Do short-term rent platforms affect rents? Evidence from Airbnb in Barcelona

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Abstract

Peer-to-peer platforms such as airbnb have recently entered the market thanks to the development of new technologies and their influence on traditional markets remains still understudied. Similarly, the multiplicity of local regulations adopted by big touristic cities in developed countries shows a lack of consensus both on the consequences and on the role of regulation. However, the actual impact of airbnb's market entry on rents remains still unknown. I assess the causal impact of the beginning of airbnb's economic activity on housing rents for the city of Barcelona using a Bartik-like instrumental strategy. Results suggest that airbnb is responsible for a 4% increase in rents.

Keywords: Housing rents, short term rentals, airbnb

JEL Classification: R10, R20, R31, Z30

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1 Introduction

The growth of contemporary urban tourism and its controversial impact on the development of cities has recently gain increasing attention, especially in media. Peer-to-peer platforms such as airbnb have recently entered the market thanks to the development of new technologies and their influence on traditional markets remains still understudied. Tourism in Barcelona has increased drastically in the recent years[1], airbnb being one of its contributors. In fact, Barcelona is currently the fifth most popular airbnb destination in the world. Concerns for the negative consequences of airbnb on the housing market together with the pressure exerted by the tourism boom have driven Barcelona's City Hall to strongly react against airbnb. However, the actual impact of airbnb's entry in the home-sharing market is still unknown.

In this paper, I assess the causal impact of airbnb entering the market on housing rents for the city of Barcelona. The main contribution of this research is the use of a Bartik-like instrumental strategy to deal with the endogeneity of airbnb placement. This is, to the best of my knowledge, the first essay to assess the impact of airbnb on rents for the city of Barcelona.

Concerns about the potential impact of airbnb affect both the tourist industry and cities' housing markets. Indeed, airbnb is thought to have contributed to the overlap of these traditionally independent markets by allowing owners of properties with residential purposes to enter into the hospitality sector (Lee, 2016). Hence, both hotel lobbies, who see airbnb as an unfair competitor, and local communities, who fear an increase in rents in their neighbourhoods have pressured mayors to regulate home-sharing platforms.

The multiplicity of local regulations adopted by big touristic cities in developed countries shows a lack of consensus both on the consequences and on the role of regulation. Different sets of measures have been adopted such as requiring a specific permit (Barcelona, Berlin, Paris, San Francisco), limiting the rental period (Amsterdam, New York, Paris, San Francisco), paying the rental tax (Amsterdam, San Francisco) or illegalising short term rents on some conditions (Berlin and New York).

In the case of Barcelona, legal action has been specially though. In particular, the City Hall imposed two fines to airbnb and hence became the first and so far the only city to ever fine the company. At the same time, a special protocol has been deployed in order to identify illegal tourist apartments and fill the information to tax authorities.

Public debate about the existence of home-sharing platforms is divided. Proponents (and airbnb founders) argue that the possibility of renting their own dwelling can help residents get an extra source of income while enabling tourists to 'live like locals'. That being true it could result in an increase of tourism, both in the extensive and intensive margin, a boost in its diversification as well as encourage neighbourhood revitalisation. From an economic point of view, home-sharing platforms can be seen as an efficiency improvement in markets where goods are not fully used (Barron et al., 2017). One could argue that having an empty apartment during a holiday period is an efficiency loss that can be solved by short-term rentals through a platform that matches offer and supply in a trustful way.

However, opponents argue that the use of residential units for touristic purposes can potentially entail negative consequences. First of all, it can have inflationary effects on

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[1]In 2015 it was the 3rd most visited city in Europe and the 20th in the world, receiving up to 8.3 million people, more than 5 times its population

rents and prices due to both a supply side effect and a demand side effect. On the supply side, if home-sharing platforms lead to owners permanently shifting from long term rentals to short term rentals and given that the supply of housing is fixed in the short term, it could lead to a contraction of the supply and hence an increase rents. On the demand side, if renters anticipate the possibility of renting their apartments (either rent full time an extra room or sporadically the entire unit) they might be willing to accept higher rents and therefore demand can as well pressure prices up.

Similarly, the presence of a short-term rental unit in a residential building can cause annoyances to the neighbours such as noise, feeling of insecurity in seeing unfamiliar faces, misuse of communal spaces or the weakening of social norms.

Lastly, the hotel industry opposes home-sharing platforms as they are viewed as a threat to fair competition. Indeed, while traditional markets are often subject to some entry and licensing restrictions, peer-to-peer markets manage to bypass these regulations. In the case of short-term rent, traditional tourist apartments need a licence to operate while airbnb hosts rent their rooms and apartments without any specific authorization nor complying with any health or accessibility requirements to which touristic facilities are subject to.

Even if airbnb is still a very recent phenomenon, there are already some research papers that try to discuss the consequences of airbnb. First, there is the paper by Zervas et al. (2014) that assesses the impact of airbnb on the hotel industry. They use a difference-in-difference fixed effects strategy to identify causal effect of airbnb's entry into the market on hotel revenues. The authors deal with the endogeneity by assuming that unobserved factors that could affect both airbnb adoption and hotel room revenue do not systematically vary both between cities and over time. They find that an additional 10% increase of the size of airbnb results in a 0.38% decrease in hotel revenue, which is significant if we take into account the exponential increase that experienced airbnb.

Second, there are two papers that try to identify the impact of airbnb's market entry on rents and prices. Sheppard et al. (2016) look at the impact of airbnb on house prices in the city of New York. They develop a theoretical model to identify the mechanisms through which airbnb increases house prices. In order to deal with endogeneity of airbnb placement, they first apply a traditional hedonic approach and then a difference-in-difference strategy with year first effects. Their strategy is similar to the one used by Zervas et al. (2014) except that they do not include census track fixed effects in their difference-in-difference strategy. Their results suggest that properties that are subject to airbnb treatment experienced an increase in prices of 31%.

Barron et al. (2017) look at the impact of airbnb on rents and house prices for all cities in the US. They use Google trends of the search of 'airbnb' as an instrument to identify the causal effect. Since their instrument is time variant but does not vary at the geographic level, they combine it with a measure of touristiness to have an instrument that varies across space. They find that a 10% increase in airbnb listings increases rents by 0.38%.

The extend to which a city's housing market is affected by airbnb's market entry depends on two factors: density of airbnb listings and profitability. Table 1 compares the airbnb density for the cities of Barcelona, New York and Madrid. It can be seen that the density of airbnb is higher in Barcelona than in the other two cities, whether it is in terms of total dwellings, of total rental contracts or of total new contracts. Even if we focus only on

entire apartments (as opposed to shared apartments) the density is still quite significant. This suggests that airbnb is more likely to have had an effect in Barcelona than in the other two cities.

Table 1: Comparison of airbnb densities

	Barcelona		New York		Madrid	
2015	Total	Entire home	Total	Entire home	Total	Entire home
Total buildings	823,709		3,422,225		1,457,819	
Rented Dwellings	247,942		2,122,185		338,214	
New Rent Contracts	40,623		352,996		55,413	
Airbnb Listings	14,539	7,816	41,187	20,594	7,808	4,543
as % of total dwellings	**1.77**	0.95	1.20	0.60	0.54	0.31
as % of rented dwellings	**5.86**	3.15	1.94	0.97	2.31	1.34
as % of New Contracts	**35.79**	19.24	11.67	5.83	14.09	8.20

Profitability of the short-term rentals is also a key factor that determines the proliferation of this type of market. In 2015, the average long term rental price in Barcelona was €28 per night (856 a month) while the average airbnb price (short term rental) was €71 per night. Hence, an owner had to rent their unit 11.5 days a months in average (138 days a year) in order to earn the same than with a long term rental. According to Coles et al. (2017), this same figure for the city of New York is 18 days per month (215 in a year). The fact that airbnb was quite profitable in Barcelona may be one of the reasons behind the high density of listings.

Discerning and identifying the consequences of airbnb, and short-term rents in general, is crucial to determine whether it needs to be regulated and if yes, how to properly design such regulation. Yet, there is still a shortage of rigorous empirical research trying to assess the consequences of airbnb. Any attempt to provide an answer will br challenged by multiple endogeneity concerns arising from the fact that airbnb placement is not random.

In this paper I use a publicly available dataset with web-scrapped information on airbnb listings in Barcelona combined with rent data from a real state website. Then, I apply an instrumental strategy using a Bartik-like instrument that combines distance to the beach with city-wide levels of tourism. I argue that such instrument captures only the variation of airbnb listings that is not correlated with rents. The main results suggest that airbnb is responsible for a 4% increase in rents between 2009 and 2016.

The paper is organised as follows: in Section 2, I establish the relevant institutional setting in terms of airbnb regulation across different cities and in terms of touristic apartments regulation in the city of Barcelona. In Section 3, I described the data used for this paper. Section 4 provides a detailed description of the empirical setting and the identification strategy. Results are reported in Section 4 and in Section 5 I provide some robustness tests for the identification strategy. Finally, I conclude in Section 6.

2 Institutional Setting

2.1 Airbnb regulation

Big cities all over the world have reacted to the arrival of airbnb in very different manners. In general, regulation has toughened in recent years due to both social pressure of local communities and lobbying by the hotel industry, who sees airbnb as an unfair competitor. In particular, local authorities have implemented regulations that can be categorised into three types: entry regulation, volume regulation and enforcement measures.

Firstly, city halls have tried to reduce the number of hosts by establishing some entry barriers. Some examples are the requirement of operating permits (San Francisco, Berlin, Barcelona, Paris, Vancouver), requirement to be a permanent resident (San Francisco) and restricting the activity to owner-occupied apartments (Vancouver starting in April 2018). Secondly, some other cities try to restrict the volume of the activity by setting a cap on the number of nights an apartment can be rented. Some examples are: Paris (maximum of 120 days a year), Amsterdam (60 days a year), London (90 days), New York (at least 30 days on a row) and Japan (a nationwide 120-days limit).

Since the monitoring of the previous two types of regulation is challenging and costly, cities have came up with two different enforcement strategies: fines and collaboration agreements with the company. New York and Barcelona impose fines to the hosts who do not comply with the regulation, those fines can be up to $7,500 and €60,000, respectively. Some other cities have tried to engage airbnb in making the hosts comply with the regulation. Since January 2018, airbnb restricts hosts from central Parisian districts to a maximum number of reservations of 120 nights per year. Finally, many cities have reached agreements with airbnb to collect occupancy taxes.

2.2 Barcelona's legal setting on housing

An important Housing Law[2] was approved in 2007 in the region of Catalonia that regulated the economic activity occurring in residential units. The obtention of a municipal permit was required to develop an activity and the absence of it was considered a serious infraction. A decree[3] was then passed in 2010 specifically regulating the touristic short-term rents. A residential unit that is to be used as a touristic apartment needs to have the corresponding business activity permit, be ceded entirely (not partially) and have the certificate of occupancy. Hence, when airbnb first arrived in Barcelona around 2010, sort-term rentals without a permit were illegal, both for entire apartments and private rooms. However the proliferation of airbnb did not seem to be hindered by the legal environment because the costly monitoring process weakened enforcement of the law.

In 2014, Barcelona's City Hall implemented a moratorium on the concession of permits for short-term rentals in an extended area in central Barcelona. This moratorium was added to a previous mandate regulating the most centric district of Barcelona, Ciutat Vella, which already limited the number of permits for short-term rentals. Therefore, since 2014 the number of legal short-term rentals in Barcelona has been frozen at 9600 units.

Since the arrival of a new mayor in May 2015, the concern for illegal short-term rentals has increased and hence enforcement of the law has been reinforced through the creation of a new municipal corps, the "apartment observers" in charge of detecting illegal

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[2]Housing Rights Act 18/2007, December 28th

[3]Decree 164/2010, November 9th, about the regulation of the touristic use of residential units

airbnb rentals. As a result, in 2016, there were 6,000 case files of ilegal apartments, half of which have been sanctioned, 2200 have received cease and desist letters and 600 have effectively been ceased. Moreover, the City Hall has also fined the airbnb platform for advertisement of ilegal business activities. After two generic sanctions of €30,000, a repeat-offender fine of €600,000 was then processed. The strengthen of the enforcement procedure may be one of the reasons of the decrease in the growth rate of airbnb listings in 2017.

3   Data

The main source of data that I use is a set of information coming directly from the airbnb website. This data has been collected at different points in time by an independent Internet user who has made his data publicly available. The dataset is called InsideAirbnb and has 6 data points going from April 2015 to April 2017. For every listing that has been advertised in the website there are the geographical coordinates, room characteristics, host id and the date of first sign in and of each review received. Moreover, listings have an identifying id that allows me to track them over time.

A very important task is to define an appropriate measure for the supply of airbnb listings. This implies computing a measure of the entire period that a listing has been active on the site, with its entry and exit date and any possible break period in between these two points. The main complication of this task is that the webscrapped information starts only in 2015 and hence a simple count of the total listings does not provide information for the entire period. Hence, to construct a measure of density of airbnb's listings for the entire period I use three different methods which have already been used by Barron et al. (2017) and by Zervas et al. (2014).

The first method consists in taking the date where the host first signed in with airbnb and assuming that dwellings never exited the supply. This method, although being the preferred one by Barron et al. (2017) is likely to significantly overestimate the supply. Indeed if a host added a listing in the past but he is no longer taking any guests, with this method this listing is wrongly counted as active. Even though this overestimation would only cause a bias if it is correlated with unobservable neighborhood characteristics (Barron et al., 2017), it is still problematic in terms of the magnitude of the effect.

In order to solve the overestimation of the previous method, I compute alternative methods 2 and 3. In method 2, I consider that a listing is active as long as there is some trace of its activity every three months. This is, a listing is active after the date it first entered the platform and for a period of three months. Then, after each review received the period of activity is increased by three more months. According to airbnb records, 72% of guests leave a review, hence the number of reviews seems to be a good proxy of the actual transactions. This method allows me to get rid of all the listings that are still in the website but that are no longer receiving any guests, and hence any reviews. For method 3 I use the same mechanisms but with 6 months instead of 3.

In table 1 I depict the evolution of listings according to the three different methods. It can be observed how, indeed, the overestimation of method 1 is quite significant. Therefore, the preferred method that I use in this paper is number 2. The cyclicality of measures 2 and 3 observed in the graph is due to a higher affluence of host during summer periods.

In order to understand the potential consequences of airbnb, it would be very useful to

Figure 1: Evolution of total listing in Barcelona by computing method
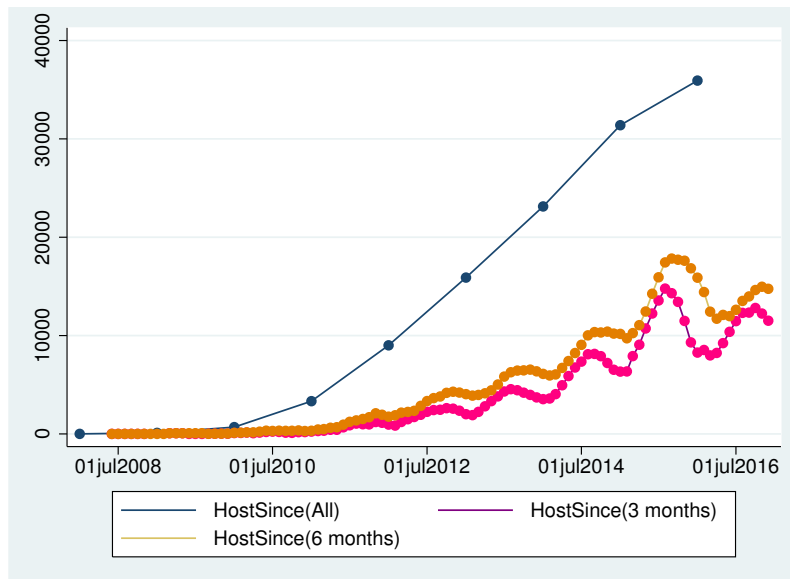
Notes: Blue line indicates the number of hosts according to Method 1, pink line is Method 2 and orange line, Method 3. Data comes from webscrapps from InsideAirbnb.com

disentangle commercial listings from casual listings. This implies identify the owners that use the airbnb platform only sporadically versus those who use airbnb as their business (Li, 2018). Unfortunately, this is not straightforward with InsidedAirbnb data. Nevertheless, there is some interesting information about the composition of the supply. In 2015, 49% of all airbnb listings were entire apartments while 50% were private rooms and only 1% were shared rooms. Casual users can be part of the first two categories since they can rent both their entire apartment (if they are away for a period of time) or only one room (if they have an extra one). Similarly, professional owners can choose to rent their units entirely or room by room. However, the small portion of shared rooms includes almost exclusively hostels using the platform to advertise their shared rooms. Finally, the average price of a listing in 2015 was €109 for an entire apartment, €37 for a private room, and €30 for a shared room. With the available data it is not possible to assess how airbnb prices evolved over time since the beginning of its activity.

It is also possible to know how many listings belong to the same host. It is reasonable to assume that owners with more than one property in the platform are more likely to be commercial users. While in the single property owners category there could be both casual and professional users. In 2015, 61% of all listings belonged to multi-property hosts while 38% where single property users. The average number of properties per host is 1.82, with the top one percent of multi-property owners (135 hosts) having 15% of the listings (3163 properties).

As for the rent data, I use data from el Idealista, a real state website where individuals can post their dwellings to rent or sell. They have information for 67 neighbourhoods[4] in Barcelona since 2011 to 2017. I combine this data with other sources to increase the time span. In particular, we use data on rents from the Department of Fiscal Studies of Barcelona's City Hall which has been estimated based on the real state ads appeared on

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[4]In Barcelona there are, since 2007, 73 neighbourhoods. However, in el Idealista they add up information for some very small and peripheral neighbourhoods due to scarcity of rental vacancies.

print media and on Internet during the period 2009-2012. The fact that both sources of data are based on similar information allows us to create a unique data set from 2009 to 2017 at the neighbourhood level. Due to some missing values on rent data, I drop three observations. In the end, my sample in composed by 64 neighbourhoods observed during 8 periods (512 observations).

The main disadvantage of using prices from advertised vacancies is that they do not represent the final transaction price but the first offer price and therefore they could be biased upwards. To verify the relevance of the bias I use rent official data from the Catalan Institute of Land which is available for the 10 districts of Barcelona. I compare the city-wide average rents from the two sources in Figure A1. It can be seen that the rents evolve in a very similar pattern and hence the concern is diluted. In any case, an upward bias would only be problematic for the identification strategy if it would not be constant over time.

4   Empirical Strategy

The attempt to assess the impact of the airbnb's market entry on rents is challenged by one main endogeneity issue: non-random location of airbnb's listings. Indeed, the location of hosts that decide to offer their apartments in airbnb is likely to be associated to some factors that at the same time can be correlated with rents. For instance, listing location is probably explained by transport accessibility, neighbourhood amenities and average level of education of the residents which are as well correlated with the level of rents. Similarly, one could think of other unobserved variables that may affect both airbnb location and rents. The omission of these factors would cause and omitted variables bias of the regression estimates.

In order to deal with endogenity concerns, I need to use only the part of the variation of airbnb location that is not correlated with the rents' distribution. In particular, I use an instrument to predict airbnb density at the neighbourhood level that, controlling for other variables, does not correlate with rents: distance to the recreational beach. The intuition behind this instrument is that, for tourists who come to Barcelona, being close to the beach is an important factor affecting their choice of location. Hence, host with properties closer to beach are more attractive to tourists. First map of Figure 2 shows that indeed airbnb density is higher the closer the neighbourhood is to the beach. One may argue that distance to the beach can affect rents as well. However, residents of Barcelona do not tend to appreciate much the city's beach and they generally prefer to go to other beaches that are a bit further away but cleaner and less crowded. These other beaches are along the coast line either north or south from Barcelona and are very accessible by transportation modes (20 minutes away by train or car). Moreover, given the size of the city, being at the point the furthest away from the beach means being at 30 minutes away by transportation, which is still relatively close. As a proof for this argument, one can look at the distribution of income across neighbourhoods (second map in Figure 2). Rich people in Barcelona do not generally locate close to the beach but rather at the north-western part of the city. The north-east side of the city is one of the poorest parts of the city and it is also far away from the beach. Hence distance to the beach does not seem to explain income distribution (the correlation between these variables is only 0.18).

Historical evidence of the city of Barcelona is crucial to understand this situation.

Figure 2: Airbnb density by neighbourhood and income distribution

Airbnb Density   Income Distribution
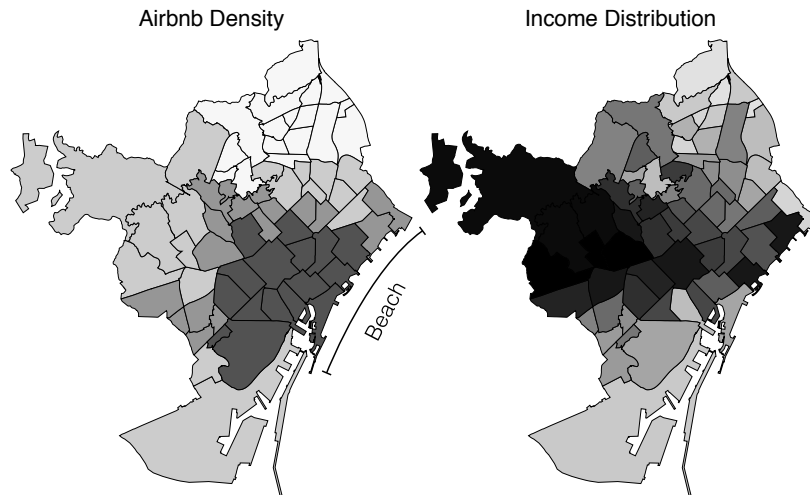
Notes: Left graph depicts the total number of airbnb listings in 2014 divided by the total number of housing units. The segment indicates the location of the recreational beach. Second graph depicts the average income distribution across neighbourhoods.

While the sea and the port have been very important for the development of the city, the beach has historically been the "backyard of the city". For the first three quarters of the XXth century the beach of Barcelona was a dumping site where all the waste and the rubble of the city accumulated. In the 70s the pile of waste reached 6 meters high and 150 meters long with approximately 2.5-3 millions of cubic meters of garbage. Many industrial factories were located at the neighbourhoods along the beach and contributed to the pollution. From 1882 to 1966, the beach was also a shack neighbourhood called *Somorrostro* where 18,000 people lived in 1,400 shacks (Riba Arderiu and Colombo Piñol, 2009). With the arrival of democracy, social pressure for the revitalisation of the beach intensified but access to the beach was still constrained by the train rails (Arranz, 1992).

It was not until 1989 with the upcoming Olympic Games that the train rails along the coast where removed and 1.5 million of cubic meters of sand were poured out to the beach (see figures A2 to A4 for graphical evidence). The recovery of more than 4km of beach together with the advertisement campaign of the 1992 Olympic Games, represented the beginning of the second boom in tourism of 'sun and beach' for Barcelona. The number of visitors went from 1.9 million people in 1992 to 3.5 million in 2000 and 9 million in 2016.

I argue that location choices seem to be still influenced by long term historical trends where the beach was not attractive. When the recreational beach was habilitated, it was quickly occupied by the tourism sector with hotels and restaurants being built. Nowadays, the beach in mainly used by temporal visitors and hence it is still no such a very important amenity for permanent residents. A pattern of location choices where rich people do not locate at the first line of the coast, although not very common in other countries, can be found in other big urban coastal Spanish cities such as Valencia, Alicante or Malaga.

All these arguments suggest that distance to the beach is less important for residents than for tourists, but, if any, this impact is likely to be constant over the period of interest in this paper (2009-2016). Indeed, it is unlikely that the average preference for closeness

to the beach suddenly becomes more (or less) important for the location decision. Hence, by introducing neighbourhood fixed effects I allow distance to the beach to have an impact on rent *levels* while assuming that it does not affect the *evolution* of rents. Therefore, the exclusion restriction that needs to hold in this case is that distance to the beach is not correlated with the *evolution* of rents.

Figure 3: Detrended rents by distance to the beach
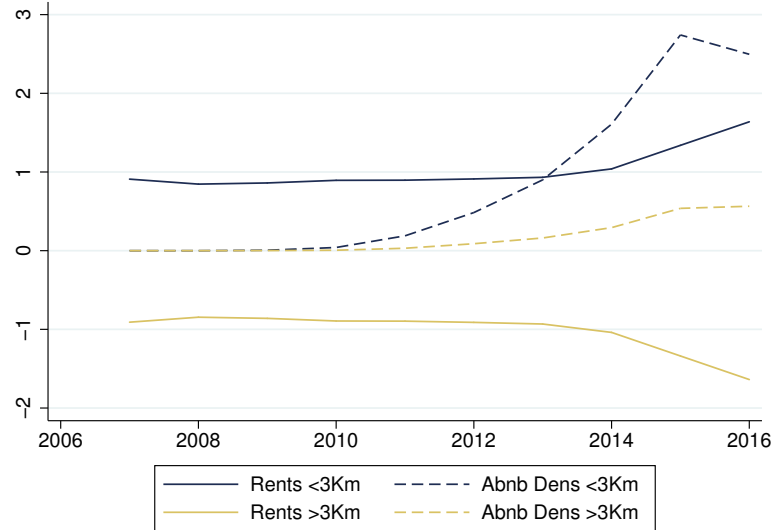
Notes: Solid lines are the predicted residuals of regressing rents on year fixed effects. Dashed lines are the average density of airbnb. Blue is for the neighbourhood that are closer than 3km from the beach and red for the other ones.

In Figure 3, we can see a simple correlation between rents, airbnb density and distance to the beach. I have divided the sample of neighbourhoods in two groups: those that are less than 3km from the beach (blue color) and those that are further away (yellow). The solid lines depict the evolution of square-meter rents discounted by the year time trends. This is, only the variation of the rents that is not explained by the yearly variation constant across all neighbourhoods is depicted. The dashed lines represent the evolution of airbnb density during the same period. Airbnb density increased much more in the neighbourhoods that are closer to the beach. It can be seen that the discounted rents increased for the neighbourhoods that are closer to the beach while they decreased for the other ones, coinciding with the increase in airbnb density. Contrary, during the period before airbnb, the trends of both groups are parallel.

A disadvantage of using a geographical instrument is that it only varies across space but not over time. This is problematic when one looks at the impact of the instrumented variable over different periods. A very common way to solve this problem is to multiply the geographical instrument by a variable that varies over time, in a "Bartik-like" instrument. In this case, I use the total volume of tourists arriving to Barcelona. In fact, the density of airbnb is likely to be higher the greatest the total number of tourists visiting the city. Yet, it is unlikely that it affects the distribution of rents across neighbourhoods. Since this variable varies over time but not across neighbourhoods, the interaction of the two provides variation in both the space and the time dimension.

In order to measure distance to the beach I use three alternative methods. First, a binary measure equal to 1 for the 25% of neighbourhoods that are closer the beach

and 0 otherwise. Second, a continuous linear measure of the distance. And third, I add a second order term to measure distance in a quadratic way. Each of these measures imposes a different functional form in the way airbnb density is explained by distance to the beach, the last one being the most flexible.

One potential challenge of this strategy would be if neighbourhoods that are closer to the beach happened to experience a different trend in housing market supply, for instance if the rate of new construction was different. In particular, one of the neighbourhoods close to the beach, el Poblenou, was affected by an industrial renovation plan called 22@ that started in 2000 and increased the rate of new construction. To deal with this issue I include time-varying controls at the neighbourhood level, such as income level, education dummies, percentage of new construction, increase in population density and average apartment surface. Any time-invariant idiosyncratic characteristics of the neighbourhood are already taken into account in the fixed effects.

Another potential issue can come from the fact that some of the neighbourhoods that are close to the beach are also the centric neighbourhoods of the Barcelona. This can be a problem since distance to the beach is partially measuring distance to the center which, according to standard urban theory, is correlated with rents. To correct for this issue I create a dummy variable equal 1 if a neighbourhood is within the 25% of neighbourhoods closer to the Central Business District[5] and 0 otherwise. Then, I include in the regression centre-specific trends in other to allow centric neighbourhood to evolve in a different way than the rest of the city.

Formally, the econometric model I estimate is the following:

First Stage

$$(1) \quad Airbnb_{i,t} = \alpha + \beta(distbeach_i * tourism_t)_{i,t} + \gamma X_{i,t} + \delta \mathbb{1}center_i * \tau_t + \mu_i + \tau_t + \varepsilon_{i,t}$$

Second Stage

$$(2) \quad log(Rent_{i,t}) = \alpha + \beta \widehat{Airbnb}_{i,t} + \gamma X_{i,t} + \delta \mathbb{1}center_i * \tau_t + \mu_i + \tau_t + \varepsilon_{i,t}$$

The First Stage (equation 1) predicts airbnb density at neighbourhood $_i$ and time $_t$ as a function of distance to the beach interacted with total volume of tourists, a set of neighbourhood controls $X_{i,t}$, centre-specific time trends ($\mathbb{1}center_i * \tau_t$) and time and neighbourhood fixed effects (τ_t and μ_i). The Second Stage computes the log of the average square-meter rents as a function of predicted airbnb density and all the same controls than in the first stage.

Finally, one should be concerned as well if neighbourhoods that are closer to the beach experienced a higher degree of gentrification that would impact the attractiveness of these neighbourhoods and hence, rents. The difficulty of controlling for gentrification relies on the complication of finding an appropriate measure for it. Even though there is now a fair amount of research about the phenomena, there is no standard way to measure it. In this paper, I use three different methods inspired by previous literature to control for urban renewal. For the first method (M1) I include three control variables that are thought to be associated with gentrification: percentage increase in income, percentage increase in college-educated and neighbourhood turnover. Indeed, one would expect that

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[5]Barcelona's CBD is located around the intersection of Avinguda Diagonal and Passeig de Gràcia (Ruiz, 1993)

a neighbourhood that is gentrifying experiences an increase in average income, however that can also be the case of neighbourhoods that were already rich. In order to exclude these last areas, I use the percentage increase in income, instead of the first difference. Similarly, as Baum-Snow and Hartley (2016) and Couture and Handbury (2016) have shown, we would also expect a link between the location choices of college-educated and neighbourhood renewal. Finally, a neighbourhood in the process of gentrification may report high population flows in and out of the neighbourhood (richer people moving in, poorer people moving out). Since one would expect both flows to be high, the measure of turnover is equal to the minimum of the inflow and the outflow.

As for the second method (M2), I allow neighbourhoods in a gentrifying process to have differentiated trends in terms of rents. This is, I include in the regressions specific-time trends with respect to each of the three *gentrification* variables previously described.

Figure 4: Gentrification in Barcelona in 2014 according to measure 3
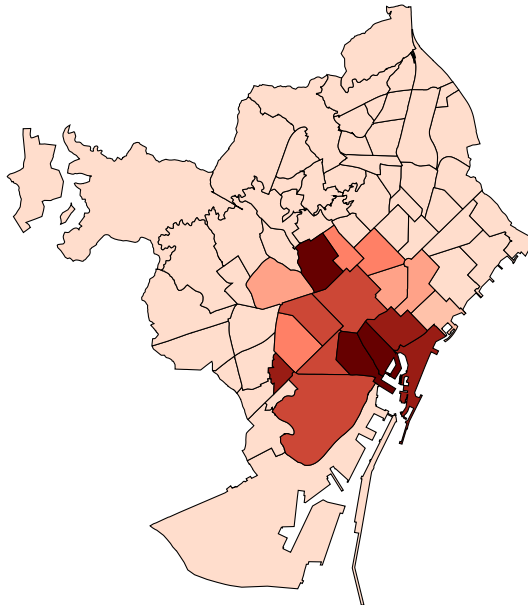
Notes: Gentrification is measured by the product of the percentage increase in college-educated times the neighbourhood turnout. It is zero for non-centric neighbourhoods.

Finally, in method 3 (M3) I create an actual measure of gentrification similar to the one used in Brummet and Reed (2017) that is equal to the percentage increase of college-educated times the neighbourhood turnout for the central neighbourhood and zero otherwise. The purpose of this calculation is to obtain a measure that matches what local residents of Barcelona understand as gentrification. Figure 4 maps gentrification in 2014, the maps for other years are similar to this one. According to this measure the top 5 gentrified neighbourhood are Barri Gótic, Vila de Gràcia, Raval, el Born and Barceloneta. Then, as in M2, I allow gentrifying neighbourhoods to evolve in a differentiated way by including gentrification specific-time trends.

5 Results

The main results of the empirical strategy are displayed in Table 2. Column 1 contains the OLS of the direct relation between rents and airbnb density. These results

Table 2: Impact of airbnb density on rents

	OLS	Dummy25	2SLS Linear	Quadratic
	(1)	(2)	(3)	(4)
AbnbDens	0.022***	0.047***	0.038***	0.041***
	(0.006)	(0.010)	(0.012)	(0.011)
First Stage F-test	-	23.054	18.029	10.528
Controls	X	X	X	X
Centre-Specific trends	X	X	X	X
Year FE	X	X	X	X
Neighbourhood FE	X	X	X	X
N	512	512	512	512

Notes: Dependent variable is the log of the square-meter rents. Column (1) is the OLS regression while (2) to (4) are 2SLS. Regressions include time-varying controls (income level, education dummies, percentage of new construction, increase in population density and average apartment surface), centre-specific time trends, year and neighbourhood fixed effects. The coefficients of interest is the airbnb density at the neighbourhood level. There are 64 neighbourhood and 8 periods (sample of 512). Data comes from el Idealista, Insideairbnb and official municipal sources.

appear to be significant and equal to a 2% increase in rents. Columns (2) to (4) show the results of the second stage of the 2SLS strategy using the three different measures of distance to the beach. All regressions include the controls described in the previous section, centre-specific trends and year and neighbourhood fixed effects. When using the 2SLS strategy coefficients are still significant and twice as high as in the OLS. One of the possible explanations for the downward bias of the OLS is if airbnb listings locate where the opportunity cost of shifting to short term rentals is lower, this is, where rents are lower. The magnitude and significance of the coefficients seems to be stable across measures of distance to the beach. However, the F-test of the first stage does decrease with the flexibility of the measure, it is reasonably superior to 10 for the dummy and the linear measure but only slightly over 10 for the quadratic measure. Since it is a Log-Linear regression, the coefficients should be interpreted as follows: a 1 percentage point increase in airbnb density is associated with a 4% increase in rents with respect to other neighbourhoods.

In Table 3 I address the concern of gentrification by trying to isolate the effect of tourism (airbnb) from the effect of neighbourhood renewal. To do so, I use methods M1-M3 explained in the previous section. Columns (1) to (3) report the coefficients of interest of the second stage of the 2SLS method with the linear measure of distance to the beach, while (4) to (6) are the results with the quadratic measure. Here, the first stage F-test only slightly around 10 for the linear measure while under 10 for the quadratic. Only the two more flexible measures are reported. It can be seen that results are quite stable to either one of the methods to control for gentrification. Coefficients are still significant and of a similar magnitude (deviation in the magnitude are not statistically significant). Hence, even when controls for gentrification are included, the impact of airbnb density on rents is still positive, significant and equal to 4.1-5.8% depending on the specification.

Table 3: Impact of airbnb density on rents, controlling for gentrification

| | Linear | | | Quadratic | | |
	(1)	(2)	(3)	(4)	(5)	(6)
AbnbDens	0.041***	0.057***	0.044***	0.043***	0.058***	0.047***
	(0.013)	(0.020)	(0.014)	(0.012)	(0.018)	(0.012)
First Stage F-test	17.229	9.735	19.664	9.467	5.581	11.989
Controls	X	X	X	X	X	X
Centre-Specific trends	X	X	X	X	X	X
Gentrification Controls	M1	M2	M3	M1	M2	M3
Year FE	X	X	X	X	X	X
Neighbourhood FE	X	X	X	X	X	X
N	512	512	512	512	512	512

Notes: Dependent variable is the log of the square-meter rents. 2SLS are reported. Regressions include time-varying controls (income level, education dummies, percentage of new construction, increase in population density and average apartment surface), centre-specific time trends, year and neighbourhood fixed effects. The coefficients of interest is the airbnb density at the neighbourhood level. There are 64 neighbourhood and 8 periods (sample of 512). Data comes from el Idealista, Insideairbnb and official municipal sources.

6 Robustness Tests

In order to check the robustness of the effects, I compute a Placebo test by splitting the sample in two periods of time. During the first period 2009-2012, the density of airbnb was very small (0.06% in average for the entire period) while, in the second period 2013-2016, the density increased significantly to 0.77% in average across all neighbourhoods. Hence, it is more likely that, if airbnb had any effect, that would have occurred during the second period.

Table 4: Placebo Test: before vs. after airbnb consolidation

| | Period 2009-2012 | | | Period 2013-2016 | | |
| | Dummy25 | Linear | Quadratic | Dummy25 | Linear | Quadratic |
	(1)	(2)	(3)	(4)	(5)	(6)
AbnbDens	0.110	0.090	0.085	0.064***	0.044**	0.060***
	(0.093)	(0.110)	(0.106)	(0.018)	(0.021)	(0.020)
First Stage F-test	16.489	14.675	8.683	15.393	10.217	5.979
Controls	X	X	X	X	X	X
Centre-Specific trends	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Neighbourhood FE	X	X	X	X	X	X
N	256	256	256	256	256	256

Notes: Dependent variable is the log of the square-meter rents. 2SLS are reported. Regressions include time-varying controls (income level, education dummies, percentage of new construction, increase in population density and average apartment surface), centre-specific time trends, year and neighbourhood fixed effects. The coefficients of interest are the airbnb density and its interaction with the year fixed effects. There are 64 neighbourhood and 8 periods (sample of 512) divided into two same-size groups (256 observations each). Data comes from el Idealista, Insideairbnb and official municipal sources.

In Table 4, I report the results of splitting the sample. First three columns show the coefficient of the effect of airbnb density on rents by the three measures of the instrument. None of these coefficients are significant. This indicates that neighbourhoods where airbnb density was going to be high in subsequent periods experienced similar trends in rents than those neighbourhoods with low future airbnb presence during the period before airbnb was fully established. On the contrary, coefficients of columns (4) to (6) are positive, significant and of a similar magnitude than in previous results tables. This suggests that all the effect

occurs solely during the second period, when airbnb density is higher.

In a second robustness test, I try to address the concern that the effects comes from centric neighbourhoods close to the beach. Indeed, the four neighbourhoods belonging to the central district of the city are the ones where touristic congestion is the highest. In fact, an equivalent of 2.5% of housing units of the district are catering and accommodation businesses. Moreover, most of the touristic attractions of the city are located in this district. In order to verify that the burden of the effect does not come exclusively from these four neighbourhoods, I exclude them from the sample. Table 5 reports the coefficients of the strategy with the restricted sample. Magnitude and significance of the coefficients remain unchanged suggesting that the effect of airbnb density on rents is not concentrated in the main centric neighbourhoods.

Table 5: Robustness Test: Excluding centric neighbourhoods

	Linear			Quadratic		
	(1)	(2)	(3)	(4)	(5)	(6)
AbnbDens	0.054***	0.068***	0.051***	0.058***	0.067***	0.055***
	(0.020)	(0.022)	(0.019)	(0.018)	(0.020)	(0.018)
First Stage F-test	16.489	14.675	8.683	15.393	10.217	5.979
Controls	X	X	X	X	X	X
Centre-Specific trends	X	X	X	X	X	X
Gentrification Controls	M1	M2	M3	M1	M2	M3
Year FE	X	X	X	X	X	X
Neighbourhood FE	X	X	X	X	X	X
N	480	480	480	480	480	480

Notes: Dependent variable is the log of the square-meter rents. 2SLS are reported. Regressions include time-varying controls (income level, education dummies, percentage of new construction, increase in population density and average apartment surface), centre-specific time trends, year and neighbourhood fixed effects. The coefficients of interest are the airbnb density and its interaction with the year fixed effects. There are 60 neighbourhood and 8 periods (sample of 480). Data comes from el Idealista, Insideairbnb and official municipal sources.

7 Conclusion

The arrival of airbnb has recently gained a lot of attention in public debate, specially in big cities. Concerns about the potential negative consequences of airbnb have led local administrations to apply a wide range of regulating measures. Indeed, home-sharing platforms such as airbnb can potentially have inflationist effects in local housing markets both in rents and prices. The mechanism behind this effect can come through the supply side – with owners permanently shifting from long term to short term rentals - or through the demand side – with renters internalising airbnb potential and accepting higher rents.

In this paper, I assess the impact of airbnb on rents for the city of Barcelona. I use an instrumental strategy to identify the causal effect based on the product of distance to the beach times the total volume of tourism. I find that neighbourhoods were airbnb density increased by one percentage point experienced an increase of 4% in rents compared to other neighbourhoods without airbnb during the period of 2009-2016. Such effect seems to be concentrated during the period 2013-2016 which is when airbnb consolidated in the city, with an average density of 0.77%.

In the period 2013-2016, rents increased on average by 28% (going from €9.66 the square meter in 2013 to €12.46 in 2016). Therefore, the arrival of airbnb exacerbated

the increase in rents that was already taking place in Barcelona during the same period. Nevertheless, there are other important factors that contributed to the increase in rents during this period such as the liberalisation of the rental market (established in the Law of Urban Rentals of 2013), the beginning of the recovery period and the increase of the attractiveness of housing with respect to other investment options.

The accelerated increase in rents during a relatively short period worries the residents who see their purchasing power reduced. The exacerbation of this increase due to airbnb is something that has to be addressed by the municipality of Barcelona. The actions taken so far are aimed at identifying illegal listings and remove them for the market, regardless of the type of listing. Potentially, a more efficient political tool would be to limit commercial listings who are responsible of reducing the long-term rentals supply. Some examples of regulations that can contribute to this objective are: limiting the airbnb activity to primary residents (like Vancouver or San Francisco), or setting caps on the number of night an apartment can be rented (like Paris and London). These regulation should come together with other enforcing actions to ensure the compliance of the rules. Probably the most effective enforcement plan would be to reach an agreement with airbnb and other home-sharing companies on the control of the hosts and their activity on the platforms.

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8 Annex

Figure A1: Average square meter rents in Barcelona by source of data

Notes: Dark line represents the evolution of square meter rents according to the real state website el Idealista. The average is an aggregate from 67 neighbourhoods. Light line depicts the evolution of rents according to the Catalan Institute of Land. The average is an aggregate of 10 districts.

Figure A2: Rubble accumulated in the beach, 1970

Figure A3: People looking for scrap metal in the beach, 1973

Figure A4: Train rails along the beach limit, 1980