ASSESSING REGULATORY, POLICY, AND MARKETING CHALLENGES ACROSS AGRI-BEVERAGE SUPPLY CHAINS

By

Aaron J. Staples

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Agricultural, Food and Resource Economics – Doctor of Philosophy

2023

ABSTRACT

Over the past decade, U.S. agri-beverage supply chains have undergone a dramatic transformation. The emergence of thousands of craft breweries, for example, has revolutionized the U.S. beer industry. Their presence has garnished debate on supply chain regulatory reform and heightened conversations on creating more diverse, flexible, and resilient value chains post-COVID-19. This dissertation explores state-level regulatory patterns in the beer supply chain, the effectiveness of COVID-19 relief programs on craft beverage manufacturer performance, and constraints and marketing opportunities in value-added food systems.

The first essay, titled "**Regulatory restrictions across the beer supply chain**," explores regulatory patterns across the three-tier beer supply chain using Mercatus Center RegData. Specifically, the study assesses the number of direct and indirect regulatory restrictions constraining the behavior of breweries, wholesalers, and retailers at the federal and state levels. The results suggest more than 125,000 regulatory restrictions constraining the average beer supply chain, with roughly 90% of the constraints imposed at the federal level. There is substantial heterogeneity at the state level, where additional rules targeting the beer supply chain vary between 1,177 and 25,399 restrictions. These findings emphasize the need for businesses to develop a deep institutional understanding of the governing constraints of each state they operate in. Discussion also surrounds how the patchwork approach to policy construction and the regional policy landscape can constrain business growth and entrepreneurial activities.

The second essay, titled **"The Paycheck Protection Program and small business performance: Evidence from craft breweries,"** evaluates the effectiveness of the Paycheck Protection Program (PPP) in the craft beer market. The PPP provided $790 billion in COVID-19 relief funds to nearly 12 million small businesses. The study examines the relationship between PPP funding and small business performance by merging PPP loan data from the Small Business Administration with a verified industry dataset of craft beer producers. Results suggest that firms that receive PPP funding are more likely to remain in operation and experience a smaller decline in annual production from 2019 to 2020. Further, using a quasi-experiment that exploits a natural break in the loan program, the study suggests a positive causal effect of the role of loan timing on short-run performance. The results provide

evidence that the PPP alleviated losses induced by COVID-19, but questions remain about the program's distribution and long-term impact.

The third essay is titled **"Hopping on the localness craze: Local value chain constraints and opportunities**." The study uses survey data from Michigan craft breweries to determine the leading indicators of local hop purchasing decisions. The U.S. is the global leader in hop production, and 96% of domestic hops are grown in the Pacific Northwest. However, with the emergence of craft breweries, there is budding interest in developing local beer value chains. The study evaluates production and marketing challenges in local hop industries to identify the key factors constraining their expansion. Results suggest that perceived input consistency and higher transaction costs are two critical limiting factors. However, as local markets overcome these challenges, there could be avenues for value-added marketing. In the survey, brewers indicate whether different initiatives would incentivize them to purchase more locally-sourced hops. Developing a unique and improved cultivar selection, as well as farm brewery legislation, are amongst the most favored initiatives. The essay offers discussion on these topics and opens avenues for future research.

Food and beverage supply chain resiliency and sustainability now dominate policy conversations, and stakeholders are searching for ways to improve supply chain efficiency and flexibility. This dissertation discusses how regulatory volume, governmental policy, and agricultural production and marketing challenges influence supply chain efficiency. Highlighting these issues, the insights are aimed to guide policymakers and industry stakeholders on future decision-making across agri-beverage supply chains.

To my mom, for being my inspiration and encouraging
me to spread my wings and fly.
To Pop-Pop, for being my research assistant,
sounding board, and top supporter.

ACKNOWLEDGMENTS

The journey through any Ph.D. program would not be possible without a strong support system. I am fortunate to have a close group of mentors, collaborators, family, and friends that have encouraged, guided, and motivated me along the way.

I would first like to thank my committee members for their guidance, starting with a special thanks to Dr. Trey Malone. Trey served as my advisor through the first three years of the program before departing for the University of Arkansas. When I arrived at Michigan State University, Trey and I instantly developed a positive rapport that translated into several successful research projects, some of which are presented here. His hands-off approach allowed me to explore new topics, dig down rabbit holes (occasionally finding dead-ends), and blossom into the researcher I am today. I am grateful for his guidance and friendship, and I look forward to our future collaborations.

I would next like to thank Dr. Vincenzina Caputo, who stepped in as the Chair of my dissertation after Trey's departure. Much of the work presented in this dissertation was completed before Vincenzina took over as Chair, but there is no one I would rather have as a mentor and supervisor as I conclude the program. I have learned so much from Vincenzina in the short time we have worked together, and I am eager to push our pipeline of research projects forward. Next, I would like to thank Dr. Rob Sirrine. I met Rob at the 2020 Great Lakes Hop & Barley Conference, and ever since, Rob has helped open doors to expand the reach of my research through industry engagement and conference presentations. The last committee member I would also like to thank is Dr. Brent Ross. His comments on the second essay helped progress the project to where it is today. Most notably, however, Brent served as my faculty advisor when I led AFRE 100: Decision-making in the agri-food system. He allowed me to make the class my own but was always there if I needed his input.

Other collaborators and coauthors outside my committee have contributed to my professional growth, including Drs. Dustin Chambers, Bart Watson, and Thomas Krumel. Dustin's insights on the first essay played a tremendous part in my academic development, and he has been a great collaborator on other research projects. Bart is the Chief Economist of the Brewers Association, and he has been an invaluable resource for me throughout the program. Without Bart's and the Brewers Association's support, the second essay of this dissertation would not have been possible. I am incredibly grateful for this collaboration, and

I am especially thankful to Bart for his comments and suggestions along the way. Thomas also deserves special recognition, as he has quietly served as one of my closest advisors, mentors, and collaborators over the past year. While we have still never met in person and reside in institutions more than 800 miles apart, Thomas and I have developed a great working relationship. I am deeply grateful for his guidance, both in research and through the job market, and I appreciate our friendship.

Outside of my research network, there is an expansive collection of family and friends that have kept me afloat. Throughout the course of the Ph.D., it is easy to become hyper-focused on degree completion, absorbed in the academic rigor. Conversations with my family and friends helped remind me of what is truly important in life, and I am eternally grateful to them. A special thank you is needed for my mom, brother, and Pop Pop. To my many aunts, uncles, and cousins of which there are too many to name here, you know how much you mean to me. To my *2 Collins* crew and high school friends, our FaceTime calls mean more than you know, and I am grateful to have such a close group of friends. I also have to thank Caitlin Herrington and Scott Knowles, who served as close friends, study partners, and shoulders to lean on when things were tough during the first few years of classes.

Finally, and most instrumental to my journey through the program, is Natalie Loduca. Through a global pandemic, microeconomic theory, and other major life events, you have seen me at my worst and supported me throughout. There is no one I would rather have by my side, and I look forward to our journey ahead.

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION 1
1.1. The craft beer revolution 1
1.2. Regulatory hurdles 3
1.3. COVID-19 and the path to recovery 4
1.4. Expanding and diversifying beer supply chains 6
REFERENCES 8

CHAPTER 2. REGULATORY RESTRICTIONS ACROSS THE U.S. BEER SUPPLY CHAIN 11
2.1. Introduction 11
2.2. U.S. beer supply chain 13
2.3. Data and methods 16
2.4. Results 25
2.5. Conclusion 29
REFERENCES 31

CHAPTER 3. THE PAYCHECK PROTECTION PROGRAM AND SMALL BUSINESS PERFORMANCE: EVIDENCE FROM CRAFT BREWERIES 35
3.1. Introduction 35
3.2. Background 38
3.3. Data 44
3.4. Probability of business survival 55
3.5. Changes in annual production 58
3.6. Quasi-experiment 62
3.7. Limitations 68
3.8. Discussion and implications 70
3.9. Conclusion 73
REFERENCES 75
APPENDIX 82

CHAPTER 4. HOPPING ON THE LOCALNESS CRAZE: LOCAL VALUE CHAIN CONSTRAINTS AND OPPORTUNITIES 98
4.1. Introduction 98
4.2. Background 99
4.3. Methodology 102
4.4. Data 105
4.5. Results 111
4.6. Discussion 115
4.7. Conclusions 117
REFERENCES 119
APPENDIX 125

CHAPTER 5. CONCLUSION 139
REFERENCES 142

CHAPTER 1. INTRODUCTION

1.1. The craft beer revolution

A shift in consumer preference for locally manufactured beverages created opportunities for entrepreneurship in agri-beverage supply chains. Most notably, the number of craft breweries in the United States increased from approximately 2,600 in 2012 to 9,200 in 2021. During this time, craft beer production increased from 13.2 to 24.5 million barrels (bbls), market share (in total dollars) increased from 6% to 27%, and brewery employment increased by 60% (Brewers Association, 2013; 2022a; 2022b). This transformation, and the boost to state and local economies that resulted (Miller et al., 2019), is dubbed the craft beer revolution (Garavaglia and Swinnen, 2017).

Craft breweries are small, independently-owned beverage manufacturers stressing product differentiation and on-premise sales to local consumers. Emphasizing the organoleptic characteristics of their products (i.e., taste and aroma), craft brewers now offer more than 170 beer styles to the variety-seeking consumer (Malone and Lusk, 2018; Price, 2019). The growth in styles and total product offerings altered the balance of the beer supply chain, with significant shifts in agricultural markets, distribution networks, and federal policy over the past decade. For example, domestic hop acreage increased 144% from 2012 to 2021 (Hop Growers of America, 2013; 2022); the number of stock-keeping units carried by the average beer distributor more than doubled (National Beer Wholesalers Association, 2022); and legislation altered tax rates, reduced ingredient and recipe requirements, and simplified beer transfers to accommodate small brewers (Craft Beverage Modernization Act of 2019, 2019).[1]

The production of smaller quantities of differentiated products at a price premium explains just part of the difference between craft brewers and other large domestic brewers. It is also critical to consider the differences in business models, revenue streams, and distribution networks. Several sales outlets exist for beer manufacturers, including distribution to bars, restaurants, retail liquor outlets, supermarkets, and supercenters. But

[1] The emergence of craft brewers also affects farmer planting decisions, as different hop varieties are preferred by craft brewers than large domestic brewers. Hops are classified as either (i) alpha/bittering hops or (ii) aroma/dual-purpose hops. In 2012, 50% of hop acreage was dedicated to aroma hop production. But as consumer preference shifted, and craft brewers began to emphasize taste and aroma in their beers, acreage shifted. Now, 82% of U.S. acreage is for aroma production (Hop Growers of America, 2013; 2022).

the most common revenue for the average craft brewer is from on-premise sales. The average craft brewery centers their business model on on-premise sales—whether through draught beer or beer packaged to-go—relying heavily on local consumer foot traffic. Indeed, it is common for 80% or more of a brewery's revenue to come from on-premise sales (Staples, Malone, and Sirrine, 2021). With this business model, craft breweries serve as a gathering place for social events and a potential tourist attraction for non-local visitors.[2]

The entrepreneurial intuition behind the craft beer business model stems from consumer preference for localness while understanding small business scale and scope. The average craft brewery does not have the financial, technological, or human capital necessary to compete at scale with large domestic brewers. For example, the average craft brewery employs 19 workers (Brewers Association, 2022a),[3] while Anheuser Busch has 19,000 employees in the U.S. alone (Anheuser Busch, 2022). Large breweries can thus devote entire teams to input purchasing, product development, marketing campaigns, expanding and diversifying distribution networks, etc. At a craft brewery, however, the same individual may be engaging in each of these tasks. As such, craft breweries face tighter resource constraints and must efficiently allocate scarce resources to grow the business.

By emphasizing on-premise consumption, craft breweries minimize planning and logistical concerns related to pick-up/drop-off schedules from distributors and retailers. This removes monetary costs—eliminating the value-add component of the distributor and retailer—and non-monetary transaction costs associated with negotiations, programming, etc. Instead, brewery leadership can devote the brunt of their attention to product development, brewing and packaging schedules, and other day-to-day operations. In other words, rather than scaling through expansive distribution networks and nationwide marketing efforts, craft breweries scale through novel beer releases and brand recognition

---

[2] Compared to craft breweries, large, non-craft brewers rely on off-premise sales through a series of extensive distribution networks. Their emphasis is on the production of high quantities of homogeneous products at a low price point. By achieving scale in production, technology, and distribution, large breweries sell their products across the country, or even across the globe, through a broader set of revenue channels.

[3] Brewers Association (2022a) reports that the craft beer industry provided 172,643 direct jobs in 2021. This figure is then divided by 9,118 (the total number of breweries in 2021) to obtain the average number of workers per brewery. The average is also skewed by regional brewers, who may employ between 500-1,000 workers. As such, the median craft brewery would have even fewer employees.

within the smaller community. This means that the highest profit margins for the average craft brewer come from on-premise sales.[4]

As entrepreneurs have entered the industry, several challenges have emerged. At the onset of the craft beer revolution, businesses were hindered by regulations that prevented self-distribution (Malone and Lusk, 2016), limited shelf and tap space (Howard, 2017), and an evolving consumer palate (Toro-González, McCluskey, and Mittelhammer, 2014). Of course, COVID-19 presented the most significant challenge the industry has faced, particularly given the shift away from on-premise consumption during the pandemic. While the industry has started to recover (Watson, 2022), threats loom. Primarily, there is growing concern over input shortages (Fromuth, 2022; Redding, 2022), consolidation from craft beer buyouts (Garavaglia and Swinnen, 2017; Hart, 2019; Richards and Rickard, 2021), and shifting preferences towards market substitutes and off-premise consumption (Bernot, 2022). With the economic impact of craft beer, the substantial entrepreneurship investments in the industry, and the ties to the local community, policymakers and industry stakeholders are searching for ways to improve the efficiency, resiliency, and sustainability of this agri-beverage supply chain. This dissertation explores these topics, including conversations on beer regulations, COVID-19 recovery, and local value chains to advise policymakers and stakeholder groups and inform their future decision-making.

1.2. Regulatory hurdles

Food and beverage policy is put in place to protect consumers, workers, and the environment. Given the public health concerns from excessive alcohol consumption, a high regulatory burden on alcohol production and distribution may be expected. But many beer regulations date back to the 1930s and have been shown to hinder entrepreneurship and prevent business growth (Gohmann, 2016; Malone and Hall, 2017). For example, after the passing of the 21st Amendment, which ended Prohibition, the federal government developed the three-tier system. This system, where beer moves from the brewery to the wholesaler and from the wholesaler to the retailer, has hurt small breweries that may lack access to

[4] It is worth mentioning that most craft breweries also utilize other market channels, and the purpose of the description provided is to provide a general overview of why craft brewers emphasize on-premise sales. For the majority of craft breweries, even when they distribute to bars, restaurants, or retail outlets, they do so within a small radius. Thus, their emphasis remains on scaling through brand recognition in a local environment.

these distribution networks (Malone and Lusk, 2016). Indeed, the federal regulatory burden on the beer supply chain is substantial, where Malone and Chambers (2017) suggest approximately 94,000 regulatory restrictions constraining the beer supply chain in 2012. However, it is also important to consider that states reserve the right to implement legislation that impacts the beer value chain.

The first essay of this dissertation evaluates the number of regulatory restrictions constraining the three-tier system (i.e., direct restrictions), as well as the value chains supplying the inputs for each tier (i.e., indirect restrictions), at the state and federal level. Put differently, the study analyzes state and federal regulations constraining breweries, wholesalers, and retailers while also exploring regulatory restrictions constraining industries supplying the three tiers of the supply chain (i.e., agricultural labor). The study uses Mercatus Center RegData to assess regulatory burden, where restrictions are probability-weighted by the likelihood it applies to a given industry. Industry relevance is measured using a machine-learning algorithm trained on industry-specific publications in the Federal Register. Thus, the study counts the probability-weighted regulatory restrictions for each tier and sums across the supply chain to obtain an aggregate measure of regulatory restrictions.

At the federal level, more than 115,000 regulatory restrictions constrain the beer supply chain, with the largest share of direct restrictions on breweries. States also implement, on average, an additional 10,200 regulatory restrictions. However, restrictions vary quite drastically by state, from 1,200 to 25,000. With COVID-19 exposing vulnerabilities in food supply chains, the results suggest that regulatory volume should be considered in future discussions on supply chain efficiency, flexibility, and resiliency.

1.3. COVID-19 and the path to recovery

Going into 2020, the craft beer industry and its corresponding supply chains were blossoming. However, the COVID-19 pandemic led to a substantial decline in brewery foot traffic (Goolsbee and Syverson, 2021). Consumers transitioned from on-premise consumption to off-premise retail sales, which had a tremendous impact on craft beer production and sales (Alcohol and Tobacco Tax and Trade Bureau, 2022).

The Brewers Association confirms these findings, reporting that craft beer experienced a 9.3% decline in production volume, a 22% drop in dollar sales, and a 1.6

percentage point decline in market share from 2019 to 2020 (Brewers Association, 2022b; Scott, 2020; 2021). Their reliance on on-premise consumption made them particularly vulnerable to the shift in consumer purchasing patterns in the early months of the pandemic. Governmental programs, such as the Paycheck Protection Program (PPP), were meant to alleviate some of the economic damages caused by the pandemic. The second essay of this dissertation evaluates the effectiveness of this legislation in the craft beer industry.

In collaboration with the Brewers Association, the study merges Small Business Administration PPP data with a verified dataset of craft beer producers to evaluate the effectiveness of the program on operational status and year-over-year performance. The results provide supporting evidence that the PPP achieved some of its (indirect) objectives. Through linear probability modeling and penalized logistic regression analysis, the study demonstrates that breweries that received PPP funding were more likely to remain in operation through the pandemic. Breweries receiving PPP funding were also more likely to experience a smaller decline in annual production from 2019 – 2020. Even within the craft beer industry, however, there are heterogeneous effects across industry segments. Breweries that operate in significant food services were most impacted by the pandemic, while larger craft breweries with a wider distribution network fared better than others. That is, pre-pandemic business models affected the ability to pivot to alternative packaging methods and distribution channels, leading to disproportionate closure rates and changes in YoY production.

Finally, the essay uses a quasi-experiment that exploits a natural break in the loan program to assess the role of loan approval timing on YoY performance. Under a reasonable set of identifying,[5] the results suggest a positive causal effect of the role of loan timing on short-run performance outcomes. Put differently, breweries that received funding earlier generally performed better YoY. However, given what is known about the shortcomings of the PPP loan distribution mechanism, equity concerns remain. Thus, while this study

[5] Doniger and Kay (2020) use the natural break in the loan program to assess the role of loan timing between tranches. They suggest that if (i) the businesses that receive funding immediately before and after the structural break are similar and (ii) the delay in loan approval did not affect loan demand, researchers can assess the role of loan approval timing.

suggests positive relationships between PPP funding and small business performance, more work is needed to understand the long-term causal impact of the loan program.

1.4. Expanding and diversifying beer supply chains

The emergence of thousands of new breweries expanded agricultural input acreage, altered farmer planting decisions, and diversified growing locations. In particular, U.S. hop acreage increased from 25,000 to 61,000 acres from 2012 to 2021 (Hop Growers of America, 2013; 2022), and the growing region became more diverse. Historically, domestic hop production has been isolated to the PNW. While 96% still is (Hop Growers of America, 2022), the growth in craft beer producers has been directly linked to the emergence of local hopyards (Dobis et al., 2019). Now, 29 states report commercial hop production (Hop Growers of America, 2022).

Michigan has emerged as the leading hop production outside of the PNW. In 2017, when hop-acreage outside of the Pacific Northwest (PNW) peaked, Michigan strung 810 acres for harvest, accounting for 32% of non-PNW hop acreage (Hops Growers of America, 2018). There are challenges in developing these local food systems, including higher production costs, pest and disease pressure, and less-developed processing chains (Lizotte and Sirrine, 2017; Sirrine et al., 2010). Additionally, boom-bust cycles in niche specialty crop markets are expected as the market determines its long-run equilibrium (Sterns, 2019), and COVID-19 added an additional wrinkle. Despite these challenges, however, there are opportunities for value-added marketing. The third essay of this dissertation identifies the central production challenges in the Michigan beer value chain and offers areas of opportunities for value-added marketing and local value chain growth.

In partnership with Michigan State University Extension, the Michigan Brewers Guild, and the Hop Growers of Michigan, the study explores brewer hop purchasing decisions and areas for value-added marketing. While the study suggests that brewers enjoy purchasing locally and want to support local growers, perceived input quality and higher transaction costs can hinder the development of local hop markets. That is, brewers will not sacrifice the quality of their product for localness, and they will also continue purchasing non-local hops if local growers cannot provide certain cultivar types or quantities.

To explore the potential for market development, brewers are asked whether different initiatives would incentive them to purchase more local hops. Among the seven options, providing unique and improved cultivar selections are the most preferred initiatives. While Michigan growers are somewhat limited in what cultivars they can grow due to pest and disease pressure and intellectual property barriers, they may be able to capitalize on providing a unique cultivar selection. There are two avenues to offer this unique selection: developing local proprietary hops for sole production in the Midwest or marketing the regional variation in hop flavor profiles. Taking advantage of these marketing tools could be a way to add value to the products, attract new consumers, and contribute to the development of regional beer identities.

REFERENCES

Anheuser Busch (2022). Behind every great beer is a dreamer. Available at *Anheuser Busch* website: https://www.anheuser-busch.com/about/culture/ [last accessed September 27, 2022].

Alcohol and Tobacco Tax and Trade Bureau (2022). Beer statistics. Available at *TTB* website: https://www.ttb.gov/beer/statistics [last accessed September 26, 2022].

Bernot, K. (June 30, 2022). The devil you don't know — breweries, trade groups divided on whether to panic over spirits-based RTDs. Available at *Good Beer Hunting* website: https://www.goodbeerhunting.com/sightlines/2022/6/30/breweries-trade-groups-divided-on-whether-to-panic-over-spirits-based-rtds [last accessed September 27, 2022].

Brewers Association (March 15, 2013). 2012 craft beer data infographic. Available at *Brewers Association* website: https://www.brewersassociation.org/press-releases/2012-craft-beer-data-infographic/ [last accessed September 26, 2022].

Brewers Association (April 5, 2022a). Brewers Association releases annual craft brewing industry production report and top 50 producing craft brewing companies for 2021. Available at *Brewers Association* website: https://www.brewersassociation.org/press-releases/brewers-association-releases-annual-craft-brewing-industry-production-report-and-top-50-producing-craft-brewing-companies-for-2021/ [last accessed September 27, 2022].

Brewers Association (2022b). National beer sales & production data. Available at *Brewers Association* website: https://www.brewersassociation.org/statistics-and-data/national-beer-stats/ [last accessed September 23, 2022].

Craft Beverage Modernization Act of 2019. Available at: https://www.finance.senate.gov/imo/media/doc/020419%20Craft%20Beverage%20Modernization%20Section-by-Section.pdf [last accessed September 27, 2022].

Delaney, E. & Haines, M. (2017). *Industry on tap: Breweries*. U.S. Bureau of Labor Statistics. https://www.bls.gov/spotlight/2017/industry-on-tap-breweries/home.htm [last accessed September 25, 2022].

Doniger, C., & Kay, B. (February 1, 2022). Long lived employment effects of delays in emergency financing for small businesses. Available at *SSRN*: dx.doi.org/10.2139/ssrn.3747223

Fromuth, K. (August 30, 2022). Navigating CO2 supply shortages. Available at *Brewers Association* website: https://www.brewersassociation.org/playlist/navigating-co2-supply-shortages/ [last accessed September 27, 2022].

Garavaglia, C., & Swinnen, J. (2017). The craft beer revolution: An international perspective. *Choices*, *32*(3), 1-8. https://www.jstor.org/stable/90015005

Gohmann, S. F. (2016). Why are there so few breweries in the South?. *Entrepreneurship theory and practice*, *40*(5), 1071-1092. https://doi.org/10.1111/etap.12162

Goolsbee, A., & Syverson, C. (2021). Fear, lockdown, and diversion: Comparing drivers of pandemic economic decline 2020. *Journal of Public Economics*, *193*, 104311. https://doi.org/10.1016/j.jpubeco.2020.104311

Hart, J. D. (2019). *Consumer preferences for local and craft beer, responses to craft brewery acquisitions, and US alcohol consumption patterns*. University of California, Davis.

Hop Growers of America (2013). 2012 statistical report. Available at *USA Hops* website: https://www.usahops.org/img/blog_pdf/10.pdf [last accessed September 23, 2022].

Hop Growers of America (2018). 2017 statistical report. Available at *USA Hops* website: https://www.usahops.org/img/blog_pdf/105.pdf [last accessed September 23, 2022].

Hop Growers of America (2022). 2021 statistical report. Available at *USA Hops* website: https://www.usahops.org/img/blog_pdf/405.pdf [last accessed September 23, 2022].

Howard, P. H. (2017). Craftwashing in the US beer industry. *Beverages*, *4*(1), 1-13. https://doi.org/10.3390/beverages4010001

Lizotte, E. & Sirrine, J.R. (2020). 2017 Michigan hop management guide. *Michigan State University Extension.* Available at: https://www.canr.msu.edu/uploads/234/71503/Pesticides_registered_for_use_on_hop_in_Michigan_2017.pdf [last accessed September 20, 2022].

Malone, T., & Chambers, D. (2017). Quantifying federal regulatory burdens in the beer value chain. *Agribusiness*, *33*(3), 466-471. https://doi.org/10.1002/agr.21507

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

Malone, T., & Lusk, J. L. (2018). If you brew it, who will come? Market segments in the US beer market. *Agribusiness*, *34*(2), 204-221. https://doi.org/10.1002/agr.21511

Malone, T., & Stack, M. (2017). What do beer laws mean for economic growth?. *Choices*, *32*(3), 1-7. https://www.jstor.org/stable/90015011

Miller, S. R., Sirrine, J. R., McFarland, A., Howard, P. H., & Malone, T. (2019). Craft beer as a means of economic development: An economic impact analysis of the Michigan value chain. *Beverages*, *5*(2), 35. https://doi.org/10.3390/beverages5020035

National Beer Wholesalers Association (2022). The U.S. beer industry 2021. Available at *NBWA: Industry Data & Reports* website: https://www.nbwa.org/resources/industry-fast-facts [last accessed September 26, 2022].

Price, E. (2019). Behind the scenes at the largest beer competition in the world. *Fortune*, Available at: https://fortune.com/2019/10/19/great-american-beer-festival-gabf-2019-behind-the-scenes/ [last accessed September 26, 2022].

Redding, J. (2022). Workforce challenges issue. Available at *Brewers Association: New Brewer Magazine*. Available at: https://www.brewersassociation.org/the-new-brewer/january-february-2022/ [last accessed September 27, 2022].

Richards, T. J., & Rickard, B. J. (2021). Dynamic model of beer pricing and buyouts. *Agribusiness*, *37*(4), 685-712. https://doi.org/10.1002/agr.21698

Sirrine, R. J., Rothwell, N., Lizotte, E., Goldy, R., Marquie, S., & Brown-Rytlewski, D. E. (2010). Sustainable hop production in the Great Lakes region. *Michigan State University Extension Bulletin E-3083. Publisher: Michigan State University Extension.* https://sandyridgefarmsinc.com/wp-content/uploads/2017/06/srf_Sustainable-Hop-Production-in-the-Great-Lakes-Region.pdf [last accessed July 25, 2022].

Staples, A. J., Malone, T., & Sirrine, J. R. (2021). Hopping on the localness craze: What brewers want from state-grown hops. *Managerial and Decision Economics*, *42*(2), 463-473. https://doi.org/10.1002/mde.3246

Sterns, J. A. (2019). Is the emerging US hemp industry yet another boom–bust market for US farmers?. *Choices, 34*(3), 1-8. https://www.jstor.org/stable/26964940

Toro-González, D., McCluskey, J. J., & Mittelhammer, R. C. (2014). Beer snobs do exist: Estimation of beer demand by type. *Journal of Agricultural and Resource Economics*, 174-187. https://www.jstor.org/stable/44131323

Watson, B. (March 18, 2020a). Impact survey shows extreme challenges. Available at *Brewers Association* website: www.brewersassociation.org/insights/impact-survey-shows-extreme-challenges/ [last accessed September 26, 2022].

Watson, B. (April 7, 2020b). Brewery sales dropping sharply, many set to close. Available at *Brewers Association* website: www.brewersassociation.org/insights/brewery-sales-dropping-sharply-many-set-to-close/ [last accessed September 26, 2022].

Watson, B. (July 11, 2022). Mixed signs at midyear for craft beer. Available at *Brewers Association* website: https://www.brewersassociation.org/insights/mixed-signs-at-midyear-for-craft-beer/

CHAPTER 2. REGULATORY RESTRICTIONS ACROSS THE U.S. BEER SUPPLY CHAIN

A version of this chapter was previously published in *Regulation & Governance* and is reproduced with the permission of the co-authors. DOI: 10.1111/rego.12403

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.

2.1. Introduction

Studies have long maintained that a large regulatory burden can restrict economic growth (Dawson and Seater, 2013; Coffey, McLaughlin, and Peretto, 2020), though the total number of regulations for a value chain have largely been understudied. This is especially the case for food and beverage products, where regulations are often drafted to protect the consumer but have the potential to increase prices along the supply chain, leading to regressive outcomes (Chambers, Collins, and Krause, 2019). These regulations are particularly onerous when they are not clearly defined and vary considerably in enforcement (Vogel, 1998).

The influence of regulations on economic outcomes has been studied since at least Stigler (1971), though fewer studies have focused on the geography of regulatory burdens in supply chains.[6] The regulations confronting any supply chain vary dramatically across legislative jurisdictions, as U.S. policy is enforced by overlapping federal, state, and local governments (Tarko and Farrant, 2019). This jurisdictional overlap is especially important in nascent industries and small businesses where entrepreneurs must spend significant cognitive capacity on understanding regulations rather than growing their firms (Teague, 2016). Indeed, places with similar geographic characteristics can have significantly different entrepreneurial outcomes due to geographic variation in regulatory constraints (Bailey and Thomas, 2017; Crum and Gohmann, 2016; Malone, Koumpias, and Bylund, 2019).

This paper uses the novel State RegData database to explore state-by-state regulatory variation in U.S. supply and value chains. The study focuses on the U.S. beer industry as an example of this variation, as the institutions governing the U.S. beer value chain were generally left to state and local policymakers following the 1933 repeal of the 18th

[6] While some indices and rankings seek to measure economic freedom (Stansel & McMahon, 2018), occupational licensing (Summers, 2007), and entrepreneurial constraints (Teague, 2016), to the best of our knowledge, none have focused explicitly on tracking regulatory volume within a specific supply chain.

Amendment and the end of prohibition. Prior research suggests that certain specific brewing regulations restrict economic activity within the sector (Burgdorf, 2019; Gohmann, 2016; Malone and Lusk, 2016; Malone and Hall, 2017). Other research has explicitly examined and modeled the evolution of U.S. and international beer regulations (Swinnen, 2017; Swinnen and Briski, 2017; Tongeren, 2011). However, no prior work has attempted to quantify the *total* number of state and federal restrictions on the beer supply and value chains.

Throughout most of the 20th century, industry concentration resulted in a declining number of breweries producing more beer. This trend reversed in the early 1980s, with entrepreneurs opening thousands of breweries between 1985 and 2020. In fact, though there were fewer than 100 breweries in the United States in the 1980s, over 8,300 breweries operated across the country in 2019 (Brewers Association, 2020a). This growth in entrepreneurial activity has significantly boosted their local economies through increases in regional employment and agricultural production (Dobis et al., 2019; Malone and Stack, 2017; Miller et al., 2019).[7] The economic potential of this nascent industry has become so enticing that state and federal governments have passed legislation promoting the growth of the burgeoning craft beer sector (Malone and Hall, 2017; Malone and Lusk, 2016). Despite its economic potential, the U.S. beer sector is often considered one of the most heavily regulated industries (Madsen, Gammelgaard, and Hobdari, 2020), though few studies have evaluated precisely *how regulated* the U.S. beer industry has become.[8,9]

[7] According to the U.S. Bureau of Labor Statistics, employment in breweries was stagnant at 25,000 employees from 2001 to 2010. From 2011 to 2016, employment in breweries more than doubled, with 58,580 employees working in breweries in 2016 (Delaney & Haines, 2017), corresponding to a surge craft brewery startups. Consequently, the hop industry in the United States has also flourished. In 2019, the Pacific Northwest harvested a record 56,544 acres, up from 31,289 in 2010 (Hop Growers of America, 2011, 2020). Additionally, hopyards have now emerged in 29 states throughout the country, and cultivation outside of the Pacific Northwest is directly tied to craft beer presence (Dobis et al., 2019).

[8] The only exception is Malone and Chambers (2017), which match 1997–2012 data from the *Code of Federal Regulations* with two-digit NAICS codes to explore federal regulatory constraints on the beer value chain. The authors find that 94,212 federal constraints directly and indirectly influenced the beer value chain.

[9] To compare the regulatory volume of the beer industry relative to other industries, we compiled the average direct state regulations by 3-digit NAICS industry. For the 65 industries reported, breweries are in the top 40% of direct state regulatory volume by industry. It is critical for us to note three points. First, breweries only represent one tier of the beer supply chain (breweries, wholesalers, and retailers), so the overall regulatory burden of the beer industry is greater than the average of direct regulations on breweries. Second, the methodology does not account for qualitative aspects to regulations. The qualitative nature of regulations is of importance to the overall regulatory burden of an industry (e.g., Prohibition was essentially one regulation that made the production, distribution, and sale of alcohol illegal), but this brings us to the last note. The objective is to focus on the absolute volume of regulatory restrictions, recognizing that tens of thousands of regulations generate non-trivial costs and create issues of non-compliance and enforcement.

The study uses the Mercatus Center's State RegData 2.0 database, which counts the number of industry-level regulatory restrictions contained in each state's body of administrative law, to assess the impact on both the supply chain of industries that produce the inputs needed to produce beer, as well as the downstream value-added industries that distribute beer to the end consumer (referred to as the value chain).[10] The findings suggest that the formal regulatory constraints vary dramatically across states, with South Dakota having the fewest restrictions (1,177) and California having the most (25,399).

The remainder of this chapter is organized as follows. Section 2.2 describes the beer supply chain in the United States, paying special attention to how regulations impact decision-making throughout the supply chain. Section 2.3 presents the data and methods, including machine learning methods to quantify differences in the number of regulatory restrictions each state government imposes on the beer supply and value chains within their jurisdiction. Section 2.4 presents the results, which suggest that the state-level regulatory restrictions targeted at the beer supply and value chains vary between 1,177 and 25,399, with the average state implementing 10,212 formal restrictions. Section 2.5 concludes with a discussion of these findings.

2.2. U.S. beer supply chain

The economic production, transport, and regulatory structure for any six-pack starts at the farm, enters the three-tier distribution system, and inevitably reaches the final consumer through an array of distribution channels (Figure 2.1).

[10] State RegData are available via the QuantGov website: https://www.quantgov.org/state-regdata

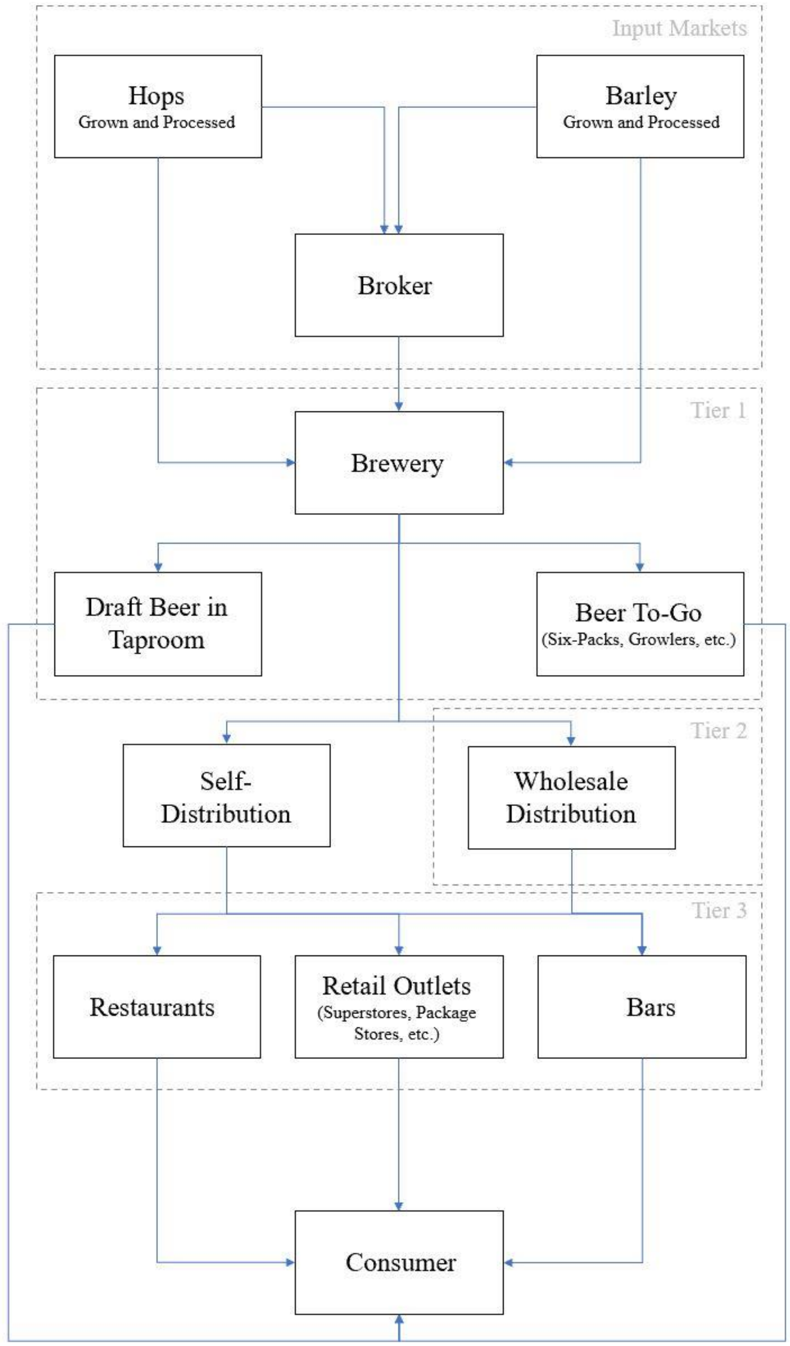


Figure 2.1. Beer supply chain

Hops and barley are the two primary agricultural inputs in beer, but brewers use many other adjuncts, such as rice, corn, wheat, oats, and rye, to achieve a wide array of flavors and sensory profiles. These commodities are grown across the country but are predominantly produced in regions that provide ideal growing conditions and benefit from scale economies (e.g., Pacific Northwest for hops; Montana, North Dakota, and Idaho for barley). Once the agricultural commodity is harvested, it is transported to a processor. For hops, the product is sent to a processing facility that converts the hop cones into pellets; for barley, the commodity is transported to a malt house and converted into malted barley. The pelletized hops and malted barley are the desired ingredients of the brewer, who acquire them directly or through a third-party broker. The direct connection between a brewer and a grower or processor is often limited as agricultural inputs needed for brewing may not be grown in the brewer's region. Thus, brewers commonly seek a third-party broker who bridges the connection from the farm to brewhouse. Once the inputs reach the brewery, the products enter the regulated, three-tier system of production and distribution modeled in this paper.

The first tier of the system starts with the brewery, where—depending on their business model—the company brews the beer, packages the product in various forms (e.g., six-packs, kegs, etc.), and sells their beer through multiple distribution channels. Figure 2.1 presents four potential distribution channels: (i) draft beer sold in the brewery's taproom, (ii) beer to-go orders, (iii) self-distribution, and (iv) distribution through a wholesaler. Smaller and medium-sized craft breweries rely predominantly on taproom sales, while regional (craft) breweries and macro breweries have more diverse revenue streams. In fact, it is not uncommon for 80% or more of a craft brewery's revenue to come from taproom sales (Staples, Malone, and Sirrine, 2020). Taproom sales include draft beer in the taproom that is sold for on-premise consumption (e.g., pints) and beer for off-premise consumption (e.g., to-go orders such as six-packs). The remaining distribution outlets involve moving the product from the brewery to retail outlets, often through a distributor.

The second tier of the beer supply chain is the wholesaler, or the distributor, who serves as a *middleman* between the brewery and the retailer. Their role is to handle sales and marketing for the beer producer, finding various outlets for the product, which include bars, restaurants, superstores, and local liquor stores. The role of the distributor has been called into question recently, as it can impose high costs on smaller breweries and ultimately limit entry into the market (Malone and Lusk, 2016). Consequently, states have pursued self-distribution legislation allowing breweries to transport their beer directly to retail outlets, bypassing the second tier of the distribution system altogether. As of 2017, 35 states allowed some form of self-distribution (Shumway, 2017), but this regulatory privilege is often capped at a given production threshold, measured in barrels (bbls) per year. For example, Michigan allows breweries that produce fewer than 2,000 bbls per year to self-distribute; before July 1, 2020, self-distribution was limited to breweries producing under 1,000 bbls per year (Michigan House Bill 5343).

Whether distributed through a wholesaler or the brewery itself, the product reaches the final tier of the beer distribution system: the retailer. Different regulatory structures surround each retail outlet depending on whether the alcohol is purchased for on-premise or off-premise consumption. In extreme cases, states only allow government stores to make certain alcohol sales. In addition, on-premise retailers like restaurants and bars are subject to restrictions on serving times. Similarly, retailers who sell for off-premise consumption have regulatory restrictions on purchasing hours; many states limit or even ban alcohol sales on Sundays.

While each state government is unique in regulating its alcohol supply chain, some semblance of the three-tier distribution system has been in place for most jurisdictions since the passing of the 21st Amendment. In summary, though the general structure of the beer supply chain is similar across the country (Figure 2.1), it is a complex system riddled with regulatory restrictions that vary from state to state.

2.3. Data and methods

2.3.1 Defining regulatory restrictions

Because the meaning of the term "regulation" can be rather ambiguous, it is critical to define the term precisely. Within the scope of this empirical analysis, "regulation" measures come from State RegData 2.0, the Mercatus Center's unique database of industry-specific state regulatory restrictions. State RegData analyzes rules and guidelines published in each state's consolidated body of administrative law, counting each instance of a binding restriction that appears in the regulatory text. Each time a word indicating an obligation or prohibition (i.e., *shall*, *must*, *may not*, *prohibited*, or *required*) is encountered, that word is counted as a regulatory restriction. These restrictions are probability-weighted by their industry relevance (as determined by a machine learning algorithm trained on the lexigraphy of industry-specific texts) and summed by industry.[11] Regulatory index values are reported by industry for each state. All empirical calculations and estimates of "regulations" refer to this regulatory restriction index from State RegData.

2.3.2 Total Regulatory Restrictions Within the Beer Value Chain and Supply Chain

To better quantify the entire impact of *federal* regulations on the beer industry, Malone and Chambers (2017) measured federal regulatory restrictions that apply to both the three-tier beer distribution system (i.e., brewing, wholesale distribution, and retail distribution) and the inputs needed to produce these goods and services (e.g., hops, grain, energy, labor). Malone and Chambers used the Mercatus Center's RegData database, which was constructed using methods similar to those used to build State RegData, except that the regulatory text being analyzed by RegData is the U.S. *Code of Federal Regulations* (CFR). Because the primary interest of this study is state regulatory restrictions, this paper adopts the methodology of Malone and Chambers. However, it uses State RegData to measure state regulatory restrictions that apply to both the beer value chain and the inputs needed to produce these goods and services.

The value chain industries are "downstream," as manufactured beer is an intermediate input that increases in value (as measured by wholesale and retail margins) as it moves through the value chain from the brewer to the consumer. The regulations that apply to these activities are labeled "direct regulations." By contrast, each value chain industry (brewing and wholesale or retail distribution) relies on a complex supply chain of inputs to produce their respective goods and services, with each input industry subject to regulation. These "upstream" supply-chain-related regulations are labeled "indirect regulations." The sum of the direct and indirect regulations represents the totality of all regulations impacting beer production and distribution.

To estimate the "upstream" regulations that apply to an industry's supply chain, Malone and Chambers (2017) follow the approach described Chambers et al. (2019).[12] That

[11] For details on the methodology of calculating measures of regulation, see McLaughlin & Sherouse (2019).
[12] Chambers et al. (2019) was first presented as a working paper by the Mercatus Center 2016: https://www.mercatus.org/system/files/Chambers-How-Regs-Affect-Prices-v2.pdf

is, they use input-output (I-O) commodity weights from the Bureau of Economic Analysis (BEA) to weight the regulatory restrictions that apply to each industry that produces the inputs required by that industry's supply chain:

$$Reg_{j,h}^{indirect} = \sum_{i} \alpha_i \cdot Reg_{i,h}^{direct} \quad (1)$$

where $Reg_{j,h}^{indirect}$ are the total indirect (i.e., supply-chain-related) state regulations that apply to industry *j* (i.e., brewing and wholesale or retail distribution) in state *h*; *i* is the index of supply chain industries that supply inputs to industry *j*; α_i are I-O commodity weights from the BEA renormalized to sum to one; and $Reg_{i,h}^{direct}$ are the direct state regulations for industry *i* in state *h* as reported by State RegData.

The BEA data are derived from the economic census (the latest data are from 2012; see BEA, 2019) and are reported as "The Use Table (Supply-Use Framework), 2012," which records the dollar value of inputs from private and public entities and industries used as intermediate inputs to produce the output of an industry.[13] Removing inputs from all non-private sector industries (i.e., federal, state, and local government enterprises),[14] which provided less than 1.27% of all inputs, the remaining inputs are renormalized to add to one (i.e., expressed as value-weighted inputs).[15] The input weights for each industry used to construct the input models for breweries (NAICS code 312), wholesale distribution (424), and retail sales (445) are provided in Table 2.1.[16] Combining these input regulations ($Reg_{j,h}^{indirect}$) with the aforementioned direct regulations ($Reg_{j,h}^{direct}$) yields a comprehensive measure of the regulatory volume faced by the beer value and supply chains, from the

[13] The data can be obtained from https://www.bea.gov/industry/input-output-accounts-data#tab-02 by clicking on Use Tables (Use of commodities by industry) for 2007, 2012 detailed (405) industries (https://apps.bea.gov/industry/xls/io-annual/Use_SUT_Framework_2007_2012_DET.xlsx). The dollar value of inputs from private and public entities and industries used as intermediate inputs to produce the output of an industry are reflected in the columns of the table.

[14] The BEA defines government enterprises as "Government agencies that cover a substantial portion of their operating costs by selling goods and services to the public and that maintain their own separate accounts" (Bureau of Economic Analysis, n.d.).

[15] RegData does not estimate regulations that pertain to public sector entities, so the scope of input activity is restricted to non-public sector entities. Moreover, the only government input sectors providing inputs to our three industries were the U.S. Postal Service and "other state and local government enterprises." In 2012, these public input sectors represented 0.25% of the intermediate inputs for breweries, 2.57% of the intermediate inputs for wholesale distribution, and 0.98% of the intermediate inputs for retail sales.

[16] Because of differences in RegData coverage across states, the following industries were dropped when calculating Indirect (Input) Regulations because they were not included in 12 state cross-sections: 425, 511, 518, 519, and 521. Fortunately, these obscure industries accounted for approximately one weighted regulation per state, so the overall rankings are not affected by their omission.

upstream, raw commodities used to brew beer to the downstream distribution networks that enable the final sale to the customer:

$$Reg_h^{beer} = \sum_j \left(Reg_{j,h}^{direct} + Reg_{j,h}^{indirect} \right). \quad (2)$$

Unfortunately, the granularity of the industry regulation data provided by State RegData is limited to the NAICS three-digit level, while Malone and Chambers (2017) exploited RegData's five-digit NAICS level of resolution. Specifically, Malone and Chambers approximated sector 31212 (Breweries) by subtracting sector 3122 (Tobacco Manufacturing) from sector 312, yielding a measure of regulations that directly apply to all beverage manufacturing (including breweries, wineries, distilleries, and soft drinks) but not tobacco manufacturing.[17] Because of State RegData's limitations, the measure of the direct regulations for the Breweries industry is proxied using NAICS code 312 (Beverage and Tobacco Product Manufacturing). While we acknowledge this limitation, most states contain neither tobacco farms nor cigarette manufacturers, suggesting that the subset of regulations in NAICS sector 312 pertaining to tobacco is likely small. Direct regulations for wholesale distribution are proxied using NAICS code 424 (Merchant Wholesalers, Nondurable Goods). This marks an improvement over the methodology utilized in Malone and Chambers (2017), wherein they use the two-digit NAICS code 42 (Wholesale Trade) as a proxy for sector 42481 (Beer Merchant Wholesalers).[18] Finally, direct regulations for retail stores (NAICS sector 44531) are proxied using NAICS code 445 (Food and Beverage Stores), the same approach utilized in Malone and Chambers.[19]

---

[17] Detailed descriptions of each NAICS-coded industry are available at the U.S. Census Bureau's website.

[18] As RegData has evolved, the precision of its industry classifier has steadily improved. Therefore, subsequent vintages of RegData have provided more data granularity. Moreover, there are examples of industries (especially in older versions of RegData) in which the level of regulation detail is limited.

[19] NAICS sector 445 includes government-owned alcoholic beverage stores and dispensaries (see https://www.bls.gov/iag/tgs/iag445.htm).

Table 2.1. Input-output supply chain industry weights

		Input Weights (α)		
NAICS	Industry Description	Breweries (312)	Wholesalers (424)	Retailers (445)
111	Crop production	0.1738	0.0109	0.0191
112	Animal production	0.0000	0.0000	0.0018
114	Fishing, hunting, and trapping	0.0000	0.0000	0.0102
211	Oil and gas extraction	0.0000	0.0001	0.0001
212	Mining (except oil and gas)	0.0051	0.0001	0.0000
221	Utilities	0.0219	0.0269	0.1126
236	Nonresidential maintenance and repair	0.0008	0.0044	0.0071
311	Food manufacturing	0.1221	0.0206	0.0453
312	Breweries	0.0060	0.0000	0.0022
314	Other textile product mills	0.0001	0.0020	0.0027
315	Apparel manufacturing	0.0000	0.0032	0.0000
316	Leather and allied product manufacturing	0.0000	0.0002	0.0001
321	Wood product manufacturing	0.0000	0.0040	0.0068
322	Paper manufacturing	0.0719	0.0119	0.0184
323	Printing	0.0050	0.0109	0.0034
324	Petroleum and coal products manufacturing	0.0200	0.0161	0.0112
325	Chemical manufacturing	0.0050	0.0097	0.0009
326	Plastics and rubber product manufacturing	0.0103	0.0215	0.0274
327	Nonmetallic mineral product manufacturing	0.1611	0.0002	0.0011
331	Primary metal manufacturing	0.0000	0.0001	0.0000
332	Fabricated metal product manufacturing	0.2267	0.0015	0.0028
333	Machinery manufacturing	0.0032	0.0021	0.0017
334	Computer and electronic product manufacturing	0.0287	0.0098	0.0042
335	Electrical equipment, appliance, and component manufacturing	0.0030	0.0002	0.0006
336	Transportation equipment manufacturing	0.0155	0.0050	0.0193
337	Furniture and related product manufacturing	0.0000	0.0003	0.0000
339	All other miscellaneous manufacturing	0.0002	0.0007	0.0018
423	Merchant wholesalers, durable goods	0.0000	0.0140	0.0010
424	Other nondurable goods merchant wholesalers	0.0051	0.0214	0.0016
425	Wholesale electronic markets and agents and brokers	0.0000	0.0145	0.0013
481	Air transportation	0.0011	0.0057	0.0005
482	Rail transportation	0.0000	0.0002	0.0001
483	Water transportation	0.0000	0.0001	0.0000
484	Truck transportation	0.0000	0.0030	0.0148

Table 2.1. (cont'd)

485	Transit and ground passenger transportation	0.0004	0.0017	0.0001
487	Scenic and sightseeing transportation and support activities for transportation	0.0007	0.0225	0.0032
492	Couriers and messengers	0.0000	0.0357	0.0061
493	Warehousing and storage	0.0003	0.0355	0.1245
511	Publishing industries (except Internet)	0.0000	0.0012	0.0028
512	Motion picture and sound recording industries	0.0000	0.0000	0.0025
517	Telecommunications	0.0011	0.0210	0.0090
518	Data processing, hosting, and related services	0.0007	0.0043	0.0098
519	Other information services	0.0000	0.0001	0.0034
521	Monetary authorities and depository credit intermediation	0.0090	0.0080	0.0141
522	Nondepository credit intermediation and related activities	0.0066	0.0270	0.0297
523	Securities, commodity contracts, and other financial investments	0.0005	0.0039	0.0032
524	Insurance carriers and related activities	0.0179	0.0167	0.0122
531	Other real estate	0.0032	0.0925	0.1711
532	Rental and leasing services	0.0019	0.0271	0.0065
533	Lessors of nonfinancial intangible assets	0.0313	0.0256	0.0129
541	Professional, scientific, and technical services	0.0141	0.1814	0.1058
550	Management of companies and enterprises	0.0132	0.1256	0.0465
561	Administrative and support services	0.0022	0.0777	0.0408
562	Waste management and remediation services	0.0057	0.0041	0.0066
611	Educational services	0.0000	0.0069	0.0147
711	Performing arts, spectator sports, and related industries	0.0003	0.0027	0.0063
713	Other amusement and recreation industries	0.0001	0.0008	0.0006
721	Accommodation	0.0010	0.0020	0.0009
722	Food service and drinking places	0.0017	0.0105	0.0115
811	Repair and maintenance	0.0013	0.0374	0.0334
812	Personal and laundry services	0.0000	0.0060	0.0009
813	Civic, social, professional, and similar organizations	0.0002	0.0008	0.0007

Table 2.2 presents the direct, indirect, and total regulatory restrictions applicable to the beer supply and value chains at the state and federal levels. Federal restrictions were estimated to demonstrate that despite minor differences in modeling assumptions, the model would likely produce similar findings to Malone and Chambers (2017). Comparing these results, Malone and Chambers report total regulatory restrictions for 2012 (the last year that estimates are available) of 94,212. The model produces an estimated 115,081 federal regulatory restrictions in 2017, which is 22% greater than the 2012 estimate. This is likely due to the comparison periods differing by five years, during which federal regulations have likely grown as the beer industry experienced its most rapid expansion. If federal beer industry regulation grew at the average pace of all industries, the expectation is a 19% growth in total regulation over a five-year period.[20] Therefore, compared to Malone and Chambers, the model presented in this paper produces federal regulatory estimates that appear to be sound and, by extension, should also produce reasonably accurate measures of state regulatory restrictions.

[20] Chambers et al. (2019) report that federal regulations (measured at the industry level) grew by an average 3.78% per year between 1999 and 2015.

Table 2.2. State-level regulatory restrictions

	Brewery restrictions			Wholesale distribution restrictions			Retail sales restrictions				
State	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**	**Total**	**Rank**
Alabama	374	1,067	1,441	156	1,628	1,785	1,684	1,099	2,783	6,009	33
Arizona	42	708	750	251	983	1,234	351	653	1,004	2,989	41
California	676	4,758	5,434	555	7,424	7,979	5,753	6,233	11,986	25,399	1
Colorado	1,919	1,891	3,810	306	4,329	4,635	1,399	2,963	4,361	12,806	12
Delaware	1,579	1,788	3,366	799	2,542	3,341	4,249	1,912	6,161	12,868	11
D.C.	1,203	600	1,803	893	1,755	2,648	1,654	1,196	2,850	7,301	28
Florida	961	1,502	2,463	636	2,396	3,031	4,773	1,782	6,554	12,048	14
Georgia	3,134	1,397	4,531	152	3,549	3,701	3,093	2,359	5,452	13,684	9
Idaho	50	570	620	151	748	899	352	580	932	2,450	43
Illinois	1,209	2,856	4,064	519	5,392	5,911	7,970	4,253	12,222	22,198	4
Indiana	2,263	1,235	3,499	129	1,519	1,648	1,023	1,193	2,215	7,362	27
Iowa	1,272	1,552	2,824	194	2,423	2,617	2,697	1,923	4,620	10,061	21
Kansas	154	622	776	204	1,167	1,370	1,092	883	1,976	4,121	39
Kentucky	828	1,328	2,156	257	1,367	1,624	1,785	1,122	2,907	6,687	30
Louisiana	982	2,386	3,368	124	2,678	2,802	5,003	2,052	7,054	13,224	10
Maine	1,149	1,430	2,579	475	3,183	3,658	2,273	2,309	4,582	10,819	19
Maryland	647	856	1,502	259	1,915	2,175	1,376	1,353	2,728	6,405	31
Massachusetts	941	1,408	2,348	546	4,221	4,766	6,657	2,989	9,646	16,760	6
Michigan	589	1,238	1,827	212	1,617	1,829	844	1,434	2,278	5,934	34
Minnesota	1,617	1,530	3,147	238	2,333	2,570	1,826	1,918	3,744	9,462	23
Mississippi	460	1,693	2,153	119	3,923	4,042	1,582	2,706	4,288	10,484	20
Missouri	1,032	756	1,788	129	1,876	2,005	649	1,399	2,047	5,840	35
Montana	405	1,088	1,492	123	1,253	1,376	411	1,129	1,539	4,408	38
Nebraska	637	642	1,279	242	1,939	2,181	849	1,307	2,156	5,616	36
Nevada	612	521	1,133	191	949	1,140	858	845	1,704	3,977	40
New Hampshire	483	1,132	1,616	367	4,596	4,963	2,162	2,948	5,110	11,688	16
New York	2,057	3,332	5,389	531	5,770	6,300	6,495	4,464	10,959	22,648	3

Table 2.2. (cont'd)

North Carolina	165	787	952	350	1,717	2,067	2,286	1,431	3,716	6,736	29
North Dakota	325	554	879	46	921	967	453	636	1,090	2,936	42
Ohio	1,451	2,087	3,538	288	2,783	3,071	2,195	2,149	4,344	10,953	17
Oklahoma	1,763	1,740	3,503	224	3,231	3,455	2,236	2,588	4,825	11,782	15
Oregon	1,056	2,398	3,454	422	4,678	5,101	3,934	3,537	7,471	16,026	7
Pennsylvania	845	1,345	2,190	239	1,942	2,182	2,077	1,438	3,516	7,887	25
Rhode Island	2,459	890	3,349	489	2,128	2,617	1,078	1,587	2,665	8,632	24
South Carolina	1,551	2,197	3,748	444	1,912	2,357	3,301	1,447	4,748	10,852	18
South Dakota	313	220	533	27	293	320	100	224	324	1,177	44
Tennessee	1,504	1,635	3,139	221	2,203	2,424	2,844	1,593	4,437	10,000	22
Texas	2,023	2,949	4,972	2,598	6,583	9,180	4,823	5,101	9,925	24,076	2
Utah	263	1,265	1,528	289	2,041	2,330	1,103	1,431	2,534	6,392	32
Virginia	803	2,593	3,396	208	4,092	4,301	4,865	3,106	7,971	15,668	8
Washington	441	2,573	3,014	753	5,090	5,843	4,941	3,775	8,715	17,573	5
West Virginia	628	1,257	1,886	195	1,939	2,134	1,680	1,679	3,359	7,378	26
Wisconsin	1,533	3,064	4,597	292	2,786	3,079	2,648	2,290	4,938	12,614	13
Wyoming	101	885	986	189	1,861	2,051	1,112	1,257	2,368	5,405	37
Federal restrictions	16,711	17,193	33,904	6,772	32,258	39,030	15,179	26,969	42,148	115,081	n/a
State summary stats											
Mean	1,011	1,553	2,564	364	2,720	3,084	2,512	2,052	4,564	10,212	
Median	893	1,371	2,406	246	2,166	2,594	1,952	1,636	4,016	9,731	
Standard Deviation	713	911	1,334	398	1,622	1,866	1,932	1,260	3,020	5,856	
Minimum	42	220	533	27	293	320	100	224	324	1,177	
Maximum	3,134	4,758	5,434	2,598	7,424	9,180	7,970	6,233	12,222	25,399	

2.4. Results

On average, each state imposes 10,212 additional regulatory restrictions on the production and distribution of beer, but the state-level regulatory volume varies drastically by state, with a minimum of 1,177 additional restrictions (South Dakota) and a maximum of 25,399 restrictions (California). As the federal regulations serve as a baseline standard that each jurisdiction must abide by, it takes an average of 125,293 regulatory restrictions to get a beer (i.e., the sum of federal regulations and the average state's regulations).

Figure 2.2 provides a distribution of state-by-state regulatory restrictions. The five least-regulated states by volume are South Dakota (1,177 regulatory restrictions), Idaho (2,450), North Dakota (2,936), Arizona (2,989), and Nevada (3,977). The five most-regulated states by volume are California (25,870 regulatory restrictions), Texas (24,076), New York (22,648), Illinois (22,198), and Washington (17,573).

The variation in regulatory constraints is not distributed explicitly across the value chain. Instead, each tier of the supply chain experiences unique concentrations of restrictions. The regulatory constraints for each state are broken down by tier in Table 2.2 and presented in Figure 2.3. On average, 26% of regulatory constraints are imposed on the breweries, 31% on the wholesale distributor, and 43% on retail outlets.

As seen in the map, the substantial regulatory variation emphasizes the need for each brewery to invest in a deeper institutional understanding of the governing constraints of each state. Many commercial and large craft regional breweries now operate in second locations outside their state of origin. For example, Sierra Nevada Brewing Company opened its first brewery location in Chico, California, in 1993 (the state with the most regulatory restrictions); in 2015, the brewing company opened a second location in Mills River, North Carolina (which ranks 29th in total regulatory restrictions) (Sierra Nevada Brewing Company, 2020). It could be that a brewery compliant with regulations in one state is already compliant with most laws in another, though the regional differences in distribution laws make this unlikely (Gohmann, 2016). Thus, a legal background is critical for understanding regional differences in beer distribution laws.

Equally important is the impact of trade and the origin of beer inputs. The indirect regulations capture regulatory restrictions outside the three-tier beer distribution system (brewer to the wholesale distributor to the retail outlet) but within the beer value chain (e.g., labor, agricultural inputs, etc.). The indirect regulations on the agricultural inputs to beer—primarily hops and (malted) barley—have disproportionate effects on certain regions.[21] Approximately 96% of domestic hops are grown in Washington, Idaho, or Oregon (Hop Growers of America, 2020), while roughly 74% of barley is produced in Montana, North Dakota, or Idaho (USDA 2019a). Thus, if the methods of capturing indirect regulations are accurate, there is likely to be more indirect regulatory restrictions in the states producing the agricultural commodities for beer, thus driving up the total number of restrictions for that state. There is preliminary evidence supporting this hypothesis, where Washington and Oregon rank 5th and 6th in total indirect regulations, respectively; 73% of Montana's regulations are indirect regulations (highest percentage overall); and 62% of Idaho's regulations are indirect regulations (8th overall). However, given the current framework, the analysis cannot explicitly parcel out the indirect regulations attributed to the agricultural production of beer inputs, as indirect regulations also come from other sources, such as brewery labor.

[21] Brewers use many other agricultural inputs in the brewing process. For example, large commercial brewers use corn or rice instead of malted barley, and quantities of hops per barrel can vary widely. Other agricultural commodities found in certain beer styles include wheat, rye, oats, spices, and others.

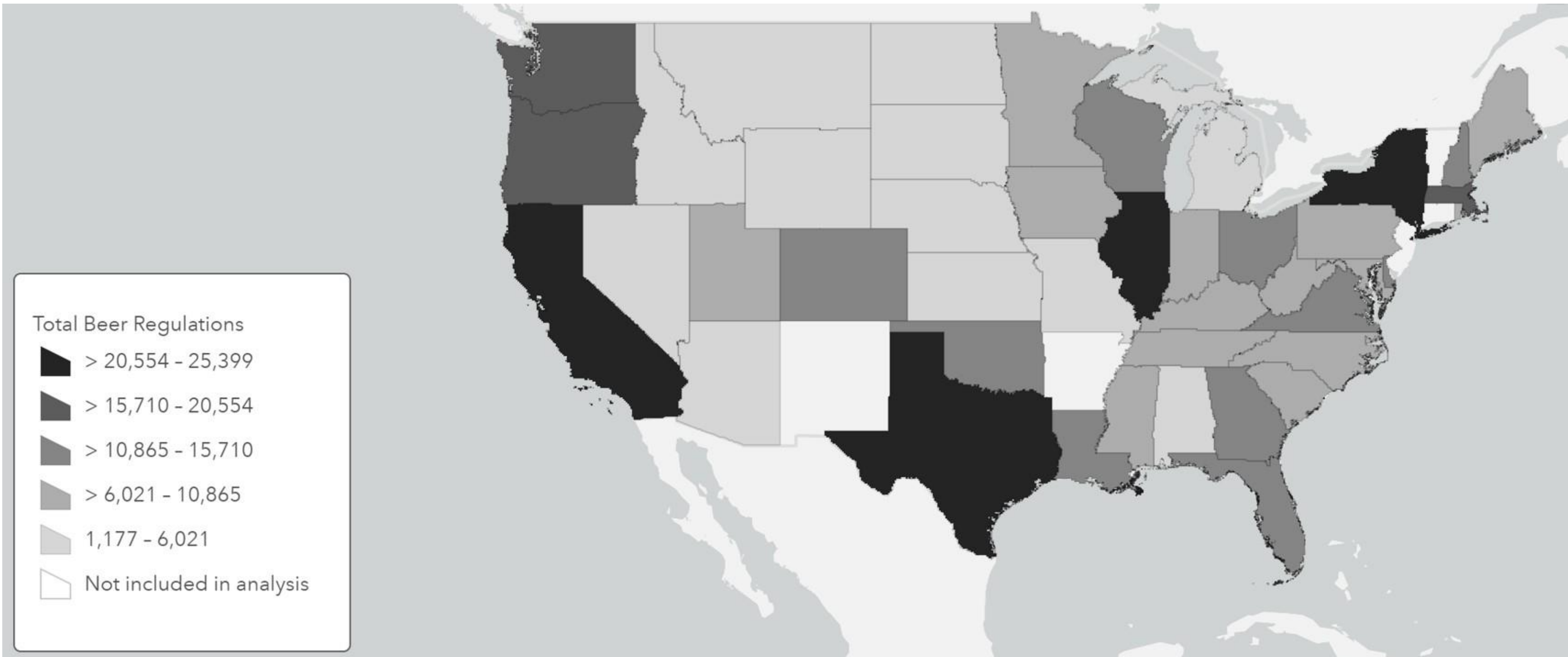
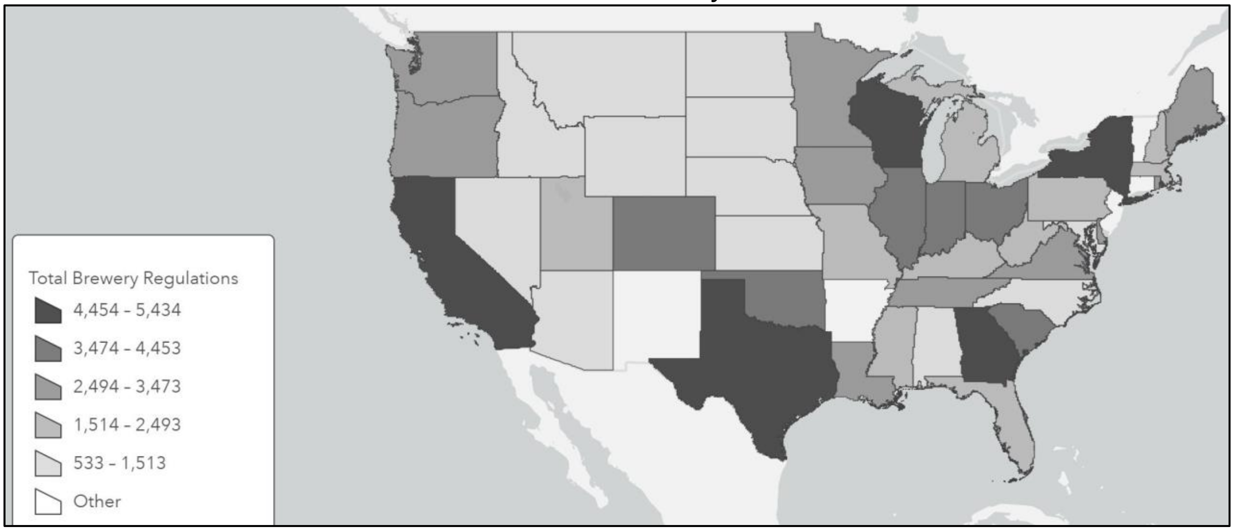
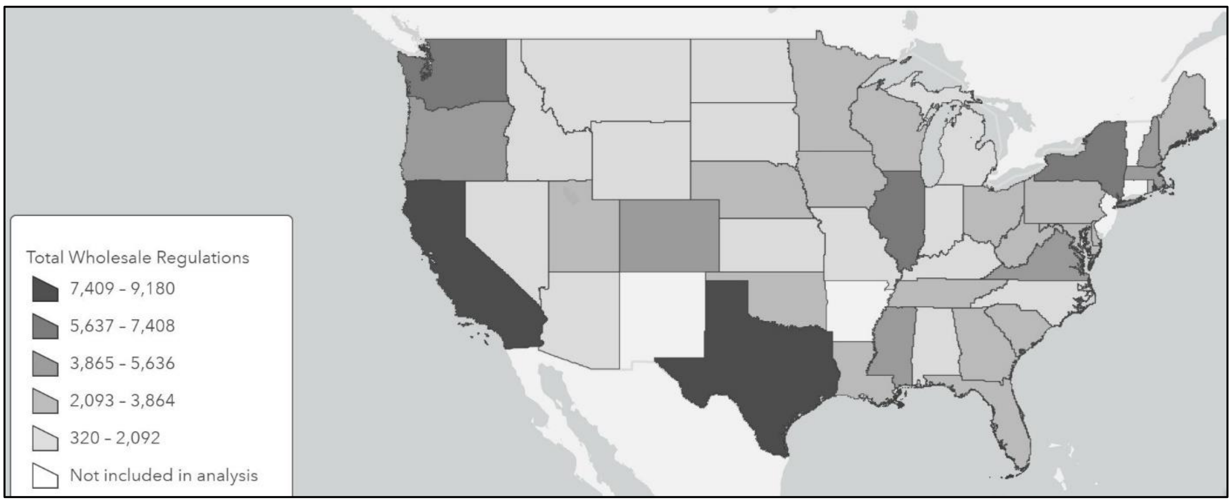


Figure 2.2. Beer supply chain regulatory constraints, by state

Panel A: Brewery



Panel B: Wholesale



Panel C: Retail

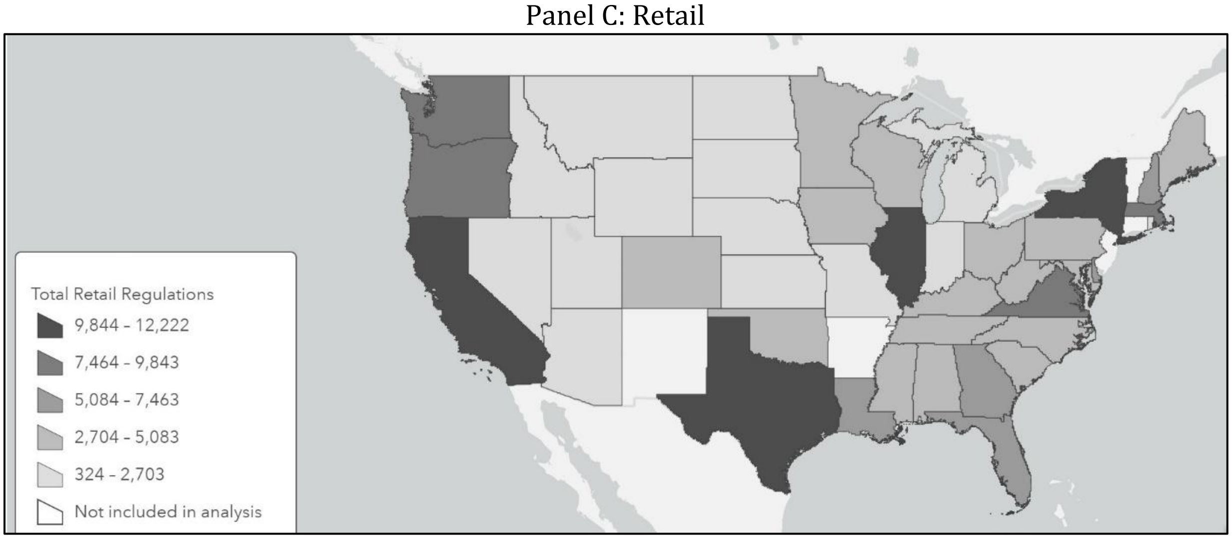


Figure 2.3. Beer supply chain regulatory constraints, by state and tier

2.5. Conclusion

Regulations can restrict economic activity, though little is known about the full extent of the regulatory burden on an entire supply chain. Supply chains have become more geographically integrated, making geographic variation in regulatory restrictions increasingly important for business growth. This article uses the beer industry as a case study to fill that gap in the literature. Results suggest that more than 115,000 federal regulatory restrictions constrain the U.S. beer supply chain, and the average state imposes an additional 10,212 restrictions. The variation in the number of regulations across states is substantial, ranging from 1,177 to 25,399 state regulatory constraints. All told, in the United States, more than 125,000 restrictions stand between each consumer and a six-pack at a retail outlet.

Some limitations remain. While this article focuses on the *total* number of regulatory restrictions in the beer supply chain, it does not account for any qualitative aspects of regulations. In other words, the study makes no reference to the objective or the quality of the regulations. Of course, real-world regulations can vary substantially in their costs and benefits to the supply chain (Swinnen, 2016; 2017). For example, one regulation (Prohibition) made the production, distribution, and sale of alcohol illegal from 1920 to 1933. Regulations that have impeded craft beer growth in recent years include shorter hours of operations compared to traditional bars and restaurants, customer serving limits, and restrictions on self-distribution (Brewers Association, 2020b; Craig, 2020; Gohmann, 2016). However, other regulations may be implemented to boost the local economy or expand local value chains. According to the analysis, New York is the third most regulated beer state, but the New York state government has also developed an advanced farm brewery law. The methodological framework of this article presents this legislation as adding regulatory restrictions. Yet, the legislation is meant to incentivize a more localized beer value chain through relaxed permit restrictions related to the purchase of state-grown inputs, onsite distribution, and the sale of other alcoholic beverages, such as cider (New York State Brewers Association, 2020).

Despite the inability to incorporate a qualitative assessment of the regulatory restrictions, this article speaks to the sheer regulatory volume of the beer industry, suggesting tens of thousands of regulatory restrictions are excessive, difficult to enforce, and may increase non-compliance. The results also indicate that there is considerable variation in how states choose to regulate the beer value chain. From an industry with 92 producers in 1980 to an industry with 8,386 producers in 2019 (Brewers Association, 2020a), the U.S. beer industry has evolved dramatically over the past few decades. This study lays a foundation for the current regulatory variation across state lines, but future research is needed to determine the evolution of the quantity and quality of regulations. A study incorporating regulations over time while controlling for cross-sectional heterogeneity (e.g., number of breweries, population, etc.) could provide a causal interpretation of the driving forces behind regulatory changes. However, this lies outside the scope of the analysis and might be an area for future research.

Our primary purpose is to highlight the complex geographic nature of regulations across interstate value chains. Poorly designed and inefficient regulations can generate many unintended consequences. Although eliminating overlapping and redundant regulations represents one possible means to reduce the regulatory volume, the negative impact of a given regulation can also be reduced through improved regulatory design (i.e., more clarity and simplicity). A growing body of research chronicles the unintended consequences of regulations—especially the cost of compliance (see Bailey, Thomas, and Anderson, 2019; Crain and Crain, 2010). Thus, not surprisingly, Vogel (1998) finds that well-written, straightforward regulations are likely to have lower compliance costs, all else equal, while Béland, Rocco, and Waddan (2016) find that ambiguous regulations can induce substantial policy drift, which, if not corrected, can lead to significant negative economic outcomes. Moreover, the regulatory landscape is not static, and the same regulation might be enforced differently over time. This is especially likely when new markets are developing, as in many agricultural and food markets. As discussions surrounding supply chain efficiency and resiliency continue, regulatory volume and burden will likely be part of the discussion.

REFERENCES

Al-Ubaydli, O., & McLaughlin, P. A. (2017). RegData: A numerical database on industry-specific regulations for all United States industries and federal regulations, 1997–2012. *Regulation & Governance*, *11*(1), 109–123. https://doi.org/10.1111/rego.12107

Bailey, J., Thomas, D. W., & Anderson, J. (2019). Regressive effects of regulation on wages. *Public Choice*, *180*(1), 91–103. https://doi.org/10.1007/s11127-018-0517-5

Béland, D., Rocco, P., & Waddan, A. (2016). Reassessing policy drift: Social policy change in the United States. *Social Policy & Administration*, *50*(2), 201–218. https://doi.org/10.1111/spol.12211

Brewers Association (2022a). National beer sales & production data. Available at *Brewers Association* website: https://www.brewersassociation.org/statistics-and-data/national-beer-stats/

Brewers Association (2022b). State laws*.* Available at *Brewers Association* website: https://www.brewersassociation.org/government-affairs/state-laws/

Bureau of Economic Analysis (October 29, 2019). Input-output accounts data. Available at *BEA* website: https://www.bea.gov/industry/input-output-accounts-data [last accessed September 16, 2022].

Bureau of Economic Analysis. (n.d.). Government enterprises. Available in *BEA Glossary:* https://www.bea.gov/help/glossary/government-enterprises [last accessed September 16, 2022].

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

Chambers, D., Collins, C. A., & Krause, A. (2019). How do federal regulations affect consumer prices? An analysis of the regressive effects of regulation. *Public Choice*, *180*(1-2), 57–90. https://doi.org/10.1007/s11127-017-0479-z

Coffey, B., McLaughlin, P. A., & Peretto, P. (2020). The cumulative cost of regulations. *Review of Economic Dynamics*, *38,* 1-21*.* https://doi.org/10.1016/j.red.2020.03.004

Craig, C. A. (2020). Managing a Craft Brewery: Competitive, Legal, and Environmental Forces. *Entrepreneurship Education and Pedagogy*, 4(3), 1-8. https://doi.org/10.1177/251512742096996

Crain, N. V. & Crain, W. M. (2010, September). *The impact of regulatory costs on small firms*. Small Business Administration, Office of Advocacy, Washington, D.C. Available at: https://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.186.537 [last accessed September 16, 2022].

Dawson, J.W. & Seater, J.J. (2013). Federal regulation and aggregate economic growth. *Journal of Economic Growth*, 18, 137–177. https://doi.org/10.1007/s10887-013-9088-y

Delaney, E. & Haines, M. (2017, December). *Industry on tap: Breweries*. U.S. Bureau of Labor Statistics. https://www.bls.gov/spotlight/2017/industry-on-tap-breweries/home.htm [last accessed September 16, 2022].

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

Fortin, N. (ed.) (2017). Introduction to food regulation in *Food Regulation: Law, Science, Policy, and Practice* (pp. 3 – 20). John Wiley & Sons. Hoboken, NJ.

Garavaglia, C. & Swinnen, J. (2018). Economics of the craft beer revolution: A comparative international perspective. In *Economic perspectives on craft beer* (pp. 3-51). Palgrave Macmillan, Cham.

Gohmann, S. F. (2016). Why are there so few breweries in the South? *Entrepreneurship Theory and Practice*, *40*(5), 1071–1092. http://doi.org/10.1111/etap.12162

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

Hop Growers of America. (2011, January). *2010 Statistical Report*. https://www.usahops.org/img/blog_pdf/12.pdf [last accessed September 16, 2022].

Hop Growers of America. (2020, January). *2019 Statistical Report*. https://www.usahops.org/img/blog_pdf/273.pdf [last accessed September 16, 2022].

Malone, T. & Chambers, D. (2017). Quantifying federal regulatory burdens in the beer value chain. *Agribusiness*, *33*(3), 466–471. https://doi.org/10.1002/agr.21507

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

Malone, T. & Stack, M. (2017). What do beer laws mean for economic growth? *Choices*, *32*(3), 1–7. https://www.jstor.org/stable/90015011

Madsen, E. S., Gammelgaard, J., & Hobdari, B. (Eds.). (2020). *New developments in the brewing industry: The role of institutions and ownership.* Oxford University Press.

McLaughlin, P. A., & Sherouse, O. (2019). RegData 2.2: a panel dataset on US federal regulations. *Public Choice*, *180*(1-2), 43-55. https://doi.org/10.1007/s11127-018-0600-y

Michigan House Bill 5343, 100th Cong., Reg. sess. (2020) (enacted). http://www.legislature.mi.gov/documents/2019-2020/billintroduced/House/pdf/2020-HIB-5343.pdf [last accessed September 16, 2022].

Miller, S. R., Sirrine, J. R., McFarland, A., Howard, P. H., & Malone, T. (2019). Craft beer as a means of economic development: An economic impact analysis of the Michigan value chain. *Beverages*, *5*(2), 35. https://doi.org/10.3390/beverages5020035

New York State Brewers Association. (2020). *Farm brewery*. https://newyorkcraftbeer.com/farm-brewery/ [last accessed September 16, 2022].

Shumway, K. (2017). *Brewbound voices: Deconstructing self-distribution (part I).* Brewbound. https://www.brewbound.com/news/brewbound-voices-deconstructing-self-distribution-part [last accessed September 16, 2022].

Sierra Nevada Brewing Co. (2020). *Our story*. Available at *Sierra Nevada Brewing Co* website: https://sierranevada.com/about/our-story/ [last accessed September 16, 2022].

Stansel, D., & McMahon, F. (2018). *Economic freedom of North America 2013*. Fraser Institute.

Staples, A. J., Malone, T., & Sirrine, J. R. (2021). Hopping on the localness craze: What brewers want from state-grown hops. *Managerial and Decision Economics*, *42*(2), 463-473. https://doi.org/10.1002/mde.3246

Staples, A. J., Chambers, D., Melstrom, R. T., & Malone, T. (2022). Regulatory Restrictions Across US Protein Supply Chains. *Journal of Agricultural and Applied Economics*, *54*(1), 1-27. https://doi.org/10.1017/aae.2021.28

Stigler, G. J. (1971). The theory of economic regulation. *The Bell Journal of Economics and Management Science*, *2*(1), 3–21. https://doi.org/10.2307/3003160

Summers, A. B. (2007). *Occupational licensing: Ranking the states and exploring alternatives*. Reason Foundation. Available at: https://www.nachi.org/documents2012/Occupational-Licensing.pdf [last accessed September 16, 2022].

Swinnen, J. (2016). Economics and politics of food standards, trade, and development. *Agricultural Economics,* 47(1), 7-19. https://doi.org/10.1111/agec.12316

Swinnen, J. (2017). Some dynamic aspects of food standards. *American Journal of Agricultural Economics*, *99*(2), 321-338. https://doi.org/10.1093/ajae/aax022

Swinnen, J. & Briski, D. (2017). *Beeronomics: How Beer Explains the World*. Oxford University Press. Oxford, U.K.

Tarko, V. & Farrant, A. (2019). The efficiency of regulatory arbitrage. *Public Choice*, *181*(1-2), 141–166. https://doi.org/10.1007/s11127-018-00630-y

Teague, M. (2016). Barriers to entry index: A ranking of starting a business difficulties for the United States. *Journal of Entrepreneurship and Public Policy*, *5*(3), 285–307. https://doi.org/10.1108/JEPP-02-2016-0007

Tongeren, F. V. (2011). The economics of beer. In Swinnen, J.F.M. (ed.) Standards and international trade integration: A historical review of the German 'Reinheitsgebot' (pg. 51-61).

U.S. Census Bureau. (n.d.). *2017 NAICS definition*. North American Industry Classification System. Retrieved July 13, 2020, from https://www.census.gov/cgi-bin/sssd/naics/naicsrch?input=312&search=2017+NAICS+Search&search=2017

USDA, National Agricultural Statistics Service. (2019a, June 30). *Acreage*. https://usda.library.cornell.edu/concern/publications/j098zb09z

USDA, National Agricultural Statistics Service. (December 18, 2019b). *National hop report.* https://www.nass.usda.gov/Statistics_by_State/Regional_Office/Northwest/includes/Publications/Hops/National%20hop_2019.pdf

Vogel, S.K. (1998). *Freer markets, more rules: Regulatory reform in advanced industrial countries*. Cornell University Press.

CHAPTER 3. THE PAYCHECK PROTECTION PROGRAM AND SMALL BUSINESS PERFORMANCE: EVIDENCE FROM CRAFT BREWERIES

A version of this chapter was previously published in *Small Business Economics* and is reproduced with the permission of Springer Nature and the co-author. DOI: 10.1007/s11187-022-00717-3

Staples, A. J., & Krumel Jr, T. P. (2022). The Paycheck Protection Program and small business performance: Evidence from craft breweries. *Small Business Economics*, 1-26.

3.1. Introduction

From February to April 2020, the number of business owners in the United States fell by 22% (Fairlie, 2020), and unemployment rates soared from 3.5% to 14.5% (BLS, 2022; Couch, Fairlie, and Xu, 2020). Business closure rates were also 25-33% higher in 2020 than pre-COVID trends over the past several decades (Crane et al., 2020). While these estimates are grim, they likely would have been worse if not for federal policies providing financial support to small businesses.

On March 27, 2020, the U.S. federal government passed the Coronavirus Aid, Relief, and Economic Security (CARES) Act (Public Law 116-136). As part of the $2.2 trillion stimulus package, $349 billion was appropriated to the Small Business Administration (SBA) to establish the Paycheck Protection Program (PPP). The PPP provided (forgivable) loans to small businesses to alleviate economic damages from COVID-19 and incentivize firms to retain employees on payroll. As the pandemic wore on, PPP funding increased, and $790 billion in funds were eventually allocated to nearly 12 million borrowers (Office of Capital Access, 2021; SBA, 2021b). Despite the vast funding and extensive coverage of the COVID-19 relief packages, little is known about the overall effectiveness of the program on small businesses.

This study aligns a verified dataset of craft beer producers with governmental data on PPP loan recipients to examine the role of PPP funding on business survival and performance. The craft beer industry makes for an ideal subject for analysis, as it comprises small, independently-owned businesses whose primary revenue stream was significantly disrupted by the pandemic. In aligning these datasets, this article determines whether receiving a PPP loan increases the likelihood of business survival and contributes to better year-over-year (YoY) production outcomes.

The study resembles work presented in Bartlett III and Morse (2020), Hubbard and Strain (2020), and Li (2021). Bartlett III and Morse (2020) analyze the effectiveness of PPP on business survival in Oakland, California, whereas Hubbard and Strain (2020) address survival rates amongst larger businesses.[22] Li (2021) uses Small Business Pulse Survey data to demonstrate that PPP loan recipients were less likely to report revenue decreases and a reduction in employee hours following loan approval. The study also draws on the work of Fairlie and Fossen (2021b), who use California administrative sales tax data to show that, on average, sales decreased by 17% during the second quarter of 2020. Moreover, their analysis shows that sales losses were most significant for the accommodation and hospitality industries, further motivating the use of the craft beer industry. Their study, however, does not explore the effects of PPP on performance, leaving an important gap in the literature.

Researchers have also explored the employment effects of the PPP (Autor et al., 2022a; Chetty et al., 2020; Dalton, 2021; Faulkender et al., 2020; Hubbard and Strain, 2020). These studies suggest an employment effect ranging from 0.9% (Hubbard and Strain, 2020) to 16-35% (Bartik, Cullen, et al., 2021), where the magnitude of the point estimate depends on the sample used and the identification strategy employed (Dalton, 2021). From a policy perspective, the effectiveness of the PPP on employment is the first-order outcome. However, for a small business, the primary objectives are survival and profitability, and thus it is critical to assess how PPP affects the operational status and revenue of the firm.

Our contribution is threefold. Primarily, to our knowledge, this is the first study to align an industry dataset of existing businesses with PPP loan data. In doing so, the article analyzes the relationship between PPP funding and two metrics of small business performance: operational status and production volume (serving as a proxy for revenue). Results suggest that firms that receive PPP funding are more likely to remain in operation and experience smaller declines in YoY production from 2019 to 2020 than firms that do not.

[22] It should be noted that the smallest loan size explored in Hubbard and Strain (2020) was $150,000. In contrast, the average loan size in our sample was $128,197 and the median loan size was $56,711. The analysis presented here is a necessary extension of Hubbard and Strain, as it teases out the relationship between PPP funding and *smaller* business performance.

Observing different market segments within the industry also allows for heterogeneity analysis, demonstrating that a firm's pre-pandemic business model contributed to its degree of flexibility and resiliency during COVID-19.

Secondly, through a quasi-experimental framework that exploits a natural break in the loan program, the study examines the role of loan timing on changes in YoY production from 2019 to 2020. The framework compares the YoY performance of firms that received funding before the initial $349 billion was exhausted and firms that received funding when it was reloaded two weeks later. The results show that breweries that receive funding before the structural break experience a decline in YoY production that is 2-4 percentage points smaller than those that receive funding in the week following the break. These findings suggest that loan approval timing affected annual performance, a result that likely generalizes to other service, hospitality, and specialized manufacturing sectors of the economy. This is the study's primary contribution, as it offers new insights for research analyzing the first-come, first-served style of the loan program.

Lastly, the study offers a methodological advancement, highlighting the shortcomings of the publicly available SBA data and speaking to the procedures necessary for future studies to achieve similar objectives. This includes discussing the limitations of the North American Industry Classification System (NAICS) coding system and inconsistencies in the PPP data. Further, evidence suggests that the loan program was subject to fraudulent claims (Beggs and Harvison, 2022; Griffin, Kruger, and Mahajan, 2022), making it difficult for researchers to address the economic contribution of the PPP. By anchoring the PPP database to a verified listing of firms at the industry level, the study provides an important advancement that significantly reduces concerns over fraudulent claims being included in the analysis. This enables a more accurate estimate of the true impact of the PPP on business performance, increasing the generalizability of the results.

The remainder of this article is structured as follows. Section 2 provides background on the PPP and explains the impact of the pandemic on the craft brewing industry. Section 3 presents the different data sources used in the analysis. Sections 4 – 6 present results analyzing business survival, YoY performance, and loan timing, respectively. Section 7 discusses the study's two central limitations. Section 8 discusses the economic significance of the results, and Section 9 concludes.

3.2. Background

3.2.1 Paycheck Protection Program

Closed premises, reduced hours, layoffs, and a loss of customers are just a few consequences for small businesses at the onset of COVID-19 (Belitski et al., 2022). To combat this early economic turmoil, the U.S. government passed the CARES Act (Public Law 116-136) on March 27, 2020. The $2.2 trillion economic stimulus package included $349 billion to establish the Paycheck Protection Program (PPP), a program administered by the Small Business Administration (SBA) to provide uncollateralized, low-interest loans to small businesses. The primary stated objective of this program was to provide small businesses with an incentive to retain employees on payroll. However, firms could also use the proceeds to pay: (i) worker benefits and protection costs, (ii) mortgage interest payments and rent, (iii) damages from looting or vandalism, and (iv) utilities (SBA, 2021a).

To qualify for a PPP loan, businesses had to meet pre-determined criteria set forth by the SBA (e.g., having fewer than 500 employees on payroll in a single location; SBA, 2021a).[23] Additionally, borrowers could also qualify for loan forgiveness if, during the covered period of eight to 24 weeks, they: (i) maintained employment and compensation levels; (ii) allocated loan proceeds to eligible costs and expenses; and (iii) spent 60% or more of the loan proceeds on payroll costs (SBA, 2021d). Table 3.1 summarizes PPP eligibility criteria, maximum loan amounts, and other program information, while Figure 3.1 provides a timeline of the loan program.

[23] According to the SBA (2021a), the following businesses were eligible to apply for a first-round PPP loan: "(i) sole proprietors, independent contractors, and self-employed persons; (ii) Any small business concern that meets SBA's size standards (either the industry size standard or the alternative size standard); (iii) Any business, 501(c)(3) non-profit organization, 501(c)(19) veterans organization, or tribal business concern (sec. 31(b)(2)(C) of the Small Business Act) with the greater of: 500 employees, or that meets the SBA industry size standard if more than 500; (iv) Any business with a NAICS code that begins with 72 (Accommodations and Food Services) that has more than one physical location and employs less than 500 per location."

Table 3.1. PPP eligibility criteria and key information, by tranche

PPP overview	1st round		2nd round
	1st tranche	2nd tranche	3rd tranche
Loan distribution			
Start date	April 3, 2020	April 24, 2020	January 17, 2021
End date	April 16, 2020	August 31, 2020	May 31, 2021
Eligibility			
Maximum number of employees per location	500	500	300
Must demonstrate a reduction in YoY gross receipts?	No	No	Yes (25%)
Loan calculator			
Loan amount = _____ the average monthly payroll costs	2.5x	2.5x	2.5-3.5x
Maximum loan amount	$10 million	$10 million	$2 million
Loan forgiveness	Yes	Yes	Yes

Note: The maximum loan amount for the 2nd round of funding was 2.5x the average monthly payroll for most businesses, but accommodations and food service establishments were allowed to use 3.5x the average monthly payroll.

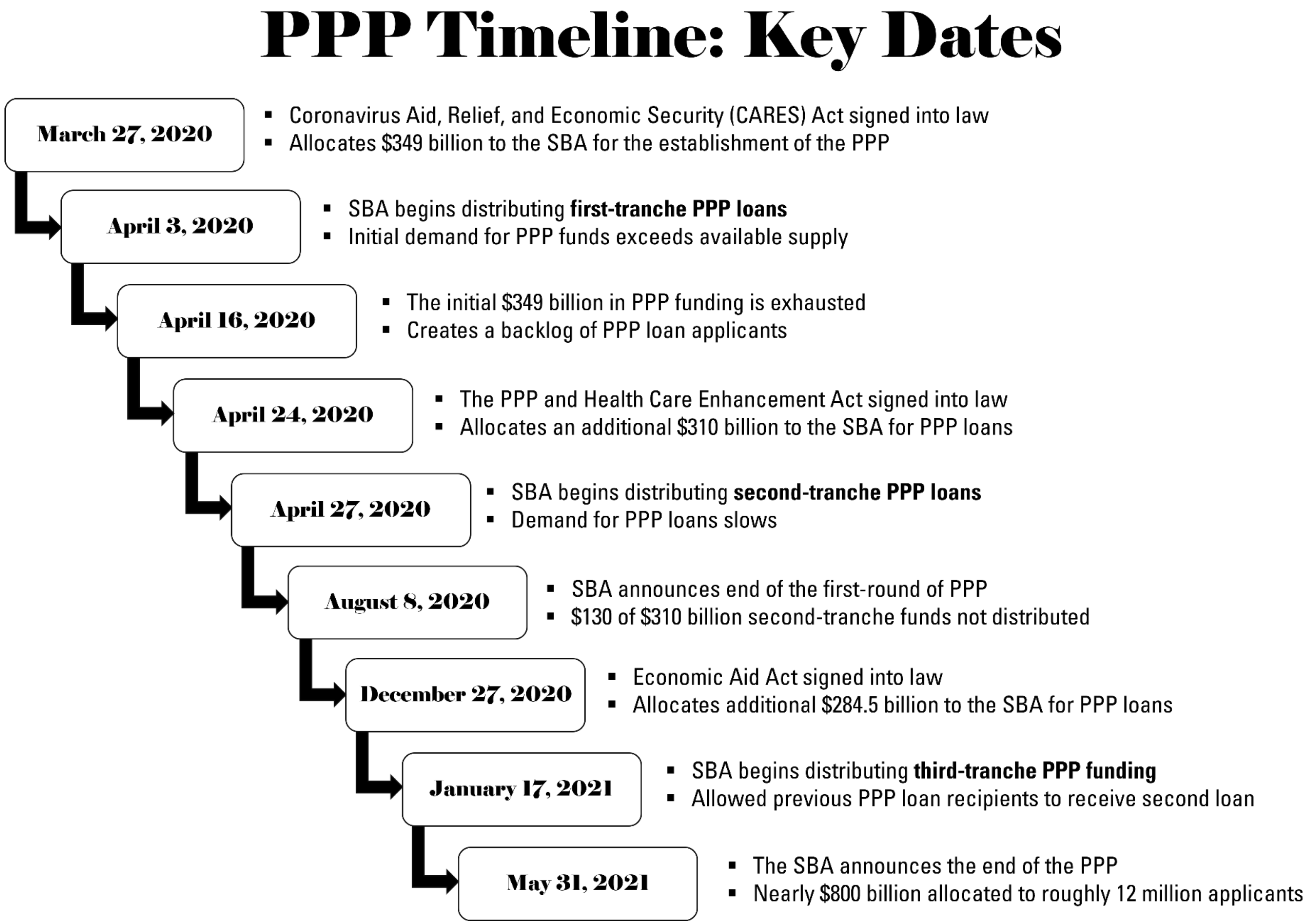


Figure 3.1. Timeline of key dates in the Paycheck Protection Program (PPP)

The SBA began distributing the first tranche of funding on April 3, 2020. With the demand for PPP loans far exceeding the available supply, the initial $349 billion was exhausted by April 16, 2020—just two weeks after the first loans were approved. Given the rush of applications and the first-come, first-served nature of the program, concerns about equity and the role of banks in loan dispersal quickly emerged (Bartik, Cullen et al., 2020; Fairlie and Fossen, 2021a; Humphries et al., 2020).

Claims in the literature suggest that the program sacrificed targeting for timeliness (Autor et al., 2022b). The majority of PPP lending came from small- and medium-sized banks (less than $50 billion in assets), which allowed for rapid, decentralized loan dispersal (Li and Strahan, 2020). But the distribution mechanism gave firms with a pre-existing relationship with a bank easier access to first-tranche PPP funding (Granja et al., 2020), and this setup negatively impacted the smallest businesses (Humphries et al., 2020). Moreover, the use of banks to distribute funding may have created a wedge between the public interests of the government (i.e., maintaining lower unemployment levels and keeping small businesses in operation) and the private interests of the banks (i.e., the profitability and longevity of their consumers) (Bartik, Cullen, et al., 2020).

As COVID-19 cases continued to surge, the Paycheck Protection Program and Health Care Enhancement Act (Public Law 116-139) was signed into law on April 24, 2020. The legislation provided the SBA with an additional $310 billion to support businesses that had not yet received a PPP loan. Distribution of the second tranche of funding began on April 27, 2020, and ended on August 8, 2020. The first and second tranches of PPP funding spanning April 3 – August 8, 2020, are referred to as the first round of PPP funding.

COVID-19 cases began to spike again in December 2020, leading lawmakers to pass the Economic Aid to Hard-Hit Businesses, Nonprofits, and Venues Act (Public Law 116-260) on December 27, 2020. In addition to allocating an additional $284.5 billion to the SBA to administer the third tranche of PPP loans, the law modified key provisions and authorized a second round of PPP funding to businesses that had previously received first-round funding. Table 3.1 highlights key differences across the first and second rounds of funding. Most notably, the third tranche targeted smaller businesses that could demonstrate a reduction in gross recipients from 2019 to 2020 of 25% or more (SBA, 2021i). The third tranche of PPP funding ran from January 11 – May 31, 2021, and is commonly referred to as the second round of PPP funding.

Over the program's lifetime, the SBA approved nearly 12 million loans totaling approximately $790 billion (Office of Capital Access, 2021). In April 2020, the Washington Post filed a Freedom of Information Act (FOIA) request for the list of PPP loan recipients. Later that year, a District Court granted the request, making the data publicly available (*The Washington Post v. U.S. Small Business Administration,* 2020).

With the PPP now closed and the data on loan recipients now available, researchers can descriptively monitor and evaluate the success of the program. For instance, several studies have analyzed the effect of first-round PPP funding on employment. Findings vary quite substantially, including small employment effects of 1-2% (Chetty et al., 2020; Hubbard and Strain, 2020), more modest estimates of 2-5% (Autor et al., 2022a), and larger effects of more than 10% (Bartik, Cullen, et al., 2020; Faulkender et al., 2020). Yet, to our knowledge, no study has sought to link PPP funding to performance outcomes. This study fills this gap in the literature using the craft beer industry, given COVID-19's disproportionate impact on the industry.[24]

3.2.2 COVID-19's Impact on the U.S. Craft Beer Industry

Over the past two decades, the number of U.S. craft breweries—an industry comprised of small, independent businesses—has increased by 500% (Brewers Association, 2022d).[25] In 2005, there were 1,394 craft breweries in the United States. By 2019, there were 8,391, representing 99% of all U.S. beer producers. Craft beer's market share, measured in dollars, also increased from 5% to 25% over the same time frame (Brewers Association, 2021).

Despite this considerable growth in market share, craft beer only accounts for 12-13% of beer by volume, measured in barrels (bbls) of production. In other words, 99% of the breweries in the United States account for just 12% of domestic beer production (Brewers Association, 2022d). The critical distinction between market share by sales dollars and

[24] Fairlie and Fossen (2021b) demonstrate that sales in California plummeted 17% YoY during Q2 of 2020, but the analysis does not concern itself with PPP. Their analysis divides sales growth by different business types, and their results suggest that accommodation businesses and (alcoholic) drinking places were the two sectors that experienced the steepest decline in Q2 YoY sales.

[25] The Brewers Association (2022c) defines "small" as producing less than six million barrels of beer per year, and they define "independent" as having less than 25% ownership from a business that is not itself a craft brewer.

market share by volume stems from the difference in business models and marketing strategies employed by craft brewers compared to large, non-craft breweries. Whereas large brewers sell high quantities of standardized products at a low price point, craft breweries brew smaller quantities of high-quality, differentiated products at a price premium to a niche group of consumers. Further, while revenue from beer sales is generated through various outlets (e.g., local liquor stores, grocery outlets, and restaurants), the average craft brewer relies predominantly on on-premise sales. Indeed, it is common for 80-100% of a craft brewery's revenue to come from sales at the brewery (Palardy et al., 2020; Staples, Malone, and Sirrine, 2021). With the emphasis on on-premise sales in a local community—as opposed to a vast distribution network of retail outlets—craft brewers were more vulnerable to COVID-19 than large, non-craft producers.

In response to COVID-19, states and local municipalities throughout the U.S. implemented public health policies that directly affected the traditional craft brewer business model. For example, stay-at-home orders limited social mobility, and capacity restrictions often limited or shut down indoor dining (CDC Tracker, 2022). However, social institutions and consumer perceptions about the prevalence of COVID-19 in their community appear to have played a larger role in decreasing consumer foot traffic (Chetty et al., 2020; Fairlie and Fossen, 2021b; Goolsbee and Syverson, 2021). For example, Goolsbee and Syverson suggest that social institutions explain much more of the decline in consumer foot traffic from January to April 2020.[26] Their results also state that drinking places ranked as one of the most negatively impacted sectors during this time frame. Irrespective of the reason for the decreased visits, breweries that rely heavily on revenue from on-premise sales needed to reconsider their business model (Morris, 2020; Romano, 2021). This included adjusting production schedules, employment levels, and packaging methods to distribute through alternative channels.

[26] Goolsbee and Syverson (2021) find that from March 1, 2020 to April 12, 2020, total foot traffic fell by 60 percentage points. Their methodology, which allows them to identify the causal effect of county-level governmental on foot traffic, suggests that shelter-in-place policies explained just 7 percentage points of the decline. Instead, much of the decline in consumer foot traffic was attributable to voluntary changes in behavior due to the perception about the risk of contracting COVID-19. In other words, businesses in counties with and without COVID-19 health policies both experienced, on average, substantial declines in consumer foot traffic during the early months of the pandemic. Those businesses operating in counties with shelter-in-place policies, on average, saw a decline in consumer foot traffic that was approximately only one-tenth larger than those in counties without the governmental mandates, holding all else constant.

In late March 2020, the Brewers Association, a 501(c)(6) not-for-profit organization aimed at promoting and protecting the interests of U.S. craft brewers (Brewers Association, 2022c), surveyed approximately 900 craft breweries on their concerns and perceptions of COVID-19. Their results showed widespread distress: 90% of respondents had already altered beer production schedules and seen a decline in on-premise sales; 61% expected layoffs; and 60% believed their business would fail in three months or less if social distancing guidelines, state and federal assistance, and costs and revenue streams remained at their mid-March levels (Watson, 2020a, 2020b). While this sentiment is not unique to the craft brewing industry (Bartik, Bertrand, et al., 2020), the heavy dependence on on-premise alcohol sales made craft brewers particularly vulnerable. The Brewers Association estimates that aggregate craft beer production fell 9%, sales decreased by 22%, and craft beer market share fell 1.7 percentage points in 2020 compared to 2019 (Brewers Association, 2022d; Watson, 2021).

To summarize the relevant literature, craft beer makes for an ideal industry to assess the relationship between PPP funding and small business performance due to (i) the growing presence of small producers over the past few decades; (ii) their vulnerability to the decline in consumer foot traffic throughout the pandemic; and (iii) the expectation of large-scale shifts in production, layoffs, and closures if economic conditions or state/federal support did not improve.[27]

3.3. Data

Data from the Brewers Association and the Small Business Administration are used to (i) explore the relationship between PPP funding and business survival; (ii) examine how YoY production changed as a function of whether a brewery received PPP; and (iii) determine whether the timing of loan approval timing affected YoY performance. The structure of each

[27] When asked what made the craft beer industry more vulnerable to COVID-19 health policies and changes in consumer behavior relative to other sectors, Chief Economist of the Brewers Association Bart Watson wrote:

> "The craft beer industry provides an interesting lens through which to study the economic effect of the COVID-19 pandemic, particularly due to the geographic and business model variations that occurred in performance. Craft brewers had high exposure to onsite hospitality shutdowns and shifts in consumer mobility, both due to the primary onsite business model of taprooms and brewpubs, as well as the much higher proportion of draught beer sales for most craft brewers relative to the overall beer industry" (Watson, personal communication, May 26, 2022).

data source is discussed in the following two sub-sections before describing the merging procedures and presenting summary statistics.

3.3.1 Brewers Association

Limiting attention to the 50 states and the District of Columbia, the Brewers Association dataset consists of 8,946 craft breweries that were in operation on April 3, 2020 (the start date of the PPP). Then, using Brewers Association records and internet searches, breweries were placed into one of three categories: (i) permanently closed since the start of the PPP; (ii) temporarily closed as of July 2021; and (iii) in operation as of July 2021.[28] July 2021 serves as an adequate date to examine operational status because it eclipses the end date of the PPP, coincides with most states lifting COVID-19 restrictions, and aligns with when nearly half of the U.S. population was fully vaccinated against COVID-19 (CDC, 2021). As of July 2021, 8,506 (95.1%) firms were active, 141 (1.6%) were temporarily closed, and 299 (3.3%) were permanently closed.[29]

The Brewers Association divides the industry into four market segments based on annual production, revenue streams, and reliance on food sales (Brewers Association, 2022b). Brewpubs are breweries that engage in significant food services, with at least 25% of annual beer production sold on-site. With their reliance on food sales, brewpubs operate much like traditional full-service restaurants with the exception that brewpubs brew their own beer. Microbreweries produce less than 15,000 barrels (bbls) of beer per year and have at least 75% of their production sold off-site. Regional breweries brew between 15,000 and

[28] Breweries were identified as permanently or temporarily closed in one of two ways. First, breweries could be identified as permanently closed by the Brewers Association, which was captured in the initial dataset the association provided. Then, Google searches were used to identify permanently closed breweries that did not report their operational status to the Brewers Association as well as temporarily closed breweries that were not identified in the initial dataset. Specifically, for each observation included in the dataset, we searched the brewery name and identified businesses that Google listed as temporarily or permanently closed. The internet searches and data collection were conducted in July 2021. Breweries that were identified as temporarily or permanently closed based on Google searches were then sent back to the Brewers Association for confirmation. The Brewers Association then analyzed the list and sent us an updated copy of the closures. Their revised set of closures was used in the analysis.

[29] Note, any brewery that closed before April 3, 2020 was excluded from the analysis. Therefore, in removing the first three months of closures in 2020, this study underreports the closure rate. As many closures occurred after COVID-19 was declared a national emergency but before the SBA began distributing PPP loans on April 3, 2020. Using historical closure data from Brewers Association (2022d), the brewery closure rate in 2020 was approximately 4.8%, up from 4.2% in 2019 and higher than the long-run average of 2.7% over the past decade. Please see the Appendix for further information on the differences between the closure rates reported in this manuscript and the ones reported on the Brewers Association website.

6,000,000 bbls of beer per year, and there is no restriction on their revenue streams or food services. However, regional breweries typically have access to a broad range of distribution networks and sell less than 5% of their beer on-site (Palardy et al., 2020). Taprooms are breweries selling 25% or more of beer on-site, with limited or no food services. Using this segmentation, the study considers whether the pandemic disproportionately impacts specific industry segments. Table 3.2 presents active and closed breweries by segment.

Table 3.2. Active breweries and closures as of July 2021 by market segment

Brewery segment	# of breweries	Active	Closures after April 3, 2020 (% closed)		
			Temporary	Permanent	Total
Brewpub	3,238	3,046	70 (2.2%)	122 (3.8%)	192 (5.9%)
Microbrewery	1,889	1,791	32 (1.7%)	66 (3.5%)	98 (5.2%)
Regional	228	221	3 (1.3%)	4 (1.8%)	7 (3.1%)
Taproom	3,591	3,448	36 (1.0%)	107 (2.98%)	143 (4.0%)
Total	**8,946**	**8,506**	**141 (1.6%)**	**299 (3.3%)**	**440 (4.9%)**

Note: The Small Business Administration began dispersing PPP loans on April 3, 2020. All closures up to April 3, 2020, are excluded from analysis, so these values represent a lower bound estimate of closures following the pandemic. COVID-19 was declared a national emergency on March 13, and many breweries closed during the weeks leading up to the dispersal of PPP funds. According to Brewers Association (2022d) data on brewpubs, microbreweries, and taprooms, approximately 4.8% of breweries closed in 2020.

Approximately 36% of the sample are brewpubs, 21% microbreweries, 3% regional breweries, and 40% taprooms. The final column of Table 2.2 presents suggestive evidence that brewpubs were disproportionately harmed by the pandemic relative to other brewing categories. Early-pandemic public health policies restricted indoor bar and restaurant capacity (or shut them down entirely), and consumers scaled back food-away-from-home purchases during the pandemic (Ellison et al., 2020). As such, breweries that rely heavily on food sales may have experienced a steeper decline in consumer foot traffic. Relative to the other craft beer market segments, brewpubs appear to have less capability to pivot production away from on-site consumption and towards off-premise channels.

The study also links brewery-specific production volume data over time, serving as a proxy for annual revenue. After removing data outliers and observations with missing data, the analysis is confined to 5,877 observations with reliable production data.[30,31]

---

[30] Data are available for 6,304 (70%) of 8,946 breweries for 2019, and 6,892 (77%) for 2020. For observations without production volume, yearly production is treated as missing data. Year-over-year (YoY) changes in production volume from 2019 to 2020 are then calculated, allowing for an assessment of how production changed throughout the pandemic. In examining the change in YoY production, there are several outliers, mainly driven by breweries that were in the process of expanding production in the time of interest or opened later in 2019 (and their estimate does not reflect a full year of production). Therefore, in the following analysis, attention is limited to breweries that experienced a negative 100% to positive 100% change in YoY production from 2019 to 2020. For example, the median YoY change in production from 2019 to 2020 is a 12.5% decline, while the mean YoY change is a positive 26.3% change in production. A 0% change in production from 2019 to 2020 is at the 75th percentile, suggesting the distribution is skewed to the left with a long tail to the right. By construction, there is a necessary lower bound of -100% change in YoY production (i.e., shutdown with zero production in 2020). An upper bound of +100% change in YoY production is imposed to remove significant outliers. For example, a brewery could have opened in November of 2019, had two months of production, and this figure reflects their 2019 annual production. Suppose that the brewery remains open for all 12 months of 2020 and reports their 2020 annual production. Then it is reasonable to expect a 500% increase in YoY production from 2019 to 2020. For this reason, the upper bound limit of +100% is placed on YoY production volume changes. After removing breweries that fail to meet the specified criteria, the sample contains 5,877 breweries with production data, or 93% of the original 6,304 observations with production data.

[31] The Brewers Association provided data on the breweries that received funding from the Restaurant Revitalization Fund (RRF). Part of the American Rescue Plan Act of 2021 (Public Law 117-2), passed into law on March 11, 2021, the RRF was an additional government aid program run through the U.S. SBA to support restaurants, bars, and other businesses that provide food or drink services (SBA, 2021e). The program, which ran from May 3, 2021 to July 2, 2021, supported more than 100,000 approved applicants and totaled $28.6 billion (SBA, 2021j). The Brewers Association identified 1,539 breweries that received RRF funds. By segment, the data suggests that 633 brewpubs, 257 microbreweries, 15 regional breweries, and 634 taprooms received RRFs from the SBA.

3.3.2 Paycheck Protection Program

Data used in the analysis were pulled from the SBA website and contain nearly 12 million PPP loan recipients through the end of the PPP (SBA, 2021b).[32] To identify the observations of interest, the study relies on the six-digit NAICS coding system.

First, a dataset of all observations coded in the six-digit NAICS code for breweries (312120) is constructed, yielding 5,405 observations. However, many breweries also operate in food service (i.e., brewpubs) and may be coded with full-service restaurants (722511). Observations coded as full-service restaurants are identified within the SBA dataset, and fuzzy matching procedures align addresses listed on the loan application with brewpub addresses.[33] These procedures result in an additional 1,481 brewpub observations coded as full-service restaurants. Lastly, breweries could be miscoded in the NAICS code for drinking places (722410). Similar fuzzy matching procedures are used to identify an additional 1,466 observations. Observations across the three NAICS industries are then combined to create a dataset of 8,352 loan observations.

As firms could receive two rounds of PPP funding, a single brewery could have two observations in the dataset. The PPP data are then reshaped to create a one-to-one mapping, yielding 5,809 unique observations.[34]

3.3.3 Merging

To merge the brewery data points with PPP observations, datasets are first separated by jurisdiction (50 states and the District of Columbia). The brewery and PPP datasets for each jurisdiction are then paired together to initiate matching. Under the assumption that the Brewers Association dataset is the entire universe of breweries, PPP borrowers either

---

[32] Data on PPP loan recipients can be accessed, here: https://data.sba.gov/dataset/ppp-foia

[33] One shortcoming with fuzzy matching is that breweries located in large plazas, malls, etc. may share a street address with another full-service restaurant but have different suite numbers. Loan recipients oftentimes failed to list their suite number on their application. Google Maps was used to make manual corrections to improperly matched locations.

[34] Stata's *reshape wide* command is used complete these procedures. However, the reshape command only works if the borrower's name is identical for both listings (including punctuation, case sensitivity, etc.). Oftentimes, small discrepancies existed between two observations for the same brewery. For instance, a brewery may list "Company Name, LLC" in round one but "Company Name LLC" in round two. With the missing comma, Stata cannot match across these two observations. Thus, manual corrections were necessary to complete the reshape procedures.

sufficiently map to one of the breweries or are excluded from the analysis. Due to limitations in the PPP data, a three-step manual matching procedure is employed.

The first step attempts to match the PPP borrower name to a brewery name. While a significant proportion of the observations match on name, shortcomings in the PPP data prevent others. For example, loan recipients would often list their official company name rather than their company's trading name (i.e., their *doing business as* name). Other applicants listed their government name as opposed to the name of the brewery. To overcome this hurdle, the second step matches the address listed on the PPP loan application to the brewery address. Again, borrowers sometimes list a residential address rather than a business address. For the remaining unmatched observations, step three involves using the borrower's name listed on the PPP application to identify trademarks, alternative trading names, etc., using online resources such as OpenCorporates (OpenCorporates, 2021). Observations were matched if the PPP borrower had a trademark that could be traced to a brewery.

On aggregate, 89% of the PPP loans are matched across 5,002 unique breweries in 1,210 different counties. The unmatched observations are excluded from the analysis.[35]

3.3.4 Summary statistics

Approximately $1.06 billion in PPP funding has been allocated to the craft brewing industry, including $576 million in the first round and $482 million in the second round. These dollars have supported nearly 98,000 jobs in the first round and over 64,000 in the second round.[36]

Figure 3.2 provides a timeline of PPP loan funding to craft breweries. Approximately 63% of first-round loans are distributed between April 3 – April 16, 2020, 94% by May 3,

---

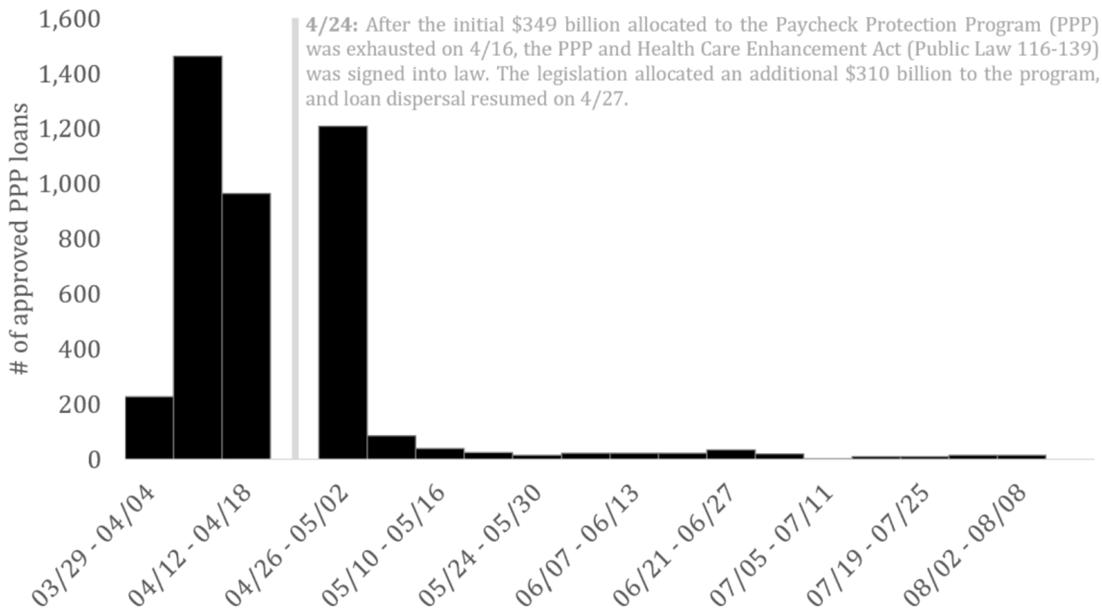
[35] Most unmatched observations included cideries, wineries, distilleries, pubs, and restaurants that were incorrectly coded into NAICS 312120. Other businesses coded in NAICS 312120 did not engage in alcohol production or distribution. Additionally, several observations that were coded into NAICS code 312120 do not fit the Brewers Association's definition of a brewery (e.g., kombucha brewers not registered with the Brewers Association). The most notable group excluded from the analysis are breweries in planning or proprietor brewers. These groups were not included in the universe of breweries provided by the Brewers Association, so they are excluded from the analysis. While this may be seen as a limitation, these observations accounted for less than 20% of the unmatched observations, i.e., less than 3% of total PPP observations.

[36] The statistics on the number of jobs supported by the PPP come directly from the PPP application, where applicants had to list the number of workers employed at the business. Unfortunately, the Brewers Association data did not contain statistics on brewery employment over time, meaning the study cannot observe changes in employment as an outcome variable. It is also worth noting that some PPP loan recipients may have more than one business specified under a parent company (e.g., a brewery is one of the trademarks of a larger company), overstating the number of jobs reported.

2020, and the remaining 6% through August 8, 2020. The second round of loan funding saw an initial spike in demand, with roughly 45% of the loans dispersed by the third full week of the loan program. Then, demand tapered off, where the last 5% of second-round loans were distributed over the last nine weeks of the loan program.

Table 3.3 provides a breakdown of summary statistics based on whether a brewery receives (i) first-round funding only, (ii) second-round funding only, (iii) both rounds of funding, or (iv) no funding. Of the 8,946 breweries in the dataset, over half receive some form of PPP funding: 23% receive first-round funding only, 6% receive second-round funding only, and 27% receive both rounds of funding; the remaining 44% receive no PPP funding.

Panel A. PPP approved and distributed loans: April 3, 2020, to August 8, 2020



Panel B. PPP approved and distributed loans: January 15, 2021, to May 31, 2021

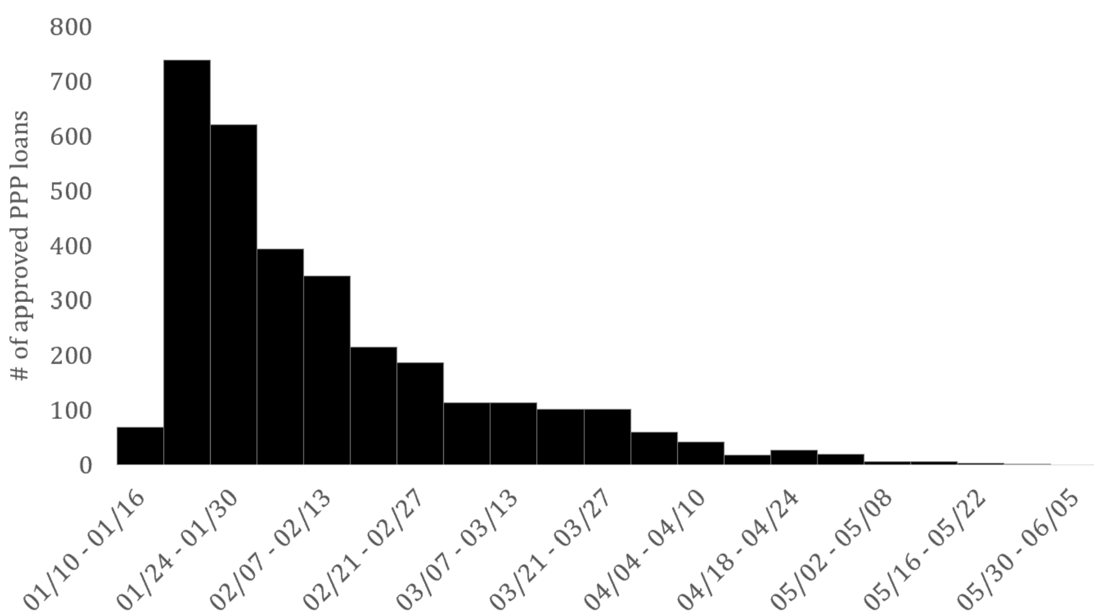


Figure 3.2. Timing and frequency of PPP loans to breweries, by week

Table 3.3. Summary statistics disaggregated by PPP funding

Variable	Population	PPP funding: 1st round only	2nd round only	Both rounds	None	p-value [a]
Number of breweries	**8,946**	**2,086**	**513**	**2,403**	**3,944**	**---**
Panel A. Outcome variables						
Open, July 2021	0.951	0.959	0.975	0.983	0.924	0.000
Prop. production change, 2019-2020[b]	-0.124	-0.056	-0.170	-0.139	-0.151	0.000
Avg. production (bbls/year), 2019	3,842.9	3,457.2	2,227.6	2,388.5	5,747.0	0.103
Avg. production (bbls/year), 2020	3,463.6	3,269.2	1,911.3	2,028.9	5,197.6	0.081
Panel B. Firm characteristics						
Proportion of obs. for each segment						
Brewpub	0.362	0.300	0.517	0.409	0.346	0.000
Microbrewery	0.211	0.215	0.189	0.206	0.215	0.505
Regional	0.025	0.033	0.014	0.021	0.026	0.030
Taproom	0.401	0.453	0.281	0.364	0.413	0.000
Prop. of primary locations	0.882	0.954	0.929	0.958	0.791	0.000
Prop. received RRF loan	0.172	0.160	0.236	0.294	0.096	0.000
Panel C. County variables						
Number of counties represented	1,547	834	316	838	1,139	---
Avg. number of COVID-19 cases						
April 3, 2020	590.2	553.3	793.0	610.6	570.9	0.048
December 31, 2020	49,420.5	42,848.9	63,926	55,614	47,376.5	0.000
Avg. ERS Amenities Score [c]	1.6	1.3	2.1	1.6	1.6	0.000

[a] The p-value denotes the results of the ANOVA procedures F-test to detect differences across the four groups.
[b] The number of observations for year-over-year (YoY) change in production varies due to limitations in data availability. Additionally, attention is restricted to observations with a -100% and +100% change in YoY production from 2019 to 2020 to exclude outliers. In total, data from 5,877 observations are analyzed, and the number of observations by group is as follows: 1st round only (1,526), 2nd round only (387), both rounds (1,886), and none (2,078).
[c] The number of observations for the ERS Amenities Score varies due to limitations in data availability. For example, data were not available for Alaska and Hawaii. Data were available for 8,842 observations, and the number of observations by group is as follows: 1st round only (2,059), 2nd round only (507), both rounds (2,369), and none (3,907).

There are differences in key outcome variables, including operational status and changes in YoY production volume, across groups. Businesses that receive both rounds of funding are most likely to be open as of July 2021 (98%), while breweries that receive no PPP funding have the lowest probability of remaining in business (92%). For changes in YoY production volume, the average brewery sees a 12.5% decline in production from 2019 to 2020. However, on average, the decline is smaller for breweries that received first-round PPP funding (-10% YoY) than those that did not (-15% YoY).

There is also variation in county-level variables, such as the total number of COVID-19 cases as of April 3, 2020 (the first day of PPP funding), indicating a need to account for observed and unobserved county-level heterogeneity in the subsequent analysis. Interestingly, breweries that received first-round PPP funding have a below-average number of total confirmed COVID-19 cases as of April 3, 2020 (the first day of the PPP funding) and December 31, 2020. This finding is in line with Granja et al. (2020), suggesting that the banks involved in distributing PPP loans were more likely to do so in areas that were not as adversely impacted by COVID-19.

Further demonstrating differences across comparison groups, Figure 3.3 plots 2018 – 2020 average annual production levels. The sample is limited to breweries open in July 2021, implying that the remainder of this section should be interpreted as YoY production volume changes conditional upon remaining in operation. With this condition, missing data, and the removal of statistical outliers, data are available for 4,257 breweries.[37]

[37] Specifically, observations are removed if (i) they are missing data in 2018, 2019, and/or 2020; (ii) the brewery experienced greater than a 100% increase in YoY production from 2018-2019 and/or 2019-2020; and (iii) they are statistical outliers that significantly skew the average. Breweries listed as producing 1 bbl of beer per year are also removed, as this may be evidence of an error in the industry production dataset where "1" signals an indicator of having produced in the corresponding year. Additionally, breweries producing above the 99th percentile of annual production in 2018 are excluded from the analysis. Specifically, 99% of the sample produces at or below 66,669 barrels of beer per year, while the remaining 1% of observations range from 66,784 to 2,175,784 barrels per year. Similar statistics hold for the 2019 and 2020 data, with 99th percentiles of 55,660 and 50,084 bbls per year, respectively. As such, the 2018 data is used as the production cutoff point.

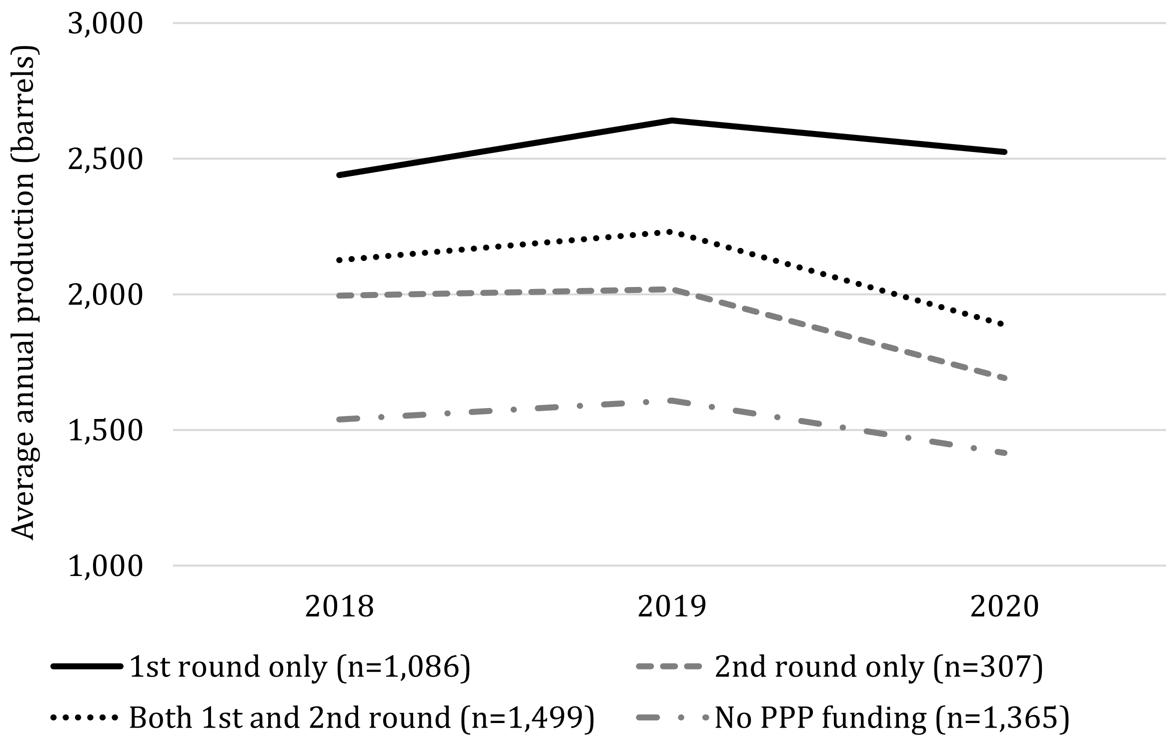


Figure 3.3. Average annual production by PPP funding, 2018-2020 (n = 4,257)

Breweries across each group demonstrate, on average, increasing production from 2018 to 2019, ranging from a YoY increase of 1-8%. Figure 3.3 suggests that larger (eligible) operations were more likely to receive first-round funds. On average, breweries that received first-round funding produced higher quantities of beer from 2018-2020 than those that did not. The graph also reflects the change in loan eligibility for second-round funding, which targeted smaller firms that experienced substantial revenue decreases in 2020. Lastly, the group with the smallest average production did not receive any PPP funding.

3.4. Probability of business survival

To understand the relationship between receiving a PPP loan and business survival, a linear probability model (LPM) estimates the likelihood of a firm being open in July 2021 as a function of whether it received PPP funding. While the LPM can produce estimates that fall outside the necessary zero-one range implied by the binary response and may be inappropriate when evaluating marginal effects on the tails of the distribution, it provides computationally convenient, consistent estimates that are a useful approximation of the marginal effect for the average observation (Wooldridge, 2010).

The left-hand side variable is a binary variable equal to one if the brewery was in operation in July 2021; zero otherwise. The primary explanatory variables of interest are indicator variables specifying whether a given brewery received a first-round loan, a second-round loan, or both a first- and a second-round loan. We hypothesize that receiving a single PPP loan will lead to a higher probability of survival (Hubbard and Strain, 2020), while receiving both rounds of PPP funding will further increase the likelihood of survival.

The study also analyzes the relationship between business survival and the brewery segment, controls for important brewery-specific variables, and includes county-level fixed effects to capture unobserved heterogeneity.[38] We hypothesize that COVID-19 will disproportionately impact brewpubs as their reliance on food and draught beer sales may have made them more vulnerable to declines in consumer foot traffic. Other segments, particularly regional breweries, could more easily pivot to alternative packaging and distribution channels. Brewery-specific variables include 2019 brewery production, whether the brewery is a primary or secondary location, and whether the brewery received a loan from the 2021 Restaurant Revitalization Fund (RRF) program.[39]

Table 3.4 presents the results from the LPM. Across specifications that control for firm- and county-level fixed effects, receiving PPP funding has a positive and statistically significant relationship with the probability of remaining in operation as of July 2021.

---

[38] Including state-level control variables in the analysis did not improve explanatory power, produced point estimates that were identical in magnitude to the preferred specification, and may be inappropriate given the inclusion of county-level fixed effects. We also consider the inclusion of local bar and restaurant policy over time instead of traditional FIPS codes. However, their inclusion is insignificant and reduces the degrees of freedom. As such, we elect to use the FIPS codes to control for unobserved, county-level heterogeneity. The relationship between local bar and restaurant policy and performance is discussed further in Section 5 and in the Appendix accompanying this manuscript.

[39] It is reasonable to expect breweries that produce a higher volume of beer per year to benefit from economies of scale and have access to more technologically advanced equipment requiring less labor. Additionally, companies may have multiple locations, with one serving as their headquarters (i.e., primary location) and the other(s) as (a) secondary location(s). Finally, a control variable is included for whether a brewery received an RRF loan. Note that the distribution of RRF loans comes immediately before the data collection on open/closed status. This is important because it is possible that some breweries were temporarily closed in, for example, early-May 2021, and then opened when they received RRF funding in late-May 2021. With the data collection in July 2021, brewery operational status only observes whether a business was open in July 2021, not seeing that they were temporarily closed weeks before. The indicator variable controlling for RRF loan funding is included in the regression analysis to overcome this shortcoming.

Table 3.4. Brewery operational status as a function of PPP funding

Variable	**(1)**	**(2)**	**(3)**
PPP Funding			
FirstRoundPPP	0.035***	0.035***	0.050***
	(0.006)	(0.007)	(0.011)
SecondRoundPPP	0.051***	0.053***	0.074***
	(0.008)	(0.010)	(0.014)
BothRoundsPPP	-0.027***	-0.030**	-0.052***
	(0.010)	(0.012)	(0.016)
Segment			
Brewpub	---	---	-0.025***
			(0.009)
Microbrewery	---	---	-0.021**
			(0.010)
Regional	---	---	-0.024
			(0.020)
Constant	0.924***	0.957***	0.870***
	(0.004)	(0.009)	(0.037)
N	**8,946**	**8,946**	**5,877**
County-level fixed effects	No	Yes	Yes
Firm-level controls	No	No	Yes
R^2	0.01	0.17	0.23

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

Note: Observations in specification (3) decrease from 8,946 to 5,877 due to data limitations and outliers in the brewery production data.

Interpreting the output from the naïve regression, firms that did not receive any PPP funding have a 92.4% chance of survival. Breweries that only received a first-round PPP loan are predicted to have a 95.9% chance of survival, and those that only received a second-round loan have a 97.5% of remaining in operation as of July 2021. Breweries that received both rounds of funding are predicted to have a 98.3% probability of survival, where the negative sign attached to the interaction term suggests diminishing marginal returns to PPP funding. There is also suggestive evidence that brewpubs and microbreweries are affected by the pandemic more than taprooms, with brewpubs appearing to be hit the hardest. This reinforces industry expectations that brewpubs were less capable of pivoting away from their pre-pandemic business model.

As a robustness check, a penalized logistic regression is estimated, accounting for rare events and forcing predictions into the zero-one binary response range (Firth, 1993). The results are fairly consistent with the LPM, where the main effects of PPP retain their sign and statistical significance. The coefficient for receiving both rounds of funding, however, loses its statistical significance, but it retains its negative sign. Concerning the industry segmentation, the results suggest that brewpubs are more likely to close, while the coefficient for microbreweries is not statistically different from zero. The results to the penalized logistic regression are available in the Appendix accompanying this manuscript.

There are two primary limitations to the empirical estimation. First, there is likely an issue of self-selection into the treatment, where breweries that applied for and received PPP could have different characteristics than those that did not. For example, the literature suggests selection issues related to firm size and firms with pre-existing relationships with a bank (Granja et al., 2020). Secondly, the reliance on a cross-sectional analysis fails to capture the temporal dimension of loan dispersion and brewery closures. These limitations are discussed in greater detail in Section 7 of this chapter.

3.5. Changes in annual production

Breweries were expected to experience a decrease in annual production from 2019 to 2020 due to the shift in alcohol purchasing patterns (Scott, 2021; Watson, 2020a). According to Watson (2020a), most breweries halted or slowed production by late March 2020 and anticipated layoffs. However, once a brewery receives a PPP loan, there is an immediate incentive to retain pre-pandemic employment and compensation levels to qualify for loan forgiveness. There are a finite number of jobs in a brewery, most of which are directly involved in beer production and packaging. Thus, breweries would struggle to reallocate labor if production stagnated.

With uncertainty surrounding how long COVID-19 would affect their business and contribute to the decline in on-premise sales, brewers understood that beer could maintain quality in cold storage for up to five months (Sierra Nevada Brewing Company, 2022). Thus, after receiving a PPP loan, a brewery can retain staff and adjust production based on future expectations despite short-term revenue decreases. However, there is no such incentive for breweries that had not received PPP funding. Breweries without PPP funding may have been more likely to downsize given tighter financial constraints (Lastauskas, 2021), contributing to further production delays and more substantial declines in YoY production. As such, we hypothesize that a brewery that receives a first-round PPP loan will, on average, experience a smaller decline in production in 2020 compared to those that do not receive first-round funds.

To test this hypothesis, the change in YoY production from 2019 to 2020 is regressed on a vector of explanatory variables using ordinary least squares. The key explanatory variable is an indicator variable specifying whether a brewery received first-round PPP funding (first or second tranche). Attention is only given to the first-round loan because these funds were available from April 3 – August 8, 2020, while second-round funds (third tranche) began in January 2021. Thus, second-round funds have no bearing on 2020 production levels. As was done when predicting a firm's operational status, brewery segment and firm- and county-specific controls are included in the regression analysis.

Using production data for 5,555 active craft breweries, the results demonstrate how YoY performance varies as a function of PPP funding conditional upon remaining in operation through 2020.[40] Table 3.5 presents these results.

The positive point estimate on the treatment indicator suggests that, on average, breweries that receive a first-round PPP loan see a smaller decrease in YoY production than breweries that do not. Naïve regression analysis suggests a decline that is 3.5 percentage points smaller for first-round loan recipients, translating to an average reduction in production of 9.4% YoY (compared to 12.9% for those without first-round funding). With fixed effects, the magnitude of the point estimate increases from 3.5 to 4.3 percentage points, meaning the relationship becomes more pronounced after including important control variables. These results may suffer from self-selection into the treatment group and other potential confounding effects, but they suggest a positive correlation between PPP funding and relative performance.

[40] The described specification was also run with the breweries that were closed as of July 2021. Unsurprisingly, results were more pronounced when these breweries were included as they saw the most substantial declines in YoY production. As a result, the approach described in the article is believed to be the conservative empirical decision that dampens estimated results.

Table 3.5. Change in annual brewery production as a function of PPP funding

Variable	(1)	(2)	(3)
FirstRoundPPP	0.035***	0.037***	0.043***
	(0.008)	(0.009)	(0.009)
Segment			
Brewpub	---	---	-0.102***
			(0.011)
Microbrewery	---	---	-0.020
			(0.013)
Regional	---	---	0.077***
			(0.029)
Constant	-0.129***	-0.157***	-0.072**
	(0.006)	(0.019)	(0.036)
N		**5,555**	
County-level fixed effects	No	Yes	Yes
Firm-level controls	No	No	Yes
R^2	0.00	0.29	0.33

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

The results also demonstrate that COVID-19 had disproportionate impacts across industry market segments. Specifically, brewpubs experienced the most substantial decline in YoY production from 2019 to 2020, while regional breweries performed relatively better than the other industry segments. According to Brewers Association benchmarking reports, the average brewery producing less than 1,000 bbls of beer per year (74% of the sample) sells 89-95% of its beer through on-site sales (Watson, 2016). Regional breweries, however, have a diverse distribution network that draws similarities to large non-craft brewers like Anheuser Busch InBev and MolsonCoors. As such, regional breweries may sell just 5% of their beer on-site (Palardy et al., 2020). It is well-established that a firm's business model affects its behavior, flexibility, and resiliency (Arend, 2013; Hennart, 2014; Kuratko et al., 2020), and thus these differences in pre-pandemic business models by segment became pertinent following the COVID-19 outbreak. For example, Figure 3.4 shows how beer consumption patterns have shifted since the spread of COVID-19 (TTB, 2022).[41]

[41] The data used in the analysis is available at the Alcohol and Tobacco Tax and Trade Bureau (TTB) website: https://www.ttb.gov/beer/statistics [last accessed October 25, 2022].

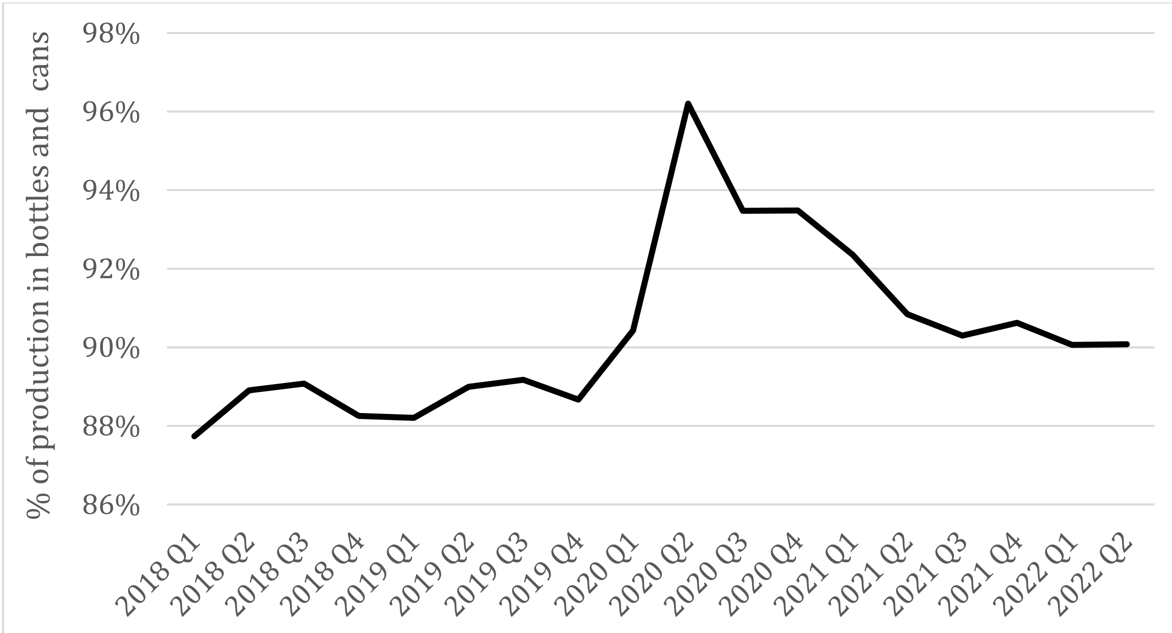


Figure 3.4. Percentage of beer packaged for bottles and cans, 2018 – 2022 by quarter

Specifically, the figure shows the percentage of all taxable U.S. domestic beer (craft and non-craft beer) sold in cans and bottles from 2018 – 2022 by quarter. Results show that, leading up to the pandemic, cans and bottle packaging made up approximately 88-89% of all beer removals. At the end of Q1 2020, the U.S. saw a substantial increase in the proportion of beer sold in cans and bottles, which then spiked to 96% by the end of Q2 2020. This shift to can and bottle production implies a considerable decline in on-premise sales, the primary revenue stream for the average craft brewer. Packaging rates have approached pre-pandemic levels but beer removals in cans and bottles are still 1-2 percentage points higher than 2019, suggesting lingering long-term effects of the pandemic on drinking behavior.

These statistics demonstrate the importance of a firm's pre-pandemic business model on its ability to react to the pandemic by shifting packaging, marketing, and distribution strategies. The smallest firms appear to have been most affected, and while there were areas for entrepreneurship during COVID-19, most initiatives were temporary and could not compensate for decline in on-site sales. Larger businesses, on the other hand, could utilize their pre-existing distribution networks, enabling an easier adjustment. The insights presented in Table 3.5 and Figure 3.4 support these claims, and future research could further illustrate how business scale and scope contributed to resiliency and profitability during COVID-19 across other industries.

One alternative hypothesis is that local COVID-19 policies are driving the decline in YoY production. To test this hypothesis, a subsample analysis across brewpubs is conducted, as they are the segment most affected by the pandemic (Tables 3.2, 3.4, and 3.5). County-level data on restaurant policy restrictiveness through the pandemic is first collected from the CDC Tracker (2022).[42] Then, the analysis presented in Table 3.5 is replicated with the inclusion of an indicator variable measuring policy restrictiveness: (i) curbside/delivery only or (ii) open. These exploratory results provide little evidence of a statistically significant relationship between policy and the decline in YoY production.[43] Instead, changes in consumption habits and pre-pandemic business models appear as the leading indicators of YoY outcomes.

3.6. Quasi-experiment

3.6.1. Loan timing and YoY performance

It is essential to consider how the timing of loan approval could impact changes in YoY production. In this section, the study assesses whether the timing of the loan approval affects 2020 performance by exploiting the natural break between the first and second tranche of PPP funding (Doniger and Kay, 2022). Specifically, the quasi-experiment compares the YoY performance of breweries that received first-round funding in the last seven days of the first tranche (April 10 – 16, 2020) to breweries that received funding in the first seven days of the second tranche (April 27 – May 3, 2020).[44]

---

[42] Brewpubs operate much like full-service restaurants, making local restaurant policy restrictiveness the ideal policy variable to analyze.

[43] These results are exploratory, as Hale et al. (2021) note the difficulty of teasing out the causal effect of COVID-19 policies due to potential confounders and endogeneity concerns. Identifying the causal effect of local restaurant policies on performance lies outside the scope of this manuscript and is left to future research. However, we can offer initial insights suggesting that policies do not appear to be the leading driver behind declines in production. For a more detailed overview of the data analysis and procedures, please see the Appendix accompanying this manuscript.

[44] Evaluating the causal effect of loan timing on performance in the quasi-experimental setting rest on two identifying assumptions: (i) loan timing did not affect loan demand and (ii) the firms before and after the gap in tranches are similar to one another (Doniger and Kay, 2020). To further assert the validity of the second assumption, we also run the analysis with a constrained framework that analyzes breweries that receive funding within three days of the gap between the first and second tranche. That is, the restricted framework explores the YoY production of breweries that receive funding in the last three days of first-tranche funding (April 14 – 16, 2020) and the first three days of second-tranche funding (April 27 – 29, 2020). The results are largely consistent with the findings reported in the main text (Tables 6 and 7). Specifically, tightening the window of analysis leads to (i) similar growth rates from 2018 to 2019 for both the treatment (8.0%) and control (6.7%); (ii) positive and statistically significant point estimates that are of similar magnitude; and (iii) a similar average treatment effect on the treated (ATT) when using propensity score matching. The seven-day

Based on the rationale that a brewery has an incentive to retain employees once they receive a PPP loan—which could shift production decisions—the period between the first and second tranche of funding is expected to be the critical window in determining YoY performance. If the firms that receive first-tranche funding experience smaller declines in YoY production than firms that had to wait for second-tranche funding, this would suggest that the timing of loan approval impacts small business performance.

To motivate the framework, first recall that the first round of PPP funding consisted of two tranches: the first tranche from April 3 – 16, 2020, and the second tranche from April 27 – August 8, 2020. Bartik, Cullen, et al. (2020) surveyed small businesses between tranches (April 25 – 27, 2020) regarding their decision to apply for PPP funding. Of the nearly 4,000 small businesses in their sample that applied for first tranche funding, 25% of applications were approved, 24% were denied, and the remaining 51% were still pending. In other words, businesses with pending applications submitted their loan application before first-tranche funding expired, yet their application was not approved (nor denied) until after second-tranche funding was available.

While data on loan *submission* dates are lacking, Figure 3.2 shows that 78% of the approved second tranche loans come within the first seven days of SBA resuming loan approvals. This suggests a backlog of loan applications as first tranche funding expired but a rapid decline in PPP loan demand a week after second tranche funding resumed. It is then reasonable to expect that most second-tranche loan recipients between April 27 – May 3, 2020, submitted their PPP loan application when first tranche funding was still available.

The quasi-experiment restricts attention to breweries that received funding between April 10 – 16, 2020, and April 27 – May 3, 2020.[45] Under the identifying assumptions that

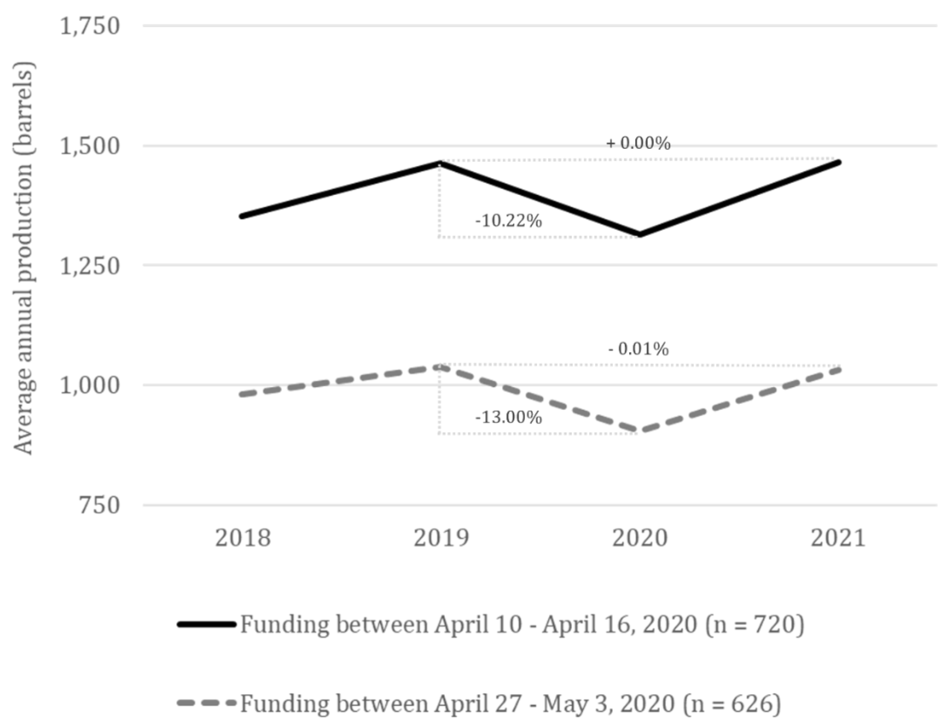
---

window is our preferred specification, as the three-day window cuts the experimental group from 1,349 to 748 (55%) and has less variation in propensity scores across observations. Nonetheless, the results of the tightened analysis with the three-day window are available in the Appendix accompanying this manuscript.

[45] Attention is also restricted to breweries with production data from 2018 – 2020 to explore pre-trends. The sample begins with the 5,555 breweries that were in operation as of July 2021 and had 2019-2020 YoY production volume changes within the bounds of -100% to +100% (analysis shown in Table 5). An additional restriction imposes an upper-bound limit on YoY production from 2018-2019 to mirror the restriction imposed on 2019-2020 YoY production changes. Lastly, outliers that significantly skew the sample mean are excluded. This includes breweries producing below the 5th percentile (≤ 100 bbls) and above the 95th percentile (≥ 7,757 bbls) in 2018. Then, given the quasi-experimental setting, this portion of the study only analyzes observations with loan approval dates between April 10 – 16, 2020, or April 27 – May 3, 2020.

businesses receiving funding before and after the structural break are similar and that the delay in approval did not affect loan demand, the quasi-experiment can confidently assess the role of loan approval timing in the two weeks between tranches. These assumptions were validated in Doniger and Kay (2020).

The quasi-experimental group consists of 1,346 observations: 720 observations with first-tranche funding (treatment) and 626 observations with second-tranche funding (control). Figure 3.5 shows the average production levels over time for the two groups.



Note: 2021 production data are only available for 1,262 of the 1,346 breweries included in the quasi-experiment. Of these 1,262 breweries, 677 received funding between April 10 – April 16, 2020, and 585 received funding between April 27 – May 3, 2020.

Figure 3.5. Average annual production of quasi-experimental groups (n = 1,346)

Breweries in the treatment are, on average, larger than those in the control. In aggregate, both groups experience growth from 2018 to 2019. On average, the group that receives first-tranche funding experiences an 8.2% increase in production over this time period, whereas the group that receives second-tranche funding experiences a 6.0% growth rate. The difference between groups is exacerbated when comparing all first-tranche loan recipients (April 3 – April 17, 2020) against all second-tranche loan recipients (April 27 – August 8, 2020). Thus, while there appears to be inherent differences between the two groups, analyzing this shorter window around the program's structural break provides the best opportunity to understand the role of loan approval timing on performance.

Table 3.6 presents the results of the quasi-experiment where the change in YoY production is regressed on a treatment indicator indicating whether the brewery receives first tranche funding between April 10 – 16, 2020; zero otherwise (i.e., April 27 – May 3, 2020). Given that each business in the quasi-experimental group receives PPP funding, the analysis controls for the loan approval amount as well as brewery-specific and county-level controls.[46]

Table 3.6. Quasi-experimental results on role of loan timing on performance

Variable	**(1)**	**(2)**	**(3)**	**(4)**
Early (April 10 – 16, 2020)	0.027**	0.036***	0.034***	0.030**
	(0.012)	(0.012)	(0.012)	(0.012)
log(PPPFunds)	---	-0.029***	-0.029***	-0.022***
		(0.006)	(0.006)	(0.008)
Constant	-0.145***	0.173***	0.172***	0.006
	(0.009)	(0.065)	(0.065)	(0.079)
N		**1,346**		
County-level controls	No	No	Yes	Yes
Firm-level controls	No	No	No	Yes
R^2	0.00	0.02	0.02	0.09

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

Results suggest that the breweries receiving first-tranche funding between April 10 – 16, 2020, experienced a decline in YoY production that is 2-4 percentage points smaller than breweries receiving second-tranche funding two weeks later. These findings are robust to the inclusion of brewery and county-specific controls. Intuitively, these results are appealing considering a brewery's decision to adjust beer production based on whether they have received PPP funding. Watson (2020a; 2020b) suggests that breweries shifted production schedules in March and April 2020 due to the decline in on-premise sales. The decision to delay production between tranches (April 17 – 26, 2020) is particularly attractive for breweries without first-tranche funding, as these businesses were experiencing a decline in

[46] County-level fixed effects are excluded given the sample size and diminished explanatory power. The models presented in Table 3.6 is also run with county-level fixed effects. The magnitude of the point estimate is similar (0.025), though it loses statistical significance. By including county-level FIPS codes, the analysis loses its explanatory power and increases its standard errors, leading to lower t-statistics. The inclusion of county-level fixed effects here may also not be appropriate given that of the 1,346 observations across 577 counties, 321 counties (56%) are represented by a single observation.

foot traffic and sales without governmental support. Therefore, breweries waiting for PPP funding may find it more economical to temporarily shut down and halt production until PPP funding arrives. But breweries that received first-tranche funding could use the loan proceeds to pay staff and adjust production despite the short-term revenue decrease. This framework would suggest that, amongst firms that received PPP funding, the period between tranches is critical in determining YoY performance. Put differently, the timing of loan approval mattered to YoY production outcomes.

While the study emphasizes the impact of loan timing on the beer industry, the finding is likely to generalize to other food service, hospitality, and specialized manufacturing sectors whose business model for optimal employment was affected by the incentive structure of the PPP.

3.6.2. Propensity score matching

One limitation to the analysis presented in Table 6—and a fundamental flaw in evaluating the PPP more generally—is that there are inherent differences between the treatment and control groups. One way to overcome these limitations is to use propensity score matching (Rosenbaum and Rubin, 1983). In short, the technique predicts the probability of treatment as a function of a set of covariates, yielding a propensity score for each observation. The outcome variable for each treatment observation is then compared to control observations with similar scores, offering an average treatment effect on the treated (ATT).

In the quasi-experimental setting, the change in YoY production for breweries that receive funding between April 10 – 16, 2020 (treatment) is compared to breweries that receive funding between April 27 – May 3, 2020 (control).[47] A probit model first predicts the probability of treatment as a function of: (i) county-level COVID-19 cases as of April 3, 2020; (ii) 2019 brewery production; (iii) the change in YoY production from 2018 to 2019; (iv) the loan amount approved; and (v) the number of jobs reported in the PPP loan application. COVID-19 cases are included as a proxy for the decline in foot traffic and sales, which may have prompted a brewery to apply for PPP funding sooner. The other four variables are included as proxies for brewery size and performance. Results to the probit are consistent

[47] A more detailed overview of the propensity score methodology and results are provided in the Appendix accompanying this manuscript.

with previously mentioned findings: COVID-19 cases are negatively associated with the probability of being placed in the treatment group, and larger breweries are more likely to be placed in the treatment. Note that changes in YoY production from 2018-2019—the pre-trends in Figure 3.5 alluded to earlier—are insignificant in predicting treatment, which lends additional credibility to the validity of the quasi-experiment results presented in the previous sub-section. The total loan amount (in dollars) increases the probability of being placed in the treatment, whereas the total number of jobs reported on the PPP loan application is marginally negative.

After calculating the propensity score for each observation, the ATT is calculated using a variety of matching methods, including: (i) kernel matching; (ii) nearest neighbor matching; (iii) radius matching; and (iv) stratification matching.[48] Table 3.7 presents the ATT for each of the matching methods.

Table 3.7. Propensity score matching results

	# of observations				
Method	**Treatment**	**Control**	**ATT**	**Std. error**	**t-statistic [a]**
Kernel matching	720	622	0.038	0.012	3.08***
Nearest neighbor matching [b]	720	351	0.030	0.017	1.80*
Radius matching	720	622	0.040	0.013	3.20***
Stratification matching	718	624	0.030	0.013	2.39**

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.
[b] Results presented use one-nearest neighbor matching procedures. When using k-nearest neighbor with $k = \{2, 3, 4, 5\}$, results suggest an ATT of similar magnitude with statistical significance that varies at the one, five, and ten percent level.

The ATT ranges from three to four percentage points, a range coinciding with the results presented in Table 3.6. The treatment effect is significant at the one percent level for the kernel and radius matching; the five percent level for the stratification matching; and the ten percent level for the nearest neighbor matching. Notice, however, that the point estimate and standard errors for the nearest neighbor matching are similar to the stratification method. The loss in statistical significance comes from the nearest neighbor method using only 351 (56%) of the 624 control group observations, placing more weight on the same observations and reducing the degrees of freedom in statistical analysis.

[48] The reader is directed to Caliendo and Kopeinig (2008) for an overview on the various matching methods as well as to Huntington-Klein (2022) for a discussion on the benefits and drawbacks of different propensity score matching procedures.

These results increase confidence in the quasi-experimental estimates presented in Table 3.6, suggesting towards a causal impact of the timing of the PPP loan approval on YoY performance.

3.6.3 Longer-run production changes

This study's primary contribution is the short-run relationship between PPP funding and changes in 2019-2020 production. From a policy perspective, however, it is necessary to explore the longer-run relationship between PPP funding and recovery. With 2021 production data now available for a subset of observations, a brief, exploratory assessment of PPP funding on 2019 – 2021 production is now possible.

Using the quasi-experimental sample, Figure 3.5 suggests a short-term benefit to receiving the PPP funding earlier (as discussed previously). However, the benefit appears to dissipate a year removed from the shock. In other words, breweries that receive first-tranche funding see a decline in 2019-2020 YoY production approximately three percentage points smaller than breweries that received second-tranche funding. But when considering the overall change in production from 2019 – 2021, both groups appear to have recovered to pre-pandemic production levels, on average.

It is critical to stress once again that these insights are exploratory. The quasi-experiment can accurately assess the short-term impacts of PPP (Doniger and Kay, 2022), but more work is needed to understand the longer-term effects. The statistics presented here do not account for important covariates or address additional confounders that may have arisen over the calendar year. Moreover, there are likely heterogeneous effects in longer-term production recovery, particularly when considering brewery size, the reduction in YoY gross receipts, etc., which are beyond the scope of analysis in this article. Quantifying the long-term effect of the program on performance should be an emphasis of future work.

3.7. Limitations

Identifying the causal effect of government policies during the pandemic is inherently difficult (Hale et al., 2021), and we identify two central shortcomings that limit portions of the analysis. First, the analysis is limited by data availability, relying on a cross-sectional dataset when a panel structure accounting for temporal variation in closure dates would provide a more compelling causal interpretation for the LPM results. Unfortunately, closure dates are unavailable for each temporarily or permanently closed brewery in the dataset. It is also probable that active breweries were temporarily closed at some point during the pandemic (Cajner et al., 2020), and others may have adjusted their hours of operation to account for decreased consumer foot traffic (Watson, 2020c). Future research that accounts for the time of business closures across the life span of the PPP could better isolate the effect of receiving a PPP loan on operational status.

Also, the SBA dataset only contains data on the loan approval date is observed, not the loan submission date. It is reasonable to assume that all loan applicants would have preferred earlier to later funding, and it is well established that demand for first-tranche PPP funding far exceeded the available supply. Yet, in the context of the quasi-experiment, we cannot definitively say that all loans approved in the first seven days of the second tranche had the same application date as those approved in the last seven days of the first tranche. If data on PPP loan application submission dates are made available, researchers could use that information to further address the pitfalls and unintended consequences stemming from the first-come, first-served design of the loan program.

The second core limitation is that the study cannot completely isolate issues that arise from self-selection into the treatment. That is, we cannot state with certainty that breweries that receive PPP funding have the same probability of survival as firms that do not receive PPP funding. Nor can we say that they had the same expected change in YoY production. For example, a brewery that had a pre-existing relationship with a bank and had more financial resources on-hand at the onset of COVID-19 may have been in a better position to remain in operation than one that did not have such resources available. It is also possible that the firms most likely to close chose not to apply for PPP funding. However, outside of total production, the firm’s pre-pandemic economic conditions are unobserved, and any further discussion would be speculation.

With these limitations, it is plausible to question whether the breweries that received PPP funding would have survived without PPP. Given the different production levels and growth rates between those that received PPP funding and those that did not, it is also possible that the breweries that experienced smaller declines in production were in a better position to adapt to production shocks from COVID-19 irrespective of PPP funding. Thus, while the results suggest a positive relationship between PPP funding and small business performance, questions remain about the efficiency and equality of the loan distribution mechanism and the program's causal impacts.

3.8. Discussion and implications

The *I Can't Go Anywhere But Here IPA* by Proclamation Ale Company and *Zoom Casual IPA* by Denver Beer Company are just two of the COVID-19-inspired beverages created by small, independent breweries that have thus far survived the pandemic. However, not all small businesses were fortunate enough to outlast the early economic turmoil generated by the pandemic. Analysis suggests that the number of business owners in the United States fell by 22% from February to April 2020 (Fairlie, 2020), and business closures were 25-33% higher in 2020 than in pre-COVID trends (Crane et al., 2020). As such, it is critical to explore whether the federal policies that provided economic relief to small businesses hit their mark.

The results suggest that receiving a PPP loan is associated with a higher probability of business survival and smaller declines in YoY production volume. These results are in line with previous findings on the PPP, where studies have suggested that PPP funding has led to a higher probability of survival (Bartlett III and Morse, 2020; Hubbard and Strain, 2020), better employment outcomes (Bartik, Cullen, et al., 2020; Doniger and Kay, 2021), and smaller reductions in revenue (Li, 2021).[49] More generally, the findings coincide with the notion that sales for the hospitality and accommodation industries decreased substantially during the COVID-19 pandemic (Fairlie and Fossen, 2021b). Industry reports also support these findings, where the Brewers Association reports a 9.3% decrease in volume, a 22% loss in dollar sales, and a 1.6 percentage point decline in market share from 2019 to 2020

[49] The PPP represents just one of the many policy levers pulled by the U.S. government to minimize the economic damages from COVID-19. Each country had its own unique response to COVID-19, and Hale et al. (2021) tracked government responses to COVID-19 across more than 180 countries. Categorizing policy responses into three overarching themes (containment and closure, economic response, and health systems), the data tracks 19 types of policy responses throughout 2020. The Oxford COVID-19 Government Response Tracker data discussed in Hale (2021) is available at: https://github.com/OxCGRT/covid-policy-tracker [last accessed October 28, 2022]. While comparing government responses to COVID-19 is not the main objective of this manuscript, other studies have considered the effects of COVID-19 economic policy responses on small business performance and entrepreneurial behavior in countries such as the United Kingdom (Yue and Cowling, 2021), Germany (Block, Fisch, and Hirschmann, 2022; Dörr, Licht, and Murmann, 2022), and China (Liu et al., 2022). These studies have shown that (i) firms adjusted their liquidity decisions in response to COVID-19; (ii) government policies often helped reduce the financial strain on small businesses; and (iii) government policies were sometimes not well targeted, leading to more substantial adverse effects on smaller businesses, entrepreneurs, and self-employed individuals. These findings generally align with those presented in this article.

(Brewers Association, 2022d; Scott, 2020; 2021). Despite these statistics and the widespread concern from craft brewers at the start of the pandemic (Watson, 2020a; 2020b), brewery closures have been lower than expected (Brewers Association, 2022d). This ability to weather the storm is likely attributable to innovation, entrepreneurship, and government support (Fairlie, 2013; Watson, 2022).

Even within a single industry, the pandemic has disproportionately impacted specific market segments. In the context of craft beer, brewpubs closed at higher rates and experienced steeper falloffs in YoY production volume, while regional breweries outperformed other market segments. These insights indicate how a firm's pre-pandemic business model affects business dynamics and resiliency in a time of crisis.[50] The COVID-19 pandemic is a once-in-a-century outbreak, and the speed at which the economic damages were felt made planning and preparation for this crisis particularly difficult. But while most businesses were forced to adjust to the new environment, some firms within a single industry could have been more or less vulnerable to the shock given their pre-pandemic business model and financial or technological constraints.

The quasi-experiment also provides evidence that the timing of the loan approval mattered. Results to regression analysis and propensity score matching suggest at the causal effect of breweries that receive late first-tranche PPP funding, on average, performing better YoY than those breweries that received early second-tranche funding. If the timing of loan approval contributes to YoY performance, then this further raises concern over the first-come, first-served style of the loan program. In the quasi-experiment, firms that received

[50] Each market segment has its unique business model, indicative of different production levels, packaging decisions, revenue streams, etc. For brewpubs, food sales constitute a large portion of their revenue relative to the other market segments, and the food sales are largely driven by on-premise dining. When public health policies limited or shut down indoor dining, and consumer foot traffic fell due to the perceived risk of contracting COVID-19 (Goolsbee and Syverson, 2021), brewpubs saw a large decline in a primary revenue channel. Further, a reliance on sales from indoor dining meant that brewpubs were also primarily selling their beer on-premise. While true that microbreweries and taprooms also rely heavily on on-premise consumption, brewpubs oftentimes have a less diverse portfolio of revenue streams. In other words, it is more common for the other market segments to have canning equipment, relationships with aluminum suppliers (upstream of the supply chain), and relationships with beer distributors and retailers (downstream), making the response to a shift in consumer behavior more likely. Without the necessary equipment and the relationships across the supply chain, brewpubs were particularly vulnerable. Thus, while state governments implemented policies alleviating some of the revenue declines—for example, allowing for to-go beer and brewery delivery—other barriers hindered a brewpub's ability to pivot away from its original business model. Industry reports and anecdotal accounts have also highlighted the disproportionate effect the pandemic has had on brewpubs (Brewers Association, 2022d; Watson, 2022).

first-tranche funding were, on average, larger and located in counties with below-average COVID-19 cases in April 2020. This finding also holds when exploring the recipients of PPP loans more generally. In sacrificing targeting for timeliness (Autor et al., 2022b), the program disproportionately assisted businesses that had preexisting relationships with a bank (Bartik, Cullen et al., 2020; Granja et al., 2020), supporting larger firms over small businesses (Humphries et al., 2020), and contributing to equality issues (Atkins et al., 2021; Autor et al., 2022b; Fairlie and Fossen, 2021a).

By merging a verified industry dataset with the SBA data on PPP loan recipients, the article provides a methodological overview and speaks to the challenges associated with achieving its objectives. COVID-19 was declared a national emergency on March 13, 2020, the CARES Act (Public Law 116-136) was passed on March 27, 2020, and the first-PPP loan recipients were approved on April 3, 2020. The quick turnaround was imperative to small businesses, but bureaucratic shortcomings make it challenging to analyze the effectiveness of the program. For instance, each loan applicant had to list their "Borrower Name" on the PPP loan application. Yet, in some cases, the borrower would list their name or official company name rather than their trading name (i.e., *doing-business-as* name). This inconsistency meant imperfect information in the merging process, which required the manual merging of data sources based on addresses and analysis of a company's trademarks.[51] Juxtaposing the PPP application with the Economic Injury Disaster Loan (EIDL) application, EIDL applicants are required to specify both the legal name of the business and the trading name (if different from the legal name). If PPP loan applicants were

---

[51] Given the number of craft breweries in the United States, the manual matching procedures described in this study were practical. With access to a verified dataset of producers from the largest craft beer industry group, the PPP observations were mapped to known breweries. However, even with less than 9,000 total producers, the matching procedures proved extremely time-intensive. If future research wishes to examine the effect of PPP on a larger industry (e.g., full-service restaurants), the matching methods are feasible but necessarily will be even more time- and labor-intensive. Additionally, researchers would need to obtain a verified dataset of existing full-service restaurants before COVID-19 and consider potentially miscoded observations to gain a more accurate representation of the impact of the PPP on the industry. While proprietary datasets (like the National Establishment Time-Series) exist, they have significant limitations which we were able to alleviate through partnering with the Brewers Association (i.e., being able to cross-validate closures, enhancing confidence that we accurately identified all firms that closed from the full universe of businesses in this specific industry and having non-imputed measures of production data). Thus, while analyzing a single, smaller industry has potential drawbacks for identifying the overall causal effect of the loan program, the practicality and internal validity of the methodology described in this paper offer substantial improvements over alternatives.

asked to provide this information, it would have enabled a much cleaner merging procedure. Clarification, consistency, and the collection of all pertinent information across loan applications are critical for future loan programs to improve the functionality of governmental data.

Researchers analyzing the economic impact of the PPP must be cognizant of the delicacies of the NAICS code classification system and the presence of potentially fraudulent observations. While the attention is on the craft breweries—an industry with its own six-digit NAICS code—we necessarily analyzed observations across three different NAICS codes. If attention was restricted to the six-digit NAICS code for breweries (312120), just 63% of the matched PPP loan observations would have been captured—severally underestimating the number of loan recipients. There are also several instances where breweries received both rounds of funding through the same bank yet were coded in different NAICS codes across the two applications (e.g., NAICS 312120: Breweries in the first round and coded with 722410: Drinking places in the second round). Observations were also incorrectly coded into the population of interest (e.g., several wineries and distilleries were coded as breweries when each has its own NAICS code). Moreover, Beggs and Harvison (2022) and Griffin et al. (2022) suggest that the loan program was susceptible to fraudulent claims, implying that researchers must be aware of their potential presence in the data. By addressing shortcomings related to the borrower name listed on the PPP loan application, matching across all pertinent NAICS codes, and removing incorrectly coded or potentially fraudulent observations, this methodology allows for a more accurate representation of PPP loan recipients by industry. This was only possible because of the externally verified universe of businesses from the Brewers Association. As such, researchers seeking to identify the impact of the PPP on a specific industry should consider the ease of obtaining a verified dataset of producers and how PPP observations may be scattered across different NAICS codes.

3.9. Conclusion

The PPP was established to incentivize small businesses to keep employees on payroll and to provide them some relief from economic damages from the COVID-19 pandemic. Using data from the Brewers Association and SBA, this study explores the role of PPP funding on small business performance. Results suggest that breweries that receive PPP funding are more likely to remain in operation and experience a smaller decrease in YoY production from

2019-2020. Further, through a quasi-experiment that exploits a natural break in the loan program, the study demonstrates that the timing of loan approval likely affected YoY performance. While the analysis lacks a full causal interpretation, the results support a positive correlation between PPP funding and small business performance.

Several avenues remain for future research. Previous studies have explored the employment effects of the PPP (e.g., Autor et al., 2022a; Chetty et al., 2020; Hubbard and Strain, 2020), but future work could link PPP and employment outcomes with YoY performance or sales data to better understand the dynamic relationship between these outcome variables.[52] Additionally, researchers have explored equity concerns over the distribution of PPP funding, but much remains unknown about the short- and long-term effects of the first-come, first-served approach of the loan program. For example, researchers could examine network effects in the PPP loan program across time, exploring PPP loan clustering and addressing the role of social networks. Future work should examine the impact of COVID-19 and the PPP on new businesses or businesses in planning. This line of research could provide critical insights into the roles of economic circumstances, government support, and entrepreneurship on short- and long-term business resiliency and growth (Kuckertz et al., 2020). Finally, from a global perspective, future research could compare the effectiveness of the PPP relative to other government efforts (Hale et al., 2021). For example, Block et al. (2022) and Dörr et al. (2022) consider how financial assistance in Germany helped small businesses. With a strong beer industry and a growing presence of small brewers (Statista, 2021), one interesting avenue could be to replicate the analysis presented here with a dataset of German producers. Doing so would enable an interesting comparison of how different policy responses influenced performance.

The PPP supported small businesses across the country, and researchers are only beginning to answer the question of whether it hits its mark. Questions remain regarding the loan program's equality, efficiency, and causal impact. As more researchers explore this line of research, we will gain a much clearer insight into the effect of the PPP on small businesses.

---

[52] The stated objective of the PPP was to keep workers on payroll. But this study evaluates performance based on changes in annual production: a secondary policy outcome but a primary concern for small businesses. The current analysis is limited by data availability, and future studies that causally link receiving PPP funding to employment and production outcomes would significantly improve our understanding of the program's effectiveness.

REFERENCES

Arend, R. J. (2013). Ethics-focused dynamic capabilities: A small business perspective. *Small Business Economics, 41*(1), 1-24. https://doi.org/10.1007/s11187-012-9415-2

Atkins, R., Cook, L., & Seamans, R. (2021). Discrimination in lending? Evidence from the Paycheck Protection Program. *Small Business Economics.* doi.org/10.1007/s11187-021-00533-1

Autor, D., Cho, D., Crane, L. D., Goldar, M., Lutz, B., Montes, J., ... & Yildirmaz, A. (2022a). An evaluation of the paycheck protection program using administrative payroll microdata. *Journal of Public Economics*, 211, 104664. doi.org/10.1016/j.jpubeco.2022.104664

Autor, D., Cho, D., Crane, L. D., Goldar, M., Lutz, B., Montes, J., Peterman, W. B., ... & Yildirmaz, A. (2022b). The $800 billion paycheck protection program: Where did the money go and why did it go there?. *Journal of Economic Perspectives*, *36*(2), 55-80. doi.org/10.1257/jep.36.2.55

Bartik, A. W., Bertrand, M., Cullen, Z. B., Glaeser, E. L., Luca, M., & Stanton, C. T. (2020). *How are small businesses adjusting to COVID-19? Early evidence from a survey* (No. w26989). National Bureau of Economic Research. doi.org/10.3386/w26989

Bartik, A. W., Cullen, Z. B., Glaeser, E. L., Luca, M., Stanton, C. T., & Sunderam, A. (2020). *The targeting and impact of Paycheck Protection Program loans to small businesses* (No. w27623). National Bureau of Economic Research. doi.org/10.3386/w27623

Bartlett III, R. P., & Morse, A. (2020). *Small business survival capabilities and policy effectiveness: Evidence from Oakland* (No. w27629). National Bureau of Economic Research. https://doi.org/10.3386/w27629

Beggs, W., & Harvison, T. (2022). Fraud and abuse in the paycheck protection program? Evidence from investment advisory firms. *Journal of Banking & Finance*, 106444. doi.org/10.1016/j.jbankfin.2022.106444

Belitski, M., Guenther, C., Kritikos, A. S., & Thurik, R. (2022). Economic effects of the COVID-19 pandemic on entrepreneurship and small businesses. *Small Business Economics*, *58*(2), 593-609. https://doi.org/10.1007/s11187-021-00544-y

Block, J. H., Fisch, C., & Hirschmann, M. (2022). The determinants of bootstrap financing in crises: evidence from entrepreneurial ventures in the COVID-19 pandemic. *Small Business Economics*, *58*(2), 867-885. https://doi.org/10.1007/s11187-020-00445-6

BLS (2022). Civilian unemployment rate. Available at *Bureau of Labor Statistics* website: www.bls.gov/charts/employment-situation/civilian-unemployment-rate.htm [last accessed May 2, 2022].

Brewers Association (2021). Brewery production: Brewery data (xls). Available at *Brewers Association* website: www.brewersassociation.org/statistics-and-data/brewery-production-data/ [last accessed August 16, 2021].

Brewers Association (2022a). 2021 annual report. Available at *Brewers Association* website: www.brewersassociation.org/annual-report-2021/ [last accessed May 3, 2022].

Brewers Association (2022b). Craft beer industry market segments. Available at *Brewers Association* website: www.brewersassociation.org/statistics-and-data/craft-beer-industry-market-segments/ [last accessed July 12, 2021].

Brewers Association (2022c). Craft brewer definition. Available at *Brewers Association* website: www.brewersassociation.org/statistics-and-data/craft-brewer-definition/ [last accessed August 18, 2021].

Brewers Association (2022d). National beer sales & production data. Available at *Brewers Association* website: www.brewersassociation.org/statistics-and-data/national-beer-stats/ [last accessed July 12, 2021].

Brewers Association (2022e). Who we are. Available at *Brewers Association* website: www.brewersassociation.org/who-we-are/ [last accessed July 12, 2021].

Cajner, T., Crane, L. D., Decker, R. A., Grigsby, J., Hamins-Puertolas, A., Hurst, E., ... & Yildirmaz, A. (2020). *The US labor market during the beginning of the pandemic recession* (No. w27159). National Bureau of Economic Research. doi.org/10.3386/w27159

Caliendo, M., & Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys*, *22*(1), 31-72. https://doi.org/10.1111/j.1467-6419.2007.00527.x

CDC (2021). Trends in number of COVID-19 vaccinations in the US. Available at *Centers for Disease Control and Prevention's COVID Data Tracker* website: www.covid.cdc.gov/covid-data-tracker/#vaccination-trends_vacctrends-fully-cum [last accessed December 1, 2021].

CDC Tracker (2022). National environmental public health tracking network. Available at *CDC* website: https://ephtracking.cdc.gov/DataExplorer/ [last accessed October 28, 2022].

Chetty, R., Friedman, J. N., Hendren, N., & Stepner, M. (2020). *The economic impacts of COVID-19: Evidence from a new public database built using private sector data* (No. w27431). National Bureau of Economic Research. doi.org/10.3386/w27431

Coronavirus Aid, Relief, and Economic Security Act. 2020. Public Law 116-136. www.congress.gov/116/plaws/publ136/PLAW-116publ136.pdf

Couch, K. A., Fairlie, R. W., & Xu, H. (2020). Early evidence of the impacts of COVID-19 on minority unemployment. *Journal of Public Economics*, *192*, 104287. doi.org/10.1016/j.jpubeco.2020.104287

Crane, L. D., Decker, R. A., Flaaen, A., Hamins-Puertolas, A., & Kurz, C. (2020). Business exit during the COVID-19 pandemic: Non-traditional measures in historical context. *Finance and Economics Discussion Series 2020-089r1. Washington: Board of Governors of the Federal Reserve System*. doi.org/10.17016/FEDS.2020.089r1

Dalton, M. (2021). *Putting the Paycheck Protection Program into perspective: An analysis using administrative and survey data*. Economic Working Papers 542, Bureau of Labor Statistics Working Paper. https://EconPapers.repec.org/RePEc:bls:wpaper:542

Doniger, C., & Kay, B. (February 1, 2022). Long lived employment effects of delays in emergency financing for small businesses. Available at *SSRN*: dx.doi.org/10.2139/ssrn.3747223

Dörr, J. O., Licht, G., & Murmann, S. (2022). Small firms and the COVID-19 insolvency gap. *Small Business Economics*, *58*(2), 887-917. https://doi.org/10.1007/s11187-021-00514-4

Ellison, B., McFadden, B., Rickard, B. J., & Wilson, N. L. (2021). Examining food purchase behavior and food values during the COVID-19 pandemic. *Applied Economic Perspectives and Policy*, *43*(1), 58-72. doi.org/10.1002/aepp.13118

ERS (August 20, 2019). Natural amenities scale. Available at *Economic Research Service* website: www.ers.usda.gov/data-products/natural-amenities-scale/ [last accessed November 30, 2021].

Fairlie, R. (2013). Entrepreneurship, economic conditions, and the great recession. *Journal of Economics & Management Strategy*, *22*(2), 207-231. doi.org/10.1111/jems.12017

Fairlie, R. (2020). The impact of COVID-19 on small business owners: Evidence from the first three months after widespread social-distancing restrictions. *Journal of Economics & Management Strategy*, *29*(4), 727-740. doi.org/10.1111/jems.12400

Fairlie, R., & Fossen, F. M. (2021a). Did the Paycheck Protection Program and Economic Injury Disaster Loan Program get disbursed to minority communities in the early stages of COVID-19?. *Small Business Economics*, 1-14. doi.org/10.1007/s11187-021-00501-9

Fairlie, R., & Fossen, F. M. (2021b). The early impacts of the COVID-19 pandemic on business sales. *Small Business Economics*, 1-12. doi.org/10.1007/s11187-021-00479-4

Faulkender, M. W., Jackman, R., & Miran, S. (December 17, 2020). The job preservation effects of paycheck protection program loans. Available at *SSRN*: http://dx.doi.org/10.2139/ssrn.3767509

Firth, D. (1993). Bias reduction of maximum likelihood estimates. *Biometrika*, *80*(1), 27-38. https://doi.org/10.1093/biomet/80.1.27

Goolsbee, A., & Syverson, C. (2021). Fear, lockdown, and diversion: Comparing drivers of pandemic economic decline 2020. *Journal of Public Economics*, *193*, 104311. doi.org/10.1016/j.jpubeco.2020.104311

Granja, J., Makridis, C., Yannelis, C., & Zwick, E. (2020). *Did the Paycheck Protection Program hit the target?* (No. w27095). National Bureau of Economic Research. doi.org/10.3386/w27095

Griffin, J.M., Kruger, S., & Mahajan, P. (2022). Did FinTech lenders facilitate PPP fraud?. *SSRN Working Paper 3906395*. dx.doi.org/10.2139/ssrn.3906395

Hale, T., Angrist, N., Goldszmidt, R., Kira, B., Petherick, A., Phillips, T., ... & Tatlow, H. (2021). A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nature Human Behaviour*, *5*(4), 529-538. https://doi.org/10.1038/s41562-021-01079-8

Hennart, J. F. (2014). The accidental internationalists: A theory of born globals. *Entrepreneurship Theory and Practice*, 38(1), 117–135. https://doi.org/10.1111/etap.12076

Hubbard, R. G., & Strain, M. R. (2020). *Has the Paycheck Protection Program Succeeded?* (No. w28032). National Bureau of Economic Research. doi.org/10.3386/w28032

Humphries, J. E., Neilson, C. A., & Ulyssea, G. (2020). Information frictions and access to the Paycheck Protection Program. *Journal of Public Economics*, *190*, 104244. doi.org/10.1016/j.jpubeco.2020.104244

Huntington-Klein, N. (2022). Matching *in The Effect: An Introduction to Research Design and Causality (pp. 267-326)*. CRC Press. Boca Raton, Florida.

Katchova, A. (March 2, 2013). *Propensity score matching* [Video]. Econometrics Academy. https://sites.google.com/site/econometricsacademy/econometrics-models/propensity-score-matching?authuser=0 [last accessed July 6, 2022].

Kuckertz, A., Brändle, L., Gaudig, A., Hinderer, S., Reyes, C. A. M., Prochotta, A., ... & Berger, E. S. (2020). Startups in times of crisis–A rapid response to the COVID-19 pandemic. *Journal of Business Venturing Insights*, 13, e00169. https://doi.org/10.1016/j.jbvi.2020.e00169

Kuratko, D. F., Holt, H. L., & Neubert, E. (2020). Blitzscaling: The good, the bad, and the ugly. *Business Horizons*, *63*(1), 109-119. https://doi.org/10.1016/j.bushor.2019.10.002

Lastauskas, P. (2022). Lockdown, employment adjustment, and financial frictions. *Small Business Economics*, *58*(2), 919-942. https://doi.org/10.1007/s11187-021-00496-3

Li, L., & Strahan, P. E. (2021). Who supplies PPP loans (and does it matter)? Banks, relationships, and the COVID crisis. *Journal of Financial and Quantitative Analysis*, *56*(7), 2411-2438. doi.org/10.1017/S0022109021000405

Li, M. (2021). Did the small business administration's COVID-19 assistance go to the hard hit firms and bring the desired relief?. *Journal of Economics and Business*, *115*, 105969. doi.org/10.1016/j.jeconbus.2020.105969

Liu, Y., Zhang, Y., Fang, H., & Chen, X. (2022). SMEs' line of credit under the COVID-19: evidence from China. *Small Business Economics*, *58*(2), 807-828. https://doi.org/10.1007/s11187-021-00474-9

Morris, C. (October 14, 2020). Craft brewers upend their business models in fight to stay alive. Available at *Fortune* website: www.fortune.com/2020/10/14/craft-beer-brewery-covid-businesss/ [last accessed December 21, 2021].

Office of Capital Access (May 31, 2021). Paycheck Protection Program (PPP) report: Approvals through 05/31/2021. Available at *SBA* website: www.sba.gov/document/report-paycheck-protection-program-weekly-reports-2021 [last accessed September 15, 2021].

Palardy, N., Costanigro, M., Cannon, J., Thilmany, D., Berning, J., & Callaway, J. (2020). Beer Sales in Grocery and Convenience Stores A Glass Half-full for Colorado Craft Brewers?. *Field to Foam Research Institute at Colorado State University.*

https://foodsystems.colostate.edu/wp-content/uploads/2020/08/FF_BeerGrocery_8-26-20.pdf [last accessed November 1, 2022].

Romano, M. (July 14, 2021). Lifting restrictions and moving forward from COVID-19. Available at *Brewers Association* website: www.brewersassociation.org/brewing-industry-updates/lifting-restrictions-and-moving-forward-from-covid-19/ [last accessed December 21, 2021].

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41-55. https://doi.org/10.1093/biomet/70.1.41

SBA (2021a). First draw PPP loan. Available at *SBA* website: www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program/first-draw-ppp-loan [last accessed July 28, 2021].

SBA (2021b). PPP data. Available at *SBA* website: www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program/ppp-data [last accessed December 21, 2021].

SBA (2021c). PPP FOIA. Available at *SBA* website: www.data.sba.gov/dataset/ppp-foia [last accessed July 12, 2021].

SBA (2021d). PPP loan forgiveness. Available at *SBA* website: www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program/ppp-loan-forgiveness [last accessed July 28, 2021].

SBA (2021e). Restaurant Revitalization Fund. Available at *SBA* website: www.sba.gov/funding-programs/loans/covid-19-relief-options/restaurant-revitalization-fund [last accessed November 9, 2021].

SBA (July 2, 2021f). SBA administrator announces closure of Restaurant Revitalization Fund program. Available at *SBA* website: www.sba.gov/article/2021/jul/02/sba-administrator-announces-closure-restaurant-revitalization-fund-program [last accessed December 21, 2021].

SBA (January 8, 2021g). SBA and Treasury announce PPP re-opening; issue new guidance. Available at *SBA* website: www.sba.gov/article/2021/jan/08/sba-treasury-announce-ppp-re-opening-issue-new-guidance [last accessed December 21, 2021].

SBA (January 13, 2021h). SBA re-opening Paycheck Protection Program to small lenders on Friday, January 15 and all lenders on Tuesday, January 19. Available at *SBA* website: www.sba.gov/article/2021/jan/13/sba-re-opening-paycheck-protection-program-small-lenders-friday-january-15-all-lenders-tuesday [last accessed December 21, 2021].

SBA (2021i). Second draw PPP loan. Available at *SBA* website: www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program/second-draw-ppp-loan [last accessed December 21, 2021].

SBA (May 10, 2021j). The SBA funds 16,000 Restaurant Revitalization Fund awards. Available at *SBA* website: www.sba.gov/article/2021/may/10/sba-funds-16000-restaurant-revitalization-fund-awards [last accessed December 21, 2021].

Scott, J. (April 14, 2020). Brewers Association releases annual growth report for 2019. Available at *Brewers Association* website: www.brewersassociation.org/press-releases/brewers-association-releases-annual-growth-report-for-2019/ [last accessed December 23, 2021].

Scott, J. (April 6, 2021). Numbers reveal all-time high of operating breweries, first production decline in modern craft era. Available at *Brewers Association* website: www.brewersassociation.org/press-releases/2020-craft-brewing-industry-production-report/ [last accessed December 1, 2021].

Sierra Nevada Brewing Company (2022). Does beer expire?. Available at *Sierra Nevada Brewing Company* website: www.sierranevada.com/blog/does-beer-expire/ [last accessed April 22, 2022].

Staples, A. J., Malone, T., & Sirrine, J. R. (2021). Hopping on the localness craze: What brewers want from state-grown hops. *Managerial and Decision Economics*, *42*(2), 463-473. doi.org/10.1002/mde.3246

Statista (December, 2021). Number of active beer breweries in Germany from 2008 to 2020. Available at *Statista* website: https://www.statista.com/statistics/447381/germany-number-beer-breweries/ [last accessed October 28, 2022].

The Washington Post v. U.S. Small Business Administration (2020). Available at: www.napa-net.org/sites/napa-net.org/files/PPP_DC%20ruling%20on%20disclosure_110520.pdf [last accessed December 21, 2021].

Timoneda, J. C. (2021). Estimating group fixed effects in panel data with a binary dependent variable: How the LPM outperforms logistic regression in rare events data. *Social Science Research*, *93*, 102486. https://doi.org/10.1016/j.ssresearch.2020.102486

Watson, B. (September 16, 2014). The rise of the microbrewery tap room. Available at *Brewers Association* website: www.brewersassociation.org/insights/microbrewery-tap-room/ [last accessed December 21, 2021].

Watson, B. (March 18, 2020a). Impact survey shows extreme challenges. Available at *Brewers Association* website: www.brewersassociation.org/insights/impact-survey-shows-extreme-challenges/ [last accessed September 15, 2021].

Watson, B. (April 7, 2020b). Brewery sales dropping sharply, many set to close. Available at *Brewers Association* website: www.brewersassociation.org/insights/brewery-sales-dropping-sharply-many-set-to-close/ [last accessed September 15, 2021].

Watson, B. (August 12, 2020c). Data on Brewery Closing Times During Reopening. Available at *Brewers Association* website: www.brewersassociation.org/insights/data-on-brewery-closing-times-during-reopening/ [last accessed April 5, 2022].

Watson, B. (2021). State of the industry. Presentation at the *Beeronomics Society* on June 25. Available at: www.brewersassociation.org/collab-hour/2020-craft-brewer-numbers-a-closer-look-at-the-brewers-associations-annual-production-report/ [last accessed July 28, 2021].

Watson, B. (January 25, 2022). How did breweries pivot during the pandemic and how have they recovered?. Available at *Brewers Association* website: www.brewersassociation.org/insights/how-did-breweries-pivot-during-the-pandemic-and-how-have-they-recovered/ [last accessed May 3, 2022].

Wooldridge, J.M. (ed.) (2010). Binary response models in *Econometric Analysis of Cross Section and Panel Data , 2nd Edition* (pp. 561-642). Massachusetts Institute of Technology.

Yue, W., & Cowling, M. (2021). The Covid-19 lockdown in the United Kingdom and subjective well-being: Have the self-employed suffered more due to hours and income reductions?. *International Small Business Journal*, *39*(2), 93-108. https://doi.org/10.1177/0266242620986763

APPENDIX

Additional data on brewery closures

Table 2.2 presents the percentage of breweries that were listed as temporarily or permanently closed in the dataset as of July 2021. Importantly, the dataset only includes closures after April 3, 2020, the starting date of the first tranche of PPP loan distribution. As such, the permanent closures reported in the manuscript represent a lower-bound estimate of total closures over 2020 and the first half of 2021. Most notably, closures during the first three months of 2020 are removed, including many breweries that closed following the declaration of COVID-19 as a national emergency but before the PPP loans were distributed (March 13 – April 2, 2020).

Using data from Brewers Association (2022), we evaluate historical data on brewery closures to gain further insights into 2020 and 2021 closures. In doing so, we compare how the 2020 closure rate differed from historical trends and speak to the estimated number of closures by industry segment. Table 3.A1 presents the number of brewery closures and the closure rates over the past 11 years.

From 2010 – 2018, the closure rate never exceeded 4%, with an average closure rate of 2.6%. In 2019, the closure rate grew to 4.2%, which increased to 4.8% in 2020. Closures then fell to just 2.0% in 2021. In other words, there was an uptick in closures leading up to the pandemic—potentially indicative of saturation in the market—and this closure rate continued to climb in the first year of the pandemic. Then, in 2021, the closure rate dropped below the long-run average.

Throughout the chapter, there is evidence that brewpubs were particularly vulnerable to the COVID-19 pandemic. Brewpubs closed at higher rates and, amongst breweries that remained in operation, experienced steeper declines in production from 2019-2020. The Brewers Association also segments historical closures by segment, and this data can be used to further support the claims that brewpubs were disproportionately affected by COVID-19.

Figure 3.A1 presents the closure rates by industry segment, comparing brewpub closures to microbrewery and taproom closures.[53] Note that the distinction between

[53] Data for regional brewery closures are not available.

microbreweries and taprooms was not made until 2019, so the Brewers Association aggregates closures across these two segments from 2010 – 2018. For ease of interpretation, microbrewery and taproom closures are aggregated from 2010 – 2021.

Outside of 2010, when there were only 1,677 breweries across the three segments, brewpubs and microbreweries/taprooms closed at similar rates. Indeed, from 2011-2019, closure rates between the segments were within one percentage point of one another, often within one-half of a percentage point. However, in 2020, the brewpub closure rate exceeded that of microbreweries/taprooms by two percentage points. By 2021, the closure rates were once again extremely similar. These data further suggest that brewpubs were hit harder by the first year of the pandemic than microbreweries and taprooms.

Table 3.A1. Brewery closures and closure rate, 2010 – 2021

Year	Closures [a]	Total breweries	Closure rate
2010	64	1,677	3.8%
2011	44	2,110	2.1%
2012	47	2,519	1.9%
2013	68	2,989	2.3%
2014	85	3,833	2.2%
2015	104	4,598	2.3%
2016	119	5,527	2.2%
2017	202	6,459	3.1%
2018	241	7,388	3.3%
2019	345	8,179	4.2%
2020	417	8,671	4.8%
2021	177	8,901	2.0%

[a] Closures and total breweries reflect brewpubs, microbreweries, and taprooms. The analysis excludes regional craft breweries, as the data on regional brewery closures are unavailable at Brewers Association (2022).

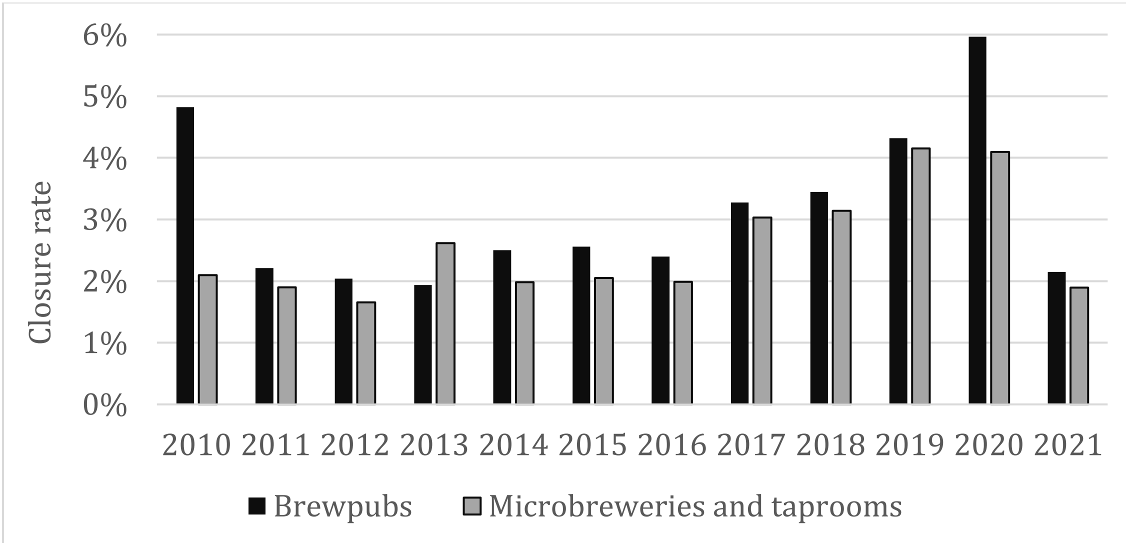


Figure 3.A1. Closure rate over time by segment, Source: Brewers Association (2022)

Penalized logistic regression

Table 3.4 presents the results of the linear probability model (LPM) that predicts the probability of being open as a function of receiving PPP funding. One criticism of the LPM is that it can produce estimates outside the zero-one range implied by the binary outcome variable. Table 3.A2 presents results from a penalized logistic regression that constrains predictions in the zero-one bound and accounts for rare events (i.e., closures only account for approximately five percent of the observations).[54]

Results are fairly consistent with the results in Table 3.4. Specifically, the main effects of receiving first-round and second-round funding are positive and statistically significant at the one percent level. These results indicate that receiving first or second-round funding increased the probability of remaining in operation. The interaction term (i.e., receiving both rounds of funding) retains its negative sign but loses its statistical significance, suggesting that the relationship between receiving both rounds of funding could be additive.

For the brewery segment, where taprooms serve as the baseline, there is again evidence that brewpubs, on average, are more likely to close. This result is consistent with the data presented in Table 3.4 and when examining year-over-year (YoY) production data.

[54] We use the *firthlogit* command in Stata to conduct this analysis. One limitation of the penalized logistic function with rare events is that it does not perform well with fixed effects (Timoneda, 2021). As such, we include county-level control variables (COVID-19 cases and Economic Research Service (ERS) Natural Amenities Score) instead of county FIPS codes.

The coefficient for microbreweries is not distinct from zero, and the coefficient for regional breweries remains insignificant.

Table 3.A2. Penalized logistic regression output

	Coef (std. error) [a]		
Variable	**(1)**	**(2)**	**(3)**
PPP Funding			
FirstRoundPPP	0.658***	0.626***	0.720***
	(0.126)	(0.126)	(0.150)
SecondRoundPPP	1.115***	1.140***	1.300***
	(0.282)	(0.282)	(0.326)
BothRoundsPPP	-0.251	-0.197	-0.253
	(0.340)	(0.342)	(0.396)
Segment			
Brewpub	---	---	-0.377***
			(.0135)
Microbrewery	---	---	-0.100
			(0.170)
Regional	---	---	-0.040
			(0.592)
Constant	2.496***	2.63***	1.166***
	(0.060)	(0.069)	(0.349)
N	**8,946**	**8,842**	**5,818**
County-level controls [b]	No	Yes	Yes
Firm-level controls	No	No	Yes
Penalized log likelihood	-1,680.5	-1,620.9	-1,073.4

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

[b] County-level controls include the total number of COVID-19 cases as of April 3, 2020, the total number of COVID-19 cases as of December 3, 2020, and the Economic Research Service (ERS) Natural Amenities Score.

Note: The number of observations differs across specifications as the ERS does not publish amenities scores for some counties. Additionally, brewery production data only exist for a subset of the observations.

Policy restrictiveness

One alternative hypothesis is that local government policies drove the decline in YoY production. This hypothesis is explored through subsample analysis across brewpubs.

In this exploratory exercise, end-of-the-month monthly county-level restaurant policy restrictiveness data is obtained from the Center for Disease Control and Prevention (CDC) National Environmental Public Health Tracking Network from March – December

2020.[55] We then test the alternative hypothesis that county-level COVID-19 restaurant policies were the driving force behind the decline in YoY production for brewpubs (as opposed to the business model). In other words, the analysis from Table 3.5 is replicated solely over brewpubs. Then, the study examines whether the inclusion of a policy restrictiveness indicator variable correlates with YoY performance. The county restaurant policy is a sufficient policy for brewpubs, as they are restaurants that brew their own beer). To briefly summarize, the results provide little evidence of a statistically significant relationship between policy and YoY performance. A placebo test is then carried out to validate these findings over non-brewpubs.

The CDC Tracker (2022) data classifies the county policies into one of the following five categories: (i) no restriction found; (ii) authorized to fully reopen; (iii) open with limitations; (iv) curbside/delivery only; (v) closed. Figure 3.A2 shows how restaurant reopening policies varied at the county level at the end of each month in 2020. Table 3.A3 summarizes how these policies vary across the sample, where the table is segmented by brewpubs (n = 2,031) and non-brewpubs (n = 3,524). It is not until May 2020 that there is sufficient variation in the policy, which dissipates in the following summer months. Therefore, the subsequent analysis focuses on the policy implemented at the end of May 2020 to understand how local restaurant policy may have influenced brewpub performance.

[55] The data used in the supplemental analysis are available at: https://ephtracking.cdc.gov/DataExplorer/ [last accessed October 25, 2022].

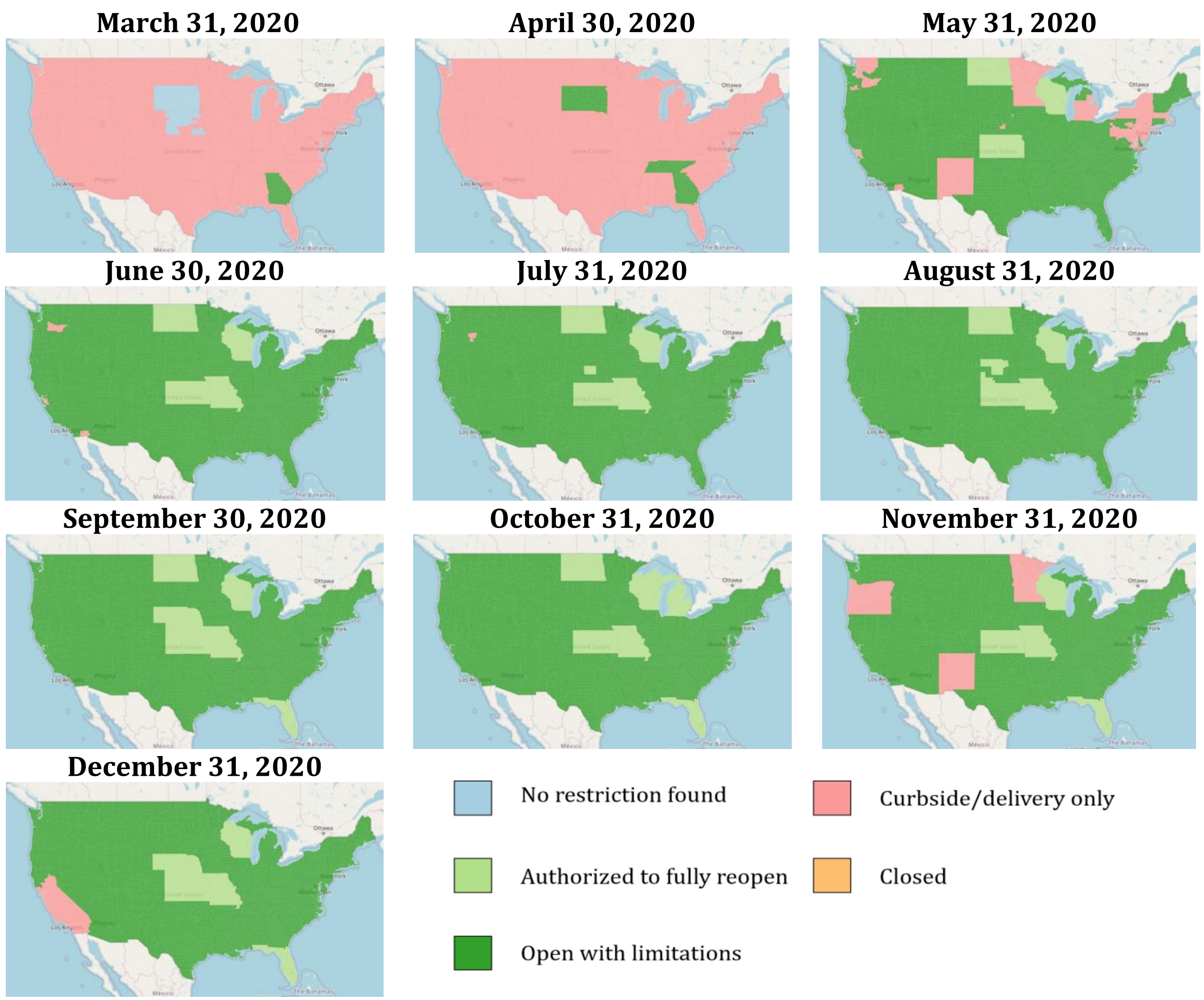


Figure 3.A2. County restaurant policy by month, Source: CDC Tracker (2022)

Table 3.A3. Restaurant policy restrictiveness over time, brewpubs v. placebo

	% observations w/ state policy				
Month	**No restriction found**	**Authorized to fully reopen**	**Open with limitations**	**Curbside/ delivery only**	**Closed**
Brewpub (n = 2,031)					
March	1.0	---	1.1	97.9	---
April	---	---	3.1	96.9	---
May	---	4.2	66.3	29.5	---
June	---	6.4	92.8	0.8	---
July	---	6.4	93.5	0.1	---
August	---	6.5	93.5	---	---
September	---	10.5	89.5	---	---
October	---	16.6	83.4	---	---
November	---	9.5	82.8	7.7	---
December	---	10.2	80.9	8.9	---
Non-brewpub (n =3,524)					
March	0.6	---	1.3	98.1	---
April	---	---	3.9	96.1	---
May	---	3.9	67.1	28.9	---
June	---	5.8	93.2	1.0	---
July	---	5.8	84.2	---	---
August	---	5.9	94.1	---	---
September	---	10.8	89.3	---	---
October	---	13.7	86.3	---	---
November	---	9.6	83.3	7.0	---
December	---	10.4	79.2	10.4	---

Source: CDC National Environmental Public Health Tracking Network (2022)

Table 3.5 reports the YoY change in performance as a function of PPP funding, where results demonstrate that brewpubs experienced the most substantial decline in YoY production. Tables 3.2 and 3.4 of the manuscript also suggest that brewpubs closed at the highest rates throughout the pandemic. Therefore, to analyze the relationship between local policy and small business performance, it is appropriate to conduct a subsample analysis on the industry segment most affected by the pandemic (i.e., brewpubs). This is particularly true given the access to local restaurant policy data, as brewpubs operate much like typical full-service restaurants (except they also brew their own beer).

Aan indicator variable for policy restrictiveness is then included in the subsample analysis across brewpubs. Table 3.A3 shows that in May 2020, 4% of brewpubs were located in counties authorized to fully reopen; 66% were located in counties authorized to open with limitations; and 30% were located in counties only authorized to have curbside/delivery. To measure policy restrictiveness, **an indicator variable is constructed, equaling one if the local policy only allows for curbside/delivery as of May 31, 2020; zero otherwise**. In other words, the indicator is equal to one if restrictive; zero otherwise.[56]

Table 3.A4 presents the results, where column (1) is the full specification from the main manuscript ran across brewpubs; column (2) is the same but with the indicator for restrictive policies. **The results provide little evidence to support the notion that local restaurant policies were behind the disproportionate decline in production for brewpubs relative to the other segments.** This generally aligns with some previous insights in the literature that have suggested that the shift in consumer purchasing patterns led to the decline in foot traffic to businesses. For example, Goolsbee and Syverson (2021) suggest that:

> "[F]rom March 1, 2020 to April 12, 2020, total foot traffic fell by 60 percentage points. Their methodology, which allows them to identify the causal effect of county-level governmental on foot traffic, suggests that **shelter-in-place policies explained just 7 percentage points of the decline.** Instead, much of the decline in consumer foot traffic was attributable to voluntary changes in behavior due to the perception about

[56] We also ran the analysis with the three levels, with fully authorized to reopen serving as the baseline. Results align with those presented in this report. But we feel the analysis described here is more appropriate given that only 4% of brewpubs were in the fully authorized to reopen category.

the risk of contracting COVID-19. In other words, businesses in counties with and without COVID-19 health policies both experienced, on average, substantial declines in consumer foot traffic during the early months of the pandemic. Those businesses operating in counties with shelter-in-place policies, on average, saw a decline in consumer foot traffic that was approximately only one-tenth larger than those in counties without the governmental mandates, holding all else constant" - Footnote 26 of this dissertation.

We also conduct a placebo test, replicating the analysis conducted over brewpubs with the non-brewpubs (i.e., microbreweries, regional breweries, and taprooms). Since these are not operating like restaurants, there should not be a significant effect of local restaurant policy on their YoY performance. Indeed, this intuitive result holds, as indicated by the noisy estimates presented in column (4) of Table 3.A4.

Table 3.A4. Change in annual production as a function of policy restrictiveness

	Brewpubs		**Placebo Test**	
Variable	**(1)**	**(2)**	**(3)**	**(4)**
FirstRoundPPP	0.022	0.022	0.043***	0.043***
	(0.018)	(0.018)	(0.012)	(0.012)
RestrictivePolicy (=1 if curbside or delivery only)	---	-0.122	---	0.067
		(0.254)		(0.105)
Constant	-0.175***	-0.297	-0.063	0.005
	(0.069)	(0.264)	(0.051)	(0.115)
N	**2,031**		**3,524**	
County-level fixed effects	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes
R^2	0.47	0.47	0.35	0.35

Note: Superscripts ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

An additional benefit of this subsample analysis is that it enables some degree of generalizability. Brewpubs operate like full-service restaurants, meaning that the limited relationship between policy and brewpub performance could serve as a proxy for full-service restaurants as well. Of course, the primary outcome variable is YoY beer production. Brewpubs are brewing their own beer while other full-service restaurants are not, which limits complete generalizability. Future research could consider identifying the causal effect of government restaurant policy on small business performance, devoting additional attention to potential confounders and endogeneity concerns.

Propensity score matching

Table 3.6 presents suggestive evidence that the timing of the Paycheck Protection Program (PPP) loan approval likely impacted year-over-year (YoY) performance. Specifically, using a quasi-experiment that exploits a natural break in the PPP funding, the results suggest that breweries that received first tranche funding between April 10 – April 16, 2020, on average, experienced a decline in YoY production that was two to three percentage points smaller than breweries that received funding two weeks later (April 27 – May 3, 2020).

One limitation to this analysis—and a fundamental flaw in evaluating the effectiveness of the PPP more generally—is that there are inherent differences between the treatment and control groups. The literature has shown that the first-come, first-served style of the loan program sacrificed targeting for timeliness (Autor et al., 2022), which benefitted larger businesses and businesses that had a pre-existing relationship with a bank (Bartik et al., 2020; Granja et al., 2020; Humphries et al., 2020). Indeed, Figure 3.4 demonstrates that firms that received the earliest funding were, on average, larger and growing faster than breweries that received funding later in the loan program. In the context of the quasi-experiment, the treatment group consists of breweries that received first-tranche funding the week of April 10- April 16, 2020, whereas the control group consists of breweries that received second-tranche funding the week of April 27 – May 3, 2020.

The differences in pre-trends limit the ability to make causal claims about the point estimates presented in Table 6. One way to overcome these limitations is to use propensity score matching (Rosenbaum and Rubin, 1983). In short, the technique predicts the probability of treatment as a function of a set of covariates, yielding a *propensity score*. Then, the outcomes of treatment observations are compared to control group observations with similar propensity scores (i.e., a similar probability of being placed in the treatment). These comparisons determine the average treatment effect on the treated (ATT). Empirically, this is estimated as:

$$ATT = \frac{1}{n_1} \sum\nolimits_{i \in \{D=1\}} \left(Y_{1,i} - \sum\nolimits_{j} w(i,j) * Y_{0,j} \right),$$

where n_1 is the number of treated observations; $Y_{1,i}$ is the observed treated outcome of observation i; $Y_{0,j}$ is the observed control outcome of observation j; and $w(i,j)$ is a weighting function (Katchova, 2013). By summing the weighted differences between the i treated observations and *j* control observations, and then dividing by the total number of treated observations, we compute the ATT.

The quasi-experiment assesses the change in YoY production as a function of loan timing. It compares breweries that received funding within the last seven days of first tranche funding (treatment) to breweries that received funding in the first seven days of second tranche funding (control). The sample comprises 1,346 breweries: 720 treated and 626 control breweries. To initiate matching, a probit model first predicts the probability of treatment (=1 if late first tranche funding; 0 otherwise) as a function of:

- The logarithm of the total number of COVID-19 cases in the brewery's county as of April 3, 2020
- The logarithm of the brewery's 2019 production volume
- The proportional change in YoY production from 2018 to 2019 (i.e., growth rate from 2018 to 2019)
- The logarithm of the PPP loan amount approved
- The number of jobs reported in the PPP loan application

We expect these variables to predict the probability of treatment. Specifically, county-level COVID-19 cases are included as a proxy for decreased foot traffic and sales, which may have prompted the brewery to apply for PPP funding sooner. Note, however, that in Section 3.3.4, breweries that received first-round PPP funding (i.e., first- or second-tranche funding) were more likely to be located in counties with below-average COVID-19 cases as of April 3, 2020. The other four variables are included as proxies for brewery size and performance. The literature suggests the loan distribution mechanism benefitted larger businesses, motivating the inclusion of production size, loan amount approved, and number of jobs supported by the loan. Also included is the YoY change in production from 2018 – 2019 as a way to factor in relative performance, which could be a proxy for the brewery's financial health. Table 3.A5 presents the probit model output.[57]

---

[57] Matching procedures are initiated using the *pscore* command in Stata. Analysis is also constrained to include a common support across groups.

Table 3.A5. Probit output predicting the probability of treatment

Variable	**Coef. (std. error)**
Log of total COVID-19 cases in county, April 3, 2020	-0.032***
	(0.011)
Log of 2019 brewery production	0.113***
	(0.039)
YoY production change, 2018-2019	0.142
	(0.137)
Log of first-round approval funds	0.167***
	(0.044)
Number of jobs reported in PPP loan application	-0.004**
	(0.001)
Constant	-2.282***
	(0.000)
N	**1,346**
Log-likelihood	-903.1

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

Interestingly, county-level COVID-19 cases as of April 3, 2020, are negatively associated with the probability of being placed in the treatment group, further highlighting concerns that the breweries that may have needed the support the most did not receive it first (Autor et al., 2022; Hubbard and Strain, 2020). Larger breweries, as expected, were more likely to be placed in the treatment. The change in YoY production, however, was insignificant in predicting treatment, meaning that growth rates did not sufficiently predict treatment. This finding lends credibility to the validity of the quasi-experiment results regarding pre-trends. Lastly, the total loan amount (in dollars) increases the probability of being placed in the treatment. In contrast, the total number of jobs reported on the PPP loan application is marginally negative.

These predicted values are the propensity scores for each treatment observation i and control observation j. Observations are then stratified into blocks based on their propensity score, where the statistical package determines the ideal number of blocks. The data were stratified into nine blocks over a common support of [.207, .810] to allow for the removal of outliers. Table 3.A6 presents the inferior bound for each block and the number of control and treatment observations placed in each.

Table 3.A6. Inferior bound and number of observations per quasi-experimental block

Propensity score bounds	Control	Treatment	Total
(0.00, 0.20]	4	0	4
(0.20, 0.40]	72	44	116
(0.40, 0.45]	93	50	143
(0.45, 0.50]	108	99	207
(0.50, 0.60]	219	306	525
(0.60, 0.65]	86	110	196
(0.65, 0.70]	36	86	122
(0.70, 0.80]	8	23	31
(0.80, 1.00]	0	2	2
Total	**626**	**720**	**1,342**

Note: Common support of [.207, .810].

Propensity score matching requires that the distribution of covariates across the treatment and matched controlled observations be balanced (i.e., the balancing property). Notably, the stratification here achieves the balancing property, and this is used to calculate the ATT.

There are various matching methods, including (i) kernel matching; (ii) nearest neighbor matching; (iii) radius matching; and (iv) stratification matching. The reader is directed to Caliendo and Kopeinig (2008) for an overview of the various matching methods and to Huntington-Klein (2022) for a discussion on the benefits and drawbacks of different propensity score matching procedures. Table 3.A7 presents the ATT for each of the four matching procedures.[58]

Table 3.A7. Average treatment effect on the treated (ATT) by matching procedure

	# of observations used				
Method	**Treatment**	**Control**	**ATT**	**Std. error**	**t-statistic [a]**
Kernel matching	720	622	0.038	0.012	3.084***
Nearest neighbor matching [b]	720	351	0.030	0.017	1.800*
Radius matching	720	622	0.040	0.013	3.197***
Stratification matching	718	624	0.030	0.013	2.385**

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.
[b] Results presented use one-nearest neighbor matching procedures. When using k-nearest neighbor with $k = \{2, 3, 4, 5\}$, results suggest an ATT of similar magnitude with statistical significance that varies at the one, five, and ten percent level.

The results suggest an ATT ranging from three to four percentage points. In other words, compared to their matched controlled observations, breweries that received the first-

[58] The ATT are calculated using the following commands: *attk* for the kernel matching; *attnd* for the nearest neighbor matching; *attr* for the radius matching; and *atts* for the stratification matching.

tranche PPP funding saw a smaller decline in YoY production by three to four percentage points. The treatment effect is significant across the kernel, radius, and stratification matching methods while insignificant at the five percent level for the one-nearest neighbor matching. Notice, however, that the point estimate and standard errors for the nearest neighbor matching are similar to the stratification method. The loss in statistical significance comes from the nearest neighbor method only uses 351 (56%) of the 624 control group observations.[59]

With these results, there is further evidence that the timing of the PPP loan mattered. Though we recognize the limitations of the analysis, this finding is notable given the concerns first-come, first-serve style of the loan distribution mechanism.

Quasi-experimental supplemental analysis: Tighter loan timing window

We provide additional supplemental analysis on the role of loan timing on small business performance and discuss the implications these could have on related industries. The reason behind this supplemental analysis is that the two identifying assumptions to identify the causal effect of loan timing on performance in the quasi-experimental setting are that (i) loan timing did not affect loan demand and (ii) the firms before and after the gap in tranches are similar to one another. While assumption (i) should be viewed as a trivial assumption (i.e., the business will still want the loan, even if they have to wait a few weeks), it is important to further assert the validity of the second assumption by constraining the window of analysis. In what follows, the window of analysis around the quasi-experiment is tightened to three days on each side of the gap in funding instead of seven. That is, observations are constrained to the breweries to the last three days of first-tranche funding (April 14 – 16, 2020) and the first three days of second-tranche funding (April 27 – 29, 2020).

Pretrends are first compared for the treatment (April 14 – 16, 2020) and control (April 27 – 29, 2020) groups. The average production from 2018 – 2020 for each group is presented in Figure 3.A3 below. As consistent throughout the analysis, the chart suggests that the average treatment brewery is larger than the average control brewery (matching Figure 3.5). From 2018 to 2019, the average treatment brewery grew by 8.0%, and the

---

[59] Using k-nearest neighbor matching procedures where $k = \{2, 3, 4, 5\}$ produces an ATT with a similar magnitude with statistical significance varying at the one, five, and ten percent levels.

average control brewery grew by 6.7%. Compared to the primary quasi-experimental analysis with the seven-day window, the tighter sample window demonstrates better parallel trends. (The average treatment observation in the seven-day window grew 8.2% from 2018 to 2019 versus 6.0% for the control group.)

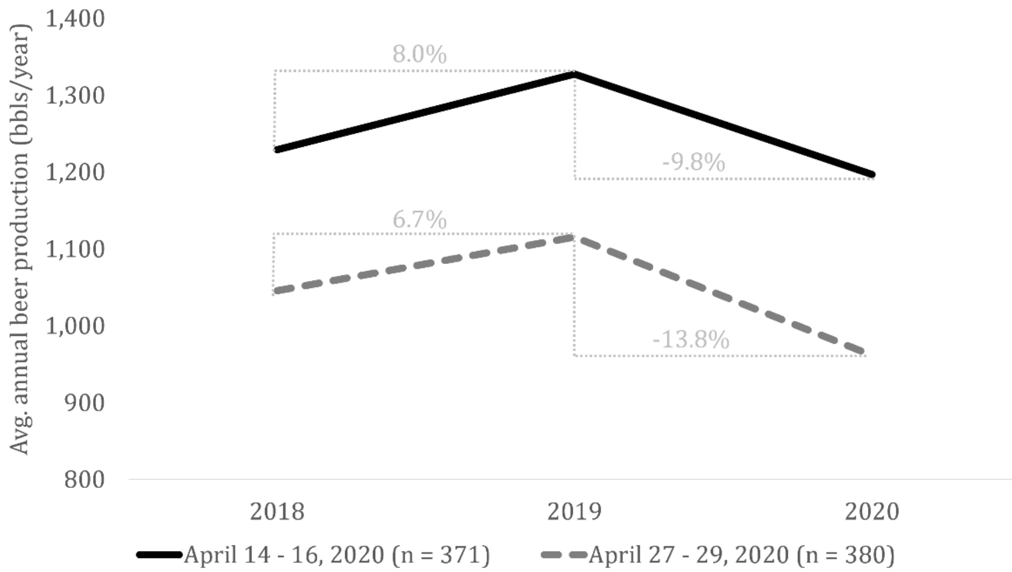


Figure 3.A3. Average annual production in tightened quasi-experiment (n = 751)

We then perform regression analysis (Table 3.A8) and propensity score matching procedures (Table 3.A9) to examine the effect of loan timing on YoY performance with the constrained sample. The analysis is identical to those described in the manuscript.

Table 3.A8. Constrained quasi-experimental results

	Coef. (rbst. std. error) [a]			
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Early (April 14 – 16, 2020)	0.038**	0.043***	0.043***	0.036**
	(0.016)	(0.016)	(0.016)	(0.015)
log(PPPFunds)	---	-0.031***	-0.030***	-0.022***
		(0.008)	(0.008)	(0.009)
Constant	-0.151***	0.189**	0.183**	0.023
	(0.011)	(0.083)	(0.083)	(0.098)
N	**751**			
County-level controls	No	No	Yes	Yes
Firm-level controls	No	No	No	Yes
R^2	0.00	0.03	0.04	0.09

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

The results of the regression analysis suggest a positive and statistically significant point estimate for the effect of loan timing on YoY performance. The estimate is similar to those described in the main text (Table 3.6).

Table 3.A9 reports the average treatment effect on the treated (ATT) across propensity score matching procedures. Results to the propensity score matching are also similar, where results are positive and statistically significant at the one percent level for kernel, radius, and stratification matching. The ATT using the nearest neighbor matching method (with replacement) is insignificant, even at the ten percent level. This result is unsurprising given that the technique only utilizes 58% of the observations.

Table 3.A9. Constrained quasi-experiment propensity score matching results

	# of observations used				
Matching method	**Treatment**	**Control**	**ATT**	**Std. error**	**t-statistic [a]**
Kernel	371	377	0.045	0.016	2.91***
Nearest neighbor	371	217	0.032	0.021	1.48
Radius	371	377	0.045	0.015	2.33***
Stratification	371	377	0.041	0.018	2.29***

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

We elect to keep the seven-day window as the primary analysis for several reasons. First is the sample size, where the quasi-experimental group is cut from 1,349 to 748 (55%). Additionally, in the propensity score matching, several of the explanatory variables used to predict treatment lose statistical significance. Thus, while the grouping meets all propensity score matching criteria (e.g., balance property), there is less variation in propensity scores across observations.

CHAPTER 4. HOPPING ON THE LOCALNESS CRAZE: LOCAL VALUE CHAIN CONSTRAINTS AND OPPORTUNITIES

A version of this chapter was previously published in Managerial and Decision Economics and is reproduced with the permission of the co-authors. DOI: 10.1002/mde.3246

Staples, A. J., Malone, T., & Sirrine, J. R. (2021). Hopping on the localness craze: What brewers want from state-grown hops. *Managerial and Decision Economics*, 42(2), 463-473.

4.1. Introduction

Buy local. Eat local. Drink local. While many consumers habitually support local food and drink, few local agricultural product sales occur between the grower and the consumer (Printezis, Grebitus, & Hirsch, 2019). Indeed, as of 2017, only 6.4% of United States (US) farms directly marketed their crops for human consumption (USDA NASS, 2017a). Even when consumers see that the final stage of a product's supply chain occurs locally, they often forget, or even neglect, where these inputs originated. Even when consumers desire local inputs, suppliers must consider that local input production generally comes from less-established supply chains with potentially ambiguous quality controls. As such, there is merit in understanding how food and beverage producer-processors value an agricultural commodity's "localness."

This study fills this gap in the agricultural product demand literature via data from Michigan (MI) craft breweries. The craft beer revolution is partially attributed to the local food movement, as 80% of adults now live within a 10-mile radius of a brewery (Herz, 2018). The study focuses on MI brewer preferences for locally produced hops, as the state ranks high in total breweries (6th in the country), breweries per capita (12th), and total hop production (4th) (Allen, 2018; Brewers Association, 2020b). Michigan is still a net importer of hops but is the largest hop producer outside of the Pacific Northwest (PNW), with 810 acres strung for harvest in 2017 (Allen, 2018). For comparison purposes, the third largest producer in 2017, Idaho, harvested 4,863 acres (USDA NASS, 2017b).

While many studies have evaluated consumer preferences for localness, the literature on *value chain* preferences for localness is thin. This gap is especially important as localized value chains have the potential to increase consumer satisfaction (Van Loo et al., 2014), improve environmental awareness (Hasselbach & Roosen, 2015), and, perhaps most importantly, boost local economies (Miller et al., 2019). Seeing the potential for economic growth, state and local governments are increasingly considering legislation to promote investment in local food systems (Brown et al., 2014), creating jobs, supporting agriculture, and attracting tourists. Indeed, craft beer value chains have been linked to considerable economic development, generating substantial annual gains for a state's economy (Malone & Stack, 2017; Miller et al., 2019). To tap into these potential economic gains, policymakers have considered farm brewery initiatives (New York Senate, 2012), changes in self-distribution laws (Malone & Lusk, 2016), and reforms to federal policy, such as the Craft Beverage Modernization and Tax Reform Act of 2019.

This article contributes to the literature in several ways. First, the study explores the value of localness throughout the beer value chain, as craft beer is an industry driven by the hyper-local movement. The results indicate that the perceived consistency of locally-grown hops is a leading indicator of purchasing decisions, while beliefs regarding the economic development and potential environmental benefits of localized value chains are not enough to drive local purchasing on their own. That is, although brewers generally support localness—and are indeed the beneficiaries of localness—they are reluctant to sacrifice the integrity of their beer simply because the inputs are grown locally. This article also seeks to spark discussion surrounding how economies of scale, transaction costs, market power, and other factors in the current hop landscape may hinder the growth of localized value chains. Finally, the article explore potential solutions to these challenges, asking brewers whether initiatives to incentivize localness would increase their use of state-grown hops.

4.2. Background

Agricultural commodities are rarely consumed directly but are mainly inputs that contribute to the flavor and aroma of food and drink products (e.g., hops as an input for beer). In many respects, the craft beer movement has been built on the localness movement, meaning craft breweries are the beneficiaries of consumer preference for "local" beer. However, most "local" breweries do not use local ingredients, which creates ambiguity when attempting to define or classify localness. While more than one hundred studies have been published estimating consumer willingness to pay for local food attributes,[60] few studies have explored the role of local demand in a multi-stage value chain. With a growing demand for locally

[60] For a thorough review of the literature, see Printezis et al. (2019).

cultivated ingredients, the more relevant literature for this article might be the "home bias" of agricultural supply chains (Wolf, 2000; Hillberry & Hummels, 2003), where buyers prefer products created closer to home.

The home bias literature creates some important lessons for studies on local foods. First, local input production generally arises from less-developed supply chains that cannot take advantage of economies of scale (Lusk & Norwood, 2011). Comparative advantage asserts that these local, less-established producers will have a higher opportunity cost of production; thus, specialization and industry consolidation should occur in regions capable of taking advantage of economies of scale. This aligns with the US hop landscape.

Currently, 96% of US hops are grown in the PNW, and until recently, all domestic, commercial hop production was isolated to the PNW. However, increased demand from U.S. craft brewers led to hop price increases, which induced growers from across the country to cultivate hops and target smaller breweries (Dobis et al., 2019). In fact, 29 states now report commercial hop production (Hop Growers of America, 2020). Increased demand for locally sourced craft beer ingredients allowed some agricultural producers to profit, though most were immediately confronted by problems associated with economies of scale. That is, producers with greater acreage can harvest at lower marginal costs, allowing them to sell at a lower price (Alston & Pardey, 2014). Because smaller agricultural producers within a localized supply chain cannot take advantage of economies of scale, their cost of production is likely higher (Sirrine et al., 2010). The value of scale is extremely relevant in commercial hop production, as the PNW has an established industry with larger operations and more efficient growing processes. PNW acreage dwarfs acreage in emerging production regions, which allows PNW growers to spread fixed costs across larger land plots and sell public hop cultivars at lower prices than smaller acreage competitors.

Lower marginal production costs are just one issue confronted by upstart hop growers. Existing relationships, greater reliability, convenience, and the ability to purchase in bulk have also led many buyers to continue purchasing most of their hops from larger producers.[61] Furthermore, larger PNW growers have access to proprietary cultivars, or hops

[61] One exception to the convenience factor, as discussed in detail later, is purchasing local hops for harvest ales. These beers utilize wet hops, which must be in the brew kettle within 24 hours of harvest. Thus, purchasing local hops for these beers lowers transportation costs and reduces the risk of quality degradation.

whose rights are owned by the creator, which increases the potential for profitability in these operations. Proprietary hops accounted for five of the top ten planted hop cultivars in the US in 2019 (Hop Growers of America, 2020). The contracts to grow these hops are almost exclusively awarded to PNW growers, allowing developers to closely monitor the production of these hops to ensure high quality. Thus, if a brewer outside the PNW intends to brew with proprietary hops, they are obligated to purchase non-local hops. If the same brewer seeks both locally-grown public varieties and proprietary hops, they likely must buy from multiple sellers.[62] This additional transaction cost—including time, money, and professional relationships—conflicts with the desire to purchase locally, irrespective of perceived quality and consistency. Likewise, there is concern that a concentrated hop market will provide great market power to the sellers of proprietary hops. That is, brewers might only receive proprietary hops if they agree to buy the public varieties from the same seller, a potential practice that could be exercised through forward contracts. Finding a buyer can be challenging even when local hop growers can produce high-quality hops, as many breweries sign hop purchasing contracts in advance. With over 170 different beer styles (Price, 2019), it is common for breweries to have sixteen beers on tap, all of which may incorporate different hop cultivars. Forward contracts can be difficult, as brewers often purchase a wide range of cultivars as they adapt to the adventurous consumer palate (Malone & Lusk, 2018; Staples et al., 2020).

Local or not, a consumer's decision to purchase a beer involves both the intrinsic (taste, aroma, etc.) and extrinsic (localness, environmental impact, etc.) attributes of the product. That is, drinkers may value a beer's localness (Ha et al., 2017; Hart, 2018) but might still be unlikely to purchase the beer if the drinker does not enjoy the beer's sensory attributes (Schmit, Rickard, & Taber, 2013). A brewery may value localness—indeed, most depend on localness themselves—but if the quality of the inputs does not meet quality standards, is priced too high, or the transaction costs of buying from multiple outlets outweighs the brewery's preference for local hops, the brewer will continue to purchase

[62] As MI hop production has grown and developed, pockets of proprietary hops have become available in the state. However, it is nowhere near enough to supply all MI brewers, and the majority are still forced to seek PNW grown proprietary hops.

nonlocal hops.[63]

Larger brewers require larger quantities of recipe-specific hops. We hypothesize that if a local grower cannot provide (i) the desired varieties and/or (ii) the desired quantities, then purchasing locally-grown hops becomes unattractive, driven by the necessity to partner with multiple sellers. Additionally, all brewers are expected to have a positive outlook on "buy local," as they themselves profit from this shift in consumer demand. Yet, their perceptions of local hop consistency may prevent them from purchasing local inputs. In other words, craft brewers are likely to prefer locally-grown inputs, but attitudes and beliefs about localness may not be enough to shift purchasing decisions. Specifically, if a local supplier cannot deliver hops at a competitive price, does not have every cultivar the brewery wants, or if the brewer perceives the hops as less consistent than their competition, the brewer will seek nonlocal hops.

4.3. Methodology

Survey data were collected in partnership with Michigan State University Extension, the Michigan Brewers Guild, and the Hop Growers of Michigan. The dependent variable in this study is the proportion of hops purchased by a MI brewery that are MI-grown. The data is analyzed using a generalized linear model (GLM) with a quasi-maximum likelihood estimator (QMLE) following Papke & Wooldridge (1996), observing the factors that drive the decision to purchase state-grown hops. While ordinary least squares (OLS) is a valid estimation method for continuous dependent variables, and may even be legitimate for limited dependent variables (Angrist & Pischke, 2009, pg. 94), OLS estimation may lead to predicted values outside the built-in bounded support of the variable of interest (Baum, 2008), and the limiting distribution of fractional distributions are generally non-normal (Opsina & Ferrari, 2012). The GLM approach takes the traditional OLS conditional mean specification and imposes a logistic transformation and a Bernoulli or binomial distribution on the response variable (Baum, 2008). Papke & Wooldridge (1996) suggest employing a Bernoulli distribution for its straightforward log-likelihood maximization procedures and its

[63] Hops are grown across the world, and brewers are actively seeking hops grown in countries such as Germany, Australia, and New Zealand. For simplicity, we will simply refer to local and non-local hops for this article.

consistent and $\sqrt{N}$-asymptotically normal estimates for $\hat{\beta}$. Thus, the model (4.1) is specified as:

$$(4.1) \qquad E(StateHops_i|x) = G(\alpha + \beta_1 LogBrewSize_i + \beta_2 MIConsistency_i + \beta_3 StateVarieties_i + \beta_4 BrewerRecommend_i + \beta_5 PropensityBuyLocal_i + \beta_6 BeliefsAboutLocal_i),$$

where $StateHops_i$ is the brewery's reported annual proportion of MI-grown hops to total hops purchased, ranging from 0 to 1; $G(\cdot)$ is the generic logistic function; α is a constant; and β_j, j = {1,2,…,6} are parameter estimates of the explanatory variables. Explanatory variable $LogBrewSize_i$ is a continuous variable measuring the logarithm of brewery *i*'s annual production, measured in barrels (bbls) per year. Variable $MIConsistency_i$ represents brewer *i*'s perceived consistency of MI-grown hops, where the response is based on a four-point Likert scale in which a value of 1 indicates *very inconsistent* hops and 4 corresponds to *very consistent* hops.[64] Perceived consistency is likely to depend on underlying, unobservable factors such as past purchasing behaviors and marketing, which could indicate a form of endogeneity in the model specification. We tested for endogeneity using two-stage least squares and generalized method of moments estimation with an instrumental variable based on various initiatives to incentivize localness (described in detail later). The procedures indicate the use of a weak instrument, failing to reject the null hypothesis that perceived consistency is exogenous. This result suggests that perceived consistency is better left treated as exogenous.[65] The variable $StateVarieties_i$ represents the total number of cultivars brewer *i* acknowledges are grown in MI, and brewer *i* has purchased this cultivar in the past year. For example, brewer *i* states they know the Chinook hop is grown in MI, and they also purchased Chinook hops. Note, this does not imply that the brewer purchased the MI-grown hop but that there is the *potential* for them to buy the MI-grown hop.

[64] Much like MI perceived consistency, we also collected data on perceived consistency of PNW hops, which could be thought of as a substitute for MI hops. These statistics are presented in the following section but are excluded from equation (1) because of: (i) limited variation in PNW perceived consistency, where 96% of breweries stated PNW hops were either *somewhat consistent* or *very consistent*; and (ii) the extreme statistical insignificance when included (p-value = 0.984) leading to a worse statistical fit.

[65] When testing for endogeneity using two stage least squares or generalized method of moments estimation, the null hypothesis is H_0: *x* is exogenous; the alternative hypothesis is H_A: *x* is endogenous. A failure to reject the null suggests that *x* is better left treated as an exogenous. The procedures testing for endogeneity are described in the supplemental file accompanying this manuscript.

The categorical variable for brewer recommendations (*BrewerRecommend*$_i$) is generated from a seven-point Likert scale response to the statement: I have had local hops recommended to me by other brewers. The seven-point scale brings a coding scheme of 1 for *strongly disagree* to 7 for *strongly agree*. Two additional Likert scale responses are included based on the propensity to buy local scale suggested in Dukeshire et al. (2011).

Two aggregated variables are generated from a collection of seven-point Likert scale responses (max of 21). The first, *PropensityBuyLocal*$_i$, is the cumulative score of responses to the three statements: (i) I like to buy inputs that are locally produced; (ii) Whenever possible, I intentionally buy locally-produced inputs; and (iii) I make it a priority to buy locally-produced inputs. The variable $BeliefsAboutLocal_i$ is created through the cumulative score of the three statements: (i) Buying locally produced inputs is good for the local economy; (ii) Buying local inputs helps the environment; and (iii) Buying local inputs means more money goes to the farmer. Table 4.1 summarizes the variables employed in equation (4.1).

We expect that breweries producing more bbls/year will, on average, utilize a lower proportion of MI-grown hops. Greater annual production requires larger quantities of hops, and likely more varieties, rendering additional transaction costs onto the brewer if the local producer cannot fulfill these requests. In addition, we expect that greater perceived consistency in MI-grown hops will increase the likelihood that a brewery decides to purchase MI-grown hops. The variables *StateVarieties*$_i$ and *BrewerRecommend*$_i$, are likely to increase the purchase of local hops. As the number of MI-grown cultivars increases, so will the likelihood that brewers will purchase MI-grown hops. Brewers interact with one another significantly (McGunnigle, 2018; Sierra Nevada Brewing Company, 2019), which suggests that recommendations from peers should increase purchasing rates of MI-grown hops. There is likely a positive correlation between the buy-local scale (*PropensityBuyLocal*$_i$) and local hop purchases. Finally, beliefs about localness stimulating the economy or helping the environment are expected to increase the share of state-grown hops used by brewers.

Table 4.1. Variables used in model estimation and their description

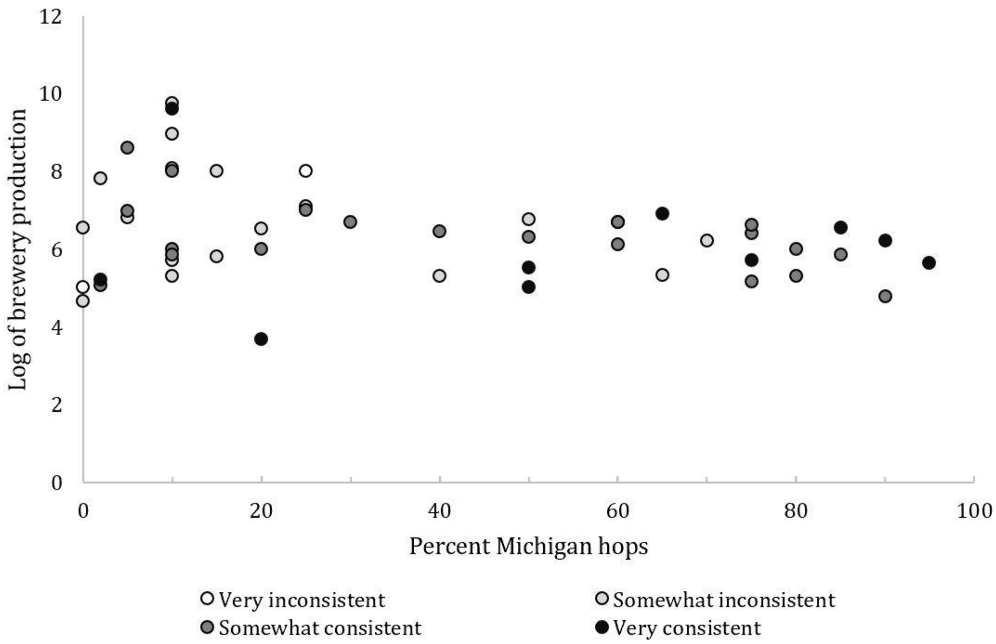
Variable	Description
LogBrewSize	The log of the reported annual production of a brewery, measured in barrels
MIConsistency	Perceived consistency of MI grown hops. (1= very inconsistent; 4 = very consistent)
StateVarieties	The total number of cultivars that brewer *i* states they both use and know are grown in MI, independent of one another.
BrewerRecommend	Likert response to the statement: I have had local hops recommended to me by other brewers. (1=strongly disagree; 7=strongly agree)
PropensityBuyLocal	Aggregate score to three seven-point Likert statements on likelihood to buy local (minimum: 3; maximum: 21): 1. I like to buy inputs that are locally produced. 2. Whenever possible, I intentionally buy locally produced inputs. 3. I make it a priority to buy locally produced inputs.
BeliefsAboutLocal	Aggregate score to three seven-point Likert statements on beliefs about local (minimum: 3; maximum: 21): 1. Buying locally produced is good for the local economy. 2. Buying locally produced inputs helps the environment. 3. Buying local inputs means more money goes to the farmer.

4.4. Data

A survey of MI brewers was conducted from February to March 2019. In total, 70 of 351 (20%) MI craft breweries in operation at the time partially completed the survey (Brewers Association, 2020b). Fifty breweries reported the necessary information to estimate equation (4.1). Figure 4.1 presents the relationship between the reported percentage of MI-grown hops and the logarithm of brewery size.

There was a wide range of reported proportions of MI-grown hop values. Three breweries, or 6% of the sample, purchased no MI-grown hops, and one brewer stated that 95% of their hops were MI-grown. The mean percentage of state-grown hop purchases is 37%, with a median of 25% and a mode of 10%. Most breweries produced under 1,000 bbls (approximately 80%), and only one brewery produced greater than 15,000 bbls, the maximum production threshold to classify as a microbrewery.[66] This is consistent with MI's brewery breakdown, as only six of the 351 craft breweries operating in 2019 exceeded 15,000 bbls (Brewers Association, 2020a).

[66] According to the Brewers Association, a brewery qualifies as a microbrewery if it does not exceed 15,000 bbls annually and 75% or more of its sales come from off-premise sales.



Footnote: The legend values correspond to brewer response to the question: "How consistent do you think MI grown hops are?"

Figure 4.1. Hop purchasing decisions, local input perceptions, and annual production

Perceived consistency is based on a four-point Likert scale ranging from 1 (*very inconsistent*) to 4 (*very consistent*). Brewers were first asked to indicate their perceived consistency of MI-grown hops, followed by PNW hops. Figure 4.2 breaks down these response frequencies. Nearly two-thirds of breweries rated PNW hops as *very consistent*, while the most common response for MI-grown hops was *somewhat consistent*. However, 40% of the respondents rated MI-grown hops as less than consistent (i.e., either *somewhat inconsistent* or *very inconsistent*). To more clearly distinguish how brewers describe consistency and quality, consider the perspective of the Director of Brewing Operations at Founders Brewing Company (Mull, 2020):

> "To a brewer, a quality hop will be true to type, free from defects, disease or pest pressure, and be processed from bine to bag with utmost care and focus on process and food safety. Year to year, yard to yard, we expect each cultivar to exhibit those same traits we fell in love with the first time we experienced it. Quality in the field is a healthy, vigorous, lush plant with minimal sprays and just the right amount of food and water. Quality hops are more than that cone you pluck off at peak ripeness. It takes a long journey from the bine to make a quality beer. It has been gently

harvested, dried to perfection at 10% moisture, processed at the earliest possible moment, and stored as cold as a Michigan winter. Then, it can finally fulfill its destiny in that glorious glass of beer."

While a brewer's definition of quality can vary depending on the cultivar and its intended use throughout the brewing process, craft brewers generally associate quality with aroma, appearance, and chemical analytics (Lafontaine and Shellhammer, 2019). Perceived consistency, while correlated with quality, is more about achieving similar aroma, appearance, and other quality metrics each year. This requires proper growing and scouting (insect- and disease-free), suitable weather conditions, efficient harvesting (lack of stems and seeds, free from foreign material/debris), and ideal drying, processing, and packaging along the value chain.

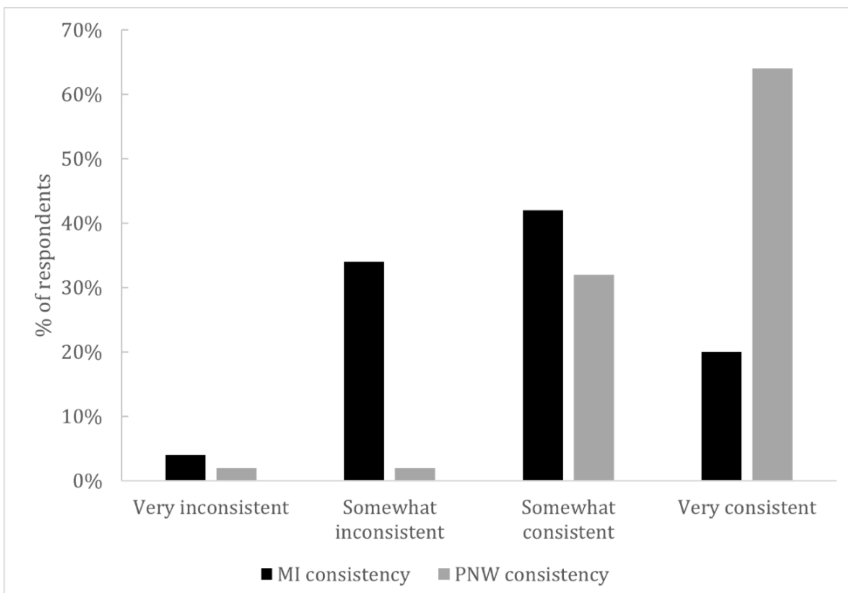


Figure 4.2. Responses to perceived hop consistency, by region

Only one brewery stated that MI hops are more consistent than PNW hops, while 17 (34%) stated they are of equal consistency. Ten of the 18 respondents who stated that MI hops are as consistent as (or more consistent than) PNW hops reported that half or more of their annual hop usage is from MI-grown hops. While 18 brewers (36%) perceived the consistency of MI hops to be better than or equal to PNW hops, 32 brewers (64%) rated PNW hops as more consistent. As expected, the majority of breweries rating PNW as more consistent than MI hops report less than 50% MI-grown hop usage. However, eight respondents stated that 50% or more of their hops are MI-grown despite ranking PNW hops above MI hops, four of which report an MI-grown hop usage of 75-85%. This is likely because these brewers have limited access to PNW hop contracts due to their relative size in a competitive market. Indeed, none of these eight brewers produced more than 1,000 bbls/year; three of the four breweries using 75-85% MI hops produced no more than 400 bbls/year. Another potential explanation could be that the brewery receives positive utility from buying local or supporting local agriculture.

Table 2 breaks down the categorical responses to the variables that comprise the propensity to buy local (*PropensityBuyLocal)* and beliefs about local (*BeliefsAboutLocal)* scales*.* The average response to each scale was 17 of 21, suggesting a generally positive view of localness. The propensity to buy local scale is the cumulative score of levels of agreement or disagreement (1 = *strongly disagree* to 7 = *strongly agree*) with statements about enjoying buying local, intentionally buying locally-grown inputs, and making it a priority to buy local, following Dukeshire et al. (2011). Similarly, the beliefs about localness scale is comprised of the responses to localness being good for the local economy, helping the environment, and providing more money to farmers. Half of the sample *strongly agree* with localness being good for the local economy, whereas the average response for the other two questions was *somewhat agree*. No respondents *strongly disagree* with any of the provided statements. Only two brewers (4%) *disagree* with the statements regarding localness being good for the environment and providing more money to farmers.

Table 4.3 presents responses regarding potential initiatives that might incentivize the use of local hops. These variables are not included in the model but are instead used *ex-post* to determine how brewers, growers, and policymakers might expand local hop production. A response of 1 indicates the initiative would *definitely not* incentivize the utilization of more local hops, while 5 indicates *definitely yes*. The most favorable initiatives include locally unique cultivars, with a mean score of 4.36, followed by improved cultivar selection (4.06), and farm brewery legislation (3.84). The least favorable initiatives were a food safety verification program emphasizing best practices (3.02) and improved marketing by growers (3.18), suggesting their implementation *might or might not* influence them to purchase more locally-grown hops.

Table 4.2. Likert scale responses to attitudes and beliefs towards purchasing local

Statement	Mean Score (1-7)	Percentage of responses: Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Neutral (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
Propensity to buy locally produced inputs								
I like to buy inputs that are locally produced.	5.78	0%	2%	0%	12%	16%	44%	26%
Whenever possible, I intentionally buy locally produced inputs.	5.46	0%	4%	0%	14%	30%	32%	20%
I make it a priority to buy locally produced inputs.	5.20	0%	6%	4%	18%	26%	28%	18%
Beliefs about locally produced inputs								
Buying locally produced inputs is good for the local economy.	6.38	0%	0%	0%	4%	4%	42%	50%
Buying locally produced inputs helps the environment.	5.30	0%	4%	4%	28%	12%	26%	26%
Buying local inputs means more money goes to the farmer.	5.22	0%	4%	4%	26%	16%	32%	18%

Note: Statements were introduced by asking each of the 50 respondents, "To what extent do you agree or disagree with the following statements?"

Table 4.3. Attitudes toward possible success of initiatives incentivizing local purchases

Attitudes towards incentivizing localness	**Mean Score (1-5)**	**Percentage of respondents** **Definitely Not (1)**	**Probably Not (2)**	**Neutral (3)**	**Probably Yes (4)**	**Definitely Yes (5)**
A local hop showcase at a major brewer event	3.44	2%	18%	30%	34%	16%
Farm brewery legislation	3.84	8%	8%	16%	28%	40%
Improved cultivar selection	4.06	0%	4%	22%	38%	36%
Locally unique cultivars	4.36	0%	2%	14%	30%	54%
Improved marketing by growers	3.18	4%	22%	36%	28%	10%
Local grower cooperative functioning as a broker	3.68	4%	6%	30%	38%	22%
A quality and food safety verification program	3.02	8%	20%	40%	26%	6%

Note: The initiatives were introduced by asking each of the 50 respondents, "Would any of the following help you decide to utilize or increase your use of local hops?"

4.5. Results

Table 4.4 presents QMLE regression results. Four of the six explanatory variables included in equation (1) are statistically significant in predicting brewery purchasing behavior with expected signs. First, larger breweries purchase a lower proportion of state-grown hops, depicted through the negative coefficient on the variable $LogBrewSize_i$ in Table 4. It is critical to note two pieces of information. First, as mentioned previously, the variance in brewery production is large, where one brewery produced 40 bbls/year (the minimum annual production reported in the sample), and a nearby brewer produced 17,000 (the maximum in the sample). Additionally, although a large, regional brewery with high annual production may utilize a lower proportion of state hops, they could use more total pounds of state-grown hops.

Table 4.4. Model estimates predicting the proportion of state-grown hops

Variable	QMLE coef. estimate[a] (rbst. std. error)
LogBrewSize	-0.376***
	(0.134)
MIConsistency	0.570***
	(0.214)
StateVarieties	0.209***
	(0.076)
BrewerRecommend	0.163
	(0.115)
PropensityBuyLocal	0.229***
	(0.069)
BeliefsAboutLocal	0.002
	(0.074)
Constant	-5.149***
	(1.536)
Log pseudolikelihood	-19.570
Number of observations	50

[a] Superscript ***, **, and * denote statistical significance at the one, five, and ten percent level, respectively.

Greater perceived consistency of local hops increases the likelihood of purchasing MI-grown hops. This is intuitively appealing, as it suggests that the more consistent a brewer perceives MI hops to be, the more likely they are to utilize a larger share of state-grown hops. Alternatively, the less consistent a brewer finds MI hops, the less likely they are to use the state-grown hops and will instead resort to PNW or international hops. Furthermore, knowing that the hop cultivars a brewer uses are grown within the state also increases the likelihood of purchasing a higher proportion of state-grown hops. The more cultivars a brewer acknowledged are grown in the state and purchased in the past year resulted in a greater proportion of state-grown hops purchased. This demonstrates the need for emerging local hop systems to emphasize cultivar diversification and brewer-grower communication.

Three Likert scale responses are also introduced, only one of which is statistically significant. Despite the tight-knit nature of the brewing community, there is no evidence to suggest that recommendations from other brewers increase a brewer's proportion of locally-grown hops. In contrast, the propensity to buy local scale is positive and statistically significant, suggesting that the more a brewer agrees with the benefits of buying local more generally, the more likely they are to utilize a greater proportion of local hops. Finally, the variable for beliefs about localness—including statements about localness being good for the economy, being better for the environment, and resulting in more money directly to the farmer—is statistically insignificant, suggesting that simply promoting these positive benefits of localness is unlikely to increase local hop sales.

Breweries, on average, support localness. Many even believe their consumers would be willing to pay a premium for including local hops in their products (Figure 4.3). However, if a brewer perceives local hops to be less consistent than non-local alternatives, they may continue purchasing nonlocal hops regardless of their attitudes and beliefs about localness.

Table 4.5 breaks down the characteristics of brewers by how they perceive the differences between hop consistency in MI and PNW. The 18 brewers who rated MI hops as consistent or more consistent than PNW hops are referred to as Group A (the second column in Table 4.5). The 32 brewers who state PNW hops are of greater consistency are referred to as Group B (the third column in Table 5). On average, Group A is smaller than Group B by approximately 400 bbls, has a less diverse revenue stream, relies more heavily on taproom sales (82% vs. 76%), and is also much more likely to utilize a greater percentage of MI-grown hops – 48.56% vs. 31.15%.

Additionally, Group A is more likely to buy their hops directly from the farmer, with an average of 39% of hops coming directly from the farm versus just 22% for Group B. In contrast, brewers in Group B are more likely to go through a broker, with an average of

71.31% of total hops purchased through a broker, just 43% for Group A. This could indicate a closer personal relationship between MI farmers and brewers.[67]

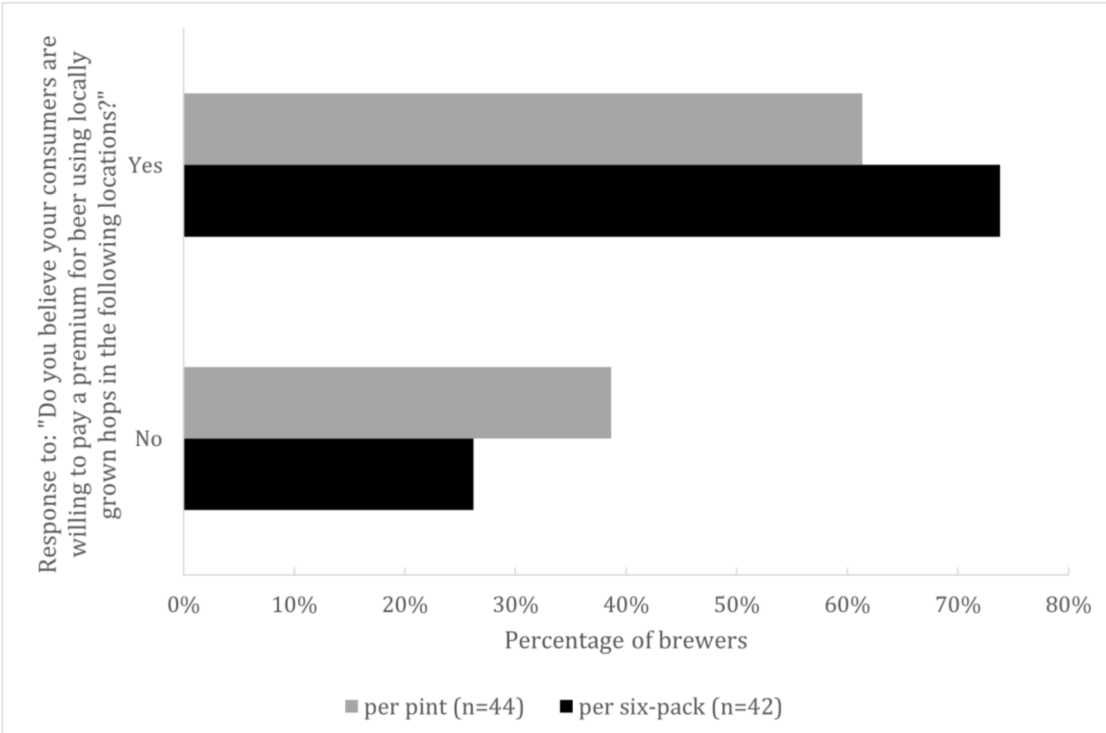


Figure 4.3. Perceptions of whether consumers would pay a premium for local hops

[67] For example, consider a brewer that purchases the majority of their hops directly from the farmer, implying direct communication and a professional relationship between the two parties. If on one occasion the brewer receives, what they perceive to be, an inconsistent order of hops, they can contact the grower directly and work through this transaction. The grower may provide a new order or ask the brewer if they would rather keep the current order at a discounted rate, as the grower would not want to lose a buyer over one (perceived) inconsistent order. Without a direct relationship between brewer and farmer (i.e., transactions through a broker) this type of interaction is less likely and one (perceived) inconsistent order could permanently drive the brewer away.

Table 4.5. Brewer characteristics, by perceived consistency responses

Variable (%)	MI hops are of equal or greater consistency (Group A)	PNW hops are of greater consistency (Group B)	Combined
Where do you purchase hops?			
Broker	43.06	71.31	61.14
Farmer	38.61	21.75	27.82
Brewer	4.72	1.41	2.60
Third-party	10.56	5.53	7.34
Other	3.05	0.00	1.10
Sales from the following channels			
Taproom	82.00 [a]	76.74 [b]	78.60 [c]
Local Liquor stores	0.82 [a]	3.26 [b]	2.40 [c]
Grocery stores	2.05 [a]	2.68 [b]	2.45 [c]
Supercenter (e.g., Walmart)	0.82 [a]	2.74 [b]	2.06 [c]
Restaurants or bars	14.00 [a]	11.94 [b]	12.67 [c]
National chain	0.29 [a]	1.26 [b]	0.92 [c]
Pharmacy or Corner store	0.00 [a]	0.10 [b]	0.06 [c]
Other	0.00 [a]	1.29 [b]	0.83 [c]
Advertising strategies			
Social media	63.24 [a]	59.22	60.61 [d]
Word of mouth	30.59 [a]	25.59	27.33 [d]
Road signs	3.24 [a]	1.47	2.08 [d]
Local newspaper	2.94 [a]	10.44	7.84 [d]
Other	0.00 [a]	3.28	2.14 [d]
Bbls/year (mean)	1,369	1,726	1,598
Proportion of state hops to total hops (mean)	48.56	31.15	37.42
Number of observations	**18**	**32**	**50**

Note: The number of observations for superscript *a* equals 17. The number of observations for superscript *b* equals 31. The number of observations for superscript *c* equals 48. The number of observations for superscript *d* equals 49.

4.6. Discussion

Growers in new and re-emerging markets must adapt to many novel production challenges, leading policymakers interested in localized food chains to consider political action to support the burgeoning industry. While producers generally value localness and believe their consumers would be willing to pay a premium for local inputs, they are less likely to substitute towards local inputs if they believe the local inputs are of a lower consistency or quality.

In this study, MI brewers are asked whether different initiatives would increase the likelihood they would purchase state-grown hops (Table 3). Michigan, which lies on a similar latitude as the PNW, is the leading US hop producer outside the traditional US growing region. The state now accounts for approximately one-third of total non-PNW hop acreage (Hop Growers of America, 2020). With a more established local hop system, albeit shadowed by the three PNW producers, MI has become the leading model for the other 25 non-PNW states reporting commercial hop production. Therefore, initiatives favored by MI brewers are likely shared by others, and non-PNW growers and legislators hoping to develop their local hop networks may consider similar initiatives. Below are the three buy-local initiatives favored the most by MI brewers.

4.6.1 Unique Cultivar Selection

The most favorable response was for MI to offer a unique selection of cultivars. If MI can develop unique cultivars that brewers demand, they can encourage greater utilization of local hops. Indeed, MI hop growers have already engaged in two related strategies. First, MI growers have introduced their own proprietary hop—Michigan Copper™. This hop was developed by Great Lakes Hops, released in 2014, and has received praise from brewers throughout the region (Great Lakes Hops, 2019; Pure Mitten Hops, 2020). The second possibility is terroir, or the idea that geographical region and climate play a distinct role in determining the product's sensory profile.

Terroir has been extensively studied in wine (Costanigro, McCluskey, & Goemans, 2010; Cross, Plantigna, & Stavins, 2011; Vaudour, 2002), but it is relatively new to the beer sector (Van Holle et al., 2017). The underlying principle is that a cultivar (e.g., Chinook) grown in the PNW will have a different flavor profile when grown in MI. If regional differences in flavor profiles exist, then MI hop producers may be able to use terroir to differentiate their hops. Indeed, some brewers are fully embracing these differences. Firestone Walker, a brewery in California, brews a "Luponic Distortion" series in which they take their original recipes and alter them slightly. In one such alteration, Firestone Walker brewed a beer by "taking two familiar hops and growing them 2,000 miles away [in MI]" (Firestone Walker, 2020). The MI-grown hops in the new beer altered the flavor profile from a piney, west-coast style IPA to a bright, citrus-filled beer (Firestone Walker, 2020).

Much like how savvy craft consumers actively seek certain hop cultivars in their beer selection, unique cultivars could also provide a spark for local beer value chains. For example, consumers who enjoy New England India Pale Ales (NE IPA) and are searching for a new NE IPA could actively seek Citra® or El Dorado® in their purchasing selection (Fisher, 2017). Likewise, suppose brewers began to market local proprietary hops (e.g., Michigan Copper™ in MI) and terroir (e.g., distinguishing MI Chinook from PNW Chinook) using a nested name structure (Costanigro et al., 2010). In this case, the hop's geographic region could serve as a differentiating factor that increases the probability that the consumer grabs a locally sourced beer off the shelf.[68] Further research might determine the true extent of consumer preference for local hops, offering particular attention to hop marketing on beer packaging.

4.6.2 Improved Cultivar Selection

Improved cultivar selection was ranked as the second most favored initiative. Ultimately, MI growers are somewhat limited in what they might grow, either by proprietary hop restrictions or disease pressure.[69] Cultivar selection is especially difficult due to the constant turnover of trends within the industry. Hops are perennial plants; if they are well maintained, they have the potential to produce a crop for 15-40+ years. If a cultivar is in high demand one year, it could be over-planted and over-supplied the next. For this reason, farmers and brewers must communicate their perceptions about current and expected future trends.

---

[68] Nested names are a way to introduce further specificity for a given product (e.g., using place of origin). One common public variety hop cultivar in the US is the Chinook hop. If terroir proves to be a biophysical reality that results in different flavor profiles when grown in different regions, then place of origin would be a useful classification to further specify the attributes of the Chinook hop. For example, MI Chinook would indicate a different flavor profile than PNW Chinook.

[69] Two of the most common diseases in hops are downy mildew and powdery mildew.

One trend that has emerged with the development of local hopyards is the *harvest ale.* These specialty beers can only be produced each fall, immediately after the hop harvest. As opposed to the "dry" hop pellets most commonly used by craft brewers, harvest ales require "wet hopping," where the hops are picked off the bine and in the kettle within 24 hours of picking (Schultz, 2012). Before the emergence of local hop yards, it was difficult for brewers outside the PNW to brew a harvest ale. Brewers, such as Founders Brewing Company in Grand Rapids, MI, had to have the wet hops shipped overnight in refrigerated units. Now, Founders produces a well-known annual harvest ale that utilizes 100% MI-grown hops (Founders Brewing Company, 2020). The development of local hop systems has not only helped with quality control for regional brewers like Founders—no longer relying on overnight shipping in refrigerated units where the product may spoil before reaching the destination (Schiessl, 2018)—but local hop systems have also allowed the smallest microbreweries to join the harvest ale trend. Across the country, brewers can drive to a nearby hop farm, hand-select their hops, and brew a beer with hops picked just hours prior.

4.6.3. Farm Brewery Legislation

Brewers ranked farm brewery legislation as the third most valuable initiative. Few states have enacted this sort of legislation, and New York state has the most advanced law of this kind, the Farm Brewing Law (S. 7727) in 2012 (Hawkins, 2015; New York State Senate, 2012). Brewers can obtain a farm brewery license if they agree to brew with a certain percentage of New York-produced inputs. The license eliminates the need for an additional permit to serve onsite, allows for producing other alcoholic beverages, and enables branch offices to sell their beverages outside of the production facility (New York State Brewers Association, 2020). MI legislators could pass this sort of bill, as it grows both hops and barley. This legislation would likely help breweries in planning and smaller breweries in operation. The effectiveness of this legislation requires future research, and an additional concern is the enforcement of legislation—verifying that brewers operating under the farm brewery license are abiding by the regulations.

4.7. Conclusions

While "buy local" has become an important rallying cry for food systems, localized value chains are often less established, leading to higher prices and higher variation in quality and consistency. Consumers state a desire for local products, but what happens when the locally-grown products are used as an input to produce local food and drink? In the case of MI-grown hops, where the true consumer is the brewer (not the beer drinker), results suggest that brewers are unwilling to sacrifice the integrity of their final product for localness values if the consistency of MI hops does not reach their standards.

This study explores the drivers of a brewery's decision to purchase state-grown hops using survey data from MI craft breweries. Results suggest that perceived consistency of MI-grown hops is a leading indicator of locally-grown hop purchasing decisions. Additionally, although brewers generally endorse localness and like to support local businesses, positive beliefs about localness stimulating the economy or helping the environment are not enough to sway the decision to buy locally. Even when the local producer grows a consistent, comparable alternative, the added transaction costs and limited market power when competing against established production chains with a comparative advantage are likely to restrict a local producer's market penetration. Finally, the study discusses potential initiatives to bypass these restrictions, including unique and improved variety selection and potential legislation. However, if local hop markets, are to thrive during this period of hyper-local demand, product quality and consistency must be met before producers hop aboard.

The primary limitation of this analysis is the small sample size of 50 MI craft breweries. Though this is a concern, brewers are a unique population, and their attitudes and behaviors are generally not well documented in the academic literature. Future work could further examine the underlying drivers of perceived consistency and hop purchasing behavior, particularly as local value chains establish themselves in the marketplace. This study hopes to lay a foundation for future work on localized hop markets, specifically studying brewer purchasing patterns, hop terroir, and farm brewery legislation.

REFERENCES

Allen, R. (2018). Mich. No. 1 In Hops Outside Pacific Northwest. *Detroit Free Press*. Available at: https://www.freep.com/story/entertainment/2018/02/14/michiganhopsfarms/31451300 2/ [last accessed September 12, 2019].

Alston, J.M. & Parley, P.G. (2014). Agriculture in the global economy. *Journal of Economic Perspectives*, 28(1), 121-146. https://doi.org/10.1257/jep.28.1.121

Angrist, J. D., & Pischke, J. S. (2009). Making regression make sense In *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press.

Atallah, S. S., Bazzani, C., Ha, K. A., & Nayga Jr, R. M. (2021). Does the origin of inputs and processing matter? Evidence from consumers' valuation for craft beer. *Food Quality and Preference*, *89*, 104146. https://doi.org/10.1016/j.foodqual.2020.104146

Baum, C.F. (2008). Stata tip 63: Modeling proportions. *The Stata Journal*, 8(2), 299-303. https://journals.sagepub.com/doi/pdf/10.1177/1536867X0800800212 [last accessed July 25, 2022].

Brewers Association (2020a). Membership Directory: Breweries. Brewers Association. Available at: https://www.brewersassociation.org/directories/breweries [last accessed May 20, 2020].

Brewers Association (2020b). State Craft Beer Sales & Production Statistics, 2019. Brewers Association. Available at: https://www.brewersassociation.org/statistics-and-data/state-craft-beer-stats/ [last accessed May 20, 2020].

Brown, J. P., Goetz, S. J., Ahearn, M. C., & Liang, C. L. (2014). Linkages between community-focused agriculture, farm sales, and regional growth. *Economic Development Quarterly*, 28 (1), 5-16. https://doi.org/10.1177/0891242413506610

Costanigro, M., McCluskey, J. J., & Goemans, C. (2010). The economics of nested names: name specificity, reputations, and price premia. *American Journal of Agricultural Economics*, 92(5), 1339-1350. https://www.jstor.org/stable/40931090

Cross, R., Plantinga, A. J., & Stavins, R. N. (2011). The value of terroir: Hedonic estimation of vineyard sale prices. *Journal of Wine Economics*, 6(1), 1-14. https://doi.org/10.1017/S1931436100001036

Deselnicu, O. C., Costanigro, M., Souza-Monteiro, D. M., & McFadden, D. T. (2013). A meta-analysis of geographical indication food valuation studies: What drives the premium for origin-based labels?. *Journal of Agricultural and Resource Economics*, 38 (2), 204-219. https://www.jstor.org/stable/23496751

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

Dukeshire, S., Garbes, R., Kennedy, C., Boudreau, A., & Osborne, T. (2011). Beliefs, attitudes, and propensity to buy locally produced food. *Journal of Agriculture, Food Systems, and Community Development*, 1(3), 19-29. https://doi.org/10.5304/jafscd.2011.013.008

Eyres, G., & Dufour, J. P. (2009). Hop essential oil: Analysis, chemical composition, and odor characteristics (Preedy, V., Ed.). In *Beer in health and disease prevention* (pp. 239-254). Academic Press.

Firestone Walker Brewing Company (2020). Luponic distortion: Tasting notes. *Firestone Walker Brewing Company*. Available at: https://www.firestonebeer.com/beers/luponic-series.php [last accessed August 4, 2019].

Fisher, N. (2017). Unlock the Secrets of New England–Style IPAs. *Beer & Brewing.* Available at: https://beerandbrewing.com/unlock-the-secrets-of-new-england-style-ipas/ [last accessed July 16, 2020].

Founders Brewing Company (2020). Harvest Ale: Wet Hopped Ale. *Founders Brewing Company.* Available at: https://foundersbrewing.com/our-beer/harvest-ale/ [last accessed May 25, 2020].

Gabrielyan, G., Marsh, T. L., McCluskey, J. J., & Ross, C. F. (2018). Hoppiness is happiness? Under-fertilized hop treatments and consumers' willingness to pay for beer. *Journal of Wine Economics*, *13*(2), 160-181. https://doi.org/10.1017/jwe.2018.26

Great Lakes Hops (2019). Michigan Copper. *Great Lakes Hops*. Available at: https://www.greatlakeshops.com/michigan-coppertrade.html [last accessed November 21, 2019].

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

Hasselbach, J. L. & Roosen, J. (2015). Consumer heterogeneity in the willingness to pay for local and organic food. *Journal of Food Products Marketing*, 21(6), 608–625. https://doi.org/10.1080/10454446.2014.885866

Hawkins, E. (2015). Great beer, good intentions, bad law: The unconstitutionality of New York's farm brewery license. *Boston College Law Review*, 56, 313. https://www.proquest.com/docview/1712244206

Herz, J. (2018). The importance of defining small and independent. *Brewers Association*. Available at: https://www.brewersassociation.org/communicatingcraft/importance defining-small-independent/ [last accessed September 12, 2018].

Hillberry, R. & Hummels, D. (2003). Intranational home bias: Some explanations." *Review of Economics and Statistics*, 85(4), 1089-1092. https://doi.org/10.1162/003465303772815970

Hop Growers of America (2020). 2019 Statistical Report. *Hop Growers of America.* Available at: https://www.usahops.org/img/blog_pdf/273.pdf [last accessed February 1, 2020].

Hop Growers of America (2022). 2021 Statistical Report. Available at *Hop Growers of America* website: https://www.usahops.org/img/blog_pdf/405.pdf [last accessed August 17, 2022].

Jirovetz, L., Eller, G., Buchbauer, G., Schmidt, E., Denkova, Z., Stoyanova, A., ... & Geissler, M. (2006). Chemical composition, antimicrobial activities and odor descriptions of some essential oils with characteristic floral-rosy scent and of their principal aroma compounds. *Recent Research Developments in Agronomy & Horticulture*, *2*, 1-12. Available at: https://www.cabdirect.org/cabdirect/abstract/20073073898 [last accessed September 20, 2022].

Kennedy, J. (2016). Why are New Zealand hops so coveted? *Punch Drink.* Available at: https://punchdrink.com/articles/new-zealand-hops-varieties-primer/ [last accessed September 20, 2022].

Lafontaine, S. R., & Shellhammer, T. H. (2019). How Hoppy Beer Production Has Redefined Hop Quality and a Discussion of Agricultural and Processing Strategies to Promote It. *Tech. Q. Master Brewers Association of the Americas Technical Quarterly*, *56*, 1-12. https://doi.org/10.1094/TQ-56-1-0221-01

Lenglet, F. (2014). Influence of terroir products meaning on consumer's expectations and likings. *Food Quality and Preference*, *32*, 264-270. https://doi.org/10.1016/j.foodqual.2013.09.003

Lizotte, E. & Sirrine, J.R. (2020). 2017 Michigan hop management guide. *Michigan State University Extension.* Available at: https://www.canr.msu.edu/uploads/234/71503/Pesticides_registered_for_use_on_hop_in_Michigan_2017.pdf [last accessed September 20, 2022].

Lusk, J.L., & Norwood, F.B. (2011). The locavore's dilemma: Why pineapples shouldn't be grown in North Dakota. *The Library of Economics and Liberty*. Available at: https://www.econlib.org/library/columns/y2011/lusknorwoodlocavore.html [last accessed July 25, 2022].

Lusk, J. L., & Schroeder, T. C. (2004). Are choice experiments incentive compatible? A test with quality differentiated beef steaks. *American Journal of Agricultural Economics*, *86*(2), 467-482. https://doi.org/10.1111/j.0092-5853.2004.00592.x

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

Malone, T. & Lusk, J.L. (2018). If you brew it, who will come? Market segments in the US beer market. *Agribusiness*, 34 (2), 204-221. https://doi.org/10.1002/agr.21511

Malone, T. & Stack, M. (2017). What do beer laws mean for economic growth? *Choices*, 32 (3), 1-7. https://www.jstor.org/stable/90015011

McFadden, D. (1974). Conditional Logit Analysis of Qualitative Choice Behavior. In Zarembka, P. (ed.) *Frontiers in Econometrics* (pp. 105-142). Academic Press.

McGunnigle, N. (2018). Crisis management: Breweries preserve through a year of natural disasters. *Beer Advocate*. Available at: https://www.beeradvocate.com/articles/17023/crisis-management-breweries-persevere-through-a-year-of-natural-disasters/ [last accessed July 25, 2022].

Meloni, G., Anderson, K., Deconinck, K., & Swinnen, J. (2019). Wine regulations. *Applied Economic Perspectives and Policy*, *41*(4), 620-649. https://doi.org/10.1093/aepp/ppz025

Meloni, G., & Swinnen, J. (2018). Trade and terroir. The political economy of the world's first geographical indications. *Food Policy*, *81*, 1-20. https://doi.org/10.1016/j.foodpol.2018.10.003

Miller, S. R., Sirrine, J. R., McFarland, A., Howard, P. H., & Malone, T. (2019). Craft beer as a means of economic development: An economic impact analysis of the Michigan value chain. *Beverages*, 5(2), 35. https://doi.org/10.3390/beverages5020035

National Institute of Standards and Technology (n.d.). Libraries, tools, and services. Mass Spectrometry Data Center of U.S. Department of Commerce. Available at: https://chemdata.nist.gov/ [last accessed September 20, 2022].

New York State Brewers Association. (2020). Farm Brewery. *New York State Brewers Association*. Available at: https://newyorkcraftbeer.com/farm-brewery/ [last accessed July 25, 2022].

New York State Senate (2012). S. 7727 Creates a farm brewery license. Available at: https://www.nysenate.gov/legislation/bills/2011/S7727 [accessed August 4, 2019].

Ospina, R., & Ferrari, S. L. (2012). A general class of zero-or-one inflated beta regression models. *Computational Statistics & Data Analysis*, 56(6), 1609-1623.

Papke, L. E., & Wooldridge, J. M. (1996). Econometric methods for fractional response variables with an application to 401 (k) plan participation rates. *Journal of Applied Econometrics*, 11(6), 619-632.

Price, E. (2019). Behind the scenes at the largest beer competition in the world. *Fortune*, Available at: https://fortune.com/2019/10/19/great-american-beer-festival-gabf-2019-behindthescen es/ [last accessed October 21, 2019].

Printezis, I., Grebitus, C., & Hirsch, S. (2019). The price is right!? A meta-regression analysis on willingness to pay for local food. *PloS one*, 14(5), e0215847. https://doi.org/10.1371/journal.pone.0215847

Pure Mitten Hops (2020). Specializing in Michigan hops. Pure Mitten Hops. Available at: https:// www.puremittenhops.com [last accessed July 25, 2022].

Richter, T. M., Silcock, P., Algarra, A., Eyres, G. T., Capozzi, V., Bremer, P. J., & Biasioli, F. (2018). Evaluation of PTR-ToF-MS as a tool to track the behavior of hop-derived compounds during the fermentation of beer. *Food Research International*, 111, 582-589. https://doi.org/10.1016/j.foodres.2018.05.056

Schiessl, C. (2018). How local Michigan hops have transformed Founders' Harvest Ale. Forbes. Available at: https://www.forbes.com/sites/courtneyschiessl/2018/10/04/founders-harvest-ale-michigan-hops/#6665a7411cdd [last accessed July 25, 2022].

Schmit, T. M., Rickard, B. J., & Taber, J. (2013). Consumer valuation of environmentally friendly production practices in wines, considering asymmetric information and sensory effects. *Journal of Agricultural Economics*, 64(2), 483-504. https://doi.org/10.1111/1477-9552.12001

Schönberger, C. & Joh. Barth & Sohn. (2014). *The hop aroma compendium: A flavour guide*. Vol. 3. Nuremberg, Germany.

Schultz, S. (2012). Notable American Craft Brewers and Their Art. In *Beer, Food, and Flavor: A Guide to Tasting, Pairing, and the Culture of Craft Beer.* Skyhorse Publishing, New York, NY.

Sharp, D. C., Townsend, M. S., Qian, Y., & Shellhammer, T. H. (2014). Effect of harvest maturity on the chemical composition of Cascade and Willamette hops. *Journal of the American Society of Brewing Chemists*, *72*(4), 231-238. https://doi.org/10.1094/ASBCJ-2014-1002-01

Sierra Nevada Brewing Company (2020). Resilience. *Sierra Nevada Brewing Company*. Available at: https://sierranevada.com/beer/resilience-butte-county-proud-ipa/ [last accessed December 8, 2018].

Sirrine, R. J., Rothwell, N., Lizotte, E., Goldy, R., Marquie, S., & Brown-Rytlewski, D. E. (2010). Sustainable hop production in the Great Lakes region. *Michigan State University Extension Bulletin E-3083. Publisher: Michigan State University Extension.* https://sandyridgefarmsinc.com/wp-content/uploads/2017/06/srf_Sustainable-Hop-Production-in-the-Great-Lakes-Region.pdf [last accessed July 25, 2022].

Staples, A.J., & Krumel Jr, T.P. (2022). The Paycheck Protection Program and small business performance: Evidence from craft breweries. *Working paper.*

Staples, A. J., Reeling, C. J., Widmar, N. J. O., & Lusk, J. L. (2020). Consumer willingness to pay for sustainability attributes in beer: A choice experiment using eco-labels. *Agribusiness*, *36*(4), 591-612. https://doi.org/10.1002/agr.21655

Sterns, J. A. (2019). Is the emerging US hemp industry yet another boom–bust market for US farmers?. *Choices, 34*(3), 1-8. https://www.jstor.org/stable/26964940

USDA NASS (2017a). 2017 Census Volume 1, Chapter 1: U.S. National Level Data. *National Agricultural Statistics Service (NASS), Census of Agriculture*. Available at: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_US/ [last accessed July 25, 2022].

USDA NASS (2017b). 2017 Hop Production Up 20 Percent from Last Year. National Hop Report. *National Agricultural Statistics Service (NASS), Agricultural Statistics Board*, *United States*. Available At: https://www.usahops.org/img/blog_pdf/102.pdf [last accessed July 25, 2022].

Van Holle, A., Van Landschoot, A., Roldán-Ruiz, I., Naudts, D., & De Keukeleire, D. (2017). The Brewing Value of Amarillo Hops (Humulus Lupulus L.) Grown in Northwestern USA: A Preliminary Study of Terroir Significance. *Journal of The Institute of Brewing*, 123(3), 312-318. https://doi.org/10.1002/jib.433

Van Holle, A., Muylle, H., Haesaert, G., Naudts, D., De Keukeleire, D., Roldán-Ruiz, I., & Van Landschoot, A. (2021). Relevance of hop terroir for beer flavour. *Journal of the Institute of Brewing*. https://doi.org/10.1002/jib.648

Van Loo, E J., Caputo, V., Nayga, Jr., R.M., & Verbeke, W. (2014). Consumers' valuation of sustainability labels on meat. *Food Policy*, 49(1), 137–150. https://doi.org/10.1016/j.foodpol.2014.07.002

Vaudour, E. (2002). The quality of grapes and wine in relation to geography: Notions of terroir at various scales. *Journal of Wine Research*, 13(2), 117-141. https://doi.org/10.1080/0957126022000017981

Watson, B. (March 18, 2020a). Impact survey shows extreme challenges. Available at *Brewers Association* website: www.brewersassociation.org/insights/impact-survey-shows-extreme-challenges/ [last accessed September 15, 2021].

Watson, B. (April 7, 2020b). Brewery sales dropping sharply, many set to close. Available at *Brewers Association* website: www.brewersassociation.org/insights/brewery-sales-dropping-sharply-many-set-to-close/ [last accessed September 15, 2021].

Wolf, H.C. (2000). Intranational home bias in trade." *Review of Economics and Statistics,* 82 (4), 555-563. https://doi.org/10.1162/003465300559046

APPENDIX

A version of this Appendix was previously published in Technical Quarterly and is reproduced with the permission of the co-authors. DOI: https://doi.org/10.1094/TQ-59-1-0408-01

Staples, A.J., Sirrine, J.R., Mull, A., Stuhr, S., Adams, A., & Malone, T. (2022). Untapping terroir: Experimental evidence of regional variation in hop flavor profiles. Technical Quarterly, 59(1), 7-16.

Offering and marketing a unique cultivar selection

As local hop markets have emerged, growers have endured various production challenges, including higher production costs, new/different pest and disease challenges, sub-optimal growing conditions and weather patterns (compared to Yakima Valley, WA or Willamette Valley, OR), and less-developed processing chains (Lizotte and Sirrine, 2017; Sirrine et al., 2010). Thus, the growth of local beer value chains may be hindered by the perception of less consistent inputs, economies of scale, limited access to proprietary hops, and the role of forward contracts. One potential avenue to overcome these challenges is through value-added marketing, highlighting the unique attributes of locally/regionally grown hops. Specifically, there is an opportunity to market *terroir* to both the brewer and the consumer.

Terroir is the notion that tastes and flavors are a product of the environment in which an agricultural commodity is grown—a function of the climate, soil, topography, and surrounding plants. While studied extensively in wine, research exploring the role of regional variation in hop production on beer flavor profiles is limited (Van Holle et al., 2021). The omission of terroir in the beer literature has become important over the past few decades as the hop industry has undergone rapid expansion and diversification since the turn of the century.

One recent example of hop terroir is shown within the widely used Cascade hop. Washington-grown raw Cascade hops display cream caramel, blackberry, and mango notes with predominant citrus notes in cold infusion. Alternatively, New Zealand raw Cascade hops are fruity, with peach, pineapple, and lavender blossom notes, and in cold infusion, they feature passion fruit, red berries, lemon, and grapefruit (Schönberger and Joh. Barth & Sohn, 2014). Because of its distinct aroma profile, New Zealand Cascade has been renamed Taiheke® (Kennedy, 2016). These sensory differences can lead to the development of regional identities, or geographical indicators, that increase the economic benefits of agricultural commodities to farmers and farming communities (Deselnicu et al., 2013; Meloni et al., 2019; Meloni and Swinnen, 2018). Put differently, regional differences in flavor profiles might provide an intriguing marketing opportunity for hop growers in unique growing regions.

In a stakeholder-driven, transdisciplinary research project, we conduct an empirical assessment that determines whether the same hop cultivar grown in different regions of the U.S. induces unique chemical and sensory profiles in beer. Specifically, we profile hop oil volatiles and hop-oil-derived constituents in beer, conduct sensory analyses using blind taste tests, and perform a labeled, stated preference, discrete choice experiment to explore the role of hop terroir in beer. The project focuses on the terroir of four Chinook hop samples (T90 pellets) from different U.S. growing regions: two from the PNW (Washington and Oregon) and two from MI (Northern MI and Eastern MI). The methods and results of each component are presented in the following sections.

Chemical Analyses

Terpene analysis

Hop samples from two MI farms and two PNW farms were obtained and sent to a professional laboratory for a terpenes and unknowns analysis. Terpenes account for the majority of the mass of these compounds in hop essential oils. They are commonly referenced as the basis of many recognizable odors detected in hop-related sensory analysis. Thus, in partnership with Cambium Analytica, a terpene analysis determines whether the hop samples exhibit differences in terpene count and terpene presence.[70]

Of the 34 terpenes analyzed, only ten were detected among the four growing locations. Figure 4.A1 summarizes the results. Three compounds, including beta-myrcene, alpha humulene, and trans-caryophyllene, accounted for between 97% and 99% of the total mass of terpenes in each sample. Additionally, of the ten terpenes detected, geranyl acetate, which is commonly associated with floral or fruity aromas (Jirovetz et al., 2006), was not detected in Hop A and alpha-Pinene, which is commonly associated with pine aromas (Sharp et al., 2014), was not detected in Hop A and Hop B.

[70] Terpenes were extracted using a solvent (ethyl acetate) that co-elutes in gas chromatography with many smaller aroma compounds of interest such as esters.

Unknowns analysis

Terpenes do not account for all the subtleties used in evaluating terroir. Therefore, an unknowns analysis is conducted for other classes of volatile chemicals, such as esters and similar small compounds (Eyres and Dufour, 2009). An unknowns analysis is a chemical analysis that determines whether variation exists in the samples without directly identifying the hop compounds in the sample.[71] It offers a qualitative chemical fingerprint that provides insights into the perceived sensory profile of the hop samples. This fingerprint can then be compared to a national database for preliminary insights into the potential sensory properties of the hop samples.

Figure 4.A2 shows the chromatogram of early eluting volatile compounds in the unknowns analysis, where the *x-axis* shows elapsed time from 8.5 to 20 minutes, and the y-axis measures, or counts, the relative presence of a given unknown compound. The results suggest that although each sample is a Chinook hop, they have quite different early eluting volatile compounds. This is indicative of potential variation in perceived sensory flavor profiles.

Differing peak heights of these unknown compounds give an analytical representation of the variability of the chemical makeup. This variability, coupled with the results of the terpene analysis, is suggestive of the terroir from growing the same variety in different locations. To see the variability in the hop aroma fingerprints, consider Figure 4.A3, which overlays the four hop samples at the 19-minute mark of the unknowns analysis. This provides a more explicit depiction of these differences in peaks, showing that Hop B peaks slightly earlier than the other hop samples, and Hop D has the largest count overall.[72]

---

[71] To search for and characterize additional unknown compounds, hop samples were analyzed on headspace GC/MS using a solventless full evaporative technique. The early eluting mass spectra (8.5-20 mins) were extracted and searched against a NIST library of GC/MS spectra (National Institute of Standards, 2020). While hundreds of compounds were identified in the unknowns analysis showing the complexity of hop volatiles, the method is indicative of a unique chemical fingerprint describing the terroir we may perceive in sensory work.

[72] The 19-minute mark is typically associated with methyl butyrate, an ester contributing to a tropical fruit aroma. It is critical to note that although Hop D has the highest peak, it does not necessarily imply that it should have the largest overall pineapple aroma. Methyl butyrate is just one of the many esters contribung to a tropical fruit aroma, and it is not just the presence of one ester that matters, but the relative presence of all other components.

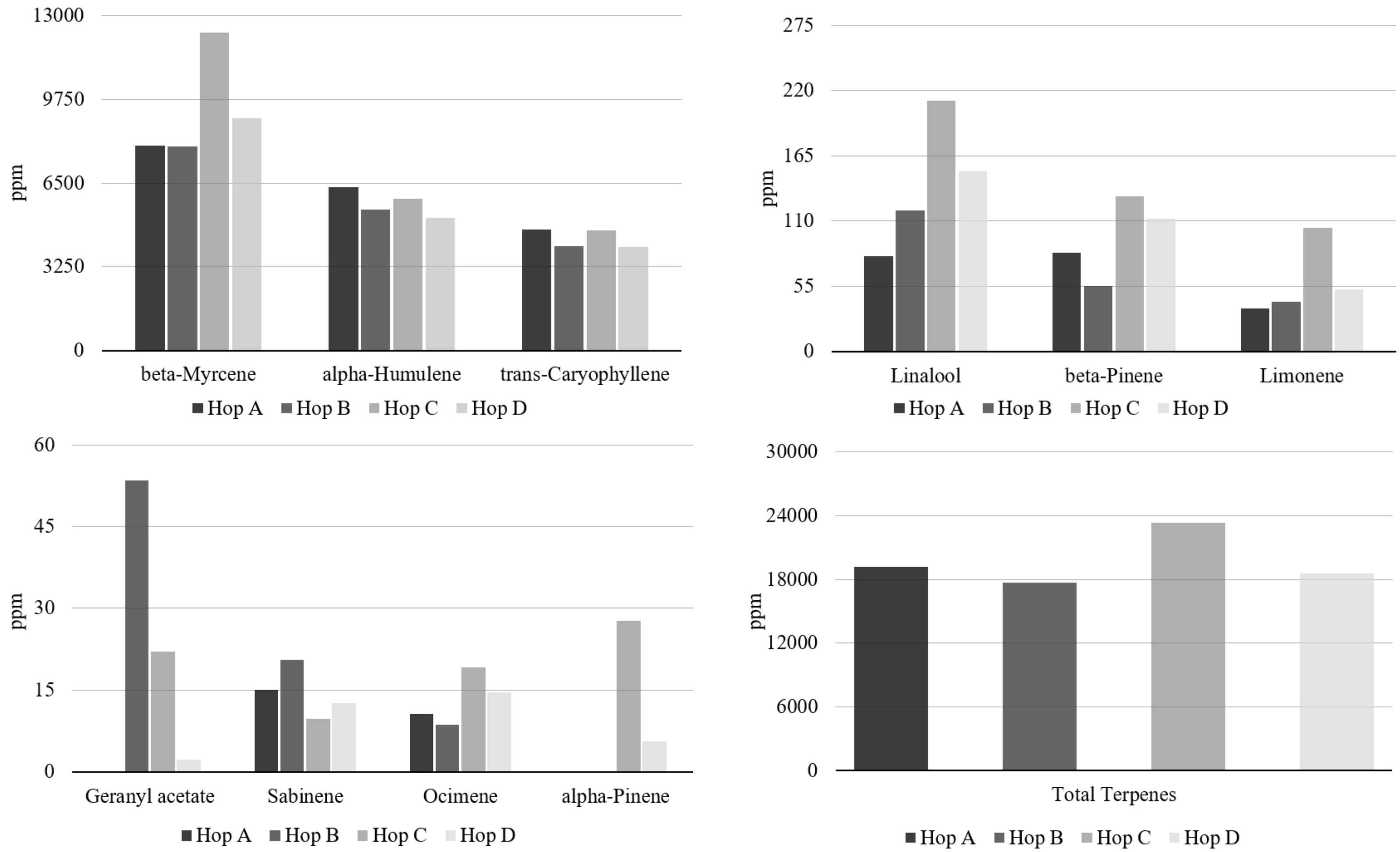


Figure 4.A1. The relative concentration of ten terpenes in four Chinook hop samples

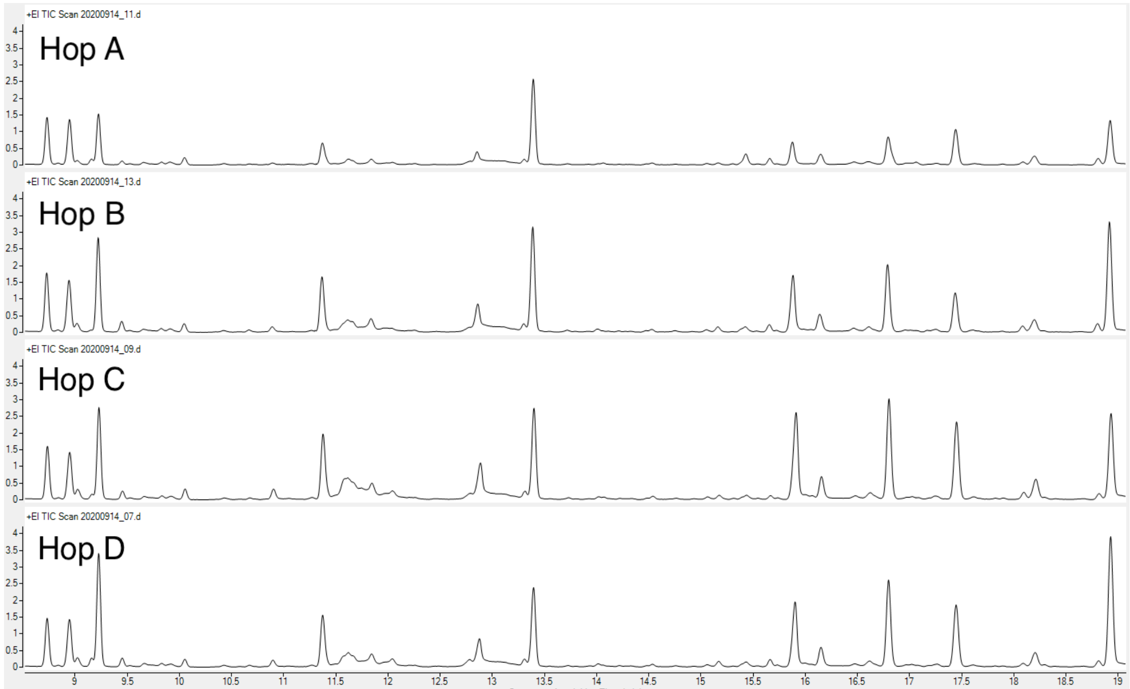


Figure 4.A2. Chromatogram providing a chemical fingerprint of the four hop samples

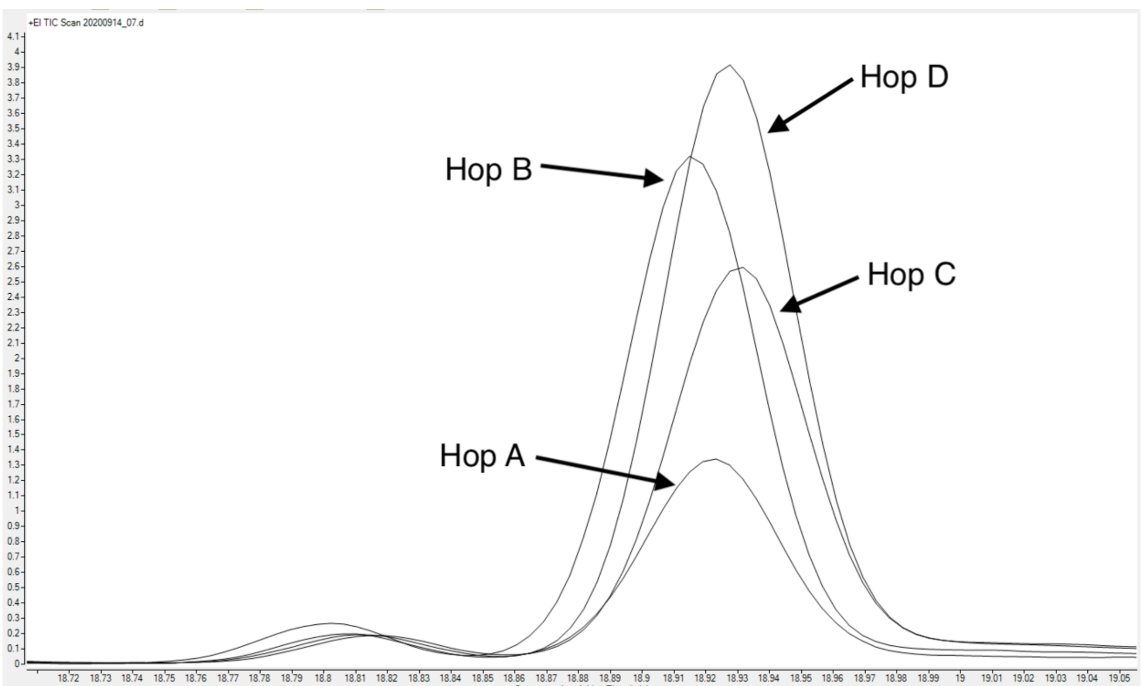


Figure 4.A3. The likely methyl butyrate peak for each hop sample

Blind taste tests and sensory analysis

Figure 4.A4 presents the brewing design employed to isolate the impact of hop origin on beer flavor profiles. In collaboration with Silver Spruce Brewing Company, a MI microbrewery, a five-barrel (bbl) kettle of baseline beer was brewed with 95% Wayermann pale malt and 5% Simpsons Crystal light malt. Then, 45 oz. of PNW Cascade hops (7.2% α-acid) to the five bbl kettle. White Labs California Ale yeast (WL001) was added to the wort to initiate fermentation. Once pitched, the beer sat at 67°F (19.4°C) for ten days. The baseline beer was then brought to 50°F (10°C), fined with a clarifying agent (Biofine) on day 12, and transferred to five one-bbl fermenters on day 14.

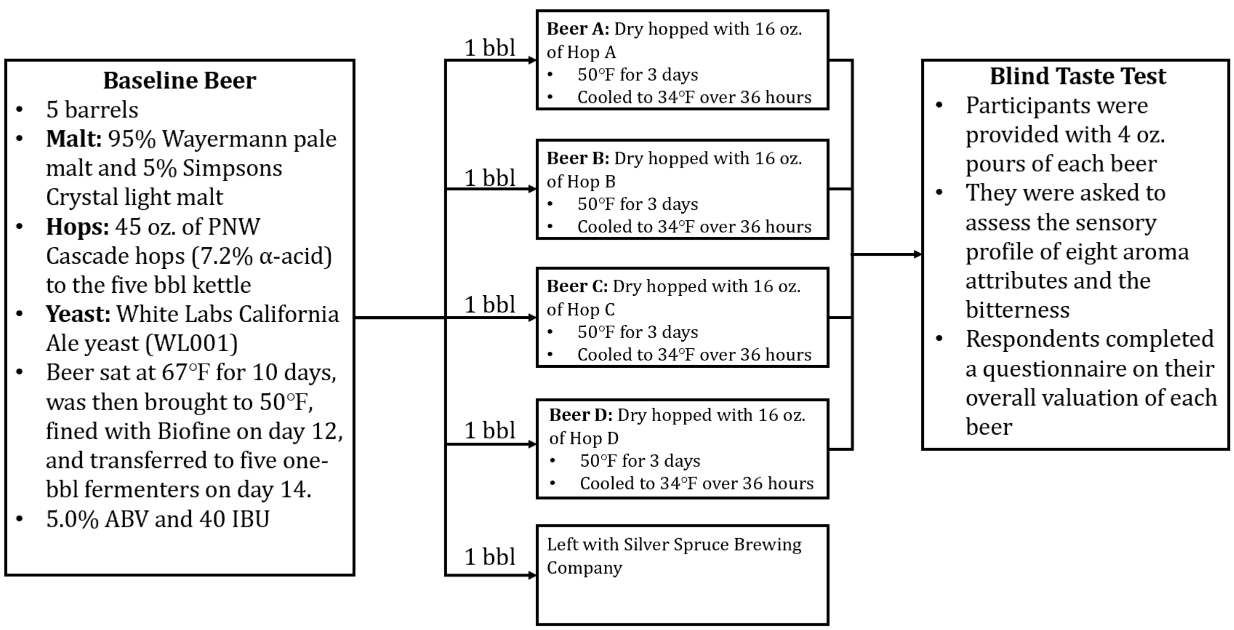


Figure 4.A4. Brewing specs for the sensory analysis and blind taste test

Four fermenters were dry-hopped with 16 oz. of Chinook hops, one for each of the four growing regions (Washington, Oregon, Northern MI, and Eastern Michigan).[73] Once the Chinook hops were added to each of the bbls, they settled for an additional 72 hours (3 days). Over this time, they remained at 50°F (10°C) before being cooled to 34°F (1.1°C) over the course of an additional 36 hours (1.5 days). Each of the final four beers had an alcohol

[73] Dry-hopping refers to the process in which brewers add hops to their beer after the boil—often during the fermentation process—to introduce various flavors and aromas.

content by volume of 5.0% and 40 international bitterness units (IBUs). The beers were transferred to kegs and transported to the sites of the blind taste tests.

Blind taste testing occurred on two occasions: the first at the annual Great Lakes Hop and Barley Conference and the second at a regional brewery's headquarters. Career beer professionals are used as opposed to a random sample of beer drinkers, as we anticipated more informed, expert opinions on the sensory profiles of the beers from industry members. Procedures were identical in both settings, and for conciseness, the first taste testing is summarized below.

Before the experiment, participants were informed about the tasting protocol. They were asked to read and sign a consent form agreeing to participate in this voluntary experiment and confirm that they were over the age of 21. Participants were then provided with four-ounce pours of the four beers, labeled Beer A, Beer B, Beer C, and Beer D. They were also given a paper survey containing a scoring table for eight beer aroma sensory attributes and one bittering attribute. Respondents were asked to rank the presence of each attribute on an eight-point scale (0=none, 1=very low, …, 7=very high) (Table 4.A1).

Table 4.A1. Sensory profile ranking system for the blind taste test

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
none	very low	low	low-medium	medium	medium-high	high	very high

Aroma characteristics	**Beer A**	**Beer B**	**Beer C**	**Beer D**
Stone fruit				
Citrus				
Tropical				
Floral				
Pine				
Onion/garlic				
Woody/earthy				
Herbal/grassy				

Once the respondents completed the sensory portion of the study, they were asked to answer valuation questions, provide demographics, and report craft beer consumption habits. Respondents were asked to state their overall liking of each beer using a seven-point Likert scale, rank the beers from most favorite to least favorite, and report their willingness to pay for a pint (16 fl. oz.) of each beer from a taproom. Each participant was allotted as much time as needed to complete the taste testing and survey, though the procedures were completed in approximately one hour.

In total, 59 individuals participated in the blind taste testing: 47 untrained (or semi-trained) panelists at the industry stakeholder conference and 12 trained panelists at the regional brewery's headquarters.[74] Participants from the industry conference are considered untrained as no training was given before the blind taste testing. However, this group is comprised of beer industry professionals, meaning the sample resembles a *semi-trained* panel.[75] Table 4.A2 presents summary statistics for the blind taste test, including the eight aroma attributes, the bitterness characteristic, and the valuation measures.[76]

A series of Kruskal-Wallis tests then determined whether statistically significant differences across beers existed for each sensory characteristic. Given the limited observations, we fail to reject the null hypothesis that the sensory attributes are the same across alternatives. In other words, we cannot state that sensory differences were detected across the samples. Overall preference and willingness to pay for each beer varied little. As such, the results of the blind taste provide inconclusive evidence of hop terroir in beer.

---

[74] While 59 respondents is regarded as a small sample in most empirical analyses, it is not uncommon for studies utilizing trained sensory panels to comprise fewer than 20 participants; for example, Van Holle et al. (2017) used 15 trained panelists for their sensory analysis of beer terroir using Washington versus Idaho hops.
[75] The most common occupations for respondents were hop growers (47.2%) and brewers (24.5%). Additionally, of the 59 respondents, 91.3% reported consuming craft beer at least once a week.
[76] Sample size per sensory attribute differs across beers because four respondents did not include a zero in responding on a scale of zero to seven as instructed, leaving many attributes—including bitterness—blank. One potential alternative for the analysis is to replace blank spaces with zeros, as respondents may have misinterpreted instructions and only rated the attributes they found in the beers. The results presented here do not make this assumption, but the radar plots for this analysis are available upon reasonable request. No additional statistically significant results were found.

Table 4.A2. Blind taste test aroma, bitterness, and valuation summary statistics

	Sample Average (std. dev.)			
Characteristic	**Beer A**	**Beer B**	**Beer C**	**Beer D**
Aroma				
Stone fruit	1.70 (1.70)	1.84 (1.93)	1.69 (1.66)	1.60 (1.65)
Citrus	2.53 (1.90)	2.42 (1.64)	2.33 (1.59)	2.29 (1.74)
Tropical	1.98 (1.86)	2.41 (2.07)	2.09 (1.61)	1.79 (1.70)
Floral	2.49 (1.96)	2.40 (1.75)	2.31 (1.54)	1.98 (1.61)
Pine	2.11 (1.91)	1.66 (1.54)	1.66 (1.46)	2.05 (1.68)
Onion or Garlic	0.56 (1.20)	0.76 (1.36)	0.65 (1.31)	0.63 (1.23)
Woody or Earthy	2.06 (1.98)	1.89 (1.94)	1.81 (1.75)	1.79 (1.61)
Herbal or Grassy	2.09 (1.51)	2.36 (1.99)	1.96 (1.61)	1.94 (1.51)
Bitterness	3.42 (1.46)	2.84 (1.44)	2.88 (1.27)	3.09 (1.42)
Overall liking (1 to 7)	4.97	4.61	4.75	4.73
Average rating (1=favorite)	2.39	2.40	2.58	2.61
Average WTP per pint (USD)	$4.56	$4.50	$4.47	$4.53

Footnote: Sample sizes differ between aroma characteristics and valuations (average rating, overall liking, and WTP per pint) due to misinterpretations on behalf of respondents.

Discrete Choice Experiment to MI craft brewers

In collaboration with agricultural extension specialists in the Land Grant university system, a stated preference discrete choice experiment (DCE) was distributed online to craft breweries in Michigan, Massachusetts, Ohio, Virginia, and Indiana via an email newsletter from each state's Brewer Associations' in early 2019. In total, 74 craft brewers completed the DCE. The majority of respondents were MI craft brewers (58 of the 74), while the remaining brewers were in Massachusetts (seven), Ohio (four), Virginia (three), and Indiana (two). As hops are a central input to beer production, each brewer purchases large quantities annually, meaning the respondents were familiar with the decisions they were asked to make in the DCE.

DCEs have become commonplace in economics, as they reveal tradeoffs individuals face in choice settings, allowing researchers to assess preferences and willingness to pay for product attributes. This DCE focuses on the tradeoff brewers make between growing region and price, allowing us to determine whether brewers are willing to pay a premium for hops grown in certain regions.

Respondents were presented with hypothetical purchasing decisions on eight occasions and were asked to select the alternative they would choose if they faced this choice in real life. Each choice task consisted of three potential hop purchasing alternatives that varied in multiple ways; the respondent could also choose to opt-out by not selecting an alternative. Respondents were instructed to envision each potential alternative as the type of hops they purchase most often and the hops as identical except for the attributes that we varied. Alternatives in each choice task included a pound of pelletized *state-grown* hops, a pound of *Great Lakes-grown* hops, or a pound of *PNW-grown* hops. Alternatives also varied in price, \$3.99, \$5.99, \$7.99, or \$9.99 per pound, and some alternatives had received a Global G.A.P. (Good Agricultural Practices) certification label, indicating that the grower abides by higher agricultural standards. Figure 4.A5 presents an example choice task.

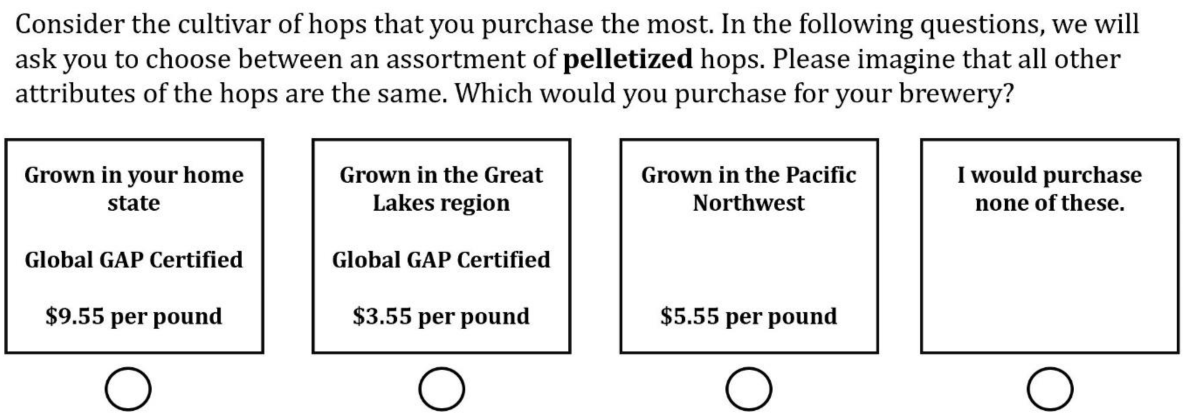


Figure 4.A5. Example choice task for discrete choice experiment

DCEs derive their explanatory power from random utility model (RUM), suggesting consumers maximize utility by comparing the attributes across alternatives, subject to a budget constraint (McFadden, 1974). The RUM states that consumer i receives indirect utility $U_{ijt} = V_{ijt}(\mathbf{X}_{jt}) + \varepsilon_{ijt}$ from selecting alternative $j \in \{home\ state\ hops, Great\ Lakes\ hops, PNW\ hops, no\ purchase\}$ on choice occasion t in the choice experiment. Indirect utility comprises two components: an observable (deterministic) component $V_{ijt}(\cdot)$ as a function of the attributes and alternatives included in the choice experiment (represented by the vector $\mathbf{X}_{jt}$) and an unobservable component, ε_{ijt}, assumed to be an independent and identically distributed type I extreme value error term. Individual *i* chooses alternative *j* if and only if $U_{ijt} > U_{ikt} \forall\ j \neq k$. However, as indirect utility is random, we can predict only the probability an individual will select an alternative in a given choice task.[77] By assuming the error term is type I IID extreme value, the conditional logit for the deterministic portion of utility is estimated as:

$$V_{ijt} = HomeState + GreatLakes + PNW + \beta GlobalGAP_{jt} + \mu Price_{jt},$$

where *HomeState, GreatLakes,* and *PNW* are alternative specific constants (ASCs) for the labeled alternatives and are equal to one if the respondent selects this alternative on a given choice task and zero otherwise; β and μ are marginal utility parameters; $GlobalGAP_{jt}$ is a dummy variable equal to one when the alternative has the certification label present and zero otherwise; and $Price_{jt}$ indicates the price of the alternative. Upon computing the parameter estimates for the ASCs and marginal utility parameters, the average willingness to pay (WTP) is calculated. Then, by comparing average WTP across alternatives, the average premium brewers attach to hops from different regions is computed.

Table 4.A3 presents marginal utility parameters and mean WTP for model (1). Each of the variables in the model is statistically significant at the 1% level with the expected sign. For each of the ASCs (*HomeState, GreatLakes, PNW)*, WTP is calculated as the parameter estimate of the location divided by the negative of the price parameter μ; for *GlobalGAP*, WTP is calculated as $-{}^{\beta}/_{\mu}$. The overall scale of WTP for the three regional locations is not overly telling, as brewer WTP is cultivar specific (i.e., the WTP for a pound or kilogram of hops depends on the type of cultivar the brewer is purchasing). Thus, the percent differences between home state, Great Lakes, and PNW hops are particularly interesting.

Results suggest that brewers are willing to pay up to 35% more for hops grown in their home state, holding all else constant. Additionally, the brewers in the sample are willing to pay a $0.97 per pound premium for hops with the Global G.A.P. certification. This finding provides evidence that brewers understand the importance of quality and safety verification programs in food and agriculture and appreciate knowing their inputs are grown using high agricultural standards.

---

[77] Mathematically, the probability individual *i* selects alternative *j* in choice task *t* is expressed as:

$$P_{ijt}(\mathbf{X}_{jt}) = \Pr\left(V_{ijt}(\mathbf{X}_{jt}) + \varepsilon_{ijt} > V_{ikt}(\mathbf{X}_{kt}) + \varepsilon_{ikt};\ \forall\, j \neq k\right)$$
$$= \Pr\left(V_{ijt}(\mathbf{X}_{jt}) - V_{ikt}(\mathbf{X}_{kt}) > \varepsilon_{ikt} - \varepsilon_{ijt};\ \forall j \neq k\right).$$

Thus, only differences in utility matter; the absolute scale of utility is irrelevant.

Table 4.A3. Marginal utility parameters and mean willingness to pay estimates

Variable	Coef. (rbst. std. error)[a]	Mean WTP ($/lb)
HomeState	5.38***	$15.91
	(0.61)	
GreatLakes	3.87***	$11.43
	(0.56)	
PNW	3.97***	$11.74
	(0.53)	
GlobalGAP	0.33**	$0.97
	(0.13)	
Price	-0.34***	---
	(0.05)	
Number of observations	592	
Log-likelihood	-479.19	

[a] Superscripts ***,**, and * denote statistical significance at the one, five, and ten percent level, respectively.

Several factors could drive the premium for local hops, and the survey results provide supporting evidence for three contributing factors.

1. **Brewers believe that localness is good for the local economy and provides more money to farmers.** As the craft brewing revolution was built on the shift in consumer demand for localness, and brewers understand the importance of local consumption in their taproom-driven business model, they may consider building community relations by supporting local agriculture.
2. **Brewers may believe that their consumers will pay a premium for beers that use locally sourced hops.** The literature suggests that consumers may be willing to pay a premium for beers that use locally-sourced inputs (Atallah et al., 2021). In the study, brewers answered an open-ended valuation question asking what premium they expect their consumers would be willing to pay for a beer made with local hops, both for a pint (16 fl. oz.) in the taproom and a six-pack from a retail outlet. Here, 62% of brewers believe their consumers would pay a premium for a pint that uses local hops, with a mean premium of $0.92 per pint; 71% of brewers believe their consumers would pay a premium for a six-pack, with a mean premium of $1.26 per six-pack.

3. **Brewers may perceive that local hops taste different from non-local hops, irrespective of hop cultivar.** After the DCE, brewers were asked to state their general agreement or disagreement with the following statement: "Local hops taste different from hops grown in other states." Of craft brewers in the sample, 90% generally agree with this statement.[78] In other words, there is some evidence that brewers believe there is hop terroir.

Summary

Is hop terroir a marketing construct and/or a biophysical reality (Cross et al., 2017)? Using a professional chemical analysis, blind taste test, and DCE, this study evaluates whether hops from different geographical origins induce unique chemical compositions, distinct sensory profiles, and varying WTP. The results suggest differences in terpene presence across the four Chinook hop samples, while the unknowns analysis suggests different chemical fingerprints. However, the blind taste test yields no statistically significant differences across product categories. Thus, the study yields mixed evidence of hop terroir. Nonetheless, the economic experiment suggests that brewers are willing to pay a premium for locally grown hops—a premium potentially driven by a preference to support the local economy and local agriculture, a belief that the consumer is willing to pay a premium, and a *perception* that local hops have a local terroir.

Marketing terroir thus becomes a potential source of product differentiation for both growers selling to brewers and brewers selling to consumers, particularly when coupled with heightened consumer demand for local inputs. Even if the average beer drinker is unable to detect or taste the difference between the beers brewed with hops from different regions, knowing the hops are sourced from a given region could tell a compelling story about the agriculture, the product quality, and the journey from the hop yard to the pint glass (Lenglet, 2014). As such, consumers may be willing to pay a premium for this designation (Atallah et al., 2021; Deselnicu et al., 2013). Further, brewers may choose to buy hops from different geographical regions or a local source irrespective of consumer willingness to pay

[78] Responses are based on a seven-point Likert scale from *strongly disagree* to *strongly agree*. General agreement with the statement is defined as the sum of responses to *somewhat agree* (15% of respondents), *agree* (41%), and *strongly agree* (34%).

for local hops, either because they believe the hops have a distinct sensory profile or because they wish to support locally grown hops.

This study has three primary limitations.

1. **Isolating the effect of geographical location on flavor profile is inherently difficult.** Outside of geographical location and climate, farming practices such as nitrogen application, irrigation, and harvest time can factor into the sensory profile.
2. **Other brewing procedures may yield different results.** Brewing a baseline beer, transferring it to smaller fermenters, and dry-hopping with the hops from different geographical regions were thought to be the most effective way to isolate the regional aromatic properties of the hop cultivar. If these procedures are adjusted, there may be more notable sensory differences across beers. It is also important for future research to examine how hop varieties interact with other ingredients in beer, such as malts and yeast (Richter et al., 2018).
3. **Hypothetical choice experiments are subject to hypothetical bias**. In hypothetical DCEs, respondents are not punished for suboptimal decision-making. This can lead to inflated WTP estimates. However, the hypothetical bias is likely consistent across alternatives, meaning that while overall WTP for each alternative may be inflated, the premium placed on local hops should be relatively consistent with actual purchasing preferences (Lusk and Schroeder, 2004). This consistency is critical because the local versus non-local premium is the study's primary interest, as price per pound is cultivar specific.

Future research across disciplines is needed to understand the extent of terroir and the demand for terroir in beer. More work is needed to determine how terpenes, esters, and other compounds translate to consumer sensory valuation. Future studies could also examine consumer preference for local hops, as it is still unclear whether they are willing to pay a premium for this product attribute. Even so, the results support the potential expansion of localized, regional flavor profiles in beer value chains. From the geographical distinctions in hop sensory profiles to the brewer premium for locally sourced hops, we may continue to see the development of beer value chains outside the PNW based on emphasizing terroir, the demand for local food, and the history of hop production.

CHAPTER 5. CONCLUSION

There are growing concerns over the flexibility, resiliency, and sustainability of post-COVID-19 beer supply chains (Brewers Association Supply Chain Subcommittee, 2022). In a period of high inflation, agricultural input costs are surging, translating to higher hop and barley prices in the United States. Wildfires and droughts are an additional concern, threatening both input quality and quantity in the primary growing regions (Staples, 2022). Aluminum, carbon dioxide, and labor shortages are also affecting production decisions (Fromuth, 2022; Pease, 2021; Redding, 2022). These costs, shortages, and risks ripple through the supply chain, increasing the cost of craft beer production and threatening the demand for the already premium-priced product. Finally, there is concern over the future of craft beer consumption, both in terms of market substitutes (e.g., seltzers, ready-to-drink cocktails, cannabis) and consumption location.

Alcohol consumption in the United States has trended downwards over the past few decades, and while beer remains the most preferred alcoholic beverage amongst U.S. adults, the gap is closing (Gallup, 2022). Other craft beverage options such as canned wine, hard seltzers, and ready-to-drink cocktails are gaining popularity. More importantly, however, is that on-premise consumption has not recovered to pre-pandemic levels (Figure 3.5). Craft brewers were forced to pivot and innovate to account for the initial decline in on-premise sales (Bivona and Cruz, 2021), but many of these shifts were temporary. With larger profit margins associated with on-premise sales, craft brewers built a business model to emphasize sales in this single revenue channel. But if on-premise consumption does not recover to pre-pandemic levels, craft brewers will have to evaluate their long-run business model.

Each of these issues will be addressed by policymakers and stakeholders, and this dissertation offers conversations on key challenges related to regulatory concerns, COVID-19 recovery efforts, and the development of local value chains.

The first essay of this dissertation uses Mercatus Center RegData to evaluate the geographical regulatory burden on the beer supply chain. Specifically, machine learning and I-O modeling are used to evaluate the number of regulatory restrictions constraining each state's three-tier supply chain. The methodology enables calculations of direct restrictions—those imposed explicitly on breweries, wholesalers, or retailers—as well as indirect restrictions—those imposed on the suppliers of the inputs for each tier. Aggregating across direct and indirect restrictions, the results suggest that the beer supply chain is constrained by approximately 125,000 regulatory restrictions. Of these, 115,000 are imposed at the federal level, and approximately 10,000 are imposed by the average state. Yet, there is heterogeneity in the way states construct their laws, signaling the importance for entrepreneurs to understand differences in regulatory regimes across state lines. More work is needed to fully understand regulatory restrictiveness and the effect of regulations on entrepreneurship and business growth. The hope is that this chapter will spark discussion on the regulatory volume across state boundaries and encourage future research on the topic of the geographical differences in beer laws.

The second essay assesses the effectiveness of the PPP on small business performance. The study merges PPP loan recipient data from the Small Business Administration with a verified dataset of craft beer producers to explore how PPP funding relates to the probability of business survival and YoY performance. The craft beer industry experienced a 9% drop in production and a 22% decline in sales from 2019 to 2020, making it one of the most impacted industries from the pandemic. However, the results to this study suggest that the PPP helped alleviate some of the COVID-19 induced losses, where brewers that received funding were more likely to remain in operation and experience a smaller decline in YoY production from 2019 to 2020. Questions remain about the program's long-term impact, and this is an area for future research.

The final essay evaluates the production and marketing challenges and opportunities in local beer value chains. The study uses a survey to Michigan craft breweries to understand how breweries make their hop purchasing decisions, identify the factors hindering the development of local hop markets, and asks which initiatives would encourage the use of more local hops. The results suggest that input consistency is a leading indicator of hop purchasing decisions, meaning that if a brewer perceives local hops as inferior to non-local hops, they will continue to purchase non-local hops. As local hop markets overcome production challenges inherent with their establishment, and they experience an initial shake-out, the hop is that the industry can achieve similar consistency to traditional growing regions and develop a reputation for doing so. Growers will also need to overcome the higher transaction costs often associated with purchasing locally. Inasmuch, we ask brewers which initiatives could incentivize them to purchase locally, finding that providing a more unique cultivar selection is the leading initiative. This opens avenues for value-added marketing through the development of local proprietary hops and promoting terroir. Through these value-added components, the industry could promote regional beer identities, or regional beer flavor profiles, that could attract local consumers and tourists alike.

Each of these chapters offer insights for policymakers and beer supply chain stakeholders. While unable to address all challenges constraining the industry, the dissertation highlights key regulatory, marketing, and policy questions in the hope of informing decision-making across this agri-beverage supply chain.

REFERENCES

Bivona, E., & Cruz, M. (2021). Can business model innovation help SMEs in the food and beverage industry to respond to crises? Findings from a Swiss brewery during COVID-19. *British Food Journal*, *123*(11), 3638-3660. https://doi.org/10.1108/BFJ-07-2020-0643

Fromuth, K. (August 30, 2022). Navigating CO2 supply shortages. Available at *Brewers Association* website: https://www.brewersassociation.org/playlist/navigating-co2-supply-shortages/ [last accessed September 27, 2022].

Gallup (2022). Alcohol and drinking. Available at *Gallup* website: https://news.gallup.com/poll/1582/alcohol-drinking.aspx [last accessed September 27, 2022].

Pease, R. (February 1, 2021). Aluminum can shortage letter. Available at *Brewers Association* website: https://www.brewersassociation.org/association-news/brewers-association-sends-letter-to-can-manufacturers-urging-actions-to-address-shortage/ [last accessed September 27, 2022].

Redding, J. (2022). Workforce challenges issue. Available at *Brewers Association: New Brewer Magazine*. Available at: https://www.brewersassociation.org/the-new-brewer/january-february-2022/ [last accessed September 27, 2022].

Staples, A.J. (June 29, 2022). Trouble is brewing for the future of beer. *360info.* https://doi.org/10.54377/1533-31ec