DIFFERENCES IN ACCESSIBILITY SPATIAL MEASURES: IMPLICATIONS FOR COMMUNITY STRATEGY

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PRESENTER DISCLOSURES

Lara Jaskiewicz

(1) **The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:**

No relationships to disclose

PURPOSE OF THE STUDY

- Explore whether different measures of spatial accessibility identify the same areas of high and low access
- Explore whether population characteristics predict supermarket accessibility similarly across spatial measures

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ACCESSIBILITY

Penchansky & Thomas (1981) framework
- Availability
- Accessibility
- Affordability
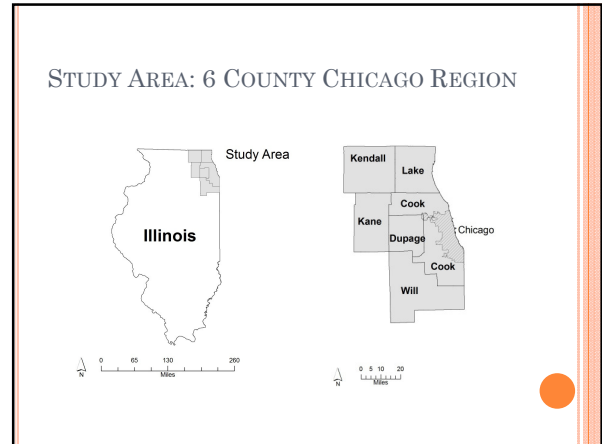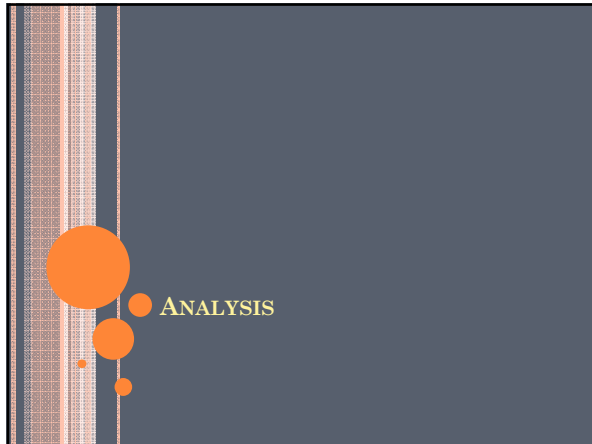- Acceptability
- Accommodation

This study—availability and accessibility

ACCESSIBILITY

- Potential vs. realized
- Different measures
  - Cumulative opportunities
  - Gravity models
  - Utility models
  - *Little comparison of measures in literature*

PREVIOUS SUPERMARKET ACCESS STUDIES

- Container measure most common
- Low-income and low-income Black usually predictive of less access
- Few studies looked at other races or ethnicities
- Limitations
  - Cumulative opportunities measures
  - Single measures
  - Modifiable area unit problem
  - Lack of independence
  - Spatial clustering

ANALYSIS

STUDY AREA: 6 COUNTY CHICAGO REGION

Study Area

Illinois

Kendall
Lake
Cook
Kane
Dupage
Chicago
Cook
Will

0 65 130 260
Miles

0 5 10 20
Miles

STUDY DATA: SUPERMARKET LOCATIONS

- Industry datasets
- Visual confirmation & additions – 2007
- Population/store
  - 10,261 in Chicago
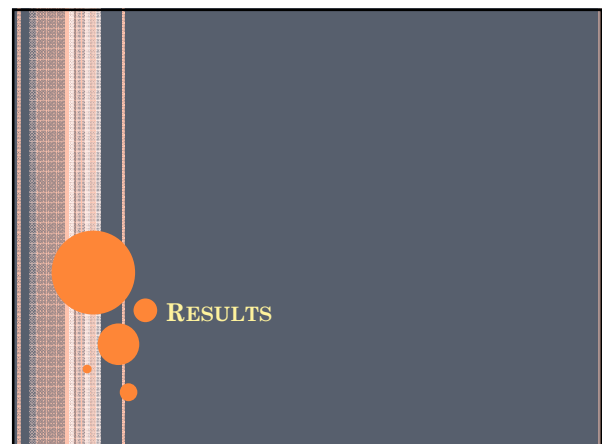 - 7,029 in McHenry County
- Supermarket = >$2 mill in annual sales

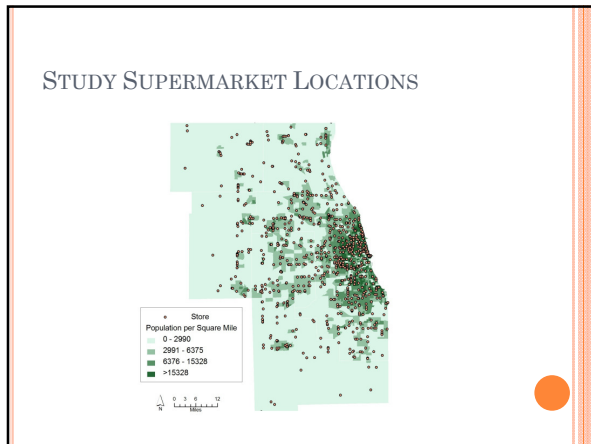| Store Type	#	%
Full Service Chain	258	31.2
Discount	118	14.3
Independent	355	43.0
Specialty	27	3.3
Supercenter	28	3.4
Wholesale and Warehouse	40	4.8
Total	826	100

STUDY DATA: POPULATION

- 2000 US Census
- Populated units
  - Block groups – 5,779
  - Census tracts – 1,826
  - Zip codes – 350
- Variables
  - Population density
  - Race/ethnicity
  - Education
  - Median & aggregate household income
  - Family size
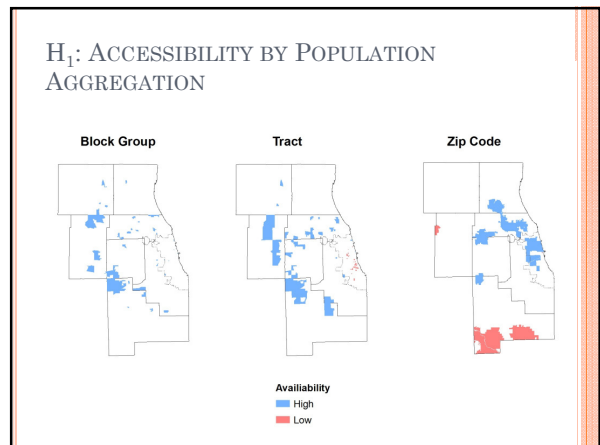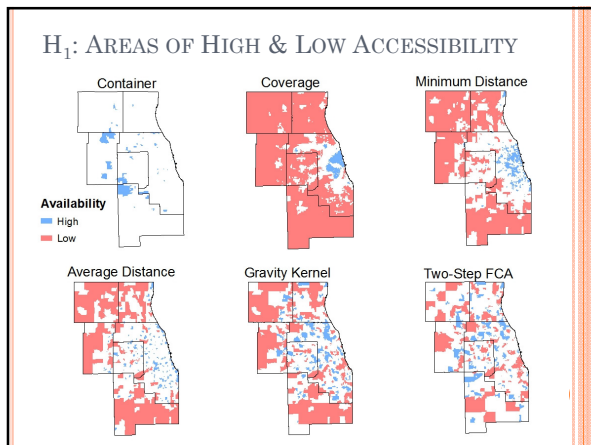 - Home ownership & value

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ACCESSIBILITY MEASURES

- 6 Measures Studied
  - Cumulative Opportunities
    - Container: # stores/area (block group, census tract, zip code)
    - Coverage: # stores w/i 2 miles of block group centroid
    - Minimum Distance: distance to closest store
    - Average Distance: avg. distance to all stores in 2 mile radius
  - Gravity Models
    - Gravity kernel: population density divided by density of stores w/i 2 miles
    - Two-step floating catchment area: facilities w/i 2 miles weighted by catchment population
- Network distance & population weighted centroids
- Software
  - ArcGIS 9.2, Network Analyst & Spatial Analyst Extensions
  - GeoDa 0.9.8.8
  - SPSS 15.0

RESULTS

Study Supermarket Locations

Store
Population per Square Mile
- 0 - 2990
- 2991 - 6375
- 6376 - 15328
- >15328

H$_1$: Different measures identify dissimilar areas of high and low access

Correlations	Moran's *I* (spatial clustering)

Correlations
- Container – lowest
  - 0.024 - 0.270
- All others higher
- Highest (>0.4)
  - Cov-MinD = 0.443
  - MinD-AvgD=0.688
  - Kernel-FCA=0.658

Moran's *I* (spatial clustering)
- Global
  - Container very low
  - Others >0.4
  - Coverage = 0.94
- Local
  - Correlations similar but much weaker
  - Two relationships >0.2
    - MinD-AvgD = 0.552
    - Kernel-FCA = 0.521

H$_1$: Areas of High & Low Accessibility

Container   Coverage   Minimum Distance

Average Distance   Gravity Kernel   Two-Step FCA

Availability
- High
- Low

H$_1$: Accessibility by Population Aggregation

Block Group   Tract   Zip Code

**Availiability**
- High
- Low

H$_1$: Similarity of Clustering

- Agreement of high/low between measures
  - Container: no low accessibility clustering and smallest number of high clustering areas
  - Min Distance: most high clustering areas – 1393
    - Urban – small geographic block group size
  - Coverage, Kernel, FCA: # low > # high
- Disagreement of high/low between measures
  - Container disagreed more with Coverage than agreed
  - Min Distance & Kernel disagreed same # as agreed
  - Min Distance disagreed more with FCA than agreed
  - Strong disagreement b/w Avg Distance and gravity measures

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H$_2$: Population Variables Differ Between Supermarket Accessibility Measures

- Correlation
- Stepwise OLS
- Spatial dependency and ML modeling
- Model fit – Akaike Information Criterion
- Variable relationships
- R^2

H$_2$: Final Model Variable Relationships – All Large Stores

Measure	Pop Dens	% Black	% Hisp	Med HH Inc	Agg HH Inc	% HH4+	Med HomVal	% Pov	Model Type	Adj. R^2
Container Zip Code			+		+				OLS	.394
Container Tract	−	−		−	+				Spatial Error	.120
Container Block Group	−	−			+	−			OLS	.055
Coverage	+		+		−	−	+	−	Spatial Lag	.461
Minimum Distance	+	+	+	−	−	−	+	−	Spatial Lag	.157
Average Distance	+		+	−	−	−			Spatial Lag	.097
Gravity Kernel	−	−				−			Spatial Lag	.076
2-Step Floating Catchment	−	−			−		−	−	Spatial Lag	.072

All p-values < 0.0001; Continued spatial dependency significant at <0.0001
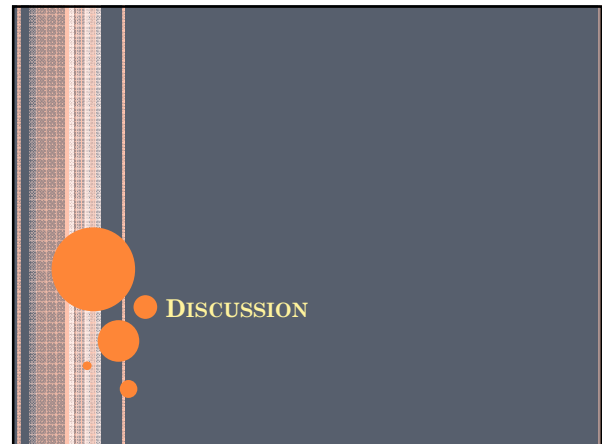
DISCUSSION

Discussion

- Know your community
- Measures are different
  - Different high/low accessibility areas
  - Different relationships with population variables
  - Cannot combine for meta-analysis
  - Match the measure to the question
  - Use more than one measure

Discussion

- Modifiable areal unit problem is important
  - Spatial dependency, independent variables
  - Choose the smallest meaningful population unit

- Spatial dependency plays a role
  - Regression modeling—maximum likelihood
  - Additional variables

- Store location explained by more than local population
  - Low R^2
  - Include other explanatory factors, e.g., taxes, space, etc.

Study Limitations

- Cross-sectional
- Ecological
  - Within/between-area variability: modifiable areal unit problem; travel distance vs. travel time
  - Unmeasured confounding: non-population store location variables; shopper preference and behavior
  - Effect modification: variables may not be discrete
  - Contextual effects: non-spatial accessibility factors
  - Measurement error: missing stores; alternate food sources
- Assumption of car use for shopping

THANK YOU