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**DO SHORT-TERM RENTALS  
IMPACT POPULATION  
MOVEMENTS? AN  
ANALYSIS IN SIX FRENCH URBAN  
AREAS**

Lauriane BELLOY

# Do short-term rentals impact population movements ? An analysis in six French urban areas

Lauriane Belloy\*

## Abstract

This paper examines the impact of short-term rentals on displacement and gentrification in six urban areas of Nouvelle-Aquitaine in France by analyzing the probability of moving as well as arrivals flows in the neighborhoods. The results show that the density of short-term rentals increases the probability of moving to a neighborhood that is poorer than the neighborhood of origin with a higher probability in areas far the Atlantic Ocean for the lowest incomes. These rentals also promote the arrival of new residents who are wealthier than their previous short-term occupants. These last results are observed with the help of net inflows of residents from wealthier neighborhoods versus inflows from poorer neighborhoods after the expansion of short-term rentals in each neighborhood.

**Keywords :** Short-term rentals, Airbnb, Displacement, Gentrification

**JEL Codes :** R23, J60

## 1 Introduction

The choice of residential location is important and responds to a balance between the costs and benefits of each individual. When a shock occurs, individuals move to places that rebalance their costs and benefits (Blanchard and Katz, 1992). These shocks are most often negative externalities on housing prices, leading to a residential displacement of populations. These shocks leading to relocation can be related to internal effects such as a change of job, an increase in salary, a change in marital status, but it can also be due to external effects such as an increase in crime, the arrival of a new population in the neighborhood, external disturbances like pollution.

One of the recent shocks in urban areas is the development of short-term rentals such as Airbnb.

For the past decade, the development of short-term rental platforms such as Airbnb has made it possible to meet the growing demand of tourists, particularly international tourists, whose arrivals have increased by 17% worldwide between 2016 and 2019 according to the World Tourism Organization. In France the second region in number of tourist nights in 2019<sup>1</sup>, Nouvelle-Aquitaine, has seen the number of active rentals triple between 2016 and 2019 from 45,234 to 135,774 active short-term rentals<sup>2</sup>, the coastline having been particularly affected with an increase of 260% between these two dates.

In recent years, the growth and development of these rentals outside of large cities has raised concerns among the population and public authorities due to their negative impacts. Many studies have looked at the impact of short-term rentals on various phenomena. Studies on the increase in real estate prices or rents are among the common studies on the development of this phenomenon that Horn and Merante, (2017) showing that the doubling of short-term rentals in the city of Boston has caused an average increase

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<sup>1</sup>According to the INSEE (Institut Nationale de la Statistique et des Etudes Economiques)

<sup>2</sup>Data from Airdna 2016-2019

in rents of 4%. Similarly across different US cities, Barron et al, (2018) showed that doubling short-term rentals increased rents by 1.8% and property prices by 2.6%. Also on the issues of rents, Koster et al, (2019) studied the impact of rules implemented in 18 cities in Los Angeles County to combat the increased supply of short-term rentals, they show a decrease in housing prices and rents by 3% after implementing these measures. Garcia-Lopez et al, (2020) studied the impact of these housing measures in Barcelona and showed increases in rents of 1.9% and property prices of 5.3% with stronger effects in neighborhoods with the highest rental activity. In addition Quattrone et al, (2016) highlighted the spread of this type of rental in London between 2012 and 2015. Similarly Calder-Wang, (2020) shows in a structural approach that tenant welfare is negative due to a rent increase. The development of these short-term rentals has also led to neighborhood changes including real estate investments (Xu and Xu, 2021) and business conversions that no longer meet resident demand (Sheppard and Udell, 2016). Almagro and Dominguez-Lino, (2020) insist on the endogeneity of amenities that include the effects of tourist congestion, reinforcing the spatial sorting of populations in cities.

These issues of nuisance, increased property prices and rents as well as investment can lead to a phenomenon of population displacement and gentrification of neighborhoods as explained by Wachsmuth and Weisler, (2018) showing that it is the additional rent generated by the potential income from short-term rentals that leads to neighborhood gentrification and displacement of residents.

This study focuses on the latter, resident displacement. The purpose of this work is to identify the impact of short-term rentals on the likelihood of residents moving to neighborhoods that are poorer than their original neighborhoods and to identify whether there is a displacement of residents by more affluent in-migrants, which would be consistent with gentrification.

In this study, displacement can be defined as the movement of individuals from the resident populations of a neighborhood to neighborhoods with lower incomes and less economic opportunity (Ding, 2016; Pennington, 2021). Gentrification can be defined as the transformation of working-class neighborhoods by the arrival of newcomers from higher social classes (socio-professional categories, educational level, higher income) (Glass, 1964). The revitalization and transformation of the built environment as well as the rise in real estate prices are the other phenomena most commonly mentioned to characterize gentrification (Gervais-Linon, 2006).

As discussed in the literature, gentrification and displacement induced by short-term rentals are often studied in aggregate at the neighborhood level or simply mentioned when the analysis focuses on other variables such as property prices or rents. The main contribution of this study is that it focuses on the direct impact on displacement by using longitudinal data at the individual level combined with an analysis of population flows at the neighborhood level to study the possible gentrification effect.

This paper is in line with studies on the causes of displacement. According to Bilal and Rossi-Hansberg, (2018) displaced people move to spaces that are less attractive than where they originally lived and more generally to lower "quality" neighborhoods with less prestigious schools, higher crime (Quiang et al., 2020) thus fostering the entrenchment of some neighborhoods in poverty and reproducing inequalities over time (Pennington, 2021). Typically, studies of resident displacement examine the links to gentrification by looking at the impact of gentrification on population displacement while emphasizing that poorer residents of gentrified neighborhoods are no more likely to move than those in non-gentrified neighborhoods (Vigdor et al., 2002; Freeman and Braconi, 2004). Newman and Wyly, (2006) show that individuals who tend to move more have particular characteristics of being poor, living in public housing, or when the head of household is a woman. Ding et al. (2016) show that resident displacement is heterogeneous across individuals and their credit risk but also across the progress of neighborhood gentrification.

Similarly several studies highlight the impact of retail transformations and changes in neighborhood

composition, Glaeser et al, (2018) show, through data from Yelp that the installation of certain types of businesses (cafes, restaurants, bars) promote price increases and the settlement of populations with higher levels of education. Similarly Schuetz, (2014) and Meltzer, (2016) identify the impact of the installation of art galleries in gentrifying neighborhoods. Behrens et al, (2018) show that the installation of pioneer businesses i.e., those that do not usually locate in these locations, would influence the gentrification of the neighborhoods in which they locate. Pennington, (2021) highlights that the creation of new housing decreases rents in the vicinity of the new constructions as well as the decrease in travel. On the other hand, new construction increases gentrification, which is consistent with non-displacement gentrification.

Compared to the literature on short-term rentals, this paper analyzes the direct impact of the development of short-term rentals on the forced displacement of individuals without going through real estate prices, from the perspective of population displacement studies, this paper shows forced displacement through moving to neighborhoods where residents have lower incomes than the moving neighborhood after the development of short-term rentals.

This paper contributes to this literature by taking short-term rentals as an independent variable in order to explain the population's movements. The analyses developed are based on two types of panel data scales: on the one hand, an analysis at the individual scale to study the probability of moving and on the other hand, an analysis at the neighborhood scale to study the flows of residents according to their neighborhood of origin and destination in order to identify the possible existence of a gentrification effect between 2016 and 2019.

This analysis focuses on six urban areas in the Nouvelle-Aquitaine region in southwestern France, which is the second most popular tourist region in terms of overnight stays. Three of these urban areas are located on the Atlantic coast (Bordeaux, La Rochelle and Bayonne) and are ideal locations for tourism development and the growth of short-term rentals. The other three urban areas (Limoges, Poitiers and Pau) are the three medium-sized cities located inland in the region. Taking urban areas into account allows us to study travel to the outskirts and therefore distance from employment centers, whereas in studies on the impact of short-term rentals, we tend to focus on metropolises without their suburbs.

The first part of this work focuses on the movement of individuals. The objective is to study the direct impact of short-term rentals on the probability of moving. This direct impact will make it possible to understand in a detailed way and not at the neighborhood level, which is generally the case in the existing literature, whether the development of short-term rentals influences the move to neighborhoods where the inhabitants have lower incomes. This study is therefore original in that it studies these movements at the individual level.

The Nouvelle-Aquitaine region being a large territory with diversified environmental and touristic characteristics, these effects can be compared according to the proximity to the ocean, places considered to be very touristic.

The first strategy is to analyze the probability that an individual will move to a neighborhood with lower incomes than the neighborhood of origin. This methodology follows Pennington (2021), i.e., categorizing poorer neighborhoods when they have a median income 10% lower than the original neighborhood. The location of short-term rentals is not random on the territory and can be explained by the same factors as the fact of moving in or out of a neighborhood, which does not allow us to identify causality. There is then a problem of endogeneity between these two variables.

In order to correct for the endogeneity of the number of short-term rentals in the neighborhood where the individual lives, an instrumental variable is used. This is the number of photographs taken outside and published on Flickr, a photo-sharing website. This variable provides an instrument that varies both annually and by neighborhood. The advantage of outdoor photography is that the density of photographs can be a proxy for the notable amenities present in the neighborhood (Gagné et al., 2021). Compared to the shift-share instruments, typically used to study the impact of short-term rentals (Barron et al., 2020; Garcia-Lopez, 2020) used photographs can take into account tourist attractiveness (representing

distance to monuments in Garcia-Lopez et al., (2020) or a measure of tourism by neighborhood in Barron et al., (2020)) but also time-varying tourist demand (representing Google Trends searches in Barron et al., (2020) and Garcia-Lopez, (2020)). As a complement, an event study is performed looking at the probability of moving to a poorer neighborhood before and after the arrival of the first short-term rentals. In order to understand whether population displacement effects are somehow forced, a multinomial probit model will compare before and after the arrival of short-term rentals both the probability of moving to a poorer neighborhood and to a richer neighborhood compared to a situation where the individual remains in an equivalent neighborhood in terms of residents income.

The second part is to identify the potential gentrification effect, the empirical analysis consists of measuring a form of population replacement at the individual level by focusing only on individuals who have moved and been replaced by wealthier individuals. Using the same method as for neighborhoods, individuals who have been replaced by individuals with a standard of living at least 10% higher than their standard of living will take the binary value of 1 and 0 otherwise. This part therefore measures the probability of being replaced by wealthier households. An aggregate analysis at the neighborhood level will identify whether or not there is a displacement with redevelopment by taking into account the flows of individuals from a richer neighborhood versus the flows of arrivals from a poorer neighborhood, thus obtaining the net flows of the number of individuals arriving from richer neighborhoods versus the flows of poorer individuals arriving in the neighborhood.

This paper is organized as follows : the first part explains the data and the methodology applied, the second part presents the results with the separation between the displacement analysis and the gentrification analysis and the last part concludes this paper.

## 2 Data

The data used to study the impact of short-term rentals on resident travel will rely on two types of panel data scales : on the one hand, an analysis at the individual level in order to study the probability of moving and, on the other hand, an analysis at the neighborhood level in order to study the flows of residents according to their neighborhood of origin and destination in order to identify the possible existence of a gentrification effect.

### Individual, housing and living environment data

The data used to study the impact of short-term rentals on the probability of moving are from the FIDELI<sup>3</sup> (Fichiers DEmographiques sur les Logements et les Individus) files for the years 2015 to 2019 provided by the CASD (Centre d'Accès Sécurisées aux Données). These files provide information on all individuals living in housing subject to the housing tax, they are composed of three main tables of information :

- The table on the locations consists of descriptive elements on the characteristics of the locations (individual characteristics such as surface area or number of rooms as well as location information) but also on the type of occupation in year N and in year N-1, the date of entry of the occupant of the location and finally information on the owner.
- The table on individuals consists of elements on the income of each individual, demographic information such as place of birth or date of birth, marital status and information on residential mobility.

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<sup>3</sup><https://doi.org/10.34724/CASD.295.2554.V1>,  
<https://doi.org/10.34724/CASD.295.3257.V1>, <https://doi.org/10.34724/CASD.295.3713.V1>

<https://doi.org/10.34724/CASD.295.2866.V2>,

- The Household Income Table which includes income information but at the household level.

Each millennium between 2015 and 2019 provides information on individuals and rentals for year N and year N-1. Because moving is a rare event, the probability of moving is unlikely to be repeated several times over the chosen study period. However, in order to account for changes in the development of short-term rentals over the study period, the presence of individuals year after year is repeated. The information on individual characteristics is fixed over time and the information indicates the year of marital status change. The moving indicator is available in the corresponding year, the date of moving to the new location is indicated and the number of years in the old location is indicated which allows to duplicate the individuals and their fixed characters the number of times they are present in the old location until they move. Only the income variable will be available for the last year of observation in the location, but income at the aggregate level can be calculated annually, which can provide information on the displacement of residents to neighborhoods that are poorer or poorer than the origin neighborhood, which can be a way to identify displacement, as in Pennington (2021) study of the impact of new construction on displacement.

The value of these data is that they provide information on moves, previous places of residence, and characteristics of residents one year before moving in. This study focuses on the residential travel of individuals with incomes, living and moving in the urban areas of the six main cities of Nouvelle-Aquitaine : Bordeaux, Limoges, Poitiers, Pau, La Rochelle and Bayonne. Three of these urban areas are located on the Atlantic coast (Bordeaux, La Rochelle and Bayonne) and are ideal locations for the development of tourism and the growth of short-term rentals. The other three urban areas (Limoges, Poitiers and Pau) are the three most important cities in the region. The impact of short-term rentals is most often analyzed within the framework of a city but does not take into account peri-urbanization and the distance of residents from city centers. The urban area zoning comes from the INSEE (Institut National de la Statistique et des Etudes Economiques), these urban areas are defined as groups of municipalities "in one piece and without enclave" rural or constituting a peri-urban ring where at least 40% of residents with a job work in this area attracted by the hub city. Income data are aggregated at the level of IRIS neighborhoods (Ilots Regroupés pour l'Information Statistique). These IRIS are micro-neighborhoods constituted in cities with more than 10 000 inhabitants and many municipalities with between 5 000 and 10 000 inhabitants, grouping together between 1 800 and 5 000 inhabitants and being cut up, in the case of the habitat IRIS, respecting the major cuts in the urban fabric such as main roads, railroads or watercourses, and being made up of homogeneous habitats. Two other types of IRIS exist, activity IRIS composed of at least 1 000 jobs and having at least twice as many jobs as inhabitants, and miscellaneous IRIS representing specific areas such as port areas, forests or theme parks. Since urban areas include rural municipalities, some municipalities do not have neighborhoods divided into IRIS, so the information is aggregated at the municipal level. In order to complete the information on the characteristics of the places of residence and thus identify the places that are more conducive to relocation, the land use zones from the Corine Land Cover 2012 data were used and make it possible to distinguish urbanized, industrial and commercial areas from vegetation and agricultural areas.

In parallel with the study of the impact of short-term rentals on the likelihood of moving, a neighborhood-level gentrification analysis will be conducted to identify inflows and outflows by neighborhood wealth in order to identify whether or not there is a displacement with replacement. In addition to these neighborhood analyses, a measure of neighborhood transformation will be conducted thanks to information on building permits and renovations, the data for which are taken from the Sitadel database (Système d'Information et de Traitement Automatisé des Données Élémentaires sur les Logements et les locaux), which makes it possible to obtain information on newly built housing and renovations between 2016 and 2019 and to identify whether there are neighborhood transformations.

## Airbnb data

The data concerning short-term rentals is provided by AirDNA, a company that provides short-term rental data for the Airbnb and Vrbo platforms. The data used is exhaustive and allows us to know monthly the number of active rentals, i.e. available for rent at least one day in the month. This data contains information on the number of days rented, available and blocked per month as well as the characteristics of the housing and the date of creation of the account. In order to eliminate the risk of taking into account housing that has been put online but is not rented between individuals, only housing that has the characteristics of being apartments, houses or any other type of housing that resembles these typologies has been kept. Rentals in hotels or campgrounds, for example, were removed from the analysis. Data were aggregated at the IRIS neighborhood level year by year between 2016 and 2019.

## 3 Methodology

### 3.1 Models for displacements

The main difficulty in studying short-term rentals on residential mobility is endogeneity. Indeed, the development of these rentals can lead to the displacement of residents but conversely this phenomenon can be due to the relocation of individuals who will start to rent their new home. In the same way, the development of these short-term rentals can be correlated to the characteristics of the neighborhood, to the accessibility to get to the housing, but also to the proximity of strategic places (museums, natural amenities...). These elements can also influence the residential location of the inhabitants and thus be correlated to the same factors. To address this endogeneity problem an instrumental variable is used. It corresponds to a density index of web photographs scanned on the FlickrR site and allowing to take into account both the changes of interest of each district over time and the tourist fame of the place. The idea behind this tool is that the places most photographed by tourists will attract short-term rentals but will not have a direct impact on the relocation of residents (The instrument should not be correlated to error terms but should be correlated to the number of short-term rentals). The location of photographs (Appendix 1: Number of photographs and number of moves between 2016 and 2019) is not in locations with a high number of moves even though sometimes there are many moves in neighborhoods relatively close to a high density of photographs. The most touristic places are therefore not where there is a strong dynamic of moves.

The first empirical strategy is to estimate binary instrumental variable models by running a linear probability model (LPM) and then a probit model. The binary variable is 1 when the individual moves to a neighborhood that is poorer than his or her original neighborhood and 0 otherwise. The first stage aims to explain the number of short-term rentals in each neighborhood with the instrumental variable representing an indicator of photographs taken by tourists. The second stage explains the probability of moving to a neighborhood that is poorer than the original neighborhood using a linear probability model and a probit model.

First stage :

$$Airbnb_{itn} = \beta_0 + \beta_1 X_{itn} + \tau_t + \tau_t \times \chi_{itn} + IV_{itn} + \varepsilon_{itn}. \quad (1)$$

The linear probability model :

$$Pr(moverpoor_{i,t,n} = 1) = \beta_0 + \beta_1 airbnb_{itn} + \beta_2 X_{itn} + \tau_t + \tau_t \times \chi_{itn} + \varepsilon_{itn}. \quad (2)$$

The equivalent probit model :

$$Pr(moverpoor_{i,t,n} = 1) = \Phi(\beta_0 + \beta_1 airbnb_{tn} + \beta_2 X_{itn} + \tau_t + \tau_t \times \chi_{itn}). \quad (3)$$

With  $airbnb_{tn}$  representing the number of short-term rentals in neighborhood  $n$  in year  $t$ .  $X_{itn}$  represents the control variables : number of years in the dwelling, occupancy, year of birth of the individual, gender, unemployment status, marital status, urban area, housing surface and the median income in the neighborhood.  $\tau_t$  represents the years from 2016 to 2019 and  $\chi_{itn}$  the category of the housing area, i.e., in an urban center or in the urban ring. The interaction between years and urban category allows us to take into account the trend of moving to urban centers over time with the assumption that the risk of moving to poorer neighborhoods increases when the individual lives in an urban center, i.e. where the development of short-term rentals is more important. The instrumental variables in equation (1) first stage represent the density of photographs from the FlickrR site in each neighborhood. Finally, in the probit model  $\Phi()$  represents a standard normal cumulative distribution function.

### 3.2 Models for gentrification

The first model studies the probability of being replaced by a richer household for individuals moving. As in the previous section, the model includes a linear probability model and a probit model.

First stage :

$$Airbnb_{i,t,n} = \beta_0 + \beta_1 X_{itn} + \tau_t + \tau_t \times \chi_{itn} + IV_{tn} + \varepsilon_{itn} \quad (4)$$

The linear probability model :

$$Pr(replacerich_{itn} = 1) = \beta_0 + \beta_1 airbnb_{tn} + \beta_2 X_{itn} + \tau_t + \tau_t \times \chi_{itn} + \varepsilon_{itn} \quad (5)$$

The equivalent probit model :

$$Pr(replacerich_{itn} = 1) = \Phi(\beta_0 + \beta_1 airbnb_{tn} + \beta_2 X_{itn} + \tau_t + \tau_t \times \chi_{itn}) \quad (6)$$

With  $i$  the displacement individual,  $t$  the year of the move, and  $n$  the neighborhood. The variables presented in this section correspond to the same variables as above for moving to a poorer neighborhood.

## 4 Results

### 4.1 Short-term rental density and displacement in poorer neighborhoods

#### 4.1.1 Instrumental variables models

Between 2016 and 2019, 7.23% of individuals in the FIDELI files of the main urban areas of Nouvelle-Aquitaine moved at least once. Between these periods, the share of residential mobility decreased slightly

from 8.35% of people moving in 2016 to 7.18% in 2019. The municipalities bordering the Atlantic Ocean as well as the municipalities representing the central municipality of each urban area have higher residential mobility rates than the peripheral municipalities. The share of these mobilities is on average 2.83 points higher in the municipalities bordering the Atlantic Ocean and the center of the Urban Areas than for the rest of the municipalities. Between 2016 and 2019, short-term rentals increased by 132% in the urban areas studied, from 26,181 rentals in 2016 to 60,680 in 2019.

Research studies the residential location choices of individuals or households through different determinants such as employment, real estate prices, amenities, taxes or proximity to transportation. Each individual or household establishes the benefits and costs related to these determinants in order to choose their place of residence. In the event of shocks that could affect one of the determinants of their residential location, individuals or households move to a place that rebalances their costs and benefits (Blanchard and Katz, 1992). The emergence of short-term rentals, created a decrease in the supply of long-term housing due to the conversion of long-term rental housing to short-term housing. At the same time, the increased demand for housing due to the increased attractiveness of the neighborhoods leads to higher real estate prices and rents. These effects are the triggers for the movement of individuals or households. The first analysis will focus on the probability of moving to a neighborhood that is poorer than the individual original neighborhood when the density of short-term rentals is high. The positive impact of the density of short-term rentals in people neighborhoods of residence may be consistent with a negative effect of this type of housing by moving residents to neighborhoods that are "degraded" compared to their original situation.

The instrumental variables used represent the photographs density (i.e. the number of photographs out of the number of housing units considered in the study) taken by tourists in each IRIS neighborhood in the given observation year and in year  $n-1$ . These photographs are from the photo sharing site Flickr. In order to eliminate any effect of variations of photographs posted on the site. The density of photographs has been standardized in order to create an index ranging from 1 to 100 and ranking these densities by year, here is the index calculation :  $1 + \frac{(variable - minimum)(100 - 1)}{(maximum - minimum)}$ . The instrumental variables must meet two conditions to be valid. The first condition is the relevance, i.e. the instrument must be correlated with the endogenous independent variable, in our case the density of short term rentals. The second condition is the exogeneity i.e. the non-correlation of the instrument with the error term.

The choice of these instrumental variables lies in the fact that the density of photographs can be a good proxy for the evolution of the tourist attractiveness of the different neighborhoods since the number of photographs varies every year and where there are many tourists there will be a higher probability of finding hotels and tourist rentals. Moreover, these photographs alone fit in the variables usually taken into account, most often of the shift-share type taking up Google Trends searches for demand for short-term rentals and the level of tourism varying over time and fixed variables of proximity to tourist amenities.

Regarding the relevance of the instrument, in the first stage, the coefficients of the instrumental variables are significant and show that the standardized photographs density index increases the density of short-term rentals in each neighborhood. Moreover the weak instrument test developed by Stock and Yogo (2005) shows a Kleibergen-Paap statistics higher than the 10% maximum instrumental variable size and higher than 10 for all regressions.

The exogeneity assumption of the instrumental variables can be explained by the low probability that individual shocks motivating travel are related to the variation of photographs taken by individuals present in the neighborhood especially in a time as limited as the years considered in the study (2016-2019). In contrast, variations in photographs may explain tourist attractiveness and the popularity of short-term rentals. Moreover, the overidentification tests of J-Hansen accept the hypothesis that the instruments are indeed exogenous at the 5% threshold.

The variable taken into account is the density of short-term rentals, i.e. the number of short-term

rentals out of the number of housing units recorded in the FIDELI data.

Taking the short-term rental density as the dependent variable, the results indicate that when the number of short-term rental increases by 100, the probability of moving to a poorer neighborhood increases by 0.22 percentage points in the case of the linear probability regression. A similar result is also found in the case of probit regression in which increasing the density of short-term rentals by one unit increases the probability of moving to a poorer neighborhood by 0.16 percentage points. An example can be given to make the results more understandable, taking a fictional neighborhood where the number of short-term rentals increases from 100 to 200 and the relocation rate in that neighborhood was 2% before the increase, the relocation rate would then increase to 2.16% after the increase of 100 short-term rentals. These results may seem small, but the primary channel for moving is the increase in real estate prices and rents. With the impact of short-term rentals on rents ranging from 1.8 percent (Barron et al., 2018) to 4 percent (Horn and Merante, 2017) and real estate prices ranging from 2.6 percent (Barron et al., 2018) to 5.3 percent (Garcia-Lopez and al., 2021), the direct impact of short-term rentals on moves cannot be as strong.

Columns (7) and (8) show the regressions before the strong development of short-term rentals; the year considered does not mean that there were no short-term rentals in the neighborhood but only the 20% of rentals present in 2019. Both results indicate that the density of short-term rentals did not influence the probability of moving to a poorer neighborhood, which may be explain by the impact of the development of short-term rentals. Similarly, the results remain consistent by changing the moving threshold, i.e. by taking respectively moves to a neighborhood with median incomes 5% or 15% lower than the original neighborhood as opposed to 10% in the baseline.

**Table 1 : Effect of short-term rentals on displacement**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LPM Airbnb ×100	Probit Airbnb ×100	LPM Airbnb ×100 (dis- placement to a neighbor- hood 5% poorer)	Probit Airbnb ×100 (dis- placement to a neighbor- hood 5% poorer)	LPM Airbnb ×100 (dis- placement to a neighbor- hood 15% poorer)	Probit Airbnb ×100 (dis- placement to a neighbor- hood 15% poorer)	LPM before STR de- velopment	Probit before STR de- velopment
<i>first stage</i>								
∴								
Normalisation								
Photographs n	0.0486*** (0.0004)		0.0488*** (0.0004)		0.0039*** (0.0000)		0.0140*** (0.0004)	
Normalisation								
Photographs n-1	0.0367*** (0.0005)		0.0369*** (0.0005)		0.0033*** (0.0000)		0.0100*** (0.0004)	
<i>Second stage :</i>								
<i>Dependante variable :</i>								
<i>Probability of moving in poorer neighborhood</i>								
Marginal effect	0.0022*** (0.0002)	0.0016*** (0.0001)	0.0027*** (0.0002)	0.0022*** (0.0002)	0.0011*** (0.0001)	0.0010*** (0.0001)	-0.0009 (0.0007)	-0.3925 (1.3239)
N	6835570	6835570	6835570	6835570	6835570	6835570	1674922	1674922
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are clustered at the individual level (\*p<0.10, \*\*p<0.05, \*\*\*p<0.01),The dependent variable is binary and corresponds to 1 if the individual moves to a neighborhood poorer than his or her original neighborhood and 0 otherwise. The instrument variables correspond to the indicator of photographs taken in the neighborhood where the individual resided before moving (if he or she moved during the year) in observation year n and in observation year n -1. The control variables correspond to the individual characteristics of the individual (sex, date of birth, marital status, number of years in the housing, occupation of the premises, housing surface), the characteristics of the environment (category of urban pole, unemployment, median income in the neighborhood).

Another instrumental variable was used to verify the interest of our previous variable, it is an interaction between the number of keyword "Airbnb (closest city with results greater than 0 in Google trends searches)" and 1/ the distance to the center of the urban area or the ocean, according to what is closer. This instrument indicates the evolution of the interest of short-term rentals on the territories and the tourist potential of the location of the individuals, the higher the indicator will be, the higher the tourist

attraction and the tourist potential will be. This instrument is similar to the shift-share type instruments used in other studies (Barron et al., 2021, Garcia-Lopez et al., 2020). As the territories studied correspond to urban areas, some peripheral municipalities are not known and may not be mentioned in Google trends searches; for this reason, in order to avoid searches equal to 0, the municipalities closest to the municipalities that have no searches have been favored in the creation of the indicator. For example, in the Bayonne urban area, if an individual is located in Arcangues, the closest commune will be Bidart, and the Google trends search will then be "Airbnb Bidart". The results using this instrument appear to be consistent with those found using our photography indicator, the increase of 100 short-term rentals in the neighborhood increases the probability of moving to a neighborhood where the median income is lower than that of the original neighborhood by 0.12 percentage points (0.15 for the LPM).

**Table 2 : Effect of short-term rentals on displacement Google trend instrumentale variable**

	<u>Dependante variable : Probability of moving to a poorer neighborhood :</u>		
	first stage : dependante variable : Airbnb ×100	second stage : LPM	second stage : Probit
Google trend instrument	2.914*** (0.2029)		
Airbnb ×100 (Marginal effect)		0.0015*** (0.0001)	0.0012*** (0.0004)
<i>N</i>	6835570	6835570	6835570
<i>Control variables</i>	Yes	Yes	Yes

Notes: Standard errors are clustered at the individual level (\*p<0.10, \*\*p<0.05, \*\*\*p<0.01),The dependent variable corresponds to 1 if the individual moves to a neighborhood poorer than his or her original neighborhood, 2 if the individual moves to a neighborhood richer than his or her original neighborhood and 0 otherwise. The control variables correspond to the individual characteristics of the individual (sex, date of birth, marital status, number of years in the housing, occupation of the premises), the characteristics of the environment (category of urban pole, unemployment) and the years.

The differentiation of spaces by distance allows for the segmentation of less touristy and less dense coastal areas such as the communes of the Landes coast that are part of the Bordeaux urban area but are less important in terms of urban population compared to the communes of the urban areas of Bayonne and La Rochelle. In this part, individuals are separated into two subsamples, one at a distance of less than 10km from the ocean and the other at a distance of more than 10km from the ocean.

The regression results indicate that a 100 unit increase in the number of short-term rentals, increases the probability of moving to poorer neighborhoods by 0.021 percentage points in the case of the linear probability model and by 0.016 percentage points for the probit model. By separating the coastal urban areas (the urban areas of Bordeaux, La Rochelle, and Bayonne) from the inland urban areas (the urban areas of Limoges, Poitiers, and Pau), the results not change in sign but is more important than for urban areas near the Atlantic Ocean. Indeed, for urban areas close to the ocean, the number of short-term rentals favors the probability of moving to poorer neighborhoods than the individuals neighborhoods of origin. On the other hand, for medium-sized cities far from the coast, the opposite is true : the higher the number of short-term rentals, the lower the probability of moving to a poorer neighborhood. These results may explain the fact that short-term rentals have a lesser impact on the resident population than in the tense areas where these housing units are developing rapidly. These results show that the

development response is stronger in places that are rather far from the ocean, which can be explained by the fact that neighborhoods close to the ocean have undergone moves to poorer neighborhoods before the periods studied.

**Table 3 : Effect of short-term rentals on displacement by distance from the ocean**

	(1)	(2)	(3)	(4)
	LPM Urban far the ocean	Probit Urban area far the ocean	LPM Urban area near the ocean	Probit Urban area near the ocean
<i>first stage :</i>				
<i>dependante</i>				
<i>variable : Airbnb</i>				
<i>× 100</i>				
Normalisation Photographs n	0.0473*** (0.0004)		0.0906*** (0.0026)	
Normalisation Photographs n-1	0.0354*** (0.0004)		0.0944*** (0.0062)	
<i>Second stage :</i>				
<i>Dependante</i>				
<i>variable :</i>				
<i>Probability of</i>				
<i>moving in poorer</i>				
<i>neighborhood</i>				
Airbnb × 100 (marginal effect)	0.0021*** (0.0002)	0.0016*** (0.0001)	0.0011*** (0.0005)	0.0007*** (0.0025)
<i>N</i>	6735333	6735333	100237	100237
<i>Control variables</i>	Yes	Yes	Yes	Yes

Notes: Standard errors are clustered at the individual level (\*p<0.10, \*\*p<0.05, \*\*\*p<0.01),The dependent variable is binary and corresponds to 1 if the individual moves to a neighborhood poorer than his or her original neighborhood and 0 otherwise. The instrument variables are the standardized number of photographs on a scale of 1 to 100 for each year of observation multiplied by the distance to the ocean or to the center of the main urban area municipality. The photographs are taken in the neighborhood where the individual resided before moving (if he or she moved within a year) in observation year n and observation year n -1. The control variables correspond to the individual characteristics of the individual (sex, date of birth, marital status, number of years in the housing, occupation of the premises, housing surface), the characteristics of the environment (category of urban pole, unemployment, median income in the neighborhood).

In this section, the results are differentiated by the individual's income percentile. The income is that of the last date of observation, i.e. at the time of the move or in the last year of observation of the individual. For all income groups, the impact of short-term rentals on moving to poorer neighborhoods is significant and positive; the number of short-term rentals increases the probability of moving to a poorer neighborhood. However, people with the lowest incomes are more affected by this rental development than the richest. The poorest 10% have a probability of moving to a poorer neighborhood of 0.023 percentage points (0.028 for the LPM) versus 0.01 percentage points for the richest 10% (0.013 for the LPM). The results are confirmed when taking into account the poorest 25% of individuals, 0.023 percentage points (0.031 for the LPM) and respectively 0.009 percentage points (0.013 for the LPM) for the richest 25%. These results highlight the fact that the development of short-term rentals can drive out the poorest residents by displacing them to poorer neighborhoods.

**Table 4 : Effect of short-term rentals on displacement according to income**

	(1)	(2)	(2)	(3)	(4)	(5)	(6)	(7)
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
	centile	centile	centile	centile	centile	centile	centile	centile
	10%	10%	90%	90%	25%	25%	75%	75%
<i>first stage</i>								
$\vdots$								
<i>dependante</i>								
<i>variable :</i>								
$\frac{\text{Airbnb} \times 100}{\text{Normalisation}}$								
Photographs	0.0512***		0.0469***		0.0503***		0.0476***	
n	(0.001291)		(0.0011)		(0.0008)		(0.0008)	
$\frac{\text{Photographs}}{\text{Normalisation}}$								
n-1	0.0347615***		0.0379***		0.0355***		0.0387***	
	(0.000363)		(0.0011)		(0.0009)		(0.0008)	
<i>Second stage :</i>								
<i>Dépendante</i>								
<i>variable :</i>								
$\frac{\text{Probability of moving in poorer neighborhood}}{\text{Airbnb} \times 100}$								
(Average marginal effect)	0.0028***	0.0023***	0.0013***	0.0010***	0.0031***	0.0023***	0.0014***	0.0009***
	(0.0021)	(0.0004)	(0.0004)	(0.0002)	(0.0004)	(0.0002)	(0.0003)	(0.0002)
<i>N</i>	682819	682819	683830	683830	1707941	1707941	1709430	1709430
<i>Control variables</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are clustered at the individual level (\*p<0.10, \*\*p<0.05, \*\*\*p<0.01),The dependent variable is binary and corresponds to 1 if the individual moves to a neighborhood poorer than his or her original neighborhood and 0 otherwise. The instrument variables correspond to the indicator of photographs taken in the neighborhood where the individual resided before moving (if he or she moved during the year) in observation year n and in observation year n -1. The control variables correspond to the individual characteristics of the individual (sex, date of birth, marital status, number of years in the housing, occupation of the premises, housing surface), the characteristics of the environment (category of urban pole, unemployment, median income in the neighborhood).

#### 4.1.2 Event study regression : increased probability of moving after the arrival of short-term rentals in tourist areas

The purpose of this subsection is to study the impact of the arrival of short-term rentals on the re-location of residents to neighborhoods that are poorer than their neighborhood of origin. Previously, our standardized short-term rental density instrumental variables appeared valid, so to confirm this, an event study was conducted to confirm the impact of short-term rentals on displacement. Indeed, our instruments might not be valid if the number of photographs varied over time for reasons other than the development of short-term rentals.

If our instrumental variables are valid, the density of short-term rentals prior to the start date of short-term rentals in each neighborhood should not be significant in neighborhoods with high photo density. In order to study the impact of short-term rentals on moves to neighborhoods that are poorer than the original neighborhoods and to identify the influence of photographs, the neighborhoods selected correspond to the 10% of the neighborhoods in which the density of photographs is the highest.

The pre-event date corresponds to the date when the 20% of short-term rentals present in 2016 and 2019 were created, before this date short-term rentals were few. The explanatory variables are the same as for the regressions with instrumental variables. A Linear Probability Model (LPM) and a probit regression were performed.

The complementary model showing the effect of the appearance of short-term rentals in each neighborhood, an event study is performed using the same explanatory variables

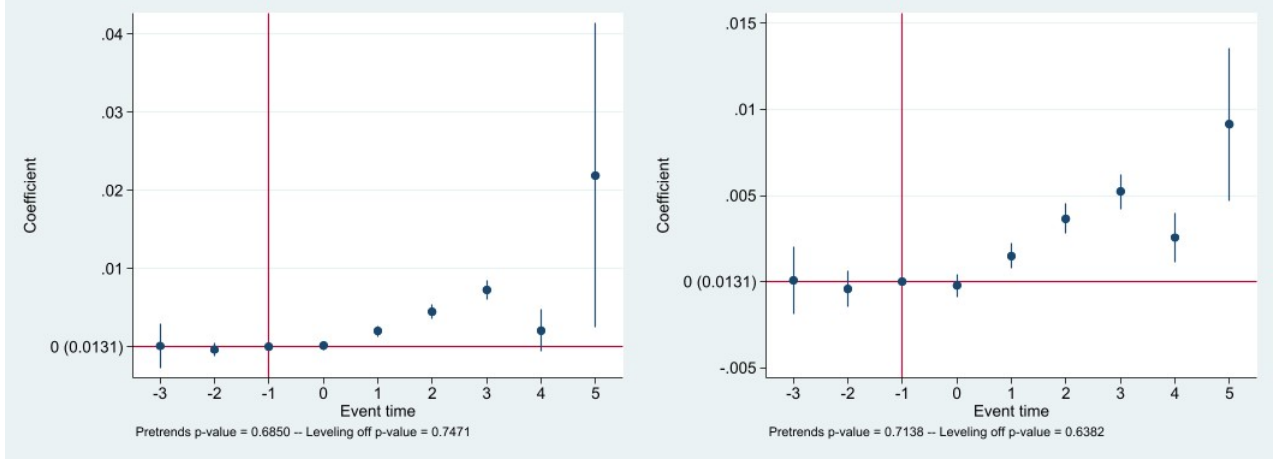
$$Pr(moverpoor_{i,t,n} = 1) = \beta_0 + \sum_{t \neq first\ STR} airbnb_{tn} + \beta_2 X_{itn} + \tau_t + \tau_t \times \chi_{itn} + \varepsilon_{itn} \quad (7)$$

$$Pr(moverpoor_{i,t,n} = 1) = \Phi(\beta_0 + \sum_{t \neq first\ STR} airbnb_{tn} + \beta_2 X_{itn} + \tau_t + \tau_t \times \chi_{itn}) \quad (8)$$

The reference year is the year in which the short-term rentals present in the Airdna database developed in the neighborhood where the individual was located. The data taken into account no longer represents the number of active short-term rentals each year but the rentals present in 2019, with the development years corresponding to the year when 20% of the rentals present in 2019 were created.  $X_{itn}$  represents, as before, the time-varying variables and  $\gamma_{itn}$  the time-fixed variables.  $\tau_t$  represents the years.

The results show a significantly higher probability of moving to a poorer neighborhood than before the date of entry of short-term rentals (or of increasing development of short-term rentals). Two years before the entry date, the probability of moving to a poorer neighborhood is not significant.

**Event studies representing the impact of the arrival of short-term rentals in the neighborhood on travel in the 20% of neighborhoods with the highest density of short-term rentals (probit model on the left and LPM on the right)**



The results are similar when the neighborhoods are extended to the 10% of neighborhoods with the highest density of photographs (*Appendix 2 : Event studies Event studies representing the impact of the arrival of short-term rentals in the neighborhood on travel in the 10% of neighborhoods with the highest density of short-term rentals* . The only difference is that at the "entry" date of short-term rentals the coefficients are not significant, i.e., the probability of moving to a poorer neighborhood does not appear significantly different from one year before the "entry" date of short-term rentals.

**4.1.3 Do neighborhoods with high densities of short-term rentals also promote displacement to wealthier neighborhoods? Answer from a multinomial probit model**

The model used in this section is a multinomial probit model whose purpose is to study the probability of moving to neighborhoods that are more or less affluent than the original neighborhood as a function of moving to an equivalent neighborhood or the same income level. The multinomial probit model is written as follows:  $D_{itn}$  corresponds to an indicator variable with  $D_i = j$  with  $j = 0, 1, 2$ , such that :

- $D_{itn} = 0$  corresponds to an individual  $i$  in year  $t$  in neighborhood  $n$  not changing neighborhood standing (the individual remains in the neighborhood or moves to an equivalent neighborhood)
- $D_{itn} = 1$  corresponds to an individual  $i$  in year  $t$  in neighborhood  $n$  moving to a neighborhood poorer than his or her original neighborhood
- $D_{itn} = 2$  corresponds to an individual  $i$  in year  $t$  in neighborhood  $n$  moving to a wealthier neighborhood than his or her original neighborhood

The variable  $D_{itn}$  is determined as follows :

$$D_{itn} = j \text{ if } D_{itn} = j, D_{kitn}^* = \sum_{t \neq \text{first STR}} \text{airbnb}_{tn} + \delta'_k X_{itn} + \tau_t + \tau_t \times \chi_{itn} + \chi_{itn} + \epsilon_{kitn} \text{ With } D_{kitn}^* \text{ a latent}$$

variable indicating the choice of the probability of move associated with the choice  $k$  that is observed is different from 1.  $\delta'$  represents the parameters to be estimated and  $X_{itn}$  the set of explanatory control variables of the model, i.e. the number of years in the dwelling, the occupation of the premises, the year of

birth, the sex, the fact that the individual is unemployed, the marital status and the urban area.  $\tau_t \times \chi_{itn}$  represents the interaction between the year ( $\tau_t$ ) and the urban category ( $\chi_{itn}$ ) in which the individual lives with the assumption that the probability of moving will change over the years depending on whether the individual lives in the urban ring or in the urban centers. Finally,  $airbnb_{tn}$  represents the period before and after the development of short-term rentals in the neighborhood of origin. The purpose of this model is to compare moving to a neighborhood that is richer or poorer than the original neighborhood with staying in or moving to a neighborhood that is comparable in terms of residents income. The results will complement the binary analysis by analyzing whether the emergence of short-term rentals has, along with the increased risk of moving to a poor neighborhood, had impacts on the probability of moving to a richer neighborhood.

**Table 5 : Multinomial probit model in the 20% most photographed neighborhoods**

	Probability of moving to a poorer neighborhood compared to moving to neighborhoods with the same income level	Probability of moving to a richer neighborhood compared to moving to neighborhoods with the same income level
3 years before STR <sup>4</sup>	0.0223 (0.0835)	0.2705*** (0.0668)
2 years before STR	-0.0283 (0.0229)	0.0191*** (0.0191)
1 year before STR (reference year) year of STR development	0.0448*** (0.0149)	-0.0959*** (0.0191)
1 year after STR	0.1990*** (0.0213)	-0.3077*** (0.0186)
2 years after STR	0.3381*** (0.0292)	-0.4914*** (0.0283)
3 years after STR	0.4480*** (0.0418)	-0.6571*** (0.0410)
4 years after STR	-0.0010 (0.1325)	-0.6063*** (0.1049)
5 years after STR	0.6270 (0.4338)	0.1710 (0.2151)
<i>N</i>	1 363 060	1 363 060
<i>Control variables</i>	Yes	Yes
<i>Log pseudolikelihood</i>	-141919.5	-141919.5

Notes: Standard errors are clustered at the individual level (\*p<0.10, \*\*p<0.05, \*\*\*p<0.01). The dependent variable is the probability to move and corresponds to 0 if the individuals not changing neighborhood standing, 1 if the individual moves to a neighborhood poorer than his or her original neighborhood and 2 if the individuals moves to a wealthier neighborhood than his or her original neighborhood. The instrument variables correspond to the indicator of photographs taken in the neighborhood where the individual resided before moving (if he or she moved during the year) in observation year n and in observation year n -1. The control variables correspond to the individual characteristics of the individual (sex, date of birth, marital status, number of years in the housing, occupation of the premises, housing surface), the characteristics of the environment (category of urban pole, unemployment, median income in the neighborhood).

The results indicate that, compared to staying or moving to a neighborhood of comparable income level, after the development of short-term rentals, the probability of moving to a wealthier neighborhood decreased, whereas before the arrival of short-term rentals, the likelihood of moving to a wealthier neighborhood was significantly positive. Conversely, before the arrival of short-term rentals in the original neighborhood, the displacement to a poorer neighborhood was not significant compared to staying in a neighborhood with the same standard of living but appears significantly positive after the arrival date of short-term rentals. The significantly positive likelihood of moving to more affluent neighborhoods prior to the development of short-term rentals may be explained by movers' attraction to neighborhoods with greater potential (more affluent residents than in the original neighborhood) and thus potentially more attractive for short-term rental development. The fact that there is a change in the probability of moving before and after the arrival of short-term rentals may indicate that there is a negative effect of the development of these rentals on the moving constraint effect that was not apparent before the development of these rentals.

## 4.2 Displacement and Gentrification Effects

### 4.2.1 Replacement by Richer Residents

In the first part, the results indicate that the density of short-term rentals favors the relocation of residents to poorer neighborhoods, but what about the replacement of individuals in the housing itself ? Indeed, after the move, are the new residents richer than the movers? The purpose of this subsection is to estimate the probability of being replaced by individuals with a standard of living 10% higher than that of the former occupants of the housing.

The analysis is limited to the replacement of residents in the year following their move for reasons of data availability. The explanatory variables are the same as in the previous regressions with the addition of housing characteristics. The results indicate that the probability that the individual moving at date  $t$  will be replaced in his or her housing at date  $t+1$  by an individual with a standard of living (at the household level) that is 10% or more higher is 17.78 percentage points when the density of short-term rentals increases by one unit. Individuals moving out are replaced by new residents who are 10% or more wealthier by about 0.18 percentage points when short-term rental density is high. Previously, the regressions indicated that the probability of moving to a poorer neighborhood increased over the years in urban municipalities, but here we note that the probability of being replaced by an individual with a higher standard of living is lower over the years in urban municipalities, which may be consistent with the fact that it is rather young (and less richer) individuals who are moving into urban areas in place of richer households seeking larger housing units in the suburbs. At the same time, in the first stage regressions, this interaction between years and urban areas favors the density of short-term rentals, which means that it is the neighborhoods where the density of short-term rentals favors the arrival of more affluent newcomers and not the attraction of the central urban municipalities.

**Table 6 : Probability of being replace by richers residents**

	<i>Dependante variable : Probability of being replace by richers residents :</i>		
	first stage : dependante variable : Airbnb $\times 100$	second stage : LPM	second stage : Probit
Normalisation			
Photographs n	0.0388*** (0.0002)		
Normalisation			
Photographs n-1	0.0236*** (0.0001)		
Airbnb $\times 100$ (Marginal effect)		0.0018*** (0.0005)	0.0018*** (0.0004)
<i>N</i>	319564		319564
<i>Control variables</i>	Yes		Yes

Notes: Standard errors are clustered at the individual level (\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ ). The dependent variable corresponds to 1 if the individual moves to a neighborhood poorer than his or her original neighborhood, 2 if the individual moves to

a neighborhood richer than his or her original neighborhood and 0 otherwise. The control variables correspond to the individual characteristics of the individual (sex, date of birth, marital status, number of years in the housing, occupation of the premises), the characteristics of the environment (category of urban pole, unemployment) and the years.

#### 4.2.2 Changes in net inflows from richer neighborhoods

In the previous subsection, we looked at the impact of short-term rental density on the replacement of former residents by residents with higher living standards. This analysis is based on the replacement of households moving in year N-1 and being replaced in N by new households. The following analysis will look at the net inflow of newcomers to each neighborhood year by year. These flows represent the net inflow of residents from richer neighborhoods (i.e., arrivals from richer neighborhoods minus departures of neighborhood residents to richer neighborhoods) minus the net inflow of residents from poorer neighborhoods (i.e., arrivals of people from poorer neighborhoods minus departures of people from neighborhoods to poorer ones). The maps below show these flows as observed before the arrival of short-term rentals in the neighborhood. For comparison purposes, the flows are divided by the number of years before or after the arrival of short-term rentals to obtain average flows per year on either side of the year of arrival of short-term rentals. For example, if the net flow of a neighborhood is -20 over the pre-short-term rental period and this period is 4 years, the flow index will be  $-20/4=-5$ . Similarly, if in this same neighborhood the post-short-term rental flows are 20 and the period is 2 years, the flow index will be  $20/2=10$ .

The model concerns the flows of residents arriving from neighborhoods that are richer than the destination neighborhood. This flow follows the analysis of Pennington (2021), Here is the flow calculation : (arrivers neighborhood richer-movers neighborhood richer)-(arrivers poorer-movers poorer)

$$flows_{richer_{nt}} = \beta_0 + \sum_{t \neq first\ STR} airbnb_{tn} + \beta_2 X_{itn} + \tau_t + \tau_t \times \chi_{itn} + \varepsilon_{itn} \quad (9)$$

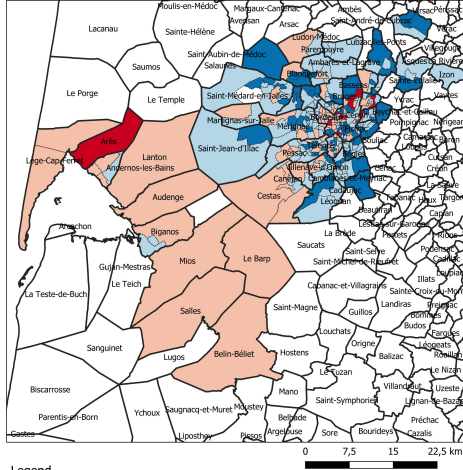
With  $n$  the neighborhood and  $t$  the year of observation. The year of reference is the year in which the short-term rentals present in the Airdna database have developed. The year taken into account corresponds to the year when 20% of the rentals present in 2019 were created.  $X_{tn}$  representing the average number of years in each housing, population density, and share of unemployed in neighborhood  $n$  in year  $t$ .  $\tau_t$  represents the year of observation between 2016 and 2019 and  $\eta$  the neighborhood fixed effects.

The various maps show that for the urban areas of Bayonne and Bordeaux there was an increase in net inflows of newcomers from richer neighborhoods in the neighborhoods or municipalities near the coast as well as in the central cities of the urban areas. In fact, in Bordeaux (Map 1), the central neighborhoods saw an increase in net inflows of new residents from wealthier neighborhoods after the date when short-term rentals began to appear, particularly in the northwestern neighborhoods. The same is true for the neighborhoods in the center of Bayonne (Map 2), where the flow was negative before the arrival of short-term rentals. In this same urban area, the neighborhoods of Biarritz near the Atlantic Ocean as well as the neighborhoods of Hendaye and Saint-Jean-De-Luz saw their flows become positive after the arrival of short-term rentals. The other urban area near the ocean, La Rochelle (Map 3), had more contrasting flow trends with net inflows still negative in the coastal municipalities, but less than before the arrival of short-term rentals. Finally, in the urban areas of cities far from the ocean (Maps 4, 5 and 6), it is the central districts of the cities that have seen their flows increase, with negative flows in peripheral municipalities such as Neuville du Poitou and Vouneuil sous Biard for the urban area of Poitiers (Map 4) or Gan for the urban area of Pau (Map 6).

# Maps showing net inflows by neighborhood before and after the arrival of short-term rentals in the six urban areas in the study

## Map 1 : Bordeaux urban area

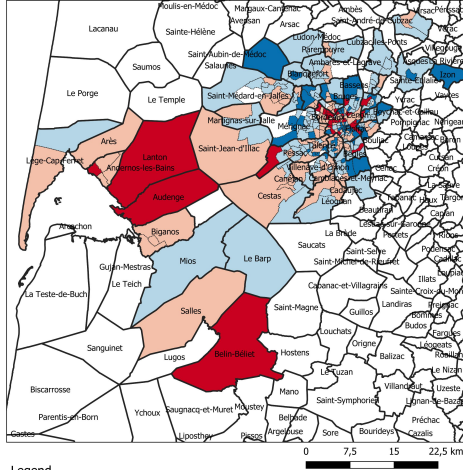
Net arrivals index from richer neighborhoods before the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Bordeaux urban area



**Legend**  
 Net arrivals index from richer neighborhoods  
 -89 - -20  
 -20 - 0  
 0 - 20  
 20 - 32  
 Municipalities  
 Neighborhoods

Source : FIDELI - 2016-2019  
 réalisation : auteur - 2022

Net arrivals index from richer neighborhoods after the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Bordeaux urban area

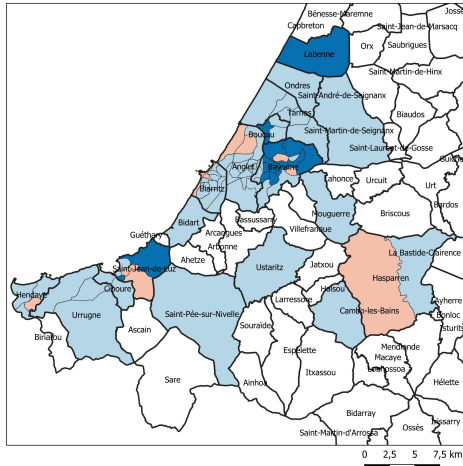


**Legend**  
 Net arrivals index from richer neighborhoods  
 -92 - -20  
 -20 - 0  
 0 - 20  
 20 - 69  
 Municipalities  
 Neighborhoods

Source : FIDELI - 2016-2019  
 réalisation : auteur - 2022

## Map 2 : Bayonne urban area

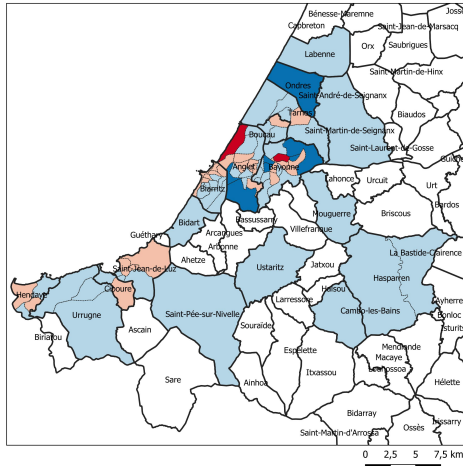
Net arrivals index from richer neighborhoods before the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Bayonne urban area



**Legend**  
 Net arrivals index from richer neighborhoods  
 -89 - -20  
 -20 - 0  
 0 - 20  
 20 - 32  
 Municipalities  
 Neighborhoods

Source : FIDELI - 2016-2019  
 réalisation : auteur - 2022

Net arrivals index from richer neighborhoods after the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Bayonne urban area



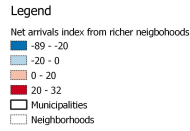
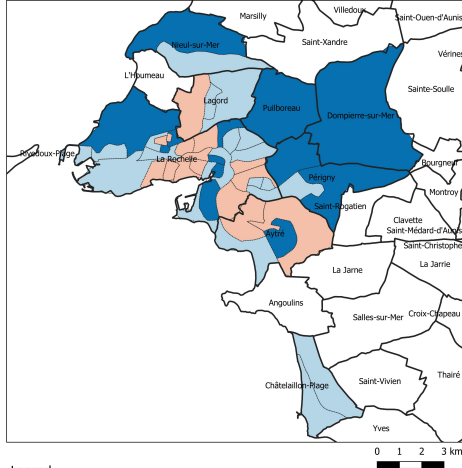
**Legend**  
 Net arrivals index from richer neighborhoods  
 -92 - -20  
 -20 - 0  
 0 - 20  
 20 - 69  
 Municipalities  
 Neighborhoods

Source : FIDELI - 2016-2019  
 réalisation : auteur - 2022

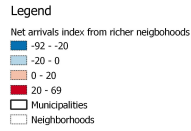
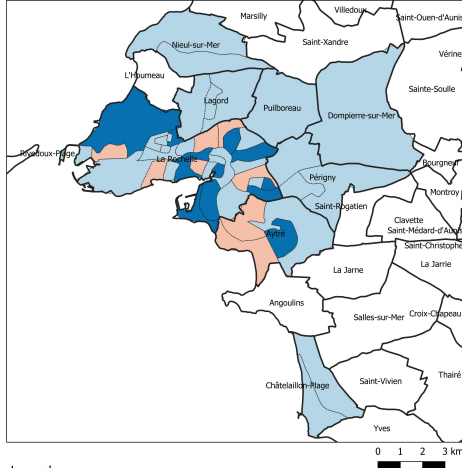
### Map 3 : La Rochelle urban area

Net arrivals index from richer neighborhoods before the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the La Rochelle urban area

Net arrivals index from richer neighborhoods after the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the La Rochelle urban area



Source : FIDELI - 2016-2019  
realisation : auteur - 2022

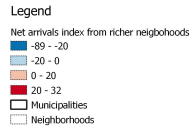
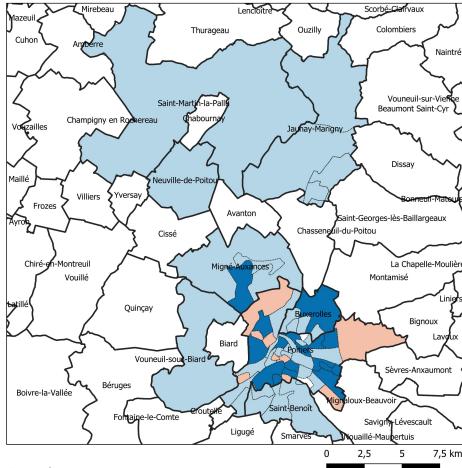


Source : FIDELI - 2016-2019  
realisation : auteur - 2022

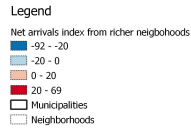
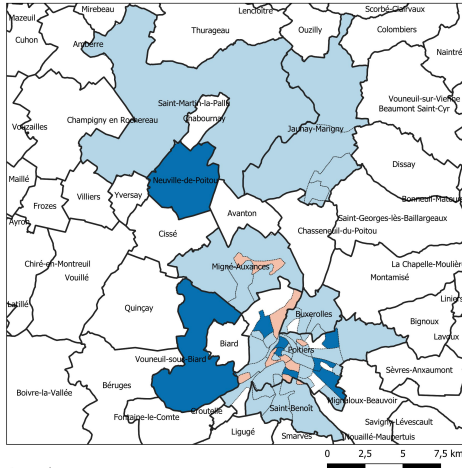
### Map 4 : Poitiers urban area

Net arrivals index from richer neighborhoods before the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Poitiers urban area

Net arrivals index from richer neighborhoods after the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Poitiers urban area



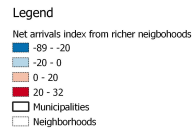
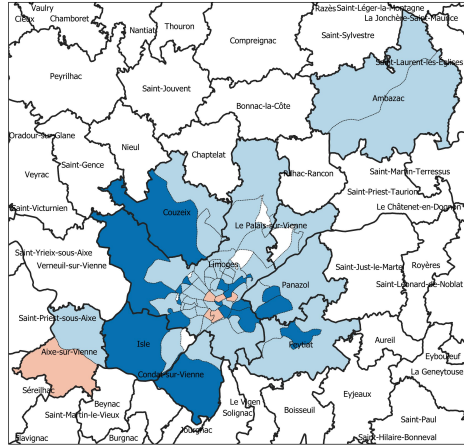
Source : FIDELI - 2016-2019  
realisation : auteur - 2022



Source : FIDELI - 2016-2019  
realisation : auteur - 2022

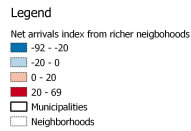
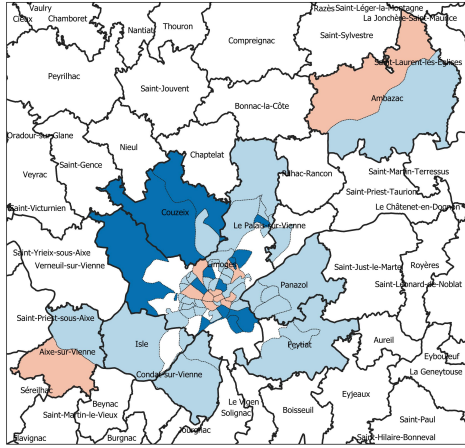
## Map 5 : Limoges urban area

Net arrivals index from richer neighborhoods before the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Limoges urban area



Source : FIDELI - 2016-2019  
realisation : auteur - 2022

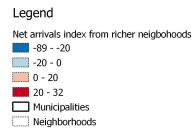
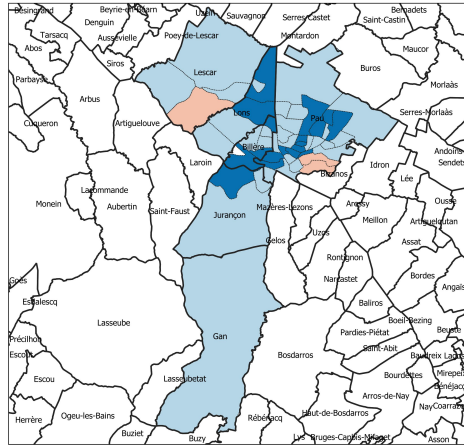
Net arrivals index from richer neighborhoods after the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Limoges urban area



Source : FIDELI - 2016-2019  
realisation : auteur - 2022

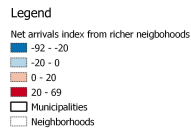
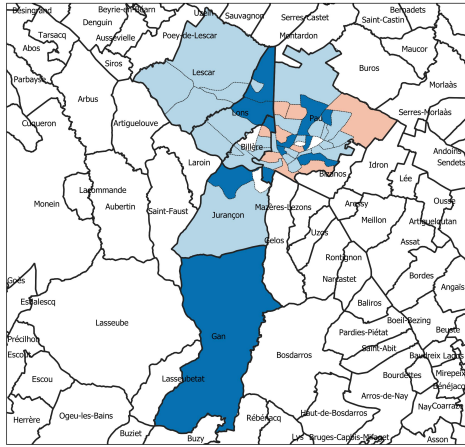
## Map 6 : Pau urban area

Net arrivals index from richer neighborhoods before the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Pau urban area



Source : FIDELI - 2016-2019  
realisation : auteur - 2022

Net arrivals index from richer neighborhoods after the emergence of short-term rentals in neighborhoods within municipalities with more than 5 000 inhabitants in the Pau urban area



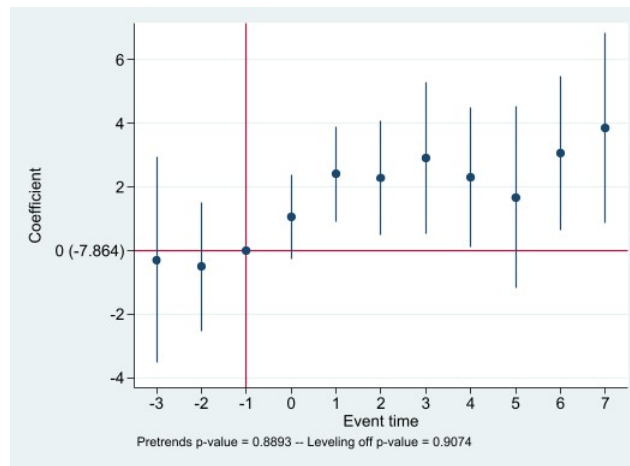
Source : FIDELI - 2016-2019  
realisation : auteur - 2022

Maps representing the net flow indices of new residents from richer neighborhoods (arrivers neighborhood richer-movers neighborhood richer)-(arrivers poorer-movers poorer) according to whether the neighborhood is observed before the arrival of short-term

rentals or after, i.e., according to the dates of creation of the 20% of short-term rentals present in 2016 and 2019. Neighborhoods appearing white in one of the maps (i.e., before or after the arrival date of the short-term rentals) indicate in the case of a blank before the arrival of the short-term rentals that there is no data before the selected date and in the case of a blank after the arrival of the short-term rentals that there is no data after the selected date.

The results of the event studies on the impact of the arrival of short-term rentals in neighborhoods indicate that the flows of residents from wealthier neighborhoods increased significantly after the dates of arrival of short-term rentals, whereas they were not significantly different before the date of arrival of short-term rentals in the neighborhood, which is consistent with some attraction for potentially wealthier individuals to neighborhoods where poorer individuals reside after the date of expansion of short-term rentals in the neighborhood.

**Event studies representing the impact of the arrival of short-term rentals in the neighborhood on the net inflow of residents from richer neighborhoods in the 20% of neighborhoods with the highest density of short-term rentals**



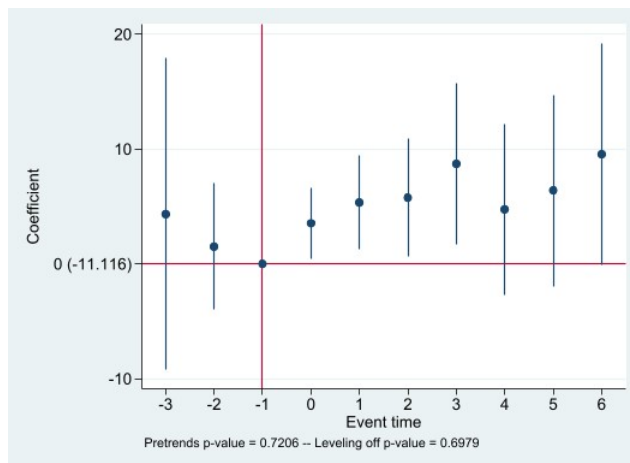
These latest results indicate a potential development of gentrification in neighborhoods where short-term rental development is significant.

This analysis is based on data from a short period of time while the process of gentrification of neighborhoods is long, yet the phenomenon of short-term rentals is a market that has developed rapidly, resulting in profound neighborhood transformations. As Waschmuth and Weisler (2018) show, short-term rentals can have short-term gentrifying effects due to a rent gap leading to higher rents because of potentially higher incomes than for long-term rentals, which can encourage rapid displacement of residents. Our results complement these studies by taking into account the net flows of new residents from more affluent neighborhoods, which allows for a detailed year-by-year study of neighborhood composition changes.

However, when the event studies are applied to two distinct samples above and below 10km from the ocean, the results appear significantly positive three years after the development of short-term rentals for residents within 10km of the ocean. The effects appear to be strong in areas of high tourism, close to the ocean, where short-term rentals have developed very rapidly.

These results can be explain by the fact that in coastal areas, an investor phenomenon may be the source of this influx of newcomers who are wealthier than the departing residents.

Event study representing the impact of the arrival of short-term rentals in the neighborhood on the net inflow of residents from richer neighborhoods in the 20% of neighborhoods by distance from the ocean



## 5 Conclusion

The rapid growth of short-term rentals in recent years has captured the interest of public opinion and policymakers in many cities around the world. The expansion of short-term rentals has generated negative externalities for local residents, in particular rising property prices and rents. This study adds to the literature on the impact of short-term rentals by looking directly at population displacement and newcomer flows. The results indicate that the density of short-term rentals favors the likelihood of moving to a poorer neighborhood than the original neighborhood, which may be consistent with moving to a poorer "quality" neighborhood. This study also shows that after the development of short-term rentals, in tourist areas, the probability of moving to a poorer area than the original area increased, while at the same time the probability of moving to a richer area decreased, which may be consistent with forced moves after the development of these rentals.

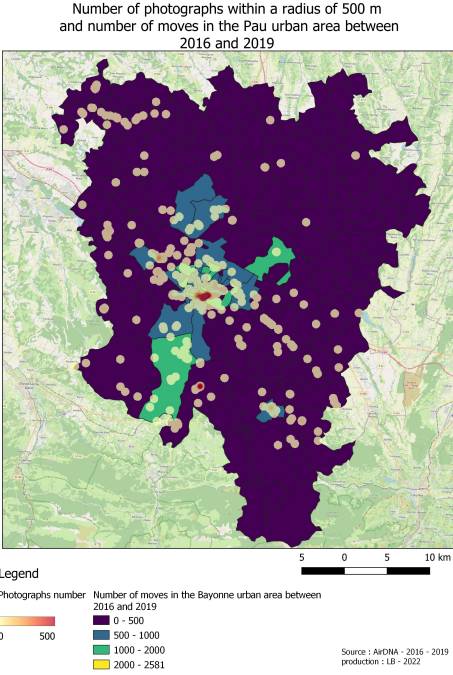
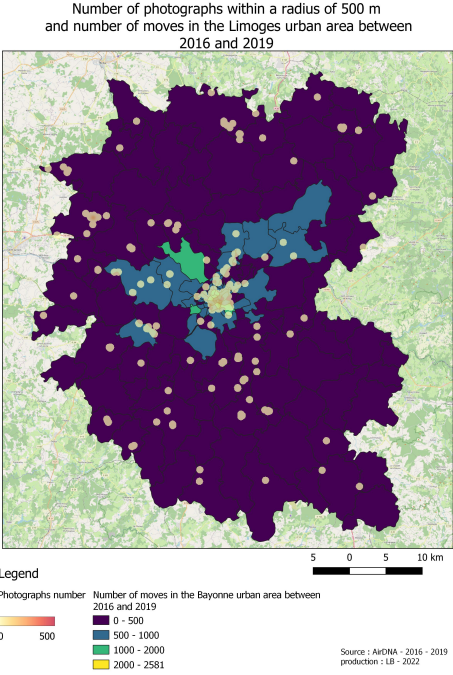
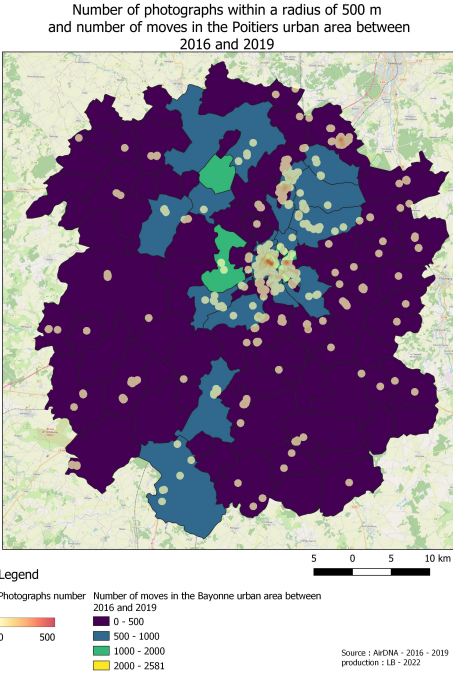
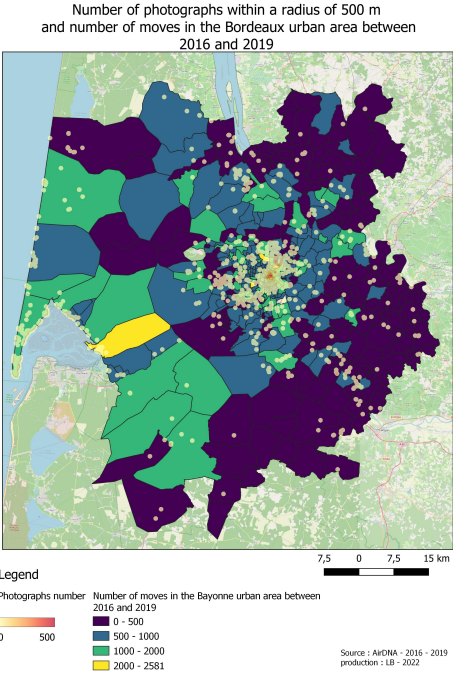
Prior to the arrival of short-term rentals, the net inflow of residents from wealthier neighborhoods was greater than the outflow from richer neighborhoods and the outflow from poorer neighborhoods was less than the inflow to poorer neighborhoods. In tourist neighborhoods with many photographs of tourists, after the arrival of short-term rentals, the probability of moving to a poorer neighborhood is significantly higher than before the development of short-term rentals. Similarly, in the short term, residents replacing older individuals are more likely to be replaced by wealthier residents in neighborhoods with more short-term rentals. This study provided a direct analysis of the impact of short-term rentals on the movement of people. However, this analysis is limited in time, which does not allow for long-term conclusions to be drawn, but it can give indications of displacement trends.

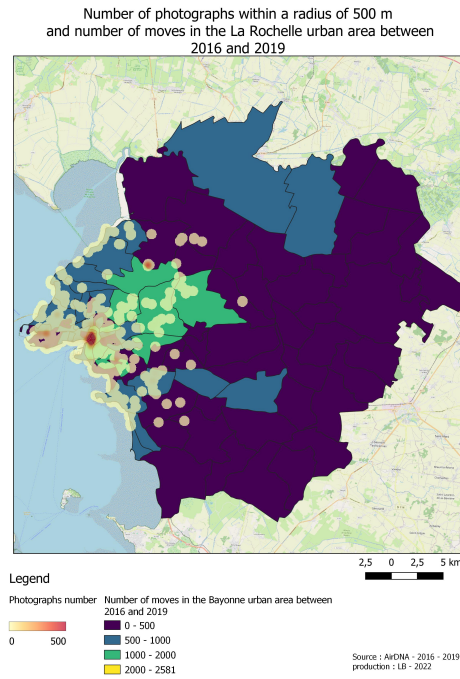
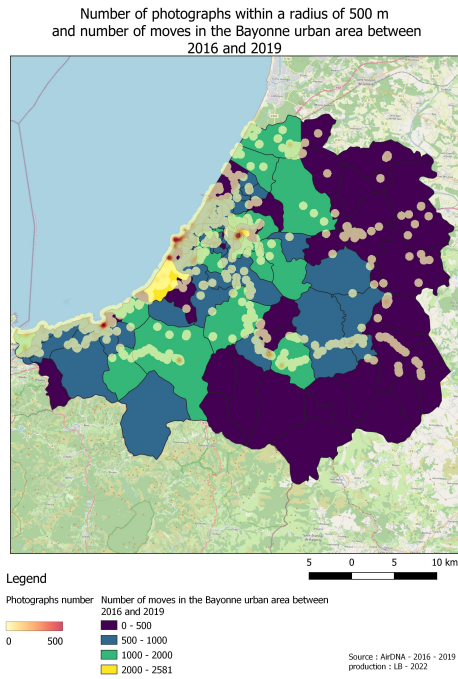
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# Appendix 2 : Number of photographs and number of moves between 2016 and 2019





## Appendix 2 : Event studies Event studies representing the impact of the arrival of short-term rentals in the neighborhood on travel in the 10% of neighborhoods with the highest density of short-term rentals

Event studies representing the impact of the arrival of short-term rentals in the neighborhood on travel in the 10% of neighborhoods with the highest density of short-term rentals (probit model on the left and LPM on the right)

