

Airbnb EU Impact Study

Executive Abstract and Motivation

The EU Commission for Coordinated Urban Planning and Touristic Development has asked me to conduct a preliminary ‘Short vs. Long’ rental [analysis](#) based on the available [datasets from Airbnb](#) and [other sources](#).

Some of their more vexing questions in need of supporting evidence:

1. **Price** index: Which are the EU’s most and least expensive cities for a short vacation?
 - a. Amsterdam (460E) ... Athens (128E)
2. **Experiences**: EU city ranking - as most desirable in value and satisfaction per Eur?
 - a. Athens (95%) ... London (90%)
3. **Market** segments: Where are the top/affluent vs. bottom/young/student 2-5% customers happier?
 - a. Athens/Amsterdam/Paris... Budapest/Vienna/Athens
4. What is the primary determinant of guests’ **satisfaction**?
 - a. **Cleanliness** (0.7) seems to trump all X features, incl. Attractivity, Distance etc.
5. **Gentrification** (ardent for locals, digital nomads, planners and tax): Is Airbnb really outpricing the locals out of their homes?
 - a. Data confirms this reality, though w/ different pressure across EU: e.g., Amsterdam is 5x stronger than Rome. This fact may be the key takeaway of this study.
6. Are the Airbnb prices predictable using simple linear regression (i.e., taxman’s calculator)?
 - a. Possible in Lisbon ($r^2 \sim 0.5$) and Amsterdam ($r^2 \sim 0.4$); however, the other cities elicit feature engineering or more advanced ML models;
 - b. Clipping the .6% outliers was the single most effective feature engineering, improving the r^2 by $>2x$.

Details

The notebook provides insights into the Airbnb rental market in EU cities, the impact on local rental prices, and the relationship between prices, guest satisfaction and various gentrification factors. We thus provide a preliminary baseline guidance for travellers, investors/developers, urban planners, EU & local tax authorities.

Throughout this analysis, we aimed to explore and understand the rental pricing and guest satisfaction trends for Airbnb accommodations in ten major European cities. Our main steps and key findings can be summarized as follows:

1. **Data Preprocessing**: We began by loading and merging data from multiple CSV files containing Airbnb listings and reviews for the selected cities. The data was cleaned, and additional features, such as city and period information, were extracted.
2. **Price Distribution Analysis**: We examined the distribution of rental prices (realSum) across all cities. We observed significant variations in pricing, with Amsterdam having the highest average price and

Budapest the lowest.

city	Average realSum	Median realSum
amsterdam	573.112795	460.244183
paris	392.531403	317.597167
london	362.469256	261.294950
lisbon	238.210479	225.375235
vienna	241.582484	208.494028
barcelona	293.753706	208.299393
berlin	244.583752	191.175096
rome	205.391950	182.591822
budapest	176.513548	152.982093
athens	151.744121	127.715417

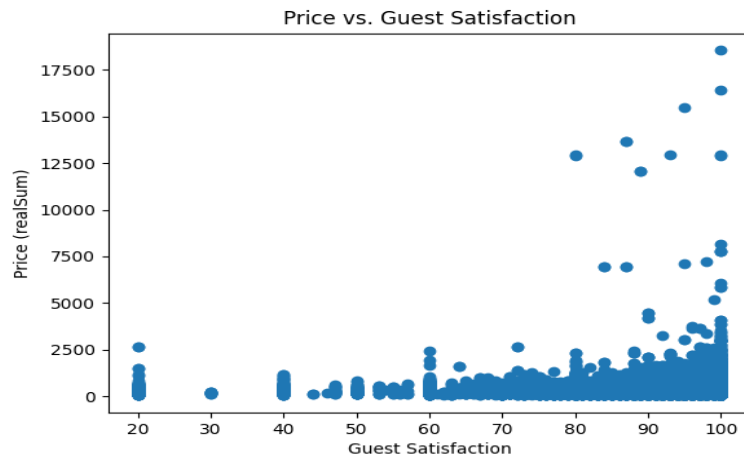
Table for Average and Median AirBnB pricing in the top 10 European cities

3. Guest Satisfaction Analysis: We explored guest satisfaction ratings across cities. Athens emerged as the city with the highest average guest satisfaction, while London received the lowest scores.

City	Satisfaction
athens	95.003598
budapest	94.585281
amsterdam	94.514423
berlin	94.323671
vienna	93.731128
rome	93.122300
paris	92.037530
barcelona	91.109072
lisbon	91.093875
london	90.645652

City Ranking from Most to Least Satisfying Stay

4. Price vs. Satisfaction Analysis: We investigated the relationship between rental prices and guest satisfaction. Surprisingly, we found a weak correlation between the two, suggesting that price is not the sole determinant of guest satisfaction.



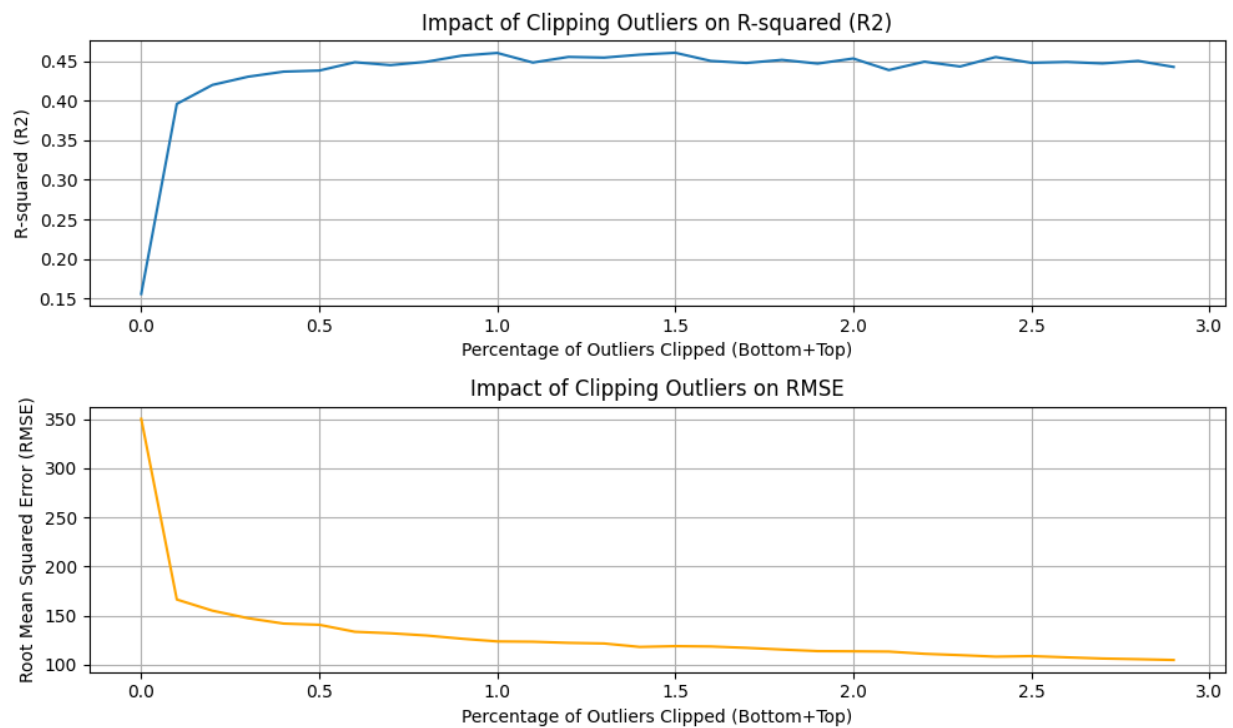
5. City-wise Price Predictability: We built linear regression models to predict rental prices for each city. Lisbon and Paris exhibited the highest predictability, with the lowest root mean square error (RMSE) values.

1. lisbon: $R^2 = 0.488$, $RMSE = 77.923$
2. amsterdam: $R^2 = 0.398$, $RMSE = 345.804$
3. london: $R^2 = 0.266$, $RMSE = 368.272$
4. rome: $R^2 = 0.265$, $RMSE = 103.167$
5. berlin: $R^2 = 0.261$, $RMSE = 153.206$
6. barcelona: $R^2 = 0.202$, $RMSE = 307.495$
7. paris: $R^2 = 0.167$, $RMSE = 368.186$
8. budapest: $R^2 = 0.085$, $RMSE = 115.316$
9. athens: $R^2 = 0.014$, $RMSE = 405.294$
10. vienna: $R^2 = 0.014$, $RMSE = 498.935$

Ranked list of cities based on price predictability (R^2 -squared and RMSE)

6. Price Predictability Comparison with L1 and L2 Regularization: We experimented with L1 (Lasso) and L2 (Ridge) regularization techniques to enhance price predictability. However, for most cities, these techniques did not significantly improve the models.

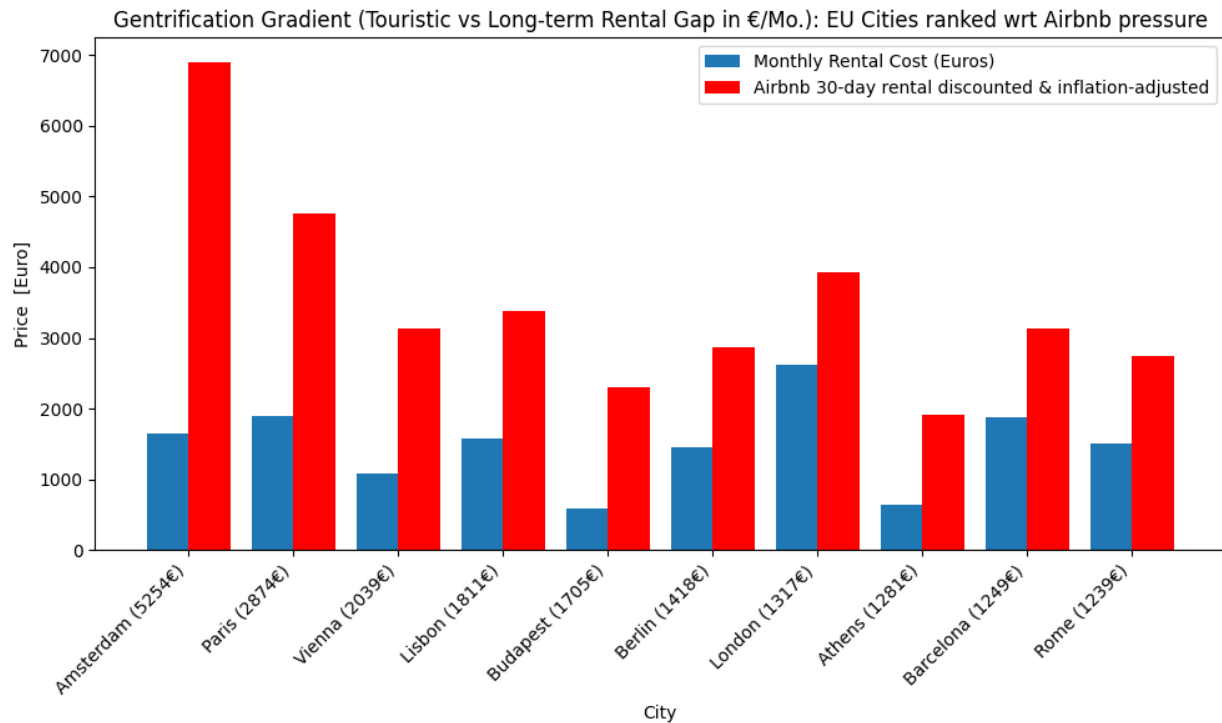
OTOH, outlier clipping has proven the most effective feature engineering, as below:



Number of rows dropped after 0.6% outlier clipping: 620 (out of 51.7K rows)
(6) LM with clipped 0.6% outliers: $RMSE: 133.631$ / $R^2: 0.449$

7. Rental Prices vs. Average Monthly Costs: We compared Airbnb rental prices with the average monthly costs of one-bedroom apartments in the same cities. Not surprisingly, rental prices were always much

lower (as rent sources) than the average and median Airbnb equivalents; hence the urban planners' gentrification dilemma of promoting tourism (high seasonal income) vs. the local (lower permanent income). The analytical evidence is overwhelmingly demanding a deeper understanding of the factors and means to regulate the balance between these 2 key markets for the local and national economy...!



8. Top and Bottom Customer Satisfaction Ranking: We ranked cities based on customer satisfaction, with Athens, Budapest, and Amsterdam leading the rankings for the most satisfying stays.

9. Top and Bottom Price Percentile Rankings: We ranked cities based on customer satisfaction for top and bottom price percentiles. Athens and Berlin maintained high satisfaction levels for the top percentiles, while Athens and Rome struggled for the bottom percentiles.

City ranking guest_satisfaction_overall for Top 2% Prices (Afluent Customers)

athens	100.000000
amsterdam	96.098901
paris	95.078431
budapest	93.555556
berlin	93.111111

City ranking guest_satisfaction_overall for Bottom 2% Prices (Young / Student)

budapest	93.241573
vienna	93.166667
athens	92.189935
rome	90.271795
berlin	88.000000

10. Overall Insights: The analysis revealed several key insights. Firstly, price is not the sole driver of guest satisfaction, indicating that other factors like cleanliness and attractiveness play crucial roles. Secondly, pricing trends in Airbnb listings differed from average monthly rental costs for one-bedroom apartments, suggesting unique factors influencing short-term rental prices. Simple linear ML models may fail to capture the germane attributes, unless SMEs will wrangle the data accordingly.

11. Limitations: The study's limitations include the use of Airbnb data, which might not represent the entire rental market, and the inability to capture recent developments after the data's cut-off.

In conclusion, our analysis provides valuable insights into the rental pricing and guest satisfaction dynamics in major European cities. By understanding these trends, hosts and travelers can make informed decisions, and policymakers can assess the impact of short-term rentals on housing markets. Further research could explore additional factors affecting guest satisfaction and consider other data sources for a more comprehensive analysis.

Bonus Feature: The Threat of Airbnb-driven Gentrification

Unsurprisingly and worrying for the urban planners, the average monthly rental costs for one-bedroom apartments in the selected cities were indeed lower (50-250% lower) than the Airbnb prices – after discounts and inflation adjustment. This finding highlights a significant difference between short-term rental pricing and traditional monthly apartment rental costs. Short-term rentals on Airbnb often command much higher prices compared to long-term apartment rentals, which eventually may have significant social and economic consequences.

This insight is particularly interesting for the digital nomads seeking medium and longer term accommodation options in these cities. It suggests that while short-term rentals on Airbnb can offer flexibility and unique experiences, they may come at a premium compared to traditional long-term apartment rentals. As a result, travelers and individuals looking for housing options need to consider their priorities and budget constraints when making decisions.

Furthermore, this price disparity between short-term and long-term rentals may have implications for housing markets in these cities. It could indicate that some property owners or investors find short-term rentals more profitable, potentially reducing the availability of long-term rental housing in certain neighborhoods. Policymakers may need to consider the impact of short-term rental platforms like Airbnb on local housing markets and explore ways to strike a balance that meets the needs of both residents and visitors.

Addressing the impact of Airbnb-driven gentrification and its effects on urban planning requires a thoughtful and multifaceted approach. Here are some possible fiscal and taxation measures that policymakers could consider implementing in the future to mitigate the negative consequences:

1. Short-term Rental Regulations: Implementing strict regulations on short-term rentals can help prevent the conversion of long-term housing units into short-term rentals. This could include limits on the number of days a property can be rented out, requirements for hosts to be permanent residents, and obtaining proper permits for short-term rentals.

2. **Occupancy Taxes:** Introducing or increasing occupancy taxes on short-term rentals can help generate revenue for local governments while also leveling the playing field between traditional hotels and short-term rental platforms.
3. **Impact Fees:** Implementing impact fees on short-term rental platforms could be used to fund affordable housing initiatives or infrastructure improvements in areas experiencing significant tourism-related pressures.
4. **Rent Controls:** In some cases, rent control measures could be considered to protect long-term tenants from displacement and ensure housing affordability.
5. **Affordable Housing Incentives:** Offering tax incentives or other financial benefits to property owners who provide affordable long-term rental units may encourage a more balanced housing market.
6. **Data Sharing:** Requiring short-term rental platforms like Airbnb to share data on rental listings with local authorities can help improve monitoring and enforcement of regulations.
7. **Zoning Policies:** Implementing zoning policies that restrict short-term rentals in certain neighborhoods or areas could help preserve the residential character and prevent the over-concentration of short-term rentals in popular tourist destinations.
8. **Community Input:** Engaging with local communities and residents in the decision-making process can lead to more informed and inclusive urban planning strategies that address the specific needs and concerns of the area.
9. **Monitoring and Evaluation:** Regularly monitoring the impact of short-term rentals on housing affordability and neighborhood dynamics is essential for adjusting policies and regulations accordingly.
10. **Collaboration with Platforms:** Collaborating with short-term rental platforms to implement responsible hosting practices, such as capping the number of listings per host and providing better enforcement of regulations, can help mitigate the negative effects of short-term rentals.

It is crucial for policymakers to strike a balance that allows for tourism and economic growth while also safeguarding the rights of long-term residents and maintaining the social fabric of communities. Adopting a comprehensive approach that combines regulatory, fiscal, and community-based solutions can help address the challenges posed by Airbnb-driven gentrification and create more sustainable and equitable urban environments.

*Conclusion: The finding that short-term rental prices on Airbnb are often by 2-5x higher than the average monthly rental costs for the similar one-bedroom apartments adds valuable insights into the housing landscape in major European cities. It underscores the importance of understanding from data and ML models the different factors driving pricing in the short-term rental market and its potential impact on housing availability and affordability. **Future research could delve deeper into the underlying factors contributing to the pricing differences and examine the implications for various stakeholders involved in the housing and hospitality sectors.***