The Impact of Banning ENDS Products on Combustible Cigarette Sales: Initial Evidence from U.S. State-Level Policies

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Research Objective

- Electronic Nicotine Delivery Systems (ENDS) are alternative products for adult smokers who seek to switch away from combustible cigarettes. A number of states and municipalities have proposed or recently enacted different types of bans on the sales of ENDS products.
- In late 2019, several states passed emergency short-term bans on the sales of ENDS, in response to an outbreak of vaping-related lung injuries (EVALI) tied to THC vaping products.
- An evaluation of the impact of these bans on cigarette sales would help policymakers understand the potential outcomes, as these types of policies may have unintended consequences.
- In this study, we utilized Generalized Synthetic Control (GSC, Xu 2017) methods to predict counterfactual cigarette sales for three US states (Massachusetts [MA], Rhode Island [RI] and Washington [WA]) that passed temporary bans on ENDS products in 2019. Comparing these counterfactual trends to actual sales in the ban time period allows us to assess the impact of these bans on cigarette sales with rigorous causal inference methods.

Study Design

State-level Policies Evaluated:

- Massachusetts [MA]: the temporary ban on all ENDS products was in place from Sept 24th, 2019 - Dec 11th, 2019.
- Washington [WA] and Rhode Island [RI]: four-month ban on flavored (non-tobacco) ENDS products on Oct 10th and Oct 4th 2019, respectively.
- Two placebo tests were conducted for robustness checks of policy impact: Michigan [MI] and Oregon [OR], both of which proposed bans on flavored ENDS products that were halted by courts in October 2019, a few days after their effective dates.

Data Sources:

- For the 3 states passing a temporary ENDS ban ("treatment"), 2 "placebo" states (passing an ENDS ban that was blocked from going into effect), and 28 control states (those without any ENDS bans or changes in ENDS taxes during the study period), the following data were captured at the state level over time:

- **Outcome**: weekly cigarette sales per capita, for both total cigarettes and for menthol cigarettes only, as measured by syndicated commercial data in tracked channels from January 2018 to December 2019, a total of 105 weeks.
- **Control variables (related to cigarette sales and demographics):** Smoking prevalence, percent of state-level tobacco control funding as compared to level recommended by CDC, cigarette tax levels, one-year lagged per capita ENDS sales, population size and age distribution, Consumer Price Index, unemployment rate, GDP, temperature and retail gasoline price.

Methods:

- We utilized a rigorous econometric method - Generalized Synthetic Control (GSC) - to create a robust model to predict what cigarette sales per capita would have looked like in each state with a ban ("treatment") if a temporary ban had not been enacted, for the ban period.
- GSC accounts for all control variables and weights the "control" states to compose meaningful counterfactuals for the states with bans ("treatment").
- The model accounts for historical trends, state-level variation in cigarette sales, and other factors that influence sales including seasonality, economic and demographic characteristics. This method also accounts for national trends such as population-level changes in smoking and ENDS prevalence, and the impact of EVALI across all states.
- Counterfactual sales were compared with actual weekly cigarette sales per capita in states with bans, to establish whether there was a statistically significant difference between observed v. expected weekly and cumulative cigarette sales per capita during the ban period.
- Numerous robustness checks were conducted to validate the results, including random permutation tests to reassign "treatment" to "control" states, cross-validation of our results with randomized subsets, and comparing the outcomes in "placebo" states to demonstrate that the observed impact was attributable to the ENDS ban policies.

Results

Key Findings:

- Our model finds that cigarette sales per capita were significantly higher than they would have been otherwise in states that banned ENDS products. As shown in **Figure 1**, the blue lines present the counterfactuals of weekly cigarette sales per capita predicted by GSC model in each state with a ban if there had not been a ban; the black lines show actual sales in the same time period.
- Alignment between the predicted and actual sales lines the pre-ban period (white) indicates that the counterfactuals predicted by the model matched actual sales closely. In the post-ban period (dark gray), the two lines diverged, as actual sales were significantly higher than predicted in states with bans.
- Overall (**Figure 1A**), our model suggests that the full ban of ENDS in MA led cigarette sales to be 8.3% (p<0.001) higher than they would have been otherwise. Similar results were seen in states with just flavor bans in Washington (4.6%, p<0.001) and Rhode Island (5.0%, p<0.001).
- Sales of menthol cigarettes (**Figure 1B**) specifically were also higher than expected: Actual sales of menthol cigarettes in MA, WA and RI were 12.3%, 6.5% and 7.1% (p<0.001) higher than predicted by their synthetic counterfactuals.
- There was no significant difference between the actual and synthetic cigarette sales in "placebo" states of MI (0.6%, p=0.63) and OR (-0.1%, p=0.91), where bans were passed but revoked by state courts (**Figure 1C**). This suggests that lack of ENDS availability, rather than smokers' risk perceptions, was the main factor related to the unexpected rise in cigarette sales.

Robustness Tests:

- Findings were robust to multiple specifications and robustness tests.
- The random permutation test found that there was no significant difference between predicted and actual cigarette sales when "control" states were assigned to the "treatment" group. This confirmed that our results were not spurious or due to random chance, but attributable to the passage of a ban.

Table 1. Summary of Differences between Observed and Predicted Cigarettes Sales During Temporary ENDS Ban Period Based on Generalized Synthetic Control Model Results

State	Cigarette Sales		Menthol Cigarettes Sales	
	Mean Difference in Weekly Cigarette Sales Per Capita (95% CI)	Cumulative Difference in Cigarette Sales (Packs)	Mean Difference in Weekly Cigarette Sales Per Capita (95% CI)	Cumulative Difference in Cigarette Sales (Packs)
Treatment States (Temporarily Enacted ENDS ban in Fall of 2019)				
Massachusetts (temporary ban on all ENDS products)	8.3%*** (6.4%, 10.3%)	1,854,775	12.3%*** (10.1%, 14.4%)	787,644
Washington (temporary ban on flavored ENDS products)	4.6%*** (3.6%, 5.6%)	877,200	6.5%*** (4.1%, 8.9%)	294,058
Rhode Island (temporary ban on flavored ENDS products)	5.0%*** (2.5%, 7.5%)	281,436	7.1%*** (3.9%, 10.3%)	156,649
Placebo States (Enacted ENDS ban in Fall of 2019 that was Revoked)				
Michigan (ban enacted and then revoked)	0.6% (-0.4%, 1.6%)	N.A.	1.3% (0.3%, 2.2%)	N.A.
Oregon (ban enacted and then revoked)	-0.1% (-1.1%, 1%)	N.A.	1.7% (-0.5%, 3.9%)	N.A.

Note: The cumulative increase in cigarette sales (packs) is based on the aggregated difference in cigarette sales between the predicted and actual weekly sales volume, from October to December 2019. *** p<0.001.

Figure 1. Observed and Predicted Weekly Per Capita Cigarette Sales in States During Temporary ENDS Ban Period Based on Generalized Synthetic Control Model Results

Figure A. Total Cigarette Sales in States with Bans

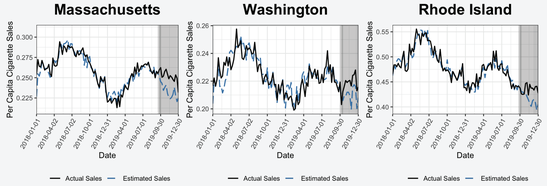


Figure B. Menthol Cigarette Sales in States with Bans

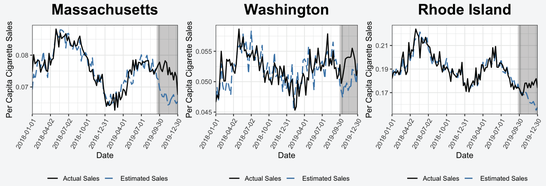
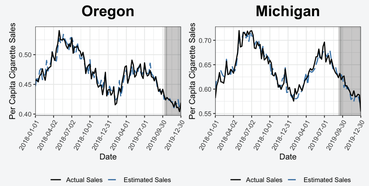


Figure C. Total Cigarette Sales in Placebo States (Enacted ENDS ban in Fall of 2019 that was Revoked)



Note: the black (solid) lines are the actual weekly per capita cigarette sales in the treatment states; the blue (dashed) lines are the counterfactual sales estimated by the generalized synthetic control methods based on weighted trends in the control states, and represent what sales would have been observed in the same time period if the states had not passed a ban.

Conclusions

- This study provides evidence that banning ENDS products can have unintended consequences, such as unexpected increases in cigarette sales.
- Overall, we estimated around 3 million additional cigarette packs have been sold during the period of the temporary bans that would not have been sold otherwise, including 1.85 million packs in Massachusetts, 877k packs in Washington and 281k packs in Rhode Island with flavor bans.
- Future research is needed to evaluate the potential spillover effects of these types of local bans, and to determine the long-term impact of these policies on use of tobacco products and net population health.

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References

Xu, Yiqing. "Generalized synthetic control method: Causal inference with interactive fixed effects models." Political Analysis 25.1 (2017): 57-76.