Did PPP Loans Distort Business Competition? Evidence from the Hotel Industry*

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Abstract

We study the effects of PPP loans on business competition. Hit hard by the Covid-19 pandemic, the U.S. airport hotel industry offers a useful empirical setting in which we observe daily prices (room rates), market shares (occupancy), and demand (airport traffic). Older and less profitable hotels were more likely to apply for PPP loans. Hotels with active PPP loans reduced average daily rates, boosting occupancy and revenues per available room compared to competitors without PPP loans. PPP hotels reduced room rates more swiftly and aggressively in response to negative demand shocks and to price drops by non-PPP competitors. Those differences between PPP and non-PPP hotels were reversed once PPP loans expired. We rationalize our findings by introducing temporary cash subsidies into a model of monopolistic competition with differentiated products and heterogeneous production costs. Combining key model constructs with our empirical estimates, we calculate that for the U.S. airport hotel industry in aggregate, with every dollar of PPP subsidies spent, hotels that obtained PPP loans earned 72.3 cents in extra profits and those without PPP loans lost 70.5 cents. Those estimates imply that every dollar of extra profit to a given hotel with a PPP loan cost a given non-PPP rival 18.6 cents. The insights of our model apply to many other sectors of the economy.

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1 Introduction

The Covid-19 pandemic that emerged in 2020 has caused a deep, global economic crisis.[1] The U.S. government has responded to this crisis with an emergency set of economic relief measures on a near-unprecedented scale. A key part of the government's $2 trillion Coronavirus Aid, Relief, and Economic Security (CARES) Act, passed in March 2020, was the Small Business Administration's Payroll Protection Program (PPP).[2] The PPP was designed to provide financial support for small businesses, helping them to remain afloat and to reduce layoffs during the onset of the Covid-19 pandemic. This program itself was enormous in magnitude, with $525 billion worth of federal loans approved by August 2020.[3] Given the significant cost of this recent government intervention, it is natural to ask whether the PPP was effective in containing the economic damage caused by the Covid-19 pandemic. While several recent papers have begun to address this important question, the degree to which PPP loans affected business competition has not been studied in detail.[4]

We outline our theoretical priors about how PPP loans may affect business competition using a model of monopolistic competition with differentiated products based on the circular city framework by Salop (1979). We adapt the circular city model to analyze firms' PPP loan application choices and their subsequent price setting decisions. The first key ingredient for our analyses is that, as in Syverson (2004), firms face heterogeneous production costs. On that basis, we model the benefits of obtaining PPP loans as temporary reductions in firms' marginal production costs. This set-up allows us to derive novel implications for equilibrium market outcomes during the period when PPP loans are active. Notably, firms with PPP loans will reduce their prices, capture larger market shares, and earn higher profits than will their competitors without PPP loans. Those effects will be reversed once PPP loans expire. However, obtaining PPP loans in the first place is not cost-less for firms. That is the second key ingredient for our analyses. We model firms' choices to apply for PPP loans as a trade-off between the expected benefits of obtaining those loans (in terms of lower marginal production costs) and a perceived cost that reflects potential

[1] Numerous studies analyze the negative economic impact of the Covid-19 pandemic in terms of industrial production (Ludvigson et al., 2020), asset returns (Jordà et al., 2020), economic uncertainty (Altig et al., 2020; Baker et al., 2020), household expectations (Coibion et al., 2020), aggregate consumption (Eichenbaum et al., 2020), welfare losses due to shutdowns (Mulligan, 2020), and labor market outcomes (Cajner et al., 2020; Forsythe et al., 2020), among others. Brodeur et al. (2021) provide a review of this fast-emerging literature.

[2] Detailed information about the PPP provided by the Small Business Administration may be found here.

[3] The Small Business Administration announced that the PPP was to reopen in 2021. See here for details.

[4] See, e.g., Bartik et al. (2020), Granja et al. (2020), Hubbard and Strain (2020), Li and Strahan (2020), Neilson et al. (2020), Agarwal et al. (2021), Fairlie and Fossen (2021), and Howell et al. (2021).

reputational damage, the risk of future government audits, and the fear of tighter regulations (see Balyuk et al. (2020) for evidence on firms' concerns around accepting PPP loans during the Covid-19 pandemic). We show that, in this setting, the likelihood of firms applying for PPP loans depends on the levels of their marginal production costs and on the magnitudes of the negative demand shocks they experienced. The predictions of our model regarding PPP loan application choices and firms' competitive strategies following the receipt of PPP loans are, to our knowledge, novel to the literature and invite empirical validation.

We examine the evidence for the testable implications derived from our theoretical model in the U.S. airport hotel industry. We believe that this industry provides us with a useful experimental setting in which to conduct our empirical analyses. For one, we can readily observe close proxies for the cross-sectional drivers of hotels' PPP loan application choices derived from our model. Those proxies include accounting measures of pre-pandemic profitability and hotel age. We also observe other key factors differentiating airport hotel products, such as, hotel location, quality class, size, and brand affiliation. Further, we can measure negative demand shocks experienced by airport hotels using daily data on airport traffic in their respective locations. Importantly, hotels set the prices for their products on a daily basis (daily room rates). Our data include those daily prices as well as the corresponding market shares (daily occupancy rates). The availability of those high-frequency observations on hotel pricing and market shares allows us to isolate the impact of PPP loans on hotels' competitive strategies. We do so by comparing the daily price setting policies and associated market shares of *the same* hotels *relative* to their local competitors during 2020, before and after those hotels receive PPP loans. Our empirical setting thus alleviates the endogeneity of hotels obtaining PPP loans. This circumstance, in turn, enables us to draw clean causal inferences about the effects of PPP loans on hotels' competitive strategies.

We first document the cross-sectional determinants of airport hotels' PPP loan application choices. Consistent with the central predictions of our model, we show that older hotels, those with weaker pre-pandemic profitability, and those that experienced larger negative demand shocks in their local airport markets were significantly more likely to apply for PPP loans. Although not a formal prediction, we further document that, in the spirit of our model, hotels operating in more competitive markets were also more likely to apply for PPP loans. Lastly, we show that significant declines in airport traffic at the beginning of 2020 prompted airport hotels in affected markets to apply for PPP loans sooner than their otherwise equivalent peers. Our results suggest that such declines in airport traffic served as early warning signals to local airport hotels about the impending negative demand shock from the Covid-19 pandemic.

Turning to the analyses of hotel competitive strategies during the Covid-19 pandemic, we show that airport hotels operating under the protection of active PPP loans significantly reduced their average daily rates. As a result, those hotels were able to boost their occupancy rates (market shares) and revenues per available room (short-term profits) compared to their peers without PPP loans. Those competitive strategies are reversed after airport hotels lose the protection afforded by PPP loans. Notably, once PPP loans expire, former PPP hotels raise their average daily rates to pre-PPP levels, at the cost of lower occupancy rates and lower revenues per available room. Those findings are consistent with the testable hypotheses derived from our model.

Lastly, we use daily data on hotel room rates to document the competition dynamics across airport hotels. Specifically, we compare the responses of hotels with and without PPP loans to two types of external shocks: a sharp decline in demand and a significant drop in average daily rates by competing airport hotels. Our results indicate that hotels with active PPP loans reduce their room rates more swiftly and more aggressively in response to negative demand shocks and in response to price drops by their competitors. In the days following such shocks, PPP hotels reduce their room rates quickly and decisively, forcing their competitors to keep their own rates lower for longer. Again, those competition dynamics are reversed once hotels' PPP loans expire. At that point, the competitive strategies of former PPP hotels become indistinguishable from those of other hotels operating without PPP loans.

The empirical results presented align with the intuition of our model, in which firms make strategic decisions to obtain PPP loans in order to alter the conditions of future competition in a manner favorable to them. Hotels with weaker pre-pandemic profitability have fewer concerns about future costs associated with obtaining PPP loans and use those loans to improve their standing against stronger local competitors. The strategic effect of obtaining a PPP loan in a setting with monopolistic competition is equivalent to an investment in a marginal cost reduction, which leads to aggressive competitive strategies. With lower marginal costs, it is optimal for firms with PPP loans to produce more output than their rivals, resulting in lower market prices. Firms with higher marginal costs (those without PPP loans) are forced to reduce their output and experience higher losses (lower profits) than they would in an economy without PPP loans available to their competitors. The intuition of our model and the supporting empirical evidence from our data analyses suggest that the provision of PPP loans resulted in a significant distortion of business competition in favor of the firms accepting those loans.

In the final step of our study, we quantify the relative costs and benefits resulting from the PPP in terms of firm profits. We do this by combining the insights from our theoretical model with key estimates derived from the empirical analyses of the firms in the U.S. airport hotel industry. Specifically, we compare hotel profits with PPP loans against the counterfactual profits those hotels would have earned in the absence of PPP loans, by rewriting the profit equations in terms of the hotels' price and market share ratios that we estimate empirically. On this basis, we estimate that every dollar spent by the government on the PPP led to 72.3 cents in extra profits to airport hotels that obtained PPP loans. At the same time, every dollar spent on PPP loans cost airport hotels that chose to forgo those loans 70.5 cents in lost profits. Those estimates imply that the net benefits of the PPP for the airport hotel industry total 1.8 cents per dollar spent on the program. The remaining 98.2 cents of the surplus accrued to consumers, who benefited from lower prices charged by hoteliers in this industry. On balance, we calculate that for every dollar of profits earned by a given hotel with a PPP loan, the losses in profits earned by a given rival without a PPP loan amount to nearly 19 cents.

Our paper contributes to the growing literature on the economic effects of the PPP. Agarwal et al. (2021), Granja et al. (2020), and Hubbard and Strain (2020) assess the program's effectiveness in supporting small businesses. Neilson et al. (2020) show that information frictions and the "first come, first serve" design of the PPP reduced its effectiveness. Bartik et al. (2020) show that delegating the distribution of PPP funds to private banks was likely justified, given the high costs of delays in access to PPP loans under alternative channels. Li and Strahan (2020) provide evidence of intermediation frictions in PPP loan distribution, where PPP loan supply reflects traditional measures of relationship lending. Howell et al. (2021) and Fairlie and Fossen (2021) explore disparities in the distribution of PPP funds by borrower race and minority status, respectively. Balyuk et al. (2020) document firms' reluctance to accept PPP loans, driven by concerns around heightened government scrutiny. We add to this work by documenting a novel, economically significant indirect cost of the PPP, namely, the distortion of business competition.

We also contribute to the literature on monopolistic competition based on the circular city model of Salop (1979). Prior studies employ this model of monopolistic competition (with differentiated products and heterogeneous production costs) to analyze market entry decisions by firms (see, e.g., Syverson, 2004). We expand on such prior studies by introducing temporary cash subsidies into the model to explore the consequences of government-sponsored financial support for firms on their competitive strategies. We derive novel implications about the economic effects of PPP loans such as application decisions, price setting, market shares, and resulting profits of firms with and without PPP loans. Importantly, our theoretical framework can be used to study the effects of other types of subsidies in monopolistic competition more widely.

In practical terms, it is often difficult to quantify the indirect effects of subsidies on firm profits that arise from the associated distortions of business competition. As a final contribution of our paper, we provide a novel approach for computing the effects of subsidies on the extra (lost) profits of firms that obtain (forgo) government-sponsored financial support. Of course, our specific numerical estimates of those effects refer to the U.S. airport hotel industry. The estimated effects on firm profits in this industry are large—likely owing to its highly competitive nature with daily fluctuations in prices and output. Nevertheless, given suitable empirical estimates for the effects of subsidies on firm's prices and market shares, our approach can be applied to evaluate the indirect effects of subsidies on firm profits stemming from distorted competition in many different industries and sectors of the economy.

We proceed as follows. In Section 2, we outline several relevant features of the PPP. Section 3 contains the model and testable implications. In Section 4, we present details on data and sample selection. We discuss the empirical results on PPP loan application choices in Section 5, those on hotels' price setting decisions in Section 6, and those on competitive dynamics between airport hotels in Section 7. We derive estimates of the relative costs and benefits of the PPP in terms of (lost) firm profits in Section 8. Section 9 concludes.

2 Background on PPP Loans

Our approach to modeling PPP loans relies on several salient features of this government-sponsored program. First, as we will formalize in Section 3, we model PPP loans as *temporary* financial support to eligible businesses. In support of this assumption, we note that PPP loan proceeds were required to be used within 24 weeks of disbursement or by the December 31, 2020, whichever was sooner.[5]

Further, we treat PPP loans as temporary cash *subsidies* to businesses, so it is important to note that PPP loans were fully forgivable.[6] Despite the fact that PPP loans were forgivable, we will argue that firms anticipated a future cost associated with obtaining PPP loans. This cost may be due to damages

[5]This rule is referred to the the Covered Period by the SBA, see here for details.
[6]See SBA note on PPP loan forgiveness here.

to firm reputation, future government audits, and regulations associated with accepting taxpayer-funded financial assistance. For example, some hotel companies returned PPP funds after receiving negative press following the receipt of PPP loans for which they were officially eligible.[7] Further, government officials threatened PPP loan applicants with audits.[8] In addition, the history of the 2008 bailout shows that accepting government funds can be costly for shareholders and top executives. During the Great Recession, the government *retroactively* imposed pay limits for top earners at firms receiving federal cash—including those that already received it.[9] Moreover, shareholders of several companies complained that the terms of the 2008 bailout were unfair to them and even sued the U.S. government over the bailout.[10]

We conduct the empirical tests of our model's predictions about the effects of PPP loans on business competition in the U.S. airport hotel industry. Thus, it is important to verify that we can reasonably expect the majority of the businesses in this industry to be eligible for PPP loans. The Small Business Administration (SBA), which was tasked with implementing the PPP, states that any small business concern that meets the SBA's size standards may qualify for the loan program. The size standard for businesses in the hotel and motel sector (NAICS 721110) is $35 million in annual revenues.[11] We note that the average total revenues for businesses in the hotel and motel industry as of 2018 were less than $2.4 million—well below the SBA's required size standard.[12] Moreover, the SBA made a special exemption for hotel businesses, allowing 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 workers per location to be eligible for PPP loans. We note that the average hotel in our data had pre-pandemic staff of approximately 130 employees at the end of 2019.

The SBA loan-level data we use in our analyses of the PPP only include information on loan approvals. Thus, we do not technically observe all PPP loan applications, as some of them may have been rejected. However, rejections of PPP loan applications were relatively rare and occurred mostly when the initial funding amount was exhausted (before it was replenished), in the event that applications contained incomplete or incorrect information, or when they were considered fraudulent, e.g., submitted by businesses that failed to meet PPP eligibility criteria.

[7] Hotel Group Will Return Tens of Millions in Small Business Loans, New York Times, September 15, 2020.

[8] At Least 30 Public Companies Say They Will Keep PPP Loans, Wall Street Journal, May 19, 2020.

[9] Bankers Face Strict New Pay Cap, Wall Street Journal, February 14, 2009.

[10] AIG shareholders win class-action status in lawsuit versus U.S., Reuters, March 11, 2013.

[11] We refer to the details on the SBA's Small Business Size Regulations outlined here and here.

[12] We obtain this statistic by dividing the total revenue of the U.S. hotel industry in 2018 of $218 billion (see here) by the total number of hotels operating in the U.S. in that year of approximately 91,000 (see here).

This review of PPP eligibility criteria, usage requirements, rules around formal loan forgiveness, and perceived costs gives us some confidence that our analyses rest on plausible assumptions about the nature of this government-sponsored program.

3 Model

In this section, we develop a model of monopolistic competition with differentiated products based on the circular city framework of Salop (1979). Following Syverson (2004), we introduce heterogeneous production costs into the model. Unlike Syverson (2004), who focuses on market entry decisions, we use our model to analyze firms decisions to apply for PPP loans and their price setting decisions with and without PPP loans.

We start by outlining the basic model. We will use this model to analyze market equilibria at four different times. We will refer to the period before the Covid-19 shock as time 0. Time 1 is a period immediately after the Covid-19 shock, during which PPP loans are active. Time 2 is a period immediately after PPP loans expire, but before the long-term implications of the Covid-19 shock are known to market participants. Time 3 corresponds to a long-term equilibrium in the aftermath of the Covid-19 shock.

3.1 Basic Model

We set up the basic model as of time 0. With appropriate modifications, this set up will apply to other times as well. At time 0, there are n firms, $i = 1, ...n$ each selling one product which is differentiated in the brand space from other products. There is a continuum of consumers whose preferences are evenly distributed around a circle of unit circumference with a density of D_0 consumers per unit length. Consumers have inelastic demand for one indivisible unit. We assume for simplicity that their utility u is high enough to ensure that all consumers purchase in equilibrium.

Consumer net utility is equal to $u - \theta x - p$, where p is the price paid to the firm for the unit, $x \geq 0$ is the length of the arc between the brand and consumer ideal preferences, and θ represents a disutility rate associated with deviations from customer tastes. Alternatively, we can interpret disutility θx as a transportation cost for a customer who has to travel distance x to a firm while paying θ per unit of distance. In either case, the effective cost p' faced by a consumer is equal to

$$p' = p + \theta x. \tag{1}$$

The competing firms are equally spaced around the preference circle, i.e., they are located $1/n$ apart from their closest neighbors[13]. For any two neighboring firms i and j, the indifferent consumer is located at a distance x^{ij} from i, where x^{ij} solves

$$p_0^i + \theta x^{ij} = p_0^j + \theta(\frac{1}{n} - x^{ij}), \tag{2}$$

and p_0^i and p_0^j are prices set by firms i and j, respectively. Solving (2) yields

$$x^{ij} = \frac{p_0^j - p_0^i}{2\theta} + \frac{1}{2n}. \tag{3}$$

Firms pay heterogeneous marginal production costs c_i. We focus on heterogeneity in marginal costs since they are directly affected by PPP loans, while assuming a common fixed cost f. As in Syverson (2004), we analyze an equilibrium in which firms set their prices without knowing their rivals' costs or prices[14].

Let $E_0(p_0)$ be the expected price charged by other firms at time 0. Then, the expected market share S_0^i of firm i is given by

$$S_0^i \equiv E_0(x^{ij}) + E_0(x^{ji}) = \frac{E_0(p_0) - p_0^i}{\theta} + \frac{1}{n}, \tag{4}$$

resulting in the expected profit of

$$\pi_0^i = S_0^i(p_0^i - c_i)D_0 - f = \left[\frac{E_0(p_0) - p_0^i}{\theta} + \frac{1}{n}\right](p_0^i - c_i)D_0 - f. \tag{5}$$

[13]This assumption is consistent with the maximal differentiation principle: Firms minimize price competition by differentiating themselves as much as possible relative to each other.

[14]Syverson (2004) argues that "while one can solve for optimal strategies in the common-knowledge construct, ... this requires computational simulations to solve the model." Syverson (2004) further argues that "assuming that producers have private information about their costs may be realistic; data-gathering empirical economists know well how famously possessive firms are about their cost data."

Maximizing this expression with respect to p_0^i yields firm i's optimal price:

$$p_0^i = \frac{1}{2}c_i + \frac{1}{2}E_0(p_0) + \frac{\theta}{2n}. \tag{6}$$

Consistent with economic intuition, the optimal price increases in the firm's own marginal cost c_i, and its expectation of its competitors' prices $E(p_0)$. Taking the expected value of (6) yields

$$E_0(p_0) = \frac{1}{2}\bar{c} + \frac{1}{2}E_0(p_0) + \frac{\theta}{2n}, \tag{7}$$

where $\bar{c} = E_0(c)$ is the expected marginal cost of other firms in the market at time 0. Thus, rivals' expected price is given by

$$E_0(p_0) = \bar{c} + \frac{\theta}{n}. \tag{8}$$

Plugging it into equations (6), (4), and (5) yields the following equilibrium price, expected market share, and expected profit of firm i :

$$p_0^i = \frac{1}{2}(c_i + \bar{c}) + \frac{\theta}{n}, \tag{9}$$

$$S_0^i = \frac{\bar{c} - c_i}{2\theta} + \frac{1}{n}, \tag{10}$$

$$\pi_0^i = \frac{D_0}{4\theta}\left[\bar{c} + \frac{2\theta}{n} - c_i\right]^2 - f. \tag{11}$$

The price p_0^i set by firm i increases in its marginal cost c_i and in the expected cost $E_0(c)$ of its competitors. A higher marginal cost c_i results in a lower market share S_0^i and expected profit π_0^i, while the "industry average" cost $E_0(c)$ has a positive effect on S_0^i and π_0^i.

3.2 Equilibria With and Without PPP Loans

In this section, we assume that, following a negative shock to the industry, which reduces demand from D_0 to D_1, the government provides temporary cash subsidies in the form of forgivable PPP loans to a subset of local competitors. Since the PPP stipulates that loan proceeds must be spent within 24 weeks (cf. Section 2), the effect of PPP loans is mostly short-term in nature. We assume that all competitors stay in the industry during this period of time and defer their decisions on whether to exit the industry permanently until the long-term effect of the shock on the demand for their products becomes clear. We will refer to period 1, during which PPP loans are being spent, as the period with active PPP loans.

If firm i obtains a PPP loan its marginal cost declines from c_i to $c_i - \rho$ during period 1. Each firm assumes that its competitors obtain PPP loans with probability $\alpha < 1$. As a result, the expected marginal cost during this period is given by $E_1(c) = \bar{c} - \alpha\rho$. This setup is consistent with our basic model, which we use to evaluate the effect of PPP loans on equilibrium outcomes. Plugging those new marginal costs into equations (9)-(11) yields the following Proposition.

Proposition 1. *During the period with active PPP loans, firm i without a PPP loan charges price p_1^i, captures expected market share S_1^i, and earns expected profit of π_1^i :*

$$
\begin{aligned}
p_1^i &= \frac{1}{2}\left(\bar{c} + c_i - \alpha\rho\right) + \frac{\theta}{n}, && (12)\\
S_1^i &= \frac{\bar{c} - c_i - \alpha\rho}{2\theta} + \frac{1}{n}, && (13)\\
\pi_1^i &= \frac{D_1}{4\theta}\left[\bar{c} - \alpha\rho + \frac{2\theta}{n} - c_i\right]^2 - f. && (14)
\end{aligned}
$$

Firm i with a PPP loan charges lower price $p_1^{i,PPP}$, captures bigger expected market share $S_1^{i,PPP}$, and earns higher expected profit of $\pi_1^{i,PPP}$:

$$
\begin{aligned}
p_1^{i,PPP} &= \frac{1}{2}\left(c_i + \bar{c} - (1+\alpha)\rho\right) + \frac{\theta}{n} < p_1^i, && (15)\\
S_1^{i,PPP} &= \frac{\bar{c} - c_i + (1-\alpha)\rho}{2\theta} + \frac{1}{n} > S_1^i, && (16)\\
\pi_1^{i,PPP} &= \frac{D_1}{4\theta}\left[\bar{c} + \frac{2\theta}{n} - c_i + (1-\alpha)\rho\right]^2 - f > \pi_1^i && (17)
\end{aligned}
$$

After PPP loans expire, all firms raise their prices to p_2^i. Firms with expired PPP loans reduce their market shares and profits from $S_1^{i,PPP}$ and $\pi_1^{i,PPP}$ to S_2^i and π_2^i, while firms without PPP loans gain *back their market shares of S_2^i and profit of π_2^i :*

$$
\begin{aligned}
p_2^i &= \frac{1}{2}(c_i+\bar{c})+\frac{\theta}{n} > p_1^i > p_1^{i,PPP}, && (18)\\
S_2^i &= \frac{\bar{c}-c_i}{2\theta}+\frac{1}{n}, && (19)\\
\pi_2^i &= \frac{D_{1.}}{4\theta}\left[\bar{c}+\frac{2\theta}{n}-c_i\right]^2 - f, && (20)\\
S_1^{i,PPP} &> S_2^i > S_1^i, && (21)\\
\pi_1^{i,PPP} &> \pi_2^i > \pi_1^i. && (22)
\end{aligned}
$$

Proof. Plugging appropriate production costs into equations (9)-(11) yields (12)-(20). All the inequalities follow from the fact that $\rho > 0$ and $0 < \alpha < 1$. □

Equations (12) – (17) in Proposition 1 describe the short-term equilibrium with active PPP loans. After PPP loans expire, the market adjusts to the new equilibrium described by equations (18) – (22). We refer to it as the equilibrium without PPP loans because the market would have been in this equilibrium from the beginning of the recession if not for the PPP. We assume the same demand in period 2 as in period 1, i.e., $D_2 = D_1$, so that we can directly compare the actual equilibrium with PPP loans to the counterfactual equilibrium without PPP loans in the same period.[15]

Proposition 1 shows that PPP loans lead to lower prices. However, firms with PPP loans reduce their prices by more than firms without PPP loans. As a result, they capture bigger market shares at the expense of the firms without PPP loans. The forgivable PPP loans boost the short-term profits of the firms that obtain them. On the other hand, the short-term profits of their competitors without PPP loans are hurt in two ways—lower prices and lower market shares—compared to the equilibrium without PPP loans.

3.3 PPP Application Decisions

Firms decide to apply for PPP loans by comparing the costs and benefits associated with PPP loans. The benefit is equal to the extra profit associated with obtaining a PPP loan:

$$B^{i,PPP} \equiv \pi_1^{i,PPP} - \pi_1^i.$$

[15]No other part of our analyses relies on the assumption that $D_2 = D_1$.

The benefits of PPP loans are always positive since $\pi_1^{i,PPP} > \pi_1^i$, according to Proposition 1. This is not surprising, as PPP loans are effectively short-term government cash subsidies. However, as outlined in Section 2, we assume that firms anticipate a future cost Z associated with obtaining a PPP loan.

We assume that, before a negative demand shock arrives, the local market had settled in an equilibrium with all rivals earning non-negative profits. This implies that there exists an upper bound on firms' marginal costs that can be sustained in a long-term equilibrium. This cutoff cost c_0^* can be found by setting (11) equal to zero:

$$c_0^* = \bar{c} + 2\theta H - \sqrt{\frac{4\theta f}{D_0}}.$$

Thus, we assume that idiosyncratic marginal costs c_i are continuously distributed according to cumulative distribution function (CDF) G with support $[c_L, c_0^*]$ and mean $\bar{c}$, where $c_L > 0$ is the lowest possible marginal cost and c_0^* is the highest possible marginal cost among the competitors. We will refer to firms with higher marginal costs as less efficient firms.

A negative shock to the industry reduces demand from D_0 to D_1 for a period of time during which firms apply and use PPP loans. This shock also creates uncertainty about long-term demand $D_3 \leq D_0$. As a consequence, the highest possible cost c_3^* sustainable in the long-term equilibrium with n firms is lower than c_0^*.

$$c_3^* = \bar{c} + \frac{2\theta}{n} - \sqrt{\frac{4\theta f}{D_2}} \leq c_0^*.$$

Thus, some firm(s) may be forced to go out of business in the long run.

When firms decide whether to apply for PPP loans at time 1, long-term demand D_3 is not known. Firms assume that D_3 is positively correlated with D_1. We do not model random variable D_3 directly. Instead, without loss of generality, we assume that the long-term cutoff cost c_3^* is continuously distributed according to CDF Q with support $[c_L, c_0^*]$. If $c_3^* = c_L$, at least one firm must exit the market, while $c_3^* = c_0^*$ means that all firms survive in the long term. In addition, c_3^* is positively correlated with short-term demand D_1, i.e., $Q(c|D_1)$ is weakly decreasing in D_1. In other words, the lower short-term demand D_1, the more likely at least some firms will exit the market in the long run.

Firms exit the market sequentially—the firm with the highest marginal cost is the first to exit—if long-term demand is sufficiently low. The probability that firm i is the first to exit is given by

$$P(c_i|D_1) = (G(c_i))^{n-1}\, Q(c_i|D_1),$$

where $(F(c_i))^{n-1}$ is the probability that firm i has the highest cost among the competitors, and $Q(c_i)$ is the probability that the long-term cutoff cost c_3^* is going to be less than the firm's cost c_i.

Firms that obtain PPP loans at time 1 are expected to pay future cost Z if they survive in the long term. Firms that go out of business will not pay Z. For simplicity, we assume that only the first firm to exit the market is exempt from paying cost Z. In addition, we assume that PPP loans are small so that they do not affect the chances of survival in the long term, which are determined instead by the firms' efficiency. Thus, the expected cost $K^{i,PPP}$ associated with obtaining a PPP loan is given by

$$K^{i,PPP} = (1 - P(c_i|D_1))\, Z.$$

Firm i applies for a PPP loan if and only if the associated benefits outweigh the costs of doing so, $B^{i,PPP} > K^{i,PPP}$, which leads to the following proposition.

Proposition 2. *Decisions to obtain a PPP loan are determined by marginal costs c_i and the magnitude of the short-term demand shock D_1.*

(i) Firms with high marginal costs apply for PPP loans, i.e., there exists $c'' < c_0^*$ such that firms with $c_i \in (c'', c_0^*]$ decide to apply for PPP loans.

(ii) If

$$Z > \frac{D_1 \rho}{4\theta}\left[2(\bar{c} - c_L) + (1 - 2\alpha)\rho + \frac{4\theta}{n}\right], \tag{23}$$

firms with low marginal costs do not apply for PPP loans, i.e., there exists $c' > c_L$ such that firms with $c_i \in [c_L, c']$ decide not to apply for PPP loans.

(iii) If (23) holds and $P(c_i|D_1)$ is convex in c_i on $[c_L, c_0^*]$, then there exists $\hat{c} \in (c_L, c_0^*)$ such that firms with $c_i \in [c_L, \hat{c}]$ do not apply and firms with $c_i \in (\hat{c}, c_0^*]$ apply for PPP loans.

(iv) Firms are more likely to apply for competitive loans in markets that are hit harder by the shock, i.e., everything else being equal, the expected number of firms applying for PPP loans is weakly decreasing in D_1.

Proof. The proof is in Appendix A. □

The intuition behind Proposition 2 is as follows. Part (i) says the least efficient firms apply for PPP loans. That is because firms that are likely to go out of business do not worry much about future government regulations, audits or damages to their reputation. Part (ii) says the most efficient firms do not apply for PPP loans when the perceived future cost associated with obtaining a PPP loan is sufficiently high. The most efficient firms are expected to survive in the long term and do not want to pay this cost.

Part (iii) requires that the probability $P(c_i|D_1)$ that firm i is the first to go out of business is convex in its cost c_i. For example, when both c_i and c_3^* are uniformly distributed on $[c_L, c_0^*]$ and c_3^* does not depend on D_1, $P(c_i|D_1) = \left(\frac{c_i - c_L}{c_0^* - c_L}\right)^n$ is convex in c_i. Under this assumption, the equilibrium can be characterized by a single threshold $\hat{c} \in (c_L, c_0^*)$ such that firms with $c_i \in [c_L, \hat{c}]$ do not apply and firms with $c_i \in (\hat{c}, c_0^*]$ apply for PPP loans.

A lower demand D_1 predicts a lower long-term demand D_3 and higher chances of firms exiting the market. As a result, firms are more likely to apply to for PPP loans at time 1, which yields Part (iv).

3.4 Testable Hypotheses

Propositions 1 and 2 imply a number of testable hypotheses. We start with firms' PPP loan application decisions. According to Proposition 2, less efficient firms are more likely to get PPP loans. While we do not observe the production costs of U.S. airport hotels directly, we can infer those costs by looking at hotel's profit margins prior to the Covid-19 pandemic and at the age of their buildings. Lower profitability in 2019 implies higher costs, and therefore, a higher probability of applying for a PPP loan in 2020. Similarly, we should expect a higher likelihood to apply for PPP Loans for older hotels, since older buildings are likely associated with higher operating costs. In addition, Proposition 2 asserts that hotels are more likely to apply for PPP loans in markets that are hit harder by the negative demand shock induced by the Covid-19 pandemic. We will use the magnitude of airport passenger traffic declines as proxy for that demand shock. This leads to the following hypotheses.

Hypothesis 1: *Hotels are more likely to apply for PPP loans if*

(a) they were less profitable than their competitors in 2019,

(b) they are older than their competitors,

(c) they are located near airports that experienced large passenger traffic declines.

Hypothesis 2 follows directly from Proposition 1. Here, we use hotel occupancy rates as measures of market shares and revenues per available room as proxy for short-term profits.

Hypothesis 2: *Compared to their competitors without PPP loans, hotels with active PPP loans*

(a) set lower average daily rates (ADR),

(b) achieve higher occupancy rates,

(c) achieve higher revenues per available room (RevPAR).

Combining Proposition 1 with Proposition 2, which says that hotels with PPP loans have higher costs, yields Hypothesis 3.

Hypothesis 3: *Compared to their competitors that did not obtain PPP loans, hotels with expired PPP loans*

(a) set higher average daily rates (ADR),

(b) achieve lower occupancy rates,

(c) achieve lower revenues per available room (RevPAR).

Next, we proceed with data analyses that test our model's empirical implications in the U.S. airport hotel industry.

4 Data and Sample Selection

We start the construction of our sample with a comprehensive census of U.S. airport hotels. The information comes from STR, the country's leading provider of hotel performance data. STR maintains an annual census of all U.S. hotels with at least 15 guest rooms, which synthesizes publicly available data on hotel characteristics, including address, chain affiliation, class, size, and open date. From the 2019 edition of this census, we obtain the sub-set of hotels that STR classifies as airport hotels, that is, those located in close proximity to an airport and those primarily serving demand from airport traffic.

In addition to the annual hotel census, STR runs a daily survey of hotel operating performance data. In this survey, participating hotels submit confidential performance metrics in return for access to industry benchmarking reports. Specifically, participants submit data on top-line hotel performance, including average daily rate (ADR), occupancy, and revenue per available room (RevPAR, computed as the product of ADR and occupancy). Not every airport hotel captured in the annual census participates in the daily performance survey. We focus on the sub-set that do, resulting in a sample of 1,945 airport hotels.[16]

For each of the airport hotels in our sample, we identify the nearest major commercial airport by physical distance.[17] To compute the distance between our sample hotels and those airports, we geo-code the hotel addresses provided in the STR census and match them with the location coordinates of the airports. Information on airport locations comes from the Federal Aviation Administration (FAA). Figure 1 depicts the locations of the 78 airports around which our sample hotels are clustered. Those airports accounted for 85% of all commercial enplanements in U.S. major airports in 2019.

[Insert Figure 1 about here.]

Next, we determine for each of our sample hotels whether the business obtained a loan under the Small Business Administrations' Paycheck Protection Program (PPP) in 2020. Specifically, our analyses focus on PPP loans approved by August 2020. The U.S. Department of the Treasury publishes loan-level data on this program, including the names and addresses of the businesses that obtained a loan, the size of the loan, and its approval date. Hotels rarely applied for PPP loans under their trade names (e.g., Embassy Suites by Hilton Nashville Airport). Instead, in most cases the companies owning the hotels submitted the applications (e.g., Century Boulevard, LLC). However, the hotels and the companies owning them typically share the same street address, allowing us to match the PPP loan data to our sample hotels by street address.

For a sub-set of hotels, STR also maintains an annual survey of hotel accounting data. This survey includes detailed information on hotel revenues, expenses, and operating profits, harmonized under the industry-standard Uniform System of Accounts for the Lodging Industry (USALI). Where available, we supplement the data on hotel characteristics and daily top-line performance metrics with historical data on operating profits from 2018 and 2019, as proxies for pre-pandemic profitability.

We further supplement our data on hotel characteristics and performance with information on reported closure and (planned) reopening dates. This information is part of the hotel performance survey program conducted by STR. The reported closure and reopening dates capture hotel managers' intentions to temporarily (or permanently) suspend operations during the Covid-19 pandemic in 2020.

[16]The hotels that participate in the STR daily performance survey tend to be larger, professionally managed, and chain-affiliated. As such, we expect those hotels to pursue sophisticated revenue management strategies.

[17]We focus on the 398 commercial airports classified by the FAA as air traffic hubs, see FAA Airport Categories.

In addition to reported closure and reopening dates, we can infer actual closure and reopening dates from the availability of daily information on ADR, occupancy, and RevPAR in the STR performance surveys. Hotels participating in this survey program typically report performance information consistently on a daily basis. However, performance information is missing during periods when the hotels were closed. Those periods of missing performance data broadly align with the stated closure periods, but provide more accurate information about actual business disruptions during the Covid-19 pandemic.

The final element in our sample construction is airport traffic information for 2020. We obtain hourly data on airport passenger traffic by security check-point from the Transportation Security Administration (TSA). We aggregate the hourly check-point observations up to the level of daily passenger traffic by airport. We use the passenger traffic data in the airports nearest to each of our sample hotels as proxy for hotel demand in their local markets.

4.1 Variable Definitions

Based on the data set described in the previous sub-section, we define the following variables in the cross-section of sample hotels. *PPP Loan* is an indicator that takes the value of one if a hotel obtained a PPP loan in 2020, and zero otherwise.

Closed for Pandemic is an indicator that takes the value of one if a hotel experienced any consecutive 30-day period in 2020 during which daily performance data were not reported, or when reported occupancy was below 5%, and zero otherwise.[18] *Closed by End-2020* is an indicator that takes the value of one if a hotel was closed during all of December 2020, and zero otherwise.

Pre-Pandemic Profitability is a hotel's gross operating profit margin in 2019 or, where that information is unavailable, the corresponding observation from 2018. Under USALI standards, the gross operating profit margin is defined as total hotel revenues minus operating costs, scaled by total hotel revenues. Operating costs include departmental costs (e.g., labor and materials) and undistributed costs (administration and general, information technology, marketing, maintenance, and utilities). We compute *Hotel Age* as the difference between 2020 and the year a hotel opened, as reported in the STR census data. Those two variables serve as proxies for hotel operating efficiency, as discussed under Proposition 2.

[18] Our results are fully consistent if we count as closed only those hotels with missing performance information.

Class Category is an ordinal variable taking values from 1 through 6, where 1 includes luxury hotels; 2 includes upper upscale hotels; 3 includes upscale hotels; 4 includes upper midscale hotels; 5 includes midscale hotels; and 6 includes economy hotels. Class categories are defined by STR based on a hotel's average room rates. *Size Category* is an ordinal variable taking values from 1 through 5, where 1 includes hotels with less than 75 rooms; 2 includes hotels with 75-149 rooms; 3 includes hotels with 150-299 rooms; 4 includes hotels with 300-500 rooms; and 5 includes hotels with more than 500 rooms. Size categories are based on STR census data on the number of rooms in each sample hotel. We employ those variables to control for key differentiating factors between hotel products that may also have an impact on their relative operating efficiency and susceptibility to negative demand shocks.

High Competition is an indicator that takes the value of one if a hotel is located in the top 25% most competitive markets. We compute market competition as the Herfindahl-Hirshman Index (HHI) based on hotel size within a hotel's class bucket and airport market. We sort hotels into class buckets by grouping those with class categories 1 and 2 into the "High" class bucket and those with class categories 3 and 4 (5 and 6, respectively) into the "Medium" ("Low") class bucket. While the level of competitiveness in a hotel's local market is not a formal component of our model, we expect competition to drive down hotels' profit margins and, hence, influence their decisions to apply for PPP loans. In the spirit of our model, we therefore include local competition in our empirical analyses of hotels' PPP application choices.

We construct several additional variables on the level of the airports around which our sample hotels are located. *Number of Airport Hotels* is the number of sample hotels located in a given airport market. *Market Size* is the total volume of airport traffic (in millions of passengers) in a given airport in 2019, based on the TSA airport traffic data. *Decline in Airport Traffic January-April 2020* is the percentage rate of change in total airport traffic between the four-month period January through April 2020 and the corresponding period in 2019. This variable serves as proxy for negative demand shocks, as discussed under Proposition 2. *Share of Airport Hotels with PPP Loans* is the ratio of hotels in a given airport market that obtained PPP loans relative to the total number of local airport hotels.

4.2 Descriptive Statistics

Table 1 presents summary statistics on the cross-section of sample hotels and their local airport markets. Out of the 1,945 airport hotels in our sample, 16% obtained a PPP loan in 2020. Nearly 12% of hotels experienced a pandemic-induced closure in 2020, and 3% of sample hotels remained closed at the end of that year. Within the sub-sample of hotels that report annual accounting data, operating profitability prior to the Covid-19 pandemic was 40% on average. The average hotel class (size) category is 2.2 (2.6). Figure 2 presents a detailed breakdown of our sample hotels across class and size categories. Panel A (Panel B, respectively) shows that 58% (56%) of our sample hotels fall into the medium class category comprising upscale and upper midscale hotels (the size category with 75-149 rooms). Nearly 25% of hotels operate in market segments characterized by high competition. The average age of our sample hotels in 2020 is 24 years.

[Insert Table 1 and Figure 2 about here.]

The average airport market in our sample contains 25 hotels (only two markets contain fewer than four hotels) and saw 8.5 million airport passengers in 2019. Airport traffic declined by nearly 40% year-on-year over the four-month period through April 2020 in the average airport market, and 17% of local hotels obtained PPP loans in 2020.

4.3 Airport Hotels During the Covid-19 Pandemic

The Covid-19 pandemic began to affect airport hotels when strict travel restrictions and lockdown orders were imposed in mid-March 2020. Figure 3 depicts the time series of weekly airport traffic and concurrent average top-line performance metrics of our sample airport hotels in 2020. Panel A shows that year-on-year percentage changes in weekly airport traffic were positive until week 10 of 2020. By week 12, weekly airport traffic had collapsed more than 90% year-on-year. Traffic volumes began to recover from week 16 onward, but remain down 40% year-on-year by the end of 2020.

[Insert Figure 3 about here.]

The precipitous decline in airport traffic had immediate consequences for the top-line performance of airport hotels. Panel B of Figure 3 shows that, from week 10 onward, mean occupancy dropped by 60% compared to the same time one year prior. Consistent with the gradual recovery in airport traffic, occupancy began to improve in week 16 but remained approximately 20% below the rates seen one year prior. Mean ADR followed the sharp drop in occupancy and declined up to 20% year-on-year in weeks 10 through 16. Average room rates remained depressed until the end of 2020. The negative effects of the decline in airport travel on hotels' ADR and occupancy compound in RevPAR (computed as the product of ADR and occupancy). From week 10 onward, mean RevPAR declined by 80% year-on-year. This performance metric then began to recover gradually, but remained 40% below the levels seen one year prior by the end of 2020.

[Insert Figure 4 about here.]

How did airport hotels respond to the decline in top-line performance caused by the Covid-19 pandemic? We summarize several important dimensions of their response in Figure 4, namely, hotels' decisions to suspend (and later resume) operations and their choices to obtain PPP loans. Panel A depicts the distribution of hotel closures by calendar week in 2020. The figure shows that over 70% of airport hotels that decided to suspend operations had done so by week 13. Panel B shows that airport hotels started resuming their operations as early as in week 16, with a concentration of reopening dates in the summer months (weeks 16 through 28). The distribution of airport hotel reopening weeks has a long right tail, stretching into the final weeks of 2020. Panel C shows that airport hotels began to benefit from the PPP loan initiative from week 14 onward. Over 40% (60%, respectively) of airport hotels that received a PPP loan in 2020 had their applications approved by week 15 (week 16). Another 25% of hotels received PPP loans in week 18. Few airport hotels received PPP loans after that week.[19]

5 Drivers of PPP Loan Applications

We begin by assessing the evidence for Hypothesis 1 of our model, documenting the factors that motivated airport hotels to take advantage of the PPP. In the analyses that follow, we first study hotels' choices to apply for a PPP loan at all in 2020. We then focus on the decisions of some hotels to apply for PPP loans sooner rather than later in the program. Those latter analyses allow us to assess which were the most pressing drivers of PPP loan application choices.

[19]We note that hotels' choices to (temporarily) suspend operations in most cases precede the availability of PPP loans. Thus, we expect PPP loans to have little impact on hotel closures and subsequent reopenings. We present evidence consistent with those conjectures in Appendix C.

5.1 Which Airport Hotels Applied for PPP Loans?

We assess the determinants of hotels' choices to apply for PPP loans during the Covid-19 pandemic in a logistic regression framework. Specifically, we estimate regressions of the following form:

$$\begin{aligned} \textit{PPP Loan}_i &= \beta_1 \textit{Pre-Pandemic Profitability}_i + \beta_2 \textit{High Competition}_i \\ &+ \beta_3 \textit{Large Air Traffic Decline (Jan-Apr)}_i + \beta_4 \textit{Controls}_i + \gamma_o + \delta_c + \theta_s + \epsilon_i \end{aligned} \tag{24}$$

where $\textit{PPP Loan}_i$ is an indicator that takes the value of one if hotel i obtained a PPP loan in 2020, and zero otherwise. $\textit{Pre-Pandemic Profitability}_i$ is the gross operating profit margin of hotel i in 2019 and, if that data point is not available, the corresponding profit margin from 2018. $\textit{High Competition}_i$ is an indicator that takes the value of one if hotel i is located in the top 25% of market segments with the highest levels of competition, and zero otherwise. We measure competition as the Herfindahl-Hirshman Index in hotel i's airport market and class bucket. $\textit{Large Air Traffic Decline (Jan-Apr)}_i$ is an indicator that takes the value of one if hotel i is located in an airport market with an above-median decline in cumulative airport traffic between January and April 2020, compared to the corresponding period in 2019. $\textit{Controls}_i$ include covariates for the age (in years) of hotel i in 2020 and for the size of the airport market in which hotel i is located, measured as the total volume of airport traffic in 2019. γ_o are hotel operation fixed effects (chain-owned and/or chain-managed; franchised; and independent). δ_c are hotel class fixed effects (luxury; upper upscale; upscale; upper midscale; midscale; and economy). θ_s are hotel size category fixed effects (less than 75 rooms; 75-149 rooms; 150-299 rooms; 300-500 rooms; and more than 500 rooms). We estimate Eq. (24) using maximum likelihood with heteroskedasticity-robust standard errors.

Table 2 presents the results. The estimates in column (1) indicate that airport hotels with poor pre-pandemic profitability were more likely to obtain PPP loans. So were hotels located in airport markets with higher competition and with larger declines in airport traffic between January and April 2020 (see estimates in columns (2) and (3), respectively). The estimates reported in column (4) show that, in the full sample, both high competition and large air traffic declines were associated with a higher likelihood of obtaining a PPP loan. Our results also indicate that older hotels were more likely to obtain PPP loans (see columns (2) through (4)). The estimates in column (5) refer to the sub-sample of hotels for which we observe annual accounting data. Those estimates show that pre-pandemic profitability and large air traffic declines are the dominant drivers of PPP loan application choices.

[Insert Table 2 about here.]

In sum, the results in Table 2 suggest that hotels that were less profitable going into the Covid-19 pandemic, older hotels, and those that experienced larger declines in local demand due to the Covid-19 pandemic were more likely than their otherwise equivalent peers to obtain PPP loans. Those results are fully consistent with Hypothesis 1. Our results also suggest that hotels located in more competitive markets were more likely to obtain PPP loans. While not reflecting a formal hypothesis, this result is consistent with the spirit of our model.

5.2 What Motivated Airport Hotels to Obtain PPP Loans Early?

We characterize the factors that drove some airport hotels to obtain PPP loans sooner than others in a logistic regression framework similar to that of Eq. (24). Specifically, we estimate the following econometric specification:

$$\begin{aligned} \textit{PPP Loan Early}_i &= \beta_1 \textit{Pre-Pandemic Profitability}_i + \beta_2 \textit{High Competition}_i \\ &+ \beta_3 \textit{Large Air Traffic Decline (Jan)}_i + \beta_4 \textit{Controls}_i + \gamma_o + \delta_c + \theta_s + \epsilon_i \end{aligned} \tag{25}$$

where *PPP Loan Early*$_i$ is an indicator that takes the value of one if hotel i obtained a PPP loan by calendar week 15 in 2020 (alternatively, by week 16), and zero otherwise. *Large Air Traffic Decline (Jan)* is an indicator that takes the value of one if hotel i is located in an airport market with an above-median decline in airport traffic in January 2020, compared to the corresponding month one year prior. This variable allows us to identify the effects on PPP loan applications of early warning signals that some airport hotels may have received about the impending collapse in demand for their rooms. The remaining variables and notation are as in Eq. (24). We estimate Eq. (25) using maximum likelihood with heteroskedasticity-robust standard errors.

[Insert Table 3 about here.]

Panel A of Table 3 presents the results for the earliest PPP loan applications in 2020, that is, those approved by week 15. The estimates show that hotels with poor operating performance going into the Covid-19 pandemic were among the first to obtain PPP loans (see columns (1) and (5)). So were hotels that received early warning signals about impending negative demand shocks: the estimates in columns

(3) through (5) show that large air traffic declines in January 2020 were associated with a higher likelihood of obtaining a PPP loan by week 15. The estimates reported suggest that local competition was a minor factor in motivating hotels to obtain PPP loans early (see columns (2), (4), and (5)).

Panel B of Table 3 presents the results for PPP loans obtained by week 16. The estimates in column (1) show that poor pre-pandemic profitability continues to be a strong predictor for hotels obtaining PPP loans early. The estimates in columns (2) and (4) indicate that hotels operating in the most competitive markets—although not among the very first ones to obtain PPP loans—also had strong incentives to obtain PPP loans early. There is some evidence that air traffic declines in January 2020 were a further driver of early PPP loan applications (see column (5)).

In all, the results presented in Table 3 suggest that hotels already performing poorly prior to the Covid-19 pandemic, and those that received early warning signals about the impending collapse in traveller demand, were the first to take advantage of PPP loans. They were followed by hotels that operate in the most competitive airport markets.

6 PPP Loans and Airport Hotel Performance

In this section, we examine the evidence for Hypotheses 2 and 3 of our model. Specifically, we study the effects that PPP loans had on airport hotels' price setting choices (average daily rates), market shares (occupancy), and short-term profits (revenues per available room). To identify those effects, we need to account for the fact that hotels' choices to obtain PPP loans are endogenous. We control for this potential selection bias by focusing our empirical tests on the sub-sample of hotels that obtained PPP loans. As we outline more formally below, our estimations compare the performance of those same hotels (relative to their local competitors) before and after they obtained PPP loans. Importantly, we simultaneously control for a saturated set of fixed effects. Those include hotel fixed effects capturing cross-sectional hotel characteristics which may influence performance and, importantly, a hotel's choice to obtain a PPP loan in the first place. Pre-pandemic profitability and hotel age in 2020 are examples of such characteristics (see Section 5). Additionally, we account for airport market×time interacted fixed effects, which hold constant market-wide trends in demand and supply that the hotels in our sample faced during the estimation period. We believe that this framework provides a clean experimental setting in which to evaluate the causal effects of PPP loans on hotel price setting, market shares, and short-term profits.

6.1 Top-Line Performance Under Active PPP Loans

The following set of empirical tests refers to Hypothesis 2 of our model. Here, we analyze the relationship between PPP loans and airport hotel performance focusing on weekly measures of ADR, occupancy, and RevPAR for the sample hotels that obtained PPP loans in 2020 (PPP hotels). Specifically, we estimate the following linear regression model:

$$Relative\ ADR_{i,t} = \beta PPP\ Active_{i,t} + \gamma_i + \phi_{m,t} + \epsilon_{i,t} \tag{26}$$

where $Relative\ ADR_{i,t}$ is the average ADR of PPP hotel i in week t, relative to the average ADR in week t of all other hotels in the same airport market and class bucket that did not obtain PPP loans in 2020 (non-PPP hotels). $PPP\ Active_{i,t}$ is an indicator that takes the value of one in every week t during which hotel i had an active PPP loan, and zero before then. We consider a PPP loan to be active for 24 weeks starting from the week of loan approval, or for the period starting from the week of loan approval until the end of 2020, whichever is shorter (cf. Section 2). γ_i are hotel fixed effects. $\phi_{m,t}$ are airport market×week interacted fixed effects. The residuals, $\epsilon_{i,t}$, are clustered by airport market and week.

We estimate Eq. (26) in the sub-sample of hotels that obtained PPP loans in 2020. For each hotel in this sub-sample, we include ADR observations from the start of 2020 up to and including the final week in which the hotel had an active PPP loan. Therefore, the coefficient β measures the marginal change in the relative ADR of PPP hotels that occurred after those hotels obtained their PPP loans, compared to the period before they obtained the loans. We replicate the estimation of Eq. (26) for $Relative\ Occupancy_{i,t}$ and $Relative\ RevPAR_{i,t}$. Those variables are constructed in the same manner as $Relative\ ADR_{i,t}$.

Panel A of Table 4 presents the results. The estimates in column (1) show that hotels reduced their ADR after receiving PPP loans, relative to the ADR of non-PPP hotels operating in the same class bucket and airport market. The magnitude of the coefficient estimate in column (1) indicates that PPP hotels undercut their competitors' prices by 3% following the receipt of their PPP loans.[20] The estimates in column (2) show that PPP hotels concurrently increased occupancy relative to their direct competitors. With an estimated magnitude of 23%, this effect is economically significant. The results reported in column (3) indicate that the improvements in occupancy for PPP hotels translated

[20] We note that the unconditional averages of $Relative\ ADR_{i,t}$, $Relative\ Occupancy_{i,t}$, and $Relative\ RevPAR_{i,t}$ among PPP hotels in 2020 equal one for each of those measures.

into higher RevPAR outcomes relative to their local competitors without PPP loans. The estimates shown imply that the economic magnitude of this effect is also significant, at 22%.

[Insert Table 4 about here.]

In sum, the results presented in Panel A of Table 4 are fully consistent with Hypothesis 2 of our model. Notably, our results suggest that hotels use PPP loans to strategically improve their standing against local competitors, enabling them to reduce their prices, gain larger market shares, and earn higher (short-term) profits than those competitors.

6.2 Top-Line Performance After PPP Loans Expired

To evaluate the evidence for Hypothesis 3 of our model, the reversal in the top-line performance measures of airport hotels after their PPP loans expire, we estimate linear regressions of the following form:

$$\textit{Relative ADR}_{i,t} = \beta \textit{PPP Expired}_{i,t} + \gamma_i + \phi_{m,t} + \epsilon_{i,t} \tag{27}$$

where $\textit{Relative ADR}_{i,t}$ is defined as in Eq. (26). $\textit{PPP Expired}_{i,t}$ is an indicator that takes the value of one as soon as hotel i's PPP loan expired, and zero before then. We consider a PPP loan to be expired 24 weeks after it was approved, or at the end of 2020, whichever is sooner (cf. Section 2). The remaining variables and notation are as in Eq. (26).

We estimate Eq. (27) in the sub-sample of hotels that obtained PPP loans in 2020 and include ADR observations for those hotels from the full calendar year. The coefficient β thus captures the marginal change in the relative ADR of PPP hotels that they experienced after their PPP loans expired, compared to the period before the expiry. We replicate the estimation of Eq. (27) for $\textit{Relative Occupancy}_{i,t}$ and $\textit{Relative RevPAR}_{i,t}$, both of which are constructed in the same manner as $\textit{Relative ADR}_{i,t}$.

Panel B of Table 4 presents the results. The estimates reported in column (1) show that PPP hotels increased their ADR by 2.3% relative to their competitors after their PPP loans expired. Those higher room rates resulted in reduced occupancy, with an estimated decline of 6.5% (see column (2)). Reduced occupancy, in turn, was associated with more than 5% lower RevPAR outcomes for PPP hotels relative to their competitors after PPP loans expired (column (3)). The documented reversal in daily pricing, market shares, and short-term profit ratios to hotels after their PPP loans expire, relative to the preceding period while they operated with active PPP loans, is fully consistent with Hypothesis 3 of our model.

In sum, the results presented in Table 4 show that PPP hotels traded more aggressively while operating under the protection of PPP loans. Notably, PPP hotels reduced their room rates relative to their direct competitors to achieve higher occupancy rates and, as a result, yield higher revenues per available room during those periods. Those competitive strategies were reversed when PPP loans expired. The evidence presented here is consistent with Hypotheses 2 and 3 of our model. In other words, PPP loans temporarily altered the competitive strategies of the hotels that received them. Because of the aggressive competitive strategies adopted by hotels with active PPP loans, significant benefits accrued to those hotels, notably, in terms of pricing, market shares, and profits. However, those gains were achieved at the cost of the competing hotels that chose not to obtain PPP loans.

7 Competition Dynamics Between Hotels

We provide additional evidence for the competitive strategies of PPP hotels versus non-PPP hotels by focusing on the daily competition dynamics between those types of businesses. Specifically, we focus on two complementary aspects of hotels' competitive strategies, namely, their responses to external demand shocks and their responses to significant price moves by their respective competitors. In the following sub-sections, we present our analyses on each of those dimensions of hotels' competitive strategies in turn.

7.1 PPP Loans and Hotels' Response to Demand Shocks

In this sub-section, we compare daily revenue management strategies in response to negative demand shocks for airport hotels operating under active PPP loans versus their peers. Specifically, we estimate the following linear regression model:

$$\ln ADR_{i,t} = \beta PPP\ Active_{i,t} \times Day\ After_t + \gamma_i + \phi_{m,t} + \epsilon_{i,t} \tag{28}$$

where $\ln ADR_{i,t}$ is the natural logarithm of the ADR set by hotel i on day t. $PPP\ Active_{i,t}$ is an indicator that takes the value of one as long as hotel i had an active PPP loan, and zero otherwise. This variable is interacted with indicators for $Day\ After_t$, where t takes values from one trough seven, denoting the seven days following a calendar week with a severe decline in airport traffic in the local airport market of hotel i. We measure a severe decline in airport traffic in a hotel's local airport market as a year-on-year decline in weekly passenger volume in excess of 20%. In the estimation of Eq. (28), we exclude the first day after a week with a severe decline in airport traffic as the reference category. The remaining variables and notation are as in Eq. (26).

In alternative specifications, we replicate the estimation of Eq. (28) but replace the $PPP\ Active_{i,t}$ indicator with the variable $PPP\ Expired_{i,t}$. This variable is an indicator that takes the value of one as soon as hotel i's PPP loan expired, and zero before then. We estimate those alternative specifications in the sub-sample of hotels that obtained PPP loans in 2020 and include observations starting from the week when those hotels obtained their PPP loans.

We summarize the results from estimating Eq. (28) graphically. Panel A of Figure 5 depicts the marginal changes in daily ADR for hotels with active PPP loans versus those of hotels without PPP loans on each day of the weeks following significant negative demand shocks. Recall that the reference category against which we measure daily changes in ADR is the first day of each of those weeks. The figure shows that hotels with active PPP loans reduce their ADR by approximately 1% on day two following a significant negative demand shock. They drop their ADR by 2% on day three, keep rates at that level on day four, and gradually raise them up to the original (day one) level over days five through seven. By contrast, hotels without PPP loans hardly adjust their ADR at all in the first four days following a demand shock. By day five, however, they abruptly drop their rates by approximately 3%, undercutting PPP hotels. As hotels with active PPP loans gradually raise their rates back up to the original levels, hotels without PPP loans follow suit, but keep their own rates below those of their competitors.

[Insert Figure 5 about here.]

The estimation behind Panel B of Figure 5 repeats a similar experiment. However, it compares the ADR changes in hotels whose PPP loans have expired with the changes made by those same hotels following an equivalent demand shock that occurred while their PPP loans were active. The figure shows an inverted U-shape pattern in the daily room rates set in response to negative demand shocks by hotels with active PPP loans. This pattern closely resembles the one we document for those hotels in Panel A. To wit, those same hotels hardly adjust their ADR following negative demand shocks of the same magnitude after their PPP loans expired. Taken together, the evidence presented in Panels A and B of Figure 5 suggests that PPP loans allowed airport hotels to undercut the room rates of their non-PPP competitors following negative demand shocks, forcing those competitors to maintain lower rates for longer. Hotels abandon those aggressive competitive strategies after their PPP loans expire.

7.2 PPP Loans and Hotels' Response to Price Drops by Competitors

We dig deeper into the price-setting strategies of airport hotels with and without PPP loans by focusing on their responses to price moves by their respective competitors. Specifically, we study the response in daily room rates of airport hotels with active PPP loans to significant price drops by their local competitors without PPP loans (and vice versa). We estimate regressions of the following form:

$$\ln ADR_{i,t} = \beta Day\ After_t + \gamma_i + \phi_{m,t} + \epsilon_{i,t} \tag{29}$$

where $\ln ADR_{i,t}$ is the natural logarithm of the ADR set by hotel i on day t. In the first instance, we estimate Eq. (29) for hotels that did not obtain a PPP loan in 2020. We include ADR observations on those hotels over the period covering calendar weeks 14 to 28 of 2020, when the PPP loan initiative was active and funds disbursed to participating hotels had not yet expired. $Day\ After_t$ is an indicator variable where t takes values from one trough seven, denoting the seven days following a calendar week with a severe drop in average ADR by hotel i's competitors that operated under active PPP loans at that time. We measure a severe drop in ADR as a year-on-year decline in weekly average ADR among those competing PPP hotels in excess of 20%. In the estimation of Eq. (29), we exclude the first day after a week with a severe decline in airport traffic as the reference category. The remaining variables and notation are as in Eq. (28).

In an alternative specification, we replicate the estimation of Eq. (29) but limit the sample to hotels that obtained PPP loans in 2020 and focus on the period during which those loans were active. In this alternative estimation, $Day\ After_t$ is an indicator variable where t takes values from one trough seven, denoting the seven days following a calendar week with a severe drop in average ADR by hotel i's non-PPP competitors. Analogous to our previous tests, we measure a severe drop in ADR as a year-on-year decline in weekly average ADR among non-PPP hotels in excess of 20%.

Figure 6 summarizes the estimation results. Panel A shows that hotels without PPP loans do not significantly adjust ADR in the four days following a significant price drop by their competitors with active PPP loans. However, those hotels drop their rates by 2% on day five, before returning to the price levels set at the beginning of the week on days six and seven. By contrast, hotels with active PPP loans reduce their ADR as soon as two days following a price drop by their non-PPP competitors. They maintain significantly reduced room rates for five days after the price shock before returning to the levels set at the start of the week.

[Insert Figure 6 about here.]

In sum, the results illustrated in Figure 6 suggest that PPP loans allowed participating hotels to respond swiftly and decisively to price drops by their non-PPP competitors. Taken together with the evidence presented in Figure 5, our findings imply that PPP loans enabled airport hotels to compete more aggressively during the Covid-19 pandemic.

8 Quantifying the Effects of PPP Loans

In this section, we combine our theoretical model and empirical estimates to quantify the effects of PPP subsidies on the profits of airport hotels. Since our approach in this section relies on empirical averages, without loss of generality, we can simplify our theoretical analyses by assuming that there are two types of firms. Fraction α are high cost firms with $c_i = c_H$ that obtain PPP loans, and the rest are low cost firms with $c_i = c_L < c_H$ that do not obtain PPP loans. To simplify the notation, we replace superscript i with H and L for high cost and low cost firms, respectively.

Each firm with a PPP loan sells $D_1 S_1^{H,PPP}$ units, where $S_1^{H,PPP}$ is given by (16) with $c_i = c_H$. The total amount of PPP subsidies is equal to

$$M = \alpha n D_1 S_1^{H,PPP} \rho, \tag{30}$$

where αn is the number of firms with PPP loans, $D_1 S_1^{H,PPP}$ is the number of units sold by a firm with a PPP loan, and ρ is the cost saving due to PPP subsidies on each unit sold.

We define gains from PPP loans as the difference between a firm's profit in the short-term equilibrium with PPP loans and the profit of the same firm in the counterfactual equilibrium with no PPP loans. Gains $\Delta\pi^{PPP}$ and $\Delta\pi$ for firms with and without PPP loans are given by

$$\begin{aligned}\Delta\pi^{PPP} &= \pi_1^{H,PPP} - \pi_2^H,\\ \Delta\pi &= \pi_1^L - \pi_2^L,\end{aligned}$$

where $\pi_1^{H,PPP}$ and π_1^L are the actual profits of a firm, depending on whether it obtained a PPP loan, while π_2^H and π_2^L are the corresponding profits in the counterfactual equilibrium without PPP loans. The effect of the PPP on the profits of all firms with PPP loans is equal to $\alpha n\Delta\pi^{PPP}$, while its effect on the profits of all firms without PPP loans is equal to $(1-\alpha)n\Delta\pi$.

Our goal is to compute gain yields

$$\gamma^{PPP} \equiv \frac{\alpha n\Delta\pi^{PPP}}{M}, \tag{31}$$

$$\gamma \equiv \frac{(1-\alpha)n\Delta\pi}{M} \tag{32}$$

that measure the gains in profits per dollar of PPP subsidies for firms with and without PPP loans. Because, we do not observe some of the model parameters directly, we express γ^{PPP} and γ in terms of parameters that we are able to estimate in the data.

Proposition 3. *The gain yields can be expressed as follows:*

$$\gamma^{PPP} = (1-\alpha)\left(1+\frac{(1-\alpha)}{2}\frac{\Delta S_1}{S_1^{H,PPP}}\left(\frac{\Delta P_2}{\Delta P_1}-1\right)\right), \tag{33}$$

$$\gamma = -(1-\alpha)\left(\frac{S_1^L}{S_1^{H,PPP}}-\frac{\alpha}{2}\frac{\Delta S_1}{S_1^{H,PPP}}\left(\frac{\Delta P_2}{\Delta P_1}-1\right)\right), \tag{34}$$

where

$$\Delta S_1 = S_1^{H,PPP} - S_1^L, \tag{35}$$

$$\Delta P_1 = p_1^{H,PPP} - p_1^L, \tag{36}$$

$$\Delta P_2 = p_2^H - p_2^L. \tag{37}$$

Proof. The proof is in Appendix B. □

Proposition 3 shows that the gain yields can be expressed using differences and ratios of market shares and prices of firms with and without PPP loans, which allows us to estimate gain yields γ^{PPP} and γ for U.S. airport hotels.

According to Panel A of Table 4, hotels with PPP loans achieve 23.1% higher relative occupancy when PPP loans are active. Thus, $S_1^{H,PPP} = (1 + 0.231)S_1^L$, which gives us the following ratios:

$$\frac{S_1^L}{S_1^{H,PPP}} = \frac{1}{1.231}, \tag{38}$$

$$\frac{\Delta S_1}{S_1^{H,PPP}} = \frac{S_1^{H,PPP} - S_1^L}{S_1^{H,PPP}} = \frac{0.231}{1.231}. \tag{39}$$

Panels A and B of Table 4 show that hotels with PPP loans charge 3.0% lower prices when PPP are active and 2.3% higher prices when PPP loans are expired. Thus, we estimate

$$\frac{\Delta P_2}{\Delta P_1} = -\frac{0.023}{0.030}. \tag{40}$$

Finally, we set $\alpha = 0.16$, since 16% of the airport hotels obtained PPP loans.

Plugging α, $\frac{S_1^L}{S_1^{H,PPP}}$, $\frac{\Delta S_1}{S_1^{H,PPP}}$, and $\frac{\Delta P_2}{\Delta P_1}$ into (33) and (34) we compute

$$\gamma^{PPP} = (1 - 0.16)\left(1 + \frac{(1-0.16)}{2}\frac{0.231}{1.231}\left(-\frac{0.023}{0.030} - 1\right)\right) = 0.723, \tag{41}$$

$$\gamma = -(1 - 0.16)\left(\frac{1}{1.231} - \frac{0.16}{2}\frac{0.231}{1.231}\left(-\frac{0.023}{0.030} - 1\right)\right) = -0.705. \tag{42}$$

The gain yields $\gamma^{PPP} = 0.723$ and $\gamma = -0.705$ imply that each dollar of PPP subsidies translated into 72.3 cents of profits for the hotels that obtained PPP loans and 70.5 cents of losses for the hotels that did not obtain PPP loans. The gain yield γ^{PPP} is less than one because hotels reduced their room rates after they received PPP loans. The gain yield γ is negative because hotels without PPP loans were forced to respond by reducing their rates and still saw their market shares decline.

Interestingly, the net effect of PPP loans on the airport hotel profits was small. For each dollar spent on PPP loans, the combined profit of airport hotels increased by only $\gamma^{PPP} + \gamma = 1.8$ cents. This means that the ultimate beneficiaries of the PPP were consumers, who ended up paying lower room rates, which resulted in gains of 98.2 cents per dollar of PPP funds allocated to U.S. airport hotels. As for the airport hotel industry, the primary effect of the PPP was to transfer profits from hotels without PPP loans to hotels with PPP loans by distorting market competition.

The gain yields γ^{PPP} and γ show the effects of PPP loans on the combined profits of hotels with and without PPP loans, respectively. We now calculate the effect of PPP loans on the profits of individual hotels. According to equations (31) and (32)

$$\frac{\Delta\pi}{\Delta\pi^{PPP}} = \frac{\alpha}{1-\alpha}\frac{\gamma}{\gamma^{PPP}} \tag{43}$$

$$= \frac{0.16}{1-0.16}\frac{-0.705}{0.723} = -0.186. \tag{44}$$

The resulting ratio of $\frac{\Delta\pi}{\Delta\pi^{PPP}} = -0.186$ implies that for each dollar of profit made by a hotel due to PPP subsidies, a competitor without a PPP loan lost 18.6 cents. The losses of individual hotels without PPP loans were relatively small compared to the gains of individual hotels with PPP loans because only 16% of the airport hotels obtained PPP loans.

9 Conclusion

In response to the deep recession caused by the Covid-19 pandemic, the U.S. government has provided economic stimulus of near-unprecedented magnitude. We focus on one particular part of the government's response to the Covid-19 pandemic, namely, the Payroll Protection Program (PPP). This program provided small businesses with temporary funds to keep staff on-payroll and to remain operational through the worst of the pandemic-induced economic slump. While several recent papers examine the effectiveness of the PPP as well as its design and distribution, we focus on its potential unintended economic side effects, in particular, its distorting effects on business competition.

We develop a model of monopolistic competition with differentiated goods and heterogeneous production costs and introduce temporary cash subsidies to study the competitive strategies of firms with and without PPP loans. Using this framework, we show that PPP loans significantly distorted business competition. We provide evidence consistent with such distortion by analyzing price setting, resulting market shares, and short-term profits in U.S. airport hotels during the Covid-19 pandemic. In particular, we find that hotels with active PPP loans reduced average daily rates, boosting occupancy and revenues per available room compared to competitors without PPP loans. Those differences were reversed once

PPP loans expired. Our results show that, while beneficial for the hotels that received them, PPP loans had significant negative effects on the profits of the hotels that chose not to apply for those loans.

Combining our empirical findings with the theoretical model, we estimate that each dollar of PPP subsidies translated into 72.3 cents of profits for the hotels that obtained PPP loans and 70.5 cents of losses for the hotels that did not obtain PPP loans. As a result, consumers, who ended up paying lower room rates, were the ultimate beneficiaries of PPP subsidies allocated to the airport hotel industry. On the other hand, the primary effect of the PPP on the airport hotel industry itself was to transfer profits from the hotels without PPP loans to the hotels with PPP loans by distorting market competition.

The insights of our theoretical model of monopolistic competition with PPP loans apply to many other sectors of the economy. As a result, the distortion of business competition caused by the PPP is unlikely to be limited to the hotel sector alone. However, we note that the strong effect of PPP loans on equilibrium market outcomes in the airport hotel industry is consistent with that industry being highly competitive, as prices are adjusted on a daily basis. While we would expect relatively weaker economic effects of PPP loans in less competitive markets, our model and empirical procedure can be used to quantify the effects of PPP loans in other industries.

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Figure 1. Airport Locations of Sample Hotels

This figure depicts the locations of the major U.S. commercial airports around which the 1,945 airport hotels in our sample are clustered. The data used to produce this figure are from STR and the FAA.

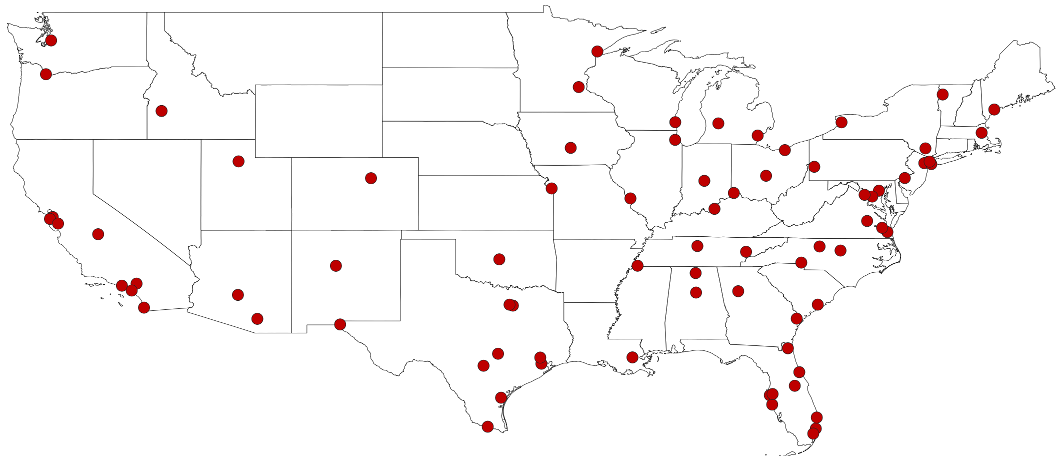
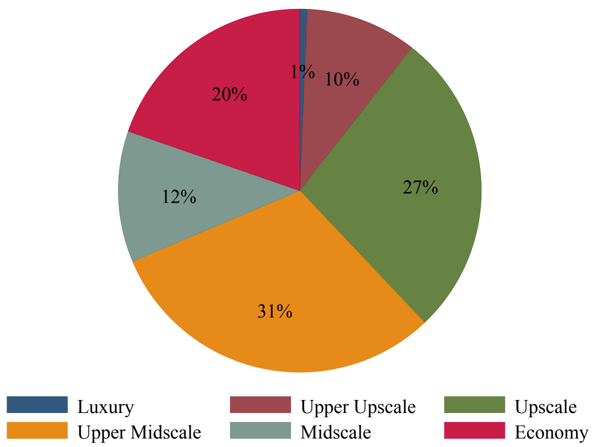
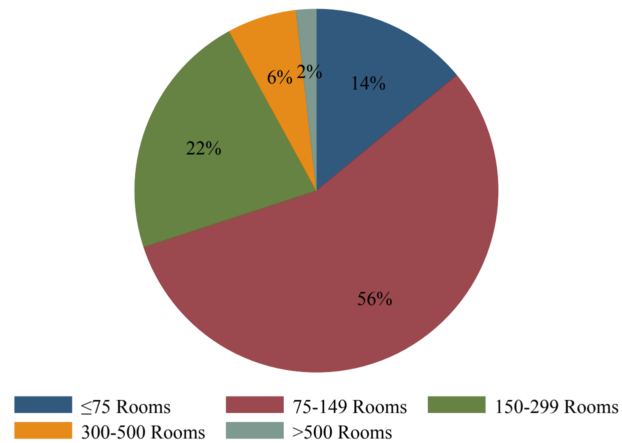


Figure 2. Breakdown of Sample Hotels by Class and Size Category

This figure depicts the breakdown of sample hotels by characteristics. Panel A presents the breakdown by hotel class category. *Class Category* is an ordinal variable taking values from 1 through 6, where class categories are defined by STR based on a hotel's average room rates. Panel B presents the breakdown by hotel size categories. *Size Category* is an ordinal variable taking values from 1 through 5, where size categories are based on STR census data on the number of rooms in each sample hotel.



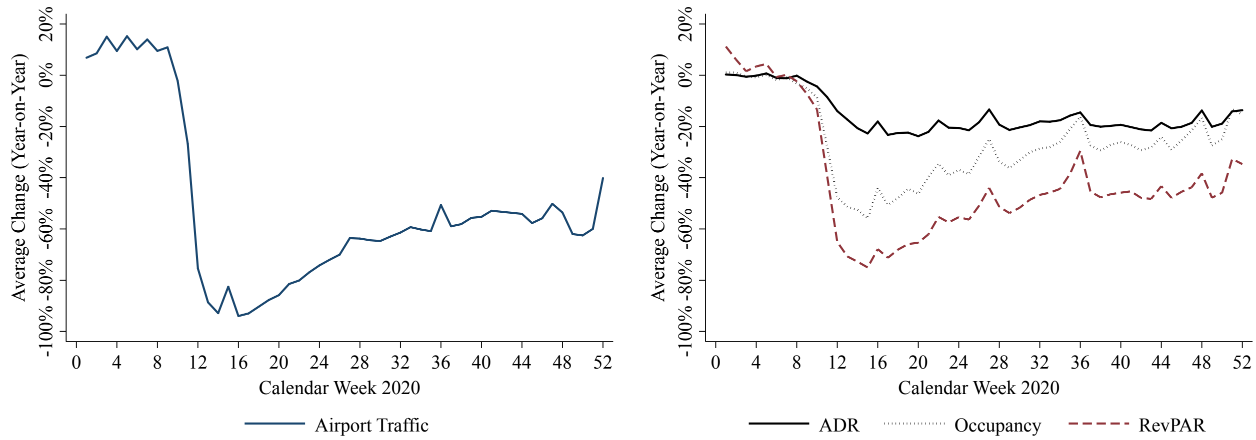
(A) Hotel Class Categories



(B) Hotel Size Categories

Figure 3. Time Series of Weekly Airport Traffic and Top-Line Hotel Performance

This figure depicts the the time series evolution of year-on-year changes in 2020 of average weekly airport traffic (Panel A) and top-line hotel performance (Panel B) for the sample airport markets and airport hotels, respectively. The data used to produce this figure are from the TSA and STR.

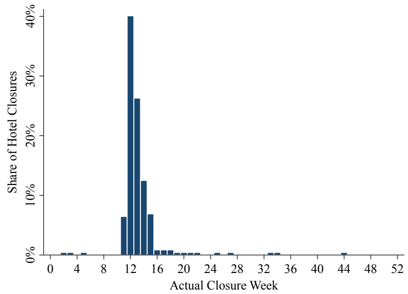


(A) Airport Traffic

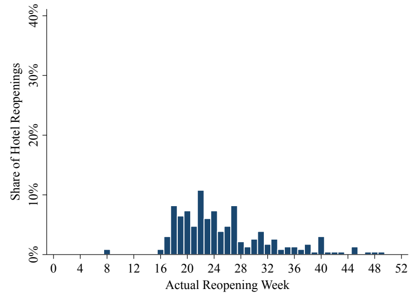
(B) Hotel Performance

Figure 4. Distribution of Hotel Closures, Reopenings, and PPP Loan Approvals

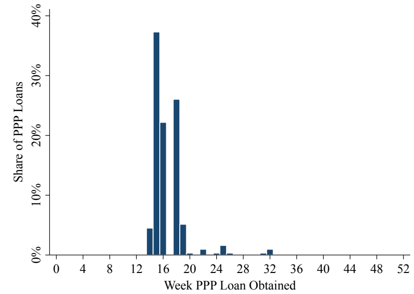
This figure depicts the the distribution of hotel closures (Panel A), hotel reopenings (Panel B), and PPP loans approved (Panel C) by calendar week in 2020. We infer hotel closure and reopening dates from STR's daily hotel performance surveys. Specifically, we consider a hotel to be closed if it did not report daily performance data for any consecutive 30-day period in 2020 or if reported occupancy was below 5%. The data on PPP loan approval dates are from the U.S. Department of the Treasury.



(A) Hotel Closures



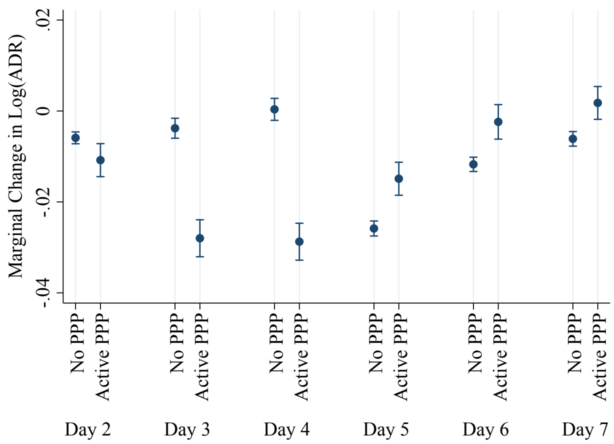
(B) Hotel Reopenings



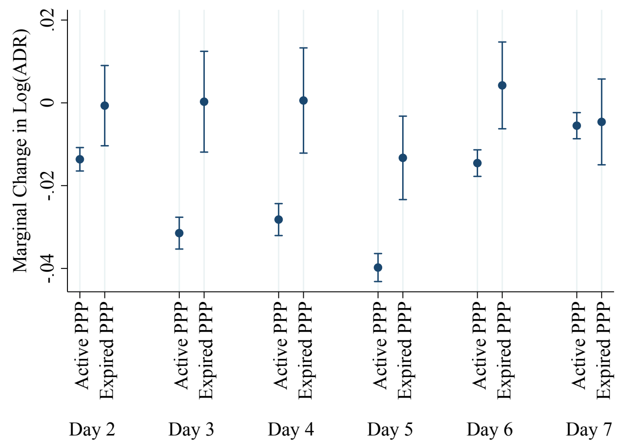
(C) PPP Loan Approvals

Figure 5. Marginal Change in Daily ADR Following Demand Shocks

This figure depicts estimated marginal changes in the natural logarithm of airport hotels' daily ADR in the seven days following a week with a significant demand shock. Panel A compares estimated changes in daily ADR between hotels with active PPP loans and those with no PPP loans. Panel B compares estimated changes in daily ADR between hotels with expired PPP loans and those same hotels while they had active PPP loans. We consider a significant demand shock to have occurred when weekly airport traffic in a hotel's local airport market declined by more than 20% year-on-year. The estimated margins are derived from Eq. (28). Bars indicate 90% confidence intervals.



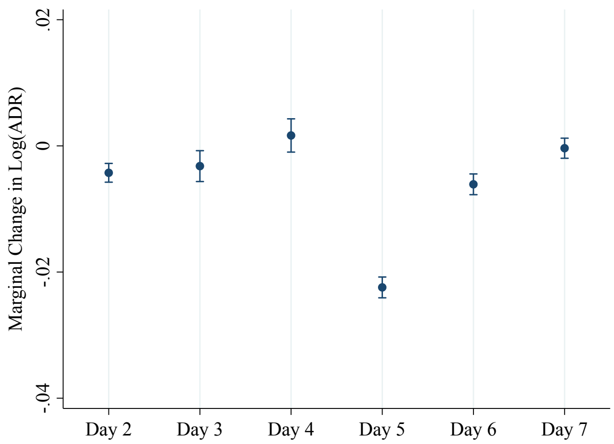
(A) Active PPP Loans



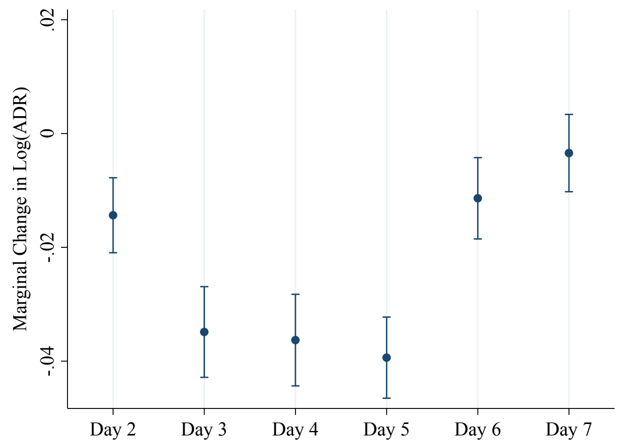
(B) Expired PPP Loans

Figure 6. Marginal Change in Daily ADR Following Price Drops by Competitors

This figure depicts estimated marginal changes in the natural logarithm of airport hotels' daily ADR in the seven days following a week with a significant ADR drop by competing airport hotels. Panel A shows estimated changes in daily ADR for hotels without PPP loans in response to significant price drops by competing hotels with active PPP loans. Panel B shows estimated changes in daily ADR for hotels with active PPP loans in response to significant price drops by competing hotels without PPP loans. We consider a significant drop in ADR to have occurred when the weekly average ADR among a PPP hotel's non-PPP competitors declined by more than 20% year-on-year (and vice versa). The estimated margins are derived from Eq. (29). Bars indicate 90% confidence intervals.



(A) Hotels Without PPP Loans



(B) Hotels With Active PPP Loans

Table 1. Descriptive Statistics

This table presents summary statistics on the 1,945 airport hotels in our sample and the 78 airport markets where those hotels are located. *PPP Loan* is an indicator that takes the value of one if a hotel obtained a PPP loan in 2020, and zero otherwise. *Closed for Pandemic* is an indicator that takes the value of one if a hotel experienced any consecutive 30-day period in 2020 during which daily performance data were not reported or when reported occupancy was below 5%, and zero otherwise. *Closed by End-2020* is an indicator that takes the value of one if a hotel was closed during all of December 2020, and zero otherwise. *Pre-Pandemic Profitability* is a hotel's gross operating profit margin in 2019 or, where that information is unavailable, the corresponding observation from 2018. *Class Category* is an ordinal variable taking values from 1 through 6, based on a hotel's average room rates reported to STR. *Size Category* is an ordinal variable taking values from 1 through 5, based on STR census data on the number of rooms in each sample hotel. *High Competition* is an indicator that takes the value of one if a hotel is located in the top 25% most competitive markets (by Herfindahl-Hirshman Index, based on hotel size within a hotel's class bucket and airport location). *Hotel Age* is the difference between 2020 and the year a hotel opened, as reported in the STR census data. *Number of Airport Hotels* is the number of sample hotels located in a given airport market. *Market Size* is the total volume of airport traffic (in millions of passengers) in a given airport in 2019. *Decline in Airport Traffic January-April 2020* is the year-on-year percentage rate of change in airport traffic in the four months through April 2020. *Share of Airport Hotels with PPP Loans* is the ratio of local hotels that obtained PPP loans in 2020.

	N	Mean	Median	SD
Hotels				
PPP Loan	1,945	0.160	0.000	0.367
Closed for Pandemic	1,945	0.119	0.000	0.324
Closed by End-2020	1,945	0.029	0.000	0.167
Pre-Pandemic Profitability	535	0.402	0.404	0.113
Class Category	1,945	4.019	4.000	1.279
Size Category	1,945	2.258	2.000	0.839
High Competition	1,945	0.249	0.000	0.432
Age	1,939	24.280	22.000	13.634
Airports				
Number of Airport Hotels	78	24.923	22.000	16.844
Market Size	78	8.527	5.191	8.917
Decline in Airport Traffic January-April 2020	78	–0.369	–0.381	0.058
Share of Airport Hotels with PPP Loans	78	0.168	0.129	0.155

Table 2. Determinants of PPP Loan Application Choices

This table presents output from Eq. (24). The dependent variable is *PPP Loan*, an indicator that takes the value of one if hotel i obtained a PPP loan in 2020, and zero otherwise. *Pre-Pandemic Profitability* is a hotel's gross operating profit margin in 2019 or, where that information is unavailable, the corresponding observation from 2018. *High Competition* is an indicator that takes the value of one if a hotel is located in the top 25% most competitive markets (by Herfindahl-Hirshman Index, based on hotel size within a hotel's class bucket and airport location). *Large Air Traffic Decline* is an indicator that takes the value of one if hotel i is located in an airport market with an above-median decline in cumulative airport traffic between January and April 2020, compared to the same period one year prior. *Age* is the age (in years) of hotel i in 2020. *Market Size* is the size of the airport market in which hotel i is located, measured as the total volume of airport traffic in 2019. Fixed effects for hotel operation, hotel class, and hotel size category are included as indicated. All regressions are estimated in the cross-section of airport hotels in 2020. Heteroskedasticity-robust standard errors are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Pre-Pandemic Profitability	–0.050***				–0.056***
	(0.016)				(0.013)
High Competition		0.410***		0.419***	–0.326
		(0.142)		(0.142)	(0.316)
Large Air Traffic Decline			0.323**	0.400***	0.778***
			(0.136)	(0.127)	(0.290)
Age	–0.011	0.020***	0.022***	0.020***	–0.005
	(0.014)	(0.005)	(0.006)	(0.005)	(0.013)
Market Size	0.123		0.301***		
	(0.174)		(0.069)		
Hotel Operation Fixed Effects	Yes	Yes	Yes	Yes	Yes
Hotel Class Fixed Effects	Yes	No	Yes	No	No
Hotel Size Category Fixed Effects	Yes	No	Yes	No	No
Observations	533	1,939	1,938	1,939	534
R-squared	0.19	0.05	0.16	0.05	0.14

Table 3. Determinants of Early PPP Loan Application Choices

This table presents output from Eq. (25). In Panel A (Panel B, respectively), the dependent variable is an indicator that takes the value of one if hotel i obtained a PPP loan by week 15 (week 16) of 2020, and zero otherwise. *Pre-Pandemic Profitability* is a hotel's gross operating profit margin in 2019 or, where that information is unavailable, the corresponding observation from 2018. *High Competition* is an indicator that takes the value of one if a hotel is located in the top 25% most competitive markets (by Herfindahl-Hirshman Index, based on hotel size within a hotel's class bucket and airport location). *Large Air Traffic Decline* is an indicator that takes the value of one if hotel i is located in an airport market with an above-median decline in cumulative airport traffic in January 2020, compared to the same month one year prior. *Age* is the age (in years) of hotel i in 2020. *Market Size* is the size of the airport market in which hotel i is located, measured as the total volume of airport traffic in 2019. Fixed effects for hotel operation, hotel class, and hotel size category are included as indicated. All regressions are estimated in the cross-section of airport hotels in 2020. Heteroskedasticity-robust standard errors are reported in parentheses.

(A) PPP Loan Applications by Week 15

	(1)	(2)	(3)	(4)	(5)
Pre-Pandemic Profitability	–0.040**				–0.039**
	(0.018)				(0.016)
High Competition		0.267		0.242	–0.425
		(0.211)		(0.211)	(0.467)
Large Air Traffic Decline (Jan)			0.328*	0.408**	0.927**
			(0.198)	(0.186)	(0.420)
Age	0.013	0.025***	0.024***	0.025***	0.030*
	(0.017)	(0.007)	(0.007)	(0.006)	(0.017)
Market Size	0.193		0.059		
	(0.241)		(0.095)		
Hotel Operation Fixed Effects	Yes	Yes	Yes	Yes	Yes
Hotel Class Fixed Effects	Yes	No	Yes	No	No
Hotel Size Category Fixed Effects	Yes	No	Yes	No	No
Observations	533	1,939	1,938	1,939	534
R-squared	0.24	0.05	0.16	0.06	0.18

(B) PPP Loan Applications by Week 16

	(1)	(2)	(3)	(4)	(5)
Pre-Pandemic Profitability	–0.056***				–0.055***
	(0.017)				(0.016)
High Competition		0.506***		0.491***	–0.002
		(0.168)		(0.168)	(0.396)
Large Air Traffic Decline (Jan)			0.153	0.243	0.697*
			(0.162)	(0.153)	(0.376)
Age	0.009	0.020***	0.022***	0.020***	0.021
	(0.016)	(0.006)	(0.006)	(0.006)	(0.016)
Market Size	0.212		0.129*		
	(0.213)		(0.076)		
Hotel Operation Fixed Effects	Yes	Yes	Yes	Yes	Yes
Hotel Class Fixed Effects	Yes	No	Yes	No	No
Hotel Size Category Fixed Effects	Yes	No	Yes	No	No
Observations	533	1,939	1,938	1,939	534
R-squared	0.23	0.06	0.16	0.06	0.18

Table 4. PPP Loans and Airport Hotel Top-Line Performance

This table presents output from Eq. (26) in Panel A and from Eq. (27) in Panel B. Across both panels, the dependent variable in column (1) is $Relative\ ADR_{i,t}$, the average ADR of PPP hotel i in week t, relative to the average ADR in week t of all other non-PPP hotels in the same airport market and class bucket. The dependent variable in column (2) (column (3), respectively) is $Relative\ Occupancy_{i,t}$ ($Relative\ RevPAR_{i,t}$), computed in the same manner as $Relative\ ADR_{i,t}$. $PPP\ Active_{i,t}$ is an indicator that takes the value of one in every week t during which PPP hotel i had an active PPP loan, and zero before then. $PPP\ Expired_{i,t}$ is an indicator that takes the value of one after hotel i's PPP loan expired, and zero before then. Hotel fixed effects and airport market×week interacted fixed effects are included as indicated. All regressions are estimated in the sub-sample of airport hotels that obtained PPP loans in 2020. The estimations in Panel A include observations on those hotels from the start of 2020 through the final week in which they operated under an active PPP loan. The estimations in Panel B include observations on PPP hotels for the full calendar year 2020. Standard errors, clustered by airport market and week, are reported in parentheses.

(A) Top-Line Performance While PPP Loans Were Active

	Relative ADR (1)	Relative Occupancy (2)	Relative RevPAR (3)
PPP Loan Active	–0.030*** (0.010)	0.231*** (0.043)	0.221*** (0.045)
Hotel Fixed Effects	Yes	Yes	Yes
Market×Week Fixed Effects	Yes	Yes	Yes
Observations	11,137	11,137	11,137
R-squared	0.80	0.64	0.68

(B) Top-Line Performance After PPP Loans Expired

	Relative ADR (1)	Relative Occupancy (2)	Relative RevPAR (3)
PPP Loan Expired	0.023*** (0.007)	–0.065*** (0.020)	–0.051** (0.022)
Hotel Fixed Effects	Yes	Yes	Yes
Market×Week Fixed Effects	Yes	Yes	Yes
Observations	14,475	14,475	14,475
R-squared	0.82	0.64	0.70

Appendix A Proof of Proposition 2

Both $K^{i,PPP}$ and $B^{i,PPP}$ are continuous functions of c_i:

$$\begin{aligned} B^{i,PPP}(c_i) &= \pi_1^{i,PPP} - \pi_1^i = \frac{D_1}{4\theta}\left[2\left(E\left(c\right) - \alpha\rho + \frac{2\theta}{n} - c_i\right)\rho + \rho^2\right] \\ &= \frac{D_1}{4\theta}\left[2E\left(c\right) + (1-2\alpha)\rho + \frac{4\theta}{n} - 2c_i\right]\rho. \end{aligned}$$

$$\begin{aligned} K^{i,PPP}(c_i) &= \left(1 - P(c_i|D_1)\right)Z \\ &= \left(1 - \left(G(c_i)\right)^{n-1} Q(c_i|D_1)\right)Z. \end{aligned}$$

(i) The cost $K^{i,PPP}$ associated with obtaining a PPP loan goes to zero as c_i approaches c_0^*, because c_i and c_3^* are continuously distributed on $[c_L, c_0^*]$ and $P(c_0^*) = 1$. On the other hand, $B^{i,PPP} > 0$. As a result, when c_i is sufficiently high, we have $B^{i,PPP} > K^{i,PPP}$, which proves part (i).

(ii) The cost $K^{i,PPP}$ associated with obtaining a PPP loan goes to Z as c_i approaches c_L, because c_i and c_3^* are continuously distributed on $[c_L, c_0^*]$ and $P(c_L) = 0$. On the other hand, $B^{i,PPP}(c_L) = \frac{D_1\rho}{4\theta}\left[2(\bar{c} - c_L) + (1-2\alpha)\rho + \frac{4\theta}{n}\right]$. As a result, if (23) holds, and c_i is sufficiently low, we have $B^{i,PPP} < K^{i,PPP}$, which proves part (ii).

(iii) When (23) holds, we have $B^{i,PPP}(c_L) - K^{i,PPP}(c_L) < 0$ and $B^{i,PPP}(c_0^*) - K^{i,PPP}(c_0^*) > 0$. If $P(c_i|D_1)$ is convex in c_i, then $B^{i,PPP}(c_i) - K^{i,PPP}(c_i)$ is convex on $[c_L, c_0^*]$. As a result, there is a unique $\hat{c} \in (c_L, c_0^*)$ such that $B^{i,PPP}(\hat{c}) - K^{i,PPP}(\hat{c}) = 0$, which proves part (iii).

(iv) Because $Q(c|D_1)$ is weakly decreasing in D_1, $B^{i,PPP}(c_i) - K^{i,PPP}(c_i)$ is also weakly decreasing in D_1. As a result, the range of costs c_i for which $B^{i,PPP}(c_i) > K^{i,PPP}(c_i)$ is also weakly decreasing in D_1, which proves part (iv).

Appendix B Proof of Proposition 3

Plugging equations (17) and (20) into the formula for γ^{PPP} yields

$$
\begin{aligned}
\gamma^{PPP} &= \frac{\alpha n \Delta \pi^{PPP}}{M} \\
&= \frac{\alpha n \left(\pi_1^{H,PPP} - \pi_2^{H}\right)}{\alpha n D_1 S_1^{H,PPP} \rho} \\
&= \frac{\left(\frac{D_1}{4\theta}\left[\bar{c} + \frac{2\theta}{n} - c_H + (1-\alpha)\rho\right]^2 - \frac{D_1}{4\theta}\left[\bar{c} + \frac{2\theta}{n} - c_H\right]^2\right)}{D_1 S_1^{H,PPP} \rho} \\
&= \frac{\frac{D_1}{4\theta}\left(2\left(\bar{c} + \frac{2\theta}{n} - c_H\right)(1-\alpha)\rho + ((1-\alpha)\rho)^2\right)}{D_1 S_1^{H,PPP} \rho} \\
&= \frac{(1-\alpha)}{4\theta S_1^{H,PPP}}\left(2\left(\bar{c} + \frac{2\theta}{n} - c_H\right) + (1-\alpha)\rho\right) \\
&= \frac{(1-\alpha)}{S_1^{H,PPP}}\left(\left[\frac{\bar{c} - c_H + (1-\alpha)\rho}{2\theta} + \frac{1}{n}\right] - \frac{(1-\alpha)\rho}{4\theta}\right).
\end{aligned}
$$

According to equation (16),

$$
S_1^{H,PPP} = \frac{\bar{c} - c_H + (1-\alpha)\rho}{2\theta} + \frac{1}{n}.
$$

Thus,

$$
\gamma^{PPP} = (1-\alpha)\left(1 - \frac{(1-\alpha)}{4S_1^{H,PPP}}\frac{\rho}{\theta}\right). \tag{B.1}
$$

We repeat the above procedure to obtain a similar expression for γ.

$$
\begin{aligned}
\gamma &= \frac{(1-\alpha) n \Delta \pi}{M} \\
&= \frac{(1-\alpha) n \left(\pi_1^{L} - \pi_2^{L}\right)}{\alpha n D_1 S_1^{H,PPP} \rho} \\
&= \frac{(1-\alpha)\left(\frac{D_1}{4\theta}\left[\bar{c} + \frac{2\theta}{n} - c_L - \alpha\rho\right]^2 - \frac{D_1}{4\theta}\left[\bar{c} + \frac{2\theta}{n} - c_L\right]^2\right)}{\alpha D_1 S_1^{H,PPP} \rho} \\
&= \frac{(1-\alpha)\frac{D_1}{4\theta}\left(-2\left(\bar{c} + \frac{2\theta}{n} - c_L\right)\alpha\rho + (\alpha\rho)^2\right)}{a D_1 S_1^{H,PPP} \rho} \\
&= \frac{(1-\alpha)}{4\theta S_1^{H,PPP}}\left(-2\left(\bar{c} + \frac{2\theta}{n} - c_L\right) + \alpha\rho\right) \\
&= \frac{(1-\alpha)}{S_1^{H,PPP}}\left(-\left[\frac{\bar{c} - c_L - \alpha\rho}{2\theta} + \frac{1}{n}\right] - \frac{\alpha\rho}{4\theta}\right).
\end{aligned}
$$

According to equation (13),

$$S_1^L = \frac{\bar{c} - c_L - \alpha\rho}{2\theta} + \frac{1}{n}.$$

Thus,

$$\gamma = -(1-\alpha)\left(\frac{S_1^L}{S_1^{H,PPP}} + \frac{\alpha}{4S_1^{H,PPP}}\frac{\rho}{\theta}\right). \tag{B.2}$$

Equations (12), (15), and (18) imply

$$\Delta P_1 = p_1^{H,PPP} - p_1^L = \frac{1}{2}\left(c^H - c^L - \rho\right), \tag{B.3}$$

$$\Delta P_2 = p_2^H - p_2^L = \frac{1}{2}\left(c^H - c^L\right). \tag{B.4}$$

Thus,

$$\rho = 2\left(\Delta P_2 - \Delta P_1\right). \tag{B.5}$$

Combining equations (16) and (19) with (B.3) yields

$$\begin{aligned} \Delta S_1 &= S_1^{H,PPP} - S_1^L \\ &= \frac{c^L - c^H + \rho}{2\theta} \\ &= \frac{-2\Delta P_1}{2\theta} \\ &= -\frac{\Delta P_1}{\theta}. \end{aligned}$$

Thus,

$$\theta = -\frac{\Delta P_1}{\Delta S_1}, \tag{B.6}$$

and

$$\begin{aligned} \frac{\rho}{\theta} &= -\frac{2\left(\Delta P_2 - \Delta P_1\right)\Delta S_1}{\Delta P_1} \\ &= -2\Delta S_1\left(\frac{\Delta P_2}{\Delta P_1} - 1\right). \end{aligned} \tag{B.7}$$

Plugging (B.7) into (B.1) and (B.2) yields equations (33) and (34).

Appendix C PPP Loans and Airport Hotel Closures

In addition to affecting hotels' competitive strategies, on a more basic level, PPP loans may also influence hotels' ability to remain open during the Covid-19 pandemic. In the subsequent analyses, we assess the empirical relationships between PPP loans and airport hotel closures — temporary and permanent — and hotel reopenings during 2020. We first focus on hotel closures and estimate the following logistic regression model:

$$\begin{aligned} \textit{Reported Closure}_i = {} & \beta_1 \textit{PPP Loan Obtained by Wk. 14}_i + \beta_2 \textit{PPP Loan Obtained by Wk. 15}_i \\ & + \beta_3 \textit{PPP Loan Obtained by Wk. 16}_i + \beta_4 \textit{PPP Loan Obtained by Wk. 18}_i \\ & + \beta_5 \textit{PPP Loan after Wk. 18}_i + \beta_6 \textit{Controls}_i + \gamma_o + \delta_c + \theta_s + \epsilon_i \end{aligned} \tag{C.1}$$

where *Reported Closure*$_i$ is an indicator that takes the value of one if hotel i reported a business closure to STR in 2020, and zero otherwise. *PPP Loan Obtained by Wk. 14*$_i$ is an indicator that takes the value of one if hotel i obtained a PPP loan in week 14 of 2020, and zero otherwise. We define four additional indicator variables that, respectively, take the value of one if hotel i obtained a PPP loan by week 15, week 16, week 18, or after week 18, and zero otherwise. The remaining variables and notation are as in Eq. (24). We estimate Eq. (C.1) in the cross-section of sample hotels in 2020, using maximum likelihood with heteroskedasticty-robust standard errors.[21] We then replicate the estimation of Eq. (C.1), replacing the dependent variable with an indicator that takes the value of one if a hotel was closed during all of December 2020, and zero otherwise (denoted *Closed by End-2020*).

We also estimate versions of Eq. (C.1) where we replace the outcome with a continuous variable capturing the planned (respectively, actual) calendar weeks in 2020 when the hotels that experienced temporary closures reopened. Data on planned reopening weeks come from hotels' stated responses to the STR performance surveys. We infer information on actual reopening weeks from the availability of daily performance data in those STR surveys. The alternative specifications relating to planned and actual reopening weeks are estimated in the sub-sample of hotels that experienced temporary closures in 2020, using OLS.

[21] In the regression specification described in Eq. (C.1), hotels that do not obtain a PPP loan in 2020 are the omitted category. The estimation results from Eq. (C.1) may thus be subject to selection bias, as hotels' choices to obtain PPP loans are endogenous. To assess the direction of the bias, we estimate the likelihood of a hotel experiencing a temporary closure in 2020 as a function of the same variables we used to predict the likelihood that a hotel will obtain a PPP loan in that year. In unreported results, we find that the variables that predict PPP loans are also associated with a higher likelihood of hotel closures. Therefore, our coefficient estimates for the effects of PPP loans on hotel closures likely understate the true magnitude of the effect.

Table C.1 presents the results. The estimates in column (1) show that obtaining a PPP loan by week 15, 16, or 18 of 2020 was associated with a lower likelihood that a hotel would report a temporary closure during that year. The estimates reported in column (2) indicate that obtaining a PPP loan either very early (by week 14) or very late (after week 18) reduced the likelihood that a hotel would be closed by the end of 2020. We view these results as early evidence on the relationship between PPP loans and permanent hotel closures, but note that our conclusions are preliminary.[22] Out of the sample hotels that experienced a temporary closure in 2020, those that obtained PPP loans late (after week 18) were likely to plan on an earlier reopening date than were those that did not obtain PPP loans at all (see column (3)). However, we find little evidence that obtaining a PPP loan was associated with a significant reduction in actual downtime (column (4)).

[Insert Table C.1 about here.]

In all, the preliminary results presented in Table C.1 suggest that PPP loans did little to mitigate disruptions to the business operations of airport hotels during the Covid-19 pandemic. This is likely due to the fact that hotels which were going to close when the Covid-19 crisis first unfolded mostly did so before the PPP began (see Figure 4).

[22] At the time of writing, we are awaiting the delivery of the 2021 STR hotel census data with updated information on the operating status of our sample hotels.

Table C.1. Determinants of Hotel Closures and Reopenings

This table presents output from Eq. (C.1). The dependent variable in column (1) (column (2), respectively) is *Reported Closure*$_i$, an indicator that takes the value of one if hotel i reported a business closure to STR in 2020, and zero otherwise (*Closed by End-2020*$_i$, an indicator that takes the value of one if hotel i was closed during all of December 2020, and zero otherwise). The dependent variable in column (3) (column (4), respectively) is *Planned Reopen Week*$_i$, based on hotel i's stated response to the STR performance surveys (*Actual Reopen Week*$_i$, based on the availability of daily performance data for hotel i in the STR performance surveys). *PPP Loan Obtained by Wk. 14*$_i$ is an indicator that takes the value of one if hotel i obtained a PPP loan by week 14 of 2020, and zero otherwise. *PPP Loan Obtained by Wk. 15*$_i$ through *PPP Loan Obtained after Wk. 18*$_i$ are defined in the same way. *Age* is the age (in years) of hotel i in 2020. *Market Size* is the size of the airport market in which hotel i is located, measured as the total volume of airport traffic in 2019. Fixed effects for hotel operation, hotel class, and hotel size category are included as indicated. The regressions in columns (1) and (2) are estimated in the cross-section of airport hotels in 2020. The regressions in columns (3) and (4) are estimated in the sub-sample of hotels that experienced a temporary closure during 2020. Heteroskedasticity-robust standard errors are reported in parentheses.

	Reported Closure (1)	Closed by End-2020 (2)	Planned Reopen Week (3)	Actual Reopen Week (4)
PPP Loan Obtained by Wk. 14	–0.119	–12.341***	–0.002	1.718
	(1.034)	(0.924)	(2.335)	(2.019)
PPP Loan Obtained by Wk. 15	–1.010*	–1.468	2.207	–3.015*
	(0.579)	(1.036)	(2.422)	(1.771)
PPP Loan Obtained by Wk. 16	1.995**	1.834	–1.071	2.746
	(0.837)	(1.318)	(3.304)	(1.868)
PPP Loan Obtained by Wk. 18	–1.578**	–1.204	–1.442	–1.753
	(0.747)	(1.191)	(2.937)	(1.491)
PPP Loan Obtained after Wk. 18	0.700	–13.612***	–4.121***	0.880
	(0.446)	(0.383)	(1.128)	(1.811)
Age	0.017**	0.009	0.001	0.033
	(0.008)	(0.011)	(0.025)	(0.033)
Market Size	0.182**	0.192*	0.945**	0.233
	(0.088)	(0.103)	(0.376)	(0.529)
Hotel Operation Fixed Effects	Yes	Yes	Yes	Yes
Hotel Class Fixed Effects	Yes	Yes	Yes	Yes
Hotel Size Category Fixed Effects	Yes	Yes	Yes	Yes
Observations	1,938	1,938	155	231
R-squared	0.13	0.15	0.35	0.22