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The Effects of Short-Term Rentals on Housing Markets

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Abstract

This study investigates the impact of new short-term rental (STR) regulations on Vienna's rental housing market using a Difference-in-Differences (DiD) approach, with Munich as a control. Implemented on July 1, 2024, the regulation restricts STRs to 90 days annually. The analysis focuses on Airbnb listings and average rental prices in Vienna's inner and outer districts. The findings reveal a significant reduction in the growth rate of Airbnb listings in Vienna post-regulation compared to Munich, suggesting initial compliance with the new rules. Within Vienna, rental prices increased less in the outer districts (10-23) than in the inner districts (1-9), with a predominance of residential zones, indicating a localized impact of the regulation. The comparison with Munich, which has strict STR regulations limiting rentals to 8 weeks per year and only 50% property use for Airbnb, highlights the potential long-term effects. In Munich, only 35% of listings are managed by commercial hosts, compared to 65% in Vienna. The study concludes that Vienna's new regulation is beginning to moderate STR market dynamics and rental price inflation. Continued monitoring is necessary to understand the long-term implications fully and to inform future policy adjustments for balancing tourism and housing market stability.

Deutsche Zusammenfassung

Diese Studie untersucht die Auswirkungen neuer Vorschriften für Kurzzeitvermietungen (STR) auf den Mietwohnungsmarkt in Wien mithilfe eines Difference-in-Differences (DiD)-Ansatzes, wobei München als Kontrollgruppe dient. Die am 1. Juli 2024 eingeführte Vorschrift begrenzt STRs auf 90 Tage pro Jahr. Die Analyse konzentriert sich auf Airbnb-Angebote und durchschnittliche Mietpreise in den inneren und äußeren Bezirken Wiens. Die Ergebnisse zeigen eine signifikante Verringerung der Wachstumsrate der Airbnb-Angebote in Wien nach der Einführung der Vorschrift im Vergleich zu München, was auf eine erste Einhaltung der neuen Regeln hinweist. Innerhalb Wiens stiegen die Mietpreise in den äußeren Bezirken (10-23) weniger als in den inneren Bezirken (1-9), den Wohnzonen, was auf eine lokale Wirkung der Vorschrift hinweist. Der Vergleich mit München, wo strenge STR-Vorschriften die Vermietungen auf 8 Wochen pro Jahr und nur 50 % der Nutzung der Immobilie für Airbnb begrenzen, hebt die potenziellen langfristigen Auswirkungen hervor. In München werden nur 35 % der Angebote von kommerziellen Anbietern verwaltet, verglichen mit 65 % in Wien. Die Studie kommt zu dem Schluss, dass die Wiener Vorschrift beginnt, die Dynamik des STR-Marktes und die Inflation der Mietpreise zu moderieren. Eine fortgesetzte Überwachung ist notwendig, um die langfristigen Auswirkungen vollständig zu verstehen und zukünftige politische Anpassungen zu informieren, um das Gleichgewicht zwischen Tourismus und Stabilität des Wohnungsmarktes zu gewährleisten.

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List of Important Abbreviations

DiD	Difference-in-difference
LTRs	Long-term rentals
STRs	Short-term rentals

Introduction

Background

The sharing economy, and especially home-sharing websites, have flourished during the past ten years due to a large increase in the number of people who are prepared to offer their houses. Despite the great value home-sharing provides to hosts and travellers, this excessive rise has some negative aspects. One of them is mainly that dwellings are being taken out of the long-term rental market, creating a growing gap between demand and supply of properties for the locals, which results in rising prices.

To mitigate this phenomenon, cities around the world have been regularly changing their regulations towards STRs (short-term rentals), aiming to find the right balance allowing hosts to share their properties while preventing extensive use of properties for STRs. The aim is to have enough supply for the local population, wishing to find long-term accommodation for a fair price. Cities practise different approaches, varying from a complete prohibition of using residential dwellings for tourism purposes, to more loose regulations, allowing it almost without any constraints.

In recent years, scholars have investigated the topic and come up with various findings, yet it is still unclear what approach cities should practice to prevent long-term rental prices from increasing. Chang (2020) examined the extent to which Airbnb affects housing prices in Taiwan during a change in a tax policy, which aimed to regulate STRs. The author found that an increase in the number of Airbnb listings positively affects rental prices, and insignificantly sales prices. The positive effect on rental prices is stronger in urban areas. Finally, the implementation of sales tax reduced this positive effect, as the tax policy resulted in a decrease in the number of Airbnb listings. Chang concluded that homes listed on Airbnb are more than just empty spare rooms, indeed resulting in fewer houses available for long-term rentals.

Similarly, Horn & Merante (2017) investigated the impact of Airbnb on the rental market prices in Boston. They found that 46% of the listings on Airbnb at that time were owned by hosts holding multiple dwellings, which means commercial operators, who use those properties for STRs rather than offering them to residents. In October 2015, a Boston-based property owner could make the same amount of revenue on Airbnb in only 12 nights as they

could in a month of long-term rentals (LTRs). This made it much more appealing to rent out properties as STR rather than LTR. Finally, the authors concluded that a one standard deviation increase in Airbnb density resulted in a rise of 0.4% in asking rents for LTRs, and therefore they encouraged policymakers to regulate the use of residential properties for tourism purposes. Later on, Barron et al. (2021) analysed the impact of Airbnb on the entire US real estate market from 2008 to 2016 and discovered that for every 1% rise in the Airbnb listings, rentals and home prices increased by 0.018% and 0.026%, respectively.

Garcia-López et al. (2020) explored the same relationship in Barcelona, Spain, and obtained closely related, although slightly different results. The scholars examined data from 2012 to 2016, while the vast expansion of Airbnb started in 2013. They found that an increase in 100 Airbnb listings in a neighbourhood, lead to a surge of 3.5% in rents and 8.5% in house prices. Since 2013, neighbourhoods with an elevated level of Airbnb activity had seen rent increases of 7% and property prices of 17%. Here, the authors discovered a more notable increase in sale prices than in rents, in contrast to Chang (2020).

Nevertheless, Ferrando (2019) examined this effect in Madrid, Spain, in April 2018, using a spatial and non-spatial regression method. The author did not find a significant impact of Airbnb on rental prices and stated that policymakers should conduct deeper investigations before launching new STR regulations.

A recent study by Hill et al. (2023) examines the price-premium that Airbnb hosts in Sydney, Australia, can earn compared to LTR. The study was conducted due to the discussion about imposing a 180-day limit on all STRs in Sydney. According to the authors, the average weekly Airbnb rent in Sydney in 2017 was 87% higher than a weekly LTR (with district-specific variations ranging from 55–131%). However, they emphasized the decline of this rent-premium (from 106% in 2015 to 78% in 2018), and that one has to consider additional costs for running Airbnb such as higher vacancy rates, furnishing, cleaning, managing and the greater risk of damage. The authors argue in line with other papers in the literature on real estate yield curves that the rental term-premium curve is downward-sloping due to higher costs and risks of STR. Since 2016, an increasing number of landlords in Sydney have taken their dwellings out of the LTR market and moved to Airbnb. This process resulted in a rise in LTRs and a fall

in Airbnb prices. Therefore, in the long term, the rent-premium on Airbnb is expected to decrease as more landlords switch their properties to the STR market.

Hill et al. (2023) also find a significant spatial variation in the Airbnb rent premium. The premium is higher in central (touristic) districts where properties receive fewer guests' reviews, indicating a higher vacancy rate. Conversely, lower premiums are found in cheaper areas where properties are likely rented out more frequently. The authors conclude that a regulation of Airbnb limiting the number of days per year that apartments can be offered (currently very popular in many cities around the world and the one to be implemented in Vienna, motivating this thesis) is expected to have a bigger impact on those cheaper areas because the properties are more reliant on being frequently occupied to generate income. Instead, touristic areas where Airbnb premiums are higher may be less affected in the end, despite the fact that calls for restrictions are more likely to come from these more expensive areas. Thus, policymakers should take these spatial differences into account when implementing Airbnb regulations.

From a slightly different angle, Balampanidis et al. (2021) studied the effects of Airbnb on different neighbourhoods in Athens. The authors report that although there is higher concentration of Airbnb rentals in the central and touristic areas, the phenomenon actually spread out to the entire city. They also point out that the rise of Airbnb boosted local businesses and created new jobs in various sectors, emphasizing its positive economic effects, which should not be ignored. However, the benefits of Airbnb were unevenly distributed, with low-income households using it as a survival strategy after the economic crisis, while upper-income households and large real estate investors exploit Airbnb for profit, often avoiding taxation.

Exploiting a quasi-experimental research design, Koster et al. (2021) investigated the impact of the regulation of STR on the housing market in 88 cities in Los Angeles, USA. Among those cities, 18 cities have implemented strict home sharing ordinances, restricting STR in most cases. The authors found that such regulation reduced Airbnb listings by 50%, and housing prices and rents by 2% in those cities. In their case, it appears that strict regulation had a noticeable impact on the housing market. Finally, Reichle et al. (2023) also examined the influence of Airbnb on rents and sales prices in 25 tourist destinations in Europe between 2010 and 2019 and found a positive correlation between Airbnb listings and rents and house prices.

The authors point out that the existing home-sharing regulations seemed to be ineffective and suggested that policymakers need to find the right policy to moderate this effect.

Research Question & Objectives

Research Gap

In the last few years, the effect of STRs on rent and sale prices has been extensively studied by academics worldwide. Most research has established a positive correlation between Airbnb density and increases in both rent and sale prices. However, little research has been done on how regulation can mitigate these price increases. Around the world, policymakers face the challenge of balancing the competing interests of permitting Airbnb for its beneficial economic impact, while restricting its potential negative effects on housing affordability for residents. Based on Reichle et al. (2023) and Hill et al. (2023), it is acknowledged that regulating Airbnb introducing an upper limit in the number of rental days is not always effective, thus other strategies must be considered. Chang (2020) found that the adoption of a sales tax helped to lower the number of Airbnb listings, particularly in cities. While most studies have focused on more general concerns related to housing affordability, they often ignore the subtleties of intra-city differences and the specific impacts inside distinct city districts. Moreover, it is uncommon to compare cities with different regulatory histories, like Munich and Vienna, especially when considering the recently enacted legislation. This thesis aims to address these gaps, comparing Munich's more developed regulatory framework with the immediate effects of new STR legislation in Vienna, drawing comparisons at district-level. In doing so, it contributes to a deeper understanding of how regulations affect STR listings and long-term rental rates, offering valuable insights for both academics and policymakers.

Research Question

Given the existing literature and current research gap, the questions of the thesis are:

1. To what extent is the new STR regulation implemented in Vienna effective in moderating Airbnb activity?
2. To what extent does Airbnb activity affect the LTR prices in Vienna?

To answer these questions, secondary research is conducted, examining the legal situation in different cities worldwide, complemented by primary research, collecting and analysing own

data using quantitative methods. The data were scraped from the official Airbnb website and from “Immowelt,” a real estate website publishing real estate offers in Austria and Germany. The focus is on the change in Viennese STR regulation, which took effect in July 2024, trying to determine how this change affects Airbnb activity and, in turn, long-term rental rates. Data were scraped weekly to track changes and look for patterns in the number of active Airbnb listings and the prices of long-term rentals in Vienna across different districts. Furthermore, also data from Munich, Germany, were harvested, which will serve as a comparative city. The difference-in-difference (DiD) method is used in the analysis to assess the effect of the regulation.

The theoretical framework of this research is related to the two following areas of knowledge.

1. **Urban Economics:** The main topic of urban economics is how cities expand and how it affects property values and the overall real estate market. Explaining the connection between LTR costs and STR regulation falls in this area. It could shed light on how these rules might affect the dynamics of supply and demand in the real estate market, and consequently, the value of the properties.
2. **Regulatory Economics:** This area of economic analysis tries to understand and assess the effects of regulations by concentrating on how they affect markets and individual economic agents. In the context of this thesis, it can serve as a framework for analysing how regulations restricting STRs affect market efficiency and the actions of various stakeholders, such as owners and tenants.

Contribution

Airbnb and similar platforms keep growing and their effects intensify year after year, mainly in tourist destinations worldwide. It appears that each city/state applies its own laws to moderate negative effects on local housing markets, without a clear, unified direction. Regulatory approaches vary from very liberal to strict, aiming to find the right balance. Recognizing the need for collective action, in July 2022, deputy mayors of 23 main cities around Europe, including Vienna, signed an open letter of the European Cities Alliance, calling for the need for regulation and enforcement of STRs (Eurocities, 2020).

In this context, there is still a need for scientific exploration into the effectiveness of different regulatory approaches and their impact. Such research can be used both for

policymakers in further decision-making processes, and scholars in future research, handling various related topics. The decision to completely prohibit Airbnb and other tourist rentals can have negative effects on the local economy, while decisions such as limiting the number of days allowed, or requiring licences, may end up having no significant impact on the local real estate market.

The thesis offers a thorough review of some of the more technical papers in the empirical literature, investigating the impact of Airbnb regulation on real estate markets in different cities around the world. The review explicitly addresses the empirical challenges associated with measuring the causal effect of this kind of policies. A comprehensive discussion of current regulations in several major US and European cities is also included in the assessment. This demonstrates that there are two primary regulatory approaches: either restricting the number of days per year for the short-term rental of residential properties, or defining certain zones or types of properties on which a complete ban is imposed.

The second part of the thesis carries out empirical analysis to explore the impact on the regulatory change recently implemented in Vienna. This is based on data collected between November 2023 and July 2024 through web scraping. Data for Vienna and Munich were collected, due to the similarities of the two cities, using Munich as control, where stricter regulation has been in place for a longer period. Despite the short period of observation, the analysis provides some interesting insights. Specifically, the pattern of Airbnb listings is similar in both cities, with much higher number of listings in Vienna than in Munich. However, after the announcement of the policy that would take effect in Vienna starting in July, the increase in the number of listings was smaller than in Munich. Also, an effect in the prices of long-term rentals is observed suggesting that these increased less in Vienna as in Munich after the policy announcement. Although none of these effects turn out to be significant in the regression analysis conducted, the exploratory analysis points in the expected direction.

An interesting observation is the differentiating impact that the policy seems to have in different parts of the city, which indicates that the policy has a more restrictive impact on the outer districts of the city. As opposed to inner districts, with more prevalence of residential buildings that were already protected by the previous regulation, our regression analysis shows

a negative differential impact in the outer districts, now facing a 90-day limit and, thus, more stringent regulation.

The observation period was done over a comparatively short period of time, and the regression analysis conducted does not include enough control that would allow us to conclude that there is a causal effect of the policy, but our preliminary results are consistent with the hypothesized effects.

The rest of the thesis is organized as follows. Section 2 provides a comprehensive literature review, and a review of the regulatory frameworks. Section 3 outlines the data and statistical methods used in the study. Section 4 presents the empirical findings, and Section 5 discusses the broader implications of the findings and concludes the key insights.

Literature Review

Airbnb and the housing market

The advent and exponential expansion of Airbnb and analogous short-term rental marketplaces have significantly transformed the housing market dynamics across the globe. Peer-to-peer lodging platform Airbnb has opened up new possibilities for both travellers and homeowners by enabling flexible and frequently more economical lodging. On the other hand, there is a serious disagreement over this trend's effects on regional real estate markets. In order to better comprehend the intricate relationship between Airbnb and housing markets, this literature review will summarize previous research on the subject, emphasizing major findings, methodology, and theoretical frameworks.

The relationship between housing markets and short-term rentals is complex, encompassing social, legislative, and economic factors. The growth of Airbnb has been associated with both favourable and unfavourable economic results. On the one hand, it can help local businesses by bringing in more tourists and bringing in additional income for property owners. However, critics contend that it exacerbates the housing crisis and raises rental costs, making homes less accessible for locals. Socially, the presence of short-term rentals in residential neighbourhoods can alter community dynamics, in some cases leading to tensions between residents and guests. Given these contradictory impacts, regulatory responses to Airbnb have varied widely, with some cities embracing the platform and others imposing strict controls to mitigate its perceived negative effects. These regulatory measures themselves become a crucial part of the discussion, as they shape the operational environment of short-term rentals and affect their wider economic and social implications.

This chapter will review key recent studies that explore these various aspects in different geographical contexts, examining the methodologies employed, and the policy implications derived from the findings. By doing so, it aims to provide a comprehensive understanding of how STRs influence housing markets and to identify contradictions and gaps in the current literature that future research might address.

In recent years, numerous scholars have investigated this topic, resulting in a wide range of findings. Chang (2020) investigates the impact of Airbnb on rental and sales prices in

Taiwan, as well as the effect of a change in tax policy to regulate Airbnb. This research considers different types of Airbnb rentals (whole homes, individual rooms, or other), their distribution, and their impact on prices. Using web scraping technology, the author collected data from the Airbnb website between February 2013 and November 2017. Monthly counts of Airbnb listings were gathered for every township, resulting in a dataset with a total of 133,516 listings, with an average of 2,302 listings every month. "Entire dwellings" comprised the majority of them (54.2%), while "private rooms" accounted for the remaining 37.5%. The authors collected Airbnb data everywhere in Taiwan, making a distinction between big cities with a greater number of listings and rural places with a lower concentration of listings, such as Eastern Taiwan. Across all Airbnb postings, the average nightly price was about NT\$ 1,269 (US\$ 42). The average price of an entire home was NT\$ 1,521 (US\$ 50), higher than that of a private room (NT\$ 926, or US\$ 31).

Room-sharing platforms such as Airbnb are frequently subject to different regulations than the traditional hotel sector, which requires company licenses and pays corporate taxes. In response to the hotel industry's protests following Airbnb's entry into the country, Taiwan changed its laws in September 2017, imposing a 20% sales tax on international e-commerce businesses like Airbnb which partners with local hosts to offer services to customers online.

The Actual Sales and Rental Prices (APRS) profile in Taiwan, a large-scale administrative housing transaction dataset, served as the foundation for the analysis of the housing market. Records of home sales and rentals dating back to August 2012 are included. While registrations of real estate sales in the APRS is mandatory, the government merely strongly encourages the registration of rental property transactions. Geographical locations, property attributes, and transaction costs are all included in the APRS data. Two datasets for home sales and rentals were created specifically for the paper. There are 82,421 records in the rental dataset, of which 26,840 are related to corporate operations and 55,581 are related to residential use. The 550,951 sale records in the housing sales dataset are primarily residential properties. The analysis contained defined variables such as property type, size, floor level, and transaction date. Sample statistics were provided for the selected variables, including differences between townships with and without Airbnb listings. Data on neighbourhood attributes, like population density, robbery incidents, and dust concentration, were also gathered from additional sources to investigate how these affected home values.

The main objective of the empirical analysis is to estimate housing price equations by integrating several housing price factors and the quantity of Airbnb listings. In order to mitigate the possibility of endogeneity bias resulting from unobservable factors that could impact sales, rental pricing, and the quantity of Airbnb listings concurrently, fixed effects are employed. Furthermore, a DiD regression was used to analyse the impact of the sales tax policy on Airbnb, looking at the combined effects of the quantity of listings and the period before to and following the regulation. The author used the following baseline model of housing price equations

$$\log(P_{ijt}) = \alpha \times \text{Airbnb}_{jt} + \beta'X_{ijt} + v_j + u_{ty} + u_{tm} + \varepsilon_{ijt}$$

where $\log(P_{ijt})$ is the logarithm of the house price (rental or sales price), corresponding to property i in township j at time t , while Airbnb_{jt} is the number of Airbnb listings in township j at t . The vector X_{ijt} contains a list property characteristics used as explanatory variables of the price. Additionally, v_j , u_{ty} , and u_{tm} are introduced representing township, year, and month fixed effects, respectively, and ε_{ijt} is the random error. Besides the fixed effects, important parameters to be estimated are α and β , where α measures the magnitude of change in the percentage of housing prices corresponding to a per-unit increase in the number of Airbnb listings, all else being equal, while β is a vector of coefficients capturing the effect of the different hedonic characteristics of the dwelling on the price.

The model was extended to include a time dummy that equals 1 if the transaction occurred during the post-policy period and 0 otherwise, and an interaction term between the number of Airbnb listings and this time dummy. This allows to analyse the effect of the new sales tax imposed on Airbnb. The formulation of the housing price equation is as follows:

$$\begin{aligned} \log(P_{ijt}) = & \alpha_1 \times \text{Airbnb}_{jt} + \gamma_1 \times (\text{Airbnb}_{jt} \times \text{After}) + \lambda_1 \times \text{After} + \beta_1'X_{ijt} \\ & + v_j + u_{ty} + u_{tm} + \varepsilon_{ijt} \end{aligned}$$

In this equation, α_1 , γ_1 , λ_1 , and the vector β_1 are the relevant parameters under consideration. The parameter γ_1 specifically captures the DiD effect, displaying the percentage change in housing prices linked to an increase in the number of Airbnb listings following the introduction of the new tax policy.

The findings indicate that both rental and sales prices are boosted by an increase in Airbnb listings. It turns out that the impact on sales prices is negligible and insignificant. In comparison to rural areas, urban areas experience a greater impact from Airbnb on rental pricing. Again, there is a notable positive influence on rental prices and a negligible positive impact on sales prices when different types of Airbnb listings, whole homes and single rooms, are taken into account. The impact on rental costs, however, differs depending on the kind of Airbnb listing. Entire homes have a price effect of 0.7% on rent, whereas private rooms have a 1.7% price effect. In terms of the policy's assessment, the data demonstrates that the sales tax's introduction reduces Airbnb's positive effect on rental costs for both whole homes and individual rooms. The tax policy has a greater impact on private rooms. On the other hand, there is no apparent impact of the sales tax policy on sales prices. This policy generally results in fewer listings on Airbnb; nevertheless, the number of listings for private rooms decreases more than other listings.

The average rental price of the study was US\$8.40 per square meter, showing an increasing trend after the debut of Airbnb, with a reduction of prices after the introduction of the sales tax policy. 54% of the rental properties had at least one nearby Airbnb listing, while the descriptive data demonstrates that such properties had higher prices. Similarly, 34% of properties for sale were located next to an Airbnb dwelling, and their rates were also higher. Similar to rental pricing, the trend in real estate prices showed an increase following Airbnb's debut and a decline after the implementation of the sales tax policy.

The study indicates that the properties available on the platform are not solely unused spare rooms or dwellings, and therefore, Airbnb has an impact on the rental prices, as the supply of the flats for longer-term contracts is lower. Comparisons with studies conducted in the USA show that the effect of Airbnb on rental prices in Taiwan is smaller, perhaps due to lower returns from Airbnb and a higher owner-occupancy rate in Taiwan. Unlike in Taiwan, there is also a more significant effect of Airbnb on housing sales prices in the USA. It has been suggested in the literature that the positive effect of Airbnb listings on sales prices may be because it increases the incentive to buy residential property not for own use, but to rent it out and produce a stream of income. The overall impact of Airbnb on the housing market in Taiwan differs from the USA. The author proposes that lower returns from Airbnb, along with higher

homeownership rates and the high housing prices in Taiwan, which act as a financial barrier for new investors, may explain this difference.

An examination of the United States reveals significant insights into Airbnb's impact on local housing markets across different cities. Barron et al. (2021) investigate the effects of home-sharing on residential property prices and rental rates, while also considering homeownership rates. The authors use an extensive dataset encompassing all properties listed on Airbnb, collected via web scraping technology, and employs various regression models and instrumental variable techniques. The data was tracked from 2012 to 2016, covering the entire United States. A panel dataset was constructed at the zip code and monthly level, detailing Airbnb listings. Additionally, the authors acquired a panel dataset of house prices and rental rates indices from Zillow, a comprehensive American real estate platform. To this dataset, they incorporated a wide range of time-varying information specific to each zip code, provided by the American Community Survey (ACS) conducted by the Census Bureau, which provided data on owner-occupancy rates. Furthermore, the study included factors related to demand for tourism, like hotel occupancy rates from STR, airport traveller data from the Bureau of Transportation Statistics (BTS), and hotel reviews from TripAdvisor.

Looking at simple correlations, the authors observed that more Airbnb listings was positively correlated with higher rental rates and higher house prices across time and location. Obviously, this does not mean that the number of Airbnb listings is the cause of higher prices, since it could be the other way around, higher prices make it more profitable to offer and attracts suppliers of Airbnb accommodation. The authors point out that the simultaneous growth of cities in population often coincides with increases in rents, housing prices, and the quantity of Airbnb listings. The purpose of the study is, therefore, to address this empirical challenge by distinguishing the effect on housing prices coming from demographic, economic, or other similar factors versus those caused by the predominance of Airbnb accommodation. They aim to carefully address the above-mentioned endogeneity problem, where Airbnb tend to concentrate in more profitable geographic areas, to understand the potential distortionary effects Airbnb may have on long-term housing markets.

The panel structure of the dataset allows for controlling effects on housing prices due to differences across locations (zip codes) or over time (year-month dates), which would have

persisted anyway independently of Airbnb presence. This includes factors such as geographical differences, seasonal variations, or long-term economic and demographic trends. Time fixed effects are incorporate at the level of Core Based Statistical Area (CBSA), capturing factors affecting the housing market for each year-month date within that area, while accounting for trends that are common across zip codes.

Finally, Barron et al. (2021) discuss that, even after controlling for the time effects at CBSA level, there may still be zip-code specific time effects that make it more or less attractive to offer Airbnb at the specific location. Controlling for those effects would help solve the endogeneity problem. To capture such effects, they construct an instrumental variable that should be uncorrelated with the short-term shocks to the housing market in that zip code, but may affect the attractiveness of Airbnb. This is done in a sophisticated way by observing the general Google search index for the term “Airbnb” complemented with a specific measure of how appealing a zip code was to tourists in a given base year, 2010. They define a zip code as touristic based on factors like the number of eateries, hotels, and other short-term lodging options within the zip code. Implicitly, the presence of this kind of services reflects a valuable amenity for tourists close-by, making it more attractive for other suppliers of touristic services to be active in the area (endogenous). They assume that landlords in areas attractive to tourists, are more likely to enter the short-term rental market in those locations after learning about Airbnb compared to those in less touristic areas, and that initial levels of tourism do not consistently predict unexpected changes in the housing market later, even if those changes coincide with spikes in Airbnb searches on Google.

Generally, increasing awareness about Airbnb is captured by the Google search index and is expected to be independent of local price changes. However, this awareness is expected to affect the supply of Airbnb accommodation more strongly in more touristic zip codes. The interaction variable consisting of the Google index and the measure of how touristic the zip code before the entrance of Airbnb provides the needed instrumental variable that allows to control for the endogenous reasons to offer Airbnb in that zip code.

The authors hypothesize a causal relationship between Airbnb supply at zip code i in CBSA c and month-year date t , $Airbnb_{ict}$, and the change in sales or rental price index at the same location and time, $\ln Y_{ict}$. Moreover, the impact of Airbnb supply on prices is expected to

vary depending on the owner-occupancy rate at that location before entry of Airbnb in the base year 2010, $oorate_{ic,2010}$. This dependence will be discussed further down. The following estimation equation is used:

$$\ln Y_{ict} = \alpha + \beta \text{Airbnb}_{ict} + \gamma \text{Airbnb}_{ict} \times \text{oorate}_{ic,2010} + X_{ict}\eta + \delta_i + \theta_{ct} + \xi_{ict}.$$

Time-varying zip code attributes, X_{ict} , were considered, as well as unobserved zip code level factors, δ_i , CBSA-year-month fixed effects, θ_{ct} , and time-varying zip code level shocks, ξ_{ict} . It is these last residuals, ξ_{ict} , that could potentially be correlated with Airbnb supply, and the reason why the instrumental variable explained above is needed. Estimation is done using a two-stage least squares approach (2SLS), first regressing Airbnb supply with the instrument, and then running OLS using the predicted Airbnb in the equation above in the second stage. Additionally, the study employs ordinary least squares (OLS) regression as a comparative approach to estimate the effects of Airbnb listings on rental rates and house prices. OLS regression provides a baseline estimate, but may be biased due to endogeneity and omitted variable concerns. By comparing the results from OLS and 2SLS regressions, the researchers can assess the robustness of their findings and identify potential biases inherent in the OLS approach.

First, the instrumental variable technique compares Airbnb listings between times of high and low awareness of Airbnb, as well as across tourist hotspots, in a manner similar to DiD coefficient estimations, as described by Christian and Barrett (2017). The purpose of this comparison is to determine whether spatial units with different levels of Airbnb exposure show similar trends before Airbnb's impact, akin to pre-trend analysis in DiD studies. To assess this, the authors analysed Zillow house price index data for zip codes categorized by quartiles of tourism from 2009 to 2016. The analysis reveals that prior to 2012, zip codes with different levels of tourism generally exhibited similar long-term house price trends, with divergence only occurring after Airbnb's rise. In order to confirm the analysis, the authors conduct a randomization test, redistributing Airbnb listings randomly across zip codes while maintaining other factors constant. The results showed statistically insignificant effects across various dependent variables, suggesting the instrument's exogeneity.

A 1% rise in Airbnb listings in zip codes with a median owner-occupancy percentage of 72% results in a 0.018% increase in rent and a 0.026% increase in property prices, according to the paper's instrumental variable results. As anticipated by Chang (2020), here as well, these effects fall off as owner-occupancy rates increase, with higher effects observed in areas with lower owner-occupancy rates. For instance, a 1% increase in Airbnb listings results in 0.024% rents increase in areas at the 25th percentile of owner-occupancy, and a 0.014% increase at the 75th percentile. The authors note that the instrumental variable estimates are larger than OLS estimates, suggesting potential biases such as measurement error and simultaneity bias. Measurement error, might occur when the number of Airbnb listings does not perfectly capture the true number of short-term rentals. Alternatively, simultaneity bias, could arise in case of a two-way relationship, means Airbnb listings influence rents or house prices, while those affect back the number of Airbnb listings. The result regarding the fact that Airbnb's influence varies with the owner-occupancy rate indicates that Airbnb's effects may be driven by the predominance of non-owner occupancy which can be more flexibly converted from long-term to short-term rentals. The study also shows that Airbnb's introduction does not affect the overall housing supply. However, it correlates with more units being left vacant for seasonal or recreational purposes and fewer units available for long-term renters.

According to this study, the rise in home-sharing services like Airbnb has boosted the cost of homes as well as rental rates. There are two basic ways in which this impact takes effect. First, by encouraging landlords to switch from long-term to short-term rentals, which raises rental rates and raises the price of homes. Second, by enabling homeowners to profit from underutilized space, they will be able to increase the value of homeownership in comparison to renting, which will raise the price of real estate. The study concludes by showing that the owner-occupancy rate affects Airbnb's impact and highlights the role of marginal homeowners in the dynamics of housing reallocation. It recommends that regulatory efforts should be directed towards reducing the excessive reallocation of housing stock from long-term to short-term rentals, while preserving owner-occupier home-sharing opportunities.

Another research, conducted a few years before in the USA, also found similar results, reinforcing the understanding of Airbnb's impact on housing markets. Horn and Merante (2017) investigated the short-term effects of Airbnb in Boston, USA, in particular whether the presence of Airbnb in certain neighbourhoods leads to a decline in the supply of properties for

long-term rentals, and whether it leads to increasing rent prices. For the study, the authors developed a measure of Airbnb density for each neighbourhood (census tract) in Boston, dividing the number of Airbnb listings in the area by the number of housing units in this area according to the US Census. This approach allows them to control for differences in population and the housing market. The authors tracked the numbers for a time period of 6 months, from September 2015 up to January 2016, and took a hedonic approach to estimate asking rents. The hedonic price method (HPM), commonly used in real estate research, is based on the premise that the value of a commodity (a housing unit), should be calculated by summing the values of all its different characteristics (Herath & Maier, 2010). The effect of Airbnb on asking rents is estimated using the characteristics of the housing unit, Airbnb density, and census tract fixed effects, to control for the impact of unobserved neighbourhood effects (such as location, demography, etc.). Additionally, Airbnb data for a particular month, was compared to rent prices of the next month. This practice minimizes the risk of reverse causation that might happen from simultaneous observation of Airbnb density and rents. Although in the past it was common to observe a year lag between demand and supply changes, more recent studies normally use a 1-6 months gap only, due to the fast flow of information of rental data on the internet and its rapid influence on landlords.

As to the data collection process, the rents were recorded weekly from a platform that gathers listings of properties for rent, including price, size, number of bedrooms and location of each listing. The Airbnb data were collected once a month, between August 2015 and January 2016, by using information from “InsideAirbnb” together with web scraping, providing the listing’s ID number, price, property type and location. On an average census tract, there were 1600 housing units, 76 listings of properties for rent, and 12 Airbnb listings. To control for potential endogeneity, another three indicators were collected in each census tract: a monthly crime rate, new building permits, and issuance of restaurants licences. These indicators do not cover every possible change within a neighbourhood, but are most salient.

Horn and Merante observed that in 2015, the vast majority (82%) of Airbnb hosts in Boston had only one listing, suggesting that many were renting out their place occasionally. However, despite only 18% of hosts being multiple-listings operators (commercial operators), their listings accounted for 46% of all Airbnb listings. This finding supports the argument that Airbnb’s presence reduces the availability of properties for long-term rentals. In the same year,

the average lessor in Boston would need rent out their unit for 12 days per month on Airbnb to earn the equivalent of a full month's rent from a long-term contract. Nonetheless, due to high vacancy rates, actual profits might not be as high as it initially appeared (Coles et al., 2017). According to utility maximization theory, if the average housing unit owner can achieve higher profits in the STR market, it can be assumed that they would choose that option.

The authors suspect that Airbnb listings affect both the demand and supply side of the rental market. On the demand side, the possibility of earning income through room sharing might boost the demand for rental properties. On the supply side, STR units are withdrawn from the LTR market. This would imply that Airbnb could have an impact on the actual vacancy rate, affecting the tightness of the rental market, and thus the rental price. This anticipation aligns with the claim of Barron et al. (2021), which did not find an overall impact of Airbnb on the housing supply, but emphasized the generation of marginal income through Airbnb and therefore the increase in the value of homeownership. Considering these expected impacts on supply and demand, Horn and Merante hypothesize that the effect of Airbnb listings on the actual vacancy rate of rental housing at any given time, AVR_t , could be captured by the following equation:

$$AVR_t = 1 - \frac{(d_t(R, U, Y, P, Z + \theta \text{Airbnb}))}{(S_{t-1} + NC_t - \delta \text{Airbnb}_t)}$$

According to this equation, when there is excess supply or demand (i.e., if the fraction in the equation deviates from 1), AVR_t would differ from zero. The demand for rental housing at time t , d_t , is determined by several factors such as the rental price per unit, captured by R , the buyer cost of ownership, U , real income per household, Y , the general price level, P , and demographic variables, Z , to which the authors add a specific fraction θ of Airbnb listings, meaning that the presence of Airbnb stimulates to a certain extent the real estate demand. On the other hand, housing supply is not given at its previous-period level, S_{t-1} , but increases due to new construction, NC_t . However, not all new units are supplied to the market. Instead, a certain amount that is proportional to the current presence of Airbnb is withdrawn, δAirbnb_t , and deviated to the STR market. In this way, Airbnb would be affecting both demand and supply of LTR units.

To establish the relationship between Airbnb listings and rents in any given census tract, Horn and Merante first construct a measure of Airbnb density on any given month, which equals the number of Airbnb listings divided by the total number of housing units in the corresponding census tract. The variable Airbnb density can be compared across different tracts of different sizes. Then they proceed to run two regression equations to test the supply effect and the price effect, respectively.

The effect of Airbnb density on the quantity of rental units offered weekly in any given month is estimated according to the following equation:

$$\text{LnCountR}_{tc} = \alpha + \beta_1 \text{Airbnb}_{tc} + \beta_2 \text{NC}_{tc} + \delta \text{Month}_t + \eta \text{Tract}_c + \varepsilon_{itc}$$

Where LnCountR_{tc} refers to the weekly average number of rental units offered in census tract c on any given month t and Airbnb_{tc} is the density in the same tract and month. The conjecture is here that units offered in the STR market are not advertised simultaneously as LTRs. The variable NC_{tc} measures new dwellings that obtained the occupancy certificate from the city in that period, expanding supply. The equation also contains Month_t and Tract_c fixed effects, to capture seasonality or differences across census tracts regarding the number of dwellings offered due to other exogenous reasons, like the size or property ratio of the census tract.

The effect of Airbnb density on the LTR price in any given tract and month is estimated according to the following equation:

$$\begin{aligned} \text{LnRent}_{it+1c} = & \alpha + \beta_1 \text{Airbnb}_{tc} + \beta_2 \text{Bed}_{it+1c} + \beta_3 \text{Bath}_{it+1c} \\ & + \beta_4 \text{Sqft}_{it+1c} + \beta_5 \text{NC}_{tc} + \delta \text{Month}_t + \eta \text{Tract}_c + \varepsilon_{itc} \end{aligned}$$

On the left-hand side of this equation, LnRent_{it+1c} is the logarithm of the asking rent of unit i in census tract c , at time $t+1$, i.e. one month after the observation of the Airbnb listings. On the right-hand side, we find Airbnb_{tc} , which is the Airbnb density at time t in tract c , as well as the variables Bed_{it+1c} , Bath_{it+1c} , and Sqft_{it+1c} corresponding to the number of bedrooms, bathrooms, and size in square feet of the rental observed, and the variable NC_{tc} , which are the new dwellings in that tract at t . Finally, the authors also include here Month_t and Tract_c fixed effects, to explain seasonal price changes and price differences across tracts that are due to characteristics of the area, like income per capita, services and amenities in the tract, etc.

This one-period lag is introduced to avoid problems of reverse causality that may arise if the number of STR increase following an increase in the rental prices. This kind of effect would go in the other direction, with prices at t causing the number of Airbnb listings at $t+1$. It can be avoided when Airbnb density at t is combined with rentals prices at $t+1$. To find out if increases in rent prices are affected by constraints in the availability of rental properties, it is crucial to assess the correlation between the average weekly quantity of properties available for rent on Airbnb during a specific measuring period and the density of Airbnb listings at the end of that period. In Boston, rental agreements are typically signed at the end of the month, requiring landlords to advertise their properties at least several weeks beforehand. Conversely, Airbnb rentals operate on a daily basis, allowing property owners to list their properties much closer to the desired occupancy date. As a result, it can be assumed that a landlord's choice to list a property on Airbnb rather than in the LTR market is likely to influence the number of properties advertised for rent in the weeks following the Airbnb listing.

Horn and Merante (2017) found that an increase of one standard deviation in Airbnb density within a census tract led to a decrease of 5.9% in the number of properties offered for rent, and to a rise of rents' prices by 0.4%, in line with the other papers previously discussed. Furthermore, in those neighbourhoods (census tracts) where Airbnb density was among the highest, this correlation had a stronger effect, with a 3.1% increase in posted rents. Nonetheless, this effect seems to be significant only in properties with two or more bedrooms. The authors stated that the results of their study are similar to the findings of other two descriptive reports from New York and San Francisco, despite the fact that at the time of the study, the use of Airbnb in Boston was significantly lower than in those other cities. While in New York City there were a number of neighbourhoods where Airbnb presence exceeded 20% of the total housing units, in Boston none of the census tracts exceeded 5%. Therefore, the results of this study present a weaker effect of Airbnb on the housing market. The authors emphasized the importance of suitable regulations in this regard, and suggested differentiating between private and commercial hosts, who run their listings as a business operation.

Turning to Europe, the literature shows analogous findings. The work of García-López et al. (2020) examines the effect of Airbnb on housing prices in Barcelona, Spain, where already in 2015 about 2% of all housing units in the city were listed on Airbnb. The reason for the high and fast penetration of Airbnb into the city, could be explained by the high premium

of STR in Barcelona at that time. In 2015, an average Airbnb host could earn a monthly income equivalent to that of a LTR within only 10 nights booked on the platform.

To explore the impact of Airbnb on residential housing markets, the authors consider first a theoretical model where property owners can choose between LTR to residents or STR to tourists. The model involves two neighbourhoods: a central one with a fixed size C and a suburban one with a housing supply curve that's not completely inelastic. All city units are owned by absentee owners. In the central neighbourhood, owners can rent to residents (long-term) or tourists (short-term), while the suburban neighbourhood only host residents. Owners in the central area can choose to rent long-term and receive an annual market rent Q_c or rent short-term to tourists and obtain a different annual rent T . Each owner faces a cost b_j to rent short-term, which is uniformly distributed across owners reflecting differences in factors like risk aversion. If the short-term rent minus the cost, $T - b_j$, is greater than the long-term rent Q_c , the owner rents short-term; otherwise, they rent long-term. Residents are assumed to be negatively affected by external effects generated by tourism. Based on assumptions about the valuations of neighbourhood amenities for residents and tourists a marginal owner who is indifferent between renting to residents or tourists, denoted b_j^* , can be identified in a market equilibrium, determining the share of units in the central neighbourhood that are rented short-term. In equilibrium, the value of b_j^* , depends on the neighbourhood size C , as well as the different in valuations for residents and tourists.

The crucial aspect of the model determining the effect that this share of STRs has on prices is that it affects residents' willingness to pay for LTRs as shown in the following equation,

$$Q_c = (1 - C)(1 + \gamma) + A_r + (C + \gamma C - \alpha) b_j^*$$

which implies that an increase in b_j^* affects Q_c in three different ways. First, the fact that units offered as STRs are not available as LTRs, implying higher prices. Second, since an increase in b_j^* forces some residents to move away of the centre to the suburbs, implying higher rents in the suburbs and, indirectly, also in the centre. Finally, on the other hand, increasing b_j^* also entails negative externalities on residents, a countervailing effect.

The authors adopt the approach of Barron et al. (2021) to establish the relationship between rents Q_c and housing prices in the central neighbourhood in equilibrium, P^c . The market is assumed to be in a steady state, and P^c will equal the present discounted value of all future cash flows to the landlord in this long-run equilibrium. The expression of this equilibrium price is shown in the next equation.

$$\begin{aligned} P^c &= \sum_{t=1}^{\infty} \delta^t \left[(1 - b_j^*)Q^c + \int_0^{b_j^*} (T - b_j)db_j \right] \\ &= \frac{1}{1 - \delta} \left[Q^c + (T - Q^c)b_j^* - \frac{(b_j^*)^2}{2} \right] \end{aligned}$$

The cash flow is computed using the discount factor δ , which takes into consideration that a fraction $(1 - b_j^*)$ of the units is rented for a long time at a price of Q^c , while the fraction b_j^* is rented for a short time at a rate of T , resulting in costs b_j^* . This takes into account that a portion of the available housing for rent yields a lower return $(T - b_j^*)$ that is higher than Q^c . The theoretical prediction of the model is, thus, that an increase in the share of Airbnb listings leads to increases in both housing prices and rents.

To empirically analyse the impact of Airbnb listings, García-López et al. (2020) use data from Barcelona, combining web-scraped information from Airbnb, in combination with comprehensive data on housing rents and real estate prices. The data are analysed at the geographical level of so-called Basic Statistical Areas (BSA) defined by the City Hall for statistical purposes, and corresponding to neighbourhoods with households of similar socio-economic characteristics. The dataset includes posted advertisements of sales and rents between 2007 and 2017 from a prominent real estate website in Spain (*Idealista*), in addition to individual-level transactions of properties sold between 2009 and 2017.

For the research, 221 units were included, each contains 7122 inhabitants on average. The Airbnb data were collected from the website “InsideAirbnb” and contain 21 data point between 04/2015-02/2018. The authors mark as “commercial use” every listing that belong to a multi-listings host, or, an “entire dwelling” that belong to a single host, who has minimum 5 reviews per quarter. More than 75% of listings on Airbnb fall under this commercial use definition. To obtain the data on long-term rentals and sales prices, the authors defined 2

measures for sales prices; transaction prices, which were tracked from the Catalan Tax Authority, and posted prices from the website *Idealista*. For the rent prices, only posted prices measurement was used through *Idealista*. The datasets were tracked in December of each year, between 2007-2017.

The empirical findings confirm the theoretical predictions of the model. The analysis of the comprehensive microdata on rents, prices, and Airbnb locations is done using different econometric techniques, and it reveals that the presence of Airbnb led to notable increases in both rents and housing prices, particularly distinct in highly touristic areas.

First, Garcia-López et al. (2020) consider specifications that include panel fixed effects, allowing different neighbourhoods to have different time patterns, or changes over time. These specifications include various features like interactions between neighbourhood characteristics (like distance from the city centre) and time trends (like whether changes are linear or curving). They also look at how these neighbourhood features interact with the overall economic performance of the region, and how much it differs from the linear trend it had before 2013.

Next, an instrumental variable strategy was applied, to tackle the endogeneity of Airbnb location. The instrument is the combination of the distance of the neighbourhoods to tourist attractions in the city (cross-sectional variation), and a measurement of changes in Airbnb activity over time by using Google Trends, tracking the number of searches for Airbnb in those neighbourhoods (aggregate time variation). The closeness of tourist attractions can forecast *where* Airbnb listings will be situated, and Google searches for Airbnb indicate *when* these listings will appear. The authors indirectly confirm that proximity to tourist attractions does not predict changes in rent and prices before Airbnb's rise in popularity before 2013.

The authors further conducted what is called event-study regressions to explore whether neighbourhoods that experienced substantial Airbnb growth after 2012 exhibited similar trends compared to other parts of the city before Airbnb's expansion. This is done including interaction terms in the regression, specifically the interaction of year dummy variables and the number of Airbnb listings for one particular year, allowing to estimate the effect of additional Airbnb listing in that year. Finally, they examined rental and housing prices around a particular landmark, "Sagrada Familia", a prominent tourist destination in the city, but also a popular residential area for upper-middle class households. Although it is located outside the city

centre, there is high Airbnb activity surrounding the Sagrada Familia. This was done to explore any gentrification effects following Airbnb's expansion.

All the above-mentioned estimation strategies provided fairly similar results, qualitatively and quantitatively, which are aligned with the prediction of the model. Airbnb was found as a factor increasing rents and housing prices, with a larger impact on prices than on rents. Here we just focus on the basic specification:

$$\log(Y_{n,t}) = \beta \text{Airbnb Count}_{n,t} + \gamma X_{n,t} + \tau_t + \mu_n + \varepsilon_{n,t}$$

where $\log(Y_{n,t})$ represents the logarithm of either housing rents or prices at the BSA level, $\text{Airbnb Count}_{n,t}$ indicates the number of active listings at time t in BSA n , the term τ_t refers to time fixed-effects, capturing overall time trends, and μ_n are BSA fixed effects, accounting for time-invariant neighbourhood characteristics. While τ_t capture general time trends, μ_n capture BSA specific, time-invariant neighbourhood factors into consideration. The dependent variable, $\log(Y_{n,t})$ is the average residual resulting from a hedonic regression that explains prices based on housing characteristics and time dummies. This controls for price fluctuations caused by variations in the mix of rented or sold units across BSAs and over time. For example, this method helps account for BSAs that gradually see a shift in the percentage of pricey flats sold or rented. The authors also provide weights to BSA-time cells according to the number of sales or advertisements that are relevant. The BSA level grouping of standard errors addresses any serial correlation within panel units.

One of the primary research issues is that Airbnb is most popular in the city's centre, which may be going through a general sociodemographic boom and, consequently, an increase in housing prices—which may not be directly related to Airbnb. To face this challenge, the authors deploy certain strategies. First, they control for BSA's average population age and density, household size, unemployment rate, income, and proportion of foreign residents. They allow neighbourhoods with different characteristics to have different time trend, linear or quadratic, and created a measurement for the interaction between the time trend and distance from the city centre, which allows for more central BSAs to have a steeper time trend. Finally, as already mentioned above, by using different regression methods, the authors apply 3 robustness tests to verify their results: instrumental variables (cross-sectional tourist amenities

index, and “Google Trend” searches for Airbnb Barcelona), event-study regression (focus on Airbnb activity specifically in 2016, in the various BSAs, and the dummies for rents, transaction prices and posted prices), and the Sagrada Família case (one of 3 main tourists amenities located outside the city centre, but causes a high Airbnb activity around it).

The main empirical results can be summarized as follows. The authors find increases of both rents and housing prices in Barcelona that could be attributed to the expansion of Airbnb. Overall, the analysis delivers strong support for the hypothesis that Airbnb affects housing prices through the channels contemplated in their model, in particular, the reduction in the supply of LTRs. Their analysis also lets them conclude that it was this, and no other underlying gentrification dynamics what led to the price changes observed. Specifically, for a neighbourhood with average Airbnb activity, rents increased by 1.9%, while transaction prices increased by 4.6%, and posted prices by 3.7%. In the most touristic neighbourhoods, rent rises reached up to 7%, with transaction and posted prices soaring by as much as 17% and 14%, respectively.

These findings align with the results of Horn and Merante (2017), who observed that areas with a higher density of Airbnb listings experienced a more pronounced effect on rental prices. Finally, the authors suggest that short-term rental platforms like Airbnb may exacerbate housing affordability issues, especially in cities with booming tourism industries, prompting the need for informed policy discussions regarding regulation and market management strategies.

Given these findings from the empirical literature studying the impact of STRs on real estate markets, the next section reviews the current regulation of STRs in different cities around the world.

Regulation of STR in various cities

The rise of the sharing economy, with Airbnb as one of the big players, has significantly changed the tourism industry. While Airbnb offers the benefits of increased overnight options for travellers and a side-income for hosts (flat owners who rent their places for tourist purposes), its fast growth has raised concerns about its impact on housing markets, its effect on residential neighbourhoods, side effects on the hospitality industry, and even on tax

revenues for municipalities. Various cities, including Vienna, have been testing legal mechanisms to find the right balance between promoting tourism alongside protecting its residents. The main instruments introduced in other big cities are:

- City registration of short-term lodging.
- Limits in the number of days that dwellings can be offered for STR.
- Restriction or reduced allowance of STRs within certain areas of the city.
- Introduction of a local tax on short-term touristic stays, collected by the host.
- Some cities, like New York and San Francisco, require that hosts are full-time residents or even present in the property during the guests' stay, and limit the number of simultaneous guests (Sharf, 2023).

Although the regulations on STRs are continuously changing, previous research for cities around the world provides valuable insights into their effects. Yeon, Kim, et al. (2020) examined the impact of regulations in New York, where STRs are regulated, compared it to Washington DC, where they are not, over the period from 2014 to 2017. They found a 4.3% decline in monthly Airbnb revenues after regulations were implemented. Koster et al. (2021) used quasi-experimental methods to analyse 18 regulated cities versus 88 unregulated ones in Los Angeles, USA, finding that STR regulations led to a 50% drop in Airbnb listings and a 2% decrease in both house prices and rents. Similarly, Bibler et al. (2022) investigated the enforcement of registration requirements in Chicago and Los Angeles, revealing that such policies led to a 40% reduction in Airbnb supply and bookings, and a 4% drop in housing prices in the regulated areas. Bekkerman et al. (2022) using a staggered DiD method to study 20 US cities, found an 18% decrease in Airbnb listings one year after the introduction of similar regulations. Finally, Bei & Celata (2023) observed the various STR regulations across 16 European cities, evaluating the specific effects of different policy mixes. They concluded that while zonal restrictions lead to a limited geographical impact, they also result in an overall decrease in the number of "entire home" listings. In contrast, time-cap policies had a less significant impact on the total number of listings, but were effective in reducing the prevalence of commercial hosts. The authors further emphasize the need for cooperation between platforms like Airbnb and policymakers to improve the implementation and enforcement of restrictions. To facilitate this cooperation, they suggest the introduction of EU-level regulations for data sharing.

In order to understand the STR phenomenon better and the current regulatory landscape, a selection of cities with different regulatory approaches were chosen for examination and are presented in the rest of this section.

New York

New York, USA, represents cities with a very strict approach towards STR, get as far as almost a complete ban. In recent years, the cost of living and high inflation in NY, mainly due to high housing costs, have been major political issues. The shortage of housing has led to increased rents, resulting in more renters spending over one-third of their income on rent. Advocates for affordable housing are criticizing platforms like Airbnb for reducing the housing supply. Therefore, in September 2023, New York City enacted a law to strictly regulate short-term rentals on such platforms. New York City's Local Law 18 includes provisions such as limiting Airbnb stays to two guests at a time, requiring hosts to be present during rentals, and mandating that all doors within the unit remain unlocked for full access by occupants. These rules aim to limit investors who converted long-term rental properties into more profitable Airbnb units, as this phenomenon became popular among landlord in NY. According to data on Inside Airbnb, before the regulation, there were 22,000 “entire unit” listings on Airbnb in New York, which after the launching of the new regulation, are no longer allowed. The intention behind this regulation is to return such dwellings to the long-term rental market, and by doing so, increasing housing supply, and lowering crime rates in certain neighbourhoods (Hines-Jones, 2019).

In January 2024, about 4 months after the introducing of the regulation, an analysis published by Airbnb demonstrated that long-term rent prices kept increasing, with a rise of 2.3% in December, comparing to the previous year. This rise approved that although thousands of listings were removed from Airbnb, it did not lead to an immediate decrease of rentals. The New York vacancy index revealed that the share of housing units available for rent in December remained the same as in September. Meanwhile, according to the Trivago Hotel Price Index, hotel prices in the city increased in 8%, compared to December of the year before (Airbnb News, 2023). Nevertheless, one should bear in mind that this analysis was published by Airbnb, which has a clear interest to oppose the regulation.

Amsterdam

Amsterdam takes a relatively strict approach to STRs, though it is not as stringent as cities like New York or Florence. As many other big European cities, Amsterdam faces housing shortages, and over-tourism significantly impacts local communities. As a result, the city has a firm policy on STRs. Amsterdam has decided for a severe time limit approach, as hosts are allowed to rent out their properties for a maximum of 30 nights per year, with strict enforcement; violations can result in fines of up to €11,600. Additionally, only four guests are allowed at a time, and hosts must comply with safety requirements, such as installing smoke detectors.

To promote energy efficiency and transparency, listing must also include the property's energy rating. The host must be the main resident of the property and is required to obtain an annual permit, which costs €71 as of 2024. Furthermore, a registration number must be displayed on the Airbnb listing, and hosts must register with the tax authorities to ensure the correct payment of income and tourist taxes. Each rental period must also be reported to the municipality in advance. Non-compliance with these rules, can lead to fines of up to €8,700 (City of Amsterdam, n.d.).

Berlin

Berlin's policymakers implemented a combination of measures aimed at curbing the rise in rental prices while preserving the positive impacts of tourism and STR. Since August 2018, Airbnb regulations in Berlin have become stricter to address concerns about housing shortages and the impact of short-term rentals on the local housing market. In order to mitigate STR's impacts, the municipality sets limits on various aspects:

- Airbnb hosts have to acquire permission and a registration number from the local authorities. This number has to be presented on the listing page.
- Hosts, who lives in the property as their primary residence, are allowed to rent out a maximum of 49% of their dwelling space without any time limitation. However, second residences can be rented out for tourist purposes up to 90 days per year. In both cases, a permit from the authorities is required (Berlin.de, n.d.).

- For non-residential properties, hosts has to display a registration number or provide contact information directly on the listing, to ensure transparency and accountability.
- Since 2013, Berlin's authorities have implemented an Overnight Accommodation Tax, which applies to all tourists and should be collected and paid by hosts (Airbnb, n.d.).

Berlin authorities actively enforce these regulations, and fine hosts for non-compliance. Their attitude has been to work with STR platforms to ensure listings comply with local laws, remove non-compliant listings, and provide resources to help hosts to understand the regulation. Nevertheless, these regulations also mean that hosts must navigate bureaucratic processes and comply with strict rules, while guests might find fewer options available.

Florence

Florence, Italy, practices an approach of limiting STR in certain parts of the city. One of the key measures, launched in June 2023, is a complete ban on new short-term rental listings in the historic city centre, which aims to address concerns about over-tourism and its impact on local housing availability. This regulation is part of broader efforts to protect the character and liveability of the historic area, ensuring that residential neighbourhoods are not overwhelmed by tourist accommodations. The new rules include prohibiting new short-term rental listings in the historic city centre since June 2023, requirement of existing hosts to comply with specific registration and reporting measurements, and assurance of safety and quality standards within of the properties (Airbnb, n.d.; Città Metropolitana di Firenze, n.d.).

According to "Inside Airbnb" website (n.d.), currently in Florence there are 11,172 registered Airbnb listings, while 68% out of them (7600 listings) considered as unlicensed, although according to the regulations, all listings have to be registered. Moreover, about 83% of the listings are under the segment "entire home", and about 50% of all listings are frequently rented, means properties that serve only for tourist purposes. The vast majority of those listings are located within the historical centre of Florence. Comparing these figures to those from June 2023, when the new regulation was implemented, it is evident that the total number of listings has decreased from 11,800. Consequently, despite the majority of listings remaining unlicensed, the regulation appears to be effective in curbing the growth of short-term rentals in Florence.

Munich

Munich, the capital of Bavaria, is one of the largest cities in Germany, with a population of almost 1.5 million inhabitants (Encyclopaedia Britannica, n.d.). Located only five hours drive from Vienna, and having similar attributes, it will be used as a referral city for this study. Although Vienna is normally visited by a larger number of tourists each year (City of Vienna, n.d.; Statista, 2023), the two cities are similar in their cultures, economies, tourist attractions, and their population, as Vienna has 1.9 million inhabitants (City of Vienna, 2022). Observing the Airbnb density in both destinations, as of December 2023 there is a lower number of active listings in Munich (7,336) as in Vienna (13,975). Additionally, almost 80% of the listings in Vienna are categorized as “entire home”, while this only makes 65.5% of the Airbnb listings in Munich, the rest being mainly private rooms within dwellings. According to data provided by the Inside Airbnb platform, hosts in Munich can expect to rent out their properties for 36 nights a year and €229 a night on average, with a total yearly income of €8,418. Instead, in Vienna an average listing is rented 69 nights a year, for €109 a night, and an average yearly income of €6,951 (Inside Airbnb, n.d.). Despite those differences, in order to track the changes expected in Vienna following the new regulation, Munich seems a suitable comparison, as the cities are similar in many ways and there are no regulatory changes expected in Munich.

Restrictions on Airbnb activity in Bavaria fall under the general regulation on the alienation of residential space (Bavarian Ministry of Justice, 2008). Additionally, Munich has its own city statutes in this regard (ZeS) (City of Munich, n.d.). The regulation states that all over the city, a person is not allowed to use more than 50% of a residential property's space for a non-residential purpose, such as short-term rental to tourists. It means that owners can rent out a room or more in their main home on Airbnb without any permit, but not more than half of their living space. Nonetheless, according to the current regulation, it is allowed to rent out a whole unit for a maximum of eight weeks per calendar year without any required permit (ZeS §4). Anything beyond these two cases requires property owners to obtain a special permission from the authorities. The conditions for this permission to be granted are generally formulated (ZeS §5):

- In case of any public concern or a legitimate self-interest which outweighs the interest of keeping the property for residential use.

- If the interest of preserving the living space is outweighed by the creation of replacement residential space or by the payment of a compensation.

The following section presents an English translation of the Statutes of the City of Munich on the prohibition of the alienation of living space (ZeS):

On the basis of Art. 1 of the Act on the Prohibition of the Misappropriation of Housing misappropriation of living space (Misappropriation Act - ZwEWG) of 10.12.2007 (GVBl. p. 864, BayRS 2330-11-B), last amended by the law of 19.06.2017 (GVBl. p. 182), the following statutes:

§ 1 Object of the statutes

(1) In the state capital of Munich, the supply of the population with sufficient housing at reasonable conditions is particularly at risk (housing shortage).

(2) These by-laws apply to the misappropriation of privately financed housing in the city of Munich. Residential space is not affected as long as the authorized person is subject to an approval requirement pursuant to Art. 16 para. 1 clause 1, nos. 2 and 3 Bavarian Housing Promotion Act (BayWoFG).

Comparing the regulations in Vienna and Munich, while Vienna's regulation is focused on zoning, Munich restricts the amount of residential space devoted to short-term rentals within each residential unit. It is thus not surprising that Vienna has more Airbnb listing offering entire dwellings, while in Munich there is a higher prevalence of private rooms. In the upcoming regulatory change in Vienna, we are expecting a time limitation of Airbnb rentals of ninety days. This is akin to the eight weeks restriction in Munich, though less restrictive. We thus expect a decrease in the number of Airbnb listings in Vienna, as in Munich the number of total Airbnb listings is significantly lower (about 50%) than this in Vienna. Additionally, currently the average occupancy (nights booked per year) in Munich is about 90% lower than in Vienna (Inside Airbnb, n.d.). Perhaps this enormous difference is caused by the limitation of 8 weeks existed in Munich. Therefore, similar to Munich, we expect the average occupancy in Vienna to decrease, as hosts might lower the yearly availability of their dwellings to a maximum of 90 nights a year in order to comply with the new regulation.

Regulation of STR in Vienna

Vienna, known for its rich history, is particularly concerned about maintaining the unique character of the city while considering the needs of tourists. Its approach to regulating Airbnb and other tourist rentals demonstrates its importance to balance between these two priorities. Overall, Vienna has implemented regulations that require hosts to register in the city authorities, collect taxes, and report statistical data on touristic stays. The official website of the municipality of Vienna provides an overview of the rules that apply when renting flats for touristic purposes (City of Vienna, n.d.). Before July 1, 2024 the main aspects of Viennese regulation can be summarized as follows.

Registration: Hosts must register their rental units for tax and statistical purposes. They also have the obligation to track their guests in a guest-directory, where they sign up every guest within 24h of arrival. This registration allows authorities to monitor the number of properties being used for tourist purposes, and their locations.

Licensing: A business licence is required only in case of more than 10 rented beds, or when the host provides a large selection of food and drinks, and hence, it is regulated under the hospitality industry. Private room-sharing owned and managed by the landlord resulting in relatively small revenues does not need a licence in general.

Taxes: Anyone who rents out short-term accommodation in Vienna for touristic purposes must have a local tax account and collect taxes from their guests. Guests in Vienna have to pay a local city tax of 3.2%. Educational stays of minors, or students, as well as persons who live in the accommodation for more than 3 months without interruption are exempted from this tax. Additionally, Austrian tax law applies to income from accommodation, which is subject to income tax and sales tax.

Reporting statistical data: Another important controlling mechanism is the collaboration of Vienna's municipality with short-term rental platforms, and in particular, with Airbnb. This collaboration involves data sharing to monitor compliance, in addition to the implementation of features that remind hosts of their legal obligations (Airbnb, n.d.).

Residential limitations: Vienna, like other cities, applied certain limitations in residential zones, in order to promote the well-being of its residents. These limitations aim at protecting

the purpose of residential neighbourhoods. Over time, this part of the legislation seems to be the most delicate and debated. First, there is a clear intention to protect the social housing sector. The use of social housing dwellings or non-profit students' dormitories for tourist purposes is not allowed. Also, long-term rental flats can be protected with restrictions on subletting that can be anchored in the rental contract. After December 2018, the Viennese building code contemplated a general prohibition of renting residential properties for a commercial use when they were located in the predefined residential zones. This included most areas in the inner districts, but not exclusively (City of Vienna, n.d.). It is important to mention, however, that this regulation does not apply to people renting out their flat occasionally, corresponding to the case of "home sharing". For example, in the case of homeowners renting out their dwellings during their holiday, this is permitted in the residential zones. This regulation seems contradictory and difficult to implement and monitor. In fact, according to existing jurisprudence of the supreme court, the use of a flat for touristic purposes may require under some circumstances the consent of all the homeowners of the building (Oberster Gerichtshof, n.d.). In most cases, the dedication of a building is for residential purposes, and therefore, in case owners would like to rent their flat repeatedly for short periods of time (touristic purposes), they would need to convert this dedication to holiday purposes. This normally requires the consent of all the flats' owners in the building.

Recent developments and planned changes of the Vienna Building Code: The difficulties in its implementation and the ongoing debate on how to limit commercial rentals in residential properties has led Vienna, like other big cities around the world, to reconsider its restrictions of short-term, touristic rentals. New regulation came into effect on July 1, 2024. According to the legal amendments, the ban of short-term rentals in residential zones will be extended to all flats in the city area. The rental of flats for touristic purposes will be limited to a maximum of 90 days per year. Anything beyond that will require an exceptional permit. The new regulation still differentiates between so-called residential zones and non-residential, in the matter of exemption permits.

Flats located outside residential zones may only be offered for short-term rental for more than 90 days per calendar year with an exemption permit limited to a maximum of five years, as per Section 129 Para. 1a BO. The issuance of this exemption permit is contingent upon meeting several criteria, including:

- The flat must not be situated in a residential zone or designated as “green land – recreational area – allotment area,” “green land – recreational area – allotment area for year-round living,” or areas temporarily used for allotment gardening.
- No housing subsidies should have been utilized in the construction of the flat.
- The majority of flats in the building must continue to be used for residential purposes in accordance with Section 119 Paragraphs 2 and 2a BO.
- No more than 50% of the usage units in the building should be designated for commercial use for short-term accommodation purposes.

Flats located within the residential zones are protected under Section 7a BO. According to Section 7a Paragraph 5 BO, certain exceptions may be granted upon request if:

- The remaining living space in the building constitutes at least 80% of the total usable space, excluding the ground floor and basement.
- The quality of living in the affected common areas is compromised by external factors such as emissions, lighting, ventilation issues, lack of other residential uses in the same building, poor ground floor location, or similar circumstances.
- Facilities intended to serve the local population are to be created or expanded.
- Equivalent living space is simultaneously created in a residential zone within the same district, matching the original flat in size, furnishings, and average achievable rent at the time of creation. The determination of this rent, in accordance with Tenancy Law, will be particularly relevant for the notional achievable rent.

Renting out a flat for STR for more than 90 days per calendar year without an exemption permit can result in fines of up to €50,000. If the fine cannot be collected, the penalty may include a prison sentence of up to two weeks (City of Vienna, n.d.).

Previously, enforcing the ban on short-term accommodations in residential areas without a permit and penalizing violations was challenging, as authorities largely relied on reports from the public. However, the new permit requirement and data exchange with tax authorities through existing local tax accounts are expected to simplify prosecution.

The following section presents an English translation of Section 7a of the Vienna Building Code (BO), handling the regulation of STR:

§ 7 a. (1) For reasons of urban structure, urban development and diversity of the urban use of building land as well as the organization of the urban living space, residential zones may be designated in the development plans both in the residential area and in the mixed building area in order to preserve the housing stock.

(2) The residential zones shall be clearly demarcated from the other areas. The boundaries of residential zones may coincide with alignment lines.

(3) Common spaces in residential zones that were dedicated or legally used as a dwelling on a main floor or parts of such a dwelling at the time the residential zone was established or that are subsequently newly constructed shall continue to be used only as a dwelling or parts of a dwelling. A common space is also used as a dwelling or part of a dwelling if activities are also carried out in it which, although not directly serving residential purposes, are usually carried out in dwellings; commercial use for short-term accommodation purposes does not constitute such an activity.

(4) In buildings in which the floor space for flats outweighs that for offices or business premises, the conversion of attics is only permitted for flats, domestic laundry rooms and the associated ancillary rooms as well as for engine rooms; para. 3 shall apply *mutatis mutandis* to the use of flats in attics.

(5) Exceptions to para. 3 shall be permitted by the authority upon application if this means that in residential areas the areas used for flats in the building do not amount to less than 80% of the sum of the usable areas of the main storeys, but excluding the ground floor; in residential areas and in mixed building areas, exceptions to para. 3 and exceptions to para. 4 shall also be permitted if the quality of living in the occupied rooms concerned is reduced by external circumstances such as emissions, lighting, ventilation, lack of other residential uses in the same building or the particularly poor location on the first floor and the like, or if facilities serving the local supply of the population are to be created or extended or if other living space is created in the vicinity to at least the same extent at the same time.

(6) The imposition of a temporary building ban on an urban area located in a residential zone shall not affect the obligations arising from the residential zone (Jusline Austria, n.d.).

The initial announcement regarding the regulatory changes was made in July-August 2023 (Trending Topics, 2023). Subsequent articles revisited the topic in September (Die Presse, 2023), November (Meinbezirk, 2023; Heute, 2023), December (OE24, 2023), January 2024 (Die Presse, 2024), March (Der Standard, 2024), April (Tourism Review, 2024; Der Standard, 2024), and finally, in June (Krone, 2024). In the June report, it was noted that by the end of May, 313 applications for exemption permits had already been submitted.

Overall, the legal situation in Vienna regarding the protection of residential areas from Airbnb, is a continuing effort to harmonize between the well-being of the residents, and promoting affordable accommodation for tourists and financial benefits for hosts and the city. Balancing the economic benefits of tourism, while maintaining the comfort of local neighbourhoods, is a challenging task. By practising solutions such registration and taxes, limiting the rental periods and protecting zoning regulations, Vienna intends to achieve coexistence between tourists and residents.

Previous Research on STR in Vienna

Short-term rentals have garnered attention in Vienna, prompting academic and regulatory research. As platforms like Airbnb have grown, studies have focused on their impacts on the local housing market, urban dynamics, and socio-economic conditions. However, the volume of research conducted on short-term rentals (STR) in Vienna remains quite limited. One of the recent studies, published by Kadi et al. (2022), emphasizes the significance of widely shared benefits from tourism activities. The authors explore the concept of inclusive tourism development and its connection to Airbnb, who become the major player in Vienna. The company presents itself as a promoter of a more inclusive form of tourism, by empowering private people to share spare space for the sake of economic benefit, while critics argue it prioritizes commercial rentals over home-sharing. Inclusive tourism, as proposed by Scheyvens and Biddulph (2018), aims to broaden tourism benefits by fostering participation from marginalized groups. One key debate based on the nature of Airbnb listings. Airbnb emphasizes "home-sharing," an occasional rent of spare space to tourists, but this model is often misused, with property owners using Airbnb for "commercial provision" of permanent holiday rentals. This commercialization, might intensify space scarcity and overcrowding, displace residents and lead to gentrification, hindering inclusivity. Generally, sharing spare

space requires fewer resources than acquiring a dedicated rental property. Hence, data on hosts' backgrounds and the conditions of space-sharing are essential for understanding the platform's actual effects.

The authors aim to understand this by examining how Airbnb rentals are offered (home-sharing versus commercial provision) and its impact on inclusivity in tourism development. Following Wachsmuth and Weiser (2018), and Cox (2017), commercial use is defined by the authors as a listing that is rented out at least 60 nights a year, and available for minimum 120 nights per year.

They propose a novel method to measure this by analysing factors such as room type, listing frequency, and host characteristics. Their study focuses on Vienna, Austria, which experiencing a rapid rise in Airbnb listings (1,300 listings in 2014 to 8,600 in 2017, capturing 10% of overnight stay revenue). Most of existing research focuses on major tourist destinations like Berlin or London. Adamiak (2018) shows a significant variation across cities, while commercial listings are more common in major tourist hubs rather than in relatively non-touristic cities. Furthermore, Schaefer and Braun (2016), who focus on Berlin, Germany, highlight how commercial activity varies within different parts of the city, concentrating in specific tourist areas.

Methodologically, current research relies on limited indicators to identify commercial activity. These indicators include listing type (entire unit vs. room), host size (number of listings), and rental duration within one year. The authors criticize these indicators, which are limited in capturing the nuances of provision practices. Focusing solely on entire unit listings, assuming that they represent commercial hosts, might overlook occasional rentals of entire dwellings by private residents, or in another scenario, commercial hosts that rent out private rooms rather than a whole unit. Similarly, focusing only on a rental duration indicator, as Cox and Slee (2016) for instance, excluding all listings that are rented out less than 60 days a year, might ignore "unsuccessful" commercial hosts. Therefore, Kadi et al. employ a combined approach to identify commercial activity. For their exploratory analysis, the authors use Airbnb's web-scraping data from August 2017 in Vienna, differentiating between 23 districts, and combine indicators for listing type, rental duration, and host size (number of listings).

The study revealed several key findings. Firstly, it highlighted the dominance of entire unit listings, comprising 69% of all listings, with significant variations across different city districts. The central areas, such as the 1st district, Innere Stadt, exhibited higher percentages of entire unit listings compared to peripheral districts like Liesing. Moreover, most central district, notably Leopoldstadt and Innere Stadt, boasted a high concentration of permanent rentals. The 1st district had a remarkable 50% of its entire unit listings available for permanent renting, contrasting sharply with peripheral areas like Simmering and Floridsdorf, which had significantly lower numbers. Furthermore, single-listing hosts were prevalent, constituting 83% of all hosts, while multi-listing hosts, though fewer, contributed substantially, providing 42% of all listings. A deeper dive into the data revealed that nearly half of all permanently rented entire units were managed by hosts with just one listing. This contradicted the conventional belief that only major property owners engaged in long-term Airbnb rentals. It emphasized the substantial involvement of small-scale landlords in shaping Vienna's Airbnb landscape.

Finally, results showed a polarization in rental patterns, with some listings rented out only a few days per year while others were available for most of the year. Despite variations in threshold criteria, approximately 38.6% of entire unit listings in Vienna adhered to criteria indicative of commercial practices, meeting the predefined occupancy rate and availability standards. This conclusion remained consistent across different threshold criteria, indicating a strong and consistent trend of commercial activity within the Airbnb market. Although Airbnb plays a role in facilitating private 'home-sharing,' which may contribute to more inclusive tourism practices, it does not fully represent the breadth of inclusive tourism.

This outcome suggests a need for policymakers to address the dominance of commercial provision on platforms like Airbnb while still supporting genuine 'sharing' practices. Similarly, Colomb & de Souza (2021) stated earlier, that without a specified threshold for time and space in the Viennese STR regulation, case-law will be required to distinguish between commercial and occasional short-term rentals in disputed cases. In addition, attempts by the city government to receive data from Airbnb have been hindered by the platform's strict conditions for data release. Platforms have sometimes agreed to provide data or remove listings only when public authorities present evidence of illegality, but this cooperation has been inconsistent. Although Vienna bans short-term rentals in public housing,

Airbnb has not complied by removing these listings. Additionally, platforms often provide only aggregate data, which is not useful for enforcement. Cities like Barcelona and Paris have imposed substantial fines on platforms for advertising illegal short-term rentals without registration numbers, but enforcing these fines is complicated and uncertain, especially when the platform headquarters are based in other countries. Taxation has also been a significant issue; in Vienna and other cities, national tax authorities have pressured platforms to share individual host data to prevent tax evasion. While Airbnb has entered into numerous 'Voluntary Collection Agreements' to collect and remit city taxes, some experts suggest these agreements make municipalities dependent on platform revenues, making them less likely to enforce stricter regulations. Berlin, for example, have declined similar agreements until Airbnb will share individual host data. As of January 2021, Airbnb is required to submit information to the Austrian tax authorities regarding the identity of hosts and their activity during the preceding year on the platform. The earnings report will contain comprehensive details about the host, including name, address, Host ID, listing details, bank account information, payout amounts, and booking information. The EU Council Directive 2021/514, which gave rise to the DAC7, required online platforms such as Airbnb to gather and disclose taxpayer data for users who were generating income through the site. This applies to those with property listings or residence in any of the 27 EU Member States. Residency for DAC7 is determined by one's primary address and any country where a tax identification number (TIN) has been issued (Airbnb, n.d.).

According to Bosio & Naddeger (2023), who examined Airbnb activity in Tyrol, Austria, despite the DAC7 regulation, authorities encounter significant challenges related to data accuracy, hindering comprehensive analysis thus far. By 2023, a new digital platform reporting law should be enacted across EU member states, enforcing stricter penalties for platforms with inadequate data quality, though initial data is anticipated only in 2024. A primary limitation of their research is its focus solely on the supply side of Airbnb listings without considering corresponding demand. The introduction of new data from regional authorities should enable an analysis based on actual data rather than just listings, offering a more comprehensive understanding of Airbnb's role. Such a demand-side analysis would facilitate the study of recent Airbnb trends.

The new regulation in Vienna, expected from July 2024, might be the right solution, as it encourages “home-sharing” and enhancing inclusive tourism, while limiting a commercial use of such platforms. The limitation of 90 days a year prevents hosts from making a commercial use, while the mandatory registration under the authorities, and cooperation between them and Airbnb, make transparency and the enforcement of the regulation easier.

Methodology

The present section presents the methods that will be used in the thesis to perform empirical analysis with the primary objective of detecting possible effects of the change in STR regulation in Vienna that may already be effective. This will be done by comparing the STR and LTR markets in Vienna and Munich, where STR regulations remained unchanged and therefore serves as the control city. For this purpose, Airbnb, the leading global platform for booking travel accommodations, is used to provide detailed data on STR listings, while “Immowelt”, a major real estate website in Germany and Austria, is used to extract information on properties offered for long-term rental. The study period spans from November 2023 to July 2024, with data collected weekly for both cities. The research is conducted in two phases: analysing Airbnb data to detect changes in the number of listings in the different census districts, and later, examining Immowelt data for rent price variations on a district level.

Data Collection

Data was collected weekly from both Airbnb and Immowelt websites, by using the platform APIFY, which provides web-scraping services. For Airbnb, the study gathers comprehensive information from November 2023 until July 2024, on all available listings in Vienna and Munich, including variables such as listing ID, price per night, property type, location, and host details. The dataset for this research encompasses a total of 102,728 Airbnb listings in Vienna, with a weekly average of 3,314 listings, and a total of 63,673 Airbnb listings in Munich, with a weekly average of 2,054 listings.

Immowelt data collection was done as well between November 2023 to July 2024, focusing on listings for long-term rentals, in each city, Vienna and Munich, capturing details such as monthly rent, property size, location, and additional features. The weekly basis scraping ensures a temporal alignment of data points for trend analysis. For Vienna, a total of 25,203 rental listings were observed over the study period, with a weekly average of 787 listings. In comparison, Munich had a total of 18,090 listings, with a weekly average of 565 listings. The listings for both cities were collected as a random sample to ensure that all price ranges and geographical areas within the cities were adequately represented. This sampling method aimed to provide a holistic view of the rental market conditions and variations, enabling a robust analysis of rental trends and pricing dynamics across different neighbourhoods and economic

segments. The lower number of observations for Munich can be attributed to the smaller pool of available rental listings compared to Vienna. This difference may reflect varying market dynamics and housing availability between the two cities, potentially influenced by factors such as housing supply constraints, and differing levels of demand for rental properties. These elements contribute to the overall rental market landscape, affecting the volume of listings accessible for analysis.

To ensure reliability and validity of the findings, a few measurements were taken. Missing data primarily arose from incomplete listings on the Immowelt platform, where only 50% of the listings provided exact addresses, although all listings included at least a city district. To address this issue, data analysis was conducted at the district level for Immowelt listings to maintain consistency. When specific key variables were missing, such as price, size, or district, these records were excluded from the analysis to avoid introducing bias. Regarding the Airbnb data, exact coordinates were available for each listing, allowing the analysis to be conducted at the census district level. Listings lacking coordinate information were excluded from the dataset. To verify the authenticity and completeness of the data obtained from Airbnb and Immowelt, cross-referencing was performed with publicly available datasets from the website “InsideAirbnb”, and real estate platforms such as “Willhaben”, to confirm the accuracy of the LTR listings. Furthermore, consistency checks were implemented to identify and rectify discrepancies or anomalies in the data. Finally, consistency checks were performed to detect and correct any discrepancies or anomalies within the data, by verifying that the coordinates of Airbnb listings matched the specified census district boundaries, and ensuring uniformity in variable names and formats. This process assured that the scraped data accurately represented real-world conditions, thereby reducing potential errors and biases.

Main hypotheses

To analyse the impact of the STR regulation on Airbnb listings and long-term rental prices across different districts in Vienna, this section formulates a set of hypotheses. The analysis will also provide a comparative perspective with Munich as a control city.

Hypothesis 1: Impact on Airbnb listings

H1: The new STR regulation will lead to a proportional decrease in the total number of Airbnb listings in Vienna, with a more significant impact in non-residential zones compared to residential zones.

The new regulation, starting from July 2024, allows individuals in all districts to rent their properties for up to 90 days per year. This provides clarity in residential zones, where there was previously ambiguity because the regulatory ban was not effectively enforced. In contrast, the regulation introduces a new restriction in non-residential zones, where there was no previous limitation on STR activity. This is expected to discourage property owners in non-residential areas, leading to a reduction in Airbnb listings in those zones.

Hypothesis 2: Variation across districts

H2: The effect of the STR regulation on Airbnb listings will vary across the different districts in Vienna, with residential zones seeing an increase in listings due to the newly allowed 90-day limit, while non-residential zones experience a decrease.

The literature does to provide conclusive evidence in this respect. Hill et al. (2023) have claimed that a regulation of Airbnb daily limit was not found effective, but the extent of the allowed days may significantly influence outcomes. This may also depend on the Airbnb rent-premium, even if the 90-day limit is relatively short. In their study for Barcelona, Gacía-López et al. (2020) found that the penetration of Airbnb in the city had varying effects on different neighbourhoods. In the case of Vienna, the 90-day limit may even motivate some property owners in residential areas to enter the Airbnb market, given that it is now clearly permitted.

Hypothesis 3: Impact on long-term rental prices

H3: The new STR regulation will affect long-term rental prices in Vienna, potentially leading to varying changes in rent levels across districts.

All studies we have reported in this thesis indicate that STR regulations have an impact on housing markets, and specifically on long-term rental prices. These price effects operate through different channels, as was clearly explained by the theoretical model in García-López et al. (2020) for example. Essentially, the literature has shown that Airbnb penetration has led to an increase in the prices of LTRs. Regarding comparisons across different neighbourhoods, Valentin (2021) discovered that prohibiting STR in a neighbourhood in New Orleans resulted in a decline in housing prices compared to other areas of the city. Additionally, Chang (2020) found that the introduction of a sales tax reduced Airbnb's impact on rental prices for both entire dwellings and private rooms. These findings suggest that the introduction of the 90-day limit and the expected changes in Airbnb activity, which may potentially differ across different districts, will also affect the LTR market in Vienna.

Null Hypothesis

H0: The introduced STR regulation has no statistically significant effect on the number of Airbnb listings or long-term rental prices.

The null hypothesis serves as the baseline assumption, if all the other hypothesis are rejected. This would mean that any observed changes in the number of Airbnb listings post-regulation are due to random fluctuations rather than the impact of the regulation itself. The analysis will focus on testing these hypotheses to determine whether the data provide sufficient evidence supporting the presence of a regulatory impact.

Model Equations

In order to test the above-mentioned hypotheses, two models will be considered:

Change in Number of Airbnb Listings

$$\Delta\text{Listings}_{d,t} = \alpha + \beta_1 \cdot \text{Regulation}_t + \beta_2 \cdot \text{InnerDistrict} + \beta_3 \cdot (\text{Regulation}_t \times \text{InnerDistrict}) + \varepsilon_{d,t}$$

In this equation, $\Delta\text{Listings}_{d,t}$ denotes the change in the number of Airbnb listings in district d at time t . The intercept term, α represents the baseline change in Airbnb listings when all other variables are zero, essentially providing a starting point for the model's predictions. The term $\beta_1 \cdot \text{Regulation}_t$ captures the effect of the new STR regulation implemented at time t on the change in Airbnb listings. Here, β_1 is the coefficient indicating the average change in listings due to the regulation, while Regulation_t is a dummy variable indicating whether the new STR regulation is in effect at time t (with a value of 1 if the regulation is in effect, and 0 otherwise). Next, InnerDistrict is a dummy variable equal to 1 if the district is one of the inner districts (1-9), with higher prevalence of residential zones, and 0 otherwise. The coefficient β_2 represents the average difference in Airbnb listings between the inner and outer districts before the regulation. Finally, $\beta_3 \cdot (\text{Regulation}_t \times \text{InnerDistrict})$ captures the interaction effect between the regulation and the district group, allowing for the examination of whether the impact of the regulation varies between residential and non-residential zones. The residual term $\varepsilon_{d,t}$ accounts for the variability in the change in listings that is not explained by the model.

Similarly, the following equation was used to capture the change in Airbnb listings in Vienna compared to Munich (control group), where City is a dummy variable, equal 1 if the city is Vienna, or 0 if Munich:

$$\Delta\text{Listings}_{c,t} = \alpha + \beta_1 \cdot \text{Regulation}_t + \beta_2 \cdot \text{City} + \beta_3 \cdot (\text{Regulation}_t \times \text{City}) + \varepsilon_{c,t}$$

Change in Long-Term Rental Prices

$$\Delta\text{Rent}_{d,t} = \gamma + \delta_1 \cdot \text{Regulation}_t + \delta_2 \cdot \text{InnerDistrict} + \delta_3 \cdot (\text{Regulation}_t \times \text{InnerDistrict}) + \eta_{d,t}$$

In this equation, $\Delta\text{Rent}_{d,t}$ denotes the change in average square meter rental price, in district d at time t . The regression is analogous to the previous one, but now tries to explain

any changes observed in long-term rents. The intercept term, γ , represents the baseline change in rental prices when all other variables are zero. The term $\delta_1 \cdot \text{Regulation}_t$ captures the effect of the STR regulation on the change in rental prices, with δ_1 being the coefficient indicating the average change in rental prices due to the regulation, and Regulation_t being the binary variable indicating whether the regulation is in effect at time t . The term InnerDistrict represents the effect of the district group on the change in rental prices, where δ_2 is the coefficient capturing the difference in rental prices between the inner and outer districts before the regulation. Finally, $\delta_3 \cdot (\text{Regulation}_t \times \text{InnerDistrict})$ captures the interaction effect between the regulation and the district group on rental prices, and $\eta_{d,t}$ is the residual term accounting for unexplained variability in rental price changes.

The dependent variables in these models are the change in Airbnb listings ($\Delta \text{Listings}_{d,t}$), and the change in average square meter rent prices ($\Delta \text{Rent}_{d,t}$), while the independent variables are the dummies STR Regulation (Regulation_t), district group (InnerDistrict), together with the interaction term ($\text{Regulation}_t \times \text{InnerDistrict}$) that captures the DiD effect of the regulation. Overall, these models allow for the analysis of how the new STR regulations in Vienna affect Airbnb listings and LTR prices, both overall and specifically within the residential zones.

Analysis Methods

Data analysis was conducted using R Studio, where data was cleaned, compared, and analysed through tables, mapping, and regression techniques. The cleaning process involved removing duplicates, standardizing variable names, and ensuring consistency across the dataset. Descriptive statistics were used to summarize key metrics such as average price, average size, and location distribution, while trend analysis tracked changes in listings, prices, and other variables over time. Following the approaches in Chang (2020) and Barron et al. (2021), a statistical analysis, including DiD regressions, was employed to estimate the coefficients and determine the significance of the variables. Analysing the causal impact of a treatment or intervention can be done statistically by using the DiD approach. A treatment group (affected by the intervention) and an unaffected control group are compared for changes in outcomes over time. In this study, the DiD approach is employed to evaluate the impact of the new STR regulation in Vienna, implemented on July 1, 2024, on two main outcomes: the

number of Airbnb listings and the average square meter rental price, in the inner and outer parts of Vienna.

Despite the relatively short duration of this study, the goal is to determine whether the regulation is expected to influence Airbnb activity and, consequently, LTR rental prices. Traditionally, a one-year lag between changes in demand and supply was standard. However, recent studies, such as those by Horn and Merante (2017), often considered a one to six months gap. This shorter timeframe reflects the rapid dissemination of rental information online and its swift impact on landlords. The geographical scope of the study covers the cities of Vienna and Munich, with the analysis period spanning ten months. The impact of the regulatory change in Vienna's STR market, effective from 1st July 2024, is analysed by comparing Vienna with Munich, where regulations remain unchanged. This comparative analysis enables the identification of potential changes in Airbnb listings and their subsequent effects on the long-term rental market in Vienna relative to Munich.

The statistical analysis performed is based on the insights gained from the literature on STR regulations and their impact on rental markets in various cities worldwide, which was summarized and presented in the first part of the thesis. It takes into account the regulatory frameworks in Vienna, Munich, and other cities to understand the different approaches to controlling STR markets, allowing to contextualize and discuss the effectiveness of these regulations and their implications for rental markets.

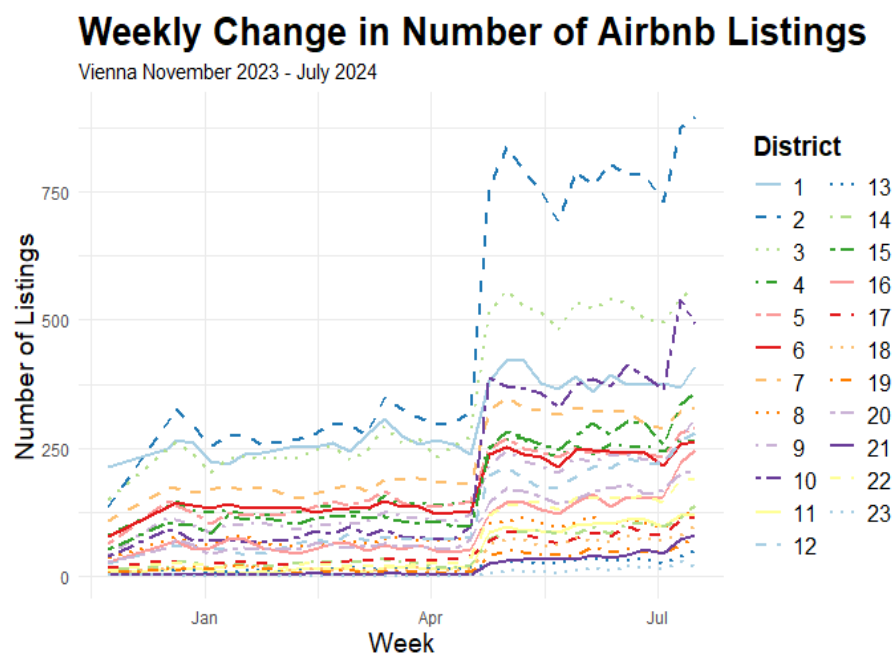
This analysis method faces several limitations that should be acknowledged. First, not all listings on Immowelt include exact addresses, with only 50% providing this detail. However, all listings do indicate the city district. Consequently, the analysis for Immowelt data is conducted on a district level, whereas Airbnb data can be analysed on a more accurate census district level using exact longitude and latitude coordinates. This discrepancy limits the precision in correlating the number of Airbnb listings with LTR prices, on a census district level, remaining results on a wider geographical measurement. Lastly, another limitation pertains to the timing of data collection. Data on both platforms was collected weekly, typically on Wednesdays, capturing listings relevant on that specific day. Different days may yield different results. However, in several weeks, data was collected on other days, which could impact the consistency of the findings.

Analysis and Results

Airbnb in Vienna and Munich

Over a period of 32 weeks, data was collected weekly on the number of Airbnb listings in each district of Vienna and Munich. As can be seen in Figure 1, a significant overall increase in the number of listings in Vienna can be observed, with a significant rise at the end of April. This rise may be attributed to seasonality, as both travel demand and supply typically increase during the spring and summer months. The most notable increases were observed in districts 2, 3, and 10. Although district 10 is not part of Vienna's central first ring, which encompasses the core districts, it experienced a substantial increase in listings. This growth could be due to the overall development of the district and numerous new constructions. Initially, the first district (the old city) had the highest number of listings during the first two months of observation. However, the increase in listings during the research period was less pronounced in this district. By the end of April, districts 2 and 3 had surpassed the first district in the number of listings.

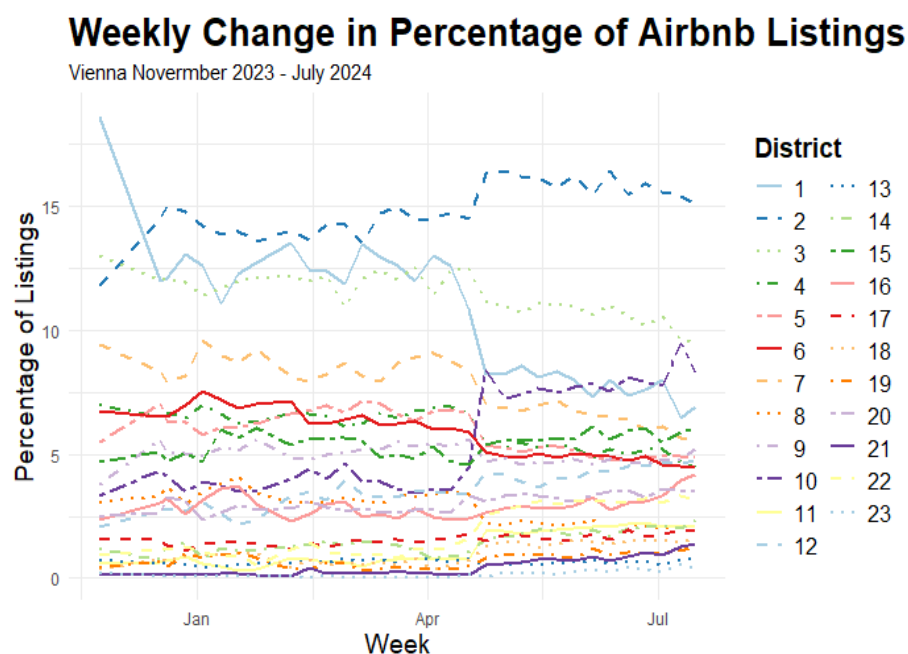
Figure 1



The first district appears to maintain a stable number of listings due to consistent demand, especially during autumn and winter, when travel activity typically decreases. In

contrast, the demand for listings in outlying areas, such as district 10 and beyond, tends to be significantly lower during these seasons, resulting in fewer offerings. A modest seasonal increase was observed in December, likely due to the popularity of Vienna's Christmas markets. This increase was mainly concentrated in districts 1, 2, 3, and 7. However, an analysis of the movements by percentage (Figure 2) reveals a different picture. While the overall number of Airbnb listings in the city increased, the proportion of listings within each district compared to the total number of listings shows that most districts remained stable. Notably, the first district experienced a significant decrease, from approximately 18% to only 7% by the end of the research period. Conversely, the 10th district saw the most substantial increase, rising from 3% to 8% of the total Airbnb listings in Vienna, and the 2nd district also increased from 11% to 15%.

Figure 2



Examining the data on a census district level in Vienna, it is noticeable that during the period from November to January, there was a significantly higher weekly average of Airbnb listings in certain areas of the first, second, and third districts, averaging around 54 listings per week in each census district (Figure 3). In the period from May to July (Figure 4), a general increase in the number of listings was observed. The highest weekly average was found in a specific central part of the second district, with 146 listings. This was followed by a central

area of the third district with an average of 126 listings per week, and a central part of the 15th district with 120 listings per week.

Figure 3

Density of Airbnb listings in Vienna
Weekly average of all dates in November 2023 - January 2024

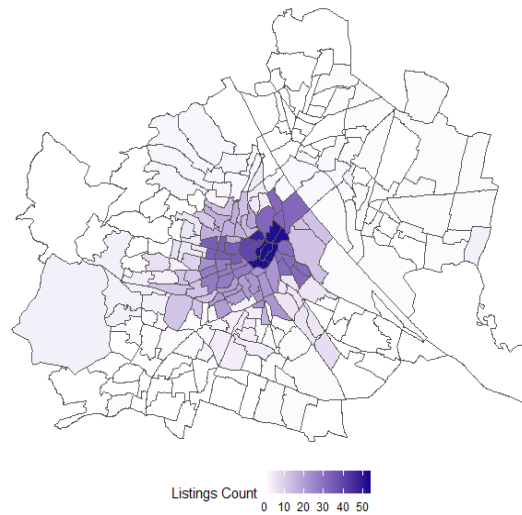
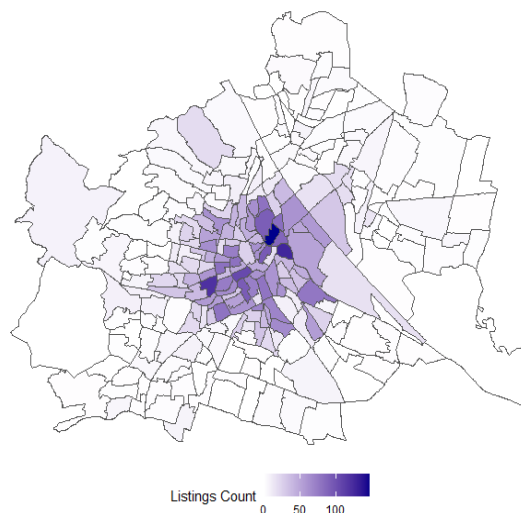


Figure 4

Density of Airbnb listings in Vienna
Weekly average of all dates in May-July 2024

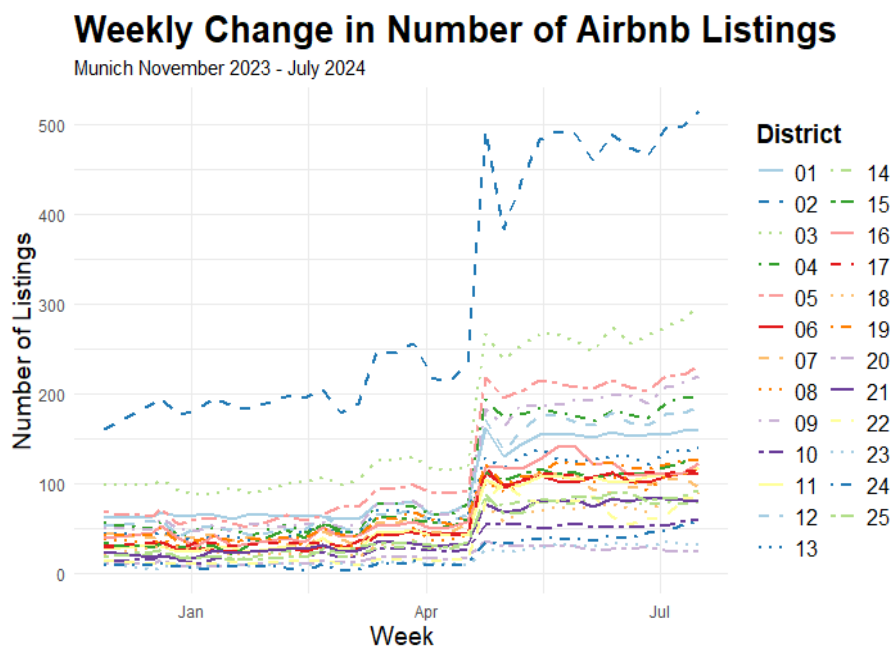


Notably, the first district experienced a significant proportional decrease in listings, likely due to the new regulation. While in the first period of the research the most popular census districts were in the first district, by the end of the research it dropped drastically.

Finally, although the 10th district ranked among the highest for Airbnb listings in July 2024 on a district level, this trend is not reflected at the census district level. This discrepancy is likely due to the even distribution of listings across its census districts.

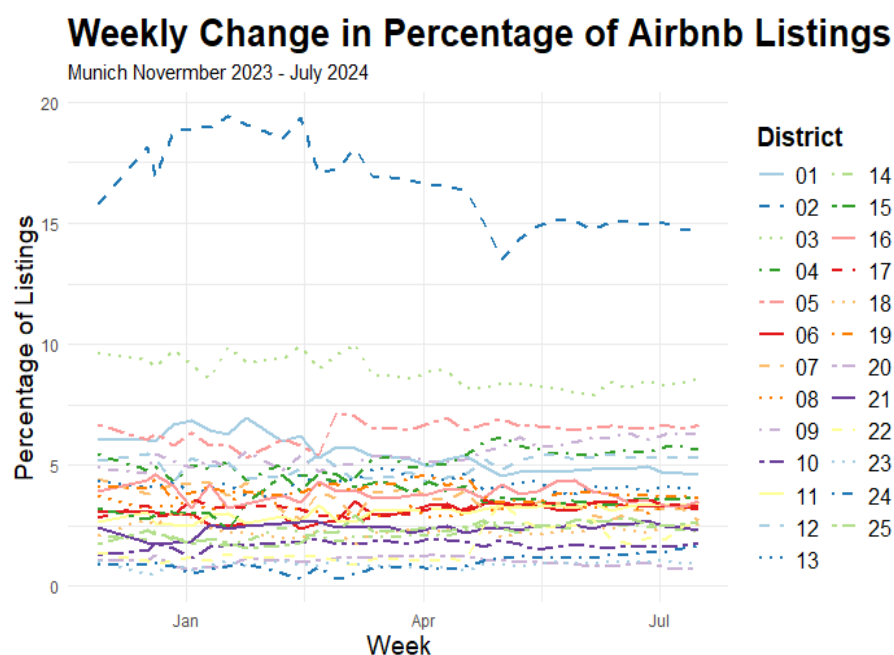
Comparing observations from Vienna and Munich (Figure 5), Munich also experienced a significant increase in Airbnb listings starting at the end of April. Similar to Vienna, districts 2 and 3 in Munich saw the most substantial rise. However, unlike Vienna, these districts in Munich already had the highest number of Airbnb listings at the beginning of the observation period, likely due to their central locations. The old city of Munich, district 1, has significantly fewer listings, while districts 2, 3, 4, 5, 9, and 12 have more. This distribution is particularly interesting and may be linked to Munich's stringent STR regulations. Overall, Munich has fewer Airbnb listings than Vienna, even after the seasonal increase observed in spring and summer.

Figure 5



When examining the percentage movements across Munich's districts (Figure 6), it is apparent that although the total number of listings increased, the proportions among the districts remained relatively unchanged. The only district that showed noticeable fluctuations in percentages over the research period is the 2nd district, which also had the highest number of Airbnb listings. Despite experiencing an increase during the winter months, the district saw a proportional decline in spring, ultimately ending with approximately 15%, similar to its initial proportion at the beginning of the study.

Figure 6



Observing the map of Munich from November 2023 to January 2024 (Figure 7), the highest weekly average of Airbnb listings was found in a central census district within the second district, with 74 listings. The next census district, also within the second district, had a significantly lower average of only 35 listings. Several census districts surrounding, but not within, the first district followed with high averages, while a census district within the first district only appeared later in the ranking with a weekly average of 16 listings. In the period between May-July 2024 (Figure 8), a general increase in the total number of Airbnb listings was observed across Munich, particularly in the less central parts of the city. The same census district in the second district continued to lead with an average of 160 listings, followed by a census district in the 17th with 99 listings. Interestingly, the highest-ranking census district

within the first district held the 33rd position, with only 36 listings. This pattern contrasts sharply with Vienna. Vienna's first district hosts a substantial number of Airbnb listings, whereas Munich's first district has significantly fewer listings compared to other parts of the city. Therefore, given these observations, it is plausible that Munich's strict STR regulations are effectively dispersing listings away from the city centre. Concurrently, the proportional decrease in Airbnb listings in Vienna's first district may indicate the gradual impact of the new regulations introduced.

Figure 7

Density of Airbnb listings in Munich
Weekly average of all dates in November 2023 - January 2024

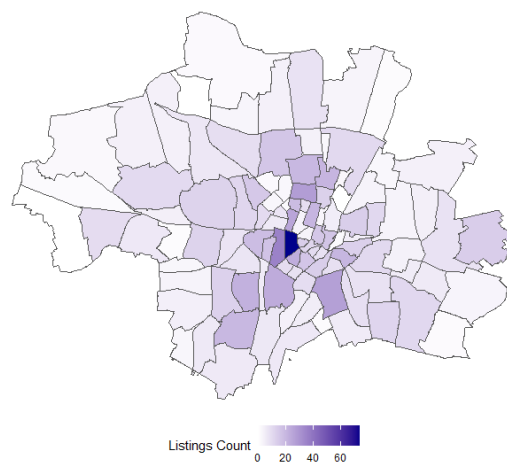
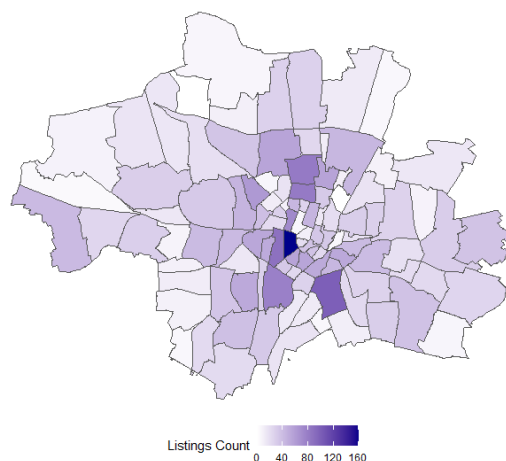


Figure 8

Density of Airbnb listings in Munich
Weekly average of all dates in May 2024 - July 2024



Analysing the data reveals that throughout the research period, the average price per night for an entire home on Airbnb in Vienna was €136, with a median of €98. In comparison, Munich's average was €200 per night, with a median of €137. Clearly, prices in Munich are higher, which aligns with the general trend of higher housing costs in Munich compared to Vienna. In Vienna, the median price per night in the first district was significantly higher than in the rest of the city, at €173 (average €235). The second-highest median price was in district 21 at €115 per night. In districts with higher amount of Airbnb listings, such as the 2nd, 3rd, and 10th, the median prices per night were €99, €107, and €82, respectively. District 15 had the lowest median price at €69 per night. In Munich, the first district also had the highest median price at €211 per night (average €281), followed by the 2nd district at €165 per night. Interestingly, while the 2nd district in both cities has the highest number of Airbnb listings, it is the second most expensive district for Airbnb in Munich, whereas in Vienna, it ranks tenth in terms of Airbnb median price per night.

Examining price changes throughout the research period reveals distinct patterns in Vienna and Munich. In Vienna, the median price per night at the beginning of the research in November 2023 was €119 (with an average of €164). This figure decreased by approximately 15% before reaching a peak of €132 (average €185) during the New Year week. Prices then dropped sharply to around €85 (average €118) per night before gradually rising from April to a median of approximately €100 (average €140) per night by the end of the research period in July. This is likely attributable to seasonal factors. In contrast, it is interesting to note that while prices in Vienna fluctuated considerably, Munich's median price started at €127 (average €194) at the end of November and remained stable throughout winter and spring, eventually rising to about €150 (average €220) in the summer.

An analysis of Airbnb listing types in Vienna reveals that the majority, about 90%, are classified as "entire homes," indicating that a complete dwelling is offered for rent. In contrast, a significantly smaller proportion (about 10%) consists of "private rooms," where only a room within a shared flat is available. Finally, listings for single beds in shared rooms or hotel rooms are almost negligible on the platform (less than 1% in total). It appears that these percentages remained relatively constant throughout the research period, although the total number of listings in Vienna increased. When analysing the situation in Munich, a different pattern emerges. Approximately 60% of the listings are entire dwellings, while around 38% are private

rooms within shared flats. Similar to Vienna, less than 1% are beds within shared rooms. However, unlike Vienna, about 2% of listings are hotel rooms, a category that is not as common in Vienna. Another notable difference is the stability of listing types over time. In Vienna, the percentages remained stable throughout the research period. In contrast, Munich experienced fluctuations: listings of entire dwellings increased from 60% to 67%, while private rooms decreased from 38% to about 32%, and hotel rooms dropped to approximately 0.5%, aligning more closely with the pattern observed in Vienna. These changes occurred at the end of April and stayed stable along the spring and summer up to the end of the research period in July. Overall, the disparities between the two cities can be attributed to the differing regulations in place. In Munich, there is a restriction that limits the rental of living space to a maximum of 50% of the total area, without the need of any permission, and this regulation appears to be effective.

It is noteworthy that while both cities have a significant proportion of single-listing hosts compared to multi-listing hosts (approximately 70%-30% in Vienna, and 80%-20% in Munich), a notable difference emerges when examining the distribution of listings by host type. In Vienna, around 65% of the listings are managed by multi-listing hosts (Figure 9), compared to only 35% in Munich (Figure 10). This substantial disparity likely results from the differing STR regulations. It is plausible that the stricter regulations in Munich have been effective in mitigating commercial Airbnb activity by requiring hosts to obtain special exemptions to own multiple properties exclusively for Airbnb use. Despite the new regulation implemented in Vienna on July 1st, the number of listings published by multi-listing hosts has seemingly increased, even though the proportion of such hosts has remained stable. This trend may indicate that private hosts are deterred by legal requirements, and smaller commercial hosts with only one dwelling have not applied for or received exemptions. In contrast, larger commercial hosts with multiple listings may have successfully secured exemptions, possibly with legal assistance, enabling them to continue operating without adhering to the new 90-day annual limit. The observed situation in Vienna parallels findings by Horn and Merante (2017), who reported that in Boston in 2015, although only 18% of hosts had multiple listings, they collectively accounted for 46% of all Airbnb listings. This evidence supports the assertion that the presence of Airbnb reduces the availability of properties for long-term rentals. Similarly,

the increase in listings by multi-listing hosts in Vienna, despite the new regulation, suggests a similar impact on the rental market.

Figure 9

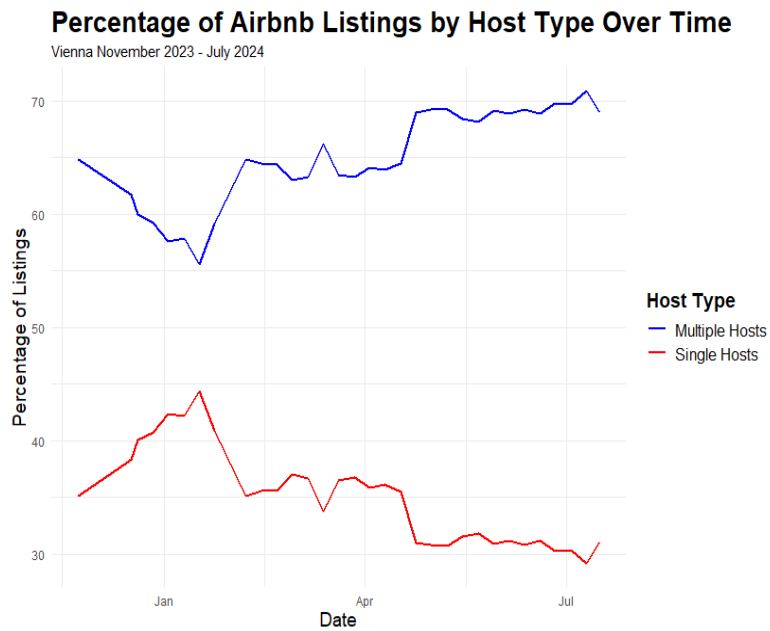
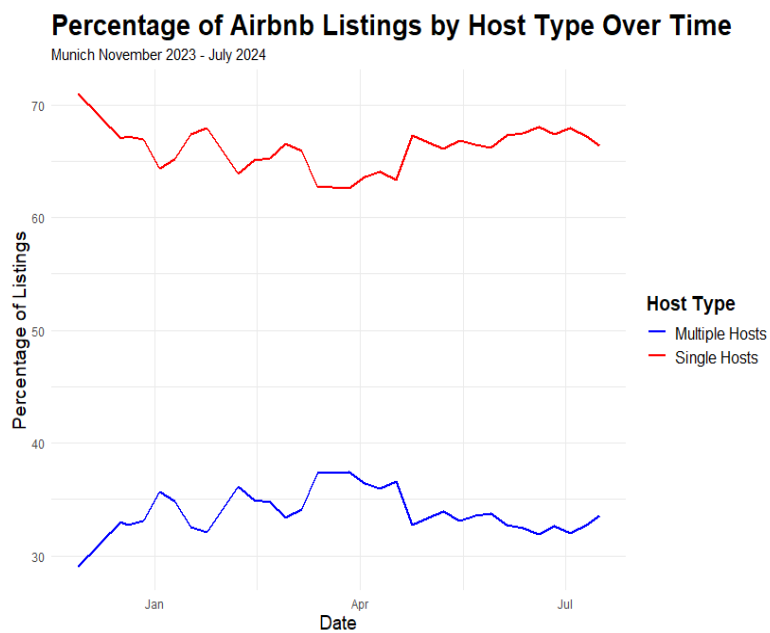


Figure 10



Airbnb DiD Regression

Comparisons across both cities

The DiD regression analysis, presented in Figure 11, was conducted to evaluate the impact of the STR regulation in Vienna, relative to Munich, as a control city. The treatment date was defined as 1/5/2024, as since this day a more intensive announcement of the new regulations was started, two months before the actual launch. The analysis provides insights into how this regulatory change influenced the Airbnb listing trends in both cities. These findings highlight the complex dynamics of regulatory impacts on Airbnb activity. The results of the DiD regression analysis are summarized in the table below:

Figure 11

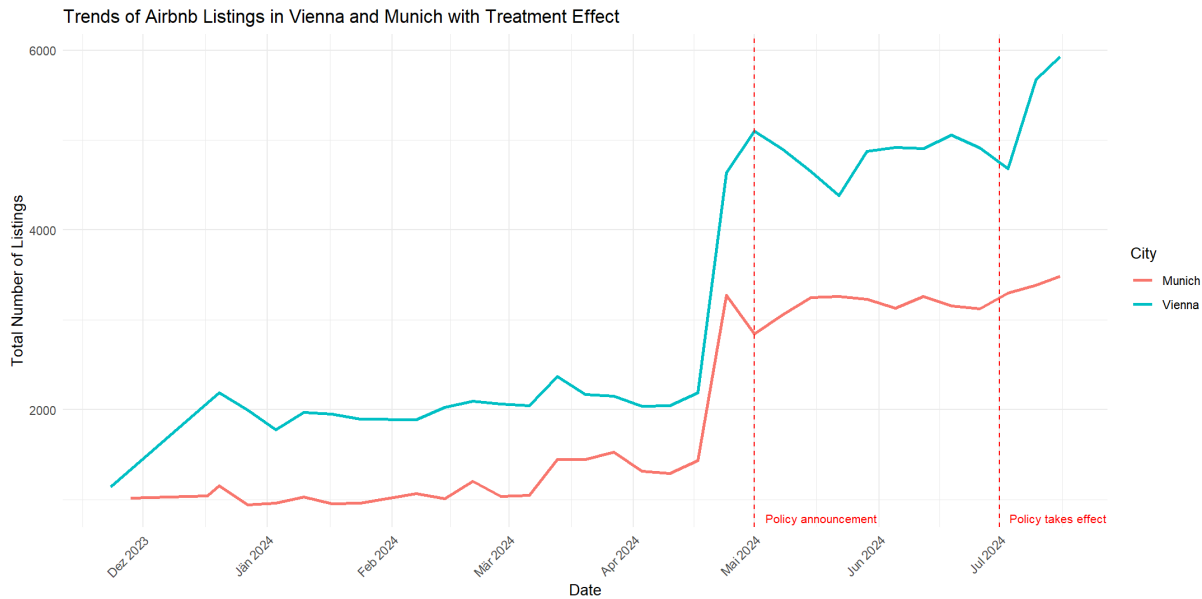
Difference-in-Differences Regression Results			
Impact of STR Regulation on Airbnb Listings in Vienna and Munich from 2024-05-01			
Variable	Coefficient	Standard Error	p-value
(Intercept)	1,259.50	111.51	0e+00
post_treatment	1,947.42	182.10	0e+00
treatment	877.10	157.70	0e+00
post_treatment:treatment	915.65	257.53	7e-04

The intercept represents the estimated average number of Airbnb listings overall in Munich (control group) before May 2024, with statistical significance. The post treatment coefficient shows an average increase of 1947.42 listings after the treatment date across both cities, highlighting a significant rise in listings post-announcement. The treatment coefficient indicates that Vienna (treatment group) had overall, on average, 877.10 more listings than Munich before the regulation was intensively announced, underscoring a significant difference between the two cities during the baseline period. The interaction term reveals that a stronger increase of listings was observed in Vienna, compared to Munich, with an estimated increase of 915.65 listings in Vienna, post-announcement. This difference is statistically significant, however, while it suggests a positive impact of the regulation announcement on the number of listings in Vienna, it is crucial to note that the rate of increase was slower compared to the general trend within Vienna. Despite the positive interaction term, the increase in Vienna was

less pronounced when compared to the general increase observed across both cities (1,947.42). This slower growth rate could indicate that the regulation announcement had a moderating effect on the rapid increase in Airbnb listings in Vienna. The regulation might take longer to show its full effects on Airbnb activity, as property owners in Vienna are adjusting more gradually to the new regulation. Over a longer period, the regulation may further influence the growth rate of Airbnb listings, potentially stabilizing or even reducing the number of new listings as the market adjusts to the new regulatory environment.

Figure 12 illustrates the trends of Airbnb listings in Vienna and Munich, highlighting the pre- and post-treatment periods in both cities. The first dashed red line marking the announcement of the regulation in Vienna (treatment point), and the second, the policy launch. The regression performed can be better interpreted as an event regression, rather than a DiD, as the effect of the announcement is presented. This event is significant, as it marks the phase where hosts are applying for permits from the city and taking the necessary steps in preparation for the policy implementation. Prior to the announcement, the growth rates in both cities followed parallel trends, with Vienna consistently having a higher number of listings compared to Munich. Between April and May, there was a significant rise in both cities, which may be attributed to seasonality, although in order to confirm it, a longer observation should be conducted. Following the policy announcement, Vienna saw significant fluctuations, with both increases and decreases. In contrast, Munich shows a relatively steady, moderate increase over the same period, likely due to its pre-existing stricter regulations.

Figure 12



Comparisons within Vienna

To assess the impact of the new regulation on Airbnb listings within Vienna’s districts, a Difference-in-Differences (DiD) regression analysis was employed as well. This approach compares the trends in Airbnb listings before and after the more intensely announcement of the new regulation (1/5/2024) across two groups of districts:

1. Districts 1-9
2. Districts 10-23

The aim was to determine whether the announcement and subsequent implementation of the regulation had a different impact on these two groups of districts. The results of the DiD regression analysis are summarized in the table below:

Figure 13

Difference-in-Differences Regression Results				
Impact of Regulation on Airbnb Listings in Vienna from 2024-05-01				
Term	Estimate	Standard Error	Statistic	p-value
(Intercept)	176.93	7.75	22.84	1.434901e-87
district_group10-23	-138.05	9.93	-13.90	3.673920e-39
post_treatment	169.32	12.65	13.38	1.067723e-36
district_group10-23:post_treatment	-73.67	16.22	-4.54	6.491648e-06

The intercept represents the estimated average number of Airbnb listings in districts 1-9 before May 2024. This value is statistically significant, indicating a substantial number of listings in these districts. The coefficient `district_group10-23` indicates that, on average, districts 10-23 had 138.05 fewer listings than districts 1-9 before the treatment point. The negative sign shows that districts 10-23 had significantly fewer listings compared to the baseline (districts 1-9). The extremely low p-value indicates that this difference is highly statistically significant. The coefficient “post treatment” captures the overall effect of the post-announcement period across both groups. It shows that, on average, there were 169.32 more listings after the announcement of the regulation, regardless of the district group (perhaps due to seasonality). This result is statistically significant, as indicated by the low p-value. Finally, the interaction term shows the differential effect of the regulation announcement on districts 10-23 compared to districts 1-9. The estimate of -73.67 suggests that the increase in listings in districts 10-23 post-announcement was 73.67 less than in districts 1-9. The negative coefficient indicates that the regulation announcement had a stronger effect in reducing the number of listings in districts 10-23 relative to districts 1-9. The very low p-value indicates that this difference is statistically significant.

The regulation appears to have had a differential impact on the number of Airbnb listings between the two district groups. While the overall number of listings increased post-announcement, the increase was significantly smaller in districts 10-23 (non-residential zones) compared to districts 1-9 (residential zones). These findings suggest that the announcement of the regulation was more effective in reducing the number of listings in the non-residential zones.

LTR in Vienna and Munich

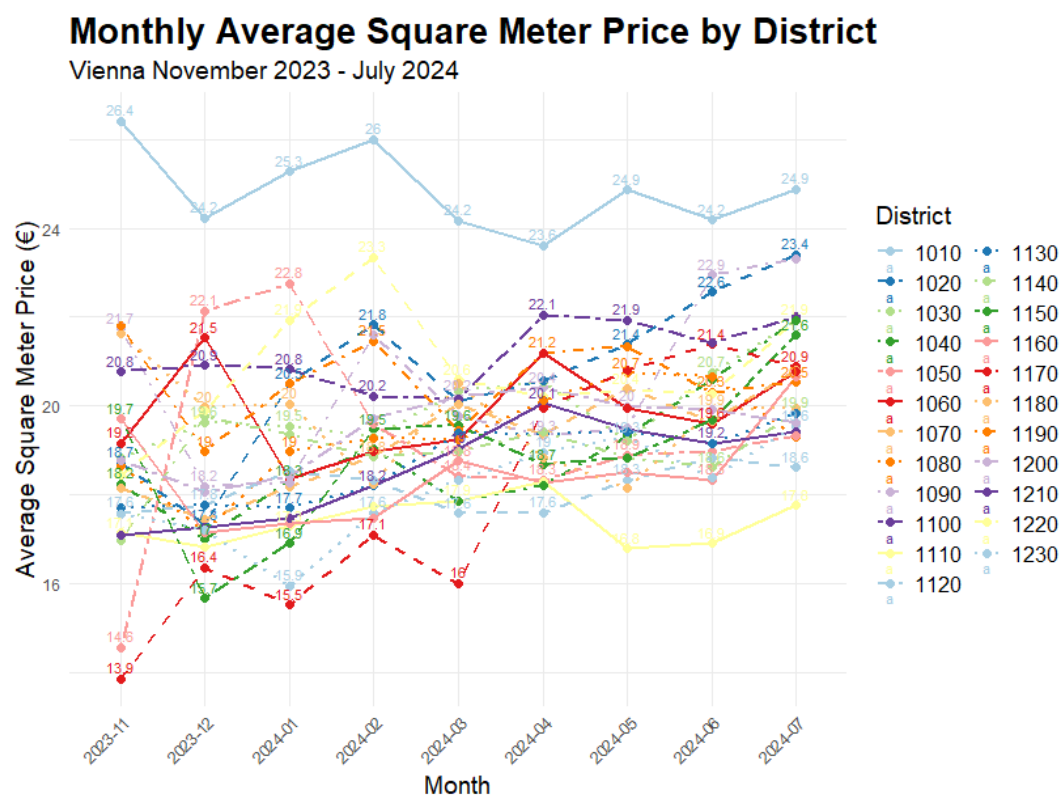
Over a 9-month period from November 2023 to July 2024, data on the rental markets of Vienna and Munich were systematically collected using web scraping technology at weekly intervals. This approach provided a comprehensive overview of the rental market dynamics in both cities, allowing for an in-depth comparative analysis of rental patterns and pricing structures across different urban districts. The analysis revealed that the overall median price per square meter in Vienna was €19.4, with an average of €19.6. In contrast, Munich exhibited a higher overall median price of €24.6 per square meter, with an average of €25. These figures underscore the relative affordability of Vienna's rental market compared to Munich's, reflecting broader trends in housing costs and market conditions in these urban centres.

A closer examination of Vienna's rental data reveals a trend of increasing prices over the research period. Analysing the median square meter price for each scraping date from November 2023 to July 2024, the rental prices rose from €18.7 to €21, marking an overall increase of 12.3%. This upward trajectory reflects the dynamic nature of Vienna's housing market, possibly driven by factors such as increased demand, or seasonal variations. On the district level, the First District emerged as the most expensive area, with a median square meter price of €24.2. This is consistent with the district's status as a central and historically significant part of the city. With a significant gap behind, the Second District follows with a median price of €21, while the Tenth and Nineteenth Districts are also noteworthy, with prices of €20.8 and €20.6, respectively. These variations in pricing among districts highlight the influence of location, accessibility, and neighbourhood characteristics on rental values within Vienna. These figures correspond with the popularity of these districts for Airbnb purposes, indicating a strong relationship between short-term rental demand and overall rental prices. Surprisingly, despite the Third District's attractiveness as a location for Airbnb listings, it ranks only sixth in terms of rental prices, with a median price of €19.9 per square meter.

Examining Figure 14, which presents a line graph of the monthly average square meter price by district in Vienna, reveals notable trends in rental prices during the research period. Specifically, there was a slight decrease in prices in the First District, as well as in the 11th and 22nd districts. In contrast, the vast majority of remaining districts experienced a price increase. Notably, the 17th District exhibited the largest rise in rental prices, with a rise of €0.04 each

month, followed by the 2nd and 15th districts, each with an increase of €0.02. These findings underscore the complexity of rental market dynamics, where certain districts demonstrate more pronounced pricing fluctuations, possibly due to factors such as district development initiatives or changes in demand for residential space.

Figure 14

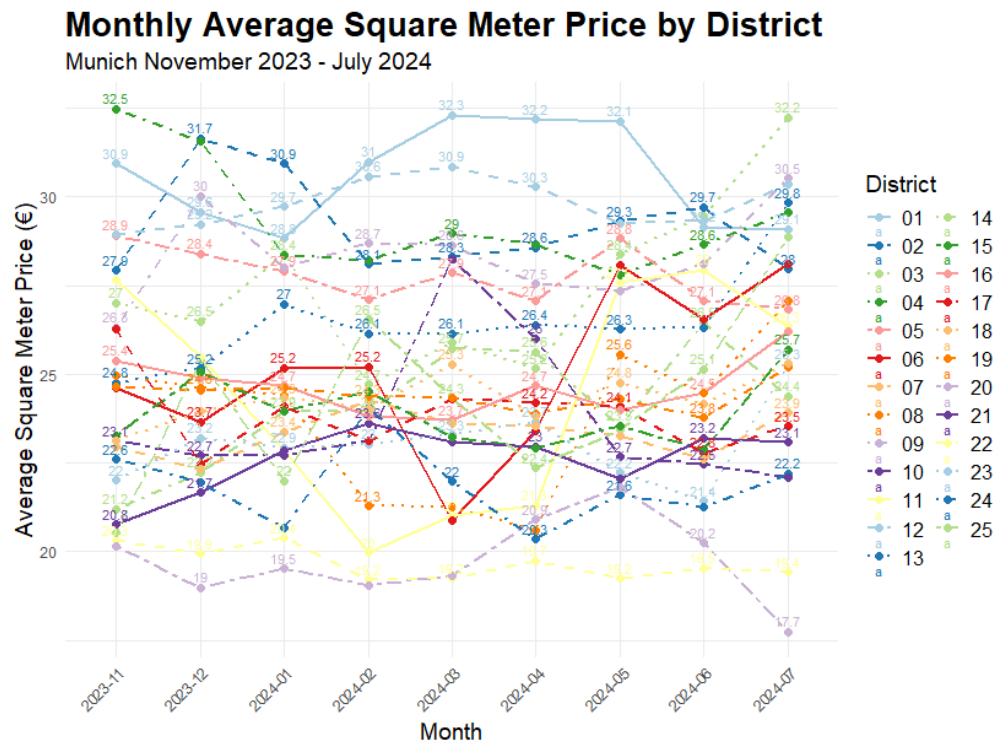


Observing the situation in Munich reveals a similar trend in rental market dynamics. During the research period, the overall median price per square meter increased from €24.6 to €27.2, indicating a rise of 10.5%. This upward trend highlights the strong demand for rental properties in Munich, likely influenced by factors such as economic conditions and housing supply constraints. At the district level, the most expensive district was the Altstadt-Lehel (First District), with a median square meter price of €30. This is followed by the Schwabing-Freimann, the 12th District, Ludwigsvorstadt-Isarvorstadt (Second District), and Schwabing-West (Fourth District), with median prices of €29.9, €29 and €28.5, respectively. Unlike in Vienna, the price gap between the First District and the subsequent districts on the list here is almost negligible. These districts, known for their central location and cultural significance,

continue to command premium rental prices, reflecting their desirability among both residents and investors. Surprisingly, despite Maxvorstadt (Third District) being centrally located and highly popular among Airbnb listings, it ranks only seventh in terms of rental prices, with a median square meter price of €27. A similar pattern is evident in Vienna, where the Third District also exhibited relatively lower rental prices compared to its centrality and popularity for Airbnb accommodations. This observation suggests that high demand for short-term rentals does not necessarily correlate with the highest rental prices, possibly due to factors such as the density of available rental properties or specific local market conditions affecting price levels in these districts.

Figure 15 reveals a distinct dynamic in Munich's rental market compared to Vienna. Ten districts in Munich exhibited no change in rental prices, while six districts experienced a decline. Among those with declining prices, the First District recorded an average monthly decrease of -€0.02. Similarly, the Twelfth District, Schwabing-Freimann, demonstrated a monthly decline of -€0.01. Notably, these districts are the most expensive in Munich. Conversely, the Third District exhibited the highest positive increase with a monthly average of €0.05, indicating a robust increase in rental prices, closely followed by the Sixth District with €0.04. Despite the fact that 16 districts experienced either stable or declining rental prices, the substantial increases observed in the remaining nine districts are sufficient to drive up the overall rental price level in Munich. This suggests that localized factors in specific districts are exerting a considerable influence on the city's rental market, contributing to the observed overall increase in prices.

Figure 15



Immowelt DiD Regression

Comparisons across both cities

To understand the impact of the new STR regulation on rental prices in Vienna, DiD regression analysis was conducted using rental data, with Munich serving as the control city. The table below presents the results for the average rental price per square meter, with the treatment date set at July 1, 2024, when the regulation came into effect. Unlike the DiD regression analysis for Airbnb activity, which used May 2024 as the treatment date, this analysis uses the actual implementation date of the new regulation in July 2024. This choice is based on the understanding that changes in rental prices typically take longer to manifest, compared to the immediate impact seen in the removal of Airbnb listings.

Figure 16

Difference-in-Differences Regression Results			
Impact of STR Regulation on LTR in Vienna and Munich from 2024-07-01			
Variable	Coefficient	Standard Error	p-value
(Intercept)	25.56	0.09	0.0000
post_treatment	1.18	0.29	0.0001
treatment	-5.79	0.12	0.0000
post_treatment:treatment	-0.20	0.41	0.6254

The intercept represents the estimated average rental price per square meter in Munich, before the regulation took effect. The statistically significant value of 25.56, indicates a stable average rental price in Munich during the baseline period. The post treatment coefficient shows the overall effect of the post-regulation period across both cities. It demonstrates an average increase of €1.18 per square meter after the regulation was launched, regardless of the city. The treatment coefficient indicates that, on average, Vienna had a €5.79 lower rental price per square meter than Munich, before the regulation was introduced. The negative sign suggests that Vienna's rental prices were significantly lower compared to Munich during the baseline period. The interaction term reflects the differential effect of the regulation on Vienna compared to Munich. The coefficient of -0.20 indicates a decrease in the rental prices per square meter in Vienna relative to Munich after the regulation was launched. However, this result is not statistically significant (p-value = 0.6254), suggesting that the regulation introduction did not have a significant impact on the rental price trends in Vienna when compared to Munich. Perhaps it is too early to notice a significant impact on the rental prices in such a short period of time.

Comparisons within Vienna

This regression analysis, presented in the following table, aims to assess the impact of the regulation on the average rental price per square meter in Vienna's inner districts (treatment group) compared to the outer districts (control group) from July 1, 2024.

Figure 17

Difference-in-Differences Regression Results				
Impact of Regulation on Average Square Meter Rental Price in Vienna's Inner and Outer Districts from 2024-07-01				
Term	Estimate	Standard Error	Statistic	p-value
(Intercept)	18.94	0.10	188.72	0.00
treatment	1.27	0.16	7.90	0.00
post_treatment	1.09	0.33	3.33	0.00
treatment:post_treatment	0.63	0.52	1.20	0.23

The intercept indicates that the average rental price per square meter in the outer districts before the regulation was approximately €18.94. The positive coefficient of the treatment, indicates that the rental square meter price in the inner districts was €1.27 higher than in the outer districts before the regulation. This difference is highly statistically significant. The post treatment coefficient presents an increase of €1.09 per square meter after the regulation was introduced, suggests a general rise in rental prices in both groups. The interaction term reflects the differential effect of the regulation on both groups, presents a higher increase in the rental prices in the inner districts relative to the outer districts after the regulation. However, the statistic of 1.20 and the higher P-value suggests that this result is not statistically significant, implying that the regulation did not have a short-term substantial impact on the rental price trends in the inner districts compared to the outer districts. Nonetheless, over the long term, the anticipated decrease in rental prices within the outer districts, may emerge as a consistent trend.

Discussion

The study's findings reveal several important insights into the dynamics of Airbnb listings in Vienna and Munich following the introduction of the new STR regulation. Despite an overall increase in Airbnb listings in both cities during the research period, likely influenced by seasonal factors, the rate of increase was slower in Vienna compared to the trend in Munich. This suggests that the regulatory measures implemented in Vienna may have begun to exert an influence on the Airbnb market, already during the intensive announcements towards the launch of the regulation, and challenges the Null Hypothesis, which posits that the new regulation will not have a statistically significant effect on the number of Airbnb listings. This finding supports Hypothesis 1, which states that the new STR regulation in Vienna will result in a proportional decrease in the total number of Airbnb listings. Although the overall number of listings did not decrease, the rate of increase was notably lower.

The well-established STR regulations in Munich has shaped its Airbnb market in significant ways. The stricter regulations have resulted in only about 35% of Airbnb listings being managed by commercial hosts (multi-listing hosts). In contrast, Vienna, which has only recently introduced its stricter regulations, currently sees about 65% of Airbnb listings managed by this type of hosts. This disparity underscores the potential long-term impact of recently-presented regulatory measures on the composition of the Airbnb market. The higher proportion of commercial hosts in Vienna suggests that a significant segment of the market may be operating at a scale that could be more substantially affected by the new regulations. As Vienna's regulations will be enforced and market participants will adapt, it is plausible to anticipate a shift similar to that observed in Munich, where the proportion of commercial hosts may decrease over time, a shift that could lead to a more balanced housing market.

Analysis of Airbnb density maps for Vienna and Munich indicates notable differences in activity patterns between the two cities. During the research period, Vienna exhibited significant fluctuations in Airbnb activity, with notable movements of prices, and in the locations and proportions of listings across districts. In contrast, Munich's Airbnb activity remained relatively stable, despite seasonal increases in listings. The higher volatility of listings in Vienna might indicate a more elastic supply of Airbnb listings, where hosts can easily enter or exit the market based on anticipated demand changes. The relative stability in Munich may

be attributed to the city's stricter STR regulations, and therefore, it is possible that Vienna will experience similar stability in the future as its new STR regulations become fully implemented and enforced.

A deeper examination within Vienna reveals further nuances. While the entire city saw an increase in Airbnb listings, this increase was significantly slower in the non-residential zones compared to the average of the residential zones. This differential impact indicates that the new regulation, which limits short-term rentals to a maximum of 90 days per year, including in non-residential areas which up to this point did not have any strict limitations, is beginning to affect the market. The proportionally stronger effect in the non-residential zones may reflect a greater sensitivity to the new restrictions. This finding supports Hypothesis 2, which asserts that the impact of the new regulation on Airbnb listings will vary across the different districts in Vienna, with an increase in listings within the residential zones, and a proportional decrease in non-residential zones. It is important to recognize that the full effects of such regulatory measures often take time to manifest. Property owners and rental operators may test the boundaries of the new regulation, or adjust their strategies gradually. Over time, as enforcement mechanisms strengthen and market participants adapt to the new rules, the impact of the regulations is likely to become more pronounced.

As to Hypothesis 3, which posits that the new STR regulation will affect long-term rental prices in Vienna, the DiD regression analysis for Vienna and Munich found a relative decrease in rental prices per square meter following the regulation's implementation. However, this decrease was not statistically significant. This suggests that the effects of the STR regulation on long-term rental prices might require more time to manifest, and indicating that a longer-term analysis may be necessary to capture the full impact of the regulation on rental prices.

Considering the long-term rental markets, an examination of rental prices in both cities reveals that rent levels are influenced by seasonal effects, with both cities experiencing an average rent increase of approximately 11% during the research period. By the end of the study in July 2024, the median rent price per square meter in Vienna was €21, significantly lower than Munich's €27.20, representing a 30% difference. In contrast, the median nightly price for Airbnb listings in Vienna was €100, compared to Munich's €150, indicating a 50% gap. In

Vienna, a 50-square-meter flat can be rented in the LTR market for €1,050 per month. However, the same revenue could be achieved in the STR market in just 10.5 nights. In Munich, a similar flat rents for €1,360 per month on the LTR market, but the equivalent revenue can be generated in only 9 nights on Airbnb. These differences may be attributed to varying dynamics within the STR market. Munich's more restricted supply could contribute to higher price premiums, as the availability of short-term rental options is more limited compared to Vienna. As the regulation takes full effect and its impacts are more fully realized, it may drive changes in both rental prices and market behaviour.

This study is subject to several limitations that should be considered. Although efforts were made to account for various factors influencing rental prices, it is important to recognize that rent prices are influenced by a complex array of elements that extend beyond the scope of this research. One limitation of this thesis is the absence of a panel regression analysis, which could have accounted for the effects of both time and district-specific variations. Incorporating such a model would have provided deeper insights into the impact of the regulation across different districts and over time. Additionally, variations in the enforcement of STR regulations between cities may impact the results. The differing effectiveness and stringency of regulatory measures in Vienna and Munich could contribute to differences that are challenging to control within the constraints of this study. Furthermore, similar to other research in this area, there may be measurement errors, as the count of Airbnb listings does not fully represent the total number of STRs. Furthermore, the relatively short duration of the study, covering trends from November 2023 to July 2024, may also be a limitation, as some effects of seasonality cannot be captured, and, the regulation's impact might only become apparent over a longer period. This time constraint has also contributed to lower statistical significance regarding rental prices. Despite these limitations, this research strives to provide a comprehensive understanding of the STR markets in Vienna and Munich, highlighting the dynamics of short-term and long-term rentals and the impact of regulatory changes.

To address the limitations of this study and enhance our understanding of the impact of STR regulations, several avenues for future research should be considered. First, extending the research period and using more sophisticated specifications such as panel regressions with time and city or district fixed-effects, would be valuable to capture the accurate long-term effects of the new regulation, considering seasonal changes as well. Additionally, broadening the

comparative analysis to include other cities with varying regulatory frameworks could yield important insights into best practices and the effectiveness of different regulatory measures. Moreover, investigating how different types of hosts, commercial versus non-commercial, adjust their strategies in response to the regulations could also provide deeper insights into market dynamics. Evaluating the effectiveness of enforcement mechanisms and compliance rates is another crucial area for future research. Finally, assessing the broader economic impact of STR regulations, including their effects on tourism and local businesses, is essential for policymakers. Given that Airbnb and the sharing economy have additional positive economic effects, understanding the broader picture will help balance the regulatory measures with their potential economic benefits.

The introduction of new short-term rental regulations in Vienna marks a crucial effort to tackle the issues arising from the growing number of Airbnb listings. While the immediate impact appears modest, especially in comparison to the established regulatory framework in Munich, the long-term effects are likely to be more pronounced. By curbing the growth of commercial listings and fostering a more balanced market, these regulations have the potential to contribute to greater housing stability and affordability.

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