The effect of Airbnb on the housing market in Europe

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Abstract

This paper examines the effect of Airbnb on the European housing market. In particular, I explore the hypotheses that the housing prices, the housing supply and the ability to meet mortgage and rent obligations influence the number of listings on Airbnb. Moreover, Airbnb indicators are added to an existing model influencing the house price index that shows that Airbnb does not affect the house price index. I present a model for each of the topics mentioned above. I then present a number of facts that are consistent with previously done research and examine alternative explanations of my findings.

Nowadays, we live in a world where it is most common to use the internet for everything. Not only for buying new shoes or ordering food, also for finding places to stay when going on vacation. One of the most popular apps now, when it comes to finding accommodation online, is Airbnb. Recently, there has been commotion regarding the practices of Airbnb. Since the law is not focused on peer-to-peer sharing economies, where there is no superior party, it has been hard to identify the limits of Airbnb. From an economic perspective, there have been some concerns as well. Airbnb is described as an Internet-based platform that creates a new way for people to share goods and services with one another (Kaplant & Nadlertt, 2017). Over the years, Airbnb has gone from a reasonable growth in the period 2008-2011 (reaching their first million booked room nights in 2011) to massive growth rates from 2011 onwards (5 million in January 2012 to 10 million booked nights half a year later) (Guttentag, 2015) . Due to the success of Airbnb, some are wondering about the effects this has on the economy. Although there is an undeniable interest for the sharing economy and many are opposed to the influence of Airbnb specifically on the hotel industry, there is a lack of empirical studies on the effect of Airbnb on the real estate market. Therefore I would like to formulate the following research question: Is there reason to be concerned about the sharing economy and its growth? This will be tested by figuring out which variables influence the presence of Airbnb and seeing whether Airbnb affects house prices, which is a big concern at the moment for several local governments.

In this paper, I investigate the relation between active listings in European cities (the presence of Airbnb) and several real estate related aspects. Since 50% of the guests visit Europe and 58% of the listings are from European hosts, it can be considered as the core of Airbnb transactions (Airbnb, 2018). Therefore, the focus of this report will be Europe and how Airbnb affects the European housing industry. This will include the following real estate aspects: (1) the effect of the housing prices, (2) the effect of the number of houses and (3) the effect of the ability to meet financial obligation. The effects are investigated on a city level and to compare, the regressions are focused on the six major cities too. These cities are London, Amsterdam, Copenhagen, Berlin, Paris and Barcelona based on the total number of listings on Airbnb in over the period 2008-2017 (InsideAirbnb, 2018).

Firstly, I start with a model that shows the relationship between the presence of Airbnb and housing prices. Previous studies have focused on the effect of Airbnb on housing and rent prices in major American cities, such as New York and Los Angeles. By examining whether housing prices and rent prices have an effect on the number of listings on Airbnb in Europe, the core of Airbnb business, I intend to provide new insights on city level. Secondly, the relation between housing demand and the presence of Airbnb is tested to see whether claims that Airbnb decreases housing supply, in cities where there is a shortage already, holds in Europe. This is essential, since many have complained that in e.g. Amsterdam it is nearly impossible to find housing (McCarthy A. , 2018). The houses offered are too pricy and other, normally affordably homes, are listed on Airbnb (McCarthy A. , 2018). Lastly, I investigate whether the presence of Airbnb is related to the ability to meet mortgage and rent obligations. The most positive side mentioned regarding Airbnb is that it provides hosts with additional income to ensure financial obligations such as rent and mortgage (McCarthy A. , 2018). The ability to meet rent and mortgage obligations as a reason to use Airbnb would suggest that the hosts have a credible reason to use the platform, therefore different variables are included in the model to test the relation between Airbnb listings and host credibility.

Overall, data shows a positive relation between the presence of Airbnb and the following variables for both panels: number of residences, proportion of rented accommodation, the value of

housing transactions, the mortgage to income ratio, the price to rent ratio outside city centers and the affordability ratio. Moreover, there is negative relationship between the presence of Airbnb and the number of houses completed within the cities, the arrears on mortgage or rent obligations and the proportion of households with financial burdens. The other relationships differ per panel, these differences will be elaborated in the results section of this paper. Moreover, we see that the number of Airbnb listings has no effect on the house price index.

The academic value of this study is present as it will serve as an inspiration source for future studies and contribute to the specific field of real estate in the sharing economy. In terms of practical relevance this study could be helpful for governments to consider regulations limiting the influence of companies within the sharing economy on e.g. the real estate market. The main difference lies in the fact that I focus on the effect of several real estate market variables on the presence of Airbnb rather than the effect of the presence of Airbnb on different real estate aspects. The focus will thus be on what determines the presence of Airbnb rather than answering the question if Airbnb is causing disruptions. To add to present studies, one model is made to determine whether Airbnb listings affect the house price index, this is also used to prove that there is not causality effect when researching whether the number of listings is affected by house prices.

The rest of the paper is organized as follows. Section I provides a brief description of Airbnb and of the sharing economy, of which Airbnb is part. Section II summarizes previous studies on Airbnb and Section III focuses on the research questions. Section IV includes data descriptions and methodology explanations leading to model formulations. Section V contains the regression results, section VI suggestions for future research and the conclusion.

I. Background

Airbnb was founded in 2008 by Brian Chesky, Joe Gebbia, and Nate Blecharczyk and is described as an accommodation marketplace (Airbnb, 2018). Airbnb currently has over 5 million Airbnb listings (from apartments and villas to castles, treehouses and B&Bs) in 81000 cities in more than 191 countries (Airbnb, 2018). The main source of their competitive advantage lies within their goal to provide unique, handcrafted activities run by locals, while partnering with local restaurants (Airbnb, 2018). Airbnb started as Airbedandbreakfast.com in the fall of 2007 when Brian Chesky and Joe Gebbia host the first guests to make rent money during a design conference (Airbnb, 2018). After the official launch of Airbed & Breakfast the hosts have tackled the problem regarding hotel shortages during big events, such as the Democratic National Convention and the Rio Olympic Games (Airbnb, 2018). Now, we see that there are almost no countries left that do not have Airbnb listings (Anderson, 2013). Over the years Airbnb has gone from only apartment listings (nowadays, over 50% of the listings) to house listings, villas, castles and many more (Anderson, 2013). The users listing homes are referred to as *hosts* and their properties are called *listings.* Each host is obliged to provide a photo, the listing, a personal statement, reviews and certified contact information. Each listing includes the location, a description, photos, availability, check-in information, cleaning fees, capacity and security deposits (Zervas, Proserpio, & Byers, 2017). Guests can rate their stay on different features, such as location, communication and cleanliness. There are no specific set of rules for the price determination, this is left to the hosts (Zervas, Proserpio, & Byers, 2017). Costs include a service fee for guests for each reservation and for hosts meant to cover payment processes (Zervas, Proserpio, & Byers, 2017).

Some financial facts include a revenues of 1.7 billion in 2016 and a value of 31 billion in 2017 with 4 million listings total (Airbnb, 2018). Over the years Airbnb has raised funds, in 2017 this amount was 34 million. Moreover, Airbnb has 700,000 corporate partners that use Airbnb to provide housing. The success of Airbnb can be measured in the nights booked, which was 1 every day in 2008 and 1 every 2 seconds in 2012 (Anderson, 2013). The growth in total nights booked is also extraordinary from less than a million in 2008 to 10 million booked nights in June 2012 (Anderson, 2013).

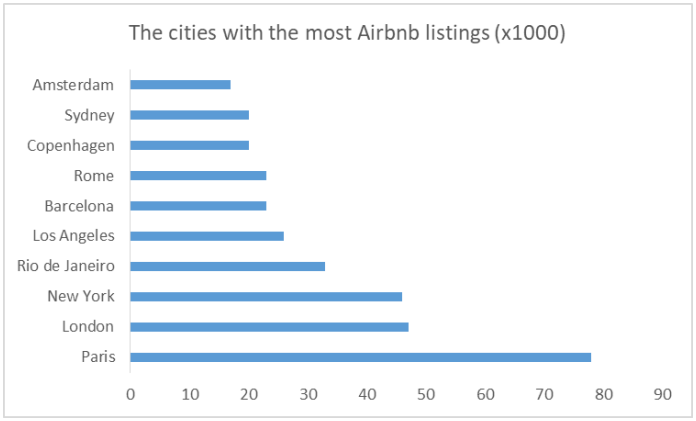

Figure 1: The cities with the most Airbnb listings globally seen. The numbers have been corrected by a factor of 1000. Source: Airbnb.com

When looking at the continents, most Airbnb listings can be found in Europe (105,000), making this the core of the Airbnb business (Anderson, 2013). The total listings in North America are second with a total of 55,000 (Anderson, 2013). In Latin America there are 20,000 listings as opposed to the 5000 listings in both Africa and Australia. Asia has a total of 10,000 listings (Anderson, 2013). The top markets by active listings are Paris, London, New York, Rio de Janeiro, Los Angeles, Barcelona, Rome, Copenhagen, Sydney, and Amsterdam (Airbnb, 2018).

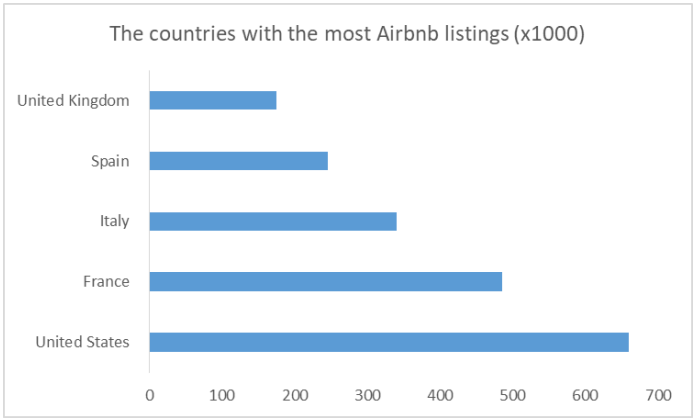

Figure 2: The countries with the most Airbnb listings globally seen. The numbers have been corrected by a factor of 1000. Source: Airbnb.com

Since the growth of internet usage in our life, it has become easier for people to find new ways of consumptions (Pfaffenrot, 2017). The so-called sharing economy, first thought of by Mr. Martin Weitzman (Weitzman, 1984), is one of these new ways offering opportunities to share otherwise expensive assets while benefiting from the monetary exchange. Thus concluding that the sharing economy will eventually improve the wealth for all people involved. The sharing economy can even be divided into two sections, according to Belk (Belk, 2010); sharing in and sharing out. Sharing in involves

personal connections, whereas sharing out focuses on the optimal usage of resources, thus deviating from any social connection between the parties. Other opinions lead to the idea that the sharing economy includes the increase of accessibility of under-utilized assets (Stephany, 2015).

Well known participants in the sharing economy are Uber, Airbnb and Bla Bla Car. These platforms are also classified as peer-to-peer platforms that rely on the sharing of resources amongst peers. The attention for these platforms comes from the fear that they threaten existing businesses such as car dealers and hotel branches (Gansky, 2012). Many studies offer an indication of this threat, while all different, one thing they all have in common: growth within the sharing economy is certain. Another aspect of the sharing economy that has added to the attention given to it, is the environmental effect. By sharing goods, a sustainable market is created that will benefit the environment. The aspect that is most dominant has not been found yet. Whereas some studies find no effect when it comes to the incentives to use the sharing economy and the environment (Moeller & Wittkowski, 2010), others point out that a considerable percentage of people (32%) within their study indicated that being green is the main reason to join the sharing economy against the 17% that indicated to do it for saving money (Piscicelli, Cooper, & Fisher, 2015).

In this study, the sharing economy is classified as a scenario where peers share goods on a short-term basis (shorter than a year) with as main purpose saving money on one side and making money on the other. I solely include Airbnb in the sharing economy in this study, other participants are not part of this paper.

II. Literature review

Airbnb started in 2008 as an idea, thought of by three students, to offer cheaper accommodation for tourists (Lee, Airbnb and L.A.'s Housing Crisis, 2016). With the use of pictures, reviews (from both sides) and a secure money exchange system (Lee, Airbnb and L.A.'s Housing Crisis, 2016), they have been able to ensure the trust needed to bind hosts and guests to the platform (Oskam & Boswijk, 2016). The success of Airbnb can be explained mainly by, according to a recent study; the mutual benefit of the transactions (Oskam & Boswijk, 2016). Other factors include the promise of *living like a local*, a trusted platform and economies of scale (Oskam & Boswijk, 2016). This has been confirmed by the low number of complaints in 2016 (5%) of the 80 million stays of which most are due to cancellation (ipropertymanagement, 2017). Another perceived issue can be linked to poor customer service, as 82% of the guests have indicated and 57% even pointed out that this was their primary complaint. These statements are confirmed by a research done by Morgan Stanley, of which a part is presented in figure 3. As we can see, the main reasons for choosing Airbnb is the price, the location and the authentic experience, thus living like a local (Morgan Stanley, 2015).

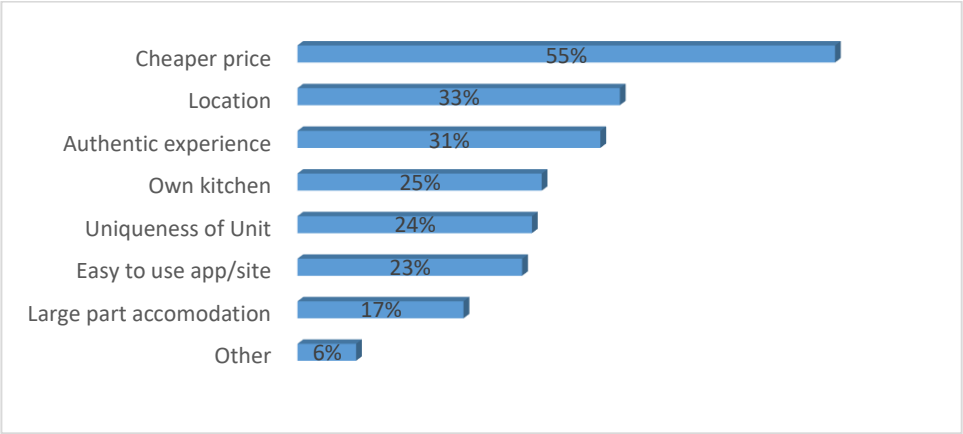

Figure 3: Responses from Airbnb users when asked what the most important factors were that led them to use Airbnb. Source: Morgan Stanley Research.

In contrast to the complaints, there have been many satisfied guests as well. In a recent survey, the majority of the guests have indicated that they have been completely satisfied with the helpfulness of the hosts. In general, guests over 25 years are content with the privacy, the cleanliness, the linens and toiletries offered and the ease at arrival (ipropertymanagement, 2017). Airbnb makes use of an internet-based platform and an application to create a market where people can share their homes, which makes it possible to use otherwise expensive goods without having to buy them (Kaplan & Nadler, 2017). This also makes it possible for home owners to lift the burden of ownership (Jefferson-Jones, 2015). Airbnb does not only participate in the so-called sharing economy, it also focuses on philanthropic projects such as proving housing to victims of natural disasters (Kaplan & Nadler, 2017) and helping out with large events (Kaplan & Nadler, 2017). In 2012, Airbnb offered housing for victims of Hurricane Sandy and in 2017 it launched the #weaccept campaign in response to the refugee ban (Airbnb, 2018). In 2014, Airbnb partnered up with the Rio World Cup and hosted more than 100,000 guests and in 2016, it offered accommodation for the Olympic Games (Airbnb, 2018).

Still, there are some studies that point out that Airbnb is not part of the sharing economy, since sharing does not involve money exchanges, and Airbnb involves market transactions (Oskam & Boswijk, 2016). Most studies, however, focus on the establishment of Airbnb within the sharing economy, its disruptive nature and its effect on the hotel industry, cities and regulation (Oskam & Boswijk, 2016). This paper will narrow the focus to the economic effects of Airbnb on the housing market. Since 50% of the guests visit Europe, 58% of the listings are from European hosts and 6 out of the top 10 markets (by active listings) are European cities, it can be considered as the core of Airbnb transactions. Therefore, the reference point will be Europe. Previous studies on Airbnb include the claim that Airbnb helps hosts make ends meet; this statement is confirmed by the fact that 50% of the Airbnb hosts have stated that they host to afford their homes (Kaplan & Nadler, 2017). This is a good cause, since many families in large cities such as Los Angeles, spend a minimum of 30% of their income on rent (Lee, Airbnb and L.A.'s Housing Crisis, 2016). Some studies, however, claim that Airbnb encourages the listing of entire buildings, making it beneficial to start *illegal hotels* (Lee, Airbnb and L.A.'s Housing Crisis, 2016). This causes a decrease in the overall housing supply. In the city of New York, however, a host earns approximately 6,000 dollars a year, which is not enough to decrease the housing availability, since the monthly rent is over 3,000 dollars already. More studies confirm this with the fact that 86% of the Airbnb hosts only have one residence listed, meaning that there is solely a small portion of hosts that want to make a business out of listing residences on Airbnb (Kaplan & Nadler, 2017). Allowing hosts to earn extra money to meet mortgage and rent obligations, also ensures less scenarios where houses have to be sold below market rate, where repairs cannot be afforded and even foreclosures (Jefferson-Jones, 2015).

Some studies indicated that Airbnb has a negative effect on the housing costs for local residents, but this has been refuted by the fact that housing prices are fundamentally driven by economic, political and demographic aspects (Kaplan & Nadler, 2017). In countries where Airbnb's presence is substantial, however, governments are worried that the willingness to live in certain cities will decrease due to over-tourism. These crowds decrease the demand for housing in certain areas, thus driving the prices down. Others believe that house prices are actually rising, since owners/landlords list unreasonably high prices in order to mask their unwillingness to sell. Laws in Amsterdam, for example, allow you to only post your "home" on Airbnb, meaning that the house listed has to be your primary home, but at the same time it is allowed to offer a second home if it is listed to be sold. To avoid this law, owners are thought to list their houses for extreme prices making it impossible to sell the house and thus allowing them to offer the house on Airbnb for the time that the house remains unsold (McCarthy A. , 2018). There are also laws limiting the total period of listings to 60 days per year, but since there is no law enforcement on this particular law, this law was broken by 6000 properties in the last year of which 5000 were listed

permanently (McCarthy A. , 2018). Another issue is that landlords are tempted to evict their tenants to place more apartments on Airbnb (Kaplan & Nadler, 2017). This removes these apartments from the housing market, thus creating a shortage (Lee, Airbnb and L.A.'s Housing Crisis, 2016). This phenomenon is made attractive due to the fact the Airbnb listings are cheaper than hotels (Lee, Airbnb and L.A.'s Housing Crisis, 2016), thus more attractive to tourists, without having the disadvantages of an hotel (Guttentag, 2015). Even though many studies focus on the effect of Airbnb on the hotel industry, this conclusion would suggest that Airbnb is directly competing with renters rather than hotel owners (Lee, Airbnb and L.A.'s Housing Crisis, 2016). The main problem is that in markets where the vacancy rates are already low, neither the market not the public sector can balance the loss of these houses given the costs, time and laws involved (Lee, Airbnb and L.A.'s Housing Crisis, 2016).

Moreover, there is the idea that hosts who have many houses just to make profit neglect their houses and by doing so drive the prices down of the houses of Long-Term residents in the area (Lee, Airbnb and L.A.'s Housing Crisis, 2016). This means that the presence of Airbnb causes a decrease in the prices of non-listed houses in the neighborhood. The houses that are listed, however, are taken from the housing supply, causing an increase in rent prices leading to a decrease in affordability (Lee, Airbnb and L.A.'s Housing Crisis, 2016). Airbnb, however, claims to have dealt with the concerns mentioned above by examining their user base and by removing hosts that were "abusing the Airbnb platform, harming their neighborhoods, and failing to provide quality accommodations" (Kaplant & Nadlertt, 2017). Other factors, explaining the lack of available housing, include lack of the actual building of units and the lack of funding (Lee, Airbnb and L.A.'s Housing Crisis, 2016). In 2014, where Airbnb reduced 1% of the housing supply in LA, rents increased by 7% (Lee, Airbnb and L.A.'s Housing Crisis, 2016). Still, the numbers suggest the existence of illegal hotels, since the 6% of the hosts with multiple listings are earning 35% of the total Airbnb revenue, leaving little for the low-income hosts that make only 11% (Lee, Airbnb and L.A.'s Housing Crisis, 2016).

Most studies involving determinants of house prices tend to focus on short-term effects vs. long-terms effects. This paper will focus on the long-term effects, including the following determinants: GDP per capita, interest rates, population size, unemployment rate and CPI (i.e. inflation). These determinants have been studies over a long period of time by multiple researchers, an overview can be found in table 1. Previous studies have shown that besides these determinants, there is also a housing demand and supply effect: "When prices go up, because of an increase in demand and a temporary shortage of houses, there is an incentive to construct new houses" (Francke, Vujic, & Vos, 2009). Droes and Minne have found similar results, a negative relation between housing supply and the house price index, along with interest rates and unemployment (Droes & Minne, 2016). Another determinant that occurs in several studies (see table 1) is the GDP index per capita, which can be seen as a proxy for economic activity and/or income (Englund & Ioannides, 1997). Suggesting that an increase in income is expected to have a positive effect on housing demand and, consequently, house prices.

Regarding demographics, population growth, age and size along with unemployment rates, are mostly part of studies on determinants of the house price index. As studies point out: If supply, at least in the short-run, is fixed due to the time it takes to construct buildings (Harter-Dreiman, 2004) or legislation and lack of available space (Hilber & Vermeulen, 2014), an increase in population is expected to have a positive effect on house prices. Glaeser & Gyourko found that population decline has a disproportionate effect on house prices, because the durability of housing means that it can take decades for negative urban shocks to be fully reflected in housing supply levels (Glaeser & Gyourko, 2005). Moreover, it seems evident within multiple studies [(e.g. (Wit, Englund, & Francke, 2013), (Adam & Füss, 2010) and (Abraham & Hendershott, 1996)] that unemployment has a negative effect on the house price index.

"The main drivers of house prices in the 19th century were construction costs, housing supply, unemployment and population. After 1900 the Gross Domestic Product per capita starts to play a role and after the 1970s interest rates as well" (Droes & Minne, 2016). The interesting part about interest rates, according to Droes & Minne, is that it can be both a demand and a supply factor. Higher interest rates will decrease the demand for housing resulting in decreasing house prices (Droes & Minne, 2016). Alternatively, a higher interest rate may also have a negative effect on the ability of construction companies to obtain a loan, which decreases the supply of new housing and, consequently, increases house prices (DiPasquale & Wheaton, 1994); (Capozza, Hendershott, Mack, & Mayer, 2002). In this study, the interest rate is perceived to be demand factor.

Consistent with economic theory, we find that in the long run real house prices are related significantly and positively to real income and to the rate of inflation as represented by the consumer price index. They are also related significantly and negatively to the unemployment rate, mortgage rates, equity prices, and the housing stock (Abelson, Joyeux, Mulunovich, & Chung, 2005).

Table 1 Overview of macroeconomic determinants of house prices investigated in previous studies

I = (Capozza, Hendershott, Mack, & Mayer, 2002)*, II* = (Malpezzi, 1999)*, III* = (Meen, 2002)*, IV* = (Gallin, 2006)*, V* = (Verburggen, Kranendonk, Leuvensteijn, & Toet, 2005)*, VI* = (Abelson, Joyeux, Mulunovich, & Chung, 2005)*, VII* = (McCarthy & Peach, 2004)*, VIII* = (Ambrose, Eichholtz, & Lindenthal, 2013)*, IX* = (Adam & Füss, 2010)*, X* = (Francke, Vujic, & Vos, 2009)*. US = United States, NL = the Netherlands, UK = the United Kingdom, OECD = the countries participating in the Organization for Economic Co-operation and Development and AU = Australia. Y = Yearly, Q = Quarterly.*

Variable	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*
GDP	*√*	*√*	*√*	*√*	*√*	*√*	*√*		*√*	*√*
Interest rates		*√*	*√*	*√*	*√*		*√*	*√*	*√*	*√*
Population Size	*√*	*√*	*√*	*√*	*√*					
Unemployment	*√*	*√*	*√*	*√*	*√*	*√*				
Inflation						*√*				
Country	*US*	*US*	*UK/US*	*NL*	*US*	*AU*	*US*	*NL*	*OECD*	*NL*
Frequency	*Y*	*Y*	*Q*	*Q*	*Y*	*Y*	*Y*	*Y*	*Q*	*Y*
Sample start	*1979*	*1979*	*1969*	*1975*	*1981*	*1970*	*1982*	*1650*	*1975*	*1965*
Sample end	*1995*	*1996*	*1996*	*2002*	*2003*	*2003*	*2004*	*2005*	*2007*	*2009*

Other studies focus on the effect on the hotel industry and the regulatory system. There are several arguments provided for this statement. Firstly, there is the claim that the offering of cheaper accommodation and additional income for guests does not benefit the workers in the hotel industry (Oskam & Boswijk, 2016). The reason why Airbnb can offer low prices is due to the fact that fixed costs such as rent and electricity are already paid and stays are not taxed (Oskam & Boswijk, 2016). Hotels, on the other hand, are less risky due to standardization, safety regulations and business reputation (Oskam & Boswijk, 2016).

Moreover, Airbnb makes it beneficial for hosts to offer accommodation without having to pay the taxes hotel owners do (Lee, Airbnb and L.A.'s Housing Crisis, 2016). This, in combination with the lost jobs for cleaners, hotel workers, the neglecting of zoning laws and public health regulations, causes an unfair competitive advantage for Airbnb hosts (Lee, Airbnb and L.A.'s Housing Crisis, 2016). In contrast, guests in e.g. New York City tend to stay longer and spend more during their visit (Kaplan & Nadler, 2017), thus increasing money earned at local businesses. On average, Airbnb guests stay 2.4x more nights and spend 2.3x more than regular guests (ipropertymanagement, 2017). This is also confirmed in European cities, such as London, where Airbnb guests tend to stay 1.5x longer and spend

2.1x more than regular guests (ipropertymanagement, 2017). In Amsterdam, Airbnb guests tend to spend 1.5x more and stay 2.1x more nights (ipropertymanagement, 2017). The same goes for Berlin, where Airbnb guests stay 2.7x longer and spend 1.8x more than hotel guests (ipropertymanagement, 2017). Another aspect that makes Airbnb competitive includes the fact that guests can "live like a local" due to their connection to locals that are renting out their homes (Kaplan & Nadler, 2017). This aspect is confirmed by the guests, since approximately 30% of the guests claimed to have not stayed where they did if there was no Airbnb (Oskam & Boswijk, 2016).

In contrast to previously mentioned studies, other studies found out that a 1% increase in Airbnb listings cause solely a 0.05% decrease in hotel revenues (Kaplan & Nadler, 2017), thus claiming that Airbnb does not compete with the hotel industry. This is confirmed by the fact that the majority of the Airbnb listings are outside central hotel districts, meaning that Airbnb targets an entirely different group of tourists that mainly focus on cost-saving and local experiences than expensive hotel rooms (Oskam & Boswijk, 2016). This claim is complemented by the fact that in major cities in America it is cheaper to rent an entire home on Airbnb ($200 in NY) than a single hotel room ($260) (ipropertymanagement, 2017). In San Francisco, this counts too, where a single hotel amounts to $270 and an entire home on Airbnb costs $200 on average (ipropertymanagement, 2017). Also, 60% of the guests are millennials (ipropertymanagement, 2017) that in general have less money to spend.

The arguments above would suggest that Airbnb complements the hotel industry, rather than competing with it, which happened before when Airbnb hosted rooms for several big events. In LA, for example, there are over 11,400 Airbnb listings while there are 97,000 hotel rooms (Lee, Airbnb and L.A.'s Housing Crisis, 2016). Moreover, of the total of 45 million tourists in LA in 2014, there were 135,000 that stayed in an Airbnb home (Lee, Airbnb and L.A.'s Housing Crisis, 2016). This is also the case in one of the biggest Airbnb cities, Amsterdam, where the number of Airbnb listings is growing, but does not exceed the number of available hotel rooms (Pas, 2017). Figure 4 shows that even though Airbnb is accused of offering unfair competition when it comes to the hotel industry, because it does not follow the same laws as hotels have to and because it is offering accommodation at a substantially lower cost due to this, it does not even touch the surface when compared to the number of hotel rooms available in big cities, such as Amsterdam. Another aspect that weighs in when it comes to choosing an hotel or an Airbnb site is trust, which is an important element in internet transactions in general (Oskam & Boswijk, 2016). Regarding this aspect it is evident that the hotel industry has an advantage due to their low risk through legal requirement in the form of e.g. safety regulations (Oskam & Boswijk, 2016). Airbnb, however, has reduced this advantage through their review system that allows hosts and guests to review the overall experience (Oskam & Boswijk, 2016).

Figure 4: The total number of hotel rooms compared to the number of Airbnb properties within Amsterdam, The Netherlands over the period 2010-2016. Source: Statista.com

Some studies point out that all problems could be solved by introducing new laws, but the problem with this is that the sharing economy is unknown territory since it involves a third category "people as a business" (Kaplan & Nadler, 2017). Airbnb tried tackling some of the problems by informing users on the laws within their Terms of Service (Kaplan & Nadler, 2017). Still, it cannot do more than rely on the fact that users follow local laws (Guttentag, 2015).

The New York City's department of Finance agrees by mentioning that Airbnb cannot collect taxes from every hosts since it's "neither a hotel operator nor a room remarketer" (Kaplan & Nadler, 2017). For Amsterdam, however, Airbnb has placed warnings on their website regarding the accommodation taxes that hosts are supposed to pay (Guttentag, 2015). The problem with hosts not paying accommodation taxes is that these taxes are meant for tourists exclusively and are then used for the promotion of destinations, which again benefits tourists (Guttentag, 2015). Since Airbnb hosts are not paying these taxes, they are considered to be "free riders" that benefit of promotions that they do not pay for (Guttentag, 2015).

One of the issues are the illegal hotels mentioned earlier, since they are unlicensed, do not have hotel permits nor insurance and do not follow city regulations (Lee, Airbnb and L.A.'s Housing Crisis, 2016). Since the introduction of Airbnb, there have been some regulatory changes. In 2010, for example, a new law prohibited hosts to have occupants staying longer than 30 days, thus ensuring that housing would solely be used for residency in New York (Kaplan & Nadler, 2017). Another law ensuring this is the multiple dwelling law implemented in New York that is supposed to maintain a certain number of dwellings that are solely used for permanent residents (Jefferson-Jones, 2015).

Studies have also provided ideas on more laws that could limit the Airbnb problem. Firstly, hosts could be obligated to pay a fee within a system that would offer a certificate that would ensure their legitimacy on Airbnb (Guttentag, 2015). Another solution would be for the governments to ban year-round listings (Lee, Airbnb and L.A.'s Housing Crisis, 2016). By legalizing Airbnb listings, taxes can be implemented which can be used for government purposes (Guttentag, 2015). Moreover, government could introduce quota limiting Airbnb listings in certain regions by the same hosts (Lee, How Airbnb Short-Term Rentals Exacerbate Los Angeles's Affordable Housing Crisis: Analysis and Policy Recommendations, 2016). Another solution is offering exemptions for developers of dwellings used for permanent residents, thus increasing the housing supply (Lee, How Airbnb Short-Term Rentals Exacerbate Los Angeles's Affordable Housing Crisis: Analysis and Policy Recommendations, 2016). The most forward solution, however, would be to implement an occupancy tax for Airbnb listings (Lee, How Airbnb Short-Term Rentals Exacerbate Los Angeles's Affordable Housing Crisis: Analysis and Policy Recommendations, 2016).

While Airbnb has many followers and users that enlighten the benefits on tourism, cultural exchange, the environment and the wallet, it also has many critics who focus on the disadvantages for the hotel industry, home seekers and governments (Lee, How Airbnb Short-Term Rentals Exacerbate Los Angeles's Affordable Housing Crisis: Analysis and Policy Recommendations, 2016).

III. The research questions

This paper focuses on answering the following question: Is Airbnb disrupting the housing market? In order to answer this question, there will be three sections of the real estate market highlighted. The first two topics focus on two of the drivers of the real estate market: the housing prices including the affordability of properties and the housing demand and supply. Regarding the first topic, it is also being research whether there is a causality effect by regressing the house price index by regular macroeconomic determinants along with at least one Airbnb presence indicator. The last topic focuses on host credibility.

H1a: The presence of Airbnb is affected by the house prices in Europe.

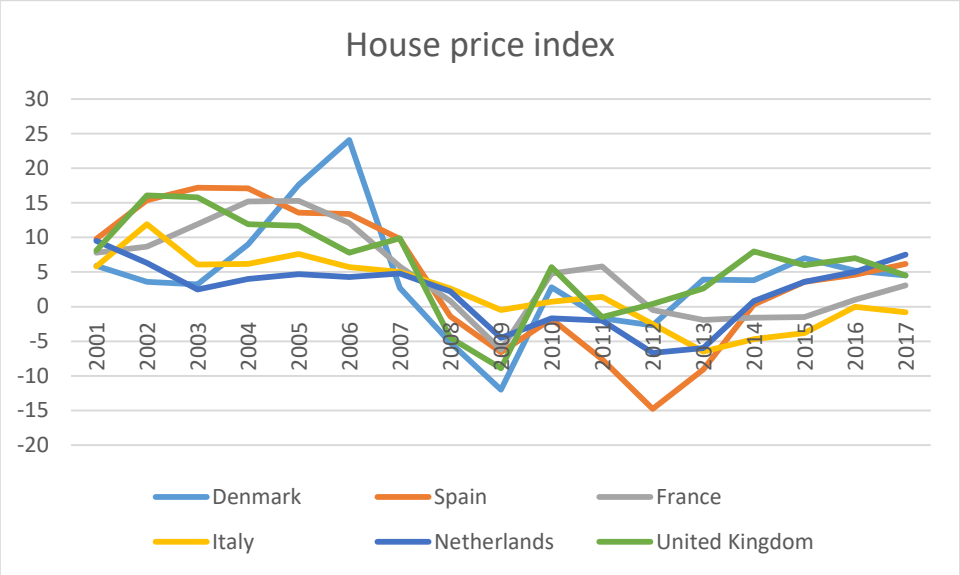

Figure 5: The house price index over the period 2001-2017 for the countries corresponding to the top six Airbnb cities. The House Price Index (HPI) measures the changes in the transaction prices of residential properties, both newly built and existing, purchased by households. Source: Eurostat. "The House price index captures price changes of all residential properties purchased by households (flats, detached houses, terraced houses, etc.), both new and existing, independently of their final use and their previous owners. Only market prices are considered, self-build dwellings are therefore excluded. The land component is included. The data are expressed as annual average index 2015=100, as 3 years % change and annual average rate of change."

As can be seen in figure 5, for most of the top six Airbnb cities, the house price index has been fluctuating since the 2001. In 2008, the year in which Airbnb was founded and the year of the global housing crisis, there has been a drop in prices in almost all countries. As of 2014, most house price indexes have remained stable. By investigating the correlation between the house prices in Europe and the presence of Airbnb throughout the years, it will be possible to see whether Airbnb is influencing these fluctuations in a way.

When regarding previous studies the hypotheses that Airbnb has a negative effect on the housing prices, it turns out that the results are very different. Since Airbnb was started (and has most of its activities) in Europe, this hypotheses has to be tested in the core of Airbnb, thus Europe. To estimate the effect of Airbnb on the real estate market it is important to consider one of the main factors within this market: house prices. By examining the relationship between Airbnb listings and the house prices in Europe, it will be possible to conclude whether there is indeed a negative influence of Airbnb on the real estate market. Answers will be provided to questions such as "are owners avoiding laws by asking extreme prices for their houses?", "Does the tourism that Airbnb creates cause housing price to go down due to the decrease in demand to live in those areas?" and "Does Airbnb drive rent prices up, thus decreasing affordability of non-Airbnb properties?".

H1b: The presence of Airbnb is affecting the house prices in Europe.

As previous studies have pointed out, there are several macroeconomic determinants of house prices. Five of them are included in a model to see if the presence of Airbnb can be included among these determinants. The ones this paper focuses on are: CPI, population size, interest rates, GDP and unemployment rate. The expected relations, based on previous studies, such as [(Droes & Minne, 2016) and (Abelson, Joyeux, Mulunovich, & Chung, 2005)], are positive for GDP and CPI and negative for the other variables. The regression of all these variables including a dummy for the biggest Airbnb countries and the number of Airbnb listings, will provide conclusion on whether Airbnb influences the House price index within Europe.

H2: The presence of Airbnb is affected by the housing supply in Europe.

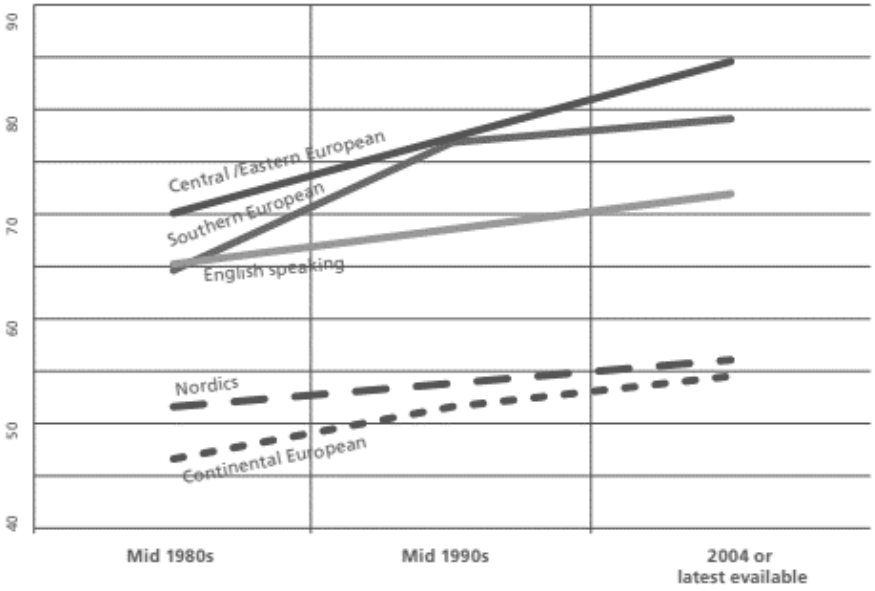

Figure 6: "The homeownership rates in each group refer to the simple average of the rate in individual countries. Nordics includes Denmark, Norway, Sweden and Finland; English-speaking includes Australia, Canada, the United Kingdom, the United States and Ireland; Continental European includes Austria, Belgium, France Germany, the Netherlands, Switzerland and Luxembourg; Southern European includes Greece, Spain and Italy; Central/Eastern includes Hungary, Poland and the Russian Federation." Source: Housing Europe Review 2012.

In general, we see that in most countries in Europe (figure 6) there has been a steady growth in homeownership rates, meaning that over the years more and more residents have acquired a home. By analyzing the effect of Airbnb on the housing supply and demand and on the other hand, vacancy rates, it is possible to draw conclusions on the questions mentioned before: "Is Airbnb encouraging housing shortage?", "Is Airbnb harming areas with an already low vacancy rate?" And "Does Airbnb make it impossible to acquire homes, since owners are unwilling to sell due to the benefits on Airbnb?". Moreover, there will be looked at the housing completed over the year per country to see if Airbnb is causing housing supply problems or another party; the government.

H3: The presence of Airbnb is affected by host credibility in Europe.

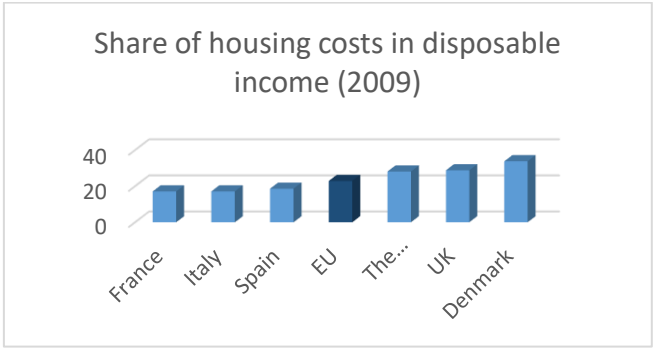

Figure 7: The share of housing costs in disposable income in 2009 for the countries corresponding to the top six Airbnb cities. The share of housing costs in disposable household income refers to the weighted mean of the distribution of the share of housing costs in disposable household income. Source: Eurostat

On average, in 2009, slightly more than 20% of the disposable income of residents was allocated to their housing costs; including rent and/or mortgage. In three of the six countries corresponding to the biggest Airbnb cities, we see that this number is above average, reaching to approximately 30%. When it comes to the mortgage costs in particular, it can be deducted from figure 8 that on average this

amounts to approximately 50% of the GDP in Europe. For Spain, the UK, Denmark and The Netherlands, however, this percentage is above average reaching even above 100% in Denmark and The Netherlands. Seeing that Airbnb is founded on the sole purpose of meeting rent obligations, it is essential to see if now, 10 years later, that is still the core of the business. Does Airbnb indeed help hosts meet their mortgage and rent obligations or has it deviated from its main purpose?

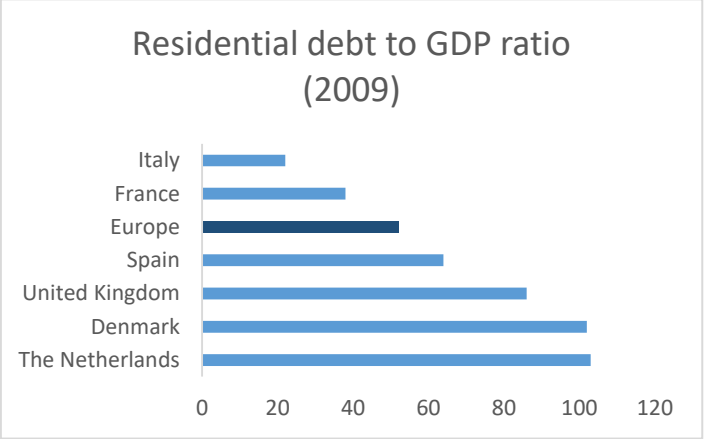

Figure 8: The residential debt to GDP ratio in 2009 for the countries corresponding to the top six Airbnb cities. Residential debt is the total outstanding residential loans and the GDP is the gross domestic product in these countries. Source: European mortgage federation.

IV. Data and methodology

Data sources

The number of active Airbnb listings per year per city has been obtained from the AirDNA database. AirDNA is a website that helps business with analytics, by providing data on the daily performance of over 10 million listings in 80 thousand markets on Airbnb and comparable sites. As they say: "Airbnb hosts, vacation rental managers, hoteliers, and real estate investors all rely on AirDNA's vacation rental insights to optimize their listings, find lucrative properties, and outperform the competition" (AirDNA, 2018).

The data on the cost of living has been obtained from the Numbeo database. These variables include the gross rental yield, price to income ratio, affordability index and the mortgage to income ratio. Numbeo has been used as a provider of data for multiple international newspapers and magazines over the years, some examples include BBC, Forbes, The Economist, China Daily and The Washington Post. Numbeo itself is described as the world's largest database involving data contributed by users on cities and countries worldwide allowing the database to provide current and timely information on e.g. cost of living, housing, health case, crime and traffic (Numbeo, 2018).

ECB: The European Central Bank (ECB) is the central bank of the 19 European Union countries which have adopted the euro. Our main task is to maintain price stability in the euro area and so preserve the purchasing power of the single currency (ECB, 2018). "The first step towards creating the ECB was the decision, taken in 1988, to build an Economic and Monetary Union: free capital movements within Europe, a common monetary authority and a single monetary policy across the euro area countries" (ECB, 2018).

Eurostat is a database containing 50 years of data about EU members (Eurostat: Official EU statistical data, 2018). This database will also provide data on housing shortages in Europe used to evaluate the effect of Airbnb on the mismatch between housing demand and supply. More data such as "the severe housing deprivation rate" and "vacancy rate" are available on Eurostat and are used to

provide additional evidence. Eurostat is the statistical office of the European Union situated in Luxembourg. Its mission is to provide high quality statistics for Europe, while focusing on respect and trust, excellence, innovation, service orientation and professional independence. “Looking for ways to continually improve its products and services, Eurostat gained the European Foundation for Quality Management "Committed to Excellence" recognition in November 2016. Providing the European Union with statistics at European level that enable comparisons between countries and regions is a key task. Democratic societies do not function properly without a solid basis of reliable and objective statistics.” (Eurostat: Official EU statistical data, 2018). Eurostat focuses on providing statistics for decision makers as well as the public and the media to be able to present an accurate picture of current situations to the outside world. An overview of all variables (see table 2) and the corresponding source can be found in table 3.

In this paper, I focus on several aspects of the real estate market that might be influencing Airbnb. To facilitate the comparison of all these aspects across years and countries, I focus on the 1990-2017 period. For every panel, the years differ based on the data available. For the housing prices this concerns 2010-2017, for the housing supply 1990-2017 and for the host credibility figures this is 2003-2017. When regarding the effect of Airbnb on the house price index, the panel data is strongly balanced over the period 2006-2017 with 370 observations.

Panel A consists of European data, whereas Panel B focuses on Capital data. For the first topic, the effect on housing prices, the data of panel A over the period 2010-2017 is unbalanced with 47 observations. Panel B however has 1084 observations and the panel data is unbalanced over the same period. For the second topic, the effect on the housing supply, the period is 1990-2017 and unbalanced too. There are 164 observations within Panel A and 520 observations for panel B. The last topic, the effect on host credibility, will be tested with data from 2003-2017 which is strongly balanced for panel A and unbalanced for panel B. For this topic there are 90 observations for panel A and 330 observations for panel B. The difference in observations is a possible problem.

The selection includes the 28 countries in the European Union; Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. Since the data on Airbnb listings is only available per city, the data from the capital cities have been collected and the capitals are used as the proxy for the countries in Europe.

Variable description

Table 2 The variable description of every variable used within this paper.

The first column shows the name given to the variables used within this paper. The sections indicate the different regressions, except for section 1, which shows the dependent variables. The second column shows the descriptions provided on the websites of the corresponding data sources.

Variable	Description
House price index	The *House Price Index* measures the changes in the transaction prices of residential properties (existing and newly built) purchased (by households) with 2015 as reference year.
Listings	The total number of active listings on Airbnb. The dummy variable Major in included as an independent variable in the regression for house price index. This variable takes the value of 1 when the presence of Airbnb is significant within the country.
Affordability	*The Affordability Index* is calculated as the inverse of mortgage as percentage of income.
Arrears	*Arrears on mortgage or rent payments* represent the percentage of people who have arrears on their financial obligations, in this case mortgage or rent payments.
Burden	*Housing financial burden* shows the percentage of households that face financial burden due to costs related to housing.
Deprived	*Severe housing deprivation rate* is the percentage of the population living in the housing which has at least one of the housing deprivation measures referring to those households (a leaking roof, no bath/shower and no indoor toilet, or a dwelling considered too dark).
Mortgage	*Mortgage as a percentage of income* is calculated as the actual monthly cost of the mortgage divided by take-home family income.
CPI	Index used to measure inflation.
GDP per capita	The GDP per inhabitant. The volume index of GDP per capita in Purchasing Power Standards (PPS) is expressed in relation to the European Union (EU28) average set to equal 100.
GRY(O)	*Gross rental yield* represents the total yearly gross rent divided by the house price. This data has been divided into the sections: within the city center and outside of the city center.
Interest Rate	The interest rates per year per country.
PTI	*Price to Income ratio* which is the ratio of median apartment prices to median familial disposable income
PTR(O)	*Price to rent ratio* is the average cost of ownership divided by the received rent (if buying to let) or the estimated rent that would be paid if renting (if buying to reside).
Size	*The population size* is the percentage of inhabitants to the total in Europe.
Unemployment	*The unemployment rate* refers to the percentage of the population that is unemployment.
Transactions	*The number of housing transaction (x1000)*
Vacancy	*The vacancy rate* signifies the proportion of non-occupied dwellings in relation to all properties used as homes.
Completions	*The number of houses completed (x1000)*
Dwellings	*The number of dwellings (x1000)* which is a self-contained unit of accommodation used as a home.
Rentals	*Total rented accommodation* represents the number of rented dwellings as a percentage of the total number of dwellings.
Value	*Value of housing transactions (in millions) The transaction value* is the contract price without transaction costs reported by notaries.

Table 3 An overview of all variables with corresponding information

The first column shows firstly the two dependent variables: the house price index and the number of active Airbnb listings. Below are the independent variables. Since two different regression model types are used (with Listings as dependent variable and the house price index as dependent variable), the variable "Listings" is also used as an independent variable in the house price index regression. The data sources are mentioned in column 2 and column 3-4 indicate the variable type with the use of unit classifications and determinant types (indicating to which regression the variables belong). In the last column, the expected sign based on previous studies is represented.

Variable	Source	Unit	Type of Determinant	Expected sign
House price index	Eurostat	Index		
Listings	AirDNA	Total		
Affordability	Numbeo	Index	Host credibility	+
Arrears	Eurostat	%	Host credibility	+
Burden	Eurostat	%	Host credibility	+
Deprived	Eurostat	%	Host credibility	+
Mortgage	Numbeo	%	Host credibility	+
Major		Dummy	House pricing	+
CPI	Eurostat	Index	House pricing	+
GDP per capita	Eurostat	Index	House pricing	+
GRY(O)	Numbeo	Index	House pricing	+
Interest Rate	ECB	%	House pricing	-
PTI	Numbeo	Index	House pricing	+
PTR(O)	Numbeo	Index	House pricing	+
Size	Eurostat	%	House pricing	+
Unemployment	Eurostat	%	House pricing	-
Transactions	ECB	Total	Housing demand	+
Vacancy	ECB	%	Housing demand	+
Completions	ECB	Total	Housing supply	-
Dwellings	ECB	Total	Housing supply	-
Rentals	ECB	Total	Housing supply	-
Value	ECB	Total	Housing supply/Demand	+

Summary Statistics

Table 4 represents the summary statistics for the entire sample used in this paper, except for the sample belonging to topic 1b, which is shown in table 4 Where you would expect that the cities where the presence of Airbnb is the most imminent have lower house prices on average compared to the rest of Europe, the data shows that this does hold in most cases, even though the differences are not substantial. When regarding the price to rent index, for example, it is evident that the index is higher in the six major cities inside and outside the city center (29.31 and 25.23) on average than the same index for Europe (24.77 and 22.68). This indicates that on average the house prices in the top 6 European Airbnb cities are lower than the rest of Europe.

For topic 2, the effect on the housing supply, there are several discrepancies. First, there are on average more dwellings (19,441 thousand) and houses completed (approximately 192 thousand) in the six major cities than number of dwellings (8847 thousand) and houses completed (approximately 79 thousand) in Europe. Even though you would expect that the housing supply is lower in these cities, data shows the opposite. When regarding the number of housing transactions (563.91 vs. 215.92 thousand in Europe) and the value of these housing transactions (85,465 vs. 30,858 thousand in

Europe), we see a substantial housing demand in the top 6 European Airbnb cities. These differences are also seen in the median of all variables within this part of the sample. When focusing on the average number of dwellings within Europe (8847 thousand) we see that these amounts are substantially higher than the median of this sample (4110 thousand). This indicates a negatively skewed data, where the housing supply for most cities within Europe is low and just a few cities are high. In the case of the number of dwellings this could be caused by the numbers within the six major cities, where we see that the housing supply data on this aspect is negatively skewed with a low mean (19,441 thousand) and a high median (24,731 thousand). For other variables within the housing supply data, we see a similar situation within panel A. The average of houses completed (78 thousand), housing transactions (215 thousand) and the value of these housing transactions (30.8 million) are much higher than the medians (30 thousand, 79 thousand and 6.7 million respectively). This too suggests a positively skewed data set, with a few cities containing many house completions, housing transactions and expensive house sales. In Panel B we see the same situation for the variable "value housing transactions" where we see a median of approximately 50 million against a mean of 85 million.

When regarding topic 3, the effect on the ability to meet mortgage and rent obligations, in Europe we see on average more houses that exhibit housing deprivations. The mean in the top 6 European Airbnb cities is substantially lower (1.94%) than the mean in Europe (4.11%). This topic is the only one with substantial differences in the standard deviations, in this case on severe housing deprivation and mortgage to income. In terms of host credibility, while all cities' average on severe housing deprivation (4.11 in panel A and 1.94 in panel B) and arrears on mortgage or rent (13.98 in panel A and 12.74 in panel B) are high, we see a low median for both variables. In panel A the medians correspond to 1.5 and 4.25 correspondingly, and the medians in panel B that are 1.0 and 4.9 respectively. The summary statistics in this section are not always consistent with the hypotheses laid out in Section I. In the following section I carefully test whether the two panels are different in a manner consistent with all of the hypotheses presented in Section I under the ceteris paribus condition.

Considering table 5, we see that the data is negative skewed, with the averages being lower than the median, except for the house price index that has a slightly lower mean (92.2) than median (97.3). The most extreme cases involve the number of Airbnb listings (2971 average against the mean of 464 listings) and the population size (3.4% average against the mean of 1.7%0, which is not a very surprising result, since Airbnb is more present in some countries than others and since the population size per country within Europe differs extremely too. This also explains why the p10-values in both cases (11 listings and 0.2%) differ enormously from the p90-values (8056 listings and 12.3%).

Table 4 Summary statistics

This table reports the summary statistics for part of the sample in this study; column 2-5 represents "Panel A" containing data on Europe and column 6-8 show the top six Airbnb cities within "Panel B". The first column of each panel contains the mean, the second the median and the last the standard deviation of the variables mentioned in the first column of the table. PTR represents the average cost of ownership divided by the received rent income (if buying to let) or the estimated rent that would be paid if renting (if buying to reside). Lower values suggest that it is better to buy rather than rent, and higher values suggest that it is better to rent rather than buy. The "O" indicates that the variable consists of data outside the city center. Dwellings, Completions and Transactions represent the number of dwellings, houses completed and housing transactions in thousands. Value represent the value of the housing transactions in millions and Deprived is the indicator of severe housing deprivation. Deprived is the percentage of the population living in the dwelling which is exhibiting at least one of the housing deprivation measures referring to those households with a leaking roof, no bath/shower and no indoor toilet, or a dwelling considered too dark. Mortgage corresponds to the mortgage amount as a percentage to income and AMR the percentage of people who have arrears on their financial obligations, in this case mortgage or rent payments. Definitions of the independent variables are in the mentioned in the variable description table on page 15. The separate parts in the table represent the division of the topics, first the effect on house prices, then the effect on housing supply and the last part corresponds to the ability to meet mortgage and rent obligations.

	Panel A: Europe			Panel B: Top 6 Airbnb cities		
Variable	Mean	Median	St. Dev.	Mean	Median	St. Dev.
PTI	10.83	10.08	5.26	14.57	14.73	6.72
GRY	4.50	4.23	1.52	3.73	3.62	1.12
GRYO	4.82	4.60	1.50	4.22	4.15	1.07
PTR	24.77	23.67	8.57	29.31	27.66	8.75
PTRO	22.68	21.74	6.91	25.23	24.12	6.29
Affordability	1.50	1.33	0.90	1.18	0.97	0.55
	Panel A: Europe			Panel B: Top 6 Airbnb cities		
Variable	Mean	Median	St. Dev.	Mean	Median	St. Dev.
Dwellings	8847.02	4110.58	11203.81	19441.64	24731.00	11264.49
Completions	78.93	30.36	116.48	192.20	181.50	148.69
Transactions	215.92	79.10	337.70	563.91	532.00	415.32
Rentals	23.60	21.70	15.85	32.81	35.18	13.66
Vacancy	7.22	6.00	7.20	7.80	5.65	6.11
Value	30858.08	6714.00	65890.68	85464.88	49686.00	99239.40
	Panel A: Europe			Panel B: Top 6 Airbnb cities		
Variable	Mean	Median	St. Dev.	Mean	Median	St. Dev.
AMR	13.98	4.25	19.53	12.74	4.90	15.92
Burden	38.67	43.80	19.57	28.86	32.20	16.20
Deprived	4.11	1.50	5.25	1.94	1.00	2.58
Mortgage	84.54	69.10	58.86	67.49	64.48	21.25

Table 5 Summary statistics

The first column shows the variables used in determining whether Airbnb has an effect on the house price index, which is the dependent variable and is listed first. The dummy variable Major is excluded, since it can only take the value of one or zero. Column 2 and 3 show the average value and the standard deviation within the data of the variable concerned. Columns 3-5 show the values for p10, p50 (the median), p90 indicate that the values noted show the border of 10%, 50% and 90% of the observations.

Variable	Mean	St. Dev.	p10	p50	p90
HPI	92.22	28.30	70.46	97.31	115.66
Listings	2971.23	6573.79	11.00	464.00	8056.00
GDP	90.25	48.51	35.00	83.00	136.00
CPI	2.19	2.62	0.00	1.70	5.50
SIZE	3.47	4.49	0.20	1.70	12.30
Unemployment	8.91	4.25	4.80	7.85	14.20
Interest Rates	5.06	6.10	0.99	3.98	7.62

Methodology

This paper uses panel data for analysis, meaning that there are three possible estimators that can be used. In order to test these estimators, two tests are done. Firstly, the chi-square test is used to determine whether to use Fixed Effects or Random Effects. This test will determine whether the covariance between X_{it} and a_i does not equal zero, in which case Fixed Effects is the better estimator. First, we regress the dependent variables on the mean of these variables. Then the mean variables are tested with a F-test using the Chi-square estimator. The results are displayed in table 6, where it is evident that for all groups there is a statistically significant relation between X_{it} and a_i. This indicates that the FE estimator is preferred in all cases over the RE estimator.

Next the residuals (errors) are tested to see whether they are serially correlated, thus to determine whether to use Fixed Effects or First Differences. Rejecting H_0 would indicate that Fixed Effects is preferred and that the errors are serially correlated. If H_0 is not rejected, both estimators are used to interpret the conclusions. The results in table 6 indicate that for four out of the six groups the Fixed Effects estimator is preferred, whereas for the other two the result is inconclusive. For these two groups both estimators will be used for testing. The same is done for the panel data that is meant for testing whether Airbnb has an effect on housing prices. Here, a chi-square coefficient of 12.66 with a p-value of 0.12 suggested that the RE estimator is actually preferred over the FE estimator.

Table 6 Determination of Panel data estimator.

*This table shows the two test to determine the panel data estimator per topic. Every column within the panels (1-3) represents the corresponding topics within this paper; the effect on housing prices, housing supply and the ability to meet mortgage and rent obligations. The table shows the coefficients of each variable with the corresponding p-value in brackets. ** and *** show the statistical significant of the variable at 5% and 1% respectively. Test 1 focuses on determining whether to use FE or RE and test 2 focuses on FE vs. FD.*

	Panel A: Europe			Panel B: Top 6 Airbnb cities		
Test	(1) Price	(2) Supply	(3) Financial Burden	(1) Price	(2) Supply	(3) Financial Burden
Chi-square	24.64*** (0.00)	157.4** (0.00)	16.02*** (0.01)	444.21*** (0.00)	239.72*** (0.00)	64.2*** (0.00)
$L\hat{u}$	0.14 (0.47)	-1.01** (0.03)	0.41** (0.04)	0.56*** (0.00)	-0.23 (0.28)	0.81*** (0.00)

V. Regression results

Table 7 An overview of all regression results with the corresponding signs

Overview of all regression results, where the +/- sign indicates inconclusive data. Column 1 shows the variables names given, column 2 the type of determinants which classifies to which regression the variables belong and column 3-4 show the expected and actual signs of the coefficient of these variables.

Variable	Type of Determinant	Expected sign	Actual sign
Arrears	Host credibility	+	-
Burden	Host credibility	+	-
Deprived	Host credibility	+	+/-
Mortgage	Host credibility	+	+
Affordability	House pricing	+	+
GRY(O)	House pricing	+	+/-
PTI	House pricing	+	+
PTR(O)	House pricing	+	+/-
CPI	House pricing (macro)	+	+
GDP per capita	House pricing (macro)	+	-
Interest Rate	House pricing (macro)	-	-
Size	House pricing (macro)	+	+/-
Unemployment	House pricing (macro)	-	+/-
Listings	House pricing (Airbnb)	+	+
MAJOR	House pricing (Airbnb)	+	+
Completions	Housing supply	-	-
Dwellings	Housing supply	-	+
Rentals	Housing supply	-	+
Transactions	Housing demand	+	+/-
Vacancy	Housing demand	+	+/-
Value	Housing supply/Demand	+	+

Is the presence of Airbnb affected by house prices?

In this section, I study the influencers of the presence of Airbnb using panel data. Table 8 shows the results regarding the effect on housing prices. I focus on four variables that previous studies have indicated as possible influencers; price to income, gross rental yield, price to rent and affordability. The regressions are shown below:

$$ActiveRentals_{it} = \alpha + \beta_1 Dwellings_{it} + \beta_2 Completions_{it} + \beta_3 Transactions_{it} + \beta_4 Rentals_{it} + \beta_5 Vacancy_{it} + u_{it}$$

$$\Delta ActiveRentals_{it} = \alpha + \beta_1 \Delta Dwellings_{it} + \beta_2 \Delta Completions_{it} + \beta_3 \Delta Transactions_{it} + \beta_4 \Delta Rentals_{it} + \beta_5 \Delta Vacancy_{it} + \gamma_t + \Delta u_{it}$$

Overall, we see a positive relationship in both panels between the presence of Airbnb and the price to income, affordability and the price to rent index outside city centers. The price to income index corresponds to the formula average rent price divided by net disposable family income. The positive relation suggests that in cities where the ratio is high, we see more Airbnb listings. This means that cities where the rent prices are high and/or disposable income is low show more Airbnb listings. These figures are statistically significant for both Panel A and B when considering the first estimator. If the PTI index would differ by 1% in two cities, we see that the difference between the two cities would amount to approximately 31 more listings in the capital cities within panel B. In panel A, however, this difference would indicate a far more significant difference of almost 295 listings between the cities. The affordability index is related to the ability to purchase a house. The positive relation between this variable and the presence of Airbnb indicates that in cities where it is affordable to buy a house, there are more Airbnb listings. Even though, only one coefficient is statistically significant in this case, there are substantial effects on the number of listings. Where a 0.1 increase in the affordability index would result in an increase of 68 listings within panel B, we see an increase of over 3000 listings in panel A.

The price to rent ratio is determined by dividing the cost of ownership by the received rent income and provides insight on whether it is better to sublet or buy a property. This data is divided over the information within city centers and outside the city centers. When regarding the data outside city centers, we see a positive relation in both panels, of which only one coefficient within panel A is statistically significant. In panel B, we see that a 1% increase in the ratio leads to an increase of 78 listings for areas outside the city center. This number is more than 20 times multiplied for the increase in listings within panel A (1624 listings). This means that overall in cities where the rent price is high and/or the cost of ownership is low, thus where the PRT ratio is low, we see less Airbnb listings. This result corresponds to previous results. For the properties outside the city center, however, we see that there is negative relation within panel A, which suggests that in the major Airbnb cities there are (within city centers) lower rent prices and/or higher cost of ownership levels compared to the top 6 Airbnb cities in Europe. This result is statistically significant in case of the first estimator within panel A and the coefficient is close to the coefficient of panel A in the previous case (within city centers).

The gross yield is the total yearly gross rent divided by the house price (expressed in percentages). This data is divided into two sections: within the city centers and outside them. When regarding the data corresponding to “within city centers”, we can state that there is a positive relation in panel B, but a negative one in panel A. This suggests that when the gross rent goes up and/or the house prices go down, thus decreasing the gross rental yield, the number of listings will decrease within the capital cities in panel B with 641 listings per 1% decrease. In the cities within panel A, however, the same percentage decrease results in an increase of nearly 12,000 listings. The data corresponding to “outside city centers” shows the same relations when regarding the first estimators in both panels.

Comparing the different estimators within panel A, we see that even though the coefficients differ immensely in most cases, in general, the sign are the same. The one exception is represented by the relation with the gross rental yield outside the city centers. Here we see a positive and statistically significant relation between the index and the presence of Airbnb. This result corresponds with the data from panel A and has less errors than the negative result from the first estimator. Overall, when considering the year dummies, we see that for both panels there are significant effects occurring outside the model in the period 2013-2017 (Panel A) and 2012-2017 (Panel B). This is not completely unexpected, since the model consists of solely price indicators. It would seem logic that there are more variables influencing Airbnb, but this model is just meant to determine whether there is any relationship to begin with.

To conclude the data is very inconclusive on the relation between rent price and the presence of Airbnb, meaning that there is not enough evidence to proof that rent price is one of the factors affecting the number of Airbnb listings. Due to this analysis with the use of several ratios, we can conclude though that there is a definite negative relation between income and the presence of Airbnb, meaning that we see a higher number of listings in cities where the average income is low. When it comes to house prices and the cost of ownership, the data again is inconclusive.

Table 8 Regression results representing the effect of price indicators on the number of Airbnb listings

*This table reports the regression coefficients. Except for the third column, the coefficient estimates are from a fixed effects model; in the third column the coefficients are estimated based on first differences between city-specific means. In the first column all capital cities are included. In the second column and third column, the scope is the six biggest Airbnb cities in Europe. Reported in brackets are the standard errors. The dependent variable is the presence of Airbnb, which is measured by the number of active rentals within a city. Inactive rentals at the time of data collection are not included. Definitions of the independent variables are in the mentioned in the variable description table on page 15. The panel data corresponds to the period 2010-2017. *, ** and *** denote statistical significance at the 10%, 5%, and 1% level correspondingly.*

Listings	Panel A: Europe		Panel B: Top 6 Airbnb cities
	(1)	(2)	(1)
PTI	2943.47***	815.44	314.97***
	(752.97)	(678.9)	(74.89)
GRY	-11890.11*	-6635.18	641.13
	(6252.04)	(4792.94)	(475.6)
GRYO	-257.38	6615.97*	190.59
	(5993.83)	(3798.42)	(501.51)
PTR	-1694.91**	-910.14	87.94
	(811.32)	(647.66)	(69.72)
PTRO	870.42	1624.02**	78.08
	(869.4)	(709.61)	(93.83)
Affordability	30269.65***	9334.24	680.96
	(10166.14)	(8409.51)	(686.99)
Year			
2011	1108.90		1246.68
	(3889.37)		(762.21)
2012	4720.48		2391.33***
	(4017.98)		(767.83)
2013	11266.32**		2717.04***
	(4293.52)		(776.40)
2014	13326.43**		3542.42***
	(4053.69)		(765.41)
2015	24650.22***		5402.62***
	(4458.06)		(763.01)
2016	22766.83***		6197.59***
	(4168.62)		(765.71)
2017	24750.36***		6425.25***
	(4019.87)		(758.15)

Does Airbnb affect housing prices?

In this section, I research whether Airbnb has an effect on the house price index, by including at least one Airbnb variable in a model with known house price determinants. The determinants used in this case are CPI (measuring inflation), GDP per capita, interest rates, the unemployment rate and the population size. Table 9 shows the results regarding the effect on housing prices. The regression model is shown below:

$$\text{Ϫ}Y = Y_{it} - \theta\bar{Y}_i;\ \text{Ϫ}X = X_{it} - \theta\bar{X}_i$$

$$\text{Ϫ}HPI_{it} = \alpha(1-\theta) + \beta_1(\text{Ϫ}Listings_{it}) + \beta_2(\text{Ϫ}MAJOR_{it}) + \beta_3(\text{Ϫ}GDP_{it}) + \beta_4(\text{Ϫ}CPI_{it}) + \beta_5(\text{Ϫ}Size_{it}) + \beta_6(\text{Ϫ}Unemployment_{it}) + \beta_7(\text{Ϫ}InterestRate_{it}) + \text{Ϫ}v_{it}$$

Firstly, we see from the year dummies that the problem discussed before is solved in general over all models, since there is only one incident where a year dummy is statistically significant at 10%. This means that we can conclude that at a 5% significant level, all models are generally complete, since there are no effects within the panel data years that are happening outside the models.

Secondly, we see interesting results when it comes to the new variables "Listings" and the dummy variable "Major" showing the difference between major Airbnb countries and countries where Airbnb is less present. First, the eminent result that the number of listings on Airbnb have absolutely no result on the house price index, since the magnitude of all coefficients equals zero. When regarding the dummy variable, however, it is evident that the house price index is higher (ranging from approximately 6 to 10 points difference) for the countries where Airbnb is most present compared to the countries where this is not the case. Half of the coefficients turn out to be statistically significant and the sign is positive across all models. This would suggest that the number of listings itself do not have an immediate effect on the house price index, but it seems to be the case that the countries where Airbnb is present most have a higher house price index. The fact that the number of listings has zero effect does imply, however, that this higher house price index could be caused by other factors such as the other ones mentioned in the model.

As expected, we see a positive relation between inflation, measured by CPI, and the house price index. Interestingly, the only significant effect is when the number of Airbnb listings is ignored and solely the dummy variable for major Airbnb countries is considered. Not only is the significance noticeable, the magnitude (3.95 when regarding the most significant coefficient) differs extremely from the coefficients within the other two regressions where the number of listings is considered by itself (0.72) and in combination with the dummy variable (0.80). Overall, the relation is positive, but in most cases CPI does not turn out to be statistically significant within this model.

Another variable that acts as expected, concerns the interest rates. As previous studies have pointed out, there is a negative effect between interest rates and the house price index. The same holds for this model. Not only is the sign as expected, all coefficients are also statistically significant. Again we see that in the last model, where solely the dummy variable for major Airbnb countries is considered, the magnitude effect is the largest (-1.02 against -0.53/-0.40).

The data turns out to be inconclusive when it comes to the demographical variables: Size (measuring the population size) and Unemployment. Previous data has shown that there is a positive relation between Size and the house price index, which holds for the majority of the models, of which one coefficient is statistically significant. The magnitude of all coefficients, however, is relatively low, seeing that a 1 percent increase in Size will increase the house price index by 0.42, which is the ultimate maximum. The same goes for the variable Unemployment, where we see that in most cases the sign of the coefficients is as expected, negative. Still, a 1% increase in the unemployment rate, will lead to a

maximum decrease of 0.63 in the house price index. Only two of these results are statistically significant, suggesting that an increase in the unemployment rate by 1% would lead to a decrease of 0.50/0.55 in the house price index. Both results are not significant when regarding the magnitude.

The most unexpected result is the relation between GDP and the house price index, which is negative. Even though, the effect on the house price index is truly low (maximum decrease of 0.08 with an increase of 1 in the GDP index), it is still statistically significant. By controlling for time effects after the crisis, the results have been altered (table 10). As normally expected, the GDP is positively related to the house price index across all panels. In most cases, the interest rates are still negatively related, but not as statistically significant. This goes for all macroeconomic determinants, the relation is as expected in most cases, but not statistically significant in all cases. The relation of CPI is inconclusive, but in panel B it is positive as expected. The same goes for Size. The unemployment rate is negatively related across all panels. Where you would expect the data of panel B (2008-2012) would be different, it does not seem to be the case. The number of listings still appears to have no effect on the house price index.

Table 9 The regression results showing the effect of Airbnb on the house price index (dependent variable)

*While the first three columns show the output of the regression with an OLS estimator, the other columns are based on the RE estimator. In additions, columns 7-9 take into account the year dummies. The year dummies indicate whether the model is complete for the corresponding years or whether there are significant activities within that year happening outside of the model that are still influencing the dependent variable "house price index". The House Price Index (HPI) measures the changes in the transaction prices of residential properties, both newly built and existing, purchased by households with 2015 as reference year. In all cases, the model considers macroeconomic determinants of house prices: GDP per capita, CPI (inflation), Size (population as a percentage of total European population), Unemployment rate and the interest rates. At least one of the two new variables are added to the model: Listings (number of active listings on Airbnb) and Major (dummy variable, takes value of 1 when it concerns a major Airbnb country and 0 if not). The panel data corresponds to the period 2006-2017. *, ** and *** denote statistical significance at the 10%, 5%, and 1% level correspondingly. Reported in brackets are the standard errors.*

HPI	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Listings	0.00	0.00		0.00	0.00		0.00	0.00	
	(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)	
Major	6.25**		7.88*	6.91		7.88	6.85		9.69*
	(2.69)		(4.16)	(4.25)		(4.16)	(4.26)		(5.77)
GDP	-0.07***	-0.06***	-0.06*	-0.08**	-0.07*	-0.06	-0.08**	-0.07*	-0.07
	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
CPI	0.66	0.71	1.54**	0.38	0.38	1.54**	0.80	0.72	3.95***
	(0.68)	(0.69)	(0.71)	(0.62)	(0.62)	(0.71)	(0.99)	(1.00)	(0.97)
Size	0.16	0.40*	-0.42	0.05	0.32	-0.42	0.08	0.35	-0.41
	(0.25)	(0.23)	(0.38)	(0.36)	(0.32)	(0.38)	(0.36)	(0.32)	(0.51)
Unemployment	-0.09	0.02	0.15	-0.55*	-0.50*	0.15	-0.45	-0.39	-0.63
	(0.23)	(0.23)	(0.40)	(0.30)	(0.30)	(0.40)	(0.30)	(0.31)	(0.47)
Interest Rates	-0.53***	-0.49***	-1.02***	-0.55***	-0.52***	-1.02***	-0.58***	-0.56***	-1.10***
	(0.15)	(0.15)	(0.23)	(0.17)	(0.17)	(0.23)	(0.18)	(0.18)	(0.27)
Years									
2007									-10.97
									(16.48)
2008									2.28
									(16.67)
2009									15.74
									(16.54)
2010									17.46
									(16.52)
2011							-1.11	-1.06	12.20
							(3.16)	(3.17)	(16.54)
2012							-3.06	-3.12	11.10
							(3.12)	(3.12)	(16.57)
2013							-4.75	-4.94	12.90
							(3.06)	(3.07)	(16.58)
2014							-2.53	-2.93	18.60
							(3.37)	(3.37)	(16.67)
2015							-1.38	-1.78	18.62
							(3.87)	(3.88)	(16.68)
2016							3.61	3.08	23.33
							(3.86)	(3.85)	(16.66)
2017							-8.14	-8.65*	16.92
							(5.16)	(5.16)	(16.52)

Table 10 The regression results showing the effect of Airbnb on the house price index per period

*The results have been divided over three panels. Panel A (columns 1-3) represents the period 2008-2017, whereas panel B (columns 4-5) shows the results of period 2008-2012 and panel C (columns 6-8) period 2013-2017, allowing panel-in-panel regressions. After testing for the best panel data estimators, estimators FD and FE are chosen for panels A and C. The FE estimator is used for the regressions in panel B. In additions, columns 7-9 take into account the year dummies. The year dummies indicate whether the model is complete for the corresponding years or whether there are significant activities within that year happening outside of the model that are still influencing the dependent variable "house price index". The House Price Index (HPI) measures the changes in the transaction prices of residential properties, both newly built and existing, purchased by households with 2015 as reference year. In all cases, the model considers macroeconomic determinants of house prices: GDP per capita, CPI (inflation), Size (population as a percentage of total European population), Unemployment rate and the interest rates. One new variable is added to the model: Listings (number of active listings on Airbnb). *, ** and *** denote statistical significance at the 10%, 5%, and 1% level correspondingly. Reported in brackets are the standard errors.*

	Panel A			Panel B		Panel C		
HPI	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Listings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
GDP	0.24	0.14	0.12	0.59	0.51	0.17	0.22	0.16
	(0.20)	(0.19)	(0.18)	(0.42)	(0.42)	(0.28)	(0.31)	(0.29)
CPI	-0.31	0.49	0.25	0.59	0.14	-2.62	-3.45	-2.93*
	(0.63)	(1.09)	(0.63)	(0.89)	(0.75)	(1.63)	(2.85)	(1.76)
Size	0.08	-0.17	-0.16	-13.19	-10.28	0.12	0.23	0.33
	(0.45)	(0.70)	(0.69)	(15.82)	(16.13)	(0.59)	(0.86)	(0.84)
Unemployment	-0.34	-1.02**	-1.14***	-0.28	-0.66	-0.22	-0.31	-0.33
	(0.47)	(0.42)	(0.39)	(0.45)	(0.42)	(1.08)	(1.03)	(0.98)
InterestRates	-0.06	-0.59***	-0.54***	-0.46	-0.54	0.11	0.13	-0.01
	(0.20)	(0.21)	(0.20)	(0.37)	(0.37)	(0.38)	(0.57)	(0.52)
Major								
Years								
2011		-0.33		-1.64				
		(3.17)		(1.93)				
2012		-1.82		-4.38*				
		(3.13)		(2.22)				
2013		-3.78						
		(3.18)						
2014		-2.07					-3.08	
		(3.62)					(4.47)	
2015		-1.94					-2.45	
		(4.27)					(5.48)	
2016		3.86					3.45	
		(4.07)					(5.12)	
2017		-7.99					-1.79	
		(5.25)					(6.82)	

Is the presence of Airbnb affected by the housing supply?

In this section of the study I focus on the effect of housing supply on the number of Airbnb listings in European cities. Again the difference has been made between European capital cities and the top six Airbnb cities within Europe. This data has been divided into two panels. For panel A, two panel data estimators have been used since the test on which one was best was inconclusive. By examining the effect of the number of dwellings (residence housing), houses completed, housing transactions and their value, rented accommodation and the vacancy rate, I draw conclusion on what determines the

presence of Airbnb when talking about housing supply. The results are reported in table 11. The regressions are shown below:

$$Lıstïngs_{it} = \alpha + \beta_1 PT\ddot{I}_{it} + \beta_2 G\ddot{R}Y_{it} + \beta_3 G\ddot{R}YO_{it} + \beta_4 P\ddot{T}R_{it} + \beta_5 PT\ddot{R}O_{it} + \beta_6 Affordabılıty_{it} + \ddot{u}_{it}$$

$$\Delta Listings_{it} = \alpha + \beta_1 \Delta PTI_{it} + \beta_2 \Delta GRY_{it} + \beta_3 \Delta GRYO_{it} + \beta_4 \Delta PTR_{it} + \beta_5 \Delta PTRO_{it} + \beta_6 \Delta Affordability_{it} + \gamma_t + \Delta u_{it}$$

When looking at the number of dwellings, there are no major differences between the two panels, both contain statistically significant coefficients with low standard errors. Moreover, there is a positive relationship between the number of dwellings and the presence of Airbnb in both panels. This result suggests that in cities where there are many dwellings, properties used as residence, we see more Airbnb listings. Even though the magnitude in both panels is not high, a change of 1000 dwellings leads to a mere increase of approximately 16 listings, this result is in contrast with previous studies. These indicated that Airbnb listings are mostly non-residence properties used for the sole purpose to rent/sublet.

Moreover, there is a positive relationship between the presence of Airbnb and the rented accommodation ratio, which represents the proportion of total dwellings that are rented properties. The main purpose of Airbnb has been said to be to help hosts meet rent obligations, which suggests that Airbnb should be more present in areas with many rented properties. The data supports this statement in both panels, where we see that an increase of 1% leads to a substantial increase in the top six cities (1912 listings) which is statistically significant. Within panel A we see a discrepancy between the two panel estimators, even though the sign are the same. Both results within panel A are not statistically significant, but do support the notion that Airbnb is most present in cities where there are more rented residences.

Another statement in previous studies is that the relationship between the presence of Airbnb and the housing supply is transported to the value of the housing. To test this statement, the variable "value of housing transactions" is included and we see that there is a positive relation between these two variables. This results indicates that Airbnb is most present in areas where the housing value is high, but the magnitude of these coefficients are so low that a change of 10 million in housing value would only increase the number of listings with 2 listings in the top six cities and no increase in Europe. These results are thus not representative when regarding the real estate market for regular residences.

Furthermore, there is a consistency when looking at the houses completed within both panels. There is a negative relation across panels between the number of houses completed in all the cities and the presence of Airbnb. This result indicates that Airbnb is most found in areas where there are less new houses completed. We see that an increase of 1000 new houses leads to a decrease in listings in Europe (approximately 140 listings) and in the six major cities (more than 300 listings). This result could be used to support the fact that Airbnb is found mostly in areas where it is most needed, where the income is low and we do not see this in majority in new areas where new housing is build.

Another argument could be that there are almost no new housing build in these areas due to the already high vacancy rate. When looking at first panel data estimator, we see that in both panels, there is a positive relation between this rate and the presence of Airbnb. This result supports the notion that Airbnb can be most found in areas where the vacancy rate is low, where housing are put online rather than rented, and thus where less housing is build. When regarding the magnitude, we see that an increase in the vacancy rate of 1% leads to an increase of 10 units in European cities. This result might not be (statistically) significant, but the magnitude in the six top cities corresponds to an impressive increase of almost 1300 listings. Within panel A, we see a discrepancy, where both results are not statistically significant. In the case of the second estimator, we see that an increase of 1% in the vacancy rate leads to a decrease in listings of 63 listings within Europe. Even though the errors are less when

using the second estimator, both results are not statistically significant, thus making it difficult to draw a conclusion.

Previous studies also claimed that Airbnb operates in areas where there is an housing shortage, where demand does not meet supply, thus where there are less housing transactions. When regarding the first estimator within the panels, the data corresponds with this statement. There is a negative relation between the presence of Airbnb and the number of housing transaction within the city. Within panel B, we see that an increase of 1000 housing transactions leads to a decrease of 78 listings which is statistically significant. The same increase would lead to either a decrease of 25 listings or an increase of 6 listings within panel A. Since both results are not statistically significant and both coefficient have approximately the same standard errors, it is impossible to determine which estimator is most reliable.

Table 11 Regression results showing the effect of housing supply and demand on the number of Airbnb listings

*This table reports the regression coefficients. Except for the second column, the coefficient estimates are from a fixed effects model; in the second column the coefficients are estimated based on first differences between city-specific means. In the first column all capital cities are included. In the second column and third column, the scope is the six biggest Airbnb cities in Europe. Reported in brackets are the standard errors. The dependent variable is the presence of Airbnb, which is measured by the number of active rentals within a city. Inactive rentals at the time of data collection are not included. Definitions of the independent variables are in the mentioned in the variable description table on page 15. The panel data corresponds to the period 1990-2017. *, ** and *** denote statistical significance at the 10%, 5%, and 1% level correspondingly.*

Listings	Panel A: Europe		Panel B: Top 6 Airbnb cities
	(1)	(2)	(1)
Dwellings	17.78***	16.27***	13.38***
	(1.62)	(3.52)	(2.02)
Completions	-139.26***	-139.43***	-311.14***
	(28.26)	(39.18)	(59.98)
Transactions	-25.78	5.96	-78.16***
	(18.91)	(18.65)	(24.49)
Rentals	4.65	41.93	1912.76***
	(46.13)	(36.76)	(521.63)
Vacancy	10.90	-63.47	1278.79
	(175.51)	(119.3)	(3649.26)
Value	0.09	0.04	0.19***
	(0.05)	(0.04)	(0.06)
Years			
2011	-974.86		-2136.08*
	(1084.05)		(953.38)
2012	-1067.01		-2717.73
	(1181.76)		(1509.77)
2013	-1734.47		-1966.42
	(1243.83)		(1458.27)
2014	-761.14		-425.40
	(1318.91)		(1311.94)
2015	1397.61		6563.66
	(1644.08)		(1829.23)
2016	228.37		-275.39***
	(2444.15)		(3160.17)

Is the presence of Airbnb affected by host credibility?

In this section of the study I focus on the effect of host credibility on the number of Airbnb listings in European cities. Again the difference has been made between European capital cities and the top six Airbnb cities within Europe. This data has been divided into two panels. For panel A, two panel data estimators have been used since the test on which one was best was inconclusive. By examining the effect of arrears on mortgage or rent, the proportion of household with financial burdens, severe housing deprivation and the mortgage to income ratio, I research what determines the presence of Airbnb when talking about host credibility. The results are reported in table 12. The regression model is shown below:

$$Lıstïngs_{it} = \alpha + \beta_1 Arrëars_{it} + \beta_2 Burden_{it} + \beta_3 Depr̈ived_{it} + \beta_4 Morẗgage_{it} + ü_{it}$$

Even though there are major magnitude differences in most cases, we see that for three variables there is consistency regarding the sign in both panels. The only exception concerns the severe housing deprivation ratio, which represents the percentage of people living in a deprived dwelling to the total population within the city. Within panel A, we see a positive relation that indicates that an increase in this ratio increases the number of listings. Still, when considering the magnitude, we see that the effect of a 1% increase is very minimal (an increase of 1 listing) which is also not statically significant. In the six major cities, however, we see a decrease of 384 listings when the same increase in the severe housing deprivation ratio occurs. These results, although not statistically significant, refute the claim that Airbnb is most presence in areas where owners neglect their houses since their sole purpose is to earn substantial income. A side note, however, is that this data only contains severe housing deprivation measures. In most cases, neglecting a house would not necessary have to be classified as a severe housing deprivation measure.

The only conclusive positive relation amongst the two panels is the relation between the presence of Airbnb and the mortgage to income ratio. This ratio is high when actual monthly mortgage costs are high and/or take-home family income is low. We see that in both panels, an increase in this ratio leads to an increase in the number of Airbnb listings. For Europe, an increase of 1% leads to an increase of almost 23 listings. In the six major cities we see a more substantial increase, namely one of over 280 listings, which is statistically significant. These results correspond with the initial purpose of Airbnb, namely helping hosts meet their mortgage and rent obligations.

Nevertheless, this claim is not conclusively supported when regarding the last other two variables within the panels: arrears on mortgage or rent and the proportion of households with financial burden. Firstly, the arrears on mortgage or rent ratio, which represents the percentage of people with arrears on their financial housing-related obligations. This ratio increase when there are more people with arrears on their mortgage or rent payments. We see that an increase of 1% in this ratio leads to a decrease of almost 1100 listings in Europe and an even more significant decrease of over 4400 listings in the six top cities. Regardless of the fact that the results are not statistically significant, they can be interpreted in two ways. The first being that Airbnb is most present in areas where the arrears are low, thus indicating that Airbnb is helping hosts meet mortgage and rent obligations in time. The second interpretation is that Airbnb is most present in areas where it is not needed (where no help is needed to meet mortgage and rent obligations), meaning that Airbnb is mostly present in “richer” areas.

Both interpretations are supported when investigation the last relationship; the one between the presence of Airbnb and the proportion of households with financial burden. This ratio is high when there are many households facing financial burden. The negative relationship in both panels suggest that an increase in this ratio leads to a decrease in the number of Airbnb listings. Since there might be a causality effect within the sample, Airbnb influencing the number of households facing financial

burden and vice versa, it is difficult to determine which interpretation is correct. An increase in the ratio would lead to a decrease between 120-140 listings within the panels, of which only the coefficient in panel A is statistically significant. Overall, when considering the year dummies, we see that for both panels there are significant effects occurring outside the model in the period 2014-2017 (Panel A) and 2013-2016 (Panel B). This is not completely unexpected, as mentioned before, since it would be safe to assume that there are more variables influencing Airbnb than just host credibility.

Table 12 The regression results showing the effect of host credibility on the number of Airbnb listings

*This table reports the regression coefficients. Both panels have been estimated with a fixed effects model. In the first column all capital cities are included. In the second column, the scope is the six biggest Airbnb cities in Europe. Reported in brackets are the standard errors. The dependent variable is the presence of Airbnb, which is measured by the number of active rentals within a city. Inactive rentals at the time of data collection are not included. Definitions of the independent variables are in the mentioned in the variable description table on page 15. The panel data corresponds to the period 2003-2017. *, ** and *** denote statistical significance at the 10%, 5%, and 1% level correspondingly.*

	Panel A: Europe	Panel B: Top 6 Airbnb cities
Listings	(1)	(1)
AMR	-1084.29	-4430.42
	(831.82)	(2922.85)
Burden	-142.98*	-126.80
	(84.00)	(511.11)
Deprived	0.99	-384.30
	(182.07)	(2338.77)
Mortgage	22.52	286.37*
	(22.85)	(157.63)
Year		
2011	695.14	4316.04
	(1554.62)	(5553.55)
2012	1451.44	8679.45
	(1586.84)	(6286.43)
2013	1945.54	11869.52*
	(1580.31)	(6533.52)
2014	3070.77*	17133.77**
	(1581.52)	(6276.30)
2015	5885.42***	28279.40***
	(1667.34)	(6897.18)
2016	7969.54***	30309.42***
	(1738.97)	(6948.65)
2017	7419.00**	16474.53
	(3264.40)	(9521.17)

VI. Conclusion & Discussion

As mentioned before, we see in most Airbnb models that there are significant effects outside the model within the time periods of the panel data. This is an element to take into account when there is more data available on Airbnb and it has been around more. Then it would be possible to construct a more inclusive model where these significant effects do not occur outside of the model. Over time it would also be possible to monitor and test the effect of regulations on Airbnb, since there are many regulations announced for the upcoming years.

As for host credibility, there seems to be no effect on the number of listings when regarding the reason why hosts use the Airbnb platform. This would suggest that the reason why Airbnb started is not the main reason why Airbnb hosts are using this platform. This supports the claim that the main incentive is not money for paying bills, but rather money in terms of profit. The fact that Airbnb has become a profitable business for many, suggests that government ought to think about regulating this market to prevent this situation of illegal hotels on Airbnb to escalate.

Regarding the price factors that have an effect on the number of listings on Airbnb, thus its presence within Europe, are mainly visible within city centers. This suggests that prices in the city center affect the number of listing more than prices in suburbs and places outside the center. This means that in places where it is already expensive to live, we see more places. These results could be interpreted as a sign that hosts are using the platform as an extra income to pay for these expensive homes, but previous results have contradicted this claim. Therefore, it seems more likely that the places have expensive housing, because Airbnb is aiding the housing shortage by allowing so-called illegal hotels. This could be one of the reasons why governments should work on legislating this unknown market, thus making these illegal hotels impossible and allowing affordable housing prices and demand.

Another element regard the demand and the supply side of housing influencing the number of listings. There are two factors clearly affecting Airbnb's presence, the number of dwellings and the number of completions. When the number of houses used as homes increases, so does the number of listings, meaning that there are many homes indeed listed on Airbnb rather than houses not used as homes. On the other hand we see that when more and more homes are completed, the number of listings drop. This suggests that new homes are either used for different purposes than listings on Airbnb, but it could also indicate that the model is not capturing the time needed to sell the homes and actually place them on Airbnb.

When regarding the effect of Airbnb on the house price index, it seems that the worries about the sharing economy is premature, which in my opinion is a good thing. By regulating the sharing economy now, when it is not necessarily critical will possibly prevent a critical situation in the future. Previous studies and overall data have shown that regulating the sharing economy is a big concern, since the market is relatively new and unregulated.

To conclude, we see that there is a significant positive effect between housing supply and the number of Airbnb listings, meaning that when there are many homes available, many are offered on Airbnb. This does not seem to be a surprising result, since many studies have indicated that Airbnb is a very profitable business for hosts. There is, however, no significant effect indication that Airbnb is driving up house prices, as many studies have claimed. We do see that the house price index is higher in the major Airbnb cities, but there could be many other reasons for that other than the presence of Airbnb. Another surprising, yet significant effect, is that within this panel data there is a negative relation between GDP and the house prices. Within the models in this paper, however, we still see a significant negative effect between interest rates and house prices as expected.

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