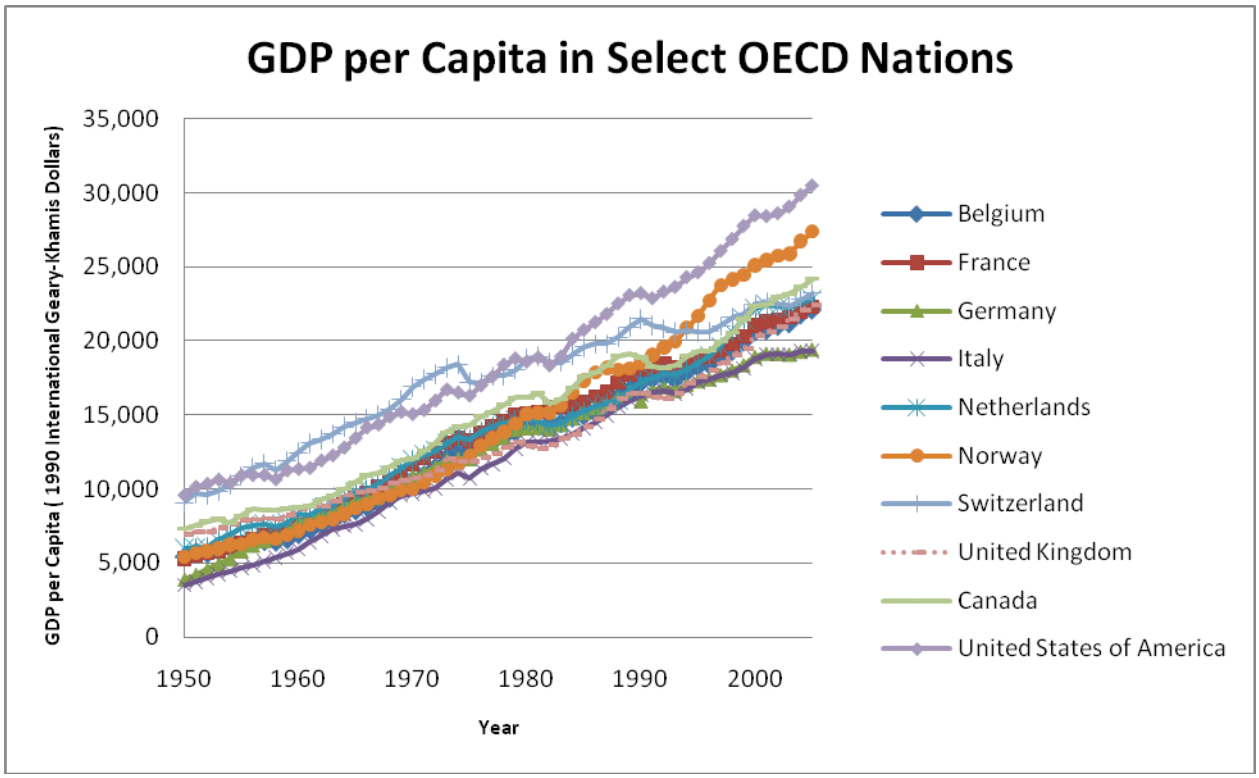

GDP per Capita in Select OECD Nations
GDP per Capita (1990 International Geary-Khamis Dollars)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1950
1960
1970
1980
1990
2000
Year
Belgium
France
Germany
Italy
Netherlands
Norway
Switzerland
United Kingdom
Canada
United States of America

Figure 2.5a

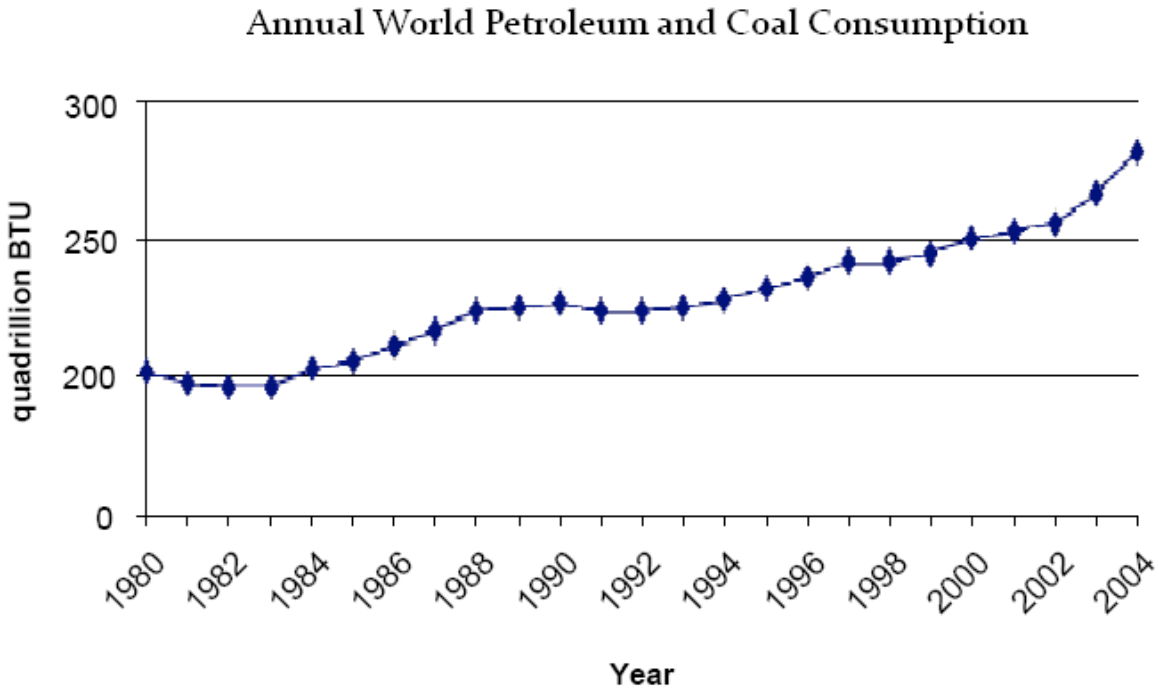

Annual World Petroleum and Coal Consumption
quadrillion BTU
300
250
200
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year

Figure 2.5b

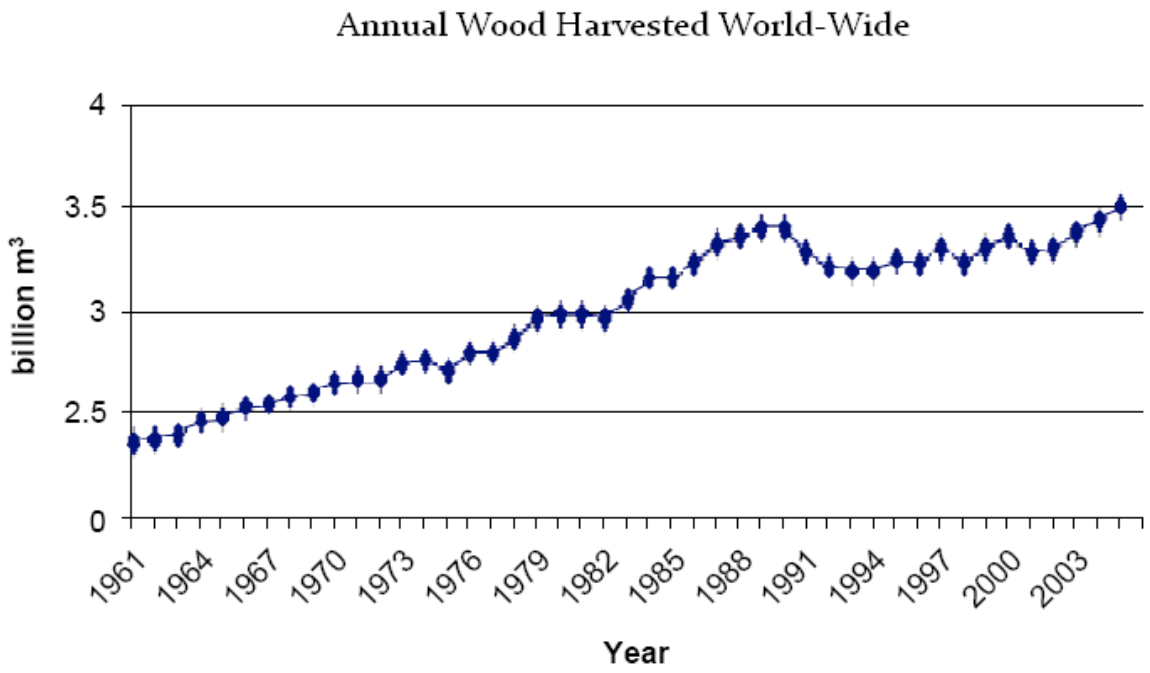

Annual Wood Harvested World-Wide
billion m3
4
3.5
3
2.5
0
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
Year

Figure 3.1

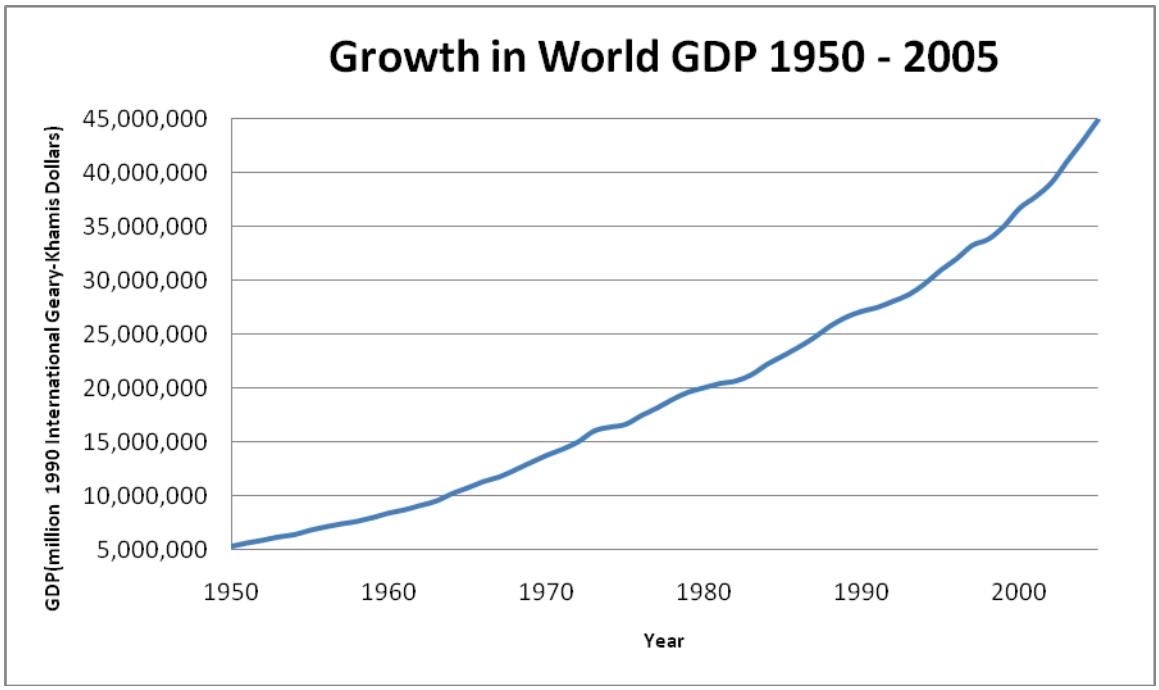

Growth in World GDP 1950 - 2005
GDP(million 1990 International Geary-Khamis Dollars)
45,000,000
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
1950
1960
1970
1980
1990
2000
Year

Figure 3.2

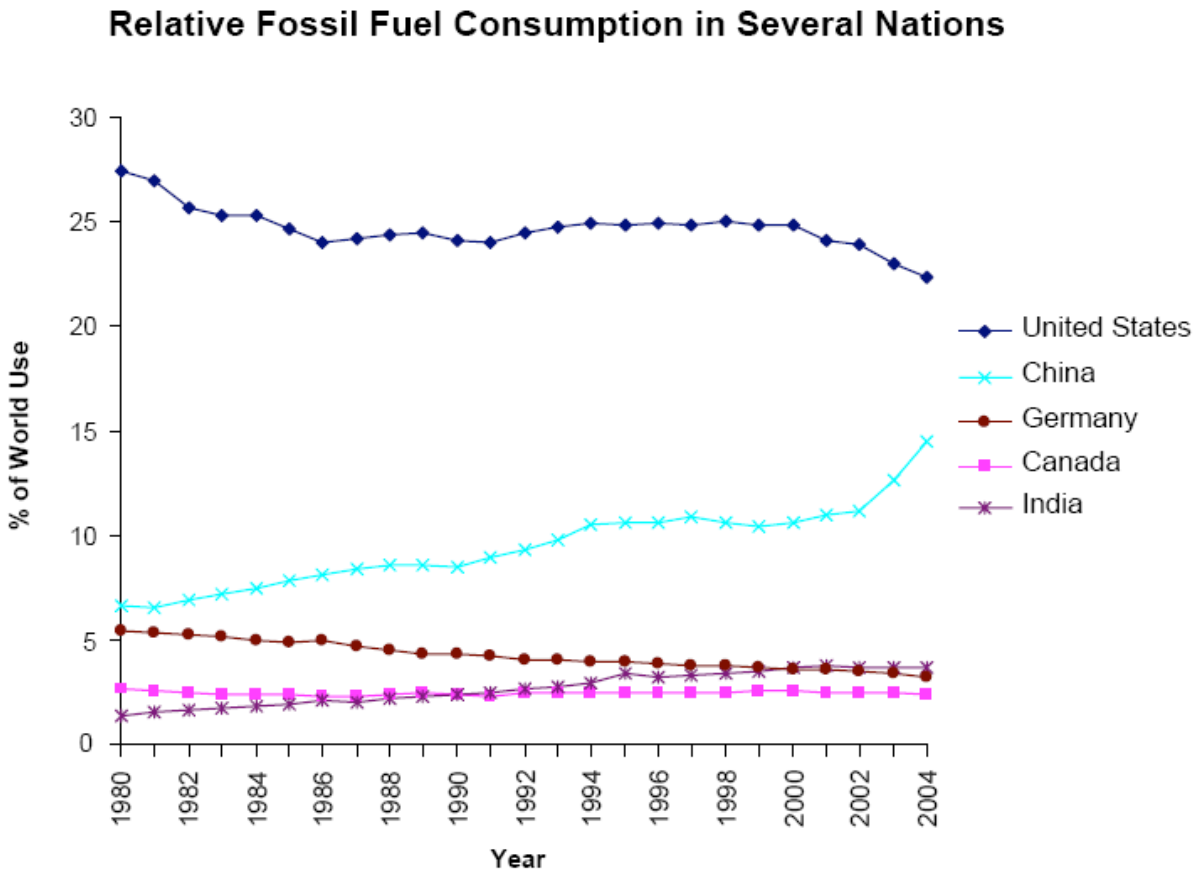
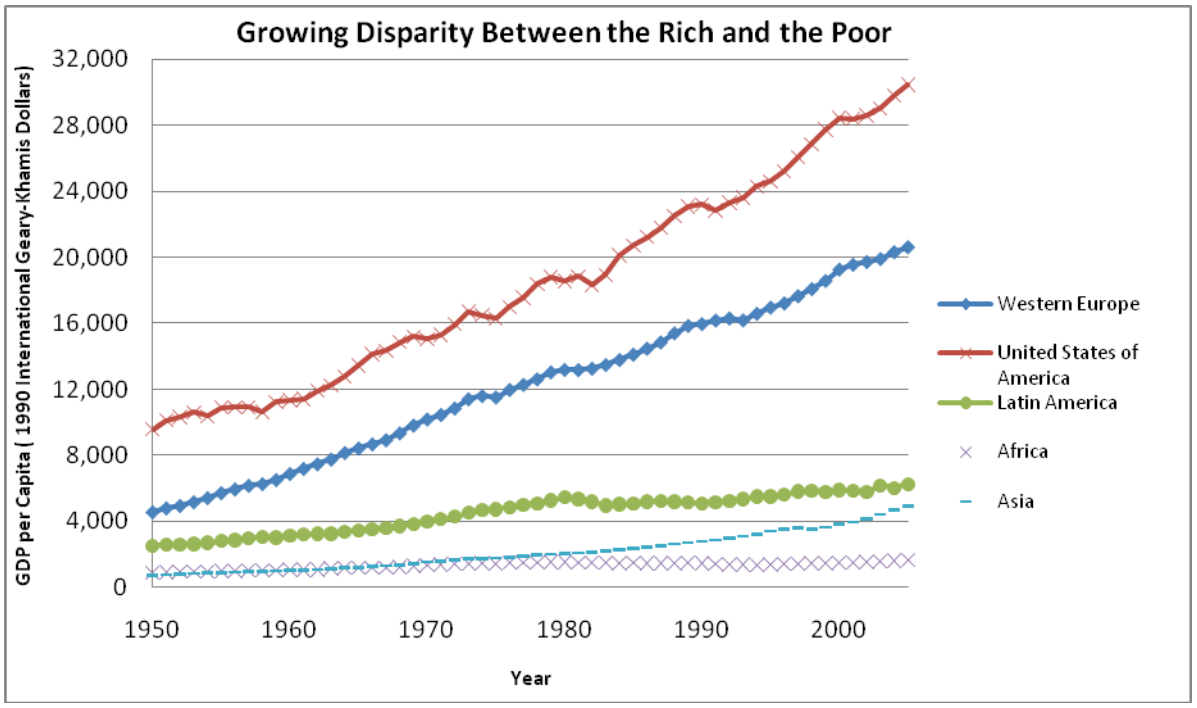

Relative Fossil Fuel Consumption in Several Nations
% of World Use
30
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year
United States
China
Germany
Canada
India

Figure 3.3


Growing Disparity Between the Rich and the Poor
GDP per Capita (1990 International Geary-Khamis Dollars)
32,000
28,000
24,000
20,000
16,000
12,000
8,000
4,000
0
1950
1960
1970
1980
1990
2000
Year
Western Europe
United States of America
Latin America
Africa
Asia

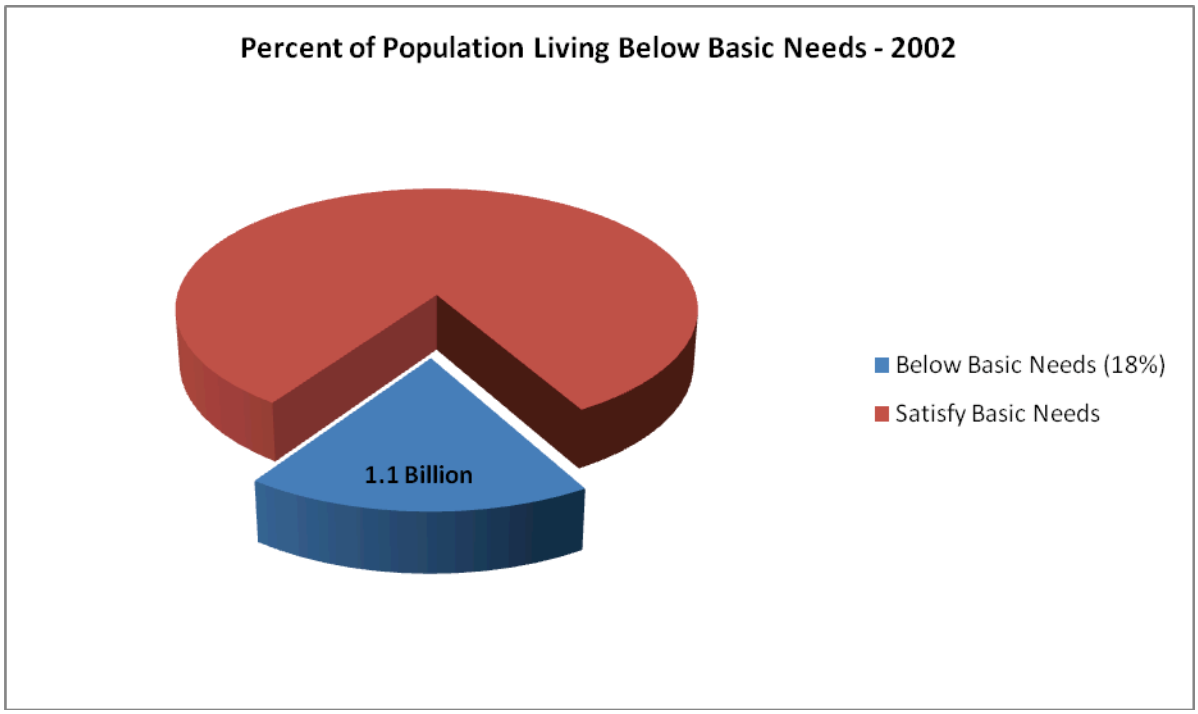

Percent of Population Living Below Basic Needs - 2002
1.1 Billion
Below Basic Needs (18%)
Satisfy Basic Needs

Figure 3.4

Conflict	Years
Russo-Japanese War	1904 - 1905
World War I	1914 - 1918
Polish-Soviet War	1919 - 1921
Greco-Turkish War	1919 - 1922
Sino-Japanese War	1937 - 1945
World War II	1939 - 1945
French Indochina War	1946 - 1954
First Arab-Israeli War	1948 - 1949
Korean War	1950 - 1953
Vietnam War	1959 - 1975
Soviet War in Afghanistan	1979 - 1989
Iran-Iraq War	1980 - 1988
Persian Gulf War	1990 - 1991
War in Afghanistan	2001 - present
War in Iraq	2003 - present

Figure 3.5

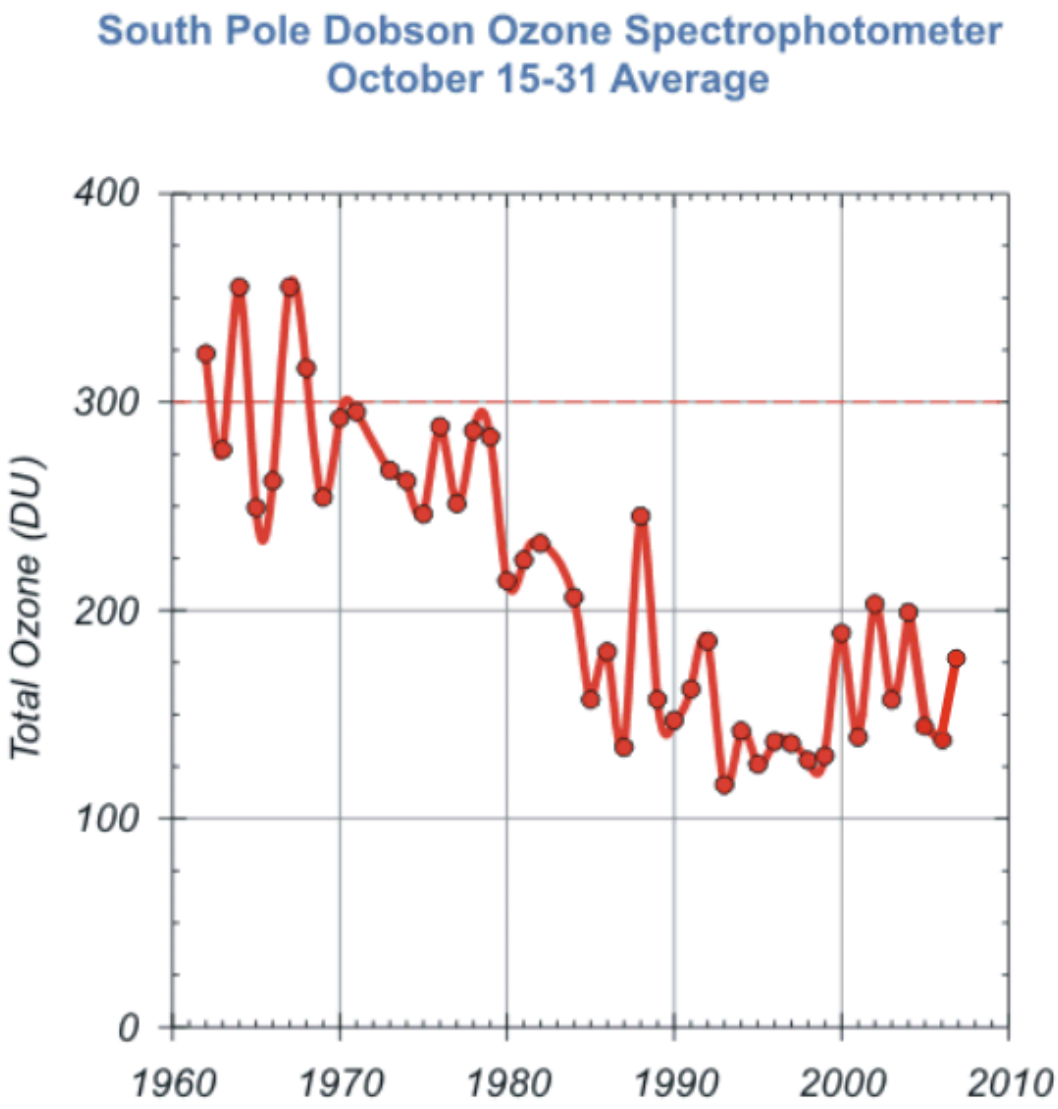

South Pole Dobson Ozone Spectrophotometer
October 15-31 Average
Total Ozone (DU)
400
300
200
100
0
1960
1970
1980
1990
2000
2010

Figure 3.6

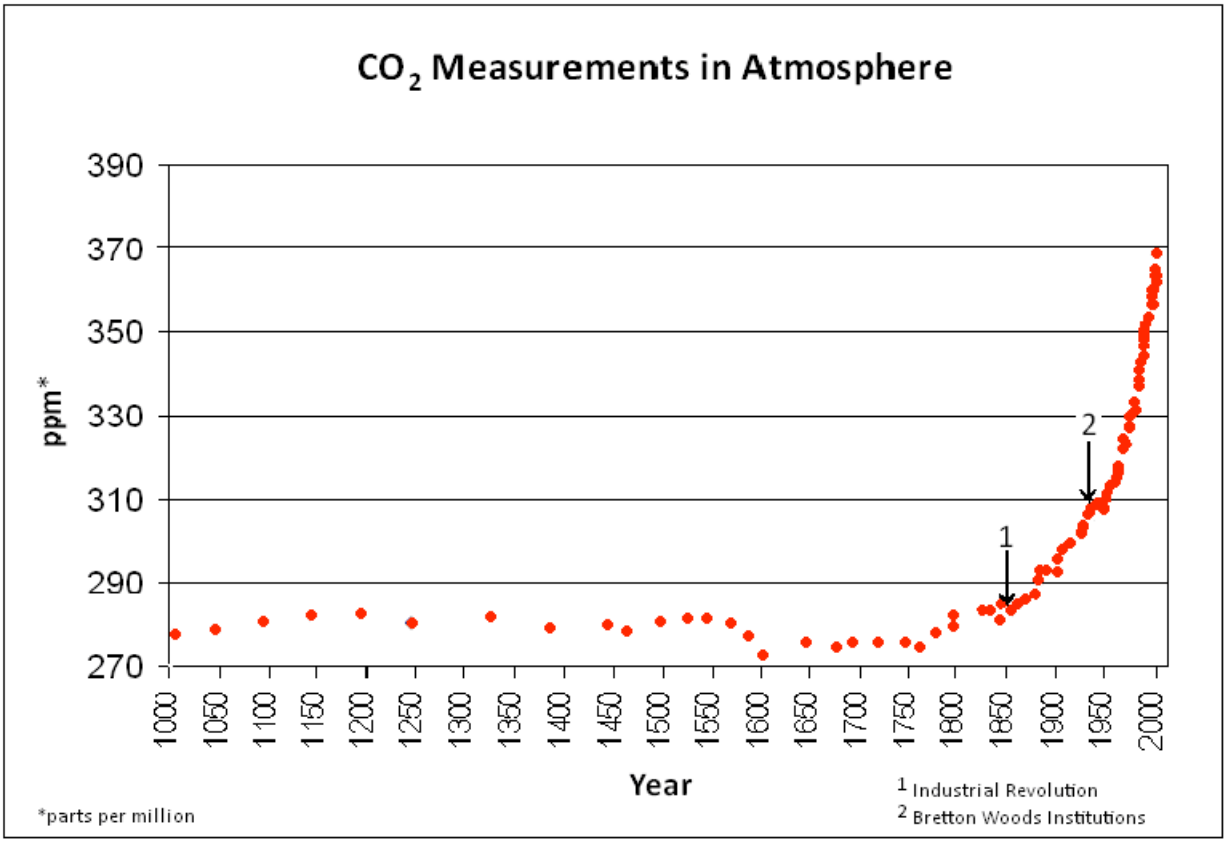

CO2 Measurements in Atmosphere
390
370
350
330
310
290
270
ppm*
1000
1050
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000
Year
1
2
*parts per million
1 Industrial Revolution
2 Bretton Woods Institutions

Figure 3.7 (Same as 2.3)

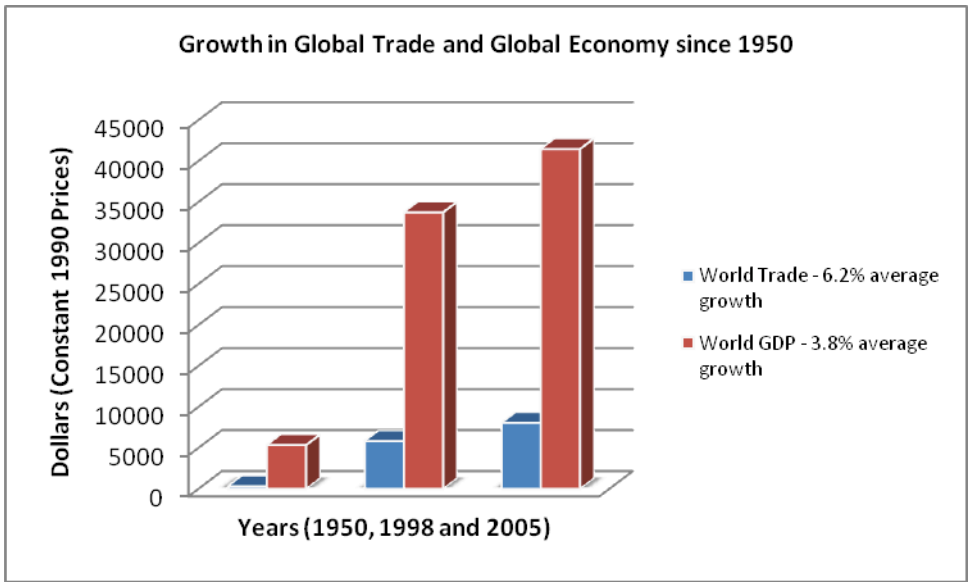


Figure 3.8

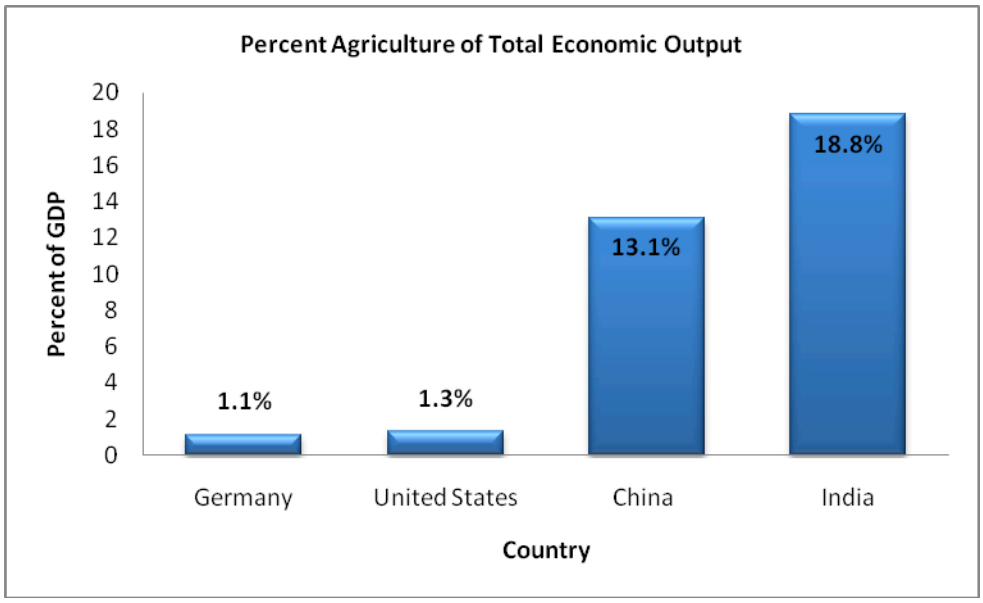

Percent Agriculture of Total Economic Output
Percent of GDP
20
18
16
14
12
10
8
6
4
2
0
1.1%
1.3%
13.1%
18.8%
Germany
United States
China
India
Country

Figure 3.9

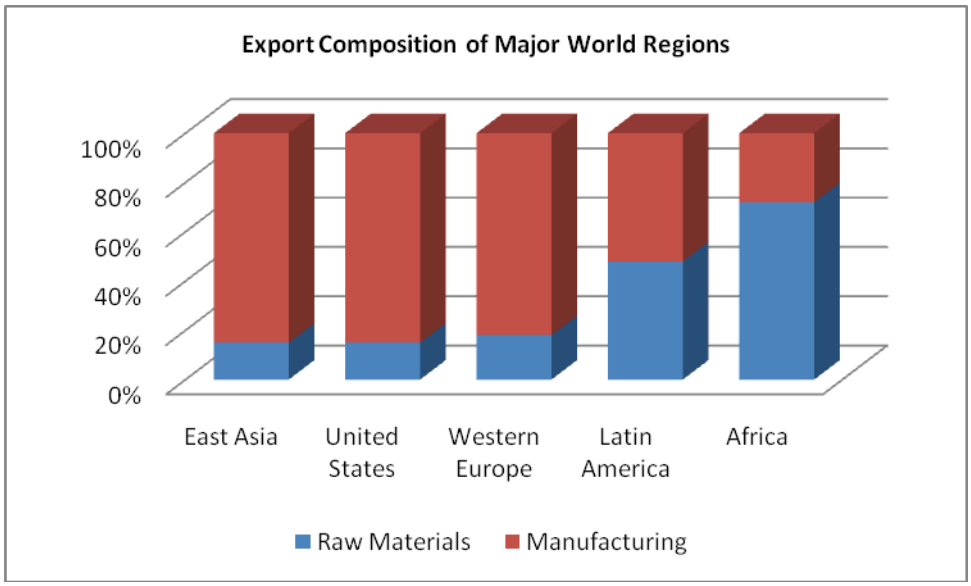

Export Composition of Major World Regions
100%
80%
60%
40%
20%
0%
East Asia
United States
Western Europe
Latin America
Africa
Raw Materials
Manufacturing

Figure 3.10

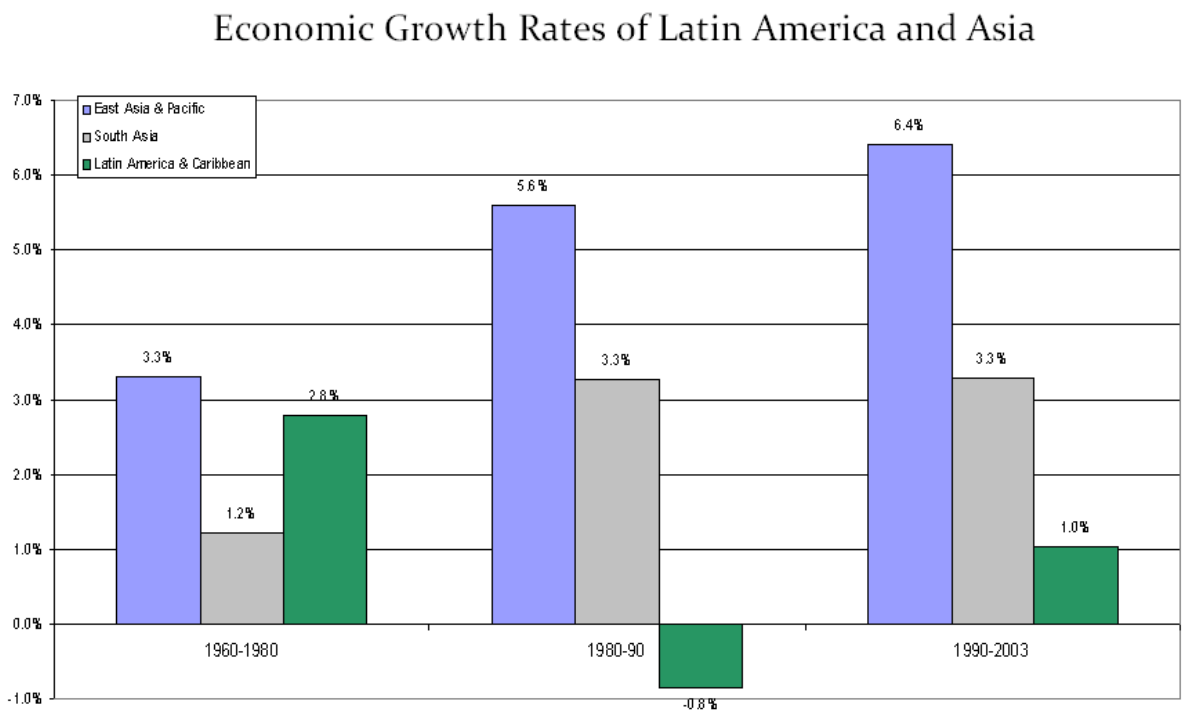
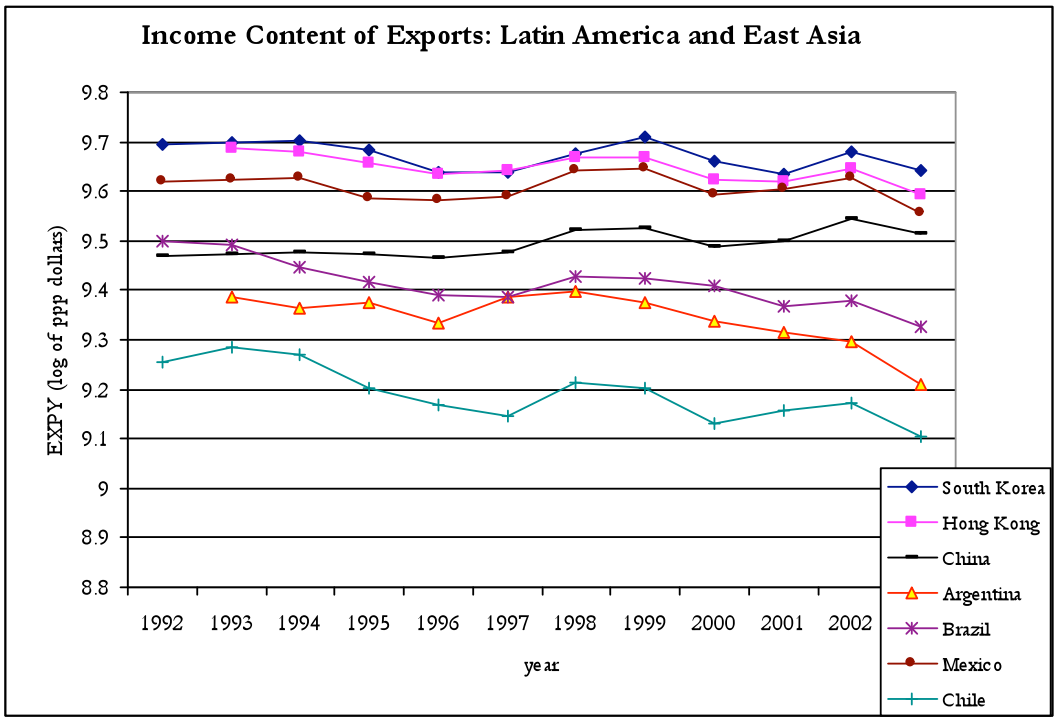

Economic Growth Rates of Latin America and Asia
East Asia & Pacific
South Asia
Latin America & Caribbean
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
-1.0%
3.3%
1.2%
2.8%
5.6%
3.3%
-0.8%
6.4%
3.3%
1.0%
1960-1980
1980-90
1990-2003

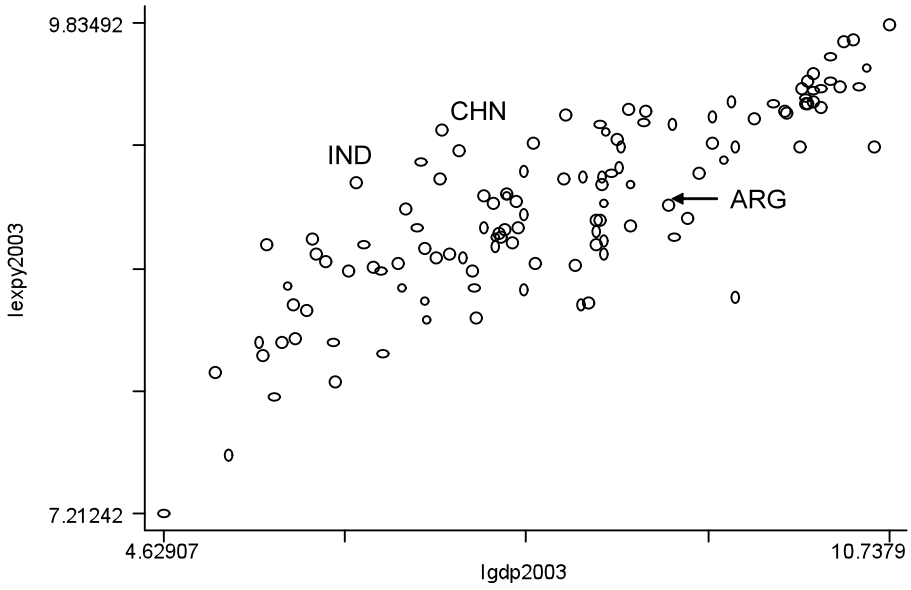
Figure 3.11

It is not how much you export but what you export



Note: “income content of exports” (*EXPY*) represents the income level of the typical country with your export basket.

Rich countries produce “rich country goods”



The remarkable rise of China

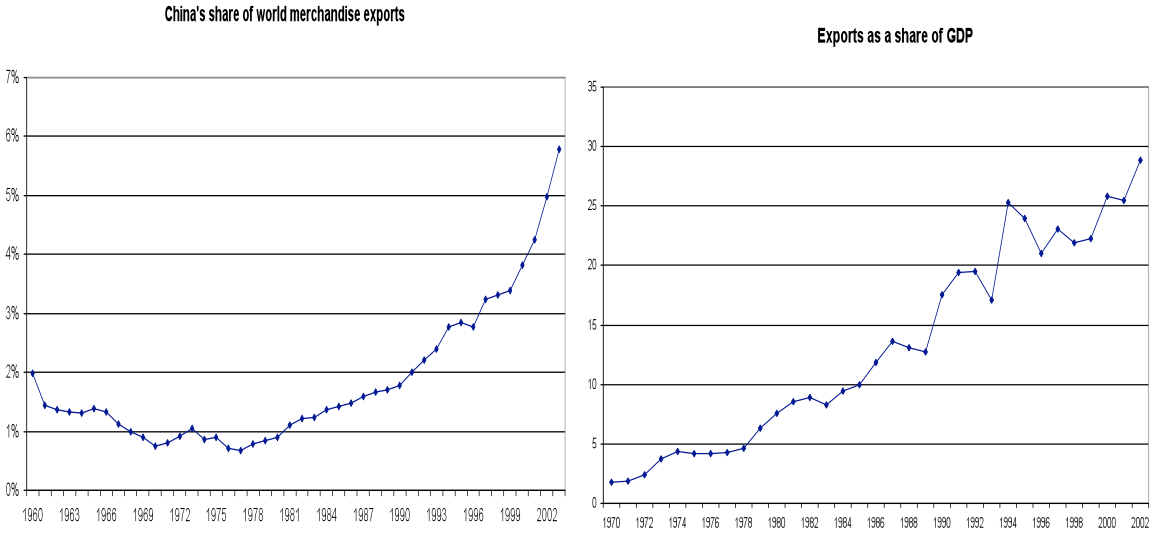
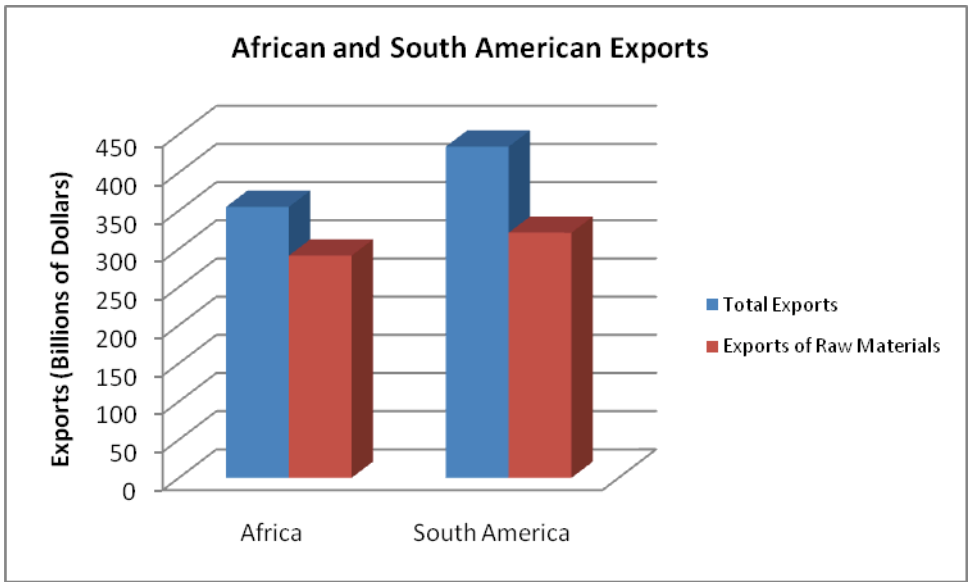
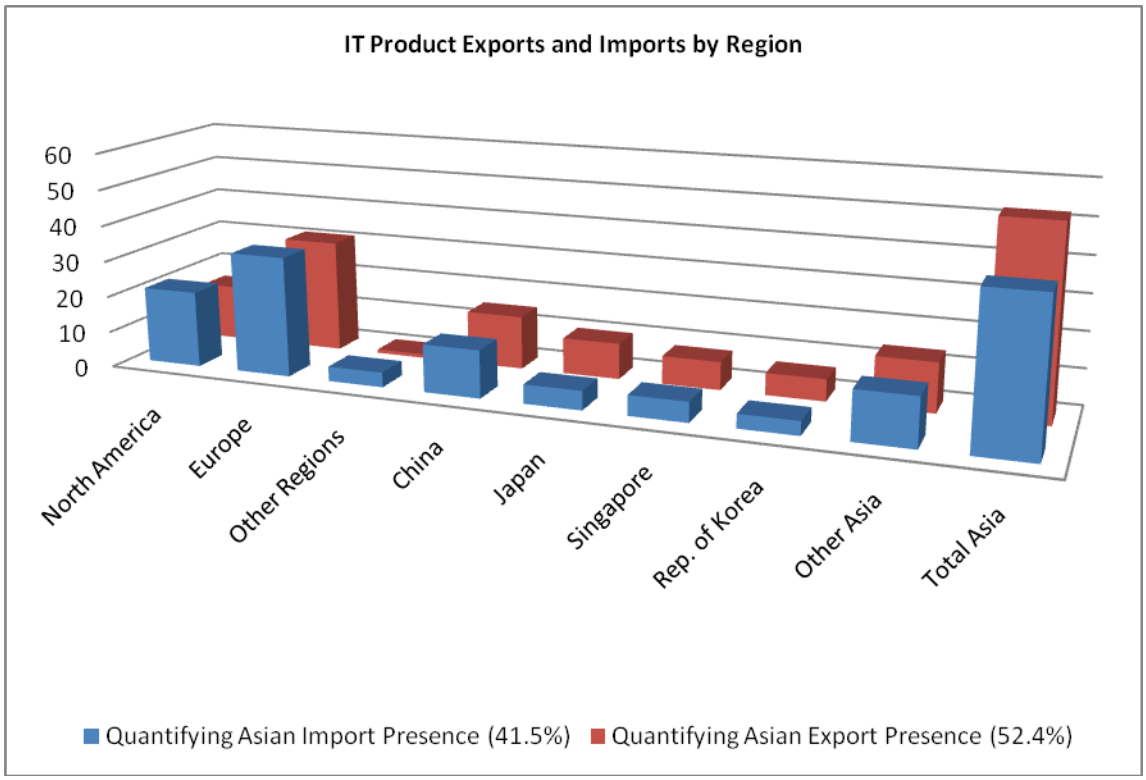


Figure 3.13


African and South American Exports
Exports (Billions of Dollars)
450
400
350
300
250
200
150
100
50
0
Africa
South America
Total Exports
Exports of Raw Materials

3.14


IT Product Exports and Imports by Region
60
50
40
30
20
10
0
North America
Europe
Other Regions
China
Japan
Singapore
Rep. of Korea
Other Asia
Total Asia
Quantifying Asian Import Presence (41.5%)
Quantifying Asian Export Presence (52.4%)

3.15

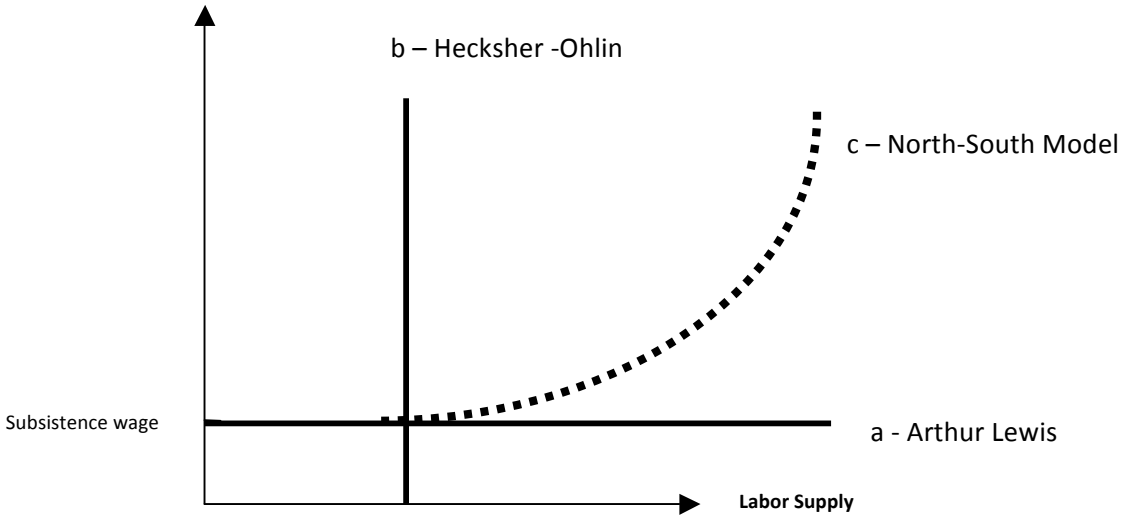


Figure 3.15

(a) Arthur Lewis Economy with Unlimited Labor Supplies
(b) Heckscher – Ohlin Economy with Fixed Labor Supply
(c) Chichilnisky North - South Economy

3.16

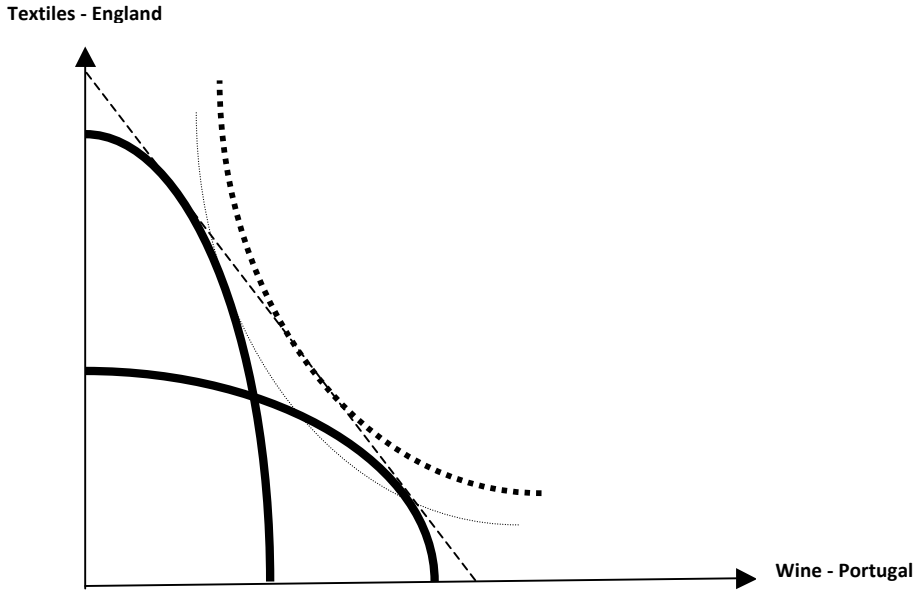
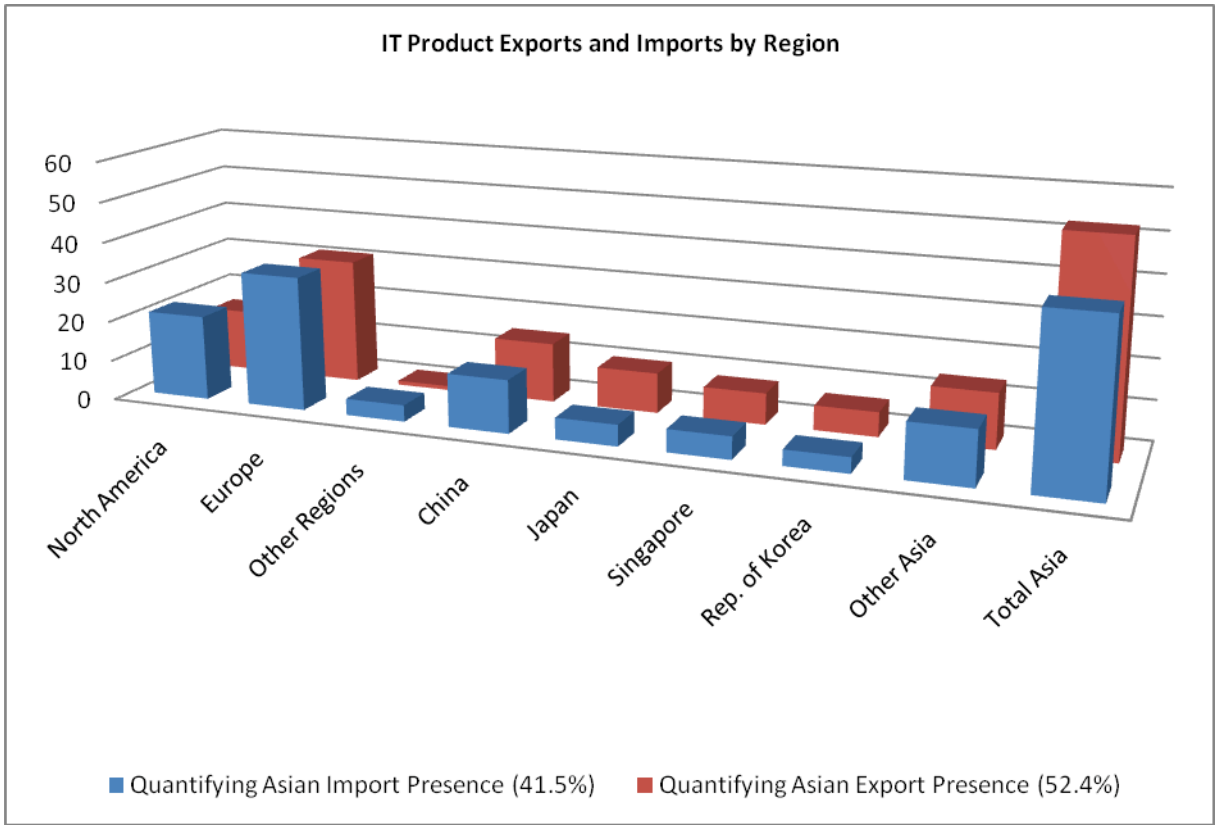


Figure 3.16

David Ricardo's comparative advantages:

UK and Portugal are better off after trade

3.17


IT Product Exports and Imports by Region
60
50
40
30
20
10
0
North America
Europe
Other Regions
China
Japan
Singapore
Rep. of Korea
Other Asia
Total Asia
Quantifying Asian Import Presence (41.5%)
Quantifying Asian Export Presence (52.4%)

4.1a

This graph corresponds to the regression system in Table 3, column 2. The curve shows the partial relation between the Gini coefficient and the log of per capita GDP, holding fixed the estimated effects of the explanatory variables other than the log of per capita GDP and its square.

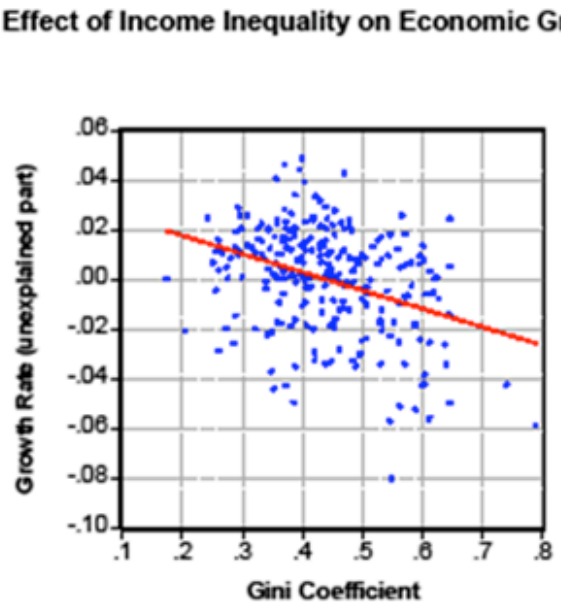


Figure 4.1b

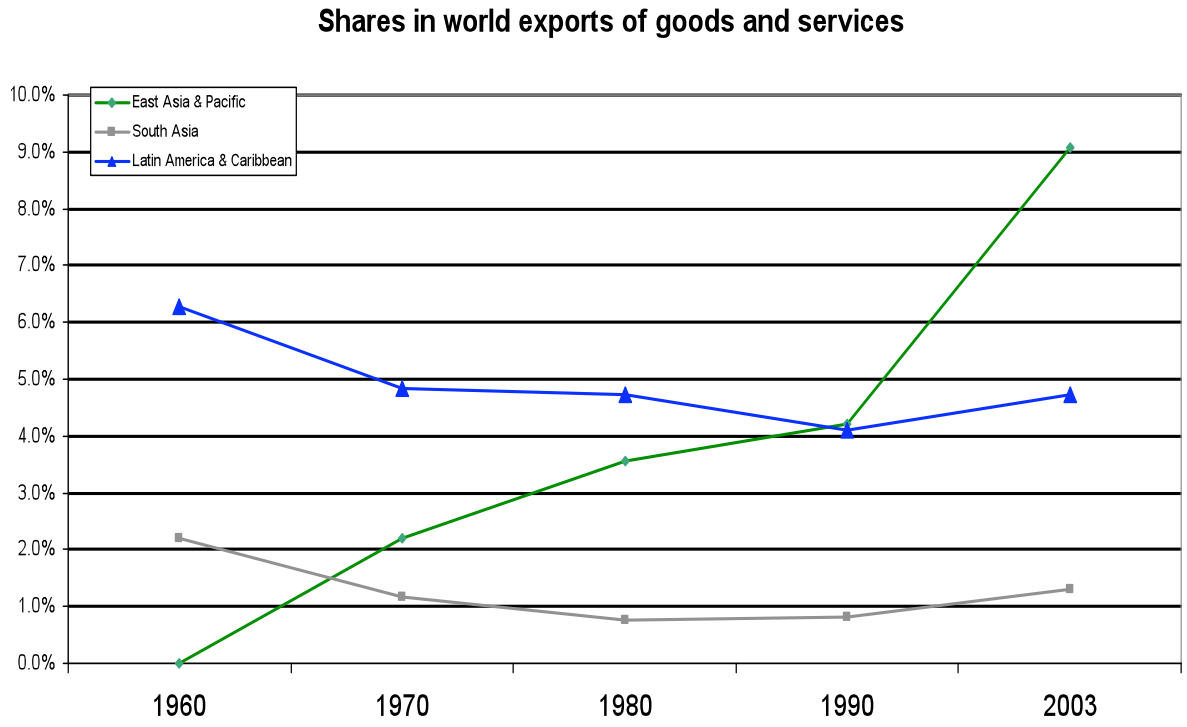
Table 3: Regression Results for Income Inequality (Kuznets curves)

Explanatory variable	Dependent Variable: Gini coefficient	Country fixed effects	Lowest Quintile	Highest Quintile
	(1)	(2)	(3)	(4)	(5)
log(per capita GDP)	0.266** (0.066)	0.292** (0.058)	0.183** (0.067)	-0.063** (0.014)	0.229** (0.050)
log(per capita GDP) squared	-0.0179** (0.0039)	-0.0182** (0.0034)	-0.0121** (0.0040)	0.0037** (0.0008)	-0.0143** (0.0029)
Dummy net income/expend.	-0.0543** (0.0091)	-0.0393** (0.0082)	-0.0426** (0.0080)	0.0100** (0.0020)	-0.0443** (0.0075)
Dummy individual	-0.0188 (0.0099)	-0.0173* (0.0087)	-0.0215* (0.0085)	0.0075** (0.0022)	-0.0095 (0.0080)
Dummy sub-Saharan Africa	--	0.092** (0.014)	--	-0.0217** (0.0034)	0.090** (0.013)
Dummy Latin America	--	0.085** (0.013)	--	-0.0187** (0.0031)	0.066** (0.011)
Dummy former colony	--	0.049** (0.011)	--	-0.0101** (0.0028)	0.0374** (0.0095)
Openness variable	--	0.026* (0.011)	0.014 (0.019)	-0.0012 (0.0026)	0.0154 (0.0089)
Number of observations	54, 78, 91 123, 94	54, 77, 90 120, 92	54, 78, 91 121, 93	47, 65, 81 117, 81	41, 57, 77 115, 81
R-squared	.14, .18,.24 .27, .47	.35, .39, .59 .57, .66	--	.17, .45, .50 .53, .60	.40, .45, .60 .58, .71
s.e. of regression	.092 .093 .096 .098 .073	.080 .081 .070 .075 .059	.054 .047 .044 .070 .046	.019 .016 .017 .016 .015	.065 .062 .054 .066 .045

*Significant at 5% level
**Significant at 1% level

Notes: See Table 2 for definitions and sources of variables. Dependent variables are Gini coefficients, lowest quintile income shares, or highest quintile income shares, as indicated. Panel systems cover 1960s, 1970s, 1980s, 1990s, and 2000s. Coefficients were estimated by seemingly-unrelated-regression technique. Standard errors of coefficients are in parentheses. Each period has an individual intercept (not shown). For the regression system in column 2, the estimated intercepts, expressed relative to that for the 1960s, are -0.011 (s.e. = 0.012) for the 1970s, -0.018 (0.013) for the 1980s, 0.012 (0.014) for the 1990s, and 0.006 (0.014) for the 2000s. A test that these four relative intercepts are jointly zero has a p-value of 0.011. The system in column 3 includes country fixed effects.

Figure 4.2 and 4.3



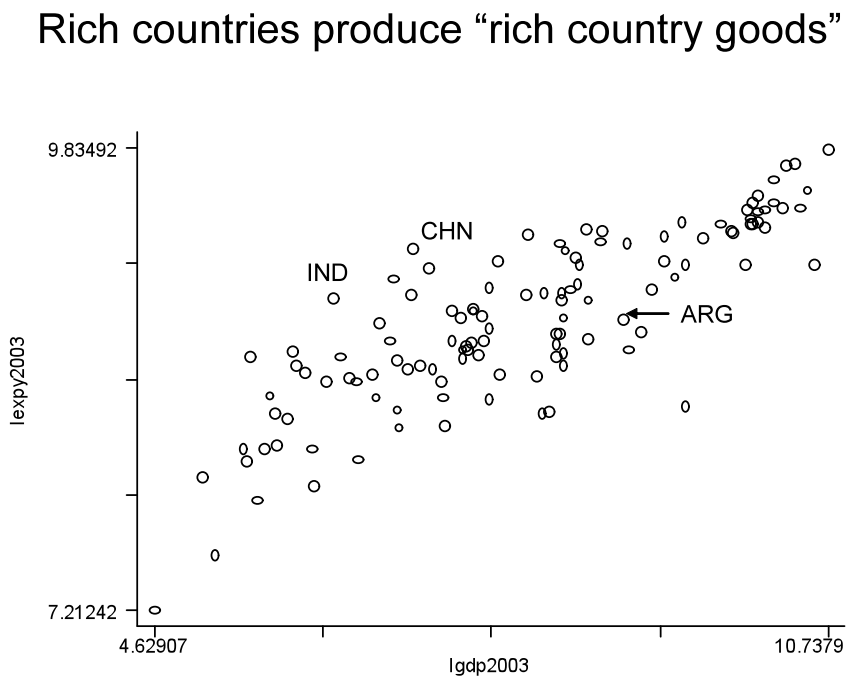


Figure 4.2 and 4.3

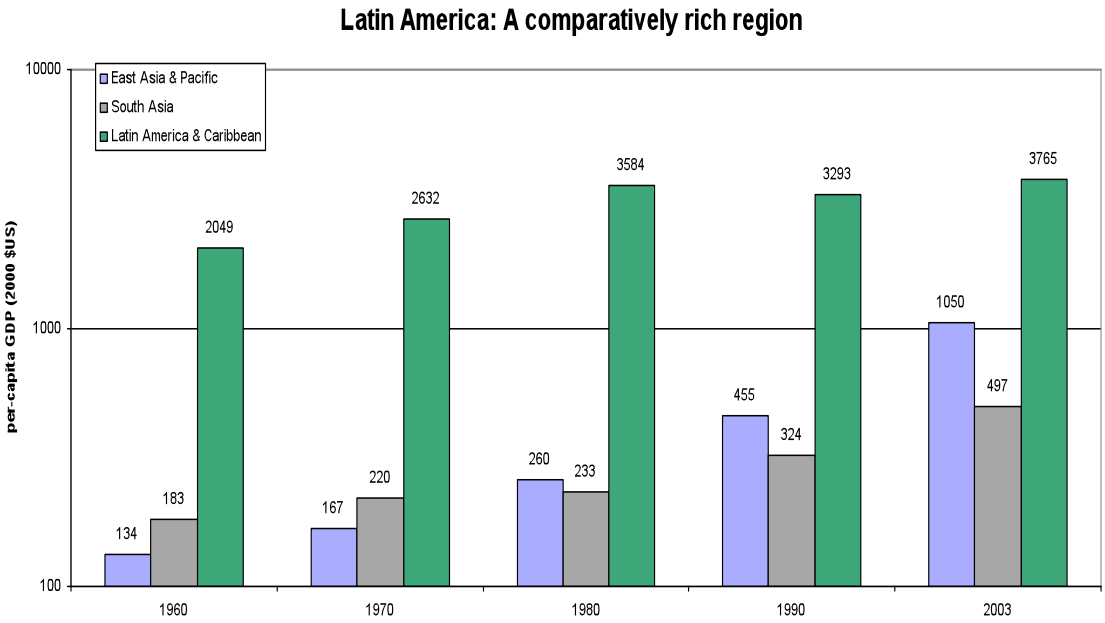


Figure 4.2 and 4.3

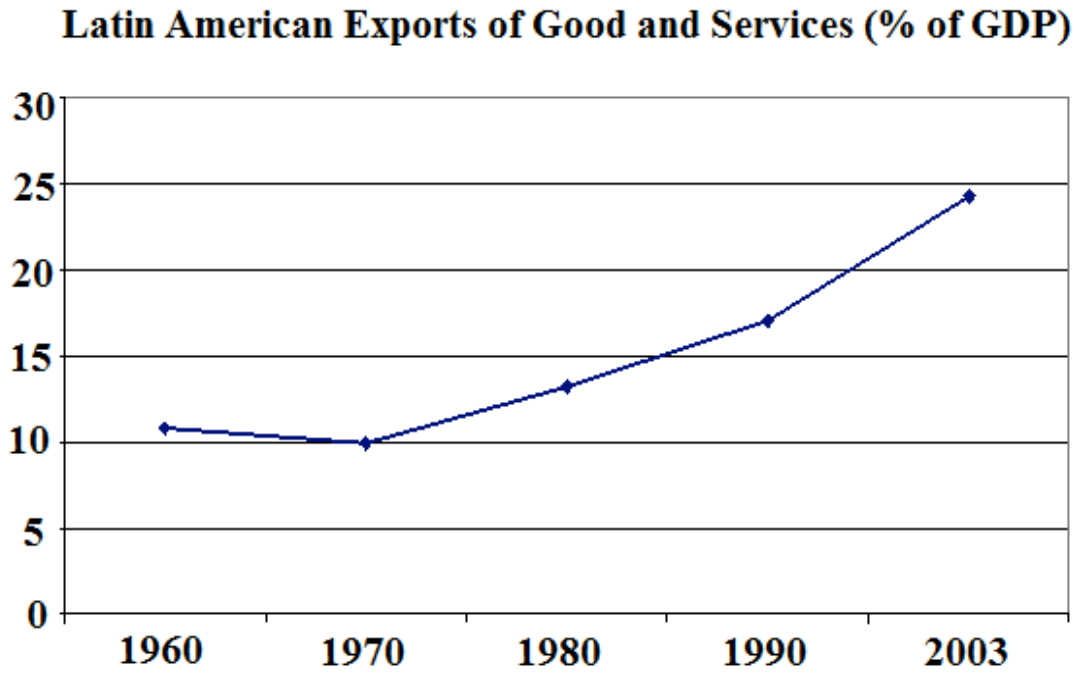
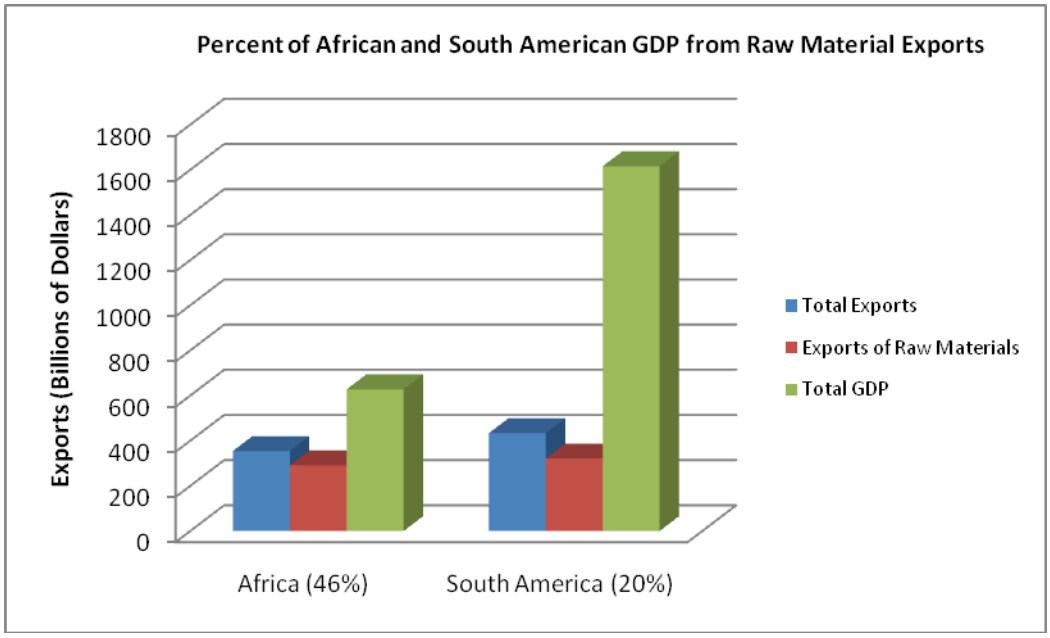
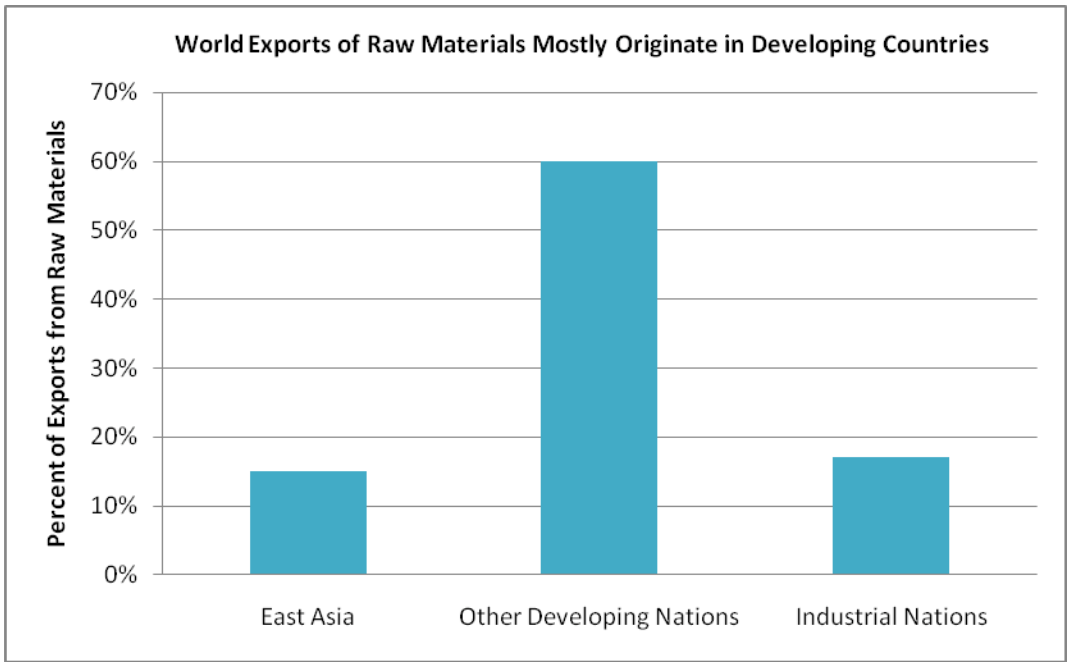


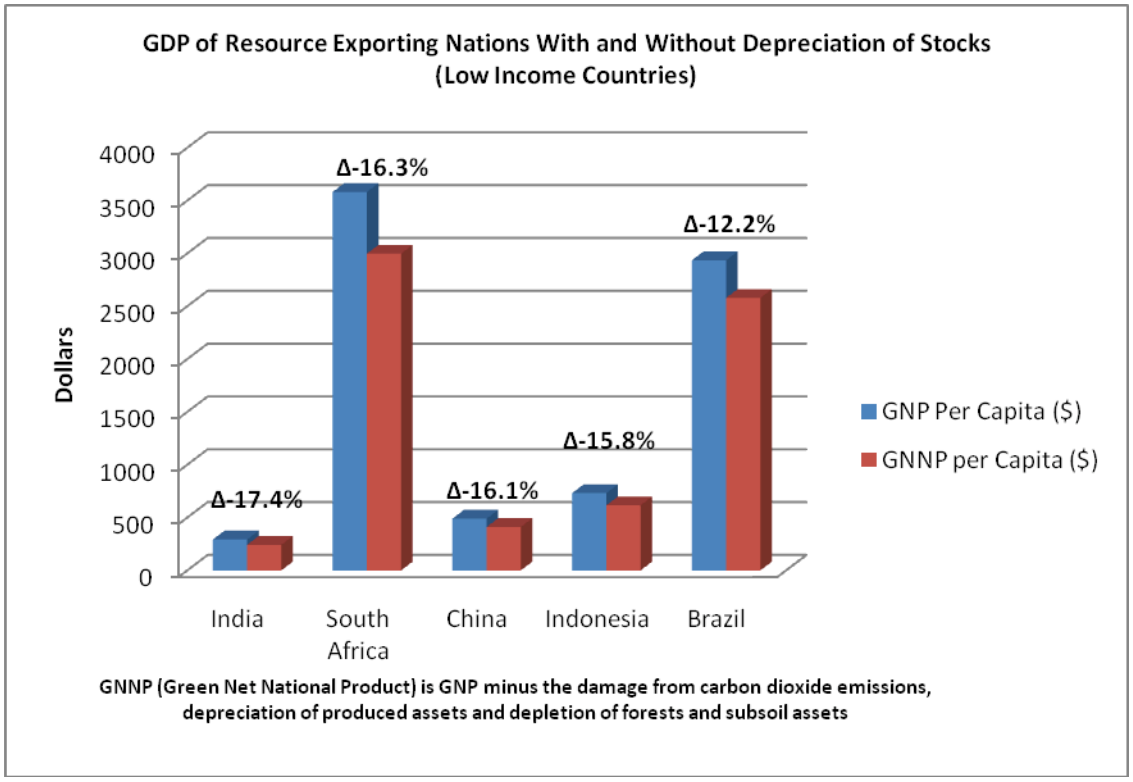
Figure 4.4


Percent of African and South American GDP from Raw Material Exports
Exports (Billions of Dollars)
1800
1600
1400
1200
1000
800
600
400
200
0
Africa (46%)
South America (20%)
Total Exports
Exports of Raw Materials
Total GDP

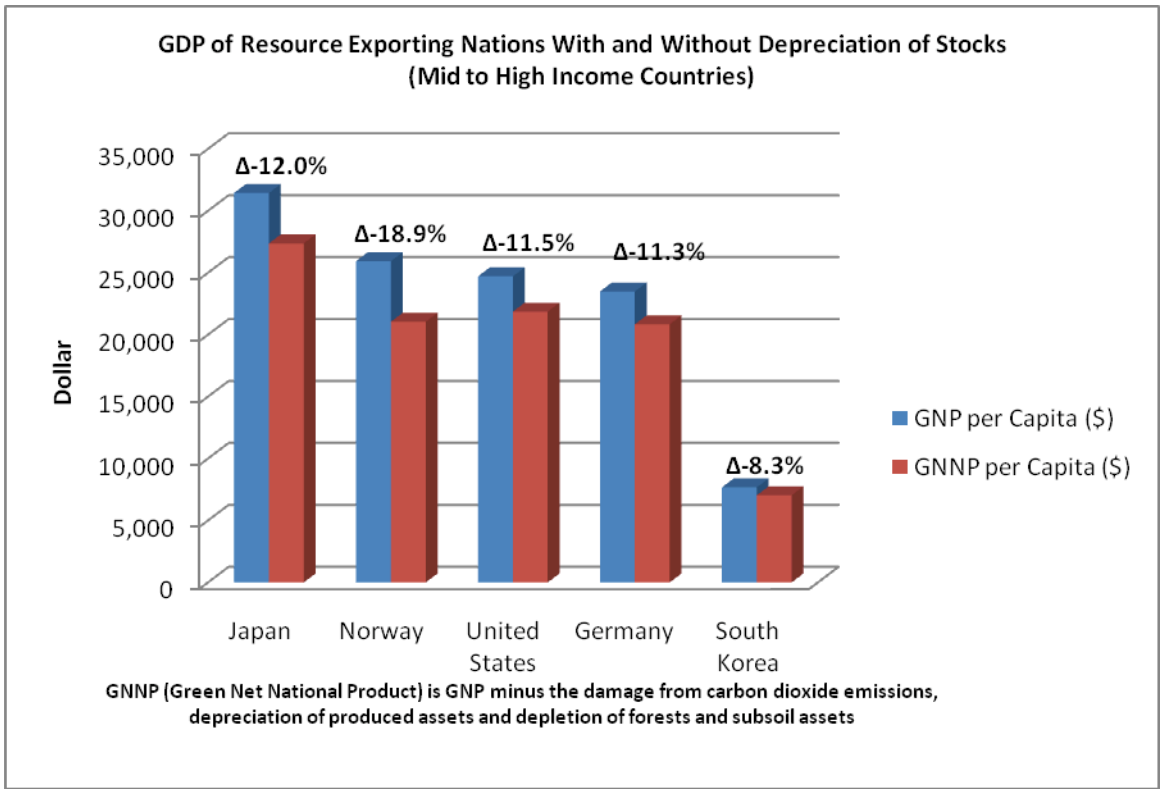
4.5


World Exports of Raw Materials Mostly Originate in Developing Countries
Percent of Exports from Raw Materials
70%
60%
50%
40%
30%
20%
10%
0%
East Asia
Other Developing Nations
Industrial Nations

4.6a


GDP of Resource Exporting Nations With and Without Depreciation of Stocks
(Low Income Countries)
Dollars
4000
3500
3000
2500
2000
1500
1000
500
0
Δ-17.4%
Δ-16.3%
Δ-16.1%
Δ-15.8%
Δ-12.2%
India
South Africa
China
Indonesia
Brazil
GNP Per Capita ($)
GNNP per Capita ($)
GNNP (Green Net National Product) is GNP minus the damage from carbon dioxide emissions, depreciation of produced assets and depletion of forests and subsoil assets

4.6b



4.6c

Green National Accounting: Taking Natural Resources into Consideration (1993)			
Country	**GNP per Capita ($)**	**GNNP per Capita ($)**	**% Fall in GNP**
India	**293**	**242**	**-17.4**
South Africa	**3,582**	**2,997**	**-16.3**
China	**490**	**411**	**-16.1**
Indonesia	**732**	**616**	**-15.8**
Brazil	**2,936**	**2,579**	**-12.2**
GNNP (Green Net National Product) is GNP minus the damage from carbon dioxide emissions, depreciation of produced assets and depletion of forests and subsoil assets			

4.7

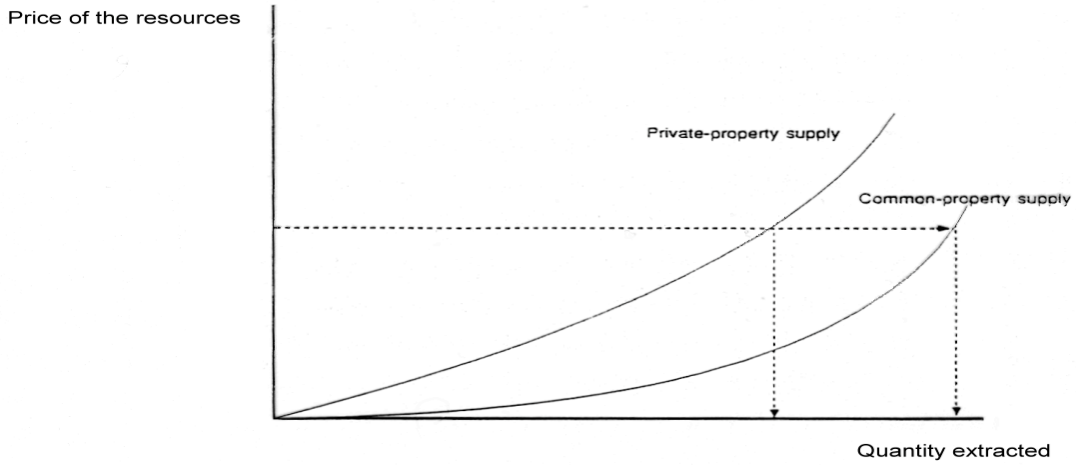
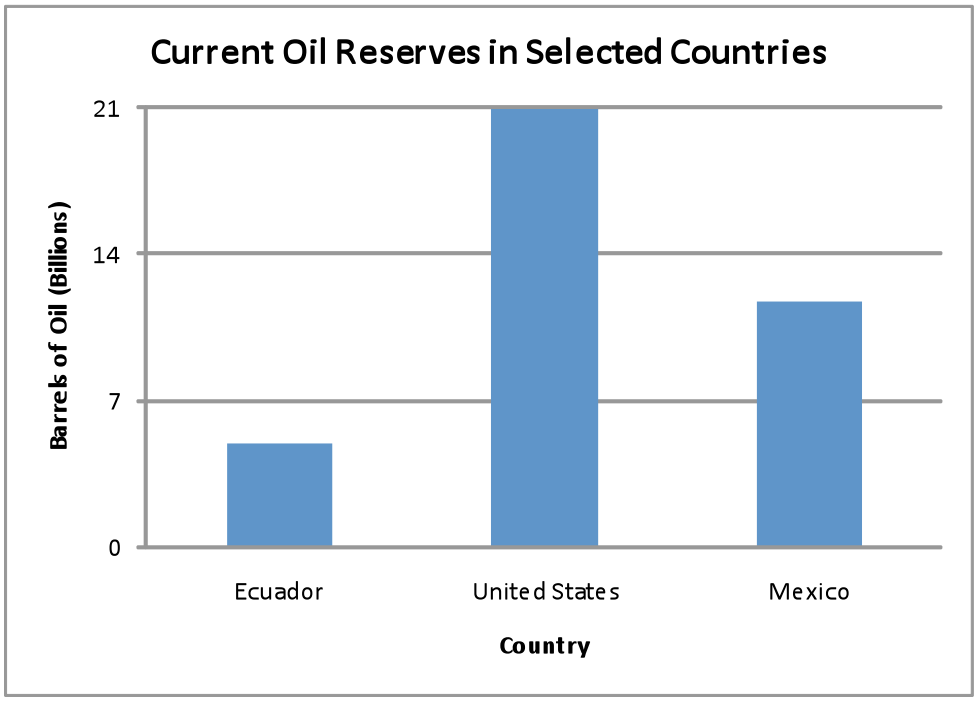


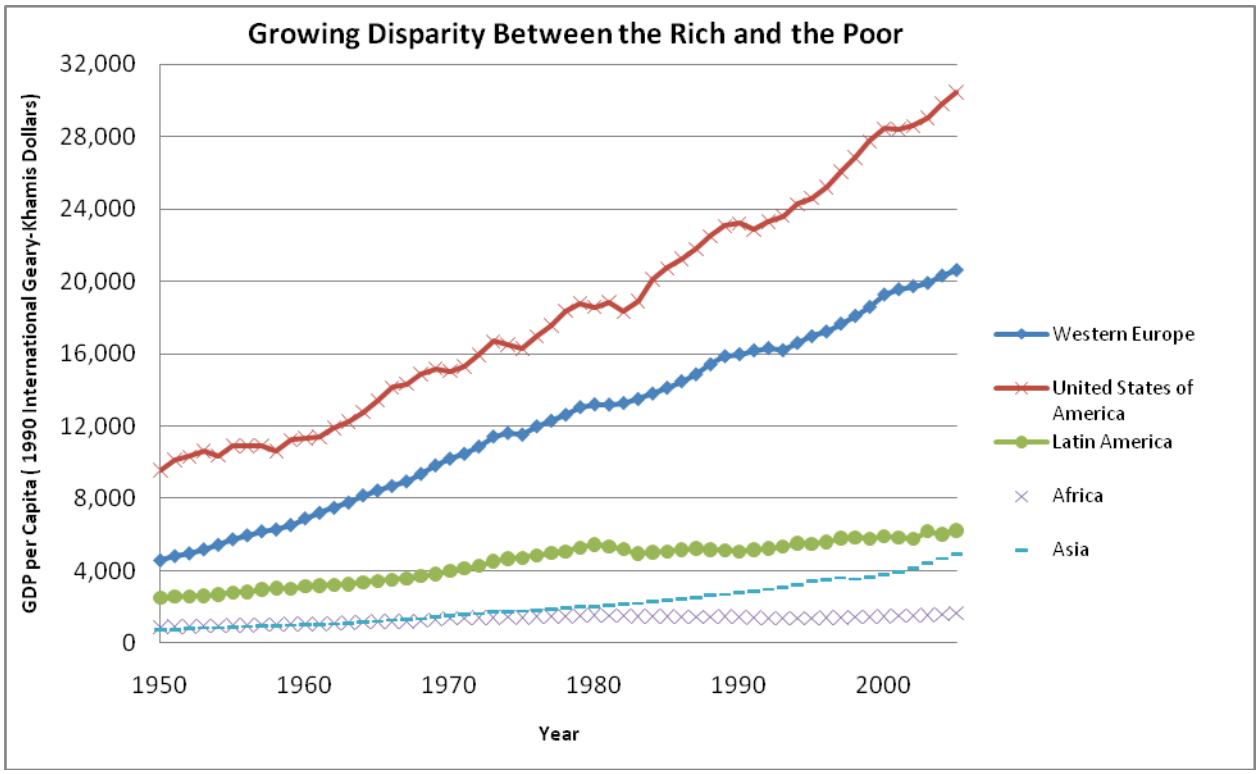
Figure 1. AT EACH PRICE, THE COMMON-PROPERTY SUPPLY EXCEEDS THE PRIVATE-PROPERTY SUPPLY

Chichilnisky, G. "North-South Trade and the Global Environment", American Economic Review, September 1994.

4.8


Current Oil Reserves in Selected Countries
Barrels of Oil (Billions)
21
14
7
0
Ecuador
United States
Mexico
Country

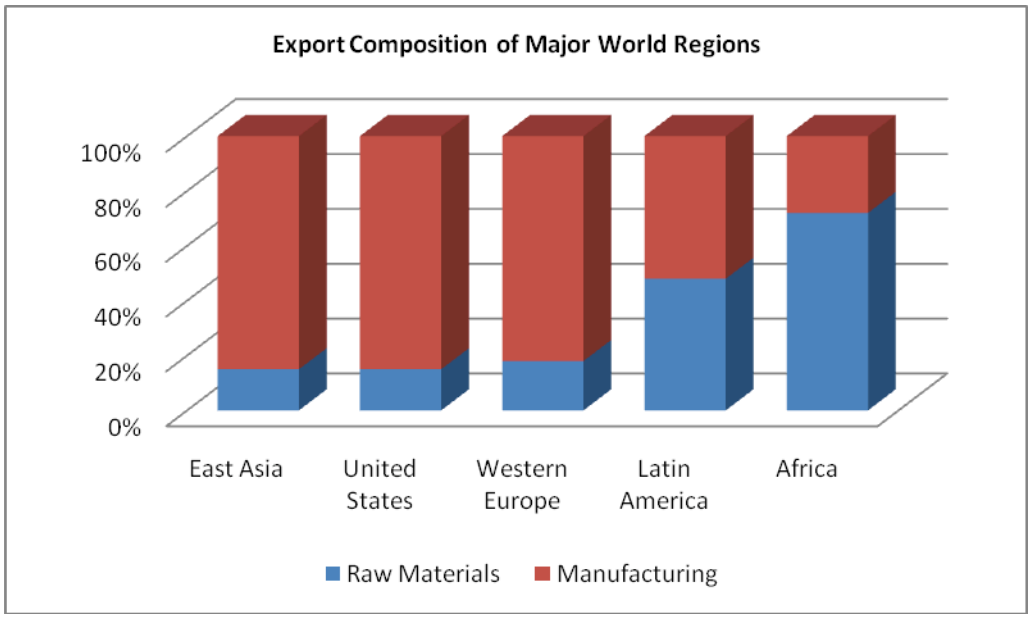
5.1


Growing Disparity Between the Rich and the Poor
GDP per Capita (1990 International Geary-Khamis Dollars)
32,000
28,000
24,000
20,000
16,000
12,000
8,000
4,000
0
1950
1960
1970
1980
1990
2000
Year
Western Europe
United States of America
Latin America
Africa
Asia

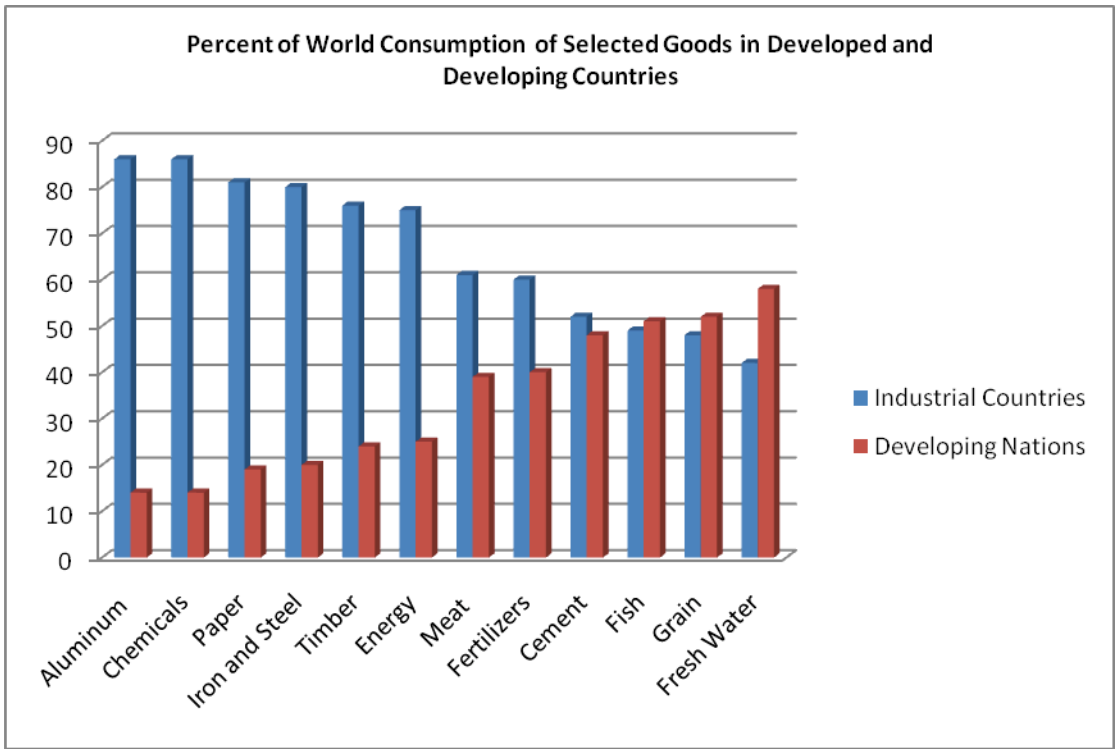
5.2 (Same as 2.3)


Growth in Global Trade and Global Economy since 1950
Dollars (Constant 1990 Prices)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Years (1950, 1998 and 2005)
World Trade - 6.2% average growth
World GDP - 3.8% average growth

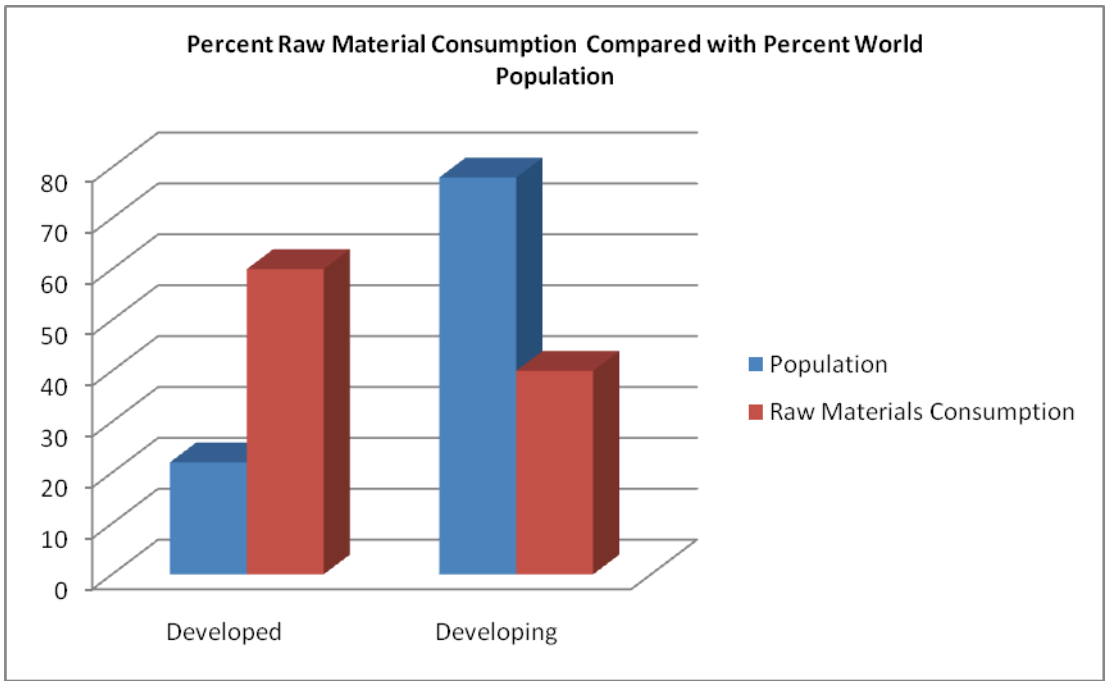
5.3a


Export Composition of Major World Regions
100%
80%
60%
40%
20%
0%
East Asia
United States
Western Europe
Latin America
Africa
Raw Materials
Manufacturing

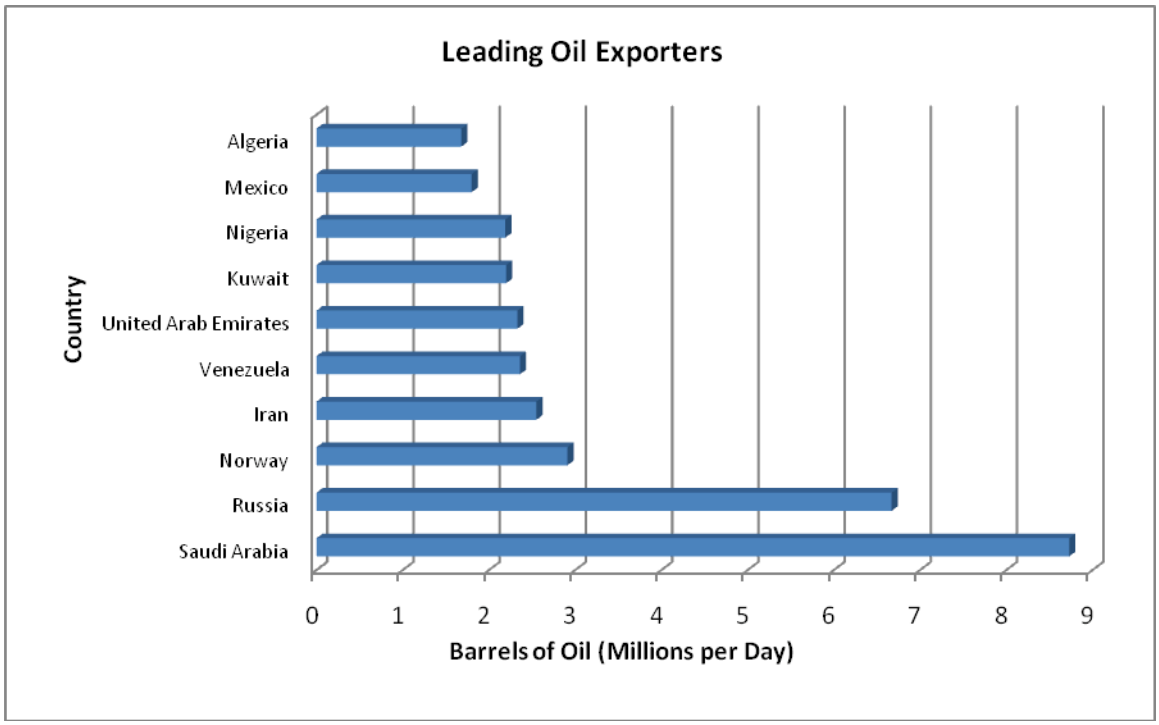
5.3b


Percent of World Consumption of Selected Goods in Developed and Developing Countries
90
80
70
60
50
40
30
20
10
0
Aluminum
Chemicals
Paper
Iron and Steel
Timber
Energy
Meat
Fertilizers
Cement
Fish
Grain
Fresh Water
Industrial Countries
Developing Nations

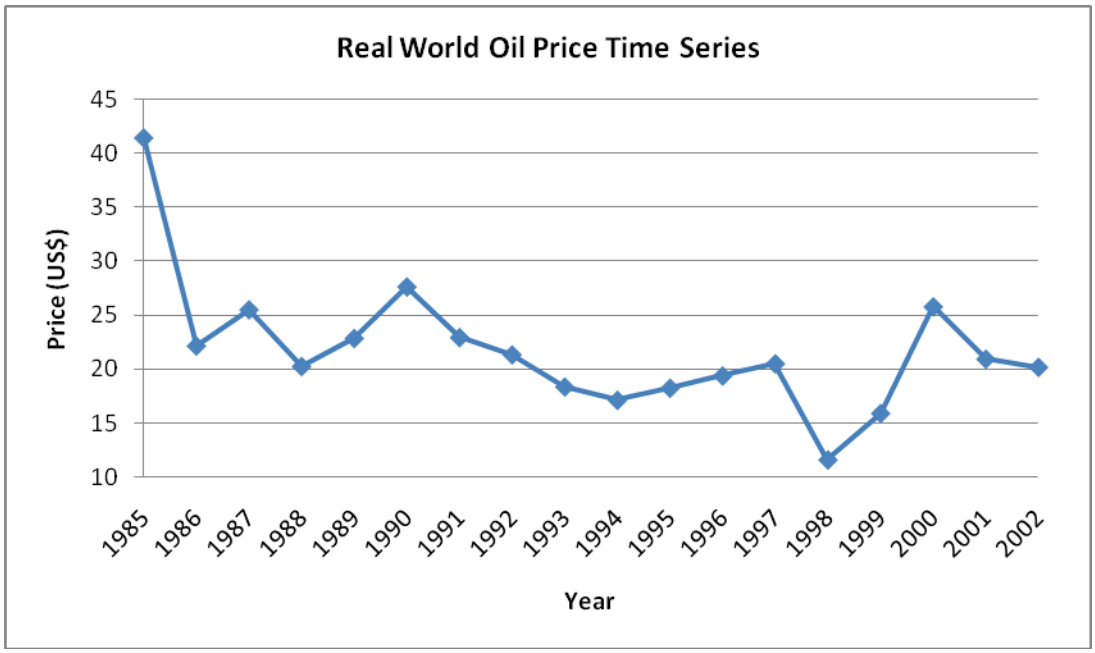
5.3c


Percent Raw Material Consumption Compared with Percent World Population
80
70
60
50
40
30
20
10
0
Developed
Developing
Population
Raw Materials Consumption

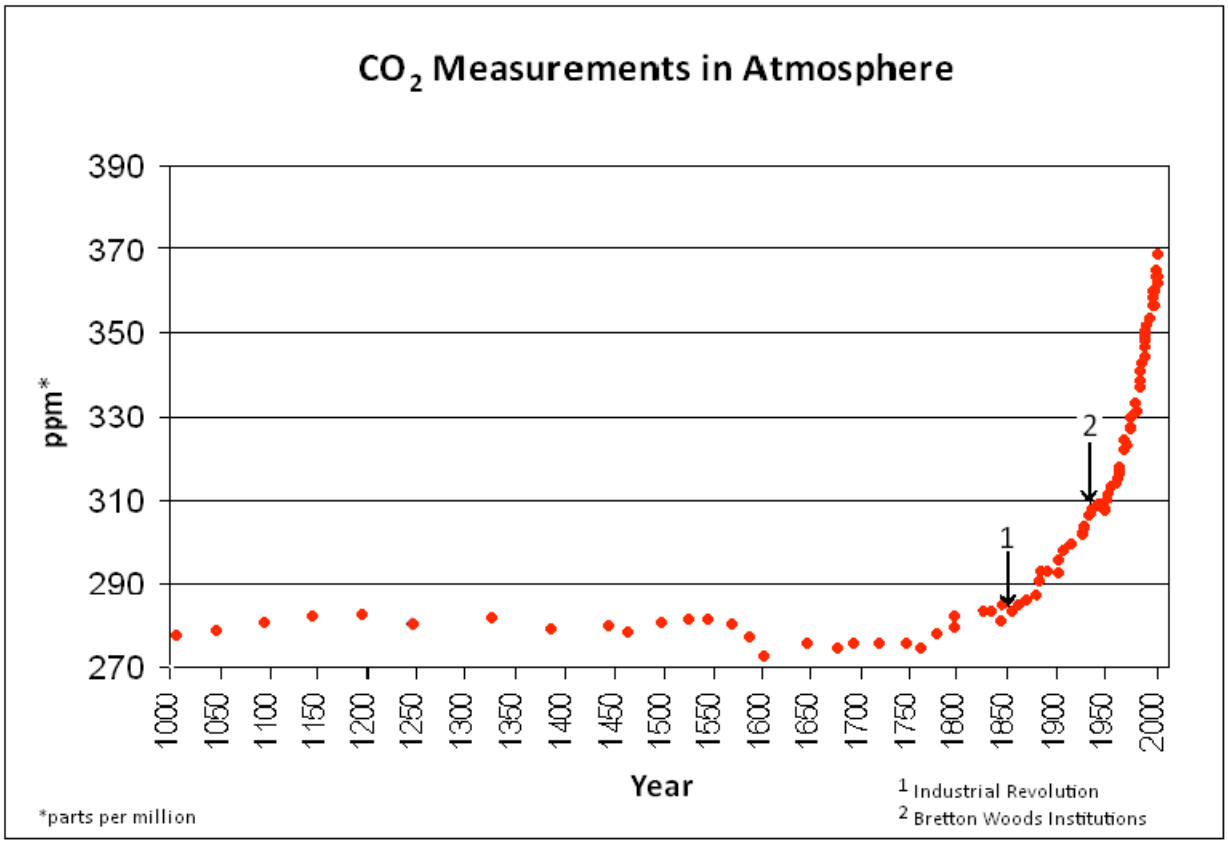
5.4a


Leading Oil Exporters
Country
Algeria
Mexico
Nigeria
Kuwait
United Arab Emirates
Venezuela
Iran
Norway
Russia
Saudi Arabia
0
1
2
3
4
5
6
7
8
9
Barrels of Oil (Millions per Day)

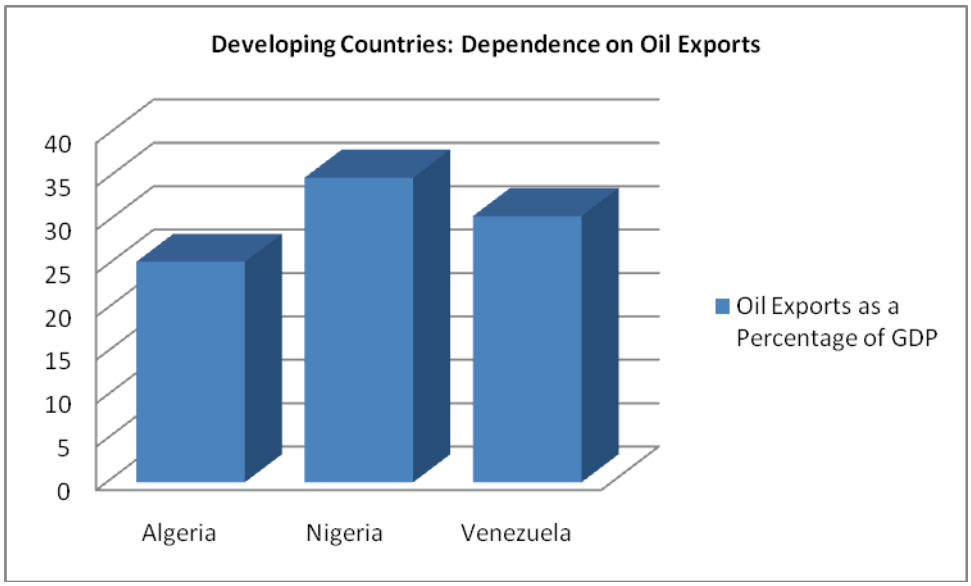
5.4b


Real World Oil Price Time Series
Price (US$)
45
40
35
30
25
20
15
10
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year

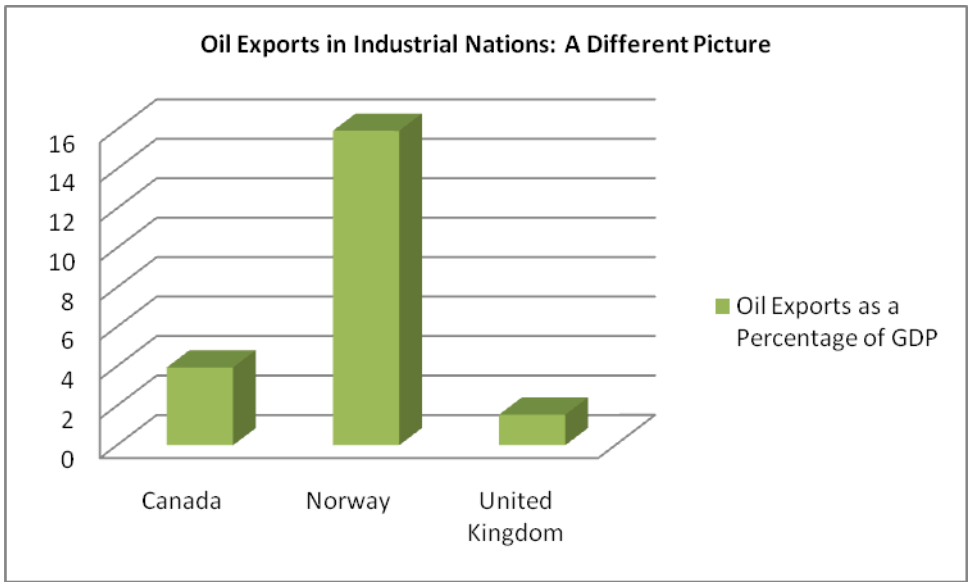
5.5


CO2 Measurements in Atmosphere
390
370
350
330
310
290
270
ppm*
1000
1050
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000
Year
1
2
*parts per million
1 Industrial Revolution
2 Bretton Woods Institutions

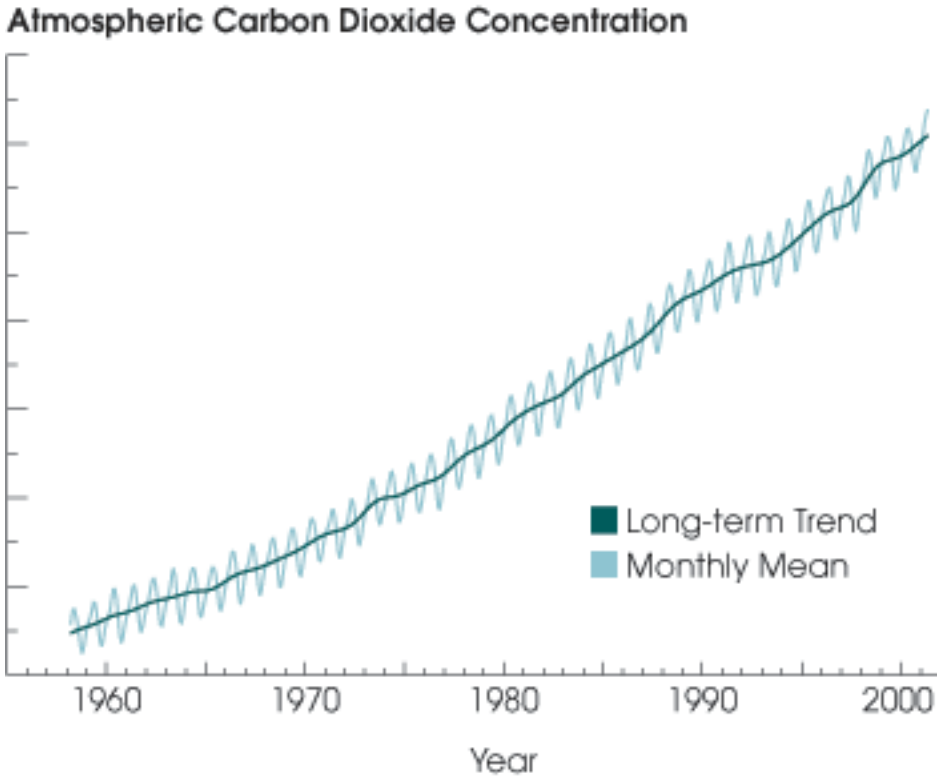
5.6


Developing Countries: Dependence on Oil Exports
40
35
30
25
20
15
10
5
0
Algeria
Nigeria
Venezuela
Oil Exports as a Percentage of GDP

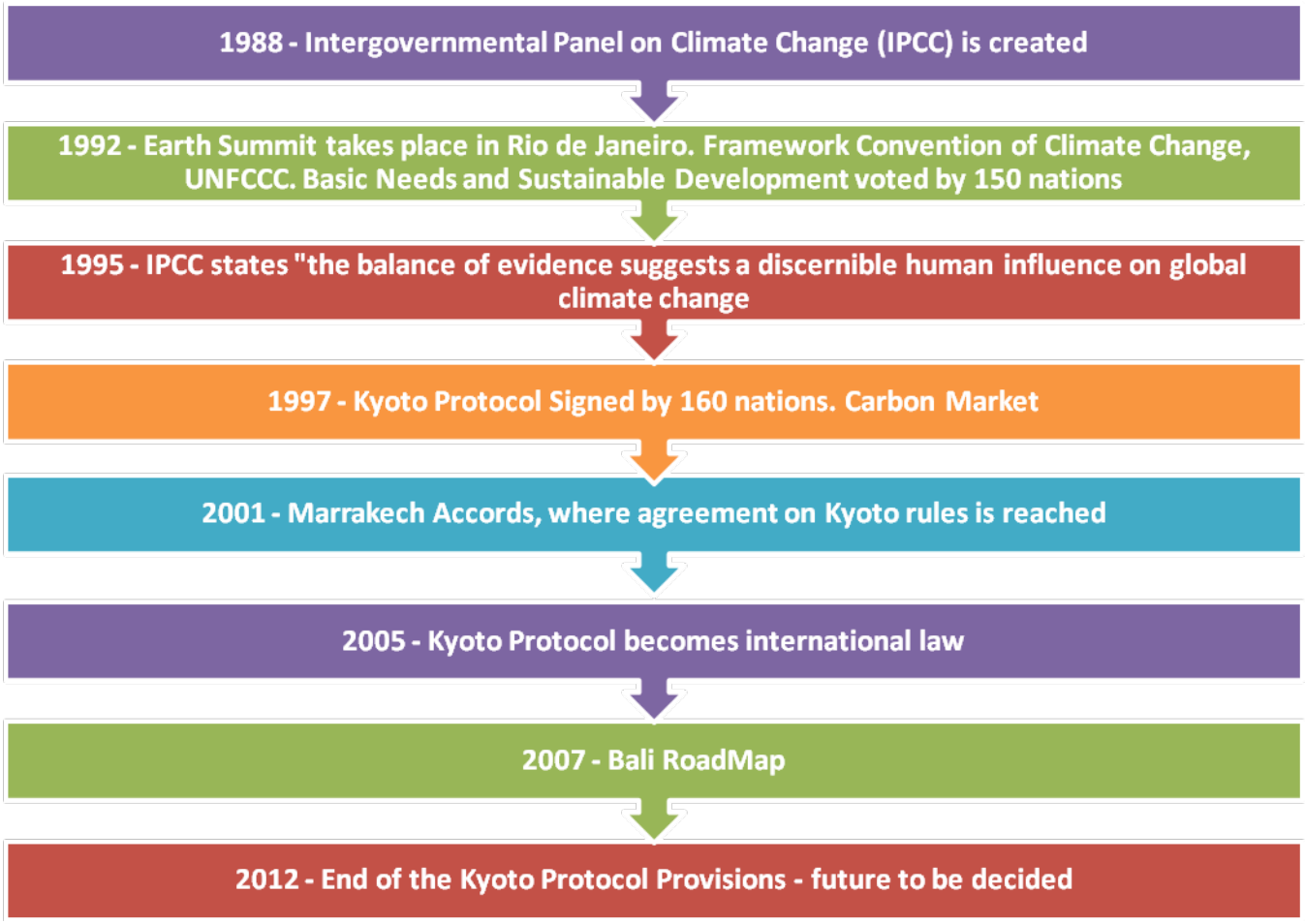
5.7


Oil Exports in Industrial Nations: A Different Picture
16
14
12
10
8
6
4
2
0
Canada
Norway
United Kingdom
Oil Exports as a Percentage of GDP

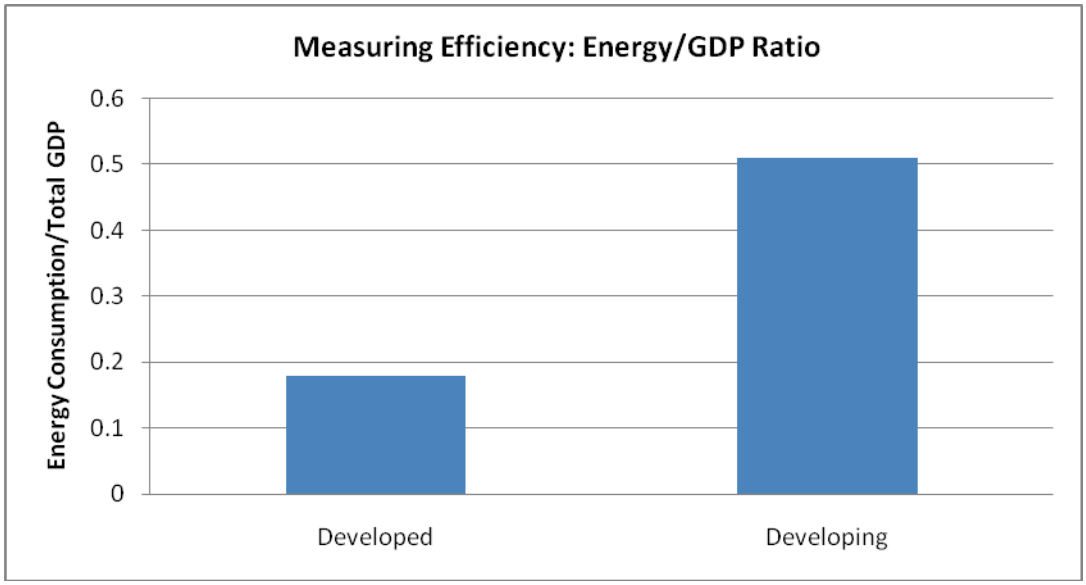
5.8


Atmospheric Carbon Dioxide Concentration
Long-term Trend
Monthly Mean
1960
1970
1980
1990
2000
Year

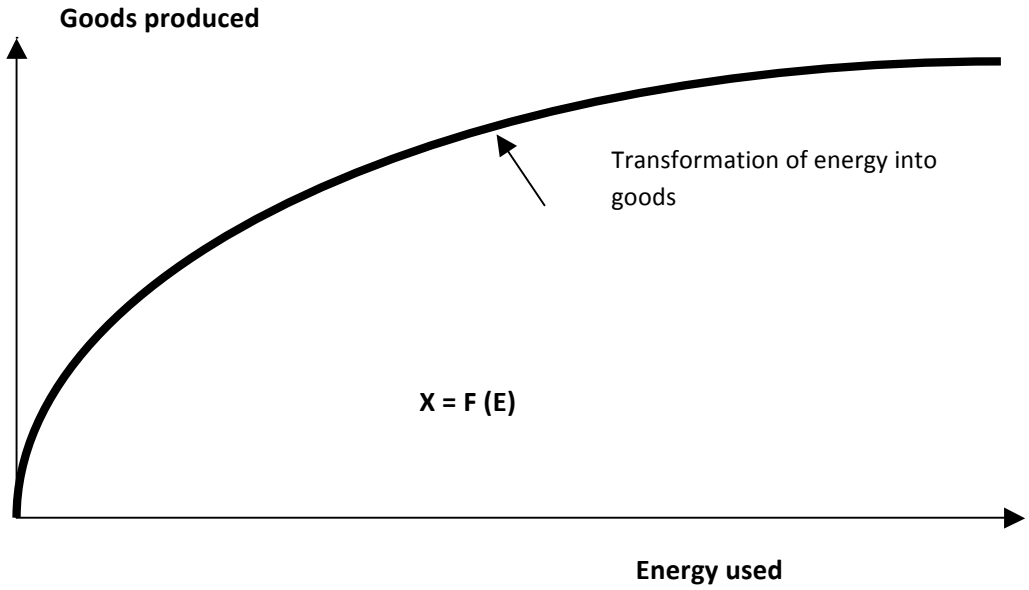
5.9


1988 - Intergovernmental Panel on Climate Change (IPCC) is created
1992 - Earth Summit takes place in Rio de Janeiro. Framework Convention of Climate Change, UNFCCC. Basic Needs and Sustainable Development voted by 150 nations
1995 - IPCC states "the balance of evidence suggests a discernible human influence on global climate change
1997 - Kyoto Protocol Signed by 160 nations. Carbon Market
2001 - Marrakech Accords, where agreement on Kyoto rules is reached
2005 - Kyoto Protocol becomes international law
2007 - Bali RoadMap
2012 - End of the Kyoto Protocol Provisions - future to be decided

5.10


Measuring Efficiency: Energy/GDP Ratio
Energy Consumption/Total GDP
0.6
0.5
0.4
0.3
0.2
0.1
0
Developed
Developing

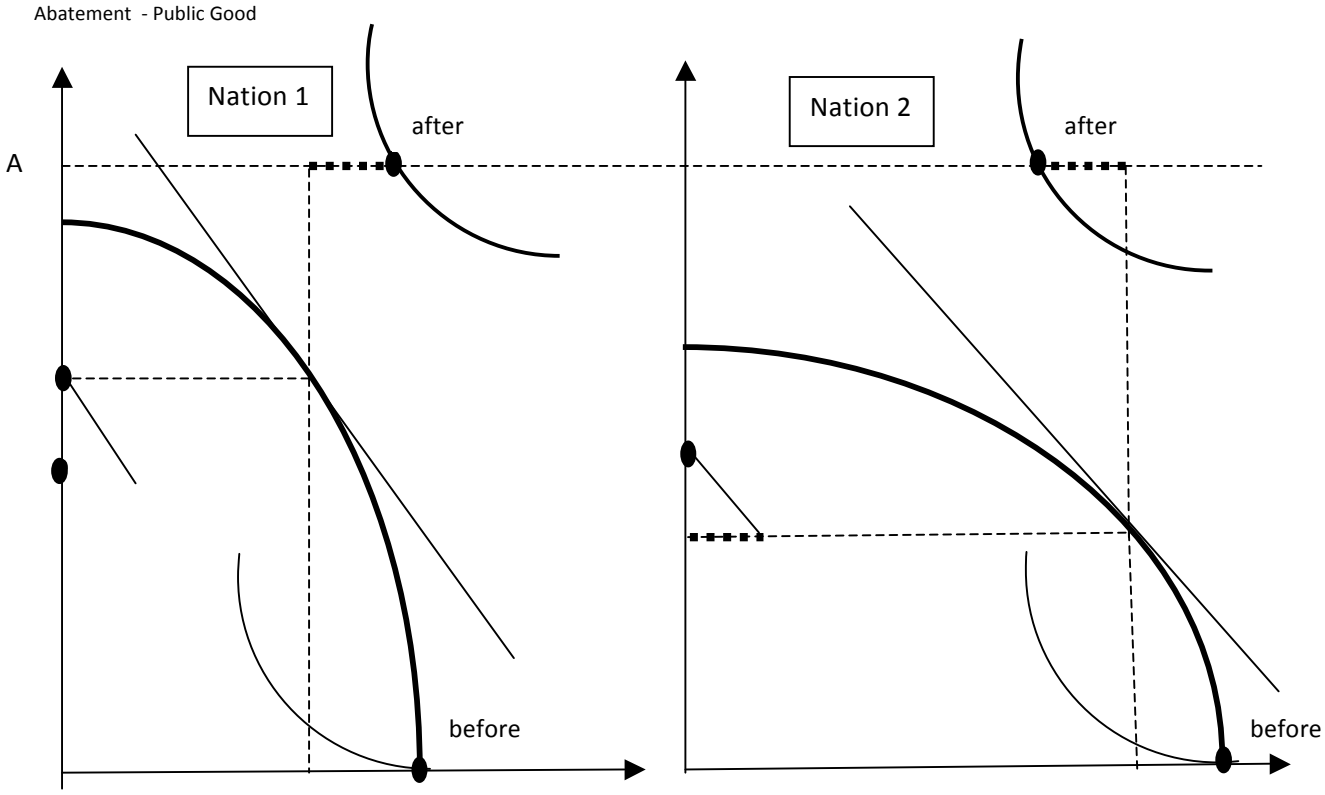
6.1


Goods produced
Transformation of energy into goods
X = F (E)
Energy used

6.2

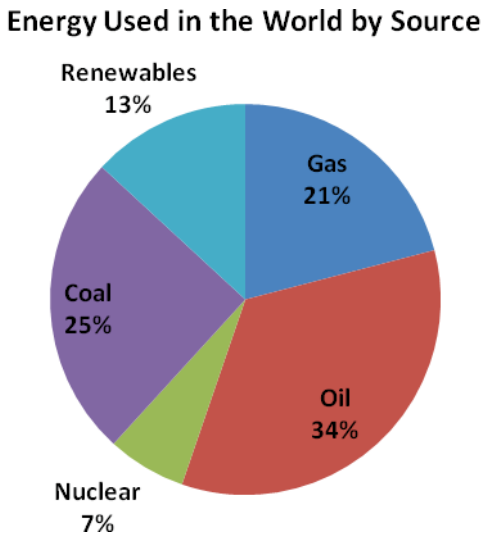
Figure 6.2 Environmental quality v. fossil energy used

6.3

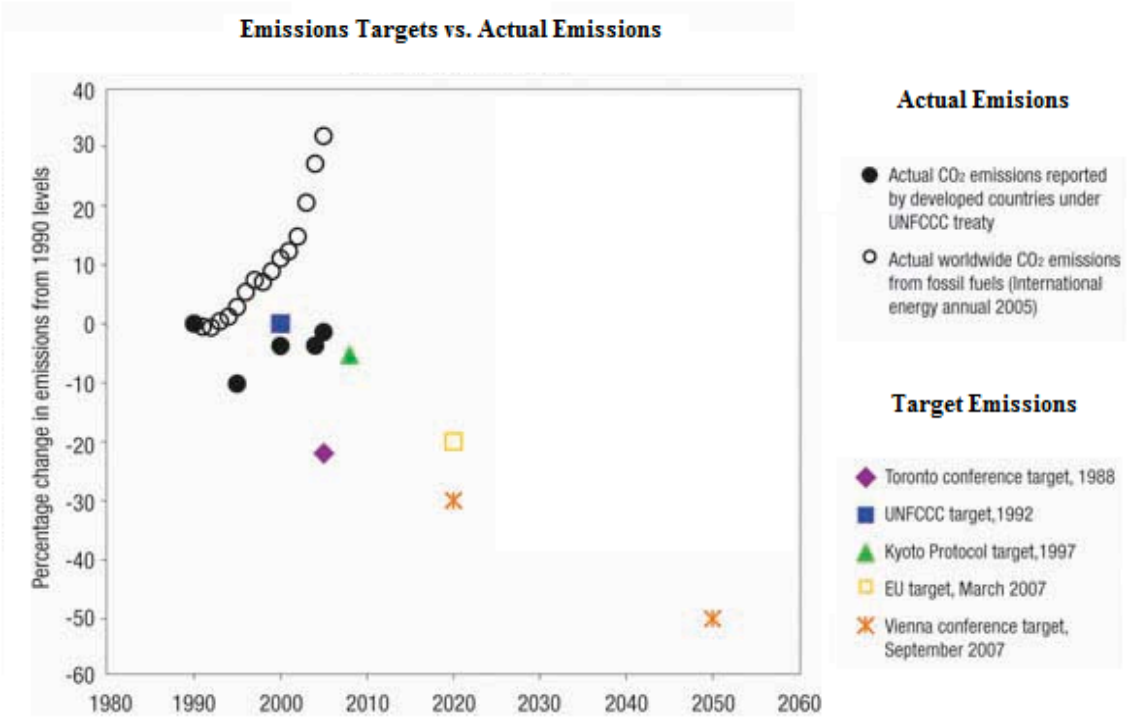


In each nation the curved lines indicate the trade – off between the production of private goods and less emissions, or a better atmosphere. Before the carbon market there is no obligation to limit emissions, and both nations consume the maximum amount of private goods they can produce, indicated by the dots on the horizontal axis. Once limits on emissions or "caps" are established, as indicated by the dots on the vertical axis, nation one sells credits and nation 2 buys them. The two nations trade their emissions rights in the carbon market, where the value of their carbon credits traded in terms of private goods is indicated with short dotted lines. In sum: after the carbon market is introduced both nations reach a higher welfare level s consuming at the points indicated "after" rather than "before", and, in addition, global emissions decrease with abatement level **A.**

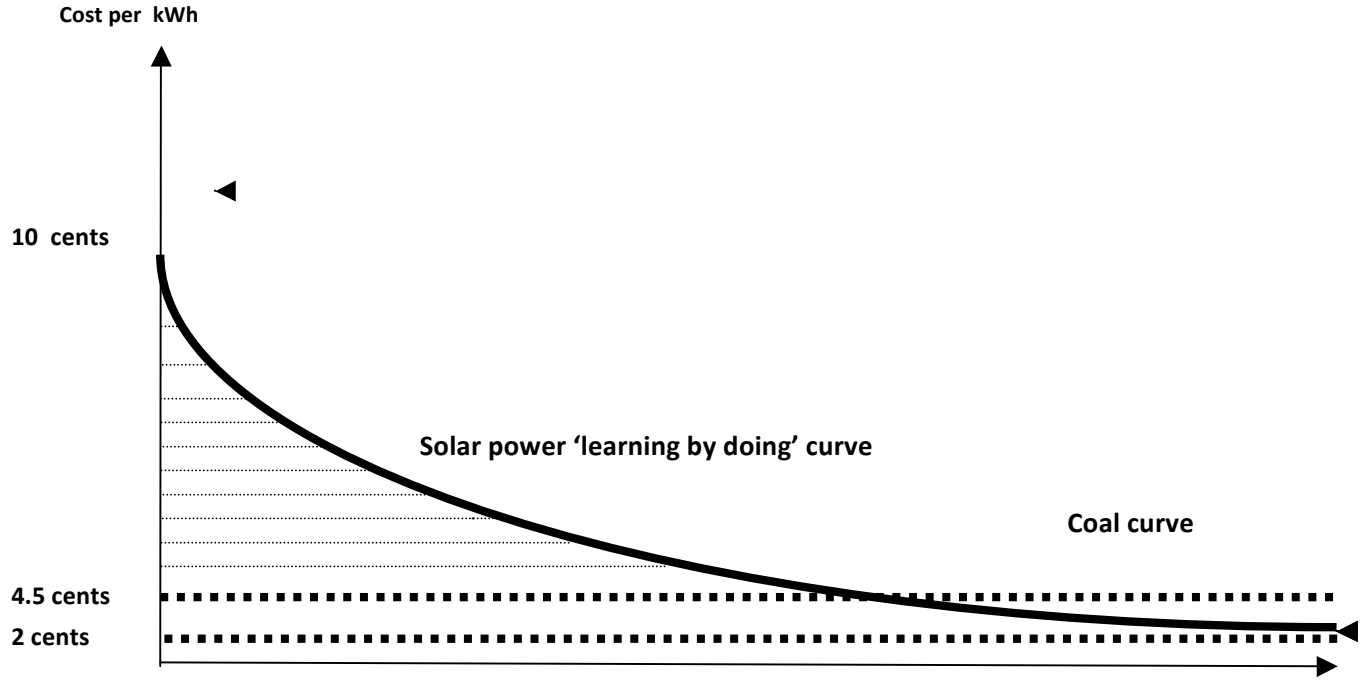
7.1


Energy Used in the World by Source
Renewables
13%
Gas
21%
Coal
25%
Oil
34%
Nuclear
7%

7.2


Emissions Targets vs. Actual Emissions
Percentage change in emissions from 1990 levels
40
30
20
10
0
-10
-20
-30
-40
-50
-60
1980
1990
2000
2010
2020
2030
2040
2050
2060
Actual Emisions
Actual CO2 emissions reported by developed countries under UNFCCC treaty
Actual worldwide CO2 emissions from fossil fuels (International energy annual 2005)
Target Emissions
Toronto conference target, 1988
UNFCCC target,1992
Kyoto Protocol target,1997
EU target, March 2007
Vienna conference target, September 2007

7.3


Cost per kWh
10 cents
Solar power 'learning by doing' curve
Coal curve
4.5 cents
2 cents

7.4

Property Insurance Premiums on Standard and Catastrophic Risks

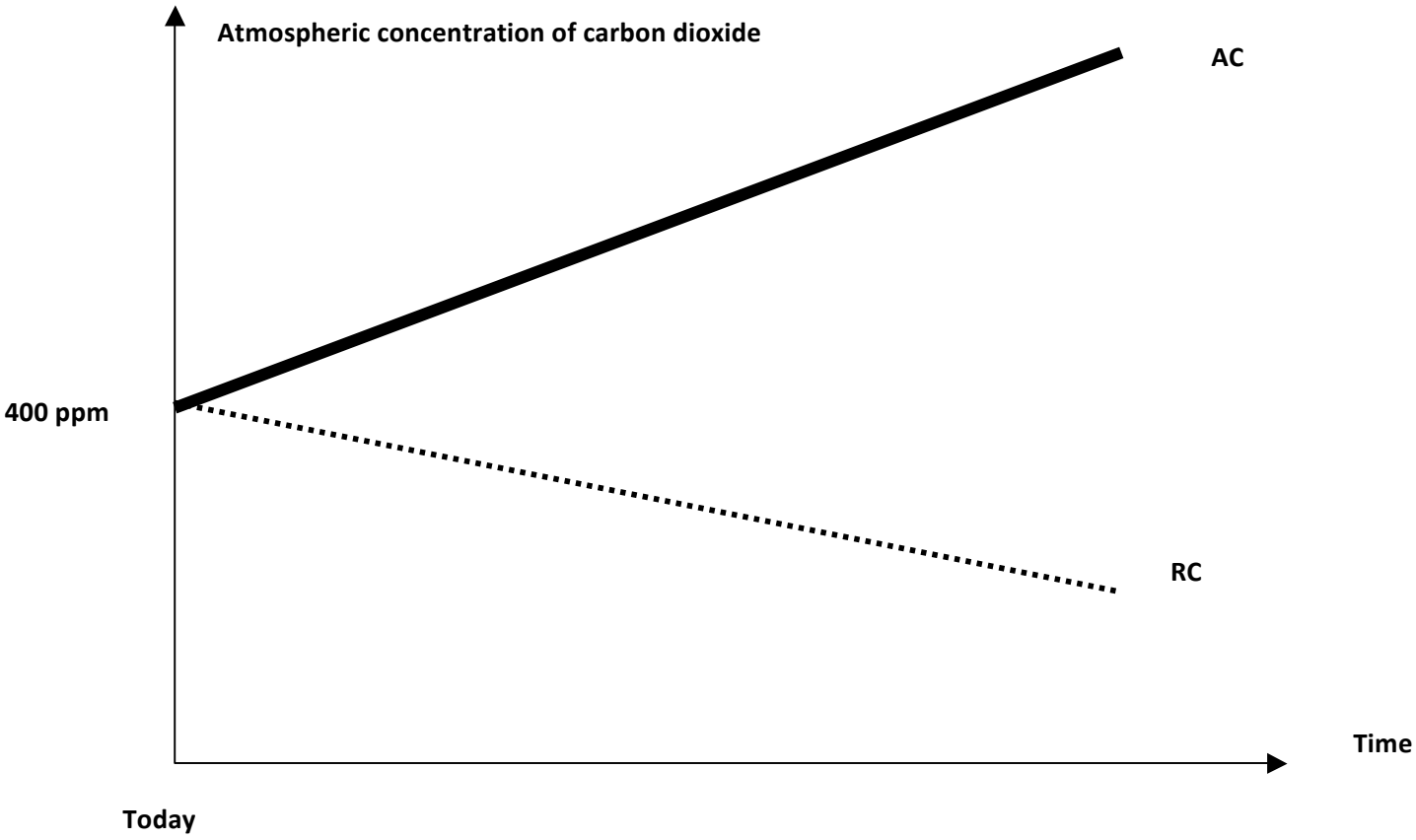
Percentage Paid to Protect Covered Amount		**Avg. Premium per $1000 Protected**
Flood[1]	2.2% to 2.8%	$22 to $28
Earthquakes[2]	1.0% to 2.2%	$10 to $22
Basic Homeowner's[3]	0.2% to 0.7%	$2 to $7

7.5

‘Clean’ Coal and Negative Carbon

AC = Avoided carbon: reduces emissions but carbon concentration continues to increase

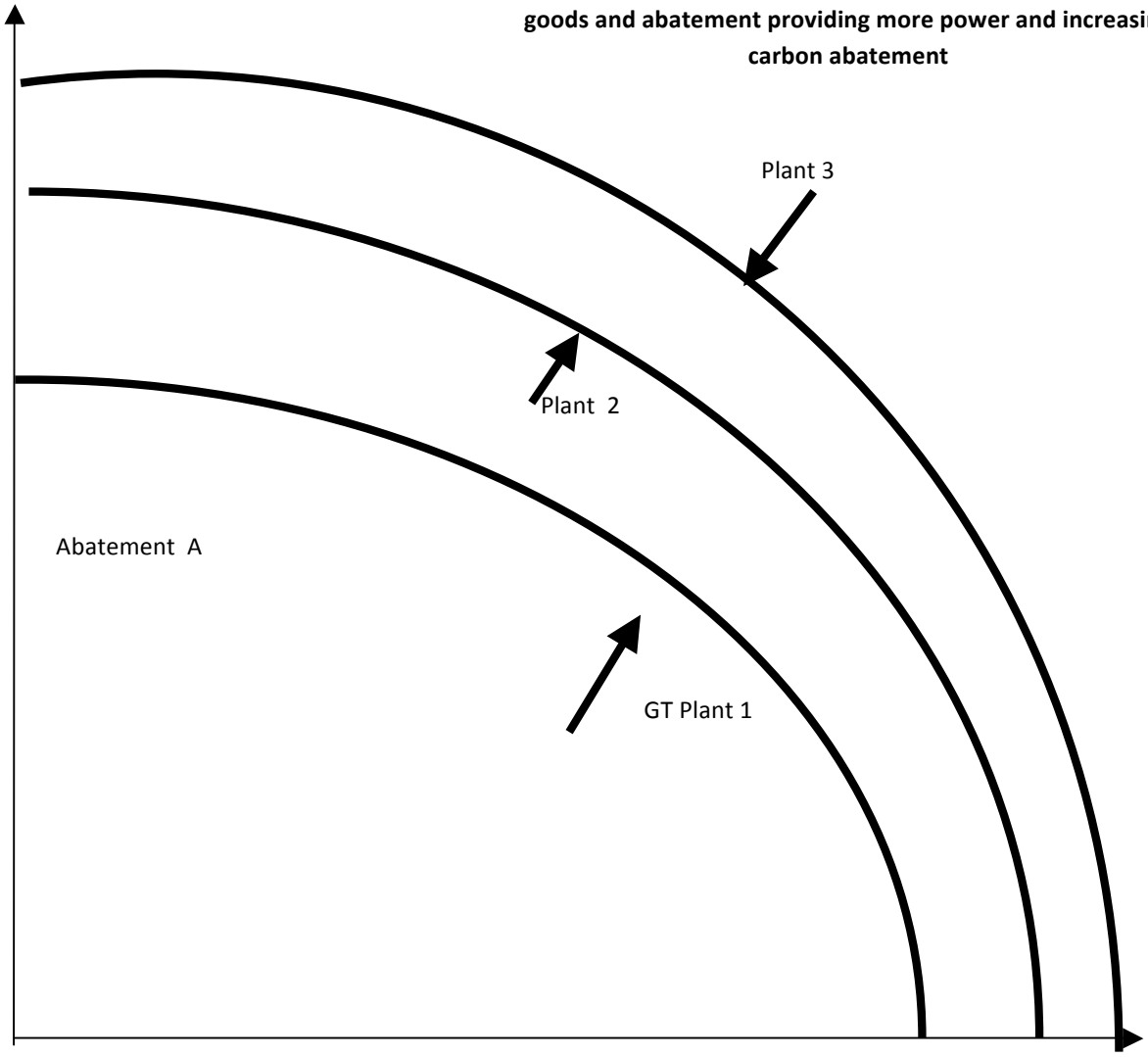
RC = Reduced carbon: reduces concentration through air capture of CO2



7.6

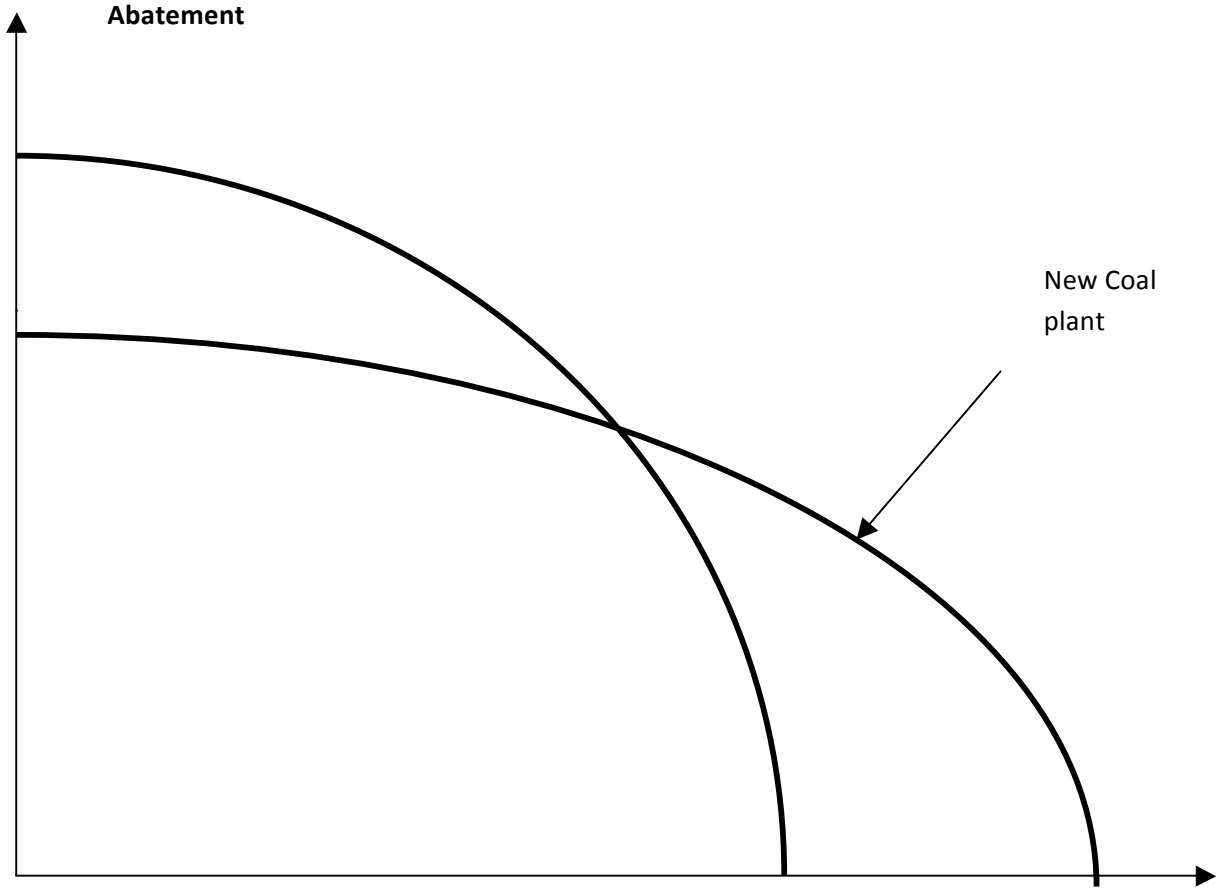
Figure 7.6

Each new GT plant changes the transformation curve between goods and abatement providing more power and increasing carbon abatement



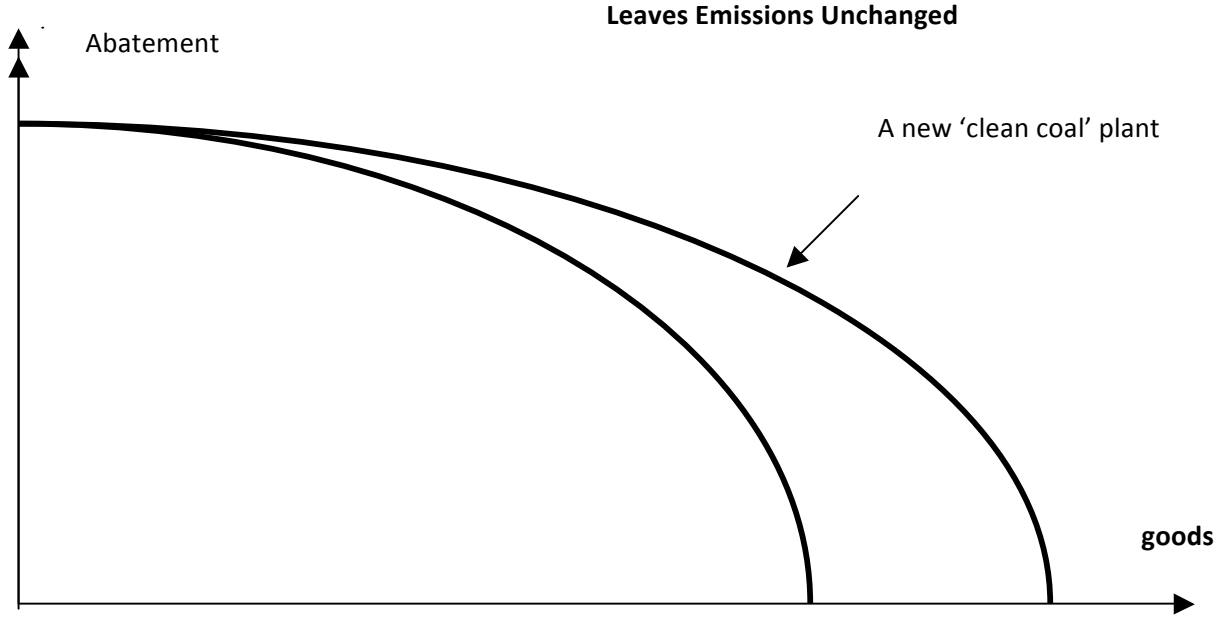
7.7

Figure 7.7: A New Coal Plant



7.8

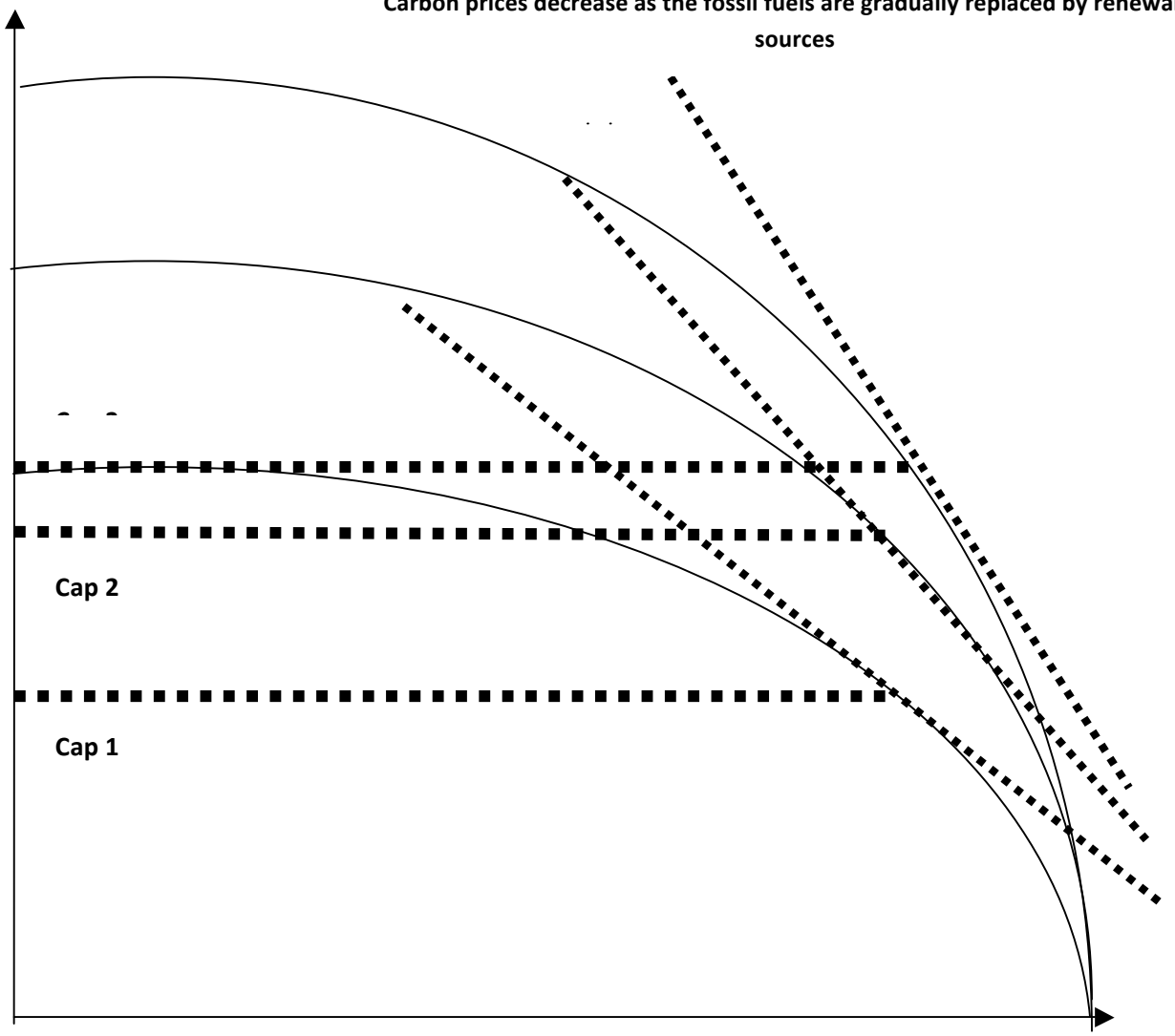
Figure 7.8: A New Coal Plant Increases Power but Leaves Emissions Unchanged



7.9

Figure 7.9

Carbon prices decrease as the fossil fuels are gradually replaced by renewable sources



7.10

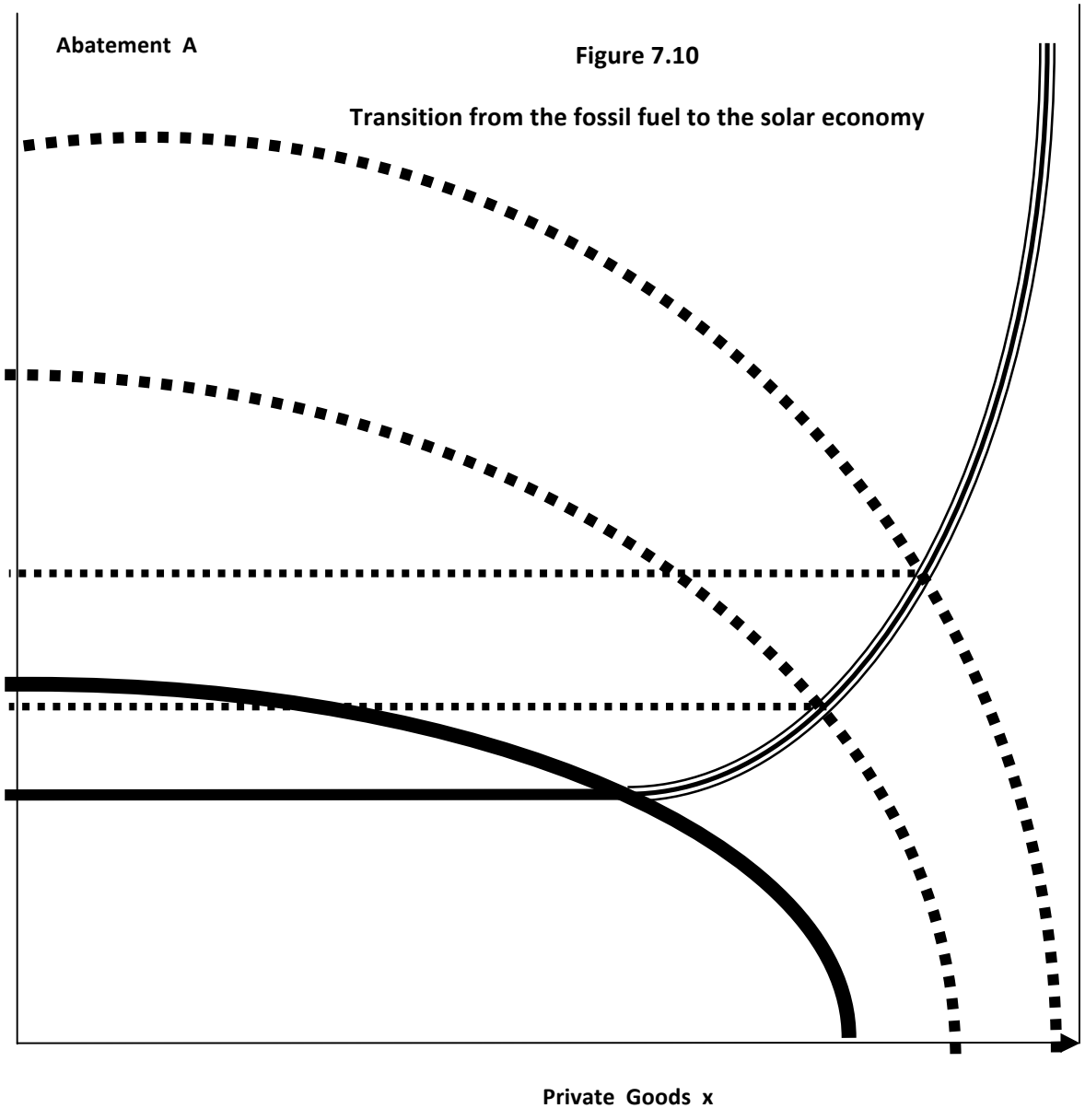
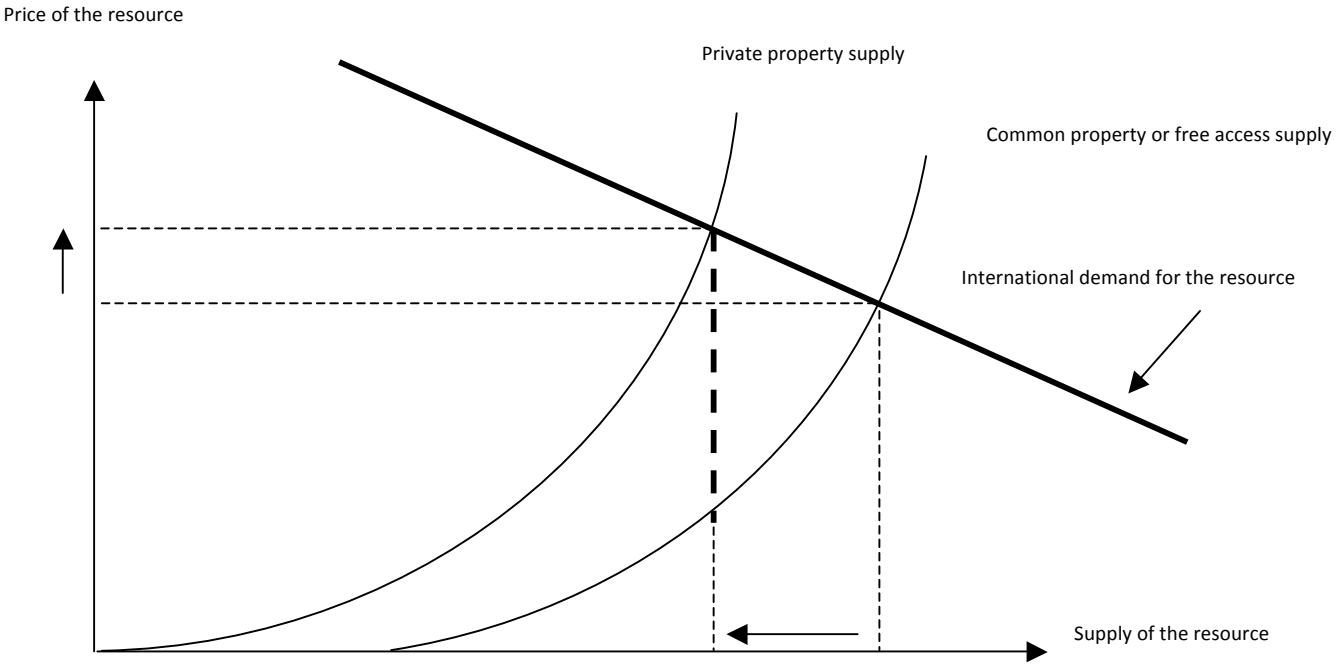


Figure 7.10

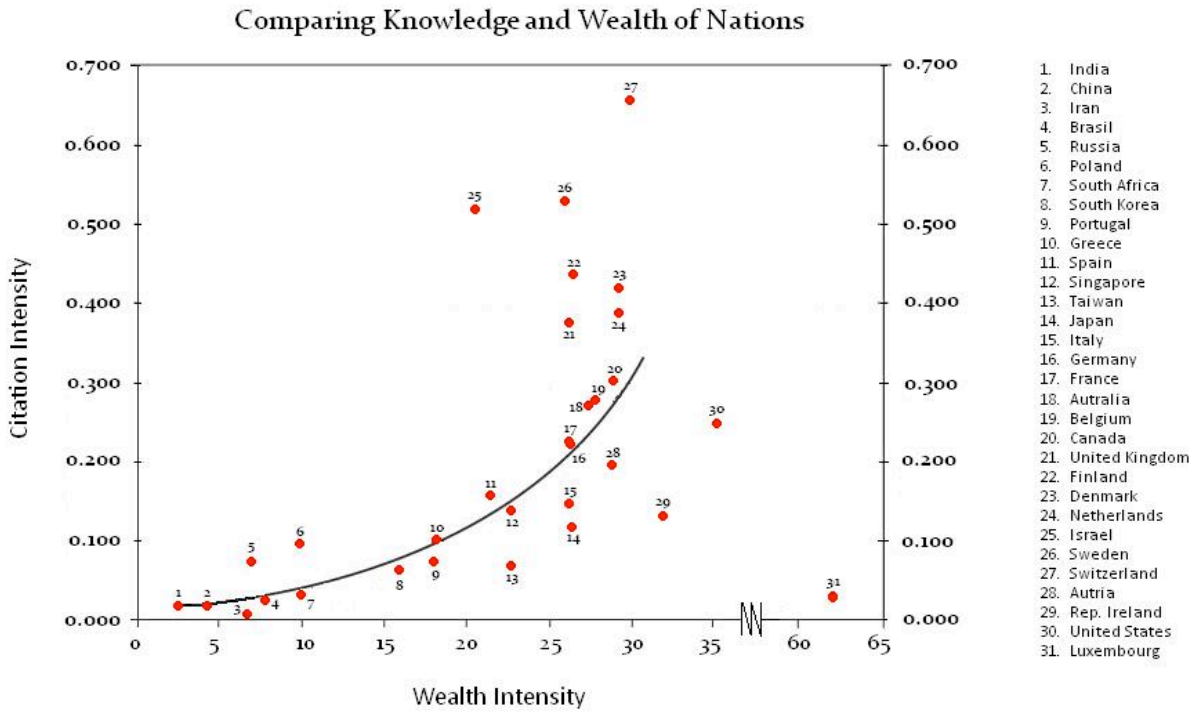
Transition from the fossil fuel to the solar economy

8.1

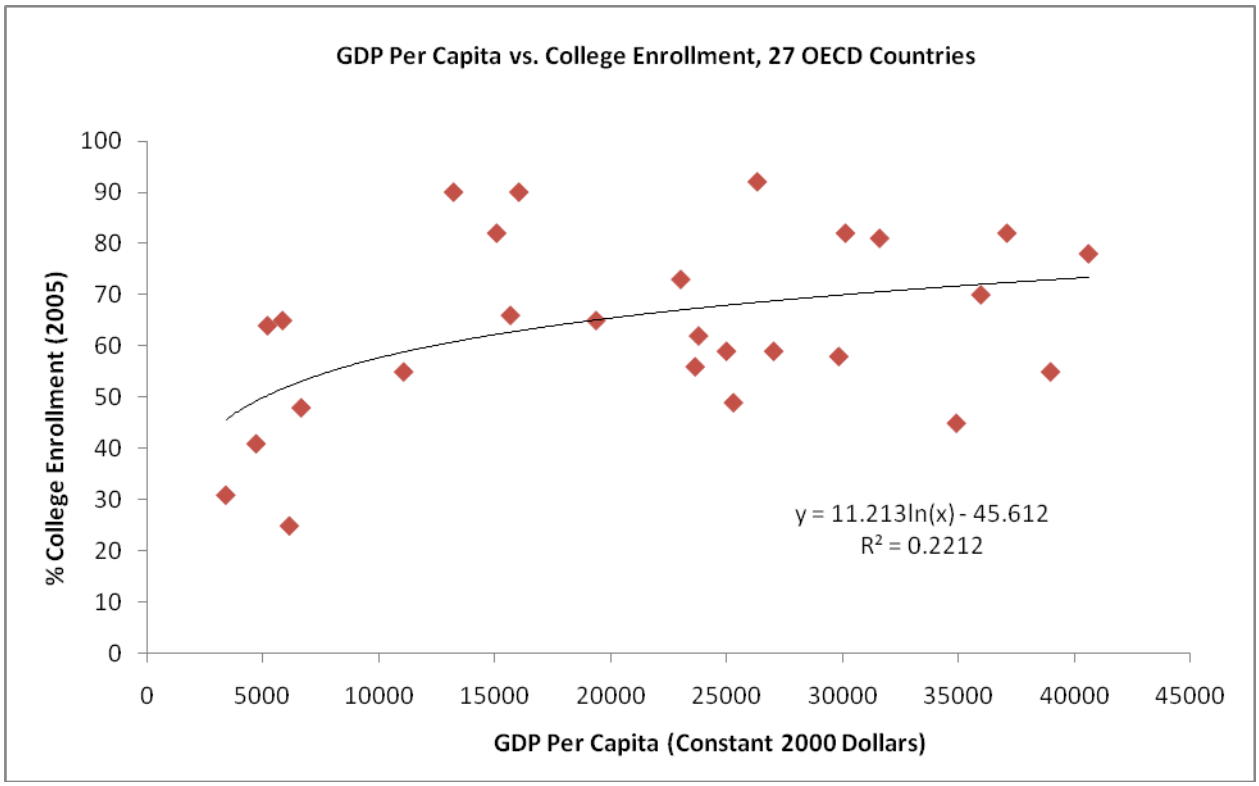


The dashed vertical line is the price of the 'credits' that an over-consuming nation has to pay in the Kyoto Protocol carbon market. This 'price signal' corrects for the externality due to lack of private property in developing nations, leading to the same market allocation that would occur with private property rights in both nations. The real price of the resource for the importing nation is supply price + credit price. The carbon market leads to less global consumption of resources, and higher real prices for the consumer.

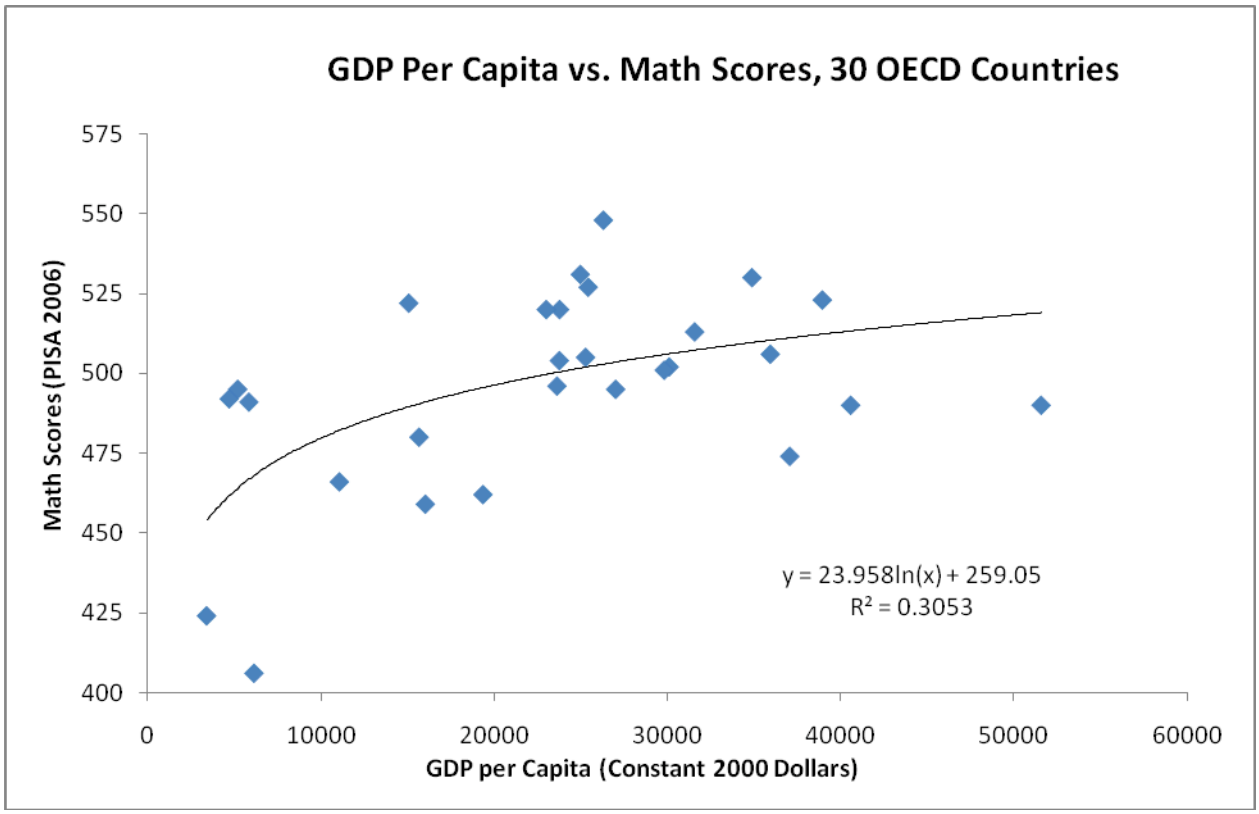
9.1


Comparing Knowledge and Wealth of Nations
Citation Intensity
Wealth Intensity
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
5
10
15
20
25
30
35
60
65
1. India
2. China
3. Iran
4. Brasil
5. Russia
6. Poland
7. South Africa
8. South Korea
9. Portugal
10. Greece
11. Spain
12. Singapore
13. Taiwan
14. Japan
15. Italy
16. Germany
17. France
18. Autralia
19. Belgium
20. Canada
21. United Kingdom
22. Finland
23. Denmark
24. Netherlands
25. Israel
26. Sweden
27. Switzerland
28. Autria
29. Rep. Ireland
30. United States
31. Luxembourg

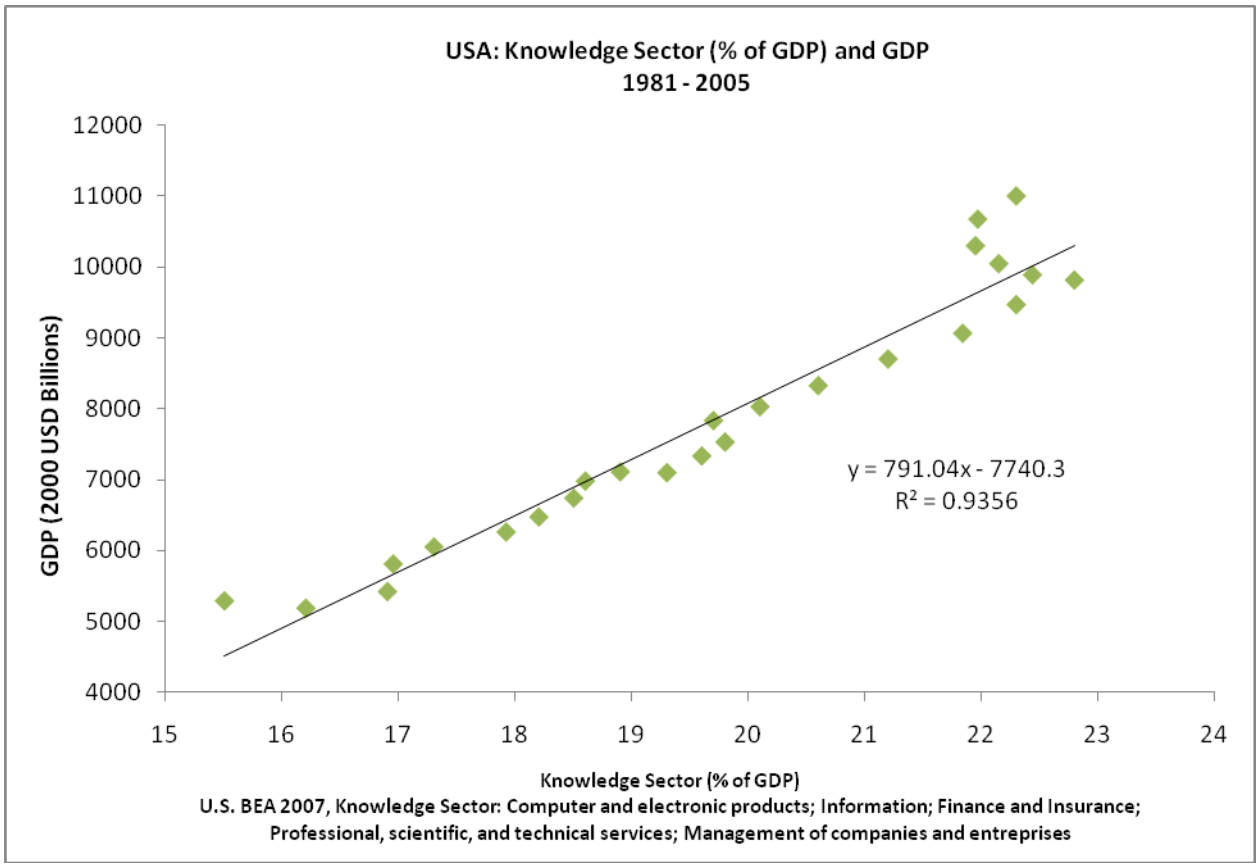
9.2


GDP Per Capita vs. College Enrollment, 27 OECD Countries
% College Enrollment (2005)
GDP Per Capita (Constant 2000 Dollars)
y = 11.213ln(x) - 45.612
R² = 0.2212
0
10
20
30
40
50
60
70
80
90
100
0
5000
10000
15000
20000
25000
30000
35000
40000
45000

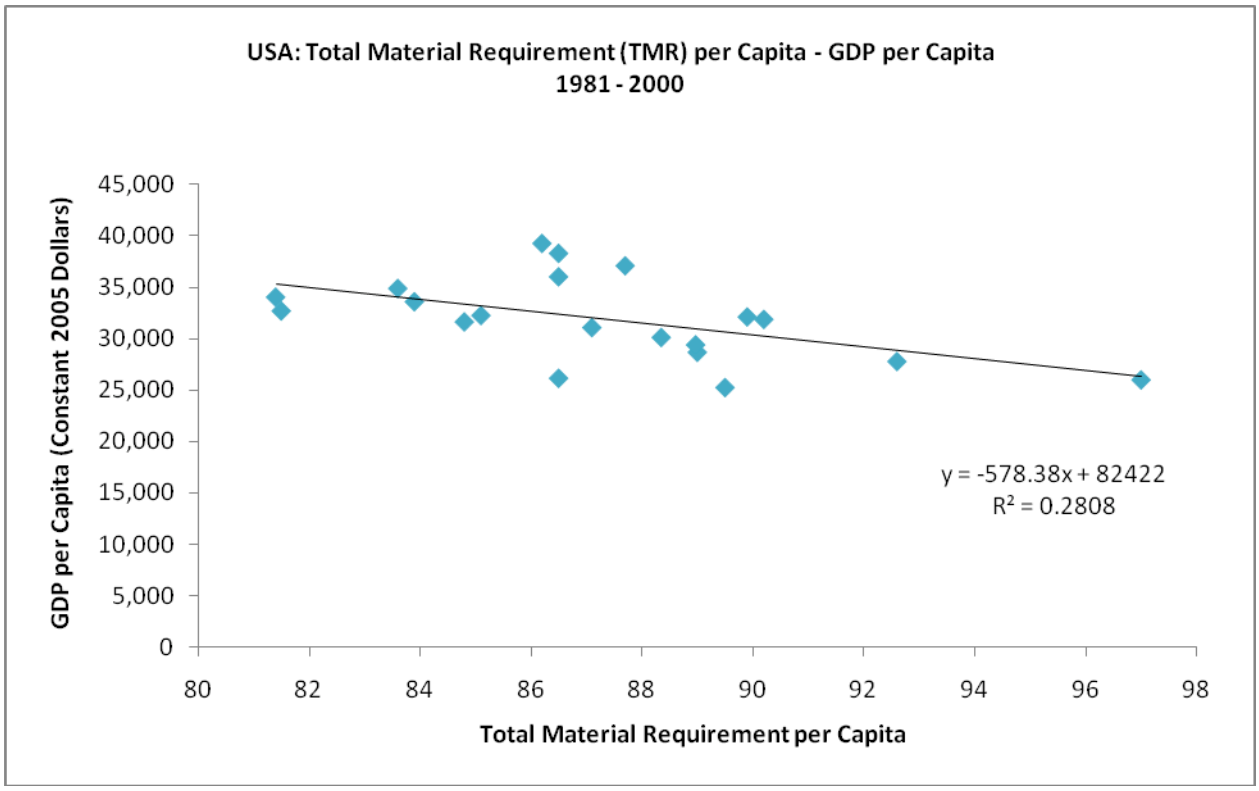
9.3


GDP Per Capita vs. Math Scores, 30 OECD Countries
Math Scores (PISA 2006)
575
550
525
500
475
450
425
400
0
10000
20000
30000
40000
50000
60000
GDP per Capita (Constant 2000 Dollars)
y = 23.958ln(x) + 259.05
R² = 0.3053

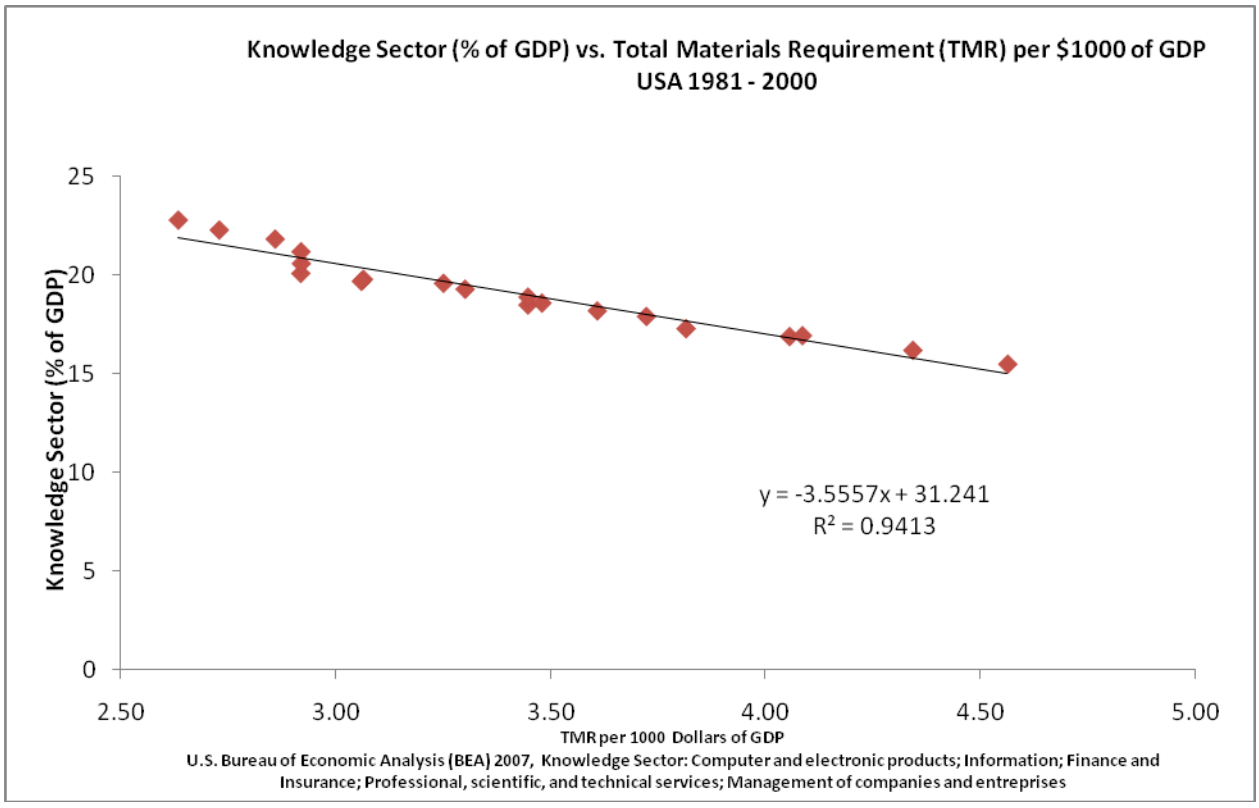
9.4


USA: Knowledge Sector (% of GDP) and GDP
1981 - 2005
GDP (2000 USD Billions)
12000
11000
10000
9000
8000
7000
6000
5000
4000
15
16
17
18
19
20
21
22
23
24
y = 791.04x - 7740.3
R² = 0.9356
Knowledge Sector (% of GDP)
U.S. BEA 2007, Knowledge Sector: Computer and electronic products; Information; Finance and Insurance; Professional, scientific, and technical services; Management of companies and entreprises

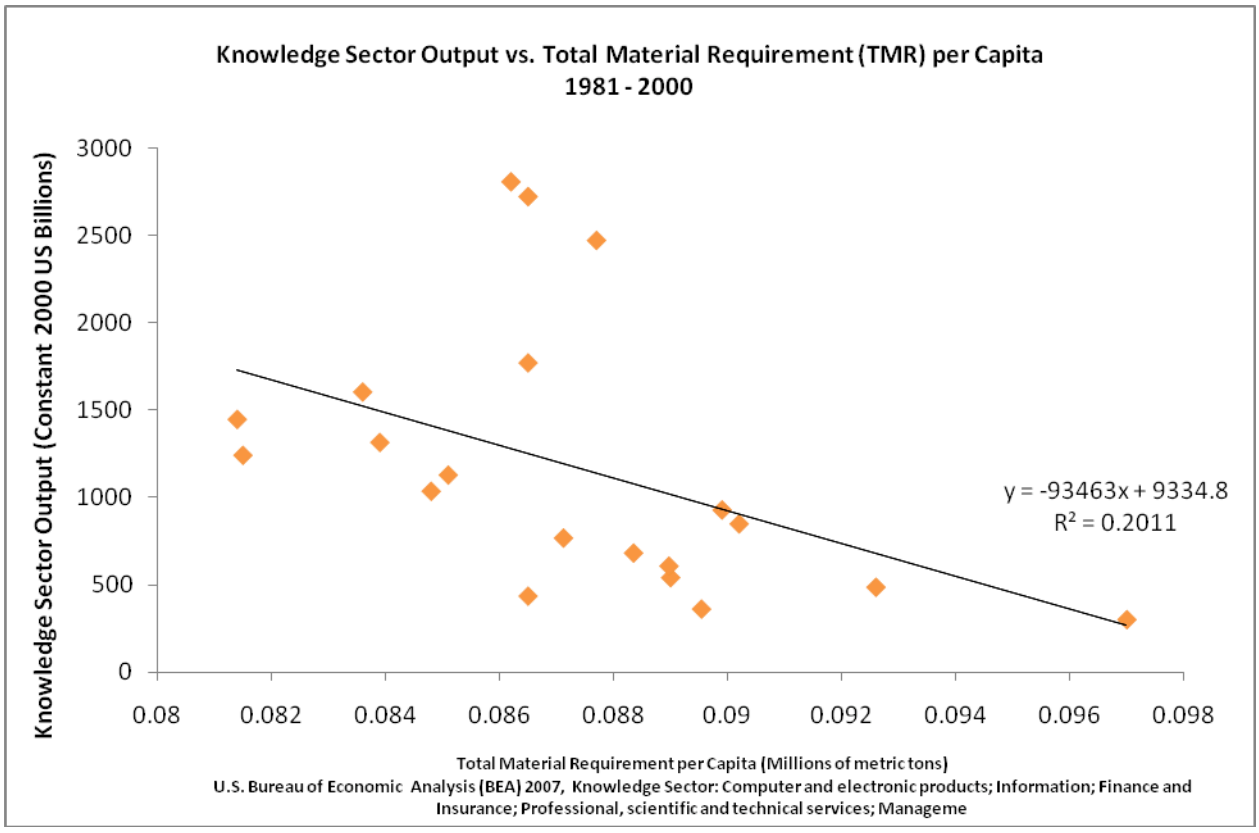
9.6


USA: Total Material Requirement (TMR) per Capita - GDP per Capita
1981 - 2000
GDP per Capita (Constant 2005 Dollars)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
80
82
84
86
88
90
92
94
96
98
Total Material Requirement per Capita
y = -578.38x + 82422
R² = 0.2808

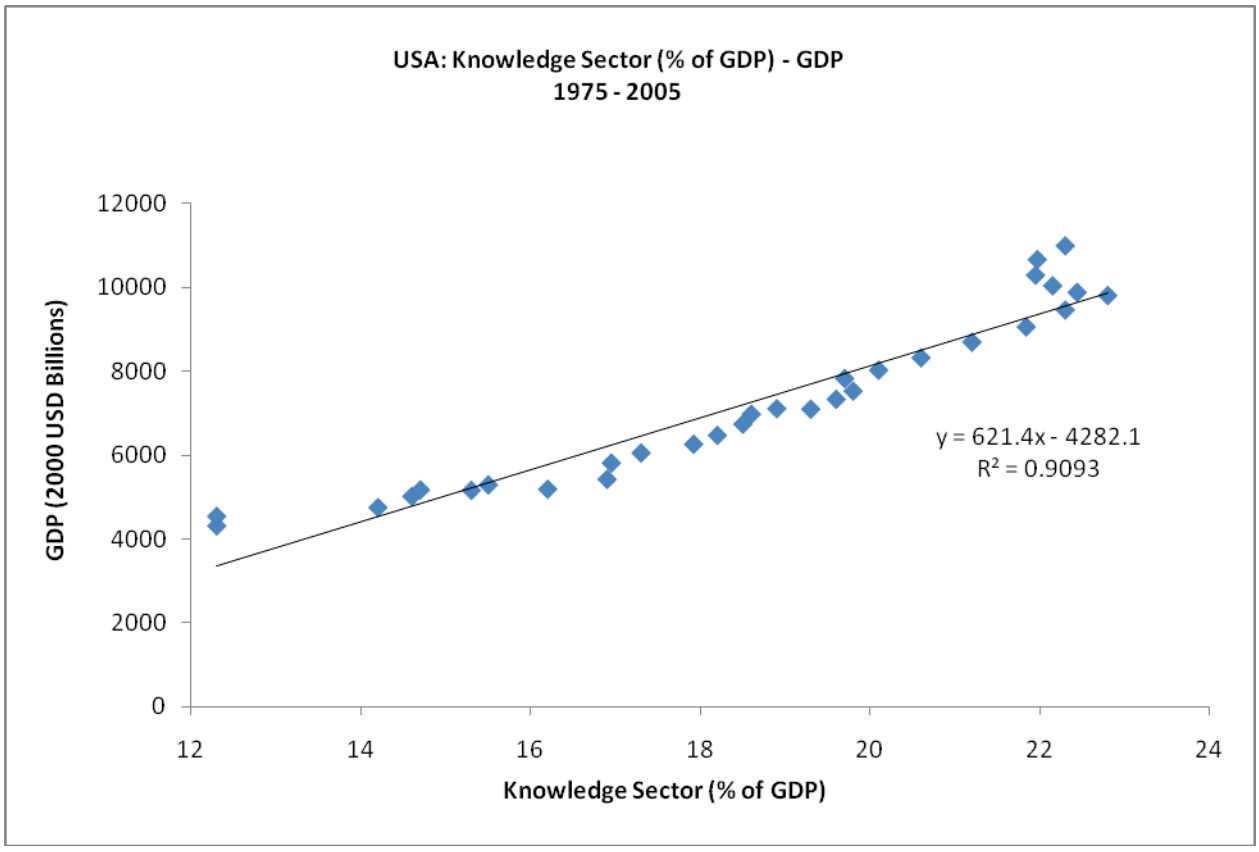
9.5


Knowledge Sector (% of GDP) vs. Total Materials Requirement (TMR) per $1000 of GDP
USA 1981 - 2000
Knowledge Sector (% of GDP)
25
20
15
10
5
0
2.50
3.00
3.50
4.00
4.50
5.00
y = -3.5557x + 31.241
R² = 0.9413
TMR per 1000 Dollars of GDP
U.S. Bureau of Economic Analysis (BEA) 2007, Knowledge Sector: Computer and electronic products; Information; Finance and Insurance; Professional, scientific, and technical services; Management of companies and entreprises

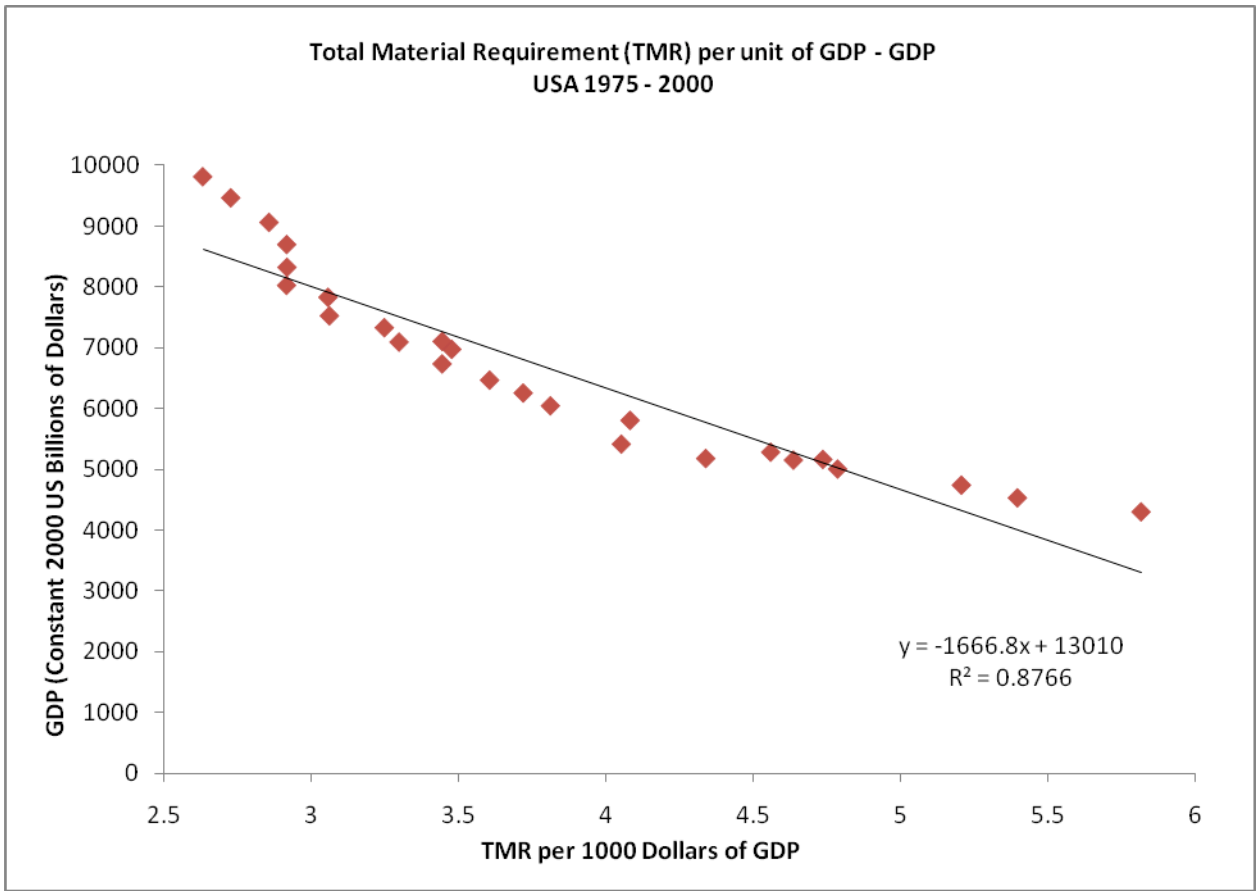
9.7


Knowledge Sector Output vs. Total Material Requirement (TMR) per Capita
1981 - 2000
Knowledge Sector Output (Constant 2000 US Billions)
3000
2500
2000
1500
1000
500
0
0.08
0.082
0.084
0.086
0.088
0.09
0.092
0.094
0.096
0.098
y = -93463x + 9334.8
R² = 0.2011
Total Material Requirement per Capita (Millions of metric tons)
U.S. Bureau of Economic Analysis (BEA) 2007, Knowledge Sector: Computer and electronic products; Information; Finance and Insurance; Professional, scientific and technical services; Manageme

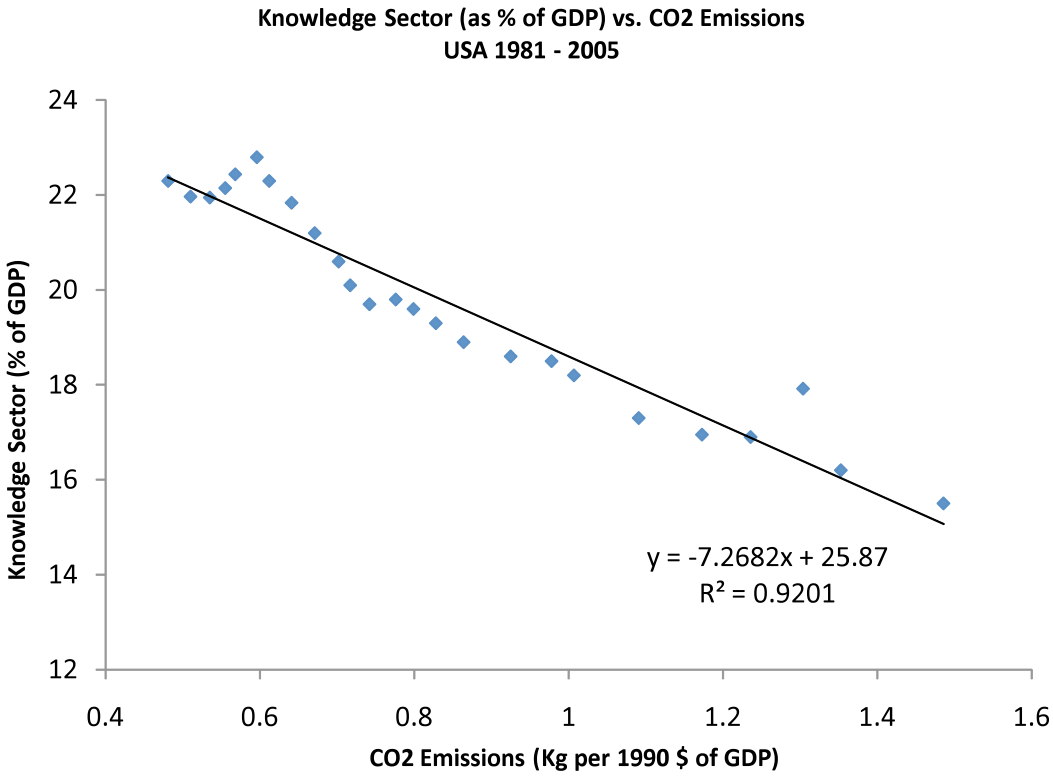
9.8


USA: Knowledge Sector (% of GDP) - GDP
1975 - 2005
GDP (2000 USD Billions)
12000
10000
8000
6000
4000
2000
0
12
14
16
18
20
22
24
Knowledge Sector (% of GDP)
y = 621.4x - 4282.1
R² = 0.9093

9.9


Total Material Requirement (TMR) per unit of GDP - GDP
USA 1975 - 2000
GDP (Constant 2000 US Billions of Dollars)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2.5
3
3.5
4
4.5
5
5.5
6
TMR per 1000 Dollars of GDP
y = -1666.8x + 13010
R² = 0.8766

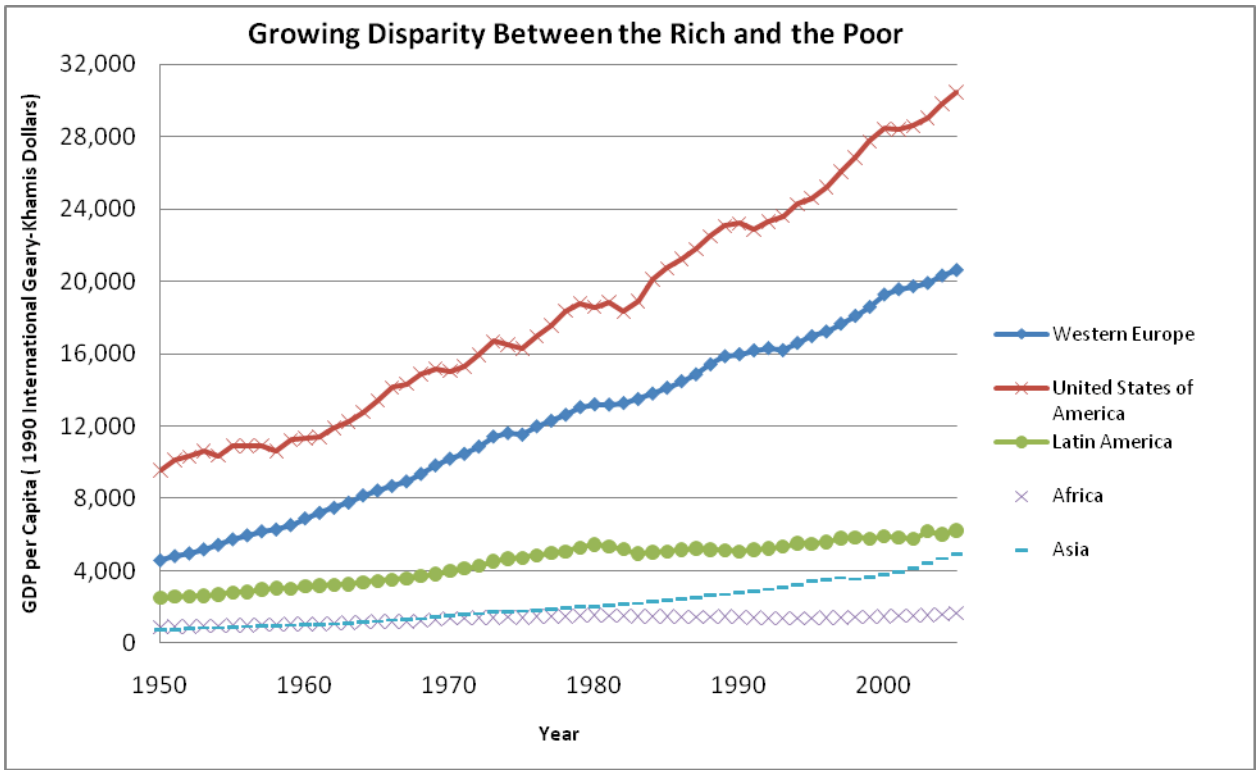
9.10


Knowledge Sector (as % of GDP) vs. CO2 Emissions
USA 1981 - 2005
Knowledge Sector (% of GDP)
24
22
20
18
16
14
12
0.4
0.6
0.8
1
1.2
1.4
1.6
CO2 Emissions (Kg per 1990 $ of GDP)
y = -7.2682x + 25.87
R² = 0.9201

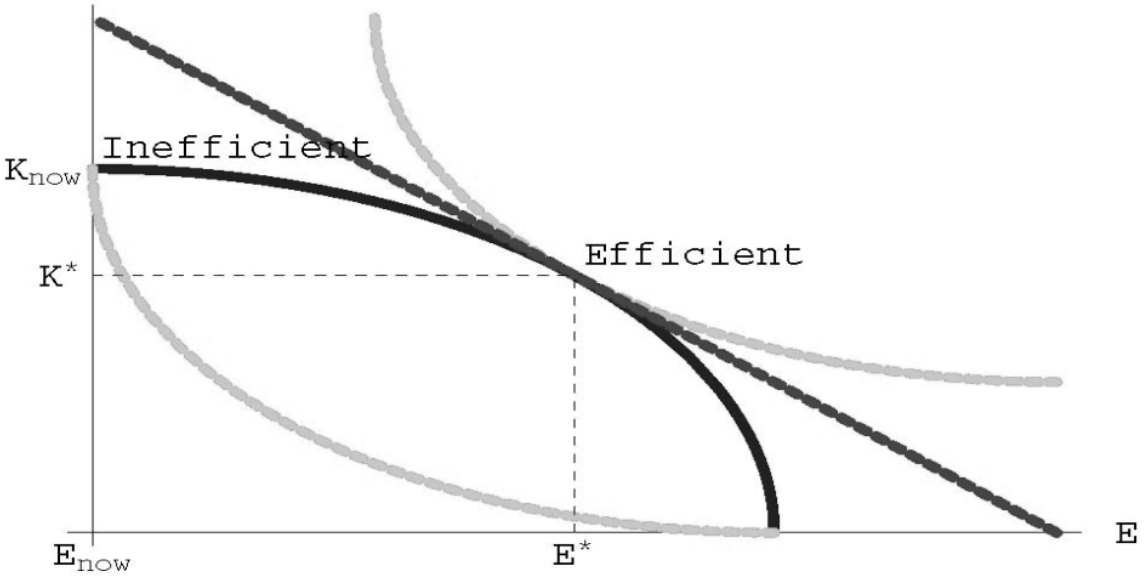
10.1a


Growth in Global Trade and Global Economy since 1950
Dollars (Constant 1990 Prices)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Years (1950, 1998 and 2005)
World Trade - 6.2% average growth
World GDP - 3.8% average growth

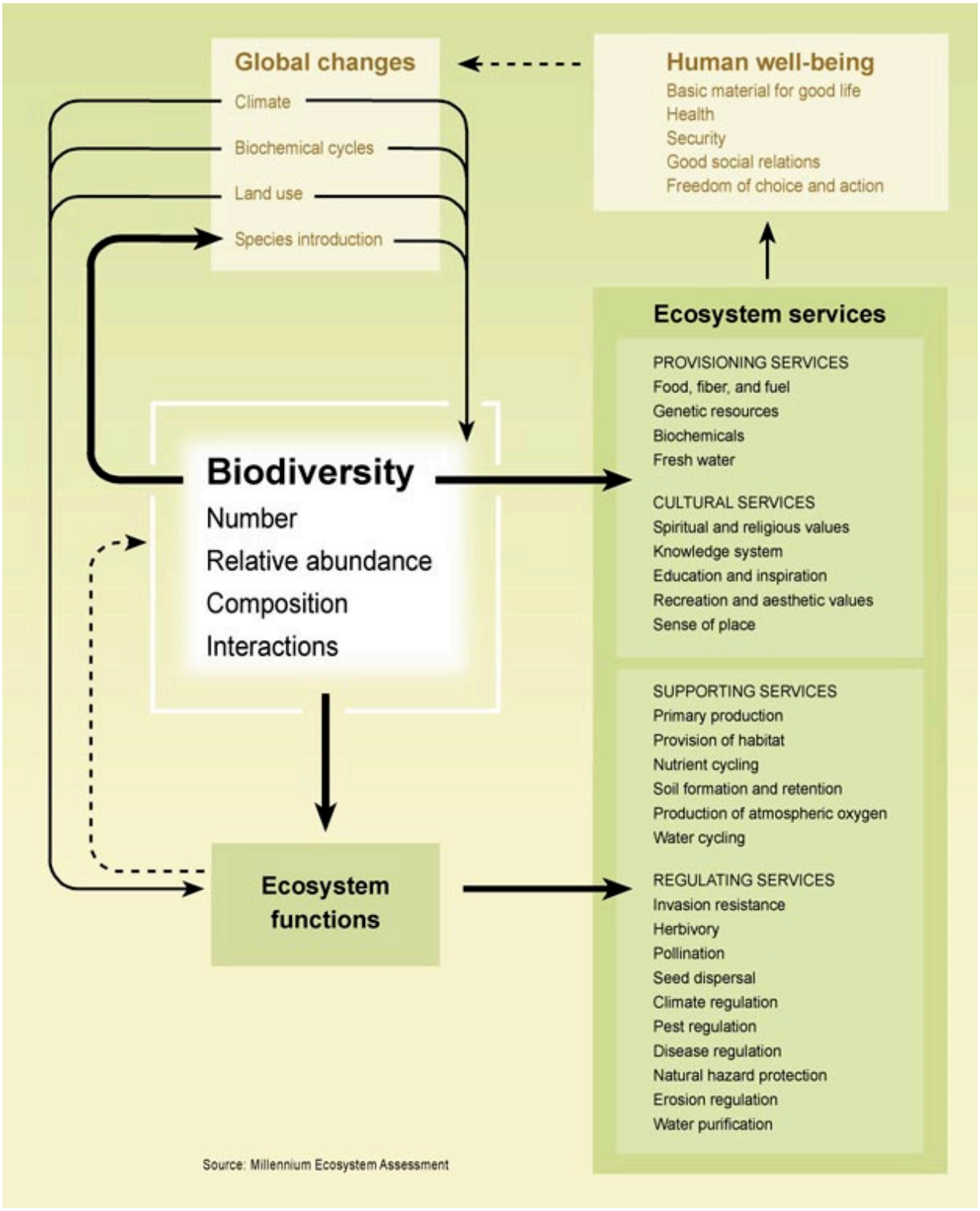
10.1b


Growing Disparity Between the Rich and the Poor
GDP per Capita (1990 International Geary-Khamis Dollars)
32,000
28,000
24,000
20,000
16,000
12,000
8,000
4,000
0
1950
1960
1970
1980
1990
2000
Year
Western Europe
United States of America
Latin America
Africa
Asia

10.2



10.3


Global changes
Climate
Biochemical cycles
Land use
Species introduction
Human well-being
Basic material for good life
Health
Security
Good social relations
Freedom of choice and action
Ecosystem services
PROVISIONING SERVICES
Food, fiber, and fuel
Genetic resources
Biochemicals
Fresh water
CULTURAL SERVICES
Spiritual and religious values
Knowledge system
Education and inspiration
Recreation and aesthetic values
Sense of place
Biodiversity
Number
Relative abundance
Composition
Interactions
SUPPORTING SERVICES
Primary production
Provision of habitat
Nutrient cycling
Soil formation and retention
Production of atmospheric oxygen
Water cycling
Ecosystem functions
REGULATING SERVICES
Invasion resistance
Herbivory
Pollination
Seed dispersal
Climate regulation
Pest regulation
Disease regulation
Natural hazard protection
Erosion regulation
Water purification
Source: Millennium Ecosystem Assessment