Pre-Conference Workshop: Spatial Dimensions of Stated Preferences

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When and why go spatial in stated preference analysis?

AN OVERVIEW AND OUTLOOK

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Approaches to consider space

- Theory led and empirically led approaches, <u>but not clear-cut</u>

Theory led
Empirical testing of *ex ante* assumptions guided by theory about why space matters

→ Theory led may aim to identify 'residual' spatial effects not explained by theory

Empirically led
Space matters but no *ex ante* theoretical assumptions;
Use of spatial econometrics

← Empirically led may seek to explain patterns using theory

The role of theory

- Theory provides considerable guidance regarding the ways in which spatial dimensions can and should be integrated into stated preference valuation, along with the type of effects that might be expected
  - For example, the travel behavior necessary to realize some types of use values implies that WTP should exhibit distance decay, ceteris paribus
- Theory can also provide considerable guidance on whether and how spatial information should be presented within questionnaires
- In other cases theory provides equivocal insight. For example, current theory provides limited guidance into whether and how nonuse values might vary over space, and thus on the expected extent of the market

Microeconomic concepts

- Distance decay
- Availability of substitutes and complements
- Diminishing marginal utility

Distance Decay

Demand in terms of WTP decreases with distance of residence from valued site(s)

- less frequent actual use of site/resource e.g. for recreation: following inverse relationship between travel cost and visitation rates Sutherland and Walsh 1985; Pate and Loomis 1997; Hanley et al. 2003; Bateman et al. 2006
- availability of substitutes for specific (non-unique) site/resource increases since relevant consideration set expands (resource use opportunities increase) Pate and Loomis 1997; Rolfe et al. 2002; Hanley et al. 2003; Bateman et al. 2006
- search and information costs increase as distance to site increases resulting in lower levels of knowledge/awareness of the site and its (quality) characteristics Sutherland and Walsh 1985; Pate and Loomis 1997; Hanley et al. 2003
- increased level of moral obligation / responsibility for closer sites compared to more distant ones Rolfe and Bennett 2002; Hanley et al. 2003; Bateman et al. 2005, 2006; Johnston and Duke 2009

Use value

Non-use value

Substitutes (and Complements)

- Availability of substitutes both explanation for distance effects and relevant spatial dimension in its own right (Pate and Loomis 1997)
- Quantity demanded depends on price of the good and price of substitutes

$Q(p, p_s, p_c)$

$\frac{dQ}{dp_s} > 0$ and $\frac{dQ}{dp_c} < 0$

- Availability (and prices) of substitutes (e.g. in a site choice context) vary spatially
- Thus, differences in available substitutes can explain spatially different welfare effects

Diminishing Marginal Utility

- Demand for additional quantity or quality of a good decreases as level of provision/endowment increases

$\frac{\partial U}{\partial x} > 0$ and $\frac{\partial^2 U}{\partial x^2} < 0$

- Marginal willingness to pay for e.g. more forests, more biodiversity, better water quality should thus be decreasing with an higher initial endowment
- This endowment can vary spatially
  - Examples: Land use changes, water quality improvements

Spatially distributed determinants

- Observable dimensions that are spatially dependent and likely affect demand/WTP
  - income
  - education
  - information availability on site quality
  - knowledge and experience of a good/site
  - …
- Not always considered in analysis – omitted variables
- Some may be related but not fully explained through microeconomic concepts e.g. knowledge/experience and distance may be correlated
- Which dimensions/variables are relevant to understanding spatial processes that result in spatial patterns of welfare effects?

Theory led approaches

- Use of microeconomic concepts to form hypotheses about spatial effects *ex ante*
- Focus on observed heterogeneity

Distance decay - approaches

- Samples of respondents at different distances from site:
  - WTP comparisons across ‘distance zones’ (Bateman and Langford 1997) or samples at discrete distances (e.g. Rolfe and Windle 2012)
- Inclusion of distance variable in bid/utility function
  - Measured based on information on respondents’ residence as travel distance; ‘as the bird flies
  - Modelled as linear distance decay or non-linear distance decay
  - Included as attribute of resource/site to be valued (e.g. Luisetti et al. 2011; Liekens et al. 2013)
- Explanatory variable in regression of ‘individual-specific’ WTP

Distance decay – lessons I

- Distance decay varies across sites and context
- Use and non-use values
  - Difficulty to disentangle use- and non-use values; reliance on distinguishing users versus non-users
  - Mixed evidence on distance effects for non-users
  - Present non-users may become users after site quality improvement
  - Distance effects <u>sensitive to choice of welfare measure</u> (equivalent loss versus compensating surplus) (Bateman et al. 2006)

Distance decay – lessons II

- Mixed evidence of presence of distance effects if non-use values dominate
  - Various explanations offered e.g. nationally ‘iconic’ sites (unique) versus more localised sites etc

- Distance effects may not be invariant to context/framing effects (Rolfe and Windle 2012)
- Distance effects may be affected by (spatial) distribution of ‘protesters’ and ‘genuine zeros’ in the sample (Söderberg and Barton 2014)

Substitutes

- Recently received more attention (e.g. Schaafsma et al. 2013; Jørgensen et al. 2013; Lizin et al. 2016; De Valck et al. 2017)
- Explicit consideration of substitute availability explains heterogeneity in preferences over and above distance effects

Substitutes - approaches

- Single site versus multi-site studies
- Direct (e.g. in labelled choice experiments) or indirect consideration of potential substitution patterns
- Definition based on site ‘similarity’:
  - Area-based versus discrete site-based definition
  - Quality-based definition (e.g. natural versus managed forest; type of activity possible)
- Respondent/User-defined versus researcher defined definition

Beyond globally uniform distance decay

- Directionality (Schaafsma et al. 2012,2013)
  - Motivation:
    - Substitute availability not uniformly distributed around site (in terms of all relevant site characteristics i.e. quality, quantity, accessibility etc.)
  - Possibility of additional complex multidirectional spatial preferences and unidentified associated substitution effects
  - Spatial expansion method/spatial trend variables

Beyond globally uniform distance decay

- Cumulative effects – effect of number and *cumulative* distance to sites and substitute sites as a measure of 'exposure' to amenity/disamenity
  - e.g. Meyerhoff 2013; Knapp and Ladenburg 2015; both wind farms/turbines

Quantity-within-distance

- Distance measures alone do not capture the effect of the proximate quantity of affected public goods (spatial scope)
- Particularly relevant if environmental change valued affects areas rather than single points/sites
- Quantity or area of an affected resource surrounding each respondent at an optimised distance band or a certain radius (Holland and Johnston 2017)
- Increasing quantity of resource to be improved in proximity implies greater level of benefits

Diminishing marginal utility

- <u>Geospatial referencing</u>

- (Large) sites with varying characteristics – characteristics of site close to place of residence affects WTP (Moore et al. 2011; Tait et al. 2012)
  - Higher quality results in lower marginal WTP for a unit of improvement
- Generic land use changes – current endowment in specific distance bands around place of residence (Sagebiel et al. 2017)
  - Greater endowment with a land use results in lower marginal WTP for an additional unit of this land use

Empirically led approaches

- Some spatial patterns cannot be easily identified and explained by microeconomic concepts – no *ex ante* assumptions on spatial distribution of WTP
  - Example: hot and cold spots of WTP
- Focus on unobserved heterogeneity

Tobler's First Law of Geography

"Everything is related to everything else, but near things are more related than distant things." Tobler (1970)

- Based on concept of friction of distance:
  - Interaction between places is related to distance; interaction between more distant places requires more energy/higher cost

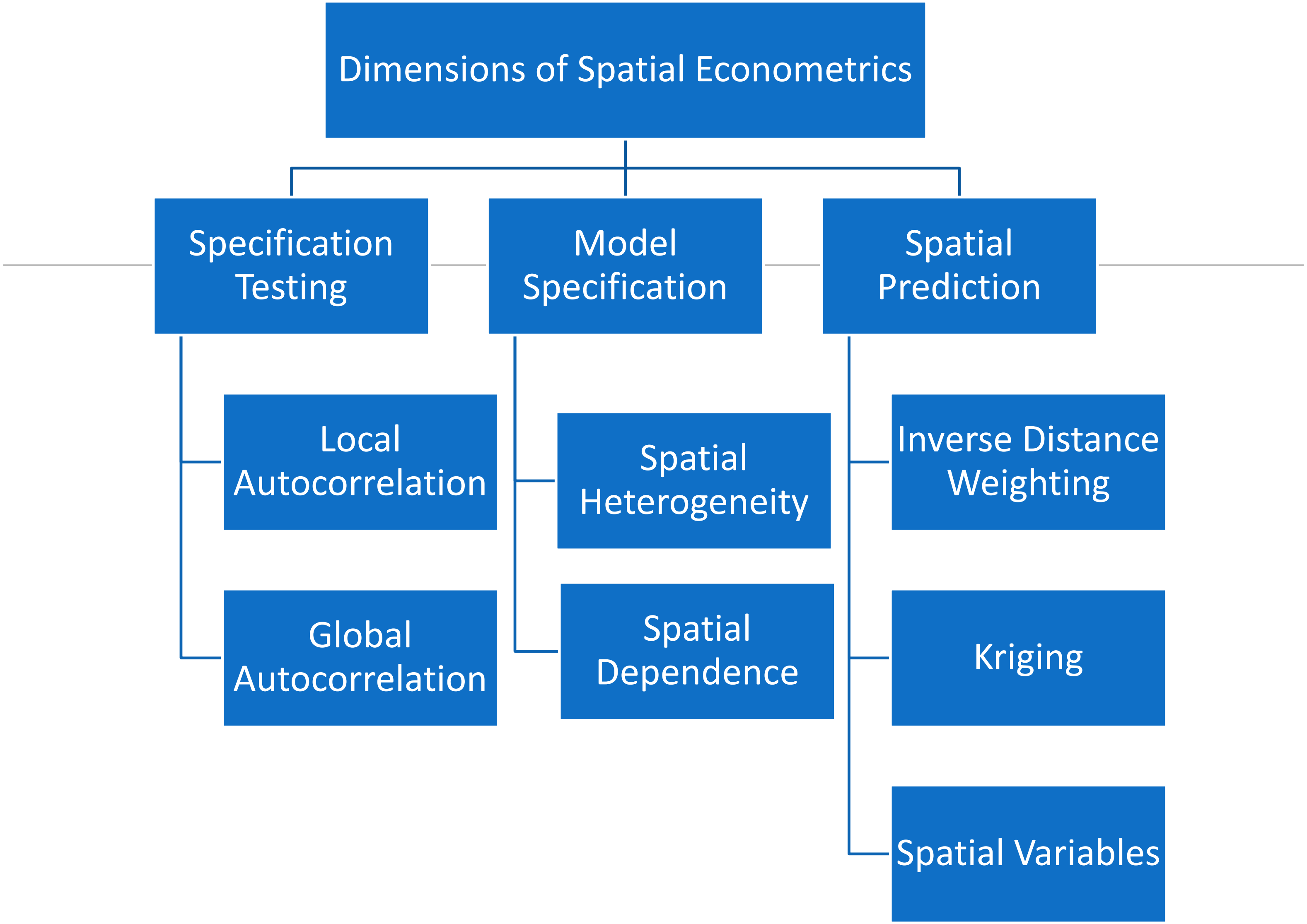
- Spatial 'effects' or processes can result in inefficiency and/or bias in parameter estimates if ignored

Heterogeneity & dependence

- Spatial Heterogeneity: "(welfare) effects are different in different areas"
  - **Variation in relationships over space**
  - Separate models for different areas
  - Use of spatial variables that enter the utility function (e.g. spatial expansion method)
  - Use models that consider parameter differences across spatial units (e.g. geographically weighted regression (Budzinski et al. 2016), spatial regimes)
- Spatial Dependence: "(welfare) effects cluster"
  - Lack of independence among observations (by definition)
  - **Functional relationship between effects/choices in one location and other locations: *spatial interaction***
  - Spatial dependence in residuals – spatial error model
  - Spatial dependence in the data (variables) – spatial lag model

Heterogeneity or dependence?

- Spatial dependence and spatial heterogeneity result in spatially varying welfare effects
- Both spatial dependence and heterogeneity are indicated by spatial autocorrelation
  - "Spatial autocorrelation (association) is the correlation among observations of a single variable (auto meaning self) strictly attributable to the proximity of those observations in geographic space" (Fischer and Wang 2011)
- Often difficult (or not possible) to distinguish between heterogeneity and dependence from an empirical perspective



Based on Anselin (2010)

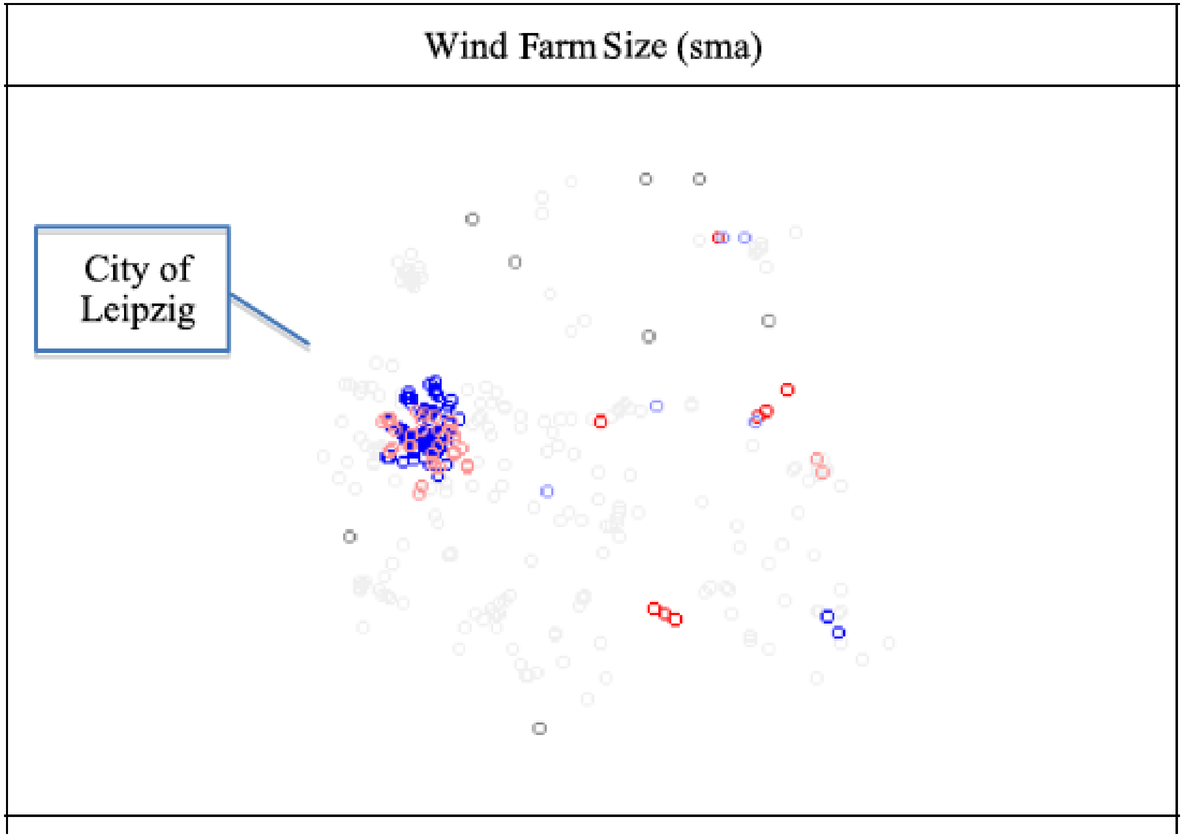
Empirically led - studies

- ±8 studies
- Based on latent class/mixed logit models with subsequent generation of ‘individual specific’ WTP estimates
- Subsequent analysis of spatial distribution of WTP ‘observations’
- Spatial pattern analysis (global and local measures of spatial autocorrelation)
- Specification testing and subsequent consideration of autocorrelation in models of spatial dependence (spatial lag or spatial error models)
- Spatial prediction (Extrapolation and mapping)

Spatial pattern analysis

- Among the first were Campbell et al. (2008, 2009) using results from DCE exploring spatial dependence and spatial distribution
- Mainly Moran's I for global autocorrelation; some use measures suggested by Geary as well (e.g., Meyerhoff 2013)
- A subset of studies investigate local clusters of WTP, e.g. patchiness/hot spots (Johnston & Ramachandran 2014, Johnston et al. 2015, Meyerhoff 2013)
- Applications vary from regional scale (Johnston et & Ramachandran; Meyerhoff 2013) to covering a whole country (Campbell et al. 2009; Johnston et al. 2015; Czajkowski et al. 2016)
- So far all studies find forms of spatial patterns
- Sensitivity of results regarding underlying assumptions (e.g. definition of spatial weight matrix)?

Hot and cold spots of WTP



Local clusters of WTP values (Local Moran's I), **red dots** (high-high WTP values), **blue dots** (low-low WTP values), **light red** (high-low WTP values), **light blue** (low-high WTP values).

Meyerhoff (2013)

Spatial dependence

- Czajkowski et al. (2016) derive individual specific WTP values for changes to national forest management in Poland
- After testing for global autocorrelation, they subsequently estimate a spatial lag model
- Spatial lag parameter is positive and significant: respondents with high WTP values are expected to have neighbours with high values
- Effects of covariates unaffected by spatial dependence: socio-demographics; forest characteristics and distance to nearest forest

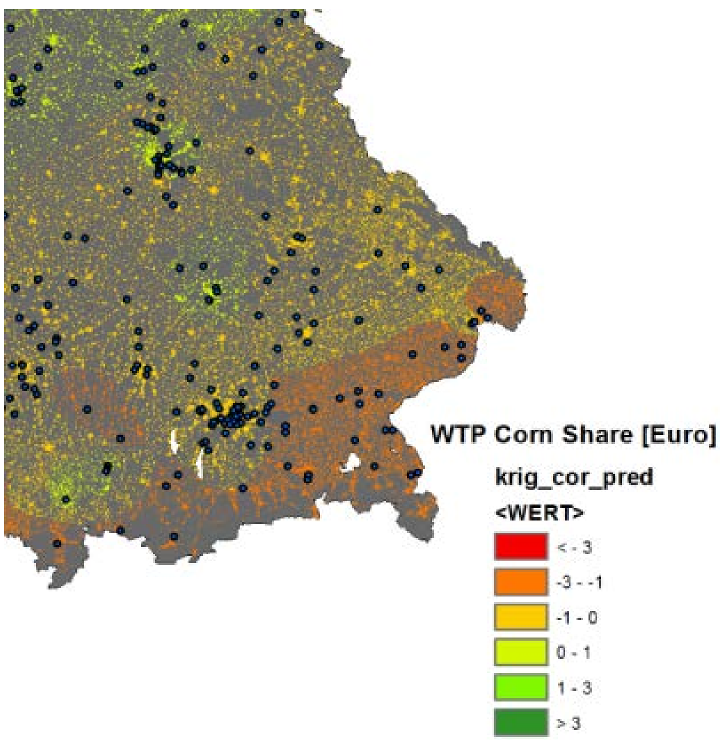
Spatial prediction of WTP

Various techniques to predict WTP values across space for locations where they have not been measured; some techniques are borrowed from geostatistics

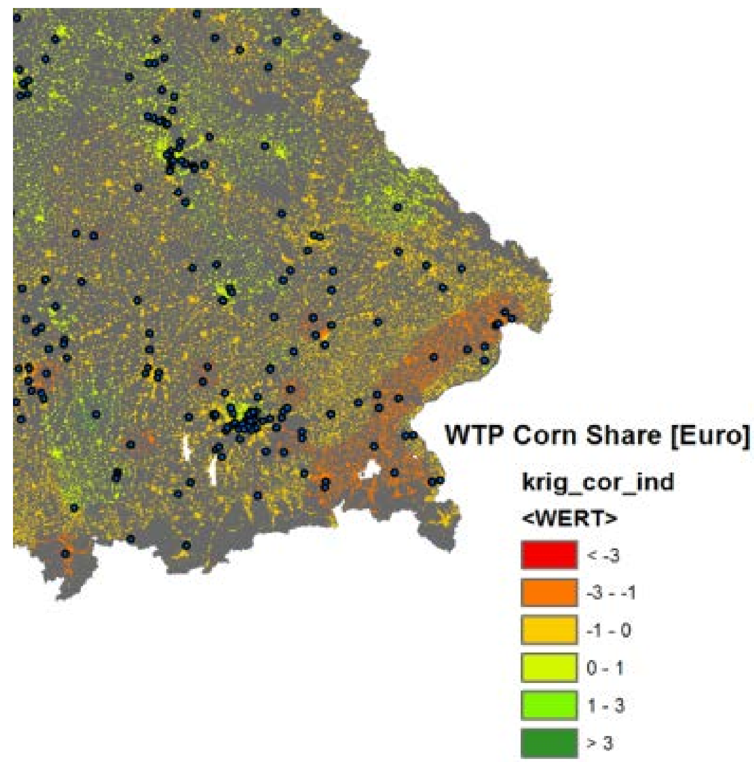
- Inverse distance weighted (IDW) interpolation (e.g., Johnston et al. 2015): rests on the assumption that things close to each other are more alike than those farther apart; it assumes that each point has a local influence that diminishes with distance
- Kriging (e.g., Campbell et al, 2009): similar to IDW but weights not depend only on distance between the measured points but also on the spatial arrangement (*spatial autocorrelation)*
- Direct regression based prediction (e.g., Sagebiel et al. 2017): uses the deterministic part of an random utility model to predict WTP values for individuals or spatial units (jurisdictions) for which no observations are available

Comparing prediction methods

regression based WTP with kriging



individual-specific WTP with kriging



Sagebiel et al. *work in progress*

Alternative concepts/approaches

- WTP differences across geographical scales or jurisdictions affected by environmental change (e.g. Morrison and Bennett 2004; Johnston and Duke 2009; Franceschinis et al. 2016)
- Important for considerations of benefit transfer across scales or jurisdictions (Johnston and Duke 2009; Martin-Ortega et al. 2012)
- Area/jurisdiction where environmental change takes place in relation to place of residence affects WTP

Alternative concepts/approaches

- Across scales:
  - Improvements conducted over smaller jurisdictions are likely to have more proximate effects than improvements conducted over larger jurisdictions
- Across jurisdictions:
  - Sense of ownership/responsibility for changes taking place in ‘own’ jurisdiction
  - Abundance and quality of substitute sites in jurisdiction (e.g. Interis and Petrolia 2016)
- Effects can differ depending on magnitude of environmental change (Brouwer et al. 2010)

The goal of this workshop

- More defensible, systematic, valid and reliable estimation of spatial dimensions within stated preference studies
- Towards a more cohesive perspective on how to address space within stated preferences
- To develop a structured understanding of the role of space for stated preferences
  - when; why; what; how

Areas for progress

- Addressing spatial dimensions within stated preference analysis requires
  - Economic theory sufficient to determine when and how these patterns are relevant for welfare analysis within particular situations
  - Survey, experimental and sampling design able to support the evaluation of spatial dimensions
  - Empirical (estimation) methods able to estimate relevant spatial patterns and identify/account for spatial non-response patterns
  - Reporting on spatial data, theory and methods necessary to use results for welfare analysis and conduct benefit transfer
  - Predicting welfare effects in space, accounting for observed and unobserved spatial patterns & implications for benefit-cost-analysis

Some key questions

- Advancing the understanding of spatial effects/processes
  - What economic arguments exist that welfare effects are spatially dependent that cannot be attributed to observable variables?
  - How can existing theory and concepts be refined or expanded to better reflect empirical findings?
  - What can we learn from other disciplines deeply concerned with space e.g. urban economics, regional economics, new economic geography?
- Advancing techniques – the toolbox
  - Are there patterns based on theoretical concepts that can be estimated better?
  - Which methods are suitable for which types of situations and how can they be employed to their best use?

Ide research fro

Which valuation contexts are meaningfully informed by theory?

What are the consequences of ignoring more complex spatial patterns?

Theory led
Empirical testing of *ex ante* assumptions guided by theory about why space matters

Theory led may aim to identify 'residual' spatial effects not explained by theory

Can similarity in spatial patterns across contexts provide insights on underlying processes?

Empirically led may seek to explain patt using theory

What are key spatially dependent variables and concepts?

Empirically led
Space matters but no *ex ante* theoretical assumptions;
Use of spatial econometrics

Advancing the Literature

- Evaluating conditions under which different types of approaches are or should be relevant (or not)
- Reconciling divergent approaches across the literature in terms of theory and relevance for welfare estimation
- Comparing competing empirical approaches in terms of empirical performance and ability to identify significant patterns
- Combining insights and methods into more holistic, valid and reliable treatments of spatial effects
- Identifying outstanding questions and research frontiers

The End ☺

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