BASQUE CENTRE FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

Asset valuation in the SEEA EEA

Professor Anil Markandya

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Core Concepts in the Valuation of Assets

- In economics, the value of an asset is the net present value of income associated with the asset, and the price of that asset is change in the net present value with respect to a change in the stock of the asset.
- For assets that are bought and sold their market prices and values are the result of trades between buyers and sellers. Since future values are unknown there will be different expectations about them.
- For assets that are not bought and sold or only very rarely, we need to estimate the income flows using the net present value method.
- This presentation reports on methods used to value assets that are part of natural capital. These are divided into renewable and non renewable assets.

Definitions of Key Terms

- The price of an asset we want is also called the **exchange value**, when the asset is traded. If it is not traded we need to estimate this exchange value.
- Flows of income should take account of conditions in markets in the future and the condition of the asset (how it is maintained).
- The “income” from the asset is the value of the service net of costs of producing it – i.e. it is **net income**. It may not be in money form but it can be converted into monetary units using valuation methods.
- For ecosystems the increase in the physical quantity of an asset over time is **regeneration** and decrease is referred to as **depreciation**.

Assets in the SNA

- Assets as defined in the SNA are entities that must be owned by some unit, or units, and from which economic benefits are derived by their owner(s) by holding or using them over a period of time.
- Consumer durables and human capital, as well as natural resources that are not owned, are excluded.
- Land is included as an asset but the atmosphere and the oceans are not. Also the value of land as an asset does not cover the value of services its owner cannot capture, such as sequestration of carbon.
- The SEEA seeks to extend this definition to include non-marketed ecosystem services derived from land and water bodies.

Ecosystems and Environmental assets

- An ecosystem is made up of a number of environmental assets.
- Environmental assets are stocks of specific biological or physical attributes that are produced through natural processes and contribute to generation of a service to people in the present or in the future.
- Examples are cubic meters of groundwater in North China aquifer, kilograms of cod in the North Sea, tonnes of coal in Inner Mongolia, and the number of giant panda in Sichuan province.
- Ecosystems can be made up of a number of environmental assets that may be interdependent (e.g. different fish species in a sea). Since they interact the value of ecosystem as an asset is not equal to the sum of the values of individual assets.

Ecosystem and Environmental Assets

- Environmental assets or whole ecosystems combine with other inputs to produce income flows, so the part attributable to the ecosystem needs to be separated from the value of production processes, such as fishing, logging etc. Methods for doing this were discussed in the valuation of ES.
- The value of an asset can be written as: $V = \sum_{t=0}^{t=T} \frac{R_t}{(1+r)^t}$.
- R_t is the net income from the asset in period *t* and *r* is the discount rate. *T* is the life of the asset, which may be infinite.
- A discount rate is needed to value or pricing natural or ecosystem assets.

The Discount Rate

- In order to compare income and costs at different points in time, the practice of applying a discount rate to future values has been developed. The difference between the value of one euro today and one euro in one year's time is referred to as the discount rate.
- The choice of the discount rate for valuing public investments and assets has focused on: (a) what rate to apply and (b) whether that rate should be constant over time?
- On (a) there is a difference between what rate should be applied on ethical grounds and the rate that is actually applied in markets and by public bodies.
- For ethical rates a survey of 197 well-known economists/philosophers on the long term social discount rate (SDR) found a mean (median) recommended long-term SDR of 2.25% (2%). While there is considerable disagreement on precise SDRs, 92% of experts are comfortable with SDRs somewhere in the interval of 1% to 3%.
- Descriptive rates also vary a lot, depending on the nature of the investment, the risks entailed and the opportunities for investment in the country. The World Bank has for long time used a 12 percent rule of thumb used in traditional project evaluation as the cut-off rate

The Discount Rate

- On (b), the view has gradually been changing away from a single fixed rate to one that declines over time.
- There is evidence to suggest that individuals and societies do not discount the future at a constant rate but rather that they adopt a declining or ‘hyperbolic’ path.
- Another argument for declining rates is that if the ´right´ discount rate is not known with certainty society should take a weighted discount rate based on ignorance. This process results in a discount factor with a certainty equivalent rate that declines over time.
- Others argue that future rates should decline because of dynamic uncertainty about future events.
- France, the UK and US now adopt declining discount rates for valuing public investments.

Valuing Future Flows of Income

- A major problem in asset valuation is to make projections of future rental flows.
- They will depend of factors that influence demand for the ES as well as supply.
- Demand is affected by income growth, population growth and preferences.
- Supply can be affected by external factors such as climate change and the management regime for the asset.
- As a guide SEEA EEA use the notion of “capacity” as a check on the sustainability of (future) flows (given current management regimes).

VALUING ASSETS IN WEALTH ACCOUNTS

- Asset valuation has been undertaken by the UK, the UN and World Bank for wealth accounting.
- The following described methods used for different assets

Methodologies Adopted in Practice: UK

- The NPV approach was used as explained earlier.
- They chose a Social Discount Rate of 3.5% (reducing to 3.0% after 30 years, 2.5% after 70 years) as recommended by UK Government.
- Flows are discounted over a 100 year asset life for renewable assets.
- Future values of services from an asset are forecast based on:
  - Factors which affect the supply of services in physical terms: E.g. Climate change, historic and current government policies on tree-planting and felling, urban growth.
  - Factors which affect the demand for services in physical terms: E.g. Population growth, air pollution levels
  - Factors which affect unit values: E.g. Income growth, future carbon prices required to meet Government targets.

UK environmental asset Valuation: Results for 2016

Service	Value £Mn.	Method Used
Provisioning		
Agricultural Biomass	118,426	Residual value resource rent after allowing for all inputs
Fish Capture	7,584	Marine fish capture in the UK EEZ valued at net profit per tonne
Fossil Fuels	95,285	Rents per tonne removed based on residual value
Mineral	5,483	Rents per tonne removed based on residual value
Timber	8,517	Stumpage price times the physical amount of timber removed
Water Abstraction	76,370	Resource rents from abstraction after deducting costs
Renewables Generation	7,887	Residual value resource rent after allowing for all inputs
Regulating		
Carbon Sequestration	103,947	Valued at the projected price of non-traded carbon, based on MAC to meet a given target
Air Pollution Removal	43,907	Valuation of health benefits based on WTP to avoid illness and premature death
Urban Cooling	11,398	Estimated cost savings from air conditioning and benefit from improved labour productivity
Noise Mitigation	-	
Cultural		
Recreation	393,707	Expenditure incurred to travel to the natural environment and incurred during visit
Aesthetic (House Prices)	9,428	Hedonic price study
Rereation (House Prices)	68,552	Hedonic price study
Total	951,323	

Limitations of UK Study

- **Future land cover/land use change.** If we expect woodland or urban areas to increase, what assumptions should we make about the location of these changes and the effect on other services?
- **Past evidence of real terms unit price increases.** If unit prices are consistently increasing in real terms (e.g. timber prices) over the last twenty years, it might be reasonable to assume they will continue to increase at the same rate in the short term but not over the next 100 years. What would be a reasonable default assumption for the longer term?
- **Economic growth, average income growth and median income growth.** The income growth assumptions interact with population growth assumptions and there may also be distributional implications for the demand for ecosystem services
- **Future changes in condition**. So far on the supply side we've only projected changes in quantity. Are there any key condition changes which we ought to model?
- **Sub-national estimates of asset values.** To what extent can such assumptions and projections reasonably be applied at more detailed spatial levels?
- **Residual value calculations** of rents are subject to error.

Inclusive Wealth Study by UN

	(1) *Produced Capital*	*(2)* *Human Capital*	*(3)* *Natural Capital*	*(4)* *Carbon damages*
Assets included	*Machinery, equipment and infrastructure. Starting from initial estimate from 1970 and adding investment and subtracting depreciation. Not including urban land.*	*Years of schooling whose value increases exponentially at rate of interest (8.5%), times the shadow price of human capital, equal to the discounted PV of compensation.*	*Sub-soil assets* *Forest resources (timber and non-timber)* *Crop and pasture land* *No protected areas*	*Global damages from total emissions worldwide, assigned to countries according to the damages they suffer*
Method used	*Perpetual Inventory Method*	*Present value of additional compensation for education*	*Present Value of rents* *Opportunity cost at 5%*	*Not related to country emissions but global emissions*

Assets Valued in UN Wealth Accounts

- Inclusive Wealth of the UN values the following assets:
  - Non-renewable (oil, gas, coal)
  - Minerals (bauxite, nickel, copper; phosphate, gold, silver)
  - Forest resources (timber, non-timber)
  - Agricultural land (cropland, pasture)
  - Fisheries
- In each case data and other factors limit ability to meet the ideal guidelines.

Non-renewable (oil, gas, coal)

- For a given resource, they start from the current stock, and then trace back past stocks by using the production of each year.
- In other words, the corresponding stock under study in year $t - 1$, $S(t - 1)$, is derived from the production, $P(t)$, and the stock in year t, $S(t)$, by: $S(t - 1) = S(t) + P(t)$.
- The price of a non-renewable resource, p_S, is the price net of extraction cost, which is sometimes referred to as the rental price.
- **The estimated rental rate as percent of the price is assumed to remain constant as is the price in the base case**.
- Past estimates are made from 1990-2013.

Metals and Minerals

- The methodology for accounting for minerals is much the same as fossil fuels.
- For rental rates, retrieved sectoral rental rates of different mineral industries were from Narayanan (2012).
- For other data of reserves, extraction and prices are obtained from the U.S. Geological Survey (2015), which is the most authorised dataset on the subject.

Agricultural Land

- Permanent cropland area data from FAO is employed.
- One cannot use the market price for agricultural land as it does not usually exist. Instead, the price is computed as the net present value of the annual flow of services per hectare. In country *i* this is:
- $RPA_{it} = \frac{1}{A}\sum_{k=1}^{N} R_{ik} Q_{itk} P_{itk}$
- *A* is the harvested area, *R* is the rental rate, *Q* quantity harvested, *P* is the price of the crop. *k* is the crop index for *N* crops (=159). *RPA* is the annual flow. To get the flow over time the net present value of this has to be taken:
- $p_{Ait} = \sum_{\tau=0}^{\tau=\infty} \frac{RPA_{it}}{(1+r)^{\tau}} = \frac{(1+r)}{r} RPA_{it}.$
- The discount rate *r* is taken as 5%

Pasture Land

- Permanent pasture area data are from FAO.
- Rental value of pasture land is taken as the same as that for cropland.
- Clearly a limitation in the calculations.

Forests: Timber

- Total forest area (excluding cultivated forest) is multiplied by timber density per area, and the percentage of total volume that is commercially available.
- Cultivated forest is a production activity in the System of National Accounts. In line with this, it is treated under produced capital.
- Weighted price of round wood and fuelwood is calculated from national data to give a gross price of timber. A rental rate for timber has been estimated and applied to this price to get a rental value.
- Flow of quantities are assumed constant and discount rate of 5% is applied.

Forests: Non-Timber

- 10% of total forest area (excluding cultivated forest) is taken for non-timber benefits based on World Bank estimates. (This is *γ* below).
- Value of non-timber benefits from forests are taken from ES valuation database of van der Ploeg and de Groot (2010). This includes estimates from many studies covering provisioning, regulating, habitat and cultural services. Estimates are USD2,091/ha/yr for boreal and temperate forests and USD2,990(ha/yr for tropical forests. These values are used as the price *P* to estimate NTF wealth as:
- $\sum_{\tau=t}^{\tau=\infty} \frac{PQ_\tau\gamma}{(1+r)^{\tau-t}} = \frac{(1+r)}{r} PQ\gamma.$
- Quantity *Q* is held constant over time as is *P.*

Fisheries

- Fish stock is difficult compared to other classes of natural capital as they cannot be estimated based on the habitat area, unlike forest or agricultural land, whose computation can be based on the area.
- A simplification they assume that the fish stock belongs to the country where harvest takes place and the resources are loaded.
- Current stock is estimated as 2 x catch of the year of data follows maximum catch; otherwise stock is estimated as 2 x maximum catch less actual catch.
- Unit price is taken as period average market price multiplied by the rental rate.

Other Adjustments for Asset Values

- **Carbon Damage**. Carbon emissions are valued at USD50/Ton carbon, which is taken from studies of the social cost of carbon (Tol, 2009).
- Emissions are estimated from all sources by country but not linked to particular assets.
- **Oil Capital Gain and Loss.** An annual increase of 3% in the rental price of oil is assumed, which corresponds to the annual average oil price increase during 1990-2014.
- **Total Factor Productivity.** Allows for an increase in the value of all assets, including environmental assets as overall productivity grows.

Issues Arising in Environmental Asset Accounting

- **Coverage** is not complete. Assets not included so far: marine ecosystems, protected areas (covered by World Bank), biodiversity.
- **Data limitations** mean a lot of approximations have to be made.
- Valuation is mostly for environmental assets and not ecosystems. Thus **interdependence** between assets in ecosystems is not taken into account.
- **Spatial variation** in the value of assets is important but has not been addressed so far.
- UN and WB estimates using similar but slightly different methodologies are quite far apart.

Issues for Different Assets.

- Non-renewable Assets.
  - Future price trends taken at 3% growth does not allow for changes in demand for fossil fuels with decarbonisation.
  - Metal and mineral coverage is not complete.
- Agricultural and Pasture Land
  - Increase in area under crops in future is not included (WB makes some estimate for this).
  - Future crop prices could be affected by growing demand.
  - Pasture land values are not the same as for crop land as it assumed.

Issues for Different Assets.

- Timber
  - Evolution of price trends
  - Changes in areas under forest due to deforestation need to be accounted for.
- Non-Timber
  - ES studies taken are a good start but values of these ES vary greatly across countries and even with countries depending on location of forests. These have not been allowed for.
  - Values of ES will almost certainly change over time. This has not been taken into account.
  - Areas generating ES (taken as 13% of forest area) is very crude.
- Fisheries
  - Modelling and estimation is very crude.
- Carbon
  - Carbon sequestration services of forest and land assets are not included.

Conclusions

- The SEEA EEA has developed a number of methods to extent valuation to assets not previously in the SNA.
- The methods raise a number of challenges that have been addressed here.
- One is the estimation of current rents to the environmental asset from market prices.
- The second is projections of these rents in the future.
- A third is to work with databases and approaches that are consistent across countries (including choice of discount rates).
- Lastly further work is also needed to expand coverage to ES not covered.