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The Impact of Airbnb on Rent Prices in Barcelona: An Econometric Approach

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Abstract

Understanding the Impact of Airbnb

In the last decade, Airbnb gained lots of popularity as it became both a really profitable solution for landlords and a cheap option for tourists in search of a place to stay during their vacation. Traditionally, property owners would earn from their property through long-term contract agreements with a lessee for a fixed fee, but Airbnb now allows them to potentially earn 2.5 times as much from the same property (AirDNA). At the same time, tourists have also benefited because they are not forced to stay in hotels, which often charge a premium for services that can be avoided by choosing Airbnb.

However, properties being dedicated to short-term rentals are the same ones that used to be offered for long-term rentals, which means that over the years there has been a consistent decline in the offer of long-term rentals parallel to the increase of 'Airbnbs'. The result is that while landlords and tourists have enjoyed great benefits from the rise of this giant platform, people living in more touristic cities have suffered by seeing the price of rent skyrocket. One city in particular that I will focus on by providing a quantitative analysis is Barcelona. According to data cited by the Mayor of Barcelona Collboni, the city has experienced a 68% increase in the price of rent over the last 10 years. In response to this problem, he announced on June 21st 2024 that he does not intend to renew any of the tourist lets which will all expire in 2028, meaning that by 2029 there will not be any apartment dedicated to short-term rental.

With this research paper I intend to perform a regression analysis to provide a quantitative description of how much the rise of Airbnb in Barcelona has impacted its rent prices. In particular, I will focus on the period going from 2014 to 2017 since those are the years for which I was able to gather data.

Introduction

Airbnb

With over five million hosts in 2023, Airbnb is ranked as the third most visited travel and tourism website worldwide, and it has been considered one of the biggest drivers of the growth of sharing and platform economy. Some of the main reasons why Airbnb has been increasingly preferred by users over traditional types of accommodation like hostels are lower costs, convenient locations, and the availability of household amenities. Meanwhile, hosts have been benefiting from Airbnb by seeing higher returns by converting long-term rental units to short-term rentals. Several key factors determine potential profitability, and AirDNA highlights Airbnb's success by showing how owners can earn up to 2.5 times more from short-term rental compared to long-term when comparing potential profitability in cities in the United States.

Sharing economy is defined as "the sharing of underutilised assets, monetised or not, in ways that improve efficiency, sustainability and community" (World Economic Forum). As explained in an article from the Guardian on Airbnb's growth, this definition is exactly what the founders of the platform had in mind when they first started the business. They imagined a way to bridge tourists who would have liked to save some money, with owners that had a spare bed and needed to cash in some extra money. Despite this idea of a peer-to-peer platform, Rodríguez-Pérez de Arenaza (2019) claims that in reality the majority of rentals on Airbnb listed in Barcelona are owned by a handful of real estate agent. This has become increasingly a problem in the Catalan city, as local residents have been responsible for the skyrocketing prices of real estate market.

Tourism in Barcelona

Since 1990 the city of Barcelona has seen an increase in tourist visits that has allowed it to become one of Europe's most visited cities with 7.78 million tourist stays in hotels in 2023 (Statista).



This trend has not solely been due to a global increase in travel, but it has largely been caused by Barcelona's intentional efforts starting from the 1980s to become a more attractive destination for tourism and foreign investment. In fact, in the 1980s approximately 150 projects aimed at creating or recovering public spaces were realized. These efforts were what allowed it to become the hosting city of the Olympics in 1992 and the Universal Forum of Cultures in 2004, both of which were a confirmation of its success in transforming itself into a city capable of attracting global interest. However, in his paper on tourism and commercial gentrification, research professor Cócola argues that "the state-led regeneration [of Barcelona] focused on public spaces, cultural infrastructures and the provision of opportunities from entertainment [...] was far from improving the quality of the housing". He supports this argument explaining how the new public spaces created did not provide facilities for the local community such as water, benches, or green spaces, while they were instead more aimed at attracting private investments and tourism. The result of this has been a process of tourism

gentrification which has forced out lower income communities out of the regenerated areas. The author Cócola then distinguishes between two consequences of this gentrification: residential displacement, the direct displacement caused by rental flats being reallocated for touristic purposes, and commercial displacement, the more indirect effect caused by the change in the nature of consumption facilities in the area; these include loss of services which low income residents rely on, privatisation of public space or affordability problems. These effects have contributed in causing tourism to become an overtourism problem, as local Catalan residents have increasingly been feeling alienated from their city. Along the housing crisis, residents have also been suffering problems of overcrowding which affected the quality of life in the most popular neighborhoods, like the Gothic quarter and Barceloneta, and have put a strain on public infrastructure as well. One of the most recent examples is the overcrowding of the bus line 116, a smaller neighborhood bus called 'Bus de Barri' which connects the city center to Parc Guell, the second most visited place in Barcelona. While it isn't unusual for such lines to experience overcrowding, what brought it to the to the attention of the news was that the overcrowing was so problematic for local residents that it forced the city to remove the bus line from Google Maps and Apple Maps. Despite some initial skepticism, the measure significantly reduced tourist overcrowding the bus. This example is just one of many of how much locals have been affected by overtourism, who have over time grown increasingly more dissatisfied towards the situation. This led in 2017 to a beginning of protests and hostility towards tourism, initially led by Arran, a radical left-wing organization



advocating for Catalan independence, who expressed their dissatisfaction through acts of vandalism such as the slashing of tires of rental bicycles and of a tour bus in Camp Nou. Another notable example is the phrase 'Tourist go home' which can be found as a graffiti in several parts of the city. More pacific protests were also

launched by the government itself in 2017 by placing bedding in strategic locations in the center with a sign saying "Just because this bed is available on the internet, doesn't mean it's legal", referring to the large number of illegally rented Airbnb apartments.

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Legislations and regulations

The bedding campaign launched in 2017 by the government was one of a series of actions taken by the government to combat the number of illegally listed Airbnbs, which had grown out of control. In fact, according to El Mundo as of June 2016, out of the total 19724 listings posted on Airbnb at that time, only 10477 of them were had a legal short term rental license, which makes 47% of them illegally posted. The reason why such a large percentage didn't have a license, was because many of them didn't legally comply with the requirement of renting out the entire apartment. This was the case of landlords who lived in the apartment while renting out on Airbnb an unused room, or landlords who rented out rooms of the same apartment to different people by creating multiple listings. While this was incredibly profitable for housing owners who could have maximized profits and efficiency, it further incentivized landlords to turn long-term rentals into short term rentals. As explained by El pais "part of the problem in dealing with unlicensed rentals is that there is no overarching national legislation: in 2013, the government devolved the decision to regional administrations, allowing property owners to take advantage of numerous loopholes and avoid applying for a license".

The 2016 Shock Plan was one of the first measures aimed at combating illegal listings. The plan implemented fines of up to 30,000 euros to owners of illegally listed properties which were shut down, and it was enforced through inspectors physically checking properties legal compliance. Even letters were sent to local residents to encourage whistleblowing. The rental platform company was instead fined with 600,000 euros, which was the highest allowed by Catalan tourism law. However, this measure proved to be only a temporary relief. As the data

I collected shows, there is a sharp dip in the number of Airbnb listings at the time the Shock Plan is implemented (time period 8 corresponding to the third quarter of 2016) which is significantly more noticeable for Eixample and Ciutat Vella.



But by the end of 2017 the number of Airbnb listings grows back close to the original level before the Shock Plan was implemented.

Stronger long-term legal measures were implemented shortly after in 2017 with the PEUAT, the Special Tourist Accommodation Plan. However, many legal challenges annulled several of its articles, and after going through review and reapproval it came back into force only on 26 January 2022. Currently, the PEUAT establishes zero growth for apartments for tourist use, meaning that new licenses can only be issued through redistribution of apartments that cease their activity.

Despite the implementation of clear legal frameworks through the PEUAT, Barcelona continues to struggle with challenges of overtourism and housing affordability. During the summer of 2024 protests have continued in the Catalan capital; in July 3000 locals marched through the streets shouting "tourists go home" and spraying them with water. In response to this unending battle, in June of 2024 Barcelona Mayor Jaume Collboni announced the radical decision that he does not intend to renew any of the 10,101 tourist rental licenses which will expire in 2028. Although parties from the political opposition argue that this will only shift apartments to be illegaly listed, this change will implicitly cause Airbnb to be unlawful, making enforcement of legal compliance way easier since any short-term rental posted on Airbnb after 2028 must be illegal, eliminating the need to track legal compliance. This move seems to be strongest decision yet in Barcelona's longstanding attempt to ease overtourism pressure and housing affordability.

Research approach

The goal of this paper is to understand quantitatively the extent to which Airbnb impacts the average rent price in Barcelona. To do so, I'm using a time-entity fixed effects approach on panel data for 10 districts in Barcelona, and 11 time periods from 2014 to 2017. Therefore, the variables for which I gathered data vary between districts and over time. Furthermore, the goal with the variables I'm using is to isolate the effect on rent price of an additional Airbnb listings from the effect of external factors. An example in particular, is the variable 'Household income', which is used in my attempt to isolate the effect of the gentrification process that I explored in my introduction.

As previously discussed in the introductory literature, we would expect the results of the regressions to show Airbnb to have a positive effect on average rent price. The conversion of housing from long-term rental to housing destined for tourism decreases supply for residents, putting upward pressure on rent prices.

Presenting the Data

First of all, I will start by introducing the data I gathered for the two most important variables of this thesis which are the rent price, the dependent variable, and the number of airbnb listings, the independent variable. Then, I will follow by presenting data that I collected for control variables. Moreover, for each data collected I will also try to explain some assumptions and limitations that affect the interpretation of the final results.

Data table

The data I gathered consists of 11 time periods spread unevenly across the years from 2014 to 2017 for 10 different districts in Barcelona. Therefore, I am studying panel data consisting of 110 observations for which I have the average rent price and the number of Airbnb listings published on the platform along with other control variables. Observation *i*-*t* consists of the number of Airbnb listings in district *i* at time *t*, and the average rent price in district *i* at time *t*. This is also a balanced panel as the variables for each entity i and each time period t are observed. A sample table with some of the data I used is provided below to better understand how the data has been organized:

District	Entity	Time period	Listings	Rent Price	Population
Ciutat Vella	1	1	3123	612.3	100685
			•••	•••	
Ciutat Vella	1	11	3922	848.1	101387
Eixample	2	1	3122	764.2	263565
	•••	•••	•••	•••	•••
Sarria Sant					
Gervasi	10	11	774	1291.9	149279

Rent price - *Quarterly variation*

Data for the rent price has been collected from the website of the *Ajuntament de Barcelona*, the administrative city hall of Barcelona which has a statistical department. More precisely, rent price refers to the average rent price for 10 different districts of Barcelona (Ciutat Vella, Eixample, Sants-Montjuïc, Les Corts, Sarrià-Sant Gervasi, Gràcia, Horta-Guinardó, Nou Barris, Sant Andreu, Sant Martí), it is based on the contracts deposited, and it is observed for 4 quarters each year. The data I have used belongs to 11 quarters from 2014 to 2017. Even though there are 48 quarters from 2014 to 2017, only 11 were used because the data for the number of Airbnb listings with which it was matched was recorded irregularly over the years. Furthermore, it isn't specified when the average rent price was observed. So it isn't possible to know if it was observed at the beginning, middle, or end of a quarter, or if it could represent an average of the period. So to more easily integrate this data with other variables that I am studying, I have assumed that it was observed at the end of a quarter.

Airbnb presence (listings) - Quarterly variation

The variable that I am using to represent the presence of Airbnb is the total number of Airbnb listings in a time period. Data for this was recorded from Tom Slee, an independent author who has collected data from Airbnb's database and made it publicly available on his blog (footnote explaining where and when this was collected from). The raw data consists of full lists of Airbnb listings, and for each listing there are corresponding details of the housing such as the district to which it belongs. Airbnb automatically assigns a district when the user inserts the housing address, so there is no risk of having districts being inaccurately represented due

to users providing that information based on 'feeling'. This is also particularly convenient because Airbnb obtains these territorial informations from local cartographers and experts, meaning that not only do Airbnb and Barcelona's administration use the same classifications for districts, but also that they most likely refer to the same geographical boundaries when referring to a district like Ciutat Vella. From this raw data, I then extracted the total number of Airbnb listings in each district.

As I previously mentioned, the author didn't collect the data at regular intervals which is why it's unevenly spread out over time. For example, for 2014 I have observations for quarters 2, 3, and 4, while for 2015 I have observations for only quarters 1 and 3. Moreover, the author didn't precisely collect data at the end of each quarter, so I had to select among the datasets available those that were closest to an end of a quarter. For example, the data that I used to represent 2014 Q4 (which should be on January 1st, 2015) was collected on January 15th, 2015. As mentioned before, I'm interested in data collected as close as possible to an end of a quarter because that's when I'm assuming rent price to have been observed.

Another important remark to consider about the intepretation of this data is that a single listing doesn't exactly correspond to a residential apartment for two reasons. The first one is that many hostels have started to use Airbnb to reach their customers. This is a problem for our study because we are interested in 'Airbnbs' as they are theoretically apartments subtracted from the offer of long-term rentals. However, most hostels were never originally destined for long-term rental to begin with, so we would never expect a new hostel room listing to have a direct effect on rent prices.

The second one is that hosts can publish a listing not only for an entire apartment, but also for individual rooms of the same apartment. This functionality exists because the platform shows customers only options available during the desired period of the stay. So by separating rooms of the same apartment, a customer can book a single room of the apartment without causing the entire apartment to be shown as unavailable. An example of this is represented in the image below:

2 rooms in Barcelona







 Room in Gràcia
 ★ 4

 Stay with Flor · Aesthetic
 Cozy room,Park Güell

 Apr. 1 – 6
 € 73 night · € 363 total



The same host 'Flor' has created two listings for two separate rooms of what we understand to be, from the identical living room furniture, the same apartment. Therefore, because of these two reasons, we wouldn't be able to intepret the effect of one more Airbnb listing directly as one less apartment available for long-term rent, but more as a generic reduction in offer.

Population – *Yearly variation*

Data for population was also obtained from Barcelona's city hall. Just like other data, the administration collects population numbers at a district level, though this is only done yearly and not quarterly. Therefore, I have made the asumption that population is constant throughout the year. This assumption was further kept with all other data that only had yearly variation.

Household income – Yearly variation

Data for household income (RDF – Renda disponible familiar) was obtained from annual reports prepared by the City Council which takes interest in studying how the distribution of income changes over time within districts. The RDF index isn't a direct measurement of household income, but it is an estimate calculated using the general average wage in Barcelona weighted for each district in Barcelona. The weight for each district is obtained using the following weighted variables: academic qualifications, labor market conditions, vehicle ownership and quality, and housing market trends (rent price and real estate price). Since gentrification is a process of socioeconomic transformation, RDF is a good representation of that as we would expect more gentrified areas to experience higher increases in household income over time. Furthermore RDF is an even stronger variable than a raw household income measure alone, because it better measures the change in socioeconomic class through factors such as academic qualifications and labor market conditions.

Construction of new homes – *Quarterly variation*

This data is provided from the City hall's website, and it comes from the final work certificates of the Associations of Installers, Technical Architects and Building Engineers of Catalonia. The data indicates the finalization, and not the beginning, of constructions.

Data visualization



The graph above plots 10 data points, one for each district in Barcelona observed in the data. The x-axis corresponds to the change in the number of listings from the first to the last period observed in the data. Similarly, the y-axis represents the change in the average price over the same period. Representing the data with this scatterplot makes it easier to distinguish graphically the effect of Airbnb for each neighborhoods.

It can be observed, in particular from the data points clustered in the lower left zone, that the relationship between Airbnb and rent price does seem to show a positive upward trend. Two data points that stand out as outliers are the ones of Gràcia and Sarrià-Sant Gervasi. The district of Gràcia experiences the highest increase in Airbnb listings (3169), yet the change in average rent price is lower than hypothesized, aligning with districts that saw much lower increases in Airbnb listings. One possible factor that could explain this is the fact that Gràcia

is also the district with the highest population number, which could cause the effect of an additional listing to be lesser than the effect in a district with lower population. This effect will be described in more detail in the following section on 'regression analysis', in which I explain how an interaction term between population and listings attempts to capture this effect. The outlier for Sarrià-Sant Gervasi instead, experiences the highest change in average rent price (335) while also experiencing a low increase in Airbnb listings (309). To understand why this might be the case, it could be taken into account that Sarrià-Sant Gervasi is a mainly residential, high-income neighborhood, located further apart from some of the main touristic attraction. Therefore, the price increase in rent could have been driven by the gentrification process of wealthier residents moving in to avoid the overtourism that other districts have been experiencing. This could instead support the idea of factors affecting the housing market that go beyond the direct effect of Airbnb.

Regression Analysis

Time-entity fixed effects model

Studying panel data offers the advantage of being able to control for unobserved variables that would otherwise be very hard to account for.

This can be done by controlling for entity effects first which allows us to capture unobservable omitted variable bias across different entities. In this case, different districts have unobserved characteristics which do not vary over time and innately affect the rent price independently of the presence of Airbnb. For example Les Corts is one of the most expensive districts for being the financial center of the city, compared to the much cheaper Nou Barris located in the outskirts of the city. A fixed-entity effects allows us to capture these characteristics and separate them from the effect of Airbnb's presence to get an unbiased estimator.

Another possibility is that there are also unobserved variables that change over time, but that are the same across districts. An example of this would be macroeconomic factors like inflation that affect all districts, or seasonal tourism trends of peaks during summer and spring. Just like the entity fixed effects, the time fixed effects allows us to control for these variables.

By combining both approaches, the general regression model becomes:

$Price_{it} = \alpha_i + \lambda_t + \beta_1 \ listings_{it} + u_{it}$

• Price:

This is the dependent variable being studied, representing the average rent price in district i at time t.

• listings

The independent variable used to represent the presence of airbnb, which resepresents the number of airbnb listings in district i at time t. The coefficient β_1 is the generic effect of listings for all entities.

α_i

This is the entity fixed effect which is an intercept representing the time-invariant effect of being in district i.

• λ_t

This is the intercept which captures changes over time that are the same across districts.

	(1)	(2)	(3)	(4)
	price	price	price	price
listings	0.0159*	0.000679	0.0336	0.00008
	(2.41)	(0.10)	(1.53)	(0.01)
population		0.0180***	0.0211***	0.0180***
		(3.81)	(4.15)	(3.85)
hincome		0.0175**	0.0178***	0.0187^{***}
		(3.33)	(3.41)	(3.55)
poplist			-0.0132	
			(-1.57)	
newhomes				-0.0857
				(-1.60)
Entity (District) Fixed Effects	Yes	Yes	Yes	Yes
Time (Quarter) Fixed Effects	Yes	Yes	Yes	Yes
cons	651.7***	-2545.7**	-3061.7***	-2571.5***
	(66.12)	(-3.39)	(-3.76)	(-3.45)
N	110	110	110	110
R^2				
Within	0.9277	0.9453	0.9468	0.9469
Between	0.0189	0.0008	0.0001	0.0014
Berneen		0 0 0 0 0 0	0.0010	0 00 10

Linear regressions

A first time-entity fixed effects regression (1) was carried by using just price and listings, the dependent and the independent variable. From the results, the two variables seem to be correlated with the number of airbnb listings having a positive effect on rent price, which is what I initially hypothesized. The coefficient of 0.0159 indicates the average rent price increase in euros caused by an additional airbnb listing in a district. This would mean that an increase in 3000 airbnb listings, has caused on average rent prices to increase by 45 euros over the observed period of 4 years.

However, this was just a simplistic exploratory model without any control variables. The inclusion of them is important because they help avoid omitted variable bias, which can cause the effect of airbnb listings to be overestimated or underestimated if there are other factors correlated with the number of airbnb listings that also affect rent prices.

In regression (2) the variables that were added to address potential omitted variable bias were population and household income (hincome). The first thing that can be seen is that with the addition of these two variables, the effect of airbnb listings almost becomes null, and in fact its t-statistic is 0.10 which is statistically not significant. This is probably happening because most of the effect of listings has now been captured by the two newly-added control variables. Population has a nuanced interpretation, as it represents the capacity or the saturation of a district. Over the short time frame of 4 years the supply of housing is relatively inelastic, and for a given number of housing supply, population increases can only be due to a reallocation of existing housing rather than an expansion of supply. This would then cause districts to get closer to their maximum capacity, which puts higher pressure on the prices of rent. For this reason, we would expect population to have a positive effect on rent prices, which is what we observe in all three of the regressions in which the variable is included (2), (3), and (4). For (2) population is statistically significant at the 5% significance level, and its coefficient of 0.0180 shows the increase in price by a unit change in population. The district of Eixample has seen an increase in population from 2014 to 2017 of around 3000 (from 263,565 to 266,416), and the regression results indicate that this population increase has contributed to an increase of 54 euros in the average price of rent in that district during that time period. Household income, as previously mentioned, is an estimated measure based on five weighted variables. The inclusion of this variable was done in an attempt to understand whether the increase in average rent price was actually driven by districts attracting wealthier families whose higher purchasing power would drive up prices. This could happen, for example, if a district experiences a gentrification process which makes the district more attractive to live in.

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Similarly to population, it has an estimated coefficient of 0.0175. The increase in household income that most neighborhoods have experienced are of around 3000 euros from 2014 to 2017. According to the results, this had an effect of increasing average rent price by 53 euros. However, the problem with this variable is a potential of reverse causality. While wealthier families can cause rent prices to increase, higher rents caused by the Airbnb effect can force lower-income groups out of the districts which results in districts being inhabited by wealthier families, not because of a gentrification process, but because they would be the only group to afford living there. This entangled effect causes endogeneity in the model, which makes it harder to understand if it truly is household income to cause average rent prices to increase. Therefore, despite the variable being statistically significant with a t-value of 3.41, it remains difficult to conclude whether it actually causes the positive effect that the coefficient indicates.

In regression (3) I ran the same regression as (2) with the addition of the variable poplist, an interaction term between airbnb listings and population. The reasoning behind this interaction is that since population is directly related to the number of houses, an increase in listings will have a much greater impact in districts where the supply of housing is already limited. Therefore, we should expect the marginal effect of listings to be higher in districts with lower population. It can be verified if this is the case in the regression results by differentiating the regression (3) with respect to listings:

$$Price_{it} = \alpha_i + \lambda_t + \beta_1 \ listings_{it} + \beta_2 \ population_{it} + \beta_3 \ hincome_{it} + \beta_4 \ pop*list_{it} + u_{it}$$
$$\frac{d(Price)}{d(Listings)} = 0.0336 - 0.0132 \ \frac{Population}{100,000}$$

(When creating the interaction term, population was scaled by a factor of 10^{-5} to get a more readable coefficient) Something that can be immediately noticed is how with the addition of the interaction term, the coefficient for listings increased from 0.0159 to 0.0336 to accommodate for the added negative effect.

By looking at a district like Les Corts where the initial population in 2014 was 81,200 the impact of one more Airbnb listing is equal to 0.023 euros.

$$\frac{d(Price)}{d(Listings)} = 0.0336 - 0.0132 \frac{81,200}{100,000} = 0.023$$

Meanwhile a district like Eixample where the population in 2014 was 263,565 the impact of one more Airbnb listing has a lesser impact with a change in -0.001 euros.

$$\frac{d(Price)}{d(Listings)} = 0.0336 - 0.0132 \frac{263,565}{100,000} = -0.001$$

Although the intended effect hypothesized of observing a lower imapct in districts with higher populations was obtained, the overall effect of listings becomes so low to the point that it becomes negative. This is contrary to what we expected to observe, and it could be attributed to the effect not being statistically significant enough (t value of -1.57).

In regression (4) I introduced the variable new houses, which represents the construction of new houses. Construction of new homes would have the effect of increasing the supply of housing, which is why we would expect them to have a negative effect on the average rent price. Its coefficient is indeed negative (-0.0857), but it is not statistically significant. One of the concerns when adding this variable was collinearity with population, since construction of new homes is strongly tied to population increases; yet, the addition of this variable didn't affect the cofficient of population. This could indicate that the model is able to distinguish their effects apart, and that collinearity is most likely not what's causing insignificant results. Another possible explanation for the insignificance of this variable can be due to the fact that the data collected for it is inconsistent. During some time periods there seem to be spikes in the costruction of new housing, while several other periods often just have no activity. Additionally, the short time frame of four years might not fully reflect the lagged effect of housing construction, as newly constructed home don't necessarily get allocated right away, and even if they did, it would take time for them to influence rental market prices.

To conclude, the analysis of these regressions suggest that regression (3) seems to be the best fitting one among the ones tested. When running regression (2) the explanatory variables are significant, but they capture so much of Airbnb listings' effect to the point that it becomes close to 0 and statistically insignificant. The third regression addresses this issue, as the addition of the interaction term between population and listings increases back the statistical significance of listings while not taking away the effect of the other two previously added variables of population and household income. In contrast, regression (4), which replaces the interaction term with a variable for new housing construction, causes the effect of Airbnb

listings to drop back to near zero, highlighting the importance of including the interaction between population and listings.

Although the effect of Airbnb listings is not statistically significant at the 95% level, with a tvalue of only 1.53, the regression is still supported at a theoretical level. The first one is that both the positive effect of airbnb listings and the negative effect of the interaction term make sense and are what we expected to observe. And the second one is the increase in listings' coefficient from 0.0159 in regression (1) to 0.0336 in (3), which shows how the regression is indeed capturing the more nuanced effect of how population and listings interact. Therefore, the results not being statistically significant enough might not necessarily imply a lack of correlation, but rather limitations with the sample size or a problem with model fitting. One possibility could be that the relationship between Airbnb listings and rent prices is not linear, which is why for the following section I ran additional regressions using combinations of price and listings expressed logarithmically.

	(1)	(2) Logprice	(3) price	(4)	(5)	(6) logprice
listings	0.0000197* (2.13)	0.0000187* (2.02)	price	price	logphee	logphee
loglistings			-161.9** (-3.39)	-162.4*** (-3.42)	-0.0515* (-2.45)	-0.0459* (-2.22)
population	0.00000520* (2.42)	0.00000505* (2.36)	0.0215*** (4.63)	0.0212*** (4.74)	0.00000462* (2.26)	0.00000444* (2.17)
poplist	-0.00000535 (-1.51)	-0.00000549 (-1.55)	-0.000542 (-0.22)		0.00000196 (1.85)	0.00000131 (1.38)
hincome	-0.00000238 (-1.08)		0.0152** (3.02)	0.0147** (3.30)	-0.00000297 (-1.34)	
Entity (District) Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time (Quarter) Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
cons	2.019*** (5.86)	1.998*** (5.81)	-2619.0*** (-3.58)	-2569.3*** (-3.71)	2.271*** (7.05)	2.229*** (6.92)
N	110	110	110	110	110	110
R ² Within Between Overall	- 0.9690 0.0219 0.0052	0.9686 0.0081 0.0003	0.9518 0.0005 0.0001	0.9518 0.0006 0.0000	0.9695 0.0391 0.0116	0.9688 0.0131 0.0009

Logarithmic regressions

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

In this section I applied logarithmic transformations to the dependent and independent variables to test whether a proportional relationship could better fit the model between Airbnb listings and rent prices. The models I tested include semi-log in (1), where rent price was expressed in logarithmic form, and (3), where listings was expressed in logarithmic form, and a log-log regression in (5), where both variables were transformed. For each model I decided to use the variables that previously showed the most statistical significance, which were population, household income, and interaction term poplist. Each model was then run a second time by dropping the explanatory variable that didn't show statistical significance.

In regression (1) I tested the relationship between the logarithm of price with Airbnb listings. This log-linear model links a unit change in listings to a percentage change in price. The results of this model are now statistically significant for listings with a t-statistic of 2.13. Its coefficient of 0.0000197 (multiplied by 100) shows the percentage change in price by a unit increase in Airbnb listings. Therefore, an increase in 1000 listings would cause price to increase by:

% dPrice = 0.0000197 * 100 * 1000 = 1.97%

If we were to consider Eixample which experienced an increase in around 3000 listings, and had an initial average rent price of 764 euros, the effect on average rent price of Airbnb listings is equal to:

$$dPrice = (0.0197 * 3 * 764) = 45$$
 euros

This change in 45 euros remains an approximation though, since the district didn't experience the increase in 3000 listings at a static price of 764 euros, but listings have increased while price has increased. Therefore, the absolute change in price would actually be a bit higher than 45 euros since the percentage change would be applied to higher price levels. However, this approximation is still enough to show the magnitude of the effect of Airbnb listings is relevant.

Regression (2) is identical to regression (1), but the variable of household income which had the lowest t-value was excluded to see if the accuracy of the results would improve. Not much changed, since dropping the variable only caused the statistical significance of listings (from 2.13 to 2.03) and its coefficient (from 0.0000197 to 0.0000187) to drop slightly.

The other two logarithmic models were done using price vs. log(listings) and, log(price) vs. log(listings). While both models had statistically significant results, t-values of -3.39 and

-2.45 respectively, their coefficients are negative. This would mean that the number of Airbnb presence has a negative impact on rent price, which is contrary to the theoretical support and to the hypothesis. Given that all the other models tested showed positive results, it might be more plausible that the models weren't able to capture the true effect of airbnb listings. A possible explanation could be that logarithmic models might not be the most suited for our data. The data for average rent price we are studying is all consistently distributed in the 600-1000 euros range, while logarithmic distrbutions could be more suitable for data that has larger-scale variations.

Therefore, the inaccuracy of the results of these last two regressions (3) and (5) would naturally also make us question the validity of the results of regression (1), which despite producing results that were coherent with what we expected, it also made use of a logarithmic transformation.

Conclusion

Results Discussion

Even though Airbnb does have a positive effect on rent prices from the results of the linear regressions, none of the models have a statistically significant effect for Airbnb at the 95% confidence level, with the highest t-statistics being 1.53. From the logarithmic regressions we do get statistically significant results from all regressions, but the models have cotradicting results. When the independent variable of Airbnb listings is linear, its efffect positive. However, when listings are transformed logarithmically their effect becomes negative. This inconcistency could make us question whether a logarithmic model is appropriate to describe the relationship between Airbnb listings and rent prices, and if a linear model would better fit their relationship. The issues encountered with linear models might therefore be tied more to limitations with methodology and data.

Study Limitations

One of the key challenges of this study can be pointed out to limits with data, in paticular with regards to consistency and availability, which could have been one of the main factors affecting the strength and reliability of the results.

The first problem around consistency is how while data for rent price and Airbnb listings was available on a quarterly basis, data for other variables like population and household income was available only on a yearly basis. This situation, which forced variables that only had yearly variation to be treated as constant across quarters within the same year, limited variation within the data, causing results to be less precise.

Something else that limited consistency was the uneven distribution of when data for Airbnb listings was recorded. For example, while data from 2014 was recorded during quarters 2, 3 and 4, data from 2015 was recorded during quarters 1 and 3. This can be a problem for this type of study because of the cyclical nature of tourism for which we would expect peaks in visits during the summer season, and as a consequence a higher presence (or a higher growth rate) of Airbnb. While time fixed effects do absorb seasonality, uneven distribution can still cause problems. Thus, having peak touristic time periods being over or underrepresented can cause bias in the estimator for Airbnb listings'. This would happen because since long-term rental prices don't generally see as much seasonal fluctuation, if touristic seasons are overrepresented, then Arbnb listings appear consistently high while rent prices remain relatively stable. This would weaken the correlation between Airbnb listings and rent prices, and would cause an underestimation of the Airbnb listings estimator.

Lastly, a really important limitation within the data has to do with sample size. Although for some models 110 observations can be a good number, when using a time and entity fixed effects model, the regression is estimating 10 dummies for districts and 11 time dummies which essentially absorb a lot of the variation within the data. This leaves much less variation to estimate the effect of Airbnb listings. Although data for the average rent price in different districts in Barcelona was available for

Another important issue that wasn't addressed in this study was potential reverse causality. Just as Airbnb listings could be causing higher rent prices, the reverse could also be true. If long-term rent prices are positively correlated to short-term rental returns, then an increase in long-term rent prices will incentivize more housing units to be converted to 'Airbnbs', driving up the number of Airbnb listings. A way to address this issue could have been through the use of an instrumental variable. This would have been a variable that could have caused an external change in Airbnb listings, unrelated to rent prices, to better isolate Airbnb's effect on rent prices. An example of such an external change is the 2016 Shock plan which caused a significant dip in the number of Airbnb listings. However, the implementation of that policy as an instrumental variable was not possible in this study because all of the variation caused by the policy already absorbed from the fixed-effects time dummy since it was uniform across all districts. A better instrument could have been more quantifiable and varying across district. For example, this could have been a tax on short-term rentals which was higher for more touristic locations, or for districts that suffered higher pressure from the presence of Airbnb.

Concluding Remarks

This paper aimed to study the relationship between Airbnb listings and rent prices in Barcelona. While the results of the linear regression and of the linear-log model were in line with our hypothesis, the lack of statistical significance and the limitations uncovered in the discussion prevent us from being able to draw a definite conclusion. Access to better data, and to a larger sample size might have allowed us to obtain more accurate results. Nevertheless, external literature widely recognizes and supports that Airbnb does indeed have an effect on the housing market. For example, a research paper from Barron finds evidence

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Conclusion

that in the United States a 1% increase in Airbnb listings leads to a 0.018% increase in rents and a 0.026% increase in house prices. Furthermore, they also find that the total supply of housing is not affected by the entry of Airbnb, supporting that an increase in short-term rental units decreases the supply of long-term rental units.

Another study published in June 2024 (Zhe Jin), highlights, however, that Chicago was successful in regulating Airbnb, showing that in two years after the ordinance of short-term regulations the city saw a decline in active listings of 16.4%. One of the main differences that allowed the city to succeed in regulating short-term rentals compared to Barcelona, was Chicago's stricter approach at enforcing compliance with regulations by having Airbnb's platform itself remove listings that didn't comply. This was different from Barcelona's PEUAT plan which required local and physical enforcement of the regulations. As a result, the Catalan capital now seems to be resorting to the most radical approach of completely banning all short-term rental licences by 2028 in an attempt to regain control over its housing market.

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