Together We Tip The Scale
The Spatial Concentration of Obesity

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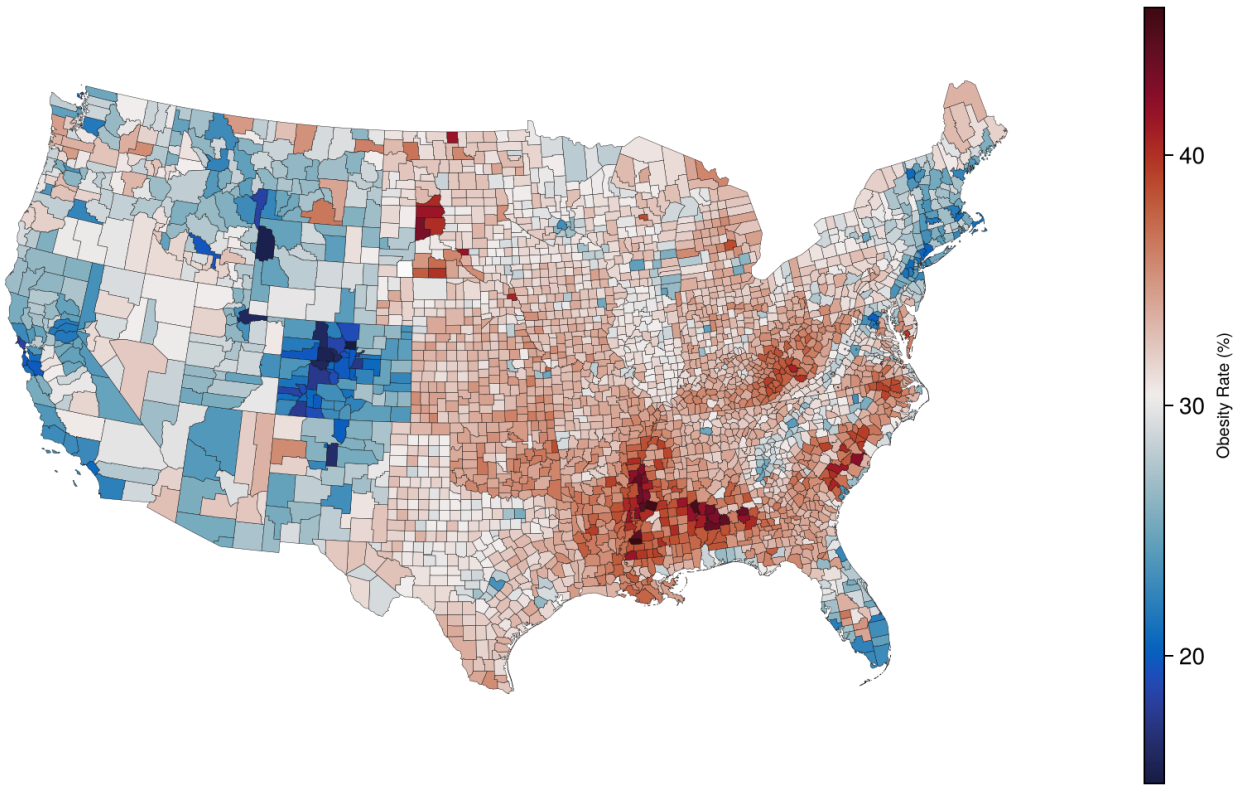
Introduction

Motivation

Figure: Prevalence of Obesity by County



Notes: Obesity is defined as body mass index (BMI) $\geq$ 30.0.

Source: CDC, 2004-16, 2020-2024.

Introduction

Motivation

- Education
- Household income
- Demographics
- Amenities
- Types of occupation
- Racial composition
- Metro/rural areas
- Food deserts

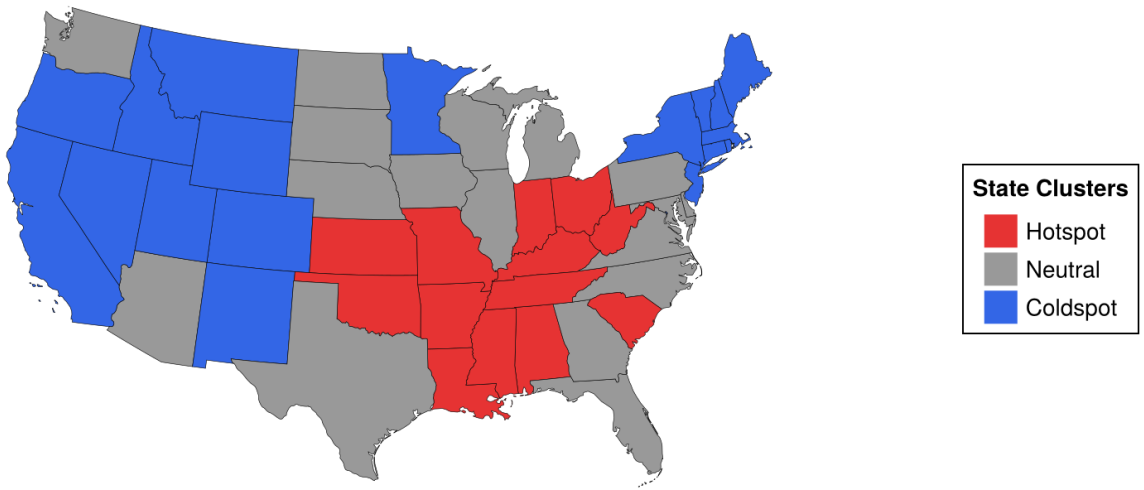
Spatial Lag OLS

	(1) Obesity Rate
Obesity Rate	
Physical Inactivity	0.213***
No Leisure-Time Activity	0.154***
Education	-0.0802***
Unemployment Rate	0.111***
Current Smoking	0.267***
High Amenities	-0.207**
Metro Area	0.124
Median HH Income	-0.405
Employment in Manufacturing	0.0351***
Recreation Facilities	-3.355***
% Age 65+	-0.0879***
% Non-Hispanic Black	0.0431***
Low Food Access	0.000152
Food Tax	1.116***
Soda Tax (Stores)	4.514***
W	
% Non-Hispanic Black	-0.120**
High Amenities	-7.102***
Metro Area	-0.645
Employment in Manufacturing	-0.474***
Recreation Facilities	-39.42**
Obesity Rate	0.400***
e.Obesity Rate	5.964***
Observations	2976

Introduction

Motivation

Figure: State Classification using Local Moran's I Statistic



Notes: A state is classified as a hotspot or a coldspot if at least 75% of its counties are classified as hotspots or coldspots respectively.

Source: CDC, 2004-16, 2020-2024.

Stylized Facts

Education

Table: Percentage of College Graduates by Cluster

Cluster	College Graduates (%)
Neutral	44.4
Hot	40.0
Cold	50.9

Source: CPS and ATUS (2003-2018)

Stylized Facts

BMI

Table: Prevalence Of Obesity By Cluster And Education

Cluster	Average	High School	College
Neutral	35.01%	38.85%	28.63%
Hot	38.63%	41.28%	32.32%
Cold	29.12%	34.49%	21.8%

Source: CPS and ATUS (2003-2018)

Table: BMI By Cluster And Education

Cluster	Average	High School	College
Neutral	28.33	29.28	28.04
Hot	28.69	29.4	28.64
Cold	27.59	28.73	27.22

Notes: To put it in perspective, college graduate of average height in the cold cluster weights 2.6 and 4.4 Kg less that a college graduate in the neutral and hot clusters, respectively. The average high school graduate in the cold cluster weighs 1.65 and 2.0 Kg less than a high school graduate in the neutral and hot clusters, respectively.
Source: CPS and ATUS (2003-2018)

Stylized Facts

Exercise

Table: Relative Time Spent Exercising By Cluster And Education

Cluster	High School	College
Neutral	0.64	0.97
Hot	0.62	0.77
Cold	0.8	1.0

Source: ATUS (2003-2018)

Stylized Facts

MET by Cluster and Education

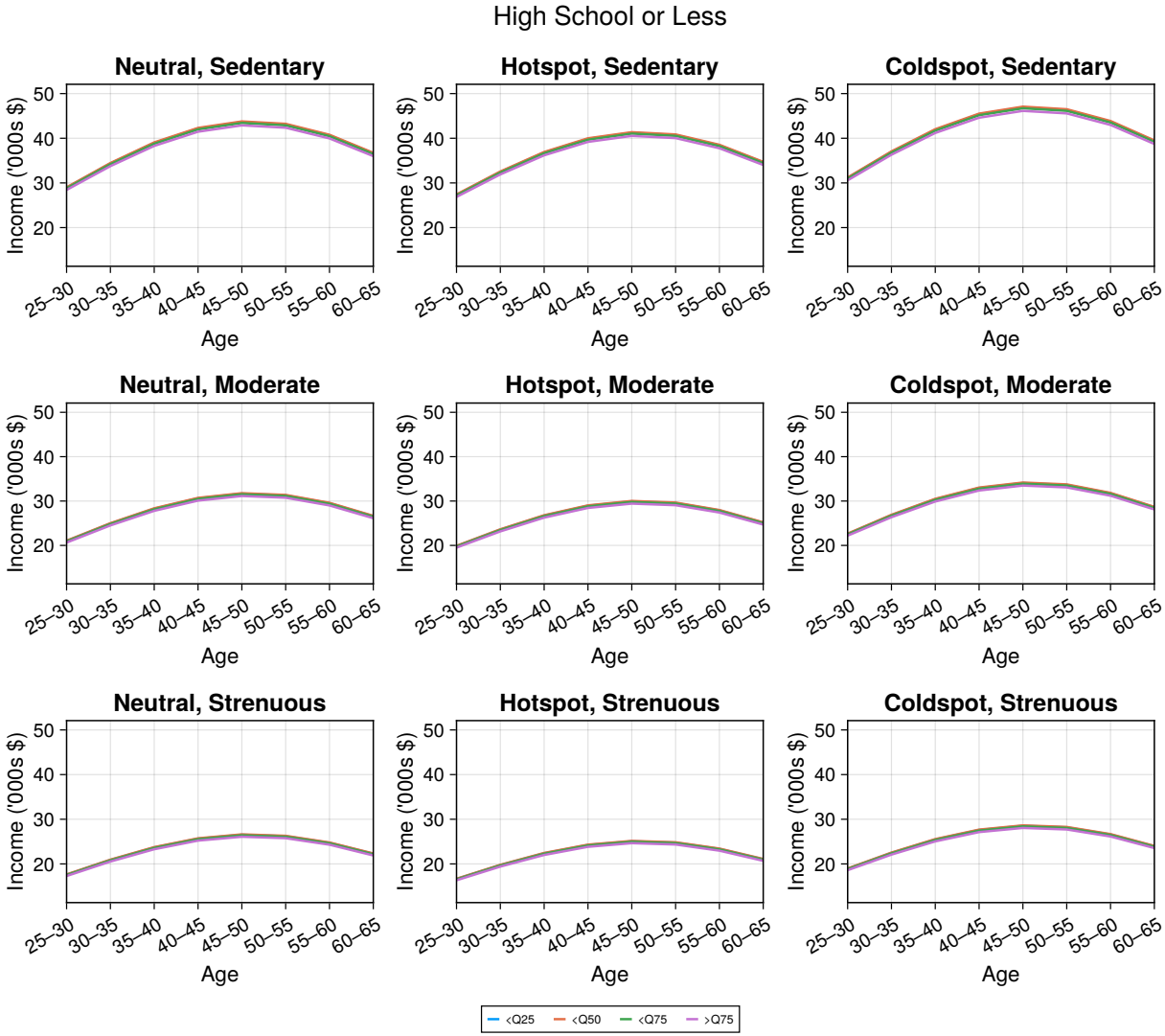
Table: Occupational Strenuousness by Cluster and Education

Education	Cluster	Sedentary (%)	Moderate (%)	Strenuous (%)
HS	Neutral	34.0	43.3	22.7
	Hot	32.3	43.4	24.3
	Cold	34.1	43.1	22.8
College	Neutral	57.7	36.6	5.7
	Hot	55.1	37.9	7.0
	Cold	58.5	36.1	5.4

Source: ATUS (2003-2018)

Stylized Facts

Income by Occupation, Cluster, BMI, and Education

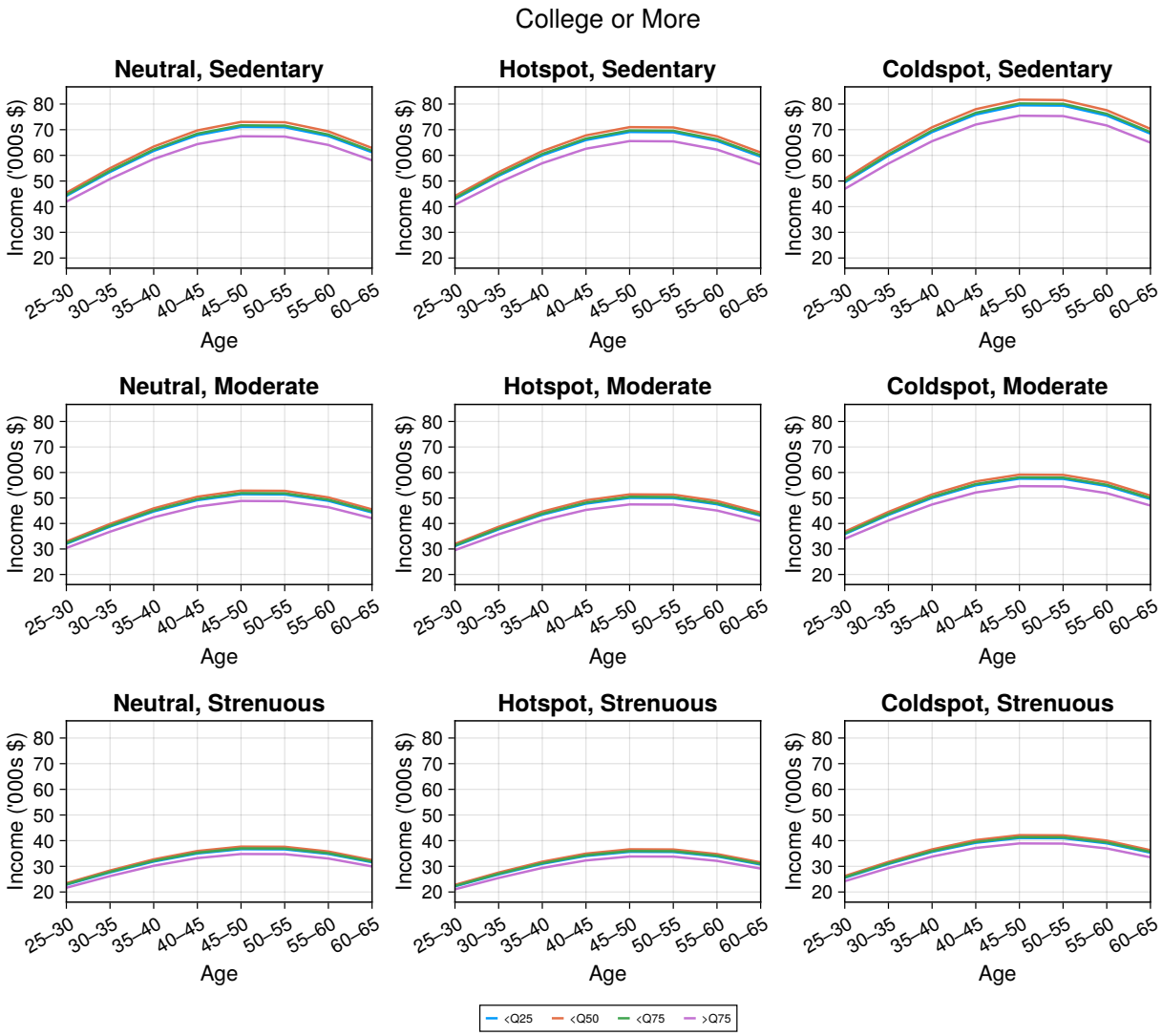


Notes: Predicted labor income in '000s of dollars by occupation, cluster and BMI classification. Individuals are classified relative to their BMI distribution of their peers in the same cluster and education group.

Source: CPS, 2004-2024.

Stylized Facts

Income by Occupation, Cluster, BMI, and Education



Notes: Predicted labor in '000s of dollars by occupation, cluster and BMI classification. Individuals are classified relative to their BMI distribution of their peers in the same cluster and education group.

Source: CPS, 2004-2024.

Introduction

What we do

Develop life cycle model to rationalize

- the spatial concentration of obesity
- obesity gradient by education

Key features are:

- Choice of food consumption and exercise
- Consequences of BMI
  - Health
  - Income (College graduates)
  - Disutility from deviating from healthy BMI and the average BMI of the reference group

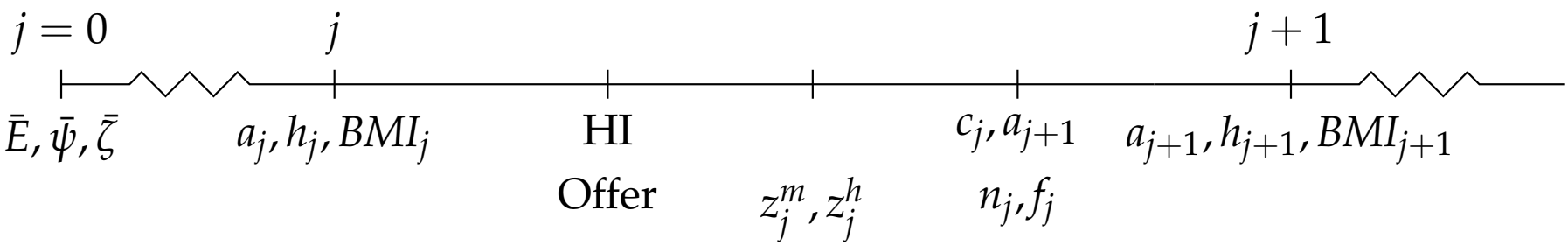
Introduction

Literature

- Empirical literature
  - Social networks (Christakis and Fowler, 2007; Cohen-Cole and Fletcher, 2008)
  - Spatial contagion (Datar and Nicosia, 2018)
  - Reference weight (Bagrowich et al., 2011)
- Life-cycle literature
  - Lakdawalla and Philipson (2002)
  - Mathieu-Bolh (2020)
  - Uta Bolt (2021)

The Model

- Life cycle model where agents derive utility from general consumption, food consumption, and disutility from exercise and deviation from healthy BMI and the average BMI of their reference group
- Agents choose consumption, savings, food consumption and exercise
- Agents are born in a cluster and are randomly assigned food preferences
- Conditional on the cluster, agents are assigned a level of education
- Conditional on the cluster and education, agents are assigned to an occupation which determines the strenuousness of work and labor income
- Agents face uncertainty with respect to curative medical spending, health, and health insurance status
- Education affects the probability of transitioning between health states and the probability of receiving GHI offer
- Health affects the probability of survival, curative medical spending shocks, and transition probabilities of health states



Model

Preferences

Agents derive disutility if their BMI (BMI_j) is above the average BMI of their cluster, and disutility is above or below the healthy BMI ($BMI_{healthy}$):

$$u_{BMI}\left(BMI_j\right) = -v\left(\alpha_E\left(BMI_j - BMI_\psi\right)^2 + \left(1-\alpha_E\right)\left(BMI_j - BMI_{healthy}\right)^2\right) \tag{1}$$

The weight share α_E is education specific.

Model

BMI

BMI is determined by calories-in and calories-out:

- Calories-in is determined by food consumption
- Calories-out is determined by:
  - Basal Metabolic Rate (BMR) - Mifflin-St Jeor Equation
    - $BMR = 10 \times weight + 6.25 \times height - 5 \times age + 5$
  - $Calories_{out} =$
    $BMR * \left(MET_{occupation} \times \ell + MET_{exercise} \times \nu + MET_{leisure} \times (1 - \ell - \nu)\right)$
- Weight change (in Kg) = $(f - Calories_{out}) \div 7700$

Model

Health

Health is a state $\{g, b\}$ and the transition probability is determined by:

- current health
- BMI
- age
- education
- cluster
- $\pi_{j,k,\psi,\bar{E}} = Pr\left(h_{j+1} = k \mid h_j = i, j, \psi, \bar{E}, BMI_j\right)$

Model

Budget Constraint

Agents face the following budget constraint:

$$\tilde{y}_j = c_j + p_i f_j + \mu_j + a_j \tag{2}$$

Where $\tilde{y}_j$ denotes total net income:

$$\tilde{y}_j = \left(1 - \tau\left(y_j\right)\right) y_j + a_{j-1}\left(1 + r\right) + ss_j + Tr_j \tag{3}$$

y_j is labor, p_i is the price of food and a_j is savings. μ_j is the out-of-pocket medical spending:

$$\mu_j = \left(1 - q\left(ins_j\right)\right) z_j^m + pr\left(ins_j\right) \tag{4}$$

where q is the coinsurance rate, z_j^m is the medical spending shock, pr is the health insurance premium, and ins_j is the insurance status.

Government provides:

- Social Security benefits and Medicare after the eligibility age
- Transfers that guarantee a minimum level of consumption

Government spending is financed by:

- Progressive income tax

$$\tau\left(y_j\right) = 1 - \tau_0 y_j^{\varphi} \tag{5}$$

- Medicare premium

Parameterization

- Two-step parameterization
  - Estimate as many parameters as possible from the data and exogenously set parameters that are common in the literature
  - Calibrate the remaining parameters
- Use data from:
  - PSID
  - CPS
  - MEPS
  - ATUS
  - USDA
  - CDC

Parameterization

Estimated Parameters - MET

- MET for occupation is estimated by merging CPS data with MET data by occupation (Tudor-Locket et al.,2011)
  - MET thresholds are set to 1.5 for sedentary, 2.5 for moderate, and 3.5 for strenuous occupations
- METs for leisure and exercise are estimated with data from the American Time Use Survey (ATUS) and MET by activity (Ainsworth et al., 2011)
  - Leisure - Average MET weighted by time spent on each activity
  - Exercise - Average MET of exercising, conditional on doing any exercise

Parameterization

Estimated Parameters - Health and Curative Medical Spending

- Health transition probabilities are estimated using PSID data, separately by health, cluster, age, and education
- Medical spending shocks are estimated using MEPS data by health, education, and age as in Margaris and Wallenius (2022)

Parameterization

Estimated Parameters - Food Prices

- We estimate the price per calorie by cluster and education using data from the USDA and CPS.
  - We estimate the consumption of calories that is consistent with current BMI, occupation, and age by cluster and education
  - We estimate the real equivalized food expenditure from the USDA by cluster and education
  - Prices per calorie are different across clusters and education

Parameterization

Exogenous Parameters - Government

Tax parameters:

Parameter	Description	Value
τ_0	Tax level	0.902
ϕ	Tax progressivity	0.036
τ^c	Consumption tax	0.05

Source: Guner et al. (2014)

Marginal replacement rates for social security:

Average Lifetime Earning	Marginal Replacement Rate
$y_i \in [0, 0.2\bar{y})$	90%
$y_i \in [0.2, 1.25\bar{y})$	33%
$y_i \in [1.25, 2.46\bar{y})$	15%
$y_i \in [2.46, \infty)$	0%

Source: Zhao (2017)

Model Fit

Exercise

Table: BMI

Cluster	HS		College		Average	
	Sim	Data	Sim	Data	Sim	Data
Neutral	29.31	29.66	28.21	28.35	28.82	29.21
Hot	29.42	29.82	28.8	29.04	29.14	29.61
Cold	28.67	29.2	27.8	27.63	28.28	28.59

Table: Exercise

Cluster	HS		College	
	Sim	Data	Sim	Data
Neutral	0.69	0.64	0.96	0.97
Hot	0.68	0.62	0.8	0.77
Cold	0.82	0.8	1.0	1.0

External Validity

Reference BMI

- Datar and Nicosia (2018) find that 1 percentage point increase in the obesity rate of the reference group increases the BMI of an individual by 0.08 points
- Counterfactual exercise:
  - Move a high school and a college graduate from the cold cluster to the hot cluster (9.5 percentage points increase in obesity rate, 1.1 point increase in reference BMI)
  - BMI increase of 0.44 for high school and 0.34 for college graduate
  - Less responsive compared to Datar and Nicosia (2018) - 0.76 on average
  - Reference BMI elasticity of 0.52 for high school and 0.41 for college graduates
- Disutility from exercise and prices are the other main drivers of the gradient
- Income cannot explain the gradient

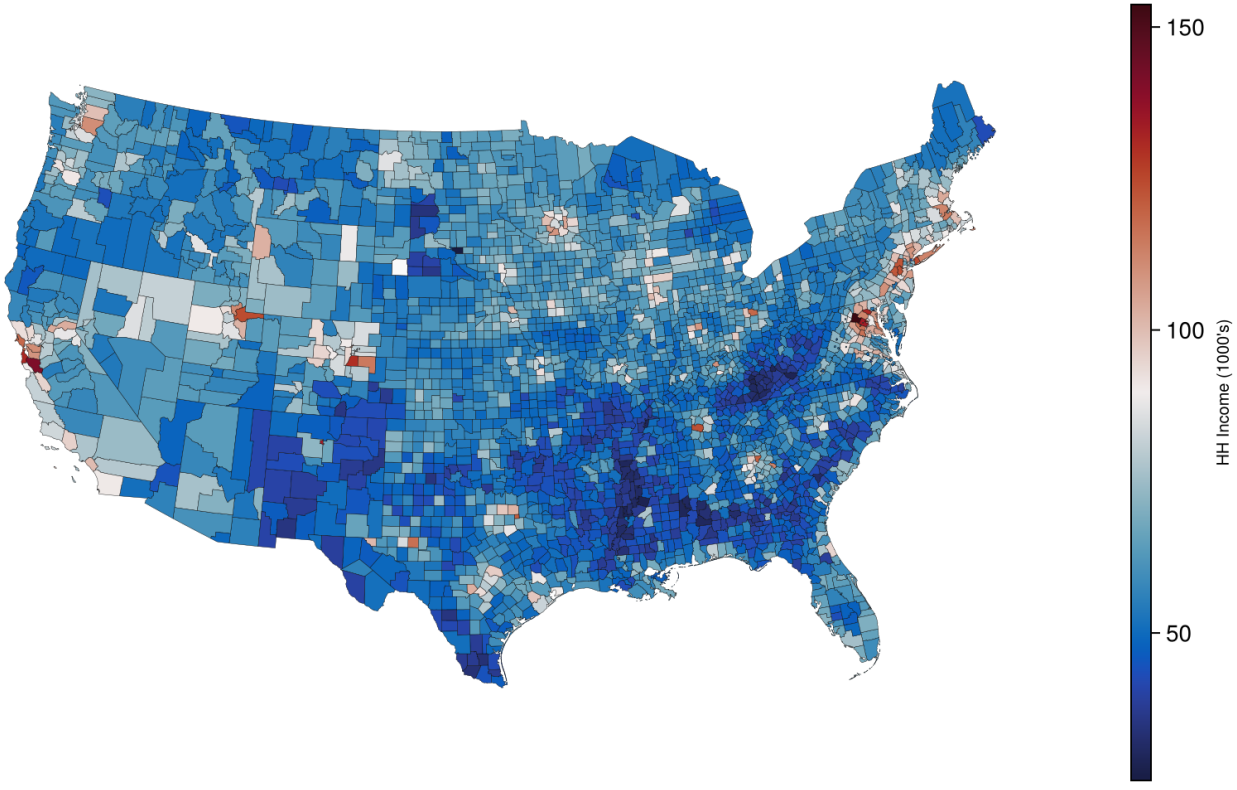
Conclusions

- We develop a life cycle model to rationalize the spatial concentration of obesity and the education gradient
- The model is able to replicate the spatial concentration of obesity and the education gradient
  - Reference BMI is an important driver of the spatial concentration of obesity
- WIP: Ozempic policy experiment

Appendix

Household Income

Figure: Household Income by County



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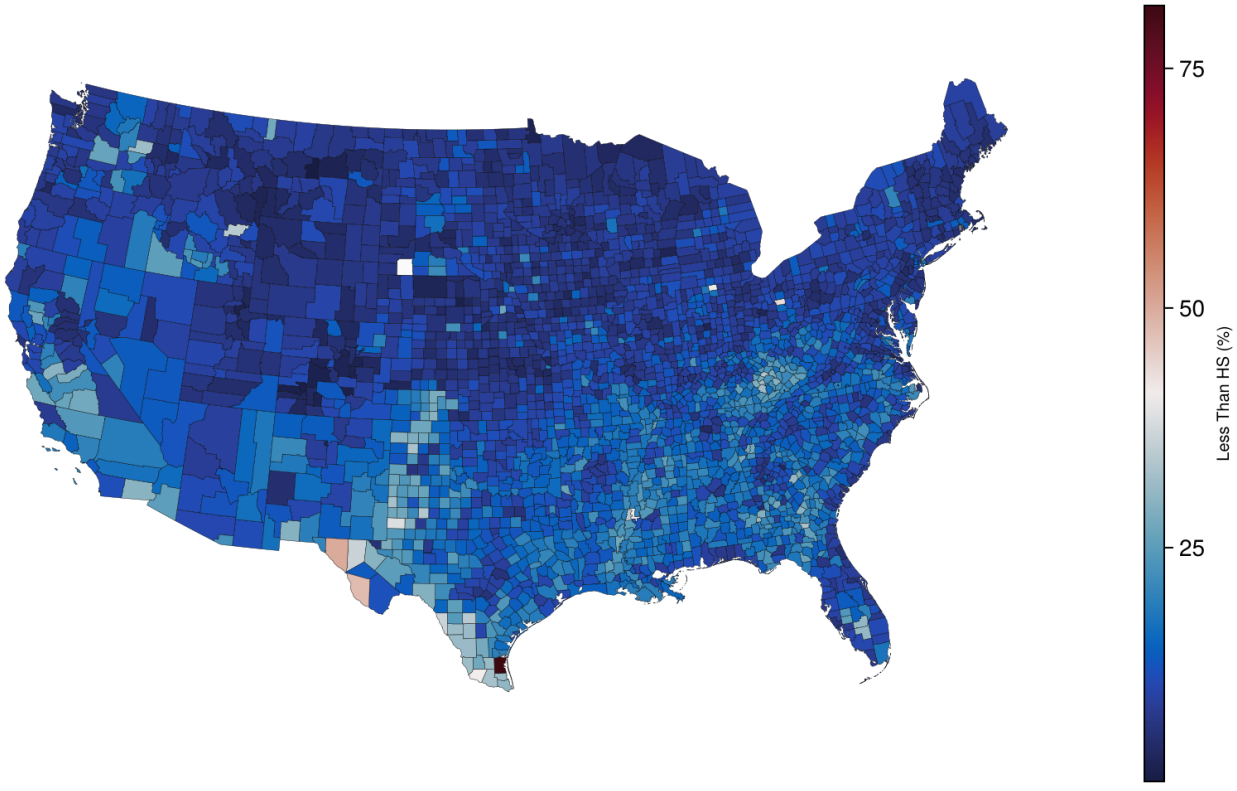
Appendix

Percent of Population with Less than High School Education

Figure: Percent of Less Than High School Education by County



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