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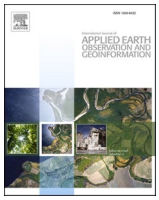

How did COVID-19 affect tourism occupancy and prices? A spatiotemporal and economic analysis of Madrid and Valencia through Airbnb geospatial data

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ABSTRACT

The COVID-19 pandemic has had a significant impact on the tourism industry worldwide. This study aims to understand the early effects of the pandemic on tourist supply and demand by analysing Airbnb's occupancy rates and accommodation prices at both city and neighborhood/district scales in Madrid and Valencia, two Spanish destinations with distinct tourism types. By considering both spatial and statistical analyses at different scales, this study provides valuable insights into the short-term impacts of COVID-19 on the tourism industry in these destinations. The findings reveal a spatial polarisation, with certain areas maintaining higher occupancy rates and prices, suggesting resilience to the crisis, particularly those near green spaces. The analysis further highlights varied effects of the pandemic across different months and neighborhoods/districts. While historic center neighborhoods experienced declines in both occupancy rates and prices, districts with a stronger tourist tradition showed greater resilience. Price rigidity is observed in some urban areas, where occupancy rates decline while prices remain relatively stable or even increase. Two key recommendations are underscored for decision makers: (1) regulating Airbnb should consider neighborhood-specific characteristics and differentiate between types of tourism, establishing minimum standards for housing conditions and the surrounding environment and (2) touristic cities should aim for a polycentric spatial structure by expanding and diversifying tourist areas, avoiding concentration in a single location.

1. Introduction

The COVID-19 pandemic has had an unprecedented impact on tourism destinations worldwide, leading to restrictions on mobility (Romanillos et al., 2021) and a shift from international to domestic tourism (Renaud, 2020; Jones and Comfort, 2020). This greatly disrupted the hospitality and food service sectors, resulting in a contraction of the economic activity of destinations (Maloney and Taskin, 2020) and polarising the society, widening the income gap between wealthy and low-income urban areas (Serrano-Estrada et al., 2022).

In line with the above arguments and following those from Gossen and Reck (2021), Boros et al (2020) and Gyódi (2021), who have analysed how COVID-19 affected the shared housing market on Airbnb, this research aims to further understand the early effects of the pandemic in the relationship between tourist supply and demand. Two variables that have been extensively utilised in these types of studies – Airbnb's occupancy rates and accommodation prices – are adopted for analysis on two scales, city and neighbourhood. Two Spanish destinations with different tourism types are used as case study cities: Madrid (urban tourism model) and Valencia (combination of urban and sun and beach model).

The methodology employed included both a spatiotemporal and economic analysis, considering urban planning and tourism economics as two intertwined dimensions (Taylor, 2018). This enables a complementary interpretation of the effects of COVID-19 on the destinations under study, and a better understanding of the relationship between the analysed variables and their environment. In relation to the time period analysed, the months selected were May to September of the year 2020,

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with the same months of the two years prior to the pandemic (2018 and 2019) used for comparison.

Drawing on a methodological comparison of two types of tourist destinations, administrative delimitation analysis, and a combination of different statistical techniques, this study provides a nuanced perspective to the management of destinations and accommodation offerings in the face of economic shocks, with proposed measures and actions for potential improvement.

This paper is structured as follows: Sections 2 and 3 justify the use of Airbnb data and introduce the chosen destinations. Section 4 describes the methodology. The findings and hypothesis validation are discussed in Sections 5 and 6, respectively. Finally, Section 7 identifies limitations and proposes recommendations for tourism stakeholders.

2. Airbnb market to study the spatial and economic effects of COVID-19 in destinations

Airbnb, increasingly capturing a larger percentage of tourism activity, has become an excellent tool for assessing the social and economic impact of COVID-19 on tourist destinations. Firstly, it provides a large amount of homogeneous information from an increasing number of destinations worldwide, facilitating the analysis of the behaviour between tourist supply and demand (as in Perez-Sanchez et al., 2018 or Chica-Olmo et al., 2020). Secondly, because of its nature, it can promote the distribution of accommodation supply throughout the territory and increase the well-being of the residents, away from places with higher population density and tourist activities (Perles-Ribes et al., 2020; Martí et al., 2019). Thirdly, as platform-based accommodations are often second homes with low associated costs, they sustained post-pandemic activity, while many hotels paused operations amidst uncertainty (Gyódi, 2022). Finally, Airbnb data is structured by administrative spatial delimitations (i.e. neighbourhoods or districts) which allows for a more granular observation of the pandemic phenomenon (Hejazi et al., 2023).

Consequently, the Airbnb market has been used for understanding the effects brought by the COVID-19 pandemic, including, for instance, the analysis of shifts in occupancy rates and accommodation income generated by the pandemic (Cimadomo et al., 2022; Shen and Wu, 2022); the study of changes in consumer perceptions and consumption patterns (Thackway and Pettit, 2021; Sequera et al., 2022; Lee and Deale, 2021; Sainaghi and Chica-Olmo, 2022); the impact of the pandemic on the use of public spaces and parks (Geng et al., 2021), the diagnosis of economic situations and the definition of strategies to attain more resilient activity (Mermet, 2022; Celata and Romano, 2022); and whether, as a result of medical recommendations, tourism has shifted towards less densely populated areas within the cities (Ferreira et al., 2023; Filieri et al., 2023; Li et al., 2023).

This research extends knowledge and contributes new insights to the understanding of changes in tourist cities by examining factors such as prices and occupancy rates of tourist accommodations – building upon earlier research, conducted before the COVID-19 pandemic, such as Moreno-Izquierdo et al. (2019), Barron et al. (2019), or Jiménez et al. (2022) – and helping to find solutions for making tourist destinations more resilient to abrupt socio economic shocks (as in Medeiros et al., 2022).

3. Madrid and Valencia as case studies

Madrid and Valencia (Spain) were chosen because they represent two cities with different types of tourism specialisation, and population characteristics, and which experienced the beginning of the pandemic with varying intensity.

The city of Madrid is the nation's capital and is located in the central region of Spain. It has a population of 3.3 million, and a relatively high density of 6,589 inhabitants per square kilometre. According to the Spanish National Institute of Statistics (INE), tourism represented 7.7% of Madrid's economic activity, and 7.4% of the employed population before the COVID-19 pandemic. Madrid's tourism, highly focused on urban and business travel, sees seasonal peaks, particularly during the summer months and holiday seasons.

Located on the Mediterranean coast, Valencia is home to approximately 800,000 people (2019), with a moderate density of 1,647 residents per square kilometre. This destination showcases a mixed urban and sun-and-beach model, with a clear distinction between the coastal area and the historical centre. Tourism contributes 13% to the economy and employs 8% of the population. Like Madrid, peak tourism occurs during the summer months and holidays.

Madrid and Valencia imposed restrictions on vacation rentals offered on Airbnb some years ago. In the case of Madrid[1], the city is divided into zones to control licences based on tourism saturation, and all holiday rentals must have independent access to the building to avoid problems with neighbours. In Valencia[2], tourist and residential housing are not allowed to share the same floor and new buildings solely for tourists are banned. Despite the restrictions, both regions still have a high volume of accommodation offered on Airbnb. As of 2019, Madrid had 26,679 Airbnb listings, which constituted 1.5% of all dwellings in the city; in the case of Valencia, there were 9,261 apartments listed, 1.15% of all houses.

Madrid and Valencia suffered a distinct impact due to the pandemic: according to the Spanish Ministry of Health, Madrid recorded one of the highest mortality rates (1,170 deaths per 100,000 inhabitants in 2020), while the rate in Valencia was less than half that (453 deaths per 100,000 inhabitants). This discrepancy could be due to various factors. Madrid adopted more relaxed COVID measures, being one of the last regions to close its borders – 14 days later than the Valencian Region (Orea and Álvarez, 2022) – and one of the first to start easing restrictions (Maza and Hierro, 2022). Greater mobility of citizens in the territory (López-Mendoza et al., 2021), and lower public health expenditure compared to the Valencian Community (Valls Martínez et al., 2023) might also have contributed to the difference.

Both cities attempted to take action against the pandemic, implementing social distancing measures, limiting hospitality activities, or closing public spaces, which undoubtedly reduced their tourist appeal. In Madrid, for example, the city council decreed the closure of the Teatro Español, the Matadero Madrid area, and many other cultural and sports centres; and in the city of Valencia, the obligatory wearing of masks on beaches was imposed. However, it is important to note that these and other measures, such as capacity limits in public spaces, depended on both national mandates and the virus's own evolution, showing progress and setbacks during the analysed period, until a new escalation of measures occurred in September 2020 due to the increase in deaths and cases (see Prades Illanes and Tello Casas, 2020; Mora-Rodríguez and Melero-López, 2021).

The economic significance of Madrid and Valencia prompts extensive studies on pandemic effects on their tourism. Madrid, in comparison with other major cities or European capitals, has been analysed in studies like Boros et al. (2020), Boto-García (2022), Llaneza Hesse and Raya Vílchez (2022) or Benítez-Aurioles (2022), utilising Airbnb data. The city of Valencia lacks specific studies on the pandemic's impact on tourism, but there is existing research on air quality (Cárcel-Carrasco et al., 2021), transportation (Seifert et al., 2023), or political response (López et al., 2021), which are partly related to tourism activity itself. Nonetheless, there are existing academic studies that encompass the Valencian Community (as well as the Community of Madrid), Duro et al. (2021), Arbulú et al. (2021), or Gil-Alana and Poza (2022).

Therefore, this research fills an existing research gap by contrasting

[1] See: https://www.madrid.org/wleg_pub/secure/normativas/contenidoNormativa.jsf?opcion=VerHtml&nmnorma=8631&cdestado=P#no-back-button.

[2] See: https://dogv.gva.es/datos/2021/02/08/pdf/2021_999.pdf.

the pandemic's influence on the tourism sectors of Madrid and Valencia. It must be acknowledged that this study indirectly scrutinises how divergent pandemic responses might have influenced tourist accommodation occupancy rates and prices, albeit not as the primary focus. Nevertheless, this comparative analysis could yield valuable insights into the resilience of tourist destinations, potentially guiding the management of future socio-economic shocks.

4. Methodology

Based on the literature reviewed and the objective set, four hypotheses are proposed. These hypotheses anticipate that the negative impact of the pandemic will be reflected in our study variables.

Hypothesis 1. *The short-term negative effect of COVID-19 on tourism caused a decrease in occupancy in destinations*.

Hypothesis 2. *The short-term negative effect of COVID-19 on tourism caused a decrease in pricing in destinations*.

Hypothesis 3. *The short-term effect of COVID-19 changed the structure in the composition of the supply and prices of accommodations on Airbnb*.

Hypothesis 4. *COVID-19 affected tourist destinations differently in the early months of the pandemic, as measured by occupancy rates and accommodation prices*.

To address the research hypotheses, Airbnb data within the temporal period ranging from May to September for three consecutive years (2018, 2019, and 2020) were analysed. This period was chosen based on three criteria: May 2020 marked the resumption of Spanish tourism after the lockdown measures begun in March 2020; the selected months represent peak tourism activity in Spain; and, September 2020 witnessed the onset of a second wave of infections and subsequent restrictive measures. By combining data from 2018 and 2019, insights into the pre-pandemic tourism landscape are gathered, while 2020 data allows an observation of the short-term effects of COVID-19 on tourism.

4.1. Database sample

The AirDNA database was adopted for this investigation. This offers comprehensive Airbnb supply information for each tourist destination, including property availability, occupancy rates, pricing, and accommodation characteristics. Various recent studies, such as Duca et al. (2021), Jang et al. (2021), and Sainaghi and Chica-Olmo (2022), have similarly relied on this database to analyse the impacts of COVID-19 in diverse scenarios.

The original sample from AirDNA for the selected months included over 80,000 unique accommodations in Madrid, spread across 60 neighbourhoods[3], and nearly 30,000 registers in Valencia, distributed among 21 districts[4] (groups of neighbourhoods) following Airbnb's original geographical classification (see Table 1).

However, it should be noted that these numbers do not fully reflect the actual Airbnb supply for two reasons. Firstly, some registered properties were marked as unavailable during certain periods within the study period. Secondly, some properties are non-competitive in terms of pricing, attributes, or location, and consequently remained vacant throughout the study period. As there are no costs associated with keeping accommodations listed on Airbnb and a significant portion of the supply comes from non-professional hosts, there is no incentive to remove these listings from the platform even if they are not offered or rented. This results in an apparent excess in supply that is ineffective in practice, as discussed by previous studies, both theoretically (Spulber, 2019) and empirically (Balasubramanian and Ragavan, 2019; Moreno-Izquierdo et al., 2020).

To address these issues, prior to the analysis, two filters were applied to the AirDNA dataset, shown in Table 1. Subsample 1 includes dwellings offered by hosts for at least one night per month, allowing analysis of the short-term effects on occupancy rates. Subsample 2 focuses on dwellings rented for at least one night, enabling analysis of changes in accommodation prices due to COVID.

Based on the data presented in Table 1, we observe a noticeable decline in the availability of listed and rented accommodations on the platform after the pandemic. In Subsample 1, offered apartments decreased by 48% in Madrid (from 40,227 to 20,962) and 45% in Valencia (from 17,438 to 9,676). Subsample 2 reveals a 60% decrease in rented apartments in Madrid and a 54% decrease in Valencia.

Despite the supply reduction, the structure of offerings remains largely unchanged. Entire apartments consistently make up 60% to 70% of listings in both Madrid and Valencia, while private rooms range from 25% to 35%. The offering of shared rooms virtually disappears during the COVID period, likely due to social distancing measures. However, their pre-COVID share was already minimal, so the effect over the supply structure is barely noticeable.

4.2. Variables used in the study and descriptive statistics

Table 2 displays the mean values and standard deviations of the variables used in this study for both cities. These variables include the occupancy rate, representing the ratio of available days to total nights rented, and accommodation prices, calculated as the monthly average of daily prices paid by tourists in USD. The table presents values for Subsample 1 (for occupancy rate) and Subsample 2 (for accommodation prices) as defined previously.

Table 2 also includes values for a subsample of accommodations available throughout the entire study period (2018, 2019, and 2020). This subsample, referred to as "Permanent Dwellings", serves for robustness tests, capturing the behaviour of accommodations that experienced the impact of COVID-19 while remaining available for rent and adapting their strategies in a changing environment.

It is important to note that the AirDNA database is structured on a monthly basis, meaning that daily or weekly prices are not available. Nevertheless, the available information provides insights into the evolution of supply and demand behaviour over time. This is depicted in Figs. 1 and 2, which present boxplots illustrating the variables used in this study for Madrid and Valencia. In this initial analysis, a sharp change in occupancy rates between the pre- and post-pandemic periods in both destinations is observed. With the pandemic, the median of occupied accommodations for both Madrid and Valencia drops to 0% (for Madrid, the median was 16.7% in 2018 and 29% in 2019; for Valencia, the results were 25.8% in 2018 and 48% in 2019). Hence, occupancy percentages that were within the interquartile range and whiskers in 2018 and 2019 are now seen as outliers. However, there is less noticeable change in the prices paid by tourists. The boxplots also reveal distinct tourism patterns, with Madrid experiencing occupancy peaks in May, June, and September, while Valencia sees peaks in July and August. Potential factors contributing to these differences will be explored with the analysis proposed.

[3] Acacias, Adelfas, Almagro, Aluche, Arapiles, Argüelles, Atocha, Casa de Campo, Castellana, Chopera, Ciudad Jardín, Ciudad Universitaria, Comillas, Cortes, Delicias, El Salvador, El Viso, Embajadores, Entrevías, Estrella, Fontarrón, Fuente del Berro, Gaztambide, Goya, Guindalera, Ibiza, Imperial, Justicia, Concepción, Legazpi, Lista, Cármenes, Jerónimos, Lucero, Marroquina, Media Legua, Moscardó, Niño Jesús, Numancia, Opañel, Pacífico, Palacio, Palomeras Bajas, Palomeras Sureste, Portazgo, Prosperidad, Pueblo Nuevo, Puerta del Angel, Quintana, Recoletos, Rios Rosas, San Diego, San Isidro, San Juan Bautista, Sol, Trafalgar, Universidad, Vallehermoso, and Ventas.

[4] Algirós, Benicalap, Benimaclet, Camins al Grau, Ciutat Vella, Campanar, Extramurs, Jesús, L'Eixample, L'Horta Nord, L'Olivereta, La Malva Rosa, La Saïdia, Patraix, Pla del Real, Poblados Marítimos, Pobles de l'Oest, Pobles del Nord, Pobles del Sud, Quatre Carreres, Rascanya.

Table 1
Structure of the original data in AirDNA and of the two subsamples used for the research.

Original dataset from AirDNA

	Obs.	Unique obs.	Entire home (% un. obs.)	Hotel room (% un. obs.)	Private room (% un. obs.)	Shared room (% un. obs.)
MAD (2018)	152,633	35,303	63.97	0.49	34.07	1.45
MAD (2019)	165,175	37,437	65.13	0.80	32.80	1.26
MAD Pre COVID	317,808	48,157	62.80	0.62	35.04	1.52
MAD COVID	147,518	32,150	66.35	0.94	31.21	1.47
VAL (2018)	68,558	15,601	62.29	0.16	36.86	0.67
VAL (2019)	72,037	16,125	63.00	0.37	35.98	0.63
VAL Pre COVID	140,595	20,440	60.00	0.22	38.95	0.75
VAL COVID	64,341	13,929	64.61	0.45	34.30	0.62

Subsample 1: AirBNB accommodations including only those offered for at least one night

	Obs.	Unique obs.	Entire home (% un. obs.)	Hotel room (% un. obs.)	Private room (% un. obs.)	Shared room (% un. obs.)
MAD (2018)	101,878	28,072	65.71	0.62	32.06	1.58
MAD (2019)	102,889	28,420	66.22	0.89	31.55	1.23
MAD Pre COVID	204,767	40,227	64.07	0.65	33.65	1.60
MAD COVID	80,313	20,962	70.69	1.03	26.71	1.55
VAL (2018)	47,062	12,959	64.20	0.20	34.95	0.64
VAL (2019)	44,894	12,276	65.24	0.48	33.68	0.59
VAL Pre COVID	91,956	17,438	61.64	0.33	37.26	0.75
VAL COVID	37,092	9,676	67.81	0.41	31.20	0.56

Subsample 2: AirBNB accommodations including only those were rented for at least one night

	Obs.	Unique obs.	Entire home (% un. obs.)	Hotel room (% un. obs.)	Private room (% un. obs.)	Shared room (% un. obs.)
MAD (2018)	65,496	20,236	70.01	0.69	28.24	1.04
MAD (2019)	75,616	21,740	68.19	1.16	29.46	1.17
MAD Pre COVID	141,112	30,511	66.45	0.84	31.48	1.20
MAD COVID	31,820	12,328	76.23	1.32	21.33	1.11
VAL (2018)	32,282	9,638	69.60	0.23	29.80	0.35
VAL (2019)	34,680	9,597	67.55	0.60	31.32	0.52
VAL Pre COVID	66,962	13,801	64.91	0.42	34.11	0.55
VAL COVID	17,602	6,411	72.82	0.61	26.34	0.21

4.3. Method of analysis

The methodology employed in this study consists of two stages: [1] an exploratory geographical representation offers insights on the spatiotemporal location of registers, and [2] statistical tests are used to support the findings from visual analysis and to further test the research hypotheses. The combined spatial and economic analysis, aligned with previous research such as those from Sun et al. (2020) or Julliard et al. (2023), allow an exploration of the relationship between supply and demand for Airbnb listings and link them to other aspects of the city. To enhance understanding of the short-term effects of the pandemic, both the city and neighbourhood/district scales are considered. This approach aligns with similar studies conducted by Garha and Botelho (2022) or Liang et al (2021).

Firstly, in the exploratory stage, QGIS, a widely used Geographic Information System, was adopted to conduct a spatiotemporal analysis (Ahasan et al., 2020). Airbnb accommodation occupancy rates and average daily prices were compared between the pre-COVID and short-term COVID periods for the two cities. A visual representation assigns a red or blue tone to each accommodation registered (coloured dots) illustrating higher and lower occupancy and price rates, respectively, in order to showcase and depict the distribution differences in areas within the spatial delimitation of districts/neighbourhoods.

As a complementary approach – but in this case considering the entire administrative delimitations as spatial units of analysis – a joint analysis is conducted in which the state space of districts/neighbourhoods is partitioned based on the co-movements of price and occupancy rate variations. Following the approach of Brida and Risso (2010), the partitions are determined using an economic interpretation. The threshold is set as the median variation (decrease) in occupancy rates, comparing the Pre-COVID and COVID periods, while for prices, whether there was a decrease or an increase in prices during the analysed period is considered. This results in four states in the areas of each city: (I) decrease in prices and a decrease in occupancy rates greater than the median; (II) decrease in prices and a decrease in occupancy rates less than the median; (III) increase in prices and a decrease in occupancy rates greater than the median; (IV) increase in prices and a decrease in occupancy rates less than the median.

From this stage, three different levels of interpretation are made in relation to: (1) the distribution patterns of accommodations over time and space; (2) specific changes in the Airbnb market that support previous studies; and (3) the identification of areas with resilient behaviour, that is, areas where changes in occupancy and pricing do not appear to be as severe as in others.

Secondly, a set of tests was employed to statistically test the research hypotheses. In order to evaluate the significance of the differences between the pre-COVID and short-term COVID data, both Student's *t*-test (Student, 1908; Fischer, 1915) and the Mann-Whitney non-parametric test (Mann and Whitney, 1947; Wilcoxon and Wilcox, 1950) were used. Although the Mann-Whitney test is not strictly necessary according to the central limit theorem, it was considered due to the presence of a high number of outliers, as indicated by the boxplots. Additionally, Cohen's *d* (Cohen, 2013) was calculated as a measure of effect size. This test allows quantifying the magnitude of the difference between the two groups, providing insight into the strength of the effects driven by the pandemic. The interpretation of the d value follows the theoretical guidelines: Very large greater than 1.0; Large, between 0.5 and 1.0; Medium, 0.2 to 0.5; and Small $\leq$ 0.2, as cited in Arrobas et al. (2020). These types of methods have been used in recent research to determine the significance of COVID-induced effects on demand decisions (Laparojkit and Suttipun, 2021; Lim, 2022) and supply-side decisions in various tourism sectors (Duman et al., 2021; Kim and Han, 2022; Kökény et al., 2022).

Next, the complementary Anderson-Darling (AD) (Anderson and

Table 2
Descriptive statistics (Occupancy rate and Accommodation Prices).

	Madrid				**València**			
	Occupancy rate				*Occupancy rate*			
	Total sample		Permanent dwellings		Total sample		Permanent dwellings	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pre COVID	***35.16***	***36.35***	***45.37***	***36.00***	***40.15***	***38.06***	***51.56***	***36.48***
May	*37.62*	*37.31*	*49.93*	*36.13*	*34.17*	*36.03*	*17.53*	*27.61*
June	*35.11*	*36.84*	*46.97*	*36.53*	*36.12*	*36.86*	*45.73*	*35.61*
July	*32.52*	*34.80*	*41.72*	*34.91*	*41.40*	*38.37*	*47.92*	*36.01*
August	*30.51*	*34.04*	*38.78*	*34.42*	*47.23*	*39.16*	*52.97*	*36.56*
September	*40.99*	*38.08*	*51.04*	*36.65*	*41.31*	*38.28*	*58.61*	*36.11*
COVID	***12.05***	***23.82***	***11.61***	***23.30***	***17.62***	***27.75***	***17.53***	***27.61***
May	*11.14*	*22.72*	*10.73*	*21.97*	*8.78*	*19.93*	*8.91*	*19.82*
June	*9.65*	*21.11*	*9.22*	*20.51*	*10.40*	*20.48*	*10.30*	*20.27*
July	*13.33*	*24.75*	*12.88*	*24.37*	*24.27*	*30.90*	*24.61*	*31.06*
August	*12.35*	*24.42*	*11.92*	*23.98*	*27.69*	*32.95*	*27.80*	*32.94*
September	*14.05*	*25.84*	*13.75*	*25.58*	*16.78*	*26.67*	*16.77*	*26.44*
	Accommodation prices (USD)				*Accommodation prices (USD)*			
	Total sample		Permanent dwellings		Total sample		Permanent dwellings	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pre COVID	***116.80***	***116.49***	***116.30***	***114.99***	***90.97***	***70.98***	***93.01***	***71.76***
May	*129.97*	*129.56*	*128.45*	*127.16*	*86.27*	*68.47*	*88.08*	*68.92*
June	*128.95*	*128.27*	*127.02*	*122.45*	*90.84*	*76.05*	*93.19*	*77.41*
July	*110.62*	*111.31*	*111.03*	*113.33*	*94.75*	*74.83*	*97.22*	*76.00*
August	*100.72*	*104.98*	*102.13*	*107.54*	*96.10*	*70.84*	*98.50*	*71.84*
September	*113.89*	*103.24*	*114.66*	*102.67*	*85.33*	*63.21*	*86.58*	*63.12*
COVID	***114.46***	***113.13***	***121.13***	***119.39***	***94.89***	***88.78***	***100.14***	***93.95***
May	*120.15*	*120.56*	*127.22*	*127.87*	*96.45*	*121.17*	*102.02*	*128.66*
June	*113.58*	*117.07*	*118.35*	*123.13*	*91.58*	*73.18*	*95.61*	*75.04*
July	*111.56*	*106.10*	*117.50*	*110.77*	*100.01*	*103.18*	*105.15*	*110.65*
August	*109.01*	*104.29*	*116.04*	*109.92*	*95.80*	*68.15*	*101.33*	*69.86*
September	*117.83*	*116.59*	*126.22*	*123.51*	*88.80*	*74.48*	*94.56*	*76.85*

Darling, 1952) and Kolmogorov-Smirnov (KS) (Massey, 1951) tests are used to analyse shifts in the distribution of the adopted variables over time. Both techniques (KS and AD) are commonly used together in research to provide greater robustness to the analyses. This approach is followed by previous studies related to COVID effects, such as those from Uba et al. (2021), Lopreite et al. (2021) and Pereira et al. (2022), which analyse changes in different sample distribution (mortality, hospitalised patients or even reactions on social networks) caused by the pandemic.

The results are then presented for each city, broken down by month, allowing a comparison of the impact of COVID-19 in both destinations. These are followed by a robustness exercise considering only the permanent dwellings during both the Pre-COVID and pandemic periods. Finally, the same tests are performed for the top ten local areas with the highest number of Airbnb listings in each case study. This complements the district/neighbourhood-level analysis conducted in the exploratory exercise.

5. Results

5.1. Exploratory geographical analysis

The results of the exploratory geographical analysis reveal four key findings. Firstly, in terms of accommodation distribution patterns, Figs. 3 to 6 provide initial evidence of changes in accommodation density due to the pandemic, with a decrease in available properties during the early stages of the pandemic. This aligns with previous studies such as that from Adamiak et al. (2019), which also observed a spread of accommodations throughout consolidated urban areas, as in the case of the city centre in Madrid and the central and coastal areas of Valencia.

Secondly, a persistent spatial polarisation is observed at neighbourhood and district levels and even in areas within their spatial delimitation. Cases of higher occupancy and average prices are Argüelles in Madrid or La Malva-Rosa and Poblats Maritims in Valencia, maintaining their status in the short-term pandemic scenario (although with a noticeable decrease in occupancy levels). Similarly, areas within neighbourhoods with initially low occupancy levels continue to lag behind. This suggests that while there may be some redistribution of demand among popular areas, areas with low tourist activity before the pandemic saw quite limited activity its the early months.

Thirdly, the analysis also allows the identification of areas that have positive (or less negative) changes after the COVID-19 restrictions, which could therefore be considered more resilient to the crisis. It is worth highlighting that these are located next to open green public spaces. Specifically, in Madrid, the Argüelles neighbourhood is close to the Parque del Oeste and Plaza de España, while Puerta del Ángel is next to Madrid Río and Casa de Campo. In Valencia, the La Saïdia district is next to the Royal Gardens and Marchalenes park, the Algirós district is next to the Blasco Ibáñez Avenue green corridor, and L'Eixample is next to the Turia Gardens.

Fourthly, the joint analysis reveals varied effects of the pandemic throughout the months analysed (occupation rate and accommodation prices, respectively, in Figs. 7 and 8) and across different neighbourhoods/districts. Historic centre neighbourhoods such as Sol in Madrid and Ciutat Vella in Valencia experienced declines in both occupancy rates and prices. However, certain districts in Valencia, such as Poblats Marítims, Camins al Grau, El Pla del Real, and Algirós, showed greater resilience, maintaining higher occupancy rates. These disparities suggest that while overall tourist demand declined during the short-term COVID-19 period, areas with a stronger tourist tradition withstood the effects better, particularly in Valencia.

These results suggest price rigidity in some urban areas, where occupancy rates decline while prices show a smaller decrease or even an increase. Furthermore, there is a significant disparity of results within

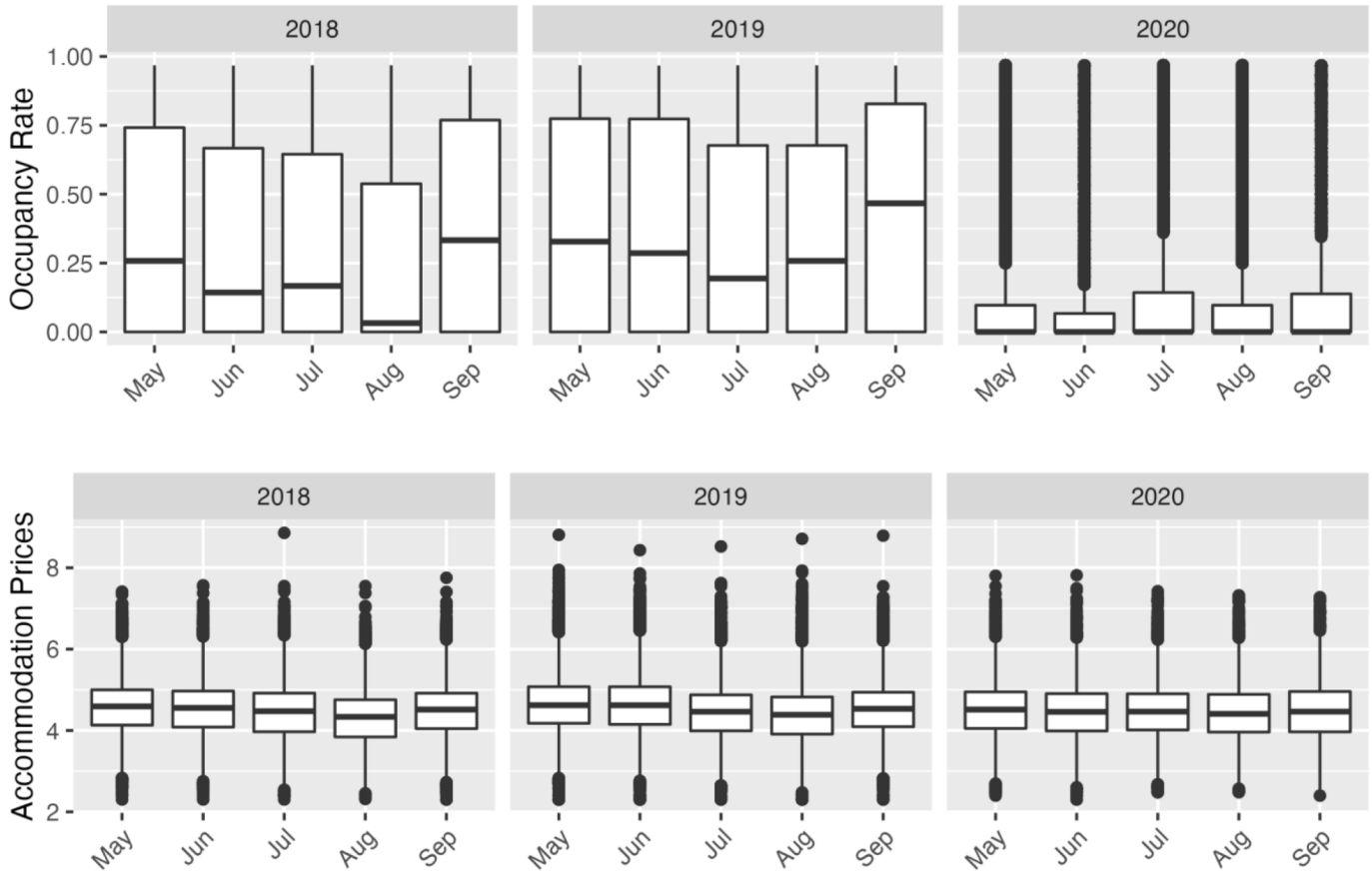

Fig. 1. Boxplots for Occupancy Rate and Accommodation Prices for Madrid.

cities, emphasising the need to consider shifts within the destinations themselves to provide better recommendations. In the following section, we statistically analyse these observed differences.

5.2. Statistically determining the impact of COVID-19 on occupancy rates and accommodation prices

Table 3 displays the results of the *t*-test, Mann-Whitney *U* test, and Cohen's *d* value, comparing accommodation prices and occupancy rates in Madrid and Valencia for the total sample. As expected from the boxplots and previously discussed results, the findings show a significant reduction in occupancy rates throughout the COVID period, with notable differences observed in May and June 2020 (Madrid: −102.4 and −103.6; Valencia: −71.25 and −71.22), while July and August show the smallest statistical difference (Madrid: −75.18 and −71.44; Valencia: −38.22 and −40.98, respectively). These results are further reinforced by Cohen's *d*, showing that the changes in occupancy rates observed for both Madrid (ranged from −0.72 to −0.84) and Valencia (from −0.64 to −0.91) are considerably high. The Mann-Whitney test results also confirm significant differences. However, for both Madrid and Valencia, the months of July and August exhibit the highest values, indicating distinct distributions during the months under investigation.

The results for accommodation prices shown Table 3 reveal that not all t-tests and Mann-Whitney tests for prices are significant in Madrid and Valencia. Interestingly, contrary to our set hypotheses, t-values reveal positive differences in August for Madrid and in May, July, and September for Valencia, indicating higher average prices during these months in 2020 than in the pre-COVID period. The Mann-Whitney *U* test supports this trend, albeit with less robust findings compared to the occupancy analysis, particularly in July and September.

Table 4, which focuses on permanent dwellings as a robustness test, confirms the significant decline in occupancy rates, with smaller differences in prices according to the *t*-test and Cohen's *d*. It is also noteworthy that while Table 3 indicates a price reduction in Madrid compared to the pre-COVID period, Table 4 shows a positive difference, suggesting different behaviours among long-standing market participants compared to newcomers or those with a more variable offering model.

Tables 5 and 6 provide the results of the tests conducted for the ten neighbourhoods and districts in Madrid and Valencia, respectively, with the highest number of unique Airbnb listings before the COVID-19 period. Regarding occupancy rates, all areas in both cities show significant negative differences and high *d* values (greater than 0.5, except for the Puerta del Ángel neighbourhood in Madrid, with $d = 0.4$). However, there are notable differences in accommodation prices. In Madrid, prices mostly decreased, except for Argüelles (a positive and significant difference of 3.97) and Puerta del Ángel (a positive but non-significant difference of 1.571). On the other hand, in Valencia, prices were mostly higher during the short-term COVID-19 period, particularly in La Saïdia (4.836) and Algirós (3.239), where the differences are significant. The *d* values for prices in both cities are mostly below 0.1, indicating minimal changes, despite the significant decline in occupancy, with the exception of of Argüelles in Madrid ($d = 0.21$) and Aligrós and La Saïdia in Valencia ($d = 0.23$ and 0.24, respectively).

5.3. Statistically ascertaining the difference between occupancy rates and accommodation prices distribution

Table 7 displays significant changes in the distribution of occupancy rates and accommodation prices between the pre-COVID and short-term pandemic periods in Madrid and Valencia, with both the Anderson-Darling (AD) and Kolmogorov-Smirnov (KS) tests showing p-values

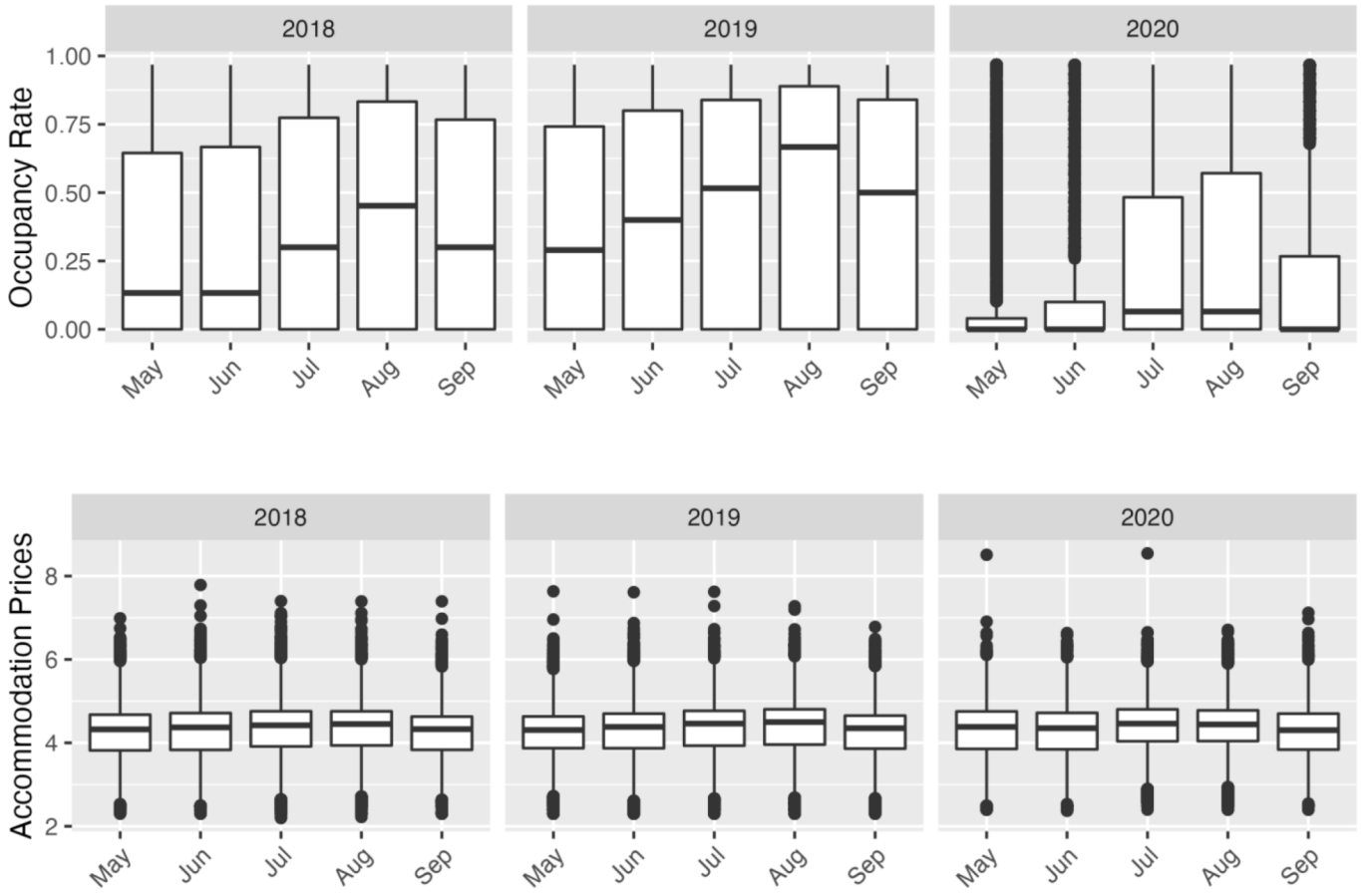

Fig. 2. Boxplots for Occupancy Rate and Accommodation Prices for València.

below 0.01 for every month. However, it is important to note that the differences in price rates were consistently smaller than those observed in occupancy rates. In terms of the comparison between cities, the KS test reveals that there are no major differences in the results between the destinations for most of the study period. Notably, the pandemic caused a greater alteration in the distribution of occupancy rates in Valencia than in Madrid. As for the accommodation prices, there is an alternation: in Valencia, higher results are observed in the months of May (0.093) and August (0.048), while in Madrid, the higher results are seen in June (0.093) and, particularly, in September (0.033). Comparing the results of the AD test, Madrid generally exhibits a better fit to the tested theoretical distribution than Valencia, which means that the distribution in Madrid generally exhibits a shape that better fits the tested theoretical distribution.

Table 8, which examines only permanent dwellings, reinforces the previous findings, but also reveals some notable differences. In Madrid, the distribution of accommodation prices appears more stable compared to Table 7, with a smaller range of KS test figures (0.051 to 0.023). Conversely, in Valencia, the distribution of prices shows a larger range (0.019 to 0.038). This exercise complements the analysis of the *t*-test and Cohen's *d* which show a greater difference in the case of Valencia than in Madrid. Therefore, the differences above the mean also entail a significant change in their composition when comparing the periods studied.

Table 9 demonstrates statistically significant differences in the distribution of occupancy rates for the top ten neighbourhoods with the highest number of Airbnb listings. However, when it comes to accommodation prices, there are some dissimilarities. In this case, the K-S and A-D tests reveal p-values above 5% for the neighbourhoods of Justicia, Goya, Puerta del Angel, and Cortes. It is important to highlight that in Table 5, Cortes and Justicia showed significant differences, indicating notable changes in average accommodation prices, although the distribution variation is not statistically significant.

Similar to Madrid, all ten analysed districts in Valencia show significant distribution differences in occupancy rates (as indicated by the KS and AD tests in Table 10). However, when analysing the changes in price distribution, only certain districts, including Ciutat Vella, Poblados Marítimos, L'Eixample, Extramurs, La Saidia, and Algirós, exhibit a significantly different price distribution. Comparing these results to the t-tests for price differences in Valencia (Table 6), there are instances where the mean does not change in a statistically significant way, but the distribution does – specifically in the districts of Poblados Maritimes, L'Eixample, and Extramurs.

To better understand the results obtained with the KD and AD tests, the graphical decomposition is presented. In the case of occupancy rates for both cities (Fig. 9), the average drops, although there is not only a shift in the curve but also a change in the distribution. For both Madrid and Valencia, a shift to the left (a general drop in occupancy) is observed, as well as a more leptokurtic distribution in the initial months and a more platykurtic distribution in subsequent months. Another observation is that both destinations exhibit different temporal patterns: Valencia remains fairly stable throughout the studied months, with slightly higher activity in August, while Madrid experiences its peak occupancy in September.

Regarding accommodation prices, in Fig. 10, the right tail of the distribution is broader in the post-restriction period for both destinations, indicating a decrease in the proportion of lower-priced accommodation and an increase in higher-priced accommodation. However, in the case of Valencia, it is especially remarkable that the distribution observed indicates a higher price for each of the analysed months during the first months of COVID restrictions.

The graphical analysis of the distribution of accommodation prices in Madrid, broken down by neighbourhoods, shows easily observable

Fig. 3. Occupancy rates in central neighbourhoods of Madrid, Spain.

discrepancies (Fig. 11). While Goya and Justicia maintain a very similar structure before and after COVID, Argüelles and Puerta del Ángel show a shift to the right (higher prices). Palacio, Cortes, Embajadores, and Universidad, on the other hand, show a left shift (predominantly lower prices). In the case of Valencia (Fig. 12), the proportion of accommodation costing under 50 USD per day decreases, while that of higher intervals increases (between 50 and 75 USD in Extramurs and L'Eixample, and over 100 USD in Poblados Marítimos). This change in structure explains the tendency to increase average accommodation prices in the city of Valencia, as observed in the previous findings. As a common element found in both cities, in this neighborhood-based decomposition of prices, a strong left skewness is clearly observed,

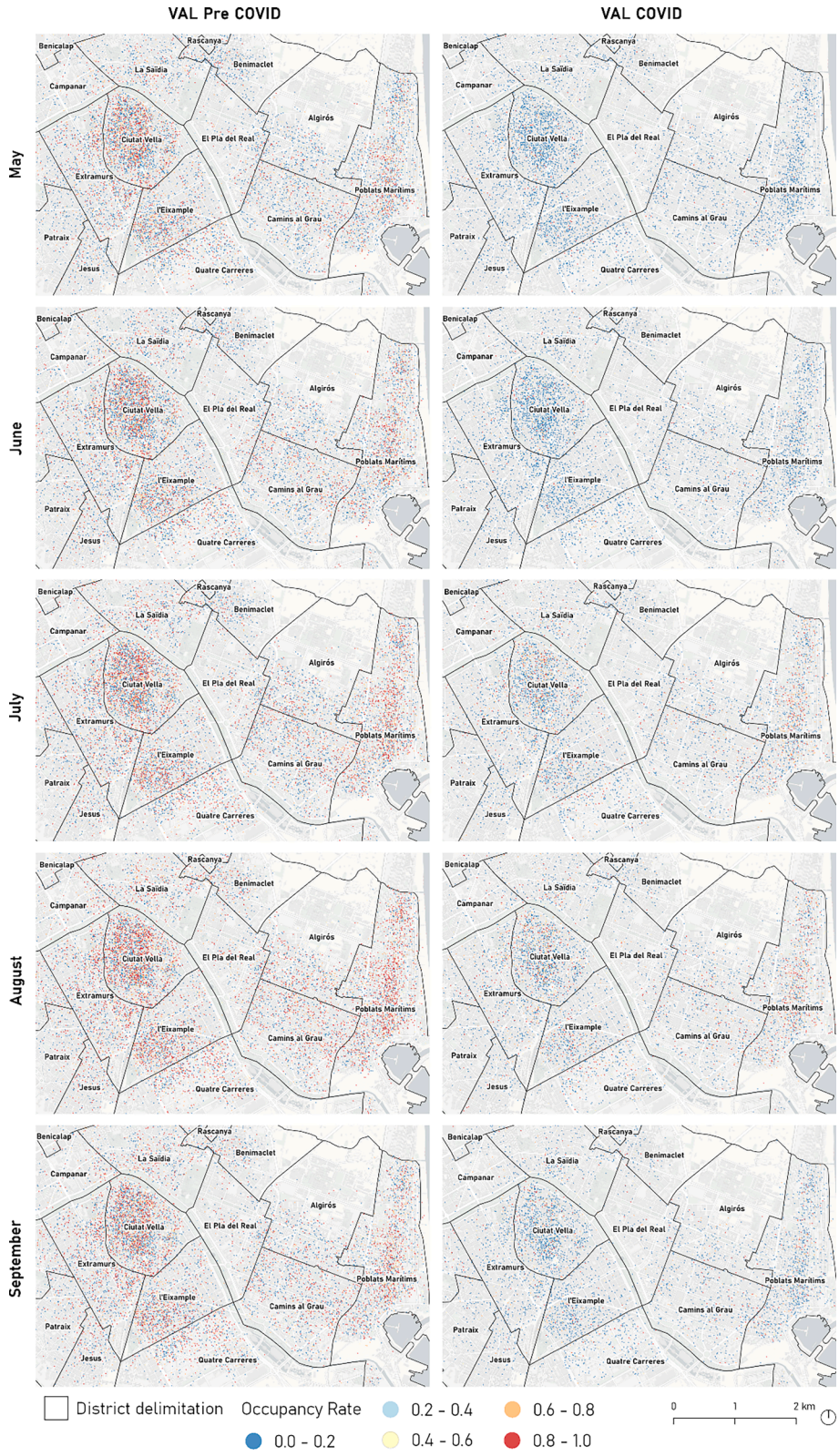

Fig. 4. Occupancy rates in Valencia's central districts, Spain.

which may be related to some of the characteristics of the Airbnb market previously mentioned, such as excess supply or low sunk costs. Both factors could explain the presence of very low prices in a large portion of the lodgings, many of which are not rented according to the data presented in this research.

6. Discussion and hypothesis validation

The results obtained allow testing of the hypotheses set, revealing findings that contribute to the field of study concerning the effects of the pandemic on tourist destinations.

Firstly, it has been observed that in the short term, COVID-19 led to a

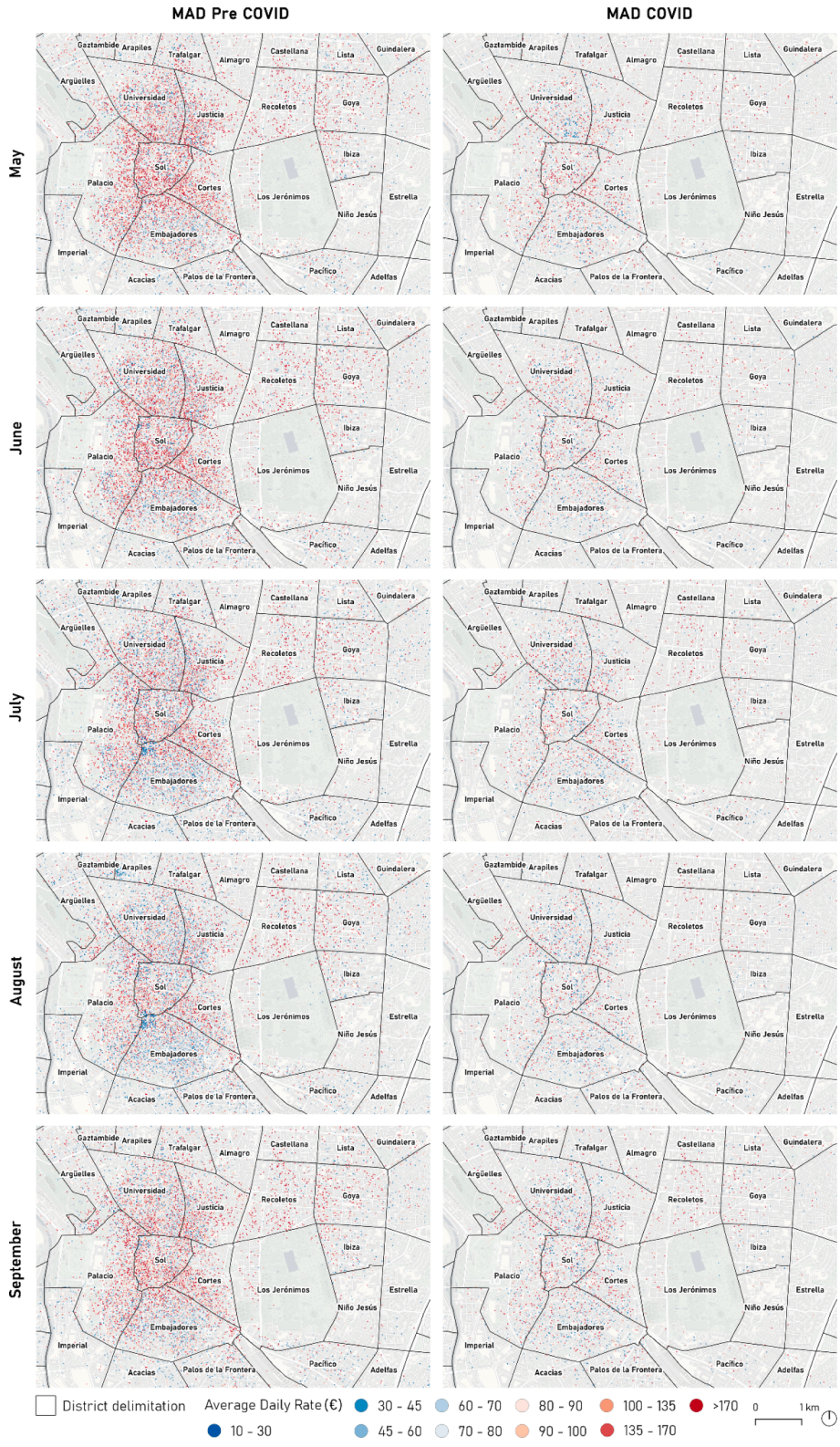

Fig. 5. Average daily rate in central neighbourhoods of Madrid, Spain.

reduction in occupancy rates for both destinations (Hypothesis 1). This means that, despite the decrease in Airbnb supply in the months following COVID-19, the decline in demand was even greater in both destinations. The reason behind this could be the reduction of international arrivals, as well as the decrease in the mobility of domestic tourists due to economic factors resulting from COVID-19 or fear of the pandemic, as suggested by previous literature.

However, Hypothesis 2, which suggests a decrease in prices due to the drop in demand, cannot be universally validated. In Valencia, an overall increase in prices throughout the analysed period was found, while a polarisation was seen in the city of Madrid, with some neighbourhoods (as occurs in Valencia with the districts) showing an increase

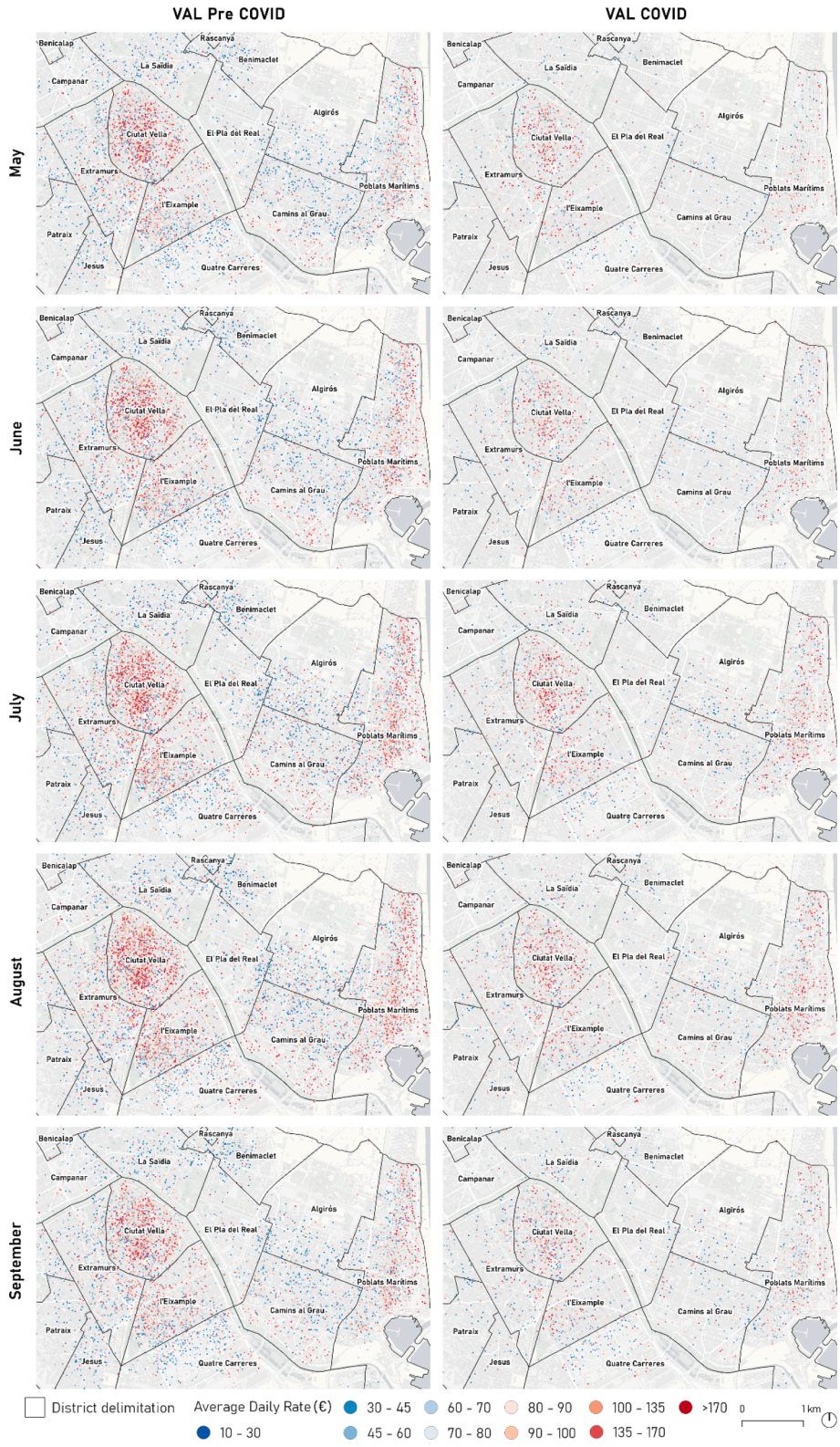

Fig. 6. Average daily rate in Valencia's central districts, Spain.

in accommodation prices. This effect was also detected by Milone et al. (2023) for a set of European cities – showing increasing Airbnb prices between 2019 and 2020 – and by Filieri et al. (2023) who describe how COVID-19 tourists were more willing to pay premium accommodation prices in 2020. However, these initial observations also differ from findings in other studies. For example, Thackway and Pettit (2021) found a decline in rental prices during the pandemic in those areas in Sydney with high Airbnb activity, while Boto-García (2022) observed a general reduction in prices due to COVID-19 in Barcelona, differentiating the results between professional and non-professional hosts.

By cross-referencing the results of accommodation prices with observations from the geographical analysis in Section 5.1, we can identify

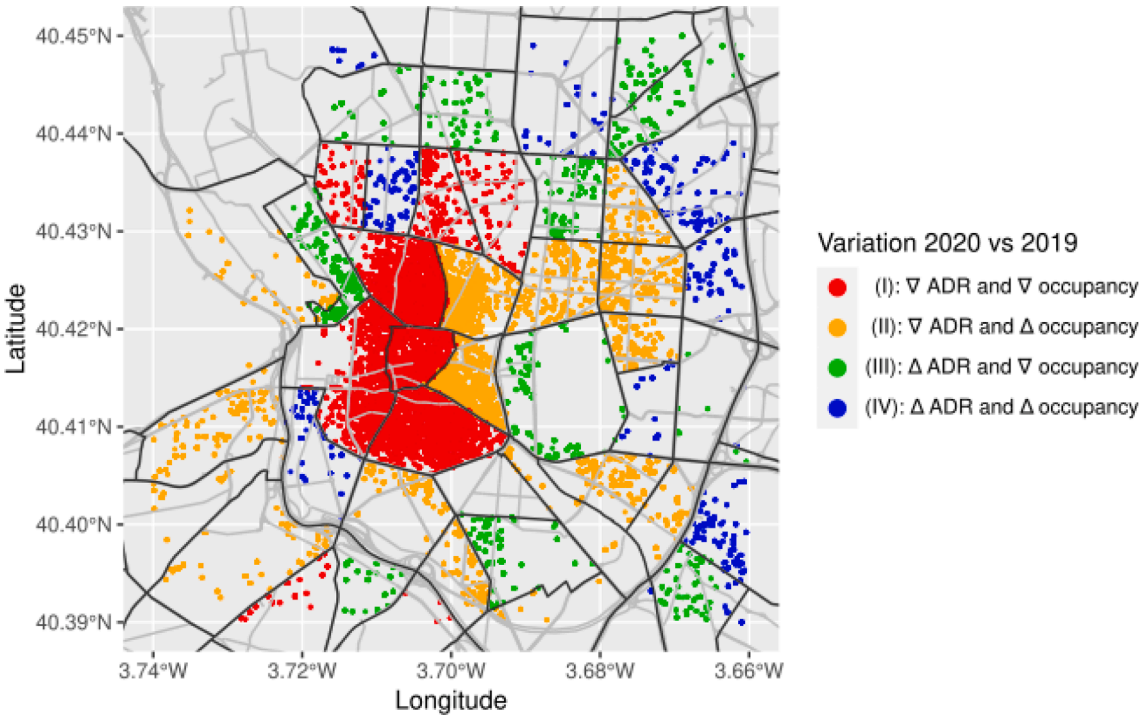

Fig. 7. Joint evolution of occupancy rates and prices between 2019 and 2020, at the neighbourhood level in Madrid.

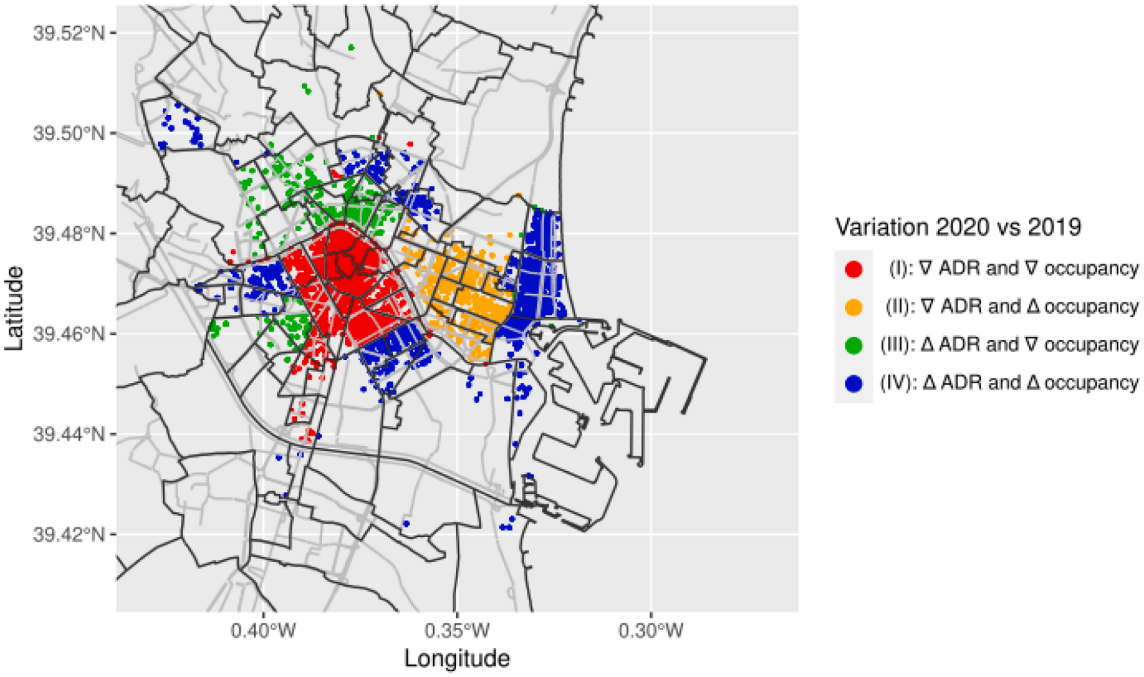

Fig. 8. Joint evolution of occupancy rates and prices between 2019 and 2020, at the district level in Valencia.

two key aspects that characterise those neighbourhoods/ districts that show a positive and significant shift. Firstly, even though there may be a redistribution of tourist demand as a result of COVID-19, it continues to be concentrated in specific neighbourhoods or districts that already had high activity before the pandemic (e.g. areas near the centre of the cities). This result was predictable, following studies like Jang and Kim (2022), Serrano-Estrada (2022) or Sun et al. (2022), which established that there are areas in cities with high tourist attractiveness or with a more consolidated tourism activity cluster, and that these did not disappear with the pandemic, allowing for greater resilience in them. Although complementary analyses are needed to provide a definitive answer, the results of this study suggest that Madrid and Valencia may grow even more unequal as the economic fallout hit the least advantaged hardest (as observed by Florida et al., 2021), at least following tourism activity data. In Valencia, central areas such as Ciutat Vella or L'Eixample were more affected than the peripheral areas near the coast in terms of both occupancy rates and accommodation prices. In Madrid, the neighbourhoods in the city centre also experienced a decline in both

Table 3
Differences in occupancy rates and accommodation prices: Pre COVID and COVID for Madrid and Valencia (Total sample).

	MAD						**VAL**					
	Occupancy rates			*Accommodation prices*			*Occupancy rates*			*Accommodation prices*		
	t-test	*M-W*	*d*	*t-test*	*M-W*	*d*	*t-test*	*M-W*	*d*	*t-test*	*M-W*	*d*
Total	−198.7***	537.3***	–	−3.31***	218.7***	–	−117.9***	117.7***	–	5.49***	62.03***	–
May	−102.4***	20.07***	−0.72	−5.39***	5.77***	−0.08	−71.25***	4.08***	−0.73	4.52***	1.21***	0.13
Jun	−103.6***	21.01***	−0.75	−8.63***	5.46***	−0.12	−71.22***	4.43***	−0.97	−0.78	1.43**	0.01
Jul	−75.19***	24.75***	−0.42	−1	7.75	0.01	−38.23***	5.64***	−0.64	1.96*	2.52*	0.06
Aug	−71.44***	23.77***	−0.35	2.8***	6.57***	0.08	−40.99***	5.07***	−0.68	−2.46**	2.43***	0.00
Sep	−93.68***	17.96***	−0.84	−0.8	6.03***	0.04	−57.3***	4.21***	−0.91	0.59	1.68**	0.05

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

Table 4
Differences in occupancy rates and accommodation prices: Pre COVID and COVID for Madrid and Valencia (Permanent dwellings).

	MAD						**VAL**					
	Occupancy rates			*Accommodation prices*			*Occupancy rates*			*Accommodation prices*		
	t-test	*M-W*	*d*	*t-test*	*M-W*	*d*	*t-test*	*M-W*	*d*	*t-test*	*M-W*	*d*
Total	−248.4***	19.61***	–	5.79***	14.05***	–	−155.9***	44.88***	–	8.52***	41.77***	–
May	−128.8***	6.47***	−0.86	−0.65	3.61***	−0.01	−87.06***	14.56***	−0.87	5.32***	0.85***	0.17
Jun	−129.5***	7.14***	−0.90	−4.55***	3.39***	−0.07	−89.23***	15.82***	−1.09	0.27	0.96	0.03
Jul	−96.04***	9.17***	−0.44	2.12**	48.68***	0.06	−55.27***	22.11***	−0.70	2.99***	16.80***	0.09
Aug	−90.52***	9.45***	−0.37	4.95***	42.28***	0.13	−57.22***	19.90***	−0.78	0.2	1.59	0.04
Sep	−112.7***	6.87***	−0.91	2.93***	38.88***	0.11	−71.00***	16.79***	−1.00	3.2***	1.16	0.12

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

Table 5
Differences in occupancy rates and accommodation prices: Pre COVID and COVID for Madrid (distributed by neighbourhoods).

	Occupancy rates			**Accommodation prices**		
	t-test	*M-W*	*d*	*t-test*	*M-W*	*d*
Embajadores	−89.42***	101.37***	−0.70	−3.56***	53.85***	−0.05
Universidad	−70.94***	80.77***	−0.66	−4.66***	35.19***	−0.08
Palacio	−68.1***	51.93***	−0.62	−6.55***	20.76***	−0.12
Sol	−68.19***	45.77***	−0.67	−2.32**	22.64***	−0.05
Justicia	−55.56***	24.99***	−0.55	−1.8*	10.53***	−0.04
Cortes	−52.81***	21.71***	−0.62	−0.31	10.33***	−0.01
Argüelles	−23.36***	2.73***	−0.67	4.48***	0.89***	0.21
Trafalgar	−26.4***	3.14***	−0.56	−0.95	0.86	−0.04
Goya	−26.25***	2.2***	−0.58	−1.5	0.83	−0.06
Puerta del Angel	−21.55***	1.51***	−0.40	1.21	0.51	0.07

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

Table 6
Differences in occupancy rates and accommodation prices: Pre COVID and COVID for Valencia (distributed by districts).

	Occupancy rates			**Accommodation prices**		
	t-test	*M-W*	*d*	*t-test*	*M-W*	*d*
Ciutat Vella	−64.88***	61.09***	−0.84	−0.63	35.23***	−0.01
Poblados Marítimos	−46.67***	30.85***	−0.68	1.9*	20.22**	0.05
L'Eixample	−45.5***	10.88***	−0.89	1.84*	5.98	0.05
Extramurs	−29.1***	7.05***	−0.89	1.56	4.84	0.04
Camins al Grau	−38.01***	8.77***	−0.60	−1.96**	3.23**	−0.06
Quatre Carreres	−28.62***	4.76***	−0.67	1.22	2.44	0.05
Algirós	−24.04***	2.15***	−0.70	3.45***	0.63*	0.23
La Saïdia	−16.45***	1.57***	−0.83	5.04***	1.2***	0.24
Benimaclet	−14.27***	0.59***	−0.70	0.55	0.17	0.04
L'Olivereta	−18.3***	0.87***	−0.71	−0.03	0.42*	0.00

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

occupancy rates and accommodation prices, while the neighbourhoods farther away from that area, while still close enough to remain attractive to tourists, faced less severe effects.

Secondly, the analysis also allowed the identification of areas that were more resilient to the COVID-19. Coincidentally these are located in close proximity to open green public spaces. In turn, the four neighbourhoods with the highest concentration of Airbnb listings in Madrid showed a drop in prices in the short-term COVID period (Embajadores: −7.09, Universidad: −5.19, Palacio: −7.51 and Sol: −4.83). The same is true for Ciutat Vella (-2.42), the district with the highest number of

Table 7
Differences in distribution in occupancy rates and accommodation prices: Pre COVID and COVID for Madrid and Valencia.

	MAD				VAL			
	Occupancy rates		*Prices*		*Occupancy rates*		*Prices*	
	K-S Test	*A-D Test*	*K-S Test*	*A-D Test*	*K-S Test*	*A-D Test*	*K-S Test*	*A-D Test*
Total	0.344***	6359.40***	0.051***	81.79***	0.345***	3916.50***	0.019***	9.69***
May	0.421***	1737.90***	0.070***	44.09***	0.437***	846.80***	0.093***	25.51***
June	0.407***	1720.20***	0.093***	74.62***	0.484***	1304.60***	0.064***	7.60***
July	0.283***	917.95***	0.033***	6.65***	0.300***	661.86***	0.032***	4.33***
August	0.234***	592.00***	0.038***	13.14***	0.314***	712.66***	0.048***	8.93***
September	0.392***	1804.60***	0.105***	64.19***	0.398***	1005.90***	0.066***	12.51***

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

Table 8
Differences in distribution in occupancy rates and accommodation prices: Pre COVID and COVID for Madrid and Valencia (sample available for the whole period).

	MAD				VAL			
	Occupancy rates		*Prices*		*Occupancy rates*		*Prices*	
	K-S Test	*A-D Test*	*K-S Test*	*A-D Test*	*K-S Test*	*A-D Test*	*K-S Test*	*A-D Test*
Total	0.388***	6314.40***	0.023***	12.63***	0.385***	3987.70***	0.038***	32.13***
May	0.487***	1846.10***	0.037***	7.87***	0.484***	895.07***	0.124***	42.64***
June	0.479***	1863.10***	0.073***	33.95***	0.530***	1282.50***	0.066***	7.19***
July	0.311***	831.80***	0.037***	9.62***	0.334***	649.81***	0.046***	9.59***
August	0.265***	570.78***	0.069***	29.81***	0.355***	720.85***	0.052***	6.15***
September	0.433***	1683.50***	0.079***	28.43***	0.435***	960.48***	0.048***	6.89***

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

Table 9
Differences in occupancy rates and accommodation prices: Pre COVID and COVID for Madrid (distributed by neighbourhoods).

	Occupancy rates		Prices	
	K-S Test	*A-D Test*	*K-S Test*	*A-D Test*
Embajadores	0.434***	1266.20***	0.067***	13.95***
Universidad	0.396***	873.59***	0.091***	30.21***
Palacio	0.410***	718.07***	0.086***	25.95***
Sol	0.420***	783.55***	0.061***	8.98***
Justicia	0.385***	430.71***	0.033	2.12
Cortes	0.406***	515.21***	0.096***	21.36***
Argüelles	0.415***	139.26***	0.146***	14.09***
Trafalgar	0.412***	112.89***	0.094**	2.81*
Goya	0.429***	142.94***	0.067	1.80
Puerta del Angel	0.361***	77.04***	0.099*	2.76*

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

Table 10
Differences in occupancy rates and accommodation prices: Pre COVID and COVID for Valencia (distributed by districts).

	Occupancy rates		Prices	
	K-S Test	*A-D Test*	*K-S Test*	*A-D Test*
Ciutat Vella	0.432***	1284.00***	0.081***	19.21***
Poblados Marítimos	0.333***	564.16***	0.052***	11.12***
L'Eixample	0.450***	531.35***	0.049*	5.99***
Camins al Grau	0.338***	208.87***	0.040	1.82
Extramurs	0.436***	447.05***	0.057**	2.64*
Quatre Carreres	0.399***	232.62***	0.035	1.72
La Saïdia	0.409***	157.97***	0.124***	14.13***
Algirós	0.365***	98.49***	0.100**	4.17**
Benimaclet	0.408***	47.92***	0.137*	2.38
L'Olivereta	0.360***	92.35***	0.060	1.98

Significance levels:*p < 0.1;**p < 0.05;***p < 0.01.

registered properties in Valencia and the only one with a negative and significant result in the city. Given that the necessary statistical tests for establishing tourists' preferences in Madrid and Valencia are not conducted in this study, we cannot guarantee that the mentioned locations are the sole reason for these differences compared to other neighbourhoods or districts. However, these findings are partially aligned with those found in Seraphin and Dosquet (2020), Filieri et al. (2023) or Li et al. (2023), who observed a redistribution of demand towards less densely populated and green areas as a consequence of short-term COVID-19 effects. In our study, although the supply continued to concentrate in traditionally tourist areas, it was observed that, among these, at least those with fewer Airbnb accommodations had a greater appeal for tourists, reflected in better price performance (or bargaining power of the supply).

Hypothesis 3, which stated that COVID-19 caused a short-term change in the distribution of the supply–demand relationship, has also been positively tested. This means that not only are changes in occupancy rates and accommodation prices evident, but also changes in their composition. However, for both cities, these changes are much more evident in occupancy patterns than in the case of prices. Indeed, although a significant overall change was found in both cities, there were neighbourhoods or districts where no change was observed in the distribution of accommodation prices (in the case of Madrid: Justicia, Goya, and Puerta del Ángel; in the case of Valencia: Camins al Grau, Quatre Carreres, Benimaclet, and L'Olivereta).

Finally, regarding the shifts between Madrid and Valencia (Hypothesis 4), we can confirm that COVID-19 had different effects on the two destinations studied. First, it is evident that the pandemic had a greater impact on tourism in the city of Madrid than in Valencia in its early months. The decline in occupancy and prices was more pronounced in the capital of Spain than in the Mediterranean city, and there was also a greater change in the distribution of both variables.

Perhaps the most notable difference among these is that while accommodation prices, on average, experienced a decline, they increased in Valencia during the studied COVID period. This situation can be attributed to multiple factors that will need to be studied in the future. One of these should be the different approaches taken by the cities in the early months of the pandemic (March to May 2020). As explained in Section 2, Madrid was one of the cities that experienced a high number of deaths, with heavily criticised management of healthcare and patient hospitalisation, along with a significant polarisation of the risk of contagion by economic level (Glodeanu et al., 2021). On the other hand,

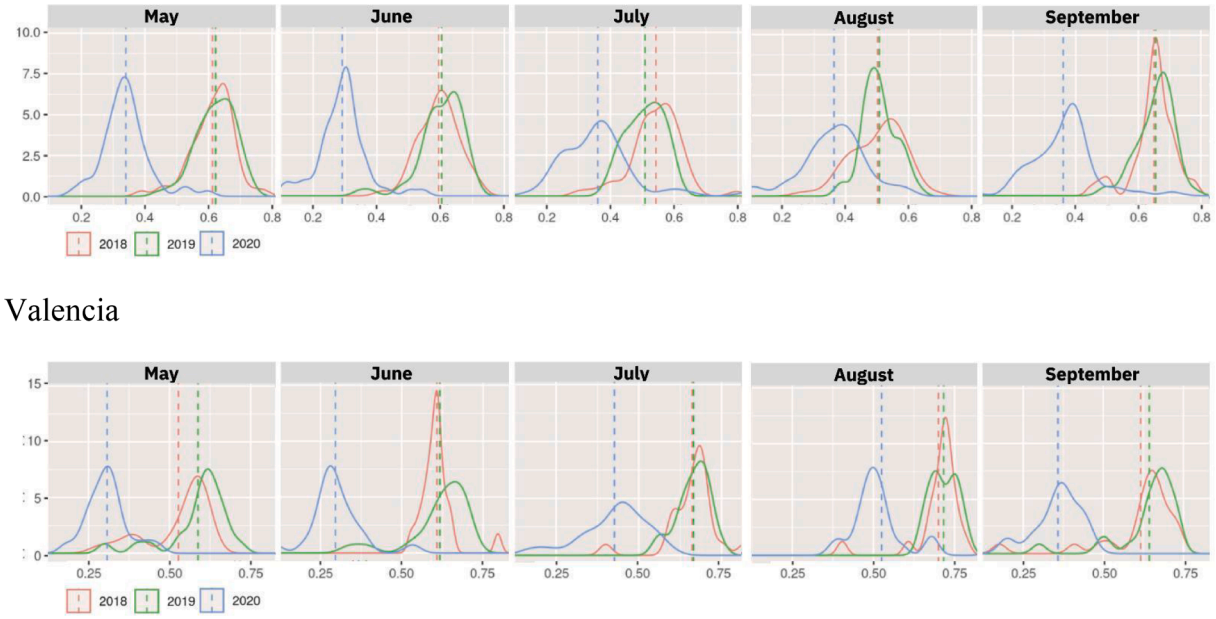

Fig. 9. Distribution of occupancy rates for Madrid and Valencia throughout the period analysed.

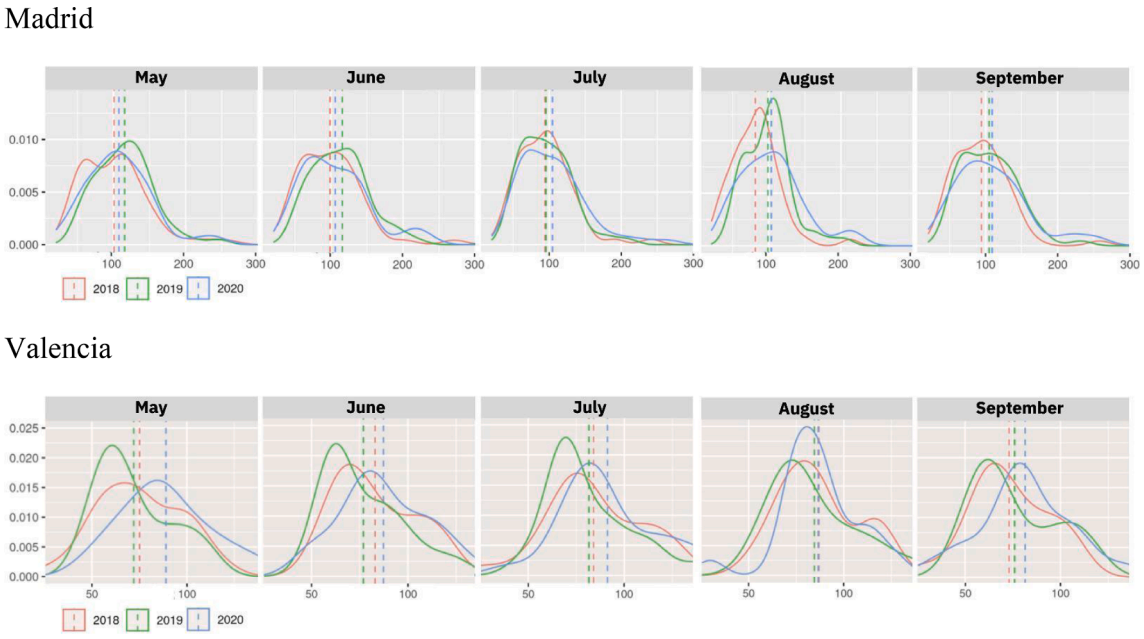

Fig. 10. Distribution of accommodation prices for Madrid and Valencia throughout the period analysed.

Valencia suffered a much smaller impact, accompanied by stricter measures. This may have resulted in a more positive perception of Valencia among tourists and, therefore, a more conservative response from accommodation providers, resisting price reductions. Although this study does not assess statistical significance for this, these elements – such as lockdown restrictions or the perception of health by tourists – have been considered in the study conducted by Kourtit et al. (2022) as differentiating factors to explain the high heterogeneity in Airbnb price behaviour in six different cities.

Another element that may have had some influence is the different seasonality of tourist activity in each destination: Valencia, being a sun and beach destination, experiences higher demand during the summer months compared to Madrid. This may have led hosts in the Mediterranean city to have more positive expectations and not reduce prices, relying on tourists' continued trust in traditional vacation destinations for their summer holidays. Furthermore, this would explain why the results are contrary to those found in Jang et al. (2021). If in that case, tourists in business-oriented destinations (such as Madrid in our study) showed a greater willingness to pay than in leisure-oriented destinations (such as Valencia), after COVID-19 (in our case) it was the opposite. To dispel doubts, future studies should analyse the months following the second wave of COVID-19 in Spain, which led to new restrictions on movement between regions in September 2020.

7. Limitations, recommendations and future research

This study has demonstrated the heterogeneous results of the initial stage of COVID-19 impact on the destinations of Madrid and Valencia,

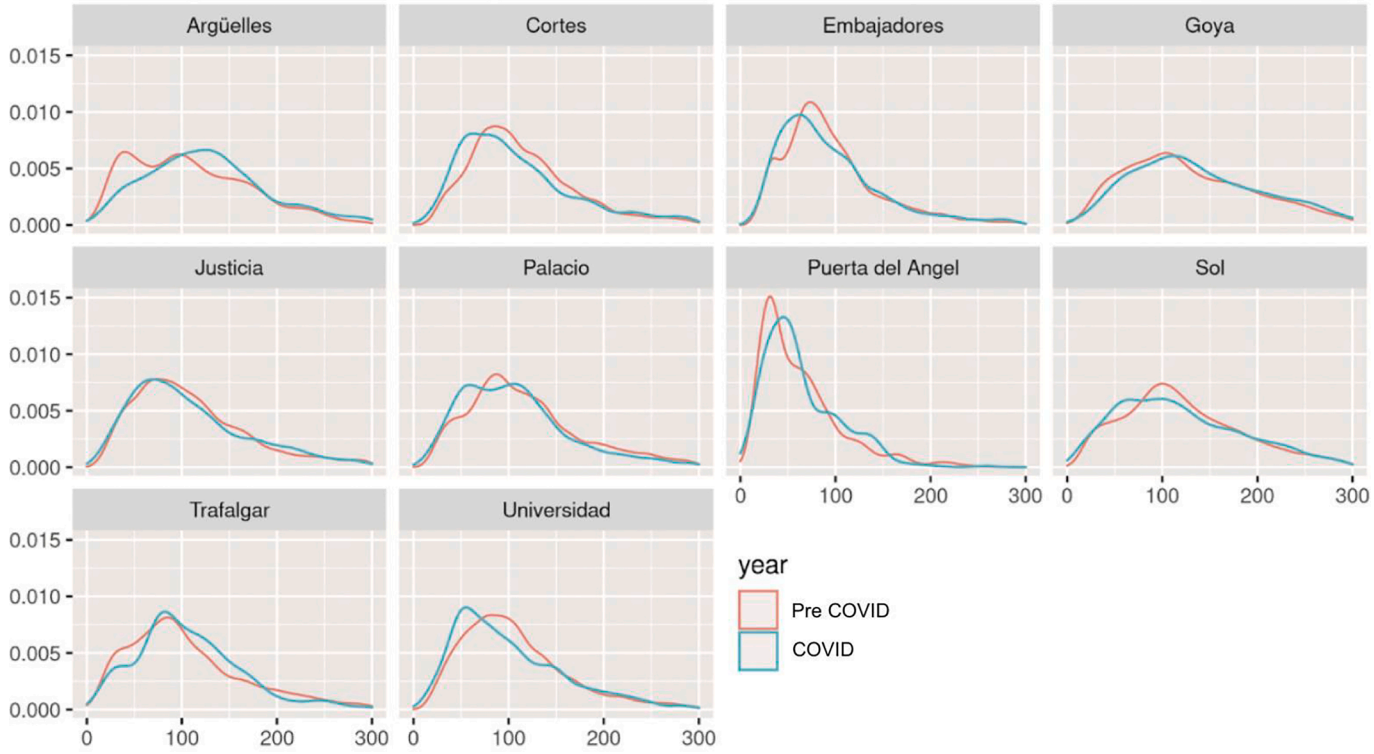

Fig. 11. Distribution of accommodation prices in Madrid (neighbourhoods).

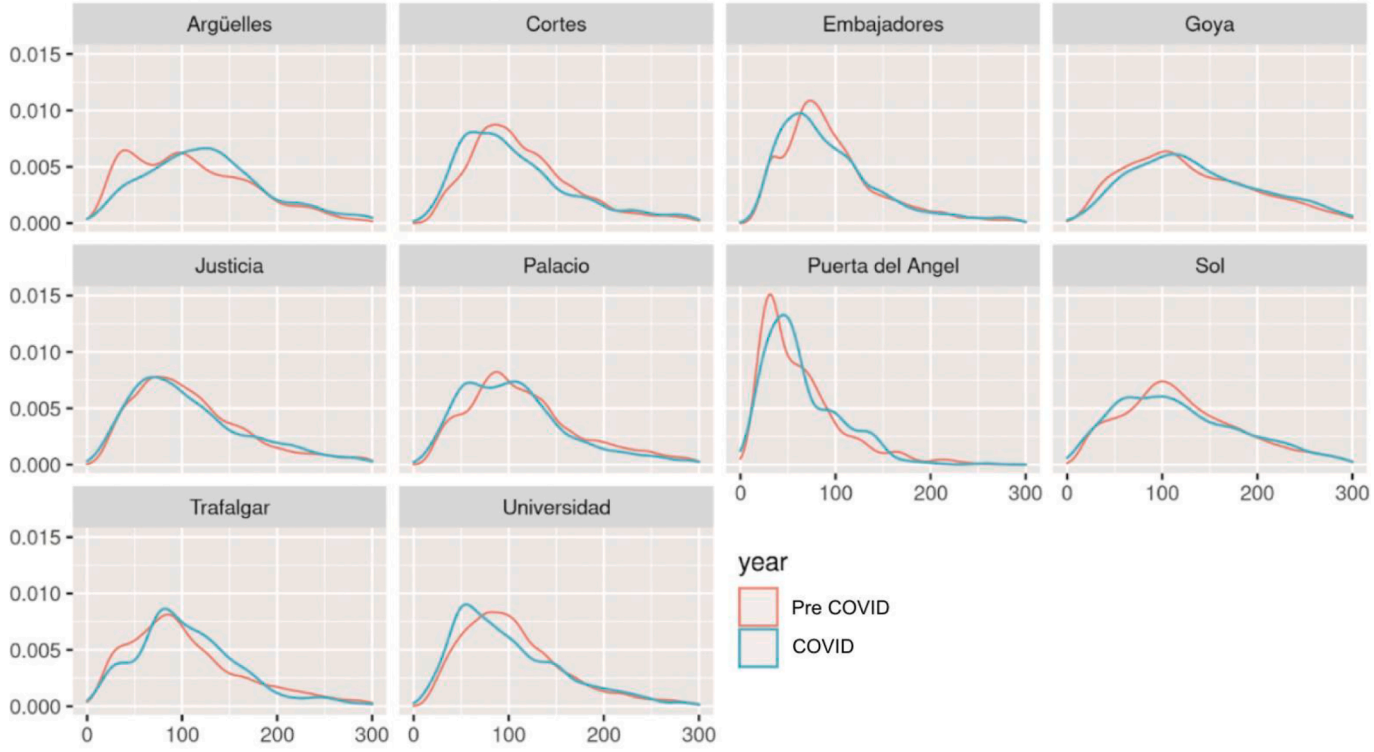

Fig. 12. Distribution of accommodation prices in Valencia (districts).

which represent two different types of tourism activity. Specifically, it has been found that in both destinations, occupancy rates were significantly reduced, while prices withstood the decline – even showing an overall increase in the case of Valencia compared to the pre-COVID situation. At the same time, notable differences were observed within the destinations themselves, measuring the effects of the pandemic on their neighbourhoods or districts.

These results are highly interesting from a theoretical perspective, as previously discussed. They demonstrate that the relationship between tourist supply and demand is quite inelastic in the Airbnb market.

Despite a significant decline in tourists, prices showed little movement. However, this pattern is not uniform across the entire city – and often not even within neighbourhoods/districts – and there may be a widening gap between affluent and disadvantaged neighbourhoods due to the decline in activity caused by COVID-19, as highlighted in previous literature.

However, in order to better understand the reasons behind these significant changes, this article should be complemented by future research that investigates the extent to which the short-term effects of COVID-19 have led to a shift in user preferences, and whether these changes are only temporary or still persist today. Future studies could benefit from employing spatial regression for causal inference and implementing additional measures to address the presence of outliers, thereby improving data quality and strengthening the analyses conducted. For example, it would be valuable to assess whether, as detected in other studies, the presence of green and open spaces has also become a determining factor in the selection of apartments by tourists in Madrid and Valencia. Additionally, exploring whether the policies implemented to tackle COVID-19 had a decisive impact would confirm that this is one of the reasons for the lower impact of the pandemic on tourism activity in Valencia compared to Madrid. Moreover, it is necessary to explore whether other economic and social variables, such as unemployment, inflation, or economic growth prospects, played a significant role, or whether other psychological factors, such as fear of contagion, had a greater influence on destination selection by the demand, as well as on the reaction of the supply (offering or not offering accommodation, and changing prices).

The database consulted in this article is insufficient to address all these questions, so it would be interesting to combine these results with the exploration of other tools used in previous works, such as Google Places (Martí and Serrano-Estrada, 2022), Foursquare (Martí et al., 2021; Bernabeu-Bautista et al., 2021) or Twitter (Huang et al., 2022), among other things, this could further contribute to understanding post-COVID supply and demand for short-term rentals.

Based in our results and previous literature, there are two recommendations for the administration of cities that could be inferred: First, the regulation of Airbnb needs to distinguish not only the type of tourism of the city but also the particularities of each neighbourhood (as suggested by Eugenio-Martin et al., 2019), and even the areas within them. Additionally, it should also consider the demands of tourists and ensure that accommodation meets minimum standards – not only in terms of housing conditions but also in relation to their surroundings. Given the reactions of tourists during the pandemic (observed partially in our research, but also in previous studies), tourism managers would do well to promote tourist accommodation in less densely populated areas of cities and provide open and green spaces in areas with higher tourist appeal. Second, there is a need to expand and diversify tourist areas in cities towards a more polycentric spatial structure (Maitland, 2013), avoiding their concentration in a single area. Before the pandemic, both cities experienced social movements that reacted against the situation of over tourism in certain areas (as discussed in Sequera and Nofre, 2018 or in Perles-Ribes et al., 2021). In our study, we observed that the cities of Madrid and Valencia continued to show a high concentration of Airbnb accommodation in specific areas of the city, even after the pandemic. It is even possible that these differences have intensified. However, we must acknowledge that this is the greatest challenge for destinations, as tourist attractions are nearly impossible to relocate. The challenge, according to our own assessment, lies in improving the living conditions of non-touristic areas and enhancing public transportation networks in the cities, reducing wealth gaps within the cities' neighbourhoods, and excessive concentration in tourism hotspots.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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