

# New ideas and future research

## Migration spatial structure

**Colorado Conference on the Estimation of  
Migration**

24 – 26 September 2004

# Spatial interaction models

- Gravity model: distance function; cost function
- Entropy maximization
  - Maximize chaos; minimize structure
  - Minimize information content
- Log-linear model
  - Probability model based on probability theory
  - Statistical inference: maximum likelihood

Bennett, R.J. and R.P. Haining (1985). "Spatial Structure and Spatial Interaction Models: Modeling Approaches to the Statistical Analysis of Geographical Data," *Journal of the Royal Statistical Society A*, 148:1-27.

# Spatial interaction models

- Incomplete data
  - Prior information
    - Marginal totals
    - Preliminary estimates (guestimates)
  - Algorithms
    - Iterative proportional fitting; bi-proportional adjustment; RAS
    - Lahr, M.L. and L. de Mesnard (2004) Biproportional techniques in input-output analysis: table updating and structural analysis. *Economic Systems Research. Journal of the International Input-Output Association*. 16(2):115-134.
  - Expectation-Maximization algorithm (EM)

# Migration spatial structure

## Spatial interaction models

- Risk indicators: counts, probabilities, rates
- Generation and distribution component
  - Outmigration rate:  $m_{i+}$ 
    - Transition rate models
  - OR: Probability of leaving region
  - Destination probability:  $\xi_{ij}$  (direct transition; multiple destinations)
    - Logit models (multinomial) for each origin separately

# Migration spatial structure

## Spatial interaction models

- Proportion: survivorship proportion  $S_{kj}$
- $S_{kj}$  depends on covariate: region of birth
  - Native/non-Native

$$\log it[S_{kj}] = \beta_{0kj} + \beta_{1kj} Y_k \quad Y_k = 1 \text{ if born in } k$$

$$\log it[S_{kj}] = \beta_{0j} + \beta_{1j} Y_1 + \beta_{2j} Y_2 + \beta_{3j} Y_3 +$$

$${}_i \bar{S}_{kj} = {}_i \alpha_{kj} {}_k \bar{S}_{kj} \quad {}_i \alpha_{kj} = \frac{{}_i \bar{S}_{kj}}{{}_k \bar{S}_{kj}} \quad \frac{\text{non-native}}{\text{native}}$$

$${}_i \alpha_{kj} = \text{relative risk}$$

# Migration spatial structure

## Spatial interaction models

- Incomplete data: best use of prior information
  - Quantitative data
    - Historical migration patterns
    - Friction factors (e.g. cost, distance)
  - Qualitative data
    - Migration expectations (forecasting)
    - Expert opinions
- Bayesian modeling

# Migration spatial structure

## Spatial interaction models

- Basic research on spatial structure
  - What is structure?
    - A. Current spatial configuration (population distribution)
    - B. Spatial interaction: transaction, exchange, flow
  - How to model A and B?