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Consumers' demand for operational licencing: evidence from Airbnb in Paris☆

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ABSTRACT

Since July 2021, Airbnb discloses whether listings in Paris hold a mandatory registration number to legally operate. Grounded on information asymmetries and moral hazard theories, this paper studies consumers' preferences for certifications of legality and minimum quality standards. We exploit the staggered disclosure of licences over time to evaluate the change in demand (reviews) compared to those that continue offering their properties without the licence. Event study and difference-in-differences estimates indicate that reviews for registered hosts increased by around 10 % relative to illegal operators. The effects are increasing over time as the licence becomes more salient to consumers. Our findings suggest that the disclosure of hosts' legal status is an effective mechanism to improve the enforcement of peer-to-peer markets regulation.

Introduction

The growth of peer-to-peer accommodations traded through online platforms like Airbnb is receiving great attention by policy makers and local authorities due to its economic effects on housing affordability and rents (Franco and Santos, 2021; Garcia-López, Jofre-Monseny, Martínez-Mazza & Segú, 2020). Although Airbnb entry has positive welfare effects through expanding accommodation supply (Farronato and Fradkin, 2022), augmenting neighbourhood investment (Xu and Xu, 2021) and being a source of income for residents (Jimenez, Ortuño & Pérez-Rodríguez, 2022), the uncontrolled growth of Airbnb in some cities has produced relevant gentrification problems (Cheung & Yiu, 2022), which has forced local authorities to implement several policy responses. Taxes, limits to the rental period, licence requirements or banning short-term rentals are some examples of existing measures (Von Briel and Dolnicar, 2021).

The literature on Airbnb regulations has pointed to important difficulties in the monitoring of hosts' compliance with the regulatory framework in practice (Furukama & Onuki, 2022; Nieuwland and van Melik, 2020). The anonymity provided by online marketplaces might induce hosts to illegally rent their properties without having to pay taxes (Jia and Wagman, 2020). Although they might be economically fined if detected, the potential benefits of continuing renting might pay off, especially when con-

sumers ignore the 'illegal' nature of the property. However, the incentive to become a legal accommodation might notably change when its legal status is publicly disclosed.

This paper studies how consumers value the tenure of a compulsory operational licence (registration number) using the Airbnb rental market in Paris as the case study. Specifically, we evaluate the impact of an exogenous policy change that forced Airbnb properties to disclose their 'legal' status on demand. Paris has one of the largest Airbnb networks in the world (Adamiak, 2018), counting around 48,000 properties in March 2021. Parisian officials have implemented different regulations, including limiting the maximum nights to 120 days a year since 2014 or the need to register the property since 2017. However, these measures have not been properly enforced and around 60 % of Airbnb supply is estimated to have been operating illegally (Cox and Haar, 2020). Similar licences are required in Amsterdam, Barcelona and Berlin. Cox and Haar (2020) report that although Airbnb removed illegal listings in Barcelona after being notified by the city, it allowed them to relist later. Following a conviction to pay 8 million euros to the Paris Council for having maintained since 2017 illegal properties, Airbnb has forced all accommodations in Paris listed on the platform to publicly disclose their registration number from 1 July 2021 onwards. Those who requested it to the city council but do not have it yet are nevertheless allowed to continue renting.

We exploit the staggered adoption of the licence among Airbnb hosts over time to investigate whether consumers exhibit preferences for legal accommodation suppliers. If so, the public disclosure of legal badges could be an effective mechanism to alleviate the share of illegal actors in the market, serving also as a potential quality signal. We use a monthly panel dataset for around 50,000 Airbnb properties in Paris for the first seven months after the policy implementation (July 2021–January 2022). The analysis of the impact of licences on demand is particularly timely during this period because the pandemic has changed consumers' preference over property characteristics (Hidalgo et al., 2021) and professionalism among suppliers (Dolnicar and Zare, 2020). Moreover, COVID-19 has triggered prices and occupancy rates down (Llaneza-Hesse and Raya-Vílchez, 2022), increasing competition in the sector and forcing low-performing and bad-quality properties to exit the market (Kourtit, Nijkamp, Östh & Turk, 2022).

Our work speaks to two streams of research. Firstly, the paper expands existing evidence on the effects of operational licencing (Kleiner, 2016) but in the Airbnb rental market. Although a large stream of literature has evaluated the effects of licencing on the supply side (Hotz and Xiao, 2011; Kleiner & Kudrle, 2000), there is far less evidence on its effects on demand. In line with the literature on the importance of trust for Airbnb consumers (Ert, Fleischer & Magen, 2016; Ert and Fleischer, 2019; Fleischer, Ert & Bar-Nahum, 2022) and operational licencing as a way to alleviate asymmetric information and moral hazard issues (Leland, 1979; Shapiro, 1986), we show that consumers prioritize properties with a registration number relative to plausibly *illegal* accommodations. This is potentially explained by strong preferences for legal badges. Therefore, we show that registration requirements work as legality signals that attenuate information asymmetries and the 'market for lemons' problem in online peer-to-peer marketplaces (Benítez-Aurioles, 2022a; Leoni, 2020; Lewis, 2011). From this viewpoint, the study adds novel insights about sellers' information disclosure (Liang, Li, Liu & Schuckert, 2019). Secondly, the paper contributes to the literature on Airbnb regulations (Benítez-Aurioles, 2021; Falk and Yang, 2021; Furukawa and Onuki, 2022; Nieuwland and van Melik, 2020; Yeon, Song & Lee, 2020) by examining whether consumers 'punish' illegal actors in terms of relatively lower demand once the legal status of the property is publicly disclosed. Since this appears to be the case, our findings have important implications for policy regulations: the public disclosure of the legal status of the listing could be a promising mechanism to improve their enforcement.

Background and literature review

Operational licencing in services

The theoretical foundations on the relationship between asymmetric information and suboptimal provision of services can be found in the works of Leland (1979) and Shapiro (1986). According to Leland (1979), when buyers do not truly know the quality of the product they buy, the introduction of licences (i.e., administrative permits that signal that the supplier fulfils some minimum quality standards) increases social welfare when a large part of consumers presents high preferences for quality, the demand side is price-inelastic and the supply side has non-increasing cost functions with respect to quality. Nonetheless, imposing requirements on minimum quality above the equilibrium is not always welfare enhancing; there is an undersupply of goods when opportunity costs of producers are increasing in quality. The model of Shapiro (1986) enriches that by Leland (1979) by allowing individuals to focus on their preferred, instead of average, quality levels, and by considering moral hazard problems due to licences. Again, markets where consumers are biased towards high-quality products, or suppliers' costs of any quality are low-sensitive before licencing, benefit from minimum quality standards. Therefore, if differences in opportunity costs are low, and producers are rather insensitive towards quality standards, average quality levels will increase while the low-quality share of the market remains unexpelled. Additionally, certifications can be superior to licences when high-quality suppliers face higher returns from investments in building up reputations.

At the empirical level, there is nonetheless a lack of consensus about the effects of decentralized mechanisms of supervision like certifications on the provision of services. For the case of regulated professions, some works have shown that licence requirements produce increases in wages and prices (Kleiner, 2000, 2016; Kleiner & Kudrle, 2000) and shrink the supply of low-quality suppliers (Hotz and Xiao, 2011). From the demand side of the market, Farronato, Fradkin, Larsen and Brynjolfson (2020) find that consumers of residential home services are more sensitive to online reviews and prices than to licencing, probably due to an ex-ante assumption that all available providers are already complying with regulations. Stringent licencing policies decrease the supply of services and raise transaction costs without producing changes in quality levels. Relatedly, Farronato and Zervas (2022)

show that restaurant online reviews complement regulatory inspections at the goal of reducing information asymmetries about cleanliness. Specifically, reviews offer relevant information concerning aspects that customers directly experience.

In the Airbnb context, operational licencing can help to alleviate information asymmetries through a reputation incentive mechanism (Lewis, 2011); similar to intangible social licences as indicators of community acceptance that generate consumer trust (Baumer, Schweinsberg, Scerri, Kaya & Sajib, 2021), *administrative* licences can serve as objective signals to consumers that the property is legal and fulfils some quality standards.

Quality signals and trust in the Airbnb market

The imposition of licencing requirements improves social welfare by reducing information asymmetries. This seems to be particularly relevant for services traded through peer-to-peer platforms like Airbnb, since transactions are highly contingent on a sufficient level of trust between agents (van der Cruijsen, Doll & van Hoenselaar, 2019). The success of Airbnb as a popular peer-to-peer marketplace largely rests on its capacity to rapidly promote trust, both in the platform and in the host. Buyers' trust can be enhanced if hosts disclose more personal information about their properties and about themselves (Liang et al., 2019).

Leoni (2020) studies the survival rate of different Airbnb listings in Ibiza, finding that user generated content is highly relevant to avoid the problem of negative selection; listings with low customer ratings are more likely to exit the market. Ert et al. (2016) show that the exhibition of hosts' personal photos in the platform significant affects guests' choices: the more trustworthy the host is perceived to be, the higher the price and the greater the probability of being chosen. Ert and Fleischer (2019) evaluate the effects of several changes in platform trust indicators on prices. They find that the implementation of the "Superhost" badge has produced price premiums through a better identification of high-quality hosts. On the contrary, the removal of hosts' photos has eliminated potential price premiums for trustworthy images. Fleischer et al. (2022) detect that drops in hosts' overall ratings produce shifts in demand from peer-to-peer to hotel accommodations. Therefore, Airbnb guests are sensitive to losses in the quality levels shown in the platform.

Nonetheless, a growing body of literature has started to highlight some flaws in Airbnb's business model and platform design, which damages trustworthiness and re-purchase intentions (Mao, Jones, Li, Wei & Lyu, 2020). Li and Tsai (2022) show that although consumers use ratings as a reference, they do not influence trust in Airbnb. Indeed, a non-negligible share of people exhibits concerns about the reliability of ratings. Shapit and Björk (2019) document that the lack of response to service failures generates distrust and a feeling of cheating. These authors argue that Airbnb should invest more resources in customer services, provide financial compensations to clients or improve the information provided in the platform by including third-party assurance. Accordingly, operational licencing granted by public authorities could complement ex-ante trust and quality assessments.

Research on Airbnb regulations

In recent years, an emerging literature has evaluated the effects of different policy regulations on short-term rentals. These policies include the prohibition and zoning of nonprimary short-term rentals (Benítez-Aurioles, 2021; Valentin, 2021), the imposition of licencing permits (Chen, Huang & Tan, 2021; Müller, Neumann & Kundisch, 2022; van Holm, 2020), changes in bureaucratic requirements (Boto-García, Baños-Pino, Del Valle & Sustacha, 2022) or setting tax collection obligations (Yang and Mao, 2019), among others. A summary of some relevant regulations implemented in the most iconic tourist destinations is presented in Von Briel and Dolnicar (2021). The aim of these policies is to avoid the shortage of affordable housing as well as the negative externalities imposed on neighbourhoods like undesired gentrification, pollution or noise (see Dolnicar, 2019). Scholars have evaluated their effects on different outcomes like Airbnb supply (Boto-García et al., 2022; Chen et al., 2021; van Holm, 2020; Yang and Mao, 2019), prices (Müller et al., 2022), usage and revenues (Valentin, 2021; Yeon et al., 2022), hotel overnight stays (Falk and Yang, 2021) and hotel revenues (Yeon et al., 2020).

Empirical evidence is mixed, as the effects of these policies vary with the degree of Airbnb penetration, competition with other types of accommodation and the strictness of regulations (Aguilera, Artioli & Colomb, 2021). In general, policy measures slow down the growth of Airbnb supply (Furukawa and Onuki, 2022). However, they do not always achieve their intended goals, and sometimes led to undesired outcomes like shifts in Airbnb supply and usage towards adjacent non-regulated neighbourhoods (Valentin, 2021; van Holm, 2020).

One common concern among this literature is the difficulty in enforcing regulations. Furukawa and Onuki (2022) argue that the nature of peer-to-peer transactions makes monitoring hosts' behaviour very costly. Nieuwland and van Melik (2020) show that European cities are laxer than US cities at implementing urban ordinances that control short-term rentals in Airbnb and other platforms. They highlight the difficultness in surveillance and enforcement of regulation, given that these suppliers do not operate as traditional businesses in an online environment. Cameron, Khanal & Tedds (2022) discuss that licencing and registration systems might fail because of a lack of awareness among hosts about the need to register their property, especially if they believe that participation in peer-to-peer markets does not represent a real business activity.

Since the lack of trust has been revealed as the main factor that prevents people to use Airbnb services (Del Chiappa, Mei Pung, Atzeni & Sini, 2021), institutional regulations on the supply side and the legal framework of short-term rentals are predicted to play a key role. Jia and Wagman (2020) evaluate the effectiveness of two enforcement events in Manhattan aimed at expelling illegal hosts. Their results indicate that some illegal hosts exited the market temporarily but re-entered later under the less-enforced category of private rooms. Van Holm (2020) investigate the effects of the establishment of a system of registration to guarantee that Airbnb properties fulfill legal requirements in New Orleans. This author documents that the regulation temporarily

Table 1
Descriptive statistics of the number of properties in the sample with and without disclosed licence.

	Obs	Num properties with disclosed licence	%	Num. properties without licence	%
May 2021	46,865	0		46,865	100
June 2021	44,997	0		44,997	100
July 2021	37,736	22,343	59.21	15,393	40.79
August 2021	38,257	23,194	60.63	15,063	39.37
September 2021	37,849	23,646	62.47	14,203	37.53
October 2021	37,771	23,887	63.22	13,894	36.78
November 2021	37,617	23,873	63.46	13,744	36.54
December 2021	37,917	24,252	63.96	13,665	36.04
January 2022	38,148	24,619	64.54	13,529	35.46

reduced supply, but growth resumed later. Similarly, Chen et al. (2021) report that costly licencing requirements constraint the entry of new listings because they involve transaction costs. Recently, Müller et al. (2022) analyse the introduction of a licencing system together with banning Airbnb supply in a popular neighbourhood in New Orleans. They show that commercial and non-commercial hosts reacted differently, with the former raising prices in the vicinity of the banned neighbourhood but decreasing them in the rest of the city.

To our knowledge, no prior work has investigated how consumers react to public knowledge about operational licences in the Airbnb market. We aim to fill this research gap to shed light on whether consumers prioritize registered properties or not.

Study context and data

Context: The Paris Airbnb market and registration requirements

Studies on Airbnb using data for Paris have shown that the disproportionate growth of peer-to-peer accommodations in the city has affected housing affordability and produced on-going dynamics of touristification and urban transformation (Dolnicar, 2019; Freytag and Bauder, 2018). Ayouba, Breuillé, Grivault and Le Gallo (2020) report that a one-percent increase in the density of Airbnb rentals in Paris has increased rents by 0.52 %. Importantly, this effect is larger as the share of professional hosts increases. This has led local officials to act and implement several different measures in recent years (Aguilera et al., 2021).

In 2014, the French government passed a national regulation (ALUR Law, 2014) to combat the shortage of long-term rentas. This law established that for a short-term rental to be legal, it must be the host's primary residence, it must be furnished, and it cannot be rented for >120 days per year. Nonetheless, those who aim to rent their properties for >120 days can ask for a change in use from the town hall. One year later, Airbnb started to collaborate with the city of Paris in collecting tourist taxes and other information about the properties announced in the platform that were officially registered as short-term rentals and to remit them to the authorities. However, only a small share of hosts was registered at that time, so that official statistics departed notably from the real supply.

In 2016, the Law for a Digital Republic (*LOI n° 2016–1321 du 7 octobre 2016 pour une République numérique*) allowed municipalities to require any person offering a tourist-furnished accommodation to hold a licence (registration number) to legally operate. In this way, public authorities set legal requirements aiming at forcing hosts to declare their short-term renting activities to the town hall. The Paris Council passed in June 2017 a complementary law requiring mandatory registration for those renting entire primary or secondary residences. The licence can be freely obtained through the city hall's website. Short-term contracts (minimum stay of 30 days) aimed at facilitating the access to housing to people "in professional training, in higher studies, in apprenticeship contract, in internship, in voluntary engagement within the framework or a civic service or on a temporary assignment in the context of his professional activity" are also allowed under the "bail mobilité" (mobility lease) scheme.

Despite the requirement to hold a registration number to legally rent an apartment, many properties continued being offered and rented on Airbnb without it. Cox and Haar (2020) estimate that around 60 % of Airbnb listings in Paris are illegal. After Airbnb refused to remove unregistered listings from the platform, the council of Paris initiated in February 2019 a lawsuit to force Airbnb to do so. After trial, on 1 July 2021, Airbnb was convicted by the Paris judicial court to a fine of around 8 million euros for having maintained listings without the registration number since 2017. A few hours later (as indicated in press releases), the platform announced it will become automatically mandatory for all the properties in Paris to hold the registration number, and no new property will be posted without it from then onwards.

Dataset and descriptive statistics

We use monthly data of properties listed on Airbnb platform during the period May 2021–January 2022. The dataset is obtained from Inside Airbnb, a well-known free-access platform that collects detailed information about properties on the platform that has been used in previous studies (Benítez-Aurioles, 2022a, 2022b; Kourtit et al., 2022). We removed from the sample those properties that did not receive any review in the last year, as they can be considered as inactive. The resulting raw dataset involves 357,157 observations that correspond to 78,112 properties owned by 45,481 different hosts.

As discussed before, prior to July 2021 the licence was legally compulsory, but Airbnb did not enforce it: hosts were allowed to continue renting without the registration number. It was from 1 July onwards when the platform required the registration number and started to show it to consumers in the host profile next to the hosts' photograph, the number of valuations or the Superhost status. That is, independently of whether the property had a registration number or not before July 2021, it was only from then onwards when such badge was publicly disclosed. The lack of transparency towards the consumers about the legal nature of the accommodation was indeed one of the reasons why the council of Paris denounced the platform. Accordingly, our analysis considers the period when the information about the licence became readily available to potential consumers.

Despite Airbnb indicated that the registration number will be mandatory since July 2021, a large share of hosts continue offering their properties without holding it. We provide some snapshots in Appendix about real Airbnb hosts in Paris with and without the licence disclosure (Figs. A1 and A2).

Table 1 presents the number of observations (properties) per period, distinguishing between those who exhibit a registration number and those who do not. We document that in the first period following the mandatory licence disclosure (July 2021), the share of licenced properties is 'only' 59.21 %. Although this share smoothly increases over time, a non-negligible 35 % of the listings do not exhibit their registration number by January 2022. In some cases, the absence of a registration number is because the licence is 'Pending'. As explained by Airbnb (2022), this refers to situations where the host has already requested the registration number, but it has not been conceded yet. However, properties with pending licence can nevertheless be booked without problems. In others, no information about the reason for the lack of licence is provided. This creates cross-sectional and temporal variation in the tenure of the licence that allows us to investigate whether consumers give value to it.

From Table 1, we also see that some hosts leave the market following the licence disclosure requirement in July 2021. This is consistent with the drop in Airbnb supply following the passing of licencing permits in Manhattan and New Orleans documented in Van Holm (2020) and Jia and Wagman (2020). These authors document that illegal suppliers reduce their provision of rental services due to the internalization of a higher risk of detection. Table A1 in Appendix presents summary statistics of the differences in property characteristics in the sample immediately before (June 2021) and after (July 2021) the policy implementation. Descriptive statistics (Table A2) and a probit regression (Table A3) indicate that cheap rentals with a reduced number of reviews are the most likely to leave the market. This pattern aligns with Chen et al. (2021), who show that delisting is more likely among those who generate low revenues from short-term rentals. Because those who exit the market are not observed during the treatment period, leavers in July 2021 are excluded from the analysis.

The variable of interest is the number of reviews received by each property per period (reviews). Because we lack information about actual accommodation bookings, we use the count of monthly reviews as a proxy of demand. This follows the practice of several related works (Alyakoob and Rahman, 2022; Benítez-Aurioles, 2021, 2022a, 2022b; Laouénan and Rathelot, 2022; Marchenko, 2019; Xu, 2020). Airbnb platform implements a simultaneous reveal review system that asks guests and the host to review each other in the 14 days following the checkout. The reviews are publicly displayed after both parties submit their reviews or after the 14 days have elapsed. Fradkin, Grewal & Holtz (2021) show that the simultaneous reveal policy in Airbnb increased review rates due to users' curiosity about what their counterparty wrote, producing a drop in retaliation. These authors also document that around 67 % of guests review the accommodation. Therefore, we believe reviews are a suitable proxy of demand in this setting. Although reviews are a lower bound of demand, we expect the variation in non-reviewing guests to be uncorrelated to the demand shock associated with the licence disclosure. Moreover, the dynamics of reviews are of interest per se because they determine subsequent transactions through herding mechanisms (Benítez-Aurioles, 2022a).

Because our empirical model includes property fixed effects, the identification of the role of the operational licence on demand is based on the temporal variation in the reviews received from one period to the following one. We therefore do not consider locational or structural characteristics that are fixed over time but only covariates that exhibit some temporal variation. We consider prices (price), the number of days the property is annually available (days_available), the minimum nights the property must be rented (min_nights) and the number of properties owned by the host (number_listings), which is usually considered as a proxy of professionalism (Boto-García et al., 2021).

Table 2 presents descriptive statistics of the variables for the pooled sample. Properties have 26 reviews and charge €115 per night, on average. The mean number of listings per host is 11, with properties being available for rent 98 days per year. The average minimum number of overnight stays is 72 days. Table A4 in Appendix presents summary statistics of properties that never disclose the tenure of a registration number (non-adopters) and those who adopt/disclose it at any period (adopters), computed in June 2021. A descriptive probit regression (Table A5) indicates that the probability of later adopting the licence is positively

Table 2
Descriptive statistics.

	Mean	SD	Min	Max
reviews	26.315	47.348	1	1145
licence	0.464	0.498	0	1
price	115.359	181.853	10	11,600
min_nights	72.788	140.489	1	365
days_available	98.213	131.786	1	365
number_listings	11.640	50.825	1	587
Observations	357,157			

associated with prices, the number of reviews, the number of days available and the host's listings count. This falls in line with Liang et al. (2019), who documented that hosts' motivation to disclose personal information increases with the volume of reviews. (See Table 3.)

Table 3 presents a t-test for mean comparison of the number reviews and the monthly variation with and without the registration number in the period July 2021–January 2022. As can be seen, both the level and the variation in reviews is significantly higher among registered properties. However, this comparison is merely exploratory, as the observed review gap might be explained by other factors. To examine this in detail, we move to a formal econometric analysis.

Empirical strategy

Panel event study estimator

We work with a panel of N properties observed in T periods. Let $Adoption_i$ denote an indicator recording the period when the property i discloses/adopts the licence. For example, if a property adopts it in September, then $Adoption_i = 5$. To formally evaluate the impact of the licence disclosure on demand (reviews), we propose the following linear panel event study model with leads and lags to the licence adoption:

$$\ln reviews_{it} = \alpha + \sum_{k=2}^{K} \mu_k (Lead\ k)_{it} + \sum_{m=0}^{M} \delta_m (Lag\ m)_{it} + \beta X_{it} + \theta_i + \gamma_t + \varepsilon_{it} \tag{1}$$

where the leads and lags are dummy variables that indicate the time to the adoption of the licence and are defined as follows:

$(Lag\ M)_{it} = 1\ if\ t \leq Adoption_i + M$

$(Lag\ m)_{it} = 1\ if\ t = Adoption_i + m, for\ m \in \{0, \ldots, M-1\}$

$(Lead\ k)_{it} = 1\ if\ t = Adoption_i - k, for\ k \in \{2, \ldots, K-1\}$

$(Lead\ K)_{it} = 1\ if\ t \geq Adoption_i - K$

(2) where M and K are the maximum lag and lead to be considered, δ_m and μ_k are the corresponding parameters of interest to be estimated, X_{it} is a set of time-varying control variables that include *price* (the higher the price, the lower the number of reviews, ceteris paribus, according to microeconomic theory), *min_nights* (to control for differences associated with minimum stay requirements), *days_available* (an indicator of the number of days the property is available for booking) and *number_listings* (a proxy of host professionalism), θ_i denote property fixed effects capturing any time-invariant unobserved heterogeneity (structural characteristics and locational attractiveness), γ_t represent time fixed effects that absorb any common time shock, and ε_{it} is a random error term that represents unobserved factors.

The model in (1) is an extension of the two-way fixed effects (TWFE) model. The specification of $\sum_{m=0}^{M} \delta_m (Lag\ m)_{it}$ and $\sum_{k=2}^{K} \mu_k (Lead\ k)_{it}$ allows licencing to have dynamic effects. These dummies should be understood as time-to-event indicators: δ_m capture the effect of the licence on reviews in post-adoption periods while μ_k measure potential anticipation effects. There are alternative ways to specify the panel event study model. In our notation, we follow Clarke and Schythe (2021) and label 'lags' ('leads') the indicators of the first adoption period being m (k) periods *before* (*after*) period t, respectively. For the sake of illustration, Table A6 in Appendix presents an example of the values of the lags and leads supposing a property adopts the licence in September 2021 ($t = 5$). The first lead is normalized to zero for identification following common practice and therefore k starts at 2.

Table 3
t-test for mean comparison of reviews by properties with and without licence (full sample period).

	reviews	Δ reviews
Without licence	15.868	0.225
With licence	33.589	0.837
Difference	−17.720	−0.611
t-test	−93.020***	−93.248***

Properties that never have a licence act as pure controls and therefore have zero values in all lag and lead terms. These lags and leads capture the difference in reviews between properties with and without licence compared to the difference in the omitted period (*t-1* in this case). As opposed to a static TWFE model that only considers contemporaneous effects, the values and statistical significance of μ_k for $k = 2, \ldots, K$ inform about the presence of pre-trends in the outcome. See Freyaldenhoven, Hansen, Pérez-Pérez and Shapiro (2021) and Clarke and Schythe (2021) for further details.

Price endogeneity

Under the assumption that reviews are suitable proxy of demand, the model in (1) can be seen as a demand equation where the elasticity of reviews to prices (β_1) is likely to suffer from endogeneity bias due to reverse causality. To correct for this, we implement a control function approach (Wooldridge, 2015) and expand eq. (1) with the residuals from the following IV panel regression:

$$\ln price_{it} = a + \theta_1 \overline{\ln price_{it-1}} + \theta_2 \underset{it-1}{\breve{\ln price}} + \tau X_{it} + \theta_i + \gamma_t + \xi_{it} \tag{3}$$

where $\overline{\ln price_{it-1}}$ is the natural log of the one-period lag of the average prices of all the properties in the city located in neighbourhoods other than j, $\underset{it-1}{\breve{\ln price}}$ is the natural log of the one-period lag of the average prices of all the properties in neighbourhoods other than j of the same type (entire versus shared/private), θ_i and γ_t are unit and temporal fixed effects and ξ_{it} is the error term.

The use of $\overline{\ln price_{it-1}}$ and $\underset{it-1}{\breve{\ln price}}$ as instruments for prices follows a long tradition in the economics literature and are known as Hausman-type instruments (Hausman and Leonard, 2002; Hausman and Ros, 2013; Nevo, 2001). The theoretical justification is that prices in other neighbourhoods can be suitable exclusion restrictions because units in the city might share common marginal costs, thereby satisfying the relevance condition. Since the exogeneity requirement could be violated if we use contemporaneous prices in the same neighbourhood through potential price mimicking (Boto-García et al., 2021), that is the reason why we use lagged average prices of properties in neighbourhoods other than that where property i locates. These prices are assumed to be independent from ξ_{it} in (3) as long as common and unit-specific demand shocks are controlled for through the unit and time fixed effects. By including the residuals $\hat{\xi}_{it}$ from (3) in (1), β_1 is a consistent estimate of the review-price elasticity.

Results

Main findings

Table 4 reports the coefficient estimates for eq. (3). Standard errors are clustered at the host level to correct for the potential residual correlation among properties that belong to the same person. Prices are negatively correlated with the lagged prices of other properties in outside neighbourhoods. In contrast, prices positively correlate with lagged average prices of properties of the same type in other neighbourhoods. These findings are consistent with asymmetric price competition in accommodation markets by quality, as documented in Lee and Jang (2013). In both cases, these instruments are statistically significant for explaining

Table 4
Coefficient estimates for the reduced-form equation for prices (in logs).

Dep. Variable: ln price	Coeff. (SE)
Lag ln $\overline{price}$	−1.062***
	(0.173)
Lag ln $\breve{price}$	0.010***
	(0.003)
Constant	9.397***
	(0.802)
Controls	YES
Time fixed effects	YES
Property fixed effects	YES
Observations	298,381
Number of units	51,105
Number of hosts	41,708

Clustered standard errors at the host level in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5
Coefficient estimates for event study estimator with time-varying covariates.

Dep. Variable: ln reviews	Coeff (SE)
Lead 4 (≤t-4 before adoption)	0.041
	(0.031)
Lead 3 (t-3 before adoption)	0.017
	(0.028)
Lead 2 (t-2 before adoption)	−0.014
	(0.015)
Lag 0 (contemporaneous)	0.097***
	(0.013)
Lag 1 (t + 1 after adoption)	0.174***
	(0.020)
Lag 2 (t + 2 after adoption)	0.240***
	(0.027)
Lag 3 (t + 3 after adoption)	0.288***
	(0.034)
Lag 4 (≥t + 4 after adoption)	0.353***
	(0.044)
Ln price	−0.894***
	(0.315)
$\hat{\xi}_{it}$	1.073***
	(0.314)
Min_nights	1.1e-04
	(7.8e-05)
Days_available	−1.2e-04***
	(4.6e-05)
Number_listings	−2.6e-04***
	(5.0e-05)
Constant	6.156***
	(1.417)
Time fixed effects	YES
Property fixed effects	YES
Observations	234,710
Number of units	34,733
Number of hosts	28,928

Clustered standard errors at the host level in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

property prices and the F statistic for the relevance condition is far above the common threshold of 10 (F = 580.7). The lower number of observations with respect to Table 1 is due to the use of one-period lags.

Table 5 presents the estimation results of the panel event study estimator in (1) expanded with the residuals $\hat{\xi}_{it}$ obtained from the model in Table 1. The model has been estimated in Stata 16 using *xtevent* module (Freyaldenhoven et al., 2021). This command also exploits *reghdfe* module (Correia, 2016) to deal with the estimation of the high-dimensional property fixed effects.
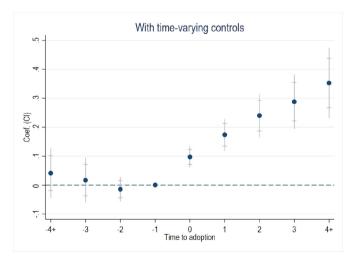

Fig. 1. Event study estimates with time-varying covariates.

Table 6
Coefficient estimates for event study estimator without time-varying covariates.

	(1)	(2)
Dep. Variable: ln reviews	Coeff	Coeff
	(SE)	(SE)
Lead 4 (≤t-4 before adoption)	0.050	0.047
	(0.031)	(0.031)
Lead 3 (t-3 before adoption)	0.016	0.014
	(0.027)	(0.027)
Lead 2 (t-2 before adoption)	−0.026*	−0.022
	(0.014)	(0.015)
Lag 0 (contemporaneous)	0.082***	0.084***
	(0.010)	(0.011)
Lag 1 (t + 1 after adoption)	0.161***	0.157***
	(0.019)	(0.018)
Lag 2 (t + 2 after adoption)	0.228***	0.224***
	(0.027)	(0.026)
Lag 3 (t + 3 after adoption)	0.274***	0.272***
	(0.033)	(0.032)
Lag 4 (≥t + 4 after adoption)	0.331***	0.337***
	(0.043)	(0.043)
Ln price		−0.602
		(0.424)
$\hat{\xi}_{it}$		0.785*
		(0.422)
Constant	2.140***	4.850**
	(0.030)	(1.904)
Time fixed effects	YES	YES
Property fixed effects	YES	YES
Observations	234,710	234,710
Number of units	34,733	34,733
Number of hosts	28,928	28,928

Clustered standard errors at the host level in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

There is a lower number of observations than in Table 4 because the estimation procedure cleans properties with a reduced number of observations or gaps (no supply) between periods. Again, standard errors are clustered at the host level.

We select a four-period time window around the licence adoption (4 lags and 4 leads) so that lags and leads beyond four periods "accumulate" at M = 4 and K = 4 (Clarke and Schythe, 2021). This is because specifying a full set of leads and lags would face identification problems due to a relatively small number of observations at the extreme leads and lags. The corresponding event plot estimates and confidence intervals are shown in Fig. 1. Using the common $exp(\delta_m) - 1$ transformation for the partial effects of dummy variables when the dependent variable is in logs, we find that the tenure of the operational licence translates into a contemporaneous review increase of around 10 percentage points relative to other properties without the registration number $((exp(0.097)\text{-}1)\times100 = 10.1)$. Interestingly, the effect is increasing over time: the reviews received by licenced accommodations increase by 19, 27, 33 and 42 percentage points in the first, second, third and fourth month following the adoption.

This pattern is potentially explained by two simultaneous compositional effects that act in the same direction: the increase in the relative supply of legal accommodations over time on one hand, and consumers' learning about the licence is now mandatory on the other. That is, the sustained increased in the share of licenced properties over time as illustrated in Table 1 increases the salience of the registration number to consumers. As time passes, consumers looking for an Airbnb accommodation likely become more aware (learn) that some hosts disclose their licence whereas others do not through a comparison mechanism. Additionally, as the share of illegal operators becomes smaller, consumers who prefer a property with operational licence are more likely to select a legal property (if available, given market demand levels at each period), which therefore increases the observed review gap between legal and illegal properties.

Importantly, the estimation results indicate that all the time-to-adoption leads are not statistically significant. A Wald test does not reject the null hypothesis that they are globally zero (F(3, 28,927) = 1.13, p-value = 0.33). This result can be taken as evidence against the existence of pre-trends in the outcome that would bias the results. Although this test does not necessarily imply that properties with and without the licence would have followed parallel trends in reviews after July 2021, if trends were similar pre licence disclosure, it is unlikely they would be non-parallel post-adoption. Moreover, parallel-trends and Granger causality tests for each pairwise combination of cohort-of-licence adopters and never adopters also do not reject the null hypothesis of no anticipation effects and pre-treatment parallel trends (Appendix, Table A7).

Taking reviews as a proxy of demand, the price elasticity is −0.89. This estimate is consistent with microeconomic theory, implying that demand (reviews) decreases with prices holding quality (unit fixed effects) and seasonal preferences (time fixed effects) constant. Moreover, this estimate indicates that reviews are price-inelastic. The coefficient estimate for the residuals from eq. (3) is positive and statistically significant. This is taken as evidence of the need to correct for price endogeneity
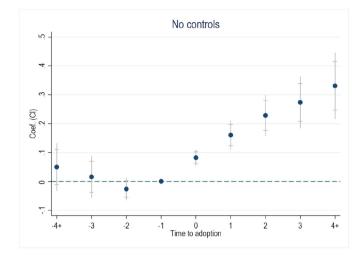
Fig. 2. Event study estimates without time-varying controls.

(Wooldridge, 2015). Furthermore, reviews are negatively associated with the number of listings owned by the host and the number of days the property is available, although the effect size of these estimates is negligible.

The consideration of time-varying covariates in (1) aims to capture differences in the dependent variable that are not due to the registration number but to changes in property characteristics over time. In this regard, recent works show that causal parameters in difference-in-differences settings are identified under conditional-on-covariates parallel trends for potential outcomes. Moreover, since the licence adoption correlates with property characteristics, the inclusion of these variables accounts for selection on observables (*unconfoundedness* assumption). That is, the event dummies capture the average difference in reviews between accommodations with and without licence over time conditional on the observed confounders (Athey and Imbens, 2017). Nonetheless, an important requirement is that the covariates do not to react to the treatment. If so, this could introduce biases in the regression (Caetano, Callaway, Payne & Sant'Anna-Rodrigues, 2022). To examine this, we have redone the analysis (i) without the time-varying covariates, and (ii) with the (instrumented) price variable only. Table 6 reports the estimates and Figs. 2 and 3 the corresponding event study plots. Although the point estimates slightly differ in magnitude as compared to Table 5, in general the findings exhibit great robustness across model specifications.

To dig further into this, we performed the following check. We first residualized all the variables by the unit and period fixed effects (Guimaraes and Portugal, 2010) and then used Abadie's semiparametric difference-in-differences estimator (Abadie, 2005) for the pooled sample and a parametric difference-in-differences estimator with propensity score matching for each cohort-of-licence adopters following the methods developed by Heckman, Ichimura & Todd (1998) (Appendix, Tables A8-A9). We compute the Average Treatment Effect on the Treated by matching treated and control units based on the pre-treatment values of the control variables. Accordingly, these estimators avoid the potential noise introduced by the time-varying covariates while adjusting for pre-treatment differences in characteristics between properties with and without the licence. The mean Average Treatment Effect on the Treated in the post-adoption period is 0.147, implying an average review increase of around 15.8 percentage points
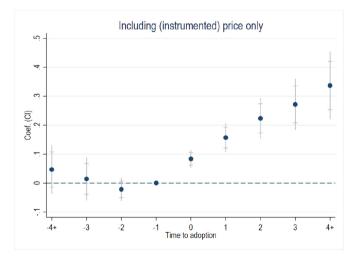

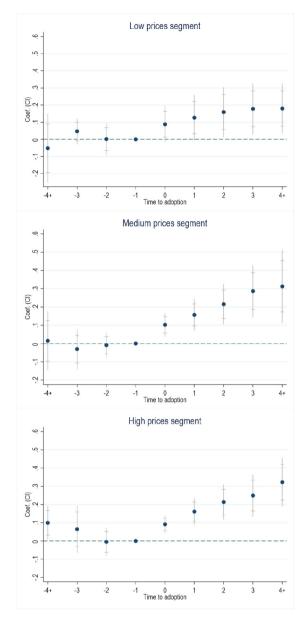**Fig. 3.** Event study estimates including (instrumented) price only.

Fig. 4. Event study estimates for the low, medium and high prices segments.

due to the licence ($(\exp(0.147)-1)\times100 = 15.8$). This figure is in line with the mean percentage changes obtained from the estimates in Table 5.

Next, as an extension, we conducted separate regressions for three subsamples of the data based on whether the property is of low, medium or high price (Appendix, Tables A10-A11). The goal here is to inspect whether the effect of licence disclosure varies depending on the price level, which partially captures quality differences. These three categories are defined according to the price distribution quantiles. Fig. 4 presents the event plot estimates. We find that the positive and increasing effect of operational licencing on reviews mainly holds for middle and high-priced accommodations. For the low-cost segments, the effects are weaker and smaller in magnitude. This is consistent with the theoretical propositions of Leland (1979) and Shapiro (1986): the certification of minimum quality standards through licencing is more relevant for quality-sensitive consumers, who exhibit greater willingness to pay. Therefore, high quality properties with high prices benefit more from disclosing their operational licence.

Robustness checks and extensions

We performed several robustness checks and extensions to our main analysis, which are presented in Appendix. First, we inspected heterogeneity based on the type of property (entire vs private/shared room). The results from separate regressions indicate that the

mean effect of registration on reviews is larger for private/shared rooms than for entire properties. Second, we used two-way clustered standard errors at the host and neighbourhood level (Boto-García, 2022). The results remain about the same as in Table 5 and Fig. 1. Third, we ran separate regressions for single- and multi-property hosts (>1 listing in the city). The results are similar to the pooled analysis, although the effect of the licence on reviews is slightly larger for multi-property hosts. Fourth, we re-estimated the model using the monthly rate change in reviews as dependent variable ($ln\ reviews_{it} - ln\ reviews_{it-1}$). We again detect a positive and increasing effect of the licence adoption, which is again larger in magnitude as time to adoption increases. Similarly, we used a proxy indicator of monthly revenues as dependent variable (see Appendix). The results indicate that registered hosts' income increased due to the demand shift induced by the licence.

Fifth, we have examined the review dynamics of non-adopters to rule out potential negative spillovers among unregistered accommodations stemming from others' licence adoption. Two-way panel fixed effects regressions with and without controls for the subsample of non- adopters (pure controls) indicate that their monthly reviews have slightly increased (rather than decreased) over time, in line with the increasing trend in the pooled sample following COVID-19 recovery (Appendix, Table A13). Accordingly, control units appear not to be affected by others' regularization.

Sixth, we examined the dynamic impact of property registration on reviews using the staggered difference-in-differences method (Callaway and Sant'Anna, 2021), which is a doubly robust estimator based on inverse probability of tilting and weighted least squares developed by Sant'Anna and Zhao (2020). Intuitively, this method estimates the Average Treatment Effect on the Treated of a policy on an outcome for each 2×2 combination of treated and control units one period before and after the licence adoption. This method offers the advantage that observations are weighted by the inverse of the propensity scores (probability of adopting the licence), thereby correcting the potential bias from self-selection into the treatment. In line with our main results, adopters experience positive increases in the number of reviews as compared with non-adopters, with the effect being larger in magnitude over time (Appendix, Tables A14-A15). Finally, we performed the following placebo exercise: we first randomly generated a staggered fake treatment among non-adopters and then re-estimated the panel event study regression using this subsample. As expected, no significant effect is detected (Appendix, Fig. A9).

Conclusions

Summary of findings

This paper has evaluated consumers' preferences for legal badges in the form of operational licences in the Airbnb rental market. We have exploited a policy change introduced by Airbnb platform in Paris in July 2021 that forced all hosts to publicly disclose whether they hold an operational licence or not following judicial conviction. Paris is a relevant case study as it stands as one of the most important Airbnb markets in Europe together with recently experiencing important gentrification problems. Descriptive statistics illustrate that a non-negligible share of hosts continue renting despite not having the licence. Since the tenure of a licence becomes publicly revealed to prospective guests after July 2021, consumers become able to distinguish legal from illegal operators from that period onwards. In a market for services in which there are important information asymmetries (Benítez-Aurioles, 2022a; Leoni, 2020), the licence also reveals whether the property has passed a filter of minimum quality standards, thereby being potentially perceived as a quality cue.

Our empirical approach has used a staggered event study estimator that uncovers dynamic effects of the licence on demand, proxied by the number of reviews. We first document a substantial drop in Airbnb following the licence disclosure, with low-quality properties being more likely to exit the market. Licenced properties receive around 10 % more reviews during the first month of adoption, on average. Interestingly, the effect becomes larger in magnitude with the passage of time. This pattern might be explained by two simultaneous factors. On the one hand, the tenure of the licence becomes more salient over time through a learning mechanism, which therefore increases their preferences over legal badges. This learning mechanism might be seen as the consequence of a process of information accumulation in the spirit of Acemoglu and Zilibotti (1999). On the other hand, when the relative supply of legal listings is low, consumers might be more willing to stay at illegal accommodations if the existing legal ones at that moment are already booked; as time passes and the relative supply of legal listings increases, consumers might find easier to find available legal accommodations, widening the gap in demand between legal and illegal properties. Overall, our findings clearly suggest that as a greater share of hosts adopt the licence, illegal operators are more 'punished' by the market.

Theoretical contribution

Our results offer relevant theoretical insights about how consumers value operational licences in Airbnb markets. Whereas much progress has been done on the supply side (Hotz and Xiao, 2011; Kleiner, 2000, 2016; Kleiner & Kudrle, 2000), there are few works that have deepened into consumers' reactions to the disclosure of licences. In line with the theoretical propositions of Leland (1979) and Shapiro (1986), legal badges improve social welfare because consumers reveal a strong preference towards those accommodations that present the registration number. Consumers appear to prioritize staying at legal accommodations, which is likely to subsequently expel low-quality and illegal operators from the market. Importantly, the licence effect is found to be greater for high-quality accommodations. Therefore, this licencing disclosure policy is effective at reducing uncertainty among Airbnb users by revealing some form of 'commitment' among suppliers (Lewis, 2011), which is likely to be positively associated to the quality provided. The policy induces new suppliers to have reputation incentives to become legal from the scratch (Atkeson, Hellwig & Ordoñez, 2015). Furthermore, since the adoption of these badges is free of charge here, and therefore

transaction costs are minimal, operational licencing is unlikely to produce welfare losses due to moral hazard problems, such as those derived from a harsher competition among quality revealers (Dranove, Kessler, McClellan & Satterthwaite, 2003) or from binding capacity constraints (Gavazza & Lizzeri, 2007).

Practical implications

From a managerial perspective, the results of this study could help Airbnb to further alleviate the intrinsic informational asymmetries of the peer-to-peer accommodation system; the platform-mediated publicly disclosure of the registration number circumvents hosts' reluctance to share private information (Liang et al., 2019). Some works have alerted that some Airbnb consumers do not truly rely on rating scores, which generates distrust in the platform and preludes them from booking (Li and Tsai, 2022). The fact that the licence disclosure produced a significant surge in reviews among legal hosts indicates that forcing hosts to reveal the tenure of a legal badge could increase consumers' trust in both the platform and the host, ceteris paribus.

In the light of our findings, the paper also offers important implications for policy regulations in the Airbnb market. Illegal hosts represent a major problem for city councils because they are not counted in official statistics. As discussed in Cox and Harr (2020), city councils generally exhibit great concern about this. Without clear information about the size and characteristics of supply, authorities find great difficulties when developing regulatory policies. What is more, illegal hosts do not pay taxes with whom to compensate the negative externalities they might generate on residents. From a consumers' welfare viewpoint, the lack of information about whether the host fulfils with all the legal standards and declares the revenues from the renting activity might generate lower attachment.

The main takeaway from the study is therefore that the public disclosure of the legality of an Airbnb listing (tenure of an operational licence) seems to be a powerful tool for the enforcement of legal regulations. As consumers 'reward' legal properties through increased demand, illegal hosts have strong economic incentives to ask for the licence and regularize their economic activity voluntarily, as predicted by economic theory (Hotz and Xiao, 2013). As such, the cooperation between public authorities and Airbnb platform seems to be crucial for this purpose.

Limitations and future research

Our study has some limitations that should be acknowledged. Firstly, we use the number of reviews received as a proxy of demand due to data availability. Future studies could expand our analysis by looking at the effects of operational licences on other relevant outcomes like occupancy rates, numerical ratings or bookings. Secondly, operational licencing is conceptualized as a credible signal for prospective consumers about the legality and quality of the property. However, not all consumers will give the same importance to legal badges, with some segments being plausibly more tolerant to being hosted by an illegal operator. If information on consumers were available, it would be interesting to inspect the heterogeneity in the demand for illegal hosts by sociodemographic profile. Finally, since other cities are starting to enforce the disclosure of registration numbers among Airbnb hosts (particularly in France), future works should evaluate potential geographical heterogeneity in how consumers' value licences depending on the type of destination, Airbnb penetration or competition with the hotel industry.

Declaration of interest

The authors have nothing to report.

Data availability

Data will be made available on request.

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