Modeling Health Insurance Coverage Estimates for Minnesota Counties

Peter Graven

State Health Access Data Assistance Center (SHADAC)
University of Minnesota, School of Public Health

Minnesota Health Services Research Conference
March, 6, 2012

Acknowledgements

- Co-author: Joanna Turner, MS

- Project supervision: Kathleen Call, PhD

- Statistical consultation: Sudipto Banarjee, PhD

- Thanks to the Minnesota Department of Health, Health Economics for their support of this work

- Special thanks to Gestur Davidson, PhD for encouraging Bayesian modeling at SHADAC

Background

- Minnesota Health Access Survey (MNHA)
  - Telephone survey conducted every 2 years
  - Provides MN and regional estimates, including estimates for select populous counties and cities
  - County level estimates are frequently requested data
- American Community Survey (ACS)
  - Estimates available for all PUMAs (Public Use Microdata Areas)
  - Estimates available for 12 Minnesota counties (out of 87)
- Small Area Health Insurance Estimates Program (SAHIE)
  - 2007 estimates for all 87 Minnesota counties
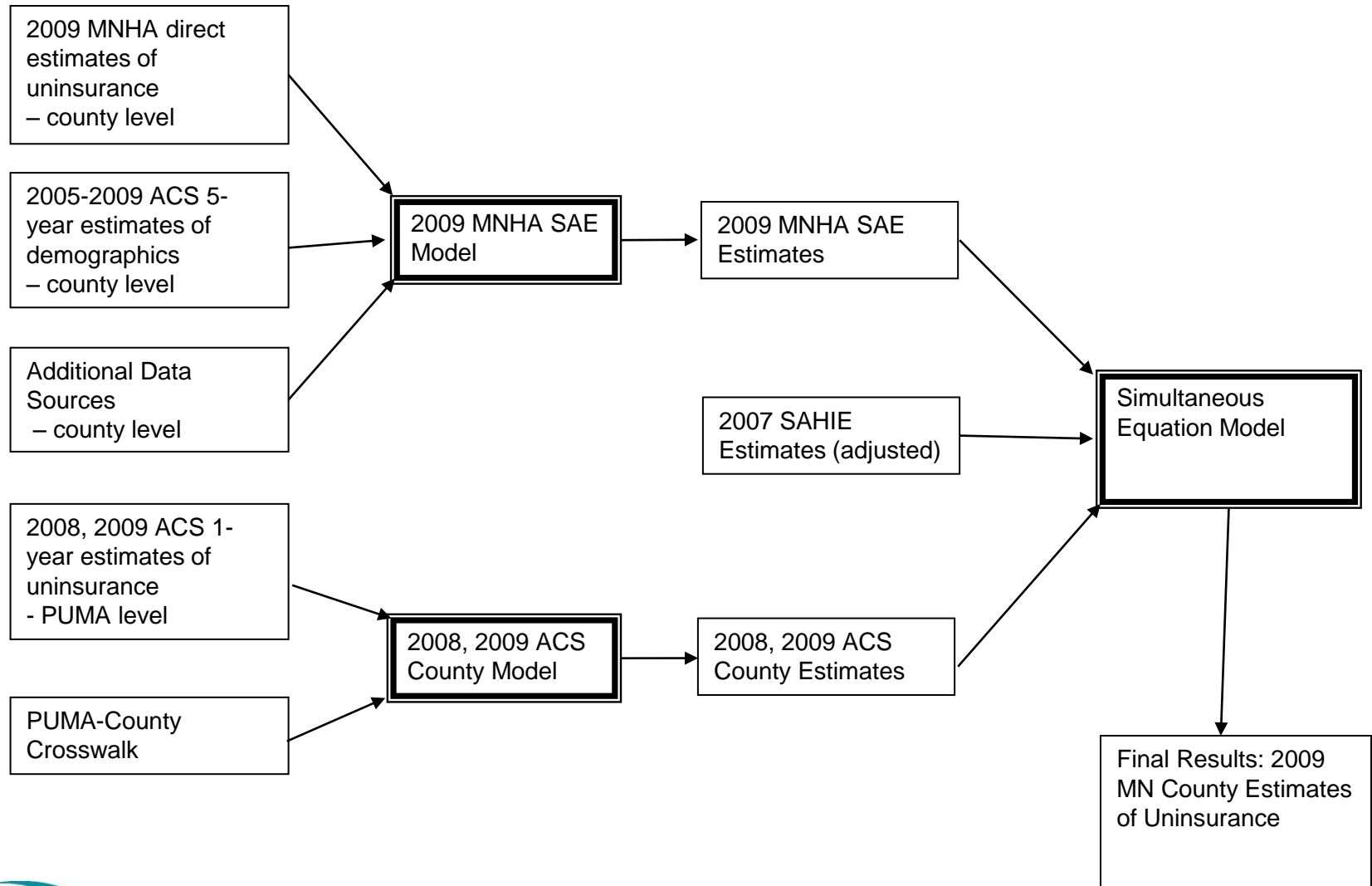 - 2009 estimates are now available but not examined in this edition of the model

Background

- Minnesota geographies and data availability

Legend

PUMA

1-year ACS County

No ACS County
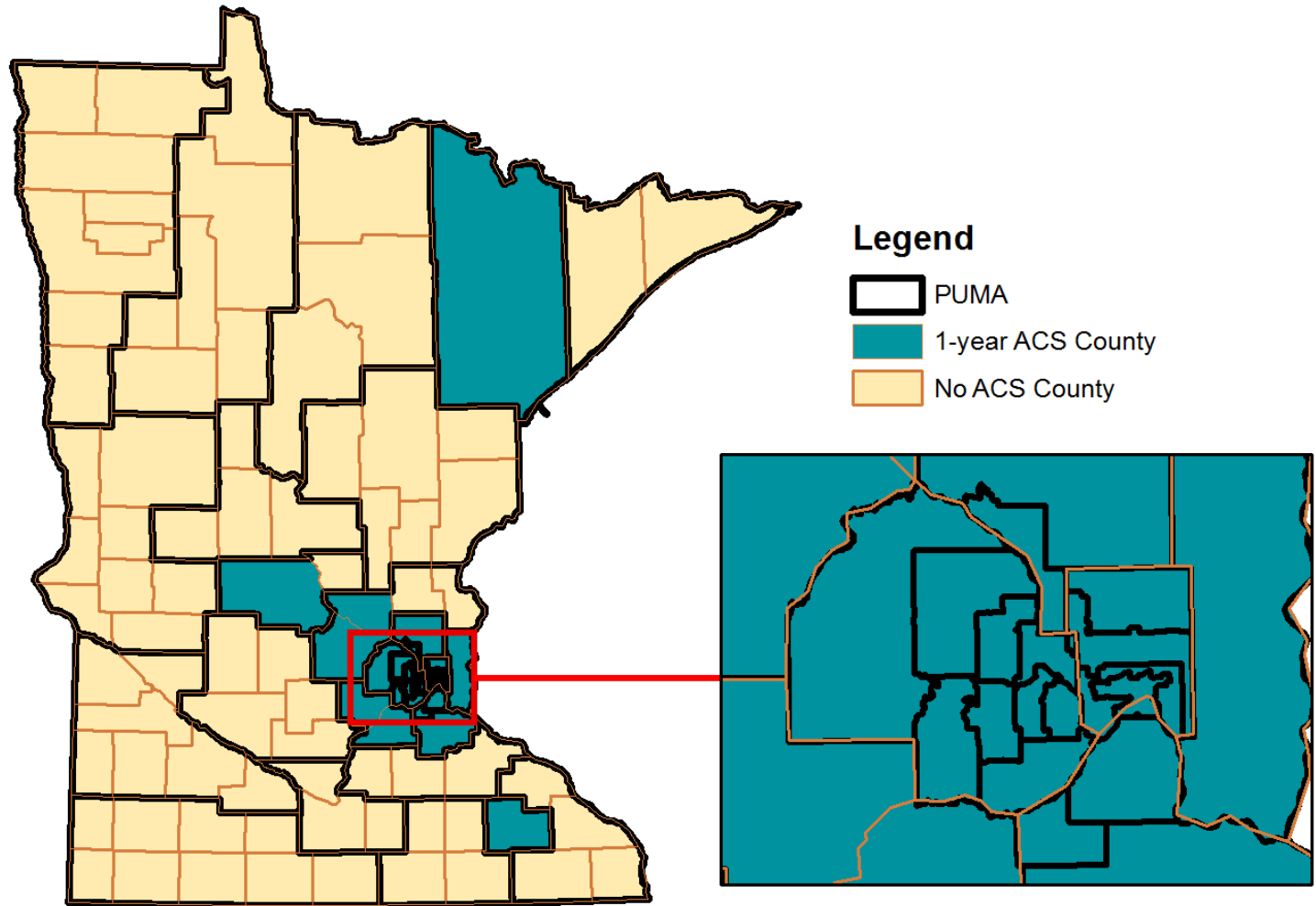
Research Objective

- Produce Minnesota uninsurance rates by county for 2009
  - Use the Minnesota Health Access Survey (MNHA)
  - Use other sources of uninsurance estimates
  - Include estimates of uncertainty
  - Allow for future input sources
  - Create methodology that is incrementally observable
  - Use methods that can be applied to other states

Methodology Overview

2009 MNHA direct estimates of uninsurance – county level

2005-2009 ACS 5-year estimates of demographics – county level

Additional Data Sources – county level

2009 MNHA SAE Model

2009 MNHA SAE Estimates

2007 SAHIE Estimates (adjusted)

Simultaneous Equation Model

2008, 2009 ACS 1-year estimates of uninsurance - PUMA level

PUMA-County Crosswalk

2008, 2009 ACS County Model

2008, 2009 ACS County Estimates

Final Results: 2009 MN County Estimates of Uninsurance

MNHA SAE: Model

- Estimates come from normal distribution

$$y_c^{MNHA-direct} \sim N\left(\bar{y}_c, \frac{1}{\tau}\right)$$

- Model the mean using covariates X and error

$$\bar{y}_c = \alpha + \beta X + v_c$$

- Error is correlated spatially with neighbors

$$v_c | v_{-c}, \sigma_v^2 \sim N\left(\sum_{j \in \delta_c} \frac{v_j}{|\delta_c|}, \frac{\sigma_v^2}{|\delta_c|}\right)$$

MNHA SAE: Model Parameters

Parameters	Prior	Median	SE
Percent Moved into State, 2005-2009	$N(0, 1/1 \times 10^6)$	1.501	0.6422
Percent White, 2005-2009	$N(0, 1/1 \times 10^6)$	-0.3024	0.1143
Percent HHLDS 65 and Over, 2005-2009	$N(0, 1/1 \times 10^6)$	0.2638	0.1089
Percent of Population Growth, 2000-2009	$N(0, 1/1 \times 10^6)$	-2.643	0.9837
Percent Land in Farms, 2007	$N(0, 1/1 \times 10^6)$	0.05293	0.02414
Percent Employed Working in Retail, 2009	$N(0, 1/1 \times 10^6)$	0.5771	0.244
Average Unemployment Rate, 2009	$N(0, 1/1 \times 10^6)$	2.102	0.3965
Weekly Wage, 2009	$N(0, 1/1 \times 10^6)$	0.02775	0.007752
Constant	$N(0, 1/1 \times 10^6)$	-16.63	13.36
Precision v	$\Gamma(0.001, 0.001)$	2.262	94.55
Precision τ	$\Gamma(0.001, 0.001)$	0.03686	0.006257
DIC		541.9	
Pd		7.788	

ACS County Model

- County estimate from 1-year ACS (12 counties)
  - Estimate and SE used directly
- County is a subset of PUMA (75 counties)
  - Use the relationship between puma and county for the poverty rate to estimate the county given a puma uninsurance rate using equations 1-3

  1) $Unin_c^{puma} = \beta_0 + \beta_1 Pov_c^{puma}; c = 1,2,\dots,87$

  2) $Pov\_diff_c^{puma} = Pov_c^{County} - Pov_c^{puma}$

  3) $unin_c^{county} = Unin_c^{puma} + \beta_1 Pov\_diff_c^{puma}$

  - SE is the PUMA estimate times the ratio of the PUMA poverty SE divided by the county poverty SE

$$unin\_se_c^{county} = unin\_se_c^{puma} \sqrt{\left(\frac{pov\_se_c^{county}}{pov\_se_c^{puma}}\right)}$$

SAHIE Estimate & Adjustment

- Census Bureau's Small Area Health Insurance Estimates (SAHIE) program produces model-based estimates of health insurance coverage

- Estimates are for 0-64 so we need to make a correction to use in our all ages model

$$Unin_{All}^{SAHIE} = Unin_{under65}^{SAHIE} - \left(Unin_{under65}^{SAHIE} * Unin_{under65}^{SAHIE}\right)$$
$$+ \left(Prop65over^{ACS5year} * Unin_{65over}^{CPS}\right)$$

Simultaneous Equation Model (SEM)

- Each survey-county estimate from a normal distribution

$$y_{sc} \sim N(u_{sc}, \tau_{sc}^u)$$

- The precision is a survey term times a survey-county specific error

$$\tau_{sc}^u = \tau_s * \tau_{sc}^\tau$$

- The survey-county error is the inverse of the estimate's variance

$$\tau_{sc}^\tau = \frac{1}{\sigma_{sc}^2}$$

Simultaneous Equation Model (SEM)

$$u_c^{MNHA\_SAE\_2009} = \alpha_1 + \beta_c \, County_c$$

$$u_c^{ACS\_2009} = \alpha_2 + \beta_c \, County_c$$

$$u_c^{ACS\_2008} = \alpha_3 + \beta_c \, County_c$$

$$u_c^{SAHIE\_2007} = \alpha_4 + \beta_c \, County_c$$

Model

$$y_c^{SEM} = (\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4)/4 + \beta_c \, County_c \longrightarrow$$ Prediction

- Specifications
  - Single Markov Chain Monte Carlo
  - 20k production cycles after 1,000 burn-in iterations

SEM: Model Parameters

| Parameters	Prior	Median	SD
$\alpha_{MNHA\_SAE\_2009}$	$N(0, 1/1 \times 10^6)$	30.49	8.282
α_{ACS_2009}	$N(0, 1/1 \times 10^6)$	29.77	8.282
α_{ACS_2008}	$N(0, 1/1 \times 10^6)$	29.4	8.283
α_{SAHIE_2007}	$N(0, 1/1 \times 10^6)$	29.7	8.281
β_{1-87}	$N(0, 1/1 \times 10^6)$	-23.94--15.21	8.29-8.428
τ	$\Gamma(0.001,0.001)$	0.5335	0.04714
DIC		1558	
Pd		91.27	

SD: Standard Deviation

Methodology Limitations/Enhancements

- MNHA SAE model could include more advanced variable selection and transformations of covariates

- MNHA SAE model could take advantage of information outside the state (eg. US counties)

- Assumptions about PUMA to county relationships for ACS are not currently testable

- SEM Model excludes non-parametric errors
  - Integrated model could propagate errors more accurately but sacrifice conceptual simplicity
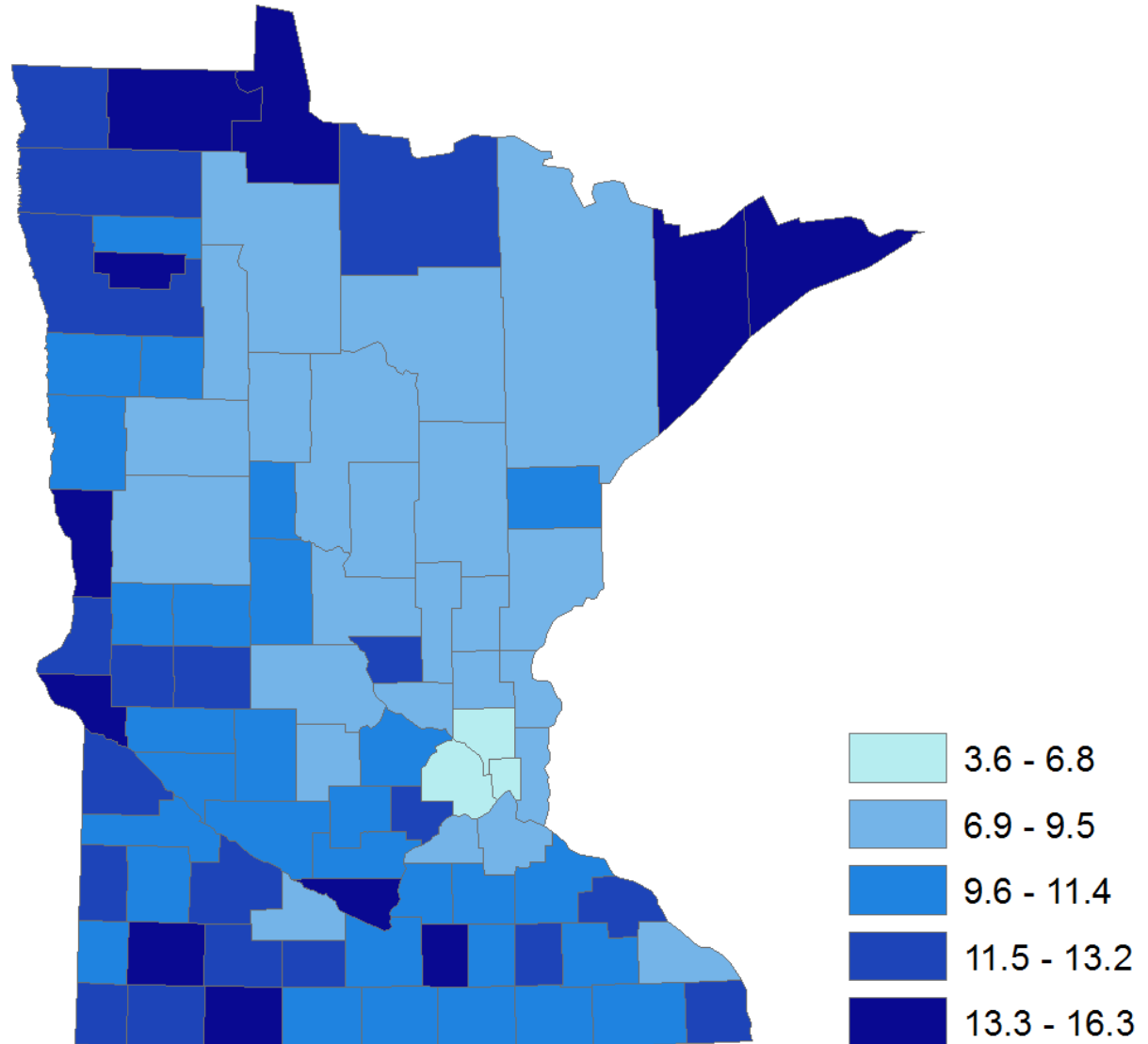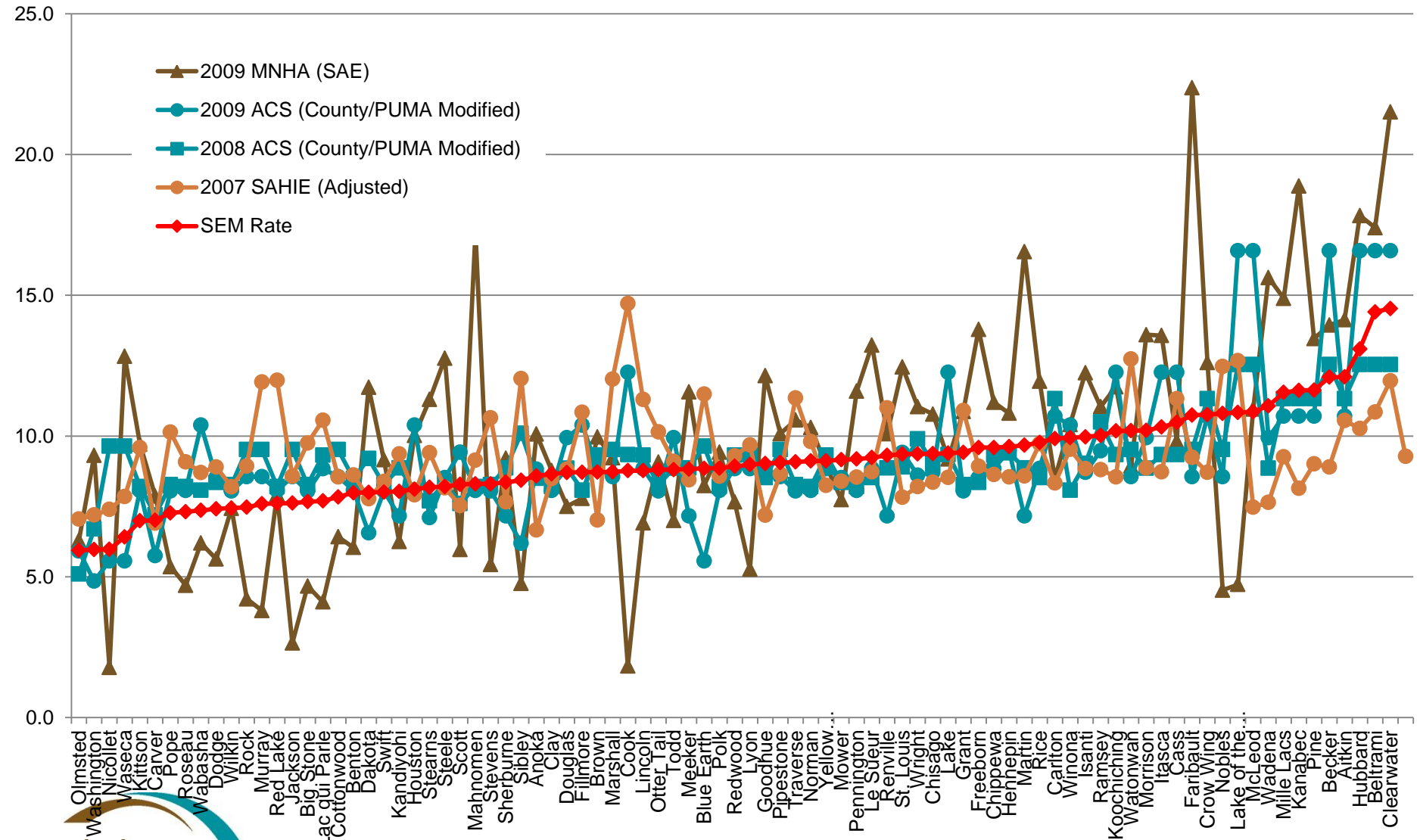
Model Results - Percent Uninsured

Legend:
- 5.9 - 8.0
- 8.1 - 9.5
- 9.6 - 10.5
- 10.6 - 12.5
- 12.6 - 14.5
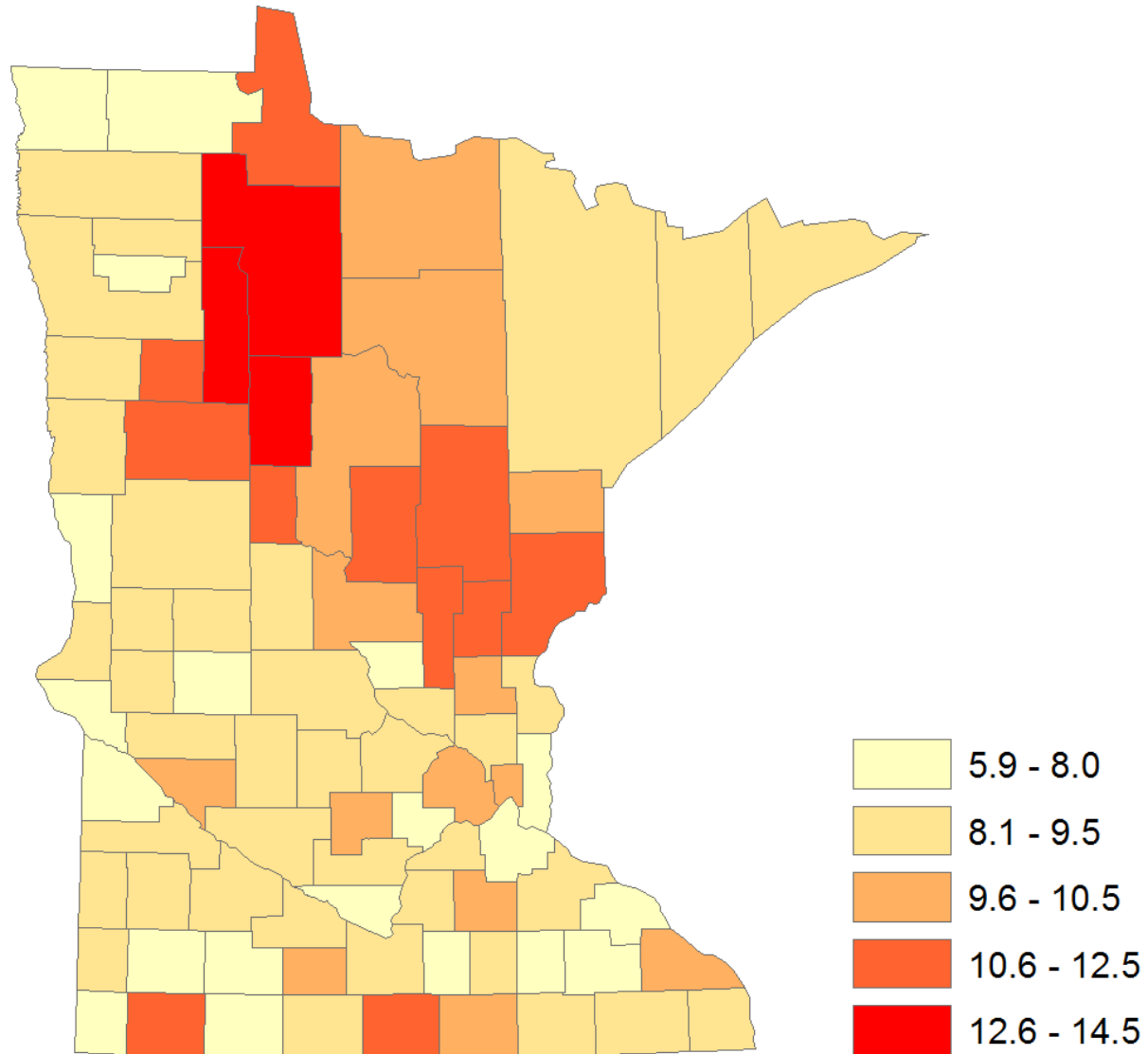
Model Results: Posterior Density
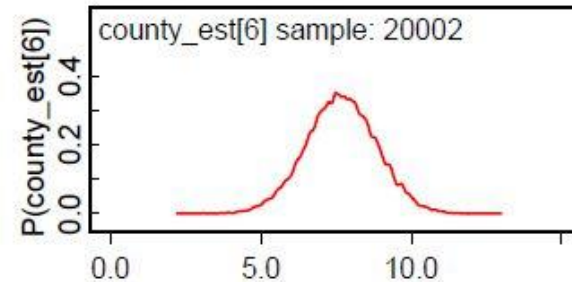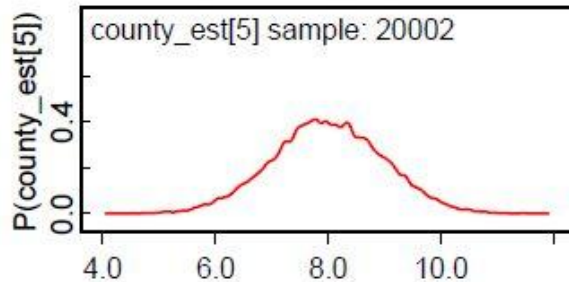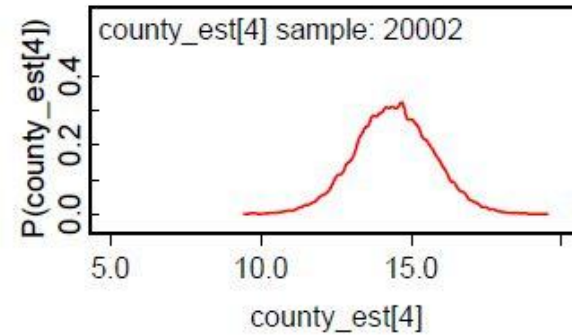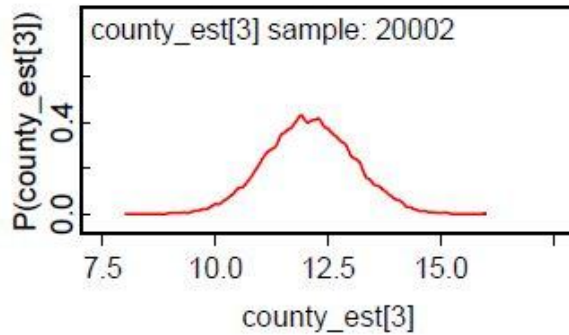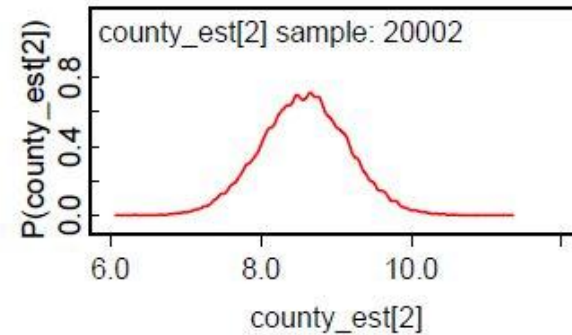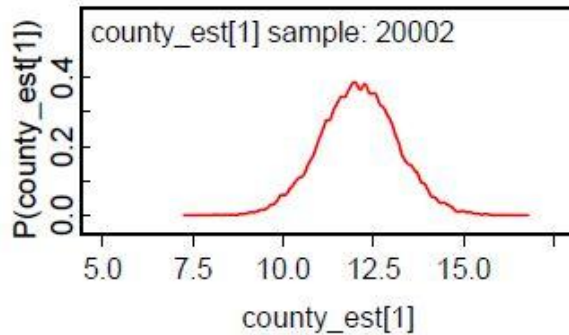
Model Results - Uncertainty

Coefficient of Variation

$$CV = \frac{SD}{EST}$$

	3.6 - 6.8
	6.9 - 9.5
	9.6 - 11.4
	11.5 - 13.2
	13.3 - 16.3

Model Results: Input Comparison

Conclusion

- Produced uninsurance estimates and estimates of uncertainty using a state survey and multiple input sources

- Methodology is accessible and can be applied to other states and new input sources

- Results are important for states who need to prepare for changes under health reform