Can energy use be limited by change in economic theories?

- Economics and its different aspects
- How to measure economic growth and wealth?
- Does economic theory offer sufficient and adequate handles for good resource (energy) policy?
- Has everything been said about these issues?
- Does politics use the results of economic analysis?
Main literature used


Economics

- **Economics** is the study of how people and societies deal with scarcity. It deals with the production, allocation, and use of goods and services.

- **Macroeconomics** focuses on studies of aggregate fluctuations and growth, and the role of policy in that context. Factors studied include inflation, unemployment, and industrial production, often with the aim of studying the effect of government policy on these factors.

- **Welfare economics** the aspects of economic theory concerned with the welfare of society and priorities to be observed in the allocation of resources. Cost-benefit analysis of the allocation of resources, economic activity, and distribution of the resulting output on a society's welfare.

- **Public economics** is the study of government policy through the lens of economics efficiency and equity, and provides a framework for thinking about whether or not the government should participate in markets and to what extent.
Economics

- **Microeconomics** analysis of the decisions made by individuals and groups, the factors that affect those decisions, and how those decisions effect others
- **Behavioral economics** researches the effects of human and social cognitive and emotional patterns to better understand economic decisions and how they affect market prices, returns and the allocation of resources
- **Experimental economics** is the application of experiments to test the validity of economic theories. How and why markets and other exchange systems function as they do. The three main types of economic experiments are market, game, and individual-decision making experiments
Economic Growth & Development

• **Economic growth**: Quantitative change or expansion in a country's economy. Conventionally measured as the percentage increase in gross domestic product (GDP) or gross national product (GNP) during one year.

• An economy can either grow
  – **extensive growth** by using more resources (such as physical, human, or natural capital) or
  – **intensive growth** by using the same amount of resources more efficiently (productively). Achieved through more productive use of all resources, including labor, resulting in higher per capita income and improvement in people's average standard of living.

• **Economic development**: Qualitative change and restructuring in a country's economy because of technological and social progress. Reflects an increase in the economic productivity and average material wellbeing of a country's population. Main indicator is GDP or GNP.
Economic growth

• Governments (and many others) set economic growth equal to growth in Gross Domestic Product (GDP)
  – ‘Gross’ means regardless of the various uses to which production can be put.
  – Total market value of all final goods and services produced in a country
    \[
    \text{GDP} = \text{consumption} + \text{investment} + \text{government spending} + \text{exports} - \text{imports}
    \]

• GDP is a measure of the economic activity, defined as the value of all goods and services produced less the value of any goods or services used in their creation based on geographical location.

• The growth rate of GDP volume is intended to allow comparisons of the dynamics of economic development both over time and between economies of different sizes

• GNP is the market value of all products and services produced in one year by labor and property supplied by the residents of a country. GNP allocates production based on ownership.
Economic growth

- Economists do not consider changes in GNP (or GDP) as the appropriate criterion to judge the progress of an economy
  - In 1934 Simon Kuznets wrote ‘...the welfare of a nation can, therefore, scarcely be inferred from a measure of national income...’
  - In 1962, Kuznets stated ‘Distinctions must be kept in mind between quantity and quality of growth, between costs and returns, and between the short and long run. Goals for more growth should specify more growth of what and for what.’
- GNP ignores the value of unpaid work, but also the correct value of usage and depreciation of natural resources and the degradation of the environment
- Already in 1933 Lindahl argued
  - that the GNP does not account for capital depreciation, and that
  - NNP is a better measure of wealth since it puts a ceiling on aggregate consumption if the economy’s wealth is not to decline
Judging an Economy

Welfare theory of green national accounts P. Dasgupta (2009)
Judging the state of an economy is based on 4 questions
a) How is the economy doing?
b) How has it performed in recent years?
   • Evaluates the economy based passage of time
c) How is it likely to perform under alternative policies?
d) What policies should be pursued?
   • Evaluates an economy before and after a (hypothetical) change was introduced

First question is answered by national income statisticians
Next three questions by students of sustainable development
Judging an Economy

What we are (or should be) looking for is

optimization of (intergenerational) well-being

- GNP (or GDP) does not measure wealth, it is a flow of money per period
- GNP is an aggregate measure of the output of final goods and services, of economic activity

GDP/GNP is not a measure of well-being for several reasons

- A € for a poor person is valued the same as for a rich person (so income distribution is out of the picture)
- They do not adequately reflect well-being from being educated, skilled and in good health
- They do not account for inter-temporal issues because they ignore depreciation of ‘assets’, such as environmental resources (ecosystems) and non-renewable (minerals, fossil fuels) resources
- Note that pollution is the depletion of natural resources
Judging an Economy

• For well-being we first of all have to account for depreciation

• We should ‘invest’ so much that wealth does not decline; or not consume too much so that we can sustain our stock of wealth

• This implies that we have to investment in reproducible capital in such a way that the rate of depletion of natural resources is covered by it
  − Question is if this is possible and if this is not, sustainable development may not be possible

• Can we link well-being and wealth?

• How do economists want to account for all this?
Judging an Economy

• For Green Accounting use shadow prices (not market prices) to value the capital assets
  – Reproducible capital assets (buildings, roads, machines, etc.)
  – Human capital (health, education and skills)
  – Natural capital (minerals, oil, and natural gas; fisheries; forests, soil resources (ecosystems))
• Social and Institutional capital comprising the social infrastructure (laws, property rights, beliefs, trust) guiding the allocation of resources (including capital). Should be included (intangibles).
• Together this is a society’s productive base
• The shadow price of a commodity is defined as its social opportunity cost, i.e., the net loss (gain) associated with having one unit less (more) of it.
• Shadow prices reflect the social value of commodities, in order to guide policy reform and the choice of public sector projects.
• Shadow prices differ from market prices when there is no perfect market or no market at all (clean air, beautiful view, etc.)
CE (2010) estimates of shadow prices

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Abatement costs</th>
<th>Damage costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>0.0250</td>
<td>0.0250*</td>
</tr>
<tr>
<td>CF₇-11</td>
<td>149</td>
<td>159</td>
</tr>
<tr>
<td>NOₓ</td>
<td>8.72</td>
<td>10.6</td>
</tr>
<tr>
<td>SO₂</td>
<td>5.00</td>
<td>15.4</td>
</tr>
<tr>
<td>NH₃</td>
<td>11.7</td>
<td>27.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N₃VOC</td>
<td>5.00</td>
<td>2.54</td>
</tr>
<tr>
<td>PO₃</td>
<td>11</td>
<td>1.80</td>
</tr>
<tr>
<td>P to water</td>
<td>10.9</td>
<td>1.78</td>
</tr>
<tr>
<td>N to water</td>
<td>7.00</td>
<td>NA</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>2.30 (50.0)**</td>
<td>41.0</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>2.30 (50.0)**</td>
<td>64.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioxins</td>
<td>92.00E06</td>
<td>5.09E07</td>
</tr>
<tr>
<td>As (arsenic)</td>
<td>466</td>
<td>811</td>
</tr>
<tr>
<td>Cd (cadmium)</td>
<td>4700</td>
<td>127</td>
</tr>
<tr>
<td>Cr (chromium)</td>
<td>36,900</td>
<td>33.5</td>
</tr>
<tr>
<td>Ni (nickel)</td>
<td>1,800</td>
<td>5.37</td>
</tr>
<tr>
<td>Pb (lead)</td>
<td>225</td>
<td>408</td>
</tr>
</tbody>
</table>

Notes: These figures are averages. Future impacts of these emissions (on environmental policy or on endpoints) have been included in these values and, where relevant, discounted to the year of emission using a 2.5% discount rate with no risk premium.
* Damage costs based on abatement costs.
** For PM10 and PM2.5 the precise policy context is as yet unclear, implying an estimated shadow prices of either € 2.30 or € 50.
Judging an Economy

Results from Welfare Economics

• For intergenerational well-being not to decline, the value of consumption must not exceed NNP

• **Comprehensive Investment** (also called **genuine savings**)
  = gross national savings
  – reproducible capital depreciation
  – depletion of natural resources
  – environmental degradation
  + human capital accumulation

• **Comprehensive Wealth** is the value of the stocks of the economy’s **productive base** valued at shadow prices

• It can be shown that comprehensive wealth is not the same as well-being, but it responds in the same direction to perturbations as well-being does

• Comprehensive wealth is a convenient index to use for responding to questions b) to d) in slide 7
Judging an Economy

• For development to be sustainable comprehensive wealth per capita should be non-decreasing when valued at constant shadow prices,

• However, if the scale of an economy becomes too large, the economy will be unable to maintain its comprehensive wealth (limit to growth)

• Development is sustained if comprehensive investment (addition to comprehensive wealth) is non-negative

• This is close to the Brundtland Commission’s definition of sustainable development

  ‘... development that meets the needs of the present without compromising the ability of future generations to meet their own needs.’

• Sustainable development requires that relative to the population, each generation should bequeath to its successor at least as large an overall productive base as it had itself inherited

• Erik Lindahl’s classic definition of NNP is very closely related to the finding that comprehensive wealth is a measure of well-being: one is dual to the other
Total Factor Productivity

• We have looked at three forms of capital (manufactured, human and nature), as well as institutions, as inputs for productive wealth. However, this is not enough to explain the increase in productive wealth.

• Total Factor Productivity (TFP) is the portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely the inputs are utilized in production.

• Understanding the determinants of technology adoption is key to explaining cross-country variation in TFP.

• Adoption of technologies is related to the role of institutions, financial markets, endowments, and policies. (The intangibles.)
Effect of using comprehensive wealth compared to GDP

- **Capital-output ratio** is the number of years GNP needed to produce the value of our capital stock

- Standard national income accounts suggest that capital-output ratios are typically of the order of 3–4 years

- First estimates of the ratio of comprehensive wealth to GNP were found to be at least as large as 10–12 years
  - And those are still substantial under-estimates because these do not include the value of ecosystems

- Conclusion: contemporary economic activities involve far greater amounts of ‘capital’ than are recorded in official national accounts

- There is evidence that several nations of the globe are failing to meet a sustainability criterion: their investments in human and manufactured capital are not sufficient to offset the depletion of natural capital

- This investment problem seems most acute in some of the poorest countries of the world
The progress of nations

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Genuine investment/GDP (%)</th>
<th>Unadjusted wealth (growth rate)</th>
<th>Population (growth rate)</th>
<th>Effect of TFP (growth rate)</th>
<th>Productive Base (per capita)</th>
<th>GDP growth rate (per capita)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>-2.1</td>
<td>-0.3</td>
<td>2.7</td>
<td>0.2</td>
<td>-2.9</td>
<td>-0.1</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>7.1</td>
<td>1.1</td>
<td>2.2</td>
<td>1.2</td>
<td>0.1</td>
<td>1.9</td>
</tr>
<tr>
<td>India</td>
<td>9.5</td>
<td>1.4</td>
<td>2.0</td>
<td>1.1</td>
<td>0.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Nepal</td>
<td>13.3</td>
<td>2.0</td>
<td>2.2</td>
<td>0.9</td>
<td>0.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Pakistan</td>
<td>8.8</td>
<td>1.3</td>
<td>2.7</td>
<td>0.7</td>
<td>-0.7</td>
<td>2.2</td>
</tr>
<tr>
<td>China</td>
<td>22.7</td>
<td>3.4</td>
<td>1.4</td>
<td>6.3</td>
<td>8.3</td>
<td>7.8</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>7.4</td>
<td>1.4</td>
<td>0.2</td>
<td>1.2</td>
<td>2.4</td>
<td>2.2</td>
</tr>
<tr>
<td>United States</td>
<td>8.9</td>
<td>1.8</td>
<td>1.1</td>
<td>0.3</td>
<td>1.1</td>
<td>2.0</td>
</tr>
</tbody>
</table>


Note: Natural capital insufficiently included
The progress of Ireland

Source: Ferreira & Moro (2011)
The progress of Ireland

A summary of data sources used to construct the Irish genuine savings.

<table>
<thead>
<tr>
<th>Natural resources</th>
<th>Production/Extraction</th>
<th>Prices</th>
<th>Costs</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>Exploration and Mining Division, Department of Communications, Energy and Natural Resources, Ireland</td>
<td>External Trade data from Eurostat</td>
<td>Ben Droms, Principal Geologist, Exploration and Mining Division, Department of Communications, Energy and Natural Resources, Ireland, personal communication May 2008</td>
<td>Wayne Cox, Senior Geologist, Exploration and Mining Division, Department of Communications, Energy and Natural Resources, Ireland, personal communication (18 June 2008)</td>
</tr>
<tr>
<td>Lead</td>
<td>Department of Communications, Energy and Natural Resources, Ireland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>Energy and Natural Resources, Ireland</td>
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</tr>
<tr>
<td>Natural Gas</td>
<td>Michael Hamrahan, Petroleum Affairs Division, Department of Communications, Energy and Natural Resources, Ireland</td>
<td>World Bank (go.worldbank.org/SCWDARYM80)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peat</td>
<td>Bord na Mona, Annual Reports, various years</td>
<td>Unit rent — Annual operating profit per tonne of peat produced, $ of annual revenue from milled peat activities</td>
<td>Charles Shier, Strategic Development Manager, Bord na Mona, personal communication (July 2008)</td>
<td>Bord na Mona, Annual Reports, various years</td>
</tr>
<tr>
<td>Forests</td>
<td>Clinch and Murphy (2001)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air pollution</th>
<th>Emissions</th>
<th>Marginal costs/damages</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM₁₀</td>
<td>World Bank (go.worldbank.org/SCWDARYM80)</td>
<td>Method 2: Damages to Ireland from worldwide emissions (assumed to be equal to European average) from Nordhaus and Boyer (2000)</td>
</tr>
<tr>
<td>Human capital</td>
<td>Labour force and educational attainment</td>
<td>Returns to education</td>
</tr>
</tbody>
</table>

Development Indicators

- **Human Development Index** = F(Life expectancy at birth, Years of schooling, Gross National Income at purchasing power parity per capita)
  - The word ‘gross’ means that depreciation of capital assets is ignored, so it is possible for a country’s productive base to shrink during a period when GNI grows
  - If GNI grows while the productive base continues to shrink, economic growth will, sooner or later, stop and reverse sign. The standard of living will then decline, without anybody seeing this coming

- **Index of Sustainable Economic Welfare** = personal consumption + public non-defensive expenditures - private defensive expenditures + capital formation + services from domestic labor - costs of environmental degradation - depreciation of natural capital

- **The Genuine Progress Indicator** (GPI) takes everything the GDP uses into account, but also adds other figures that represent the cost of the negative effects related to economic activity (such as the cost of crime, cost of ozone depletion and cost of resource depletion, among others). The GPI nets the positive and negative results of economic growth to examine whether or not it has benefited people overall.

- They all don’t guarantee sustainable growth
Sufficient and adequate handles for good resource (energy) policy?

• Comprehensive wealth can be used as criterion to evaluate where we stand and this accounts for the different types of energy use

• If exhaustible resources are sufficiently important in production and consumption it is conceivable that sustainable development is not possible

• Technological progress (in the broadest sense) is required to substitute different forms of capital, but it is difficult to judge how much of one type of capital is needed to compensate the loss of one unit of another type (for example, manufactured capital replacing nature)
  – Ecological economics tries to understand the ways in which different kinds of natural capital contribute to human well-being and the extent to which they are substitutable for one another
  – An important complication is that the potential for substitution can vary by location. A natural resource in one place, like a local woodland, is not the same economic commodity as the same natural resource in another place.
Has everything been said about these issues?

• No way, we are only at the start of investigating the different forms of capital and how to value them, and how they are linked
• Scholars and the World Bank work together to solve the many problems, such as Correct concepts, Measurement problems, Role of technology in the broadest sense
• This economic analysis gives sufficient connecting factors to work with other disciplines to ‘solve’ the problems at hand
  – For example in estimating shadow prices: Nonlinearities in ecosystem dynamics imply serious downside risks related to the losses of natural capital. Central estimates of the shadow prices for natural capital are likely to be too low if we only consider central cases rather than the entire distribution of potential outcomes from losses of natural capital.
• Research is needed to identify the areas where current consumption poses a threat to sustainability and to quantify the potential losses.
• We need to develop better data quantifying the losses of natural capital and the potential for substitution between various forms of capital.
Do politicians use the results of economic analysis?

- This differs per country, but basically they seem to take what is convenient for them.
- For governments GDP growth generally means more income which helps to solve short run budget issues.
- Energy policies differ widely among European countries. This seems to be based more on political choices than on economic considerations.
- Increasing gap between economic science and economic practice
  - Economic science mid seventies: stop using large models because they have serious flaws (Lucas critique, Sims’ critique)
  - Policy institutes (OECD, IMF, CPB): repair them and use them
- Market vs. non-market
- Do all economists support the view presented here today?
- Do we need economic growth?
- Not discussed: Income distribution within and among countries
Thank you