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ASSESSING THE IMPACT OF WINE SALE REFORM: A CASE STUDY OF TENNESSEE

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Executive Summary

Background

In the United States, alcohol-related policies vary significantly across states and are constantly evolving. A central ongoing policy debate is whether grocery stores should be permitted to sell wine and how such a change would affect the operational activities of liquor stores and overall alcohol consumption.

This study evaluates the effects of a 2016 Tennessee policy allowing wine sales in retail food stores, including grocery and convenience stores. This policy shift may have implications for consumer behavior and alcohol retail management. Opponents of these reforms claim that allowing wine sales in retail food stores could significantly reduce liquor store sales, potentially leading to staff reductions and store closures. Proponents of wine sale reform counter these claims, arguing that allowing wine sales in retail food stores could enhance consumer well-being[1] and intensify competition in the alcohol market[2]. Additionally, allowing wine sales could increase state and local sales tax collection and, ultimately, state revenue. In fact, past FMI research has found that the benefits of allowing wine sales in food stores include job creation, increased government revenues, and consumer choice.[3]

This research informs this debate by assessing the impact of allowing retail food stores to sell wine in two key areas: 1) the number of liquor stores in Tennessee and 2) changes in wine sales tax volume before and after the implementation of the reform.

Methods

We use synthetic control methods to achieve our two objectives. This approach constructs a synthetic version of Tennessee based on a weighted average of control states that did not undergo the policy change, thus allowing the estimation of the counterfactual outcome for Tennessee had the policy reform not taken place. To evaluate the impact of the Tennessee wine sale reform on the number of liquor stores (objective 1), we used annual state-level data from the 2004-2019 NIQ – TDLinx panel maintained by the Nielsen Company. To assess the effect of the policy reform on wine sales tax volume (objective 2), we collected monthly state tax receipts and tax collection report data from 2011 to 2019. This data was sourced from various publicly available sources, including state departments of revenue across different states. Various robustness tests and supplemental analyses were also done to check the sensitivity of our results.

[1] Aldrich, Anna Zarra. "UConn Research Informs Policy Debate over Wine Sales in Grocery Stores" UConn Today. February 21, 2023. https://today.uconn.edu/2023/02/uconn-research-informs-policy-debate-over-wine-sales-in-grocery-stores/#

[2] Illanes, G., & Moshary, S. (2020). Market structure and product assortment: Evidence from a natural experiment in liquor licensure (No. w27016). National Bureau of Economic Research.

[3] FMI. (2012). The Economics Impact of Allowing Shoppers to Purchase Wine in Food Stores. Available at *FMI* website: http://fmi.org/docs/state-affairs/fmi_wine_study.pdf?sfvrsn=0

Results

The data indicates that the number of liquor stores selling wine in Tennessee grew from 505 in 2004 to 728 in 2019, though most states also saw an increase over this time horizon. The data also suggests that Tennessee liquor stores held the largest number of licenses to sell wine in the state despite expanding sales to retail food stores. However, the alcohol industry underwent significant change during this time frame, indicating the need for a more in-depth analysis to evaluate the effects of this policy change.

The results from the synthetic control method indicate that Tennessee had 10.29 fewer liquor stores per capita (per million people) selling wine in the post-reform period from 2016 to 2019 than was predicted for the synthetic control/counterfactual (control states with no wine reform). However, this reduction is not found to be statistically significant compared to the control states, indicating that the wine sale reform did not significantly decrease the number of liquor stores selling wine in Tennessee. Rather, this indicates that the number of liquor stores stabilized following the reform. This finding is consistent across supplemental analyses ensuring the robustness of our results.

In assessing the change in wine sales tax volume, we show that the policy increased wine sales and sales tax revenue in Tennessee. Specifically, synthetic Tennessee would have exhibited a gradual growth trend in wine sales tax volume. After the wine sale reform in 2016, however, real-world Tennessee experienced a significant surge in wine sales. These new sales accounted for approximately 23% of the total wine sales tax volume. The research suggests that Tennessee's expansion of wine sales to retail food stores led to a statistically significant increase in state wine sales tax volume and, consequently, increased tax revenues overall.

Conclusion

This examination of Tennessee's wine sale reform provides a case study into some of the economic implications of allowing retail food stores to sell wine. The results suggest that the reform did not lead to a significant reduction in liquor stores. Meanwhile, the reform resulted in a noteworthy increase in wine sales tax revenue, contributing to increased state revenue. This increase in tax volume can be attributed to factors such as increased convenience and consumer demand, expanded consumer choices, and potentially improved market competition within the wine industry.

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[4]Mrs. Jiayu Sun and Dr. Aaron Staples were PhD students at the time of the research. Jiayu Sun assisted Dr. Caputo with the data analysis, while Aaron Staples assisted Dr. Caputo with collecting some descriptive statistics and reviewing the report. Dr. Achilleas Vassilopoulos provided comments on the data analysis.

Bio: Dr. Vincenzina Caputo is an agricultural and food economist. She serves as a Professor and the Homer Nowlin Chair in Consumer and Food Economics at Michigan State University. Her research program focuses on three key areas: 1) empirical analysis of consumer decision-making behavior to advance knowledge on how people make food choices, 2) methodological innovations to evaluate the effects of these choices on food systems, supply chains, and policies, and 3) outreach and extension activities to translate findings into practical recommendations for key stakeholders, including farmers, processors, retailers, food companies, consumers, and policymakers.

Dr. Caputo's empirical and outreach efforts guide food industry and policy decisions, while her methodological research contributes to the academic literature and debate. Her work is published in well-respected academic journals, including the *American Journal of Agricultural Economics*, *European Review of Agricultural Economics*, *Journal of Economic Behavior & Organization*, *Economic Inquiry, Journal of Agricultural Economics*, *Food Policy*, among others. Her research is supported by public entities such as National Science Foundation and the United States Department of Agriculture; national industry players like the FMI Food Industry Association and Farm Foundation; commodity groups such as United Egg Producers and United Soybean Board, and local institutions like M-AAA and Project GREEEN. She serves as one of the editors-in-chief of the *European Review of Agricultural Economics* and holds positions as an associate editor or advisory board member for *Food Policy*, *Agricultural Economics*, and the *American Journal of Agricultural Economics*. She also serves on the board of directors of the Agricultural & Applied Economics Association and is the co-founder and co-director of the *Survey Design and Experimental Methods in Applied and Agricultural Economics* international workshop. Beyond academia, Dr. Caputo's expertise is highly sought after by industry leaders in agriculture and food, where her evidence-based solutions influence decisions and address specific industry challenges.

The Market of Wine in the United States

The wine industry in the United States has experienced significant growth and evolution over the past two decades, becoming a major player in the global wine market. On the production side, the United States is one of the largest wine-producing countries worldwide, alongside countries like France, Italy, and Spain. California is the leading wine-producing state, responsible for most of the country's wine production, followed by Washington, Oregon, New York, and Texas[5]. Over time, there has been a notable increase in the total number of wine producers in the United States (see **Figure 1**). From 2010 to 2021, the number of wine producers has grown by 60%, from 6,941 to 11,053[6]. California alone accounts for approximately 50% of all wineries in the United States[7] and 84% of the country's domestic wine production[8].

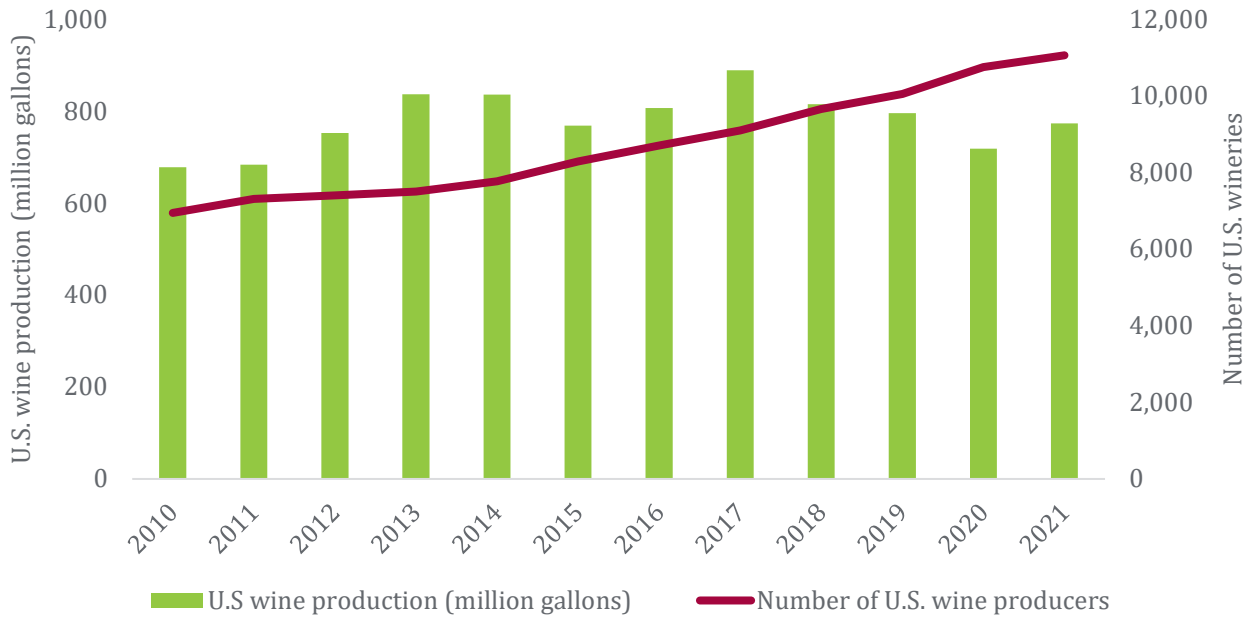

Figure 1. Domestic wine production and the number of producers over time, Sources: Wine Institute (2022a), and Wines Vines Analytics (2021, 2023)

However, despite the 60% increase in wine producers from 2010 – 2021, domestic wine production only grew by 14% during the same period (see **Figure 2**). This indicates a trend of smaller-sized wineries in the United States. Approximately 47% of wineries produce less than 1,000 cases of wine per year, while

[5] The National Association of American Wineries (2018). Top 10 Wine Producing States. Available at the National Association of American Wineries website: https://wineamerica.org/policy/by-the-numbers/

[6] Wines Vines Analytics (January 2021). Number of wineries in the United States in 2021, by production size. Available at Statista website: https://www.statista.com/statistics/259395/number-of-wineries-in-the-us-by-production-size/ [last accessed March 16, 2023]

[7] VinePair (November 24, 2021). The States with the most wineries in 2021. Available at VinePair website: https://vinepair.com/articles/map-states-wineries/ [last accessed March 16, 2023]

[8] Wine Institute (September 2022a). California & US wine sales. Available at Wine Institute website: https://wineinstitute.org/our-industry/statistics/california-us-wine-sales/ [last accessed March 17, 2023]

just 3% produce more than 50,000 cases per year[9]. In addition, the growth in the wineries has expanded to non-traditional grape-growing regions (see **Figure 2**). This trend is driven by the increasing consumer preference for locally manufactured craft beverages[10].

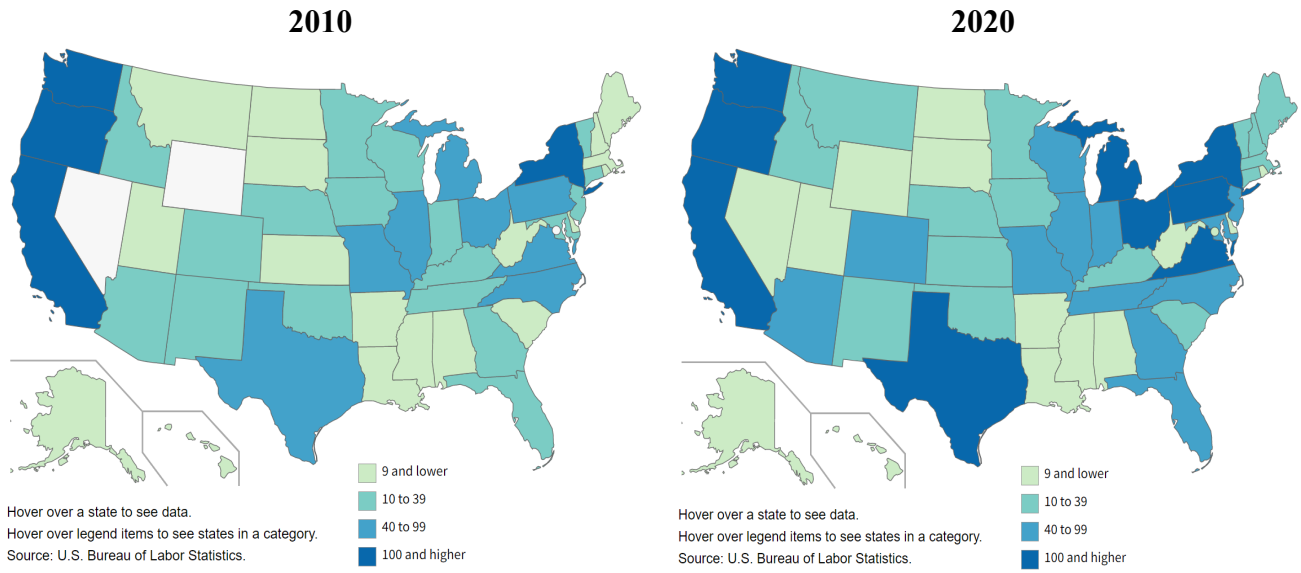

Figure 2. Geographical variation in wineries over time, Source: BLS (2021)

On the demand side, statistics indicate a steady increase in wine consumption over the years, both at home and away from home. From 2010 to 2021, U.S. wine consumption grew by 38%, reaching over 1 billion gallons in 2021[11]. A few factors contribute to the difference in growth rates between domestic wine production and consumption. First, there is a time lag between wine production and consumption due to aging. Second, domestic consumption relies heavily on imported wine, where the United States is the world's largest importer of wine[12]. **Figure 3**, sourced from the USDA Economic Research Service

[9] Wines Vines Analytics (January 2021). Number of wineries in the United States in 2021, by production size. Available at Statista website: https://www.statista.com/statistics/259395/number-of-wineries-in-the-us-by-production-size/ [last accessed March 16, 2023]

[10] Dobis, E. A., Reid, N., Schmidt, C., & Goetz, S. J. (2019). The role of craft breweries in expanding (local) hop production. Journal of Wine Economics, 14(4), 374-382. https://doi.org/10.1017/jwe.2019.17; Farris, J., Malone, T., Robison, L. J., & Rothwell, N. L. (2019). Is "localness" about distance or relationships? Evidence from hard cider. Journal of Wine Economics, 14(3), 252-273. https://doi.org/10.1017/jwe.2019.42; Hart, J. (2018). Drink beer for science: An experiment on consumer preferences for local craft beer. Journal of Wine Economics, 13(4), 429-441. https://doi.org/10.1017/jwe.2018.38

[11] Wine Institute (October 2022b). Total wine consumption of the United States from 2005 to 2021 (in million gallons) https://www.statista.com/statistics/233722/total-wine-consumption-of-the-us-by-wine-type/ [last accessed March 17, 2023]

[12] Observatory of Economic Complexity (n.d.). Wine in the United States. Available at OEC World website: https://oec.world/en/profile/bilateral-product/wine/reporter/usa [last accessed March 16, 2023].

(ERS), illustrates the value of wine imports from various countries. Italy and France are the top importers, and their imports have increased in recent years[13].

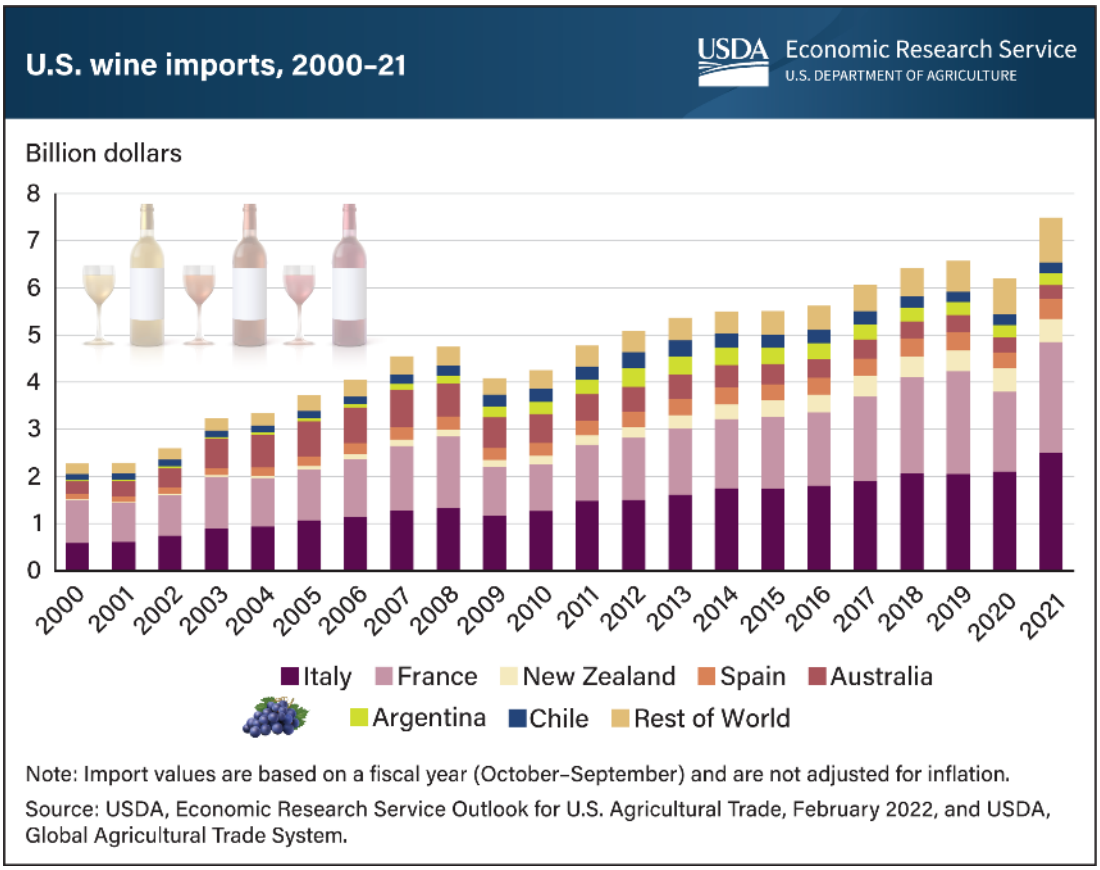

Figure 3. Value of U.S. wine imports over time, 2020-2021, Source: USDA ERS (2022)

Figure 4 presents the retail value of U.S. wine sales over time, including domestic and imported wines. The graph shows that, except for 2020, total retail wine sales have been increasing over time. As of 2021, total U.S. retail wine sales approached $80 billion in value[14]. During the first year of the pandemic, it is estimated that the retail value of wine sales fell by approximately 10%. However, the industry recovered in 2021, where wine sales were 5% higher relative to their pre-pandemic 2019 levels.

Despite the growth in retail sales, wine's market share has declined over the past five years. Since 2017, wine's market share has fallen 1.3 percentage points - from 17.3% to 16%[15]. The U.S. alcohol industry

[13] USDA ERS (May 24, 2022). U.S. wine imports reach nearly $7.5 billion in 2021. Available at USDA ERS website: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=103967 [last accessed March 17, 2023].
[14] Wine Institute (September 2022a). California & US wine sales. Available at Wine Institute website: https://wineinstitute.org/our-industry/statistics/california-us-wine-sales/ [last accessed March 17, 2023].
[15] Distilled Spirits Council (February 9, 2023). Annual economic briefing: Support tables – 2022. Available at Distilled Spirits Council of the United States website: https://www.distilledspirits.org/wp-content/uploads/2023/02/ECONOMIC-BRIEFING-SUPPORT-TABLES-2022.pdf [last accessed March 17, 2023].

was valued at $247 billion in sales in 2021[16]; 1.3% of $247 billion is more than $3 billion. This market share decline is primarily the result of an evolving alcohol landscape and variety-seeking consumers. Over the past few years, the market saw the emergence of new products, including hard seltzers[17] and ready-to-drink cocktails[18]. Market research has shown that these products could be economic substitutes for wine, particularly for younger consumers. This is critical as younger consumers transition to wine slower than other alcohol categories[19].

Figure 4. Total wine retail sales and wine market share over time, 2010 – 2021, Sources: Distilled Spirits Council (2022) and Wine Institute (2022a)

Regulatory Framework

The U.S. wine industry operates under various federal, state, and local alcohol regulations. On the federal front, the Alcohol and Tobacco Tax and Trade Bureau (TTB) enforces the Federal Alcohol Administration Act, which regulates, among other things, alcohol production, labeling, and advertising. However, state and local regulations were established following the end of Prohibition in 1932, leading to a significant variation in alcohol regulations across states[20].

[16] Beverage Information Group (September 2022a). Total alcoholic beverage sales in the United States from 2006 to 2021(in million U.S. dollars). Available at Statista website: https://www.statista.com/statistics/207936/us-total-alcoholic-beverages-sales-since-1990/ [last accessed March 17, 2023].

[17]Hard Seltzer (2023). Revenue-United States. Available at Statista website: https://www.statista.com/outlook/cmo/alcoholic-drinks/hard-seltzer/united-states#revenue [last accessed March 17, 2023].

[18]Distilled Spirits Council (September 14, 2022). Spirits-based ready-to-drink beverages experience tremendous market growth. Available at Distilled Spirits Council of the United States website: https://www.distilledspirits.org/wp-content/uploads/2022/09/Final-DISCUS-Handout-9.14.22-v2-1.pdf [last accessed March 17, 2023]

[19] McMillan, R. (2023). State of the U.S. wine industry. Available at Silicon Valley Bank Wine Division website: https://www.svb.com/globalassets/trendsandinsights/reports/wine/svb-state-of-the-wine-industry-report-2023.pdf [last accessed March 16, 2023]

[20]Staples, A. J., Chambers, D., & Malone, T. (2022). How many regulations does it take to get a beer? The geography of beer regulations. Regulation & Governance, 16(4), 1197-1210. https://doi.org/10.1111/rego.12403

One area of particular interest is the state-level variation in alcohol retail laws. Most notable is the variation in state policy surrounding whether grocery and other food retail stores can sell beer, wine, and distilled spirits. **Figure 5** depicts the legality of alcohol sales by category, including wine, by state as of March 2023. States can be categorized into four policy types regarding alcohol sales in retail food stores.

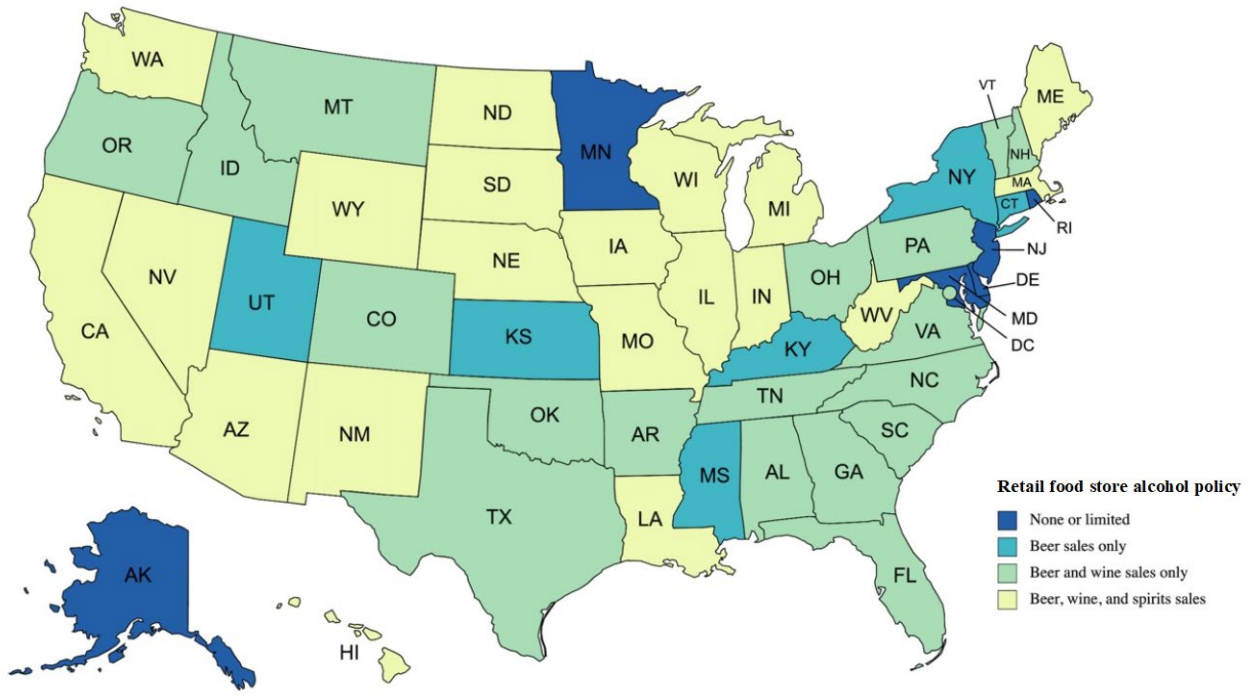

Figure 5. Retail food store alcohol policy across the United States[21]

The first policy category shown in Figure 5, "none or limited," prohibits alcohol sales in retail food stores. Under this regulatory regime, only liquor stores, specialized shops, or other licensed establishments can sell wine, beer, and spirits. This policy is becoming less common, with only six states currently implementing it: Alaska, Delaware, Maryland, Minnesota, New Jersey, and Rhode Island. The second policy limits alcohol sales in retail food stores to beer only and is currently in place in six states as of March 2023. These states are Connecticut, Kansas, Kentucky, Mississippi[22], New York[23], and Utah. The third policy permits beer and wine sales in retail food stores, with 19 states adhering to this policy: Alabama, Arkansas, Colorado, Florida, Georgia, Idaho, Montana, New Hampshire, North

[21]Please note that the specific states mentioned in the examples are subject to change since the time of research. Hence, it is advisable to consult the current laws and regulations of each state for accurate and up-to-date information on alcohol sales in grocery stores.

[22] Mississippi only allows grocery stores to sell wine with less than 5% ABV, but there is no standard wine below this threshold (Park Street, 2020).

[23] New York only allows grocery stores to sell wine coolers with less than 6% ABV (New York State Liquor Authority, July 31st, 2013).

Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Vermont, Virginia; and also, the District of Columbia. The fourth policy permits the sale of beer, wine, and distilled spirits in retail food stores. Twenty states follow this policy: Arizona, California, Hawaii, Illinois, Indiana, Iowa, Louisiana, Maine, Massachusetts, Michigan, Missouri, Nebraska, Nevada, New Mexico, North Dakota, South Dakota, Washington, West Virginia, Wisconsin, and Wyoming.

Therefore, at the time of this report, 39 states allow retail food stores to sell wine. However, even within these states, there are different regulations on selling hours, display requirements, etc. For instance, Arkansas prohibits the sale of wine on Sundays.[24] In addition, different states have different limits on the alcoholic content of wine sold in retail food stores. Oklahoma, Tennessee, and Arkansas have set limits of 15%, 18%, and 20% volume, respectively, for wine sold in retail food stores.[25]

Figure 6 provides an overview of wine sales in the country from 2018 to 2022, categorizing them into three channels: grocery stores, liquor stores, and convenience stores. The data shows that grocery stores have the highest wine sales, ranging from $8.9 to $10.9 billion. This is followed by liquor stores with sales between $5.6 and $5.9 billion, and convenience stores at $1.1 to $1.5 billion. Importantly, it should be noted that the popular wine products differ across these channels. Red still wine[26] dominates grocery and liquor store sales, accounting for 45% and 47% of wine sales, respectively. On the other hand, white still wine holds the largest share of wine sales (44%) in convenience stores (NIQ – RMS Bev Al Data – for FMI, calculated by own).

[24] AR Code § 3-3-210, 2017.
[25] Oklahoma Senate Bill 383 (2016), Section 21, Part B, Page 47; Tennessee Code § 57-3-803; AR Code § 3-5-1802 (2017).
[26] According to 27 CFR § 24.10, still wine is defined as wine containing less than 0.392 grams of carbon dioxide per 100 milliliters of wine. The NIQ – RMS dataset classifies wine into still wine and sparkling wine (e.g., champagne). Still wine is further classified into red still wine, white still wine, and others.

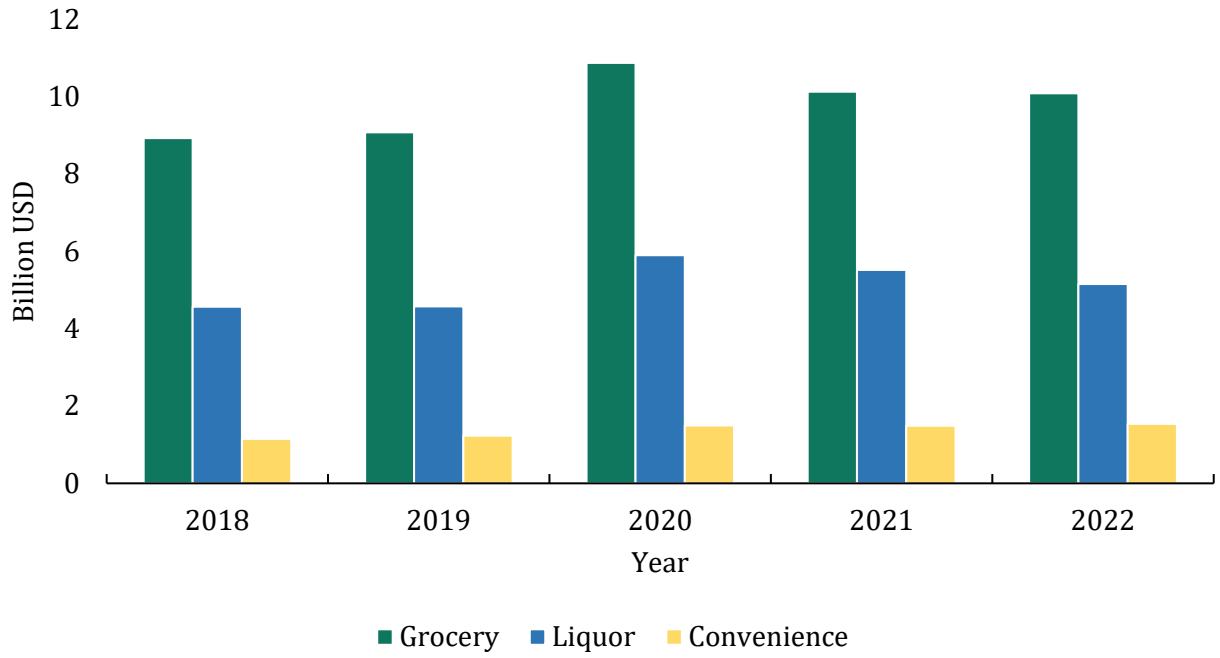

Figure 6. Wine sales in the United States, by different channels, 2018-2022, Source: NIQ – RMS Bev Al Data – for FMI, created by own.

The Case of Tennessee

Background

The Tennessee wine industry has experienced significant growth over the past two decades. On the production side, the number of wineries in Tennessee has more than tripled, increasing from 11 in 2001 to 47 wineries in 2020 (see **Figure 7**). As a result, the employment opportunities within Tennessee wineries have grown by over 500%, with the number of workers increasing from 78 in 2001 to 476 in 2020. As of 2022, the production volume of bottled wine in Tennessee has reached 537,740 gallons [27].

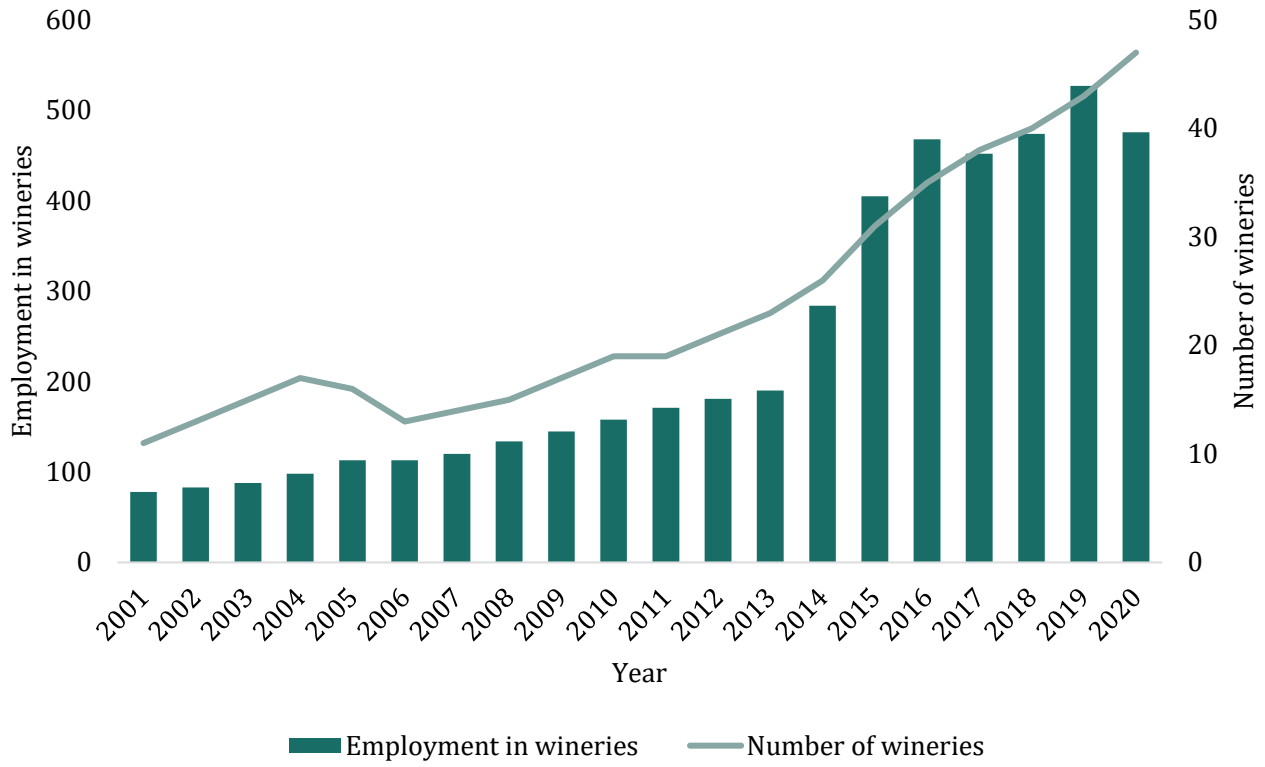

Figure 7. Number of wineries and winery employment in Tennessee, 2001-2020, Source: U.S. Bureau of Labor Statistics

On the demand side, Tennessee has also experienced significant growth in wine consumption over the past two decades. From 2001 to 2021, there has been a noteworthy 119% increase in annual per capita wine consumption, rising from 0.16 to 0.35 per capita (see **Figure 8**). In 2021 alone, Tennessee consumed 15.72 million gallons of wine, which ranks it 19th among all the U.S. states.[28]

[27] TTB. (March 10, 2023). Production volume of bottled wine in the United States in 2022, by state (in thousand gallons). Available at Statista website: https://www.statista.com/statistics/737529/leading-bottled-wine-producing-states-us /
[28] Vinepari (2023). The States that drink the most wine in America. https://vinepair.com/articles/map-states-drink-wine-america-2023/

Figure 8. Per capita annual wine consumption in Tennessee, 2001-2021, Source: Slater and Alpert (2023)

Before July 1, 2016, only liquor stores, also known in Tennessee as "package stores," could sell wine. However, the signing of the "Sale of Wine in Retail Food Stores Act"[29] on March 26, 2014, set the stage for wine sales in food retail stores. Upon enactment, the law immediately allowed liquor stores to sell beer, snacks, ice, mixers, cigars, cigarettes, and party supplies. To allow the sale of wine in food retail stores, the law required voters to decide, so each municipality in Tennessee was authorized to collect a certain number of signatures to place the issue on their local ballot. Beginning July 1, 2016, food retail stores[30] in municipalities that approved the initiative began selling wine six days a week (Monday – Saturday), mirroring liquor store days and hours.

On April 20, 2018, legislation allowing Sunday wine sales was enacted.[31] Liquor stores could immediately start selling wine seven days a week, whereas retail food stores could begin selling wine on Sundays on January 1, 2019. In addition to Sundays, wine may now be purchased on Labor Day, the

[29] Tennessee SB 837, Public Chapter C554.
[30] According to Tennessee Code § 57-3-802, "*retail food store' means an establishment that is open to the public that derives at least twenty percent (20%) of its sales taxable sales from the retail sale of food and food ingredients for human consumption taxed at the rate provided in § 67-6-228(a) and has retail floor space of at least one thousand two hundred square feet (1,200 sq. ft.)*".
[31] Tennessee HB 1540, Public Chapter 783

Fourth of July, and New Year's Day in liquor stores and retail food stores. However, these sales remain prohibited on Thanksgiving, Christmas, and Easter.

The expansion of wine accessibility through these policy changes has the potential to influence consumer shopping behavior and impact alcohol retail management.[32] Allowing retail food stores to sell wine offers convenience to consumers, purchasing groceries and wine in one trip, saving travel time and costs[33]. Research indicates that consumers who prioritize convenience and price tend to buy wine in grocery stores, while those seeking a more specialized experience, such as better service or tasting options, opt for other outlets like liquor stores.[34]

There is a long history of studies examining the effects of alcohol policy on societal outcomes. Many studies have focused on the liberalization of beer regulations on the number of producers[35], consumption[36], economic growth[37], and pricing[38]. Only a few studies have examined the effect of retail wine sale regulations on wine consumption and sales across retail channels. Among the first was Rickard (2012), who simulated the potential effects of wine grocery stores in New York. Rickard's results suggest that the state's tax revenue would increase by $22 million due to increased sales. This would also benefit in-state wineries, whose revenues were expected to increase by 13%. However, liquor store owners would experience a 28% decline in expected revenue as the grocery stores give consumers an alternative place of purchase. Thus, much of the pushback for legalizing grocery sales of different alcohols comes from liquor store owners and their affiliated lobbying groups[39]. Further research analyzing grocery store

[32] FMI. (2012). The Economics Impact of Allowing Shoppers to Purchase Wine in Food Stores. Available at FMI website: http://fmi.org/docs/state-affairs/fmi_wine_study.pdf?sfvrsn=0; Ho, S. T., & Rickard, B. J. (2021). Regulation and purchase diversity: Empirical evidence from the US alcohol market. International Review of Law and Economics, 68, 106008. https://doi.org/10.1016/j.irle.2021.106008

[33] Ritchie, C., Elliott, G., & Flynn, M. (2010). Buying wine on promotion is trading-up in UK supermarkets: A case study in Wales and Northern Ireland. International Journal of Wine Business Research. https://doi.org/10.1108/17511061011061685; Seo, B. (2019). Firm scope and the value of one-stop shopping in washington state's deregulated liquor market. Kelley school of business research paper, (16-70). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2863094

[34] Ritchie, C., Elliott, G., & Flynn, M. (2010). Buying wine on promotion is trading-up in UK supermarkets: A case study in Wales and Northern Ireland. *International Journal of Wine Business Research*. https://doi.org/10.1108/17511061011061685

[35] Malone, T., & Lusk, J. L. (2016). Brewing up entrepreneurship: Government intervention in beer. Journal of Entrepreneurship and Public Policy, 5(3), 325-342. https://doi.org/10.1108/JEPP-02-2016-0004; McCullough, M., Berning, J., & Hanson, J. L. (2019). Learning by brewing: Homebrewing legalization and the brewing industry. Contemporary Economic Policy, 37(1), 25-39. https://doi.org/10.1111/coep.12394

[36] Meany, B., Berning, J., Smith, T., & Rejesus, R. M. (2017). The Effect of Sunday Alcohol Sales Bans on Teen Drinking in Georgia. Applied Economic Perspectives and Policy, 40(3), 461-481. https://doi.org/10.1093/aepp/ppx046; Palardy, N., Costanigro, M., Cannon, J., Thilmany, D., Berning, J., Bayham, J., & Callaway, J. (2023). Beer sales in grocery and convenience stores: a glass half-full for craft brewers? Regional Studies, 1-14. https://doi.org/10.1080/00343404.2023.2166914

[37] Malone, T. & Hall, J. (2017). Can liberalization of local food marketing channels influence local economies? A case study of West Virginia's craft beer distribution laws. Economics and Business Letters 6(2), 54-58. http://zbw.eu/econis-archiv/bitstream/11159/849/1/2017%202%205.pdf

[38] Burgdorf, J. (2019). Impact of mandated exclusive territories in the US brewing industry: Evidence from scanner level data. International Journal of Industrial Organization, 63, 376-416. https://doi.org/10.1016/j.ijindorg.2018.12.001

[39] Rickard, B. J. (2012). The economics of introducing wine into grocery stores. Contemporary Economic Policy, 30(3), 382-398. https://doi.org/10.1111/j.1465-7287.2011.00272.x

alcohol policy suggests that states that allow wine sales have lower wine prices and higher wine consumption rates.[40]

This study adds to the existing literature by evaluating two key aspects: 1) the effect of the Tennessee wine sale reform on the number of liquor stores in the state, and 2) the changes in wine sales tax volume before and after implementing the reform. In the following section, we describe the data used, outline the methodologies employed, and present the findings for each research area.

The Impact of Tennessee Wine Sale Reform on the Number of Liquor Stores

Methodology

We employed the Synthetic Control Method (SCM)[41]. This approach offers distinct advantages over difference-in-difference and other methods commonly used in policy evaluations.[42] For instance, unlike difference-in-difference, the SCM is robust to non-parallel trends and suitable for situations with limited sample sizes and few observed interventions. [43] In our application, for example, the SCM allows us to 1) estimate the effects of infrequent events that exclusively affect a single unit (Tennessee) and) 2) evaluate the impact of a policy intervention by leveraging a restricted set of control units (other states with similar pre-intervention characteristics) within a panel data framework,.

The SCM also differs from traditional comparative case studies that select a single control unit. Instead, the SCM selects a group of control units with similar pre-intervention characteristics to the treated unit[44]. The idea behind the SCM is to construct a synthetic counterfactual outcome that takes a weighted average of these control units, thereby creating a synthetic counterpart that closely aligns with the characteristics of the treated unit (in our case, Tennessee)[45]. This methodological approach ensures a more robust evaluation of policy interventions with limited samples. For this reason, the SCM method has been widely used in various sub-fields of applied economics to estimate the effects of various policies, including immigration policies[46], taxation[47], and healthcare programs[48]. Within agricultural and food

[40] Rickard, B. J., Costanigro, M., & Garg, T. (2013). Economic and social implications of regulating alcohol availability in grocery stores. *Applied Economic Perspectives and Policy*, 35(4), 613-633.
[41] Abadie, A., & Gardeazabal, J. (2003). The economic costs of conflict: A case study of the Basque Country. *American economic review*, *93*(1), 113-132.
[42] Athey, S., & Imbens, G. W. (2017). The state of applied econometrics: Causality and policy evaluation. *Journal of Economic perspectives*, *31*(2), 3-32.
[43] Abadie, A. (2021). Using synthetic controls: Feasibility, data requirements, and methodological aspects. *Journal of Economic Literature*, 59(2), 391-425. https://pubs.aeaweb.org/doi/pdfplus/10.1257/jel.20191450
[44] Abadie, A. (2021).
[45] Abadie, A. (2021).
[46] Bohn, S., Lofstrom, M., & Raphael, S. (2014). Did the 2007 Legal Arizona Workers Act reduce the state's unauthorized immigrant population?.*Review of Economics and Statistics*, 96(2), 258-269. https://doi.org/10.1162/REST_a_00429.
[47] Kleven, H. J., Landais, C., & Saez, E. (2013). Taxation and international migration of superstars: Evidence from the European football market. American economic review, 103(5), 1892-1924. https://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.103.5.1892
[48] Kreif, N., Grieve, R., Hangartner, D., Turner, A. J., Nikolova, S., & Sutton, M. (2016). Examination of the synthetic control method for evaluating health policies with multiple treated units. Health economics, 25(12), 1514-1528. https://doi.org/10.1002/hec.3258

economics, SCM has been used to evaluate the effect of a soda tax[49], alcohol tax[50], and tobacco control programs[51].

Data and Sampling Strategy

We used annual state-level NIQ – TDLinx panel data maintained by Nielsen to conduct the analysis. The data includes the number of stores selling alcohol in different channels - liquor stores, grocery stores, convenience stores, mass merchandisers, wholesale clubs, and cigarette outlets, from 2004 to 2022. The number of stores selling wine were counted in December of each year. **Figure 9** depicts the trend in the number of stores selling wine across these channels in Tennessee, where the wine sales reform was launched, from 2004 to 2022. Throughout this period, liquor stores consistently held the highest number of licenses, starting at 505 in 2004 and increasing to 733 in 2022. As expected, following the wine sale reform in 2016, there was a significant growth in the number of grocery and convenience stores selling wine. In 2016, 408 grocery stores started selling wine, peaking at 647 in 2018. Although convenience stores have been allowed to sell wine since 2016 as well, the data show that convenience stores primarily entered the market in 2018, and there were 452 convenience stores selling wine in 2018. In addition, we observe a decrease in the number of stores selling wine in all channels from 2020 to 2021, likely driven by COVID-19.

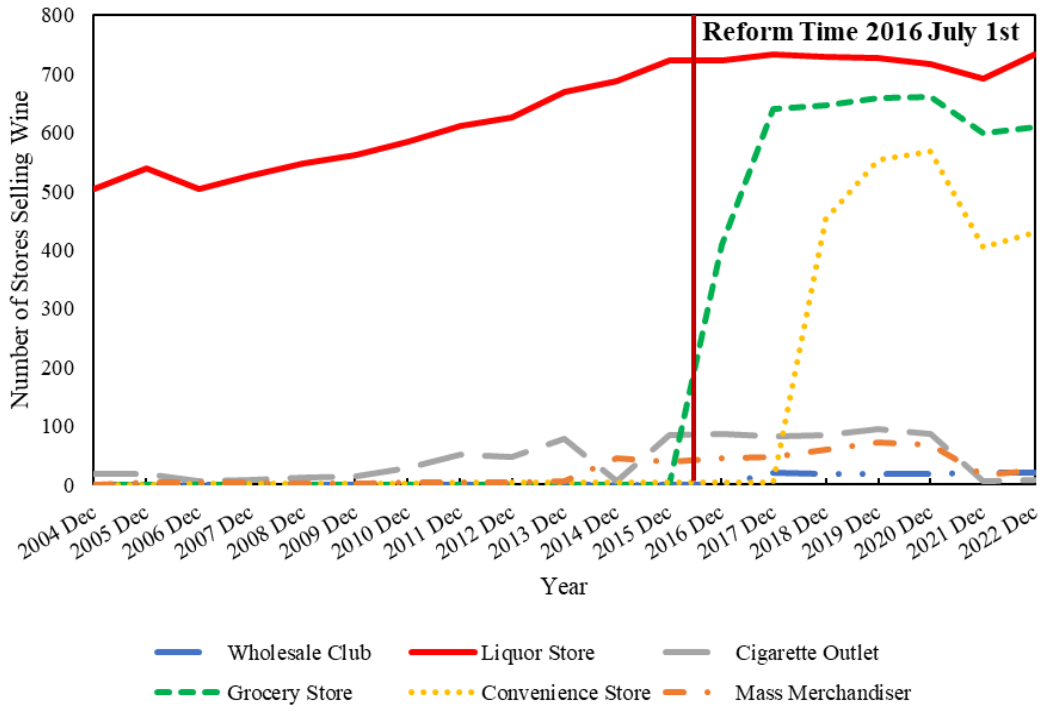

Figure 9. Number of licenses for selling wine across channels in Tennessee, 2004-2022, Source: NIQ – RMS Bev Al Data.

[49] Grogger, J. (2017). Soda taxes and the prices of sodas and other drinks: evidence from Mexico. American Journal of Agricultural Economics, 99(2), 481-498. https://doi.org/10.1093/ajae/aax024
[50] McClelland, R., & Iselin, J. (2019). Do State Excise Taxes Reduce Alcohol-Related Fatal Motor Vehicle Crashes?. Economic Inquiry, 57(4), 1821-1841. https://doi.org/10.1111/ecin.12811
[51] Abadie, A. (2021).

In this study, we focus on the channel of liquors stores and evaluate the effects of wine sales reform on the number of liquor stores in Tennessee. Specifically, we employ SCM to assess the impact of wine sales reform on the number of liquor stores per capita in Tennessee.[52] To do so, we followed two steps. In the first step, we defined the treated state or unit (Tennessee) and the pool of potential control states. As the control states should have similar pre-intervention characteristics as the treatment state (Tennessee), we had to study the wine-related reforms implemented in the 50 states and identify states that do not allow grocery stores to sell wine. From this process, we identified 12 states that, to date, do not allow grocery stores to sell wine. These states are Utah, Kansas, Colorado, Alaska, Delaware, Minnesota, New Jersey, Rhode Island, Connecticut, Kentucky, Mississippi, and New York.

In the second step, we followed Abadie et al. (2010)[53], Grogger (2017)[54],and Mohan (2017)[55] to redefine the pool of control states and the timeframe for analysis. We applied two criteria. The first is the "*data-overlap*" criterion, which requires that for all predictors and the outcome (number of liquor stores per capita) there were states with values that were both above and below that of Tennessee. This is crucial for constructing a reliable counterfactual scenario, that relies on interpolation and not extrapolation. This is also the reason that weights in the synthetic control method are restricted to be non-negative and sum to one[56]. The second criterion is the "*other alcohol reforms*" criterion, aimed to verify that besides wine-related policy reforms, there were no other alcohol-related policy changes in these 12 selected states. This criterion ensures the comparison group remains unaffected by other alcohol-related policy reforms, allowing us to isolate the specific impact of the wine-related policy reforms on per capita liquor store numbers in Tennessee.

Regarding the first criterion ("*data-overlap*"), the descriptive statistics concerning the number of liquor stores per capita before and after the wine reform in the 12 selected states of the control group (see **Figure 10**). **Figure 10** shows that only Utah has fewer liquor stores per capita than Tennessee. This indicates that Utah must be included in the pool of control states to meet the "data overlap" criterion[57].

[52]The number of liquor stores per capita is selected as the outcome variable of interest because it is more comparable across states and time than the total number of liquor stores. As a robustness check, we also use the standardized total number of liquor stores as the outcome variable of interest. These results are consistent with our main findings, and results from this supplemental analysis are available in Appendix A [Click Here].

[53]Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American statistical Association*, *105*(490), 493-505.

[54]Grogger, J. (2017). Soda Taxes and The Prices of Sodas And Other Drinks: Evidence From Mexico. *American Journal of Agricultural Economics*, *99*(2), 481-498.

[55]Mohan, P. (2017). The economic impact of hurricanes on bananas: a case study of Dominica using synthetic control methods. *Food policy*, *68*, 21-30.

[56]Convex combinations can only replicate exactly variables whose value for the treated unit lies in-between those of the donor unit.

[57]According to the figures in Appendix C [click here], the predictors reveal no issues with the other variables used in the model.

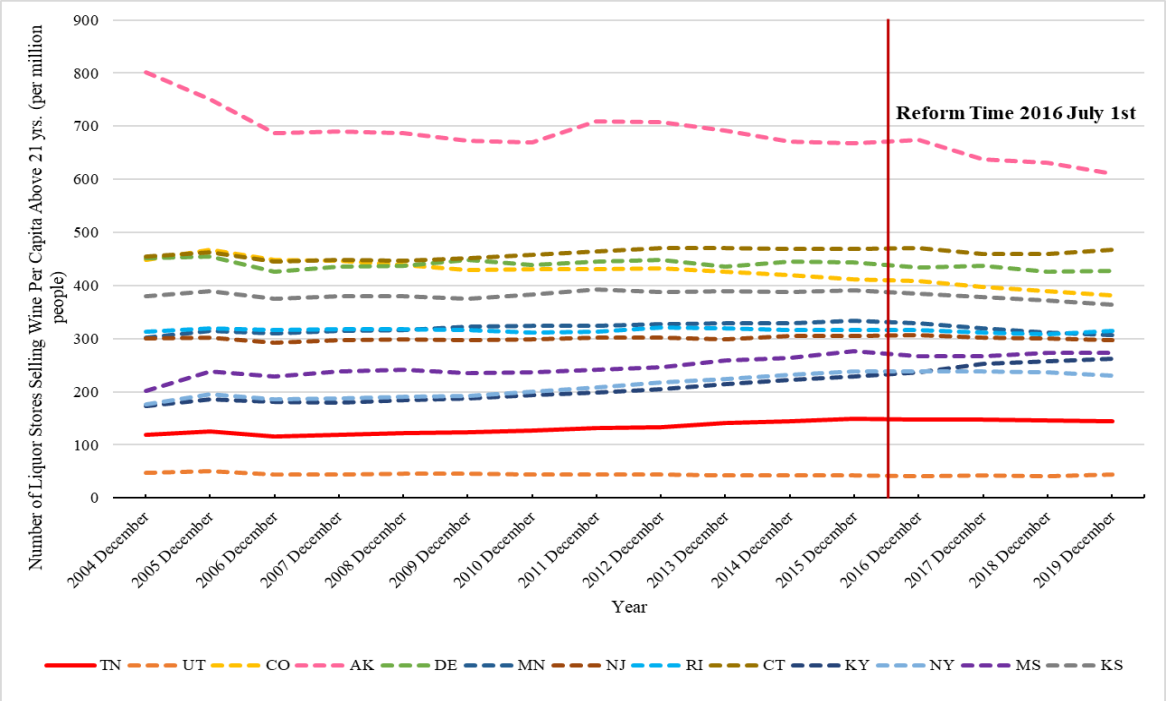

Figure 10. Number of liquor stores per capita selling wine across states, 2004-2019, Source: NIQ – RMS Bev Al Data.

To assess the second criterion ("*other alcohol reforms*"), we analyzed the retail-level alcohol policy reforms enacted across various states, utilizing the Alcohol Policy Information System (APIS) as our primary source of data (https://alcoholpolicy.niaaa.nih.gov/). We identified 10 distinct reforms, summarized in **Table 1**, which have been implemented in different times across the 12 potential donor states, as shown and outlined in **Table 2**. We consulted previous studies to discern the direct or indirect impact of these reforms on liquor store activities. We considered reforms that implemented beverage sales training (reforms 1 and 2), repealed sales bans (reform 3), and enacted fiscal reforms (reforms 4, 5, and 6) as having no discernible effect on the number of liquor stores.[58, 59, 60, 61] On the other hand, we excluded policy reforms such as allowing grocery stores to sell beer (reform 10) and retail distribution reforms (reforms 7, 8, 9) as they can have an impact on the number of liquor stores.[62] Including the reform allowing grocery stores to sell beer complicates the analysis, as it becomes challenging to isolate

[58] Chinman, M., Burkhart, Q., Ebener, P., Fan, C. C., Imm, P., Osilla, K. C., ... & Wright, A. (2011). The premises is the premise: understanding off-and on-premises alcohol sales outlets to improve environmental alcohol prevention strategies. *Prevention science*, *12*, 181-191.

[59] Kerr, W. C., Williams, E., & Greenfield, T. K. (2015). Analysis of price changes in Washington following the 2012 liquor privatization. *Alcohol and Alcoholism*, *50*(6), 654-660.

[60] Gehrsitz, M., Saffer, H., & Grossman, M. (2021). The effect of changes in alcohol tax differentials on alcohol consumption. *Journal of public economics*, *204*, 104520.

[61] Connolly, C., Graziano, M., McDonnell, A., & Steinbach, S. (2023). In Cervisia Veritas: The impact of repealing Sunday blue laws on alcohol sales and retail competition. *Journal of Wine Economics*, *18*(4), 312-323.

[62] As a robustness check, we also apply a stricter criterion to select the control states and time framework. We excluded from the analysis states with the reform of allowing grocery stores to sell beer (reform 10), retail distribution reforms (reforms 7, 8, 9), and any fiscal policy reforms (specifically, reforms 4, 5, and 6) that are ongoing in the focused time framework. The results from the robustness check, which are available in Appendix B [Click Here], are consistent with our main results as presented in the following section.

the impact of beer sales reform from wine sales reform. In addition, distribution reforms might redefine alcohol content criteria for beer, wine, and spirits in retail distribution, potentially resulting in some wines with low alcohol content being classified as beer and sold in grocery stores. [63,64] This factor makes it difficult to disentangle the impact of beer sales reform from wine sales reform.

Table 1: Alcohol retail reforms from 2004 to 2022 in potential donor states.

	Reform	Description
Beverage Sells Training		
(1)	Mandatory Beverages Sell Training	Laws specifying requirements for retail alcohol outlets to participate in server training programs (often referred to as Responsible Beverage Service).
(2)	Voluntary Beverage Sell Training	Laws specifying incentives for retail alcohol outlets to participate in server training programs (often referred to as Responsible Beverage Service).
Sales Ban Repealed		
(3)	Sunday Sales Ban Repealed	Laws banning Sunday sales of alcoholic beverages for off-premises consumption as of January 1, 1998 and repeals from that date forward.
Fiscal Policies		
(4)	Change in Beer Tax	Change of laws (usually change the tax volume) specifying the two major types of taxes levied on beer – "specific excise taxes" (taxes levied on the quantity of a beverage) and "ad valorem excise taxes" (taxes levied on the price of a beverage).
(5)	Change in Spirit Tax	Change of laws (usually change the tax volume) specifying the two major types of taxes levied on distilled spirits – "specific excise taxes" (taxes levied on the quantity of a beverage) and "ad valorem excise taxes" (taxes levied on the price of a beverage).
(6)	Change in Wine Tax	Change of laws (usually change the tax volume) specifying the two major types of taxes levied on wine – "specific excise taxes" (taxes levied on the quantity of a beverage) and "ad valorem excise taxes" (taxes levied on the price of a beverage).
Retail Distribution		
(7)	Change in Retail Distribution for Beer	Change of laws addressing retail distribution (usually change the definition, such as alcohol content, of beer) of beer including State-run, private licensed sellers, or combination systems.
(8)	Change in Retail Distribution for Spirit	Change of laws addressing retail distribution (usually change the definition, such as alcohol content, of distilled spirits) of distilled spirits including State-run, private licensed sellers, or combination systems.
(9)	Change in Retail Distribution for Wine	Change of laws addressing retail distribution (usually change the definition, such as alcohol content, of wine) of wine including State-run, private licensed sellers, or combination systems.
Beer Grocery store reform		

[63] Palardy, N., Costanigro, M., Cannon, J., Thilmany, D., Berning, J., Bayham, J., & Callaway, J. (2023). Beer sales in grocery and convenience stores: a glass half-full for craft brewers?. *Regional Studies*, *57*(10), 1981-1994.
[64] APIS. Retail Distribution Systems for Beer. https://alcoholpolicy.niaaa.nih.gov/apis-policy-topics/retail-distribution-systems-for-beer/5/changes-over-time#page-content

(10)	Start to allow Grocery Store Sell Beer	Please click the links to check the details for the reform in each state. UT (link), KS (link), and CO (link).

Table 2: Alcohol-related reforms implemented from 2004 and 2022.

	Year	Treated	Potential Control Pool										
		TN	AK	CO	CT	DE	KY	MN	NJ	NY	RI	UT	KS	MS
Pre-reform Time Period	2004										3			
	2005						4,5,6						3	
	2006	2						4,6				1		
	2007							2						
	2008			3								7,8,9		
	2009								5,6	4,6				
	2010												4,5,6	
	2011				4,5,6									
	2012				3									7
	2013	4					3				4,5,6		4,5,6	
	2014	1												
	2015						4,6						4,5,6	
Post-reform Time Period	2016			1			4,6							
	2017					4,5,6	4,6	3					10	
	2018	3					4,6							
	2019			10	4,5,6							3,4,7,10		
	2020													
	2021													
	2022													

Notes: 1) Numbers in the table refer to the 10 reforms reported in Table 1. 2) The selected control states and time frame for further analysis are highlighted in yellow.

Overall, the application of these two criteria ("*data-overlap*" and "*other alcohol reforms*") led us to select the timeframe of 2009-2018. Time periods before 2009 were excluded because Utah implemented a change in retail distribution for beer reform in 2008, while time periods after 2018 were excluded because three donor states (Utah, Connecticut, and Colorado) started to allow grocery stores to sell beer in 2019. Applying these two criteria reduced the number of control states from 12 to 10. Kansas is excluded, as it began allowing grocery stores to sell beer in 2018. Mississippi is also excluded due to distribution reforms implemented in 2012 that altered the definition of beer's alcohol content from 5%

alcohol by weight (ABW) to 8% alcohol by volume (ABW). Therefore, the final control pool comprised Utah, Colorado, Alaska, Delaware, Minnesota, New Jersey, Rhode Island, Connecticut, Kentucky, and New York. These states prohibited food retail stores from selling wine and did not undergo other significant alcohol sale reforms during our study period.

Empirical Model and Specification

Our sampling strategies described above resulted in a pool of 10 control states, 10-year timeframe ($T = T_{Pre} + T_{Post} = 10$), spanning from 2009 to 2018, with seven years of pre-intervention ($T_{Pre} = 7$) and three years of post-intervention ($T_{Post} = 3$). To initiate our data analysis and calculate the net effect of the reform, we began by selecting the outcome variables. These variables represent the number of liquor stores per capita selling wine after the reform in both Tennessee and the control states. We denoted $\mathbf{Y_{Post}^{1}}$ as the outcome variable for Tennessee after the reform ($T_{Post} \times 1$ vector), and $\mathbf{Y_{Post}^{0}}$ for the J control states ($T_{Post} \times J$ vector). The descriptive statistics of the outcome variable are presented in Table 3.

Next, to capture the pre-intervention characteristics and trends in both Tennessee and the control states, we selected K pre-intervention predictive variables. These were denoted as $(\mathbf{X_{Pre}^{1}})$ for Tennessee and $(\mathbf{X_{Pre}^{0}})$ the control states, representing the $(K \times J)$ vectors of pre-intervention variables. These variables were chosen to reflect various aspects such as population density, demographic factors, economic indicators, and liquor store data. We selected 9 variables as follows: 1) population density (persons per square mile, 2010), 2) proportion of civilian population above 21 years old (2009-2015), 3) average income per capita ($, 2009-2015), 3) wine consumption per capita (gallons, 2009-2015), 4) proportion of population (>25 yrs.) with college degree and above, 5) number of wineries (2009-2015), 6) unemployment rate (%, 2009-2015) 7) proportion of non-white population (2010), 8) number of liquor stores per capita in 2009, and 9) number of liquor stores per capita in 2015. The descriptive statistics of these predictors are presented in **Table 3**.

Next, we estimated the weights assigned to each control unit state to construct a "synthetic" Tennessee. This involved creating a simulated version of Tennessee that closely resembles its pre-intervention characteristics using data from the control states. Accordingly, the number of liquor stores in synthetic Tennessee after the reform was expressed as:

$$\mathbf{Y_{Post}^{1}}^{*} = \mathbf{Y_{Post}^{0}}\mathbf{W}^{*} \tag{1}$$

where $\mathbf{W}^{*}$ represents the solution obtained by minimizing the difference between the pre-intervention predictor variables of Tennessee ($\mathbf{X_{Pre}^{1}}$) and the weighted average of the control units ($\mathbf{X_{Pre}^{0}}\mathbf{W}$) according to the equation:

$$\min \sqrt{(\mathbf{X_{Pre}^{1}} - \mathbf{X_{Pre}^{0}}\mathbf{W})'\mathbf{V}(\mathbf{X_{Pre}^{1}} - \mathbf{X_{Pre}^{0}}\mathbf{W})} \tag{2}$$

where $\mathbf{V}$ is a $(k \times k)$ symmetric and positive semidefinite matrix. To assess the similarity between the outcome variable of Tennessee and its synthetic counterpart, we calculated the pre-treatment root mean square prediction error (RMSPE) using the formula:

$$Pre - Treatment\ RMSPE = \sqrt{(\frac{1}{T_{Pre}} \sum_{t=1}^{T_{Pre}} (Y_t^1 - \boldsymbol{Y_t^0 W}^*)^2)} \quad (3)$$

A smaller pre-treatment RMSPE indicates a better fit for synthetic Tennessee to actual Tennessee.

Finally, to estimate the reform effect, we calculated the difference between the observed outcome in Tennessee and its synthetic counterpart:

$$\hat{\boldsymbol{\alpha}} = \mathbf{Y_{Post}^1} - \mathbf{Y_{Post}^1}^* \quad (4)$$

where $\hat{\boldsymbol{\alpha}}$ represents the estimated reform effect. The statistical significance of these estimates was evaluated using placebo tests, which computed p-values based on the estimated placebo effect for each control state (Mohan 2017; Grogger 2017):

$$p - value_\alpha = \Pr(\hat{\alpha}^{PL} \leq \hat{\alpha}) = \frac{\sum_{j=2}^{J} 1[\hat{\alpha}_j^{PL} \leq \hat{\alpha}]}{J} \quad (5)$$

where $\hat{\alpha}_j^{PL}$ is the estimated placebo effect for each control state j (Alaska, Colorado, Connecticut, Delaware, Kentucky, Minnesota, New Jersey, New York, Rhode Island, and Utah). The p-value measures determine the probability of observing a decrease in the number of liquor stores selling wine larger than the estimated reform effect ($\hat{\boldsymbol{\alpha}}$) under the null hypothesis of no reform.

Descriptive statistics

Table 3 reports the descriptive statistics of the outcome variable ($\boldsymbol{Y_{Post}}$) and predictors ($\boldsymbol{X_{Pre}}$) for Tennessee and the ten control states. For the outcome variable, Tennessee (148 per million people) has a higher average number of liquor stores per capita from 2016 to 2018 than Utah (42 per million people), but lower than the other nine control states, which is consistent with **Figure 10**. For the predictors, Tennessee has a lower population density than Delaware, New Jersey, Rhode Island, Connecticut, and New York but higher than Utah, Colorado, Alaska, Minnesota, and Kentucky. Tennessee has a comparable proportion of population above 21 years, unemployment rate, and non-white population to the control states. Most states have a higher average income per capita and wine consumption per capita than Tennessee, except for Utah and Kentucky. In addition, Tennessee has more wineries than Utah, Alaska, Minnesota, Delaware, Rhode Island, and Connecticut but fewer than Colorado, New Jersey, Kentucky, and New York.

Table 3. Summary statistics for predictors: Tennessee *versus* control states

	Treated	Control Pool									
	TN	**UT**	**CO**	**AK**	**DE**	**MN**	**NJ**	**RI**	**CT**	**KY**	**NY**
Outcome Variable (Y_{Post})											
The number of liquor stores per capita (per million people, 2016 Dec – 2018 Dec)	148 (1.05)	42 (0.68)	399 (7.98)	648 (18.56)	433 (4.59)	320 (6.63)	303 (2.26)	312 (2.98)	463 (4.99)	249 (8.79)	238 (0.96)
Predictors (X_{Pre})											
Population density (persons per square mile, 2010)	153.9 (--)	33.6 (--)	48.5 (--)	1.2 (--)	460.8 (--)	66.6 (--)	1195.5 (--)	1018.1 (--)	738.1 (--)	109.9 (--)	411.2 (--)
Proportion of civilian population above 21 years old (2009-2015)	0.73 (0.00)	0.64 (0.01)	0.72 (0.01)	0.70 (0.01)	0.73 (0.01)	0.72 (0.00)	0.73 (0.00)	0.74 (0.01)	0.73 (0.00)	0.73 (0.00)	0.74 (0.01)
Average income per capita ($, 2009-2015)	38524 (2690)	35783 (3070)	45742 (4358)	52672 (3327)	43976 (2428)	46769 (3749)	55247 (3594)	45571 (2868)	64170 (2564)	35483 (2261)	53176 (3916)
Wine consumption per capita (Gallons, 2009-2015)	0.24 (0.02)	0.19 (0.01)	0.50 (0.02)	0.53 (0.02)	0.69 (0.02)	0.39 (0.02)	0.59 (0.02)	0.56 (0.02)	0.61 (0.02)	0.20 (0.02)	0.50 (0.02)
Proportion of population (>25 yrs.) with college degree and above, 2015	0.25 (--)	0.32 (--)	0.39 (--)	0.24 (--)	0.31 (--)	0.34 (--)	0.38 (--)	0.33 (--)	0.38 (--)	0.23 (--)	0.35 (--)
The number of wineries (2009-2015)	22.3 (4.5)	2.7 (1.4)	36.7 (6.8)	3.6 (0.9)	2.1 (0.8)	21.6 (2.1)	42.3 (6.4)	2.1 (1.4)	21.9 (3.6)	23.6 (9.1)	151.7 (18.7)
The unemployment rate (%, 2009-2015)	8.1 (1.5)	5.5 (1.7)	7.0 (1.9)	7.3 (0.7)	7.0 (1.3)	5.8 (1.4)	8.3 (1.4)	9.6 (1.9)	7.9 (1.3)	8.3 (1.9)	7.6 (1.2)
The proportion of non-white population (2010)	0.20 (--)	0.09 (--)	0.14 (--)	0.26 (--)	0.27 (--)	0.12 (--)	0.29 (--)	0.16 (--)	0.20 (--)	0.10 (--)	0.32 (--)
The number of liquor stores per capita (per million people, 2009 Dec)	123 (--)	45 (--)	429 (--)	673 (--)	449 (--)	323 (--)	298 (--)	317 (--)	452 (--)	188 (--)	193 (--)
The number of liquor stores per capita (per million people, 2015 Dec)	150 (--)	43 (--)	413 (--)	668 (--)	444 (--)	334 (--)	305 (--)	317 (--)	470 (--)	228 (--)	238 (--)

Notes: 1) Population density, civilian population above 21 years old, education, race, and income from the U.S. Census Bureau (2020). 2) The number of wineries in each state from the U.S. Bureau of Labor Statistics (2020). 3) The wine consumption per capita from the National Institute on Alcohol Abuse and Alcoholism (2023). 4) Numbers in Parentheses are standard deviations. "--" refers to the statistics based on one year. 5) Please check the details of the predictors in Appendix C [Click Here].

Results from Synthetic Control Analysis

Based on the methodology outlined earlier, we constructed the synthetic Tennessee using equations (1) and (2). Our findings reveal that the trend of the number of liquor stores selling wine in Tennessee prior to the reform can be most accurately replicated by a combination of Utah (0.448), Kentucky (0.327), and New York (0.225) (see **Table 4**). The other control states have zero weights, indicating their no contribution to synthetic Tennessee. This is common in synthetic control studies because weights are typically sparse.

Table 4. Synthetic Weights

State	Synthetic Control Weight
UT: Utah	**0.448**
CO: Colorado	0.000
AK: Alaska	0.000
DE: Delaware	0.000
MN: Minnesota	0.000
NJ: New Jersey	0.000
RI: Rhode Island	0.000
CT: Connecticut	0.000
KY: Kentucky	**0.327**
NY: New York	**0.225**

Table 5 compares pre-reform predictors among Tennessee, synthetic Tennessee, and the simple average of 10 control states. The results show that the characteristics of synthetic Tennessee more closely match those of actual Tennessee than the simple average of the control states does. This suggests that synthetic Tennessee offers a more accurate comparison base with actual Tennessee. Exceptions include a slightly lower proportion of the civilian population over 21 years old and a higher number of wineries in synthetic Tennessee.

Table 5. Summary statistics for predictors: Tennessee *versus* synthetic Tennessee *versus* simple control average

Variables	TN	Synthetic TN	Average of 10 Control States
Population density (persons per square mile, 2010)	153.9	143.5	408.4
Proportion of civilian population above 21 years old (2009-2015)	0.73	0.69	0.72
Average income per capita ($, 2009-2015)	38,524.43	39,598.26	47,858.86
Wine consumption per capita (Gallons, 2009-2015)	0.24	0.26	0.48
Proportion of population (>25 yrs.) with college degree and above, 2015	0.25	0.29	0.32
The number of wineries (2009-2015)	22.29	43.05	30.83
The unemployment rate (%, 2009-2015)	8.14	6.89	7.44
The proportion of non-white population (2010)	0.20	0.15	0.19
The number of liquor stores per capita (per million people, 2009 Dec)	123.45	125.14	336.61
The number of liquor stores per capita (per million people, 2015 Dec)	149.75	147.26	345.92

Note: "Average of 10 Control States" is the unweighted average of Utah, Colorado, Alaska, Delaware, Minnesota, New Jersey, Rhode Island, Connecticut, Kentucky, and New York.

Figure 11 illustrates the trends in the number of liquor stores selling wine per capita in Tennessee and synthetic Tennessee during the studied period. Focusing on the pre-reform period, synthetic Tennessee closely aligns with actual Tennessee, as evidenced by an RMPSE of 1.565. This close fit suggests that synthetic Tennessee follows the trajectory of Tennessee in the number of liquor stores selling wine per capita throughout the entire pre-reform period. Consequently, synthetic Tennessee serves as a reliable proxy for estimating the number of liquor stores selling wine per capita in actual Tennessee from 2016 to 2018, had the reform not been implemented.

After the reform, the difference in the per capita number of liquor stores selling wine between Tennessee and synthetic Tennessee indicates the net effect of the reform. Post-reform analysis reveals that, unlike actual Tennessee, the number of liquor stores per capita selling wine in synthetic Tennessee continued to increase. This finding implies that the reform may have prevented an increase in the number of liquor stores selling wine in Tennessee, unlike its synthetic control where the number of liquor stores continued

to grow. However, it remains to be determined whether this increase in the number of liquor stores in the synthetic Tennessee is statistically different from the one in Tennessee.

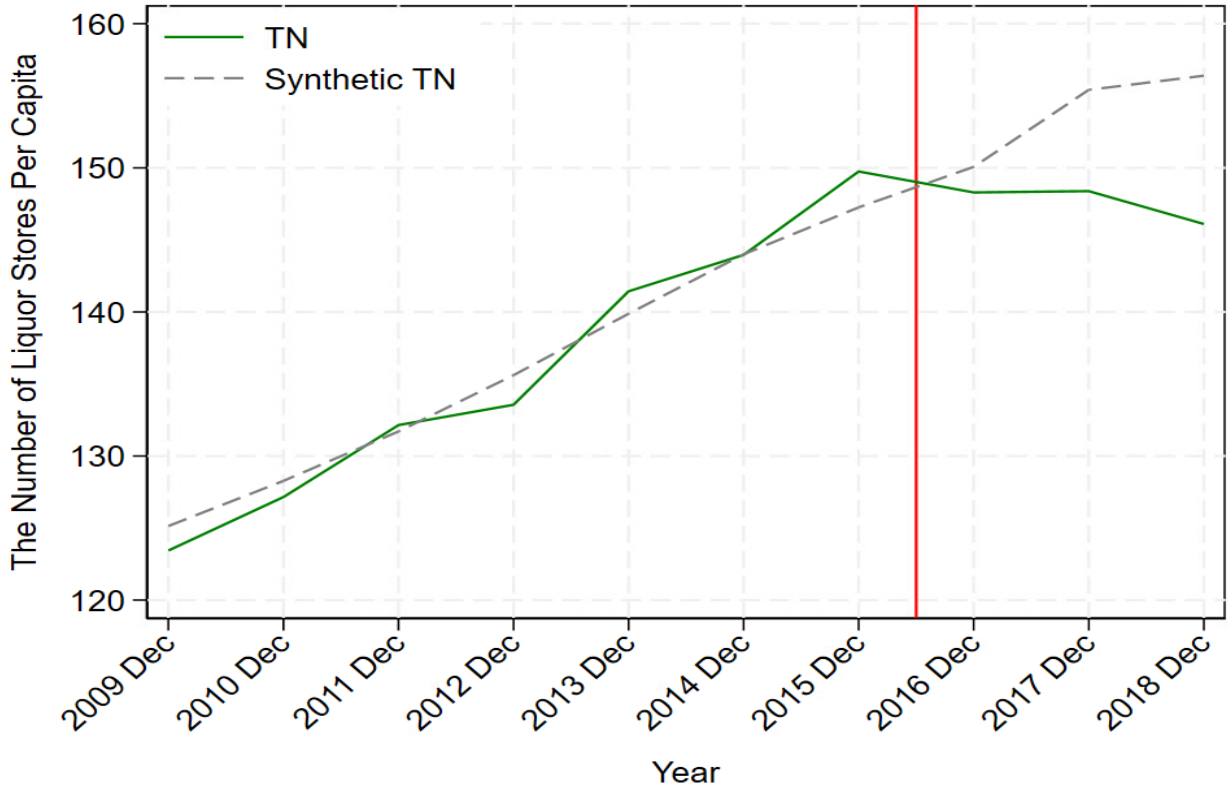

Figure 11. Trends in the number of liquor stores selling wine per capita: Tennessee *versus* Synthetic Tennessee

To determine if the difference in the number of liquor stores between Tennessee and its synthetic control after the reform is statistically significant, we report the SCM coefficient estimates in **Table 6**. These coefficients quantify the effect of the wine reform on the per capita number of liquor stores, as outlined in Equation (4). Negative (positive) coefficients indicate a reduction (increase) in the number of liquor stores after allowing grocery stores to sell wine. The standardized p-values[65] shown in parentheses indicate whether the coefficient estimates are statistically significant. Our coefficient estimates are all negative, indicating that the per capita number of liquor stores decreased by 1.78 in 2016, 7.03 in 2017, and 10.29 in 2018. However, the large standardized p-values (ranging from 0.38 to 0.50) for each post-treatment year, as outlined in Equation (5), suggest that these reductions are not statistically significant in any post-treatment period.

[65]Standardized p-values are calculated by dividing all estimated effect in formula (5) by their corresponding pre-treatment match quality (pre-treatment RMSPE)

Table 6. The SCM estimates of the reform impacts on the number of liquor stores

Post Year (After Reform)	The Number of Liquor Store Per Capita
2016	-1.78 (0.50)[a]
2017	-7.03 (0.38)
2018	-10.29 (0.38)

[a] Number in parentheses are standardized p-values.

To test the robustness of our findings, we conducted an in-space placebo test following previous literature.[66, 67] This test evaluates whether similar or larger effects of the wine sales reform could be observed in states that were not exposed to the reform, known as "placebo effects." The test was performed in three steps: 1) reassigning the "reform" treatment to the 10 control states included in our study, 2) re-running the SCM for each reassignment, 3) comparing the effect size of the wine sales reform in Tennessee to the placebo effect sizes in the control states with the treatment artificially reassigned. The effect size for the wine sales reform and the placebo effects are measured by the post-treatment to pre-treatment Root Mean Squared Prediction Error (RMSPE) ratio.[68]A larger ratio indicates a more significant reform or placebo effect. If larger ratios of post-treatment to pre-treatment RMSPE are observed in the artificially treated control states than in Tennessee, it would imply that the observed impact of the wine sales reform on the number of liquor stores could be due to chance rather than a causal effect of the reform.

The post- and pre-treatment RMSPEs from the in-space placebo test are presented in **Table 7**. Tennessee has the fourth-highest post- to pre-treatment RMSPE ratio (4.54) among the 11 states considered (Teneness plus 10 control states). This ratio is lower than those of states like Kentucky (15.27), New York (9.29), and Minnesota (7.21), even though these states did not implement the policy. Indeed, in

[66] Abadie, A., Diamond, A., & Hainmueller, J. (2015). Comparative politics and the synthetic control method. *American Journal of Political Science*, *59*(2), 495-510.
[67] Chen, Q., & Yan, G. (2023). A mixed placebo test for synthetic control method. *Economics Letters*, *224*, 111004.
[68] The calculation of pre-treatment RMSPE is in equation (3). The post-treatment RMSPE could be calculated as follows:

$$Post-Treatment\ RMSPE = \sqrt{\left(\frac{1}{T_{Post}} \sum_{t=T_{Pre}+1}^{T_{Post}} (Y_t^1 - \boldsymbol{Y_t^0 W^*})^2\right)}$$

The post-treatment RMSPE measures the gap between synthetic TN and actual TN. It should be noticed that a large post-treatment RMSPE is not indicative of a large effect of the reform if the pre-treatment RMSPE is also large. Thus, the ratio of post- and pre-treatment RMSPE is employed to indicate the impact size of the reform.

about 36% (joint standardized p-value is 0.36) of the cases (or 4 out of 11 times), other states showed larger changes than Tennessee when the policy was hypothetically applied to them for the test. It indicates that the average negative impact of the wine sales reform on the per capita number of liquor stores over the three years is not statistically significant. These changes in states unaffected by the policy suggest that the observed changes in Tennessee might not be directly attributable to the policy. This indicates a lack of statistically significant impact from the wine reforms in Tennessee. Thus, the results from the SCM pass the in-space placebo test.

Table 7. Post- and pre-treatment RMSPEs from in-space placebo test

	Pre-Treatment RMSPE	Post-Treatment RMSPE	Ratio
KY	1.72	26.24	15.27
NY	2.24	20.80	9.29
MN	1.69	12.19	7.21
TN (Real Treated)	1.57	7.11	4.54
CT	4.70	10.23	2.18
CO	6.15	11.79	1.92
DE	6.26	8.66	1.38
RI	2.36	3.17	1.34
UT	92.67	105.36	1.14
NJ	2.77	2.36	0.85
AK	220.00	185.20	0.84

Alternative empirical strategies

In addition to the in-space placebo test, we used various alternative modeling approaches to further assess the robustness of our findings. The first approach is the Synthetic Difference-in-Difference (Synthetic DID) method introduced by Arkhangelsky et al. (2021)[69] and applied in studies such as Porreca (2022)[70] and Huang et al. (2023)[71]. Second is Conformal Inference by Chernozhukov et al. (2021), which incorporates machine learning techniques. Detailed descriptions of these methods and their results are provided in the following subsections.

[69]Arkhangelsky, D., Athey, S., Hirshberg, D. A., Imbens, G. W., & Wager, S. (2021). Synthetic difference-in-differences. *American Economic Review*, *111*(12), 4088-4118.
[70]Porreca, Z. (2022). Synthetic difference-in-differences estimation with staggered treatment timing. *Economics Letters*, *220*, 110874.
[71]Huang, H. C., Ma, Y., & Wang, Y. (2023). Open data policy and journal impacts: a synthetic difference-in-differences approach. *Applied Economics Letters*, 1-6.

Synthetic Difference-in-Difference

The Synthetic DID method combines features of the SCM and the difference-in-difference approach. Like SCM, the Synthetic DID constructs a synthetic control state from a weighted average of a control group, reducing reliance on parallel trend assumptions (Arkhangelsky et al., 2021). Concurrently, it is invariant to additive state-level shifts, akin to the difference-in-differences method, which is advantageous for analyzing data across many states over time. Arkhangelsky et al. (2021) demonstrate that Synthetic DID performs competitively or even dominates SCM in terms of bias and RMSE, especially when the control pool and time framework expand.

We applied the Synthetic DID method to estimate the impact of wine sales reform on the per capita number of liquor stores in Tennessee, using the same control pool and time frame as in the SCM analysis. **Figure 12** plots the trends in the per capita number of liquor stores in Tennessee (treated) compared to the synthetic control created by Synthetic DID. The shaded green area in the figure indicates the optimal pre-treatment weights. We observe that the per capita number of liquor stores in Tennessee is lower than that in the synthetic control state. This discrepancy arises because the Synthetic DID aims to align the trends between Tennessee and the synthetic control, focusing on parallel trends rather than copying the exact number of liquor stores per capita in Tennessee as the SCM does. The parallel trends in the pre-treatment period lend credibility to the Synthetic DID results. The change in the gap between Tennessee and the synthetic control, before and after the wine sales reform, indicates the impact of the reform on the number of liquor stores in Tennessee. Notably, the parallel trend between Tennessee and the synthetic control remains consistent before and after the reform, suggesting that the wine sales reform has not affected the number of liquor stores in Tennessee.

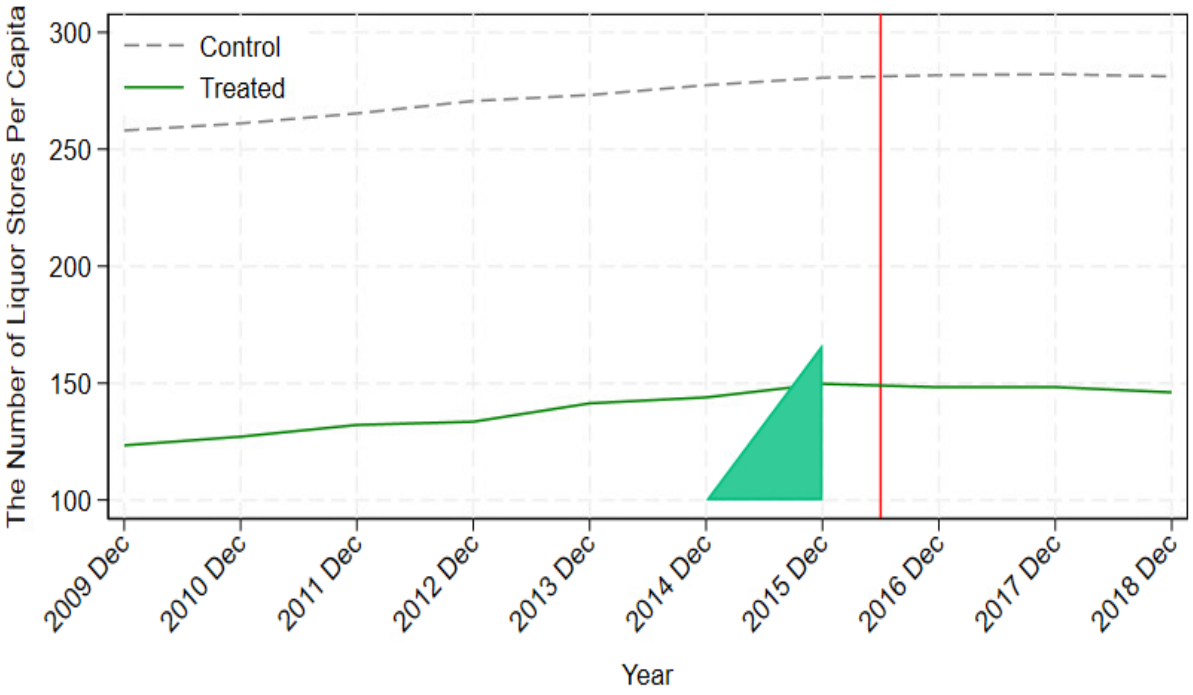

Figure 12. Trends in the number of liquor stores per capita: TN vs. weighted control.

Table 8 presents the results from the synthetic DID. The negative sign of the coefficient means the per capita number of liquor stores decreased by an average of 3.8 from 2016 to 2018 after the reform. However, a high p-value of 0.739 indicates that this decrease is not statistically significant over the three years following the reform. Thus, the findings from synthetic DID align with those from SCM.

Table 8. The treatment effect from Synthetic DID

	The Number of Liquor Store Per Capita
Treatment	-3.80 (0.739)

Note: The p-values are in parentheses, which are based on 1,000 placebo replications.

Conformal Inference (Machine Learning)

The conformal inference, introduced by Chernozhukov et al. (2021),[72] is a new inference procedure that uses the LASSO technique to create synthetic controls. Its distinguishing feature lies in its robustness to model misspecification, producing reliable results even in instances where the foundational assumptions of the model may not fully align with the underlying data, as long as the predicted errors behave consistently under the hypothesis being tested. Unlike SCM and Synthetic DID, which only use pre-treatment data to calculate control weights, conformal inference also incorporates post-treatment data.[73] This method has been shown to perform well in situations with small sample sizes, as evidenced by simulations conducted by Chernozhukov et al. (2021).

We used the conformal inference approach to construct synthetic control and evaluate the impact of wine sales reform on the number of liquor stores in Tennessee. **Table 9** presents the weights assigned to states in the control pool by conformal inference. Unlike SCM, conformal inference permits negative weights for control states. This flexibility, stemming from removing the non-negativity constraint on weights, results in conformal inference weights that significantly differ from those derived via SCM. Minnesota and New York received positive weights of 0.31 and 0.44, respectively, while Colorado, Delaware, and Rhode Island were assigned negative weights of -0.14, -0.05, and -0.06. Utah, Alaska, New Jersey, Connecticut, and Kentucky were given zero weights.

[72]Chernozhukov, V., Wüthrich, K., & Zhu, Y. (2021). An exact and robust conformal inference method for counterfactual and synthetic controls. *Journal of the American Statistical Association*, *116*(536), 1849-1864.

[73] Unlike SCM, conformal inference using constrained LASSO allows extrapolation. Thus, another robustness check could be to run the conformal inference but this time without worrying about the "data-overlap" criterion when choosing the donors. This would also give us more pre-treatment periods (which were excluded because of Utah) that results in better more robust estimates in conformal inference. To compare the results from conformal inference and SCM, the results presented in this section are based on the same donor pool and time framework as those in SCM. However, as a robustness test, we re-select the donor pool and time framework with relief of the "data-overlap" criterion. The results are presented Appendix F [Click Here].

Table 9. Conformal Inference Weights

State	Conformal Inference Weight
Utah (UT)	0.00
Colorado (CO)	-0.14
Alaska (AK)	0.00
Delaware (DE)	-0.05
Minnesota (MN)	0.31
New Jersey (NJ)	0.00
Rhode Island (RI)	-0.06
Connecticut (CT)	0.00
Kentucky (KY)	0.00
New York (NY)	0.44

The difference between Tennessee and synthetic Tennessee in the post-treatment periods reflects the impact of wine sales reform on the number of liquor stores per capita in TN. **Figure 13** plots the difference between Tennessee and synthetic Tennessee from 2016 to 2018, along with 80% confidence intervals.[74,75] The graph indicates a negative difference across all three post-treatment years, suggesting a reduction in the per capita number of liquor stores in Tennessee following the wine sales reform. However, the broad confidence intervals, which overlap with zero, imply that these reductions are not statistically significant at the 20% significance level for any of the post-treatment years. Specifically, the p-values for the effects of the wine sales reform are 0.60 using Moving Block Permutations and 0.64 using iid Permutations. Therefore, the results obtained from conformal inference align with those from SCM and synthetic DID.

[74] Following Chernozhukov et al. (2021), we conducted the placebo tests and plots the residues for the conformal inference in Appendix D [Click Here], which provides evidence of the credibility of conformal inference method.

[75] With seven pre-treatment periods, we utilize eight time periods in total to construct the p-value metric for conformal inference, which is the proportion of residuals whose absolute values are at least as great as the absolute value of the residual for the treated period. Consequently, a p-value of 0.125 (1/8) is attainable for any treatment effect under the null hypothesis, as its residual is always as extreme as itself. Thus, a p-value of 0.125 (1/8) is achievable for any treatment effect under the null (its residual is always as extreme as itself). We chose an 80% confidence interval (p-value < 0.2) as it captures treatment effects that, when posited as the null hypothesis, produce at least one pre-treatment-period residual—2 in total, including the post-treatment residual—as extreme or more extreme than the post-treatment residual.

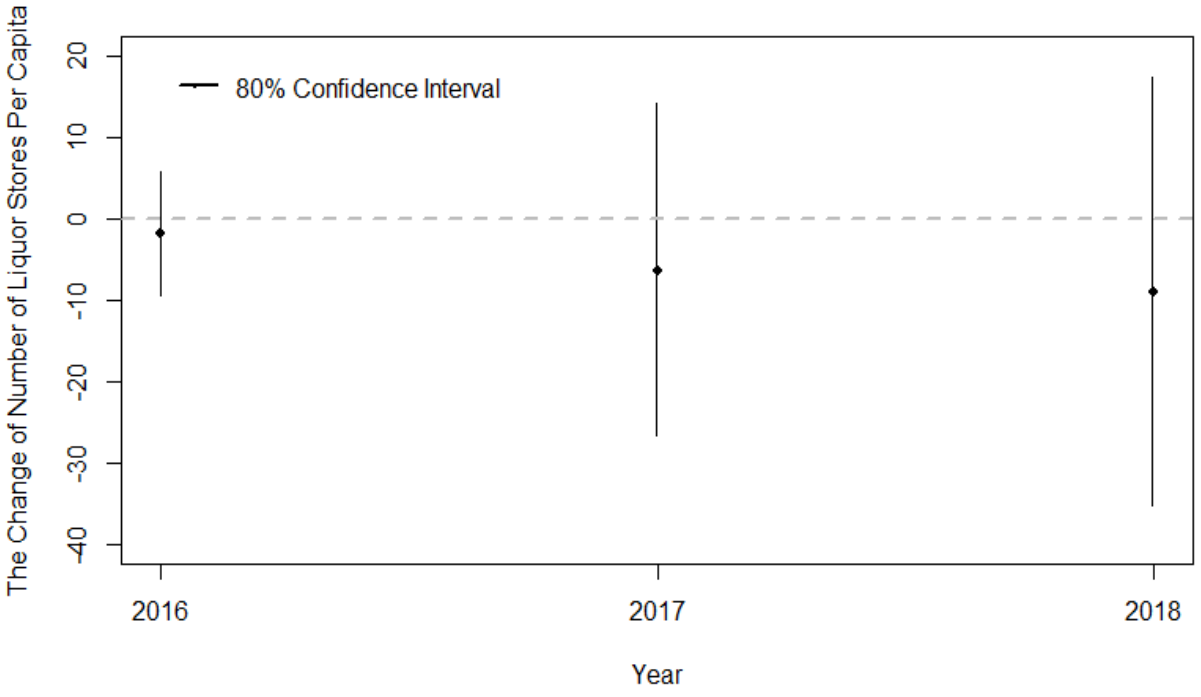

Figure 13. The difference between TN and synthetic TN Confidence Intervals

The Impact of Tennessee Wine Sale Reform on Overall Wine Sales Tax

Methodology

To assess the impact of the Tennessee wine sales reform on overall wine sales tax revenue, we applied the SCM, mirroring the approach taken to analyze its effect on the per capita number of liquor stores. Tennessee served as the treated state in this analysis as well. However, the selection criteria for the time framework and control states diverged from those used in the liquor store estimation, owing to the specific nature of the impact on tax revenues. We considered fiscal policy reforms (namely, reforms 4, 5, and 6), the authorization for grocery stores to sell beer (reform 10), and retail distribution reforms (reforms 7, 8, and 9) as significant factors. It is critical to consider these reforms because they are directly relevant to wine sales tax, thus guiding our selection of control states and the study period.

Given the revised criteria incorporating other alcohol reforms, the time frame is narrowed to 2014-2018. This adjustment accounts for a beer tax reform in Tennessee in 2013. Delaware and Kentucky were excluded due to fiscal policies affecting them in 2017 and from 2015 to 2018, respectively. Also, New Jersey, Rhode Island, and Utah were removed from the control group because they did not fully report wine sales tax data during 2014-2018. Therefore, our analysis focuses on the 2014-2018 period, with a control pool consisting of five states: Alaska, New York, Minnesota, Connecticut, and Colorado.

Data

We gathered annual wine sales tax data for Tennessee (the treated state) and the control states from Fiscal Year (FY) 2014 to 2019. Data were obtained from state tax receipts and tax collection reports from the following sources: Department of Revenue, Tennessee; Alaska Department of Revenue – Tax Division; New York State Department of Taxation and Finance; Minnesota Department of Revenue; Connecticut State Department of Revenue Services; Colorado Department of Revenue. Each fiscal year begins in July of the previous calendar year and ends in June of the current year. For instance, FY 2014 includes wine sales tax data from July 2013 to June 2014. As the reform took effect on July 1, 2016, marking the beginning of FY 2017, the post-reform period includes FY 2017, 2018, and 2019.

Similar to analyzing the number of liquor stores per capita, we use wine sales tax per capita as the outcome variable to make it comparable across time and states. **Figure 14** presents the trend in wine sales tax per capita from FY 2014 to 2019. The wine sales tax per capita in Tennessee is higher than New York, Minnesota, and Colorado but lower than Connecticut and Alaska. Notably, the wine sales tax per capita in Tennessee increases in FY 2017, a trend not observed in the control states.

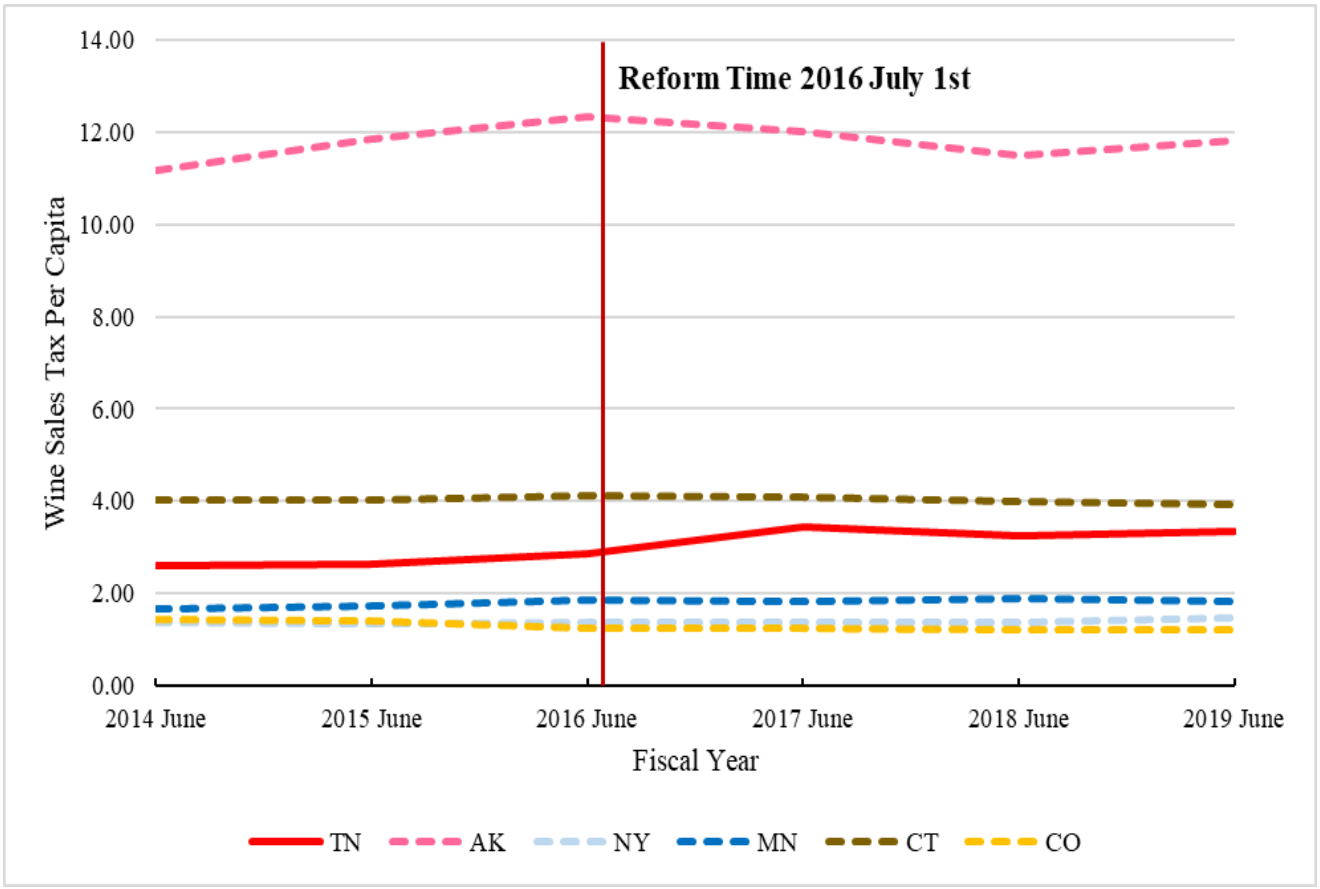

Figure 14. Trends in wine sales tax, FY 2014-2019: Tennessee *versus* control states

Similar to estimating the policy impact on the number of liquor stores per capita, nine variables are included as predictors: 1) population density, 2) proportion of civilian population above 21 years old, 3) average income per capita, 3) wine consumption per capita, 4) proportion of the population with a college degree and above, 5) the number of wineries, 6) unemployment rate, 7) the proportion of non-white population, 8) wine sales tax per capita in FY 2014, and 9) wine sales tax per capita in FY 2016. The descriptive statistics of these predictors are presented in **Table 3** and **Figure 14**.

Results from Synthetic Control Analysis

Following the methodology outlined earlier, we constructed synthetic Tennessee using equations (1) and (2). Our analysis indicates that the trend of wine sales tax per capita in Tennessee before the reform is most accurately replicated by a combination of Alaska (weight: 0.101), Minnesota (weight: 0.711), and New York (weight: 0.225) (see **Table 10**). The remaining control states have zero weights, signifying their negligible contribution to the synthetic Tennessee.

Table 10. Synthetic Weights

State	Synthetic Control Weight
CO	0.000
AK	**0.101**
MN	**0.711**
CT	0.000
NY	**0.225**

Table 11 compares the pre-reform characteristics (predictors) among Tennessee, synthetic Tennessee, and the simple average of the five control states. The results indicate that the characteristics of synthetic Tennessee resemble those of actual Tennessee, except for the unemployment rate and proportion of the non-white population. Therefore, the synthetic Tennessee provides a more accurate basis for comparison with actual Tennessee than the simple average of the control states.

Table 11. Summary statistics for predictors: Tennessee *versus* synthetic Tennessee *versus* simple control average

Variables	TN	Synthetic TN	Average of 5 Control States
Population density (persons per square mile, 2010)	153.9	124.8	253.1
Proportion of civilian population above 21 years old (2009-2015)	0.73	0.73	0.73
Average income per capita ($, 2009-2015)	42350.33	53732.80	57539.13
Wine consumption per capita (Gallons, 2009-2015)	0.28	0.46	0.52
Proportion of population (>25 yrs.) with college degree and above, 2015	0.25	0.33	0.34
The number of wineries (2009-2015)	30.67	53.44	57.27
The unemployment rate (%, 2009-2015)	5.63	4.53	5.12
The proportion of non-white population (2010)	0.20	0.17	0.21
Wine sales tax per capita in fiscal year 2014	2.61	2.56	3.93
Wine sales tax per capita in fiscal year 2016	2.86	2.83	4.18

Note: "Average of 5 Control States" is the unweighted average of CO, AK, MN, CT, and NY.

Figure 15 depicts the trends in wine sales tax per capita in Tennessee and synthetic Tennessee. Synthetic Tennessee closely mirrors the actual trajectory of Tennessee during the pre-reform period, with an RMPSE of 0.044, indicating a close fit. This suggests that synthetic Tennessee provides a reasonable approximation of wine sales tax per capita in actual Tennessee from FY 2017 to 2019 in the absence of the reform.

The difference between wine sales tax per capita in Tennessee and synthetic Tennessee after the reform represents the net effect of the reform. Comparing outcomes post-reform, it is evident that wine sales tax per capita in synthetic Tennessee remains stable, while in actual Tennessee, it increased in FY 2017 before stabilizing. This suggests that the wine sales reform led to an increase in wine sales tax per capita in Tennessee, contrasting with states where the reform was not implemented, and wine sales tax per capita remained unchanged.

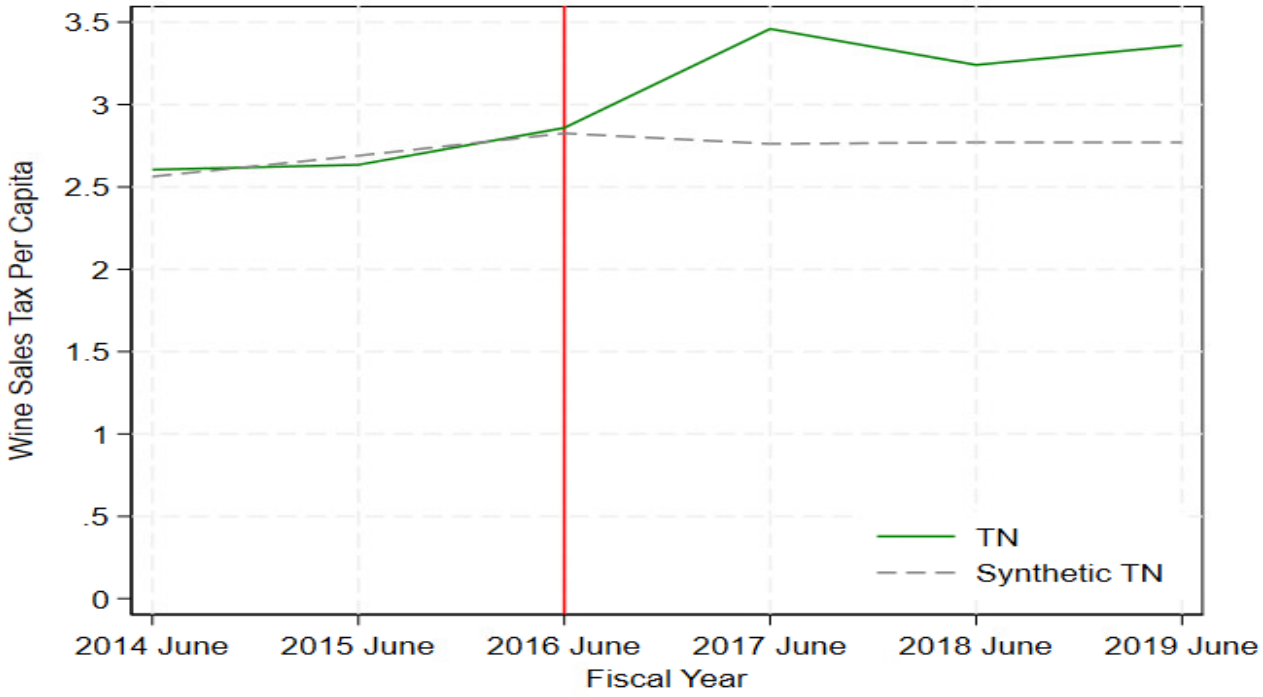

Figure 15. Trends in wine sales tax per capita: Tennessee *versus* Synthetic Tennessee

To determine the significance of the differing trends in the number of liquor stores between Tennessee and its synthetic control after the reform, we applied the SCE method, and the results are reported in Table 11. The results indicate that wine sales tax per capita increased by 0.698 in Fiscal Year (FY) 2017, 0.417 in FY 2018, and 0.590 in FY 2019 after the reform. The standardized p-values (<0.001) for each post-treatment year suggest that these increases are statistically significant in all post-treatment fiscal years.

Table 12. The SCM estimates of the reform impacts on wine sales tax per capita

Post Year (After Reform)	Wine Sales Tax Per Capita
FY 2017	0.698 (0.000)[a]
FY 2018	0.471 (0.000)
FY 2019	0.590 (0.000)

[a] Number in parentheses are standardized p-values.

To assess the robustness of our results, we conducted the in-space placebo test once again. Table 13 presents the post- and pre-treatment RMSPEs from this test. Tennessee exhibits the highest post- to pre-treatment RMSPE ratio at 13.52, approximately 10 times higher than the other states. Conversely, states such as New York, Colorado, Connecticut, Alaska, and Minnesota have ratios close to or below 1, indicating no treatment effect in these states. The significantly higher ratio observed in Tennessee supports our findings that the wine sales reform significantly increased the wine sales tax in TN. Indeed, there are no cases (joint standardized p-value is 0.00) showing larger changes than Tennessee when the policy was hypothetically applied to them for the test. It indicates that the average positive impact of the wine sales reform on the wine sales tax over the three years is statistically significant. Thus, the results from the SCM pass the in-space placebo test.

Table 13. Post- and pre-treatment RMSPEs from in-space placebo test

	Pre-Treatment RMSPE	Post-Treatment RMSPE	Ratio
TN	0.04	0.59	13.52
NY	0.10	0.17	1.75
CO	0.38	0.57	1.49
CT	0.07	0.07	1.02
AK	7.74	7.77	1.00
MN	0.11	0.07	0.64

Alternative empirical strategies

Synthetic Difference-in-Difference

Based on the same control pool and time framework used in SCM, we employed Synthetic DID to estimate the impact of the wine sales reform on wine sales tax per capita in Tennessee. Figure 16 illustrates the trend of wine sales tax per capita in Tennessee (treated) alongside the synthetic control constructed by Synthetic DID. Again, the shaded green area represents the optimal pre-treatment

weights. Notably, wine sales tax per capita in Tennessee is observed to be lower than that in the synthetic control state. The parallel trends of Tennessee and the synthetic control in the pre-treatment period enhance the credibility of the Synthetic DID results. The change in the gap between Tennessee and the synthetic control before and after the wine sales reform reflects the impact of the reform on wine sales tax per capita in Tennessee. It is observed that the wine sales tax per capita trend remains stable after the reform, while there is an increase in wine sales tax per capita in Tennessee. This suggests a positive impact of the wine sales reform on wine sales tax per capita in Tennessee.

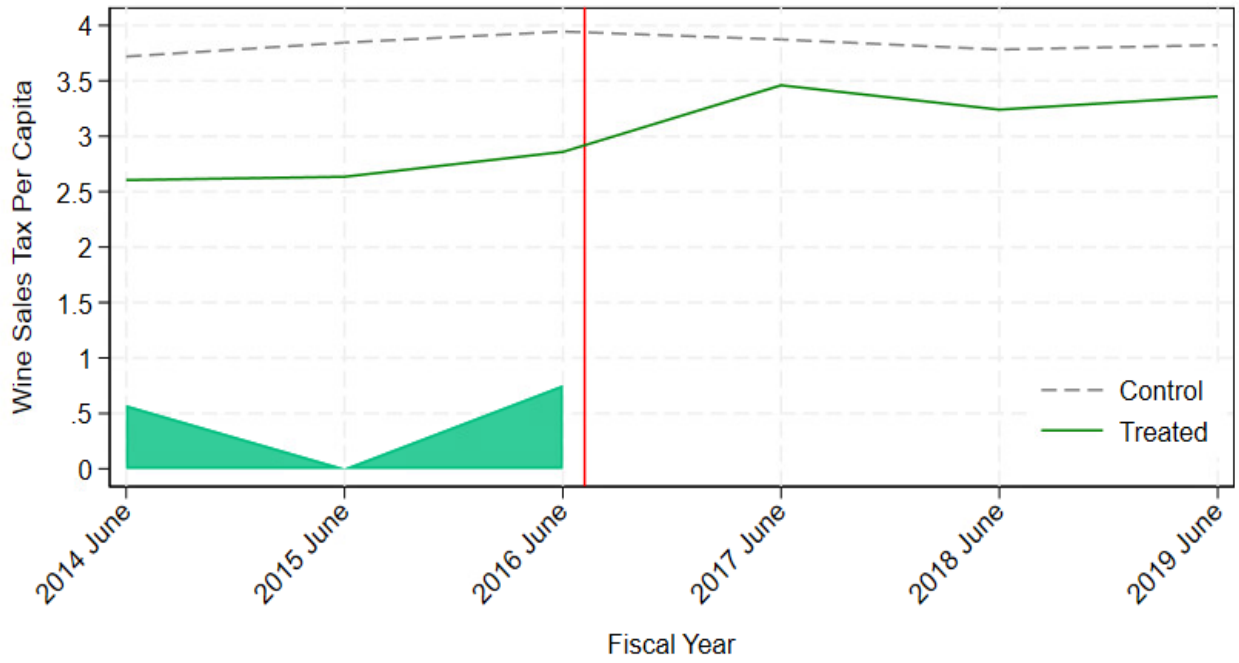

Figure 16. Trends in wine sales tax per capita: TN vs. weighted control

Table 14 presents the results from synthetic DID, indicating that the reform generated a wine sales tax per capita increase of 0.614 from FY 2017 to FY 2019. The p-value (0.022) suggests this increase is statistically significant at the 5% level over three post-treatment fiscal years. Thus, the result of synthetic DID is consistent with that from SCM.

Table 14. The treatment effect from Synthetic DID

	The Wine Sales Tax Per Capita
Treatment	0.614 (0.022)

Note: p-values are in parentheses, which are based on 1,000 placebo replications.

Conformal Inference (Machine Learning)

Similar to the methodology employed for estimating the impacts on the number of liquor stores per capita, we utilized conformal inference to construct synthetic control and assess the impact of the wine sales reform on wine sales per capita in Tennessee. Table 15 presents the conformal inference weight of states in the control pool. According to conformal inference, Alaska (0.05) has a positive weight, while Colorado (-0.95) has a negative weight. Alaska, Minnesota, and Connecticut have zero weights.

Table 15. Conformal Inference Weights

State	Conformal Inference Weight
AK	0.05
NY	0.00
MN	0.00
CT	0.00
CO	-0.95

The difference between Tennessee and synthetic Tennessee in the post-treatment periods reflects the impact of wine sales reform on the per capita wine sales tax in Tennessee. **Figure 13** plots the difference between Tennessee and synthetic Tennessee from FY 2017 to FY 2019 and 70% confidence intervals.[76] It shows that the difference between Tennessee and synthetic Tennessee is positive across three post-treatment years, which means there is an increase in wine sales tax per capita in Tennessee after the wine sales reform. However, the result is only statistically significant at the 30% level, which could be attributable to the small size of the control pool. Indeed, the p-values of the wine sales reform effects are 0.66 based on Moving Block Permutations and 0.56 based on iid Permutations, respectively. The effects from conformal inference are consistent with those from SCM and synthetic control, but it is not statistically significant.

With three pre-treatment periods, we utilize four time periods in total to construct the p-value metric for conformal inference, which is the proportion of residuals whose absolute values are at least as great as the absolute value of the residual for the treated period. Consequently, a p-value of 0.25 (1/4) is attainable for any treatment effect under the null hypothesis, as its residual is always as extreme as itself. Thus, a p-value of 0.25 (1/4) is achievable for any treatment effect under the null (its residual is always as extreme as itself). We chose an 70% confidence interval (p-value < 0.3) as it captures treatment effects that, when posited as the null hypothesis, produce at least one pre-treatment-period residual—2 in total, including the post-treatment residual—as extreme or more extreme than the post-treatment residual.

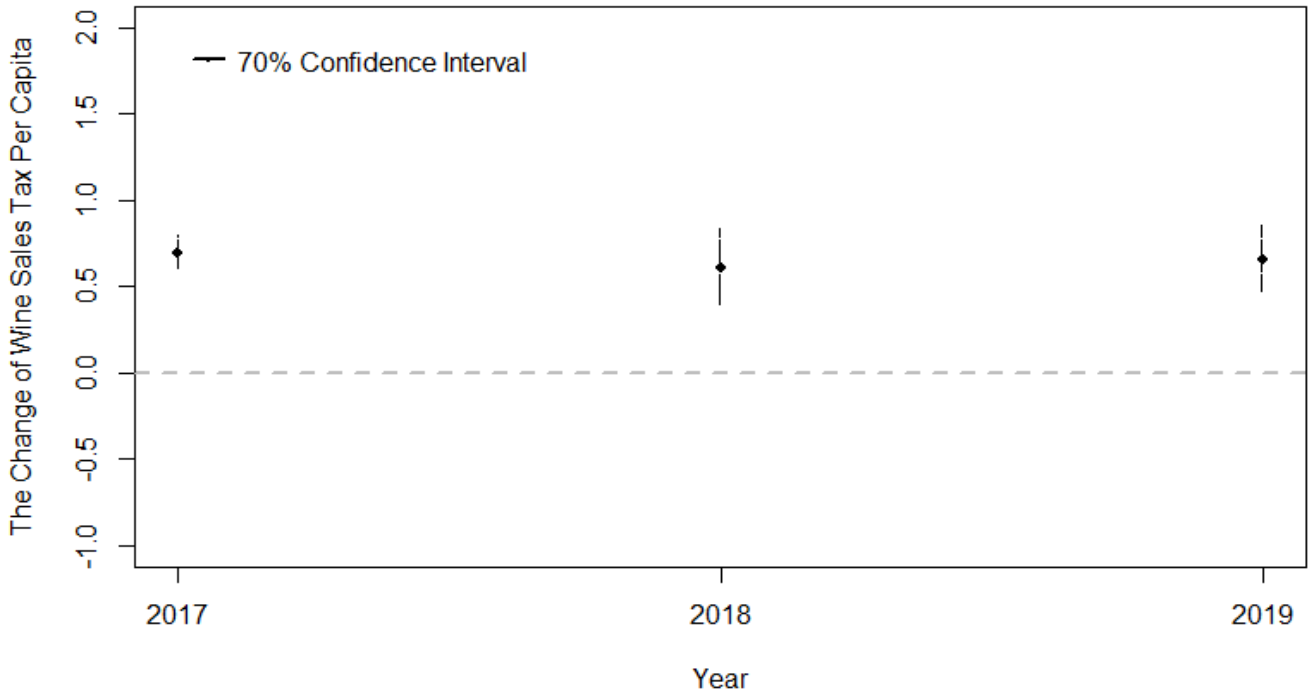

Figure 13. The difference between TN and synthetic TN Confidence Intervals

Final Remarks

Tennessee's expansion of wine sales to retail food stores did not result in significant liquor store closures. While this study does show that the reform may have prevented further increases in liquor stores selling wine compared to a hypothetical synthetic Tennessee without the policy reform, any such restraint on growth was not statistically significant. At the same time, wine sales expansion triggered a significant surge in sales tax collected and, consequently, in state revenue.

It is also necessary to note the study's limitations and areas for future evaluation on the research topic. First, our assessment of the Tennessee policy reform represents just one case study into the effect of wine grocery store sales on liquor store closures and sales. The Tennessee policy serves as a natural experiment with tremendous policy relevance, but other research could consider the effects seen in other states that have implemented similar policies to see the generalizability of our findings.

On a related note, it is important to consider how the effects of legalizing wine in grocery stores could be different from legalizing beer or distilled spirits sales in grocery stores. In the case of Tennessee, grocery stores could already sell beer. This could mean that the marginal effect on liquor store closures could have been dampened by the fact that grocery stores could already sell beer. With this, it would also be worth exploring how allowing distilled spirit sales would impact outcomes. Tennessee does not allow grocery stores to sell distilled spirits, which means consumers must still go to a liquor store for these products. As Tennessee consumers are among the leading consumers of whiskey (VinePair,

2021)[77], liquor stores could, for example, specialize in whiskey product offerings while supplementing sales with general beer and wine offerings. If this policy were to change, where grocery stores could also sell distilled spirits, the effect on liquor stores could be stronger than what we observe here. Therefore, stakeholders and policymakers should exercise caution when applying these results to other beer, wine, and spirit policy reforms.

The study is also constrained by data availability, where we only have access to the number of liquor store licenses by retail channel. We do not observe sales volume by retail channel, meaning we cannot assess the effect of the reform on liquor store sales following the reform. Past research simulated how allowing grocery stores to sell wine in grocery stores could influence sales in New York, suggesting that liquor store owners could experience a 28% decline in revenue (Rickard, 2012). Without access to sales data across different channels and across the treatment and control states, we cannot address this outcome. Thus, while the study demonstrates a non-statistically significant effect of the policy on liquor store closures, there could still be an impact on liquor store sales and revenue. Relatedly, we do not observe how average wine prices changed following the reform. Further analysis is needed to address this question.

Lastly, another limitation of our study is the focus on three post-policy reform periods due to data and/or SCM requirements. This potentially affects our ability to confidently assess long-term effects and trends that may emerge over a more extended period; as well as our ability to observe and analyze the adaptation behaviors of the affected entities and the market as a whole, which might only become apparent after a longer period. Taken together, these factors highlight the need for further research with extended post-policy data.

Despite these limitations, our results provide important insights into the liberalization of wine sales in grocery stores. Consumers consistently tell pollsters they prefer to purchase wine with their food. A recent review of the literature finds a "*consensus that consumers prefer having a large number of marketplace choices that are more convenient, easily accessible and reasonably priced.*"[78] Balanced against this clear consumer preference is the fear among opponents of the policy that expanding wine sales to food stores will result in the closure of existing liquor stores. This potential tradeoff must be considered on a case-by-case basis, as concerns over the unintended consequences of these reforms are not entirely unjustified. However, in the case of Tennessee's grocery store wine reform, we find non statistically significant effects on liquor store closures and a statistically significant increase in wine sales.

[77] Vinepair (2021). The states that drink the most American whiskey. https://vinepair.com/articles/states-drink-most-american-whiskey-map/

[78] Center for Public Private Partnerships in Health, University of Delaware, College of Health Sciences. (2021). *The Economic Benefit of Beer and Wine Sales in Grocery Stores*.

References

Abadie, A. (2021). Using synthetic controls: Feasibility, data requirements, and methodological aspects. *Journal of Economic Literature*, *59*(2), 391-425. https://pubs.aeaweb.org/doi/pdfplus/10.1257/jel.20191450

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American statistical Association*, *105*(490), 493-505. https://doi.org/10.1198/jasa.2009.ap08746

Abadie, A., & Gardeazabal, J. (2003). The economic costs of conflict: A case study of the Basque Country. *American economic review*, *93*(1), 113-132. https://pubs.aeaweb.org/doi/pdfplus/10.1257/000282803321455188

Aldrich, Anna Zarra. "UConn Research Informs Policy Debate over Wine Sales in Grocery Stores" UConn Today. February 21, 2023. https://today.uconn.edu/2023/02/uconn-research-informs-policy-debate-over-wine-sales-in-grocery-stores/#

Arkansas Alcoholic Control Act (2010). https://law.justia.com/codes/arkansas/2010/title-3/chapter-1/3-1-101/

Barber, N., Dodd, T., & Ghiselli, R. (2008). Capturing the younger wine consumer. *Journal of wine research, 19*(2), 123-141. https://doi.org/10.1080/09571260802622225

Berni, P., Begalli, D., & Capitello, R. (2005). An occasion-based segmentation approach to the wine market in Denmark. *Journal of international food & agribusiness marketing, 17*(1), 117-145. https://doi.org/10.1300/J047v17n01_07

Beverage Information Group (September 2022a). Total alcoholic beverage sales in the United States from 2006 to 2021(in million U.S. dollars). Available at *Statista* website: https://www.statista.com/statistics/207936/us-total-alcoholic-beverages-sales-since-1990/ [last accessed March 17, 2023]

BLS (2021). Industry on tap: Wineries. Available at *BLS Spotlight on Statistics* website: https://www.bls.gov/spotlight/2021/industry-on-tap-wineries/home.htm [last accessed March 17, 2023]

Bohn, S., Lofstrom, M., & Raphael, S. (2014). Did the 2007 Legal Arizona Workers Act reduce the state's unauthorized immigrant population?. *Review of Economics and Statistics*, *96*(2), 258-269. https://doi.org/10.1162/REST_a_00429

Brierley-Jones, L., Ling, J., McCabe, K. E., Wilson, G. B., Crosland, A., Kaner, E. F., & Haighton, C. A. (2014). Habitus of home and traditional drinking: a qualitative analysis of reported middle-class alcohol use. *Sociology of health & illness, 36*(7), 1054-1076. https://doi.org/10.1111/1467-9566.12145

Burgdorf, J. (2019). Impact of mandated exclusive territories in the US brewing industry: Evidence from scanner level data. *International Journal of Industrial Organization*, *63*, 376-416. https://doi.org/10.1016/j.ijindorg.2018.12.001

Caputo, V., & Just, D. R. (2022). The economics of food related policies: Considering public health and malnutrition. In *Handbook of agricultural economics* (Vol. 6, pp. 5117-5200). Elsevier. https://doi.org/10.1016/bs.hesagr.2022.03.008

Chang, K. J., Thach, M. L., & Olsen, J. (2016). Wine and health perceptions: Exploring the impact of gender, age and ethnicity on consumer perceptions of wine and health. *Wine Economics and Policy, 5*(2), 105-113. https://doi.org/10.1016/j.wep.2016.09.001

Connecticut State Department of Revenue Services. Annual Report. Available at *Connecticut State Department of Revenue Services* website: https://portal.ct.gov/DRS/DRS-Reports/Annual-Reports/Department-of-Revenue-Services-Annual-Reports

Census Bureau (n.d.). Quick facts. Available at *U.S. Census Bureau* website: https://www.census.gov/quickfacts/fact/table/US/PST045221 [last accessed March 17, 2023].

Center for Public Private Partnerships in Health, University of Delaware, College of Health Sciences. (2021). *The Economic Benefit of Beer and Wine Sales in Grocery Stores*.

Department of Revenue, Mississippi. Annual Reports. Available at *Mississippi Department of Revenue* website: https://www.dor.ms.gov/statistics

Department of Revenue, Tennessee. Monthly & Fiscal Year Tax Collections. Available at *Tennessee Department of Revenue* website: https://www.tn.gov/revenue/tax-resources/tax-collections-information/monthly-fiscal-year-collections.html

Distilled Spirits Council (September 14, 2022). Spirits-based ready-to-drink beverages experience tremendous market growth. Available at *Distilled Spirits Council of the United States* website: https://www.distilledspirits.org/wp-content/uploads/2022/09/Final-DISCUS-Handout-9.14.22-v2-1.pdf [last accessed March 17, 2023]

Distilled Spirits Council (February 9, 2023). Annual economic briefing: Support tables – 2022. Available at *Distilled Spirits Council of the United States* website: https://www.distilledspirits.org/wp-content/uploads/2023/02/ECONOMIC-BRIEFING-SUPPORT-TABLES-2022.pdf [last accessed March 17, 2023]

Dobis, E. A., Reid, N., Schmidt, C., & Goetz, S. J. (2019). The role of craft breweries in expanding (local) hop production. *Journal of Wine Economics*, *14*(4), 374-382. https://doi.org/10.1017/jwe.2019.17

Farris, J., Malone, T., Robison, L. J., & Rothwell, N. L. (2019). Is "localness" about distance or relationships? Evidence from hard cider. *Journal of Wine Economics*, *14*(3), 252-273. https://doi.org/10.1017/jwe.2019.42

FMI. (2012). The Economics Impact of Allowing Shoppers to Purchase Wine in Food Stores. Available at *FMI* website: http://fmi.org/docs/state-affairs/fmi_wine_study.pdf?sfvrsn=0

Grogger, J. (2017). Soda taxes and the prices of sodas and other drinks: evidence from Mexico. *American Journal of Agricultural Economics, 99*(2), 481-498. https://doi.org/10.1093/ajae/aax024

Hard Seltzer (2023). Revenue – United States. Available at *Statista* website: https://www.statista.com/outlook/cmo/alcoholic-drinks/hard-seltzer/united-states#revenue [last accessed March 17, 2023]

Hart, J. (2018). Drink beer for science: An experiment on consumer preferences for local craft beer. *Journal of Wine Economics*, *13*(4), 429-441. https://doi.org/10.1017/jwe.2018.38

Ho, S. T., & Rickard, B. J. (2021). Regulation and purchase diversity: Empirical evidence from the US alcohol market. *International Review of Law and Economics, 68*, 106008. https://doi.org/10.1016/j.irle.2021.106008

Kleven, H. J., Landais, C., & Saez, E. (2013). Taxation and international migration of superstars: Evidence from the European football market. *American economic review*, *103*(5), 1892-1924. https://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.103.5.1892

Kreif, N., Grieve, R., Hangartner, D., Turner, A. J., Nikolova, S., & Sutton, M. (2016). Examination of the synthetic control method for evaluating health policies with multiple treated units. *Health economics*, *25*(12), 1514-1528. https://doi.org/10.1002/hec.3258

Malone, T. & Hall, J. (2017). Can liberalization of local food marketing channels influence local economies? A case study of West Virginia's craft beer distribution laws. *Economics and Business Letters 6*(2), 54-58.
http://zbw.eu/econis-archiv/bitstream/11159/849/1/2017%202%205.pdf

Malone, T., & Lusk, J. L. (2016). Brewing up entrepreneurship: Government intervention in beer. *Journal of Entrepreneurship and Public Policy*, *5*(3), 325-342. https://doi.org/10.1108/JEPP-02-2016-0004

McClelland, R., & Iselin, J. (2019). Do State Excise Taxes Reduce Alcohol-Related Fatal Motor Vehicle Crashes?. *Economic Inquiry*, *57*(4), 1821-1841. https://doi.org/10.1111/ecin.12811

McCullough, M., Berning, J., & Hanson, J. L. (2019). Learning by brewing: Homebrewing legalization and the brewing industry. *Contemporary Economic Policy*, *37*(1), 25-39. https://doi.org/10.1111/coep.12394

McMillan, R. (2023). State of the U.S. wine industry. Available at *Silicon Valley Bank Wine Division* website: https://www.svb.com/globalassets/trendsandinsights/reports/wine/svb-state-of-the-wine-industry-report-2023.pdf [last accessed March 16, 2023]

Meany, B., Berning, J., Smith, T., & Rejesus, R. M. (2017). The Effect of Sunday Alcohol Sales Bans on Teen Drinking in Georgia. *Applied Economic Perspectives and Policy*, *40*(3), 461-481. https://doi.org/10.1093/aepp/ppx046

Mississippi House Bill 239. (2022). http://billstatus.ls.state.ms.us/2022/pdf/history/HB/HB0239.xml

Mohan, P. (2017). The economic impact of hurricanes on bananas: a case study of Dominica using synthetic control methods. *Food policy*, *68*, 21-30. https://doi.org/10.1016/j.foodpol.2016.12.008

NIH NIAAA (n.d.). Surveillance reports. Available at *NIH NIAAA* website: https://pubs.niaaa.nih.gov/publications/surveillance.htm [last accessed February 21, 2023].

Observatory of Economic Complexity (n.d.). Wine in the United States. Available at *OEC World* website: https://oec.world/en/profile/bilateral-product/wine/reporter/usa [last accessed March 16, 2023].

Office of State Budget Director, Kentucky. Monthly Tax Receipts. Available at *Office of State Budget Director, Kentucky* website: https://osbd.ky.gov/Publications/Pages/Monthly-Tax-Receipts.aspx

Oklahoma House Bill 1349. http://www.oklegislature.gov/BillInfo.aspx?Bill=HB1349&Session=2300

Ritchie, C., Elliott, G., & Flynn, M. (2010). Buying wine on promotion is trading-up in UK supermarkets: A case study in Wales and Northern Ireland. *International Journal of Wine Business Research*. https://doi.org/10.1108/17511061011061685

Rickard, B. J. (2012). The economics of introducing wine into grocery stores. *Contemporary Economic Policy*, *30*(3), 382-398. https://doi.org/10.1111/j.1465-7287.2011.00272.x

Rickard, B. J., Costanigro, M., & Garg, T. (2013). Economic and social implications of regulating alcohol availability in grocery stores. *Applied Economic Perspectives and Policy*, *35*(4), 613-633.

Palardy, N., Costanigro, M., Cannon, J., Thilmany, D., Berning, J., Bayham, J., & Callaway, J. (2023). Beer sales in grocery and convenience stores: a glass half-full for craft brewers?. *Regional Studies*, 1-14. https://doi.org/10.1080/00343404.2023.2166914

Pennsylvania Liquor Control Board Act 166 (2016). https://www.lcb.pa.gov/Legal/Pages/Act-166-of-2016.aspx

Seo, B. (2019). Firm scope and the value of one-stop shopping in washington state's deregulated liquor market. *Kelley school of business research paper*, (16-70). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2863094

Slater, M. E., & Alpert, H. R. (2023). Surveillance Report# 120 Apparent Per Capita Alcohol Consumption: National, State, And Regional Trends, 1977–2021.

Staples, A. J., Chambers, D., & Malone, T. (2022). How many regulations does it take to get a beer? The geography of beer regulations. *Regulation & Governance*, *16*(4), 1197-1210. https://doi.org/10.1111/rego.12403

Tennessee Code § 57-3-803. https://law.justia.com/codes/tennessee/2014/title-57/chapter-3/part-8/section-57-3-803

Tennessee Code §§ 57-3-406. https://law.justia.com/codes/tennessee/2021/title-57/chapter-3/part-4/section-57-3-406/

The National Association of American Wineries (2018). Top 10 Wine Producing States. Available at *The National Association of American Wineries* website: https://wineamerica.org/policy/by-the-numbers/

TTB. (March 10, 2023). Production volume of bottled wine in the United States in 2022, by state (in thousand gallons). Available at *Statista* website: https://www.statista.com/statistics/737529/leading-bottled-wine-producing-states-us/

USDA ERS (May 24, 2022). U.S. wine imports reach nearly $7.5 billion in 2021. Available at *USDA ERS* website: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=103967 [last accessed March 17, 2023]

U.S. Bureau of Economic Analysis. (2023). Per capita personal consumption expenditures: Food and beverages purchased for off-premises consumption (Dollars). Available at *BEA* website: https://apps.bea.gov/itable/?ReqID=70&step=1

U.S. Census Bureau. (2020). State Population by Characteristics: 2010-2020. Available at *U.S. Census Bureau* website: https://www.census.gov/programs-surveys/popest/technical-documentation/research/evaluation-estimates/2020-evaluation-estimates/2010s-state-detail.html

VinePair (November 24, 2021). The States with the most wineries in 2021. Available at *VinePair* website: https://vinepair.com/articles/map-states-wineries/ [last accessed March 16, 2023]

Wine Institute (September 2022a). California & US wine sales. Available at *Wine Institute* website: https://wineinstitute.org/our-industry/statistics/california-us-wine-sales/ [last accessed March 17, 2023]

Wine Institute (October 2022b). Total wine consumption of the United States from 2005 to 2021 (in million gallons) https://www.statista.com/statistics/233722/total-wine-consumption-of-the-us-by-wine-type/ [last accessed March 17, 2023]

Wines Vines Analytics (January 2021). Number of wineries in the United States in 2021, by production size. Available at *Statista* website: https://www.statista.com/statistics/259395/number-of-wineries-in-the-us-by-production-size/ [last accessed March 16, 2023]