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Possibilities and challenges in transfer and generalization of monetary estimates for environmental and health benefits of regulating chemicals

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Value transfer (VT) / Benefit Transfer

- Transfer economic value of public good from *study* site (primary valuation study) to *policy* site; (often termed *benefit* transfer, but both benefits and costs can be transferred
- Increased use of cost-benefit analysis (CBA), and lack time and money to conduct new primary study on policy site

  → Use VT, but are transfer errors acceptable?

Transfer Error (TE)

- Percent difference between the transferred (WTP_T) and policy site primary estimate (WTP_P)

$$TE = \frac{\left|WTP_T - WTP_P\right|}{WTP_P}$$

Transfer Error – Example
Environmental impacts/ecosystem services

- Lindhjem & Navrud (2007) test the reliability of meta analysis (MA) of non-timber benefits of forests for international VT

  → Mean transfer error MA-VT: 47-126 %

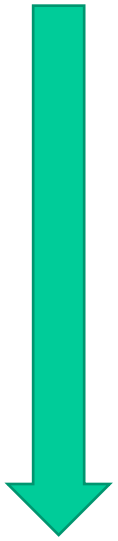
  while simple unit VT: 62- 86 %

  → More MA of primary studies from other countries and other environmental goods needed before final conclusion can be drawn on MA for VT of environmental impacts

  → Does VT provide sufficient accuracy for policy use ?

Policy use of monetary estimates of environmental and health impacts of chemicals

- **Raising awareness** of social costs
- **Cost-Benefit Analysis (CBA)** of measures and regulatory frameworks
- **Environmental Accounting** (adjusting national accounts)
- **Environmental Costing** for regulation
- **Natural Resource Damage Assessment (NRDA)** (calculating compensation payments after acute releases of chemicals)



Increased accuracy needed

Acceptable Transfer Errors

Need higher level of accuracy in NRDA than for CBA, since NRDA is directly used to determine the compensation to be paid by the identified polluter

What is the acceptable transfer error level for CBA ?

→ Depends on the decision-making situation;

If Costs and Benefits are close; higher accuracy is needed in order to decide whether B > C (NPV >0)

Four basic requirements for valid VT:

1) Complete, searchable and accessible **database** of domestic and foreign valuation studies (to transfer values from)

2) Guidelines for **assessing quality of primary valuation studies**

3) **Value transfer techniques**

4) **Value transfer guidelines**

1) Valuation Databases- examples

- **International**

  - EVRI – Environmental Valuation Reference Inventory

  www.evri.ca (4490 studies; includes public health impacts)

  - ENVALUE (Australia and International)
  - RED - Review of Externality Data
  - BeTa – Benefits Table
  - NOAA´s databases on Marine and Coastal resources (Coastal recreation and Coral Reef Valuation etc.)

- **National**

  - New Zealand NMDB
  - ValueBase SWE
  - UK Defra Environmental Valuation Source List
  - USDA NRCS (Natural Resource Conservation Service)
  - US Recreational Value Database, Ecosystem Val.; Coastal Res.

2) Quality assesment of primary valuation studies

- **Quality assessment** of candidate studies;

  both published and unpublished studies (including «Grey literature» in terms of M.Sc.-theses, research reports), using check lists like e.g

  Söderquist, T and Å. Soutukorva (2006):

  An instrument for assessing the quality of environmental valuation studies. Report, Swedish Environmental Protection Agency

  https://www.naturvardsverket.se/Documents/publikationer/620-1252-5.pdf

3) Value Transfer methods

1. **Unit Value Transfer**
   - i) Simple (naïve) unit transfer
     - use value: Consumer surplus/activity day
     - non-use value: WTP/houshold/year
     - mortality: VSL (VOLY)
     - morbidity: WTP per symptom day/episode
   - ii) Unit transfer with income adjustments
   - iii) International transfer: PPP-adjusted exchange rates
2. **Value Function Transfer** (from *one* similar study)
3. **Meta-analysis** (Value function from *many* studies with different scope in terms of size of the environmental /health impact and different baselines (and fr environmental goods: availability of substitute sites, habitats vs. single species, ecosystem services, recreational use vs. non-use)

Unit value transfer with income adjustment

Adjusted benefit estimate B_p' at the policy site:

$$B_{p'} = B_s \, (Y_p / Y_s)^{ß}$$

B_s	primary benefit estimate (e.g. WTP) from study site,
Y_s, Y_p	income levels at the study and policy site, respectively
ß	income elasticity of WTP for public goods (0.3-1.0 range)

Jacobsen & Hanley (2007) found that GDP per capita (i.e wealth in society) was a better predictor of WTP than respondent´s income (i.e. Individual wealth) in a meta analysis of 46 CV studies of WTP for nature conservation

Value function (VF) and Meta analysis (MA)

VF: $WTP_{ij} = b_0 + b_1 G_j + b_2 H_{ij} + e$

WTP_{ij} = willingness-to-pay of household i at site j,
G_j = set of characteristics of public good at site j,
H_{ij} = set of characteristics of household i at site j

MA: $WTP_s = b_0 + b_1 G_j + b_2 H_{ij} + b_2 \mathbf{C_s} + e$

WTP_{ij} = mean willingness-to-pay/household of study s
C_s = set of methodological characteristics of study s
n = number of studies (but also several estimates from each study)

Meta analyses (MA) of Biodiversity - examples

- **Rereational use values of ecosystems (TC and CV)**
  - Rosenberger and Loomis (2003), US studies
  - Shrestha and Loomis (2003), US studies
  - Zandersen and Tol (2005) (9 European countries)

- **Non-use values (mainly CV)**
  - Loomis & White (1996) Rare and endangered species
  - Brouwer et al (1999), Brander et al (2006), and Ghermandi (2007) - Wetlands
  - Brander et al (2007) - Coral reefs
  - Nijkamp et al (2007) - Biodiversity and Habitat Services
  - Jacobsen and Hanley (2007)- Biodiversity; 46 CV studies worldwide
  - Lindhjem (2006); and Lindhjem and Navrud (2007)
    - MA and VT based on MA of 30 studies in Norway, Sweden and Finland; non-use values of coniferous forests
  - Tuan and Lindhjem 2008:Biodiversity in Asia and Oceania

Meta Analyses (MA) of Mortality (VSL) - examples

- OECD (2012), Lindhjem et al (2013) – MA of Stated Preference (SP) studies

- Viscusi and Aldy (2003) – MA of Revealed Preference (RP) studies

Validity tests - transfer errors

- Average transfer error for spatial value transfers both *within and across* countries tends to be in the range of 25% - 40% for morbidity endpoints (Navrud, 2004, Ready and Navrud 2006 – Special issue of *Ecological Economics* on VT)
- Individual transfers could have errors as high as 100 % or more.
- *Function transfer* should perform better than *unit value* transfer, but do not always in practise.
- *Meta analyses* can be helpful, but should be limited in scope (no. of studies included) in terms of similar type health/environmental impact valued and state-of-the-art valuation method

4) Value Transfer Guidelines*

1) Identify the change in the environmental good to be valued at the policy site

(i) Type of environmental and health impact

(ii) Describe baseline, magnitude and direction of change

2) Identify the affected population at the policy site

3) Conduct a literature review to identify relevant primary studies (from the EVRI database or specific databases like OECD Stated Preference valuation studies of VSL).

* Navrud (2006): *Benefit Transfer Guidelines. Report to Danish EnvironmentalProtection Agency*; and Bateman et al (2009): *Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal. Value Transfer Guidelines. Report to UK Defra.*

VT Guidelines (cont.)

4) Assessing the quality of study site values for transfer

(i) Scientific soundness; the transfer estimates are only as good as the methodology and assumptions employed in the original, primary studies

(ii) Relevance; primary studies should be similar and applicable to the “new” context

(iii) Richness in detail; primary studies should provide a detailed dataset and accompanying information

VT Guidelines (cont.)

5) Select and summarize the data available from the study site(s)

6) Transfer value estimate from study site(s) to policy site

(i) Determine the transfer unit

(ii) Determine the transfer method for spatial transfer

(iii) Determine the transfer method for temporal transfer

7) Calculating total benefits or costs

8) Assessment of uncertainty and acceptable transfer errors (and sensitivity analysis for size of «affected population»)

Criteria for Judging Similarity

I) Characteristics of the good

- Similar good? (e.g similar type forest/water body, similar use and/or non-use value components; similar recreational activities, similar ecosystem services, mortality risk change, morbidity endpoint)
- Similar *baseline*, *size* and *direction* of change in the public good valued?
- To avoid scaling up and down values according to the size of the area, involving strict assumptions in terms of e.g. constant value per ha of use and/or non-use values; rather consider foreign study sites with nearly similar size than domestic study sites with a very different scale. The same applies to the baseline and the direction of the change. However, the general recommendation is to choose a domestic study site as close as possible geographically).
- Similar *availability of substitute* sites? (For use values: recreational sites; For non-use values: National parks and other preserved areas and the ecosystem services they contain)
- Similar natural resource management regimes/public health care systems ?

Criteria for Judging Similarity (cont.)

II) Population characteristics

- Similar average *income* level (and income distribution)? (If not, income adjustments should be made when performing the value transfer)
- Similar *gender, age and educational* composition?
- Similar *size* of affected population? Expected similar *distance decay*, if any, in non-use values?
- Similar rights to using areas for recreation?
- Similar attitudes to preservation of forests, water, agricultural landscape, mortality risk, morbidity episodes etc. ? (attitudinal and cultural factors)

Four categories of ”Similarity” between Study Site and Policy Site

Category	**Level of fit between study and policy sites**	**Percentage transfer error**
1	Perfect Fit	± 20
2	Acceptable fit	± 50
3	Poor fit	± 100
4	No fit	Discard study for this VT

Environmental Impact - Scaling up over size of:

1) Affected Population

- uniqueness – local, regional or national importance and population
- take account of availability of substitutes and their quality
- distance decay in WTP
- aggregate over households rather than individuals (to avoid overestimating WTP)

2) Ecosystem

- *unit of valuation* needed for policy making (e.g. ha of an ecosystem) is not the same as those directly meaningful to ecologists; or how people think about biodiversity and ecosystem services (which is what determines the unit used in Stated Preference surveys)
- discrete changes valued (providing average values per unit of area), while marginal values needed
- Marginal values are not constant; and baseline quality/quanitity matters.
- Aggregate at ecosystem level (not at the level of individual species)

Meta Analytic Transfer and Scaling Up of Environmental Impacts

- MA could be potentially very useful when scaling up due to the variability in size, quality, ecosystem services, baseline quality, availability of substitutes. etc of primary studies included.
- Depend on the number of explanatory variables and explanatory power of the estimated Meta-analytic regression model (which could be improved if the scope of the analysis is narrowed in terms of domestic vs. international studies, valuation methods included, definition of ecosystem etc.)

Scaling up over the size of the ecosystem

- Avoid another Constanza et al exercise
- Lindhjem (2006) in a MA of 30 studies in Norway, Sweden and Finland of mainly non-use values of coniferous forests

  →**WTP does not vary with size** of forest area

  → transfers and scaling up-exercises using value pr. ha will be biased

  → Need to test validity of meta-analytic VT (and construct more primary studies with VT in mind)

Challenges (and possibilities) in Value Transfer for Chemicals

1) **Ability to translate risk assessments to health and environmental endpoints** for valuation and value transfer.

2) **Lack of primary valuation studies** for value transfer for each identified endpoint

3) **Frequent need for international value transfer** in a situation with a limited number of primary studies internationally

Main Challenges (cont.)

4) Addressing the **“scaling issue”,** when there are few primary studies and a need to scale the result from the primary study up or down

5) **Temporal transfer**, both in terms of transferring values over time from existing primary studies, but also when predicting future values in CBAs with a time horizon of many decades. Account for increased income, changinging preferences and scarcity of public goods

Main Challenges (cont.)

6) Addressing the **“adding-up”-issue**. Moving from benefit assessment of regulating one chemical to also address a larger groups of chemicals covered by regulations like REACH, one need to take account of possible interactions between these chemicals in all stages of the damage function /impact pathway approach

Is it possible to transfer/generalise from assessment of one or a few chemicals to evaluate regulatory frameworks like REACH?

- **NO**
- In theory: Use damage function/approach (DFA) for each chemical, as done for air pollutants in CBA of air quality regulations

  But: lack dose-response functions for many chemicals and health and environmental impacts
- Environment /Health Canada Choice Experiment of environmental and health risk characteristics of chemicals in general → fit for their regulatory CBAs, but not for VT/DFA approach for individual chemicals

Tentative Approaches to Value Benefits of Chemicals Regulatory Frameworks

1) **Improve existing assessments of individual chemicals**

   i) better spatial and temporal value transfer,

   ii) cover more health endpoints (morbidity)

   iii) cover more cost components (loss in well-being; now COI and Productivity loss),

   iv) better utilisation of risk assessments to establish causational relationships

   v) identify which parts of damage function where more research could provide the «highest benefits» in terms of more comprehensive and accurate asessment

Tentative approaches (cont.)

2) **Utilize the extensive literature on lost DALY (and QALY) for many chemicals in Global Burden of Disease** Assessments; and combine the aggregate impacts in terms of DALYs multiplied by Value of a Life Year (VOLY)

but questions about the theoretical foundation and reliability and relevance of combining QALY/DALY numbers with VOLY, and reliability and relevance of VOLY estimates.

Conclusion

- **Learn from the Damage Function Approach work on air pollutants** (e.g. ExternE-project series www.externe.info), which is a result of extensive and long term research efforts
- For chemicals; large knowledge gaps in dose-response functions and impact assessment, as well as valuation of relevant health endpoints (new morbidity endpoints; acute and chronic) and environmental endpoints («translated» into ecosystem service impacts). **But** start now conducting **new primary valuation studies** of expected endpoints **designed for VT**