Understanding Elevated Mortality Disparities in Virginia Coal Regions: Extract Coal-Mining Health Effect from Other Major Risk Factors

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UNDERSTANDING ELEVATED MORTALITY DISPARITIES IN VIRGINIA COAL REGIONS: EXTRACT COAL-MINING HEALTH EFFECT FROM OTHER MAJOR RISK FACTORS

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Overview

- Motivation
- Model Specification
- Data and Variables
- Results
- Conclusions and Implications

Motivation

- Longstanding health disparities in central Appalachia
  - Coal county effect—higher mortality rates of
    - Chronic obstructive pulmonary disease (COPD) (Hendryx and Ahern 2008)
    - Lung cancer (Hendryx, O'Donnell, and Horn 2008)
    - Chronic heart diseases (Esch and Hendryx 2011)
  - Many contributing factors
    - Poor local economy (Barker et al. 2010)
    - Lack of health access (Meacham et al. 2013, Denham, Wood, and Remsberg 2010)
    - Health risk factors: high smoking rates (Borak et al. 2012)

Is the coal county affect constant across coal mining counties? Or does it vary by these other factors?

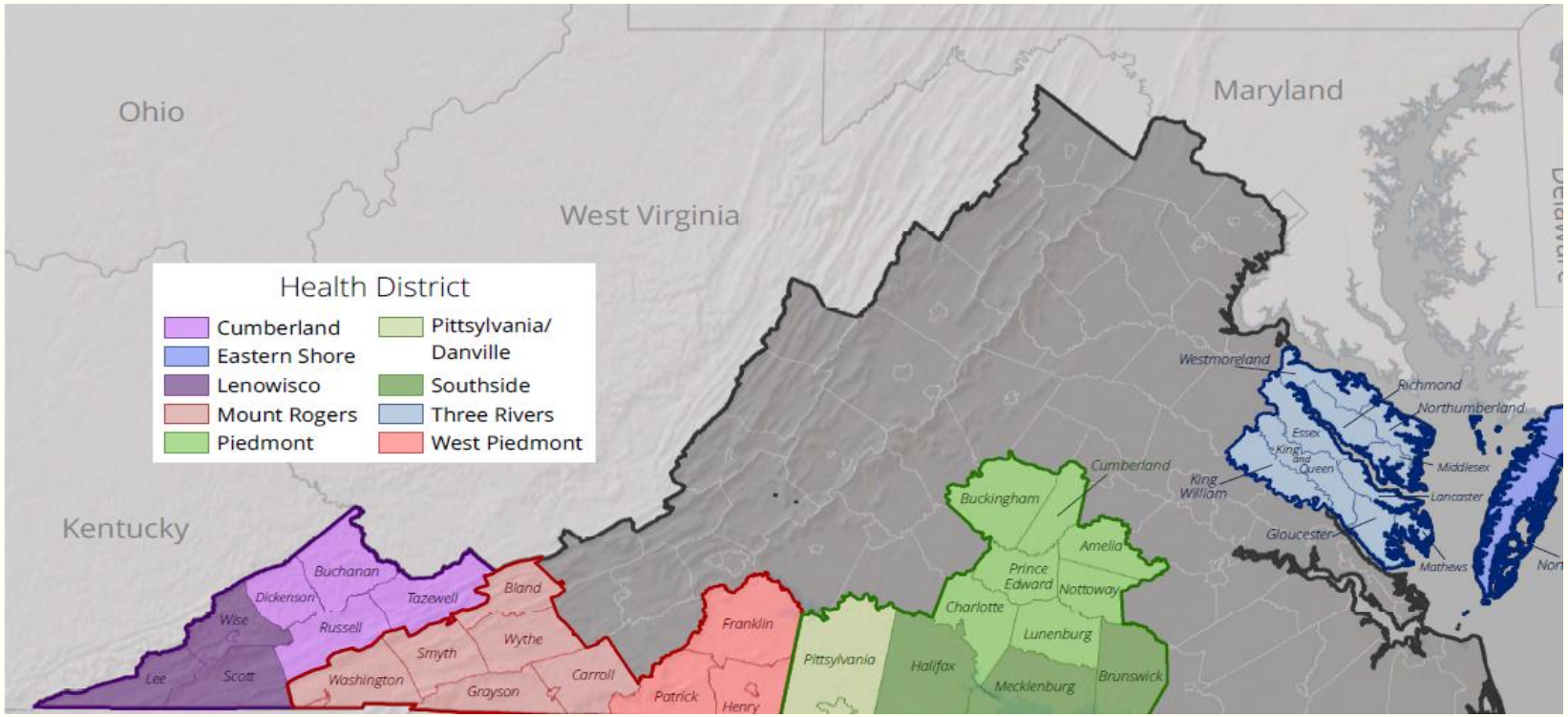
Research Questions

- **Q1:** Whether the coal-county health effects are similar across counties? Or does coal production affect some counties more than others?
- **Q2:** Whether living in a coal county or adjacent county contributes to higher likelihoods of dying from several chronic diseases, after adjusted by other contributing factors?

--- The objective of this study is to estimate the impact of living in a coal region, on the mortality rate from various diseases and to provide some insights into reducing health disparities in this region.

Study Area

As shown in the following figure, we limit the study area to coal-mining counties (purple area), adjacent coal counties (Washington, Smyth and Bland County) and tobacco counties (green area) as economic comparison counties (Hendryx and Ahern 2009).



Data Source: Appalachian Research Initiative for Environmental Science (2016)

Model Specification—level 1

y_{ij}^* is the latent index of the probability of individual *i* in county *j* dying from non-malignant respiratory disease (NMRD):

$$y_{ij} = \begin{cases} 1 & if\ y_{ij}^* > 0 \\ 0 & if\ y_{ij}^* \leq 0 \end{cases}, \qquad \text{where}$$

$$y_{ij}^* = \beta_{0j} + c_{1j} d_{incoal} + c_{2j} d_{adjcoal} + \boldsymbol{X_{ij}'\beta_1} + \boldsymbol{d_{year}'\sigma} + \varepsilon_{ij}$$

where d_{incoal} is an indicator that if the deceased lived in a coal-mining county, and $d_{adjcoal}$ indicates if the deceased lived in a county adjacent to coal-mining counties. The error term ε_{ij} is assumed to be correlated within counties

- y_{ij}: death indicator
- $\boldsymbol{X}$: a vector of individual demographic characteristics

Model Specification—level 2

Three varying parameters

- β_{0j} is the county mean value of y_{ij}^{*}, conditional on other variables
- c_{1j} is the coal-county effect
- c_{2j} is the adjacent-coal-county effect

For a county *j,* magnitudes of β_{0j}, c_{1j} and c_{2j} can be affected by vectors of county's socioeconomic status (**SES**), health access (**HA**), risk factors (**RF**) and county coal production (Prod)

Data and Variables

Here are the variables in the varying parameter equations.

- $\boldsymbol{SES}$: county unemployment rate, median household income and rural-urban category
- $\boldsymbol{HA}$: county number of doctors (active M.D.s and D.O.s), hospital beds and health centers per 1000 population, and health insurance rate
- $\boldsymbol{RF}$: county smoking rate, obesity rate and physical inactivity prevalence rate

Data Sources

- Individual death records from VDH.
- 2015-2016 AHRF access data from HRSA.
- Rural-Urban continuum code from USDA ERS
- Small Area Health Insurance Estimates
- Model-dependent estimates based on BRFSS data from CDC

Result

Q1: Whether these three parameters are varying? —Wald test

$H_1: \mathbf{R\eta \neq 0}$ $H_0: \mathbf{R\eta \neq 0}$

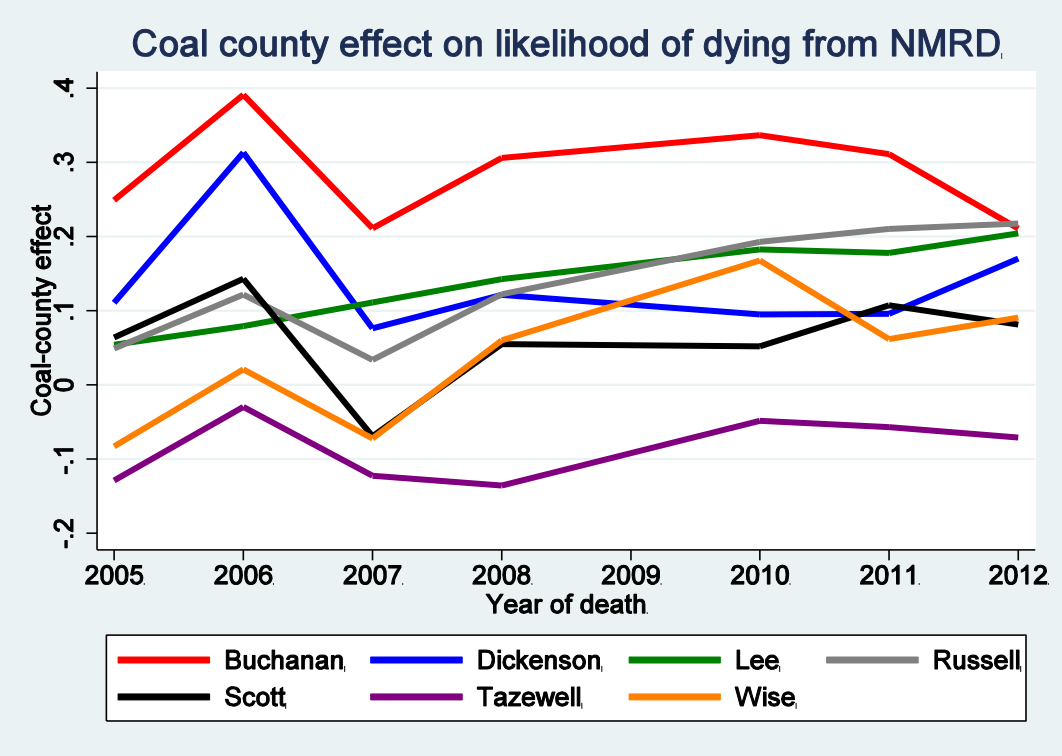
1. $\beta_{0j} \Longrightarrow \beta_0$
2. $c_{1j} \Longrightarrow c_1$
3. $c_{2j} \Longrightarrow c_2$

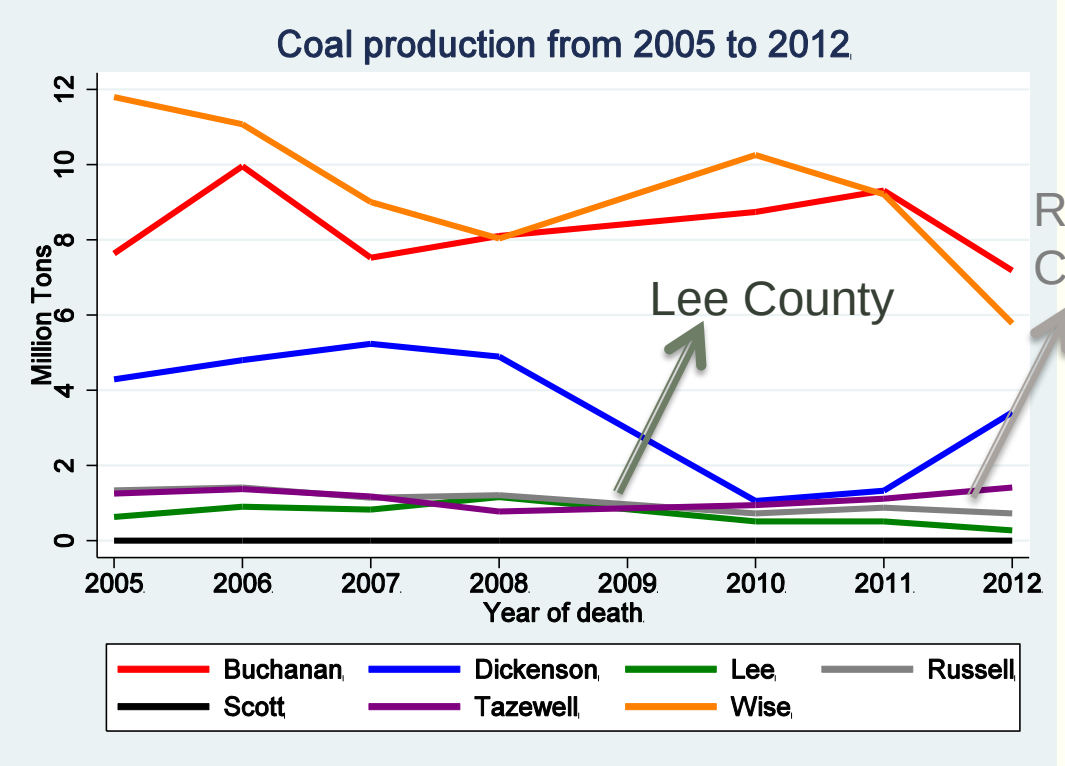
?

Wald tests suggest that county specific means and coal-county effects are varying and mainly depend on accessibility of healthcare rather than county SES or behavioral risk factors.

Q2: Whether living in a coal-mining county contributes to higher likelihood of dying from NMRD? –Recover the varying coal-county effect

The following figures show predicted c_{1j} (coal-county effect) and county coal production from 2005 to 2012.

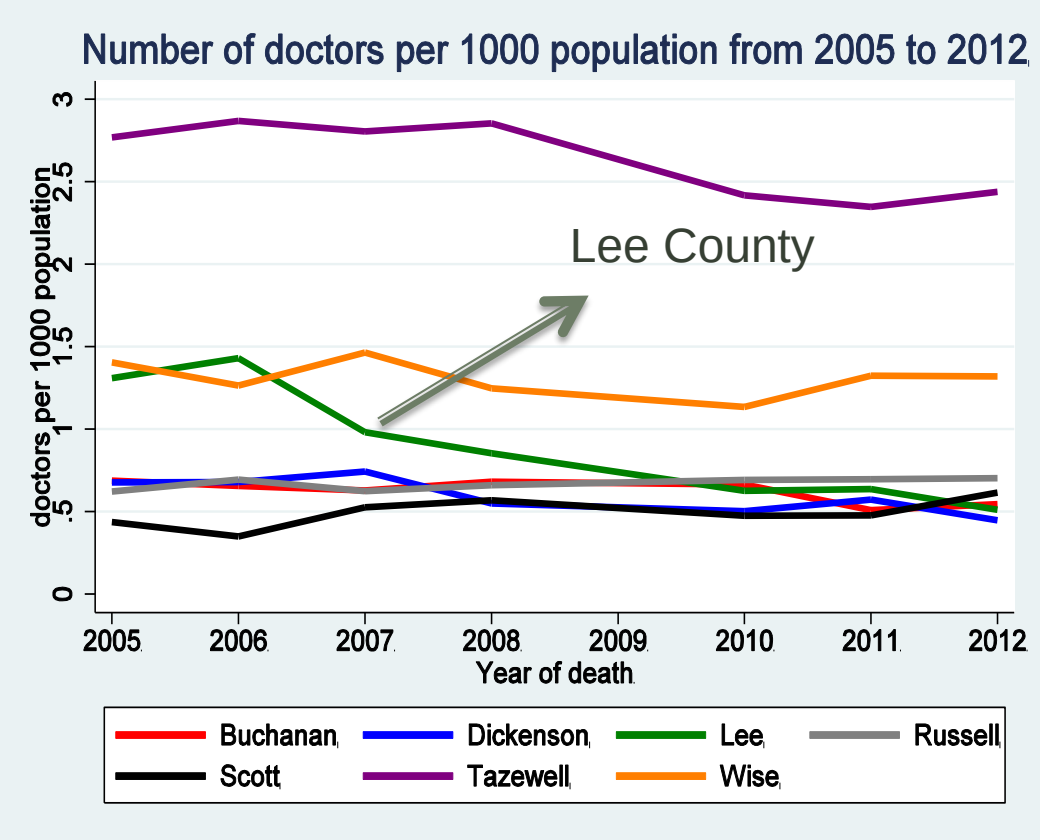


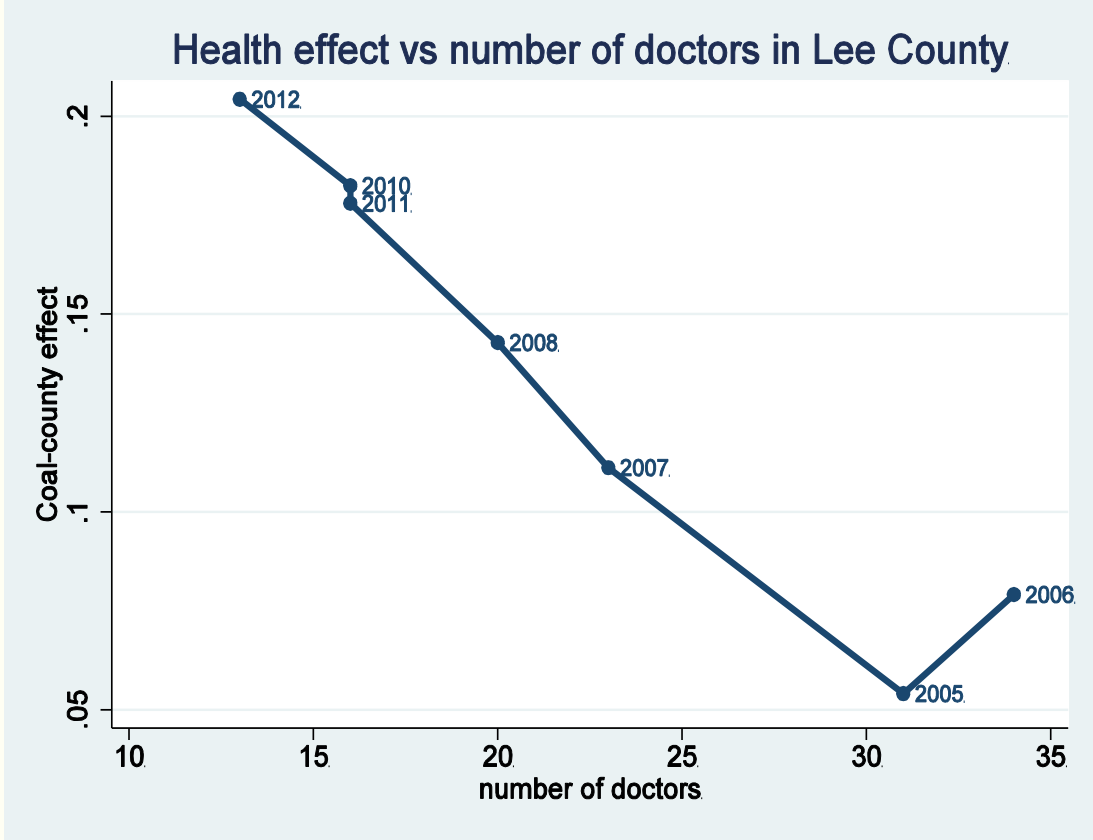


- Low coal production but relatively high health impact: Lee County and Russell County

Result

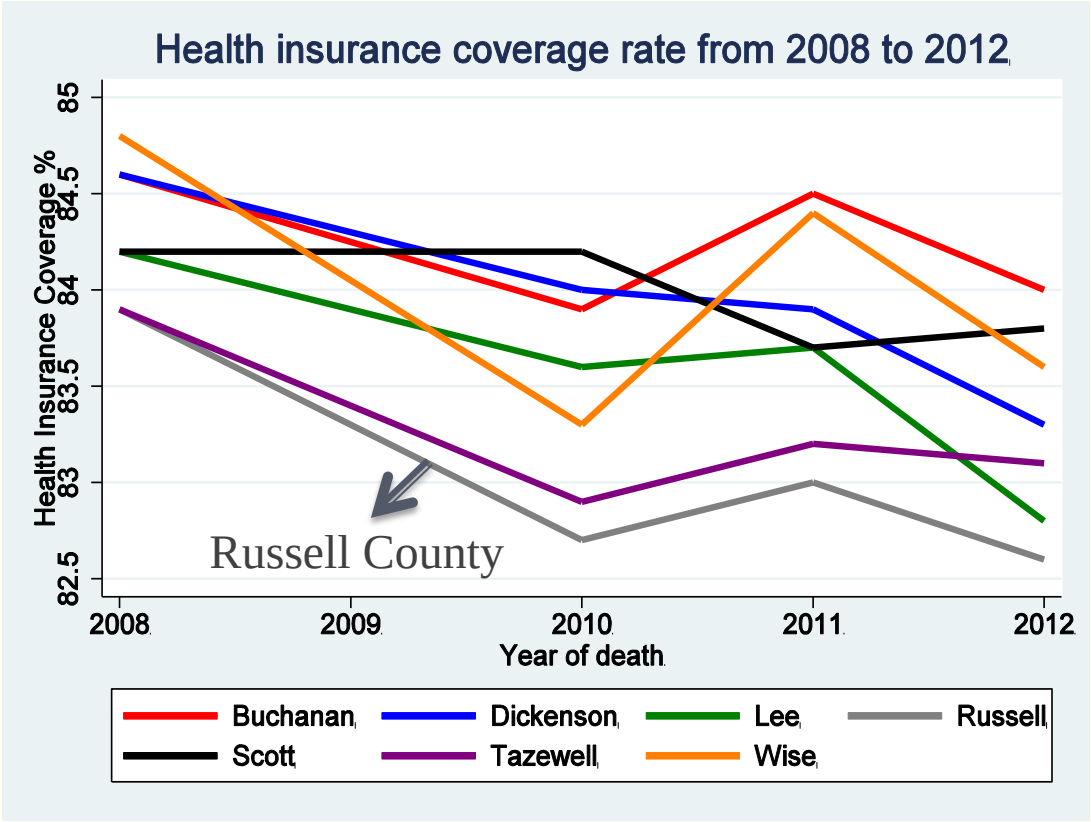
Case 1: The following figures show the impact of number of doctors on Lee County's coal-county effect

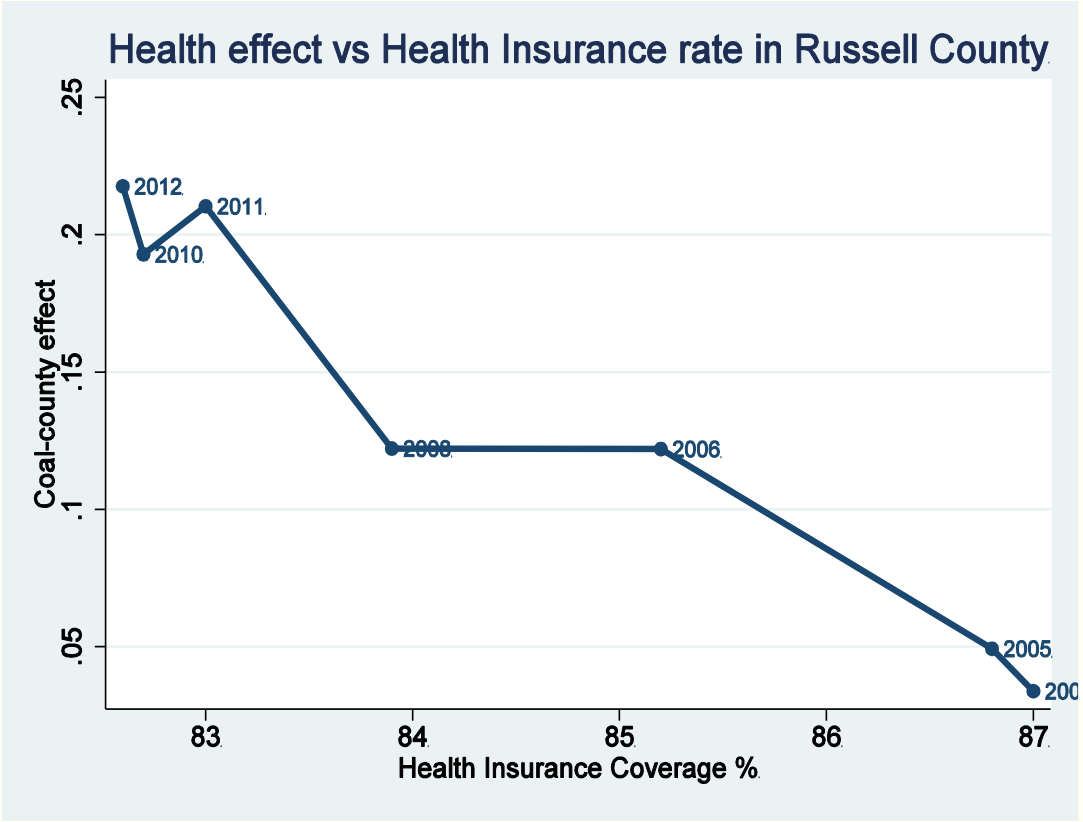




Result

Case 2: The following figures show the impact of low health insurance on Russell County's coal-county effect.





Conclusions

- Compared with SES or behavioral risk factors, accessibility of healthcare affect coal county health disparities the most.
- After adjusted by county characteristics, living in a coal county is associated with higher likelihoods of dying from kidney cancer, and non-malignant respiratory disease (NMRD) including chronic obstructive pulmonary (COPD).
- Health insurance coverage and more doctors significantly offset negative health impacts of living in a coal region.

Limitations and Implications

- **Limitations**
  - County of residence
  - Miner effect
  - Lack of individual-level information
- **Implications**

--improve health access could be a good strategy to reduce health disparities in Virginia coal region

  - Health insurance: *Coal Industry Retiree Health Benefit Act ("Coal Act")* in 1992
  - Doctors: undiagnosed or late diagnosed diseases

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Thank You !

Question and comment?