Using Linked Micromaps for Evidence-Based Policy

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Joint Statistical Meetings (JSM)

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Acknowledgements and Disclaimers

The authors thank John Eltinge and Jeff Gonzalez for helpful discussion of the topics presented today.

The views expressed here are those of the authors and do not necessarily reflect the policies of the U.S. Bureau of Labor Statistics and the U.S. Census Bureau.

Authors are not subject matter domain experts with respect to the data presented and interpretations.

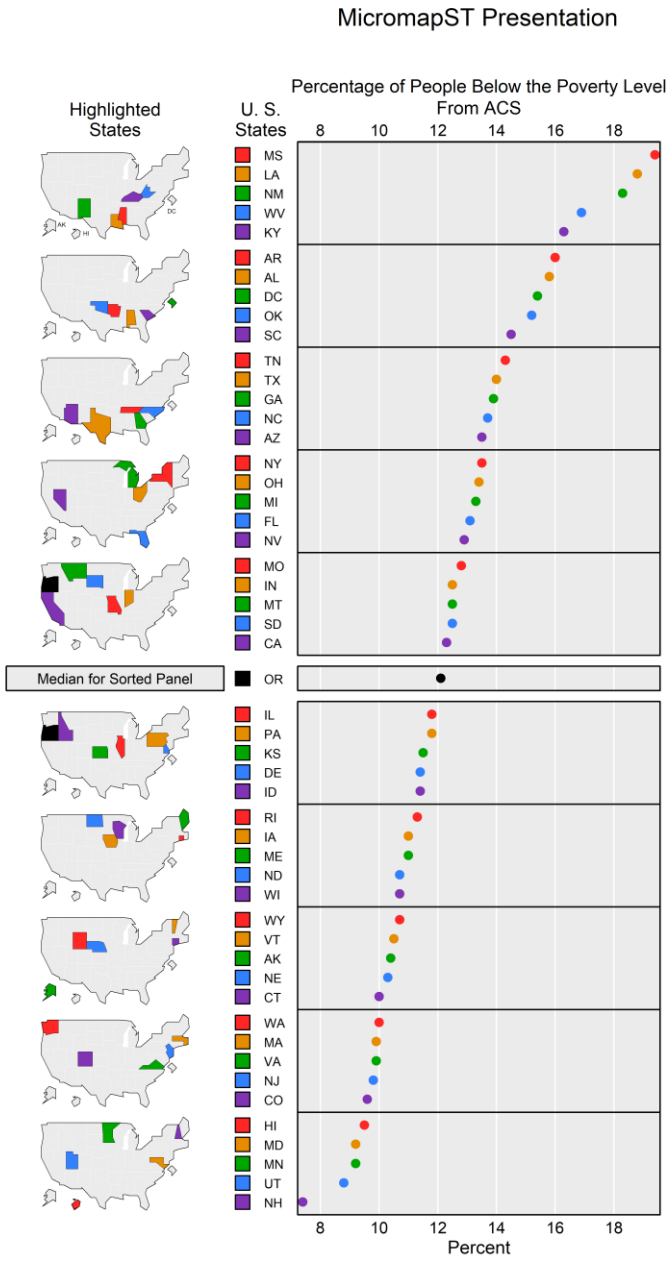
Outline & Goal

- Introduce linked micromaps
- Discuss current ways of visualizing U.S. state level data
- Show examples of micromaps with real data

- **GOAL**: To introduce linked micromaps and show how they can be used for improved visualization and data exploration

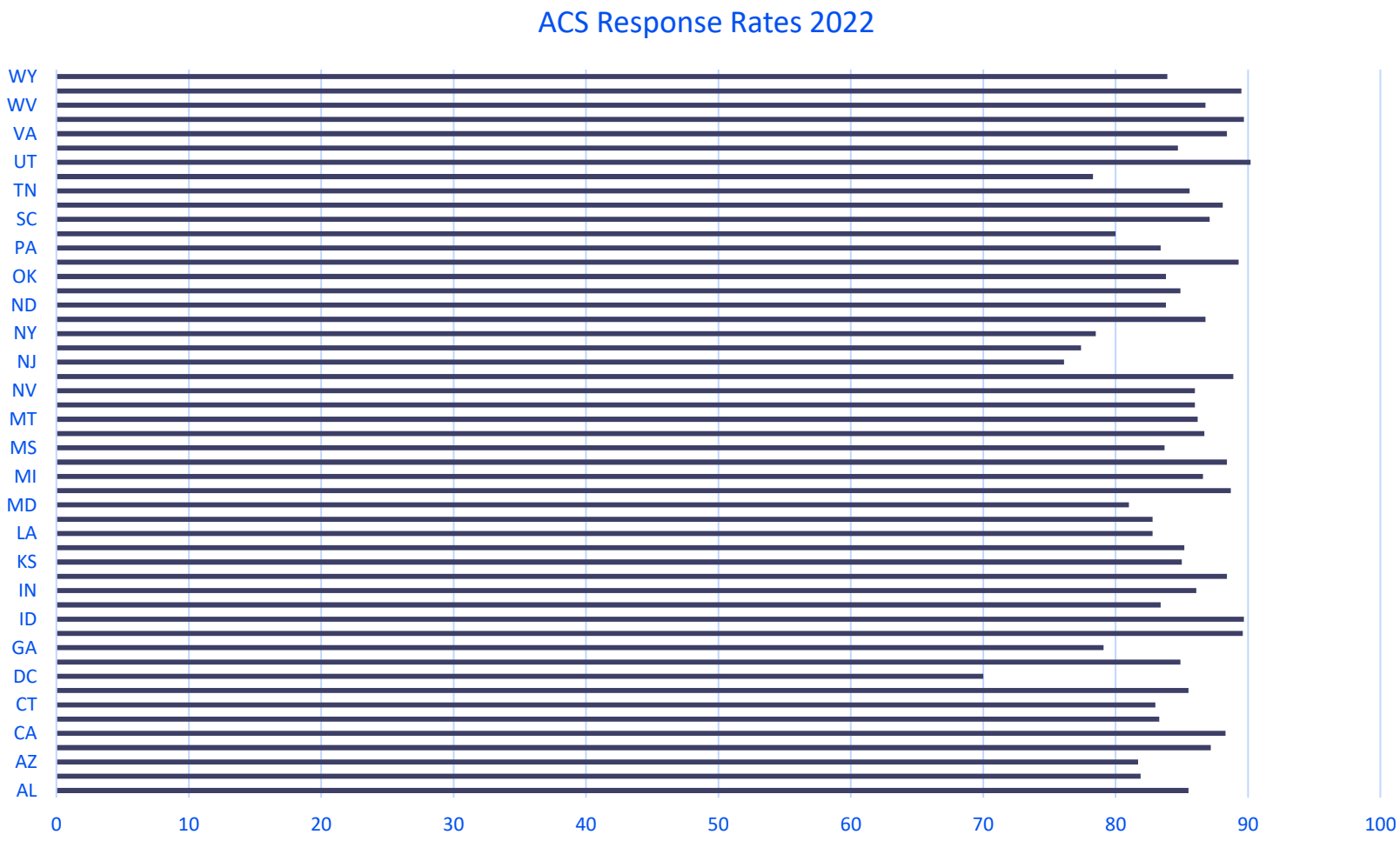
What is a Micromap?

- Micromaps used for geographically indexed data
- Two R packages
  - **`micromap`**
  - **`micromapST`**
- Focus of this talk is on **`micromapST`** used for US state level data

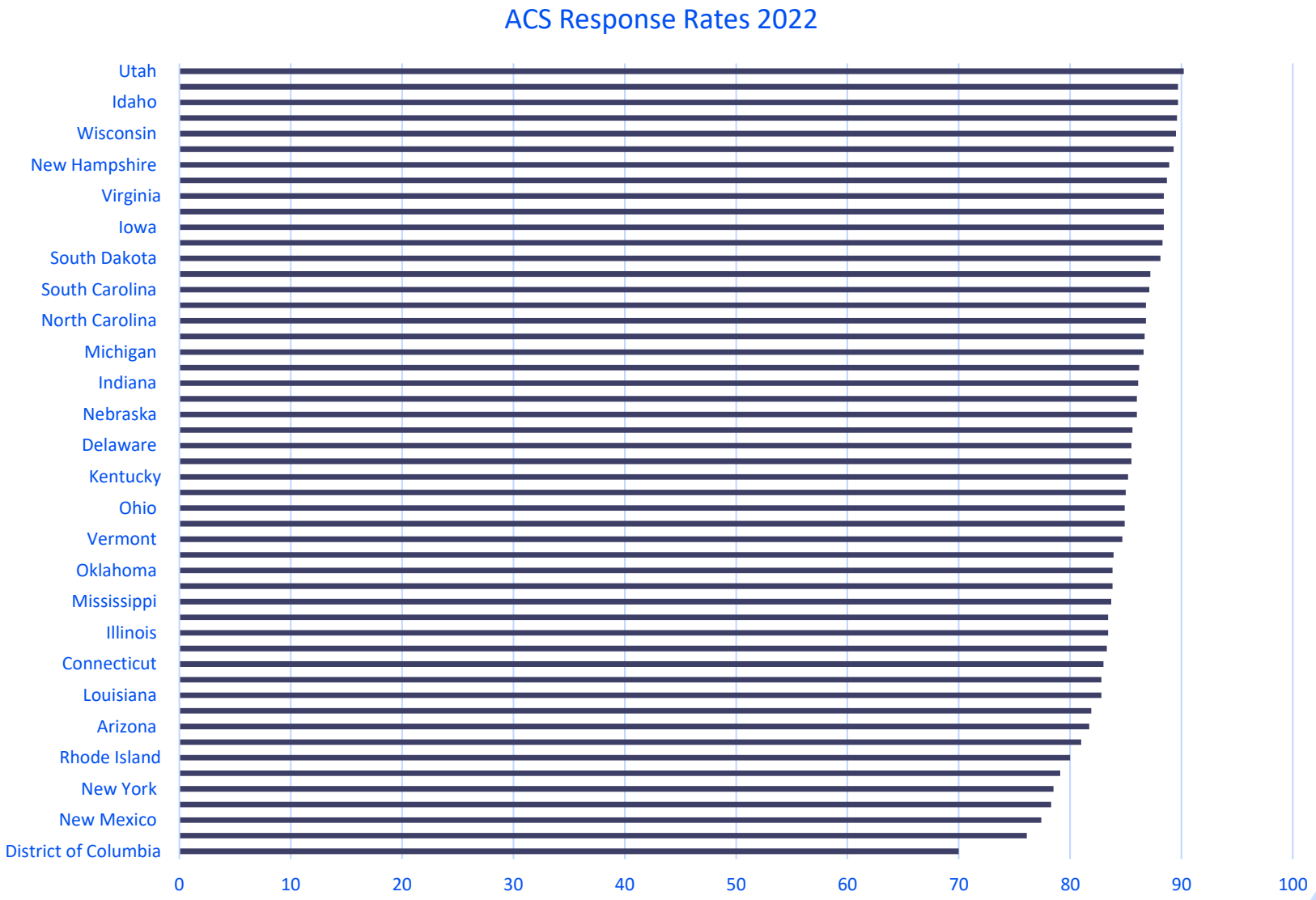


What are some current ways we display state-indexed data?

Ordered by State Name – Alphabetical – Excel



Ordered by Variable Value – Excel



Could use a table…

Table 14. Person Match Ratios Between AR Census and Decennial Census, 2010 and 2020, by State

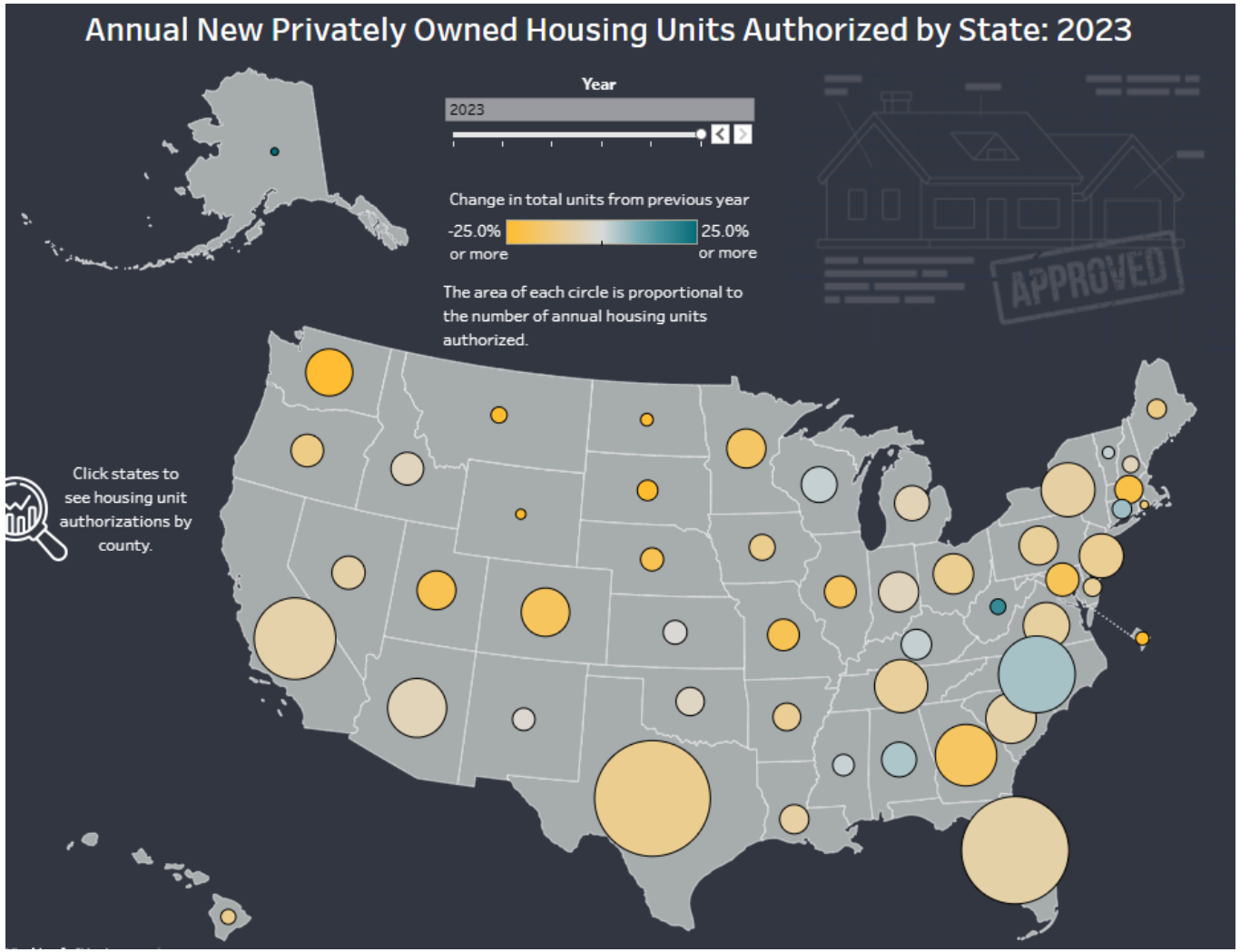
	Percentage of decennial census person records with an AR census person match	
State	2010	2020
U.S. total	88.60	81.86
Alabama	88.50	83.12
Alaska	89.50	78.05
Arizona	84.00	78.24
Arkansas	89.90	84.83
California	84.80	77.97
Colorado	87.30	82.91
Connecticut	91.00	82.97
Delaware	88.70	82.09
District of Columbia	85.00	76.33
Florida	87.70	80.45
Georgia	86.00	79.74
Hawaii	86.90	74.02
Idaho	89.10	84.88
Illinois	89.90	83.22
Indiana	91.90	86.37
Iowa	93.60	87.08
Kansas	92.00	85.60
Kentucky	90.70	86.42
Louisiana	88.20	81.45
Maine	93.30	86.12

https://www2.census.gov/programs-surveys/decennial/2020/program-management/evaluate-docs/EAE-2020-admin-records-experiment.pdf

Cuts across two pages …

State	Percentage of decennial census person records with an AR census person match	
	2010	2020
Maryland	89.20	82.34
Massachusetts	91.50	83.07
Michigan	90.10	87.24
Minnesota	93.30	88.00
Mississippi	89.60	83.49
Missouri	91.70	86.04
Montana	90.00	83.27
Nebraska	92.10	86.39
Nevada	83.40	78.45
New Hampshire	93.30	85.34
New Jersey	89.10	80.75
New Mexico	85.00	77.67
New York	86.80	77.62
North Carolina	87.90	82.22
North Dakota	94.10	85.84
Ohio	92.40	86.19
Oklahoma	89.10	81.46
Oregon	89.30	83.05
Pennsylvania	92.10	84.85
Rhode Island	90.60	79.15
South Carolina	89.60	83.47
South Dakota	91.60	85.05
Tennessee	89.90	84.08
Texas	85.90	78.25
Utah	89.80	83.31
Vermont	94.10	86.08
Virginia	90.10	83.86
Washington	89.70	82.95
West Virginia	89.40	84.78
Wisconsin	93.40	87.33
Wyoming	89.30	82.93

Bubble Charts

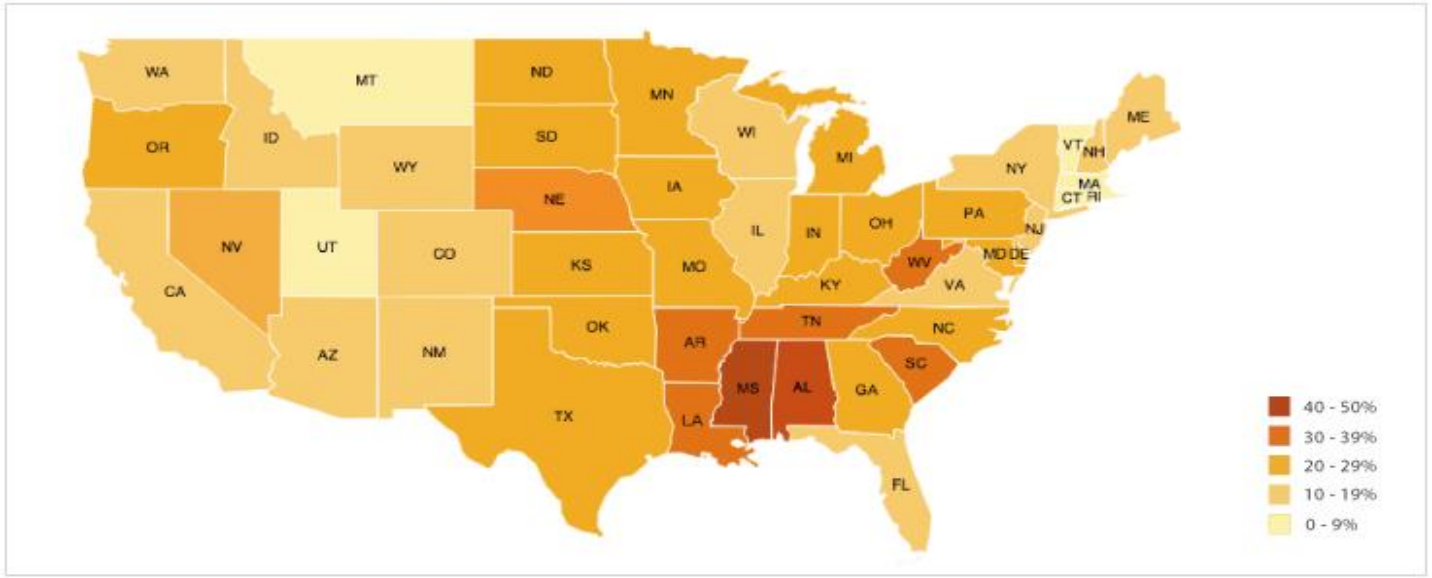


https://www.census.gov/library/visualizations/interactive/annual-new-privately-owned-housing-units.html

Typical Method: Choropleth Maps

- Color indicates value
- Hard to convey additional information/statistics
- No order, except through legend
- Hard to distinguish values using color

Choropleth Map

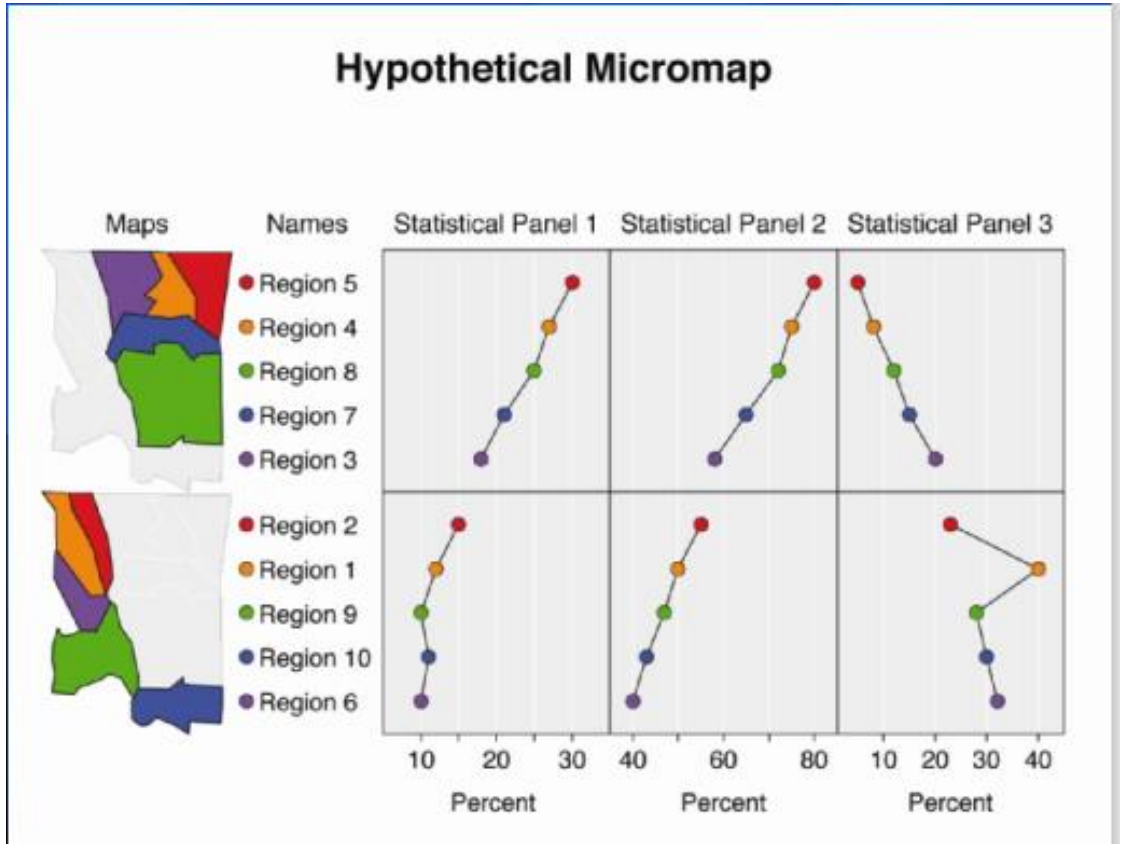


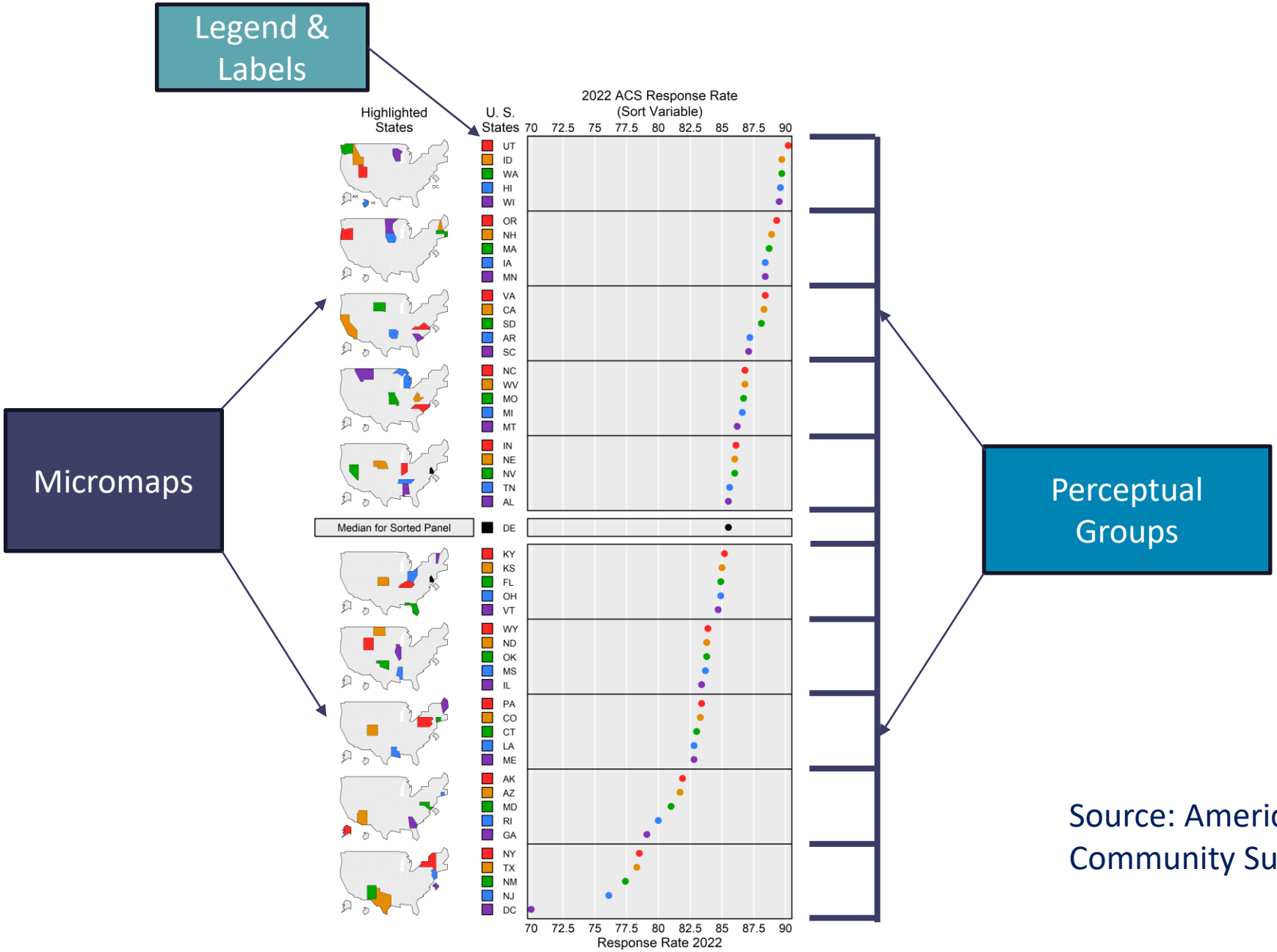
https://datavizcatalogue.com/methods/choropleth.html

Details on linked `micromapST`

Linked Micromap Elements

- Link quantities to geographical region
- Color provides index connecting map region and values
- Different than choropleth maps where color represents a value





Source: American Community Survey

Key Features of `micromapST`

- We use **`micromapST`** package in R.
- Provides an easier way to create linked micromaps for 51 U.S. states
- Lots of options: Dots, Arrows, Bars, Boxplot, Scatterplots, Time series, error bars, confidence bands

Now for some examples …
American Community Survey (ACS)

ACS Response Rates on Web

- American Community Survey:
  - www.census.gov/acs/www/methodology/sample-size-and-data-quality/response-rates/
- No visualizations on the site – just tables

Select Nation/State Go

Download Response Rates

United States

Response Rates and Reasons for Noninterviews (in percent) — Housing Units

	Housing Unit	Reasons for Noninterviews							
Year	Response Rate	Refusal	Unable to Locate	No One Home	Temporarily Absent	Language Problem	Insufficient Data	Maximum Contact Attempts Reached	Other
2022	84.4	9.0	0.1	1.8	0.1	0.2	0.7	1.0	2.7
2021	85.3	8.6	0.1	1.9	0.1	0.2	0.7	1.3	1.7
2020	71.2	8.0	0.2	1.7	0.1	0.2	0.4	1.3	16.9
2019	86.0	4.7	0.1	1.2	0.1	0.2	0.5	1.1	6.1

All States per Year

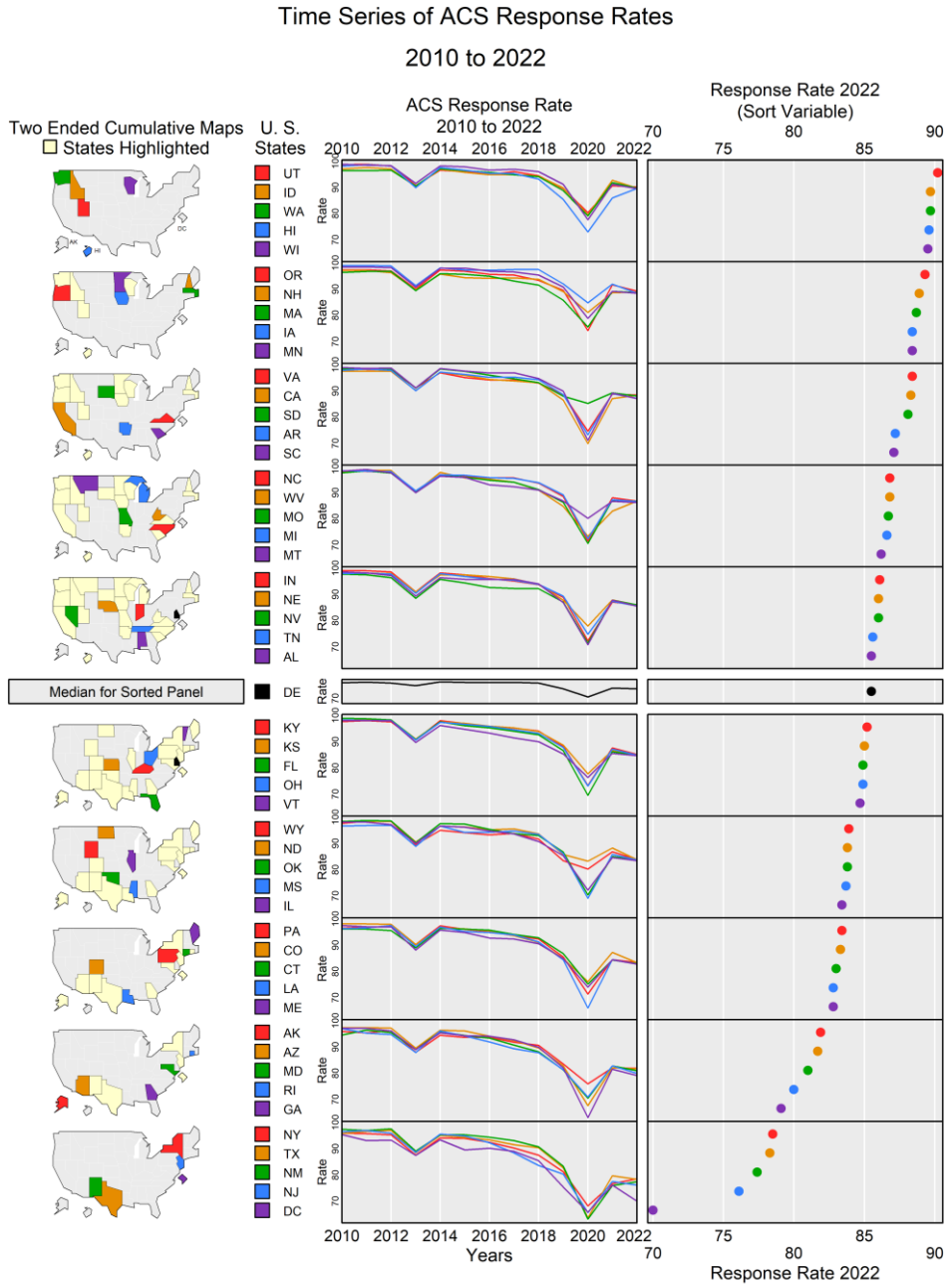
Select Nation/State Go

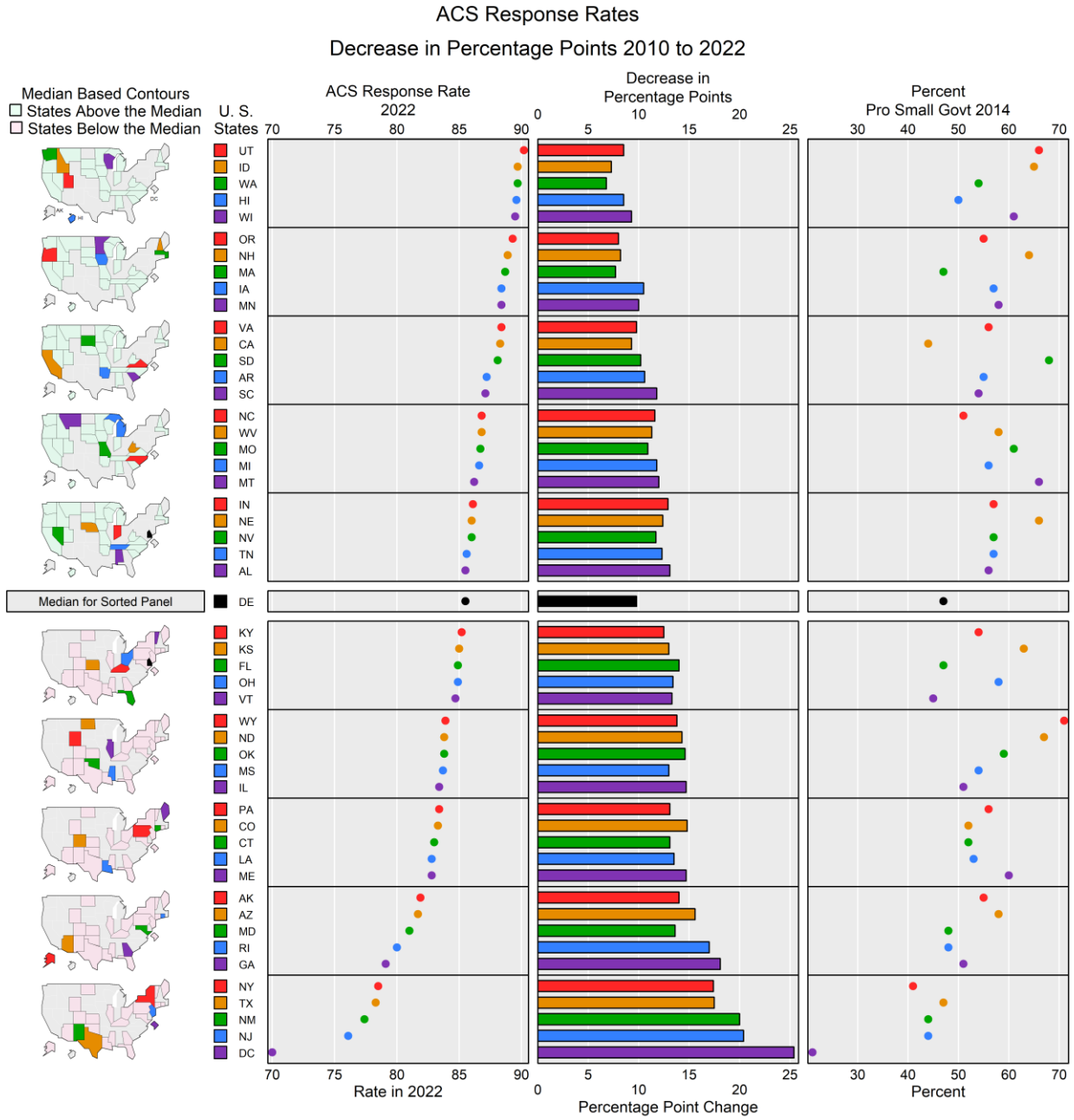
Download Response Rates

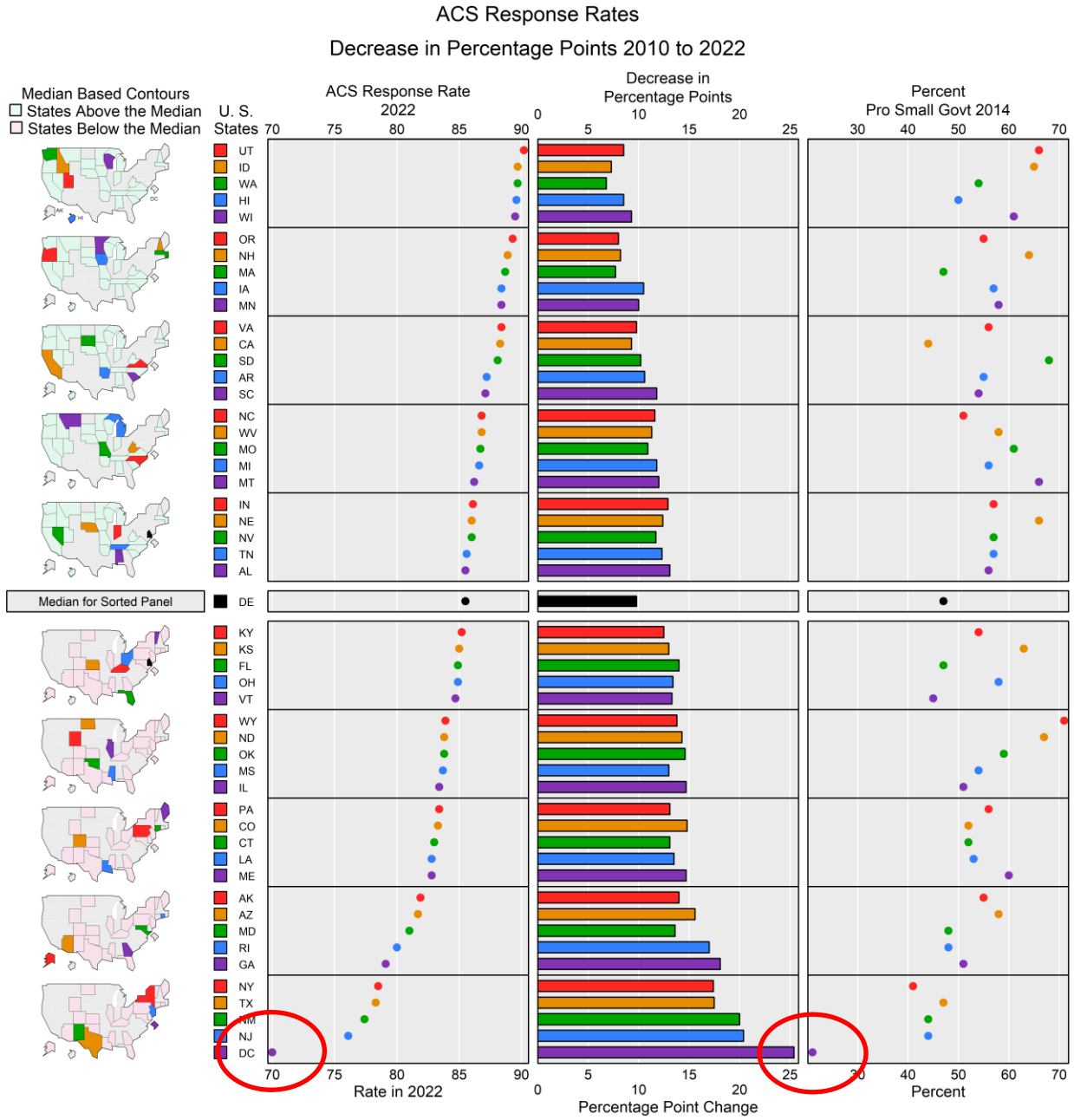
All States 2022

Response Rates and Reasons for Noninterviews (in percent) — Housing Units

	Housing Unit	Reasons for Noninterviews							
State	Response Rate	Refusal	Unable to Locate	No One Home	Temporarily Absent	Language Problem	Insufficient Data	Maximum Contact Attempts Reached	Other
United States	84.4	9.0	0.1	1.8	0.1	0.2	0.7	1.0	2.7
Alabama	85.5	7.5	0.1	1.3	0.1	0.2	0.5	0.9	3.9
Alaska	81.9	9.4	0.5	0.4	0.2	0.0	0.8	1.2	5.6
Arizona	81.7	13.9	0.1	0.9	0.1	0.2	0.8	0.7	1.6
Arkansas	87.2	7.4	0.1	2.4	0.1	0.2	0.5	0.7	1.4
California	88.3	6.1	0.1	1.2	0.1	0.2	0.7	1.2	2.1
Colorado	83.3	12.1	0.1	2.2	0.1	0.1	0.8	0.4	1.0


Time Series of ACS Response Rates
2010 to 2022
Two Ended Cumulative Maps
States Highlighted
U. S. States
ACS Response Rate
2010 to 2022
Response Rate 2022
(Sort Variable)
UT ID WA HI WI
OR NH MA IA MN
VA CA SD AR SC
NC WV MO MI MT
IN NE NV TN AL
Median for Sorted Panel
DE
KY KS FL OH VT
WY ND OK MS IL
PA CO CT LA ME
AK AZ MD RI GA
NY TX NM NJ DC
Rate
2010 2012 2014 2016 2018 2020 2022
70 75 80 85 90
Years
Response Rate 2022


ACS Response Rates
Decrease in Percentage Points 2010 to 2022
Median Based Contours
States Above the Median
States Below the Median
U. S. States
ACS Response Rate 2022
Decrease in Percentage Points
Percent Pro Small Govt 2014
UT ID WA HI WI
OR NH MA IA MN
VA CA SD AR SC
NC WV MO MI MT
IN NE NV TN AL
Median for Sorted Panel
DE
KY KS FL OH VT
WY ND OK MS IL
PA CO CT LA ME
AK AZ MD RI GA
NY TX NM NJ DC
70 75 80 85 90
Rate in 2022
0 5 10 15 20 25
Percentage Point Change
30 40 50 60 70
Percent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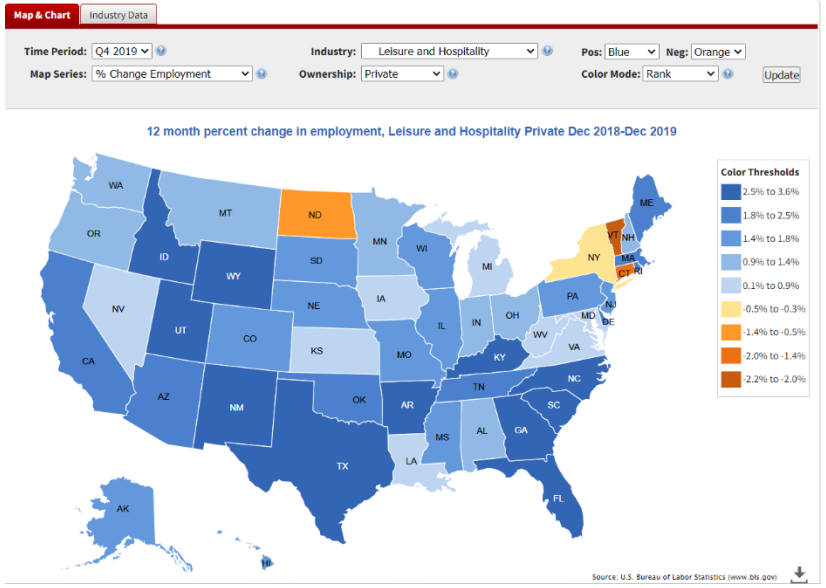
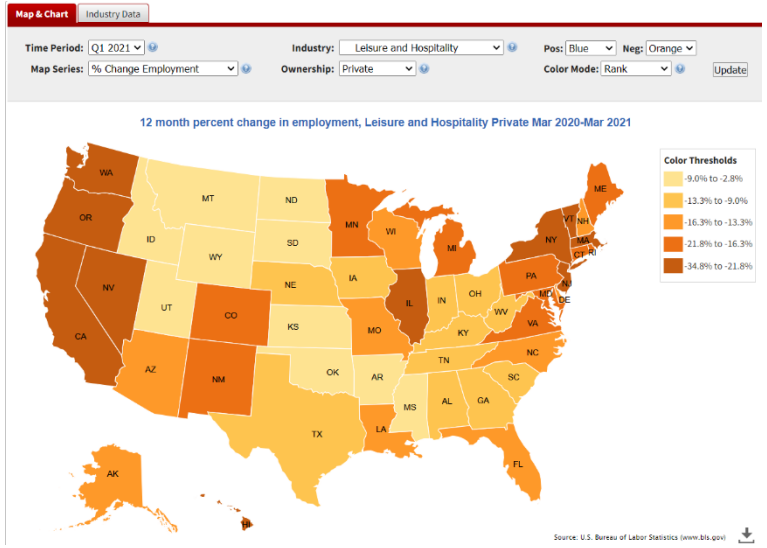
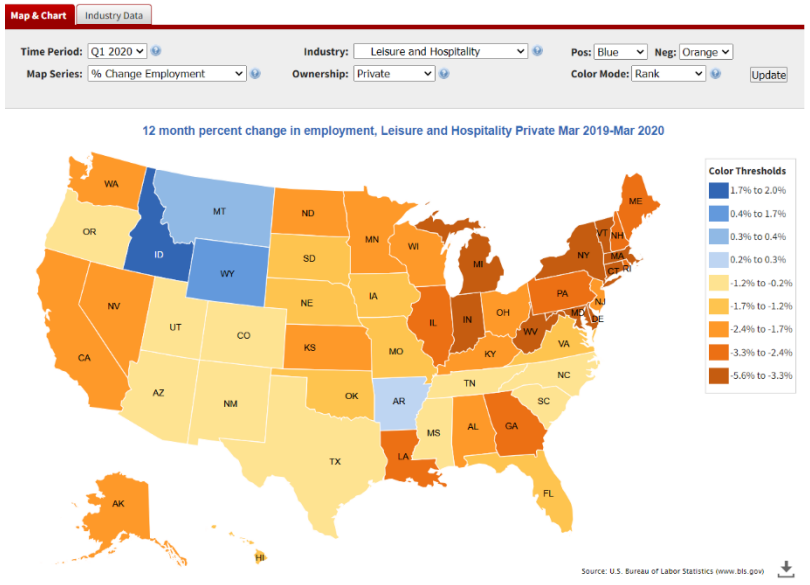
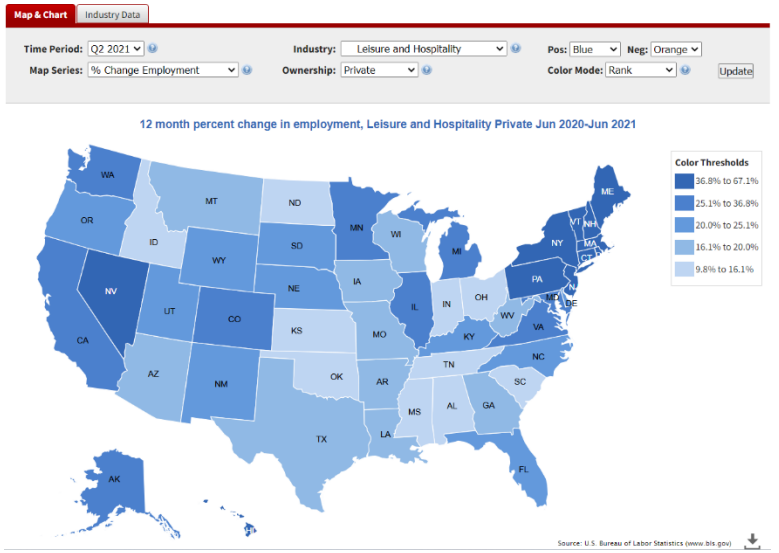
70 75 80 85 90
Rate in 2022
0 5 10 15 20 25
Percentage Point Change
30 40 50 60 70
Percent

Quarterly Census of Employment and Wages (QCEW) Example









Leisure and Hospitality: Effects of the Pandemic on Employment

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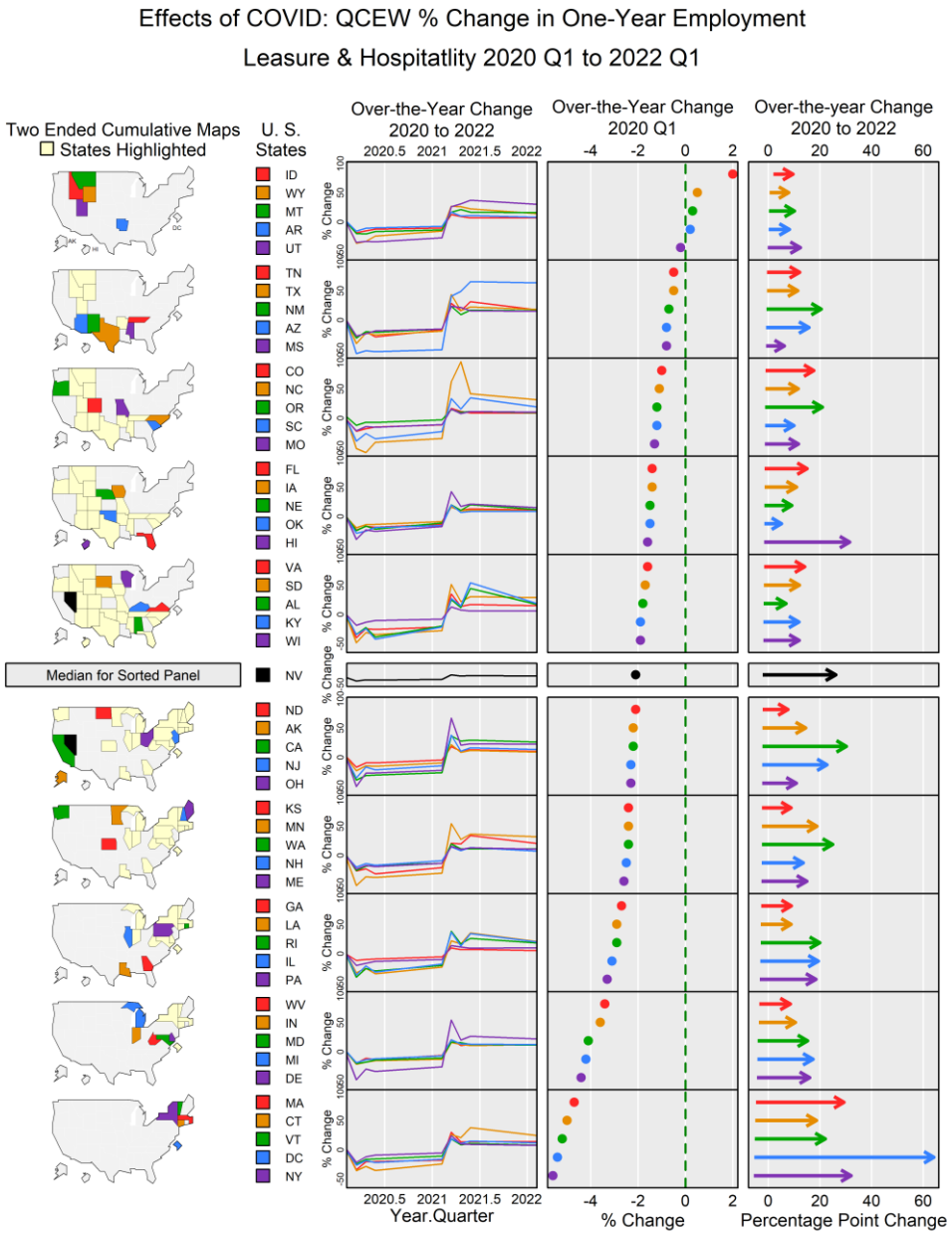
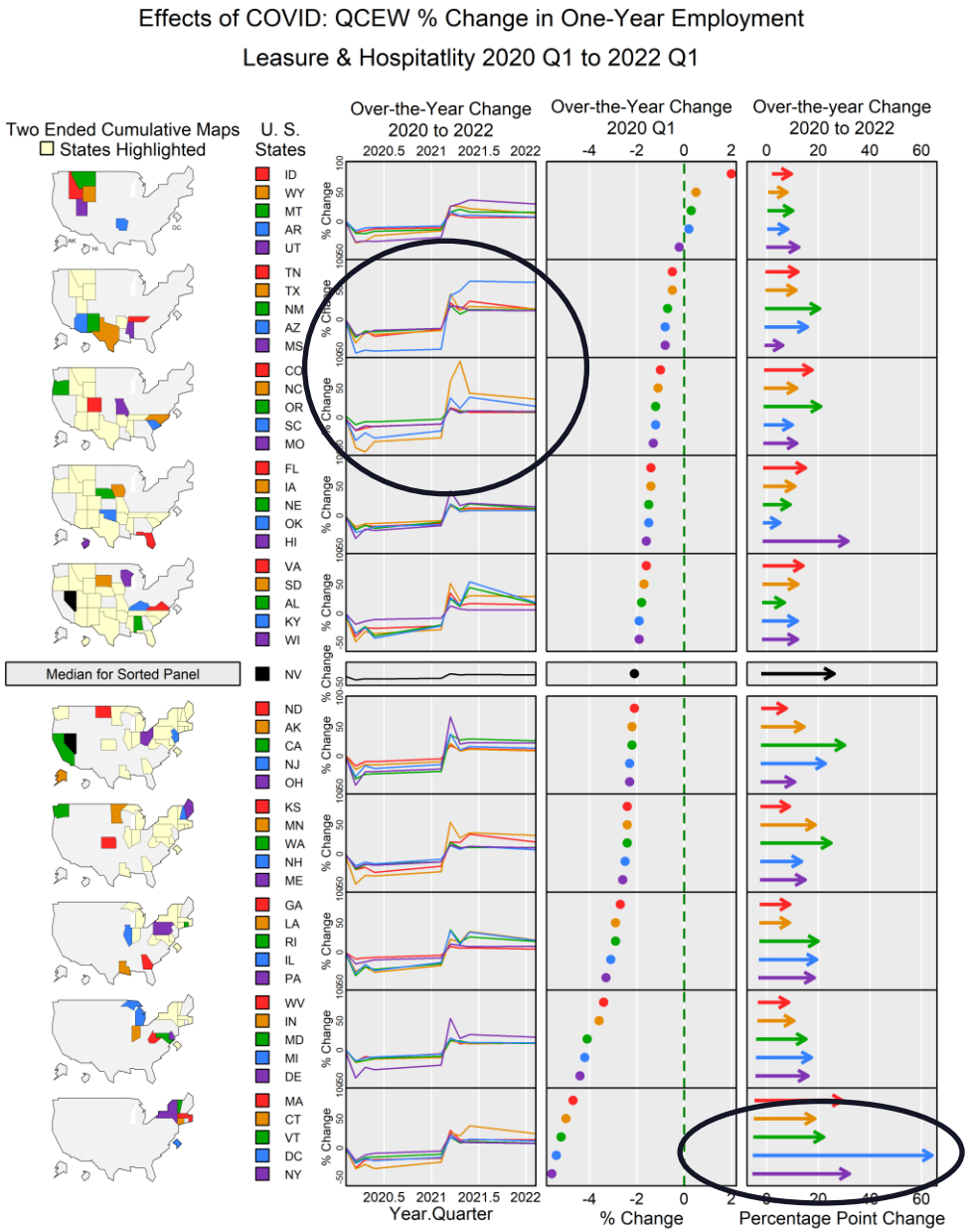


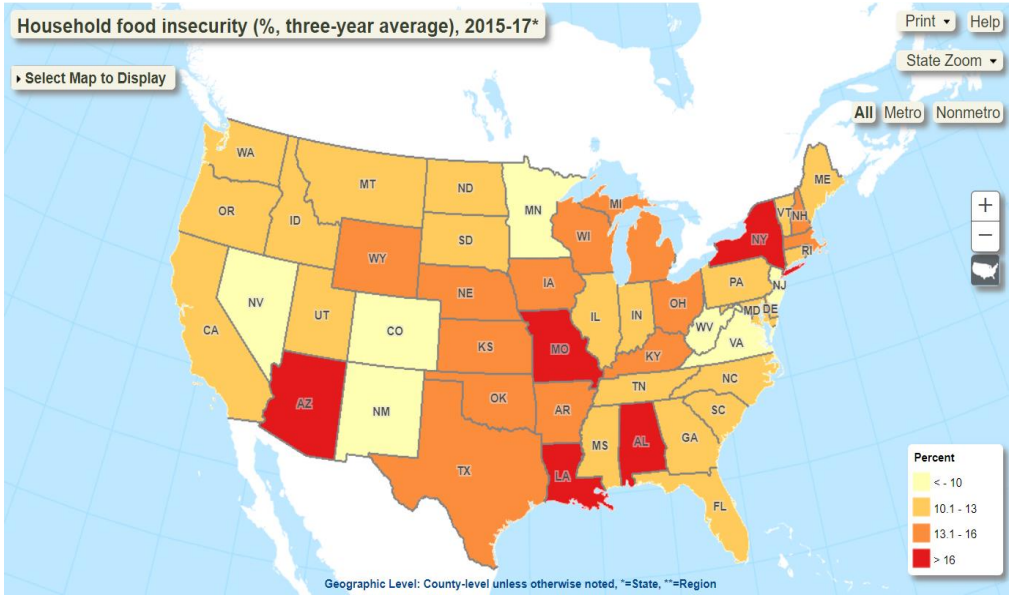
Leisure and Hospitality: Effects of the Pandemic on Employment

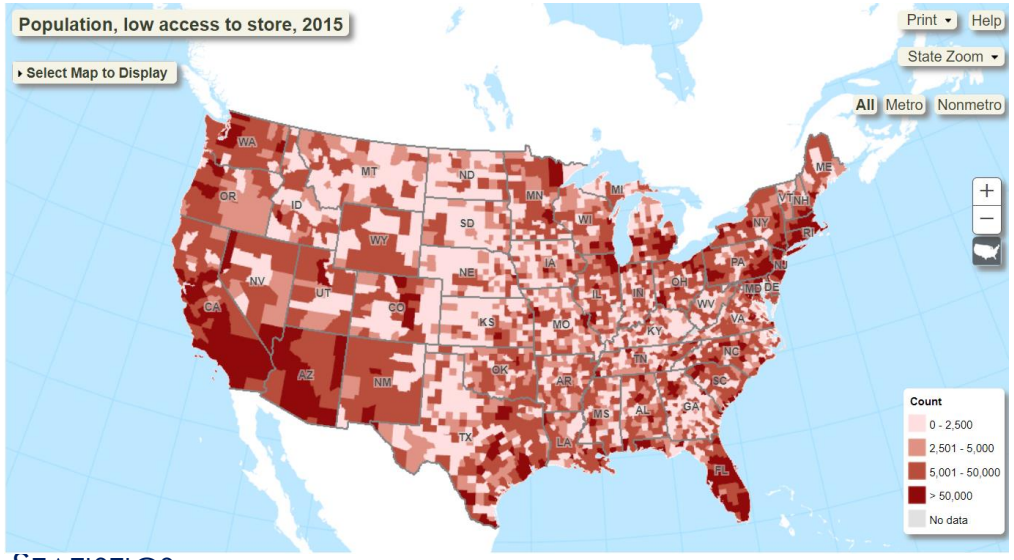


Economic Research Service (ERS) Example

ERS Plots from Food Atlas

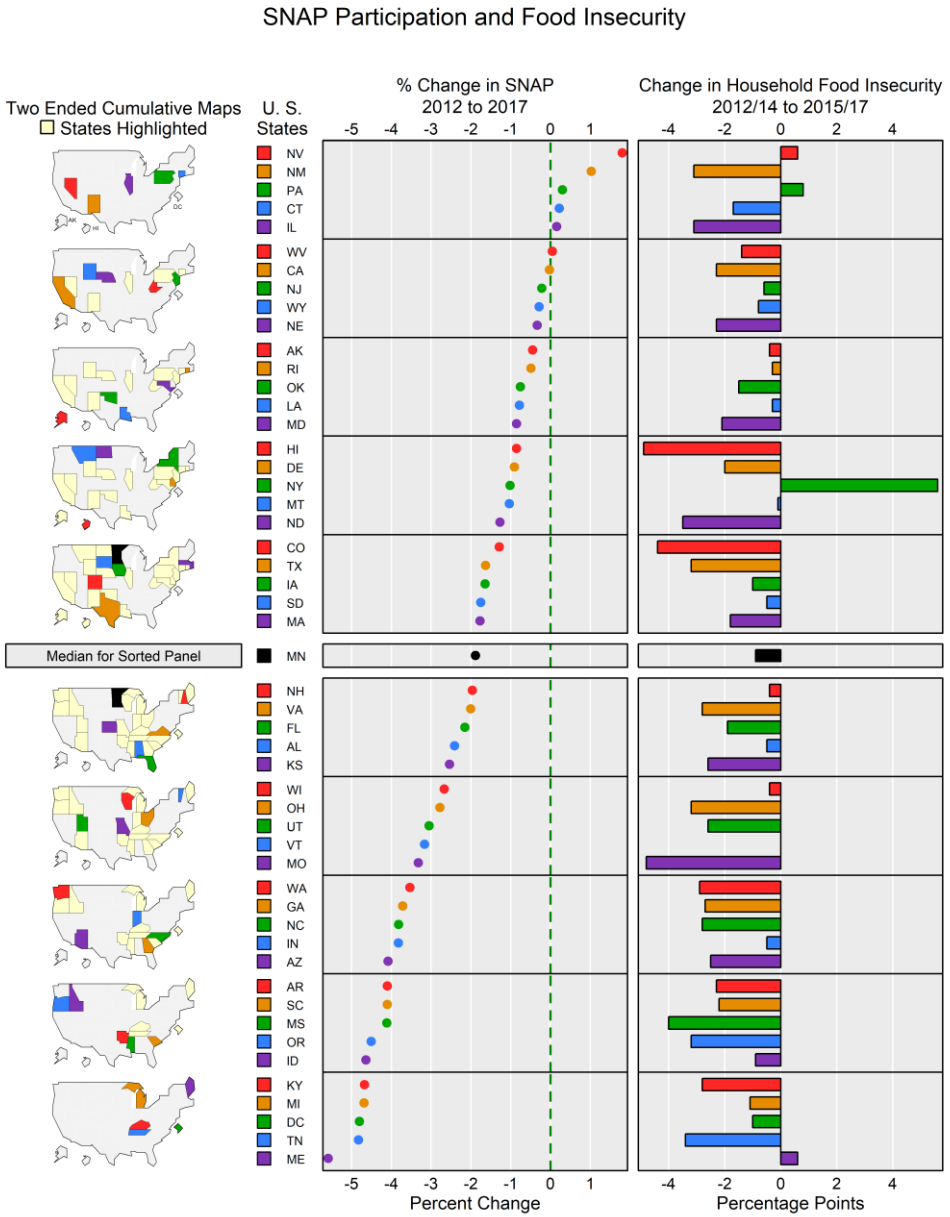
- Food Atlas is a mapping/data tool to explore food environment factors that potentially influence food choices and diet quality.
- Research is needed to identify causal relationships and effective policy interventions.
- Displays choropleth maps for variables over states and counties.



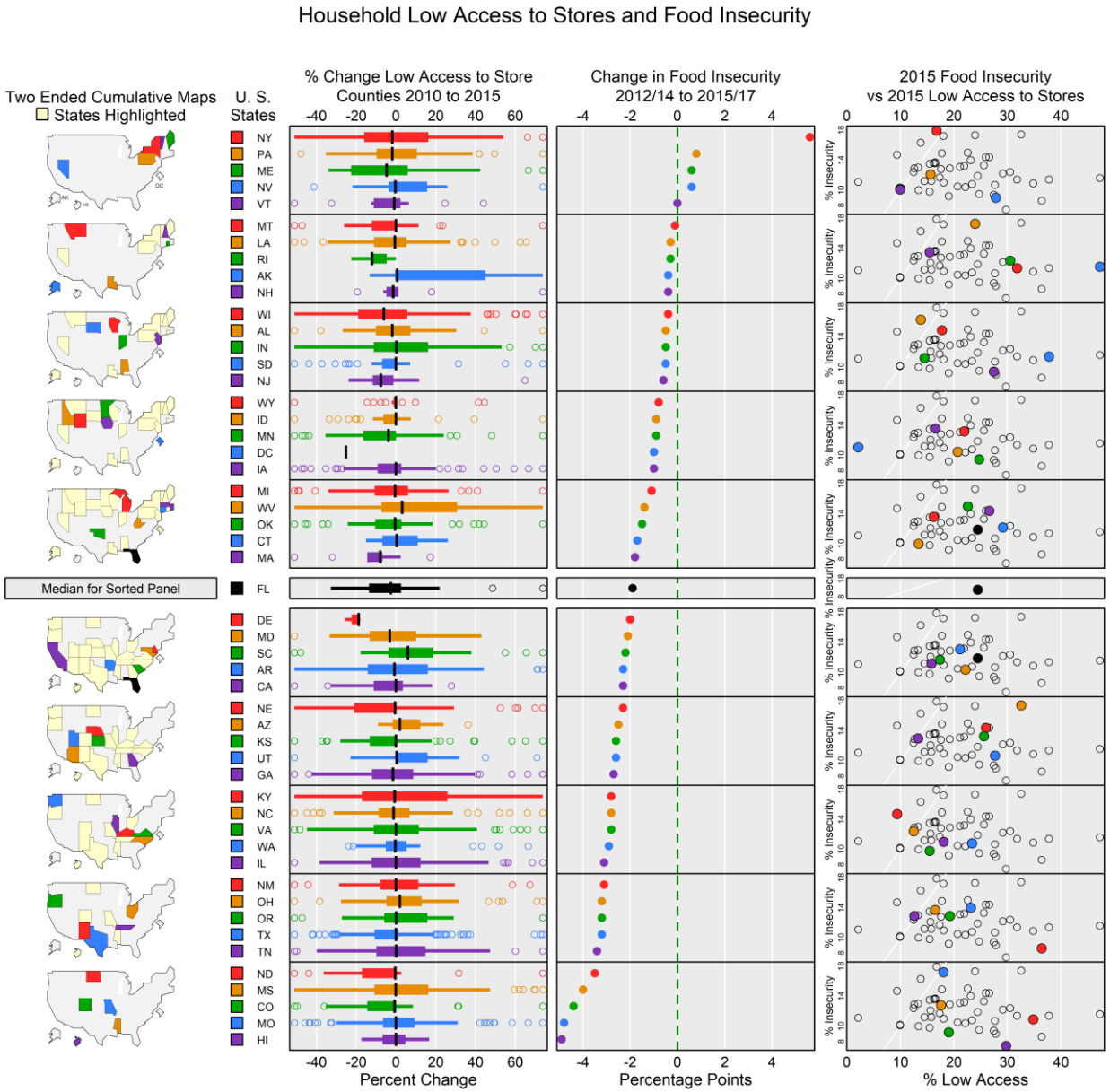


State Food Insecurity 2015 – 2017 and Percent Population Low Access to Store, 2015

- What is the effect of programs on Food Insecurity?
- Let's look at SNAP participation and Food Insecurity.



- Now, let's look at Low Access to Stores (household).
- How is it associated with Food Insecurity?



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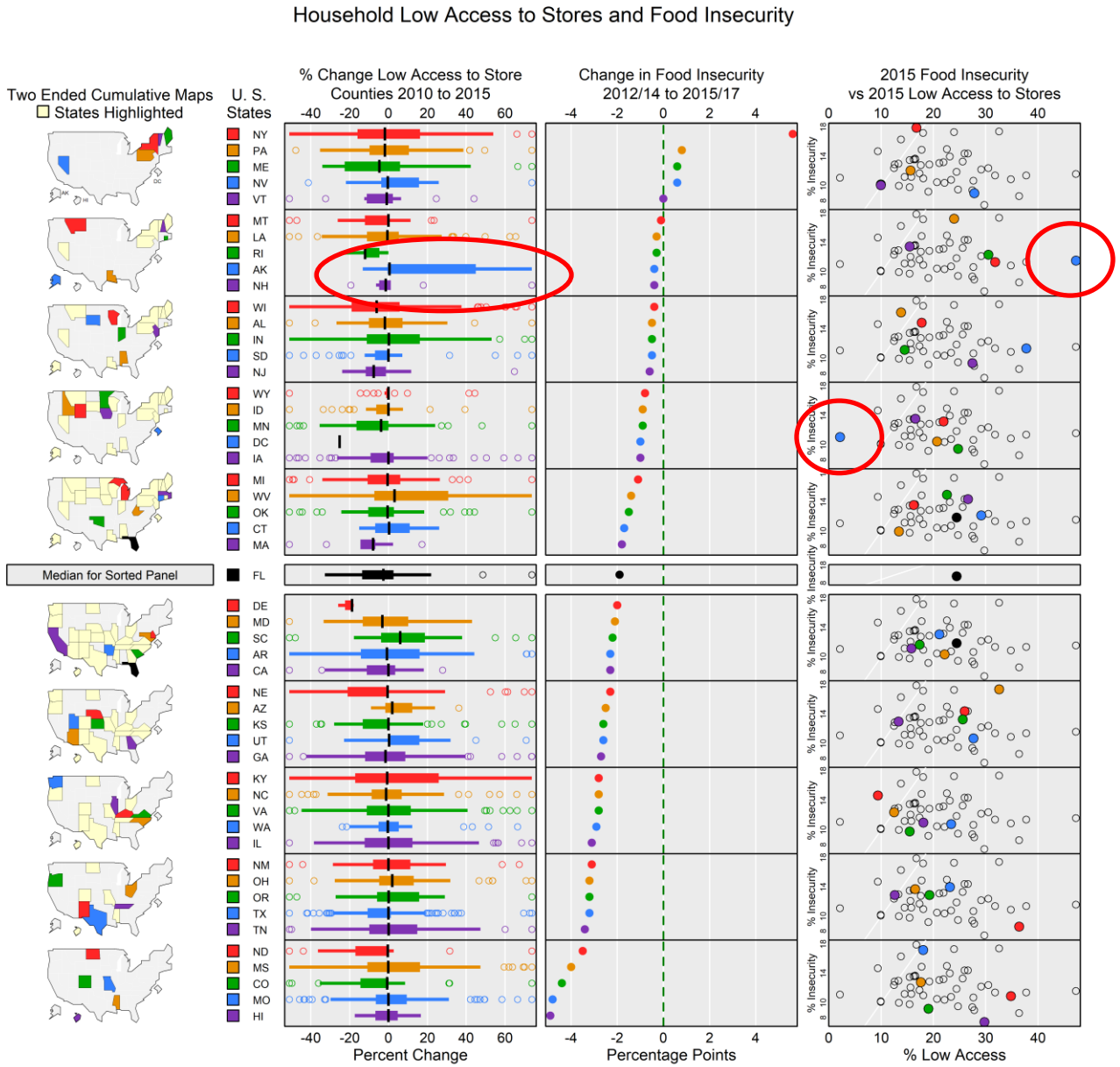
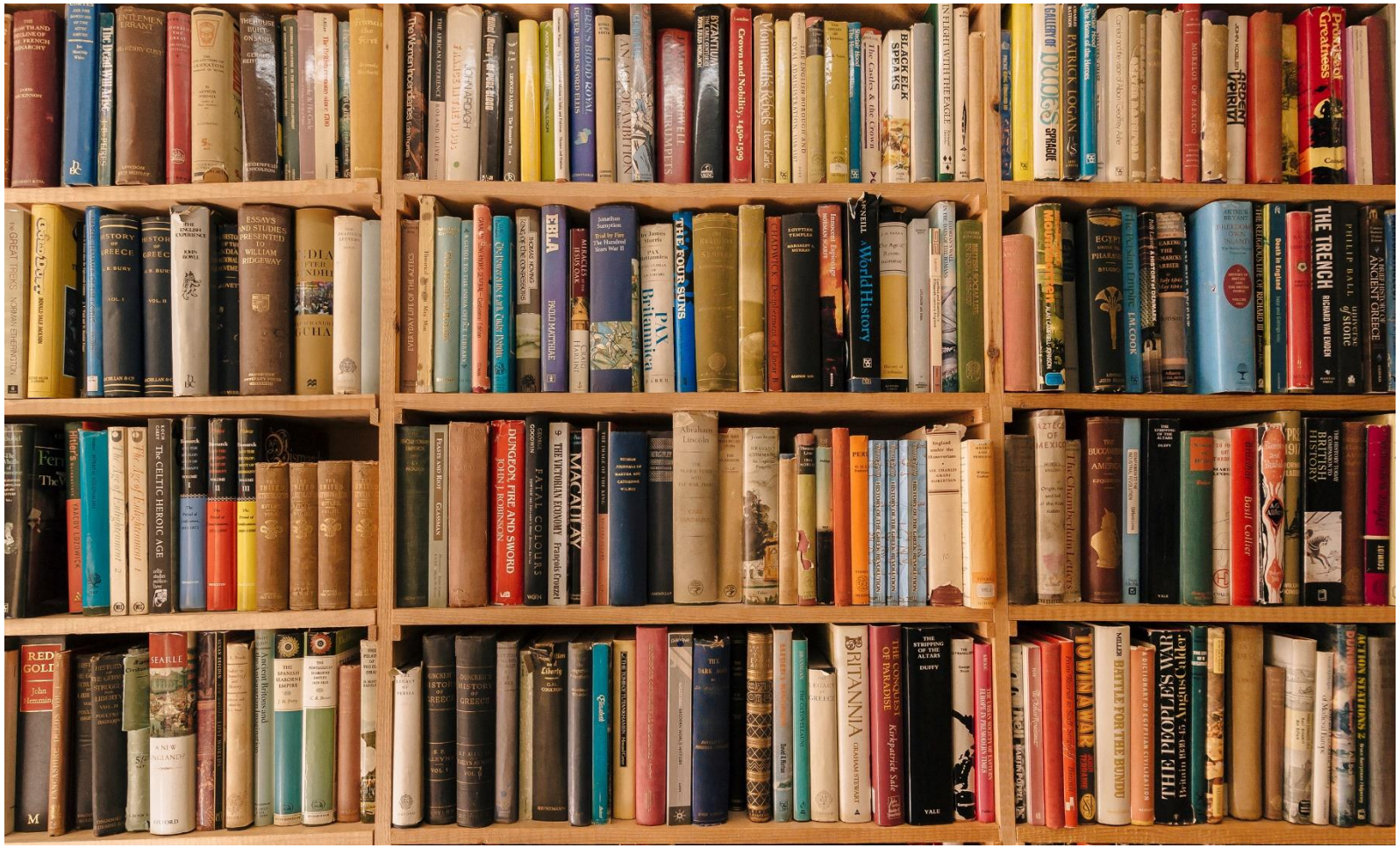


Summary

- Introduced linked micromaps for visualizing geographically linked statistics
- Showed how it is an improvement over typical methods
- Provided examples using real-world data
- For code, data, and slides see…

https://github.com/wlmcensus/Joint-Statistical-Meetings-Presentation-2024

Resources


BLACK ELK SPEAKS
THE FOUR SUNS
PAX Britannica
World History
THE TRENCH
MACAULAY
DUNGEON, FIRE AND SWORD
BRITANNIA
THE PEOPLE'S WAR

Journal of Statistical Software

January 2015, Volume 63, Issue 2. *http://www.jstatsoft.org/*

micromap: A Package for Linked Micromaps

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US Environmental Protection Agency

Anthony R. Olsen
US Environmental Protection Agency

Thomas M. Kincaid
US Environmental Protection Agency

Abstract

The R package **micromap** is used to create linked micromaps, which display statistical summaries associated with areal units, or polygons. Linked micromaps provide a means to simultaneously summarize and display both statistical and geographic distributions by linking statistical summaries to a series of small maps. The package contains functions dependent on the **ggplot2** package to produce a row-oriented graph composed of different panels, or columns, of information. These panels at a minimum typically contain maps, a legend, and statistical summaries, with the color-coded legend linking the maps and statistical summaries. We first describe the layout of linked micromaps and then the structure required for both the spatial and statistical datasets. The function `create_map_table` in the **micromap** package converts the input of an **sp** `SpatialPolygonsDataFrame` into a data frame that can be linked with the statistical dataset. Highly detailed polygons are not appropriate for display in linked micromaps so we describe how polygon boundaries

Journal of Statistical Software

January 2015, Volume 63, Issue 3. *http://www.jstatsoft.org/*

micromapST: Exploring and Communicating Geospatial Patterns in US State Data

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StatNet Consulting LLC

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George Mason University

Abstract

The linked micromap graphical design uses color to link each geographic unit's name with its statistical graphic elements and map location across columns in a single row. Perceptual grouping of these rows into smaller chunks of data facilitates local focus and visual queries. Sorting the geographic units (the rows) in different ways can reveal patterns in the statistics, in the maps, and in the association between them. This design supports both exploration and communication in a multivariate geospatial context. This paper describes **micromapST**, an R package that implements the linked micromap graphical design specifically formatted for US state data, a common geographic unit used to display geographic patterns of health and other factors within the US. This package creates a graphic for the 51 geographic units (50 states plus DC) that fits on a single page, with states comprising the rows and state names, graphs and maps the columns. The graphical element for each state/column combination may represent a single statistical value, e.g., by a dot or horizontal bar, with or without an uncertainty measure. The distribution of values within each state, e.g., for counties, may be displayed by a boxplot. Two values per state may be represented by an arrow indicating the change in values, e.g., between two time points, or a scatter plot of the paired data. Categorical counts may be displayed as horizontal stacked bars, with optional standardization to percents or centering of the

Data Sources

ACS Response and Refusal Rates

- www.census.gov/acs/www/methodology/sample-size-and-data-quality/response-rates/

PEW Religious Landscape Survey

- www.pewresearch.org/religious-landscape-study/database/

QCEW State and County Map

- data.bls.gov/maps/cew/us

Economic Research Service Food Environment Atlas

- www.ers.usda.gov/data-products/food-environment-atlas/go-to-the-atlas/

Resources

- **Journal of Statistical Software**
  micromap: A package for Linked Micromaps
- **Journal of Statistical Software**
  micromapST: Exploring and Communicating Geospatial Patterns in US State Data
- **George Mason University** Visualizing Data Patterns with Micromaps
- **R Bloggers** Luke-warm about micromaps
- **Utah State University** Visual Data Mining via Linked Micromap Plots in R
- Fundamentals of Spatial Data Access and Analysis in R

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- States might make policies to improve health outcomes.
- How effective are they?
- Let's look at obesity.
- Increased everywhere!