

Introduction to Environmental Economics (IKT3620)

**Economic growth, Environment and Sustainable
Development**

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Asst. Prof. Tunç Durmaz

GNP & GDP

- **GDP:** An estimated value of the total worth of a country's production and services, within its boundary, by its nationals and foreigners, calculated over the course on one year
 - $GDP = C + I + G + E - Im$
- **GNP [now, GNI- Gross National Income]:** An estimated value of the total worth of production and services, by citizens of a country, on its land or on foreign land, calculated over the course on one year
 - $GNP = GDP + NR$ (Net income inflow from assets abroad or Net Income Receipts) - NP (Net payment outflow to foreign assets)

GNP

GNP has been widely criticized as a measure of well-being.

- The effects of the economy on the environment are not well measured by GNP
 - Oil spill: A lot of money spent on cleaning up → GNP can rise even if citizens are in a worse situation
- Changes in natural resource stock do not show up in GNP
 - Farming → if there is soil erosion, productive stocks of soil can be severely affected
- GNP does not tell how fairly the economic pie is divided up
 - GNP per capita can be rising but at the same time income inequalities can worsen.

Why do economies grow?

- Economies grow because of
 - Increasing resources
 - If a country experiences an increase in its resource base, GNP can increase.
 - Resource base:
 - K: Produced capital, Human capital, Social capital, Natural capital
 - L: labor supply can rise with population growth, migration...
 - Land: land resources can increase with exploitation of overseas territories, conversion of marginal land to more profitable uses
 - Energy & Material resources: can increase through new discoveries such as oil or gas deposits. Tech. progress can drive down the costs of exploiting natural resources and make more of the physical resource stock profitable to exploit
 - Economic reserves can increase with tech. progress.

Why do economies grow?

- Economies grow because of
 - Productivity growth: productivity refers to the value of output we derive from inputs to production
 - Average productivity of agricultural land in terms of yields per m² have increased over time
 - Drivers of increasing productivity
 - Technological progress
 - Exogenous: an effect of 'time passing' or experience
 - Endogenous: firms or the state take deliberate decisions to invest resources in developing better technologies
 - LbD: despite no changes in the machinery, workers increased their output by 2% each year simply by becoming more experienced in the job (Sweden, 1800s)
 - Education
 - School and university education and training
 - Range of additional benefits in terms of long-run economic development
 - Better health, lower crime, higher cover turnout, faster transmission of new technologies

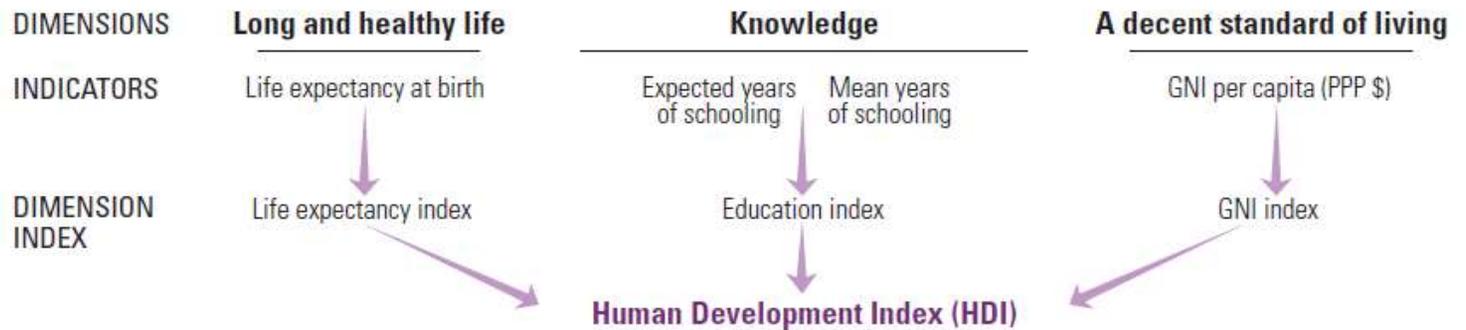
Growth vs. Development

- Growth and Development are not usually the same
 - Development has a broader definition
- Development necessitates a bunch of other indicators that would be improving over time
 - GNP/capita
 - Reduction in income inequality
 - Improvement in infant mortality
 - Reductions in morbidity (illness) and mortality (death) rates among adults as well as children
 - Improvement in a range of environmental indicators

Growth vs. Development

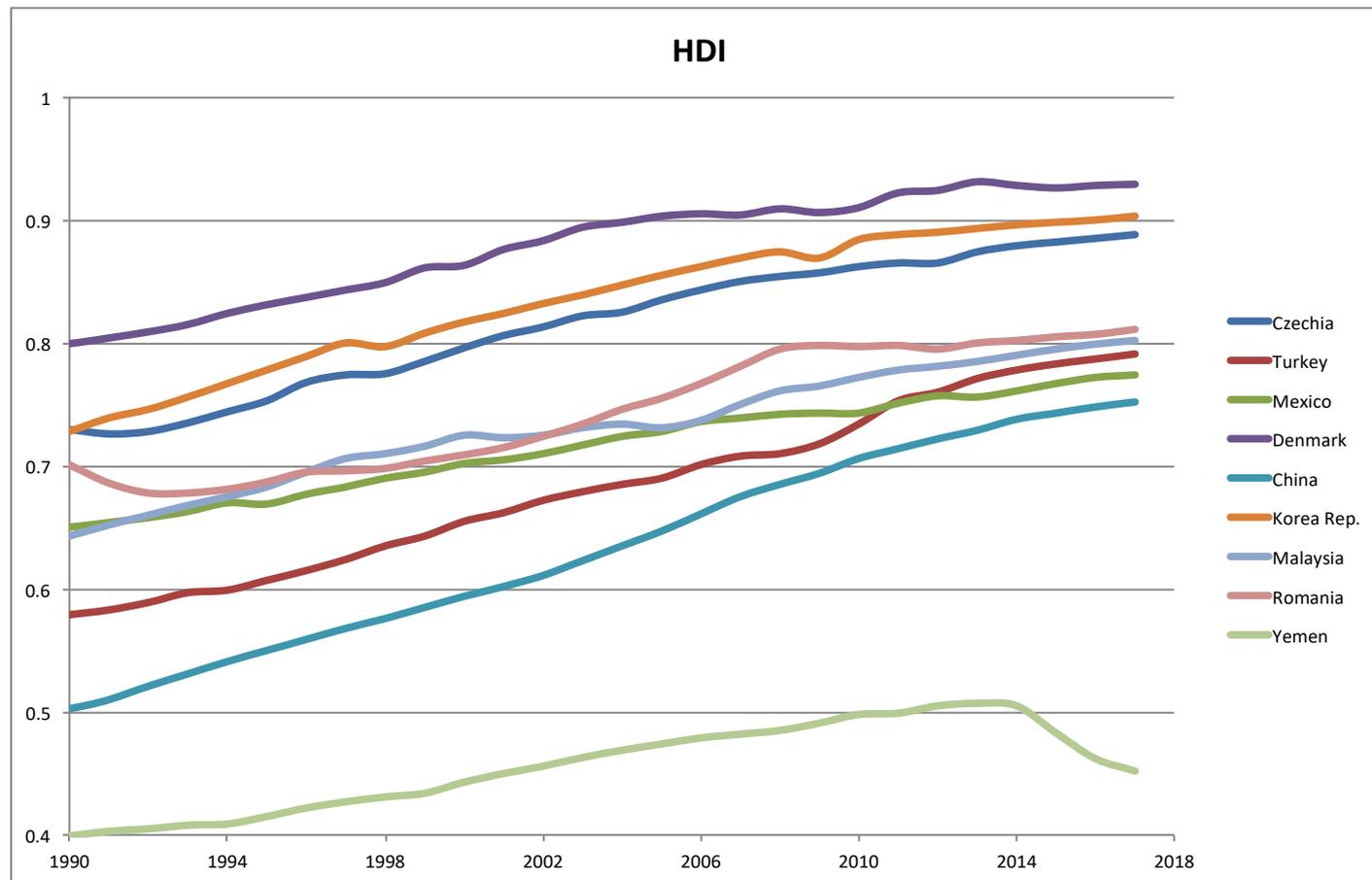
- The human development Index (HDI) was introduced by the United Nations (UN) in 1990 and is published annually
 - A set of three indicators was chosen to represent aspects of development for a nation
 - Life expectancy
 - Education level
 - GNI (previously known as **GNP**)

Human Development Index (HDI)



Growth vs. Development

Human Development Index (HDI)



Growth vs. Development

Rank on HDI	Country	HDI score	GDP per capita in PPP
1	Norway	0.97	53,433
2	Australia	0.97	34,923
3	Iceland	0.96	35,742
4	Canada	0.96	35,812
5	Ireland	0.96	44,613
157	Uganda	0.51	1,059
158	Nigeria	0.51	1,969
159	Togo	0.49	788
160	Malawi	0.49	761
161	Benin	0.49	1,312

Source: Human Development Report (2009).

Growth vs. Development (HDI – 2018)

-	Rank ▼	Country	Human Development Index (HDI) (value)	Life expectancy at birth (years) SDG3	Expected years of schooling (years) SDG 4.3	Mean years of schooling (years) SDG 4.6	Gross national income (GNI) per capita (PPP \$) SDG 8.5
	1	Norway	0.953	82.3	17.9	12.6	68,012
	2	Switzerland	0.944	83.5	16.2	13.4	57,625
	3	Australia	0.939	83.1	22.9	12.9	43,560
	4	Ireland	0.938	81.6	19.6	12.5	53,754
	5	Germany	0.936	81.2	17.0	14.1	46,136
	6	Iceland	0.935	82.9	19.3	12.4	45,810
	7	Hong Kong, China (SAR)	0.933	84.1	16.3	12.0	58,420
	7	Sweden	0.933	82.6	17.6	12.4	47,766
	9	Singapore	0.932	83.2	16.2	11.5	82,503
	10	Netherlands	0.931	82.0	18.0	12.2	47,900

Growth vs. Development (HDI – 2018)

	157	Nigeria	0.532	53.9	10.0	6.2	5,231
	158	Rwanda	0.524	67.5	11.2	4.1	1,811
	159	Lesotho	0.520	54.6	10.6	6.3	3,255
	159	Mauritania	0.520	63.4	8.6	4.5	3,592
	161	Madagascar	0.519	66.3	10.6	6.1	1,358
	162	Uganda	0.516	60.2	11.6	6.1	1,658
	163	Benin	0.515	61.2	12.6	3.6	2,061
	164	Senegal	0.505	67.5	9.7	3.0	2,384
	165	Comoros	0.503	63.9	11.2	4.8	1,399
	165	Togo	0.503	60.5	12.4	4.8	1,453
	167	Sudan	0.502	64.7	7.4	3.7	4,119

Growth vs. Development (HDI – 2018)

	50	Montenegro	0.814	77.3	14.9	11.3	16,779
	51	Bulgaria	0.813	74.9	14.8	11.8	18,740
	52	Romania	0.811	75.6	14.3	11.0	22,646
	53	Belarus	0.808	73.1	15.5	12.3	16,323
	54	Bahamas	0.807	75.8	12.8	11.1	26,681
	55	Uruguay	0.804	77.6	15.9	8.7	19,930
	56	Kuwait	0.803	74.8	13.6	7.3	70,524
	57	Malaysia	0.802	75.5	13.7	10.2	26,107
	58	Barbados	0.800	76.1	15.3	10.6	15,843
	58	Kazakhstan	0.800	70.0	15.1	11.8	22,626
	60	Iran (Islamic Republic of)	0.798	76.2	14.9	9.8	19,130
	60	Palau	0.798	73.4	15.6	12.3	12,831
	62	Seychelles	0.797	73.7	14.8	9.5	26,077
	63	Costa Rica	0.794	80.0	15.4	8.8	14,636
	64	Turkey	0.791	76.0	15.2	8.0	24,804
	65	Mauritius	0.790	74.9	15.1	9.3	20,189
	66	Panama	0.789	78.2	12.7	10.2	19,178

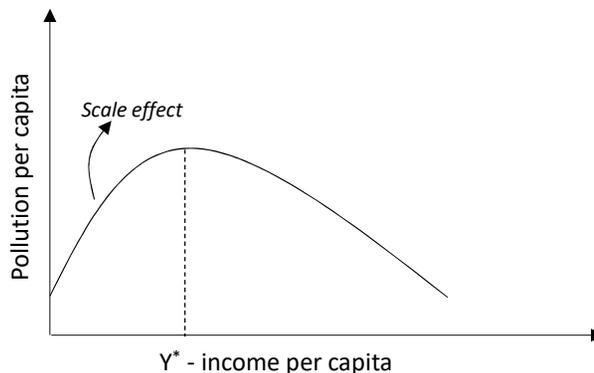
Growth vs. Development

- STRONG CORRELATION BETWEEN THE TWO
 - Income is a major determinant of the other measures of well-being in HDI
 - **Both HDI and GNP measures omit any direct account of environmental degradation**

Growth and the Environment: The Environmental Kuznets Curve

- Simon Kuznets (1955) – hypothesized that inequality will first increase but then decrease as a country gets richer
- Can economies grow their way out of environmental problems?
- What are the links between economic growth and environmental quality?
- The '**limits to growth**' school argued strongly that the relationship between growth and env. is negative
 - Economic growth is by definition bad for the env.
 - It leads to more resource use and more pollution
- **Environmental Kuznets Curve (EKC)** hypothesis suggests otherwise
 - The EKC hypothesis states that as per capita incomes grow, environmental impacts rise, hit a maximum, and then decline.

Scale effect: economic growth results in an increasing use of resources which due to the first law of thermodynamics leads to an increase in wastes



Why emissions/pollution can fall?

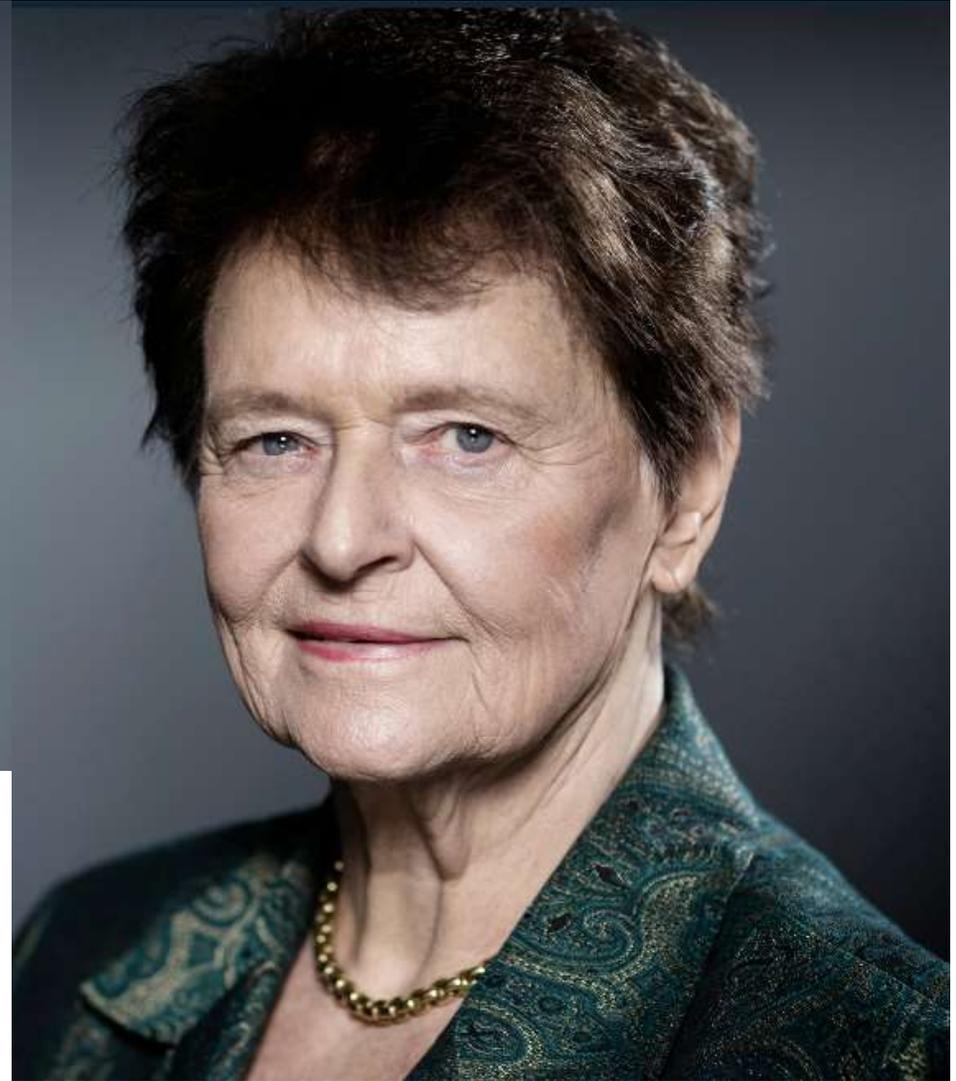
- Increasing demand for env quality
- Tech improvements over time make production cleaner while economies of scale in pollution abatement can also kick in
- Increasing scarcity of 'environmental quality' drives up the relative price of environment
 - Yet, because of the non-market nature of env means that this can fail
 - Or when pollution increases, marginal damage goes up increasing the incentive for pollution reduction

The economics of sustainable development: Definitions

- Developed nations started to be more aware of the environmental issues due to industrialization and economic growth.
- 1984: The Brundtland Commission - BC (more formally, the World Commission on Environment and Development, WCED).

GRO HARLEM BRUNDTLAND

First woman Prime Minister of Norway; a medical doctor who champions health as a human right; put sustainable development on the international agenda.



The economics of sustainable development: Definitions

- The Brundtland Commission's mandate was to:
 - re-examine the critical issues of environment and development and to formulate innovative, concrete, and realistic action proposals to deal with them;
 - strengthen international cooperation on environment and development and to assess and propose new forms of cooperation that can break out of existing patterns and influence policies and events in the direction of needed change; and
 - raise the level of understanding and commitment to action on the part of individuals, voluntary organizations, businesses, institutes, and governments.
 - “The Commission focused its attention in the areas of population, food security, the loss of species and genetic resources, energy, industry, and human settlements - realizing that all of these are connected and cannot be treated in isolation one from another”

The economics of sustainable development: Definitions

- UN's Brundtland commission → Our Common Future (1987)
- Conclusion:
 - 1. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

The economics of sustainable development: Definitions

- 2. Thus the goals of economic and social development must be defined in terms of sustainability in all countries - developed or developing, market-oriented or centrally planned. Interpretations will vary, but must share certain general features and must flow from a consensus on the basic concept of sustainable development and on a broad strategic framework for achieving it.
- 3. Development involves a progressive transformation of economy and society. A development path that is sustainable in a physical sense could theoretically be pursued even in a rigid social and political setting. But physical sustainability cannot be secured unless development policies pay attention to such considerations as changes in access to resources and in the distribution of costs and benefits. Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation.

The economics of sustainable development: Definitions

- Dec, 1987: Brundtland commission dissolved officially after releasing the report.
- The report crafted the most prevalent (yaygın) definition of sustainability

□ Brundtland Report, 1987

- Also known as "Our Common Future", submitted by World Commission on Environment and Development (WCED), which was founded in 1983
- Alerted the world to the urgency of making progress toward "sustainable development".
- The report also highlighted three fundamental components to sustainable development: environmental protection, economic growth and social equity.
- Following the recommendation of the report, the UN General Assembly decided to establish the United Nations Conference on Environment and Development (UNCED).

□ Earth Summit, 3-14 June 1992, Rio De Janeiro

- The first UNCED, also known as the Rio Summit.
- An important achievement was an agreement on the Climate Change Convention which in turn led to the Kyoto Protocol.
- Produced the Rio Declaration consisted 27 principles intended to guide future sustainable development around the world.
- Also produced Agenda 21, which is a comprehensive blueprint of action to be taken in every area in which humans impact on the environment.
- Established Commission on Sustainable Development (CSD).

□ Millennium Summit, 6-8 September 2000, New York

- 55th Session of the UN General Assembly
- Adopted the Millennium Declaration and Millennium Development Goals (MDGs) – Target year: 2015



- World Summit on Sustainable Development (WSSD), 2-4 September 2002, Johannesburg, South Africa (Rio+10, 10 years after the first Earth Summit in Rio de Janeiro)
 - Also called Earth Summit II and nicknamed "Rio+10".
 - Adopted the Johannesburg Declaration; but U.S. president George W. Bush boycotted the summit and did not attend.



- Earth Summit 2012: UN Conference on Sustainable Development (UNCSD), 20-22 June 2012, Rio De Janeiro, Brazil (RIO+20)
 - Two themes:
 - (1) a green economy in the context of sustainable development and poverty eradication;
 - (2) institutional framework for sustainable development
 - Adopted the outcome document entitled “The Future We Want”
 - **Sustainable Development Goals (SDGs) are to be adopted and will serve as the successor framework to the MDGs after they expire in 2015.**

□ United Nations Sustainable Development Summit 2015, 25-27 September 2015, New York

- Adopted Sustainable Development Goals (SDGs) as the 2030 Agenda



- Unlike the MDGs, which were drawn up by a small group of experts, SDGs have been drafted by an Open Working Group.
- SDGs - new development agenda for the period 2016-2030

SDGs

- GOAL 1 End poverty in all its forms everywhere
- GOAL 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- GOAL 3 Ensure healthy lives and promote well-being for all at all ages
- GOAL 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- GOAL 5 Achieve gender equality and empower all women and girls
- GOAL 6 Ensure availability and sustainable management of water and sanitation for all
- GOAL 7 Ensure access to affordable, reliable, sustainable and modern energy for all
- GOAL 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- GOAL 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDGs

- GOAL 10 Reduce inequality within and among countries
- GOAL 11 Make cities and human settlements inclusive, safe, resilient and sustainable
- GOAL 12 Ensure sustainable consumption and production patterns
- GOAL 13 Take urgent action to combat climate change and its impacts*
- GOAL 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- GOAL 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- GOAL 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- GOAL 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development

**SCHEDULE FOR NEXT WEEK
(LECTURE ROOM TO BE ANNOUNCED) :**

25.11 MON- 16:00 - 18:50

26.11 TUE- 16:00 - 17:50

28.11 THU- 10:00 - 12:50

The economics of sustainable development: Definitions

- There are other definitions
- A common feature of many definitions is that SD is primarily concerned with fairness over time.
- Therefore, SD is principally an equity issue rather than an efficiency issue

The economics of sustainable development: Definitions

- Economists' views:
 - Outcome approach:
 - Outcome approach states that the utility of the present generation is maximized subject to the condition that utility of the future generation is not less than that of the present generation.
 - Opportunity approach
 - it must be ensured that this generation leaves the next generation a stock of capital no less than what is available today.
 - '*Weak sustainability*' of this approach says that equality of total amount of man-made capital, human capital and natural capital between the present and future generations ensures sustainable development.
 - '*Strong sustainability*' version claims that each of the capital goods is to be preserved for the future generations rejecting the possibilities of substitutability.

The economics of sustainable development: Definitions

- **Four** forms of capital can be distinguished:
 1. Produced capital, K_p
 - Machinery, roads, bridges, phone networks, satellites, and so on.
 - May be used up in the production of consumption goods and services
 - Depreciation that needs to be offset with new investment, else K_p will decline
 2. Human capital, K_h
 - Includes all skills and knowledge embodied within people
 3. Social capital, K_s
 - Social networks that facilitate mutually beneficial collective action
 - Co-operative groups that manage common-access resources can agree to implement rules for utilizing such resources for mutual, long-term benefits (e.g.; coastal fisheries, grazing lands).
 - Quality of a country's institutions: the degree of corruption, political openness, or the quality of justice.

The economics of sustainable development: Definitions

4. Natural capital, K_n
 - Comprises all gifts of nature
 - Renewable and non-renewable energy and material resources
 - Clean air and water
 - Nutrient and carbon cycles
 - Biodiversity
 - Natural capital can clearly be depreciated when for example
 - A non-renewable resource such as oil is used up
 - When a species dies out
 - When global stock of atmospheric carbon increases
 - Investment in K_n
 - Forest replanting
 - Cutting emissions of GHGs
 - Restocking of fisheries
- *'Strong sustainability:'* K_n cannot be substituted for by increases in other forms of capital

The economics of sustainable development: Definitions

- Economic work on SD typically proceeds from the assumption that the natural capital stock can be aggregated in monetary units
- This way we can add the value of forest stocks to the value of agricultural land to the value of oil reserves...
- Things get more complicated with stock of biodiversity, carbon sinks...
- Conceptually, we can think of shadow prices existing for all forms of natural capital, which can be used to add together different elements of this stock
 - Such shadow prices would indicate how much better of society would be if the stock of any capital asset was increased by one unit.

The economics of sustainable development: Definitions

- Share of capital in total capital

	Natural capital share (%)	Produced capital share (%)	Intangible capital share (%)
Low-income countries	26	16	59
Middle-income countries	13	19	68
High-income countries	2	17	80
World	4	18	78

Note: 'Intangible' includes human and social capital.

Source: World Bank (2006).

The economics of sustainable development: Definitions

- **Hartwick's rule:** Defines the amount of investment in produced capital (buildings, roads, knowledge stocks, etc.) that is needed to exactly offset declining stocks of non-renewable resources.
 - Hartwick's rule – often abbreviated as "invest resource rents" (difference between P and MC)– requires that a nation (dependent on a non-renewable resource) invests all rent earned from exhaustible resources currently extracted, where "rent" is defined along paths that maximize returns to owners of the resource stock. The rule extends to the case of many types of capital goods, including a vector of stocks of natural capital.
- The difference between total investment in some kinds of capital and total disinvestment in other types of capital → **Genuine savings**
- A positive value for a nation's genuine savings has been linked to the possibility of long-run economic sustainability.

The economics of sustainable development: Definitions

- **Hartwick's rule:** Two problems
 - Assumes that utility depends on consumption only and that the environment is only important as a resource of inputs to production
 - The rule holds if the various forms of capital are good enough substitutes for each other (weak sustainability)

Regardless, the rule does warn that countries that do not reinvest a sufficient amount of the rents from natural resource exploitation may well be doing so at the expense of their future well-being

Measuring Sustainability

- At the Earth summit in Rio in 1992, the nations agreed to produce annual statistics on the sustainability of their economics
- SD is such a broad concept that one measure is unlikely to tell us all about sustainability of the economic-environmental system.
- It may therefore be better to talk of indicators of “System performance”
- We will discuss two:
 - GREEN NET NATIONAL PRODUCT
 - GENUINE SAVINGS

GREEN NET NATIONAL PRODUCT (GNNP)

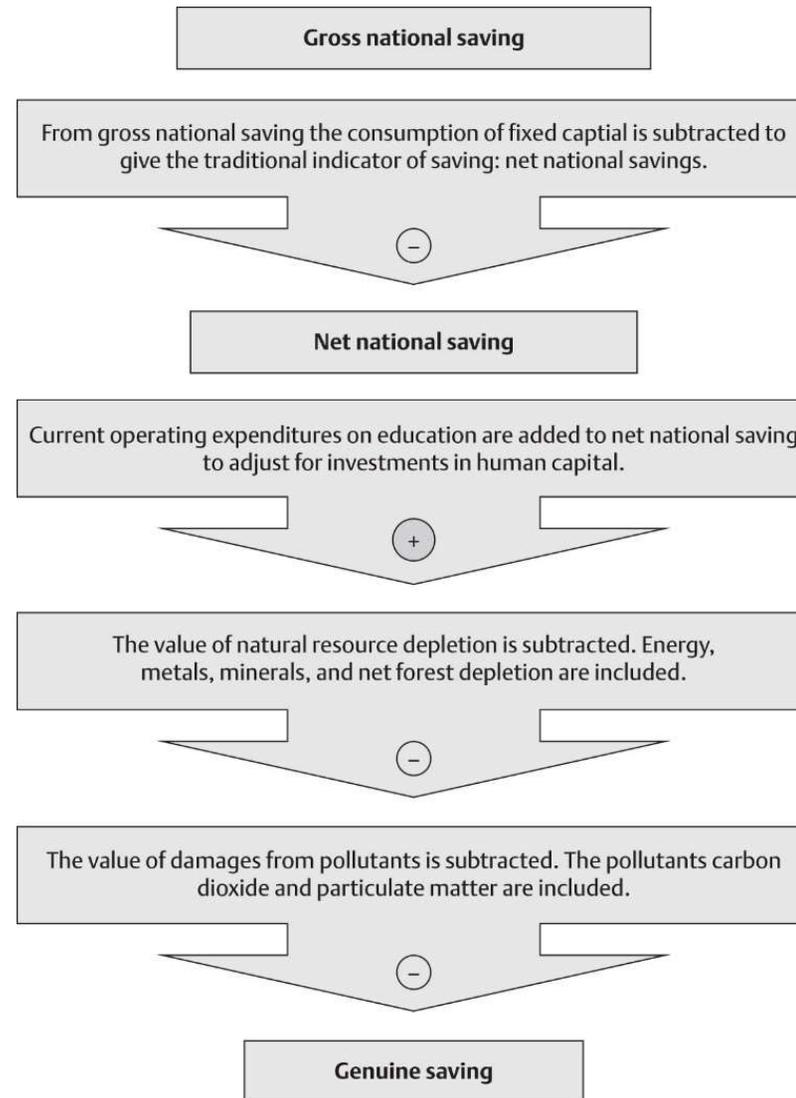
- The national accounts omit many of the inputs that the environment provides
 - b/c these inputs are unpriced by the market
- When a country depleted its natural capital, this is typically ignored in the national accounts; **but depreciation of man-made capital is allowed for**
 - **To convert GNP to net national product (NNP)**
- Calculating GNNP involves correcting for these omissions, and for other changes that impact well-being; e.g., POLLUTION
 - $GNNP = NNP - (p_1 - mc_1)\Delta NR - (p_2 - mc_2)\Delta R - v(S)$
 - $\Delta NR = Q_{NR} - N_{NR}$ and $\Delta R = Q_R - G_R$
- If GNNP is rising over time, then development can be judged to be sustainable.

GREEN NET NATIONAL PRODUCT

- There are challenges with determining the correct prices and marginal costs
- Well-known problems of **property rights** mean that using **market prices** to undertake green adjustments will not deliver the desired outcomes

Genuine savings (Adjusted net savings)

$$GS = S - \Delta p - \Delta n$$



	Gross savings	Consumption of fixed capital	Education expenditure	Net forest depletion	Energy depletion	Mineral depletion	Carbon dioxide damage	Local pollution damage	Adjusted net savings
2016	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI
Czech Republic	28.7	23.8	3.9 ..		0	0	1.7	0.1 ..	
Germany	27.1	17.3	4.5	0	0	0	0.6	0.1	13.6
Greece	10	20.5	3.1	0	0	0	1.1	0.1	-8.6
Romania	23.4	19.2	2.8	0	0.5	0	1.4	0.2	4.8
Turkey	24.8	15.5	4.3	0	0	0.1	1.4	0.2	11.8
United States	17.8	15.4	4.8	0	0.1	0.1	0.9	0.1	6.1
Poland	20.2	11.9	4.7	0.1	0.1	0.2	2	0.2	10.5

More detailed definitions

- Adjusted savings: gross savings (% of GNI)
 - Gross savings are the difference between gross national income and public and private consumption, plus net current transfers.
- Adjusted savings: consumption of fixed capital (% of GNI)
 - Consumption of fixed capital represents the replacement value of capital used up in the process of production.
- Adjusted savings: education expenditure (% of GNI)
 - Education expenditure refers to the current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment.
- Adjusted savings: net forest depletion (% of GNI)
 - Net forest depletion is calculated as the product of unit resource rents and the excess of roundwood harvest over natural growth. If growth exceeds harvest, this figure is zero.

More detailed definitions

- **Adjusted savings: energy depletion (% of GNI)**
 - Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime. It covers coal, crude oil, and natural gas.
- **Adjusted savings: mineral depletion (% of GNI)**
 - Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime. It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.
- **Adjusted savings: carbon dioxide damage (% of GNI)**
 - Cost of damage due to carbon dioxide emissions from fossil fuel use and the manufacture of cement, estimated to be US\$30 per ton of CO₂ (the unit damage in 2014 US dollars for CO₂ emitted in 2015) times the number of tons of CO₂ emitted.
- **Adjusted savings: particulate emission damage (% of GNI)**
 - Particulate emissions damage is the damage due to exposure of a country's population to ambient concentrations of particulates measuring less than 2.5 microns in diameter (PM_{2.5}), ambient ozone pollution, and indoor concentrations of PM_{2.5} in households cooking with solid fuels. Damages are calculated as foregone labor income due to premature death. Estimates of health impacts from the Global Burden of Disease Study 2016. Data for other years have been extrapolated from trends in mortality rates.

- Adjusted net savings, including particulate emission damage (% of GNI)
 - Adjusted net savings are equal to net national savings plus education expenditure and minus energy depletion, mineral depletion, net forest depletion, and carbon dioxide and particulate emissions damage.