

NISKANEN C E N T E R

Carbon tax effects on air quality

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In addition to mitigating long-term climate impacts, policies that reduce greenhouse gasses can provide immediate health benefits. The project described in this paper models the air quality and health improvements that a carbon tax would bring about at the county level in the United States. Specifically, the research focuses on fine particulate matter (PM_{2.5}), which are particles that are 2.5 micrometers or less in diameter. Research¹ has shown this pollutant, primarily produced by fossil fuel combustion, is responsible for a range of negative health impacts, including heart disease, respiratory infections, chronic lung disease, and cancers.

The air quality analysis considered three different policy scenarios: a carbon tax that starts at \$35 per ton of CO₂ emitted and increases 3 percent annually; a carbon tax starting at \$35/ton increasing at 5 percent annually; and a tax that starts at \$15/ton and then rises to \$30/ton (See Table 1).

The annual monetary benefits from reduced premature mortality risk stemming from exposure to PM_{2.5} are summarized in Table 2. Over time, each of the policies yield increasing benefits from PM_{2.5} reductions. This occurs because as the carbon tax rates rise, less pollution is emitted. Benefits under the 3 percent and 5 percent policies in 2035 are estimated to be \$105 billion and \$106 billion annually. The \$15-30/ton policy is estimated to produce benefits of \$92 billion in 2035².

Figure 1 shows that the air quality improvements occur predominantly in the Eastern U.S. in 2030, and the results for both 2025 and 2035 align very closely (geographically) with those for 2030. This

1. Krewski, D. et al., Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality. Res. Rep. Health Eff. Inst., 5-114, discussion 115-136 (2009). Lepeule, J., F. Laden, D. Dockery, J. Schwartz. Chronic exposure to fine particles and mortality: An extended follow-up of the Harvard Six Cities study from 1974 to 2009. Environ. Health Perspect. 120, 965-970 (2012). Thangavel P, Park D, Lee YC. Recent Insights into Particulate Matter (PM_{2.5})-Mediated Toxicity in Humans: An Overview. Int J Environ Res Public Health. 2022 Jun 19;19(12):7511. doi: 10.3390/ijerph19127511. PMID: 35742761; PMCID: PMC9223652. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9223652/>

2. To provide some context for these results, recent estimates of total monetary damage from PM_{2.5} range between \$500 billion and \$1 trillion. (Tschofen, P, I. Azevedo, N.Z. Muller. 2019. "Fine Particulate Matter Damages and Value Added in The U.S. Economy". PNAS. www.pnas.org/cgi/doi/10.1073/pnas.1905030116.)

stems from the fact that coal-fired and, to a lesser extent, natural gas-fired power plants are the most responsive to the carbon tax policy. Since most coal and natural gas generation capacity is located east of the Rocky Mountains, PM_{2.5} falls appreciably in the eastern U.S. In the East, the largest air quality improvements occur in the Ohio River Valley and in isolated areas that are close to large power plants. The avoided human health impacts (Figure 2) and monetary benefits (Table 2) align closely with the mapped air quality changes. Thus, metropolitan areas in the Ohio River Valley — including Pittsburgh, Louisville, Ky., and Charleston, W.V. — are estimated to experience significant improvements in human health status due to the carbon tax policies examined in this study.

This research also illustrates that while a carbon tax will provide substantial health benefits through improved air quality, these benefits won't be shared equally across the country. As noted above, fossil fuel-fired power plants are the most responsive to the carbon tax policies analyzed. Since the largest of these facilities are located in rural and exurban places, communities situated nearby tend to incur the largest air quality improvements. Even though changes in PM_{2.5} are smaller in distant cities, total health impacts and benefits are larger because these places are more populous. Although not explored directly in this project, carbon pricing raises revenue which provides a means to fund public good provision, generally, such as mitigating climate change and pollution impacts on vulnerable communities.

Table 1: Tax scenarios, 2015 USD per ton CO₂

YEAR	START AT \$35/ TON, RISING 5% ANNUALLY	START AT \$35/ TON, RISING 3% ANNUALLY	\$15/TON RISING TO \$30/TON
2020	\$35.00	\$35.00	\$-
2025	\$44.67	\$40.57	\$15.00
2030	\$57.01	\$47.04	\$30.00
2035	\$72.76	\$54.53	\$30.00
2040	\$92.87	\$63.21	\$30.00
2045	\$118.52	\$73.28	\$30.00
2050	\$151.27	\$84.95	\$30.00

Table 2: Air quality benefits from carbon tax policies in select years

	START AT \$35/ TON, RISING 5% ANNUALLY	START AT \$35/ TON, RISING 3% ANNUALLY	\$15/TON RISING TO \$30/TON
Year	Benefits (\$ billion)	Benefits (\$ billion)	Benefits (\$ billion)
2025	56	77	0.75
2030	99	101	87
2035	105	106	92

Figure 1: This map depicts the predicted change in air quality in 2035 with a 5% annual increase scenario. The changes shown represent an improvement in air quality.

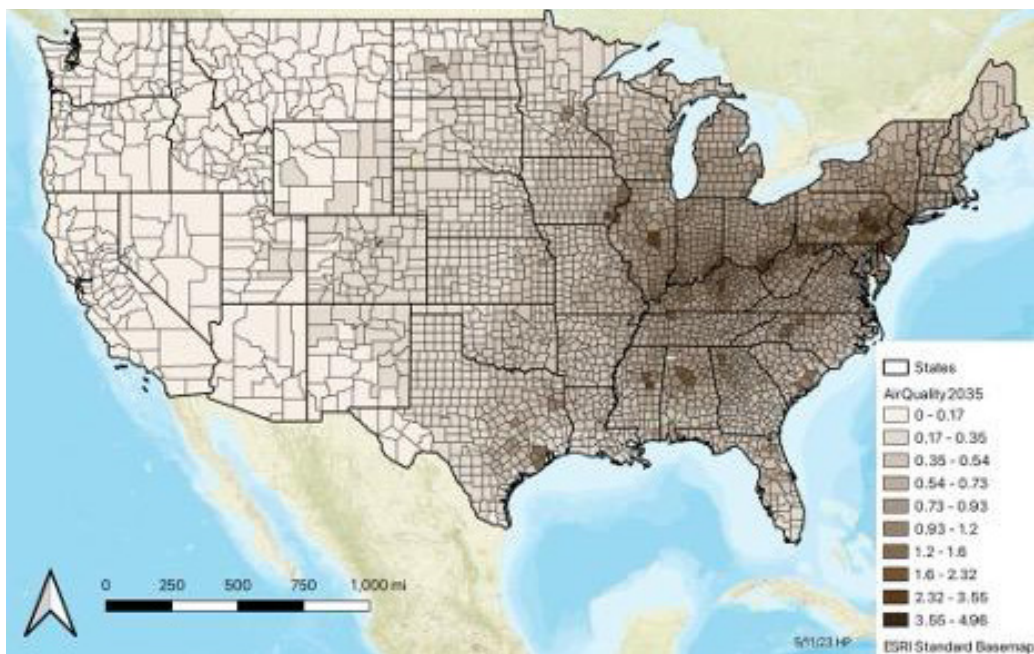
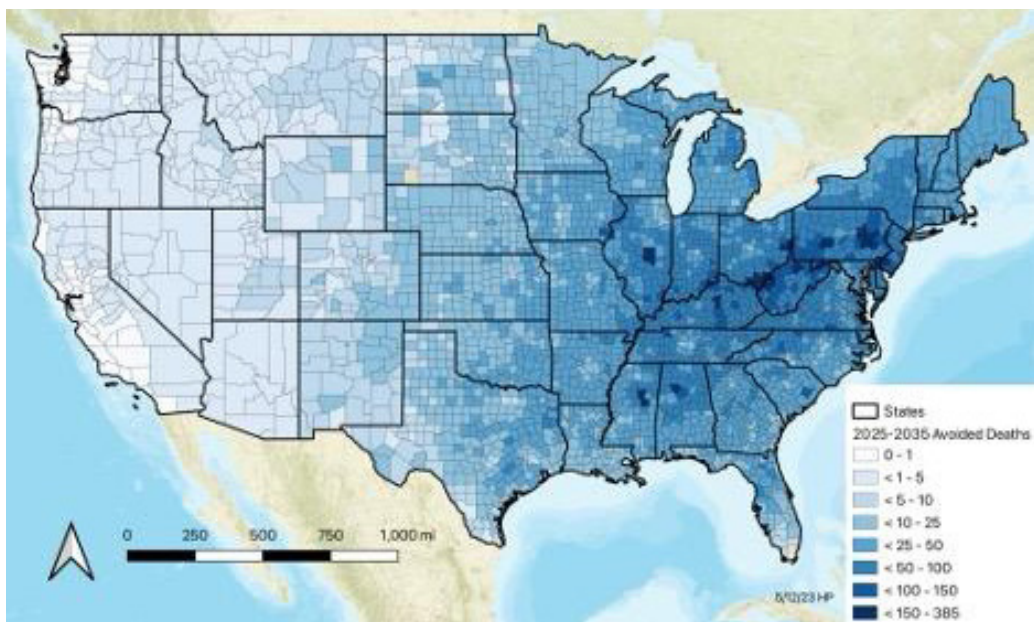


Figure 2: This map displays cumulative normalized predicted change in deaths from 2025 to 2035 from a 5% annual increase carbon tax scenario.



About the author

Nicholas Z. Muller is the Lester and Judith Lave Professor of Economics, Engineering, and Public Policy at Carnegie Mellon University. His interdisciplinary research focuses on air pollution and climate damages from economic activity in the United States and around the world. Recent work explores how environmental regulation impacts municipal finance systems and how disclosure laws influence firm behavior. Muller's research has appeared in top economics and general interest science journals.