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Residential Location Models: Analyzing Segregation, Borrowing Constraints, and Policy Implications

Nathalie Picard[1] and André de Palma[2]

Abstract

This chapter explores residential location models through a comprehensive review of the literature, key facts, theoretical frameworks, estimation methods, and simulation techniques. It focuses on the factors driving residential segregation using a standard individual discrete choice model, specifically a nested logit framework. This model incorporates household preferences for local amenities, dwelling types, and homeownership. The analysis is extended by introducing borrowing constraints that restrict some households' ability to purchase property. To illustrate, the framework is applied to the Paris region. By relaxing borrowing constraints, we simulate a hypothetical redistribution of socio-demographic characteristics across the region and demonstrate how this tool can be employed for policy analysis. A comparison of actual and simulated distributions reveals that easing credit constraints encourages households to relocate farther from the city center. However, if only poor households benefit, they are less likely to integrate with wealthier households, thereby intensifying segregation. This finding highlights those policies designed to support low-income households might inadvertently increase segregation citywide, necessitating careful re-evaluation

JEL classification codes : R21, R23, R31

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1 Introductory observations

1.1 A city is a complex dynamic system

A major issue in the study of cities is the linearity between causes (public actions, city policies) and effects (their consequences on the city). Spatial segregation can be seen as a process of structuring the city, or, to take a physical image, a process of increasing order (or decreasing entropy).

The city can be conceptualized as a nonlinear dynamic system with bifurcations. In this context, a city is not merely a collection of static buildings and infrastructures but a complex, evolving entity influenced by a multitude of interconnected factors such as demographics, economics, politics, social interaction, and culture. We have analysed this type of dynamic integrated land use and transportation model (LUTI model) with UrbanSim (Picard, de Palma, 2019) and welfare implications (Antoniou, Picard, 2015a). Interested readers may consider some historical background of dynamic urban models in Allen et al. (1981) or in Weidlich (1997) in the context of self-organizing structures. See also Sanders et al. (1997) on system dynamics and agent-based simulations.

In these studies, the city is constantly evolving and undergoing restructuring, reflecting a dynamic spatial organisation marked by patterns of segregation and desegregation. Nonlinear dynamics refers to the study of systems where small changes can lead to disproportionately large effects, often resulting in nonlinear behaviour such as the emergence of organized structures out of chaos (Prigogine, Nicolis, 1977). In the context of cities, this means that small changes in one aspect of the urban system can have significant and sometimes unexpected consequences on the city as a whole (see Bénabou, 1996, discussed later on in this chapter).

Bifurcations, in this context, represent critical points or thresholds where the behaviour of the urban system undergoes qualitative changes. These bifurcations can arise from various factors such as changes in population density, economic conditions, infrastructure development, or social dynamics. The point is that small microscopic variations can lead to large or macroscopic changes.

Bifurcation may also mean changing qualitatively trajectory. For example, the growth of a city may initially lead to increased economic opportunities and prosperity. However, at a certain point, further growth may lead to congestion, pollution, and social inequalities, resulting in a branching where the city transitions from a state of growth to one of decline or stagnation. Similarly, urban planning policies and interventions can also lead to bifurcations in the urban system. For instance, the implementation of a new transportation network may initially alleviate

traffic congestion, but if not carefully managed, it could lead to unintended consequences such as increased urban sprawl or social segregation. In the urban context, Papageorgiou and Smith, (1983) have studied empirically the emergence of multi-states patterns. For the theoretical analysis of the emergence of cities (on the infinite line), see also de Palma et al. (2019).

Understanding cities as non-linear dynamic systems with bifurcations highlights the importance of adopting a holistic and adaptive approach to urban planning and management. It emphasizes the need for policymakers and urban planners to anticipate and respond to the complex, interconnected dynamics of cities to promote sustainable development and enhance the quality of life for urban residents (see Antoniou and Picard, 2015a). This discussion highlights the role of models and sensitivity analysis. One approach to managing a city is to develop a sufficiently detailed model to predict trajectories based on the implementation of urban policies. This chapter aims to outline the process of building such a model, without investigating into all the technical details, as that would go beyond the scope of this discussion. See Picard and Antoniou (2011) and Antoniou and Picard (2015b) for details on econometric specification of such model.

The analysis presented here focuses on developed countries. This focus reflects the current state of knowledge rather than a deliberate choice. It is highly likely that emerging cities require far more economic analytical tools than mature cities, where most major decisions have already been made. However, we prefer a cautious approach and leave the description of the extraordinary urban transformations occurring in developing countries to other authors. We refer the reader to Henderson and Venables (2009) who provide insights into urban development dynamics, particularly distinguishing between developing and developed contexts. For further insights into integrated theoretical models of land use and transportation, see Zhi-Chun, De-Ping, and de Palma (2024).

1.2 Pros and cons of segregation

Residential segregation is often considered a situation to be fought against in cities. However, the researcher must explain the objective arguments accounting for the positive or negative aspects of segregation. Segregation is well documented in various studies in economics, regional science, geography political economy, and sociology (see: Burgess, 1928; Clark, 1986; or Burgess, Wilson, Lupton, 2005). One of the first models of segregation is due to a scholar in mathematical sociology: Thomas Schelling (Schelling, 1969): “My conjecture is that the interplay of individual choices, where unorganized segregation is concerned, is a complex system with collective results that bear no close relation to individual intent.”. We adopt here a similar approach to explain the emergence of segregation as the outcome of a myriad of individual decisions (see also Schelling, 1971). In the application under consideration,

individuals are described as discrete decision-makers, with a focus on their social interactions (see de Palma, Lefèvre, 1983, Scheinkman, 2008 and Durlauf, Ioannides, 2010).

Segregation in cities is generally considered "bad" for several reasons, briefly outlined below.

Social Injustice: Segregation can lead to social and economic inequalities by concentrating certain population groups in disadvantaged neighbourhoods, thereby limiting their access to essential resources and opportunities such as quality education, employment, healthcare, accessibility or environment (see de Palma et al, 2007).

Reinforcement of Stereotypes and Prejudices: Segregation can also reinforce stereotypes and prejudices by isolating ethnic, cultural, or socio-economic groups from each other. It can lead to mutual distrust, intercommunity tensions, and economic, social, or even religious conflicts (see, for example, Light and Thomas, 2019).

Social Fragmentation: Segregation can result in social fragmentation by creating physical, social, and economic barriers between neighbourhoods. This situation can reduce interactions between different population groups and weaken the social fabric of a city. A city is primarily a place of exchange, and this exchange is reduced if population groups remain isolated.

However, some other stakeholders in the city argue that segregation can also have positive effects. They may also pressure public authorities (through regulations related to land use, for example) to exclude populations or economic activities deemed undesirable from their territories. These actions are based on arguments briefly listed below:

Cultural and Social Affinity: Segregation can allow population groups sharing cultural, linguistic, or religious similarities to live together, which can strengthen their sense of belonging and promote the preservation of their cultural identity. Segregation can also contribute to preserving community cohesion by allowing residents to share common values, traditions, and cultural practices without external influence (see, Bezin and Moizeau, 2017).

Community Autonomy: Segregation can allow communities to self-govern and meet their specific needs in terms of housing, education, healthcare, and other social services, which can strengthen their resilience and capacity to organize (see Weller and Wolff, 2005).

Local public goods and infrastructure: Different population groups aspire to different types of local public goods and specific infrastructures: medical equipment, specialized education, sport equipment, theatres, airports, railway stations, and the like. See de Palma et al (2007) for an empirical illustration.

Overall, although segregation may offer some advantages for certain population groups, its negative effects on social justice, social cohesion, and equality of opportunities generally make it a phenomenon considered harmful in the long term for society. We will not pretend to perform

a cost-benefit analysis of segregation, which would be particularly complex, nor to make a definitive judgment on this matter. This chapter rather aims at analysing the intended and unintended consequences of public policies on segregation.

This chapter investigates residential location choices, tenure status, and the effects of liquidity constraints. Section 2 reviews theoretical models and econometric tools for analysing housing and location preferences, focusing on how borrowing constraints influence household behaviour. Section 3 introduces the empirical framework, detailing data sources and the nested logit model used to capture interactions between tenure status, dwelling type, and location, using the Paris region as a case study. Section 4 examines simulation results, showing how relaxing constraints affects residential distribution and market dynamics. Section 5 explores the broader implications of liquidity constraints on segregation and mobility. Finally, Section 6 discusses policy interventions, emphasizing the need for targeted approaches to balance homeownership promotion and social integration.

2 Housing policies

We examine the impact of housing policies aimed at facilitating homeownership for low-income households, particularly their influence on residential segregation and social mobility. It explores key policy mechanisms, such as financial assistance programs, regulatory reforms, and tenure status dynamics, while emphasizing the role of liquidity constraints and their potential to exacerbate urban segregation. The analysis is framed within the broader context of urban economics, drawing from significant contributions in spatial sorting, agglomeration effects, and the interplay between housing consumption and tenure choice (Henderson, Ioannides, 1986 and Elder, Zumpano, 1991).

Various housing policy measures are implemented to facilitate homeownership for low-income households in many countries. These measures typically target some key geographical areas to address barriers to homeownership for disadvantaged populations. These housing policy measures aim to promote social equity, economic mobility, and community stability by expanding homeownership opportunities for low-income households. By addressing financial barriers and providing support throughout the home-buying process, these initiatives strive to make the dream of homeownership a reality for individuals and families with limited resources. Governments may allocate funds to develop affordable housing units specifically designed for low-income families. These units are often rented out at reduced renting prices, or sold at below-market rates, in order to make homeownership more attainable. Rent-to-own programs allow tenants to rent a property with the option to purchase it at a later date. A portion of the

rent payments may be credited toward the down payment or purchase price, providing renters with an opportunity to transition into homeownership gradually. Governments may also offer homeownership counselling and educational programs to help low-income individuals navigate the home-buying process, understand their financial options, and improve their creditworthiness.

Land trusts acquire land and hold it in trust, making it available for affordable housing development. This can help reduce land costs for affordable housing projects and ensure long-term affordability by placing restrictions on resale prices. Governments may provide financial assistance or subsidies to help low-income households cover down payments, closing costs, or mortgage payments. These subsidies can take the form of grants, low-interest loans, or tax credits.

But the acquisition of property may be a complex process. For this reason, some Governments implement regulatory reforms to streamline the home-buying process, reduce bureaucratic barriers, and make it easier for low-income households to qualify for mortgages. On the same line, down payment assistance programs provide grants or loans to help low-income individuals cover the upfront costs of purchasing a home, such as the down payment and closing costs.

The SRU law ("*Solidarité et Renouvellement Urbain*") requires French communes to respect a minimum social housing quota.

All these laws favour social mix, but it remains to better understand how the combination of these laws at the local or country levels shapes urban areas.

We will focus here on another law that aims to protect low-income households from over-indebtedness: households are not allowed to buy housing if the mortgage repayment plus insurance represents more 35% of their income, which would jeopardize their financial stability by preventing them from being able to move around, feed themselves, or access essential goods and services. One of the aims of this chapter is to understand how objectives that are laudable in themselves may lead to greater urban segregation.

Measures such as the deductibility of mortgage interests have been rapidly abandoned, while other measures such as the provision of zero-interest-rate loans have been implemented under various forms and restrictions. One of the objectives for implementing such measures is to enhance social mobility by enabling the poorest households to cumulate and transmit housing assets.

Insufficient attention has been devoted to examining how policies aimed at promoting homeownership impact residential segregation, although this represents a crucial factor influencing social mobility. We discuss below two major contributions in this area.

Combes, Duranton, Gobillon (2008) show that spatial wage disparities can arise from differences in workforce skills, non-human resources, and local interactions. To discern among these factors, they analyse the dynamics of wages across local labour markets. They use a comprehensive panel of French workers. Their results indicate that individual skills play a significant role in spatial wage disparities, suggesting strong evidence of skill-based spatial sorting. Interaction effects, or agglomeration effects are primarily influenced by local employment density.

Note that agglomeration effects play a role in spatial sorting, but in this case, firms are more "responsible" than households. Agglomeration effects refer to the advantages that arise from the concentration of economic activity, population, and infrastructure in urban areas. The standard reasons are economies of scale, knowledge spillovers, labour market efficiency, and benefits of specialization. These agglomeration forces are not treated in this chapter (the interested reader is referred to Combes et al. (2012), and subsequent papers.

Gobillon et al. (2011) investigate econometrically the relative impact of residential sorting and true local effect on unemployment duration in the Paris region. According to their econometric findings, 30% of the unemployment spatial disparities can be explained by resident characteristics. The remaining is captured by local indicators, in particular residential segregation. One can add that in neighbourhoods with high unemployment rates, social norms may influence (negatively) the search for a job.

In the context of this chapter, which focuses on financial constraints, one advocates that easing ownership for low-income households may exacerbate residential segregation. Therefore, the expected benefits of social mobility could be significantly reduced. Therefore, it is crucial to evaluate how liquidity constraints either intensify or mitigate residential segregation to determine the effectiveness of promoting homeownership in advancing social mobility.

A dilemma arises from the potential preference of eligible households to purchase homes in economically challenged suburbs rather than renting in more affluent urban areas. To address this issue, we explore the role of household liquidity constraints in understanding the dynamics of social sorting in the Paris region. The methodology we present involves modelling household preferences for housing characteristics and tenure status (ownership versus tenancy), while also considering the influence of liquidity constraints on location choice.

We assess the impact of liquidity constraints on segregation by comparing the spatial distribution of households with and without such constraints. This analysis, conducted in a purely normative framework, considers that prices are fixed. Our objective is to gauge the preferences of each household under observed circumstances, and predict how the behaviour

of a given household would change if borrowing constraints were alleviated only for this household, all else being equal.

By contrast, a descriptive and predictive examination of policy measures would entail evaluating their collective effects on the endogenous equilibrium of the housing market. This would include analysing alterations in socio-demographic composition, housing prices, and plausible responses of real estate supply to shifts in demand. Such a predictive analysis falls beyond the scope of this chapter.

In the economic literature, tenure status (i.e. homeownership versus home renting) and housing consumption (the surface of the housing unit) have traditionally been examined in isolation, which neglects the trade-off between these two housing decisions.

The study of tenure status typically involves comparing the monthly costs of owning versus renting a housing unit (see Henderson, Ioannides, 1983 and Ioannides, Rosenthal, 1994 for an overview of early work, and Raya, Garcia, 2012, Sissons, Houston, 2019 for more recent contributions). Households are indifferent between owning or renting a housing unit only under a set of heroic assumptions: no tax distortions, no borrowing constraints, and a perfectively competitive housing market. Typically, for example, supply is consistently smaller than demand for dwellings to rent in the Parisian area: market-clearing seems to be an unreachable target. With the new environmental regulation in France, housing supply will be more and more constrained, so the situation will likely worsen.

Conversely, when analysing housing consumption, it is often assumed that tenure status is predetermined and households maximize the utility derived from housing consumption (see, e.g. Artle and Varaiya, 1978).

However, as underlined by Lee and Trost (1978) or Rosen (1979), housing consumption and tenure choice both result from the same utility maximization process, which implies that they are determined by common variables.

In conclusion, this analysis highlights the complexity of housing policies aimed at promoting homeownership for low-income households, particularly their unintended impact on residential segregation and social mobility. While such policies aim to address financial barriers and enhance equity, the role of liquidity constraints reveals that easing homeownership may inadvertently exacerbate segregation. Understanding these dynamics requires evaluating household preferences, spatial sorting, and the interplay between tenure choice and housing consumption. This nuanced approach underscores the need for carefully designed interventions to balance the goals of social mobility and urban integration. We analyse these complex issues in the sequel of this chapter.

3 Location choice, tenure status and segregation

In this section, we lay the foundations for an integrative framework that links tenure status and housing consumption, which will be further developed in the subsequent sections.

3.1 Tenure choice and life cycle

We describe now how households make tenure choices at different stages of the life cycle (see Aqzzouz and Picard, 2024 for a detailed analysis of residential location over life cycle), highlighting the influence of market imperfections on these decisions. Household decision to rent or own a dwelling serves dual purposes: housing investment and housing consumption.

Households opting to invest in owning a dwelling often commit to long-term mortgages, requiring adjustments to their consumption patterns. Consequently, life-cycle considerations may significantly influence tenure choice. Artle and Varaiya (1978) argue that household tenure choice stems from maximizing their life-cycle consumption of non-housing goods. Some households facing liquidity constraints may opt to delay their home purchase, striving to accumulate sufficient savings to meet the down payment requirement. However, if this delay extends for a prolonged period, there is a risk of the purchase being abandoned altogether.

Theoretically, more patient households would purchase a home early in their life cycle, accumulate housing equity (through enlarging or improving their dwelling) mid-life, and eventually liquidate their housing equity by selling and transitioning to renting later in life. Conversely, less patient households may prioritize current consumption and opt for permanent renting. However, bequest motives or altruism towards descendants might delay the transition from ownership to renting among the elderly (Megbolugbe et al., 1997; de Palma et al., 2015).

Henderson and Ioannides (1983) developed a two-period model, considering housing as both an investment and a consumption good. This model integrates housing demand for consumption and investment purposes under a shared budget constraint, applicable to both owners and renters (considering that owner-occupiers rent to themselves). Their analysis demonstrates that the decision to own-occupy a dwelling, rather than rent it, hinges not only on wealth but also on the income over life cycle. Individuals anticipating a decrease or slower increase in future income (e.g., those with lower education or inheritance) are more inclined to own-occupy. These authors reveal an intriguing observation regarding housing investment and income over life cycle, holding total wealth constant. Surprisingly, they find that the level of wealth does not significantly influence housing investment, whereas income path plays a pivotal role. These

dynamics results in a counterintuitive scenario where the wealthiest individuals tend to opt for renting rather than ownership. The authors propose that factors such as rental externalities and a progressive tax system may render tenancy less appealing to the affluent, prompting them to choose owner-occupancy instead.

Factors like liquidity constraints, transaction costs (see Ben-Akiva, de Palma, 1986), and distorting taxes can alter the return on housing investment, potentially making it less competitive than savings. Consequently, the budget constraints may vary between owner-occupiers and renters in imperfect financial markets. For instance, landlords face taxes on rental income that owner-occupiers do not, making renting out less profitable. Conversely, benefits like the deductibility of mortgage interest and zero-interest loans incentivize housing investment. Furthermore, lower mortgage rates or larger borrowing amounts for wealthier households may drive their preference for purchasing their home.

Liquidity constraints may impact residential segregation by influencing household mobility decisions and location choices upon moving. Gobillon and Le Blanc (2004, 2008) developed another two-period tenure choice model with individual-specific borrowing limits, focusing on the French zero-interest loan PTZ (*Prêt à Taux Zéro*). As expected, they find that this policy increases ownership among poorer households who might otherwise remain in rented dwellings. However, its benefits primarily accrue to households that would have moved and purchased regardless of the PTZ.

Expanding on this work, we present a simple and stylized framework which capture the effects of liquidity constraints on simultaneous household decisions regarding tenure status, housing consumption, and residential location. This straightforward framework is demonstrated using data from a specific case study.

3.2 Residential segregation

To fix idea, we mainly focus on the Paris region. Residential segregation in the Paris region is predominantly characterized by the clustering of affluent households within Paris itself and the affluent western suburbs, juxtaposed with the concentration of lower-income households in the Northern and Eastern suburbs. This pattern resonates with a monocentric model, wherein household income exerts a more pronounced positive influence on the perceived value of accessibility to the Central Business District (CBD) -here represented by Paris *intra muros*- compared to its effect on the demand for dwelling size (see Alonso, 1964; Mills, 1967; Muth, 1969; Wheaton, 1977). Additionally, residential segregation can be elucidated through a mechanism akin to Tiebout (1956) model, in which affluent households gravitate towards the

CBD, consequently driving up housing prices and actually excluding lower-income households from the CBD.

By contrast, residential segregation in the Lyon metropolitan area is distinctly marked by the concentration of affluent households in the upscale neighbourhoods of the Presqu'île and the western suburbs, contrasting sharply with the prevalence of lower-income households in the eastern and peripheral areas of the city. ~~By contrast,~~ Often in American cities like Detroit, the poor residents are located in the city centre and the rich ones in the suburbs. Unlike the typical monocentric model observed in some cities, Detroit's CBD and adjacent areas have historically been home to lower-income populations due to the (1) decline of the automotive industry and associated job losses led to depopulation and disinvestment in the city center, leaving lower-income households to occupy areas close to the CBD, where housing values fell significantly; (2) Housing Policies and Urban Development: Historical redlining and exclusionary practices concentrated lower-income and minority populations in central urban areas, while wealthier households moved to suburban neighborhoods; (3) Urban Renewal and Displacement Effects: Urban renewal projects often left fragmented neighborhoods in the CBD, creating pockets of low-income housing while wealthier households settled in the suburbs (Darden, 1976).

We summarize below the main findings of the seminal paper of Bénabou (1996), who presents a comprehensive model to study community formation and human capital accumulation. He then analyses the effects of these inputs on economic segregation, equity, and productivity. Particular attention is paid to the role of education in segregation (see also Burgess, Wilson, Lupton, 2005). Minor differences in resources, preferences, or financial access can lead to significant polarization, exacerbating income inequality between generations. The persistence of wealth inequality is also important. Excessive stratification reduces the benefits to society, and the effectiveness of school resource equalization at the State level (see, Bayer, Ferreira, and McMillan, 2007) depends on the interaction of purchasing, social, and family factors in education and mobility choices (and in particular access to employment (see, de Palma, Picard, Inoa, ,2014). In the latter scenario, social stratification is likely to intensify due to imperfections in financial markets, potentially hindering economically disadvantaged families from securing loans to obtain their desired dwelling size and location. Brueckner, Thisse, and Zénou (1999) present an alternative model wherein location choice is influenced not only by housing prices and commuting costs but also by the level of amenities, initially assumed to be exogenous in their basic model. Furthermore, they posit that the valuation of amenities increases with income, at a faster rate than housing consumption. Their analysis reveals that if the CBD offers substantial amenity advantages, affluent households are inclined to concentrate in the city centre, while

lower-income households gravitate toward the suburbs. Conversely, if amenity levels decrease slightly or even increase with distance from the CBD, a reversal in this trend may occur. This explains why the concentration of wealthy households in the CBD is amplified in cities like Paris, where the CBD is rich in amenities, while the opposite occurs in places like Detroit, where suburbs offer more amenities (see, Gaigné, et al. 2022).

As suggested earlier, another plausible explanation for residential segregation could stem from unequal access to homeownership. However, existing models of residential segregation often overlook tenure choice decisions, limiting their capacity to assess the impact of ownership barriers on residential segregation.

A final note highlights the importance of considering both historical and environmental factors when analysing urban development patterns. The configuration of London's neighbourhoods, with wealthier residential areas traditionally located in the west, is influenced by various historical and socio-economic factors. Among these, the direction of prevailing winds, which typically blow from west to east, has played a role in dispersing industrial pollutants towards the east, making the west more desirable for affluent residents. Recent studies indicate that despite efforts to improve air quality, disparities persist between the east and west of the city. For example, real-time data shows that some areas in East London continue to record less favourable air quality indices compared to the west. However, it is important to note that air quality in London is influenced by a combination of factors, including local emissions, traffic density, and weather conditions, which can vary significantly between neighbourhoods. In summary, while prevailing winds have historically contributed to lower pollution levels in West London, other factors have also shaped the socio-economic distribution of neighbourhoods across the city (see IQAir). The same phenomena can be observed in several other cities. See Pradana, Dimyati (2024) for a comprehensive review of urban sprawl research, focusing on the integration of remote sensing and GIS technologies to analyse spatial and temporal patterns.

We are now ready to investigate the phases of modelling, estimation, and simulation, which will be addressed in the following sections.

4 Model specification: theory

4.1 Structural monocentric model[3]

In this section, we build a three-step monocentric model wherein households sequentially make choices regarding their tenure status (s) in the initial step, followed by determining their distance (d) from the CBD and their level of local amenities (z), and finally, they allocate their consumption between housing (H) and other goods (C) in the final step. The sole source of diversity among households explored here is income.

The proposed approach is largely based on the amenity-centric location framework pioneered by Brueckner et al. (1999), particularly focusing on the dynamics of endogenous equilibrium prices. Rather than investigating into the determinants of these equilibrium prices, we adopt their assumptions and findings concerning endogenous prices. Our objective is to examine household decisions conditional on prices and to extend their conclusions regarding household behaviour and heterogeneity.

We incorporate a differentiation between homeowners and renters. Initially, we expand the model to include a possible liquidity constraint. Subsequently, we advance it to a more practical discrete choice framework, where household preferences exhibit diversity, and factors such as distance (d) to the CBD and local amenities (z) are determined by discrete location (j). Additionally, we augment the model by integrating dwelling type (T), which may be either a flat or a house, into the initial step of the process, simultaneously with tenure status (S). Consequently, prices are influenced by dwelling type (T) as well.

Household i is characterized by income y_i , and by a utility function $U(.)$ depending on tenure status S, on the amount of local amenities z, on floor space H, and consumption C of a composite good, the *numéraire*. Local amenities, denoted by z, are valued by an increasing and concave function $\psi(z)$. The dwelling price, denoted by $\pi^S(d,z)$ equals its expected use cost when bought (S = O for *own*) and its rental price when rented (S = R). The commuting cost $t(d)$ is continuous and twice derivable on $\mathbb{R}^+$, increasing and convex.

To illustrate this approach, we consider a specific standard form (Cobb-Douglas) for household utility as a function of consumption C, floor space H, local amenities z and tenure status S:

$$U\left(C,H;z;S\right)=\beta^S\cdot\psi\left(z\right)+(1-\beta^S).\left(\gamma^S.\ln C+\left(1-\gamma^S\right).\ln H\right),\ 0<\gamma^S<1;\ 0<\beta^S<1. \qquad (1)$$

[3] Part of the material in this and subsequent sections builds on our earlier work (Picard and de Palma, 2022).

The parameter γ^S measures the preference for consumption *C*, over floor space *H*, whereas the parameter β^S measures the preference for amenities *z* over consumption bundle (*C*, *H*).

Most of the results obtained here would still hold if the utility function were only assumed additively separable, increasing in amenities *z* and increasing and concave in consumption *C* and in floor space *H*, with standard Inada conditions (that is infinite marginal utilities at zero consumption levels).

We consider a single period. The budget constraint is:

$$y_i = C + \pi^S(d,z)\cdot H + t(d). \tag{2}$$

Such model is usually solved backward in three steps program (i.e., starting with the last step).

In the **third step** of the program, household *i* maximizes its utility (1) subject to the budget constraint (2), given household income y_i, tenure status *S*, distance *d* (such that $t(d)<y_i$), and local amenities *z*, by choosing the optimal levels of housing good $H^*(d,z;S;y_i)$ and of other goods $C^*(d,z;S;y_i)$. Substitution of these optimal levels in the direct utility function leads to the indirect utility function (maximum utility the household can achieve given the constraints):

$$\begin{aligned} U^*(d,z;S;y_i) &= U\left(C^*\left(d,z;S;y_i\right),H^*\left(d,z;S;y_i\right);z;S;y_i\right) \\ &= k^S + \beta^S\cdot\psi\left(z\right)+\left(1-\beta^S\right)\cdot\ln\left(y_i - t\left(d\right)\right)-\left(1-\beta^S\right).\left(1-\gamma^S\right).\ln\pi^S\left(d,z\right) \end{aligned}, \tag{3}$$

where k^S is a non-linear combination of the coefficients β^S and γ^S.

The **second step** of the program consists of choosing the distance *d* to CBD and the amount of local amenities *z* to maximize the indirect utility $U^*(d,z;S;y_i)$, conditional on tenure status *S* and income y_i. The second step of the program determines the optimal distance, $d^*(S;y_i)$, and local amenities, $z^*(S;y_i)$. Optimal location results from a trade-off between the price, which decreases when moving farther away from the CBD, and the transportation cost, which increases when moving farther away from the CBD. Under reasonable assumptions, price decreases faster closer to CBD, whereas transportation costs increase faster when farther away from the CBD. The second step of the program results in the "Second-Level" indirect utility $U^{**}(.)$ of household *i* with income y_i conditional on tenure status *S*:

$$U^{**}(S;y_i) \equiv U^*\left(d^*\left(S;y_i\right),z^*\left(S;y_i\right);S;y_i\right). \tag{4}$$

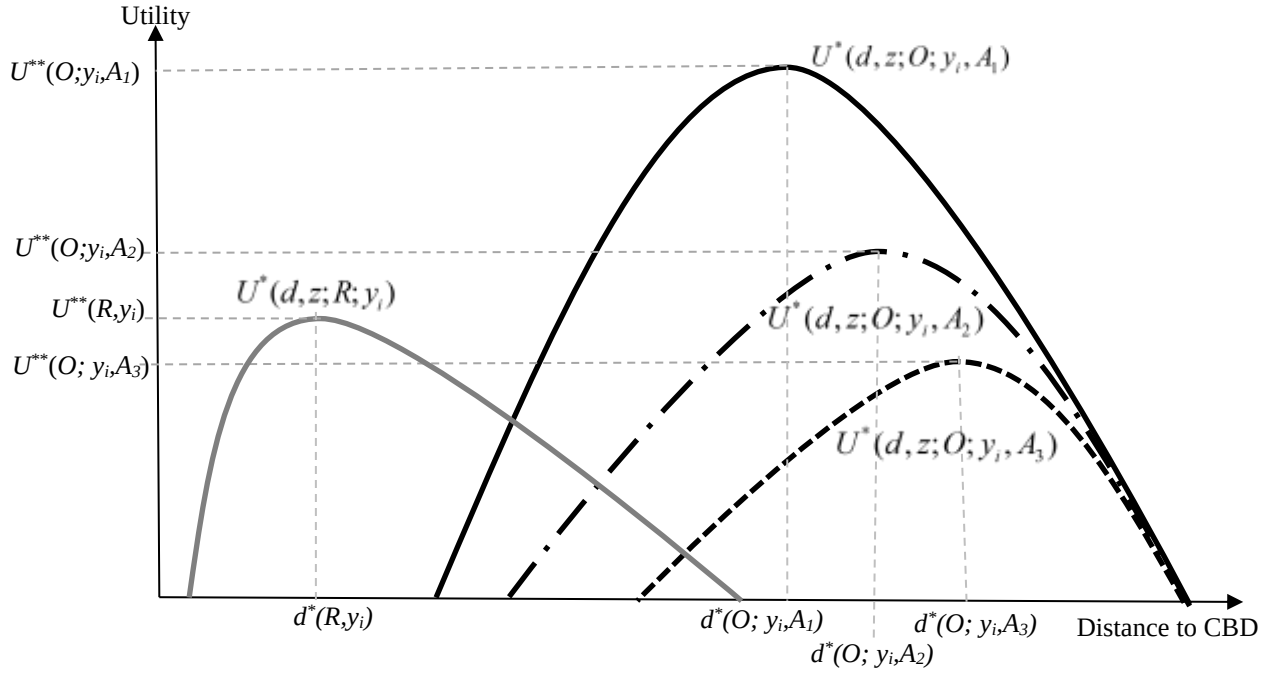
The **first step** of the program simply consists of choosing, among the two possible tenures, the one which provided the highest "Second-Level" indirect utility: household *i* buys a dwelling if and only if $U^{**}(O;y_i)>U^{**}(R;y_i)$, and it rents a dwelling iff if $U^{**}(O;y_i)<U^{**}(R;y_i)$.

4.2 Introducing a liquidity constraint

The program developed in Section 4.1 neglects the liquidity constraints that may affect some households if they want to buy a dwelling. To formalize the role of such constraints, we introduce in the model of an upper limit $A_i^{\max}$ on the amount that can be spent on *buying* a household (no similar limit on the maximum amount of rent). With obvious notations, $A_i^{\max}$ is added to the list of determinants of indirect utility $U^*(d,z;O;y_i,A_i^{\max})$, of optimal location $d^*(O;y_i,A_i^{\max})$ and of further indirect utility $U^{**}(O;y_i,A_i^{\max})$.

Such *potential* constraints do not affect the utility of renting a dwelling and thus do not modify the tenure choice of a household that prefers renting to buying. In contrast, Figure 1 illustrates the case where household *i* would prefer buying over renting ($U^{**}(O;y_i)>U^{**}(R;y_i)$) when unconstrained. In this case, there exists a threshold $\overline{A_i^{\max}}(y_i)$, defined by the condition $U^{**}\left(O;y_i,\overline{A_i^{\max}}(y_i)\right)=U^{**}(R;y_i)$ such that household buys a dwelling if only moderately constrained ($A_i^{\max}>\overline{A_i^{\max}}(y_i)$), by rents a dwelling if strongly constrained ($A_i^{\max}<\overline{A_i^{\max}}(y_i)$). When $A_i^{\max}=\overline{A_i^{\max}}(y_i)$, the household is indifferent between renting (typically close to the CBD) and buying far from the CBD.

Figure 1: Illustration of the effect of borrowing constraint on tenure choice and optimal distance



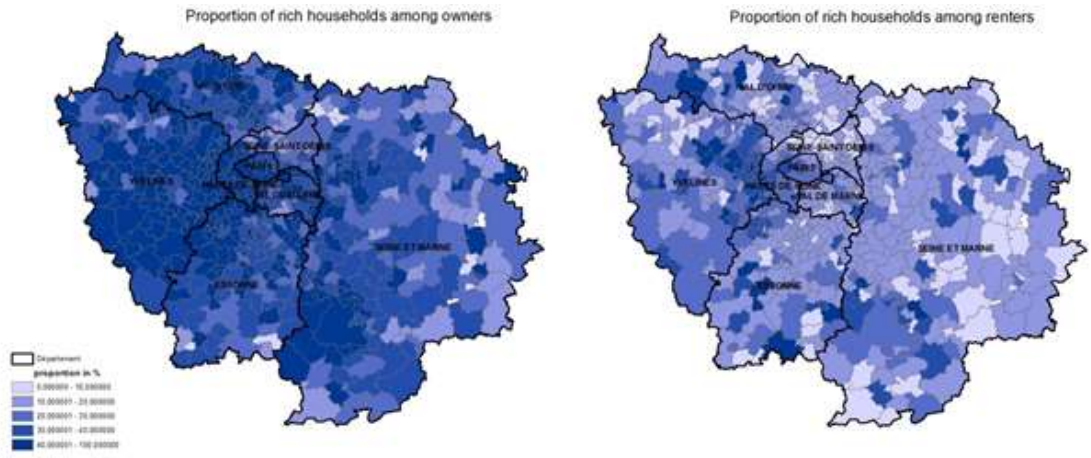
When $A_i^{\max}>\overline{A_i^{\max}}(y_i)$ (e.g. for A_1 or A_2), the household purchases a dwelling despite facing liquidity constraints. The optimal distance to the CBD increases smoothly (e.g. from $d^*(O;y_i,A_1)$ to $d^*(O;y_i,A_2)$) when the maximum borrowable amount decreases from A_1 to A_2. When the

constraint becomes too severe, i.e. $A_i^{max} > \overline{A_i^{max}}(y_i)$ (e.g. for A_3), the optimal distance to the CBD $d^*(O;y_i,A_3)$ increases so much that the further indirect utility in case of buying, $U^{**}(O; y_i,A_3)$, becomes less than the further indirect utility in case of renting, $U^{**}(R; y_i)$. As a consequence, the severely constrained household (subject to A_i^{max} equals A_3) prefers to rent a dwelling close to the CBD, at $d^*(R; y_i)$, rather than buying very far from the CBD, at $d^*(O;y_i,A_3)$.

Liquidity constraints may, or may not, affect residential segregation, depending on parameter values. The aggregate effect of liquidity constraints on residential segregation depends on the correlation between income y_i and maximum borrowable amount A_i^{max}.

If the borrowable amount A_i^{max} increases with income (which is the case in France, where A_i^{max} is typically such that mortgage repayment plus insurance represents 35% of y_i), households which are only moderately constrained will buy their dwelling, and sort spatially by income, with the richest households located close to the CBD and the poorest households located farther away. By contrast, severely constrained households will rent a dwelling close to the CBD. Income segregation is then be more severe among owners than among renters. This is consistent with Figure 2.

Figure 2: Local proportion of rich households among those who moved in 1998, by tenure status



Source: Author's computations, using 1999 French Census

In the next sub-section, we extend the proposed framework in several directions, consistent with the empirical application.

4.3 Extension: heterogeneous preferences, discrete location, unconstrained choice set

Theory is useful to set the early stages of a framework and to derive some intuitions, that need later on to be confirmed (or not) by an empirical application grounded with empirical data.

First, household preferences are heterogeneous. This means that the parameters β^S and γ^S in Eq.

(3) typically depend on household socioeconomic characteristics, such as income, household head age and nationality, or household composition (see Table 2 to Table 3). In addition, depending on their socioeconomic characteristics, households value differently the various types of local amenities *z*. For example, the willingness to pay for parks and other green spaces of households with children is expected to be higher than that of singles. This implies that the aggregate function $\psi(z)$, which implicitly assumes that all households agree on the value of local amenities has to be replaced with a household-specific function value function $\psi_i(z)$.

Second, distance to CBD is a poor proxy for commuting costs, which also depend on the specificities of the (public and private) transportation network. As a result, it seems more realistic to replace the continuous variables *d* and $\psi(z)$ by a discrete list of potential locations, namely the different "*communes*".

The transportation costs used are provided by the microeconomic-based dynamic transport model METROPOLIS (see Vickrey, 1969 and Javaudin and de Palma, 2024), which also provides micro-founded accessibilities consistent with discrete choice frameworks used in later on in this next section.VRAI ?

Third, as discussed in Section 3, imperfections in financial and real estate markets mean that renting and buying prices are not equivalent, as they would be in a perfectly competitive market. Rather, prices per square meter vary significantly by dwelling type, with the prices of flats and houses showing little statistical correlation.

We follow here the three steps described in the previous section.

In the first step, households choose their tenure status *S* and their dwelling type *T*.

In second step, they choose their location *j* in a discrete set. Location determines distance *d* to CBD and local amenities *z*.

Finally, in the third step, they choose the optimal quantities of housing and other goods.

Liquidity constraints are neglected in this section, so that the third step of the program is the same as in Section 4.1, with some obvious change in notation.

Location *j* is characterized by a series of tenure-and-type-specific prices π_j^{ST}. Eq. (3) is then replaced with the indirect utility for household *i* of choosing location *j*, conditional on tenure status *S* and dwelling type *T*:

$$U_{ij}^{ST} = \alpha_{1i}^{ST} + \alpha_{2i}^{ST}.Z_j - \alpha_{3i}^{ST} \ln \pi_j^{ST} + \varepsilon_{ij}^{ST}, \quad (5)$$

where $\alpha_{ki}^{ST}, k = 1,...,3$ are household-specific preference parameters. By contrast with the theoretical model, Z_j now represents a multidimensional bundle of observed local amenities,

which are valued differently by different households.

Note that income y_i does not appear explicitly in the indirect utility function U_{ij}^{ST}, but only indirectly in the preference parameters $\alpha_{ki}^{ST}, k = 1,...,3$ (see **Table 1**). Similarly, the distance *d* to CBD does not appear explicitly in U_{ij}^{ST}, but only indirectly in the distance-related local amenities such as travel time or accessibility measures listed in **Table 1**.

Whereas the rental price of a housing unit is observed, the user cost of a purchased housing unit is not observed and has to be proxied by the purchasing price. Consequently, in Eq. (3), the use cost π^s is replaced by the rental price when the dwelling is for rent (S=R)and by the selling price when for sale (S=O).

The residual terms ε_{ij}^{ST} reflects unobserved heterogeneity in the preferences and the valuation of unobserved local amenities. While some of factors are not observable, on may assume some (standard) distribution function of these factors and estimate their variance of such parametrized distributions. The limiting case when this variance goes to zero corresponds to a deterministic model.

In the simplest (but unrealistic) model, one assumes that each household simultaneously chooses the tenure *S*, the dwelling type *T* and the location *j*, that is, the alternative (*S, T, j*), which leads to the highest utility. In this case, the probability that alternative (*S, T, j*) is chosen by household *i* is given by the law of comparative judgement, standard in discrete choice theory (see Ben-Akiva and Lerman, 1985):

$$P_i(S,T,j) = \Pr(U_{ij}^{ST} = \underset{S',T',j'}{Max} U_{ij'}^{S'T'}). \tag{6}$$

Under the assumption that the residuals are i.i.d. (over *S'*, *T'* and *j'*) with a Gumbel distribution, the probability that alternative (*S, T, j*) is chosen by household *i* can then be written using the multinomial Logit formula (see Mc Fadden, 1978 and Anderson, de Palma and Thisse, 1992):

$$P_i(S,T,j) = \frac{\exp\left(V_{ij}^{ST}\right)}{\sum_{S'=\text{own,rent};T'=\text{house,flat};j'\in\mathcal{J}} \exp\left(V_{ij'}^{S'T'}\right)}, \tag{7}$$

where $\mathcal{J}$ denotes the set of locations *j* and $V_{ij}^{ST} = U_{ij}^{ST} - \varepsilon_{ij}^{ST}$ denotes the deterministic part of indirect utility. The parameters $\alpha_{ki}^{ST}, k = 1,...,3$ measuring marginal utilities can then be estimated using standard maximum likelihood techniques for the multinomial logit model.

The potential drawback of such simple joint model is that it relies on the Independence of Irrelevant Alternatives (IIA) property, which stipulates that the ratio of the choice between two alternatives is not affected by the availability of other alternatives; it only depends on the utility

of these two alternatives. Even if the multinomial logit model is still widely used in the literature, this hypothesis does not seem plausible (as explained below) when households choose both tenure status *S*, dwelling type *T* and location *j*. It is more appropriate to assume that when the alternative (*S, T, j*), preferred by household *i* is no more available or becomes less attractive, then household *i* will likely select a different location *j'*, but will tend to still select the same tenure status, *S* and the same dwelling type, *T*. The multinomial logit (MNL) model requires an extension to address the undesirable independence of irrelevant alternatives (IIA) property, commonly illustrated by the "blue bus/red bus" paradox introduced by D. McFadden (1978; see Bierlaire, 2021 for a pedagogical illustration). The nested logit (NL) model, which generalizes the MNL model, overcomes this limitation. Therefore, we adopt the NL model in the following analysis. Further details and justifications, particularly in the context of job location in urban areas, can be found in Inoa, Picard, and de Palma (2015).

Renting a dwelling is often a temporary alternative before buying one, so that the observable and unobservable characteristics that determine the rent of a dwelling might be different from those that determine the decision to buy a similar dwelling. In particular, the expected future sale price of a dwelling, which is part of the unobservable determinants of its purchase, is irrelevant when renting with no future purchasing intention. Moreover, houses and flats differ in their average size and use cost (lower or no condominium fees for flats, but larger real estate taxation and maintenance cost for houses) so that some unobservable determinants might be specific to the dwelling type.

The effect of observed household characteristics on the generic preference for a given tenure status and dwelling type (whatever its location) can be imbedded in the parameter, α_{1i}^{ST}, both in the MNL and in the NL model. The observation that the local price in location *j* is specific to tenure status and dwelling type is imbedded in the price variable, $\ln \pi_j^{ST}$, and the observation that price elasticity may depend on tenure status and dwelling type is imbedded in the coefficients α_{3i}^{ST} (indexed by *i* to reflect the fact that it may depend on observable household characteristics such as income). Similarly, the observation that the willingness to pay for a better accessibility and for local amenities depends potentially on tenure status, on dwelling type and on observable household characteristics is imbedded in α_{2i}^{ST}, both in the MNL and in the NL model.

An additional parameter α_{1i}^{S} is added to reflect intrinsic preference for tenure status depending on observed characteristics. To account for the potential correlation between the error terms by dwelling type and tenure status, a type-tenure-specific error term, ε_{iT}^{S} and a tenure-specific error

term, ε_{iS} are also added to the empirical specification. They correspond, respectively, to unobserved heterogeneity of preferences for dwelling type and for tenure status:

$$U_{ij}^{ST} = \alpha_{1i}^{ST} + \alpha_{1i}^{S} + \alpha_{2i}^{ST}.Z_j - \alpha_{3i}^{ST} \ln \pi_j^{ST} + \varepsilon_{ij}^{ST} + \varepsilon_{iT}^{S} + \varepsilon_{iS} \tag{8}$$

The deterministic part of the utility can be expanded into three additive deterministic utilities, which leads:

$$U_{ij}^{ST} = V_{ij}^{ST} + V_{iT}^{S} + V_{iS} + \varepsilon_{ij}^{ST} + \varepsilon_{iT}^{S} + \varepsilon_{iS}\,, \tag{9}$$

with:

$$\begin{aligned} V_{ij}^{ST} &= Z_j.\alpha_{2i}^{ST} - \alpha_{3i}^{ST} \ln \pi_j^{ST} \\ V_{iT}^{S} &= \alpha_{i1}^{ST} \\ V_{iS} &= \alpha_{i1}^{S} \end{aligned} \tag{10}$$

The term V_{ij}^{ST} denotes the deterministic utility provided to household *i* by location *j* conditionally on dwelling type *T* and on tenure status *S*; the term V_{iT}^{S} denotes the deterministic utility provided to household *i* by dwelling type *T* conditionally on tenure status *S* (whatever location *j*), and the term V_{iS} denotes the deterministic utility provided to household *i* by tenure status S (whatever location *j* and dwelling type *T*).

Under the standard assumptions of a nested logit model (see Anderson et al. 1992), the probability that household *i* chooses location *j* in the discrete set $\mathcal{J}(S,T)$, conditionally on dwelling type, *T* and tenure status, *S* is given by the usual Multinomial Logit formula:

$$P_i(j|T,S) = \frac{\exp(\mu_{ST} \cdot V_{ij}^{ST})}{\sum_{k \in \mathcal{J}(S,T)} \exp(\mu_{ST} \cdot V_{ik}^{ST})} \tag{11}$$

The probability that household *i* chooses a house (*T=H*) rather than a flat (*T=F*) conditionally on tenure status *S* is given by a nested logit model:

$$P_i(T = H|S) = \frac{\exp\left[\lambda_S \cdot \left(V_{iH}^{S} + \frac{1}{\mu_{SH}}.I_{iH}^{S}\right)\right]}{\sum_{T' \in \{H,F\}} \exp\left[\lambda_S \cdot \left(V_{iT'}^{S} + \frac{1}{\mu_{ST'}}.I_{iT'}^{S}\right)\right]}, \tag{12}$$

where $I_{iT}^{S} = \ln\left(\sum_{k \in \mathcal{J}(S,T)} \exp(\mu_{ST} \cdot V_{ik}^{ST})\right)$ refers to the inclusive value of the nest $\mathcal{J}(S,T)$. This term corresponds to the expected maximum utility of household *I*, conditional on tenure *S* and on dwelling type *T*.

Finally, the probability that household *i* chooses to own a dwelling is:

$$P_i(S=O)=\frac{\exp\left[\phi\cdot\left(V_{iO}+\frac{\phi}{\lambda_O}.I_{iO}\right)\right]}{\exp\left[\phi\cdot\left(V_{iO}+\frac{\phi}{\lambda_O}.I_{iO}\right)\right]+\exp\left[\phi\cdot\left(V_{i\mathrm{R}}+\frac{\phi}{\lambda_\mathrm{R}}.I_{i\mathrm{R}}\right)\right]}, \quad (13)$$

where $I_{iS}=\ln\left(\sum_{T'\in\{\mathrm{H,F}\}}\exp\left[\lambda_S\cdot\left(V^S_{iT'}+\frac{1}{\mu_{ST'}}.I^S_{iT'}\right)\right]\right)$ is the inclusive value of tenure status *S*. It represents the expected maximum utility of household *i*, conditional on the choice of tenure *S*.

The probability that household *i* chooses a dwelling of type *T* with tenure status *S* in location *j* is the product of the three probabilities defined by Eq. (11) to Eq. (13). This intuitive derivation derived by Ben-Akiva and Lerman (1985), was formally rationalized as a one-step discrete choice formula by McFadden (1978). To estimate the parameters of those equations, one of the scale parameters must be normalized: we choose to normalize the parameter of the total disturbance, which was set to one w.l.o.g., i;e.: $\phi=1$.

In conclusion, the nested logit model provides a structured framework for modeling household location choices, accounting for dwelling type and tenure status.

4.4 Extension: constrained choice set

The coefficients estimated from the nested logit might reflect not only household preferences, but also the liquidity constraints they may face. As shown by the structural models of Section 4.2, the maximum borrowable value $A_i^{\max}$ affects the tenure and location choices when liquidity constraint on household is binding.

Moreover, this constraint is likely to modify the choice set faced by households: when the optimal housing consumption that household can afford to buy in location *j* is lower than the minimal affordable housing service in *j*, dwellings for sale in *j* disappears from *i*'s choice set.

Liquidity constraints are then likely to bias the estimation of the marginal utilities by implicitly reducing each household *i*'s choice set of buyable alternatives to the dwellings whose value is less than $A_i^{\max}$.

Constraints on the choice set can be taken into account by distinguishing several choice sets instead of considering only one. Hence, the corresponding model is a discrete choice model with latent (or endogenous) choice sets. In such a model, the probability that a household chooses a dwelling is not only the probability that this dwelling provides the highest utility to

this household but it also depends on the probability that this dwelling is available to this household. Stated differently, the choice maximizes utility in the feasible set of alternatives. For example, Ouazad and Rancière (2019) estimate a location choice model in which the choice set depends on mortgage approval probability, but they only consider dwellings for sale. Thus, unlike in the present chapter, they implicitly assume that liquidity constraints do not affect tenure choice but only affect location choice.

In this section, we consider the particular case where the constraint on maximum borrowable amount is binding for some households and extend the previously analysis of the nested logit to account for this constraint. We assume that constrained households face a choice set which contains only alternatives to rent (bottom part of Figure 3), whereas unconstrained households face a choice set which contains both alternatives to rent and to buy (upper part of Figure 3). The probability to face this choice set, implicitly modelled as a binary logit, is integrated to the previous nested logit.

The previous assumptions about the choice between renting/buying and house/flat still hold so that the location choice among the unconstrained choice set can be modelled along the same 3-levels nested logit as considered before. Eq. (11) to Eq. (13) still hold for unconstrained households. By contrast, the choice for constrained households is restricted to the two lower levels: the choices of the commune and of the type of dwelling. The parameters of location and dwelling type are assumed to be the same, whether the household is constrained or not.

The propensity to be constrained is not observed, but inferred from the model by modifying the formula of the probability to buy in the nested logit and by maximizing the corresponding likelihood function. The probability of choosing to buy a house become:

$$P_i(S=O) = P_i(S=O \mid \text{constraint}=0) \times P_i(\text{constraint}=0) \tag{14}$$

with:

$$P_i(S=O \mid \text{constraint}=0) = \frac{\exp\left[\phi \cdot \left(V_{iO} + \frac{\phi}{\lambda_O}.I_{iO}\right)\right]}{\exp\left[\phi \cdot \left(V_{iO} + \frac{\phi}{\lambda_O}.I_{iO}\right)\right] + \exp\left[\phi \cdot \left(V_{i\mathrm{R}} + \frac{\phi}{\lambda_\mathrm{R}}.I_{i\mathrm{R}}\right)\right]}, \tag{15}$$

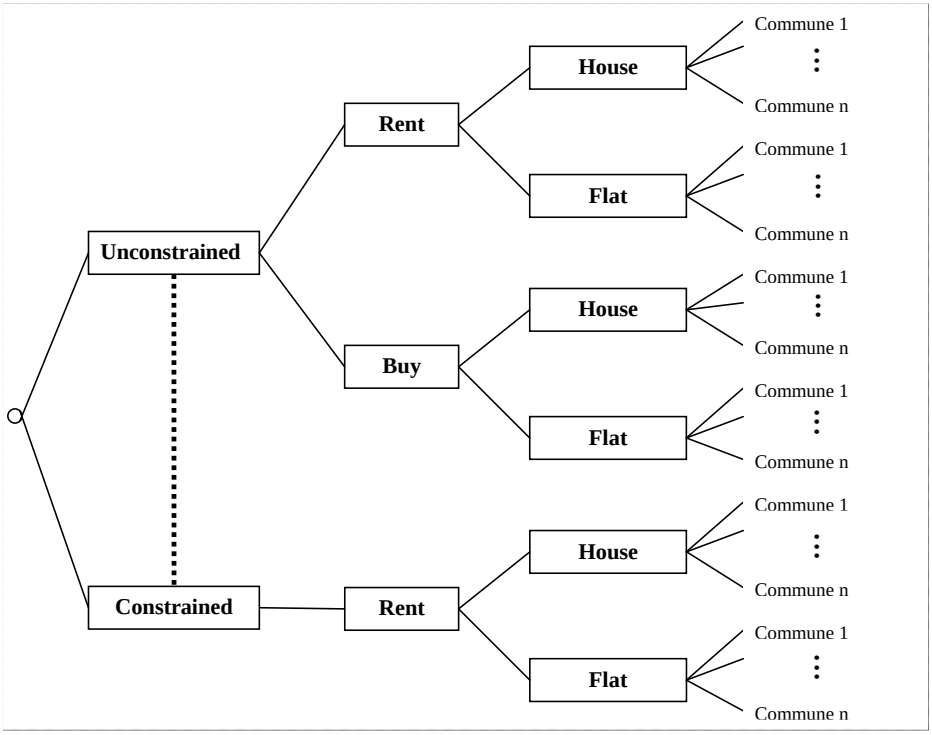
and with:

$$P_i(\text{constraint}=0) = \frac{1}{1+\exp(X_i\delta)}. \tag{16}$$

Distinguishing the effect variables on constraints from their effect on choice is made possible by our definition of latent choice. Here the latent variable determines which choice set each

household will face. By contrast, the variables that influences its choice given the latent choice set correspond to preferences. The same variable can affect both constraint and preferences; this might be the case of income, for instance.

Figure 3: Location choice model with constraints



5 Estimation results

We present findings from the Paris Region, covering both the city of Paris and its surrounding suburbs, in 1999 (last exhaustive census in France). The city itself is home to around 2 million residents, forming part of a regional population of 11 million. This region sustains 5.1 million jobs. Spanning over 12,000 square kilometers (just 2% of France's land area), it hosts 19% of the national population and 22% of the country's jobs. Paris city is divided in 20 "*arrondissements*", while the suburbs is divided into two the "*inner ring*", comprising three counties adjacent to Paris, and the "*outer ring*", made up of four counties located farther away. Paris region has a three-tier administrative structure: one regional authority, eight counties ("*départments")*, and 1,300 municipalities ("*communes*"), grouped in 725 "*pseudo-communes*". *Pseudo-communes* are aggregations of communes that account for their size. *Pseudo-communes* inside Paris correspond to its partition in 20 arrondissements. A *pseudo-commune* corresponds to a *commune* when it is large enough, which is typically the case in the

inner Ring. In contrast, small, adjacent communes are grouped together into larger *pseudo-communes*. Such grouping is typical in the *outer ring*.

The study focuses on households that relocated in 1998. We exclude households hosted for free and those where the household head is a student, resulting in a refined sample of 521,132 households. This dataset provides detailed information on household attributes, including size, number of children, gender of the household head, occupation, educational background, and the previous county of residence. Since household per capita income is not directly recorded, we estimate it using household characteristics, achieving a highly accurate fit.

To illustrate the bias in the estimation of household preferences implied by borrowing constraints, we compare the estimation results of the model depicted in Sections 4.3 (no constraints) and 4.4 (constrained choice set).

Both models use the same method to estimate a discrete location choice model for each of the four defined nests (*T, S*). This estimation is based on households choices within the sample that opted for this nest. Each nest represents 725 alternatives, mirroring the 725 *pseudo-communes*.

To calculate the inclusive value for each nest (*T, S*) as used in Eq. (12), we determine the utilities of all 725 pseudo-communes for each household within a nest, based on the coefficients derived from the first step, and apply the usual log-sum formula $I_{iT}^{S} = \ln\left(\sum_{k \in \mathcal{J}(S,T)} \exp(\mu_{ST} \cdot V_{ik}^{ST})\right)$.

These values are then used in the second step to estimate household preferences for dwelling type and tenure status. This step involves the simultaneous estimation of equations for dwelling type and tenure choice. Equations (11) to (13) are estimated to determine the parameters for the unconstrained model, while Eq. (11), (12), (15) (16) are used for the constrained model.

5.1 Location choice

The first step of our estimation requires both data on households that relocated in 1998 and on local amenities. By aggregating some Census variables by pseudo-commune, we derive local characteristics such as the proportions of low-income and high-income households, as well as households consisting of one or two members.

Furthermore, Census data facilitated the assessment of housing demand within each pseudo-commune, segmented by dwelling type and tenure status for 1998. By correlating these demands with the number of vacant dwellings in each pseudo-commune, we could gauge the supply of housing, detailed by dwelling type. In Paris and its immediate suburbs, the housing supply primarily consists of flats. In contrast, the suburbs offer a more balanced mix of houses and flats, with a notably high proportion of flats in the eastern part of the region. Local dwelling

prices (per square metre) are published by *Editions Callon* in their "Annual Guide to Market Values" at the commune level, with separate entries for renting and buying, and for flats and houses. Unfortunately, this guide is limited to communes with over 5,000 inhabitants, which in 1998 included only 287 communes along with the arrondissements of Paris. Since prices per square meter in other communes are unavailable, a hedonic price model is used to estimate these values, which are subsequently aggregated by pseudo-commune.

Given that our analysis focuses on the choice between *pseudo-communes* rather than between specific dwellings, the alternatives in the model represent a set of statistically identical actual alternatives. To accommodate this aggregation, the logarithm of the number N of dwellings in each *pseudo-commune* is included among the explanatory variables (see, McFadden, 1978 for a justification; for further details, we refer the reader to de Palma et al., 2005).

The extensive number of alternatives (725) presents computational challenges in the estimation process, notably the computational burden and probabilities very close to zero. To circumvent these issues, we employ sampling within each nest of our model (see Ben-Akiva and Lerman, 1985). As the Independence from Irrelevant Alternatives (IIA) assumption is valid among alternatives within the same nest (but not across different nests), consistent estimates of the preference parameters can be achieved through random sampling of *pseudo-communes* at the lower tier of our model. In our empirical application, 8 *pseudo-communes* are included in each household's choice set (see Hensher, Rose, Greene, 2005 and Train, 2009). Our sampling method ensures that the chosen alternative is always included in the sample. To account for the sampling, we add a corrective term in the utility equation. Results corresponding to Eq. (5), estimated separately by tenure status and dwelling type, are presented in **Table 1**.

The intrinsic preference for the different *départments* display notable differences by tenure status and dwelling type. For instance, the negative coefficients for flats for *department* 93 indicate a lower likelihood, *ceteris paribus*, of choosing a commune located in *Seine-Saint-Denis* (rather than in the reference, Paris), for households moving to a flat. Economic factors, such as price and local taxes, influence decisions as expected, with higher costs decreasing the likelihood of selecting a more expensive housing option.

As anticipated, across all samples, price negatively impacts the probability of selecting a location. The absolute value of price elasticity decreases among wealthier households, as demonstrated by the positive interaction effect between price and the centred log income per capita. Conversely, the interaction between price and the age of the household head suggests that price elasticity increases with age, especially for flats.

The strong positive effect of the "*Same County*" indicator -indicating whether a *pseudo-commune* is within the same county as the household's previous residence- highlights a significant preference for relocating close to the prior location. This preference likely stems from households' reluctance to leave areas where they have established routines and social ties (see Liaw and Frey, 2003). Notably, the *Same county* effect diminishes as per capita income rises but becomes stronger with the age of the household head, reflecting greater geographical mobility earlier in the lifecycle.

The accommodation tax rate discourages households, particularly among richer households moving to a flat, and poorer households moving to a house.

Table 1: Location choice

	rent		**Buy**		
	flat	house	flat	House	
Seine-et-Marne (77)	0.295	***0.455	***0.424	***2.096	***
Yvelines (78)	0.302	***0.446	***0.826	***1.915	***
Essonne (91)	0.328	***0.374	***0.565	***2.018	***
Hauts-de-Seine (92)	0.090	0.477	***0.186	***1.345	***
Seine-Saint-Denis (93)	-0.223	***2.170	***-0.180	***2.760	***
Val de Marne (94)	-0.036	1.655	***0.279	***2.328	***
Val d'Oise (95)	0.257	***0.449	***0.719	***2.006	***
Corrective term	-0.873	***-1.086	***-0.835	***-0.913	***
Log(N)	0.958	***0.787	***1.069	***0.811	***
Log(price)	-0.699	***-0.073	-0.785	***-1.419	***
Log(price)*(age-20)/10	-0.390	***-0.354	***-0.093	***0.012	
Log(price)* centered log income	3.762	***0.661	***4.049	***4.078	***
Same district	2.125	***2.748	***2.007	***2.452	***
Same district *centered log income	-0.783	***-0.521	***-0.715	***-0.428	***
Same district*(age-20)/10	0.138	***0.120	***0.149	***0.194	***
Accommodation tax rate	-0.003	***-0.017	***0.003	-0.017	***
Accommodation tax rate *centered log income	-0.030	***0.022	***-0.006	0.053	***
Number railway stations	0.009	***-0.006	-0.008	***-0.048	***
Number railway stations*centered log income	0.022	***0.065	***0.024	***0.121	***
Number subway stations	0.001	-0.006	-0.016	***-0.008	
Number subway stations*centered log income	0.028	***-0.026	***0.003	0.022	***
Airport noise	-0.024	** -0.090	***0.181	***-0.020	
Density	0.000	-0.022	***0.012	***-0.021	***
Fraction of surface with: forest	0.064	***-0.173	***0.216	***-0.020	
forest*#children	-0.188	***0.497	***0.374	***-0.066	
public gardens	0.212	***-0.454	***0.131	-0.585	***
public gardens*#children	0.212	***0.660	***0.247	** 0.682	***
lake	-0.805	***-0.739	***-0.307	** -0.870	***
lake/river*#children	0.236	***0.359	0.585	***-0.424	**
urban renewal zone	0.118	** -0.246	0.137	-0.123	
public administration	0.504	***-1.357	***0.166	-1.963	***
infrastructures	-0.168	-0.290	-2.675	***-0.877	*
hospitals	-0.125	* 0.639	* -0.665	***-0.325	
sport areas	-0.059	-0.166	1.324	***0.623	***

% build before 1915	-0.012	*** 0.004	** -0.013	*** -0.001	
% build in 1915-1967	-0.001	*** 0.002	*** -0.004	*** 0.005	***
% build after 1989	0.001	0.009	*** 0.006	*** 0.009	***
Homogamy_poor	0.391	*** 1.494	*** -2.984	*** 1.840	***
Homogamy_middle income	0.682	*** 1.258	*** -0.389	* 4.844	***
Homogamy_rich	2.591	*** 3.182	*** 3.780	*** 2.901	***
Homogamy_young	3.396	*** -2.540	*** 2.613	*** -3.152	***
Homogamy_middle age	-0.107	-0.423	** -0.516	*** -0.205	
Homogamy_old	0.625	*** 0.944	4.029	*** 1.664	***
Homogamy_1-person hh	3.173	*** 1.828	*** 3.539	*** 1.134	***
Homogamy_2-person hh	0.256	1.976	*** 1.499	*** 3.033	***
Homogamy_+2-person hh	2.447	*** 1.966	*** 0.406	*** 0.263	**
Homogamy_no-active hh	0.598	*** 0.750	4.228	*** 1.778	***
Homogamy_1-active hh	1.433	*** -1.159	*** 1.324	*** -2.929	***
Homogamy_2-active hh	0.674	*** 1.193	*** 1.720	*** 2.824	***
Homogamy-foreign head	6.601	*** 3.968	*** 7.079	*** 6.251	***
Pseudo-R^2	0.2991	0.1862	0.2986	0.2104	
Log-likelihood	-711184	-60810	-136373	-119248	
# observations	368931	27127	70437	54637	

The richest households moving to a flat enjoy the proximity of subway and railway stations, whereas the effect of stations id more mitigate for households moving to a house, or poorest households. This ambiguous effect may be related to adverse externalities associated with such infrastructure, such as noise and crowding, partially balancing the positive effect of stations on accessibility. This balanced result may be explained by the fact that wealthier households place greater value on accessibility or can afford measures to mitigate the negative impacts.

Airport noise has a negative effect on the likelihood of selecting a location if living in a house, whereas its impact is less significant or occasionally positive for those living in a flat. This contrast may arise because house occupants often have gardens where noise is more disruptive, whereas proper insulation may protect against noise in flats.

More population density attracts households seeking a flat, but negatively affects those seeking a house, reflecting house occupants' aversion to externalities associated with high density.

The likelihood of enjoying their private garden may explain why childless house occupants are less inclined to live in communes where a significant portion of the land is devoted to public gardens, woods, and lakes. In contrast, this variable has either an insignificant or a positive effect on the location choices of households seeking flats. The marginal utility of most of these green amenities increases with the number of children.

The provision of public services (measured by the proportion of land dedicated to administrative buildings, infrastructures, hospitals, and sports facilities) has mixed effects on utility. This ambiguity likely stems from a balance between the attraction to these services and

the reluctance to bear the associated local tax burden. See Aqzzouz and Picard (2024) for a deeper analysis of household sensitivity to local amenities over the life cycle.

The presence of a larger proportion of old buildings decreases the probability of choosing a commune when looking for a flat, which may reflect the fact that old flats might have a larger use cost (energy, charges…). In contrast, both the percentage of recent buildings (after 1989) and old ones (built before 1967) have a positive effect on house-occupants' utility. The architectural quality and prestige of old dwellings appear to be valued in location decisions for households who can afford living in a house.

The interaction effect between a household characteristic x and the proportion of similar households (denoted as Homogamy_x in **Table 1**) underscores the self-attracting tendencies among families sharing attributes such as income, household composition, number of working members, or the nationality of the household head. However, some exceptions emerge: households with a single active member tend to avoid living near others with similar characteristics when selecting a house, and poorer households may avoid flats in areas heavily populated by other low-income households.

5.2 Tenure status and dwelling type

Focusing on households who moved in 1998, Table 2 shows that Paris mainly attracts singles, foreigners and rich households, whereas the outer ring rather attracts couples with children, French and medium-income households. Renting is more common among young, singles, poors and foreigners, whereas ownership is more specific to couples with children, to older, richer and French households. Qualitatively similar results (available on request) hold for the whole population, although the distributions are quantitatively different between the stock and the flow of movers (about 10% of households move each year in Ile-de-France).

Table 2: Distribution of location, tenure status and dwelling type for households which moved in 1998

	Paris	Inner Ring	Outer Ring	Rent flat	Own Flat	Rent House	Own House
Total	27.58%	36.35%	36.07%	70.79%	13.52%	5.21%	10.48%
Single	38.23%	34.66%	27.11%	81.08%	13.99%	2.74%	2.20%
couple w/o children	27.13%	35.97%	36.90%	69.53%	15.08%	5.28%	10.10%
couple with children	15.64%	38.61%	45.75%	59.92%	11.74%	8.00%	20.35%
Young	28.92%	36.09%	34.99%	79.07%	10.03%	4.49%	6.41%
middle-age	25.12%	36.99%	37.89%	60.73%	15.79%	6.82%	16.66%
Old	28.54%	35.61%	35.85%	58.30%	25.80%	3.63%	12.27%
Poor	26.90%	39.26%	33.84%	83.92%	8.84%	3.86%	3.38%
medium income	25.99%	35.52%	38.48%	69.93%	13.09%	5.71%	11.28%
Rich	31.03%	33.49%	35.48%	53.35%	20.88%	6.35%	19.43%
French	27.24%	35.16%	37.60%	69.10%	14.46%	5.35%	11.09%
Foreign	29.53%	43.10%	27.37%	80.38%	8.19%	4.37%	7.06%

The distribution of the flow of population (bottom part of Table 3) is significantly different from the stock (upper part of Table 3). For example, owners represent nearly half of the stock, but only a quarter of movers. The fraction of owners is larger in the outer ring (60% of the stock, 32% of movers) than inside Paris (about one third of both the stock and the movers). The fraction of houses (as opposed to flats), either rented or owned, is negligible in Paris (around 1%), whereas it is above 10% of movers and 20% of the stock in the inner ring, and about one third of movers and half the stock of households in the outer ring.

Table 3: distribution of households by tenure status, dwelling type and location

		Rent Flat	Own Flat	Rent House	Own House
All households	Total	49.45%	21.98%	3.45%	25.11%
	Paris	66.49%	32.46%	0.45%	0.60%
	Inner Ring	55.61%	23.55%	2.50%	18.33%
	Outer Ring	33.74%	14.39%	6.10%	45.78%
Movers	Total of Movers	70.79%	13.52%	5.21%	10.48%
	Paris	82.55%	16.60%	0.55%	0.30%
	Inner Ring	75.27%	14.26%	3.35%	7.12%
	Outer Ring	57.30%	10.41%	10.63%	21.66%

Table 4 presents the determinants of dwelling type and tenure status, first neglecting borrowing constraints (left part), then assuming a homogenous probability to be constrained (*Simplified model* in the middle part), and finally considering a heterogeneous probability to be constrained (*Extended model* in the right part).

Here, the parameters of the probability to be constrained (Eq. (16)) are not obtained from the observation of constraint but inferred from the structure of the model by observing only the chosen dwelling. The drawback of such models is the lack of concavity of the log-likelihood, which may lead to a local maximum. To circumvent this problem, we implemented an "Expectation-Maximization" algorithm to maximize the log-likelihood[4] of the models assuming borrowing constraints.

Starting with **dwelling type choice**, the most striking result concerns the effect of log-income, which significantly reduces the probability of selecting a house conditional on buying, but increases the probability of selecting a house conditional on renting. The effect of income on selecting a house conditional buying is severely biased when borrowing constraints are

[4] This algorithm consists in iterating an Expectation step and a Maximization step, until the convergence of the estimated coefficients. The « Maximization » step consists in estimating the coefficient of the model by maximizing the log-likelihood for a given value of the probability to be constrained. The « Expectation » step consists in deducing a value of this probability from the estimated coefficients. The seminal paper by Dempster, Laird, and Rubin (1977) formally introduced the EM algorithm and is a foundational reference for understanding how the algorithm works, including its theoretical basis and applications.

neglected. Indeed, the coefficient of log-income is divided by more than 2 when considering a heterogeneous probability of being constrained (right part of Table 4). This suggests that the main reason for poor (or intermediate-income) households to select a flat rather than a house when they buy their dwelling is not that they prefer flats, but rather that they are denied the right to borrow an amount large enough to afford a convenient house.

Consistent with the assumptions of the nested logit, he coefficients of inclusive values I_{iT}^{S} (maximum expected utility conditional on dwelling type *T*) appearing in Eq. (12) are positive and less than one. The inclusive value coefficients are larger for houses than for flats, suggesting more unobserved heterogeneity in the utilities provided by flats than by houses. The inclusive value coefficient are smaller for dwellings for sale, suggesting that the unobserved quality of housing services offered by dwelling for sale is less homogeneous than that offered by dwelling for renting. The inclusive value coefficients are hardly affected by borrowing constraints.

As anticipated, the presence of children significantly increases the likelihood of selecting a house, especially for owners. The magnitude of this effect peaks at 3-6, and then slowly diminishes with children's age, possibly reflecting a reduced emphasis on house (as opposed to flats)-specific dwelling amenities as children grow older and become more likely to leave home.

Turning to **tenure choice**, the most striking result once again concerns the effect of log-income, which is positive and highly significant when borrowing constraints are neglected, positive and highly significant when heterogeneous borrowing constraints are considered, and non-significant when the same probability to be constrained is assumed for all households. This suggests that the observed effect of income on the decision to buy a dwelling is a mix of the effect of income on preferences for ownership and on the probability to be denied the right to borrow a large enough amount. Increasing income does not increase the preference for ownership, but the capacity to borrow (since it reduces a lot the probability to be constrained).

An increased number of children is associated with a greater likelihood of homeownership, likely driven by the intent to leave a future inheritance to children. This effect peaks for children aged 3-6. Given that the birth of children typically occurs early in the lifecycle, this pattern aligns with the theoretical observation that younger households are more inclined to own their homes, as noted by Artle and Varaiya (1978) and Öst (2012).

Household head employment status significantly impacts the appeal of homeownership, but once again, the measured effect of employment status on ownership is severely biased by the omission of borrowing constraints. When the household head is unemployed or has a temporary contract, this does not reduce his preference for ownership, but his capacity to borrow (since it

increases his probability to be constrained). Conversely, when the household head is retired, this increases his capacity to borrow, and hence his probability to buy his dwelling, although this reduces his preference for buying. Neglecting borrowing constraints would make retired households' behaviour apparently inconsistent with the Artle and Varaiya's (1978) findings that older individuals tend to liquidate housing capital and rent at the end of their life-cycle.

Similarly, the preference for ownership is considerably reduced when the household head is inactive, whereas the probability to be owner is only marginally reduced. This may be explained by the fact that inactive household heads are rich enough to be less likely constrained.

Public sector workers have a slightly lower likelihood of purchasing a home than their counterparts in the private sector, but this difference is not explained by preferences.

The impact of income on homeownership likelihood becomes significantly negative, indicating that as income rises, preference for homeownership declines. However, the strong negative correlation between income and liquidity constraints suggests that this effect is less about preference and more about financial eligibility. Wealthier households are more likely to own homes not because they desire homeownership more but because they are better positioned to meet financial requirements.

Employment status also affects homeownership, with inverse coefficients (except for inactive and self-employed heads). For instance, households with retired heads show lower purchase propensity in this model but higher in the unconstrained model. This aligns with Artle and Varaiya's (1983) findings that retired households are generally less inclined toward homeownership. Similarly, employment status influences homeownership not through preferences, shaped by life-cycle effects and income paths, but through constraints.

The number of children significantly impacts utility, suggesting that the asset transmission motive linked to homeownership may be more critical than indicated by the nested model. The inclusive value for the "own" nest exceeds its previous estimate and the theoretical upper bound of one, while the "rent" nest value decreases significantly. This indicates that variability in rental choices is primarily driven by liquidity constraints.

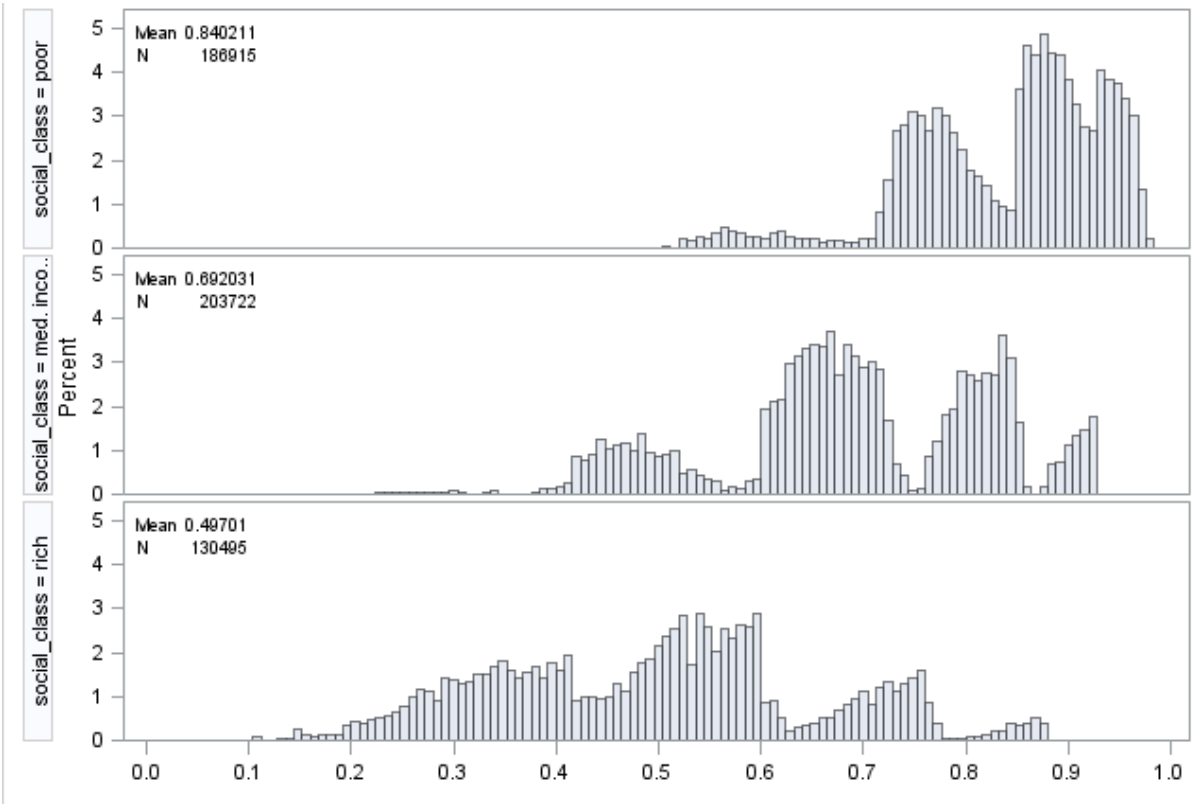
The analysis also reveals an inverse relationship between income and the likelihood of facing constraints, with higher income reducing the probability of being constrained. Households led by retirees or self-employed individuals are less likely to face constraints compared to those headed by unemployed individuals or those on temporary contracts. This relationship explains the shifting impact of employment status on homeownership. Additionally, owning more cars reduces the likelihood of constraints, stressing the role of wealth in easing liquidity constraints.

Table 4: Choice of tenure and dwelling type in the model with and without constraints

	Without contraints		Simplified model		Extended model	
Dwelling type choice	**own**	**rent**	**own**	**rent**	**own**	**rent**
Inclusive value (house)	0.451 ***	0.510 ***	0.444 ***	0.515 ***	0,397 ***	0,519 ***
Inclusive value (flat)	0.176 ***	0.455 ***	0.188 ***	0.458 ***	0,283 ***	0,454 ***
Intercept (house)	-0.596 ***	-3.330 ***	-0.528 ***	-3.348 ***	0,135 ***	-3,41 ***
#centered log income	-10.577 ***	5.662 ***	-9.767 ***	5.675 ***	-4,46 ***	5,625 ***
# children <3 years	0.772 ***	0.267 ***	0.782 ***	0.261 ***	0,878 ***	0,243 ***
# children aged 3 to 6	0.861 ***	0.338 ***	0.870 ***	0.333 ***	0,928 ***	0,325 ***
# children aged 7 to 11	0.725 ***	0.311 ***	0.731 ***	0.306 ***	0,763 ***	0,3 ***
# children aged 12 to 16	0.601 ***	0.292 ***	0.601 ***	0.288 ***	0,619 ***	0,284 ***
# children aged 17 to 18	0.501 ***	0.245 ***	0.496 ***	0.243 ***	0,514 ***	0,234 ***
Tenure choice						
Inclusive value (own)	0.451 ***		0.620***		1.837***	
Inclusive value (rent)	0.316 ***		0.411***		1.560***	
Intercept (own)	-0.694 ***		-0.162***		3.899***	
#centered log income	0.529 ***		0.018		-10.376***	
#foreign	-0.402 ***		-0.440***		-0.815***	
# children <3 years	0.120 ***		0.144***		0.836***	
# children aged 3 to 6	0.149 ***		0.184***		1.400***	
# children aged 7 to 11	0.052 ***		0.068***		0.692***	
# children aged 12 to 16	0.014		0.026*		0.739***	
# children aged 17 to 18	-0.009		0.006		0.702***	
# hh head's employment status:						
permanent-contract worker	-		-		-	
self-employed	0.158 ***		0.252***		0.118**	
temporary-contract	-0.828 ***		-0.906***		0.167**	
public-contract	-0.102 ***		-0.118***		0.066	
retired	0.215 ***		0.226***		-1.382***	
unemployed head	-0.778 ***		-0.856***		0.811***	
inactive head	-0.054 **		-0.061**		-1.200***	
Probability to be constrained						
Intercept			-0.978***		1.628***	
#centered log income					-1.418***	
# hh head's employment status:						
permanent-contract worker					-	
self-employed					-0.070***	
temporary-contract					0.802***	
public-contract					0.088***	
retired					-0.886***	
unemployed head					0.811***	
inactive head					-0.395***	
#1 car in hh					-0.754***	
#2 cars in hh					-1.485***	
Pseudo-R^2	0.4197		0.4201		0.4326	
Log-likelihood	-419249		-418930		-409881	
#observations	521132		521132		521132	

The probability of households being financially constrained is illustrated in Figures 5 and 6. As depicted in Figure 4, while income per capita does not perfectly distinguish between constrained and unconstrained households, the distribution of the probability to be constrained shifts towards lower values as income increases. Specifically, this probability ranges from 55 to 100% among low-income households, from 35 to 90% among middle-income households, and is below 85% among high-income households. These figures are significantly higher than the uniform probability of 27.32% derived from the initial estimation using the latent choice set model, indicating that this model tends to underestimate the significance of financial constraints. In subsequent analyses, any references to the latent choice set model, or the model with constraints, will pertain to the "extended" model that incorporates a household-specific probability of being constrained.

Figure 4: Distribution of the probability to be constrained among rich, medium-income and poor households

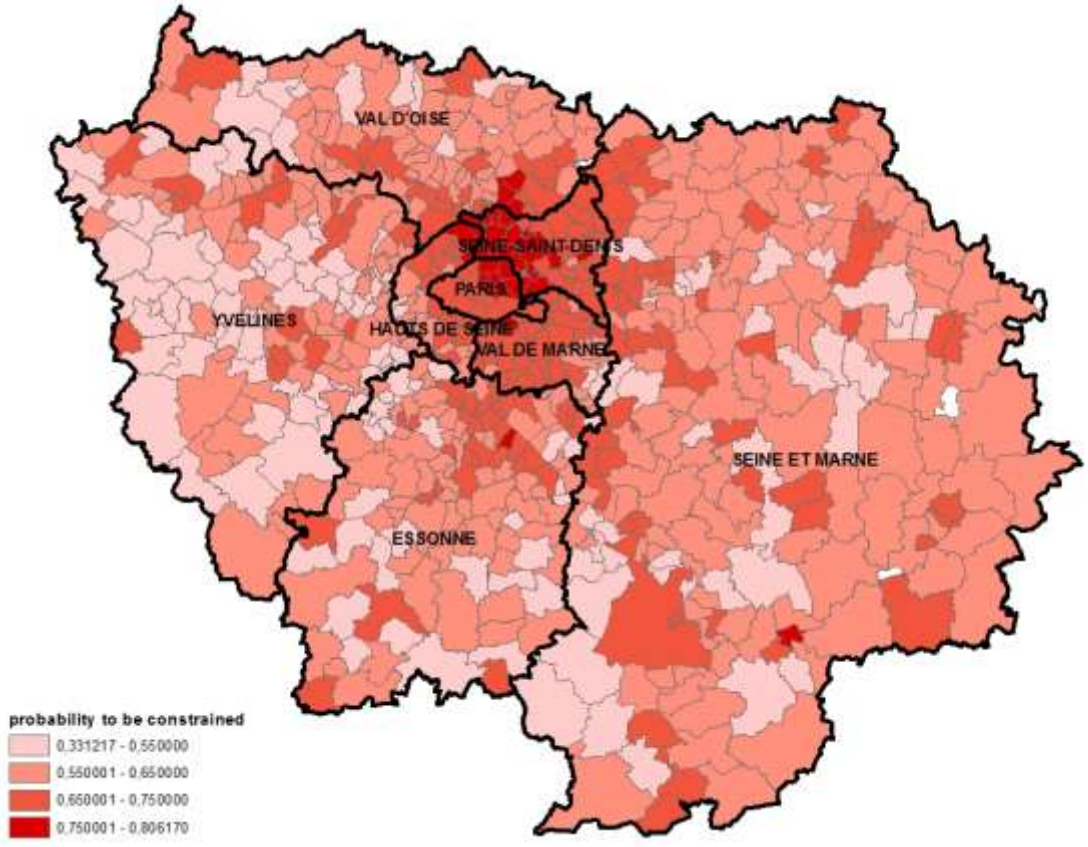


The distribution of the constrained households among the households is far from being geographically uniform and is very close to the distribution of poor households. As the map in Figure 4 shows, the percentage of constrained households among the movers (which is equivalent to the mean probability to be constrained) is higher in Paris and the cities at the north-east of Paris (particularly the Seine-Saint-Denis district). The Seine-Saint-Denis district is known to be one of the poorest in France and to concentrate many poor, mono-parental, or

foreign families The high level of constraints among households who choose to move there is not surprising. In Paris however, the high level of constraint among Paris immigrants might be due to a strong proportion of low- and middle-income singles who can't afford to buy their home but can afford to rent in Paris.

Further from Paris, the distribution of constrained movers is less clear: at the West, households which installed in 1998 are less constrained whereas, at the East, pseudo-communes with high and low proportions of constrained immigrant households are mixed.

Figure 5: Proportion of constrained households among movers by pseudo-commune



In conclusion, the distribution of financial constraints among relocating households highlights significant socioeconomic inequalities. These disparities are particularly evident in regions like Seine-Saint-Denis, where economic hardship strongly correlates with limited mobility. Similarly, in Paris, the prevalence of low- to middle-income singles demonstrates how economic barriers restrict homeownership opportunities, leaving rental options as the primary alternative. The movement of constrained households further from Paris—ranging from the less constrained western areas to the economically diverse eastern regions—illustrates the complex relationship between geography and economic mobility. This geographic variation in financial constraints underscores the need for targeted housing policies that address the unique

challenges of different communities, promoting more equitable housing opportunities throughout the region.

Building on these findings, the next section explores the potential effects of removing financial constraints on household mobility and housing choices through a simulation, providing insights into how these changes might reshape the distribution of relocating households across the region.

6 Simulation results: Changes in destinations

A simulation was conducted to cancel (nullify) the probability of being constrained (from the model with constraints) in order to assess how the distribution of moving households would appear under the hypothetical scenario where changes in demand do not influence prices.

Such a cancellation modifies the probability of owning a dwelling and consequently the choice probability of each pseudo-commune: $\sum_{\substack{T\in\{\text{house,flat}\}\\S\in\{\text{own,rent}\}}} P_i(j|T,S)$. By modifying the allocation of households among house-owners, house-tenants, flat-owners, and flat-tenants, the cancellation of the latent constraints modifies the valuation (and then the demand) for a pseudo-commune.

This simulation should be approached with caution, as it does not account for the potential impact of increased demand on dwelling prices or the longer-term effects on local characteristics, such as social composition and school quality. It is likely that changes in demand would trigger price adjustments, potentially offsetting some of the benefits of removing financial constraints. Consequently, these partial-equilibrium simulations may not fully capture the demand patterns that could emerge with improved access to financial markets.

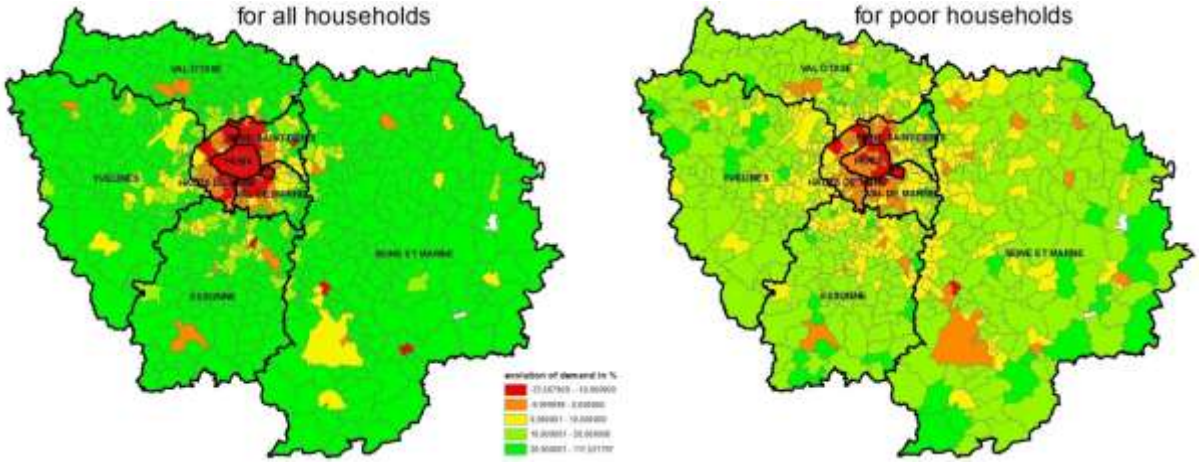
Demands for a pseudo-commune are simulated by aggregating households' predicted probability of choosing it. Predictions are achieved first under the assumption that the actual probability to be constrained equals its predicted value and then under the hypothesis that this probability equals zero for poor households. Comparing the two corresponding demands indicates strong changes in the demand for some pseudo-commune when the latent constraint is cancelled.

As illustrated in Figure 7, if latent constraints were removed for all households while keeping prices and socio-demographic composition constant, demand for housing in Paris and its nearby suburbs would decrease. Conversely, demand would rise slightly in the more distant pseudo-communes of the Inner Ring and increase progressively as the distance from Paris grows. Specifically, predicted demand in the Outer Ring would rise by less than 10% in pseudo-

communes near the central counties, between 10% and 20% in western and southern pseudo-communes farther out, and by more than 20% in eastern pseudo-communes located further from Paris. This asymmetry may be explained by higher housing prices in the western part of Paris compared to the eastern areas.

If latent constraints were removed exclusively for relocating households with the lowest per capita income, while holding prices and socio-demographic composition constant, the decrease in demand for Paris would be slightly smaller, and the increase in demand for more distant suburbs would be less pronounced. This suggests that low-income households are not the only ones likely to move farther from the central district when liquidity constraints are lifted. To better understand the factors driving the reduced appeal of central districts and the growing attraction to the Outer Ring, Table 5 examines the distribution of households by county, dwelling type, and tenure status across different income categories.

Figure 6: Evolution in the demand (%) when probability to be constrained is cancelled



The strong suburbanization trend would primarily result from a decline in demand for rental dwellings, which would be only partially offset by an increase in demand for purchased dwellings in Paris. This decline would particularly affect the demand for rental flats, while the rise in ownership demand would include both flats and houses (except in Paris, where houses are exceedingly scarce). In other districts, a similar pattern would emerge; however, due to a larger supply of houses, the surge in demand for houses for sale would significantly outweigh the decline in demand for rental properties. As a result, demand would decrease slightly in Paris but rise sharply in other areas, particularly in the eastern pseudo-communes, where a greater availability of houses at lower prices per square meter drives the trend.

The increase in demand for more distant suburbs among poorer households clearly indicates that relaxing liquidity constraints would enhance their land consumption more than their preference for local quality-of-life factors. While this shift could reduce the concentration of

low-income households in pseudo-communes near Paris, it may also lead to a higher presence in the Eastern pseudo-communes. Consequently, the overall effect on residential segregation within the Paris region remains uncertain and requires further study.

Table 5: Simulated destinations of households from model with constraints by district, dwelling type and tenure status

			Actual choices				Preferred choices				Changes in poor households' demand	
			all	Poor	Med.	Rich	all	Poor	Med.	Rich		
Paris (75)	flat	rent	22.90	25.01	22.46	20.58	8.20	8.43	8.12	8.00	-5.95%	2.33%
		own	3.69	1.79	3.20	7.16	12.58	11.90	11.69	14.94	3.63%	
	house	rent	0.24	0.26	0.20	0.27	0.06	0.06	0.05	0.09	-0.07%	
		own	0.12	0.05	0.07	0.32	0.32	0.24	0.22	0.60	0.07%	
Hauts-de-Seine (92)	flat	rent	11.28	6.67	5.21	2.92	1.38	1.77	1.27	1.00	-2.95%	-0.53%
		own	2.44	0.63	0.88	1.00	3.03	4.01	2.78	2.03	2.27%	
	house	rent	0.44	0.77	1.19	1.17	0.23	0.16	0.22	0.34	-0.10%	
		own	0.71	0.78	3.12	3.85	6.94	4.22	9.20	7.28	0.25%	
Seine-St-Denis (93)	flat	rent	7.73	8.00	6.25	5.07	1.82	2.13	1.59	1.73	-2.88%	-0.23%
		own	1.16	1.17	1.52	2.84	5.96	7.37	4.87	5.64	2.37%	
	house	rent	0.58	0.65	1.00	1.58	0.24	0.14	0.20	0.47	-0.16%	
		own	0.95	0.63	2.06	4.19	5.48	3.35	6.00	7.73	0.90%	
Val-de-Marne (94)	flat	rent	7.27	6.80	5.19	3.17	1.42	1.79	1.30	1.07	-2.31%	0.07%
		own	1.57	0.84	1.08	1.35	3.96	5.40	3.42	2.73	2.04%	
	house	rent	0.46	0.47	0.76	0.95	0.16	0.10	0.15	0.28	-0.10%	
		own	0.86	0.54	1.98	3.03	4.73	2.93	5.77	5.67	0.44%	
Essonne (91)	flat	rent	5.26	11.94	11.21	10.46	3.68	3.70	3.51	3.92	-1.79%	0.56%
		own	1.06	1.20	2.11	4.71	7.82	7.53	7.09	9.38	1.64%	
	house	rent	0.71	0.35	0.42	0.60	0.11	0.08	0.09	0.18	-0.13%	
		own	1.73	0.18	0.50	1.78	1.68	0.87	1.47	3.17	0.86%	
Seine-et-Marne (77)	flat	rent	5.16	10.82	7.54	3.60	2.05	2.78	1.89	1.23	-1.76%	0.47%
		own	0.82	1.13	1.34	0.92	5.04	7.75	4.53	1.94	1.21%	
	house	rent	1.03	0.56	0.66	0.48	0.12	0.11	0.11	0.13	-0.22%	
		own	2.47	0.53	1.27	1.03	3.13	3.04	3.91	2.04	1.23%	
Yvelines (78)	flat	rent	6.58	8.93	7.31	4.82	2.11	2.50	2.01	1.70	-2.11%	0.91%
		own	1.73	1.07	1.61	2.22	5.63	6.76	5.31	4.50	2.23%	
	house	rent	1.02	0.36	0.48	0.56	0.10	0.07	0.09	0.16	-0.18%	
		own	2.08	0.29	0.93	1.57	2.34	1.51	2.74	2.94	0.97%	
Val d'Oise (95)	flat	rent	4.58	5.78	4.62	2.81	1.19	1.46	1.09	0.94	-1.55%	0.61%
		own	0.99	0.73	1.02	1.29	3.65	4.74	3.30	2.61	1.44%	
	house	rent	0.73	0.53	0.81	0.89	0.16	0.11	0.15	0.25	-0.15%	
		own	1.67	0.54	1.97	2.81	4.69	2.98	5.87	5.30	0.87%	

In all counties, the decline in rental demand would impact all income groups, whatever dwelling type. However, the rise in ownership demand does not exhibit the same uniformity. Demand for both flats and houses would increase among middle-income households and even more among poor households. In contrast, demand among wealthy households for flats would remain relatively unchanged, while their demand for houses would rise significantly. This suggests that

latent constraints not only restrict the ability of poor and middle-income households to access homeownership but also limit wealthier households' housing service consumption, thereby encouraging greater land consumption among the affluent.

Table 6: Social composition of new households' population

	Actual choices			Preferred choices		
	Poor	Med.	Rich	Poor	Med.	Rich
Paris (75)	36.07%	37.60%	26.32%	30.04%	41.16%	28.81%
Hauts-de-Seine (92)	32.96%	37.47%	29.56%	30.48%	38.86%	30.66%
Seine-St Denis (93)	44.91%	40.57%	14.52%	46.08%	39.71%	14.21%
Val de Marne (94)	37.61%	39.78%	22.61%	38.03%	39.51%	22.45%
Seine-et-Marne (77)	33.47%	42.89%	23.63%	36.64%	40.85%	22.51%
Yvelines (78)	32.84%	37.13%	30.03%	37.82%	34.38%	27.80%
Essonne (91)	35.45%	40.26%	24.29%	39.36%	37.82%	22.82%
Val d'Oise (95)	34.17%	41.34%	24.48%	38.86%	38.40%	22.74%

Section 6 highlights the complexities of location choice, tenure status, and household decision-making, particularly in the context of liquidity constraints. It examines how these financial barriers shape residential segregation by influencing household mobility and relocation decisions. By modelling preferences for housing characteristics and tenure (ownership versus rental) and analysing the role of liquidity constraints, the section explores how alleviating these constraints could alter household behaviour. Using a normative framework that assumes fixed prices, the analysis compares the spatial distribution of households under scenarios with and without constraints. The findings suggest that while easing access to homeownership for low-income households might seem beneficial, it could unintentionally intensify residential segregation, undermining the anticipated advantages of improved social mobility. This nuanced relationship underscores the importance of designing policies that account for the intricate effects of financial constraints on urban residential patterns.

7 Concluding comments

This chapter serves as a comprehensive review, introducing a variety of modelling and econometric tools applied specifically to the Paris region. However, the insights gained extend far beyond this particular context. By examining how household characteristics and liquidity constraints influence residential location, dwelling type, and tenure status, the chapter provides a framework that can be adapted to analyse similar dynamics in other urban areas. The methodologies and findings discussed are highly transferable, offering valuable lessons for addressing residential mobility, segregation, and housing market dynamics globally.

In addition to the approaches explored here, other frameworks merit attention for their potential to enrich our understanding of residential patterns. For instance, agent-based models and machine learning techniques (Mullainathan, Spiess, 2017) can capture the complexity of individual decision-making and interactions in ways that traditional econometric models cannot (see Brueckner, 2011 and Glaeser, Gyourko, 2018). Behavioural economics approaches (Thaler, Sunstein, 2009). could also shed light on how cognitive biases and social norms influence location and housing choices). Incorporating these methods alongside the structural models reviewed in this chapter could provide a more holistic perspective on the interplay between economic constraints, preferences, and urban development.

More specifically, in this chapter, we analyse how households choose their residential location, dwelling type, and tenure status, and how these choices are impacted by liquidity constraints. It is evident that household characteristics influence not only location choice but also decisions regarding dwelling type and tenure status. For instance, the likelihood of choosing a house strongly correlates with household size, while tenure status choices are primarily influenced by the characteristics of the household head. Introducing constraints into the discrete choice model reveals that poorer households have a significantly stronger preference for buying than the unconstrained model suggests.

Simulated demands under various assumptions highlight the critical role of liquidity constraints. Alleviating these constraints would substantially alter market (dis)equilibrium prices, the social composition of locations, and the local balance of dwelling types, necessitating significant construction, particularly in the Outer Ring, while leaving some urban flats and houses vacant. The broad effects of unconstrained demand suggest that meeting such demand with additional supply would be challenging due to market imperfections.

The potential removal of liquidity constraints would also significantly impact rental prices in Paris, making renting less attractive compared to buying, thus reducing purchase prices within the city. Furthermore, while simulations indicate that eliminating liquidity constraints does not necessarily improve social mixing, they suggest changes in the residential patterns of wealthier households might (slightly) alter segregation dynamics, particularly if only poorer households benefit from relaxed constraints. In such scenarios, policy interventions like zero-interest loans might have minimal impact on segregation across the Paris region, potentially increasing suburbanization among lower-income groups without attracting middle-income and wealthier residents to these areas.

These findings imply that social sorting is largely influenced by households' preferences for land and public amenities. Therefore, mitigating segregation effectively might require enforced

social mixing strategies, such as building public housing in affluent areas or subsidizing wealthier households to move into less affluent neighbourhoods, as proposed by Bénabou (1995). This approach could be more effective in enhancing social integration than merely easing financial constraints.

Three additional types of interactions remain to be incorporated into the proposed framework. First, joint family interactions analyzed, e.g., by Picard, Dantan, de Palma (2018) or de Palma, Lindsey, Picard (2015); second, social interactions in the style of Schelling (Schelling, 1971); and third, agglomeration effects (Combes et al., 2012). These effects naturally combine with the financial logic described in this chapter and will amplify segregation. It is important to note that agglomeration effects, whereby geographically clustered firms benefit from increased productivity, add another layer to this dynamic.

This last comment highlights the delicate balance between equity and productivity—a balance that ultimately falls within the realm of political decision-making rather than purely economic analysis. The role of the economist, in this context, is to inform political decisions and the public by providing the necessary insights to foster an informed democratic debate.

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