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Does a positive density perception increase the probability of living in the ideal housing type? Evidence from the Loire-Atlantique *Département* in France.

Abstract

What does the ideal housing type look like? A 2015 online survey of individuals living in the Loire-Atlantique Département in France provided 1,134 interviews, which we analyze using a mixed-effect probit model. We look at the probability of living in the ideal housing type related to 28 variables of dwelling and respondent characteristics, density perception, district perception, type of municipality, and proximity to education, healthcare and food facilities. The issue is important because certain housing types yield greater land consumption and longer trips. Local governments support infill developments with higher built-up density levels to conserve land and support walking, cycling, and transit. We find that the probability of living in the ideal housing type has no relationship to density perception. What matters is a positive district perception and proximity to healthcare. Well-designed infill development with higher built-up density levels can succeed, associating a higher probability of living in the ideal housing type with suitable urban forms given the physical constraints of territories, in a sustainable development framework.

Keywords: housing type, density perception, district perception, built-up density, mixed-effect probit model

JEL Classifications: R31, R14, R28, C25, D62

Une densité perçue positivement augmente-t-elle la probabilité de vivre dans son habitat idéal ? Le cas du département de Loire-Atlantique (France).

Résumé

Qu’est-ce qu’un habitat idéal ? A partir d’une enquête en ligne réalisée en 2015 auprès de 1134 individus résidant dans le département de Loire-Atlantique (France), nous analysons les déterminants individuels influençant la probabilité de considérer son habitat comme idéal. Nous examinons cette probabilité à partir de 28 variables décrivant le logement et les caractéristiques des répondants. A partir d’un modèle probit à effets mixtes, nous prenons en compte la perception du quartier, la proximité des commerces alimentaires et des établissements d'enseignement et de santé ainsi que le type de territoire de résidence (urbain, périurbain, rural) et la densité perçue par les répondants de leur habitat. L'enjeu est important puisque certains types d’habitat sont à l’origine de consommations foncières plus élevées et de déplacements plus longs pour les ménages. Afin de mieux préserver les espaces naturels et agricoles et d’encourager les modes de déplacement alternatifs à la voiture individuelle (marche, vélo, transport collectif, etc.), les collectivités locales soutiennent des opérations d’aménagement à forte densité bâtie. Nous révélons que la probabilité de considérer que l’on vit dans le type d’habitat idéal est sans rapport avec la densité perçue. Ce qui importe, c'est une perception du quartier positive et la proximité des services de santé. Bien pensées, des opérations d’aménagement à forte densité bâtie peuvent donc permettre la conciliation d’un habitat considéré comme idéal par ses résidents avec le respect de formes urbaines compatibles avec les contraintes morphologiques des territoires, dans un contexte de développement durable.

Mots-clés : habitat, densité perçue, perception du quartier, densité bâtie, modèle probit à effets mixtes

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Does a positive density perception increase the probability of living in the ideal housing type? Evidence from the Loire-Atlantique *Département* in France.

1. Introduction/ Literature Review

In most developed countries, housing policies are confronted to a triple challenge: build the types of housings individuals want to live in, provide them at an affordable price, and meet at the same time the other public policy goals pursued by the local authority (in terms of transport, energy, land-use or social issues). Such objectives are not necessarily those pursued by households when choosing their housing type and location.

For long literature has studied residential location choices. Urban economics showed that the current housings households live in are the results of individual tradeoffs, under budgetary constraint, between the lot size (as high as possible) and the distance to the city center (as low as possible) (Alonso, 1964; Fujita, 1989; Brueckner, 2011; Le Boennec, 2014; Ehrlich *et al.*, 2018). Compared with their ideal housing, households are thus forced, when choosing, either to give up a part of the surface area to which they could claim (if their ideal housing is at first located at a maximum distance from the city center), or to move away from the city center (if their ideal housing is at first defined by a minimum surface area).

For a given housing price, households' choices for larger lot sizes further from the city center lead to greater distances to jobs and other activities (such as shopping and leisure). Each time households do not choose to live within cities, catering to individuals' choices leads to urban sprawl and difficulties in proposing efficient public transport in less-dense areas and accentuates greenhouse-gas emissions (GHG) from individual motorized transport (Le Boennec and Sari, 2015; Bulteau, 2016). More generally, the additional land consumption required by urban sprawl reduces agricultural and open land, has a negative impact on biodiversity, and renders territories more vulnerable to natural hazards, and especially the risk of urban overheating due to artificial ground surfaces (Kaplan and Austin, 2004; Robinson *et al.*, 2005).

The drivers of land pressure and urban sprawl are not only found in households' choices for remote locations, but also in demographic pressure and household structure, the size of which has fallen over time.[1] This pattern is common to most developed countries, and reflects

[1] The average household size in France fell from 2.9 people in 1975 to 2.26 in 2011.

population aging, lower fertility and the diversification of lifestyles and family structures. However, housing only represent part of the problem; other drivers of land development and urban sprawl are the location of jobs and the space used for transport infrastructure (representing 58% of artificial ground surfaces in France, ADEME, 2018).

Limiting urban sprawl and the artificialization of land by making cities responsive to social and environmental issues now forms part of local public policies (ADEME, 2018), and public authorities now prioritize living in the city center or close to it (Commission of the European Communities, 1990). Regarding housing demand, living closer to the city center is generally thought to combat urban sprawl by promoting higher density.

The concept of density is double: objective, and perceived. Objective density applies to various types of variables: people or building (ADEME, 2018). It is systematically based on a reference scale, from global (the municipality) to local (the building). When it addresses people, the concept of density measures either population (the number of inhabitants per unit area) or job density (the number of jobs per unit area); the sum gives the human activity density. All measures of density may be gross (if the unit area comprises public equipment, streets and green spaces) or net (without them). Regarding building, two measures of density have to be distinguished: the residential or housing density is given by the number of dwellings per unit area; the built-up density is given by the footprint (of the building) divided by the surface of the parcel, multiplied by the average number of building stories.[2] The built-up density makes it possible to understand the building limit in its three dimensions.

Beside objective density, perceived density corresponds to the subjective perception of the density levels specific to each individual (ADEME, 2018). Density perception may have little in common with objective density. It first depends on the geographical context: density in urban centers, suburban and periurban areas may be perceived differently, both in terms of density indices and architectural (at the building scale) and urban forms (at the neighborhood scale[3]). In particular, the feeling of being crowded may reflect the difference between density perception and inhabitants' ideal level of built-up density (ADEME, 2018). The shape, volume

[2] An index of 1, for instance, indifferently refers to a one-story dwelling built over its entire parcel, or to a two-story dwelling built over half of the parcel.

[3] Garau and Pavan (2018) define neighborhood scale as "*a small but relatively independent area of dwellings, retailers, employers and civic places, and its residents and employees identify with their immediate environment in terms of social and economic attitudes, lifestyles and institutions*."

and height of buildings are crucial for density perception. The relationship between open and built space, the distance between buildings and the structure of public spaces (size, vegetation and street width) also help determine density perceptions.

The various objective density indices indirectly refer, for a given population size, to heating and travel issues such as whether individuals can walk or bike to services, shops and public transport. If the relationship must be taken with caution (Gaigné *et al.*, 2012; Kahn and Walsh, 2015), higher built-up density has frequently been connected to lower GHG emissions in the literature (Glaeser and Kahn, 2010; Heinonen *et al.*, 2015; Borck, 2016; Ding and Cao, 2019). In addition to land preservation, energy concerns affect local governments' desire to better control local urban sprawl in the context of rapidly-rising land prices in and around urban centers.

There thus exist strong relationships between built-up density, urban design and environmental issues. Urban sustainability can be defined in a number of different ways. Kenworthy (2006) proposes a simple conceptual model associating compact and mixed-use urban form, well-defined higher density, human-oriented centers, efficient public transport, and favorable conditions for active modes, protection of natural areas, and food-producing capacities. Jabareen (2006) establishes a list of seven design concepts: compactness, sustainable transport, density, mixed land use, diversity, passive solar design, and greening.[4] Heinonen *et al.* (2015) introduce a brief summary and discussion of 16 articles dealing with the interactions between human communities and GHG emissions. A large literature has addressed the relationship between urban design and energy consumption (Breheny, 1995; Wiedenhofer *et al.*, 2013; Larson and Yezer, 2015; Legras and Cavailhès, 2016; Denant-Boemont *et al*. 2018) and Vehicle Miles Travelled or VMT (Handy *et al.*, 2005; Cervero and Murakami, 2010). These urban attributes are moreover supposed to enhance inhabitants' quality of life. Kyttä *et al.* (2016) show, for instance, that in certain geographical contexts, proximity to services contributes to a higher perceived level of environmental quality.

Nevertheless, addressing urban sustainability in the form of high levels of built-up density are not always the only way. Breheny (1992) notes that extremely compact cities are both unrealistic and undesirable, with various forms of decentralized concentration, based around

[4] Density is here defined as a specific threshold such as "the number of people within a given area becomes sufficient to generate the interactions needed to make urban functions or activities viable".

single cities or groups of towns being more appropriate.[5] Bramley *et al.* (2009) find that residential satisfaction falls with residential gross density. The "compact city paradox" refers to the inverse relationship between city sustainability and livability (Neuman, 2005; Garau and Pavan, 2018). Moreover, this lack of livability may have a perverse effect in the long-term if the city boundaries are not closed and yield at the end additional urban sprawl.

Whereas public policies favor residential locations within the city or close to it and compatible housing types, it appears that when the urban design in city centers is not appropriate, households still generally consider suburbs and periurban areas (where natural amenities are expected) to be more livable. This is why, beside objective density, working on density perception is crucial so that inhabitants accept higher levels of objective density. In other words, the urban-planning challenge for local authorities is to combine the adequate level of built-up density given the geographical context, the quality of urban development, and the quality of life (ADEME, 2018; Garau and Pavan, 2018).

In the field of urban planning, experiential knowledge is defined as "*a planning strategy that is sensitive to the local context and respects the inhabitants' place experiences*": Kyttä *et al.* (2013) find a positive relationship between densely-built areas and social quality in Helsinki. Schmidt-Thomé *et al.* (2013) show that the perception of density by inhabitants at the time of the interview matters, but that this is not incompatible with alternative levels of objective density.[6] Zahirovich-Herbert and Gibler (2014) find that the construction of houses of the average size in the reference group (the district) has little effect on existing house prices. These results underline that households may not be hostile to higher local levels of built-up density.

In this article, we propose to assess the influence of density perception in the probability that the inhabitants' current housing is of same type as their ideal, exploring the idea that a positive density perception could increase the value of this probability.

2. Materials and Methods

The data we use here come from a public Housing Survey carried out by the Loire-Atlantique (L.A.) *Département* in France. This survey aimed to measure inhabitants' density perceptions

[5] The expression 'compact city' being here used as 'shorthand for a variety of approaches to the planning of towns and cities which stress the merits of urban containment' (Breheny, 1995).

[6] Four different measures of density were calculated within a buffer zone of 250 meters around each mapped home location: number of dwellings, floor space, residential floor space and number of people living.

in the L.A. *Département*. As noted above, the concept of density is major concern for local authorities such as *Départements* in France, as they are in charge of the direction of local urban development.

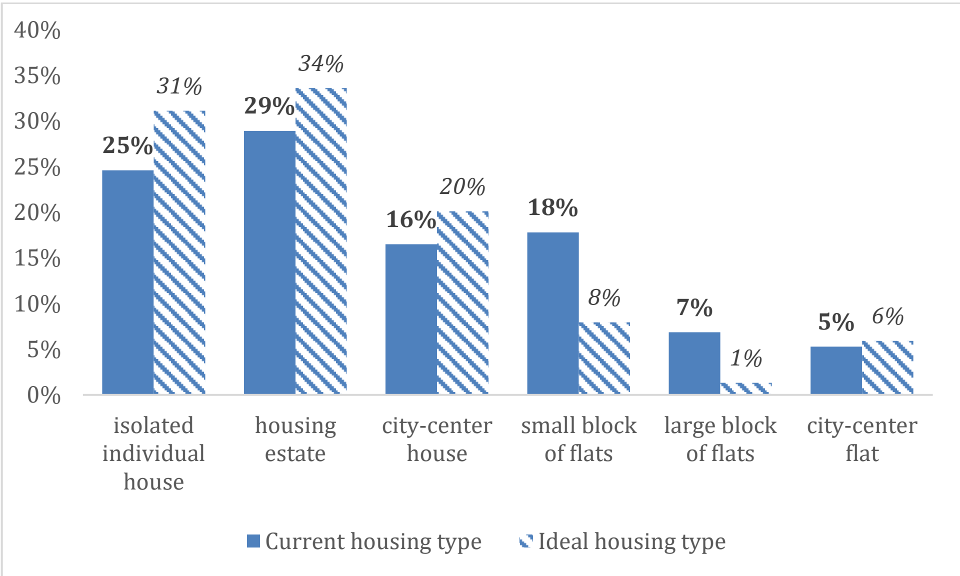
Prior to determining policy in this area, the L.A. *Département* decided to collect information on inhabitants' density perception, in regards with their dwelling place, lifestyle, and household characteristics. The online housing survey of L.A. *Département* inhabitants collected information on around 1,400 respondents between May and September 2015. We analyze data from 1,134 interviews due to missing values (refusal, incomplete answers, etc.). The survey has five parts. The first concerns the current residence: house or flat, owner or renter, number of rooms, and surface area. The second part covers the characteristics of the district, while the third refers to density perception. The fourth part concerns the respondent's reported ideal housing type, and the last their socioeconomic characteristics (age, gender, income, children, etc.).

We use the survey to construct a variable giving indication about the gap between the current and the ideal housing type. Two solutions were available to estimate this variable. First, we could use a direct question "Is the type of housing you live in today your ideal? (Yes, absolutely/ Yes / No / Absolutely not)". In this case 79% of respondents live in an ideal housing type ('Yes, absolutely' and 'Yes'). Nonetheless, in the case of self-reported of subjective well-being measure we observe a social desirability bias that may lead to an overestimation of it (Heintzelman *et al*., 2014; Dolan and Kavetsos, 2016). One way to limit desirability bias is to measure well-being by using measurement scales (Adler and Seligman, 2016), but the design of this survey did not allow it.

In order to minimize this bias, we decided to construct the measure of ideal housing type, based on two independent questions in the survey. There is first a question on the current housing type, based on photos shown during the interview (see Appendix A1). These depict six housing types: an isolated individual house, a housing estate, a city-center house, a small block of flats, a large block of flats, and a city-center flat. Respondents then answer a question on their ideal housing type using the same photos. By comparing the two answers, we thus know whether respondents currently live in their ideal housing type. If the same picture is chosen in both questions it means that individuals are currently living in an ideal housing type. If not, their current housing type does not match their ideal. Thus, we use the contingent-valuation data (stated preferences) to construct a variable reflecting the probability of living in the ideal housing type: we do not then estimate the stated preferences as such, but rather the concordance of the answers to two separate questions. Our method thus is a mixture of stated and revealed preferences, which decrease potential bias in well-being measurement.

The final sample used to estimate the probability of living in the ideal housing type is, unfortunately, not entirely representative of the French population (Appendix A2): we have an excess of managers and intellectual occupations, as well as women. With respect to the latter, we are mostly interested in household behavior, so that the gender imbalance should not matter. Regarding managers and intellectual occupations, we decided not to weight our dataset, but will be cautious in our estimations. In our sample, 24.6% of respondents live in individual houses, while 31.1% of respondents consider this as ideal. On the contrary, 6.9% live in large blocks of flats, but only 1.3% considered this is ideal. Overall, 59.2% of our respondents live in their ideal housing type (Figure 1).

Figure 1. Current *versus* ideal housing type



Source: Authors

We explain the probability of living in the ideal housing type by 28 variables. We first use current housing characteristics (surface area, and individual house or flat) and respondent characteristics (gender, owner or tenant, age of children and profession). We also include the current municipality type: (1) Urban centers (the city centers and their suburbs); (2) Periurban municipalities (around an urban center but not directly attached to it); (3) Rural municipalities; and (4) Coastal municipalities (as Loire-Atlantique is a coastal area). This typology was suggested in *Département de Loire-Atlantique* (2017). It is based on various ways of 'living': living inside, living outside municipalities that are attracted by the city (in particular in terms of job location), living in isolated municipalities and, last, considering a specific amenity (the seaside).

We also construct three variables reflecting the perception of the district and the perception of density. Two factor analysis are conducted. First, one based on the district perception, to bright a common perception across respondents out, if relevant (see table 1). This first factor analysis yields two main factors. The first encompasses eight variables, some positively (nice, clean, safe, and calm) and some negatively (overpopulated, oppressive, run-down, and unsightly), and can be considered as reflecting positive perceptions of the district (hereafter called 'Positive'). The second includes three variables (lively, bustling, and convivial) and can be considered as the social perception of the district (thereafter called 'Social'). The second factor analysis is on density perception (see table 1) and produces one main factor, covering four variables (overcrowding, noise pollution, neighborhood issues, and insecurity). It can be considered as a negative perception of density (thereafter called 'Density Perception'). Thus, some people have a negative perception of density, which they defined as overcrowding, linked with noise pollution, neighborhood issues, and insecurity; while others do not perceived density linked to this negative definition.

Table 1: Constructed variables through factor analyses

Question used	Significant variable (and associated signs)	Constructed variables	Cronbach's alpha statistic	Bartlett test	KMO
Factor analysis #1 *'My District is':* (1) nice, (2) lively (3) clean (4) bustling (5) safe (6) calm (7) convivial (8) green (9) isolated (10) overpopulated (11) oppressive (12) run-down (13) unsightly *('Yes'* or *'No')*	+: nice, clean, safe and calm. -: overpopulated, oppressive, run-down and unsightly.	**Positive**	0.76	p-value = 0.000	0.821 - meritorious
	+: lively, bustling and convivial.	**Social**	0.60		
Factor analysis #2 *'What does density evoke to you?'* (1) overcrowding (2) noise pollution (3) neighbourhood issues (4) insecurity (5) social diversity (6) conviviality (7) a nice living environment *('Totally agree', 'Agree', 'Disagree', 'Totally disagree')*	-: overcrowding, noise pollution, neighbourhood issues and insecurity.	**Density perception**	0.81	p-value = 0.000	0.792 - middling

Note: *To determine the internal consistency of items we use Cronbach's alpha statistic. A score of 0.7 is an acceptably reliable coefficient, but lower thresholds are sometimes used in the literature (see Nunnally, 1978). Factors with an eigenvalue over one are retained. Bartlett test is Bartlett test of sphericity and KMO is the Kaiser-Meyer-Olkin measure. Number of Observations:1,134. Source: Authors, based on L.A Density survey (2015).*

We complement this survey data (considered to reflect housing demand) with some observed data on housing supply, describing the living environment. We use the database of current facilities from the French National Institute of Statistics and Economic Studies (INSEE).[7] For each municipality, we construct indicators on proximity to healthcare facilities, to kindergartens and elementary schools, and to food stores. We calculate the number of each type of facilities per inhabitant.

[7] INSEE (2016). *Base permanente des équipements*.

The healthcare-proximity variable is continuous and counts the number of health-related facilities in the municipality.[8] This variable is a proxy for individual healthcare proximity, which we would expect to increase the probability of living in the ideal housing type. These facilities are often close to each other but counting all of them allows us to take a size effect into account. The healthcare-facilities figure ranges from 0 to 229 in L.A. areas.

Another supply variable is the proximity to kindergartens and elementary schools. We focus on these as we consider that facilities for younger children, who are less independent, are more of a constraint than those for (more independent) older children. We count the number of kindergartens and elementary schools in each area and avoid a city size effect by taking the figure per 1,000 inhabitants. The resulting figure in L.A. ranges from 0 to 2.82 per 1,000 inhabitants, depending on the municipality, with kindergartens and elementary schools being counted separately even if they are in the same physical place. We consider that the probability of living in the ideal housing type may also depend on shopping facilities, limiting ourselves here to food outlets. We distinguish two kinds of the latter, large retail stores and food shops (bakeries, butchers, fishmongers, minimarkets and frozen-food stores). The number of large retail stores ranges from 0 to 0.88 per 1,000 inhabitants, and the number of food facilities from 0 to 5.77 per 1,000 inhabitants, depending on the municipality.

Some variables were tested but not retained. We first did not keep household income, as this is too correlated with the occupancy status. Second, we constructed some municipality-level variables regarding local wealth (median income and tax potential) and other characteristics (distance from Nantes – the L.A. capital, and the average price per square meter of old properties), but due to great disparities within municipalities and a lack of significant results we decided to drop these. Third, we constructed variables for the proximity to non-food stores, police stations and courthouses, and secondary and high schools, but as these were insignificant, we dropped these as well.

We end up with fifteen variables (including five ‘supply’ variables) that we use to explain the probability of living in the ideal housing type in the L.A. *Département*. We model these in a mixed-effect probit model, which contains both fixed and random effects. The random effects

[8] These include pharmacies (462 at the L.A. level), ambulance services (141), medical laboratories (80), long and short stays (72), facilities for mental health (65, including 33 with outpatient facilities), medical centers (44), dialysis centers (12), pluridisciplinary healthcare centers (10), maternity (7), emergencies (6), cancer treatment (3), home care (3), and blood-transfusion centers (3).

are useful for the modeling of intra-cluster correlation (Rabe-Hesketh and Skrondal 2012). In this model, the observations (the individuals) comprise the first level and the current housing type the second. For a series of M independent clusters, and conditional on a set of fixed effects $\boldsymbol{x}_{ij}$ and a set of random effects $\boldsymbol{u}_j$,

$$Pr\,(x_{ij}, u_j)\ = H(x_{ij}\beta + z_{ij}u_j) \quad (1)$$

For $i=1,\ldots,N$ individuals and $j=1,\ldots,M$ clusters, here the type of current housing type. We distinguish six of the latter: isolated individual houses, housing estate, city-center houses, small blocks of flats, large blocks of flats, and city-center flats (Appendix A1). The x_{ij} are the covariates of the fixed effects, as in a standard probit regression model, with regression coefficient β. The z_{ij} are the covariates corresponding to the random effects at the current housing type level. $H(\cdot)$ is the standard normal cumulative distribution function (StataCorp, 2015).

3. Results

The results of the probit model are presented in Table 2.

Table 2: Probability of living in the ideal housing type – Mixed-effect probit model

	Coefficient	Standard error
District perception		
Positive	0.271***	(0.056)
Social	0.060	(0.056)
Density perception	-0.009	(0.049)
Dwelling type *(ref: apartment)*	-0.351	(0.294)
Surface area	0.069	(0.051)
Owner *(ref: renter)*	0.434***	(0.117)
Gender *(ref: men)*	-0.183**	(0.090)
Having Children *(ref: no children or not in the aged category)*		
aged of five or less at home	-0.653**	(0.321)
aged of five or less at home and living in a house	0.810**	(0.346)
aged from six to ten at home	-0.622*	(0.352)
aged from six to ten at home and living in a house	0.591	(0.376)
aged from eleven to fourteen at home	0.239	(0.341)
aged from eleven to fourteen at home and living in a house	-0.283	(0.370)
aged fifteen and more at home	-0.103	(0.370)
aged fifteen and more at home and living in a house	0.115	(0.372)
Profession *(ref: retired)*		
Farmers	-0.075	(0.836)
Craftsmen, merchants, small employers	-0.328	(0.275)
Managers, intellectual occupations	-0.372***	(0.144)
Intermediate occupations	-0.322**	(0.142)
Student	-0.296	(0.215)
Without occupation	-0.672***	(0.233)
Type of municipality *(ref: coastal)*		
Major urban area	0.149	(0.235)
Near major urban area	0.224	(0.245)
Rural area (countryside)	0.255	(0.297)
Proximity to		
Healthcare	0.001**	(0.001)
Large food shops	0.359	(0.368)
Small food shops	0.042	(0.102)
Schools	-0.104	(0.206)
Constant	-0.186	(0.467)
Variance		
Living place characteristics	0.417	0.299
Number of observations	1,134	
Log likelihood	-604.2989	

Note: *The gap has been estimated with a mixed-effect probit model. LR test versus probit model: chibar2(01) = 26.13 (Prob >= chibar2 = 0.0000). Standard errors are in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. Cross-effects have been checked in regard to Ai and Norton critics (Ai and Norton, 2003).*

3.1. Ideal housing type and survey variables

We first present the results of our factor analysis. The perception of the district affects the probability of living in the ideal housing type. The constructed 'Positive' factor (the perception of the district as nice, safe, clean and calm, see table 1) has a positive effect, while the estimated coefficient on considering the district as lively, bustling and convivial ('Social' in table 1) is insignificant. We find that our variable of interest, the perception of density in the district ('Density perception' in table 1) has no impact on the probability of living in the ideal housing type.

The dwelling type, meaning living in a house or an apartment, does not influence the probability of living in the ideal housing type, as depicted in Appendix A1. Home ownership increases the probability of living in the ideal housing type, regardless of the type of dwelling, while surface area does not have an impact. The probability of living in the ideal housing type is lower for people with young children (either children aged five or less, or from six to ten) unless they live in a house. While young children reduce the probability of living in the ideal housing type, the estimated coefficient on the interaction between young children and living in a house attracts a positive coefficient that offsets the first. This effect is not however found for teenagers (aged 11 to 14) or young adults (aged 15 or over): older children do not affect the probability of living in the ideal housing type. This may reflect that young children can go outside easily when living in a house (generally with a garden) while this becomes less essential for older children. In the case of living in a house, that is not the size of outdoor that matters for parents but the secure dimension of enclosed gardens, that weakens as the children grow up.

For profession the retired are the reference group, as we consider that they are more likely to live in the ideal housing type. The retired do indeed have the highest probability (72.2%) alongside farmers. We do not consider the latter as the reference group for two reasons. First, the choice of living place for farmers is more constrained by their occupation, and second the percentage of farmers in the sample (while close to the national average), is low. Three professions significantly live less frequently in the ideal housing type than the retired, for two distinct reasons. The unemployed and inactive, as well as the working class, are less likely to live in the ideal housing type probably for budgetary reasons. This limits their access to ideal housing types, as either owners or renters. Furthermore, this income effect can be accentuated by life-cycle theory, where for example some life events like having children lead to the search for larger (and thus costlier) places to live (Clark and Onaka, 1983; Brécard et al., 2018). This lower probability of living in the ideal housing type could potentially be lasting. On the other hand, the budgetary constraint for managers is likely weaker, at least in the long run as they could expect regular career advancements, and the difference between the current and the ideal housing type linked to higher aspirations may not be lasting.

3.2. Ideal housing type and observed variables

With respect to the observed factors, we see that municipality type itself does not affect the probability of living in the ideal housing type: living in a major urban center, the periphery of a major urban center, the countryside or at the seaside (more precisely: in a coastal municipality) does not significantly increase the probability of living in the ideal housing type.

On the contrary, certain local proximity supply variables are valued by individuals: this is notably the case for healthcare proximity (see the ‘Materials and methods’ section for details). Both short and long-term explanations can be proposed here. In the short-term, local healthcare facilities are useful for current or future families regarding maternity departments and doctors in case of ill children. In addition, ideal housing also involves projecting oneself over the long-run, which is why healthcare facilities for the elderly may also be appreciated.

Proximity to healthcare facilities turns out to be the only significant local-accessibility variable in our model. Respondents assign no premium to education and food facilities (which we tested in a variety of forms). This result clearly provides no support for the dense city, as individuals do not seem to mind traveling longer distances to daily services (or at least they agree with the travel times they currently endure for proximity to these daily services, whatever the transportation mode). Theoretically, several levels for such variables could be built, but our proxy of public and private facilities were constructed at the municipality level (the finest available).

Finally, it seems as if individuals are mainly concerned with the characteristics of the district: some essential residential attributes do not matter (the dwelling type, the surface area) and nor does the type of the municipality where they live. However, the district in which the dwelling is located is important for respondents. The estimated variance of the random intercept at the living-area level is 0.42, so that the probability of living in the ideal housing type differs by housing type. The Likelihood-Ratio (LR) test shows that there is sufficient variability between housing types to make the mixed-effect probit regression a better fit than the ordinary probit regression.[9]

4. Discussion and conclusion

We have found that not all individual and accessibility characteristics affect the probability of living in the ideal housing type. With respect to the existing literature dealing with housing or neighborhood satisfaction or quality of life, there are a number of differences.[10]

Sociodemographic characteristics may have a variety of effects on housing satisfaction. Our results are partially in line with Yang (2008), who emphasizes the positive role of children on neighborhood satisfaction (within a 100-meter buffer around a surveyed unit); on the contrary, household income has no effect in this study. Schmidt-Thomé *et al.* (2013) also systematically find a positive relationship between the presence of children and density acceptance, whatever the neighborhood housing density. However, they do not distinguish by child age, as we do here. We also find results comparable to Schmidt-Thomé *et al.* (2013) regarding occupancy status: owners are more prone to accept density than renters.

Is the probability of living in the ideal housing type related to density perception? Conversely to Bramley *et al.* (2009), who find a negative relationship between residence satisfaction and density in five medium-sized British cities, we show that having a positive or negative perception of density in the L.A. *Département* does not influence the probability of living in the ideal housing type. Yang (2008) even finds that higher (objective) density is sometimes associated with higher neighborhood satisfaction: this is notably the case in Portland, but not in Charlotte, United States. The geographical context, building, street, block, district or municipal, such as the current level of built-up, housing or human density, matters. Schmidt-Thomé *et al.* (2013) underline that inhabitants expect comparable density levels to those where they currently live, whatever the definition of density. However, this contribution also finds no correlation between the density of new infill development and inhabitants' acceptance of higher density. There may be a gap between objective density, that is to be maximized in dense projects, and the perception of built-up density, that result from visual urban characteristics that are optimized by planners and may be attractive for potential future inhabitants of the district. However, we

[9] After the estimation of the intracluster correlation ratio (ICC=0.292, s.e. 0.148) we conclude to the presence of heterogeneity within living areas.

[10] Housing satisfaction has been found to correlate with neighborhood satisfaction (Lu, 1999; Parkes *et al*., 2002).

here in L.A. find that, whatever those visual urban characteristics, the probability that inhabitants live is the ideal housing type is not sensitive to the positive or negative perception of density they have in their district. This is a quite original result.

The probability of living in the ideal housing type in L.A. rather depends on positive values associated to the district (nice, safe, clean, and calm), which actually may have little to see with either objective or perceived density at the same geographic scale. Comparable results are found in Bramley *et al.* (2009), but not in Schmidt-Thomé *et al.* (2013), who show that those living in attractive neighborhoods are ready to accept higher density levels.

Social aspects of the district, the second axis of our factor analysis, are not significantly associated with the probability of living in the ideal housing type in the L.A. *Département*. Comparable results are found in Temkin and Rohe (1998) and Ross *et al.* (2000), who find that invisible social capital such as increased relationships, emotional support and collective efficacy is rarely reflected in housing premiums. Conversely, the quality of social life in the neighborhood is valued in the city of Helsinki (Kyttä *et al.*, 2013).[11] However, this difference may be due to the different types of area studied: strictly urban *versus* larger areas.

Concerning the accessibility variables, Kyttä *et al.* (2016) find that service proximity reduces well-being in suburban settings, whereas it increases quality of life in city-center contexts. In our case, the presence of food or education facilities in the municipality are not valued by respondents.[12] On the contrary, some work has emphasized the positive role of proximity to an elementary school in price capitalization, such as Kane *et al.* (2006), Gibbons and Machin (2008) and Li *et al.* (2014). The positive influence of healthcare facilities on the probability of living in the ideal housing type that we find has only rarely been mentioned in the previous literature, although these are considered to contribute to quality of life (Bayulken et al, 2015; Garau and Pavan, 2018). Bramley *et al.* (2009) and Kyttä *et al*. (2016) consider proximity to

[11] The positive items of the social life in Kyttä *et al.* (2013) are the following: 'The residents take care of the surroundings well', 'The people significant to me are nearby', 'Neighbor relations here are harmonious', 'The social life is vibrant', 'The diversity of residents is adequate', 'I feel socially secure', 'Reputation of this place is good', 'The residents care for each other'.

[12] We interacted the food and education variables with municipality type (urban center, periurban, rural and coastal) but found no significant relationships.

healthcare facilities as a component of social sustainability of cities.[13] Kyttä *et al.* (2016) take a similar approach, identifying the positive role of health, regarded as a basic need to be taken into account in cities' social sustainability.

Overall, our work here has produced three novel results. First, positive or negative density perceptions at the district level are not correlated with the probability of living in the ideal housing type. Second, the geographical scale of development is important, with positive values being found at the district level. Third, surprisingly, short daily travel distances are not correlated with the probability of living in the ideal housing type, whereas potentially important (but less frequent) ones are (regarding proximity to healthcare facilities).

These results are central for urban planners when they design new or renovated districts: proximity to education and food facilities may not be what households search for search for in such districts. They should moreover concentrate on the positive outcomes at the district level rather than on optimizing built-up density at the same scale. This finding is in line with the meta-analysis in Park *et al.* (2016), who propose a better combination of different New Urbanist design features in new or renovated districts. Last, these recommendations may apply only to certain levels of infill development projects. A single street in a run-down district may not be ideal for inhabitants. On the contrary, very-large scale projects, including a significant part of the city, may spread the potential positive effects over too large an area, which may then become invisible to the inhabitants. The appropriate level of neighborhood perception by individuals, leading to the ideal housing types, is rather intermediate.

This is why acting on perceived density and urban frameworks at the relevant geographical scale may have various positive impacts on the inhabitants' perception of their district (ADEME, 2018). Such impacts may concern: (1) the living environment, (2) architectural quality, (3) urban practices (transport modes, public spaces use, innovative technologies), (4) environmental quality (energy consumption, soil and water deterioration, flood resorption, protection of biodiversity). Dealing with all these categories through a smart infill project may contribute to fill the gap between the current and the ideal housing type of inhabitants, given different built-up density levels. For example, improving green spaces quality, working on

[13] Social sustainability in Kyttä *et al*. (2016) consists of two main dimensions: accessibility (social equity) and experiential outcomes (sustainability of community) such as: pride in and attachment to the neighborhood; social interaction; safety or security; perceived quality of the local environment; satisfaction with the home; stability; and participation in civic activities.

urban ambiances, guaranteeing health quality for public spaces: all these contribute to the construction of a desirable living environment for the inhabitants.

As the degree of spatial disaggregation does not go down to the district level *(Ilot Regroupé pour l'Information Statistique, or IRIS in French)*, we do not know the exact location of the dwelling and the district where it is located. This may be why the *'Type of municipality'* variable ends up being insignificant. We did also test the inclusion of an additional variable on municipality as the third level in a mixed-effect model: here again the results are insignificant. The lack of spatial disaggregation may also explain why accessibility variables apart healthcare is not significant in our model (food, education), as an immediate proximity to these community facilities may be valued by households. Yet, as a more disaggregated administrative level may still not yield the expected results, the field of neighborhood geographies could also help, enhancing inhabitants to delineate their own neighborhood boundaries.

Last, there are missing variables that could potentially affect the probability of living in the ideal housing type that we unfortunately could not take into account. These variables can often be identified from the hedonic-pricing literature. The survey data that we used concentrated on individual density perception in relation to neighborhood features; some intrinsic residential characteristics were not measured (comfort attributes, such as the number of bathrooms, the presence of a balcony in a flat, home parking facilities etc.). Moreover, some neighborhood attributes were not considered either: this was the case for environmental variables such as noise exposure and air quality. These may well prove to be significant in determining the ideal housing types. These analyses are left for future research.

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Appendices

A1. List of the Visual Types of Housing

Fig. A11. Isolated individual house

Fig. A12. Small block of flats

Fig. A13. Housing estate

Fig. A14. Large block of flats

Fig. A15. City-center house

Fig. A16. City-center flat

A2. Sample and Population Characteristics

Table A2: Sample and population characteristics (%)

			Sample	France	L.A.
Gender					
	Men		0.381	0.484	0.478
	Women		0.619	0.516	0.521
Age					
	18-24 years	15-29 years	0.083	0.144	0.192
	25-34 years		0.209	0.145	
	35-49 years	30-44 years	0.349	0.236	0.206
	50-64 years	45-59 years	0.268	0.234	0.198
	65-74 years	60-74 years	0.079	0.127	0.127
	75 years and over		0.012	0.111	0.080
Profession					
	Farmers		0.003	0.009	0.009
	Craftsmen, merchants, small employers		0.033	0.034	0.031
	Managers, intellectual occupations		0.306	0.089	0.089
	Employees, Workers, Intermediate occupations		0.399	0.440	0.458
	Retired		0.146	0.266	0.256
	Others (without occupation; students)		0.118	0.163	0.155

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