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Beer sales in grocery and convenience stores: a glass half-full for craft brewers?

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ABSTRACT

We study how regulatory changes influence the market dynamics underlying business location decisions by investigating how a 2019 law introducing full-strength beer into grocery and convenience stores in the US state of Colorado impacted craft brewers a year after implementation. A state-wide survey reveals that the new channels brought limited change to how craft breweries sell beer. Access to grocery stores advantages larger craft breweries, while smaller breweries face significant logistical barriers. Analysis of mobile phone geolocation data reveals a modest reduction in visitation to liquor stores. Results suggest that the policy change will not impair Colorado's ability to draw craft beer investment.

KEYWORDS

alcohol distribution laws; policy evaluation; three-tier system; store traffic; interrupted time-series analysis; state-space forecasting

JEL L5, L66, R5

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1. INTRODUCTION

Craft brewing is an important sector of the US food and beverage economy, with more than 8000 breweries accounting for US\$29.3 billion in sales, or 25% of the total US beer market (Brewers Association, 2020b). While craft accounts for just a quarter of the total beer market, the industry is often touted as a boon for regional economies, and municipalities frequently compete to draw investment from craft breweries (Malecki, 2004; Reid & Gatrell, 2015). To highlight concerns about the resiliency of this sector, in 2021, President Joe Biden issued Executive Order 14,036, 'Promoting Competition in the American Economy', in part to reduce the trend of corporate consolidation and provide more diverse market opportunities for small businesses and entrepreneurs to compete (US Treasury Department, 2022). In particular, the directive noted the need '[t]o protect the vibrancy of the American markets for beer, wine, and spirits, and to improve market access for smaller, independent, and new operations', and called for an assessment of any unnecessary regulatory barriers or other practices that may thwart the resiliency of independent alcoholic beverage enterprises.

There are reasons to believe that craft brewers are vital to the regions where they locate, operate and sell. Focused on variety and small batch production,¹ craft breweries are inherently more labour intensive than large-scale mass producers (Tremblay & Tremblay, 2004), creating *in situ* job opportunities (Miller et al., 2019). Driven by a need for ample, low-cost spaces in the proximity of potential customers, breweries can act as first entrants and anchor point in the redevelopment of depleted urban neighbourhoods (Weiler, 2000), increasing the value of nearby residential properties (Nilsson & Reid, 2019). Independent and often employee-owned craft brewers espouse a culture of embeddedness and activism in local communities (Reid & Gatrell, 2015), create economic opportunities through tourism, (e.g., the 'ale trail'; Plummer et al., 2005) and, perhaps more importantly, contribute to the entertainment and lifestyle sought by high income professionals, attracting the creative talent that can promote growth (Florida, 2002; McGranahan & Wojan, 2007).

The success of the craft brewing industry in the United States is a fragmented story. Regions of bustling activity (e.g., California, Colorado, Michigan, Washington and

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Oregon) stand in stark contrast to the ‘craft beer deserts’ found in central and southern states (Reid et al., 2014). The reasons for such heterogeneity are numerous, but regulations governing alcohol sales and distribution are known to play a pivotal role (Malone & Lusk, 2016). Following the 21st Amendment and the repeal of prohibition in 1933, the federal government established the basic principles of the three-tier system, separating alcohol production, distribution and retailing, but delegating to individual states the power to regulate alcohol sales (Lam, 2014). Local authorities, in turn, struck different balances between temperance and the development of a local alcoholic beverage sector, creating a patchwork of regulatory ecosystems which fostered craft brewing in some states, while stifling it in others. Recent policy changes in Colorado, Oklahoma, Kansas and Utah now permit alcohol sales outside of liquor stores, altering key competitive drivers (e.g., distance, product selection) known to influence spatial shopping patterns of consumers (Cadwallader, 1981), to the potential benefit of some alcohol producers and detriment of others. This study contributes to two bodies of literature. First, we contribute to the nascent policy literature investigating how alcohol regulations, and in particular the distribution and retail environment, can promote or damage the craft brewing sector. Second, we contribute to the body of regional literature that investigates how key drivers of retail competition, namely distance and store attributes, drive consumer behaviour using this case study as an illustrative example of how policy may influence such drivers.

We examine the case of a recent regulatory change in Colorado, a core region for craft beer production in the United States (Moore et al., 2016; Reid et al., 2014). Craft beer has an economic impact totalling over US\$3 billion in Colorado (Watson, 2020) and the state ranks second in the total number of craft breweries (Brewers Association, 2020a). On 1 January 2019, in the biggest change since the end of prohibition, full-strength beer sales at grocery and convenience stores were legalized. Even though liquor stores retained nearly exclusive rights to sell wine and spirits, more than 1700 new full-strength beer retailers (Sealover, 2018b) entered the market, more than doubling the number of retail outlets selling beer and greatly increasing competition. This change created both opportunities and threats for craft breweries in this region: on the one hand, the possibility of entering the larger food distribution chain presented an opportunity to reach new consumers and increase sales; on the other, some (e.g., Kessinger, 2019) feared that competition at the retail level would cause the demise of liquor stores, threatening the channel through which Colorado craft brewers traditionally reached consumers outside of the brewery.

One year after the new policy was enacted, we conducted two studies to explore two main research questions of relevance to regional retail economics:

- To what extent have craft brewers been successful in distributing through grocery and convenience stores

following a major change in the regional regulatory environment?

- To what extent has the changed competitive drivers stemming from full-strength beer at grocery and convenience stores altered consumer shopping patterns at liquor stores?

Together, the studies provide an insight into how the liberalization of alcohol sales affects the decisions of producers and consumers, delivering a more complete understanding of the policy impact on Colorado craft brewers and providing evidence for other states considering greater liberalization of alcohol distribution.

For the first study we worked in collaboration with the Colorado Brewers’ Guild to survey a representative sample ($n = 76$) of craft breweries and understand how brewers adapted distribution strategies to new shopping patterns at new and traditional beer retailers. We collected primary (self-reported) data on total production, packaging practices, distribution strategies and volume sold by market channel for 2017 (pre-policy change) and at the end of 2019 (one-year post-policy). These data were then analysed by brewery size to reveal any scale-dependent differences in the effect of the policy.

For the second study we obtained a unique dataset on liquor store foot traffic patterns in Colorado and Minnesota (a control state where alcohol distribution policies did not change) from SafeGraph Inc., a company compiling geospatial cell phone-tracking data. We estimated the causal effect of the policy change on foot traffic by means of interrupted time-series analysis (Lopez Bernal et al., 2018) and state-space forecasting (Hyndman et al., 2008).

2. A LITERATURE-BASED CONCEPTUAL MODEL

While our focus is on the craft brewing industry, the results fit within the broader retail gravity model literature examining how the location and business patterns among competing retailers, as well as changing distribution and sales regulations, may influence the alcohol retail environment.

2.1. The policy environments for alcoholic beverages

Examining the more specific literature focused on craft brewers, two broad legislative trends are evident: on the one hand, many states recognize the importance of the alcoholic craft beverage industry and grant special allowances for smaller scale producers. For example, McCullough et al. (2019) found that states that legalize home brewing are more likely to have a vibrant craft industry. Malone and Lusk (2016) found that counties allowing on-premise sales and self-distribution had a significantly higher number of craft beer producers. Malone and Hall (2017) found that West Virginia’s legalization of on-premise brewery sales lead to higher wages but not employment. Conversely, Burgdorf (2019) showed that states forcing breweries and distributors to establish exclusive

distribution territories increases prices reduces the quantity of craft beer sold and has a disproportionate impact on small scale craft breweries.

A second legislative trend is one towards increased liberalization of the alcoholic beverage sector, aimed at loosening regulations for both large and small producers and relaxing rules limiting when, what type and where consumers can purchase alcoholic beverages. For example, 'blue laws', prohibiting the sale of alcohol on Sunday, are being progressively amended or abandoned (Gerber et al., 2016). As for what type and where alcohol can be sold, some US states do not permit any alcohol sales at grocery and convenience stores (e.g., Delaware), while other states allow only beer (e.g., Colorado post-2019), beer and wine (e.g., Oregon), or beer, wine and liquor (e.g., California) (Rickard et al., 2013). The general trend is towards the fully liberalized California model where direct to consumer shipping of wine by mail is also permitted.

While it is known that wider retail availability decreases alcohol prices and increases consumption, existing studies focus on the public health and social effects of liberalization (Meany et al., 2018; Rickard et al., 2013), and little is known about how deregulation impacts the market dynamics and regional business patterns of the craft beverage sector. One may presume that market liberalization will increase economic activity and favour smaller breweries but, as we learned from this study, such an outcome is by no means assured.

2.2. A cognitive gravity model of the Colorado beverage alcohol retail sector

Krugman (1991) first elevated the idea of economic geography as a means to address the scant treatment that place is given in discussions of the marketing strategies of industry stakeholders and how they are shaped by consumer behaviour. Of particular relevance is the concept of a gravity model, which suggests that economic agents consider a variety of spatial interactions between all the possible location pairs when making decisions about where to locate, sell or buy products. More specifically, in a retail gravity model one can imagine a boundary between the market areas of two locations competing over the same market based upon the intensity of their respective drivers or interactions. The two key drivers at work in such a model are the centroid or mass that serves to attract business (and depends on characteristics of the store and surrounding shoppers' preferences) and the distance or transport friction shoppers face when choosing the location where they will shop (Cadwallader, 1981). We used the key tenets of the literature on retail gravity models to conceptualize the model presented in Figure 1 showing how store and consumer attributes, as well as distances between stores, will interact to determine how the pull of the gravitational centroid will interact with distance to influence consumer shopping behaviour.

The idea of analysing the differential pull of various retail environment factors in a gravity model builds on earlier work by Cadwallader (1981) exploring consumer

behaviour across space. Sixty years after the four cornerstones of retail location theory were laid down, Cadwallader (1981) developed and tested a cognitive gravity model and found that the mass component (the gravitational centroid in our model) was far more important than the distance component for spatial competition. He also found evidence to suggest that the relative importance of the individual store attributes varies from store to store. More recent studies on regional retail landscapes (Hansen & Solgaard, 2004; Leeuwen & Rietveld, 2011; Verhetsel et al., 2022) found that a variety of factors, such as consumer attributes and the type of shopping trip (e.g., exceptional, daily, fun, groceries) interact with the distance component and influence the pull of the centroid.

For our study, Figure 1 illustrates how the introduction of beer into grocery and convenience store channels may disrupt the retail environment for consumers, with potential effects on both store attributes (the range and selection of beverage offerings) and distance to the nearest store (given the distance between two nearest full-strength beer retailers likely changed in a way that altered the trade-off consideration for shoppers). But, as Cadwallader (1981) suggests, consumers could evaluate those trade-offs in heterogeneous ways depending on whether they consider full-strength beer as a recurring staple of their purchases or, alternatively, a fun or exceptional purchase for special occasions. Moreover, the distribution strategy of craft brewers may change due to their perceptions of how strong the draw (gravitational centroid) of their products in the new market channels would be, and more importantly, if grocery or convenience stores perceive the same draw. Beer on the shelves of the new retailers will also affect the ability of liquor stores, the traditional and exclusive market channel for beer before the policy disruption, to draw consumers.

3. THE COLORADO CASE STUDY

The road to the (partial) liberalization of alcohol retail in Colorado was a tortuous one. Under the prior regulatory framework, the sale of full-strength beer, wine and spirits was largely restricted to liquor stores. For all other locations, grocery and convenience stores could obtain a fermented malt beverage (FMB) licence to sell beer less than 3.2% alcohol by weight (ABW).

As we conducted this study, one of the most fascinating learning experiences relates to the political economy of the lobbying forces that enabled the passage of the new distribution laws. The first change to the status quo occurred in 2016 when SB16-197 was passed to deter a ballot initiative, sponsored by grocery and convenience stores, that would have asked voters to expand where full-strength beer and wine may be sold (Vela, 2016). Following extensive lobbying from liquor stores, SB16-197 was passed as a compromise. It delayed the entry of full-strength beer into grocery and convenience stores until 1 January 2019 and created a working group to make recommendations on how to implement the transition. When the working group failed to reach a consensus,

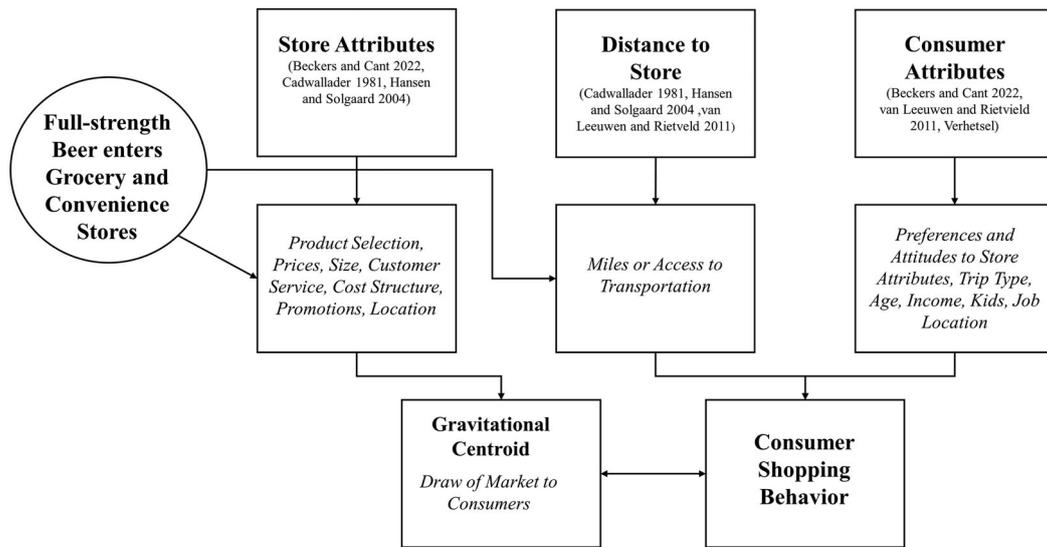


Figure 1. Cognitive gravity model of the Colorado beverage alcohol retail sector.

SB18-243, sponsored by the trade association for liquor stores, was introduced to mitigate potential losses (Sealover, 2018a). The most salient impacts of these two pieces of legislation are as follows:

- As of 1 January 2017, grocery stores, mass-merchandisers and club stores with pharmacies can obtain additional licences to operate up to four liquor-licensed drugstore locations in Colorado. This implies a

relatively minor change, as grocery chains such as King Soopers, which operates 152 stores in Colorado (Laxen, 2018), would be allowed only four liquor-licence drugstore locations.

- Starting on 1 January 2017, liquor store owners can obtain an additional liquor licence and operate up to two locations. The provision balances the grocery allowance and was included to help liquor stores compete on a level playing field.

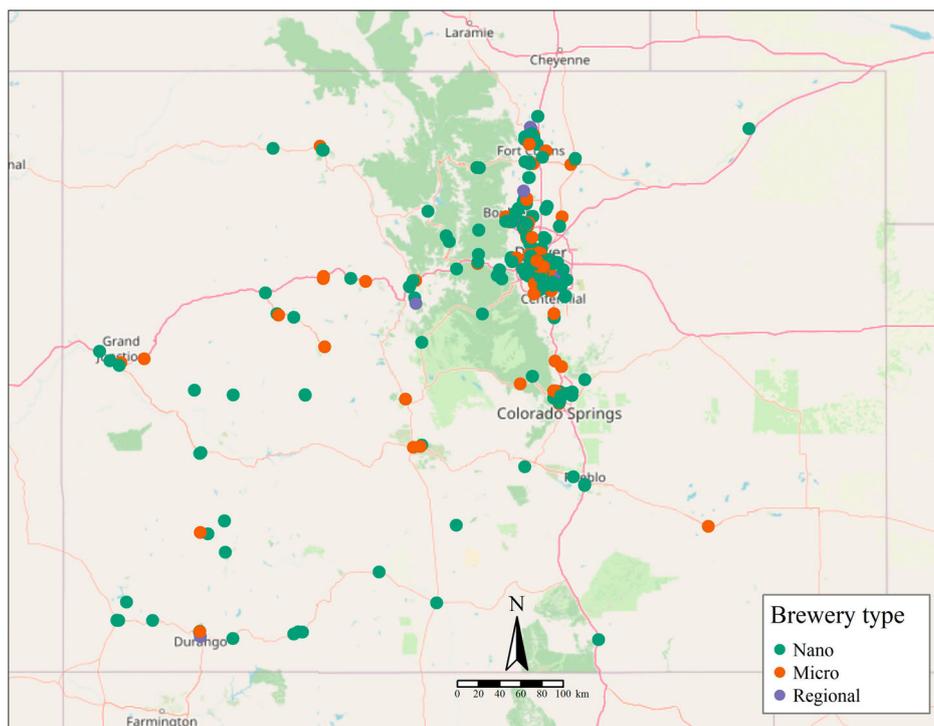


Figure 2. Map of Colorado craft breweries.

Source: Data were obtained from the Brewers Association (2018b). Nanobreweries produce fewer than 1000 barrels (bbls) annually, microbreweries produce 1000–14,999 bbls, and regional breweries produce 15,000–6 million bbls.

- As of 1 January 2019, retailers with 3.2% ABW (also known as near beer) licences can now sell full-strength beer, but not wine or liquor. This is the most consequential change and significantly alters the Colorado alcohol retail market.

These changes are better understood in the context of the existing laws stipulating a brewery's ability to sell directly to a retailer (self-distribution). Colorado allows breweries to obtain a distributor licence and sell directly to retailers anywhere in the state irrespective of the size of the brewery (Colorado Revised Statutes §44-3-402, 2018). Hybrid models are also allowed, whereby a self-distributing brewery can contract with an independent distributor, with one caveat: that the distribution territory of the brewery and that of the distributor may not overlap.

4. STUDY 1: HOW THE LIBERALIZATION OF FULL-STRENGTH BEER SALES CHANGED CRAFT BREWERS' DISTRIBUTION STRATEGIES

As of 2019, Colorado had 425 craft breweries and brewpubs that range from taproom breweries producing fewer than 100 barrels (bbls) annually to regional giants producing nearly 1 million bbls (Brewers Association, 2020a). Data show that the majority of craft breweries in the state are small, producing fewer than 1000 bbls annually (Brewers Association, 2018a). Figure 2 reveals that craft breweries are clustered along Colorado's densely populated Front Range, specifically from Colorado Springs north to Fort Collins. The Eastern Plains of Colorado is sparsely populated, predominately agricultural and contains almost no breweries. Western Colorado, characterized by mountains and a popular tourist destination, has breweries scattered throughout. Nanobreweries (under 1000 bbls), microbreweries (1000–14,999 bbls) and regional breweries (15,000–6 million bbls) can be found in metro areas and tourist towns connected to major roads, while only nano- and microbreweries locate in more isolated areas. Prior literature supports our visual assessment that population, tourism and access to infrastructure influence the location decision of craft breweries (Moore et al., 2016; Reid & Gattrell, 2015).

Our state-wide survey, conducted in the second half of 2019 in collaboration with the Colorado Brewers Guild, asked craft breweries about their distribution strategy before and after full-strength beer entered grocery and convenience stores. While primary data collection presents its own challenges, secondary data provide little information about the distribution strategies craft brewers are using. Scanner data do not include all retail channels and are available for academic research only with a one-year lag; and excise tax data on alcohol sales are aggregated at the state level and, problematically, do not separate sales by market channel.

Of the 425 breweries operating in 2019, our survey was sent to all 184 craft breweries, excluding brewpubs,² open throughout the entire study period, from January 2017 to

2019. Our objective is to identify changes in distribution strategies and any barriers to entry in specific market channels. We received 76 complete responses (41% response rate) from 57 nanobreweries, 16 microbreweries and three regional breweries. Though we have few responses from regional breweries, our sample is consistent with and representative³ of the number of non-brewpub craft breweries in Colorado, which in 2017 numbered 123 nano-, 55 micro- and 11 regional breweries.⁴ Note that macrobreweries and wholly owned subsidiaries (e.g., MillerCoors and Blue Moon) were not included in the survey. We asked breweries to estimate the overall volume sold in 2017 and 2019 as well as the percentage of volume sold through each market channel: brewery taprooms, restaurants and other on-premise retailers,⁵ liquor stores, grocery stores and convenience stores.

Survey responses show that total volume sold through liquor stores declined by 17,000 bbls, or 16%, while the volume sold through grocery stores increased by 28,000 bbls. Overall, convenience stores remain of marginal importance to craft breweries. Partitioning the sample by brewery size (Table 1) generates more insight.

Nanobreweries remain anchored to the taproom and on-premise retailers, which combined account for over 90% of sales by volume. This strategy is also visible in the packaging choices, as the vast majority of volume sold is moved through kegs and serving tanks. The most substantial change from 2017 to 2019 for the nanobrewing sector is its growth, with a 51% increase in total volume sold (an absolute increase of 12,000 bbls). The growth fits the national trend reported by the Brewers Association, which finds that recent increases in craft sales are largely owed to smaller, newly opened breweries (Gatza & Watson, 2019).

Results for microbreweries show that off-premise sales stay anchored to liquor stores, which increased from 33% to 35% of overall sales by volume. Additionally, microbreweries reported a 41% increase in volume sold, or 18,000 bbls overall. Even though off-premise sales increased, the importance of grocery and convenience stores remained marginal. Half of the firms reported having access to the grocery channel, but it accounted for only 5% of sales by volume, and convenience stores sales are negligible. Of the volume sold through grocery stores, 75% was handled by a distributor and third-party distribution increased substantially among microbreweries in 2019, suggesting distributors may provide key access to the grocery channel.

The three regional breweries in our dataset reported substantial changes, but the overall effect appears to be a shift in where consumers buy craft beer rather than an increase in overall demand. Volume sold in the grocery channel increased by 25,000 bbls, or 19% of overall sales by volume. Meanwhile, liquor store sales contracted by a corresponding 25,000 bbls. Convenience store sales remained modest, growing only from 2% to 3% of sales by volume. In stark contrast to the growth in the other brewery sectors, total volume sold remained virtually flat for regional breweries between 2017 and 2019.

Table 1. Distribution strategy by brewery type 2017 versus 2019.

	Indicator	Nano		Micro		Regional	
		2017	2019	2017	2019	2017	2019
Production	Total volume (bbls)	25,454	38,331	43,854	61,927	183,000	183,250
	% firms offering 3.2 beer	4%	8%	0%	6%	33%	67%
Packaging	% vol serving tanks	21%	17%	9%	8%	0%	0%
	% vol kegs	63%	63%	40%	39%	33%	31%
	% vol bottles	10%	8%	3%	4%	28%	16%
	% vol cans	6%	12%	48%	49%	39%	53%
Access to market	% firms with taproom	96%	98%	100%	100%	100%	100%
	% firms in rest. & OOP	88%	89%	100%	100%	100%	100%
	% of firms in the LS channel	44%	55%	69%	81%	100%	100%
	% of firms in the GS channel	2%	11%	13%	50%	33%	100%
% Volume by market channel	% firms in CS channel	0%	2%	6%	19%	33%	67%
	% vol taproom	81%	76%	41%	34%	5%	5%
	% vol rest. & OOP	13%	16%	25%	25%	37%	34%
	% vol LS	7%	7%	33%	35%	52%	38%
	% vol GS	0%	0%	1%	5%	5%	19%
Third-party distribution	% vol CS	0%	0%	0%	1%	2%	3%
	% of firms with distributor	7%	7%	25%	43%	100%	100%
	% sold through a distributor	2%	2%	31%	36%	86%	86%
	% vol rest. & OOP	1%	1%	11%	11%	33%	32%
	% vol LS	1%	1%	19%	20%	46%	35%
Self-distribution	% vol GS	0%	0%	1%	4%	5%	16%
	% vol CS	0%	0%	0%	1%	2%	3%
	% vol rest. & OOP	12%	15%	14%	14%	3%	3%
	% vol LS	6%	7%	14%	15%	6%	3%
	% vol GS	0%	0%	0%	1%	0%	3%
	% vol CS	0%	0%	0%	0%	0%	1%

Note: Percentages may not add up to 100% due to rounding.

While some of the challenges may dissipate as industry members adapt to the new environment, the comments section of our survey is particularly insightful in explaining why smaller breweries failed to enter grocery stores (for the full industry report, see Appendix A1 in the supplemental data online). Reported barriers include the lack of personal relationships, lack of a trained salesforce, complex paperwork to register products, costly insurance requirements and the request to distribute to a minimum number of stores. Once in the grocery channel, breweries faced costly challenges in the form of stocking and rotating their own products. Avoiding self-distribution may circumvent some of the barriers, but even breweries using a third-party distributor reported issues associated with restocking. Overcoming these distribution challenges appears to be easier for the larger regional breweries as compared with smaller nano- and microbreweries.

Follow-up interviews with a micro- and regional brewery provide additional context. A microbrewer was particularly concerned about access to grocery store shelves. One store placed the brewery on a waiting list pending the performance of products already on the shelf and

another simply refused to buy beers not sold by the store's preferred distributor. Conversely, a regional brewer reported that the biggest challenge is self-distribution. The number of retail accounts serviced by the brewery doubled with the policy change, requiring a rapid scaling up of distribution capacity. Even with the logistical challenge, sales in the grocery channel more than offset a decline at liquor stores. Overall, our survey results and interviews suggest that the scale of operations of nano- and microbreweries are not well suited for the mass alcohol retail market of grocery stores.

5. STUDY 2: FOOT TRAFFIC DYNAMICS IN ALCOHOL RETAIL STORES BEFORE AND AFTER THE LIBERALIZATION OF FULL-STRENGTH BEER SALES

Study 1 was valuable in offering a brewer's perspective of how the new retail environment affected their competitive position in selling through various channels, but as a complement to that work, we also explore consumer responses. Brewers' perspectives are well-informed, but

commonly developed through the lens of their discussions with retailers and distributors, while consumer foot traffic represents a very direct measurement of the change in choices that may occur when the product selection at nearby retailers change and expand.

We investigate how the liberalization of full-strength beer sales affected liquor store foot traffic using a unique dataset from SafeGraph Inc., a geospatial data company. The SafeGraph Patterns dataset tracks foot traffic patterns at over 3.6 million points of interests using anonymized geolocation data including approximately 10% of the mobile devices (i.e., phones) in the United States (Squire, 2019). Members of the SafeGraph panel opt in by accepting the terms of service of various mobile apps. The percentage of SafeGraph devices in Colorado relative to the state population averages approximately 10% during our study period, and about 9% in Minnesota, a state where distribution laws remained substantially similar to pre-2019 Colorado. The proportion of SafeGraph mobile devices in each county closely correlates with proportion of the overall population and suggests there is little geographical bias (Squire, 2019). SafeGraph maps almost 100% of all businesses (Hoffman, 2018) and is updated each month and is therefore timelier and more comprehensive compared with other datasets, such as Nielsen scanner data. To our knowledge we are the first to use SafeGraph data to study alcohol-purchasing behaviour.⁶

Our dataset spans from January 2017 to February 2020 and includes firm characteristics such as the store name, North American Industry Classification System (NAICS) code and geographical coordinates, as well as monthly observations on the number of visits. We end our study period in February 2020 to avoid potential confounding of the results from public safety concerns and stay-at-home orders due to the COVID-19 pandemic. After cleaning the data to include only liquor stores open throughout the whole study period (see Appendix A2 in the supplemental data online), we aggregate the foot traffic at all liquor stores in each month of the study period to create state-level time series for Colorado and Minnesota. Each time series has 38 observations, 24 in the pre-policy period spanning January 2017–December 2018 and 14 in the post-policy period from January 2019 to February 2020.

5.1. Methods and identification strategy

We identify the effects of the partial liberalization of alcohol sales on Colorado liquor store foot traffic using two approaches: interrupted time-series analysis (ITSA) and state-space forecasting. The identification strategy of ITSA and state-space forecasting are somewhat different. Single-group ITSA uses the pre-policy trend projected into the post-treatment period as a counterfactual, and multi-group ITSA compares the change observed in the treatment group to that observed in the control group. Single-group ITSA relies on the assumption that no systematic factor affects the observed unit, other than the

treatment itself, while multi-group relies on the critical assumption that the trend is the same in both groups. The identification strategy of the state-space forecasting approach is similar to a single-group ITSA in that it uses data from the pre-treatment period to train a model and generate a forecast not influenced by the treatment, which serves as a counterfactual to the observed realization of the series in the post-treatment period.

Similar identification strategies to that used in our ITSA analysis can be found in other studies investigating the effect of policy interventions, such as price leadership between distribution channels for lodging following the removal of price restrictions imposed by online travel agents (Hunold et al., 2018), traffic and opioid-related fatalities following the legalization of cannabis (Lane & Hall, 2019; Livingston et al., 2017), and wine sales after grocery stores started to sell wine in New Zealand (Wagenaar & Langley, 1995). Forecasts using state-space models have been used in a variety of applications, including to predict the price of Bordeaux (Bazen & Cardebat, 2018) and future alcohol consumption (Voon & Fogarty, 2019). Using a forecast as a counterfactual is not entirely novel. Bridge et al. (2020) use exponential smoothing methods to create a counterfactual forecast of suicide rates, and Linden (2018) uses linear regression, exponential smoothing and autoregressive integrated moving average models (ARIMA) to create counterfactual forecasts of cigarette sales.

Following the recommendation of Bernal et al. (2018), we implement single- and multi-group ITSA to estimate the effect of the policy change on liquor store foot traffic in Colorado. Single-group ITSA limits potential confounding due to between group differences, while multi-group ITSA controls for unobserved time-varying effects that impact both locations. If the results from the single- and multi-group ITSA align, there is strong evidence that the policy change had a casual effect on liquor store foot traffic. The single-group ITSA regression model takes the following form:

$$Y_t = \beta_0 + \beta_1 T_t + \beta_2 Treat_t + \beta_3 Treat_t * (T_t - 25) + \sum_{j=1}^{S-1} \gamma_j D_{jt} + \epsilon_t \quad (1)$$

where Y_t is the normalized foot traffic to liquor stores aggregated at the state-level in time period t ; and T_t is a linear time trend. $Treat_t$ is a dummy variable indicating the post-treatment time periods, so that $Treat_t * (T_t - 25)$ is 0 in all periods before the policy change and begins sequentially at 0 in the period immediately following the policy change. D_{jt} are dummy variables for each month and account for seasonality. The coefficient β_2 captures the immediate effect and the level change that results from expanded retail outlets whereas the coefficient β_3 captures difference in the slope between the pre- and post-policy period.

The multi-group ITSA regression model is only slightly more complex:

$$\begin{aligned}
 Y_t = & \beta_0 + \beta_1 T_t + \beta_2 Treat_t + \beta_3 Treat_t*(T_t - 25) \\
 & + \beta_4 Z + \\
 & \beta_5 Z*T_t + \beta_6 Z*Treat_t + \beta_7 Z*Treat_t*(T_t - 25) \\
 & + \sum_{j=1}^{s-1} \gamma_j D_{jt} + \epsilon_t
 \end{aligned} \tag{2}$$

where Z is an indicator variable that equals 1 when the observation belongs to the treated state (Colorado). Therefore, β_4 is the difference in the level between treated and control (Minnesota); β_5 is the difference in the slope between the treated and control; β_6 is the change in the difference of the level between the treated and control in the period immediately following the policy change; and β_7 is the change in the difference of the slope between the treated and control in the post-policy period. The policy effect is captured by β_2 and β_3 in the single-group ITSA, and by β_6 and β_7 in the multi-group ITSA.

If there are no structural breaks in the time series before the treatment is administered, a forecast generated using a model trained on the pre-policy time period can serve as a plausible counterfactual (Linden, 2018). Observed values consistently above or below the prediction interval of the forecast indicates a structural change in foot traffic patterns in the post-policy period. We estimate a seasonal model with multiplicative errors to create a forecast for liquor store foot traffic in Colorado and Minnesota. Following Hyndman et al. (2002), we calculate a prediction interval for the point forecast by simulating 5000 forecasting paths conditional on the final (pre-treatment) state equations and random draws of the disturbance, and identify the 0.025 and 0.975 quantiles of the simulated values. The policy effect is measured as the difference between the observed post-treatment trajectory and simulated forecasts. We expect a negative effect in Colorado and no effect in Minnesota. For a full discussion of state-space methods and the forecasting techniques employed, see Appendix A2 in the supplemental data online.

5.2. Results

Figure 3 provides a graphical comparison of the aggregated monthly liquor store foot traffic in Colorado and Minnesota before and after the policy change. The purple and green lines represent time series of monthly visits to all liquor stores in Colorado and Minnesota, respectively, by members of the SafeGraph visitor panel. Throughout the pre-policy period, liquor stores in Colorado received approximately 20,000 more visits each month compared with Minnesota. The flat, stable, pre-policy trend in Colorado improves the credibility of our single-group ITSA (Linden, 2015). The time series for Colorado and Minnesota exhibit similar seasonality and trend, supporting our use of Minnesota as a control in the multi-group ITSA.

The results for the single- and multi-group ITSA (Table 2) provide evidence that alcohol liberalization had a negative effect on liquor store foot traffic. The coefficient on $Treat$ in the single-group regression indicates that level of monthly visits to Colorado liquor stores fell by 1351 visits immediately following the policy change: a 2% decline from the pre-policy average. The single-group ITSA limits selection bias due to between-group differences but is vulnerable to threats from unobserved events that coincide with the policy change (Bernal et al., 2018). Our multi-group ITSA uses a time series of liquor store foot traffic in Minnesota to account for historical threats that may have impacted foot traffic in both states. The multi-group ITSA results are qualitatively similar: the coefficient on $Z*Treat$ suggests that the level of monthly visits fell by 3276 visits in the month following the policy change, a 5% decline from the pre-policy average. We do not find any change in the slope of foot traffic from the pre- to the post-policy periods. Importantly, the coefficient on $Z*T$ is small and insignificant, indicating that there is no substantial difference in the pre-policy slope of foot traffic between Colorado and Minnesota and supporting our use of Minnesota as a control. For a graphical representation of our single- and multi-group ITSA, see Figure A2 in Appendix A in the supplemental data online.

The left side of Figure 4 provides a visual representation of the state-space forecast⁷ (top) and the treatment effect (bottom) in each month after the policy change in Colorado. The estimate of the treatment effect in each month is obtained by subtracting the point forecast from the observed values and the corresponding 95% confidence interval. The counterfactual forecast is consistently above the observed foot traffic after 1 January 2019, and the observed values often lie beneath the 95% prediction interval, providing evidence that the policy had a substantial negative effect on foot traffic. Notably, our graph of the policy effect shows that the impact is larger in warmer months (April–October), which coincides with peak demand for beer, and undetectable in the holiday season, which is when demand for wine is highest (Hirche et al., 2021). The average treatment effect (ATE), which is the average effect of the policy over the entire post-policy period, is -3332 (95% confidence interval (CI) = $[-1116, -6215]$) and corresponds to a 4.9% decline in monthly liquor store foot traffic. Note that the ATE is similar in magnitude to the effect estimated by the multi-group ITSA, providing further evidence of a moderate, negative effect on liquor store foot traffic.

We test the robustness our state-space forecast by performing a placebo analysis on Minnesota (right side of Figure 4), where we would not expect to see an effect from Colorado's policy change. In contrast to our Colorado analysis, observed liquor store foot traffic in Minnesota lies within the 95% prediction interval in 10 of the 14 months after the policy change. The ATE ($-1,988$ (95% CI = $[586, -3786]$)) is not significantly different from zero. The null results from our placebo analysis supports our state-space findings in Colorado.

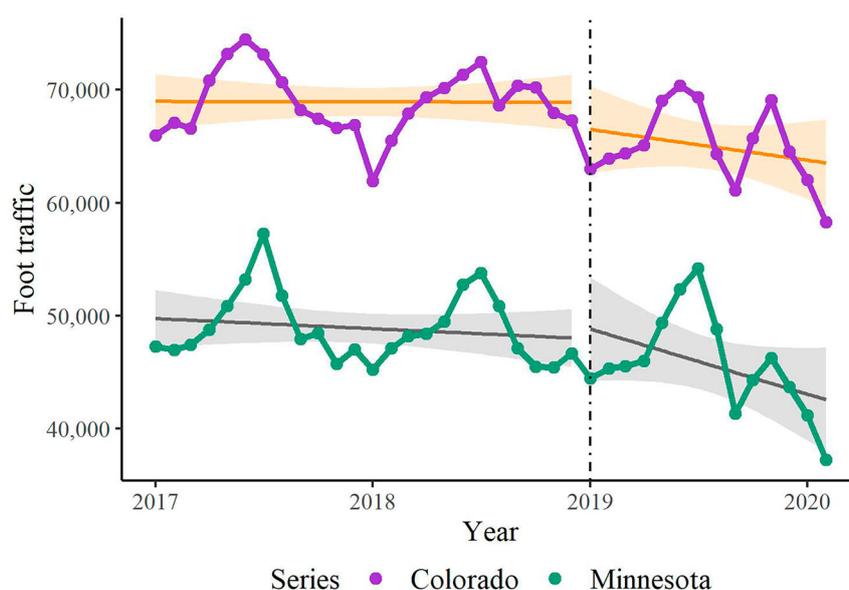


Figure 3. Time series of monthly foot traffic in Colorado and Minnesota.

Note: The upper (lower) line represents the aggregated liquor stores foot traffic in Colorado (Minnesota). Shadings depict the linear time trends in Colorado and Minnesota. The vertical line indicates when Colorado implemented the policy change.

Table 2. Interrupted time-series analysis (ITSA) results for liquor store foot traffic.

	Single group	Multi-group
<i>Treat</i>	-1351.359** (549.455)	1647.094** (776.358)
<i>Treat</i> *($T_t - 25$)	-112.887 (100.832)	-289.270*** (77.065)
$Z * T_t$	-	71.527 (50.434)
$Z * Treat$	-	-3276.071*** (840.050)
$Z * Treat * (T_t - 25)$	-	181.879 (126.092)
Observations	38	38
Average visits pre-policy	68,931	68,931
Percentage change in visits	-1.9	-4.7
Constant	Yes	Yes
Seasonal dummies	Yes	Yes
Newey–West SE	Yes	Yes
Autocorrelation p -value	0.050 (11th order)	0.025 (9th order)
<i>F</i>	197.24***	953.14***

Note: Standard errors are reported in parentheses. We use the Cumby–Huizinga general test to check for autocorrelation up to 12 lags. We report the highest order autocorrelation with a significant p -value. The Breusch–Pagan test for heteroskedasticity was insignificant.

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

These results provide strong evidence that the policy change had a negative impact on liquor store foot traffic, but the effect was moderate, most likely in the neighbourhood of a 5% reduction.

6. DISCUSSION

When the Colorado Brewers' Guild supported introducing full-strength beer into grocery and convenience stores, the expectation was that the new market channels would offer an opportunity for craft breweries to grow sales (Sealover, 2018b). Even though the effects of the legislation are still unfolding, our survey, interviews and analysis of liquor store foot traffic provide an early picture of how a diverse set of craft brewers adapted to the new distribution environment. The opening of the grocery and convenience channels changed market dynamics, creating both opportunities and threats for craft brewers. Our assessment is that partial alcohol liberalization did not harm the competitiveness of a core region for craft beer production, but rather handed Colorado craft brewers a glass half-full.

For nano- and microbreweries, which account for most craft beer producers, sales in the new market channels remained negligible. This is no surprise in the case of nanobreweries, as they generally have a taproom-focused business model, but it is somewhat unexpected for the microbrewing segment. In 2017, microbreweries already bottled or canned and were distributing to off-premise retailers. And yet, in 2019, microbreweries remained solidly anchored to liquor stores and only 5% of volume was sold in grocery stores. Despite lower foot traffic at liquor stores and minimal sales in the new market

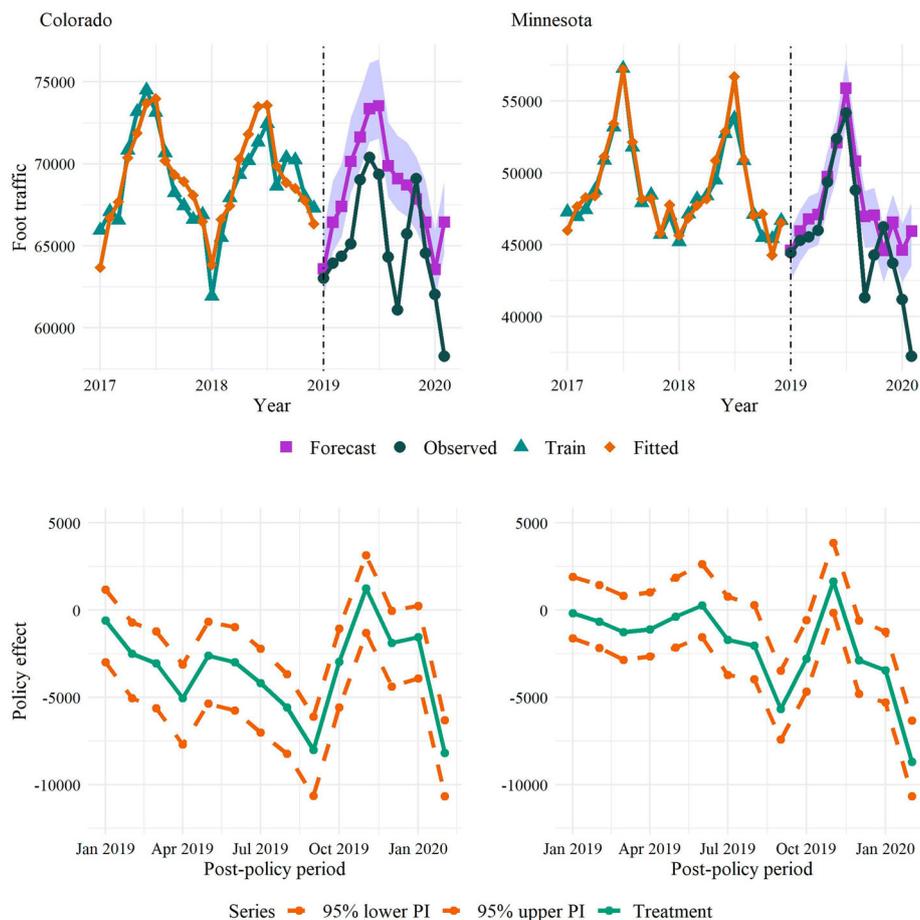


Figure 4. State-space forecast and the estimated policy effect in Colorado and Minnesota.

Note: The left (right) column presents our state-space forecast and estimated policy effect for Colorado (Minnesota). In the top row, the orange line represents the model trained on observed foot traffic (blue) in the pre-policy period, the purple line is the point forecast with a 95% prediction interval, and the green line indicates the observed values in post-policy period. The bottom row visualizes our estimate of the policy effect in each month of the post-policy period.

channels, both nano- and microbreweries substantially increased overall volume sold. In short, nano- and microbreweries did not substantially enter the new market channels, but the policy change did not appear to immediately harm small breweries as some had feared.

Regional breweries gained a solid foothold in grocery stores, a major success if one considers that regional breweries account for a large share of the craft market volume. However, growth in the grocery channel was counterbalanced by a decline at liquor stores, resulting in a mere transfer of sales from one channel to the other. Of course, it is possible that sales for regional breweries would have decreased in the counterfactual world without access to grocery stores. We also cannot determine how the transfer of sales from liquor to grocery stores affects overall profitability, as we have no data on the distribution costs and profit margins.

The new channels appear to be demanding. Simply getting on the shelf may present significant barriers to entry for brewers and distributors, such as expensive insurance requirements, onerous paperwork and the capacity to sell product in a minimum number of stores. Less tangible, an unmentioned barrier is that grocery stores might simply perceive the brands of smaller craft breweries as lacking the

ability to draw in consumers. Even if a brewery gets on the shelf, regular stocking and service demands appear to be much greater than in other channels. All these costs – sales, logistics and servicing – are largely fixed. Regional breweries can spread these costs over a larger sales volume, but on a per barrel basis, micro- and nanobreweries may find entry into grocery stores less profitable. Barriers to entry may be less of an issue for craft breweries that contract with distributors and have already incurred some of these investments, and our survey suggests that pivoting towards third-party distribution may allow microbreweries to adapt to the new regulatory environment.

To our surprise, the convenience channel failed to capture any significant craft beer sales. Our interpretation is that craft brewers face three obstacles when attempting to sell in convenience stores. First, distribution is once again key, and the sheer number of outlets imposes a capillary distribution network. Second, as with grocery stores, shelf space is limited, and the introduction of craft beer would displace another product. The third obstacle, related to the second, is brand recognition. According to the National Association of Convenience Stores (NACS), the average time it takes a customer to walk

in, purchase an item and depart is between three and four minutes (NACS, 2018). A quick in-and-out and small floor space implies that convenience stores are more suited for beer brands with mass recognition and the ability to draw in shoppers, generally owned by macrobreweries. This last consideration likely applies similarly to grocery shoppers, which are less involved than liquor store shoppers.

Our analysis allows us to identify some winners and losers among industry players. Grocery stores are clear winners, selling 28,000 more bbls of beer from our sample of breweries in 2019 and accounting for over 13% of the sample volume sold. Meanwhile, craft beer sales by volume in liquor stores declined by 16% and foot traffic declined in the channel by around 2–5%. In the context of our conceptual model (Figure 1), the results imply that the policy change strengthened grocery stores as gravitational centroids, either by providing more desirable store attributes or by being more conveniently located, at the expense of liquor stores. This is not entirely surprising, as the regional literature suggests that if consumers perceive beer as groceries, general location factors that favour grocery stores such as floor space (Leeuwen & Rietveld, 2011) become more important to consumers. While these reductions at liquor stores will certainly have long-term economic consequences, they are generally inconsistent with the wave of closures threatened by the liquor store association in the wake of the policy change (Sealover, 2018a). The key factor is that liquor stores retained exclusive rights to sell wine and liquor, which minimized the effect of competition and preserved some of their appeal to consumers.

Though we do not have data from macrobreweries, they hold the largest share of the beer market (Brewers Association, 2020b), and our work allows us to infer that Colorado's new regulatory framework favours breweries operating at larger scales. As we determined in study 1, the high barriers to entry limiting access to grocery and convenience stores diminish with the scale of production, consequently the larger regional craft and national brewers are best equipped to succeed in these mass distribution channels. In addition, the marketing literature suggests that low involvement consumers in the new market channels are more likely to make purchase decisions based on price and brand familiarity (Hollebeek et al., 2007; Lockshin et al., 1997), which further benefits macrobreweries. Thus, presence of macro-beer in the new market channels likely multiplies the strength of the gravitational centroid of grocery and convenience stores at the expense of liquor stores.

Abstracting from any potential health effects, the restructuring of Colorado's alcohol retail environment appears to benefit consumers. Though we do not observe prices, prior literature provides evidence that alcohol liberalization increases competition between market channels and reduces prices for consumers (Rickard et al., 2013). New channels provide consumers with more choices in where to shop, increasing surplus and, as shown in study 2, the feared exodus away from liquor stores never materialized.

While our findings provide important insights, our study is only a step towards a full understanding of how liberalizing alcohol retail laws affects craft breweries and other industry players. Substantive limitations include the lack of first-hand price information, knowledge of how profits are distributed across the marketing channels, and direct access to information about macro-beers sales. Another concern is anticipation effects: liquor stores may have increased marketing efforts to boost foot traffic and consumer loyalty. Our estimate of the policy effect may be biased downward if efforts were widespread and successful enough to influence foot traffic in the pre-policy period. Similarity in Colorado foot traffic from 2017 to 2018, as well as similarity to Minnesota's foot traffic before the policy change, suggests little to no anticipation effects, but we are unable to rule them out entirely. Finally, because consumer shopping habits can be slow to change, the identified 2–5% decline in liquor store foot traffic based on a relatively short post-policy period may not capture the entire long run impact of liberalizing alcohol sales on liquor stores.

More research is needed to confirm and broaden our results. Future work could perform a hedonic analysis of the value of liquor stores before and after the policy change or use scanner data to evaluate the impact on the macro-beer segment, which is likely where the biggest shifts occur. Comparisons can also be made between states that have liberalized wine and/or liquor sales in addition to beer. One large unknown is the impact of COVID-19 on the craft brewing industry. Based on our survey, it is easy to predict that breweries with limited distribution (i.e., nano- and, to some extent, micro-) are the most affected by social distancing measures, but early data suggest that overall alcohol consumption has increased during quarantine. Future studies should investigate the relationship between market channels and a brewery's resiliency to the COVID shock.

7. CONCLUSIONS

The liberalization of full-strength beer sales implemented in Colorado does not appear to have harmed the regional competitiveness of the craft beer industry, but neither has it produced visible benefits. Nano- and microbreweries continue to rely on liquor stores for off-premise sales, and regional breweries merely transferred sales from one channel to another. While grocery stores absorbed a significant share of the regional craft brewery sales (and possibly even more of the macro-brands sales), the negative effect on liquor stores has been limited.

Our main finding relates to the distribution barriers faced by small producers as they attempt to enter the mass retailing environment. Even though Colorado allows breweries to self-distribute, third-party distribution contracts were revealed to be a key factor to enter the grocery channel and a bottleneck in the distribution system. As the wholesale tier keeps consolidating (Pellechia, 2020; Tobiassen, 2021), fewer, larger distributors with extensive brand portfolios have little incentive to acquire and

promote small production breweries with no established demand, exacerbating the problem.

Four years after Colorado liberalized beer sales, the same coalition of grocery and convenience stores sponsored a successful ballot initiative that will expand wine sales beginning 1 March 2023 (Chuang, 2022). While we can only speculate about the effects of broader alcohol liberalization, we see no logical argument suggesting that it would benefit Colorado's craft brewers. Increased competition from grocery stores would lower traffic in liquor stores further, while existing barriers to enter the new market channels would remain, further tipping the scale in favour of large-scale alcohol producers. Small breweries relying on the on-premise business model centered on tap-room sales remain largely unaffected by these trends. However, increasing scale of operation beyond the tap-room requires expanding into off-premise sales, and full liberalization is likely to make this step more difficult, possibly limiting growth. On the other hand, direct competition from grocery stores may force liquor store owners to increase offering and specialize in more niche products, perhaps creating more space for smaller brands.

Jointly, the results have substantive implications for policymakers in three neighbouring states (Oklahoma, Kansas and Utah) that recently enacted partial alcohol liberalization, as well as other regions attempting to harness the craft brewing sector as an engine for economic growth. Officials should be skeptical of claims that liberalization benefits craft alcohol producers, especially when it comes to small and mid-sized breweries. Based on our findings, alcohol liberalization is likely to mostly benefit national and international brands produced in large scale macro-breweries, which generally contribute little to the growth of local economies. Policymakers wishing to support a nascent or growing craft alcohol sector should therefore proceed cautiously, especially because liberalization is hardly reversible. Public sentiment across the United States increasingly favours more widespread availability of alcoholic beverages, and the industry groups benefiting from this are quite powerful. Once freed, putting the proverbial cat back in the bag is unlikely.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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NOTES

1. According to the American Brewers Association, the two defining characteristics of a craft brewery are scale of production (fewer than 6 million barrels) and independent ownership (no more than 25% of external ownership).
2. Though breweries and brewpubs produce the same type of product, we focus only on breweries because the services, distribution channels, quality control and marketing differ distinctly between the two (Moore et al., 2016).
3. A Kolmogorov–Smirnov test did not reject the hypothesis that our sample is consistent with the distribution of breweries across market segments in Colorado. Survival bias should also be considered, since our survey only included breweries that survived from 2017 to 2019. Using national-level data from the Brewers Association, we determine that around 3% of breweries producing fewer than 15,000 bbls shut down in each year of our study period, suggesting that the potential effect of survival bias is low.
4. Based on all licensed craft breweries from the Colorado Department of Revenue with production estimates from the Brewers Association.
5. Other on-premise retailers are all businesses where alcohol purchases are consumed on-premise.
6. A recent study used SafeGraph data to investigate how social distancing efforts to control COVID-19 in one region is affected by policies in neighboring regions (Cook et al., 2020).
7. Our smoothing parameter estimates are all < 0.3 , indicating there is little random change in the level and seasonality.

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