The Paycheck Protection Program & Small Business Performance: Evidence from Craft Breweries

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Abstract: The Paycheck Protection Program (PPP) provided approximately $790 billion in COVID-19 relief funds to nearly 12 million small businesses. We use data from the craft beer industry to explore the role of PPP funding on small business performance. By merging an industry dataset of producers with data from the Small Business Administration on PPP loan recipients, we examine the relationship between PPP funding, business survival, and changes in year-over-year production volume. Results suggest that firms that receive PPP funding are more likely to remain in operation and experience a smaller decline in annual production. Further, we use a quasi-experiment that exploits a natural break in the loan program to demonstrate that the average decrease in YoY production is smallest for breweries that receive the earliest funding. Using regression analysis and propensity score matching, results suggest towards a positive causal effect of the role of loan approval timing on short-run performance outcomes. These results provide evidence that the PPP alleviated losses induced by COVID-19, but questions remain about the program's distribution and long-term impacts.

Plain English Summary: The U.S. federal government created the Paycheck Protection Program (PPP) to minimize economic damages to workers and small businesses during the pandemic. One industry hit particularly hard by the pandemic was the craft brewing industry. Therefore, we use this industry to explore whether the PPP achieved its objectives. The results show that receiving a PPP loan increases the likelihood of remaining in business. Additionally, while most craft breweries experienced a decline in production from 2019 to 2020, firms that receive a PPP loan see a smaller decline. Breweries that receive the earliest funding also performed the best, suggesting that the timing of loan approval plays a key role in determining annual performance. Taken together, our study suggests that the government program helped to reduce economic damages, but more work is needed to fully understand the program's impact.

Keywords: annual performance, breweries, COVID-19, closures, Paycheck Protection Program, small business

JEL codes: H12, L66, M20

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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 their 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 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) for the establishment of the Paycheck Protection Program (PPP). The PPP provided (forgivable) loans to small businesses to alleviate economic damages from COVID-19 and incentivize businesses to retain employees on payroll. As the pandemic wore on, PPP funding increased, and $790 billion in PPP 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, much is unknown about the overall effectiveness of the program on small businesses.

By aligning an industry dataset of producers with governmental data on PPP loan recipients, we examine the relationship between PPP funding and small business performance. Specifically, we use data from the U.S. craft beer industry to explore the role of PPP loans on business survival and annual production. The craft beer industry is comprised of small, independently-owned businesses whose primary revenue stream was significantly disrupted by the pandemic, making it an ideal subject for analysis. As such, the objective of

65 this article is to determine whether receiving a PPP loan increases the likelihood of business
66 survival and contributes to better year-over-year (YoY) production outcomes.

67 Our study resembles work presented in Bartlett III and Morse (2020), Hubbard and
68 Strain (2020), and Li (2021). Bartlett III and Morse (2020) analyze the effectiveness of PPP
69 on business survival in Oakland, California whereas Hubbard and Strain (2020) address
70 survival rates amongst larger businesses.[1] Li (2021) uses Small Business Pulse Survey data
71 to demonstrate that PPP loan recipients were less likely to report revenue decreases and a
72 reduction in employee hours following loan approval. We also draw on the work of Fairlie
73 and Fossen (2021b), who use California administrative sales tax data to show that, on
74 average, sales decreased by 17% during the second quarter of 2020. Their analysis, however,
75 does not explore the effects of PPP on performance, leaving an important gap in the
76 literature. Fairlie and Fossen also show that sales losses were most significant for the
77 accommodation and hospitality industries, further motivating our use of the craft beer
78 industry.

79 Researchers have also explored the employment effects of the PPP (Autor et al.,
80 2022a; Chetty et al., 2020; Dalton, 2021; Faulkender et al., 2020; Hubbard and Strain, 2020).
81 These studies suggest an employment effect ranging from 0.9% (Hubbard and Strain, 2020)
82 to 16-35% (Bartik, Cullen, et al., 2021), where the magnitude of the point estimate depends
83 on the sample used and the identification strategy employed (Dalton, 2021). From a policy
84 perspective, the effectiveness of the PPP on employment is a first-order outcome. However,

[1] It should be noted that the smallest loan size explored in Hubbard and Strain (2020) was $150,000. In contrast, the median loan size in our sample was $56,711. We view our analysis as a necessary extension over this important work, in that was are able to tease out the effect more specifically on smaller businesses.

for a small business, the primary objectives are survival and profitability, and thus it is critical to assess how PPP affected the operational status and revenue of the firm.

Our contribution is threefold. Primarily, to our knowledge, we are the first to align an industry dataset of existing businesses with PPP loan data. In doing so, we provide analysis on 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. Additionally, our ability to observe different segments of the craft beer industry allows us to perform within industry heterogeneity analysis. The results indicate that a firm's pre-pandemic business model contributes to its ability to adapt to the sudden shock of COVID-19, which is also a novel contribution.

Secondly, through a quasi-experimental framework, we examine the role of loan timing on changes in YoY production from 2019 to 2020. We use a natural break in the loan program to compare the YoY performance of firms that receive funding before the initial $349 billion was exhausted and firms that receive funding when it was reloaded two weeks later. We find 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 contributes to 2020 performance, which is an important new insight for research analyzing the first-come, first-served style of the loan program.

Lastly, we offer 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 a discussion on 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, we provide an important advancement that significantly reduces concerns over fraudulent claims being included in the analysis. This means we can more accurately estimate the true impact of the PPP on business performance, increasing the generalizability of our 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 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 our results, and Section 9 concludes.

2. Background

2.1 Paycheck Protection Program

To combat the economic turmoil felt at the onset of COVID-19, the CARES Act (Public Law 116-136) was signed into law on March 27, 2020. Included in the $2.2 trillion economic stimulus package was $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, businesses 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).[2] 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 1 summarizes PPP eligibility criteria, maximum loan amounts, and other program information, while Figure 1 provides a timeline of the loan program.

[TABLE 1 HERE]

[FIGURE 1 HERE]

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

[2] 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."

equity and the role of the banks 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 provided firms that had 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 and states implemented new, or extended old, stay-at-home orders, 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 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 it 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, and the data were made 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, we 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 business performance metrics. We fill this gap in the literature using the craft beer industry given COVID-19's disproportionate impact on the industry.[3]

[3] 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.

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).[4] 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 total 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 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 a variety of outlets (e.g., local liquor stores, grocery outlets, and restaurants), craft brewers rely predominantly on on-premise sales. Indeed, it is common for 80-100% of a brewery's revenue to come from on-premise sales, and this is especially true for the smallest craft breweries (Staples, Malone, and Sirrine, 2021). With the emphasis on taproom sales in a local

[4] 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.

213 community—as opposed to a wide distribution network of retail outlets—craft brewers
214 were more vulnerable to COVID-19 than large, non-craft producers.

215 In response to COVID-19, states and local municipalities throughout the U.S.
216 implemented public health policies that directly affected the traditional craft brewer
217 business model. For example, stay-at-home orders limited social mobility, and capacity
218 restrictions often limited or shut down indoor dining. But social institutions and consumer
219 perceptions about the prevalence of COVID-19 in their community also played a role in
220 decreased foot traffic (Chetty et al., 2020; Fairlie and Fossen, 2021b; Goolsbee and Syverson,
221 2021). Indeed, Goolsbee and Syverson suggest that social institutions explain much more of
222 the decline in consumer foot traffic from January to April 2020.[5] Their results also state that
223 drinking places ranked as one of the most negatively impacted sectors. Irrespective of the
224 reason for the decreased visits, breweries that rely heavily on revenue from on-premise sales
225 needed to reconsider their business model (Morris, 2020; Romano, 2021). This included
226 adjusting production schedules, employment levels, and alternative revenue streams.

227 In late March 2020, the Brewers Association, a 501(c)(6) not-for-profit organization
228 aimed at promoting and protecting the interests of U.S. craft brewers (Brewers Association,
229 2022c), surveyed approximately 900 craft breweries on their concerns and perceptions of
230 COVID-19. Their results showed widespread distress: 90% of respondents had already

[5] 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.

altered beer production schedules; 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 (Fairlie and Fossen, 2021b). According to Brewers Association estimates, aggregate craft beer production fell 9% in 2020, sales decreased by 22%, and craft beer market share fell 1.7 percentage points compared to 2019 (Brewers Association, 2022d; Watson, 2021).

To summarize the relevant literature, the craft beer industry 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) their perceptions of large-scale shifts in production, layoffs, and closures if economic conditions or state/federal support did not improve.[6]

3. Data

We use data from the Brewers Association and the Small Business Administration to achieve our primary objectives. These objectives are to (i) explore the relationship between PPP

[6] 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).

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. We discuss the structure of each data source in the following two sub-sections before describing our merging procedures and presenting summary statistics.

3.1 Brewers Association

We first identify active breweries as well as ones that temporarily or permanently closed during the COVID-19 pandemic. Analysis is limited to the 50 states and the District of Columbia, and we restrict closures to those that occurred after the April 3, 2020 start date of PPP funding. The sample consists of 8,946 breweries. Utilizing Brewers Association records and internet searches, breweries were placed into one of three categories: (i) permanently closed since the start of the PPP (April 3, 2020); (ii) temporarily closed as of July 2021; and (iii) in operation as of July 2021.[7] 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

[7] 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, 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, we used Google searches. Specifically, for each brewery included in the dataset, we searched the brewery name and identified breweries 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 the 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.

active, 141 (1.6%) were listed as temporarily closed, and 299 (3.3%) were identified as permanently closed.[8]

The Brewers Association divides its 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-premise. Microbreweries are breweries that produce less than 15,000 barrels (bbls) of beer per year with 75% of production sold off-premise. Regional breweries brew between 15,000 and 6,000,000 bbls of beer per year with no restriction on their revenue streams or food services. Taprooms are breweries selling 25% or more of beer on-premise with limited or no food services. Using the Brewers Association's industry segmentation, we examine whether certain segments of the industry are disproportionately impacted by the pandemic. Table 2 presents active and closed breweries by segment.

[TABLE 2 HERE]

Approximately 36% of our sample are brewpubs, 21% microbreweries, 3% regional breweries, and 40% taprooms. The final column of Table 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

[8] Note, any brewery that closed before April 3, 2020 was excluded from analysis. Therefore, in removing the first three months of closures in 2020, we are underestimating 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. The reader is directed to the Appendix accompanying this manuscript for further information on the differences between our closure rates and the ones reported on the Brewers Association website.

purchases during the pandemic (Ellison et al., 2020). As such, breweries that rely heavily on food sales may see a steeper decline in consumer foot traffic. Relative to the other craft beer market segments, brewpubs exhibit less capability to pivot production away from on-premise, draught consumption towards canning or other off-premise channels.

We also obtain brewery-specific production volume data over time and link these estimates to the universe of breweries where available. Annual production volume serves as a proxy for annual revenue, and 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, driven largely by breweries that were in the process of expanding production in the time of interest or opened later in 2019 (and thus their estimate does not reflect a full year of production). Therefore, in the analysis that follows, attention is limited to breweries that experienced a negative 100% to positive 100% change in YoY production from 2019 to 2020.[9] In doing so, the sample is confined to 5,911 (94%) of the initial 6,304 observations with available production data.[10]

[9] For example, our 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). We impose an upper bound of +100% change in YoY production as 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, we place the upper bound limit of +100% on our YoY production volume changes.

[10] We also partner with the Brewers Association to collect information on which breweries 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

303

304 *3.2.2 Paycheck Protection Program*

305 Data used in the analysis were pulled from the SBA website on June 23, 2021 and contain
306 nearly 12 million PPP loan recipients through May 31, 2021, the end of the PPP (SBA,
307 2021b).[11] To identify our observations of interest, we use the six-digit North American
308 Industry Classification System (NAICS) coding system.

309 We first construct a dataset of all observations coded in the six-digit NAICS code for
310 breweries (312120), yielding 5,405 observations. However, a significant number of
311 breweries also operate in food service (i.e., brewpubs) and may be coded with full-service
312 restaurants (722511). To account for these businesses, we pull all PPP loan recipients coded
313 as full-service restaurants and use fuzzy matching procedures to align the address listed on
314 the PPP loan application with brewpub addresses.[12] This results in a dataset of 1,481
315 brewpub observations coded as full-service restaurants. Lastly, breweries could be coded in
316 the NAICS code for drinking places (722410). Similar fuzzy matching procedures are used to
317 identify an additional 1,466 observations. We then aggregate observations across the three
318 NAICS industries (312120: Breweries; 722511: Full-service restaurants; and 722410:
319 Drinking places) to create a dataset of 8,352 loan observations.

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.

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

[12] 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, and thus we manually corrected for improperly matched locations using Google Maps.

As firms could receive two rounds of PPP funding, a single brewery that receives two loans has two observations in the dataset. To create a one-to-one mapping across the Brewers Association data and PPP data, we reshape the PPP data yielding 5,809 unique observations.[13]

3.3 Merging

To merge the brewery data points with PPP observations, we separate both datasets by jurisdiction (50 states and the District of Columbia). For each jurisdiction, we then pair the breweries and PPP data to initiate matching. As we assume that the Brewers Association dataset is our entire universe of breweries, PPP borrowers either sufficiently map to one of the breweries or are excluded from the analysis. Due to limitations in the PPP data, we resort to a three-step manual matching procedure.

First, we attempt to match the borrower's name listed on the PPP loan application to the brewery's 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 shortcoming, the second step matches the address listed on the PPP loan application to a brewery's address. Again, borrowers would sometimes list a residential address rather than a business address. For the remaining unmatched

[13] We use the *reshape wide* command in Stata to compete 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.

observations, step three involves using the borrower's name listed on the PPP application to identify trademarks, alternative trading names, etc. of the loan applicant using online resources such as OpenCorporates (OpenCorporates, 2021). If the PPP borrower had a trademark that could be mapped to a brewery, these observations were matched.

On aggregate, we match 89% of the PPP loans across 5,002 unique breweries in 1,210 distinct counties. The unmatched observations are excluded from our analysis.[14]

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 gone to support nearly 98,000 jobs in the first round, and over 64,000 in the second round.[15]

Figure 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, 2020, and the remaining 6% through August 8, 2020.

[FIGURE 2 HERE]

[14] Most observations that remained unmatched consisted of cideries, wineries, and distilleries that were incorrectly coded into NAICS 312120 as well as pubs or restaurants that do not qualify as breweries. 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 analysis are breweries in planning or proprietor brewers. These groups were not included in our universe of breweries from the Brewers Association, and so they are excluded from analysis. While this may be seen as a limitation, these observations accounted for less than 20% of the unmatched observations, or less than 3% of total PPP observations.

[15] 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. We unfortunately did not have data on number of jobs from the Brewers Association over time, which means we are unable to overserve changes in employment as an outcome variable in our analysis.

Table 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 received 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.

[TABLE 3 HERE]

Examining key outcome variables (Panel A in Table 3), we see differences in operational status and changes in YoY production volume across groups. Businesses that received both rounds of funding are most likely to be open as of July 2021 (98%), while breweries that had 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) compared to breweries that do 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), which support the use of county-level fixed effects. 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); similarly for 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 our comparison groups, Figure 3 plots 2018 – 2020 production levels. The sample is limited to breweries that are 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, along with missing data and the removal of statistical outliers, data are available for 4,257 breweries.[16]

[FIGURE 3 HERE]

Breweries across each group demonstrate, on average, increasing production from 2018 to 2019, ranging from a YoY increase of +1-8%. Figure 3 suggests that larger (eligible) operations were more likely to receive first-round funds. Breweries that receive first-round funding, on average, produce 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.

4. Probability of business survival

To understand the relationship between receiving a PPP loan and business survival, we utilize a linear probability model (LPM) that 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

[16] Specifically, we remove (i) observations that are missing data in 2018, 2019, and/or 2020; (ii) breweries that experienced greater than a 100% increase in YoY production from 2018-2019 and/or 2019-2020; and (iii) outliers that significantly skew the average. We remove breweries that were listed as producing 1 bbl of beer per year, as this may be evident of an error in the industry production dataset where "1" signals an indicator of having produced in the corresponding year. Additionally, we remove breweries producing above the 99th percentile of annual production in 2018. The 99th percentile was chosen based on the distribution of the 2018 production data. Specifically, 99% of our sample produces at or below 66,669 barrels of beer per year, while the remaining 1% of observations ranges from 66,784 to 2,175,784 barrels per year. Similar statistics held for the 2019 and 2020 data, with 99th percentiles of 55,660 and 50,084 bbls per year, respectively. As such, we use the 2018 data as our production cutoff point.

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 is 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 but at a decreasing rate.

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.[17] 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, such as regional breweries and taprooms, could more easily pivot to alternative packaging methods and distribution channels. Brewery-specific variables include 2019 brewery

[17] We also consider the inclusion of state-level control variables. However, during estimation procedures, their inclusion did not improve our explanatory power, produced point estimates that were identical in magnitude to our preferred specification, and may be inappropriate given the inclusion of county-level fixed effects.

414 production, whether the brewery is a primary or secondary location, and whether the
415 brewery received a loan from the 2021 Restaurant Revitalization Fund (RRF) program.[18]
416 Table 4 presents results from the LPM. Across specifications that control for firm- and
417 county-level fixed effects, receiving PPP funding has a positive and statistically significant
418 relationship with the probability of remaining in operation as of July 2021.
419 [TABLE 4 HERE]
420 Interpreting the output from the naïve regression, firms that did not receive any PPP
421 funding have a 92.4% chance of survival. Breweries that only received a first-round PPP loan
422 are predicted to have a 95.9% chance of survival, and those that only received a second-
423 round loan have a 97.5% chance of survival. Breweries that received both rounds of funding
424 are predicted to have a 98.3% probability of survival, where the negative sign attached to
425 the interaction term suggests diminishing marginal returns to PPP funding. There is also
426 suggestive evidence that brewpubs and microbreweries are affected by the pandemic more
427 than taprooms, with brewpubs appearing to be hit the hardest. This reinforces industry
428 expectations that brewpubs were less capable of pivoting away from their pre-pandemic
429 business model.
430 As a robustness check, we also estimate a penalized logistic regression, which
431 accounts for rare events and forces predictions into the zero-one, binary response range

[18] We may 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, we control for whether a brewery received an RRF loan. Note that the distribution of RRF loans comes immediately before our 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 our data on temporary and permanently closed breweries in July 2021, we would only observe that these breweries were open in July 2021, not seeing that they were temporarily closed weeks before. We attempt to overcome this shortcoming through the inclusion of a control variable for breweries that received an RRF loan in regression analysis.

(Firth, 1993). The results are fairly consistent with that of the LPM, where the main effects of PPP retain their sign and statistical significance. However, the coefficient for receiving both rounds of funding loses its statistical significance, though it retains its negative sign. Concerning the industry segmentation, the results of the penalized logistic regression also suggest that brewpubs are more likely to close, while the coefficient for microbreweries is not statistically different from zero. These results are available in the Appendix accompanying this manuscript.

There are two primary limitations to our 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 breweries that did not. For example, the literature suggests there were selection issues related to the size of the firm and whether the firm had a pre-existing relationship with a bank (Granja et al., 2020). Secondly, our reliance on a cross-sectional analysis fails to capture the temporal dimension of loan dispersion and brewery closures. We acknowledge these limitations and discuss them in greater detail in Section 7 of the manuscript.

5. Changes in annual production

With their reliance on on-premise consumption, we anticipate that most breweries experience a decrease in annual production from 2019 to 2020 (Scott, 2021; Watson, 2020a). According to Watson (2020a), the majority of breweries halted or slowed production by late March 2020, and most breweries anticipated having to make 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.

Craft beer can 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, for breweries that do not receive PPP, or for breweries that are waiting to be approved, there is no such incentive. This could then lead to further delays in production, translating to 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, we regress the change in YoY production from 2019 – 2020 on a vector of explanatory variables using traditional ordinary least squares. The key explanatory variable is an indicator variable that specifies 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 as early as April 2020 while second-round funds (third tranche) were not available until January 2021. Thus, second-round funds have no bearing on 2020 production levels. As was done when predicting a firm's operational status, we also include brewery segment and firm- and county-specific controls.

Using 2019 and 2020 production data for active breweries, we analyze how YoY performance varied as a function of PPP funding. The sample consists of 5,555 breweries,

and the results can be interpreted as the relationship between receiving first-round funding on YoY production conditional upon remaining in operation.[19] Table 5 presents these results.

[TABLE 5 HERE]

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. This translates to an average decline in production of 9.4% YoY compared to a 12.9% YoY decrease for those that do not receive 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 the inclusion of important control variables.

While these results may suffer from self-selection into the treatment group and other potential confounding effects, our results suggest a positive correlation between PPP funding and relative performance.

6. Quasi-experiment

6.1 Loan timing and YoY performance

It is important to consider how the timing of loan approval could impact changes in YoY production. We assess whether the timing of the loan approval impacts 2020 performance by exploiting the natural break between the first and second tranche of PPP funding (Doniger

[19] We also ran the described specification including breweries that were closed as of July 2021. Unsurprisingly, results were more pronounced when we include breweries that closed since these breweries saw drastic declines in YoY production. As a result, we believe our approach to be the conservative empirical decision and dampens our estimated results.

and Kay, 2022). Specifically, we develop a quasi-experiment that 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).

Based on the rationale that a brewery has an incentive to retain employees once they receive a PPP loan—which could shift production decisions—we anticipate the period between the first and second tranche of funding to be a critical window in determining YoY performance. Specifically, we hypothesize that firms that receive first tranche funding will experience smaller declines in YoY production than firms that had to wait until second tranche funding became available. If true, this would suggest that the timing of loan approval impacts a small business's YoY performance.

To motivate our framework, first recall that the first round of PPP funding consisted of two tranches, with 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 April 25 – 27, 2020 regarding their decision to apply for PPP funding. Critically, their data collection occurred after the first tranche funding expired but before the second tranche funding was distributed. 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 the first tranche of funding expired, yet their application was not approved (nor denied) until after the second tranche of funding was available.

While we lack the data on loan *submission* dates, Figure 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 the majority of loan recipients that receive second tranche funding between April 27 – May 3, 2020 submitted their PPP loan application when first tranche funding was still available.

Our quasi-experiment restricts attention to breweries that received funding between April 10 – 16, 2020 and April 27 – May 3, 2020.[20] Under the identifying assumptions that businesses who receive funding before the structural break and after the structural break are similar and that the delay in approval did not affect loan demand, we are confident in our ability to 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 and 626 observations with second tranche funding. Figure 4 shows the average production levels over time for our two groups.

[FIGURE 4 HERE]

Breweries that receive funding in the last seven days of the first tranche are larger than those that receive funding in the first seven days of the second tranche of PPP funding.

[20] We also restrict attention to breweries with production data from 2018 – 2020 to explore pre-trends We begin with the sample of 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). We also impose an upper-bound restriction on YoY production from 2018-2019 to mirror the restriction imposed on 2019-2020 YoY production changes. Lastly, we remove outliers that significantly skew our sample means by excluding breweries that produced below the 5th percentile (≤ 100 bbls) and above the 95th percentile (≥ 7,757 bbls) in 2018. Then, given the quasi-experimental setting, we only analyze observations with loan approval dates between April 10 – 16, 2020 or April 27 – May 3, 2020.

In aggregate, both groups experience growth from 2018 to 2019. The group that receives first tranche funding experiences, on average, 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 6 presents the results of the quasi-experiment where we regress the change in YoY production 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, we control for the loan approval amount, and we also include brewery-specific and county-level controls.[21]

[TABLE 6 HERE]

Results suggest that the breweries receiving first tranche funding between April 10 – 16, 2020 experience a decline in YoY production that is 2-3 percentage points smaller than breweries that received second tranche funding two weeks later. These findings are robust to the inclusion of brewery and county-specific controls. Intuitively, these results are appealing as we can consider a brewery's decision to adjust beer production based on

[21] County-level fixed effects are excluded given the sample size and diminished explanatory power. We also run the model presented in Table 6 with county-level fixed effects, and the magnitude of the point estimate is similar (0.025), though it loses statistical significance. By including the county-level FIPS codes in our regression, we are significantly reducing our explanatory power and increasing our 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.

whether they have received PPP funding. Watson (2020a; 2020b) suggests breweries shifted production schedules in March and April 2020. The decision to delay production between April 17 – 26, 2020 (i.e., the gap between tranches) is particularly attractive for breweries that do not receive first-tranche PPP funding. These breweries had experienced a decline in foot traffic and sales without governmental support. Therefore, breweries waiting for PPP funding may find it more economical to temporarily shut down or halt production until PPP funding arrives. But for breweries that did receive first tranche funding, they can 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.

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, which then yields a propensity score for each observation. The outcome variable for each treatment observation is then compared to that of control observations with similar propensity scores, and in doing so yields an average treatment effect on the treated (ATT).

In the quasi-experimental setting, we compare the change in YoY production for breweries that receive funding between April 10 – 16, 2020 (treatment) to breweries that

receive funding between April 27 – May 3, 2020 (control).[22] We first run a probit model that 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 were 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 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 4 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, we calculate the ATT using a variety of matching methods, including: (i) kernel matching; (ii) nearest neighbor matching; (iii) radius matching; and (iv) stratification matching.[23] Table 7 presents the ATT for each of the matching methods.

[TABLE 7 HERE]

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

[23] 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.

We find an ATT ranging from three to four percentage points, a range that coincides with our results presented in Table 6. In other words, compared to their matched controlled observations, breweries that receive the first-tranche PPP funding see a smaller decline in YoY production by three to four percentage points. 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.

These results increase confidence in the quasi-experimental estimates presented in Table 6 and allow us to suggest towards a causal impact of the timing of the PPP loan approval on YoY performance.

6.3 Longer-run production changes

The short-run relationship between PPP funding and changes in 2019-2020 production is this study's primary contribution. From a policy perspective, however, it is also important to explore the longer-run relationship between PPP funding and recovery. With 2021 production data now available for a subset of observations, we provide a brief, exploratory assessment of how receiving a first-round PPP loan relates to brewery production from 2019 – 2021.

Using the quasi-experimental sample, Figure 4 suggests that amongst this group there is a short-term benefit to receiving the PPP funding earlier (as discussed previously). However, the benefit appears to dissipate once we are a year removed from the shock. In other words, breweries that receive first tranche funding see a decline in 2019-2020 YoY production that was approximately three percentage points smaller than breweries that received second tranche funding. But when considering the overall change in production from 2019 – 2021, however, both groups appear to have recovered to pre-pandemic production levels, on average.

It is critical to once again stress that these insights are exploratory. We can accurately construct a quasi-experiment that assesses the short-term impacts of PPP (Doniger and Kay, 2022), but more work is needed to understand longer-term impacts. 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 to be 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.

7. Limitations

We identify two central limitations to our study. First, our analysis is limited by data availability. Specifically, we rely on a cross-sectional dataset, whereas a panel structure that accounts for temporal variation in closure dates would enable a more compelling causal interpretation for our LPM results. Unfortunately, we lack closure dates for all breweries classified as either temporarily or permanently closed in our 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, within the SBA dataset on PPP loan recipients, we observe only the loan approval date and not the date when the loan application was submitted. It is reasonable to suggest 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 we 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 had the same probability of survival as firms that do not receive PPP funding. Nor can we state 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

666 production, we cannot observe the firms' economic conditions before the pandemic, and any
667 further discussion would be speculation.
668 With these limitations, it is plausible to question whether the breweries that received
669 PPP funding would have survived without PPP. Given the different production levels and
670 growth rates between those that receive PPP funding and those that did not, it is also possible
671 that the breweries that experienced smaller declines in production were in a better position
672 to adapt to production shocks from COVID-19 irrespective of PPP funding. Thus, while the
673 results suggest a positive relationship between PPP funding and small business
674 performance, questions remain about the efficiency and equality of the loan distribution
675 mechanism as well as the program's causal impacts.
676
677 **8. Discussion and implications**
678 The *I Can't Go Anywhere But Here IPA* by Proclamation Ale Company and *Zoom Casual IPA* by
679 Denver Beer Company are just two of the COVID-19-inspired beverages created by small,
680 independent breweries that have thus far survived the pandemic. However, not all small
681 businesses were fortunate enough to outlast the early economic turmoil generated by the
682 pandemic. Analysis suggests that the number of business owners in the United States fell by
683 22% from February to April 2020 (Fairlie, 2020), and business closures were 25-33% higher
684 in 2020 than in pre-COVID trends (Crane et al., 2020). As such, it is critical to explore whether
685 the federal policies that provided economic relief to small businesses hit their mark.
686 The results suggest that receiving a PPP loan is associated with a higher probability
687 of business survival and smaller declines in YoY production volume. These results are in line
688 with previous findings on the PPP, where studies have suggested that PPP funding has led to

689 a higher probability of survival (Bartlett III and Morse, 2020; Hubbard and Strain 2020),
690 better employment outcomes (Bartik, Cullen, et al., 2020; Doniger and Kay, 2021), and
691 smaller reductions in revenue (Li, 2021). More generally, our findings also coincide with the
692 notion that sales for the hospitality and accommodation industries decreased substantially
693 during the COVID-19 pandemic (Fairlie and Fossen, 2021b).

694 Industry reports support these findings, too. The craft beer industry experienced a
695 9.3% decrease in volume, a 22% loss in dollar sales, and a 1.6 percentage point decline in
696 market share from 2019 to 2020 (Brewers Association, 2022d; Scott, 2020; 2021). Industry
697 reports and anecdotal accounts have also highlighted the disproportionate effect the
698 pandemic has had on brewpubs (Brewers Association, 2022d; Watson, 2022). Despite these
699 statistics and the widespread concern from craft brewers at the start of the pandemic
700 (Watson, 2020a; 2020b), brewery closures have been lower than expected (Brewers
701 Association, 2022d). This ability to weather the storm is likely attributable to innovation,
702 entrepreneurship, and government support (Fairlie, 2013; Watson, 2022).

703 Even within a single industry, different market segments may have been
704 disproportionately impacted by the pandemic. In the context of craft beer, brewpubs closed
705 at higher rates and experienced a steeper falloff in YoY production volume from 2019 to
706 2020. This result is likely indicative of their inability to pivot to alternative packaging
707 channels and distribution methods due to either financial or technological constraints
708 (Watson, 2022).[24] Of course, the COVID-19 pandemic is a once-in-a-century outbreak and the

[24] 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

speed at which the economic damages were felt made planning and preparation for this crisis particularly difficult. While most businesses were forced to adjust their business to the new environment, some businesses within an industry could have been more vulnerable to the shock given to their pre-pandemic business model.

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 in 2020 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 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).

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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 their original business model.

To our knowledge, we are the first to merge a verified industry dataset with the SBA data on PPP loan recipients. In doing so, we provide a methodological overview and speak to the challenges associated with achieving our 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 instances, the borrower would list their name or their official company name rather than their trading name (i.e., *doing-business-as* name). This inconsistency meant imperfect information in the merging process, which then required the manual merging of data sources based on addresses and analysis of a company's trademarks.[25] Juxtaposing the PPP application with the Economic Injury Disaster Loan (EIDL) program 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 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

[25] Given the number of craft breweries in the United States, our manual matching procedures was practical. For a larger industry, such as matching across an industry dataset of all full-service restaurants, would be feasible, but more time consuming. However, the extra attention to remove improperly coded observations based on NAICS codes as well as potentially fraudulent observations allows for a more accurate representation of the impact of the PPP.

observations. While our attention is on the craft breweries—an industry that has its own six-digit NAICS code—we necessarily analyzed observations across three different NAICS codes. If we limited attention to the six-digit NAICS code for breweries (312120), we would have captured just 63% of our total matched PPP loan observations—severally underestimating the number of loan recipients. There were also several instances where breweries applied for both rounds of funding through the same bank yet were coded in different NAICS codes across the two applications (i.e., coded in NAICS 312120: Breweries in the first round and coded with 722410: Drinking places in the second round). Observations were also incorrectly into our 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, and so 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, our 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 that we received from the Brewers Association.

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, we explore the role of PPP funding on small business performance. Breweries that receive PPP funding are more likely to remain in

769 operation and experience a smaller decrease in YoY production. Further, through a quasi-
770 experiment that exploits a natural break in the loan program, we demonstrate that the timing
771 of loan approval likely affected YoY performance. While we lack a full causal interpretation,
772 our analysis provides support for a positive correlation between PPP funding and small
773 business performance.

774 Several avenues remain for future research. While previous studies have explored the
775 employment effects of the PPP (e.g., Autor et al., 2022a; Chetty et al., 2020; Hubbard and
776 Strain, 2020), future work should link PPP and employment outcomes with YoY performance
777 or sales data to better understand the dynamic relationship between outcomes. The stated
778 objective of the PPP was to keep workers on payroll, but in this study, we evaluate
779 performance based on changes in annual production: a secondary policy outcome, but a
780 primary concern for small businesses. The current analysis is limited by data availability,
781 and future studies that causally link receiving PPP funding to employment and production
782 outcomes would significantly improve our understanding of the program's effectiveness.
783 Additionally, researchers have explored equality concerns over the distribution of PPP
784 funding, but much remains unknown about the short- and long-term effects of the first-come,
785 first-served approach of the loan program. For example, researchers could examine network
786 effects in the PPP loan program across time, exploring PPP loan clustering and addressing
787 the role of social networks. Lastly, future work should examine the impact of COVID-19 and
788 the PPP on new businesses or businesses in planning. This line of research could provide
789 critical insights into the roles of economic circumstances, government support, and
790 entrepreneurship on new business performance during COVID-19.

The PPP provided support to small businesses across the country, and we 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, but as more researchers explore this line of research, we will gain a much clearer insight into the impact of the PPP on small businesses.

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Tables and Figures

Table 1. PPP eligibility criteria and key information, by tranche

	1st round		2nd round
PPP overview	**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 calculated as 2.5x the average monthly payroll for most businesses. However, businesses in accommodations and food services were allowed to use 3.5x the average monthly payroll.

Table 2. Active brewery locations and temporary and permanent closures as of July 2021 by market segment (n=8946)

			Closures after April 3, 2020 (% closed)		
Brewery segment	**# of breweries**	**Active**	**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, and so our 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.

Table 3. Summary statistics disaggregated by PPP funding

		PPP funding				
Variable	**Population**	**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, we restrict attention to observations that saw between a -100% and +100% change in YoY production from 2019 to 2020 to exclude outliers. In total, we analyze data from 5,877 observations, 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 as are follows: 1st round only (2,059), 2nd round only (507), both rounds (2,369), and none (3,907).

Table 4. Linear probability model predicting brewery operational status (open or closed) 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.

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

Table 5. Change in brewery annual production from 2019 to 2020 as a function of whether the brewery received 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.

Table 6. Quasi-experimental results on change in brewery annual production from 2019 to 2020 as a function of whether the brewery received *late* first-tranche funding (April 10 – April 16, 2020) or *early* second- tranche funding (April 27 – May 3, 2020)

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.

Table 7. Propensity score matching results

	# of observations used				
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.

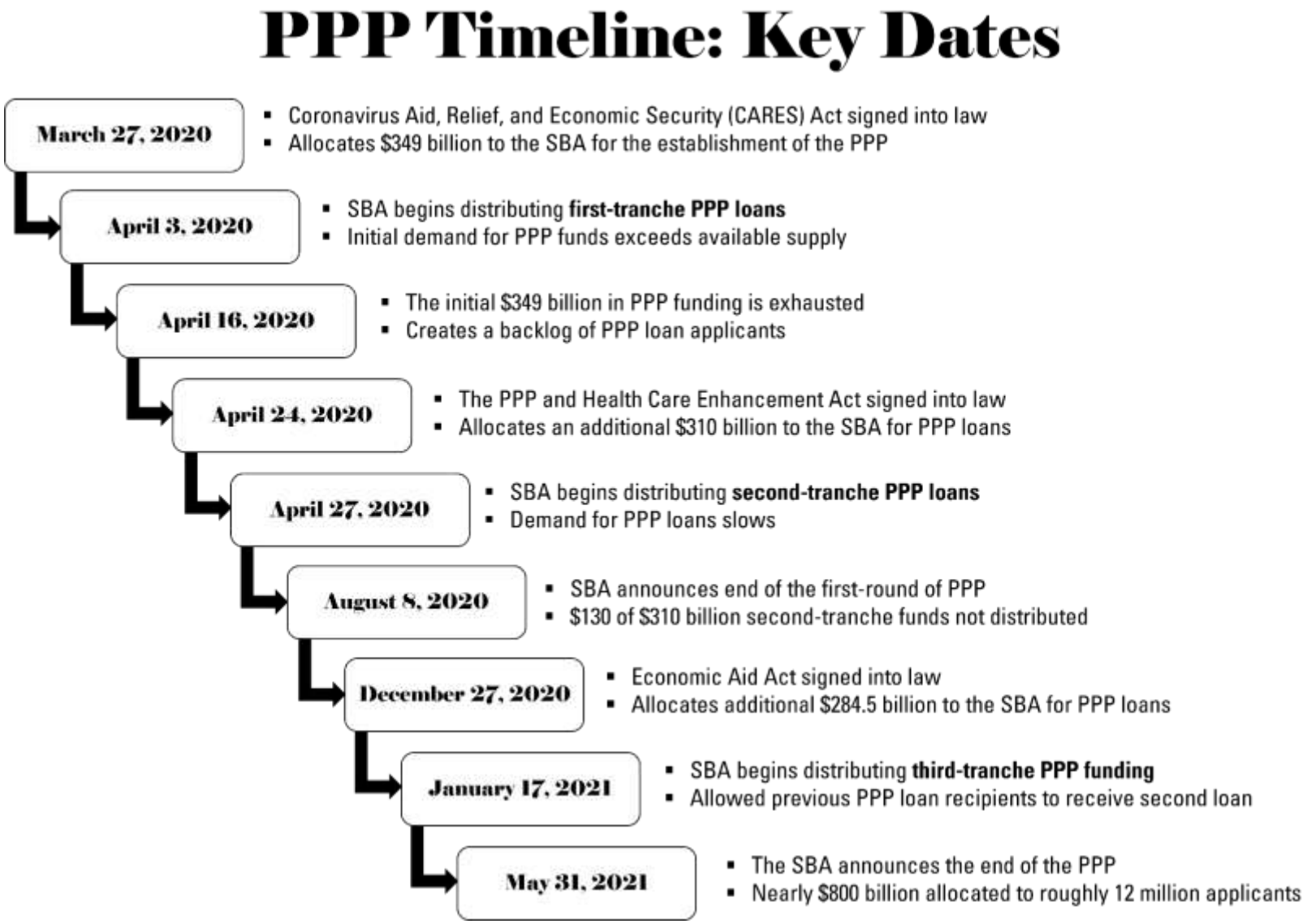
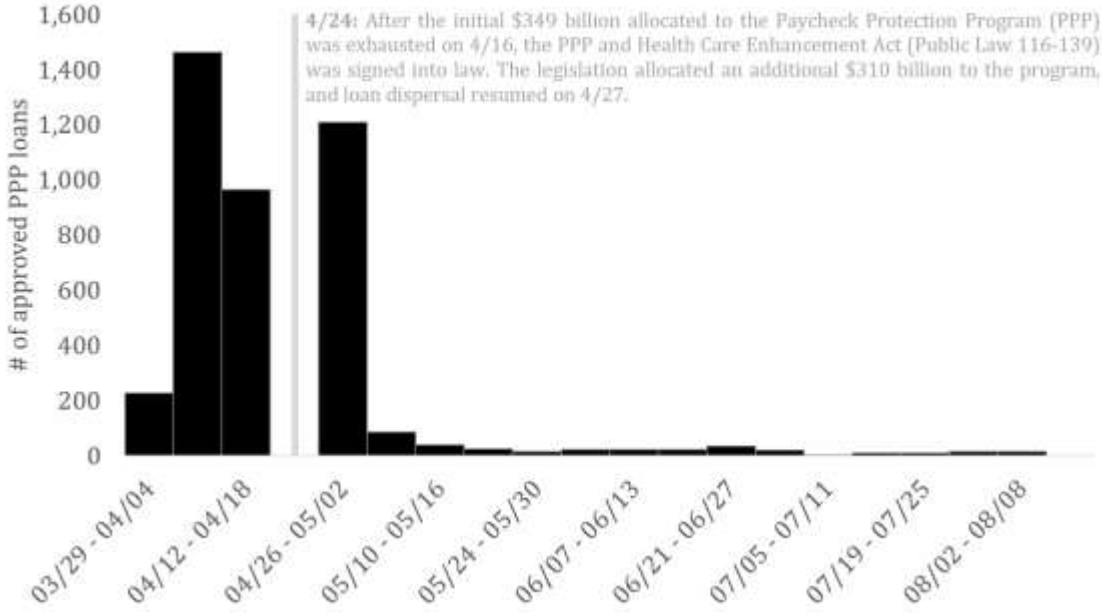


Figure 1. Timeline of key dates in the Paycheck Protection Program (PPP)

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

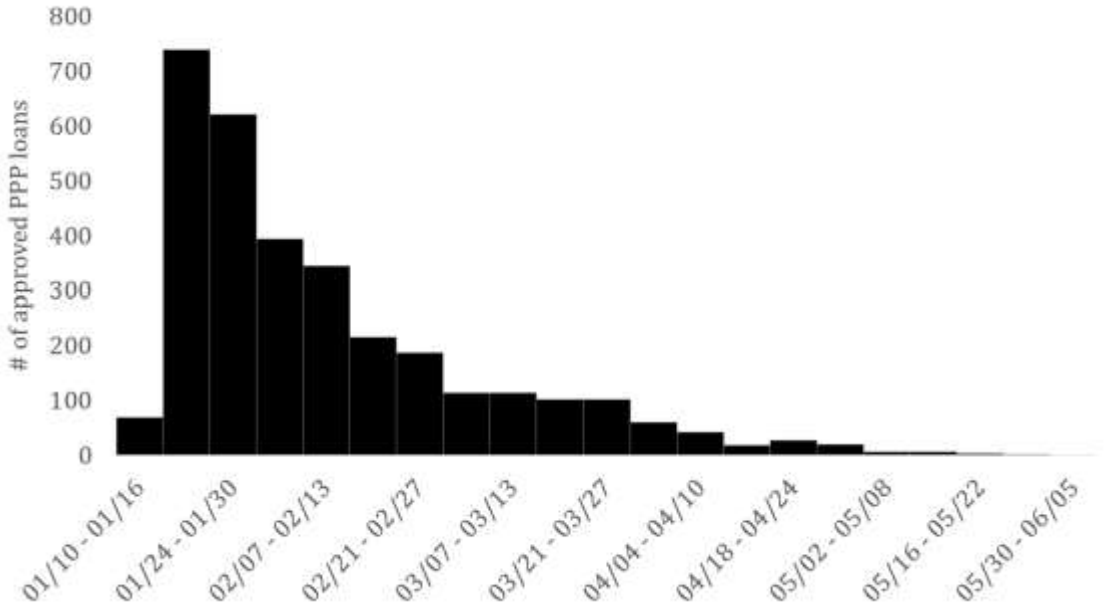


Figure 2. Timing and frequency of PPP loans to breweries, by week

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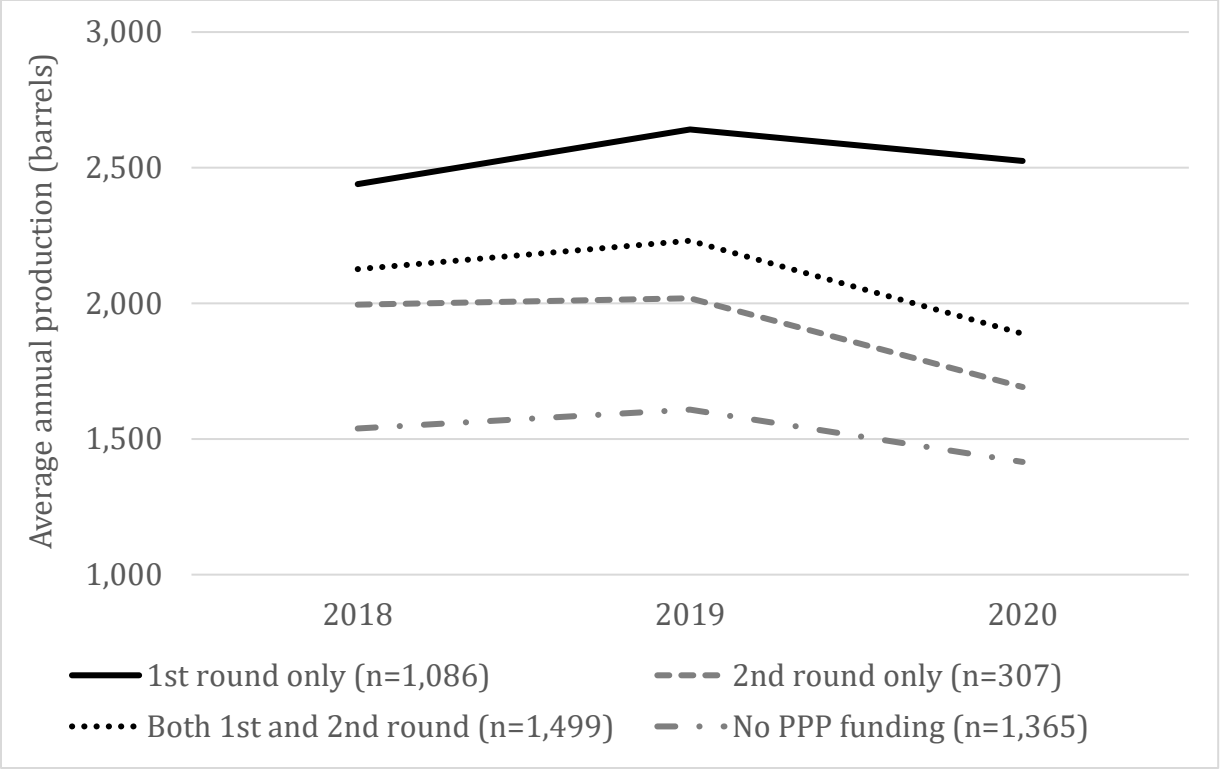
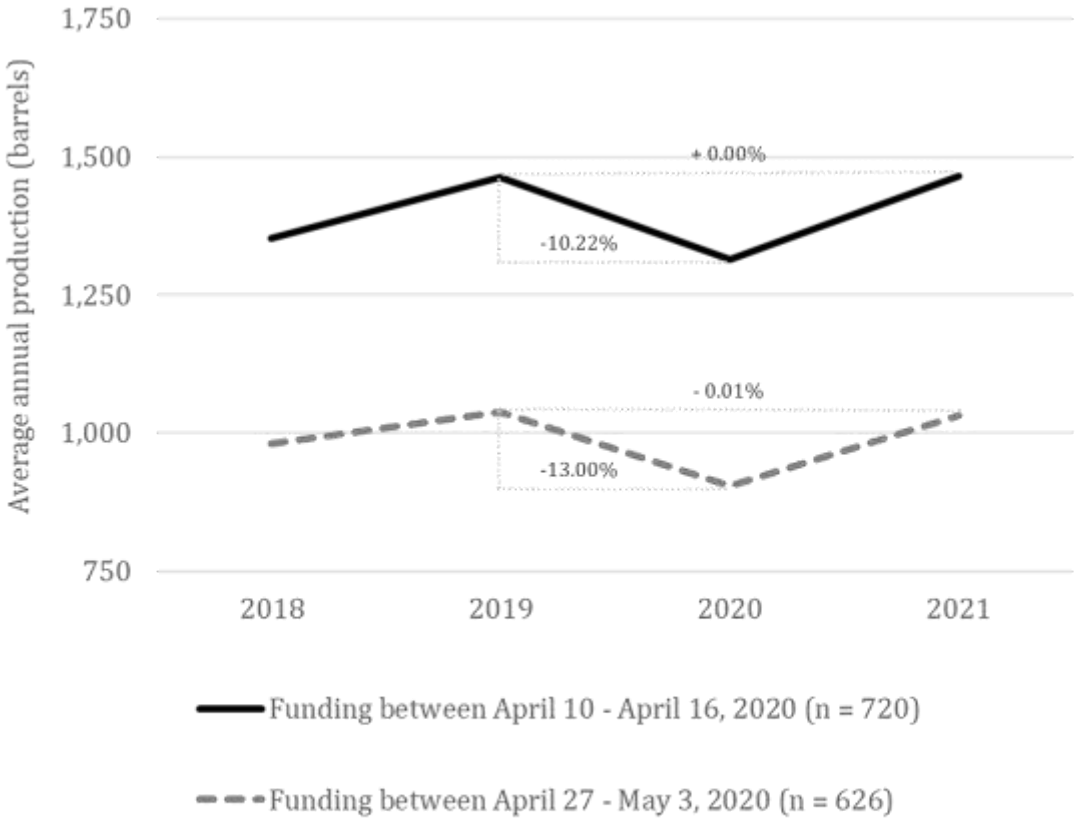


Figure 3. Average annual production (barrels/year) by PPP funding, 2018-2020 (n = 4,257)



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 4. Average annual production (barrels/year) of breweries that received PPP funding between April 10 – 16, 2020, and April 27 – May 3, 2020 (n = 1,346)

Appendix

1. Additional data on brewery closures

Table 2 of the manuscript presents the percentage of breweries that were listed as temporarily or permanently closed in our dataset as of July 2021. Importantly, our dataset only includes closures that occurred after April 3, 2020, the starting date of first tranche 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, we are removing closures that occurred during the first three months of 2020, 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 A1 presents the number of brewery closures and the closure rates over the past 11 years.

Table 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 not available at Brewers Association (2022).

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%, and this 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 manuscript, we present 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 we can use this data to further support our claims that brewpubs were disproportionately affected by COVID-19.

Figure A1 presents the closure rates by industry segment, comparing brewpub closures to microbreweries and taprooms closures.[26] Note that the distinction between microbreweries and taprooms was not made until 2019, and so the Brewers Association aggregates closures across these two segments from 2010 – 2018. For ease of interpretation, we aggregate microbrewery and taproom closures from 2010 – 2021.

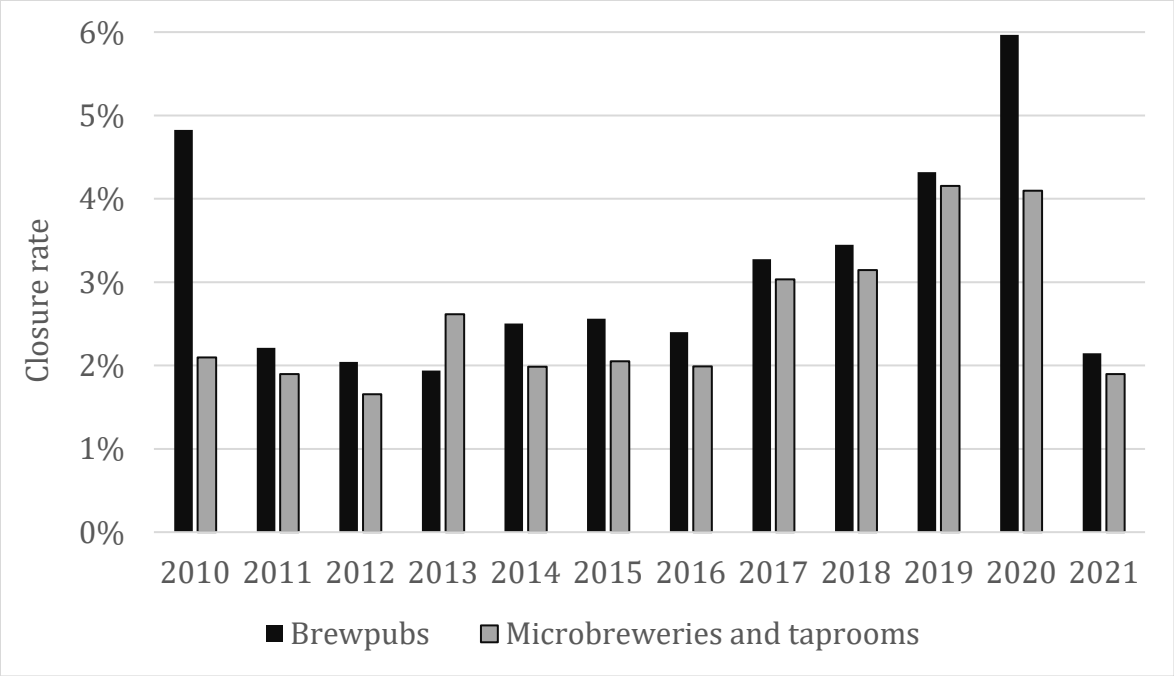


Figure A1. Closure rate over time by industry segment, brewpubs v. microbreweries and taprooms, Source: Brewers Association (2022)

Outside of 2010, when there were only a total 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; oftentimes 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 when compared to microbreweries and taprooms.

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

2. Penalized logistic regression

Table 4 of the manuscript 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 that lie outside the zero-one range implied by the binary outcome variable. Here, we present 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).[27]

Table 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 . Additionally, brewery production data only exists for a subset of the observations.

[27] 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.

Results are fairly consistent with the results presented in Table 4 of the manuscript. 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, we again see evidence that brewpubs, on average, are more likely to close. This result is consistent with the data presented in Table 4 as well as when examining year-over-year (YoY) production data. The coefficient for microbreweries is not distinct from zero, and the coefficient for regional breweries remains insignificant.

3. Propensity score matching

In Table 6 of the manuscript, we present suggestive evidence that the timing of the Paycheck Protection Program (PPP) loan approval likely had an impact on 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, in Figure 4 of the manuscript, we demonstrate that firms that received the earliest funding were, on average, larger and growing at a faster rate 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 our 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 that have a similar propensity score (i.e., a similar probability of being placed in the treatment). Through these comparisons, the average treatment effect on the treated (ATT) is determined. Empirically, this is estimated as:

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

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.

In the quasi-experimental setting, we are interested in comparing the change in YoY production for 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). Our sample consists of 1,346 breweries: 720 treated breweries

and 626 control breweries. To initiate matching, we first run a probit model that predicts 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 3.4 of the manuscript, we saw that 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. We also include 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 A3 presents the probit model output.[28]

Table A3. 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.

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

Interestingly, county-level COVID-19 cases as of April 3, 2020 is 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 at predicting treatment meaning that growth rates did not sufficiently predict treatment. Note, this finding lends credibility to the validity of the quasi-experiment results with regards to pre-trends. Lastly, 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.

The predicted values are our propensity scores for each treatment observation *i* and control observation *j*. Observations are then stratified into blocks based on their propensity score, where the number of blocks is determined by the statistical package. The data were stratified into nine blocks over a common support of [.207, .810] to allow for the removals of outliers. Table A4 presents the inferior bound for each block as well as the number of control and treatment observations placed in each.

Table A4. Inferior bound and the number of treated and controls for each 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). Importantly, the stratification here achieves the balancing property, and we use this analysis 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 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. We present the ATT for each of the four different matching procedures in Table A5.[29]

Table A5. 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-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.[30]

With these results, we see 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.

[29] 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.
[30] 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.