Food Insecurity, Poverty, SNAP and Obesity in the United States as a Complex Economic System

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Background & Justification

- Food environment factors such as community's access to and acquisition of healthy, affordable, and nutritious food and community characteristics interact to influence food choices and diet quality.

  (source: USDA Food Environment Atlas, 2013)

- Complex set of factors determine the interaction between food insecurity, poverty, obesity and participation in food assistance programs

Background & Justification

- Indicators of food choices
  - Access and proximity to a grocery store
  - Number of food stores and restaurants
  - Expenditures on fast food
  - Participation in food assistance programs
  - Food prices
  - Availability of local foods

(Source: USDA Food Environment Atlas, 2013)

Background & Justification

- Health and wellbeing of food environment of a community
  - Food insecurity
  - Food deserts
  - Obesity
  - Physical activity levels

    (Source: USDA Food Environment Atlas, 2013)

Background & Justification

- Other characteristics affecting food environment and food choices
  - Demographic composition
  - Income
  - Poverty status
  - Unemployment
  - Other macroeconomic factors

(Source: USDA Food Environment Atlas, 2013)

Background & Justification

- Research is beginning to emerge on this complex interaction of variables affecting food availability, accessibility and choices

- Several studies in the extant literature addressing issues related to food insecurity, food deserts, food assistance, health…
  - Nord *et al*., 2010
  - Gundersen *et al*., 2011
  - Meyerhoefer and Yang, 2011

- Only few variables are considered at a time and lack of holistic picture

Background & Justification

- Our goal
  - Attempt to map a more complete picture with regards to food insecurity, poverty, obesity and food assistance in the United States as a “Complex Economic System”
  - Use of causality structures modeled through artificial intelligence and directed acyclic graphs
  - Provide path to effective policy interventions thorough complete causal relationships

Objectives

- Specific objectives are
  - To model complex system involving food insecurity, poverty, obesity and food assistance using causality structures developed through directed acyclic graphs
  - To compare and contrast our findings with those of extant literature offering a more definitive path to effective policy analysis

Analytical Framework

- To develop causal relationships we use recent work in computer science
  - Judea Pearl, 1995 & 2000
  - Spirtes, Glymour and Scheines, 2000
  - Chickering, 2002
- We use two algorithms
  - PC Algorithm
  - GES (greedy equivalence search) algorithm

Analytical Framework

- PC Algorithm
  - Tests vanishing correlation and partial correlation to remove edges
  - Choice of significance level
  - Use *d*-separation to direct edges (Pearl, 1995)
    - Applications of this algorithm have become prevalent in recent years following Swanson & Granger, 1997; Bessler and Akleman, 1998

Analytical Framework

- GES Algorithm (Chickering, 2002)
  - Looks over equivalence classes of DAGs starting from a DAG representation with no edges
  - Distributionally equivalent
    - Same Markov probability structure
  - Independence equivalent
    - Same independence structure
  - Stepwise search over more complicated representations
  - Bayesian scoring criterion

Analytical Framework

- GES Algorithm (Chickering, 2002)
  - Parameterized Bayesian-Network model represents a joint distribution of set of variables, characterized by Markov Condition

$$p_B(X_1 = x_1, \ldots . X_n = x_n) = \prod_{i=1}^{n} p(X_i = x_i | \boldsymbol{Pa}_i^{\mathcal{G}} = \boldsymbol{pa}_i^{\mathcal{G}}, \boldsymbol{\theta}_i)$$

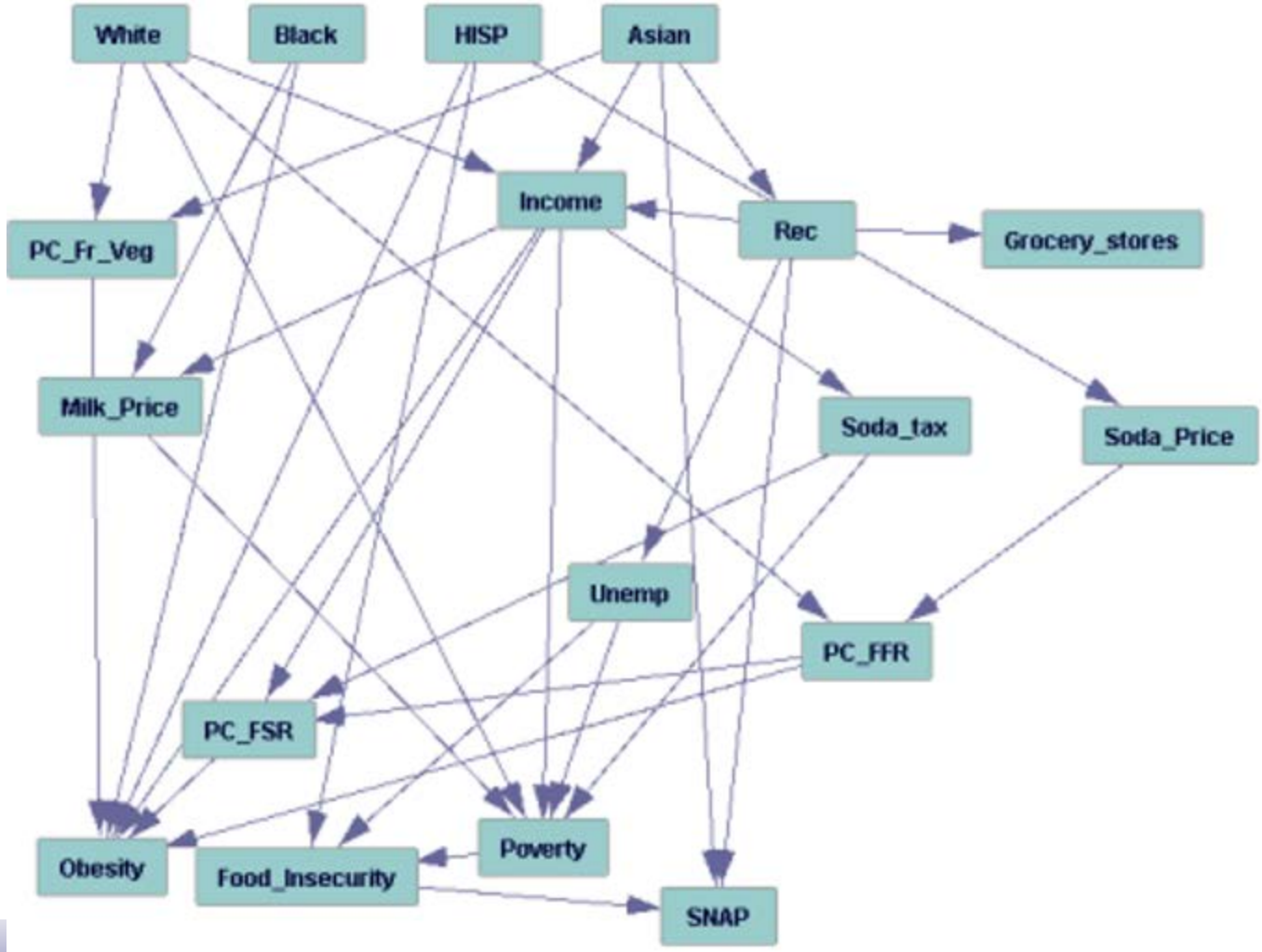
  - Bayesian scoring criterion for the DAG (*theta* is the ML estimate of network parameters, *d* is the number of free parameters of DAG, *m* is number of observations in data *D*

$$S(\mathcal{G}, \boldsymbol{D}) = \ln p\left(D \middle| \hat{\theta}, \mathcal{G}^h\right) - \frac{d}{2} \ln m$$

Data: USDA Food Environment Atlas
State level (excluding Alaska and Hawaii)

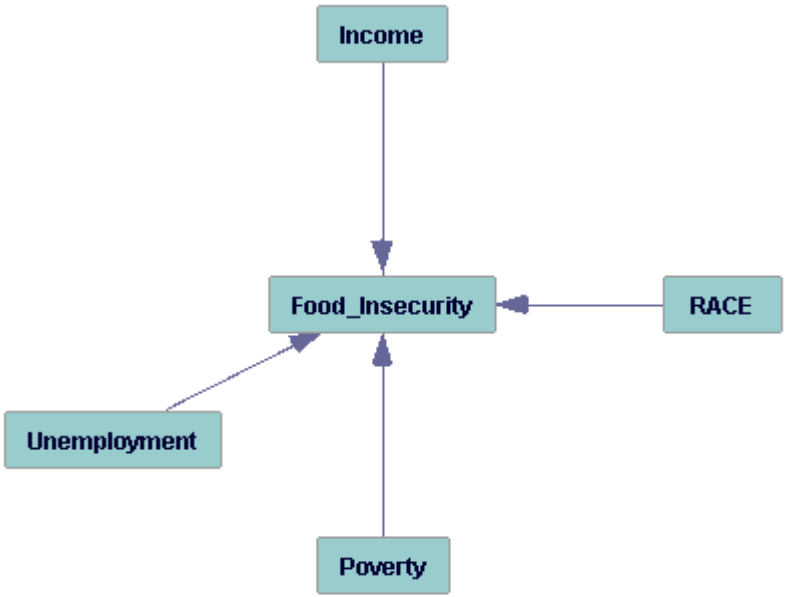
Variable Name	Variable Category
Percentage of Obese Adults	Health
Poverty Rate	Socio-economic character
Median household income	Socio-economic character
Average monthly SNAP participation	Food assistance
Soda price	Food price
Milk price	Food price
Soda tax	Food tax
Number of grocery stores	Availability of food stores
Per capita fast food restaurant sales	Expenditure food away-from-home
Per capita full service restaurant sales	Expenditure food away-from-home
Per capita fruits/vegetable consumption	Food at-home
Number of recreation facilities	Physical activity level
Percentage White, Black, Hispanic, Asian	Socio-economic character
Unemployment rate	Socio-economic character
Food insecurity rate	Food insecurity

Empirical Results

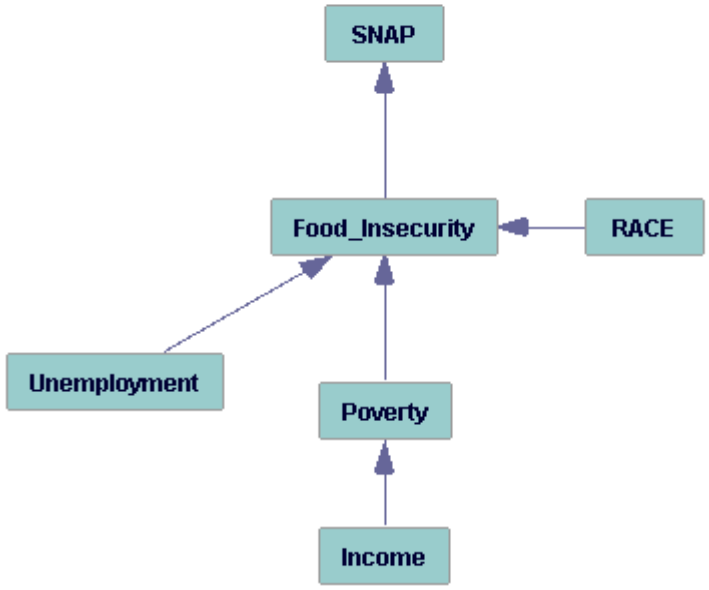


Empirical Results: Comparisons

- Gundersen, Engelhard, Brown, Waxman (2011)



- Dharmasena, Bessler and Capps, (2013)



Empirical Results: Comparisons

- Tiehen, Jolliffe and Gundersen (2012)
- SNAP→Poverty

- Verplog & Ralston (2008); Cawley & Meyerhoefer (2010); Dixon (2010); Finkelstein et al., (2009)
- SNAP→Obesity

- Dharmasena, Bessler and Capps, (2013)
- We find obesity and poverty are not directly caused by SNAP

Conclusions

- Conclusions
  - Obesity, Food insecurity, Poverty and SNAP participation are endogenous
  - Host of other exogenous and weakly exogenous factors
- Implications
  - Important to identify complex causal relationships for good policy making

Thank You

Questions/Comments?