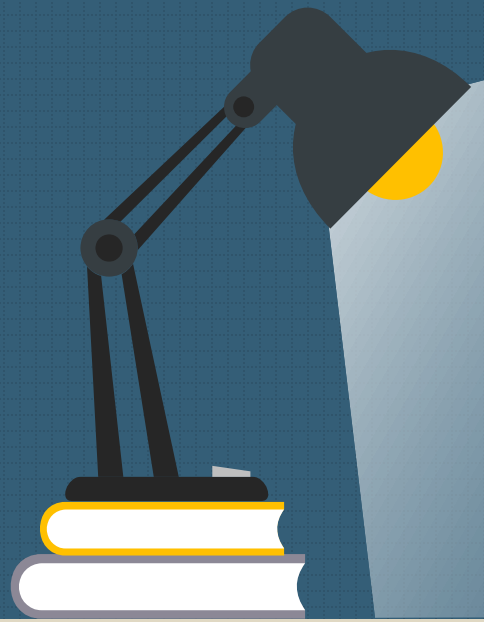

Research Paper

Regional disparity in the uninsurance rate impact of COVID-19: a spatial machine learning approach

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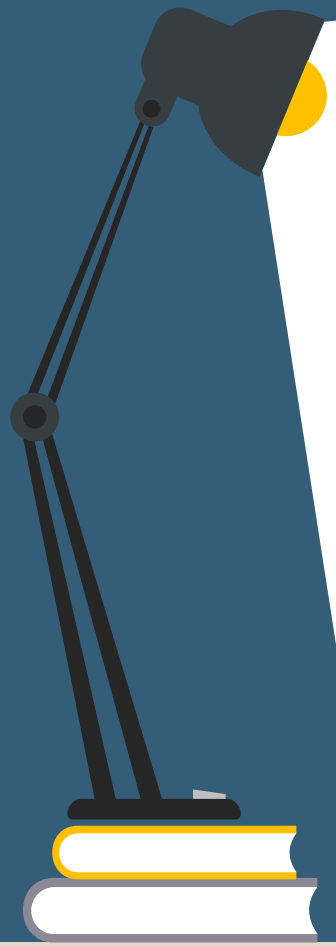

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Introduction

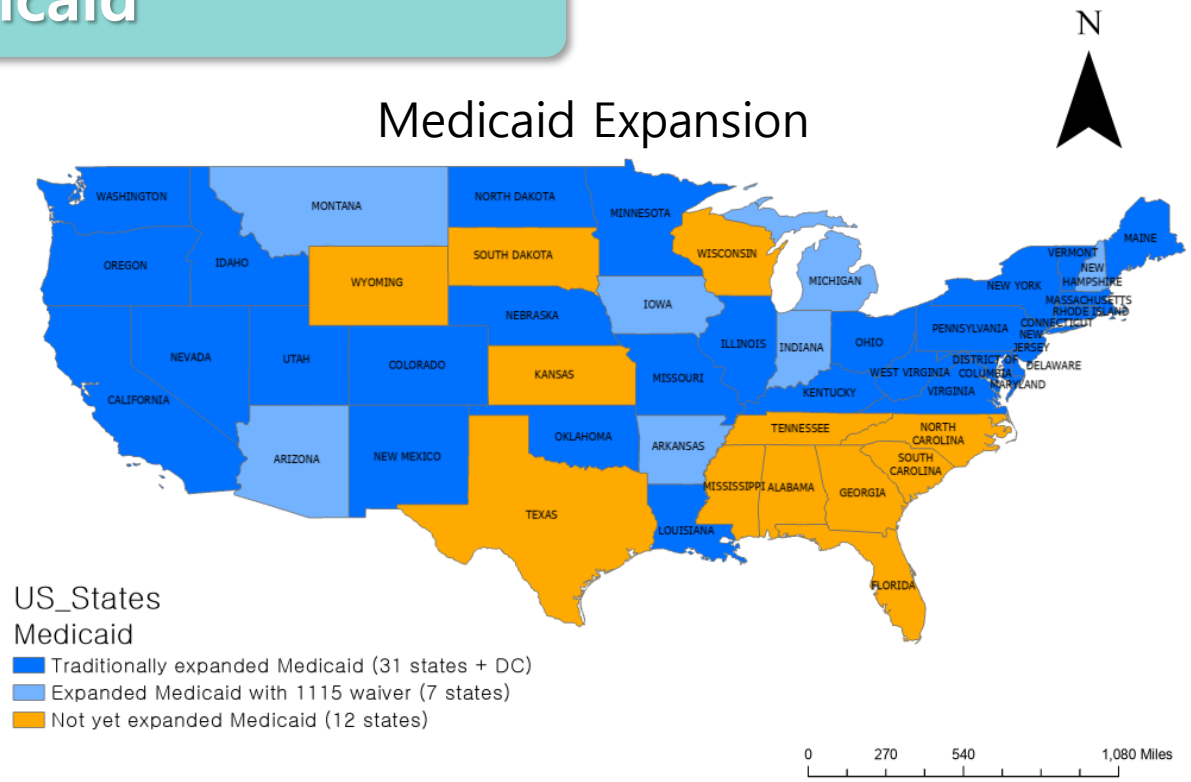
- The primary form of private insurance in the United States is Employer-Sponsored Insurance (ESI).
- Medicare and Medicaid subsidize the health insurance system to a limited extent.
- Most Americans cover their medical problems with private health insurance.

- The problem is that COVID-19 has caused massive unemployment in American society, which has increased the uninsured rate.
- The US government and each state government have eased Medicaid enrollment standards and simplified procedures to reduce the damage caused by COVID-19.

Frameworks

Medicaid

Source: National Library of Medicine



- Medicaid is a public health insurance program in the United States that provides low-income people
  under the age of 65, children under the age of 19, pregnant women, and people with disabilities.
- It is jointly financed by the federal and state governments and operated by the state governments.
- To mitigate the impact of COVID-19, several states have expanded Medicaid standards.
- However, discussions on the effect of Medicaid expansion are still conflicting.

Frameworks

Medicaid Expansion

Positives for Medicaid Expansion

Soni, A. (2020); Creedon et al. (2022); Bellerose, Collin, & Daw. (2022); Dong, Gindling, & Miller (2022).

- Reduce ethnic disparities in fertility and preterm birth rates.
- Increase investment in healthy behaviors among low-income people.
- Increase flu vaccination rates.

▶ Medicaid expansion **reduces uninsured**, privately insured rates.

Skepticism over Medicaid Expansion

Ghosh, Simon, & Sommers (2019); Takvorian et al. (2020); Kandilov, & Kandilov (2022)

- No evidence of an improvement in the appropriate treatment rate was found.
- The effect varies by state, county, and region.
- It does not affect the private insurance subscription rate according to the type of work.

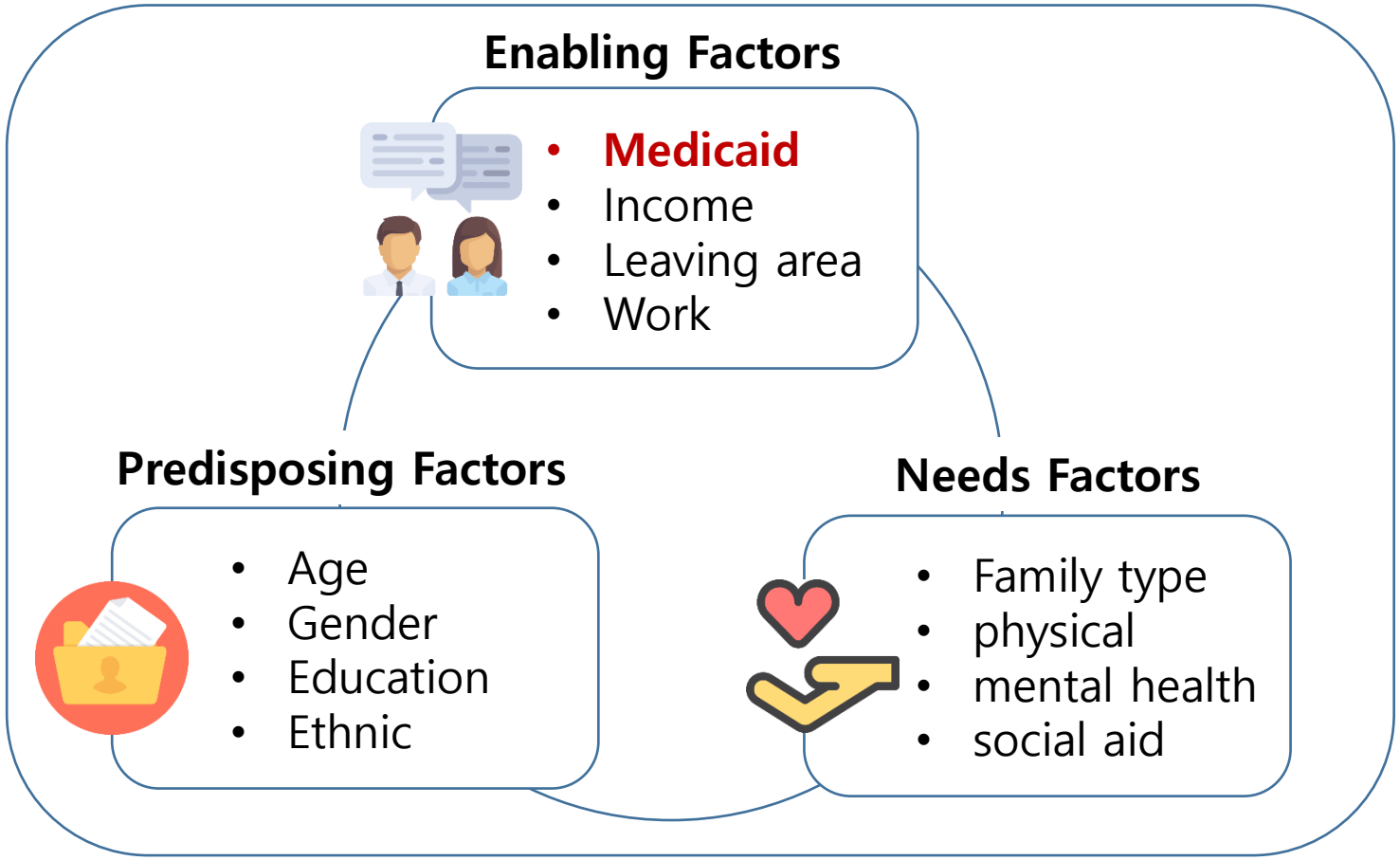
▶ The **empirical evidence** of decreasing uninsured rates **is inconsistent across regions**.

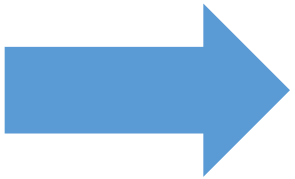
Frameworks

Anderson Behavior Model

Andersen & Newman, 1973; Van Houtven & Norton, 2004

- This model is an analytical framework that predicts medical behavior by considering internal and external factors.





Health Outcome

- Insurance
- Vaccination

Frameworks

Research Goal

Effects of Medicaid Expansion and Other Social Factors on Health Insurance Uninsured Rates.

- Existing statistical estimation methods are limited in considering various social factors simultaneously and cannot predict changes in the importance of each variable in the future.
- Therefore, this study creates the importance index between variables, and a prediction model using machine learning approaches.

Whether there is an influence of the spatial patterns of the counties.

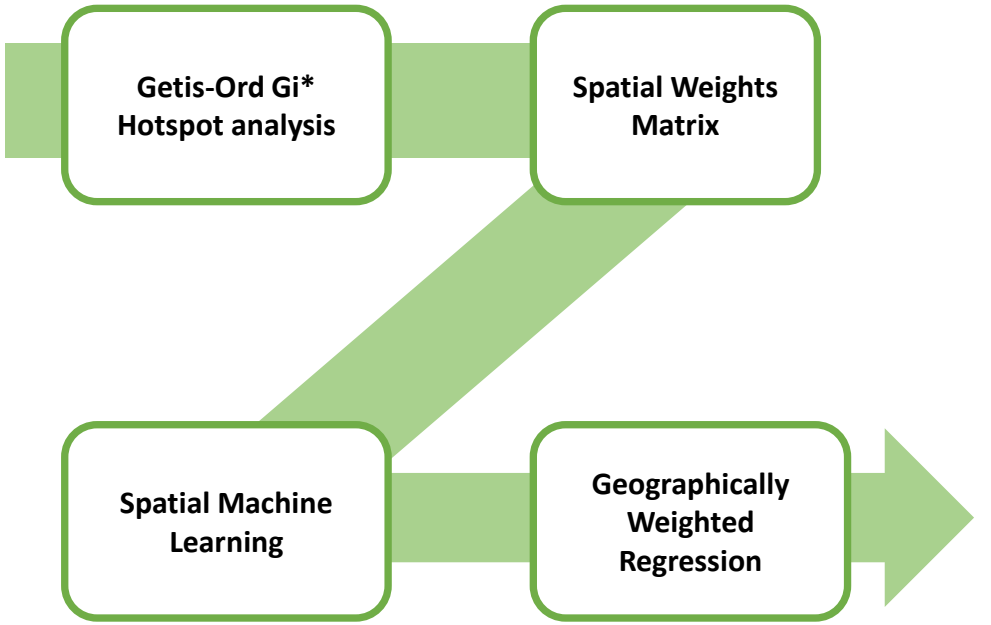
- In various preceding studies, social variables, including Medicaid, have different influences depending on regional characteristics. Therefore, I want to reflect on the spatial features in the model.

Research Design

- Unit of Analysis: **US counties (3,108)**.
- Research time scope: **2019, 2020, and 2021**.
- **County Health Ranking Data** (the University of Wisconsin's Population Health Institute)

- **Gi* Hotspot** show the county's spatial autocorrelation and regional patterns.
- **Spatial ML** shows the importance of variables and predictive models based on **spatial weights matrix**.
- **GWR** illustrates the coefficient value for each county of the variable.

Data Flow



Data and Variables

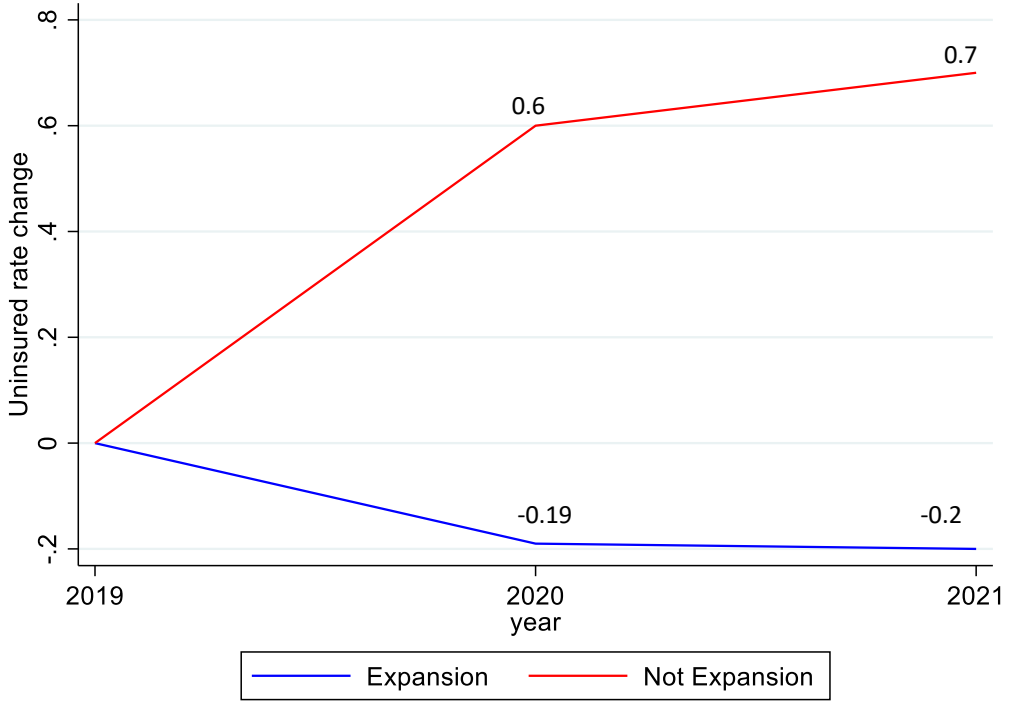
Variables			Descriptive
Target Variable	Change of Uninsurance Ratio		$Uninsurance\ Ratio_t - Uninsurance\ Ratio_0$
Feature **Variables**	Medicaid		Medicaid expansion during COVID19
	Enabling Factors	Income inequality	Ratio of household income at the 80th percentile to income at the 20th percentile
		Unemployment	Percentage of population ages 16 and older unemployed but seeking work
		Life expectancy	Life expectancy
	Needs **Factors**	Adult smoking	Percentage of adults who are current smokers
		Adult obesity	Percentage of the adult that reports a BMI greater than or equal to 30 kg/m2
		Food environment	Index of factors that contribute to a healthy food environment, from 0 (worst) to 10 (best).
		Children in single-parent households	Percentage of children that live in a household headed by a single parent
		Social associations	Number of membership associations per 10,000 population
	Predisposing **Factors**	Age ratio	Percentage of 65 and over
		Ethnic	Percentage of Hispanic
		Gender	Percentage of Female
		Education	Percentage of adults ages 25-44 with some post-secondary education
		Population	Number of Population

Results

Descriptive statistics

Variables		Before COVID	After COVID	
		2019	Year 1 (2020)	Year 2 (2021)
Uninsurance Ratio (%)		11.05	11.41	11.45
Medicaid (%)		63.4 (0.48)	63.4 (0.48)	63.4 (0.48)
Enabling Factors	Income inequality	4.51 (0.74)	4.51 (0.76)	4.50 (0.77)
	Unemployment	4.57 (1.56)	4.09 (1.39)	3.96 (1.39)
	Life expectancy	75.84 (11.38)	75.75 (11.71)	75.89 (11.41)
Needs Factors	Adult smoking	17.83 (3.57)	17.44 (3.55)	21.30 (4.11)
	Adult obesity	32.08 (4.58)	32.85 (5.42)	33.46 (5.94)
	Food environment	7.43 (1.28)	7.41 (1.26)	7.41 (1.27)
	Children in single-parent households	32.36 (10.53)	32.32 (10.67)	24.42 (10.00)
	Social associations	13.81 (7.05)	11.72 (5.88)	11.62 (5.90)
Predisposing Factors	Age ratio	18.86 (4.56)	19.31 (4.65)	19.80 (4.75)
	Ethnic	9.51 (13.81)	9.69 (13.90)	9.81 (13.93)
	Gender	49.92 (2.18)	49.91 (2.23)	49.91 (2.21)
	Education	57.61 (11.67)	57.89 (11.82)	58.14 (11.93)
	Population	104102(334347)	104571 (334793)	104920 (334768)
*The Observations for all variables are 3,108.				

Changes in non-insured rates according to Medicaid Expansion

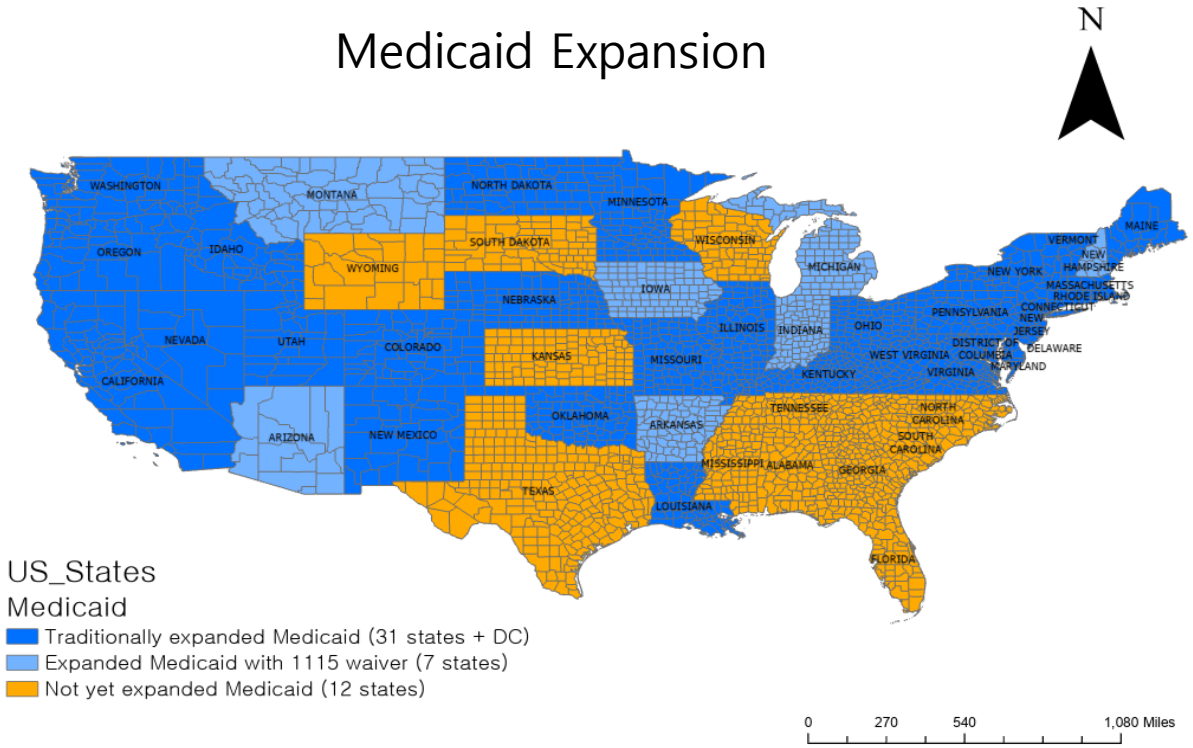


Results

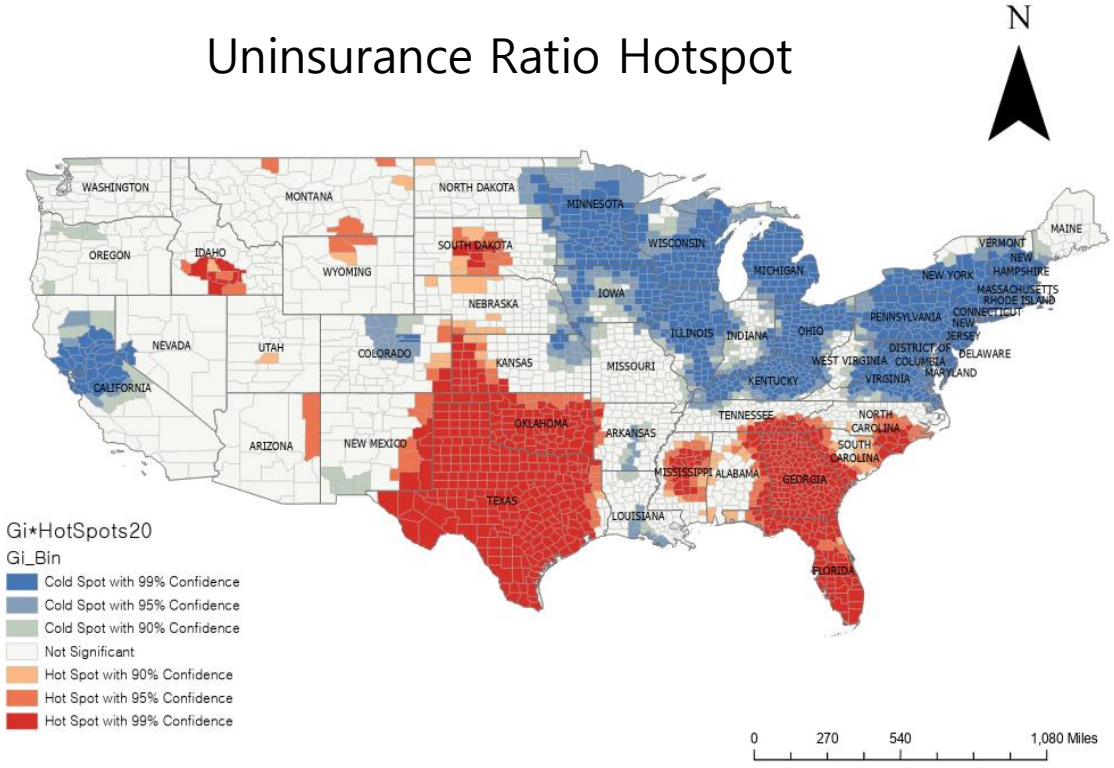
Getis-Ord Gi* Hotspot analysis

Global Moran's I
- Moran's Index: 0.3729
- Expected Index: -0.0003
- Variance: 0.00003
- z-score: 66.411

Medicaid Expansion



Uninsurance Ratio Hotspot



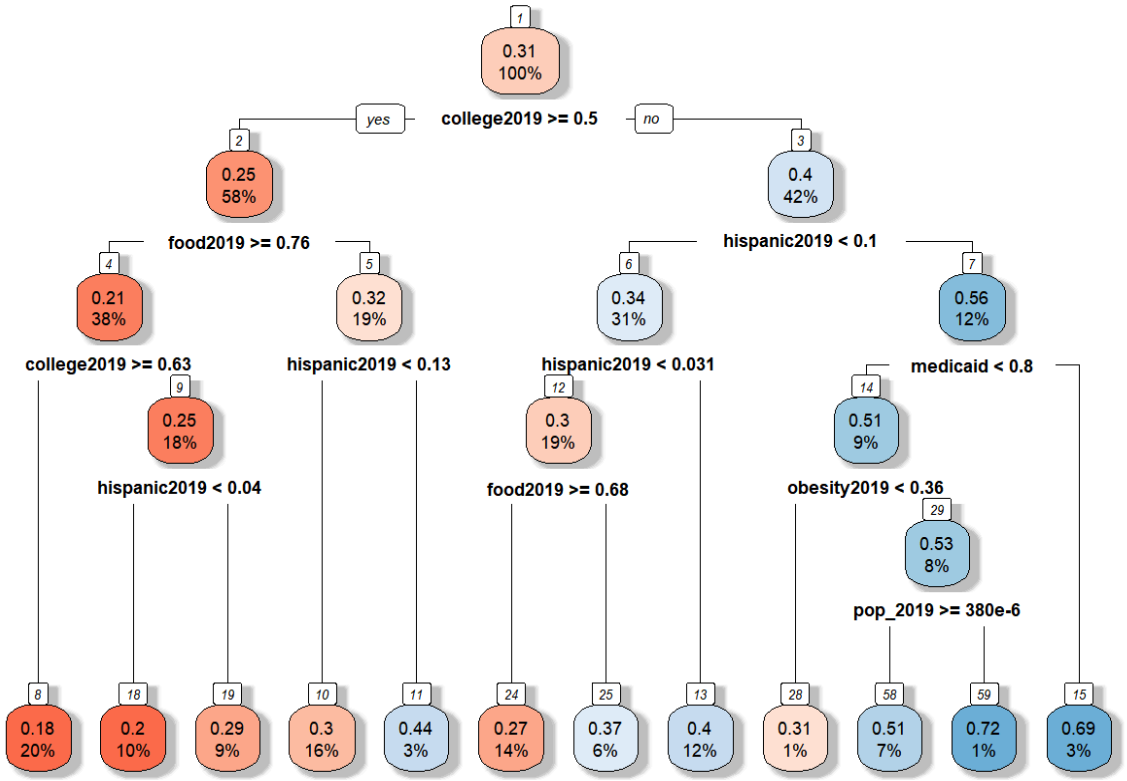
- Red: Areas with increased uninsured rates compared to surrounding areas
- Blue: Areas with reduced non-insurance rates compared to surrounding areas
- There are areas where Medicaid has been implemented, but the non-insurance rate has rather increased, and vice versa.

▶ Medicaid has been implemented state by state, but its **effectiveness varies by county**.

Results

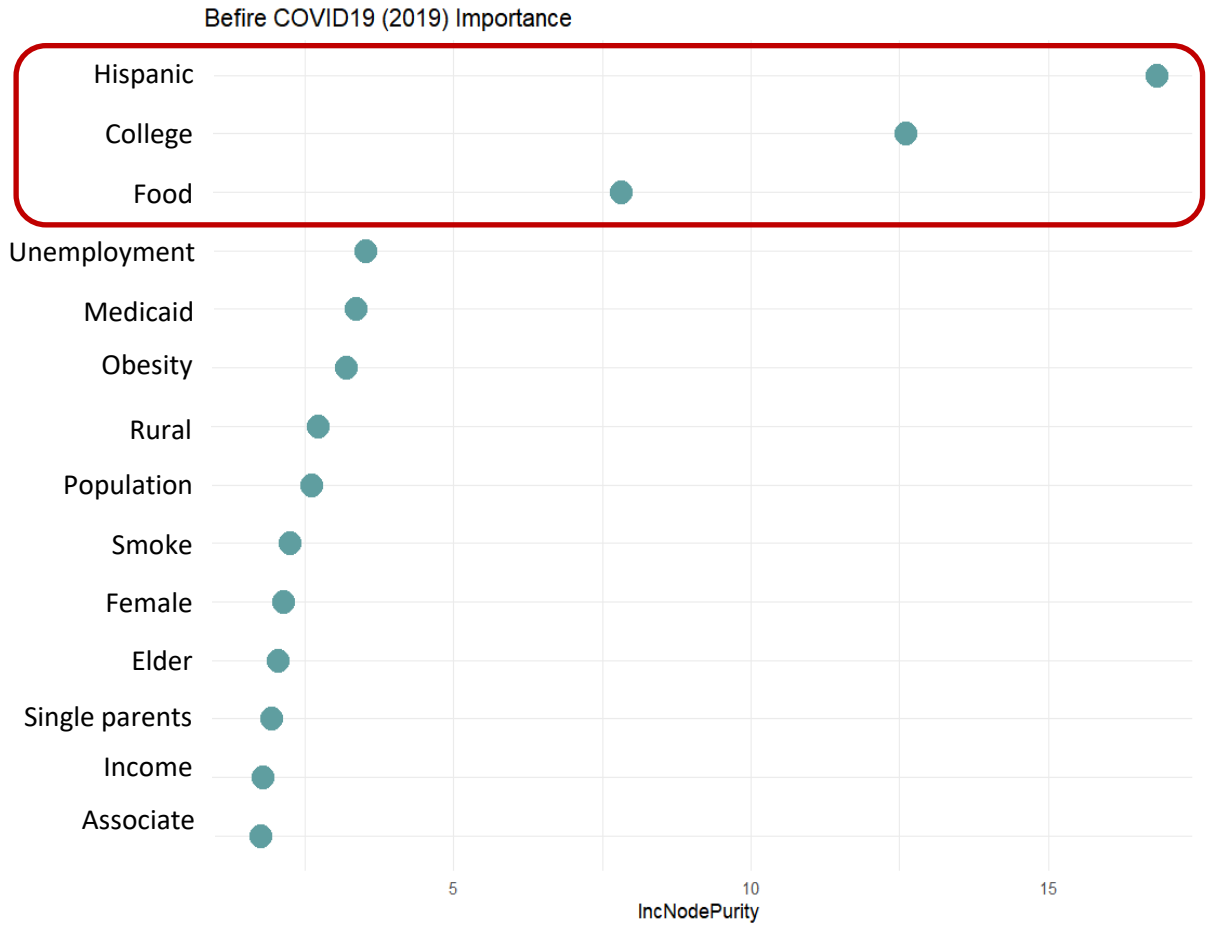
Spatial Machine Learning

Before COVID-19 (2019)



MSE: 0.0168 / RMSE: 0.1296

Spatial Random Forest

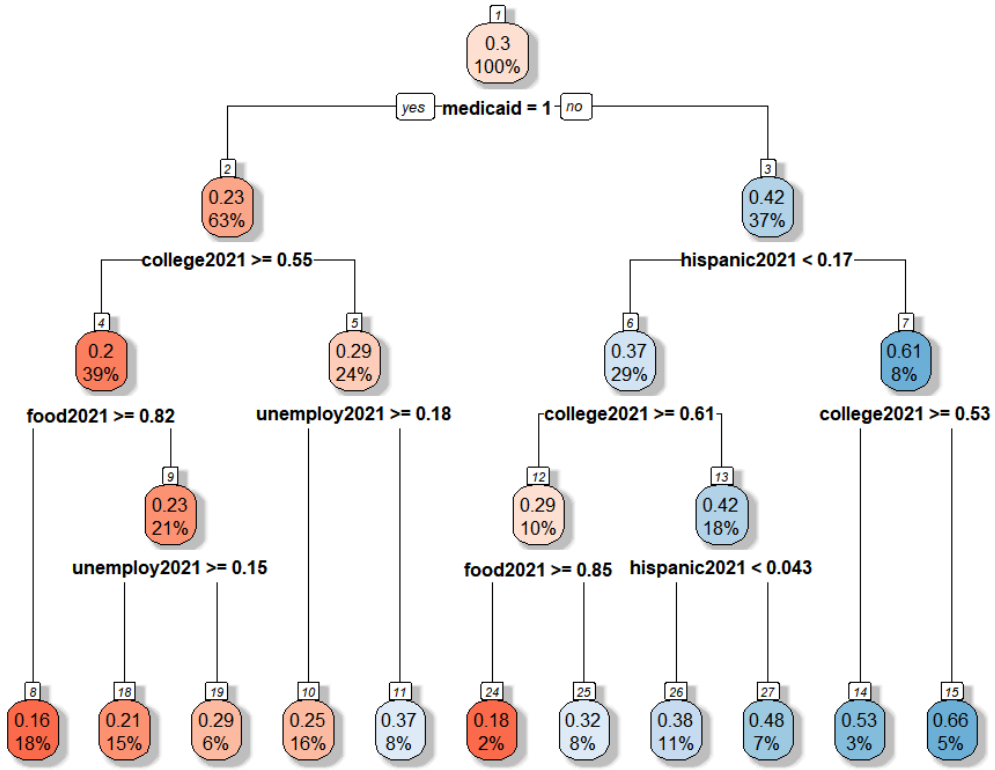


MSE: 0.0098 / RMSE: 0.0.0994

Results

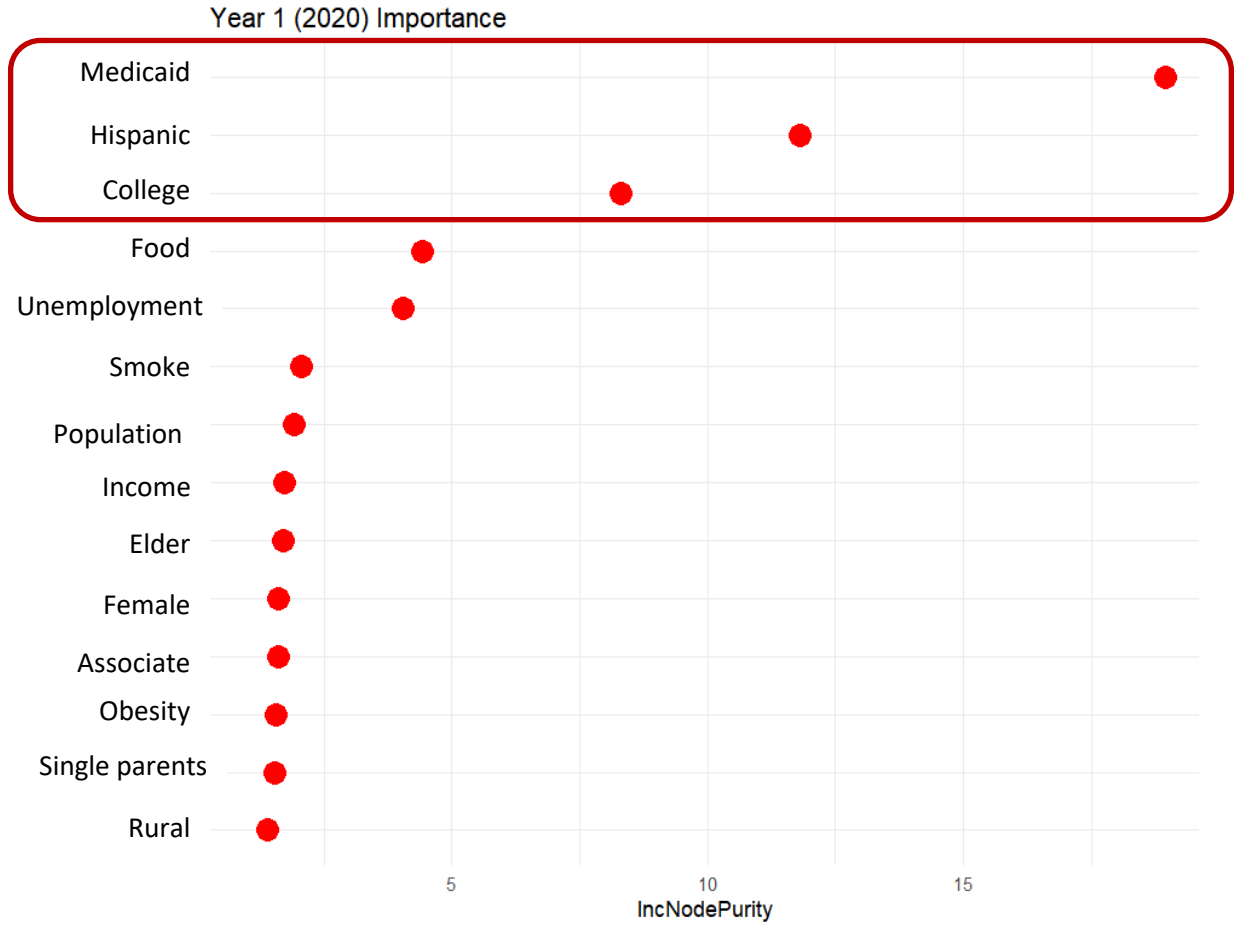
Spatial Machine Learning

Year 2 Effect (2021)



MSE: 0.0118 / RMSE: 0.1086

Spatial Random Forest

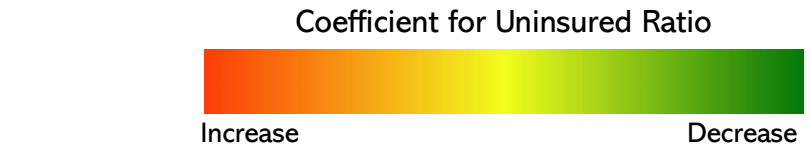


MSE: 0.0078 / RMSE: 0.0888

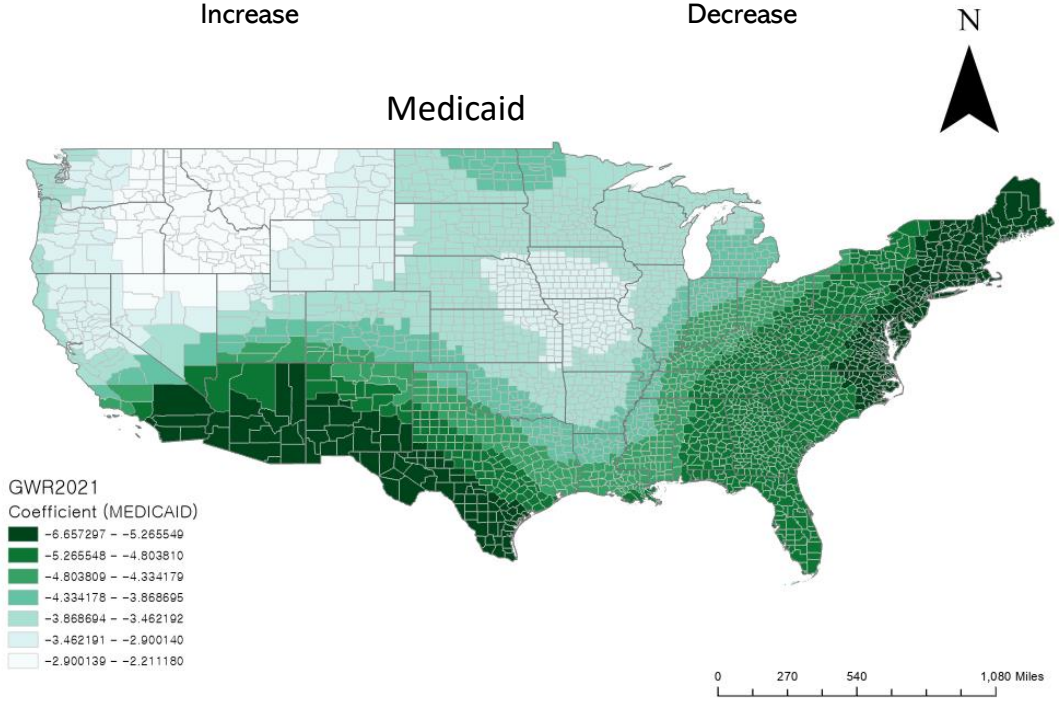
Results

Geographically Weighted Regression

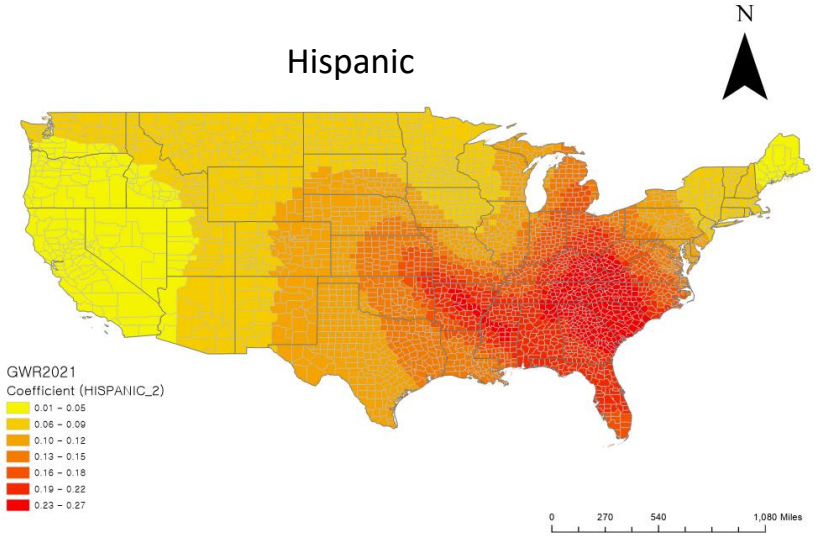
Year 2 Effect (2021)



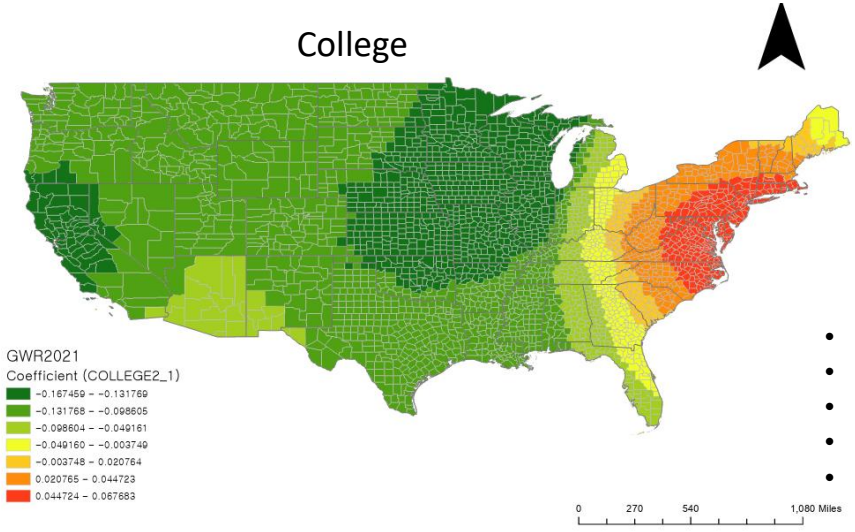
Medicaid



Hispanic



College



- Number of Features: 3108
- R2: 0.5844
- AdjR2: 0.5793
- AICc: 15893.1147
- Sigma-Squared MLE: 9.5382

Conclusion

Conclusion

▶ This study reflected the **spatial pattern of uninsured rates that occurred during COVID-19**.

- Using Gi* Hotspot analysis, patterns were found at the county level.
- Spatial ML was used to calculate the importance of each variable for predicting the non-insurance rate.
- Coefficient values of important variables were examined by county through GWR.

▶ **The results support** previous studies that **Medicaid affects the reduction of non-insured rates**.

- Through Spatial ML, we found that Medicaid, Hispanic ratio, and education level were important variables during the COVID-19 period.
- GWR showed that the influence of each variable had spatial characteristics.

▶ The influence of Medicaid expansion policy affects each other by county's spatial characteristics and neighboring counties and interacts with other social and economic factors.

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Regional disparity in the uninsurance rate impact of COVID-19

Q & A