



On the links between natural amenities, residential processes and urban planning: lessons from an Alpine urban region

Dominik Clemens Cremer-Schulte

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THÈSE

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Présentée par

Dominik Clemens CREMER-SCHULTE

Thèse dirigée par **Madame Nathalie BERTRAND**

préparée au sein de l'UR DTM - Développement des Territoires Montagnards, Irstea, Centre de Grenoble
et de l'École doctorale Sciences Economiques

On the links between natural amenities, residential processes and urban planning

Lessons from an Alpine urban region

Thèse soutenue publiquement le **15 juin 2016**,
devant le jury composé de :

Monsieur JEAN-CHRISTOPHE DISSART

Professeur en aménagement, Université Grenoble Alpes, Président

Monsieur FRANCIS AUBERT

Professeur d'économie, AgroSup Dijon CESAER, Rapporteur

Monsieur MARTIN SCHULER

Professeur de géographie, École polytechnique fédérale de Lausanne, Rapporteur

Monsieur GUILLAUME POUYANNE

Maître de Conférences en sciences économiques, GREThA UMR - CNRS 5113, Examineur

Monsieur BENOÎT PARENT

Urbaniste, Directeur de l'agence d'urbanisme de Grenoble, Invité

Madame NATHALIE BERTRAND

ICPEF/HDR économiste, Irstea, Directrice

Monsieur MIHAI TIVADAR

Chargé de recherches en sciences économiques, Irstea, Co-encadrant



Für Clemens & Gabriele

*Wege entstehen dadurch,
dass man sie geht.*
- Franz Kafka

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Abstract

URBAN regions in and close to the Alps have specific characteristics: they combine a limited land resource for urban development with particular environmental quality in their mountainous hinterland. This combination makes them particularly prone to peri-urbanisation, and potentially social segregation. In the context of continued metropolisation, both of these processes work against central objectives of urban planning, notably compactness of settlement patterns, functional mix, social equity and cohesion. In Alpine urban regions, the links between the mountain environment, urban planning policies and residential processes remain, however, not well understood.

This thesis deals with urban planning and residential decisions in Alpine urban regions. It seeks to understand the links between the mountain environment, urban planning and notably two residential processes: peri-urbanisation and social segregation. Its general objective is to investigate how and to what extent these residential processes are influenced by (i) the mountain environment and (ii) urban planning policies and to develop recommendations for urban and regional planning. The thesis does this via three distinct contributions which use the urban region of Grenoble in the French Alps as a central study area.

The first contribution addresses changes in contemporary urban planning practice in the study region. Based on qualitative research, it focuses on the shift towards strategic spatial planning and on territorial re-scaling towards large urban - peri-urban planning perimeters. The chapter shows the creation of new governance arenas which call into question local planning cultures.

The second contribution investigates the links between preferences for the natural environment, residential location choices and social segregation. Using location choice models for the study region and the Marseille metropolitan area, this chapter presents a counterfactual segregation analysis that compares segregation outcomes “with” and “without” preferences for the natural environment. The main result is that households’ search for natural environments has significant impacts on social segregation. It most

often contributes to reinforcing segregation, but can also be an attenuating factor.

The last contribution investigates the influence of different urban planning policies on residential processes. The chapter develops a residential location choice model in order to predict and analyse residential demand patterns for different planning policy scenarios in terms of concentration, segregation and mountain development. The scenario results show that continued trends in urban planning policies would sustain and potentially reinforce peri-urbanisation in the region. Confining planning policies are found to be capable of curbing and potentially reversing demand dispersion. Policies that aim at re-centralising demand sustain and potentially increase social segregation levels.

The results of this thesis call for a stronger integration of the natural environment in urban and regional planning. If spatial disparities in environmental qualities contribute to residential processes that are detrimental to compact urban forms and an equitable access to environmental quality, then planning should incorporate and account for these disparities in order to prevent further sprawl, socio-spatial fragmentation and environmental inequality, not only in an Alpine urban region context.

Résumé

LES régions urbaines alpines et en proximité des Alpes présentent des caractéristiques spécifiques : elles combinent une ressource foncière limitée pour l'urbanisation et une qualité environnementale particulière dans l'arrière-pays. Cette combinaison les rend particulièrement propices à la péri-urbanisation, et potentiellement à la ségrégation sociale. Dans le contexte d'une métropolisation croissante, ces deux processus entravent des objectifs centraux de la planification urbaine, à savoir la compacité des formes urbaines, la mixité fonctionnelle, l'égalité territoriale et la cohésion sociale. Dans les régions urbaines alpines, les liens entre l'environnement montagnard, les politiques de planification et les processus résidentiels à l'œuvre restent toutefois peu connus.

Cette thèse analyse la planification urbaine et des choix résidentiels en région urbaine alpine. Elle cherche à comprendre les liens entre l'environnement montagnard, les politiques de planification urbaine et deux processus résidentiels : la péri-urbanisation et la ségrégation sociale. Son objectif général est de mettre en lumière comment et dans quelle mesure ces processus résidentiels sont influencés par (i) l'environnement montagnard et (ii) les politiques de planification pour ainsi fournir des recommandations pour la planification territoriale en région urbaine. Pour cela, nous nous appuyons sur trois contributions distinctes en utilisant la région urbaine de Grenoble comme zone d'étude centrale.

La première contribution porte sur les changements dans la pratique de la planification urbaine contemporaine dans la région d'étude. Basée sur une recherche qualitative, elle se concentre sur l'émergence d'une planification territoriale stratégique et sa montée en échelle vers des périmètres de planification plus larges intégrant les espaces péri-urbains. Le chapitre montre la création de nouvelles arènes de gouvernance qui remettent en question les cultures de planification locale.

La deuxième contribution analyse les liens entre les préférences pour l'environnement naturel, les choix de localisation résidentielle et la ségrégation sociale. En utilisant des modèles de choix de localisation pour la région d'étude et la région métropolitaine de

Marseille, cette partie présente une analyse de ségrégation contrefactuelle qui compare les résultats de ségrégation « avec » et « sans » les préférences pour l'environnement naturel entre les deux régions. Le principal résultat est que la recherche des milieux naturels par les ménages a des effets significatifs sur la ségrégation sociale. Cette recherche a le plus souvent tendance à renforcer la ségrégation, mais peut également être un facteur d'atténuation.

La dernière contribution étudie l'influence de la planification urbaine sur les processus résidentiels. Le chapitre développe un modèle de choix discrets pour créer et analyser des simulations de demande résidentielle pour différents scénarios de politique de planification. Les résultats illustrent que les scénarios tendanciels de planification soutiennent et potentiellement renforcent la périurbanisation dans la région d'étude. Des politiques de planification plus contraignantes semblent capables de freiner et potentiellement d'inverser la dispersion de la demande. Les politiques visant à ré-centraliser la demande tendent à maintenir, voire accroître les niveaux de ségrégation sociale.

Les résultats de cette thèse suggèrent l'importance d'une prise en compte plus grande de l'environnement naturel dans la planification urbaine et territoriale. Si les disparités spatiales dans la qualité environnementale contribuent aux processus résidentiels qui portent atteintes à la compacité et à un accès équitable à la qualité environnementale, les politiques de planification devraient rendre compte de ces disparités afin de limiter l'étalement urbain, la ségrégation sociale et l'inégalité environnementale, non seulement dans un contexte de région urbaine alpine.

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Publications

Related and non-related work of the author has previously appeared in the following publications (or has been submitted for publication):

Peer-reviewed publications

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Bertrand, N., **Cremer-Schulte, D.** & Perrin, M. (2015). Strategic Spatial Planning and Territorial Asymmetries. Grenoble and Greater Geneva: Two Alpine City Regions Put to the Challenge of Coherence. *Journal of Alpine Research — Revue de géographie alpine* (online), 103-3, DOI:10.4000/rga.3126.

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Acronyms

AIC Akaike information criterion 147, 151

AURG *Agence d'urbanisme de la région grenobloise* (Urban planning agency of the Grenoble region) 128

CBD Central business district 116, 148, 150, 151, 155, 156, 157, 187

DEM Digital elevation model 121

EPCI *Etablissement public de coopération intercommunale* (Public body for inter-municipal cooperation) 21, 22

FUA Functional urban area 109, 110, 113, 115, 163

GIS Geographical information system 115, 121

INSEE *Institut national de la statistique et des études économiques* (National Institute for Statistics and Economic Studies) 78, 109, 116, 118, 128

LAU Local administrative unit 21

LOESS Local Regression Smoothing 208, 209, 211

LR Likelihood ratio 147

MAUP Modifiable Aerial Unit Problem 194

NUTS Nomenclature of Territorial Units for Statistics 21

OLS ordinary least-squares 107, 108, 147, 150, 208, 209, 211, 216

PNR *Parc naturel régional* (Regional nature park) 110, 121, 128, 134, 135, 136, 137, 138, 142, 163, 164, 171, 176, 177

SCoT *Schéma de Cohérence Territoriale* (Territorial Cohesion Scheme) 18, 21, 22, 80, 81, 109, 110, 118, 121, 122, 123, 127, 123, 128, 133, 134, 135, 136, 138, 139, 163

VIF Variance inflation factor 148, 151

vs. versus 121, 138

ZAU *Zonage en aires urbaines* (French functional area classification) 116

Chapter 1

Introduction

“[T]he city will diffuse itself until it has areas and many of the characteristics, the greenness, the fresh air, of what is now country, leads us to suppose also that the country will take to itself many of the qualities of the city. The old antithesis will, indeed, cease, the boundary lines will altogether disappear.”

- H.G. Wells, 1901¹

1.1 Problem statement

IN only 50 years, the majority of the Earth’s human population has become urban. In 2014, 54 % of the 7 billion world population lived in cities; and this fraction is supposed to increase to 66 % in 2050, adding some 2.5 billion urban dwellers worldwide (United Nations, 2014). Its rapidity and its omnipresence make urbanization, here understood as the concentration of population in cities and their hinterlands², one of the most striking global trends of our time (McKinsey Global Institute, 2015), driving global socio-economic and environmental change (Steffen et al., 2007, 2011). Meanwhile in Western Europe, the societies already are essentially urban. 79 % of the population lived in urban areas in 2014, of which three quarters reside in medium-sized or small city regions (United Nations, 2014). While the urbanization process is much less dynamic than in other parts of the world³, the share of urban dwellers is expected to reach 86 %

¹See reprint in Population & Development Review (Wells, 2008).

²Tisdale (1942) defined urbanization in this way already in 1942.

³Average annual growth rate of the urban population of 0.3 % between 2010 and 2015, compared to 1.5 % in Asia or 1.7 % in Eastern Africa (United Nations, 2014)

by 2050 (ibid.).

At the heart of urbanization processes are individual migrations (Saunders, 2011). In Western Europe, where natural population growth stagnates, migrations are a critical factor for regions, cities and neighborhoods: between 10 and 20 % of households change their residence within two years (Caldera Sánchez and Andrews, 2011). The majority of migrations takes place within city regions⁴, where they are called residential moves.⁵ They produce aggregate residential processes and patterns that transform urban social and spatial structure (Batty, 2012).

This thesis investigates urban planning and residential decisions within an urban region in the European Alps. It sheds light on two aggregate residential processes that drive contemporary urban change and challenge urban-rural sustainability, especially in urban regions situated in or close to mountains: peri-urbanisation and social segregation. Both processes work against central urban planning objectives, notably compactness of settlement patterns, functional mix and social cohesion.

*Peri-urbanisation*⁶ describes the process of urban dispersion, i.e. population movements from urban centres to the urban periphery (Bauer and Roux, 1976, Cavailhès, 2004, Le Jeannic, 1997). It is the consequence of the spatial separation of land use and human activities, accompanied by increased mobility levels (Kabisch and Haase, 2011, Larondelle and Haase, 2013, Westerink et al., 2013). Over the last six decades, it has been supported by national and urban transport policies as well as by the evolution and availability of individual transport, notably the automobile: travel-to-work distances stretched beyond the limits of cities' built-up areas and large transition zones emerged in which low-density development blurred the morphological boundary between the city and the countryside: peri-urban areas⁷. These areas are characterised by a mix of urban

⁴We understand city regions as functional urban areas composed of an urban centre and its hinterland, statistically defined e.g. by commutersheds (Kabisch and Haase, 2011, Le Jeannic, 1996, Peeters, 2011).

⁵We distinguish residential moves from migrations. The former are migrations of households that primarily adjust their housing consumption within a city region; the latter occur over longer distances and have predominantly economic motives (Dieleman, 2001, Lee, 1966, Ravenstein, 1885). A residential move is the outcome of an individual household's housing decision-making process (Cadwallader, 1992, Wong, 2002), implying the decision to move (residential mobility decision) and the residential location choice.

⁶The term was first coined in France in the framework of a new urban-rural typology in the 1990s (Le Jeannic, 1996). Already in the 1970s, Bauer and Roux (1976) described the extension of cities and towns under scattered forms to rural areas around them in France, coining the term *rurbanisation*. Perlik (2001), analysing peri-urbanisation in the Alps, the PLUREL project (Piorr et al., 2011) and the ESPON functional urban areas database (Peeters, 2011) brought the term also to the European level.

⁷Urban researchers worldwide use a variety of terms to describe these dynamic and complex areas that include residential, agricultural and commercial land uses (Antrop, 2004, Ekers et al., 2012), e.g. exurban and suburban areas (Taylor, 2009), the rural-urban fringe (Pryor, 1968), post-suburbia (Phelps et al., 2010), territories in between (Wandl et al., 2014) and *Zwischenstadt* (in-between city) (Sieverts,

and agricultural land use and by rapid land use change. Since the 1950s, European cities grew by 78 per cent in extent while only growing by 33 per cent in population (European Environmental Agency, 2006). In France, between 1999 and 2008, peri-urban areas increased by 40 per cent in both land area and population (Floch and Levy, 2011).⁸

Peri-urbanisation causes a myriad of economic, social and environmental effects that research has elaborately highlighted (Burchell et al., 1998). It notably increases urban sprawl and leapfrog development, i.e. the development of low-density, non-compact and dispersed features of urban land use in peripheral areas (Irwin and Bockstael, 2004), and drives land consumption (Antrop, 2004, European Environmental Agency, 2006, Ewing, 2008). Thereby, it contributes to the loss and the fragmentation of valuable agricultural land, open space and natural areas, fosters the loss of habitats and biodiversity and seals soils, globally reducing the capacity of eco-systems to provide important functions, goods and services (Burchell et al., 1998, European Environmental Agency, 2006, Larondelle and Haase, 2013, Seto et al., 2011, Zasada, 2011). Peri-urbanisation is also linked to increased energy consumption (Newman and Kenworthy, 1999), higher public and private spending on transport and infrastructure (Schiller and Siedentop, 2005, Wegener and Fürst, 1999), automobile dependence, increased traffic, congestion and greenhouse gas emissions and finally higher air and noise pollution levels that often exceed the agreed human safety limits and deteriorate public health⁹.

By contrast, *residential segregation* describes the voluntary or involuntary spatial separation of groups of the population. It can be seen as the translation of social structure into space (Häußermann and Siebel, 2001). Segregation is not a new phenomenon: people have - or got - separated along many dimensions, including race, ethnic group, social status and religion throughout history (Schelling, 1971). Whereas ethnic or racial segregation describes spatial concentrations with regard to country of origin, cultural belonging, nationality and self-identification, social segregation occurs with regard to socio-economic position of individuals in society, i.e. age, income, education, social status and lifestyle (with positive correlations between them). The levels of social segregation are

1997).

⁸Currently, peri-urban areas in different European countries account on average for 20 to 50 per cent of the urban population and for 40 to 80 per cent of the urban land area, dependent on measurement (Eurostat, 2016). Typically, peri-urban zones are statistically delimited using data on functional interactions between the urban centre and its rural hinterland, especially data on commuting. A municipality is defined peri-urban if the share of the working population commuting to the urban centre exceeds a certain threshold (see Eurostat (2016), Floch and Levy (2011), Perlik (1999) for different applications). In France, with a threshold of 40 %, peri-urban areas accounted for 24 % of the urban population and 38 % of land surface in 2008.

⁹Europe loses 200 million working days a year to air pollution-related illness (European Environmental Agency (EEA), 2005)

currently increasing in European cities (see figure 1.1, also Marcińczak et al. (2015)).¹⁰ Social segregation results from discriminatory behaviour and practices of individuals and organizations, neighbourhood effects, specialized communication systems (e.g. different languages) and from other dimensions of spatial segregation such as job location and transport access (Marcińczak et al., 2015, Schelling, 1971). Selective intra-urban migration is not the only driver at work: downward social mobility, socially differentiated natural change, ageing processes, cohort effects, immigration and emigration also play an important role in segregation across neighbourhoods (Bailey, 2012). Current urban and societal transformations, notably rising social inequality (Bonesmo Fredriksen, 2012), may also significantly contribute to rising levels of segregation (Cassiers and Kesteloot, 2012).¹¹

Social segregation may have both negative and positive effects on households, neighbourhoods and cities. On the one hand, segregation strengthens social and cultural identities and facilitates integration into social networks, which again may provide easier access to income opportunities, transport and social life (Cutler et al., 2008, Saunders, 2011). Segregation generally creates benefits by “reducing the costs of assimilation to the host society” (Cutler et al., 2008, p. 763). On the other hand, segregation contributes to social and spatial exclusion that brings additional social and economic disadvantages to already disadvantaged population groups (Cassiers and Kesteloot, 2012, Cutler et al., 2008, Musterd et al., 2012, van Ham et al., 2014). Although beneficial in the short run, segregation reduces the opportunities of individuals and groups in the long run, notably via social exclusion with regard to the labour market, politics, culture and education (Musterd, 2005). Segregation restricts both the geographic and social mobility of disadvantaged individuals and groups and results in a reduction of economic and cultural assimilation. Disproportional exposure to similar individuals is capable of maintaining group characteristics for a longer time, which implies lower education and income levels for present and future generations of disadvantaged population groups (Cutler et al., 2008). Social segregation, once established, may thus sustain itself, ultimately leading to greater social and economic exclusion (Cassiers and Kesteloot, 2012). High levels of social segregation are considered detrimental to economic efficiency, social equity and

¹⁰In general, larger cities show higher levels of segregation (Charlot et al., 2009), and the highest social strata are the most segregated ones (Marcińczak et al., 2015, Musterd, 2005). Segregation levels heavily depend on spatial scale of measurement. For France, Guyon (2012) shows that levels of income segregation on neighbourhood level remained stable in the 2000’s except for the lowest income decile.

¹¹Social inequality has reached an all-time-high in the OECD countries. The wealthiest 10 % of the population earn 9.6 times the income of the poorest 10 % (Organisation for Economic Cooperation and Development (OECD), 2015). The World economic forum ranks severe income disparity and social instability among the risks the most likely to manifest within the next ten years (World Economic Forum, 2013).

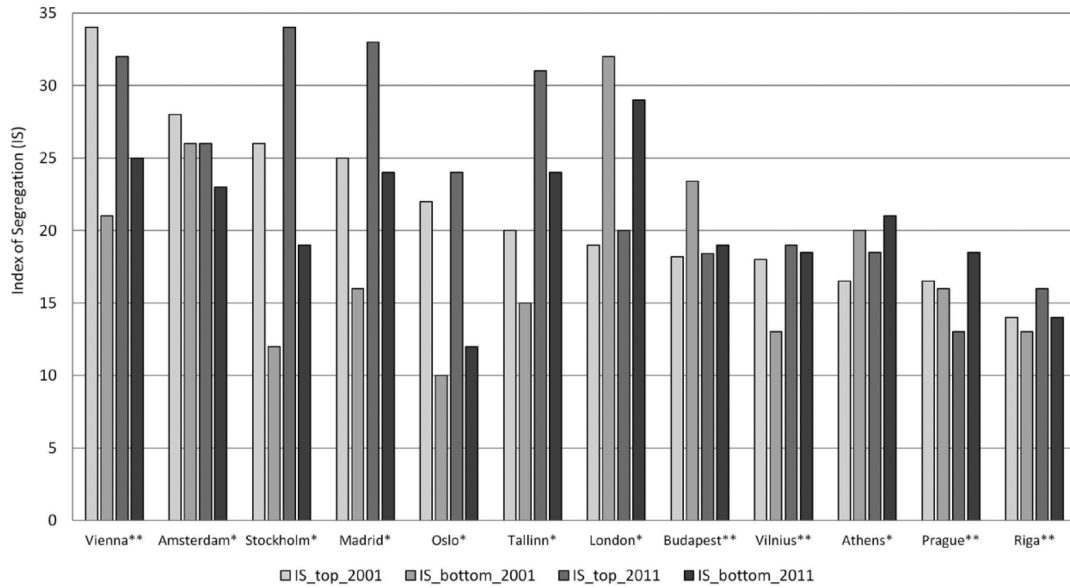


Figure 1.1 – Segregation index scores for top and bottom social categories

Notes: *Metropolitan area, **City; Social groups: managers and elementary occupations for Madrid, Tallinn, London, Budapest, Vilnius, Athens, Prague, Riga; Highest and lowest income quintile for Amsterdam, Oslo, Stockholm; University degree and compulsory education for Vienna. *Source:* Marcińczak et al. (2015)

cohesion.

While the two processes outlined above are often regarded separately, they are also interlinked (Cavallières and Selod, 2003, Pouyanne, 2006). Both are results of individual residential mobility and location decisions and may be seen as two sides of the same coin: whereas peri-urbanisation highlights the quantitative dimension of population distribution, segregation emphasises its qualitative dimension, taking into account the social structure of the population (Pouyanne, 2006). Peri-urbanisation may, for example, result from selective migration behaviour of high-income groups (Bayoh et al., 2006, Charlot et al., 2009).

Both processes are all the more problematic in the Alps, where the urban reality has often been neglected in people's minds: two thirds of the Alpine population, approximately nine million people (Perlik and Messerli, 2004), live in areas under strong urban influence. In the various urban regions situated in or close to the Alps, both of these residential processes are observed and may undergo influences from the mountain environment (Bairoch, 1988, Gloersen, 2012, Messerli, 1999). On the one hand, the

mountain environment makes cities particularly prone to peri-urbanisation and linked urban sprawl (Baetzing, 2003, Borsdorf, 2004, 2006, Debarbieux et al., 2011, Haller and Borsdorf, 2013, Löffler et al., 2011, Marzelli, 2011, Perlik et al., 2001). In the Alps, foothills and accessible mountain areas have become the preferred residence for households who want to combine the advantages of urban life with the attractiveness of unspoilt countryside (Perlik, 2006, 2010). Cities such as Grenoble and Innsbruck and larger metropolitan areas on the Alpine periphery such as Geneva-Lausanne, Lyon, Marseille, Munich, Milan, Nice, Torino and Zurich have seen their functional areas extending towards the mountainous hinterland (see figure 1.2 for population dynamics in Alpine and peri-Alpine municipalities from 2001 to 2010). The attractiveness and resulting dynamism of these areas is, however, combined with natural and topographic constraints for urban and transport development. Steep slopes, terrain ruggedness and cold climates make large parts of the Alps unsuitable for human settlement (Permanent Secretariat of the Alpine Convention, 2007): most of the developable land is situated in the valleys and foothills below altitudes of 1,000 m a.s.l., where 90 per cent of the 14 million inhabitants of the Alps live (Borsdorf, 2006).¹² The result of the combination of residential attractiveness, limited land resources and constraints to transport development is a high competition between residential and other land uses, high housing prices, urban sprawl and leapfrog development, increased traffic and pollution.¹³ In dynamic Alpine urban regions, residential pressure on land may be considered higher compared to locations in the plain.

On the other hand, the mountain environment might also play a role in social segregation and gentrification¹⁴ (Bertrand and Marcelpoil, 2005, Ghose, 2004, Haller and Borsdorf, 2013, Perlik, 2010, 2011, Romero and Ordenes, 2004, Stockdale, 2010). Alpine hinterlands provide attractive living and recreation conditions for urban middle- and high-income classes: quietness, security, proximity to near-natural environments, well-exposed terrains, scenic views, lower pollution levels, cooler temperatures in summer and possibilities for close-to-home summer and winter outdoor recreation. Air pollution, industrial sites, urban density and related disamenities (e.g. crime) are predominantly concentrated in urban centres and in the major valleys. This unequal distribution of environmental quality may affect selective migration between cities and their mountainous

¹²Only 17.3 % of the land area of the Alps (Alpine Convention perimeter) can be considered appropriate for permanent settlement (Debarbieux et al., 2011). This makes the Alps the most densely populated mountain area in the world (Permanent Secretariat of the Alpine Convention, 2007).

¹³In the Alps, stable temperature inversions can exacerbate pollution in the valleys during the winter months.

¹⁴Gentrification is defined as in-migration of affluent households to neighbourhoods and communities, where they increase housing prices and potentially displace local population groups (Stockdale, 2010).

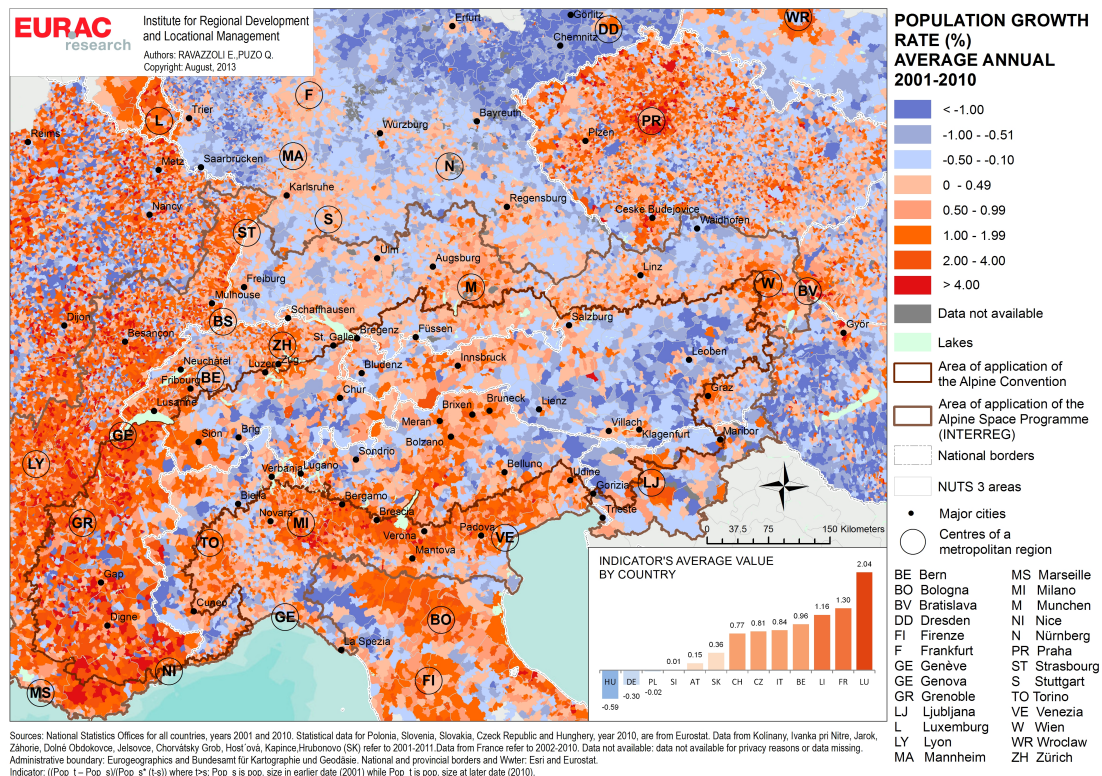


Figure 1.2 – Average population growth rate for municipalities in the Alps and their surrounding areas 2001 – 2010

Note: Major cities indicated with circles. *Source:* Eurac research, Institute for Regional Development and Location management, August 2013.

hinterlands, especially in the Alps where urban influence is high (Perlik, 2006). Residential location choices of middle- and high-income classes are assumed to contribute to segregation processes (Haller and Borsdorf, 2013, Perlik, 2011). The context of rising social inequality and a shift in societal trends from material living conditions to well-being, health and quality of life in Western Europe might in addition reinforce such segregation processes in Alpine peri-urban areas.

Situated at the heart of Europe, the Alps have raised the particular attention of environmental organisations and international and national politics. International and national policies and programmes aim at a sustainable spatial development of this sensitive area, notably the 1991 Alpine Convention: the Alps host important biodiversity hotspots, provide crucial ecosystem services for a major part of the European population and are internationally recognized for their unique natural and cultural heritage (De-

barbieux et al., 2011, European Environmental Agency (EEA), 2010). These features and functions - and access to them - are, however, put under threat by the effects of metropolisation, peri-urbanisation and social segregation. In this regard, the combination of limited land resources and residential quality makes urban regions in and close to the Alps showcase territories, where concentration and dispersion processes unfold under increased pressure. Urban and regional planning need to integrate and cope with this specific context in order to steer urban spatial structure, land use and population distribution towards more sustainable pathways both in terms of an economical use of natural resources and social equity and cohesion.

‘Europeanisation’¹⁵, increased transnational cooperation and learning have led to a certain convergence of objectives and practices in regional and urban planning policies (Faludi, 2010, Stead, 2013), already expressed in the European spatial development perspective (Informal Council of Ministers responsible for Spatial Planning, 1999). Similar to elsewhere, urban planning across the Alps has developed strategic planning processes and documents for urban regions that integrate vast peri-urban areas in order to improve planning efficiency. However, planning policies as well as the magnitudes of peri-urbanisation and social segregation vary across Europe (Kabisch and Haase, 2011, Marcińczak et al., 2015). There is thus the need to better understand the links between the mountain environment, urban and regional planning policies and residential processes, especially in urban regions in the Alps.

1.2 Objectives & research questions

This thesis analyses the effects of the mountain environment and urban planning on residential processes in the context of Alpine urban regions. Its general objective is to investigate how and to what extent residential flows and patterns, notably with regard to peri-urbanisation and social segregation, are influenced by (i) the mountain environment and (ii) urban planning policies. The thesis thus seeks to better understand the links between the mountain environment, urban planning policies and residential processes, and to provide information and recommendations for planning and decision-making in Alpine urban contexts. The thesis does this via three distinct contributions which use the urban region of Grenoble in the French Alps as a central study area. All three contributions have specific aims and research questions.

The first contribution addresses changes in contemporary urban planning policy-making and practice. In Europe, urban planning adapts to rising uncertainty, spatial

¹⁵See e.g. Nadin and Stead (2008).

interrelatedness and complexity by developing large-scale strategic planning processes for functional urban areas that comprise urban and peri-urban territories. These processes create new governance arenas in which planning decisions are made but which potentially leave room for new definitions and imbalances of power and competence. **How does contemporary spatial planning policy deal with regional challenges in Alpine city regions? How do new strategic planning processes transform planning decision-making on regional and local level? Which effects arise from these processes for local planning practice, notably in mountain areas?**

The second contribution addresses the link between the natural environment, specifically the mountain environment, and residential processes. It considers that the Alpine environment influences residential processes, notably via significant spatial disparities in environmental quality between the urban centre and peri-urban areas. More specifically, it considers that - besides classic ‘hard’ location factors such as housing prices and access to work - specificities of the Alpine environment - understood as ‘soft’ location factors - influence residential location choices. Soft location factors relate especially to environmental quality (Dinda, 2004) and *natural amenities* (McGranahan, 1999, Moss, 2006, Power, 2005), location-specific features of the natural environment that enhance a location’s (residential) quality. Their effects might produce differentiated residential flows and patterns of dispersion and segregation. Alpine specificities relate to environmental quality and accessibility, both of which show stronger spatial disparities between urban centres and peri-urban areas (and within them) in mountain areas - compared to urban regions in the plain. Some population groups might be stronger attracted or repelled by these specificities, leading to selective migration. Such selective migration flows affect population distribution not only quantitatively but also qualitatively, i.e. with regard to socio-economic characteristics of movers and destinations. The related research questions are therefore: **Does the mountain environment have an influence on residential location choices in Alpine urban regions? If yes, which and to what extent? Does the mountain environment amplify or mitigate processes of peri-urbanisation and social segregation? Which implications result from these findings for spatial planning in Alpine urban regions?**

Besides effects from the mountain environment, urban planning policies not only has an influence on urban spatial structure and land use but also on residential decisions of individual households. By affecting both ‘hard’ and ‘soft’ location factors of neighbourhoods and municipalities, planning creates incentives and constraints for the mobility of households and their location choices. Thereby, it influences on processes of peri-urbanisation and social segregation that are driven by residential moves. In the third

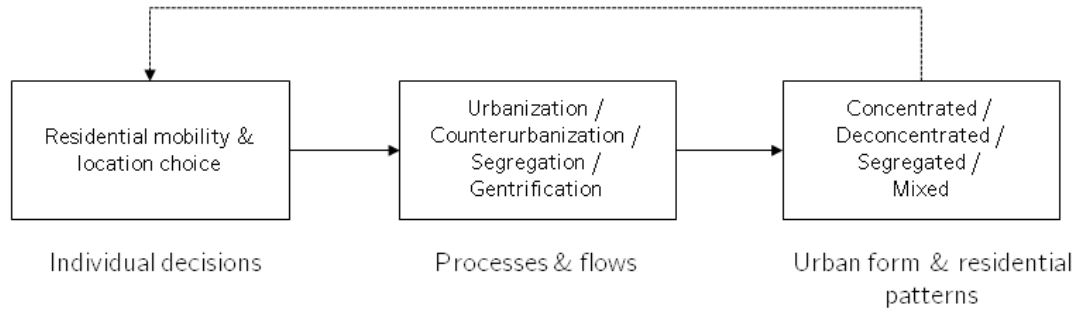


Figure 1.3 – Research perspective

Source: own graphic

contribution, therefore, this thesis considers that different planning policy scenarios may have differentiated effects on residential processes. It aims at investigating the link between planning policies and residential processes and patterns in order to inform planners and decision-makers about potential policy outcomes in terms of residential development. Associated research questions are: **Which effects result from current urban planning objectives in terms of residential processes and patterns in Alpine urban regions? Are anti-sprawl policies able to curb peri-urbanisation? Which links exist between planning effects on peri-urbanisation and social segregation? And finally, which recommendations can be made for urban planning in Alpine urban regions?**

1.3 Research perspective & methods

Urban research considers cities and their regions as complex systems, developing from bottom-up (Batty, 2012). This thesis builds upon this idea. In its general perspective, it considers residential processes and development patterns as aggregate products of millions of individual and group decisions of households, developers and urban planners. Households' residential decisions strongly contribute to aggregate residential processes in an urban region. Such aggregate processes of concentration (dispersion) and segregation affect urban spatial and social structure of neighbourhoods and the whole region. The created urban and residential patterns affect in turn (other) households' residential decisions. Figure 1.3 describes this general perspective of the thesis.

With regard to the research perspective, the thesis takes both a planning and an

urban economics perspective. On the one hand, contemporary planning research focuses on actors, institutional levels, scale and their articulation in government and governance processes. It usually is qualitative in nature and involves an actor-centred approach to investigate planning processes and practice. On the other hand, the field of micro-economics uses econometric models to quantitatively explain consumer behaviour, notably how and why individuals make choices via the utility maximization principle. More specifically, urban economics studies urban spatial processes and structure and the decisions of households and firms that contribute to them. The methods used in this thesis reflect both of these perspectives: we use qualitative research methods to analyse changes in contemporary urban planning practice, notably document analysis and semi-structured interviews. In order to explore the links between the natural environment, urban planning and residential processes - the general objective of this thesis -, we make use of econometric modelling to analyse households' residential behaviour, housing prices and simulate residential patterns. We use notably the (micro-economic) discrete choice framework to analyse household decisions of mobility and location choices. Theory and methods of this framework have been developed by Daniel McFadden (McFadden, 1974).¹⁶ Discrete choice models are widely used in research or as part in wider urban modelling frameworks.

1.4 Chapters & main results

The thesis provides three distinct contributions which can be read on their own.¹⁷ Every chapter takes a different perspective and relates to a specific literature strand.

The second¹⁸ chapter relates to the research field of strategic spatial planning. It addresses changes in contemporary urban planning practice, notably the emergence of new forms of spatial planning and territorial re-scaling towards large urban - peri-urban planning perimeters. We analyse the recent strategic spatial planning episode in Grenoble urban region around the SCoT strategic plan, adopted in 2012, using document analysis and interview material. The chapter sheds light on the creation of new governance arenas through strategic planning, and shows how they call into question local planning practices and cultures. The in-depth case study shows moreover the importance of path dependency for urban planning and governance in a region, the existence

¹⁶McFadden won the Nobel prize in 2000 in Economic Sciences for his pioneering work in this field (McFadden, 2001)

¹⁷The reader might however find some repetitions in literature reviews, methods or the study area descriptions since the applied methods and questions are related.

¹⁸The first chapter is the introduction.

of power imbalances between actors and territories and the changing role of planners in spatial policy-making.

The third chapter relates to the field of urban economics, and more specifically to the study of segregation. It investigates the links between preferences for the natural environment, residential location choices and social segregation in the study region and the Marseille - Aix-en-Provence - Toulon metropolitan area. Using different discrete choice models with large household samples on municipality level, the chapter analyses the role played by the natural environment in the emergence of segregated patterns. The chapter presents a counterfactual segregation analysis that uses Monte Carlo simulations in order to compare segregation outcomes “with” and “without” preferences for the natural environment. We notably find that households’ search for natural environments has significant impacts on social segregation. It most often contributes to reinforcing segregation, but can also be an attenuating factor. Residential segregation is strengthened if the socio-spatial outcomes of the “natural amenity-driven segregation channel” and the “standard segregation channel” coincide - and attenuated if not.

The last chapter combines these two perspectives and is inspired by applied urban modeling. It investigates the influence of different urban planning policies and residential processes. The chapter uses residential mobility and location choice models with endogenous housing prices to predict and analyse residential demand patterns for different planning policy scenarios - notably the Grenoble SCoT strategic plan - in terms of concentration, segregation and mountain development. Besides the effects of classic location factors on households’ residential behaviour, the estimation results show general preferences for peripheral locations and effects of the mountain environment on peri-urbanisation and social segregation. The analysis of demand predictions shows that continued trends in urban planning policies would sustain and potentially reinforce peri-urbanisation to rural and mountain areas in the region. More confining planning policies such as the SCoT appear to be capable of curbing and potentially reversing demand dispersion. Policies that aim at re-centralising demand sustain and potentially increase social segregation levels with regard to socio-professional status and age.

1.5 Contribution of the thesis

This thesis and its three chapters add to the existing literature by addressing several gaps. First, the thesis contributes to the planning literature by pointing at effects of large-scale strategic planning processes in (Alpine) city regions. Although the governance processes behind such planning episodes are place-specific, they have common objectives

and might therefore have common traits and effects.

Second, the thesis contributes to research in urban economics and location choice studies. Household preferences for ‘soft’ location factors, in contrast to classic ‘hard’ location factors, have gained more and more interest from researchers over the last decades. Economic research has highlighted the effects of the natural environment on housing prices, residential and urban spatial development (see e.g. Brueckner et al. (1999), Cavailhès et al. (2005), Cavailhès et al. (2004), Waltert and Schläpfer (2010), Wu and Plantinga (2003)). In addition, specific features of mountain regions, similar to coastal regions, may provide particular environmental quality (Moss, 2006). Empirical studies have, however, only analysed location choices and housing markets in urban regions on the Alpine periphery, i.e. in Greater Zurich (Bürgle, 2006, Schaerer, 2008, Schirmer et al., 2013), Greater Lyon (Kryvobokov et al., 2009) and Geneva (Schaerer, 2008). This work adds to the literature by analysing the effect of the natural environment in residential location choice models. To our knowledge, it is the first econometric analysis of residential choices and its determinants in an urban region situated in the European Alps.¹⁹

Last, the thesis adds to the literature in urban modelling. The last chapter develops a complex residential location choice model that can inform planners and decision-makers about outcomes of urban planning policies in terms of residential demand distributions. By simulating residential demand for the Grenoble SCoT strategic plan and alternative policy scenarios, this chapter has an evaluative and an exploratory character and links outcomes of demand concentration (dispersion) to demand segregation.

¹⁹Considering the perimeter of the Alpine Convention (Permanent Secretariat of the Alpine Convention, 2010).

Chapter 2

Strategic spatial planning & territorial re-scaling in Grenoble urban region

“Sustainability is said to require a climate of ‘dialogue’, ‘partnership’ and ‘shared responsibility’, rather than centralized ‘command and control’ policies.”

- L. Griffin, 2010¹

Preamble

This chapter presents work related to the first aim of this thesis, i.e. to investigate how contemporary spatial planning practice deals with local and regional challenges in enlarged Alpine city regions. Using an in-depth case study and qualitative methods, it highlights the process of re-scaling of politics, governance and spatial planning practice in Grenoble urban region. It focuses in particular on strategic spatial planning episodes and the use of new governance modes. A slightly different version of the article was published in *Planning Practice and Research* under the title *With or without you? Strategic spatial planning & territorial re-scaling in Grenoble urban region* in June 2014 (see Cremer-Schulte (2014), DOI:10.1080/02697459.2014.929844).

The results of this chapter are based on interview material and data collected in the course of the *respont* project (07/2012 – 12/2014), a side project of this thesis,

¹Griffin (2010)

conducted in collaboration with CIPRA France. Two further documents have been published within the larger scope of this project: recently, the article *Strategic Spatial Planning and Territorial Asymmetries. Grenoble and Greater Geneva: Two Alpine City Regions Put to the Challenge of Coherence* appeared in the *Journal of Alpine research*, 103-3 (Bertrand et al., 2015)². The article analyses recent strategic planning initiatives in Grenoble and Geneva. It shows that governance processes embedded in strategic spatial planning projects tend to reveal, or even to maintain, disparities between urban and peripheral mountain areas, notably in the ability to influence on these projects. These disparities might put at risk territorial coherence and cohesion.

A second publication is a collection of factsheets on urban planning in Alpine city regions (Irstea Grenoble and CIPRA France, 2014)³. The factsheets give an overview on spatial planning systems in six countries of the Alpine Convention (Austria, France, Germany, Italy, Slovenia and Switzerland) and highlight planning practises and dynamics in six city regions (Bolzano, Grenoble, Geneva, Innsbruck, Ljubljana and Munich). As a communication tool for CIPRA France (Commission internationale pour la protection des Alpes), they target urban planners and elected representatives on regional and local level.

²The article is available online: DOI:10.4000/rga.3126.

³Available online at www.cipra.org (last accessed on April 17 2016).

Strategic spatial planning & territorial re-scaling in Grenoble

Dominik Cremer-Schulte

Abstract

Spatial planning across European city regions is undergoing substantial changes. The paper draws on the framework of territorial re-scaling, strategic spatial planning and the emergence of new governance modes in order to analyse strategic planning episodes in Grenoble urban region (France). The paper aims at showing how strategic planning processes by means of new governance arenas call into question local planning cultures, especially by re-shaping planning perimeters, territorial identities and actors' roles. In particular, it shows the importance of path dependency for strategic planning, the effects of power imbalances between local actors and the crucial role planners play in spatial policy-making.

Keywords

Strategic spatial planning, re-scaling, city region, governance, France

2.1 Introduction

SPATIAL planning across European city regions is undergoing substantial changes. On the one hand, and although no formal planning competence is established at EU level, the so-called Europeanization of spatial planning has led to changes in planning policies, systems and approaches due to national responses to EU initiatives (Böhme and Waterhout, 2008). In particular, one could mention here the great influence of EU sector policies, structural funds, the Interreg programmes, the Territorial Agenda and the European Spatial Development Perspective (Faludi, 2010). On the other hand national regulatory and institutional frameworks for spatial planning have evolved not only due to Europeanization, but also due to domestic dynamics and changes in planning paradigms. Two key dynamics concern territorial re-scaling - the emergence of new (soft) scales especially at supra-local and city region scale (Allmendinger and Haughton, 2009, Brenner, 2003) - , and the rise of strategic planning (Albrechts, 2006, Healey, 2004). Whereas the former relates more globally to transformations of state-spatiality and better policy-delivery, the latter is seen as a result of shortcomings of traditional planning approaches to cope with complexity, uncertainty, conflicting interests and increased environmental awareness (Albrechts, 2004). Both of these processes are accompanied by a shift

towards collaborative, communicative and integrative governance approaches (Healey, 2007, Rhodes, 2007). Despite these transformations, planning research argues that current spatial planning is a combination of formal regulatory planning practice, based on historic trajectories of local political culture, and new informal arenas and modes of planning – an “intriguing hybrid” (Allmendinger and Haughton, 2009, p. 621) somewhere in between government and governance. This condition raises the question of implications of strategic planning processes for local planning culture and practice.

A noteworthy example for recent transformations in spatial planning is France. Officially decentralized since 1982, the French territory undergoes episodes of restructuring due to a continuous decentralization process. Notably since 1999, the French state heavily incites and reinforces inter-municipal structures and territorial projects, making the institutional framework more complex. Spatial planning’s traditional character was a top-down state *aménagement du territoire* (state & regional spatial planning) in combination with municipal land use planning (*planification urbaine*). Recently, new supra-local territorial scales together with legislative reforms in spatial planning have fostered strategic spatial planning (*planification territoriale et stratégique*). Notably, the *Schéma de Cohérence Territoriale* (Territorial Cohesion Scheme) (SCoT) are strategic planning projects that create new spaces for metropolitan governance and use extensive communicative and collaborative approaches.

In this paper, I shed light on a recent strategic spatial planning episode in Grenoble urban region and situate it within the theoretical context of territorial re-scaling, shifts towards strategic spatial planning with more communicative and integrative processes of governance. My objective is to show how strategic planning processes by means of new governance arenas transform local planning cultures, especially by re-shaping planning perimeters, territorial identities and actor’s roles. In particular, I highlight the importance of path dependency for strategic planning, the effects of power imbalances between local actors and the crucial role planners play in spatial policy-making.

The material presented in the paper is based on the analysis of planning documents of the SCoT, together with in-depth interviews with urban region planners, researchers in urban planning and elected representatives of the local level that had a stake in the SCoT process. Interviewees have been asked questions about their experiences within the SCoT planning process, changes in local planning culture and practice they have perceived, urban-rural relationships and changes in actors’ roles.

2.2 Transformations of spatial planning

Recent transformations of spatial planning across Europe have occurred within wider processes of political and administrative re-scaling, state re-territorialisation and the emergence of new governance modes. These processes have nourished the increased significance of city regions in a global framework, which have become key players for both spatial planning and territorial policy (Brenner, 1999, Oliveira and Breda-Vazquez, 2010). Recent research in state theory suggests that economic globalization, European integration and increased mobility of capital have led to the rescaling of traditional, hierarchically organized entities of state action towards a new metropolitan regionalism in Europe, characterized by locational policy and inter-spatial competition of city regions (Brenner, 2003). Research in this field suggests a weakening of the role of the nation-state level in favour of the local, regional or territorial level on the one hand and the global level on the other hand (Brenner, 2003, Swyngedouw, 2004). This is generally described as a decline in steering capacity of the nation state - a so-called *hollowing out* (Jessop, 2000, Rhodes, 2007). This should, however, not be understood as a reduction of state power, but rather as the state taking the role of a meta-governor who shifts powers and responsibilities to lower existing or new scales, through re-territorialisation and rescaling, in search for new 'spatiotemporal fixes' (Allmendinger and Haughton, 2009, Jessop, 2000). Others describe this also as *filling-in* of new governance scales in between formal scales of government action (Allmendinger and Haughton, 2009, Jones et al., 2005, Olesen, 2012).

The emergence of new forms of spatial planning, away from statutory land use planning and towards *episodes* (Healey, 2004, p. 45) of strategic planning based on new governance modes, is deeply embedded within these processes of re-scaling and re-territorialisation of the state (Allmendinger and Haughton, 2010, Healey, 2004). Spatial planning, which traditionally is both a particular state policy field as well as a means of wider policy delivery, has taken a new role as a part of the "meta-governance apparatus" of government (Allmendinger and Haughton, 2010, p. 808), adapting to recent spatio-political and socio-economic dynamics: globalization, the economic competitiveness as well as sustainable development agendas, the need to adapt to new scales of social and economic life, the diffusion of common planning objectives and principles via the Europeanisation of spatial planning, to name only a few (Albrechts et al., 2003). This has led to a widening of the spatial planning notion both in scale and scope with a renewed emphasis of the need for long-term thinking, visioning, strategy-making, new identities of place, policy integration and inclusion of external stakeholders, skills and resources

(Albrechts, 2006, Allmendinger and Haughton, 2010, Healey, 2004, 2007). Particularly, the concept of strategic spatial planning has seen a revival and has become the prevailing planning paradigm in European urban regions in the last two decades or so (Albrechts, 2004, Zepf and Andres, 2011). Patsy Healey (Healey, 2004, p. 46) sees the strategic approaches of spatial planning in city regions as

“self-conscious collective efforts to re-imagine a city, urban region or wider territory and to translate the result into priorities for area investment, conservation measures, strategic infrastructure investments and principles of land use regulation.”

Accordingly, cornerstones of strategic spatial planning episodes are a focus on space and new territorial identities, collective efforts that relate to governance and participation processes, an integrated perspective according to a strategic development vision and selected priorities for sectoral dimensions that contribute to this vision (Albrechts, 2006). Planning theorists have long-time underlined that the performance of strategic planning lies not in the outcome but rather in the process of planning, engaging multiple stakeholders in a mutual learning process that is more or less directed by public authorities (Albrechts, 2004, Faludi, 2000, Rivolin, 2008). In contrast to land use planning that aims at shaping local spatial development, strategic spatial planning aims at shaping the minds of actors who have a stake in spatial development (Rivolin, 2008). It hence places much more emphasis on the elaboration and communication processes in new formal and informal governance spaces or arenas, in which visions, opinions and decisions on spatial development are prepared and elaborated.

Some planning theorists have shifted their focus towards these arenas, which have emerged across European city regions with varied formality and competence. Strategic spatial planning literature and recently the concept of soft spaces – a concept developed in the UK but finds application across the EU (see e.g. Allmendinger and Haughton (2009), Metzger and Schmitt (2012), Olesen (2012), Walsh et al. (2012)) – , argue that planning needs a rather loose framework that can cope with both uncertainty and complex networks of stakeholders in order to be efficient in shaping places (Allmendinger and Haughton, 2009). Planning at formal scales is not seen irrelevant but insufficient and thus, a large part of planning takes place outside the formal planning system in so-called “soft spaces with fuzzy boundaries” (Allmendinger and Haughton, 2009). Olesen (2012) understands these soft spaces as particular strategy-making episodes, in which strategic spatial planning efforts leave the formal planning system in order to destabilize existing planning cultures. For present purposes, I refer here to Friedmann’s (2005, p. 184) definition of planning cultures “as the ways, both formal and informal, that

spatial planning in a given [...] city [or city region] is conceived, institutionalized, and enacted". Besides a positive reputation for providing spaces for non-adversarial dialogue and really getting things done (Metzger, 2011), research highlights potential drawbacks of planning through informal arenas. Research sees these processes as displacement of politics to other spheres of society, moving beyond the rigidities of the formal planning framework, thereby raising problems of democracy such as accountability, transparency and legitimacy (Allmendinger and Haughton, 2010, Metzger, 2011, Olesen, 2012). The loss of a formal character in planning might open up the floor for powerful vested interests of different actors in strategy- and decision-making. New urban governance spaces might cause problems in coalition and alliance formation of local actors due to diverging interests and goals, leading to instability and in particular to opening up ways for powerful positions, lobbies and individuals (Harvey, 1989).

However, (Metzger, 2011) sees the crucial problem not in the displacement of burning issues outside the rigid system of democracy itself, but in its reformulation by selected actors that increases the likeliness of the outcome to be as beneficial as possible for them. For example, some authors see new forms of planning as helping to gain legitimacy for objectives of economic development and competitiveness; objectives of social housing, public services and environmental protection become voluntary or even redundant (Allmendinger and Haughton, 2010, Waterhout et al., 2013). Olesen (2012) thus sees soft spaces as mechanisms of roll-out neoliberalism, which has led to increasing concerns with economic development promotion, effectiveness and policy delivery in spatial planning. On the other hand, it is crucial to note that despite these developments, planning cultures and practices are strongly embedded in local political culture and history. They are path-dependent and might show inertia to politico-institutional changes and other external influences (Friedmann, 2005). Local cultures of spatial planning thus are still characterized by both traditional, more regulative forms of planning, and new forms based on more informal spaces and practices. Allmendinger and Haughton (2010) see this condition intriguing; especially if in formal spaces prepare the way for formal planning instruments. This dualism might provoke clashes in governance processes and raises questions of implications for local planning cultures.

Above, I have highlighted how recent transformations of spatial planning have created new informal spaces of governance that have come to play a crucial role in spatial policy-making. It remains to be seen which implications arise for local planning cultures and practices. In the next section I thus explore how such episodes by means of governance arenas shape planning culture and practice in Grenoble urban region.

2.3 Strategic spatial planning in Grenoble urban region

In France, territorial re-scaling and strategic planning processes for vast urban territories have gained particular importance in the recent decade, expressed e.g. by the introduction of the SCoT policy. These efforts try to overcome the fact that French spatial and urban planning has not been able to regulate and cope with contemporary urban development (Jourdan, 2011). Historically, the effects of long-term centralization and historical territorial fragmentation into over 36,000 municipalities of equal status have impeded the emergence of city regions in the political and administrative sense (Protière, 2012). Continuous decentralization efforts undertaken since 1982 have led to a strengthening of regional and inter-municipal levels, but also to a configuration popularly described as a *mille-feuille* territorial (multi-layered territory) composed of administrative regions (*régions*, Nomenclature of Territorial Units for Statistics (NUTS) II), *départements* (glsnuts III), municipalities (*communes*, Local administrative unit (LAU) II) and a range of *Etablissement public de coopération intercommunale* (Public body for inter-municipal cooperation) (EPCI) that all share competences.

The SCoT planning instrument was established by the SRU Law (solidarity and urban renewal) in 2000, superseding former strategic planning instruments in place since 1967. Its objective is to integrate a wide range of sectoral policies and actors around a sustainable spatial development project (Jourdan, 2011), notably developing strategic guidelines and principles for spatial development for a period of 20 years. The SCoT's nature might be seen as both an informal bottom-up political process and a formal planning instrument. Their perimeters are defined by negotiations between municipalities and EPCI, pushed by state incentives. The SCoT document has direct influence on lower level plans, such as sectoral planning documents for housing or transport provision, and the municipal zoning plan (*Plan local d'urbanisme*, PLU). These plans have to be compatible to, but not conform with the SCoT. The Grenelle laws in 2009 and 2010 have substantially reinforced the environmental dimension in the SCoT projects, and strictly incited the generalization of the SCoT across the French territory.

The establishment of the SCoT of the Grenoble urban region was due to legislative obligation (SRU law 2000). Local authorities perceived changes in legislation, notably through the Grenelle laws, as opportunity to re-think spatial planning orientations and address burning issues such as continuous and polarized urban growth based on dynamic high-tech industries (Sanderson, 2011) and barely controlled sprawl at larger scale. In 2008, the SCoT public body (*Etablissement Public du SCoT de la Région Urbaine Grenobloise*), federating several EPCI of the urban region, entrusted the Grenoble

urban planning agency (*Agence d'urbanisme de la région urbaine grenobloise* (AURG)) with the planning process and elaboration of documents. After three years of discussion, consultation and elaboration and another year of final public participation, the SCoT public body approved the plan in 2012. It stretches over 273 municipalities, 13 EPCI and 7 implementation sectors summing up to 740,000 inhabitants on more than 3,500 km² (EP SCoT RUG, 2013, see figures 2.1 and 2.2). It covers the Grenoble agglomeration EPCI (hereafter *La Métro*, with 400,000 inhabitants), the major alpine valleys and some rural as well as mountain territories.

2.3.1 Planning culture, path-dependency & power imbalances

Since a couple of decades, territorial actors in the Grenoble urban region have shown openness for strategic planning efforts. Planners recognize a particular culture of dialogue in planning issues among actors (see 2.1, quote 6), which manifested itself in the adoption of the SCoT project and resulting plan by the majority of local mayors. They see this culture to have evolved with the different episodes of strategic planning and other territorial projects over time. Two strategic plans preceded the SCoT, regrouping 115 and then 157 in 1973 and in 2000 respectively. Especially the 2000 plan (*Schéma directeur*, see figure 2.1) has further shaped the strategic planning dialogue in the region and thus prepared the SCoT. In the SCoT process then, considerable consultation and negotiation efforts have finally led to the inclusion of rural and mountain territories up to almost 1.5 hours from the urban centre, enlarging the perimeter to 273 municipalities.

We might see the presence of a certain planning culture in Grenoble urban region as a product of continuous dialogue between conflicting positions that has developed over time, albeit with considerable inertia and concerning specifically the centre of the urban region. Municipalities and their actors that are part of the functional agglomeration or located in its immediate proximity have taken part in both inter-municipal cooperation and several strategic planning episodes for over 40 years. Territories farther away from these processes do initially not share this common planning culture. An urban planner of the planning agency stated that, notably at the beginning of a planning process, not every territory or actor is on the same level of dialogue (see table 2.1, quote 6).

Indeed, politicians and researchers highlight a longstanding and on-going reluctance of peripheral territories to approaches developed in - and by - the agglomeration, the “core” of the region (see table 2.1, quote 3, Bertrand et al. (2006), Martin (1997)). In 1973, state services, the Grenoble municipality and urban planning agency established the first strategic plan in a top-down manner. It already revealed local political tensions with regard to spatial development, specifically diverging political convictions between

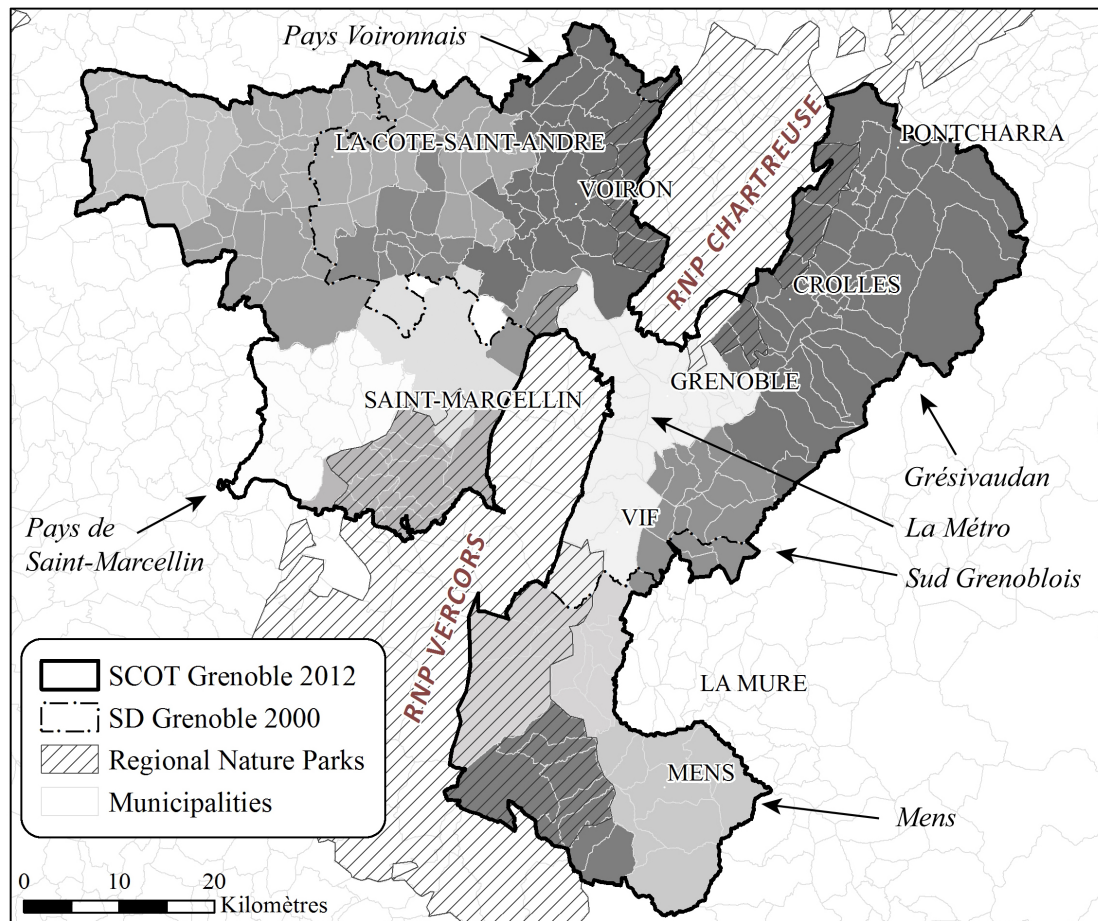


Figure 2.1 – Grenoble urban region political context

Note: SCoT 2012 and SD 2000 planning perimeters, Regional Nature Parks, EPCI (grayscale) and municipalities. EPCI as of 2010, perimeters change frequently.

Source: Author's map, based on data from DREAL Rhône-Alpes, IGN, FPNRF and Corine Land Cover (2006)

municipalities of the banlieue and the city. Further research has shown that peripheral territories took self-affirming and defensive positions vis-à-vis the agglomeration (Martin, 1997). Their diverging political and also cultural norms have particularly found their expression in the assertion of own territorial identities, which notably built on local agriculture to vindicate rural identities and position themselves against a “technopolitan” spatial development vision of the agglomeration (Bertrand et al., 2006, p. 333). Continuous claims for territorial identities, self-administration and vindications of self-interest have thus shaped the current inter-municipal landscape: different rural EPCI bodies have emerged around the Métro from the 70s onwards (see figure 2.1). Today, different rural EPCI continue to merge, searching to re-affirm their positions based on common identities. The surrounding mountain territories have built on own, independent territorial projects to assert their own rural and natural identity in close proximity to the agglomeration – two Regional Nature Parks with own planning projects, with another one developing (see figure 2.1).

Unsurprisingly, the recent SCoT processes have once more underlined peripheral claims and fears concerning local interests, competences and territorial identities (see table 2.1, quotes 1, 4, 5). Peripheral actors strongly perceived the SCoT consultations as a means of urban government to impose its spatial development vision (see table 2.1, quote 4). This rural-urban aversion, profoundly and historically rooted in the region, has continued to exist for several reasons. There is on the one hand simply the weight of the agglomeration. According to an elected member of the Métro, peripheral aversion is based on the social, economic and political polarization of the region around Grenoble municipality and the agglomeration (see table 2.1, quote 4; the Métro’s population share is more than 50 %). On the other hand, there are power imbalances between urban and rural representatives. Although they do not have a political majority in the SCoT body, urban actors represent the core of the region in terms of population and employment. Research on mayors’ and local councillors’ profiles in France confirms that urban representatives are more influential than their rural counterparts due to education, profession and political power (Koebel, 2012). In recent SCoT processes, influential politicians thoroughly chose those representatives for key positions in agglomeration and SCoT bodies, who better represent their development vision and are able to take influence on peripheral representatives in consultations (interview with an urban planner of the Grenoble urban planning agency, 2013). It thus became possible to push forward a comprehensive strategic development vision based on an urban perspective, based on territorial attractiveness, quality of life assets and urban sprawl control, for which the agglomeration actors needed the surrounding rural and mountain areas as “reserves of

Table 2.1 – Selected quotes from interviews with local stakeholders

Interviewee ^a	(1)	“We have had several requests to change the name of the SCoT. They [municipalities and elected representatives] did not want to have it called SCoT of Grenoble urban region. It should have been called SCoT of the Alpine region instead... something like that, in order to integrate the mountains, and not to make an allusion to the city in the name of the SCoT.”
	(2)	“And [the president of the public body] said «yes, to what is in the sector plan, we are not going to oppose it.” [And afterwards:] “The Trièves thus had his own flexibility, but the SCoT public body said, at a given moment, together with the agency: “If you want to produce a sector plan, ok, but it is you who is going to pay for it.”
	(3)	“So, it was better to work together and to say to the SCoT public body ‘come and work at our place’. [...] And from that point we gave up some of our prerogatives, but why not, since the heart, the core as they say, is the city. There is no reason to want to play such a role ourselves.”
Interviewee ^b	(4)	“No, there is a distrust of politicians or technicians from elsewhere with regard to the Métro... which is the biggest EPCI in the Grenoble region. There is always a suspicion that is sometimes legitimate and sometimes illegitimate, absolutely, towards the big.”
	(5)	“I assure you that the first visit we made on the Vercors plateau, local politician to local politician, we were received like the Chinese arriving on the Tibetan Plateau. Something like ‘You come to colonise.’ ”
Interviewee ^c	(6)	“There were really a lot of elements close to the SCoT that allowed us to say: ‘Well, we’ll start talking to create these elements there’. However, not everyone is on the same level, right? We are fortunate enough in the Grenoble region to have a culture of planning and urbanism that is more integrated among the local politicians.”

Notes: ^aMayor of a peripheral municipality, ^bElected member of *la Métro* in charge of spatial planning, ^cUrban planner of the Grenoble urban planning agency; all interviews of 2013.

fresh air” (interview with a mayor of a peripheral municipality, 2013, author’s translation).

Finally, there is a – also historically rooted - relational and geographical proximity between urban politicians of the Métro or Grenoble municipality and the urban planning agency. The SCoT body, led by Métro actors, entrusted the agency with the SCoT process. In addition, the process and especially the elaboration of documents are to a large extent technocratic and resource-demanding, and exceed by far peripheral municipalities’ capacities and resources. The result is that peripheral actors often make no difference between governance processes that are brought up by elected representatives of the agglomeration or by planners from the urban planning agency (interview with an elected member of the Métro, 2013).

2.3.2 Governance & hierarchy

The governance arena SCoT, and as its facilitator the urban planning agency, have successfully tried to resolve and overcome diverging political views and confronting ideologies in order to establish a collective strategic project for a heterogeneous territory. The SCoT body and the urban planning agency primarily used soft instruments such as consultations and focus groups to spread knowledge, raise awareness and mediate conflicts - although legislation is strict with regard to obligation of establishment of the SCoT, local actors largely decide on how to implement them. It thereby tried to shape the minds of local actors ‘softly’. But, not all agreements were reached on the basis of compromises and mutual concessions; local actors have simply not equal voice in governance processes in such heterogeneous territory due to the aforementioned power imbalances. Some experiences point at something that might be interpreted as urban dominance or power plays.

As an example, I present here the case of the Trièves territory south of the Métro, which joined the SCoT process rather late after lengthy negotiations. Defensive views see it as an area apart and claim an own identity, characterized by a particularly rural character (see figure 2.2). Nonetheless, functional relationships with the urban agglomeration are hard to deny, at least for the northern part. Frequently, urban politicians and planners bring up the idea of a fresh air reserve for the city. Spatial analyses in the SCoT process revealed it as a major zone of urban sprawl, and the SCoT body tried to “take control” over the area (interview with a mayor of a peripheral municipality, 2013, author’s translation). The Trièves decision to join the SCoT was not completely taken voluntarily, but rather based on more pragmatic considerations. The Grenelle laws oblige all municipalities in France to integrate a SCoT before 2017, or alternatively

develop their own SCoT. Otherwise, they would have to cede local land use regulation powers to the département. As the SCoT process and documents require considerable technical knowledge and extensive participation of the civil society, local resources of the Trièves EPCI - both financial and personal - would simply not have permitted to produce an own SCoT. There was in fact little choice for the local mayors but to join the SCoT process. The decision was further facilitated by concessions of the agglomeration, guaranteeing the Trièves an own sector plan that safeguards some autonomy. This latter turned out to be an elusive argument from the SCoT body, though, as the SCoT board together with the urban planning agency decided that Trièves actors have to afford this process on their own (see table 2.1, quote 2; see figure 2.2). Ideologically, in a way, the Trièves actors had to abandon the perspective of an auto-development for their territory, thereby admitting both the functional interdependence with the urban region and new territorial representations. Even more importantly, they admitted the dependence on urban policy (table 1, quote 3).

We might interpret these negotiations as part of wider informal governance processes, in which the SCoT board benefits from the formal legislative framework in combination with technocratic and political power in order to shape, in a rather authoritarian manner, the minds of local actors. We might understand this as an expression of hierarchy in governance processes. The example of the Trièves, albeit very particular, is a showcase for how the SCoT process has become an arena in which agreements and decisions are influenced by supra-local power imbalances between territorial representatives. The SCoT process is used by influential, mostly urban actors (planners and elected representatives) to put forward urban interests and to extent the planning perimeter by means of governance to peripheral territories. In this regard, it is not only soft governance in strategic planning, such as collective efforts and mutual learning, which shape peripheral actors' minds.

2.4 Discussion & concluding remarks

With regard to the special issue's theme, I presented recent transformations of local planning culture due to strategic spatial planning in Grenoble urban region. Analysing the large-scale SCoT strategic planning process, I explored how such new governance spaces impact the local planning culture, and are successful in enlarging planning scale and regroup a vast amount of territories in collective strategy-making. We have seen that the SCoT process is an arena for discussion and consensus-building for politicians and planners, in which spatial strategies and planning objectives for the urban region

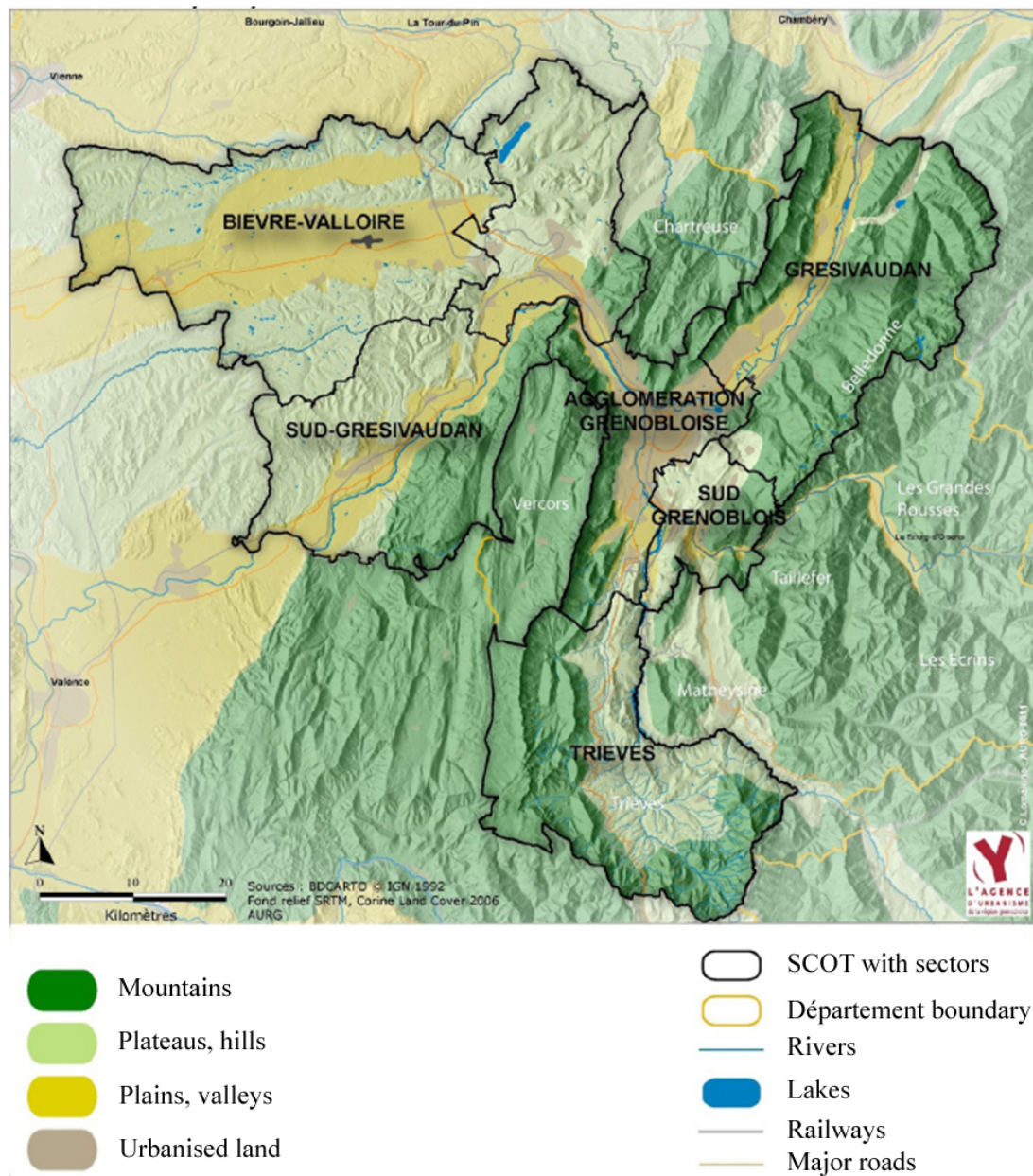


Figure 2.2 – Grenoble urban region geographical context

Note: Land use, SCOT perimeter and implementation sectors.

Source: Grenoble urban planning agency 2012, author's translation.

are collectively set (Healey, 2007). I would like to highlight and discuss three major lessons for city region strategic planning that the analysis has revealed.

First, the analysis underlined the importance of path-dependency for local planning culture, and here, specifically for the emergence of a local climate of dialogue. This has, however, evolved over a long period of time along with former strategic planning episodes, inter-municipal collaborations and different territorial projects. Moreover, we might argue that geographical proximity, neighbourhood and functional relationships that connect territories are beneficial for such a climate. With increasing distance to the core of the agglomeration, territories are also likely to be farther away in dialogue, like it was case for the Trièves. Over the decades, though, governance processes around strategic planning episodes seem to have smoothed conflicting positions as well as cleavages of planning and cultural norms between urban and rural territories. Consistent with literature, this finding emphasizes the importance of path-dependency of governance processes in local planning culture and wider urban policy-making (Brenner and Theodore, 2002, Haughton et al., 2013, Nadin and Stead, 2008). Grenoble region shows that the governance efforts in the direction of non-adversarial dialogue over time may open up the door for large-scale collective efforts in spatial strategy-making.

Second, the analysis revealed the rolling-out of power plays, notably between agglomeration and rural representatives. It thus sheds light on how new governance spaces and processes might be sensitive to or even create power imbalances between actors. Planning and social theory argue that governance processes and bottom-up approaches may leave room for powerful vested interests and influential individuals in coalition and alliance formation (Allmendinger and Haughton, 2010, Harvey, 1989, Metzger, 2011). In my example, spatial cleavages between urban and rural territories and especially territorial identities appear on the scene and actors strongly perceive them. In the SCoT arena, urban actors use strategic positioning of influential representatives in the SCoT board to destabilize the existing actors and networks, reinforce urban interests and take control of the process. Already former works that dealt with territorial organisation in the region have used the figure of speech “neither with you nor without you” (Martin, 1997) to state a culture of ‘forced openness’ towards collective supra-local efforts. Interests of powerful actors seem to shape the SCoT strategy, an issue that occurs when political debates are displaced to softer governance spaces (Metzger, 2011).

Finally, the analysis draws our attention to the role of planners in governance processes and their influence on strategic policy-making. Both in scale and scope, their field of action has become diversified. In planning theory, collaborative or communicative planning approaches refer to the planner’s role as one of an objective mediator among

various actors in planning processes (Healey, 2007). But planners might in fact take on different roles, depending on context (Briassoulis, 1999). Besides ever-more present technocratic plan-making, planners of the urban planning agency took on the roles of information processors, diffusers and educators with regard to policy reforms and planning norms at the service of local authorities. To some extent, we might argue that the traditional relationship decision-making politician – executing planner has been undermined. It is planners, endowed with greater liberties, who have technical knowledge and means to strongly influence decision- and policy-making, especially as opposed to local and rural decision-makers. The urban planning agency acts, in a certain way, as a think tank for wider territorial policy-making. But we should critically reflect on their historical, relational and geographical proximities with influential urban representatives that might have created a rather closed and powerful governance network that is able to steer development.

All in all, the lessons from the Grenoble experience with strategic spatial planning show the need to reflect on how strategic visions, planning culture and territorial identities are formed by powerful actors and networks in new planning arenas. We might see this even more critical if we consider that these processes produce strong planning instruments. Although the paper draws on a rather particular episode of strategic spatial planning efforts in France, I do believe that it delivers some valuable insights into how local actors translate recent urban policy reforms to their territories and which drawbacks exist. In the French context in general, contemporary spatial planning reform and a new wave of decentralization reinforce considerably inter-municipal land use planning and the scale of the agglomeration. The municipality level as smallest entity of local government is likely to lose large parts of its competences in land-use planning in the medium run. Future research could move beyond these results in focusing especially on power imbalances, actor inclusion and the concept of spatial justice in governance processes. In the end, the performance of strategic planning processes, notably for sustainable development, is strongly dependent on how local actors (re-)shape a collective culture of dialogue and, rural-urban partnership and share responsibilities.

Chapter 3

Natural amenity-driven segregation: evidence from location choices in French metropolitan areas

“It is some hardship to be born into the world and to find all nature’s gifts previously engrossed, and no place left for the newcomer.”

- John Stuart Mill, 1865¹

Preamble

This chapter presents work related to the second aim of this thesis, i.e. to investigate the links between natural amenities, residential location choices and socio-spatial segregation. It does this via a comparison of location choice model results and counterfactual predictions - switching off natural amenity effects - between our study region and the Marseille - Aix-en-Provence - Toulon metropolitan region. The paper is the result of a close collaboration with colleagues at Irstea Grenoble who worked on the EFFIJIE project, investigating residential location choices in the Marseille-Aix-en-Provence region.

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¹Mill (1865)

Yves Schaeffer and me are the main authors (responsible for research idea, data sets and variables, general method, R-scripts and writing), Mihai Tivadar and Cosmina Tartiu participated in specific steps (Monte Carlo simulation method and data set compilation for Marseille, respectively). Due to a greater work share in the revision process (notably estimations of the mixed logit model), Yves Schaeffer and me agreed to change first authorship. A previous version of this paper was presented at the 8th Congress of Social Sciences held in Grenoble in December 2014.

Natural amenity-driven segregation: evidence from location choices in French metropolitan areas

Yves Schaeffer, *Dominik Cremer-Schulte*, Cosmina Tartiu, Mihai Tivadar

Abstract

Casual observation and numerous studies in economics and psychology suggest that households care about the natural environment of their living places. This paper investigates the role played by natural amenities in the formation of segregated residential patterns with respect to household size and socio-professional status. We estimate residential location choice models for large household samples in two metropolitan areas in France: Grenoble in the Alps, and Marseille on the Mediterranean coast. In a second step, we perform counterfactual segregation analysis using Monte Carlo simulations, to compare segregation outcomes “with” and “without” preferences for natural amenities. Our main result is that households’ search for natural amenities has significant impacts on residential segregation. It most often contributes to strengthening segregation, but can also be a factor attenuating segregation. Residential segregation is strengthened if the socio-spatial outcomes of the “natural amenity-driven segregation channel” and the “standard segregation channel” coincide, and attenuated if not.

Keywords

environmental amenities, residential segregation, residential choice model, counterfactual simulations, Monte Carlo simulations

3.1 Introduction

IN Western Europe, residential segregation - defined as inequality in the spatial distribution of socio-economic, demographic or ethnic population groups in a residential area - has been on the rise since the turn of the millennium (Cassiers and Kesteloot, 2012, Musterd, 2005). This evolution is generally thought problematic for economic efficiency, social equity and cohesion (Bygren and Szulkin, 2010, Cassiers and Kesteloot, 2012, Musterd et al., 2012, van Ham et al., 2014). It is presumed to bring additional economic disadvantages to the most disadvantaged groups, and make intergenerational dialogue and solidarity less likely (Hagestad and Uhlenberg, 2005, 2006). Across Europe over recent decades, political agendas have set objectives and introduced measures to promote social diversity at the municipality and neighbourhood levels. For instance, in

France, the law on solidarity and urban renewal (voted on in 2000 and strengthened in 2013) obliges all urban municipalities with more than 3,500 inhabitants to increase the share of social housing to at least 25 % of primary residences. Failure by the municipality to achieve this threshold attracts a fine. Urban municipalities also need to have in place a construction programme for catching up and contributing to the objective to decrease residential segregation in urban areas.

In this context, research on residential segregation is needed to better understand its mechanisms and its resolution through public policies. Scholars have pointed to several factors likely to influence segregation. In the economics literature, residential segregation is considered mostly as the outcome of households' selective migrations into an urban region based on their location preferences, which differ according to their socio-economic, demographic and ethnic attributes. The most influential explanatory frameworks are Tiebout-type models, urban economic models and social interaction models. Tiebout (1956) seminal work suggests that households "vote with their feet" and move into the community that maximizes their utility with regard to taxes and local public goods. The association of an unequal ability to pay for public goods, and varying patterns of preferences leads to the segregation of similar households across local jurisdictions. Standard urban economics models analyse households' trade-offs between two main location factors: job accessibility and land consumption. Segregation by income and size is expected to occur in a pattern of concentric circles around a central business district (Fujita, 1989). Lastly, Schelling-type social interaction models assume a process of segregation where the ethnic or social composition of the neighbourhood enters the household utility function (Grauwin et al., 2012, Schelling, 1971).

Using insights from these theoretical models, an extensive body of empirical studies analyses residential location behaviours in many urban and metropolitan areas around the globe. Based on data on stated or revealed preferences, and applying especially discrete choice models (McFadden, 1978), this work confirms the importance of these factors in location decisions, and provides evidence of differences in location preferences across population groups (see (Guo, 2004, Schirmer et al., 2014) for reviews). Also, recent studies show the impacts of some of these factors on aggregate segregation outcomes (Bayer and McMillan, 2012, Goffette-Nagot and Schaeffer, 2013).

Some theoretical and empirical studies question the role of the natural environment on residential segregation. Scholars have defined natural amenities as location-specific features of the natural environment which make a locality more attractive as a place to live (Power, 2005). For instance, Banzhaf and Walsh (2008) extend a Tiebout-type model to analyse households' reactions to changes in local environmental quality (air

pollution), while (Wu, 2006) shows that patterns of segregation may be better explained using an urban economic framework that takes account of the spatial distribution of area-featured (e.g. parks) and line-featured (e.g. rivers) natural amenities. Discrete choice analyses (e.g. de Palma et al. (2007b), Van Duijn and Rouwendal (2013)) confirm that environmental amenities and disamenities affect households' location choices at the municipality or neighbourhood level.

However, to our knowledge there are no empirical studies that explicitly link households' natural amenity preferences with outcomes in terms of residential segregation levels. This is the main contribution of this paper. In the absence of insights on this link, urban policies aimed at countering segregation could overlook the importance of the natural environment and, thus, might fail to address its mechanisms or become self-defeating.

Our research questions are the following: (1) do natural amenities have a significant impact on residential segregation processes? and, if yes, (2) does this impact reinforce or attenuate the other segregation dynamics stressed by urban economics, Tiebout-type and social interaction models? We investigate these questions with the help of two French cases with specific sets of natural amenities: the mountainous metropolitan area of Grenoble and the coastal metropolitan area of Marseille. We focus specifically on supposedly attractive natural amenities: green amenities (e.g. forest areas), blue amenities (e.g. lakes) and case-specific amenities related to mountains and coastline. We investigate segregation mechanisms according to household size and socio-professional status.

The data on households' residential mobility comes from the 2008 French population census, provided by the National Institute of Statistics and Economic Studies (hereafter Insee). The methodology is based on a two-step approach adapted from Goffette-Nagot and Schaeffer (2013). In the first step, we estimate conditional and mixed logit models (Train, 2009) for the two regions to analyse the determinants of households' location choices. Our explanatory variables include standard location factors such as job accessibility, local public services and housing prices, and variables for natural amenities. The second step is a counterfactual segregation analysis. Households' choice probabilities are computed using the models estimated in the first step (realistic scenario), and partial models where estimates corresponding to preferences for natural amenities are set to zero (counterfactual scenario). Then, Monte Carlo simulations of households' location choices allow us to compute distributions of segregation indices for each scenario, and to compare the segregation patterns with and without preferences for natural amenities.

The estimation results confirm that preferences for natural amenities differ signif-

icantly by household size and socio-professional status. The counterfactual analysis shows that they most often contribute to strengthening segregation dynamics. However, in some cases, they act as a factor attenuating segregation. Residential segregation is strengthened if the socio-spatial outcomes of the “natural amenity-driven segregation channel” and the “standard segregation channel” coincide, and attenuated if not.

Section 2 provides a brief overview of the related literature; Section 3 describes the model, the data and the methods employed; Section 4 presents the model estimates and the results of the counterfactual segregation analysis. Section 5 concludes the paper.

3.2 Related literature

Residential segregation has been portrayed as the projection of the social structure onto space (Häußermann and Siebel, 2001). Research generally considers its main driver to be selective migrations linked to household income and life cycle stage.² This empirical paper is about natural amenity preferences and their impact on location choices and segregation processes at the metropolitan scale. Here, we briefly review several strands of the economic literature connected with this topic. The fact that households care about the natural environment of their living places is well documented by hedonic price studies. The view that natural amenities can play a role in (socially selective) residential migration and the formation of spatial economic disparities is supported by migration and regional development studies. The households’ preferences for natural amenities are also investigated at the metropolitan scale by a few residential location choice studies. And theoretical urban and public economic models encompassing environmental amenities show they matter to urban segregation dynamics.

3.2.1 Preferences for environmental amenities

The hedonic price framework statistically disaggregates housing prices into a schedule of implicit marginal prices for housing, neighbourhood and the property’s locational attributes (Baranzini et al., 2008, Munroe, 2007). Various studies show positive impacts of environmental amenities on housing prices, e.g. for natural zones (Baranzini and Schaerer, 2011), environmentally sensitive areas (Costanza et al., 2006), land use such as open spaces, agricultural land and forests, land cover diversity, proximity to lakes and rivers (Baranzini and Schaerer, 2011, Cavailhès et al., 2009, Cho et al., 2008, Costanza et al., 2006, Geoghegan et al., 1997, Luttik, 2000, Nilsson, 2014), beaches or proximity

²Some of the literature challenges this view and highlights aspects such as natural demographic change, immigration and emigration. See Bailey (2012) for a discussion.

to the coast (Blomquist et al., 1988, Costanza et al., 2006), and urban green spaces and parks (Travers et al., 2013), see Waltert and Schl pfer (2010) for an extensive review). Research shows also that altitude (Nilsson, 2014, Wu et al., 2004), scenery and views over specific natural amenities can have positive impacts on land and house prices (Baranzini and Schaerer, 2011, Bastian et al., 2002, Cavailh s et al., 2009). Some scholars study environmental disamenities, showing that poor air and water quality, noise and proximity to transport infrastructure, harmful land uses and polluted sites have negative impacts on house prices (see Boyle and Kiel (2001) for a review).

The literature on migration and rural development examines the preferences related to environmental amenities and the link with population flows and spatial inequalities. This research emphasizes the capacity of environmental amenities to attract migrants and human capital, and to stimulate regional economic growth (Knapp and Graves, 1989, Waltert and Schl pfer, 2010). The influence of climate, topography, protected areas, scenic views, open spaces, forests and water areas on population flows and employment growth, has been identified, especially for the US. Several studies show that environmental factors attract specific population groups (e.g. retirees - (Duncombe et al., 2001, Poudyal et al., 2008), higher income households - (Hand et al., 2008), or members of the creative class - (McGranahan et al., 2011, van Oort et al., 2003) and jobs, encouraging greater regional disparities (Waltert and Schl pfer, 2010). In this context, there is longstanding debate over the traditional economic view that people follow jobs versus the amenity perspective where jobs follow people attracted by environmental amenities (Partridge, 2010). This strand of work suggests that households care about the spatial proximity of environmental amenities and, also, that differences in preferences among households might influence the formation of regional disparities. However, it does not explain the role of environmental amenities in the residential segregation processes observed in many metropolitan regions.

These works suggest that households care about the spatial proximity of environmental amenities and, also, that differences in preferences among households might influence the formation of regional disparities. But it does not explain the role of environmental amenities in the segregation processes observed within many metropolitan regions.

3.2.2 Residential segregation and the environment

Tiebout (1956) seminal work in public economics suggests that households “vote with their feet” and select the community that maximizes their utility with regard to taxes and local public goods and services. The association between an unequal ability to pay for public goods and varying patterns of preferences leads to (at least partial) segregation

of similar households across jurisdictions. This fundamental idea has been formalized (Ellickson, 1973, Epple and Platt, 1998) and extended to many sources of local externalities (Benabou, 1993, Durlauf, 1994, 1996). Tiebout (1956, p. 418) states that this behaviour holds also for non-economic location features not captured by taxes, such as social composition and environmental quality. Drawing on Tiebout, Banzhaf and Walsh (2008) devise a locational equilibrium model and test for environmentally motivated migration decisions in response to exogenous changes in air pollution. They find robust evidence that increased pollution in a given location leads to emigration of richer households and immigration of poorer households.

Another canonical setting for explaining segregation is the monocentric city model (Alonso, 1964, Fujita, 1989). Households' location choices are modelled as a trade-off between two location factors: job accessibility and land consumption. Segregation by income and by size adopts a pattern of concentric circles around a central business district (CBD). A few papers consider urban and environmental amenities in this framework (Brueckner et al., 1999, Fujita, 1989, Wu, 2006, 2010, Wu et al., 2004, Wu and Plantinga, 2003). Brueckner et al. (1999) suggest that a central location provides historical urban amenities, while natural amenities are abundant in the periphery. Assuming that historical amenities are more important in Paris than in the Detroit, and that their valuation rises sharply with income, provides an explanation for why patterns of segregation by income differ between these two cities (see also Tivadar (2010), with endogenous urban amenities). Wu (2006) shows that urban patterns, such as sprawl and leapfrog developments, and varying socio-economic community characteristics can be better explained by taking account of the spatial distribution of area-featured (e.g. parks) and line-featured (e.g. rivers) natural amenities. This latter paper provides explicit answers to our two research questions: natural amenities are shown to have a significant positive impact on segregation by income. However, an empirical verification is lacking.

3.2.3 Residential location choice models

Using insights from the theoretical frameworks presented above, a group of empirical studies in the economics, transport and urban planning literatures, analyses residential location behaviour in urban and metropolitan areas. These studies reveal trade-offs in households' location decisions and emphasise systematic differences in preferences according to stage in the life-cycle, income group and ethnic background (see (Guo, 2004, Schirmer et al., 2014) for reviews). They consider typical location characteristics including urban economic factors such as job accessibility, housing provision and house prices, and public economics factors such as local public goods and socio-economic,

demographic and ethnic composition of the resident population. A few of them also consider urban and environmental (dis)amenities.

Van Duijn and Rouwendal (2013) investigate the effects of cultural heritage, water and natural land areas, in households' location choices in the Netherlands. In line with Brueckner et al. (1999) assumption, they show that highly educated households – especially single households – put a higher valuation on historic amenities. Highly educated singles also value higher inner-city waterfront areas, while the natural living environment is more important to larger households, elderly people and double earners. In a study which employs a conjoint choice stated preference experiment, Rouwendal and Meijer (2001) show that double income households are more likely to accept longer commutes in order to reside in a small town or in the countryside. A study by Frenkel et al. (2013) investigates the residential choice behaviour of knowledge-workers in the Tel-Aviv metropolitan area using a web-based revealed preference survey. They find that standard factors, such as affordability of housing, socio-economic context and access to jobs are the most important drivers of knowledge-workers' location choices. However, cultural and educational land uses and population density also have significant positive effects on these household's location choices. In a study of location choices related to Paris, de Palma et al. (2007b) consider the effects of environmental amenities and disamenities (noise) and show that households avoid noisy areas and prefer proximity to parks and forests (households with children), sports spaces and water areas.

This literature review confirms that households' location choices are influenced by natural amenities. In addition, theoretical models show that natural amenities are likely to affect dynamics of urban segregation. Yet, there are no empirical study of the relationships between households' preferences for natural amenities and residential segregation outcomes at the metropolitan scale. This is the gap we want to fill in the subsequent sections.

3.3 Data & methods

The impact of natural amenities on residential segregation processes are investigated using two large household samples from the most populated mountainous and coastal metropolitan areas in France - Grenoble and Marseille. The method is based on a two-step approach: the estimation of residential location choice models for each metropolitan area, and a counterfactual segregation analysis that allows comparison of “realistic” and “counterfactual” segregation outcomes generated by Monte Carlo simulations.

3.3.1 The data

Study zones

The Grenoble metropolitan area (hereafter Grenoble), situated in the Rhône-Alpes administrative region, is regarded as the capital of the French Alps. It consists of a dynamic, medium-sized city of around 500,000 inhabitants and a mountainous hinterland accommodating some 170,000 inhabitants. The Marseille metropolitan area (hereafter Marseille), is a major polycentric metropolitan area³ of nearly 2.5 million inhabitants situated on the Mediterranean coast in the Provence-Alpes-Côte d’Azur (PACA) administrative region. It is organized around the municipality of Marseille, which hosts more than 850,000 inhabitants, and the smaller municipalities of Aix-en-Provence and Toulon, each populated by around 150,000 inhabitants, and its hinterlands of typical hilly Provence landscapes. Figure 1 shows the location and the extent of the two study areas.

Household samples and community characteristics

The study is based on individual migration data from the 2008 French population census, provided by Insee.⁴ This data set provides information at the individual household level with regard to current and previous municipality of residence, and socio-demographic characteristics. In line with other studies (e.g. de Palma et al. (2007b), Nechyba and Strauss (1998), Schmidheiny (2006)), we consider the household level to be the relevant unit for location decisions, and the municipality level as appropriate for location choice analysis.⁵ The house price data created constraints that led to residential location choice sets composed of 79 municipalities in Grenoble (ca 40 % of municipalities) and 112 in Marseille (ca 70 % of municipalities).

Also in line with other studies (e.g. Goffette-Nagot and Schaeffer (2013), Schmidheiny (2006)), we focus on recent movers - i.e. those moving house and staying or not in the same municipality in 2001-2008 - rather than the whole population. A move entails the household adjusting its location to its preferences; therefore, the location choices of

³The metropolitan area of Grenoble is a monocentric functional urban area defined by Insee. Delimitation of the metropolitan region of Marseille is based on recent Insee research (Adaoust et al., 2013), which uses network analysis to identify networks of nested functional urban areas.

⁴The dataset used here is based on surveys and covers 25 % of households in municipalities with less than 10,000 inhabitants, and approximately 40 % of households in municipalities with 10,000+ inhabitants. We focus on households whose primary residence is a house or flat, and exclude dwellings with special characteristics, e.g. retirement homes, etc.

⁵Given the availability of the data, we made an exception for the municipality of Marseille; here we consider locations at the level of the 16 *arrondissements* (districts), which we describe here as municipalities.

recent movers are a better reflection of their preferences than the locations of immobile households. Also, we restrict our samples to internal movers (i.e. immigrants into the study regions are excluded), since they are supposed to be better informed than immigrants about the location and housing opportunities, and the quantity and quality of amenities. Table 3.1 presents sample sizes and selected socio-demographic characteristics of movers and non-movers in the two regions.

Table 3.1 – Household samples descriptive statistics

	Grenoble		Marseille	
	Non-movers	Movers	Non-movers	Movers
# Observations (unweighted)	45,886	21,074	225,030	98,048
# Observations (weighted)	147,489	60,050	65,7395	248,203
% ^a Executives	13.6	19.5	8.6	12.5
% ^a Retirees	43.9	8	45.1	11.6
% ^a Other categories	42.5	72.5	46.2	75.9
% One-person	32.6	31.4	34	34.1
% Two-person	35.1	28.2	34.5	28.1
% 3-or-more-person	32.3	40.3	31.5	37.8

Notes: ^asocio-professional status of the reference person of the household. *Source:* Own calculations based on Insee MIGCOM 2008 dataset (Insee, 2008).

Natural amenity variables

We consider three classes of natural amenity variables: *green amenities* (i.e. natural land area); *blue amenities* (i.e. water bodies); and case-specific amenities, i.e. *mountain* and *coastal amenities*. Several types of measures have been used to quantify the presence and amount of and access to natural amenities at a given location: binary variables (e.g. presence of specific natural features), area and proportion measures (e.g. surface area or percentage of forest in a municipality), proximity variables (e.g. distance to the nearest area of forest), and composite amenity indices (Waltert and Schl  pfer, 2010). Here, we use binary variables and proportion measures incorporating a proximity dimension.

In each municipality, we characterize green amenities in the proximity of inhabited spaces: our variables are land cover shares within a buffer zone of 1 km around settlements.⁶ We distinguish between forest areas, and all other green areas, termed

⁶Thus, we avoid measurement errors arising from the use of administrative boundaries to calculate shares (e.g. in Chi and Marcouiller (2012), Cremer-Schulte and Dissart (2013), Hand et al. (2008), Waltert et al. (2011)). In mountainous areas, in particular, municipalities cover vast territories, far

‘open spaces’ (urban green spaces, agricultural and semi-natural areas). Blue amenities are captured by a dummy variable indicating the presence of major rivers or lakes in the municipality (including the Berre Lagoon in Marseille, a large inland water area connected to the sea). Mountain amenities are proxied by the average altitude of the municipal settlement area, and coastal amenities by a dummy variable indicating coastal municipalities.

Control variables

Commuting time is a major driver of location choice (Schirmer et al., 2014). Since our dataset does not provide information on households’ work locations, we compute travel times from all municipalities to the closest major job centre (i.e. Grenoble, Marseille, Aix-en-Provence or Toulon). The presence of a significant bundle of facilities and services is indicated by a dummy variable.⁷ Average income by consumption unit at the municipal level proxies for the socioeconomic level of the population. House prices are proxied by mean prices based on apartment sales in each municipality.⁸

Other controls are: (1) proxies for the housing supply: natural log of the number of primary residences⁹, percentage of apartments, and percentage of social housing in the housing stock; (2) proxies for migration costs: a ‘stay’ dummy variable (which equals 1 if the household moves within the same municipality and 0 otherwise) (de Palma et al., 2007b, Goffette-Nagot and Schaeffer, 2013) and a migration distance variable (road travel time to all alternatives from prior location) (see Schirmer et al. (2014), Zondag and Pieters (2005)); and (3) proxies for disamenities linked to ‘harmful’ land uses: share of landfills and mines, industrial and commercial zones, and transport infrastructures in a 1 km buffer around settlement areas. Table 2 presents descriptive statistics for the municipality variables and their sources for both regions.

exceeding inhabited areas. Data on populated zones are from INSEE’s population raster data (200 x 200 m).

⁷See Brutel and Levy (2012) for a presentation of the method applied by the authors to 2007 data on local equipment and services. These bundles are provided by both large urban centres and smaller towns located in the suburbs and hinterlands.

⁸The diffusion threshold of these data - at least 5 transactions - forced us to reduce the number of municipalities in the location choice sets (i.e. the least inhabited municipalities are excluded). To attenuate this constraint, we aggregated transactions for three successive years.

⁹which acts as a correction term in aggregate models of location choice at municipality level (Ben-Akiva and Bowman, 1998)

Table 3.2 – Descriptive statistics of alternative characteristics

	Grenoble				Marseille			
	N = 79				N = 112			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
# ^a Primary residences	2,898	8,631	70	75,227	8,043	11,278	508	73,849
% ^a Flats	32.3	23.6	0.9	95.5	36	26	2	95
% ^a Social housing	10.9	8.4	0	37.5	9	11	0	47
^b Travel <i>t</i> center (min)	20.7	12.2	0	46.6	41.9	22.8	0	97
^c Bundle of services	0.3	.	0	1	0.8	.	0	1
^d Income (€)	18,018	6,006	11,939	41,710	14,648	3,308	7,758	25,324
^e Price (€)	2,419	558	1,057	3,831	1,026	338	487	2,093
^f % Harmful land use	6	8.3	0	35.6	7	7	0	35
^f % Forest	34.1	16.4	3	76.9	23	16	0	75
^f % Other open spaces	43.3	18.4	5.6	79.4	39	18.7	1.5	93.4
^g Water	0.8	.	0	1	0.6	.	0	1
^g Coast					0.3	.	0	1
^g Elevation (m)	424	227	215	1,208	143	108	2	399

Source: Own calculations based on: ^aFrench population census INSEE RGP 1999; ^bODOMATRIX, INRA UMR1041 CESAER, from IGN Route500®, BD ALTI 500®, RGC®; ^cPermanent database for facilities INSEE - BPE 2007; ^dFrench tax database INSEE IRPP 1999 (Marseille), 2000 (Grenoble); ^eReal estate database “Notaires de France-PERVAL” 1998-2000 (Marseille), 2006-2008 (Grenoble); ^fEuropean Environmental Agency Corine Land Cover (CLC) 2000 (Grenoble), OCSOL 1999 database of the Regional Centre for Geographical Information of PACA (Marseille); these databases are comparable but OCSOL is worked out to correct some imprecisions of CLC; ^gIGN - BDTOPO® V2.1 database 2008.

3.3.2 Methods

The location choice model

We use multinomial discrete choice models (Train, 2009). Consistent with random utility theory, this family of models proposes that a household n chooses the alternative i , from a set of mutually exclusive alternatives J , which maximizes its utility function. As some attributes of the alternatives and the household are unobserved by the researcher, overall utility U_{ni} is composed of an observed utility component V_{ni} and an unobserved one, the error term ϵ_{ni} , which is treated as random to capture the idiosyncratic heterogeneity:

$$U_{ni} = V_{ni}(x_i, s_n) + \epsilon_{ni}, \quad (3.1)$$

where x_i are attributes of alternative, i , s_n are attributes of household n . Specifying the observed part of utility to be linear in parameters, the overall utility U_{ni} can be written as:

$$U_{ni} = \beta' x_{ni} + \epsilon_{ni}, \quad (3.2)$$

where x_{ni} are attributes of alternative, i , for household n , and β' is a vector of the parameters to be estimated.

The most commonly used model is the conditional logit (CL) model (McFadden, 1978). It is obtained by assuming that the error term is an independently and identically distributed type I extreme value. The probability of household n choosing alternative i from the overall choice set J can be calculated as:

$$P_{ni} = \frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}}, \quad (3.3)$$

where X and Z are vectors of attributes of household n and municipalities i and j , and β' is a vector of parameters to be estimated.

The CL model has advantages which have contributed to its popularity in applied econometrics, such as ease of computation, relative success in predicting market shares, and ability simultaneously to test a large set of variables (Frenkel et al., 2013). There is however a major drawback to its use: Equation 3.3 implies that the odds ratio between two alternatives does not change if another alternative is included or excluded (a property called Independence of Irrelevant Alternatives, or IIA); it is related to the assumption that error terms are independent across alternatives, and the CL yields inconsistent estimates and unrealistic substitution patterns if this assumption is violated.

The mixed logit (ML) model relaxes the IIA hypothesis. In addition, it explicitly accounts for dispersion in tastes within population sub-groups: its parameters are individual-specific based on the assumption that they follow a random distribution. Overall utility can be written as:

$$U_{ni} = \beta'_n x_{ni} + \epsilon_{ni}, \quad (3.4)$$

where β'_n ($\beta'|\theta$) and θ are the parameters (mean and variance) of the distribution of β'_n over the population. The most common practice is to assume a normal distribution for the random coefficients (Dahlberg et al., 2012). Since β'_n is random, the choice probability is the integral of the logit formula over the density of β'_n (Train, 2009). While the CL model is estimated using a standard maximum likelihood procedure, the ML model is estimated via simulated maximum likelihood estimation.¹⁰

The specifications of these models (see Annex 3.5) were selected from various alternative specifications, based on insights from economic theory, goodness of fit measures and statistical hypothesis testing.¹¹ To be able to analyse cross-group heterogeneity in tastes, and to simulate segregation dynamics, all natural amenity variables and controls (except correction terms) are interacted with household socio-demographic dummies.

Endogeneity issues and treatments

Price endogeneity

A variable that is likely to be endogenous in residential location models is the dwelling unit price. As Guevara and Ben-Akiva (2006) stress, the researcher cannot recognize all relevant quality attributes correlated with price. The result is an upward bias of the estimated price coefficient: individuals who choose more expensive dwellings in order to benefit from these attributes may appear insensitive to price or even to prefer a higher price. This problem exists in our framework where only the mean price in a municipality is known. In addition, this price variable might be correlated with unobserved locational attributes, and is correlated with other explanatory variables, especially income (.62 and in Marseille and .71 in Grenoble) and commuting time (-.65 in Grenoble).

Following Guevara and Ben-Akiva (2006), Guevara and Ben-Akiva (2012) and Petrin and Train (2003), we implement the two-stage control function (2SCF) method to address this endogeneity issue. The price must be regressed by OLS on all other observed

¹⁰All estimations are performed with the authors' own scripts in R, using the mlogit package (Croissant, 2013), taking sample weights into account. The scripts are available from the authors on request.

¹¹We thank an anonymous reviewer for his advice on the specification.

choice characteristics and an appropriate instrument (i.e. that is correlated with the price, but has no direct effect on choices), and the residuals of this price equation must then be introduced in the choice model. Our instrument is the average prices in surrounding municipalities (the correlation with the price variable equals .65 in Marseille and .68 in Grenoble).¹²

Income endogeneity

Another variable likely to be endogenous is average income at the municipal level. *Ceteris paribus*, some households may want to live in a municipality with high average income for two reasons: (i) because they want to be close to high-income neighbours, or (ii) because they have a taste for other unobserved attributes correlated with high average income.¹³ Some unobserved attributes may emerge endogenously in municipalities with sufficient concentrations of high income households (e.g. higher quality of local private or public services, see Tivadar (2010)). These may be attractive to high income as well as other categories of households. Other unobserved attributes may not be explained by the social mix, but may nevertheless be correlated with high average income, due to their specific attractiveness for high income households and their related impact on past residential flows (e.g. scenic landscapes, etc.).

The consequence of omitting relevant attributes is bias on the estimated coefficient.¹⁴ We do not treat this bias, but rather consider the income variable as proxying for all these unobserved attributes. Importantly, this endogeneity is not likely seriously to affect the estimates for the natural amenity variables, since correlations between the income variable and the natural amenity variables are low (maximum values .24 for the forest variable in Marseille and -.11 for the open space variable in Grenoble).

Counterfactual segregation analysis

In order to study the impact of the preferences for natural amenities on segregation processes, we propose an original approach inspired by Schmidheiny (2006) and especially (Goffette-Nagot and Schaeffer, 2013), adapted to our specific questions and improved by

¹²This spatially lagged price variable is computed using a k-nearest neighbour spatial weight matrix, with GeoDa (Anselin et al., 2006). The OLS regressions are run with R (R Core Team, 2013) and results of are available upon request.

¹³Or conversely a distaste for unobserved attributes correlated with a low average income (e.g. crime rates).

¹⁴A simultaneity issue might be another source of econometric bias. However, this is avoided since the income variable is taken from the 1999 census, while the choices occur during the 2000-2008. Our assumption is that most households do not check the municipality's true average income, but rather get information on its reputation, which makes a lagged variable appropriate.

statistical hypothesis testing. The core idea is to compare ‘realistic’ and ‘counterfactual’ distributions of households in terms of segregation levels.

First, we compute the choice probabilities for each household-alternative observation using two distinct models: the complete model of residential choice which accounts for all preferences (realistic scenario), and a partial model where parameter estimates corresponding to preferences for natural amenities are set to zero (counterfactual scenario).¹⁵ Second, we simulate the location choices of households, using a random process constrained by the distribution of choice probabilities. These Monte Carlo simulations are repeated 100 times for each scenario allowing us to compute segregation indices distributions (considering either movers only or the whole population), and to calculate standard statistics for the random variables (mean and standard deviation). This procedure allows us to compare the means corresponding to each scenario - with and without preferences for natural amenities - and to test whether the difference between the two scenarios is statistically significant. We applied the Welch’s two sample t-test (Welch, 1947), which is adapted from the student t-test for two samples with possible unequal variance.

Segregation can be defined in relation to various dimensions such as evenness, exposure, clustering, concentration or centralization (Massey and Denton, 1988). We focus on evenness because it is the most obvious and most widely used dimension of segregation: it corresponds to the concept of inequality applied to the distribution of population groups across spatial units: *unequal* distributions are considered *segregated*. We use Duncan and Duncan (1955a) segregation index S and dissimilarity index D because of their ease of interpretation. The S -index measures departure for one group from a completely even distribution, where the distribution of this group among spatial units would be proportional to the distribution for the whole population. It varies between 0 and 1, and also represents the share of the group’s population that would have to change its place of residence to achieve an even distribution. Formally, it is defined as:

$$SI = \frac{1}{2} \sum_{i=1}^N \left| \frac{x_i}{X} - \frac{t_i - x_i}{T - X} \right|, \quad (3.5)$$

where x_i and t_i are group and total population proportions in spatial unit i , X and T are group proportion and population size of the whole area, made up of N spatial units. Similarly, D measures the segregation between two groups X and Y across all spatial units N . It also varies between 0 and 1 and indicates the share of group X or Y

¹⁵We use the predict function of the mlogit package (Croissant, 2013).

that would have to move to achieve evenness. The formula, based on 3.5, is:

$$SI = \frac{1}{2} \sum_{i=1}^N \left| \frac{x_i}{X} - \frac{y_i}{Y} \right|, \quad (3.6)$$

where y_i and Y are a second group's proportion in spatial unit i and a second group's total population in the whole city.

These indices are known to be sensitive to population size and minority proportions (Cortese et al., 1976, Taeuber and Taeuber, 1965). However, in our case of a comparison between realistic and counterfactual scenarios of location choices, where population structure and size are unchanged, they can be used without concern for these limits. Another problem related to these indices is that, by definition, their benchmark (i.e. the value 0) is an 'ideal', perfectly equal distribution of population groups rather than a random distribution (Cortese et al., 1976, Winship, 1977). Our aim is to compare the simulated distributions, and the methodology we developed to test the statistical significance of our results, based on Monte Carlo simulations, takes account of the stochasticity of these distributions.

3.4 Results

3.4.1 Estimation results for natural amenity variables

For reasons of space, the complete estimation results of CL and ML models are reported in Annex 3.5. All the models are statistically significant and have good explanatory power, as shown by the very high values of adjusted McFadden (1974) and Estrella (1998) goodness-of-fit measures.¹⁶ The estimation results are quite consistent between both model types regarding the signs and significance of the parameters. Significant intra-group heterogeneity of preferences is observed, indicating that ML models should be preferred. This section comments on the ML models estimation results for natural amenity variables, presented in Table 3.3.

Table 3.3 reveals significant effects of natural amenities on location choices. Many interaction terms are significant, showing that preferences for natural amenity systematically differ according to the household's size and socio-professional status (despite the often significant intra-group heterogeneity of preferences). Forest amenities appeal especially to retirees and large households, and green amenities generally are attractive for

¹⁶Statistical properties of the Estrella indicator are similar to those of the standard R^2 measure for linear models.

most households with the exception of executives. Water is an attraction for all households except retirees in Grenoble (a wetter climate might explain this specific distaste). Elevation is mostly an attractive feature in Marseille, but is a strong negative factor for retirees and large households in Grenoble (again, this might be due to the harsher climate in that area). In Marseille, retirees seek proximity to the coast, whereas other households (executives to a lesser extent) tend to avoid it.

Table 3.3 – Estimation results (natural amenity variables)^a

	Mixed logit - Marseille		Mixed logit - Grenoble	
	(1)		(2)	
	Mean	Std. Dev.	Mean	Std. Dev.
% Forest	−0.23 (0.15)	0.37 (0.12)**	0.55 (0.24)*	0.38 (0.34)
x executive	−0.59 (0.21)**	0.79 (0.31)**	−1.91 (0.28)***	1.10 (0.62)
x retiree	1.43 (0.25)***	0.35 (0.35)	1.05 (0.51)*	1.95 (0.80)*
x 1-person	−0.19 (0.20)	0.22 (0.21)	−0.33 (0.30)	2.32 (0.44)***
x 3-person	0.89 (0.19)***	0.63 (0.18)***	1.64 (0.28)***	0.79 (0.48)
% Open spaces	0.19 (0.09)*	0.02 (0.09)	0.82 (0.27)**	0.95 (0.24)***
x executive	−0.27 (0.13)*	0.12 (0.24)	−0.93 (0.32)**	0.53 (0.60)
x retiree	−0.33 (0.15)*	0.26 (0.26)	1.25 (0.60)*	1.12 (0.70)
x 1-person	0.16 (0.12)	0.04 (0.15)	0.03 (0.35)	0.54 (0.48)
x 3-person	0.06 (0.11)	0.04 (0.16)	0.27 (0.31)	0.97 (0.36)**
Water	0.12 (0.02)***	0.01 (0.03)	0.13 (0.07)	0.11 (0.14)
x executive	−0.02 (0.04)	0.22 (0.08)**	−0.07 (0.06)	0.00 (0.33)
x retiree	0.04 (0.04)	0.21 (0.09)*	−0.41 (0.12)***	0.22 (0.46)
x 1-person	−0.01 (0.03)	0.10 (0.05)	0.26 (0.12)*	0.73 (0.21)***
x 3-person	0.03 (0.03)	0.14 (0.05)**	−0.05 (0.06)	0.11 (0.20)
Elevation	0.81 (0.22)***	0.11 (0.17)	0.21 (0.28)	1.55 (0.20)***
x executive	1.01 (0.31)***	1.40 (0.44)**	0.45 (0.36)	1.46 (0.43)***
x retiree	−0.86 (0.36)*	0.17 (0.49)	−3.04 (0.86)***	3.13 (0.64)***
x 1-person	0.17 (0.29)	0.50 (0.30)	0.62 (0.35)	5.22 (0.47)
x 3-person	−0.29 (0.27)	0.13 (0.30)	−1.60 (0.34)***	1.15 (0.40)**

Continued on next page...

Table 3.3 – continued from previous page

	Mixed logit - Marseille		Mixed logit - Grenoble	
	(1)		(2)	
	Mean	Std. Dev.	Mean	Std. Dev.
Coast	−0.15 (0.03)***	0.02 (0.03)		
x executive	0.12 (0.04)**	0.01 (0.09)		
x retiree	0.51 (0.05)***	0.10 (0.09)		
x 1-person	−0.07 (0.04)	0.02 (0.06)		
x 3-person	0.04 (0.04)	0.02 (0.06)		
<hr/>				
Control variables	<i>yes</i>		<i>yes</i>	
# Observations	98,048		21,074	
# Observations (weighted)	248,203		60,050	
Alternatives	112		79	
logLikelihood	−208,135		−48,022	
McFadden R2 (adj.)	0.550		0.477	
Estrella R2 (adj.)	0.999		0.997	

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$; std. error of the estimates in brackets.

^aComplete estimation results of CL and ML models are reported in annex 3.5. Source: own estimations, with R - mlogit package (Croissant, 2013).

These average group preferences may be at the source of natural amenity-driven segregation dynamics. In a nutshell:

- Segregation by household size: preferences for forest amenities might foster segregation by size; a preference for living at an altitude might also be critical in the mountainous region.
- Segregation by socio-professional status: a preference for green amenities and for elevation might foster social segregation; a preference for proximity to the coast and to water might also play a role in the coastal and the mountainous regions respectively.

3.4.2 Segregation analysis

The estimation results suggest that preferences for natural amenities might drive residential segregation among households according to their size and socio-professional status.

This conjecture is tested using a counterfactual segregation analysis, whose results are presented in Tables 3.4 and 3.5.¹⁷

Table 3.4 provides Duncan segregation indices (hereafter S-indices) for two classifications of households - by size and by socio-professional status. For each population group, five values are given corresponding to: [1] observed levels of segregation (i.e. S-indices based on the households dataset), [2] estimated levels of segregation (i.e. means and standard deviations of the S-indices predicted by our complete models), and [3] counterfactual levels of segregation (i.e. means and SD of the S-indices predicted by partial models which do not account for preferences for natural amenities). The last column indicates the relative differences between the estimated and counterfactual S-indices, and their statistical significance levels. Table 3.5 provides Duncan dissimilarity indices (hereafter D-indices) for the same population groups and the same observed, estimated, or counterfactual spatial distributions of households.

As for observed and estimated levels of segregation, Tables 3.4 and 3.5 are consistent. The estimated indices are close to, but lower than the observed indices. Regarding size groups, as expected, two-person households are the least segregated group, and the greatest segregation is between one-person and large households. In terms of socio-professional status, also as expected, executives are the most segregated group, and retirees and reference households show the lowest spatial opposition.

The main result: a significant impact of natural amenities on segregation

The fundamental step of the segregation analysis is the comparison between the values of estimated and counterfactual segregation indices, which relate to spatial distributions of households simulated with and without preferences for natural amenities. If there were no significant differences between these values, then it would mean that, although preferences for natural amenities differ systematically according to the household's size and socio-professional status (see section 3.4.1), their impact on segregation levels is negligible. On the opposite, our conjecture is that preferences for natural amenities play a role in segregation dynamics.

¹⁷We focus on segregation among movers. The results of the analysis including non-movers are quite similar, although - as one would expect - less pronounced. They are available from the authors upon request.

Table 3.4 – Results for Duncan segregation indices (S-Indices)

	Group	Obs. S-index	Simulated S-index		
		[1]	with amenities [2]	w/o amenities [3]	^a Diff. (%)
^b GRE	1-person	0.191	0.179 (0.007)	0.120 (0.006)	***49.0
	2-person	0.061	0.061 (0.006)	0.060 (0.006)	2.3
	3+-person	0.199	0.188 (0.007)	0.130 (0.006)	***44.8
	Executive	0.183	0.165 (0.007)	0.170 (0.008)	***-3.1
	Retiree	0.110	0.100 (0.009)	0.123 (0.010)	***-18.8
	Other	0.141	0.124 (0.007)	0.111 (0.005)	***11.6
^c MAR	1-person	0.176	0.153 (0.003)	0.154 (0.003)	*-0.6
	2-person	0.043	0.039 (0.003)	0.039 (0.002)	-1.0
	3+-person	0.172	0.147 (0.002)	0.145 (0.003)	***1.1
	Executive	0.219	0.197 (0.004)	0.192 (0.004)	***2.4
	Retiree	0.140	0.120 (0.003)	0.090 (0.003)	***32.7
	Other	0.137	0.126 (0.003)	0.119 (0.003)	***5.5

Notes: SD in brackets; ^aDifference calculated as $([2]-[3])/[3]*100$, with non-rounded values; ^bGrenoble; ^cMarseille; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$ (Welch t-test). Source: Own calculations.

Table 3.5 – Results for Duncan dissimilarity indices (D-Indices)

	Groups	Obs. D-index	Simulated D-index		^a Diff. (%)
		[1]	with amenities [2]	w/o amenities [3]	
^b GRE	1p vs. 2p	0.118	0.112 (0.007)	0.080 (0.007)	***41.2
	1p vs. 3p+	0.248	0.233 (0.008)	0.158 (0.007)	***48.0
	2p vs. 3p+	0.147	0.145 (0.008)	0.110 (0.007)	***31.7
	Exec. vs. ret.	0.200	0.180 (0.011)	0.224 (0.012)	***-19.7
	Exec. vs. other	0.185	0.166 (0.008)	0.166 (0.008)	-0.2
	Ret. vs. other	0.104	0.096 (0.009)	0.108 (0.010)	***-11.8
^c MAR	1p vs. 2p	0.121	0.108 (0.003)	0.110 (0.004)	***-2.3
	1p vs. 3p+	0.220	0.190 (0.003)	0.190 (0.004)	0.1
	2p vs. 3p+	0.119	0.100 (0.003)	0.097 (0.003)	***2.6
	Exec. vs. ret.	0.250	0.214 (0.006)	0.204 (0.005)	***5.3
	Exec. vs. other	0.219	0.197 (0.005)	0.193 (0.004)	***2.2
	Ret. vs. other	0.139	0.123 (0.004)	0.092 (0.004)	***33.9

Notes: SD in brackets; ^aDifference calculated as $([2]-[3])/[3]*100$, with non-rounded values; ^bGrenoble; ^cMarseille; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$ (Welch t-test). Source: Own calculations.

This conjecture is supported by Tables 3.4 and 3.5, which show that most of the differences between estimated and counterfactual segregation indices are indeed significant. These significant differences are generally positive, but some of them are negative. We can immediately deduce the main result of the present paper:

The analysis reveals a significant role of preferences for natural amenities in residential segregation dynamics: these preferences most often contribute to strengthening segregation, but can also be a factor attenuating segregation. Segregation is strengthened if the distribution of standard location factors and that of site-specific natural amenities coincides, and attenuated if not.

Interpretation and cartographic visualisations

An intuitive explanation for this result can be proposed and illustrated. Suppose two segregation channels are simultaneously active in the real world: the first is based on preferences for natural amenities and the second is based on all other (say *standard*) location factors. In a counterfactual context where movers choose their location based only on their preferences for natural amenities, we would observe what we might call a *natural amenity-driven pattern of segregation* among municipalities. In another counterfactual context where movers choose their location based only on their preferences for standard location factors, we would observe what we might call a *standard pattern of segregation* among municipalities. If the two counterfactual patterns have similarities, then the two segregation channels are likely to be mutually reinforcing in the real world. That is, preferences for natural amenities make the households within a group choose a location which is where this group is already overrepresented, for other reasons. However, if the two counterfactual segregation patterns differ, then in the real world the preferences for natural amenities may work against other segregation tendencies, and thus attenuate residential segregation.

Figure 3.1 depicts the case where the natural amenity-driven segregation pattern coincides with the pattern of segregation driven by other location factors. It presents predicted shares of retirees among movers in the municipalities of Marseille based on three models: (A) the counterfactual scenario model where only standard factors are at work; (B) another counterfactual model which accounts only for preferences related to natural amenities (here choice probabilities are computed setting to zero all coefficients which are not related to natural amenity variables except the housing stock); (C) our complete realistic model. On maps A and B, we observe clear preferences of retirees for coastal municipalities and for the north-east forested hinterland. Both channels of segregation are mutually reinforcing and generate the pattern C, which corresponds to a

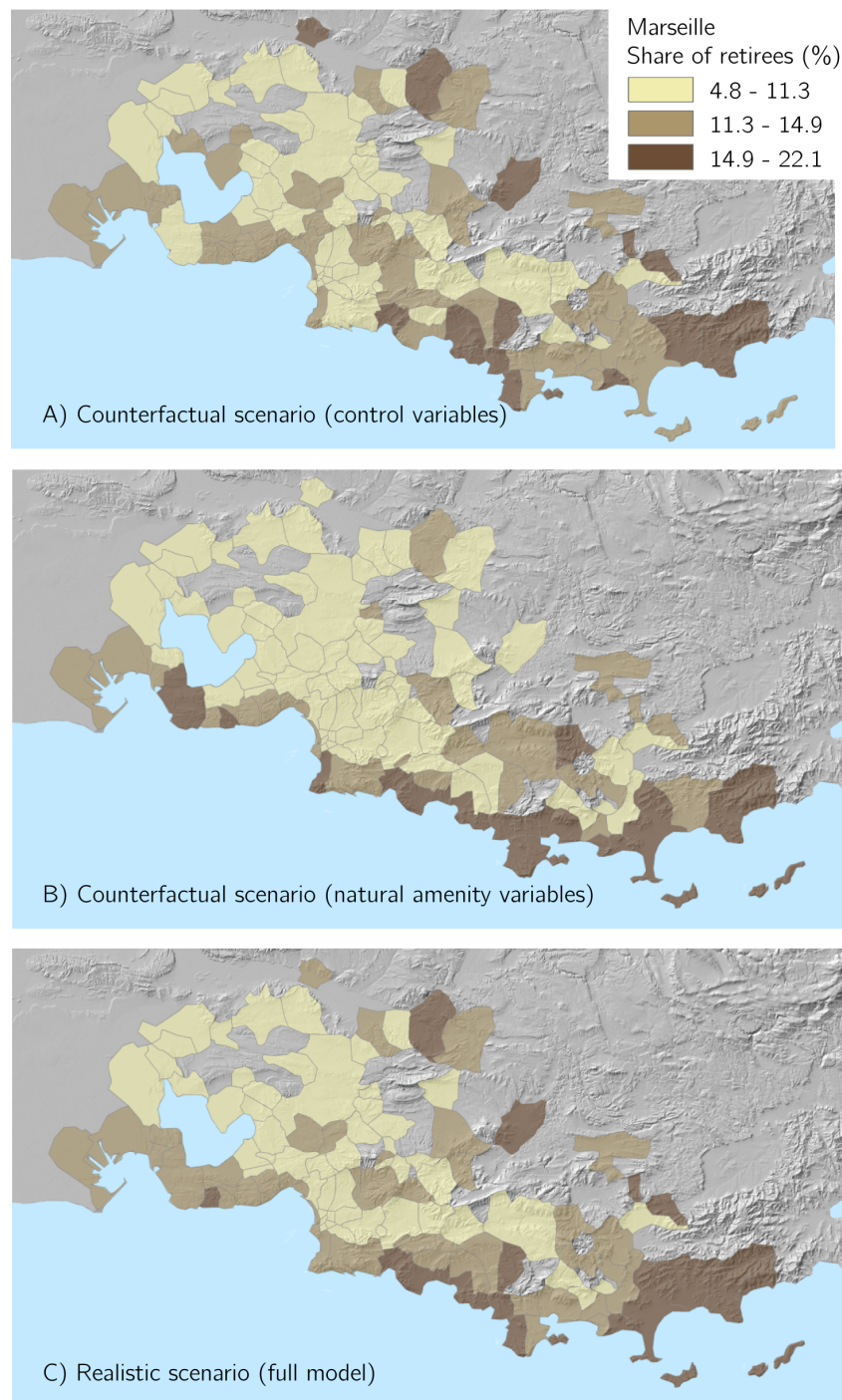


Figure 3.1 – Household group distributions according to scenarios, in Marseille

Note: Classes are based on the Jenks natural breaks of the simulation A.

Source: own simulations, IGN BDcarto 2011 for administrative boundaries, IGN BD ALTI® 2008 for digital elevation model.

much more segregated outcome than A (Table 3.4 shows that the S-index for retirees is 32.7 % higher in the realistic scenario compared to the counterfactual scenario without preference for natural amenities).

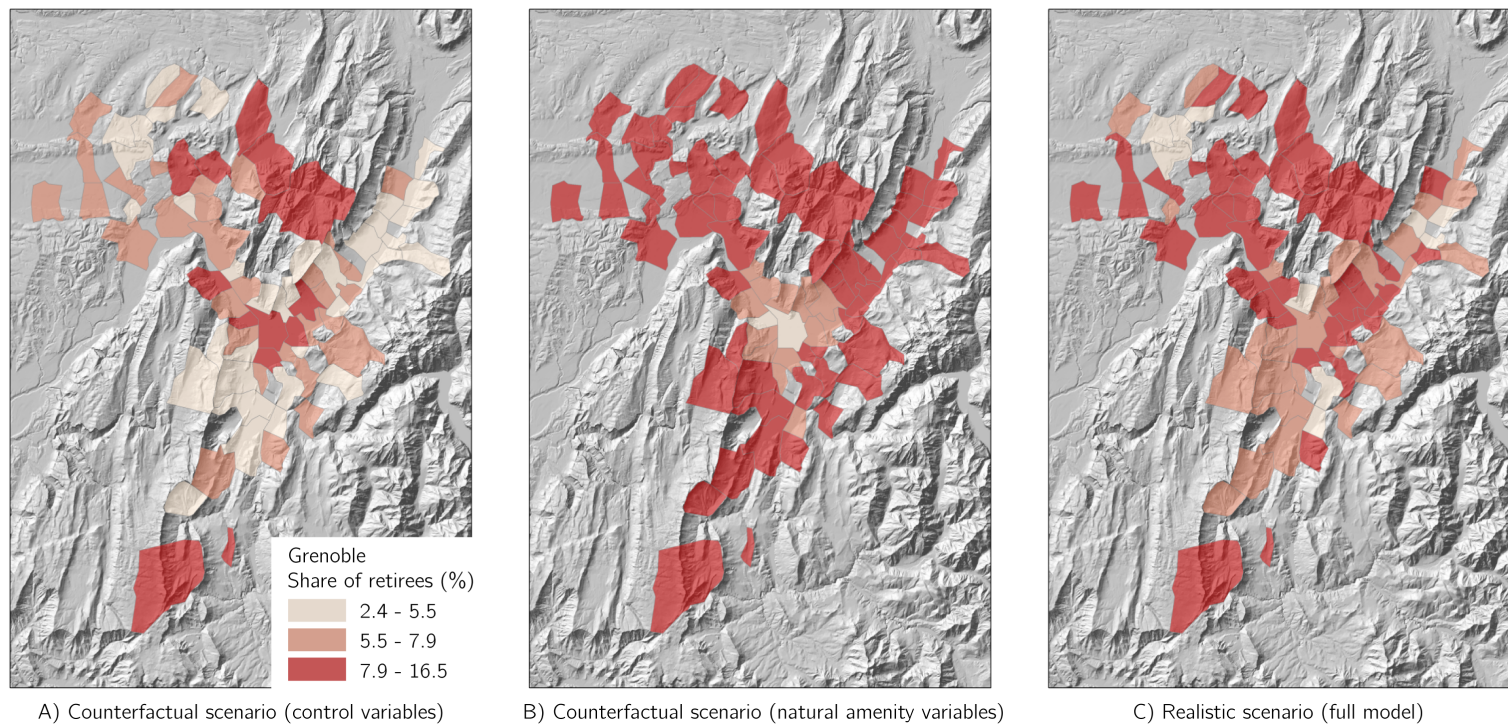


Figure 3.2 – Household group distributions according to scenarios, in Grenoble

*Note: Classes are based on the Jenks natural breaks of the simulation A.
Source: own simulations, IGN BDcarto 2011 for administrative boundaries, IGN BD ALTI® 2008 for digital elevation model.*

Figure 3.2 depicts the same three predictions in the case of Grenoble, and illustrates the case where the preferences for natural amenities work against standard segregation mechanisms. Map A shows that standard factors attract retirees in the core of the metropolitan area (and also in the most northerly and most southerly municipalities). In contrast, Map B shows that retirees tend to avoid the city of Grenoble and its nearby urbanized suburbs and look for the green amenities offered by the valleys and foothills of the more distant suburban ring. As a consequence, retirees are more scattered on Map C than on Map A, which would seem to explain why their S-index is 18.8 % lower in the realistic scenario compared to the counterfactual scenario without preference for natural amenities (see Table 3.4).

Detailed results: place-specific effects of natural amenities

The cartographic visualisations presented above suggest that the interplay between the natural amenity-driven segregation channel and the standard segregation channel (e.g. related to job accessibility, facilities, or social interactions) is complex and produces place-specific outcomes. The detailed examination of Tables 3.4 and 3.5 confirms this idea.

On the one hand, *natural amenities have the strongest positive impact on the segregation of retirees in Marseille, and size groups in Grenoble*. In Marseille, as has already been pointed out, the S-index for retirees is 32.7 % higher in the realistic scenario compared to the counterfactual scenario without preference for natural amenities. The factors driving this increase are stressed in section 3.4.1: preference for green amenities, elevation and proximity to the coast. The D-indices reveal a much stronger increase in the segregation of retirees with reference households (33.9 %) than of retirees with executives (5.3 %). This is likely explained by coastal amenities (estimates of the interaction variables for retirees and reference households have the opposite signs and are both highly significant, see Table 3.3).

Increases in the S-indices are even greater for one-person and large households in Grenoble (resp. 49 % and 44.8 %), while Table 3.5 shows a strong increase in their degree of mutual segregation (48 %). The estimation results (see section 3.4.1) suggest the role of a preference for forest, and more specifically for elevation, in explaining these values. We also observe strong increases in the mutual segregation between two-person and one-person households (31.7 %), and between two-person and large households (41.2 %). However, there is only a small and non-significant increase of the intragroup segregation of two-person households (2.3 %).

On the other hand, *natural amenities have a highly significant negative impact on*

the segregation of retirees and executives in Grenoble. In the realistic scenario, S-indices are 18.8 % and 3.1 % lower than in the counterfactual scenario, and their intergroup D-index decreases by 19.7 %, showing that their location choices are more similar when their preference for natural amenities is taken into account. This result might seem surprising: executives tend to avoid amenities such as forests and open spaces while retirees actively seek them; and retirees dislike elevated locations and water bodies. However, as explained and illustrated in the previous section, what is crucial is the interplay between natural amenity-driven and standard segregation channels, and socially-specific preferences for natural amenities may help counteracting other segregative tendencies.

Other substantial differences between estimated and counterfactual indices are related to the reference households: S-indices increase by 11.6 % and 5.5 %, respectively in Grenoble and Marseille. In Grenoble, this increase might seem inconsistent with the fact that their level of segregation with retirees decreases by 11.8 % and that there is no significant changes in their level of segregation with executives. In Marseille, their levels of segregation with retirees and with executives both increase.

3.4.3 Discussion

Consistency with the related literature

As pointed out in Section 3.2, few papers have investigated the impact of natural amenity preferences on location choices and segregation processes at the metropolitan scale.

A notable exception is Wu (2006), who shows theoretically that a heterogeneous distribution of natural features causes economic segregation across communities, with high-income households living in areas with higher level environmental amenities. In Marseille, our analysis confirms a significant positive impact of natural amenities on economic segregation - proxied by the mutual segregation between executives and other economically active households, but not in Grenoble. In addition, our estimations show that high-income households tend to avoid green amenities.

Wu (2006) models the US case. Our estimation results may be more consistent with the hypothesis of Brueckner et al. (1999) that historic amenities are more important in European cities than in the US, and that their valuation rises sharply with income. And with the location choice analysis of Van Duijn and Rouwendal (2013) in the Netherlands, showing that highly educated households put a higher value on historic amenities than on natural ones.¹⁸ In this European context, contrarily to the predictions of Wu, natural

¹⁸In the Netherlands also, Koster et al. (2016) show that rich households have a higher willingness to pay for a view on historic amenities and therefore sort themselves within cities in historic districts.

amenities may not necessarily be a factor increasing economic segregation.

In relation to size groups and retirees, our estimations are consistent with those in Van Duijn and Rouwendal (2013), which show that green amenities (but not water amenities) are attractive to large households and elderly people, and also with de Palma et al. (2007b), which show that households with children prefer proximity to parks and forests in the Paris region. We are not aware of any studies at the metropolitan area scale that have previously considered the impact of these specific preferences on segregation by size, or between retirees and economically active households, although our results suggest that they can play a critical role.¹⁹ In our view, this is a result that deserves further investigation.

Political implications (1): environmental policies against residential segregation?

Existing studies of urban public policies considering the link between spatial distributions of natural amenities and of social groups mainly focus on issues of unequal access to natural amenities and of environmental gentrification (i.e. when the quality of the environment in a place attracts richer households and leads to displacement of the original residents). For instance, Thorsnes et al. (2015) analyse a historical experience in Dunedin, New Zealand, where the government housing authority implemented large-scale production of public low-income housing in high-amenity areas. Thorsnes and colleagues conclude that this policy allowed low-income households to benefit from natural amenities, whereas the more recent liberalization of the housing sector (i.e. sale of state rentals) triggered the environmental gentrification of these areas. Another (theoretical) example is provided by Wu and Plantinga (2003), who find that urban open space policies tend to benefit high-income households more than low-income households. In the extreme, at the end of a gentrification process, new open spaces will be completely surrounded by high-income neighbourhoods.

Beyond ‘access’ and ‘gentrification’, our findings raise the issue of the impact of public policies related to the natural environment on residential segregation. Correspondingly, they suggest the need for greater consideration of the natural environment in policies aimed at mitigating segregation. For instance, public policies should be careful to preserving natural amenities that play a role in attenuating segregation. Also, urban renewal strategies could focus on increasing access to natural amenities in less attractive (e.g. to retirees or families) municipalities, in order to redirect residential flows

¹⁹Segregation by size itself has almost not been studied. Beckmann (1973), Fujita (1989) and an unpublished paper by Theisen (2012) are exceptions.

so that they counteract other segregation processes (e.g. related to social interactions or job accessibility). And desegregation policies focusing on ‘non-natural’ location factors (e.g. social housing) should bear in mind that the natural amenity-driven segregation channel is active and must be counteracted. Our comparison between two study regions has shown that the interplay between what we named the ‘natural amenity-driven segregation channel’ and the ‘standard segregation channel’ is strongly place-specific (see section 3.4.2). Thus political strategies should be defined based on a thorough knowledge of the local context, allowing identifying the most likely interactions. In fact, the definition of appropriate policies with respect to the urban natural environment, considering their impacts on segregation dynamics at the metropolitan scale, is a very complex issue which has not yet been addressed.²⁰ This is left to future research.

Political implications (2): should residential segregation be mitigated?

Of course, further policy-oriented investigations make sense only if avoiding segregated residential patterns is a relevant and supported political objective. Some authors are critical of such objectives. Cheshire (2009) argues that policies for mixed neighbourhoods treat the symptoms rather than the causes of poverty. In his view, efforts to improve social equity would be more effective if directed towards the individual rather than to moving people around to mix neighbourhoods. Although he might be right, these policies could be a second best option to improve social equity when politics precludes more direct forms of redistribution. In addition, as demonstrated theoretically by Bjorvatn and Capelen (2003), segregation and redistribution may be intrinsically linked: high-income individuals raised in mixed neighbourhoods may be more likely to vote for income redistribution. Another response is that the most recent studies of neighbourhood effects, investigating long-term exposure to poverty in neighbourhoods owing to longitudinal data, bring strong evidence of continuity of neighbourhood poverty across both generations and the individual life course (Hedman et al., 2015). And beyond economic segregation, other forms of segregation explored in the present paper (by size or between retirees and economically active households) may be an issue with respect to intergenerational cohesion. This is why we believe more research on residential segregation and, more specifically, on the impact of urban environmental policies on segregation is needed.

²⁰On racial segregation, Banzhaf and Walsh (2013) advance the literature in that direction combining features of Schelling and Tiebout models into a general equilibrium model to study the effects of place-based investments (e.g. parks).

3.5 Conclusion

This paper shows that the search for natural amenities can play a significant role in selective migration and, thus, residential segregation dynamics. Residential location choice models, estimated on French migration data for two metropolitan areas highly endowed with natural amenities, provide evidence that preferences for these amenities differ significantly according to household size and socio-professional status. An original counterfactual analysis, based on Monte Carlo simulation methods, suggests that these preferences most often contribute to strengthening segregation tendencies, but, in some cases, can attenuate segregation. Segregation is strengthened if the distribution of standard location factors and that of site-specific natural amenities coincides, and attenuated if not.

Our findings could provide policy-makers with a better understanding of urban development processes influenced by contrasting natural amenity distributions such as are encountered in coastal and mountainous metropolitan regions. Residential segregation is shown to depend on the interplay between both natural amenity-driven and standard segregation mechanisms (e.g. related to job accessibility, facilities and services, social interactions, etc.). This would suggest the need for consideration of the natural environment in public policies aimed at mitigating residential segregation.

There are several possible directions for future research. Methodological improvements to the counterfactual analysis should be considered, for instance, to confirm our results in a setting with explicit housing market equilibrium (see Bayer and McMillan (2012)). To generalize our findings, future research could investigate segregation processes in other high-amenity areas across the globe, if possible based on more detailed data sets and taking account of other dimensions of segregation than evenness. Studies of public policies are also needed to identify the appropriate levers for action on these segregation dynamics. Qualitative research, inspired by amenity, tourism and urban studies, could also help to deepen our understanding of the underlying mechanisms. In our view, in order to effectively achieve more spatial equality, a greater attention to the human-nature relationship is essential.

Annexe

Annexe 1: Estimation results

Control variables are important for simulating segregation dynamics. Here is a short account of the main ML models estimation results related to these variables.

ML models estimates for the price variable and the related correction term (see section 3.3.2) are reported in table 3.6, along with the results of similar models but without correction term. We expect negative coefficients of the house price variable. In the models without correction term, we obtain positive and significant coefficients in both regions for the reference category (0.18 in Grenoble and 0.25 Marseille), which confirms the endogeneity of prices. The inclusion of the correction term has the desired impact: the average coefficients for the reference group become negative and significant in Grenoble (-0.94) and close to zero and non-significant in Marseille (0.05). In Grenoble, as expected, all households prefer lower prices and executives and one-person households appear to be less sensitive to price. In Marseille, the correction is not perfect, since only large households prefer lower prices and one-person households still exhibit a preference for higher prices.

Table 3.6 – Estimation results (mean coefficients for price variable and correction term)

	Final model	Model	Final model	Model
		w/o correction		w/o correction
Price	0.05 (0.07)	***0.25 (0.05)	** -0.94 (0.35)	*0.18 (0.08)
x executive	-0.10 (0.07)	-0.07 (0.07)	***0.45 (0.10)	***0.44 (0.10)
x retiree	0.11 (0.08)	0.11 (0.08)	0.09 (0.17)	0.01 (0.17)
x 1-person	***0.31 (0.06)	***0.31 (0.06)	**0.37 (0.12)	**0.30 (0.11)
x 3-person	***-0.47 (0.06)	***-0.45 (0.06)	-0.02 (0.10)	0.00 (0.10)
Price residuals	***0.27 (0.06)		***1.13 (0.34)	
Control variables	yes	yes	yes	yes
Amenity variables	yes	yes	yes	yes

*Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$; std. error of the estimates in brackets. Source: own estimations, with R - mlogit package (Croissant, 2013)..*

The complete estimation results are provided in table 3.7. We observe a positive impact of (the log of) housing stock. This variable is also included as a correction term since we model community choice and not dwelling unit choice. The estimates are close to 1, the theoretically correct value (Ben-Akiva and Bowman, 1998). As ex-

pected, one-person households prefer locations with larger shares of apartments, which are less attractive to large households. The social housing variable is mainly significant in Marseille: households tend to dislike locations with larger shares of social housing (executives and one-person households especially), but large households which are not executive households prefer them.

Estimates for travel time to the city centre show that the preference for suburban locations is significantly stronger for retirees (no employment constraints) and large households (demand for more housing space), and weaker for one-person households and executives. Regarding the local income variable, large households are more likely to choose affluent locations, what may be related to the search by families for the benefits associated with the presence of high income households (peer effects at school, network effects in the neighbourhood, better quality of local public services for children, see Durlauf (2004)). In Marseille, we also capture socially selective migrations by socio-professional status -i.e. a positive coefficient for executives and a negative one for less affluent households, but not in Grenoble. The dummy for the presence of facilities and services reveals differing patterns of preferences between the two regions. The estimations confirm households' preferences for remaining in or moving not too far from the prior location. Previous studies have found this effect and argue that households prefer continued proximity to their social networks, value a familiar neighbourhood and have potentially more information on local housing offers (de Palma et al., 2007b, Goffette-Nagot and Schaeffer, 2013, Schirmer et al., 2014, Zondag and Pieters, 2005). Executives appear to be the least attached to their former location and more likely to move to more distant locations.

The last control is share of 'harmful' land uses close to residential areas. We find that executives tend to avoid them, but more surprisingly, large households show a preference for higher shares. These latter households, which are the most constrained in terms of daily mobility, might prefer proximity to transport infrastructures and/or commercial areas despite related disamenities such as increased exposure to noise and air pollution.

Table 3.7 – Complete estimation results for location choice models

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
# Dwellings (log)	***0.72 (0.02)	***0.88 (0.02)	*0.07 (0.04)	***0.65 (0.01)	***1.04 (0.01)	***0.25 (0.01)
Price	*** − 1.16 (0.35)	** − 0.94 (0.35)	0.09 (0.13)	− 0.02 (0.07)	0.05 (0.07)	0.07 (0.05)
x executive	***0.42 (0.10)	***0.45 (0.10)	0.08 (0.27)	** − 0.21 (0.07)	− 0.10 (0.07)	− 0.25 (0.13)
x retiree	− 0.02 (0.16)	0.09 (0.17)	0.10 (0.39)	0.11 (0.08)	0.11 (0.08)	** − 0.32 (0.12)
x 1-person	*0.29 (0.12)	**0.37 (0.12)	0.18 (0.20)	**0.20 (0.06)	***0.31 (0.06)	− 0.06 (0.08)
x 3-person	− 0.04 (0.10)	0.02 (0.10)	0.03 (0.20)	*** − 0.46 (0.06)	*** − 0.47 (0.06)	0.07 (0.08)

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
Price residuals	***1.29 (0.34)	***1.13 (0.34)	0.00 (0.22)	0.10 (0.06)	***0.27 (0.06)	−0.10 (0.09)
Travel time to center	11.00 (8.45)	*17.45 (8.59)	***42.09 (3.75)	***3.63 (0.63)	***12.25 (0.67)	***−7.22 (0.65)
x executive	−4.50 (7.09)	*−16.83 (7.28)	7.24 (7.24)	−1.34 (0.95)	***−3.64 (1.03)	−3.45 (1.97)
x retiree	16.59 (10.95)	*36.29 (14.47)	18.32 (13.96)	1.67 (0.96)	*2.64 (1.12)	**5.13 (1.85)
x 1-person	−12.57 (7.65)	**−22.40 (8.04)	***37.31 (8.40)	*−1.60 (0.79)	***−4.20 (0.88)	***−8.95 (1.10)
x 3-person	***26.67 (6.88)	***30.53 (6.83)	***29.51 (7.02)	**2.48 (0.77)	***5.16 (0.83)	***−4.67 (1.11)
% Flats	***1.15 (0.29)	**0.91 (0.29)	0.10 (0.21)	***0.46 (0.08)	0.08 (0.09)	***1.91 (0.06)
x executive	***−0.71 (0.20)	***−0.94 (0.21)	0.18 (0.43)	0.20 (0.10)	0.18 (0.12)	***0.96 (0.17)
x retiree	0.49 (0.32)	**1.29 (0.42)	***2.54 (0.39)	***−0.74 (0.11)	***−1.10 (0.14)	***1.96 (0.18)
x 1-person	0.36 (0.22)	**0.71 (0.23)	0.4 (0.36)	***1.17 (0.09)	***1.87 (0.11)	***−1.66 (0.11)
x 3-person	***−0.85 (0.21)	***−1.12 (0.20)	0.04 (0.32)	***−1.18 (0.09)	***−1.54 (0.10)	***0.97 (0.11)

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
% Social housing	−0.36 (0.34)	−0.28 (0.33)	0.87 (0.58)	*** − 0.53 (0.10)	*** − 0.78 (0.12)	−0.03 (0.15)
x executive	−0.45 (0.40)	−0.32 (0.40)	0.26 (1.45)	*** − 1.35 (0.16)	*** − 1.23 (0.19)	−0.68 (0.43)
x retiree	− 1.03 (0.61)	− 1.17 (0.69)	1.76 (1.65)	* 0.35 (0.17)	** 0.60 (0.23)	0.79 (0.42)
x 1-person	−0.26 (0.44)	−0.39 (0.43)	0.29 (1.15)	*** − 0.87 (0.13)	*** − 0.78 (0.16)	−0.05 (0.26)
x 3-person	0.24 (0.39)	* 0.74 (0.38)	1.05 (0.86)	*** 1.08 (0.13)	*** 1.40 (0.15)	0.06 (0.23)
Income	0.03 (0.02)	0.02 (0.02)	0.01 (0.01)	*** − 0.02 (0.01)	*** − 0.03 (0.01)	0.00 (0.00)
x executive	0.01 (0.01)	0.00 (0.01)	0.01 (0.02)	*** 0.07 (0.01)	*** 0.08 (0.01)	−0.00 (0.01)
x retiree	** 0.04 (0.01)	** 0.05 (0.02)	0.00 (0.03)	** − 0.02 (0.01)	− 0.01 (0.01)	−0.00 (0.01)
x 1-person	* − 0.03 (0.01)	* − 0.03 (0.01)	* 0.03 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.00 (0.01)
x 3-person	** 0.02 (0.01)	* 0.02 (0.01)	0.00 (0.02)	** 0.02 (0.01)	* 0.02 (0.01)	−0.01 (0.01)

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
Service bundle	0.05 (0.04)	0.10 (0.05)	***1.03 (0.10)	0.04 (0.04)	0.03 (0.04)	*** − 0.19 (0.05)
x executive	0.08 (0.05)	0.08 (0.06)	0.24 (0.27)	−0.05 (0.06)	0.12 (0.07)	***0.71 (0.12)
x retiree	−0.10 (0.07)	−0.15 (0.09)	0.03 (0.39)	***0.27 (0.07)	***0.49 (0.08)	***0.48 (0.13)
x 1-person	−0.09 (0.05)	* −0.16 (0.05)	***0.35 (0.19)	0.03 (0.05)	**0.14 (0.05)	*** − 0.32 (0.07)
x 3-person	0.03 (0.05)	0.04 (0.06)	0.25 (0.22)	*** − 0.23 (0.06)	−0.10 (0.06)	*** − 0.48 (0.08)
Same municipality	***1.36 (0.04)	***1.28 (0.05)	***1.34 (0.10)	***3.10 (0.02)	***4.21 (0.08)	***8.81 (0.22)
x executive	*** − 0.22 (0.06)	*** − 0.38 (0.08)	0.07 (0.37)	*** − 0.17 (0.03)	*** − 1.40 (0.11)	***2.59 (0.26)
x retiree	***0.56 (0.08)	**0.38 (0.13)	0.78 (0.47)	0.03 (0.03)	***0.84 (0.11)	***4.59 (0.29)
x 1-person	0.05 (0.06)	0.07 (0.07)	***1.03 (0.19)	***0.22 (0.02)	***0.61 (0.08)	***1.59 (0.14)
x 3-person	***0.53 (0.06)	***0.40 (0.07)	***2.15 (0.21)	*0.05 (0.02)	***1.73 (0.10)	***7.66 (0.26)

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
Migration distance	*** − 93.52 (2.38)	*** − 110.35 (2.96)	*** 20.27 (4.39)	*** − 21.93 (0.26)	*** − 36.23 (0.37)	*** − 16.67 (0.35)
x executive	* 8.30 (3.80)	4.52 (4.68)	*** 38.46 (7.35)	*** 3.79 (0.39)	*** 5.21 (0.57)	*** 10.72 (1.12)
x retiree	− 2.59 (4.85)	*** − 69.80 (11.31)	*** 91.78 (11.13)	*** − 1.43 (0.43)	− 0.29 (0.59)	*** − 6.91 (1.12)
x 1-person	− 5.45 (3.20)	*** − 23.13 (4.89)	*** 45.58 (5.88)	*** 3.79 (0.33)	*** 2.55 (0.46)	*** 10.98 (0.67)
x 3-person	* − 7.38 (3.16)	*** − 33.23 (4.33)	*** 54.26 (3.98)	*** − 5.74 (0.35)	*** − 7.86 (0.43)	*** − 4.31 (0.74)
% Harmful land use	− 1.16 (0.70)	− 0.82 (0.70)	0.38 (0.54)	** − 0.57 (0.18)	* − 0.53 (0.22)	− 0.10 (0.24)
x executive	* − 1.27 (0.56)	** − 1.82 (0.57)	0.93 (1.18)	*** − 1.33 (0.28)	*** − 1.49 (0.33)	0.15 (0.73)
x retiree	1.53 (0.85)	1.66 (0.99)	1.35 (1.80)	** − 0.76 (0.29)	*** − 1.32 (0.38)	0.97 (0.69)
x 1-person	0.21 (0.59)	0.41 (0.59)	0.19 (0.95)	0.18 (0.22)	− 0.02 (0.28)	0.57 (0.40)
x 3-person	*** 2.33 (0.54)	*** 1.79 (0.54)	0.61 (0.83)	** 0.63 (0.22)	** 0.73 (0.27)	** 1.02 (0.37)

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
% Forest	−0.04 (0.24)	*0.55 (0.24)	0.38 (0.34)	−0.00 (0.14)	−0.23 (0.15)	**0.37 (0.12)
x executive	*** − 1.92 (0.26)	*** − 1.91 (0.28)	1.10 (0.62)	− 0.38 (0.21)	** − 0.59 (0.21)	** − 0.79 (0.31)
x retiree	0.47 (0.40)	*1.05 (0.52)	*1.95 (0.80)	***1.02 (0.23)	***1.43 (0.25)	0.35 (0.35)
x 1-person	−0.30 (0.27)	−0.33 (0.30)	***2.32 (0.44)	−0.27 (0.19)	−0.19 (0.20)	0.22 (0.21)
x 3-person	***1.87 (0.26)	***1.64 (0.28)	0.79 (0.48)	***0.72 (0.18)	***0.89 (0.19)	***0.63 (0.18)
% Open spaces	0.51 (0.27)	**0.82 (0.27)	***0.95 (0.24)	**0.23 (0.08)	*0.19 (0.09)	−0.02 (0.09)
x executive	** − 0.95 (0.32)	** − 0.93 (0.32)	0.53 (0.60)	* − 0.24 (0.12)	* − 0.27 (0.13)	−0.12 (0.24)
x retiree	*1.18 (0.49)	*1.25 (0.6)	1.12 (0.71)	0.05 (0.14)	* − 0.33 (0.15)	0.26 (0.26)
x 1-person	−0.34 (0.35)	0.03 (0.35)	0.54 (0.48)	0.04 (0.11)	0.16 (0.12)	−0.04 (0.15)
x 3-person	*0.66 (0.31)	0.27 (0.31)	**0.97 (0.36)	0.06 (0.11)	0.06 (0.11)	0.04 (0.16)

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
Elevation	0.36 (0.26)	−0.21 (0.28)	***1.55 (0.20)	−0.15 (0.21)	***0.81 (0.22)	−0.11 (0.17)
x executive	***1.07 (0.30)	0.45 (0.36)	***1.46 (0.43)	0.42 (0.31)	***1.01 (0.31)	**−1.40 (0.44)
x retiree	−1.00 (0.51)	***−3.04 (0.86)	***3.13 (0.64)	−0.48 (0.35)	*−0.86 (0.36)	0.17 (0.49)
x 1-person	**1.01 (0.34)	0.62 (0.35)	0.52 (0.47)	0.47 (0.28)	0.17 (0.29)	−0.50 (0.30)
x 3-person	***−1.60 (0.31)	**1.15 (0.34)	45.16 (0.40)	−0.49 (0.27)	−0.29 (0.27)	−0.13 (0.30)
Water	**0.20 (0.07)	0.13 (0.07)	0.11 (0.14)	0.04 (0.02)	***0.12 (0.02)	−0.01 (0.03)
x executive	−0.03 (0.07)	−0.07 (0.06)	0.00 (0.33)	0.01 (0.04)	−0.02 (0.04)	**−0.22 (0.08)
x retiree	***−0.38 (0.10)	***−0.41 (0.12)	0.22 (0.46)	−0.02 (0.04)	0.04 (0.04)	*0.21 (0.09)
x 1-person	*0.15 (0.07)	*0.26 (0.12)	***0.73 (0.21)	0.02 (0.03)	−0.01 (0.03)	−0.10 (0.05)
x 3-person	−0.06 (0.07)	−0.05 (0.06)	0.11 (0.20)	−0.03 (0.03)	0.03 (0.03)	**−0.14 (0.05)

	Grenoble			Marseille		
	Conditional logit	Mixed logit		Conditional logit	Mixed logit	
	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)	Estimate (std. error)	Estimate (mean) (std. error)	Estimate (error) (std. error)
Coast				*** − 0.14 (0.03)	*** − 0.15 (0.03)	0.02 (0.03)
x executive				***0.12 (0.04)	**0.12 (0.04)	−0.01 (0.09)
x retiree				***0.38 (0.04)	***0.51 (0.05)	−0.10 (0.09)
x 1-person				−0.03 (0.03)	− 0.07 (0.04)	0.02 (0.06)
x 3-person				−0.02 (0.03)	0.04 (0.04)	−0.02 (0.06)
# Observations	60050	60050		248203	248203	
# Alternatives	79	79		112	112	
Log Likelihood	−48508	−48022		−211860	−208135	
Log Likelihood at 0	−92082	−92082		−462639	−462639	
McFadden (adj.)	0.472	0.477		0.542	0.550	
Estrella (adj.)	0.996	0.997		0.999	0.999	
Time to convergence	0h : 02m : 35s	10h : 43m : 33s		0h : 25m : 21s	32h : 38m : 34s	

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$; std. error of the estimates in brackets. Source: own estimations, with R - mlogit package (Croissant, 2013).

Chapter 4

To sprawl or not to sprawl: Effects of urban planning scenarios for an urban region in the Alps

“Undoubtedly, urban sprawl in Europe has accelerated in response to improved transportation links and enhanced personal mobility that has made it possible either to live increasingly far from city centers while retaining all the advantages of a city location, or to enable personal choices to live in one city and work in another; this reflects social values that place great emphasis on individual achievements rather than on group solidarity.”

- Ronan Uhel, 2008¹

Preamble

This chapter presents work notably related to the last aim of this thesis, i.e. to develop a residential location choice model and use it to explore residential outcomes of different urban planning policies - notably the SCoT planning strategy - for the urban region of Grenoble. Whereas chapter 3 has used a location choice model and counterfactual predictions to highlight effects of natural amenities on segregation, this chapter takes a

¹Uhel (2008)

more global approach: we develop a more sophisticated location choice model considering the mobility decision and endogenous housing prices, create four distinct urban planning scenarios for the region and predict their residential demand patterns. The various estimation results and the analysis of predicted demand patterns enable us to investigate the links between urban planning and transport policies on the one hand and the development of residential demand on the other hand, i.e. ultimately concentration and segregation processes. Such exploratory scenario approach can provide valuable information for planners and decision-makers and can trigger off reflections on *desirable* Alpine urban-rural futures.

In this chapter, attention is again brought to the effects of natural amenities in the socio-spatial processes, which relates the presented work also to the second aim of this thesis. It deepens the insights from chapter 3 where model specifications of the two regions - Grenoble and Marseille - were harmonised to allow for comparison, implying a loss of detail for the Grenoble model. The work presented in this chapter has neither been published nor submitted (yet).

To sprawl or not to sprawl: Effects of urban planning scenarios for an urban region in the Alps

Dominik Cremer-Schulte

Abstract

This chapter investigates the influence of different urban planning policies and residential processes. The chapter uses residential mobility and location choice models with endogenous housing prices to predict and analyse residential demand patterns for different planning policy scenarios - notably the Grenoble SCoT strategic plan - in terms of concentration, segregation and mountain development. Besides effects of classic location factors in households' residential behaviour, the estimation results show effects of the mountain environment on peri-urbanisation and social segregation. The analysis of demand predictions shows that continued trends in urban planning policies would sustain and potentially reinforce peri-urbanisation to rural and mountain areas in the region. More confining planning policies such as the SCoT appear to be capable of curbing and potentially reversing demand dispersion. Policies that aim at re-centralising demand sustain and potentially increase social segregation levels with regard to socio-professional status and age.

4.1 Introduction

UNCERTAINTY prevails in urban planning practice and political decision-making at city region scale (Albrechts, 2006, Faludi, 2000). This is due to the multitude of interests, actors and their complex interactions in spatial development and its related markets (Batty, 2012, Wegener, 2004, Wegener and Fürst, 1999). Urban modelling is particularly apt in contributing to the understanding of spatial processes, in providing information for decision-making and in exploring potential outcomes of spatially relevant policies. Whilst there has been much progress in urban modelling frameworks since the 1960s including land use, firm and employment location choices, transport and travel behaviour and increasing the integration of these components (see e.g. Timmermans (2006), Wegener and Fürst (1999), and Wegener (2004) for an overview on integrated models²), a crucial and persistent interest of researchers and practitioners lies in the representation of households' residential location choices.

²So-called land use-transport interaction (LUTI) models (Wegener, 2004).

The choice of a home and the related choice of location are among the most important decisions in an individual's life: home is where people spend most of their time, is usually an important place for social life and a also a major personal and financial investment (Cheshire and Sheppard, 2004, Guo, 2004, Wong, 2002). Since every house has a precise geographic location, the choice of it affects access to work and job opportunities, to social networks, to public services, local provisions, leisure and recreation opportunities. Empirical research frequently finds commuting behaviour, housing affordability and socio-economic characteristics of the neighbourhood to be the most important and thus 'classic' residential location factors for households (Frenkel et al., 2013, Guo, 2004, Lawton et al., 2013, Mokhtarian and Cao, 2008, Reid, 2013, Schirmer et al., 2014). By choosing a location a household self-selects into a neighborhood based on his income, life-cycle stage, ethnic group, work location and preferred transport mode. He matches his own characteristics with the social profile of the neighbourhood.

For urban and transport planners, households' residential location choices are equally important. They affect growth and decline of neighbourhoods as well as their social profiles, housing markets, land use and spatial development, public service provision, traffic conditions, pollution and overall energy consumption (Benenson, 2004, de Palma et al., 2007b, Kakaraparthi and Kockelman, 2011). They generate aggregate flows, i.e. selective migration, that contribute to observed socio-spatial processes, notably peri-urbanisation and residential segregation (Andersson and Bråmă, 2004). For urban planners, it is crucial to understand the determinants of household location choices in order to respond to the aggregate processes they generate; and which challenge urban sustainability.

In this chapter, we develop a model of residential location choices for the wider functional urban region of Grenoble in order to i) investigate the determinants of residential location choices in the area and ii) analyse potential outcomes of different comprehensive planning policies. We add to existing literature by addressing three gaps. First, to our knowledge, this chapter presents the first econometric study investigating residential choices with disaggregate household data in an urban region situated in the Alps³. In the world's most densely populated mountain area, two thirds of the 14 million inhabitants live in urban areas under strong urban influence (Borsdorf, 2006, Perlik, 2001). With 680,000 inhabitants in 2012 (*Institut national de la statistique et des études économiques* (National Institute for Statistics and Economic Studies) (INSEE) data), Grenoble urban region is by far the largest inner-Alpine urban area and dynamic: the functional urban area grew by 90,000 inhabitants in the period from 1990 to 2010, and 100,000 more in-

³Considering the perimeter of the Alpine Convention (Permanent Secretariat of the Alpine Convention, 2010).

habitants are expected until 2030 (EP SCoT RUG, 2013). Research has highlighted the importance of migration and residential mobility in the Alps and their urban regions for spatial development and local and regional disparities (Bender and Kanitscheider, 2012, Camenisch and Debarbieux, 2011, Corrado, 2014, Perlik, 2006, 2011). Prior studies in geography have used aggregate inter-communal migration data to analyse interregional migrations in Switzerland (Camenisch and Debarbieux, 2011), and peri-urbanisation processes across the entire Alpine arc (Perlik, 2001). Studies in economics and urban planning analysed residential location choices and housing markets in urban regions on the Alpine periphery, i.e. in Greater Zurich (Bürge, 2006, Schaerer, 2008, Schirmer et al., 2013), Greater Lyon (Kryvobokov et al., 2009) and Geneva (Schaerer, 2008). A quantitative analysis of residential choices and its determinants in an Alpine geographical context is, however, lacking to date.

Secondly, household preferences for ‘soft’ location factors, in contrast to classic ‘hard’ location factors, have gained more interest from researchers over the last decades. Soft location factors relate especially to environmental quality (Dinda, 2004) and *natural amenities* (McGranahan, 1999, Moss, 2006). This gain in interest has to be seen within the context of continued urbanization of societies (United Nations, 2014), increased standards of living and extended leisure time (Zasada, 2011). Linked to that, societal emphasis on health, well-being and individual quality of life is increasing and demand for contact with nature is on the rise (Hartig, 1993, Matsuoka and Kaplan, 2008).⁴ Amenity research defines natural amenities as location-specific features of the natural environment that enhance a location’s residential attractiveness, i.e. they have a positive impact on perceived quality of life (Deller et al., 2005, Moss, 2006, Power, 2005). Economic research believes that environmental amenities are normal goods, at least in metropolitan areas, i.e. their demand rises with income (Brueckner et al., 1999, Costa and Kahn, 2000, Deller et al., 2005, Dorfman et al., 2011, Hand et al., 2008, Knapp and Graves, 1989). Since they are location-specific, households can only vary their consumed quantity by relocating.

Economic theory has highlighted the effects of natural amenities on residential and urban spatial development, particularly on urban sprawl, leapfrog development but also on income sorting (see e.g. Brueckner et al. (1999), Caruso et al. (2007), Cavailhès et al. (2004), Coisnon et al. (2014), Wu (2006), Wu and Plantinga (2003)). Hedonic price studies have confirmed the capitalisation of natural amenities into housing prices

⁴Research in environmental psychology argues that the need for contact with nature for psychological restoration influences individuals’ preferences (Hartig and Staats, 2006, van den Berg et al., 2007). Research on happiness shows positive influences of nature on subjective well-being and life satisfaction (Brereton et al., 2008, MacKerron and Mourato, 2013).

(see e.g. Baranzini et al. (2008), Baranzini and Schaerer (2011), Boyle and Kiel (2001), Cavailhès et al. (2009), Cheshire and Sheppard (1995), Nilsson (2014), Waltert and Schläpfer (2010)), which thereby affect location choices. Only few location choice studies have, however, integrated natural amenities in their models so far. Moreover, mountain regions, similar to coastal regions, may provide specific natural amenities linked to the mountain environment, such as altitude, views and near-natural areas (Moss, 2006). There, the supply with natural amenities is, at least theoretically, more unequal than in the plain: hillsides and mountain zones provide high natural amenity values and have bigger chances in Alpine urban regions to play a role in location choices. Besides the classic residential location factors such as commuting, housing prices and socio-economic environment, disparities in natural amenity distribution might significantly influence residential location choices.

Finally, the mountain environment imposes constraints on urban development and accessibility due to topography and scarcity of land. At the same time the Alps are a major ‘hotspot’ of biodiversity in Europe and have highly valued cultural and natural landscapes that developed over centuries (Debarbieux et al., 2011, European Environmental Agency (EEA), 2010), and thus show a high share of protected land area. For local and regional populations, the mountain environment provides important ecosystem functions and services whose provision needs to be safeguarded and equally distributed. The combination of a scarce land resource and mountain residential amenities make Alpine city regions particularly prone to peri-urbanisation (Perlik, 2001), urban sprawl and leapfrog development. The SCoT 2030 strategic plan for Grenoble urban region⁵(Agence d’urbanisme de la région urbaine grenobloise (AURG), 2012) is a regulatory urban planning policy that has been adopted by 273 mayors in 2012 and should significantly reduce urban sprawl, promote higher density development along public transport axes and increase social cohesion within the region until 2030. A residential location choice model can inform planners and decision-makers about likely outcomes of such policy and other, alternative policy scenarios.

4.1.1 Aims & methods

The aim of this chapter is twofold: (i) to identify the determinants of residential location and specify a residential location choice model for the Grenoble urban region, and (ii) to use this model to test the effects of different urban planning and transport policy scenarios on the distribution of residential demand. We are on the one hand interested

⁵*Schéma de Cohérence Territoriale de la Région Urbaine Grenobloise* (hereafter SCoT, territorial cohesion scheme)

in the effects of the SCoT planning policy, and on the other hand in the effects of more radical and opposed planning scenarios on residential demand in different areas of the region, specifically in the mountains. The research questions are as follows:

- Which are the major determinants of household location choices in an urban region situated in an Alpine environment? Controlling for classic ‘hard’ location factors, are there specific ‘soft’ location factors related to the Alpine environment that influence household location choices?
- Assuming the validity of the specified residential choice model and its predictive power, how would different planning and transport policy scenarios likely affect residential processes? What are the links between quantitative demand distribution - concentration - and qualitative demand distribution - segregation -, and finally demand for the mountains?
- Which effects result from the SCoT policy as a regulatory planning tool, especially for peri-urbanisation and housing prices in the region? Which sectoral planning interventions drive residential processes the most?
- How and to what extent do more radical planning and transport policies influence residential demand across the region?

In order to answer these questions, our methodology follows three steps. We first develop a residential location choice model at municipality level for the study region, using discrete choice models (McFadden, 1978, Train, 2009). Since the location choice is part of the wider housing decision-making process of a household, we develop separate models of residential mobility and dwelling type choice. For the analysis, we use a disaggregate household population data set from the French population census that contains information on recent migrations on municipality level. Different studies have similarly modelled disaggregate choices for aggregate locations such as census tracts or municipalities (Ben-Akiva and Bowman, 1998, Dahlberg et al., 2012, de Palma et al., 2007a, Frenkel et al., 2013, Goffette-Nagot and Schaeffer, 2013, Nechyba and Strauss, 1998, Schmidheiny, 2006). Finally, the model framework considers endogeneity in housing prices by interacting the location choice model (demand) with a housing price model.

In a second step, we simulate residential demand patterns for different counterfactual⁶ planning scenarios. More specifically, we select four integrated urban planning and transport scenarios from urban planning documents and existing foresight studies for

⁶A logic expressing what has not happened but could, would, or might under differing conditions.

the study region: (1) a baseline scenario, (2) a SCoT planning scenario that reflects the objectives of the 2030 strategic plan for Grenoble urban region, (3) a scenario focusing on the preservation of mountain territories, and (4) a scenario representing economic innovation and growth in mountain territories. In addition, the second scenario (2) is split up in sectoral policy scenarios, namely housing, transport and amenities. These scenarios are quantified and translated to model variables. We then use the scenario data in our model to simulate residential demand distributions for each scenario.

In a last step, we analyse and compare the simulated residential demand patterns and housing prices of the scenarios with the help of mapping and descriptive statistics. We compare residential demand patterns using indices of population concentration, segregation and mountain development.

4.1.2 Main results & chapter outline

Our estimation results for the location choice model show a general preference of households for space, peripheral and mountain amenities over central city access. The estimation results of residential mobility and dwelling type choice models reveal, as expected, systematic variations in household decisions based on demographic and socio-economic attributes.

Controlling for various classic location factors, we find that the mountain environment contributes to peri-urbanisation and to residential sorting, notably via the capitalisation of mountain amenities into housing prices (view), but also via systematic heterogeneity in household preferences for mountain amenities according to demographic (age, household composition) and socio-economic household attributes (income, education).

The analysis of simulated residential demand patterns for the planning scenarios shows that continued trends in planning and transport policies would sustain and potentially reinforce peri-urbanisation to rural and mountain areas in the region. More confining planning policies such as the SCoT planning directive appear in general to be capable of curbing and potentially reversing the peri-urbanisation process. A re-centralisation of demand, however, may lead to problems of housing affordability. Policies that constrain peripheral growth and increase urban density seem moreover to sustain and potentially increase segregation levels based on socio-professional status and age. By contrast, segregation of households with children tends to be lower in such scenarios.

In our scenarios, policies that increase building densities in central areas alone do not lead to a re-centralisation of residential demand. Neither housing construction objectives nor improvements in urban quality reach the magnitude of the effect of changes to

transportation and accessibility, and specifically household preferences. Without changes in household preferences, the overall trend of peri-urbanisation is likely to continue. A ‘mountain innovation’ policy - relating to a change of paradigm in planning and economic development policies, technological change and decreased mobility constraints - would actively promote population growth in rural and mountain territories.

The remainder of this chapter is organized as follows. Section 2 reviews the related literature on residential location choices, natural amenity effects in this context and on effects of spatial planning on the housing market. Section 3 details the modelling approach, data as well as the scenario approach. Section 4 presents the estimation and scenario results in detail, followed by a discussion. Section 5 concludes.

4.2 Related literature

4.2.1 Residential location choices & natural amenities

Prior research has shown the complexity of the household’s housing decision-making process. Economic and location choice research have continuously tried to conceptualize and better represent the process (Wong, 2002). Studies assume and model the process as an sequential order of individual choices - satisfaction with the current dwelling unit, choice to move, dwelling type choice, neighbourhood choice and new dwelling unit choice - depicted in decision trees (Clark and Onaka, 1985, Eluru et al., 2009, Lee and Waddell, 2010, Quigley, 1985). There is, however, consensus that in reality, the choice process does not consist of sequential choices separated from each other. Instead, choices are interlinked and interdependent, potentially with simultaneous decisions (Timmermans, 2006). Still, integrated urban modeling as well as most of the location choice research have continued to model them separately.

Housing search and decision-making processes might also vary across households depending on household attributes such as income, education and family composition. With regard to the decision to move, substantial empirical literature has found that mobility is notably related to age, education, income and housing tenure (Caldera Sánchez and Andrews, 2011, Dieleman, 2001, Quigley and Weinberg, 1977, Rabe and Taylor, 2010, Wong, 2002). The most mobile groups are frequently found to be “the young, the highly educated, those in high-level occupations, private tenants and higher income households” (Rabe and Taylor, 2010, p. 532).

A substantial number of empirical studies in transport, urban planning and urban economics has investigated residential location choices quantitatively using the discrete choice framework (McFadden, 1978, Train, 2009). Quigley and Weinberg (1977), Guo

(2004) and Schirmer et al. (2014) review a large number of such studies, resuming and categorizing the main location factors of households within a city region:

- access to work (commuting),
- access to non-work opportunities (e.g. public services, leisure, recreation, shopping),
- housing supply (availability, types and quality),
- housing price levels,
- neighbourhood composition (e.g. school quality, average income, local taxation, ethnic and social composition, crime levels, unemployment),
- social network (proximity to family, friends),
- neighbourhood and environmental quality (e.g. air pollution, noise, land use, built heritage, urban density, urban parks, open space, natural features, coast, scenic views),
- and attributes of the dwelling unit itself⁷.

Among these, housing price levels, access to work and neighbourhood composition are frequently found to be the most important location factors for households (Frenkel et al., 2013, Lawton et al., 2013). But studies have also revealed variations in the importance of these location factors among households. Income and education, stage in the household life-cycle, family structure, lifestyle and preferences for housing and the living environment affect residential preferences and location choices (Hand et al., 2008, Kim et al., 2005, Lindberg et al., 1992). For instance, Bayoh et al. (2006), using a hybrid conditional logit model to describe homeowners choice among school districts within the Columbus, Ohio area, provide on the one hand evidence for a ‘natural evolution’ of households to the suburbs related to job location, residential sorting, segregation by income and life-cycle effects. On the other hand, their results confirm the ‘flight from blight’ hypothesis (see also Cullen and Levitt (1999)), in which richer and older households leave central locations due to a higher crime rates, lower school quality and lower average income levels. They find school quality to exert the strongest effect on these movers, whereas effects from household income and other individual characteristics are relatively modest.

⁷In many location choice studies, these attributes are unobserved due to limited data availability.

Empirical work suggests that sub- and peri-urbanisation processes are mainly driven by choices of certain households - double earners, middle- and high-income families and retirees - based on adjustments in housing consumption and differences in neighborhood and environmental quality between the city and peripheral areas (Bayoh et al., 2006, Kim et al., 2005, Van Duijn and Rouwendal, 2013). In this way, location decisions based on systematically varying preferences for location factors across household groups may contribute to residential sorting and segregation (see e.g. Bayer and McMillan (2012), Charlot et al. (2009), Schmidheiny (2006)).

Location choices & natural amenities

The literature has for a long time studied effects of environmental quality of the location and the neighbourhood on household mobility, location choices and housing prices. These relate to location-specific features of natural and urban environments, called amenities. Studies first considered especially air quality, urban density and crime levels (Graves and Linneman, 1979, Graves et al., 1988). Older Studies on urban disamenities have supported the ‘flight from blight’ hypothesis. Factors such as crime, residential density, proximity to industrial sites, local expenditure on culture and recreation and other factors of neighbourhood affect location choices of households differently (Guo, 2004). more recently, studies frequently consider noise, land use and mix, built and cultural heritage, open space, scenic views and natural features (Waltert and Schlöpfer, 2010).

In regional science, research has found influences of natural amenities such as climate, topography, land use and water areas on differential migration flows, especially in the US (Cheshire and Magrini, 2006, Chi and Marcouiller, 2009, 2012, McGranahan et al., 2011, Rodríguez-Pose and Ketterer, 2012, Waltert and Schlöpfer, 2010). It has been found that amenities may attract certain population groups - e.g. higher-income and older workers (Hand et al., 2008), retirees or other non-labor force participants (Djissa, 2013, Duncombe et al., 2001, Poudyal et al., 2008, von Reichert and Rudzitis, 1994) and knowledge workers (Florida, 2002a, van Oort et al., 2003) - and possibly jobs (Dorfman et al., 2011), thereby increasing regional disparities. Rodríguez-Pose and Ketterer (2012), studying net migration data for 133 European regions between 1990 and 2006, find that regional amenities might exert a more important influence on migration in Europe than previously believed.

At urban region scale, theoretical and empirical findings on natural amenity effects have gained particular attention in the last decades. In urban economics, researchers have noticed unequal distributions of natural amenities across urban regions (de Palma et al., 2007a). Theoretical research in this strand recognizes that households value dif-

ferent cultural amenities in central locations and natural amenities in peripheral areas of city regions, e.g. recreation sites, open spaces and agricultural land (Brueckner et al., 1999). In a mono-centric framework, this might lead to varying bid-rent curves and thus to varying patterns of rich-poor household concentrations. In the same sense, analysing effects of amenities on urban form, Wu (2006), Wu et al. (2004) illustrate that urban patterns such as sprawl and leapfrog development as well as community characteristics and income inequalities within a city region can result from a heterogeneous spatial distribution of natural amenities. Similarly, Ng (2008) shows that differences in household preferences can lead to various types of residential location patterns and higher average commuting distances to the central city. (Cavailhès et al., 2004) explain peri-urbanisation processes by households' urban fringe location decisions which value rural landscape amenities created and maintained by farmers. Socio-spatial patterns in urban areas, or different rich-poor distributions, thus result at least partially from heterogeneous spatial distributions of natural amenities.

Few empirical studies do quantitatively investigate the influences of natural amenities on residential location choices. de Palma et al. (2007a) consider environmental amenities and disamenities at fine scale in the Paris region. The authors take into account detailed measures of accessibility, noise and land cover in their discrete choice approach on both municipal and smaller grid cell level. They show that households generally avoid noisy areas and prefer proximity to sports facilities, forests and parks (only with children) and water areas.

Kim et al. (2005) study home and workplace location choices simultaneously based on survey data in Michigan. They reveal differences in trade-offs between close-to-work and close-to-nature decisions according to life-cycle stage. Households in the child-rearing stage trade-off quality of the natural environment with job accessibility, whereas others trade-off neighbourhood characteristics, small lots and shared open space with job accessibility.

Analysing disaggregate migration data on county level in the Southwest United States, Hand et al. (2008) find evidence that forest and natural characteristics determine, in part, residential location decisions. They also explore income and life-cycle effects on demand for such amenities and confirm their presence: older and richer households and young retirees are more attracted to amenable locations, whereas amenity demand decreases for older retirees.

More recently, Van Duijn and Rouwendal (2013) investigate the role of urban and rural amenities for household location choices in the Netherlands. In their model, they show that higher educated households and especially singles are less sensitive to high

housing prices in central locations; their appreciation of inner city built and cultural heritage is higher. A more rural living environment is important for double earners, larger households and elderly people, whereas water areas, often also in urban central zones, are preferred by highly educated singles.

Frenkel et al. (2013) analyse residential choice behaviour of knowledge-workers in the Tel-Aviv metropolitan area. Using discrete choice models with revealed preference data from an own survey, they find socio-economic level, housing affordability and commuting time the most important location factors. Urban and environmental amenity factors such as cultural and educational land-use as well as culture-oriented leisure activity patterns play a subordinate role.

Lawton et al. (2013) question the assumption of Florida (Florida, 2002a,b) that knowledge workers have strong residential preferences for amenities, contrary to those of the general population. Examining residential preferences of workers in the creative and knowledge sectors in Dublin, they find significant heterogeneity across workers in these occupations in the preferences for soft, amenity-oriented factors such as those provided by long-established urban neighbourhoods (urban amenities). Their results emphasize a continued importance of classic location factors, especially housing prices, commuting time and the quality of transport infrastructure. The study also reveals the importance of personal trajectories. Inner urban region location choices thus depend on a combination of classic location factors and shifts in residential preferences throughout the life-cycle. The results do not highlight a notable difference between location factors of knowledge workers and the more general population.

Finally, economic studies have also shown that natural and urban amenity values are capitalized into wages, housing prices and other local prices (Knapp and Graves, 1989, Roback, 1982, Waltert and Schläpfer, 2010). In urban regions, natural amenities influence residential location choices through their capitalisation into housing prices. The hedonic price literature shows capitalization of natural amenities such as open space, forests, the coast, scenic views and water bodies into housing prices (Baranzini et al., 2008, Baranzini and Schaerer, 2011, Boyle and Kiel, 2001, Cavailhès et al., 2009, Cheshire and Sheppard, 1995, Geoghegan, 2002, Irwin, 2002, Nilsson, 2014, Travers et al., 2013, Waltert and Schläpfer, 2010). Especially open space and natural features in the surroundings of a dwelling unit influence positively its price (Geoghegan et al., 1997). However, capitalization of natural amenities into housing prices is found to show significant intraregional heterogeneity (Cho et al., 2008, Nilsson, 2014). It depends on proximity to the sold home or land parcel, the nature of the natural amenity (natural amenities are a heterogeneous commodity), the scarcity of natural amenities in the surrounding areas,

population and dwelling unit densities and elasticity of supply and income elasticity of demand. Finally, besides the effect of current land use in the surrounding on the price of a home, prices may also capitalize future land use of the surrounding area (Pouyanne et al., 2013).

Therefore and under certain circumstances, natural amenities may contribute to income sorting (segregation) and to the emergence of spatially segregated patterns. In addition, a rise in housing prices due to a demand shock or significant in-migration of affluent households to high-amenity peri-urban and rural areas can lead to gentrification (see e.g. Nelson et al. (2010), Phillips (1993), Stockdale (2010) in rural studies). Gentrification is a concept that describes social, economic and environmental transformations at the level of a community or a neighbourhood. Although its definition is contested (Stockdale, 2010), gentrification is generally defined as in-migration of affluent households - relative to the incomes of the local population - to neighbourhoods and communities, where they increase housing prices and potentially displace local population groups (Stockdale, 2010). The process operates over different timely phases (Stockdale, 2010): whereas relative affluence of immigrants is important in the beginning, it diminishes over time as shares of affluent households rise.

Location choices & migration in the Alps

Geographical research has extensively studied factors of residential migrations in mountain areas, developing concepts and typologies for observed processes (Bender and Kanitscheider, 2012, Borsdorf, 2009, Camenisch and Debarbieux, 2011, Haller and Borsdorf, 2013, McIntyre, 2009, Moss, 2006, Perlik, 2006, 2011): rural exodus of the mountain population to urban centres, brain drain of young and highly educated individuals, peri-urbanization from urban centres to accessible mountain hinterlands, amenity migration, i.e. the differential movement of wealthy and footloose population groups to mountain areas based on preferences for mountain amenities: near-natural environments, aesthetic scenery and views, tranquility but also senses of community, tradition, identity and spirituality (Moss, 2006, Phillips, 2005). The majority of geographers and sociologists believes that these processes are influenced by changes in accessibility, transport and information and communication technology, but also social change: rising incomes, increases in discretionary time, more flexible forms of work organisation, establishment of elites, differentiation of life-styles and related changes in behaviour and preferences (Martin, 2012, Moss and Glorioso, 2012, Perlik, 2006, 2011).

Specifically the definition of amenity migration has created ongoing scientific debate (Borsdorf, 2009, McIntyre, 2009). Whereas amenity migration is frequently defined as

population movements to remote rural and mountain areas (Cognard, 2010, Ghose, 2004, Glorioso and Moss, 2007, Nelson et al., 2010), research has shown that the European Alps as a high-amenity area are particularly prone to peri-urbanisation (Perlik, 2006) from close, outer- and inner-Alpine metropolitan areas such as Geneva-Lausanne, Milano, Munich, Torino, Vienna, Zurich, Grenoble or Innsbruck.

Perlik (2006) emphasizes that the narrow concept of amenity migration used by studies from the US or Australia, in which people move permanently to peripheral places to create businesses, does not fit to the Alpine context. He assumes that attraction of metropolitan regions in Europe has increased, and the move to peripheral areas is not more than a stage in a household's life-cycle. As urban proximity is higher in the European Alps, amenity-seeking occurs more through processes of urbanization, peri-urbanization and metropolisation than through migration to remote areas. Territorial attractiveness of the concerned Alpine territories is twofold: households benefit from the proximity of urban (modern) and natural amenities at the same time by locating in the foothills and accessible mountain zones. Thus, different migration motives overlap in Alpine peri-urbanisation and rural migrations. Amenity motives combine with traditional motives for migration within functional urban areas. Bender and Kanitscheider (2012), based on the work of Perlik (2006) and Zelinsky (1971), propose a terminology for mobility types to Alpine territories (see figure 4.1).

In this context, Perlik (2011) has introduced the concept of 'Alpine gentrification'. It describes a spatio-temporal process triggered by the in-migration of affluent urban middle-class households to mountain villages that become "metropolitan neighbourhoods" in terms of lifestyle, values and preferences of their inhabitants. The concept is related to amenity-led migration (Moss, 2006), lifestyle migration (Benson and O'Reilly, 2009, McIntyre, 2009) and rural gentrification coined by (Phillips, 1993) and investigated in rural areas in Europe and in the US (Nelson et al., 2010, Stockdale, 2010). The latter concept, equally called "greentrification" (Phillips, 2005) explains social, political and environmental transformations in rural areas based on in-migration of urban middle-class households in search for lower housing prices and a green, natural and healthy living environment.

Situating such processes in a metropolisation context, Perlik (2011) puts forward the idea that affluent households move permanently (or temporarily) to mountain communities more or less close to Alpine urban centres that are endowed with high-quality natural amenities. This has several impacts also highlighted in the amenity literature (Glorioso and Moss, 2007): they contribute to a dispersion of urban lifestyles and values, are likely to establish *entre-soi* and influence local politics (e.g. zoning decisions), increase housing

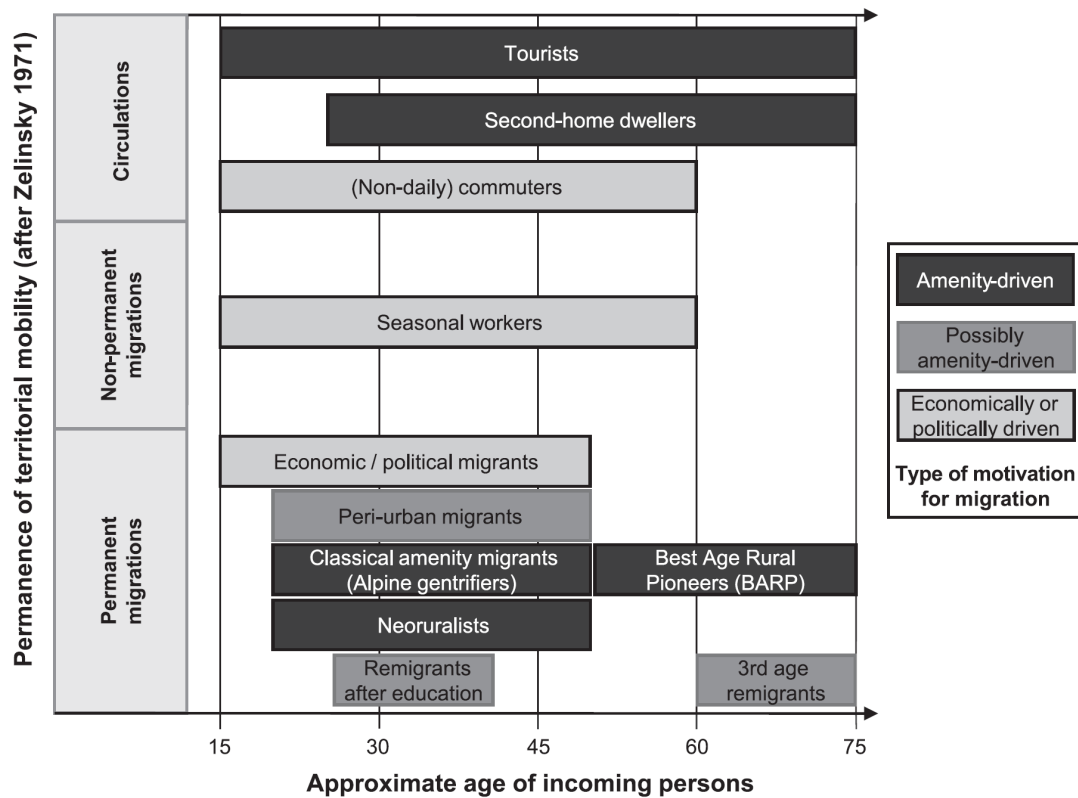


Figure 4.1 – Proposed terminology for mobility types to Alpine territories

Source: Bender and Kanitscheider (2012)

prices and costs of living for the local population, which might in turn reinforce segregation, exclusion and lead to displacement (Ghose, 2004). Whereas empirical studies have highlighted the presence of peri-urbanisation processes in many regions of the Alps (Perlik, 2001), previous studies have not investigated the hypothesis of such “Alpine” gentrification processes (Bürgele, 2006, Camenisch and Debarbieux, 2011, Schirmer et al., 2013).

Residential location behaviour: a story of work, family life-cycle and income

To resume the above findings from literature, we can describe a general residential life-cycle story of households in space (see also Hand et al. (2008), Kim et al. (2005), Lindberg et al. (1992)). Younger households may be most concerned with the establishment of job careers, making them choose smaller dwellings in central locations of urban areas, close to work and education facilities. At this stage, preferences are stronger for job access, urban and modern amenities than for natural amenities. These preferences change when households start a family, and potentially become homeowners. Together with an increasing housing demand, their preferences shift away from self-establishment and work towards satisfying other preferences such as quality of life, including natural amenities. Child-rearing households in Europe continue to have strong preferences for locations in the countryside, thought to be the optimal setting for health, security and development of children (Kim et al., 2005).

Meanwhile, households without children, e.g. power couples, might continue to place a high priority on access to transportation, job and service accessibility, and proximity to urban and modern amenities. Further on in the life-cycle, older active households and younger retirees show a strong attraction to amenable locations. Households can again adjust their housing consumption once children leave their home (empty-nesters) or when they retire. In the latter case, they loose the job accessibility constraint, and subjective quality of life considerations become predominant, potentially including natural amenities. At later stages, older retirees may shift their preferences again from natural amenities towards areas with better access to transportation, health care, social service or proximity to adult children (Hand et al., 2008).

The above life-cycle story is also intrinsically linked to subjective quality of life considerations of the household, and related preferences for natural amenities such as mountain landscapes. Although contact with nature is considered a general need and desire of households in urbanized societies (van den Berg et al., 2007), landscape research argues that natural beauty lies in the ‘eye of the beholder’ (Lothian, 1999): different groups of people prefer different types of natural (and cultural) landscapes (Dramstad

et al., 2006). Consequently, the higher the preference for the mountain environment, the higher the probability a household moves to a mountain area in the course of his life-cycle. But preferences for natural amenities also vary systematically across households: natural amenities are considered normal (or even superior) goods (Brueckner et al., 1999, Dorfman et al., 2011, Hand et al., 2008), i.e. their consumption (or even their proportion in consumption) rises with household income. The higher the income, the higher the probability a household moves to amenity-rich areas in the course of his life-cycle.

This life-cycle perspective shows the importance to see household location decisions as events over individuals' life-spans, i.e. in their spatio-temporal context. They are elements of spatio-temporal processes that are expression of *habitus*⁸, changing needs and preferences as well as social differentiation (see e.g. Valentine and Sadgrove (2012) on social differentiation along the life-cycle).

4.2.2 Planning effects on housing markets, urban spatial form & segregation

Spatial planning, here specifically in its regulatory function⁹, has become widely applied and at the same time more restrictive at metropolitan region and local jurisdiction level across the globe and over the last decades. From an economic point of view, administrations and urban planners design land use and zoning regulations to internalise social, economic and environmental externalities that negatively affect public welfare and competitive markets do not account for (Hilber and Robert-Nicoud, 2013, Klosterman, 1985, Nelson et al., 2002, Wilson et al., 2008, Zellner et al., 2010), i.e. market failures such as congestion, pollution, segregation, neighbourhood effects, urban sprawl, agricultural land consumption, habitat fragmentation and loss of biodiversity.

Theoretical and empirical economic research has investigated the effects of zoning and regulatory land-use planning instruments on land and housing markets for a long time (for reviews please refer to Cheshire and Sheppard (2004), Lecat (2006), Pogodzinski and Sass (1990), Quigley and Rosenthal (2005)). Examples are zoning of land uses¹⁰, density

⁸Defined as a "set of dispositions related to particular practices which are not necessarily cognitive or instrumental and which may lead to regularities in patterns of 'common sense' behaviour across time or generations" (Valentine and Sadgrove, 2012, p. 2059)

⁹For strategic spatial planning see Albrechts et al. (2003), Healey (2007)

¹⁰With its origin in the sanitary movement, zoning reflects the willingness of public action to address levels of population concentration and proximity of housing to industrial production sites that have negative effects on living conditions (see e.g. Wilson et al. (2008)). This led to the separation of land uses to improve public health and environmental quality. Later, urban planning and zoning objectives shifted away from public health (now accounted for at individual person level) to pursue other goals such as esthetic value of the urban environment, but also economic and social goals of the privileged.

controls and minimum lot sizes. At metropolitan and urban region levels, common zoning instruments that aim specifically at limiting urban sprawl across multiple jurisdictions are urban growth boundaries and green belts (Brueckner, 2000, Gennaio et al., 2009). In many countries, municipal zoning is the most important way in which local authorities affect housing markets and hence residential choice and mobility (Lecat, 2006, Mills, 2005, Pogodzinski and Sass, 1990).

There is a consensus among economists that land use regulation affects land and housing markets. There is evidence that by making land and housing supply scarcer, land use regulation increases land and housing prices (see e.g. Lecat (2006)). However, economic research shows that links between land use regulation, markets and public welfare are more complex and results can be counterintuitive (see e.g. (Pogodzinski and Sass, 1990)): urban sprawl might notably increase if land-use regulations curtail higher densities which free market mechanisms would have produced otherwise (Zellner et al., 2010). Land use regulation may also contribute segregation via exclusionary zoning (see e.g. Wilson et al. (2008)). This is because housing and land markets are also driven by other factors such as macro-economic forces, changes in household preferences and market agents' profit-seeking behavior. Land use policies, rather than affecting a single driving force, affect all actors and processes in the housing market simultaneously. The housing market is inherently "full of distortions" (Magliocca et al., 2012, p. 409). Land use regulation can thus be both: a policy response to and a source of market failure (Zellner et al., 2010). "Zoning is welfare improving if it reduces the level of negative externalities to which consumers and firms are exposed by an amount greater than costs associated with implementing and enforcing zoning" (Pogodzinski and Sass, 1990, p. 295).

Economic theory

In their seminal paper providing a review on theoretical studies, Pogodzinski and Sass (1990) underline the complexity of land use regulation and zoning effects by distinguishing six categories. These are

- supply-side effects that concern effects on suppliers and the land market,
- demand-side effects that refer to effects on residential demand and choice,
- Tiebout (Tiebout, 1956) effects that result from residential mobility in response to zoning,

- externality effects that describe positive effects such as efficiency gains in the provision of public goods, decreased congestion and agglomeration economies, but also costs such as increased commuting time,
- endogenous zoning that accounts for endogeneity in the establishment of zoning regulations, e.g. exclusionary zoning and rent-seeking behaviour of developers.

Economists have used different models¹¹ to investigate these effects - often separated from one another. Those studies that integrate externalities show that zoning can indeed be welfare improving (Pogodzinski and Sass, 1990). In the real world, however, all of these effects are simultaneously present, making it hardly possible (i) for empirical research to isolate land use regulation effects on housing prices and urban spatial structure from other influences (Brueckner, 2000), (ii) and for planners and administrations to implement zoning policies that anticipate potential side-effects of zoning. For instance, Brueckner (2000) states that without sufficient understanding of the sources of market failure and the exact level of regional urban over-expansion, planners and administrations might develop far too rigid zoning policies that inappropriately increase housing prices and urban densities. Economic opinion therefore diverges on the questions on the effects of zoning and, more generally, its efficiency in increasing public welfare. In the following sections, we present theoretical considerations on demand-side and price effects, and also on Tiebout and endogenous zoning effects. We close with some empirical findings from the US and Europe.

More specifically, economic theory conveys the standard idea - frequently confirmed by empirical literature (see below) - that zoning and land use regulation increase housing and land prices (Lecat, 2006, Pogodzinski and Sass, 1990). Considering a model without externalities, restrictions on land use - either through zoning or other growth control measures - make land and homes pricier (Cheshire and Sheppard, 2004, Engle et al., 1992, Hilber and Robert-Nicoud, 2013, Pogodzinski and Sass, 1990). This is the result of a reduction in land and housing supply (developable land and number of dwellings) that leads to scarcity effects in the supply curve and finally housing price increases (Engle et al., 1992). A second zoning effect that is qualified to increase (or decrease) housing prices are externality effects, e.g. amenity effects. Zoning creates location advantages, e.g. stability and quality of the built, social and natural environment, reduction of pollution and proximity to harmful land uses, and efficiency gains in transport and service provision (agglomeration effects). If such effects are accounted for in theoretical models, they also lead to increases in housing prices. If zoning and density controls reduce

¹¹E.g. demand and supply models, models considering externalities, mono-centric models *à la* Alonso-Muth-Mills and Tiebout-type models (Pogodzinski and Sass, 1990).

negative externalities in addition to their scarcity effect, increases in prices become even more likely Grieson and White (1981). Engle et al. (1992) underline the importance to distinct between scarcity and externality effects, since these forces determine empirical conclusions: whereas an increase in prices due to a scarcity effect of planning is interpreted as welfare-reducing, an increase in price levels due to amenity effects would be interpreted as welfare-increasing.

Beyond scarcity and externality effects, the relationship between zoning and housing prices depends on the spatial and local jurisdictional context of the area of study (closed vs. open city). Considering an aspatial context, e.g. a closed urban area composed by only one jurisdiction, Dawkins and Nelson (2002) assume that housing is a necessity good and consequently, demand is completely inelastic: a reduction in housing supply would increase land prices more than proportionally. Similarly, if housing supply is completely inelastic, an increase in demand would result in increasing land prices. This corresponds to a short term vision of the housing market: housing supply reacts with some inertia to positive demand shocks due to delays in revision of planning documents and construction.

A more realistic view considers several local jurisdictions and/or a more elastic housing supply. In a spatial context of various small municipal jurisdictions with diverging growth controls, the price-elasticity of residential demand increases. Dawkins and Nelson (2002), supposing a reduction in developable land due to restrictive land use planning in one jurisdiction, suggest that if there is a relative price-elasticity of demand, such reduction would lead to a partial shift of the residential demand to jurisdictions in close vicinity. The increase in local prices due to planning would consequently be lower. Put differently, in an open city, households may decide to build in areas where land use restrictiveness and hence prices are lower. For example, Mills (2005), using a conventional mono-centric model, shows that city-wide imposed density limits expand the size of the city, which increases both housing prices and commuting distances. Residents might be better-off if they prefer lower densities, but extra commuting and dwelling costs might result in welfare reductions for households. In the extreme case of a completely open city, i.e. under the hypothesis of infinite demand-elasticity, no zoning effect would be observed on the housing market and prices; only the presence of externalities would explain observed zoning effects on the housing market (Grieson and White, 1981). Last, if housing supply is elastic, a demand increase would increase land prices also less than proportionally, but would increase dwelling construction. This corresponds to a long-term vision, in which housing supply is able to adjust to demand.

Tiebout-type models (Tiebout, 1956) internalise services and public goods such as ed-

ucation, public safety and parks, which leads to residential sorting between local jurisdictions that show different price levels: households vote with their feet. This phenomenon can be amplified by high-income households' desire to form separate jurisdictions with regard to public goods, in order to avoid (i) paying more for public services than poorer households and (ii) ending up with lower public spending than they would prefer in a mixed jurisdiction (Brueckner, 2000).

Finally and related to Tiebout effects, endogenous zoning studies explain the emergence of land use regulation policies in local jurisdictions endogenously, rather than treating zoning as an exogenous factor (Pogodzinski and Sass, 1990).¹² Such studies integrate the characteristics of communities and market agents to analyse the emergence of planning regulation in political processes and to explain planning effects on housing and land markets. The planning system may reflect 'insider' interests that affect raise prices and overlook and potentially exclude 'outsiders' seeking affordable housing opportunities (Taylor, 2011).

Empirical evidence

Empirical research on land use regulation has observed positive effects prices on land and housing prices due to different regulatory planning instruments that cause restrictions in supply (Quigley and Rosenthal, 2005). Glaeser and Ward (2009) investigate notable increases in housing prices and a decline in construction in the Greater Boston area over the last decades, reflecting an increasingly restricted housing supply. They find that minimum lot size measures are most important in constraining construction: each extra acre per lot is associated with about 40 % fewer permits between 1980 and 2002 (p. 278). Other regulations are weaker but still account for decreases of permits around 10 %. With regard to effects on prices, their findings confirm basic (urban) economic theory, which states that one should not expect the price of a good to rise if its supply is restricted, relative to a perfect substitute (p. 275). In a first regression analysis, not accounting for other area characteristics, minimum lot size measures are associated with higher prices of houses (each extra acre increases prices by 12 %).

On the other hand, when controlling for area characteristics such as demography and density, this price effect disappears. Houses are likely to be closer substitutes, and thus quantity restrictions do not increase prices. The authors analyze small towns (= jurisdictions), a context where houses might be closer substitutes for households than in larger jurisdictions where competition is lower. In the latter case, literature has found significant positive effects of growth limitations on prices (see e.g. (Quigley and

¹²See Taylor (2011) for a recent thesis on this issue

Raphael, 2005, Quigley and Rosenthal, 2005)(p. 79). Finally, the authors find modest effects of density levels on land prices, and argue that municipalities are not choosing density levels that would maximize their land values.

Ihlanfeldt (2007) uses a unique database on Florida municipalities to estimate the effects of restrictiveness of land use regulation on housing and land prices. Using sales prices as dependent variables and a regulation restrictiveness measure as an endogenous variable, he finds that land use regulation has important effects on the prices of housing and vacant land, but these effects depend on the market setting. His results suggest reductions in housing affordability depend on the number of competing jurisdictions within the local housing market, thereby confirming theory (see above). Where the choice is limited for households, they will be confronted with higher prices. In addition, he also finds that newly constructed dwellings are larger where regulation restrictiveness is higher, which further increases average housing prices.

Although empirical research finds a positive relationship between regulation restrictiveness and higher housing prices (Saiz, 2008), there is no consensus about whether this effect bears a causal relationship (Quigley and Rosenthal, 2005). Empirical research fails to recognize the complexity and endogeneity of local policy-making and regulatory behavior. There is a great variety of local regulation practices across metropolitan regions, and data availability on regulation is often poor. Households seek to maximize home values and minimize tax burdens, and influence the politics underlying land use regulation (p. 70).

Urban spatial form & segregation

Zoning and land use regulation also affect urban spatial form and segregation (Magliocca et al., 2012, Zellner et al., 2010). Zellner et al. (2010), using experimental simulations based on an agent-based model (ABM), highlight the importance to consider the combined effects of zoning regulations, externalities and residential preferences in affecting development patterns in peri-urban areas. Former research in this strand has shown that preference heterogeneity, positive peri-urban externalities and negative urban externalities tend to increase sprawl (Caruso, 2005, Wu and Plantinga, 2003). With simulations based on their land-use change agent-based model where zoning is implemented either as an upper bound density restriction or a preferred density set by the first resident arrived, they show that sprawl is not inevitable even if the majority of the population prefers low-density development. Negative externalities contribute to sprawl, and decrease average utility and flatten the utility distribution. They show that zoning can reduce sprawl by concentrating residential development in some areas, but at the expense of overall

utility and inequality in utility. Heterogeneous preferences and different levels of zoning enforcement reinforce or attenuate these effects, leading to the suggestion that there are conditions under which zoning is preferable and others under which it is not.

Magliocca et al. (2012), using an agent-based model of land use in a hypothetical urban fringe community, analyse effects of large-lot zoning on land use, land prices, and the development of urban form. The model simulates the decisions of heterogeneous households, developers, and landowners in land and housing markets. They show that zoning in the form of minimum lot size restrictions have varying effects according to restrictiveness of regulation: smaller minimum lot sizes have little effect on the spatial patterns of development, but they increase land and housing prices; larger minimum lot size restrictions increase development in the city center, leaving vacant land in peri-urban undeveloped until quite late in the model simulations. House prices are higher with larger minimum lot size zoning. Their model highlights the time-related transitional dynamics of urban development within a growing urban region.

Irwin and Bockstael (2004), using parcel data on residential land conversion, estimate a hazard model of land development to investigate how land use externalities and several ‘smart growth’ policies that aim at managing urban growth and preserving open space influence urban spatial development in an exurban county south of Washington D.C.¹³ They find that planning policies significantly influence land conversion. They find evidence that parcels with greater amounts of preserved open space in the surrounding are more likely to be converted. This occurs due to the positive amenity value associated with open space preservation. In other words, instruments of land use regulation may affect urban spatial development “not only because they create an area in which development cannot occur, but also because they may create areas that attract neighboring development.” (Irwin and Bockstael, 2004, p. 724) If these effects are sufficiently strong, they will foster leapfrog development and sprawl.

Wilson et al. (2008), in the context of the US, discuss how planning and zoning may contribute to inequitable residential development and socio-spatial fragmentation, and how this has implications for health disparities and environmental injustice. More specifically, they highlight exclusionary zoning practices of municipalities that increase property values, exclude certain land uses and population groups, and thereby contribute to their political and economic self-interest. Municipal sovereignty enables them to serve best their community interests and define themselves public welfare in their own jurisdiction. The result is discriminatory planning and exclusionary zoning - “limiting

¹³In the US, definitions of exurban zones vary: exurbs can be defined as commutersheds, or as a zone at the limits of metropolitan areas, i.e. the rural-urban fringe (Taylor, 2009).

access of all citizens to affordable housing, public transportation, good school systems, and economic infrastructure” (Wilson et al., 2008, p. 212). This may lead to segregation and the creation of an ‘urban underclass’ that is denied access to opportunities. They also highlight the production of ‘riskscapes’.

4.3 Methods & Data

In order to answer the research questions, this section first develops a residential location model at municipality level for the study region with endogenous housing prices. We also develop separate models of residential mobility and dwelling type choice in the modelling framework. The section then describes household and municipality data sets, and the development of the planning scenarios. Finally, the section depicts the methods and measures used to analyse the predicted residential demand patterns: mapping, descriptive statistics, concentration and segregation indices.

4.3.1 Model of residential demand

In order to predict residential demand patterns for different planning and transport scenarios in the region, our model of residential demand has to fulfill three criteria: (i) it accurately represents residential location choice, (ii) it comprises significant variables that are appropriate to represent differences in planning policies (hereafter scenario variables), and (iii) it allows for the prediction of overall population distributions for the study area. We develop a modelling approach based on a sequence of models. It combines two binomial discrete choice models - decision to move and dwelling type choice -, a multinomial discrete choice model for the location choice, and a spatial autoregressive housing price model.

Discrete choice models are widely used to analyse and simulate residential choice behaviour in research or as part in wider urban modelling frameworks (de Palma et al., 2007b, Lee et al., 2010), notably due to the appealing utility-maximising principle to explain individual behaviour, their relative success to predict market shares and their ability to simultaneously test a large set of hypotheses (variables) (Frenkel et al., 2013). The output of these models, namely probabilities, elasticities and market shares, are easily interpretable and make them an appropriate tool for the analysis of policy scenarios. They can be derived from random utility theory. In this framework, an individual or household n chooses alternative i , who maximises his utility, from a set of mutually exclusive alternatives J . The level of utility provided by an alternative derives from a set of attributes that is unique to each alternative, and that is evaluated by

the decision-maker. Since attributes of the decision-maker do not vary across alternatives, differences in utility across decision-makers (systematic preference heterogeneity) can only be explained by evaluating attributes of the decision-maker relative to each alternative (interaction variables). As not all the information on attributes of the alternatives and of the decision-maker are known, a random error term is added to the utility function which accounts for unobserved attributes.¹⁴

We model residential demand using the standard discrete choice models for binomial and polytomous choice situations, the binomial logit and the conditional logit model (CL, also multinomial discrete choice model) (McFadden, 1978, Train, 2009). In these models, the random error term is assumed to be independently, identically distributed extreme value. The conditional logit model is one of the most popular empirical models of location choice (Schmidheiny and Brülhart, 2011), notably due to its closed form which eases computation. This implies, however, a strong hypothesis on the substitution patterns between alternatives. The independence of irrelevant alternatives (IIA) property holds that there is no unobserved correlation across alternatives.

In such models, a straightforward and consistent estimate of the number of decision-makers in the whole population N who choose alternative i , labeled \hat{N}_i , is sample enumeration (Train, 2009). It simply consists of calculating the weighted sum of the vector of choice probabilities across alternatives considering the weight of each decision-maker.

Modelling approach

Our modelling approach (see figure 4.2) starts with an overall household population at t_0 . All households of the sample enter the residential mobility model. The model predicts households' probability to move, which we use to generate a random sample of moving households (hereafter movers) and non-moving households (hereafter stayers). The movers data set then enters the dwelling type choice model. Again, we use probabilities to establish random samples of households choosing a house and those choosing a flat. In both prediction steps, we use a single random draw from a binomial distribution (based on the estimated probabilities from the binomial logit models) to generate one data set of stayers, movers, house and flat choosers for all scenarios. We create the scenarios by altering the data of our location choice alternatives (municipalities) according to changes expected in planning and transport policies and household behaviour.

In our model (see figure 4.2), the movers data set then enters an iterative prediction procedure in which location choices are predicted jointly with the housing price model. As de Palma et al. (2005) note, prices depend on the supply and demand for housing,

¹⁴See Train (2009) for a complete derivation.

and demand depends on price. The two models should, therefore, be estimated jointly to correct for bias due to price endogeneity. Demand also depends on endogenous changes in the socio-economic environment of a location (updated demand distribution) due to changes in price. We also consider, therefore, endogenous changes in the distribution of different household groups. We calculate aggregate demand for an alternative with sample enumeration (see above). An estimate of the number of households who choose a municipality is the weighted sum (average for market shares) of the households' choice probabilities for this municipality, each of them multiplied by the household's sampling weight.¹⁵

At the start of the iterative prediction procedure, the initial demand is predicted with observed housing prices at t_0 . The predicted initial demand then enters the housing price model, predicting new prices, which are again fed back to the location choice model, and so on. Besides the correction for endogeneity, the procedure allows households to react on changes in prices and the socio-economic environment. Convergence of the iterative procedure is achieved when the average difference in individual municipal housing prices between iteration t and iteration $t - 1 \approx 0$.¹⁶ The system converges usually after *ca.* a dozen iterations. Convergence is achieved when an equilibrium price is found. Finally, by adding the stayer population to the predicted demand of movers, we obtain an overall demand distribution for each scenario.¹⁷ By using this residential demand model, we implicitly assume that the following hypotheses hold:

- H.1. The sequence of models accurately represents the residential location choice process;
- H.2. Planning and transport policy scenarios do not affect the propensity to move of a household or the preferences to choose a house over a flat;
- H.3. The estimated location preferences in the location choice model are stable over time and across household groups;
- H.4. Weighted cumulated choice probabilities across municipalities reflect alternative residential demand patterns.

¹⁵Another possible approach is to simulate k location choices for each household based on the predicted probabilities, which would yield a statistical distribution of k residential demand patterns for each scenario (similar to the method in chapter 3). Due to the long computation time for simulation with the location choice - housing price interaction model, location choice simulations were not feasible.

¹⁶For computational tractability, this is achieved when the average difference in individual municipal housing prices between iteration t and iteration $t - 1 < 10$ cents.

¹⁷We model a closed city, i.e. no immigration and emigration takes place. Price changes do not influence on the mobility decision, thus not on stayer and mover populations.

Decision to move & dwelling type choice

Residential choice behaviour is also influenced by the conditions in different housing sub-markets and notably by the availability of different dwelling types. In addition to the mobility decision, we consider the decision for the dwelling type because housing supply for different dwelling types is not equal across municipalities. Similarly, the demand for housing services is not equally distributed across the household population. Households seeking to live in a house are less likely to choose municipalities with high flat shares, and vice versa. We therefore account for a simple differentiation of the housing good by assuming a choice between two types of dwellings, i.e. house or flat. We assume correlation between house and flat prices¹⁸, which allows us to keep our location choice model rather simplistic: we only need to model one general housing market (universal demand and supply) instead of different sub-markets with different demand and price models.¹⁹

Research examining residential mobility and dwelling type choice has used binomial discrete choice models derived from random utility theory (Bartel, 1979, Lee and Waddell, 2010, Rabe and Taylor, 2010, Tu and Goldfinch, 1996). In his dissertation, Homociano (2009) estimates binomial logit models to analyse residential mobility in the Lyon urban region, using the same French data source than we do here. In the random utility framework, the conditional probability that household n decides to move depends on his characteristics Z , location attributes X and an unknown error term ϵ . Using the logistic function as a specification for ϵ , the model specifies that the conditional probability of moving is given by

$$P_{ni} = \frac{e^{\beta Z_n X_i}}{1 + e^{\beta Z_n X_i}} \quad (4.1)$$

where β are parameters to be estimated. The models are estimated by maximum likelihood using the function

$$L = \prod_n \frac{e^{\beta Z_n}}{1 + e^{\beta Z_n}} \prod_m \frac{e^{\beta Z_m}}{1 + e^{\beta Z_m}} \quad (4.2)$$

where n refers to those who moved and m to those who stayed in their previous home.

¹⁸Pearson correlation coefficient is .77 for 165 observations (out of 224 municipalities, 59 municipalities have no data for apartment prices).

¹⁹It would be interesting to estimate residential demand and housing prices separately for different housing submarkets, including property, rental, public-rental markets with different types of dwellings. This would, however, by far exceed the scope and only slightly add to the objective of this paper.

Hypotheses & Model specification

According to the literature, our model specification integrates individual and locational characteristics that are suspected to influence a household's decision to move (dwelling type choice). We expect the young, the highly educated, those in high-level occupations, and private tenants to be the most mobile. Similarly, we expect older, higher income households and those choosing to own their home to be more likely to choose a house. We suppose that both decisions are also influenced by the former location of a household: households that lived in suburban or peri-urban areas before are less likely to move and are more likely to choose a house. Both binomial choice models have the same specification. Representative utility V_n of household n to move, is defined as

$$V_n = \beta'_1 SPC_n + \beta'_2 TEN_n + \beta'_3 AGE_n + \beta'_4 COMP_n + \beta'_5 TYPE_i, \quad (4.3)$$

where SPC_n is a vector of dummy variables describing a household's socio-professional category, TEN_n is a vector of dummy variables describing current housing tenure, AGE_n is a continuous variable describing age, $COMP_n$ is vector of dummy variables describing household composition, $TYPE_i$ is a dummy variable indicating the location of household n (urban centre, suburban or peri-urban areas) before his move, and $\beta'_{1...5}$ are vectors of parameters to be estimated. The model specification for choosing a house is accordingly.

Location choice model

In the CL model, the probability P_{ni} of household n to choose municipality i from the overall choice set J of mutually exclusive municipalities is

$$P_{ni} = \frac{e^{\beta' X_i Z_n}}{\sum_j e^{\beta' X_j Z_n}}, \quad (4.4)$$

where X and Z are vectors of attributes of household n and municipalities i and j , and β' is a vector of parameters to be estimated.

The IIA is a major drawback of the CL model (see above). For location choices, this assumption may be called into question since we can suspect correlation of the error terms across certain alternatives. Moreover, research on residential location choices has highlighted that households might follow a two-step procedure in the search process (Cahill, 1994), categorising location alternatives. We estimate a conditional logit model

(CL) and a nested logit model (NL) (McFadden, 1978, Train, 2009). Similar to Frenkel et al. (2013) in their studies of residential locations, we relax the IIA hypothesis and account for some unobserved similarities across municipalities by estimating the nested logit model. In the standard NL model, alternatives are grouped into K non-overlapping nests $N_1, N_2, \dots, N_k, \dots, N_K$ according to presumed similarities in unobserved factors, so that the IIA holds within nests but not across them (Train, 2009). By categorizing the alternatives, the IIA is partially relaxed. The probability of choosing alternative j , $y = j$, in nest N_k can be written as

$$P_{ni} = \frac{e^{(\beta' X_i Z_n / \lambda_k)} (\sum_{j \in N_k} e^{(\beta' X_j Z_n / \lambda_k)})^{\lambda_k - 1}}{\sum_{s=1}^S (\sum_{j \in N_s} e^{(\beta' X_j Z_n / \lambda_s)})^{\lambda_s}}, \quad (4.5)$$

where X and Z are vectors of attributes for household n and municipalities i and j , N_k and N_s are nests, λ_k and λ_s are measures of the degree of independence in unobserved utility among the municipalities in nests N_k and N_s (termed inclusive values or dissimilarity parameters) and β' is a vector of parameters to be estimated.

Price endogeneity, i.e. the correlation of housing prices with unobserved attributes entering the error term, can be a severe issue in location choice modeling because it may create biased estimates (Guevara and Ben-Akiva, 2006). In order to control for price endogeneity, we use the two-step-control function (2SCF) method which basically consists in introducing the residuals of a simple housing price regression in the location choice model. The housing price regression uses all location characteristics from the location choice model as explanatory variables, plus an instrumental variable. Guevara and Ben-Akiva (2006) use house prices in proximity as an instrument. Here, we use the spatially lagged price of housing in each location, which we calculate with a 5 nearest neighbours weights matrix (Anselin, 2005, Anselin and Bera, 1998, Anselin et al., 2006). As the error term from the control function is not correlated with price, it should capture that part of the error term of the location choice model which is correlated with price.

Hypotheses & model specification

The model integrates variables that are suspected, with regard to theoretical and empirical findings, to influence residential location choice behaviour. We make the following hypotheses:

- H.1. Our main hypothesis is that natural amenities, varying significantly across municipalities and their inhabited areas, has a significant impact on household location choices. Since households value these features differently, we expect differentiated

effects of amenity features across households according to household age, size and income.

- H.2. We further suppose differentiated effects from accessibility variables on location choices, notably by household age, size and income. We expect younger, smaller and poorer households to settle closer to the CBD, whereas older, larger and richer households move farther away.
- H.3. We suppose that high housing prices in a municipality have a negative impact on location choices in general. Richer households, however, may have less constraints to move into these areas than poorer households.
- H.4. We suppose that local attachment and migration distance constrains intermunicipal mobility. We expect negative impact of migration cost on household location choice, and conversely, a positive impact of location attachment. Moreover, younger and richer households are supposed to be less sensitive to migration costs and location attachment.
- H.5. We suppose that housing offer, structure and quality, to have differentiated effects on households location choices. Housing consumption is supposed to rise with age, income and household size, and households might in general avoid deprived neighbourhoods.

The representative utility V_{ni} of household n to choose municipality i is a function of municipality characteristics interacted with household attributes:

$$V_{ni} = \beta'_{1k} SC_i + \beta'_{2k} ACC_i Z_{nk} + \beta'_{3k} Pr_i Z_{nk} + \beta'_{4k} MIG_i Z_{nk} + \beta'_{5k} HOU_i Z_{nk} + \beta'_{6k} SOC_i Z_{nk} + \beta'_{7k} URB_i Z_{nk} + \beta'_{8k} AMEN_i Z_{nk}, \quad (4.6)$$

where SC_i is a vector of scaling variables that whose coefficient combines preferences, fitting considerations and correcting factor for municipality size effects (de Palma et al., 2007b), ACC_i is a vector of variables describing accessibility and public transport provision in a municipality, Pr_i is a vector of average housing prices, MIG_i is a vector of variables describing migration costs and attachment to a location, HOU_i is a vector of variables describing housing supply and dynamics, SOC_i is a vector of variables describing socio-demographic composition, URB_i and $AMEN_i$ are vectors of variables

capturing urban and natural (dis)amenities, Z_{nk} is a vector of household attributes²⁰ of length k , and $\beta'_{1k\dots 8k}$ are vectors of parameters to be estimated.

Housing price model

The price of housing is a major determinant in residential location choices since it capitalizes location factors, also natural amenities. It thus enters the household's utility function. We model housing prices using a spatial hedonic regression model, which accounts for the spatial nature of the data (Won Kim et al., 2003). The theoretical framework of hedonic prices holds that housing, as a heterogeneous good, can be differentiated into a bundle of dwelling attributes H and location attributes X (Rosen, 1974). Whereas dwelling attributes relate to the residential structure, location attributes relate to accessibility, neighbourhood attributes, urban form, public service provision and other urban and natural amenities (Can, 1992, Cavailhès et al., 2009, Gaschet and Pouyanne, 2011, Waltert and Schlöpfer, 2010). It is not the dwelling itself that makes up its value, but its different attributes and its relative location. The hedonic price function creates a functional relationship between observed housing prices, Pr , and a vector of characteristics of the residential unit $H = (h_1, h_2, \dots, h_k)$ and its location attributes $X = (x_1, x_2, \dots, x_l)$ (Can, 1992). The price of any attribute in k and l is called its equilibrium marginal (implicit) price.

In the housing market, prices also depend on supply and demand (de Palma et al., 2005). In market equilibrium, prices ensure market-clearing. Changes in prices will change location preferences and aggregate demand for residential areas (Waddell et al., 2003). Conversely, housing prices result from the interaction between residential demand and housing supply at a location, i.e. changes in demand or supply imply the adjustment of housing prices. Since we model choice on aggregate municipality level, our hedonic housing price model leaves out dwelling-specific attributes H . The hedonic price model is thus given by

$$Pr_i = \beta'_1 S_i + \beta'_2 D_i + \beta'_3 X_i + \epsilon_i \quad (4.7)$$

where Pr_i is the observed housing price at location i , S_i and D_i are aggregated supply and demand, X_i is a vector of location-specific attributes, $\beta'_{1\dots 3}$ are parameters to be estimated and ϵ_i is an error term that is identically and independently distributed (iid, with mean zero and variance σ^2) across observations.

²⁰For readability, we do not detail the different dimensions of this vector here, such as socio-professional category, age, household composition and nationality.

A problem that arises from analysing spatial data such as housing prices is spatial autocorrelation. Dubin (1998, p. 304) states that “[i]f the location of a house influences its price, then the possibility arises that nearby houses will be affected by the same location factors”. If the researcher does not incorporate these effects, regression error terms will be correlated, resulting in inefficient ordinary least-squares (OLS) estimators and biased variance of the estimators. Correcting for spatial autocorrelation may increase precision of the estimates, reliability of hypothesis testing, and can make predictions more accurate (Dubin, 1998). Different specifications exist to include spatial effects in a regression model, among which the spatial lag and the spatial error specifications are the most popular (Anselin and Lozano-Gracia, 2008). The spatial lag model, also called the spatial autoregressive model, assumes that “nearby or neighbouring observations of housing prices partially explain local housing price” (Won Kim et al., 2003, pp. 29), and more specifically, that the “spatially weighted average of housing prices in a neighborhood affects the price of each house (indirect effects) in addition to the standard explanatory variables of housing and neighborhood characteristics (direct effects)” (Won Kim et al., 2003, pp. 29). The spatial lag model is particularly appropriate to model structural spatial interaction in the market and precisely measure neighbourhood effects. We thus opt for the use of a spatial lag model given by

$$\log Pr_i = \rho W \log(P_j) + \beta'_1 S_i + \beta'_2 D_i + \beta'_3 X_i + \epsilon_i \quad (4.8)$$

where ρ is a spatial autocorrelation parameter, W is a $N \times N$ spatial weight matrix (where N is the number of observations), Pr_j is a vector of housing prices in j neighbouring zones, and the other notation is as above. Since, as the name states, the spatial autoregressive model introduces endogeneity through the spatial lag term, estimators obtained with OLS for the lag specification are biased and inconsistent (Won Kim et al., 2003). We use maximum-likelihood estimation instead.

Model specification

The model integrates variables that are suspected, with regard to empirical findings, to influence housing prices. We consider specifically supply (suspected negative effect), demand (positive effect), accessibility (positive effect), service supply (positive effect), social composition (positive effect from the presence of richer households), housing dynamics (positive effect), urban and natural amenities (positive effects). The average housing price P_i in municipality i is a function of the following municipality attributes:

$$Pr_i = \rho W \log(P_j) + \beta'_1 S_i + \beta'_2 D_i + \beta'_3 ACC_i + \beta'_4 SERV_i + \beta'_5 SOC_i + \beta'_6 HOU_i + \beta'_7 URB_i + \beta'_8 AMEN_i + \epsilon_i, \quad (4.9)$$

where S_i and D_i are aggregated housing supply and demand, ACC_i is a vector of variables describing accessibility, $SERV_i$ is a vector of variables describing level of service supply, SOC_i is a vector of variables describing socio-demographic composition, HOU_i is a vector of variables describing housing dynamics, URB_i and $AMEN_i$ are vectors of variables capturing urban and natural (dis)amenities, $\beta'_{1...8}$ are parameters to be estimated and ϵ_n is a vector of error terms.

4.3.2 Study area & data

Grenoble urban region is situated in the dynamic *Sillon alpin*²¹, 100 km south-east of Lyon. With 330,000 jobs the urban region is the second most important employment zone in the Rhône-Alpes-Auvergne region. It is a major hub of research and micro- and nanotechnologies (Sanderson, 2011), and frequently advertised as the French Silicon Valley due to the politically promoted and long-standing alliance between university, research and industry (Fioraso, 2014, Munford, 2013). Population in the region grew by 13 % in the period from 1990 to 2009 (+ 90,000 inhabitants), employment by over 21 %. Over the last decade, population grew moderately mainly due to natural growth. Planners expect that continuous growth over the next 15 to 20 years will add another 100,000 inhabitants to the region (EP SCoT RUG, 2013).

According to the classification of INSEE, Grenoble functional urban area comprises 196 municipalities (see figure 4.3). The perimeter of the SCoT territorial cohesion scheme stretches significantly beyond this delimitation, covering 273 municipalities. For our scenario approach, we adjusted the functional area of Grenoble to better fit the planning perimeter of the territorial cohesion scheme. INSEE's Functional urban area (FUA) approach defines functional interdependence for a municipality based on a threshold share of commuters among the active population who travel for work to the urban centre. We decreased this threshold from 40 % to 30 %.²² Figure 4.3 shows the INSEE

²¹Consecutive valleys from Geneva over Annecy, Chambéry and Grenoble to Valence in the Rhône valley

²²We created an algorithm that allows us to generate functional urban areas dependent on commuter thresholds. Mihai Tivadar helped with the coding. The R-scripts are available from the author upon request.

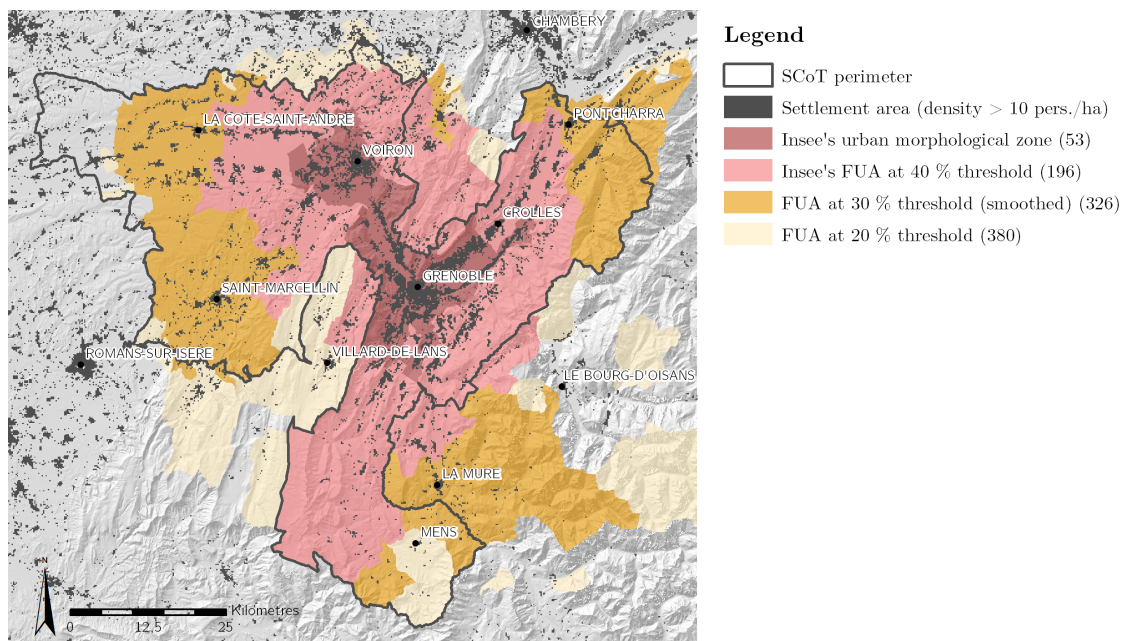


Figure 4.3 – Grenoble: Functional urban area delimitation

Source: own illustration based on Insee (RP08, MOBPRO 2010, ZAU 2010, population carroyée 2013) and DREAL Rhone-Alpes. Geographical boundaries: IGN BDcarto 2008

perimeter of the FUA and our extension to 326 municipalities in orange.²³ Our final study area comprises 326 municipalities situated in three different administrative departments: Isère, Savoy and Drôme. Overall population is around 770,000 inhabitants (ca. 330,000 households) in an area of 4,300 km².

The final perimeter better corresponds to the SCoT territorial cohesion scheme perimeter. Some zones of the SCoT are, however, still lacking; others again are comprised, which are not in the planning perimeter. This indicates a discrepancy between observed territorial interdependence and political decision-making on local and intermediate levels.

²³Figure 4.3 also shows that a further extension with a commuter threshold of 20 % would exceed the planning perimeter significantly. Differences between our approach and INSEE's arise for different reasons: we use a more recent commuter dataset (2010), we do not take into account multipolarized municipalities and the INSEE version has been smoothed for esthetic reasons. The outcome list of municipalities belonging to our 30 % threshold version has been altered manually in a GIS in order to account for spatial proximity (fill gaps), to smooth the perimeter and to remove spatial outliers (islands). The following municipalities were removed from the area: Monestier d'Ambel (*département* 38), Clavans-en-Haut-Oisans (38). The following municipalities were added to the perimeter: Les Echelles (73) and Chamrousse (38). By changing the threshold to 30 %, we increased the functional area by ca. 1,800 km², 100,000 inhabitants, 43,000 households and 33,000 jobs.

The urban region consists of Grenoble agglomeration²⁴ (hereafter also *La Métro*) and its peri-urban commutershed. The region is highly mono-centric: Grenoble municipality accounts for one fourth of the overall population and employment in the region. The agglomeration (city + its suburbs), composed of 53 municipalities, accounts for $\frac{2}{3}$ of the inhabitants and 75 % of all jobs. The peri-urban commutershed, covering 80 % of the region's area (2,645 km²), comprises a great variety of rural and mountainous territories. Average density in the agglomeration municipalities (1,000 persons/km²) is five times higher than in the peri-urban areas (around 180 persons/km²). The region is characterized by a y-shaped valley configuration and its three surrounding mountain ranges, with peaks up to 2,900 meters: Chartreuse to the North, Vercors to the South and Belledonne to the East. One fourth of the FUA municipalities entirely comprised in two Regional nature parks (PNRs), Chartreuse and Vercors.

Over the last four decades, sub- and peri-urbanization processes of both population and employment have been remarkable. Since 1968, the whole region grew by over 40 % in population, peri-urban areas (threshold 40 %) almost doubled their population (+95 %). From 1999 to 2009, periurban area were more than four times more dynamic than the urban centre (7 % per cent to 28 %). In this process, intra-regional migration plays a key role: the migration balance alone caused a population growth of 18 % in peri-urban areas in the same period. Against this, the city centre and suburban areas loose population due to migration. During this period, employment grew by 18 % in the urban centre and 27 % in periurban areas.

From another perspective, social segregation on municipality level is remarkable in the region. Figure 4.4 shows a significant spatial concentration of executive households - the highest income group - in central locations and Alpine foothills. The two upper quartiles of executives (> 12 % and > 20 %) can be found in proximity to Grenoble, to Voiron and Crolles (both secondary centres), along motorways and in accessible foothills of Belledonne, Chartreuse and Vercors ranges. By contrast, blue-collar worker households - among the lowest income groups - concentrate in suburbs and in peri-urban areas farther away from the centre, especially in the eastern territories in the plain. These are territories under less urban influence, traditional industrial locations in areas at significant distance from the primary urban centres. Both, maps and observed segregation indices (see section 4.3.4 and table 4.12 in the results section), draw a picture of a significantly unequal distribution of households with regard to socio-professional categories and life-cycle status in the region, indicating residential segregation.

²⁴Its politico-administrative perimeter is called *communauté d'agglomération de Grenoble*, or *Grenoble-Alpes Métropole*.

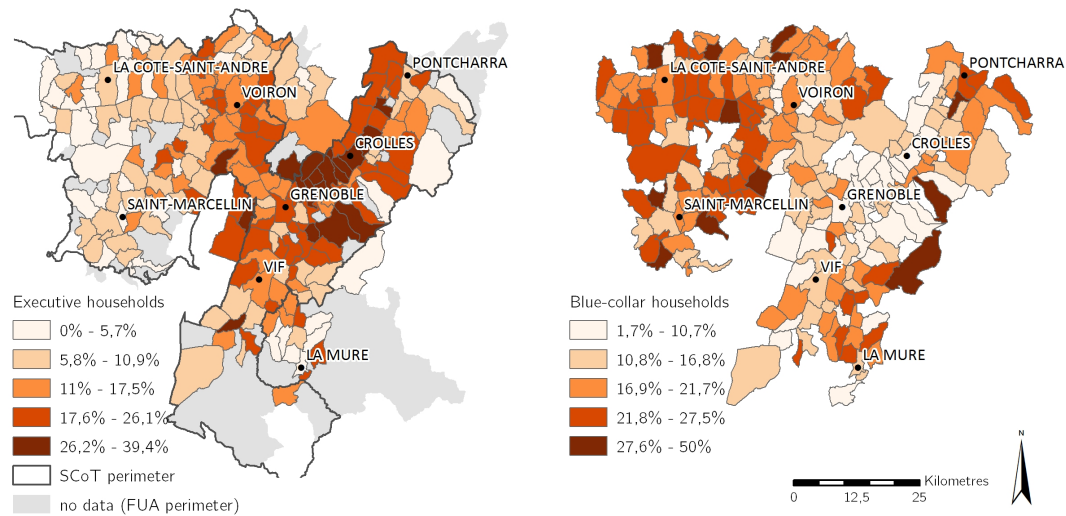


Figure 4.4 – Household distribution of executives and blue-collar workers

Source: own illustration based on Insee's 2008 population census. Geographical boundaries: IGN BD-carto 2008

Household migration data

The study is based on individual migration data from the French 2008 population census (Insee, 2008), with data collected between 2006 and 2010.²⁵ The data describe households with regard to their residence municipality, their residence municipality five years beforehand and characteristics relating to demography, professional status, education and housing. Each household has a sampling weight which has to be used to calculate aggregate population and group sizes (sample enumeration). For estimation of the residential choice model, a subset of households was selected that declared to have changed residence in the last five years²⁶, i.e. households that moved within the boundaries of a municipality and beyond. 69.8 % of those households stayed in the same municipality.

²⁵Since 2006, the census is based on annual surveys which achieve full territorial coverage within five years. Every year, a comprehensive survey of all inhabitants is carried out for 20 % of small municipalities (<10,000 inhabitants) and for a representative sample of 8 % for large municipalities (>10,000). After five years all small municipalities have undergone a comprehensive survey, as well as 40 % of the population of large municipalities. Survey results are presented with regard to a primary and a complementary analysis: primary results use data from all questionnaires, complementary evaluation results stem from 25 % of questionnaires of small municipalities and all questionnaires of large municipalities. The latter give more precise information on households such as on occupational status, economic sectors, and household structure. Due to sampling in the census procedure, the data set contains sampling weights for each individual.

²⁶The lack of a survey date for each household in the data set makes it impossible to derive the year in which the household actually moved.

Boehm et al. (1991) find that a separation of intra-urban moves and interregional migrations for the purpose of estimation increases model precision. Households that already lived in the area (internal movers) have better knowledge on the local housing market, on location and housing opportunities and their quality. They are more likely to be able to adjust their utility to their housing needs and neighbourhood preferences. We thus consider all moves that took place within the Grenoble urban region and additionally incoming moves within a distance of 25 km to account for nearby incoming movers.²⁷ Our final dataset comprises 84,995 households, which have moved within the Grenoble urban region over the period from 2001 to 2010.

Table 4.1 shows aggregate internal migration flows for our household data set according to FUA categories. The migratory balance shows that Grenoble municipality and its suburbs have lost 2,800 households in favour of the peri-urban areas. The majority of households that move tend to stay in their prior FUA category; fewer moves take place between those categories. Moving households in suburban and peri-urban locations are more likely to stay in those categories, whereas 40 % of moving households in Grenoble leave the centre municipality. Households that moved out of Grenoble relocate to a higher degree in the suburbs (29 %), fewer move to peri-urban areas (11 %). Households that moved from the suburbs relocated to a similar extent in the centre or in peri-urban areas. Of those households which move in the peri-urban areas, 72 % stay in the peri-urban zone, 17 % move to the suburbs and less than 10 % move to the centre municipality.

Table 4.1 – Aggregate internal migration flows: functional urban area categories

Origins	Destinations (%)			Outgoing	Balance
	Grenoble	Suburbs	Peri-urban		
Grenoble	59.56	29.06	11.38	23,246	-1,289
Suburbs	15.23	67.06	17.71	37,953	-1,562
Peri-urban	9.79	17.59	72.62	23,796	2,851
Incoming	21,957	36,391	26,647	84,995	

Household attributes

The three main household attributes for which we assume that they influence residential behaviour are age, household structure and social status since these are proxies for life-

²⁷We furthermore excluded moves to special housing categories (free housing, retiree homes, informal dwellings, hotel rooms). Other motivations (non-observables) might play a key role in these situations, and their relatively small share makes them negligible for our study.

cycle stage, education and income. For individual characteristics such as age and socio-professional category, we use data of the household head. With regard to age, we either use a continuous variable or three dummy variables that relate to household structure. Young singles are households younger than 30 and living alone, and old households are households aged 55 or more²⁸ that have no more than two members. For convenience, we term the remaining households ‘middle-aged’ households. In addition, we specifically consider a couple with children dummy since this is a major household category in our dataset (35 % of households).

Social status of the household head relates to education and income of the household. We use data on socio-professional categories as defined by the French population census.²⁹ We only consider certain categories which reflect the wealthiest income group, executives, and a variety of lower income groups (than average). These groups are often used to investigate socio-spatial segregation and are supposed to have systematically varying residential behaviour (Goffette-Nagot and Schaeffer, 2013, Schwabe, 2011): white-collar workers (more central locations, services), blue-collar workers (close to long-standing and recent locations of industrial production) and non-actives (central locations, poorer municipalities). We also account for a sorting mechanism of foreign households and residential self-selection into municipalities based on preferences for transport mode (Mokhtarian and Cao, 2008, Wee, 2009). For this, we use a dummy variable to indicate foreign households as well as a dummy to indicate if a household head usually chooses public transport for commuting.³⁰

Finally, the data also provides information on former and current residential location on municipality level for each household. Using network algorithms and road network data, we calculated the migration distances in minutes between municipality centres (without congestion). This variable can be understood as a proxy for tangible as well as intangible migration costs, i.e. monetary costs as well as local attachment, school enrolment of children and local social networks that create spatial inertia (Caldera Sánchez

²⁸We set the threshold to 55 years in order to capture residential behaviour of a larger part of older households, including e.g. empty-nesters, silver-agers and younger retirees.

²⁹The 2012 mean annual income in France was 20,100 €. In terms of socio-professional category, this level is similar to the annual income of persons in intermediate professions (22,500 €). Executives have by far the highest annual income (ca. 40,000 €), whereas blue-collar and white-collar workers range significantly below the mean annual income, with 14,900 € and 13,600 €, respectively (Institut National de la statistique et des études économiques (INSEE), 2014, p. 57).

³⁰In reality, the relationship between transport behaviour and residential location choice is much more complex. There are more variables influencing transport mode choice than only individual preferences, e.g. income. The analysis of travel mode choice goes beyond the scope of this paper. See e.g. Mokhtarian and Cao (2008) for more information on this topic. Here, we use a simple means to control for such self-selection, being aware that the coefficient of the self-selection variable is potentially biased.

and Andrews, 2011). Moreover, since information on workplaces is not available in our dataset, migration distances might also capture effects of access to work. Table 4.2 shows the different shares of household types in our sample.

Table 4.2 – Household attributes & group shares

Variable	Categories (%)				
Socio-prof. status	Executives 18.87	Blue-collars 21.64	White-collars 15.67	Non-actives 5.31	Others 38.51
Nationality	French 93.70	Foreigner 6.30			
Age	Young 10.62	Middle 76.83	Old 12.55		
Couple with children	Yes 35.01	No 64.99			
Public transport	Yes 9.55	No 90.45			
FUA location	Grenoble 27.44	Suburbs 45.32	Peri-urban 27.23		
N					84,995
Migration distance (min)				Mean 4.85	Std. dev. 10.43

Notes:

The alternatives: municipality attributes

In our model, since dwelling unit choice is not observed in the migration data set, households choose their preferable location from a choice set composed of all municipalities of the Grenoble urban region. We can split the explanatory variables, altogether municipality attributes, into ‘classic’ location factors and (natural) amenity variables.

Accessibility and transport provision are major location factors in residential behavior. They determine the constraints a household faces at a location in carrying out desired activities, such as working, living, shopping or visiting relatives and friends, in different places (Wee, 2009). Similarly and since dwellings are a completely immobile commodity, research in housing economics sees housing prices overwhelmingly determined by location and thus to access. Regarding access to work, our household data set does not provide information on an individual’s work place. We consider three travel time variables (no traffic) to capture effects of employment access, calculated between municipality centres using Geographical information system (GIS) and road network

data³¹:

- (a) travel time to Grenoble municipality,
- (b) travel time to the closest urban centre excluding Grenoble (Chambéry, Lyon, Saint-Marcellin, Voiron), and
- (c) travel time to the closest employment sub-centre excluding the municipalities of Grenoble agglomeration.

By using the travel time to the Central business district (CBD) variable we assume a mono-centric configuration of the region³², i.e. any municipality is a feasible residential location, implying a commute to the CBD. Research generally presumes that, for shorter residential moves within a labour market area, the residential location can be chosen without reference to the work place (if commuting time is not too long). Dieleman (2001, p. 254) calls these moves partial displacement moves, as the household changes residence but not job. The same variable also captures distance effects to central city and urban amenities such as public and health services, shopping possibilities and specifically cultural and urban amenities in the old town centre (Brueckner et al., 1999) and disamenities such as crime, air pollution and noise.³³

With reference to the work of Coffey and Shearmur (2001), we identify employment sub-centres as municipalities that have at least 1,000 jobs, a job/active population ratio of at least 0.9 and are situated at > 15 minutes from Grenoble. Other research uses contiguity of employment density to identify larger sub-centres (notably > 5,000 jobs) composed of multiple territorial units (see e.g. Gaschet and Pouyanne (2011)). Since primary employment centres are identified using the *Zonage en aires urbaines* (French functional area classification) (ZAU) classification, we aimed especially at identifying smaller peri-urban centres, which rarely stretch over various units.

Other important location factors are access to non-daily services for the population and access to public transport. Access to services is proxied by a travel time variable to intermediate service centres, using the centres identified in INSEE's 2003 study on

³¹The ArcGIS network analyst extension enables the user to build a network data set based on road network data and to compute distance matrices with the help of a multiple-origin, multiple-destination algorithm that is based on Dijkstra's algorithm. The latter solves a shortest-path problem on an undirected, non-negative weighted graph.

³²The descriptive statistics on the study region above show that such an assumption is valid. In addition, preliminary analyses of job access using several distance and gravity-based measures and identifying sub-centres showed high levels of correlation among variables and highlighted the predominance of the travel time to the centre variable.

³³The municipality scale hindered the use of more detailed, location-specific data.

bassins de vie (service areas). For public transport, we use a simple dummy indicating whether a municipality has at least a railway or a tramway station (the 2000 bus network is considered negligible).

Average housing prices (€/m²) are obtained from flat and house sales data, only available for the period 2006 to 2012. Data comes from the database of individual transactions by French notaries³⁴. A single housing price was averaged on municipality level from both house and flat sales. We weighted house and flat prices by the fractions of houses and flat in the municipality. In order to compromise maximum size of the overall municipality choice set and the validity of the average price, we set the minimum transaction number to six for each municipality, resulting in average real estate prices for 224 municipalities (reducing by 30 % the municipalities in our data set. See section 4.5 for correlations between average house and flat prices).

Since we use 2006-2012 price data, we introduce simultaneity bias in our location choice model, i.e. bias is due to possible effects of location decisions on housing prices. However, price data is mainly used as a control and not as a variable of direct interest. Prices have generally increased throughout the 2000s for the Isère department, with a recent shock linked to the real estate market crises. The 2006 to 2012 price data reflects price development, but we assume that weighting and averaging across transactions and house/apartment data attenuates simultaneity bias. For convenience, we make the assumption that price variations across municipalities have been stable over the last decade.

Housing supply is described by the total number of primary residences. Individual dwelling unit attributes and especially quality remain unobserved in our model. Some housing characteristics, such as size and type of housing, can yet be averaged at municipality level. Although such variables cannot directly capture preferences for individual dwelling attributes, they are able to capture preferences for built environment, type and quality of neighbourhood. In order to capture household preferences for dwelling size, we use the average number of rooms which is highly correlated with the share of individual houses (Pearson's $r = .86$). We further use the share of social housing to consider different effects of preferences for the presence of this type of housing and tenure. Social housing in France is primarily located in urban areas, and there are huge discrepancies in the intra-urban location of the stock: 90 % of social housing is concentrated in only 6 % of municipalities (Lévy-Vroelant et al., 2014). In the Grenoble region, high shares of social housing are concentrated in peripheral locations of the centre municipality, and in traditionally industrial suburbs, predominantly left-wing oriented municipalities

³⁴Perval society; the data covers 85 % of real estate sales in France

(Martin, 1997). High-income, mountain and rural municipalities have significantly lower shares. Besides capturing direct preferences for social housing, the variable is related to several other factors that influence residential location choice: high built densities (greater number of flats per building in social housing), the presence of *Zones urbaines sensibles* (ZUS, deprived neighbourhoods with specific policies) in which on average 60 % of households are social tenants, and a social orientation in local politics, all of which might systematically attract or repel certain population groups (e.g. foreign immigrants, see Barrett et al. (2013)).

A last variable relating to housing supply is construction. A measure of construction can capture effects of housing market dynamics and local planning regulations on location choices. For instance, research on residential mobility has shown that a more responsive housing supply is associated with higher levels of residential mobility, with greater effects on the mobility of younger households (Caldera Sánchez and Andrews, 2011). Moreover, differences in the responsiveness of housing supply reflect local policies which regulate, more or less restrictively, land use. Here, we use the total number of dwellings constructed per year and per 1,000 inhabitants from 1990 to 2000 as a proxy for construction. The only direct planning variable in our model, it is similarly used in the SCoT to set out construction objectives for the next decade.

Social interaction and residential location studies have shown that location choices are affected by neighbourhood composition (Bhat and Guo, 2004, de Palma et al., 2007a, Ioannides and Zanella, 2008). We account for neighbourhood composition by calculating simple shares of the above-mentioned household types: executives, blue- and white-collar workers, non-actives, young, old, foreign households and households with children. There are also effects of local employment on prices (Osland and Thorsen, 2008) and on location choices: we calculate employment growth for each municipality as the number of jobs created or lost per 1,000 inhabitants for the period 1990-1999.

Last, economic and planning research has recognized the effects of natural and urban (dis)amenities on both location decisions and housing prices. The problem with environmental amenities concerns measurement errors, especially when dealing with data on municipal level. For instance, a household considers the presence of open space in the surrounding of a dwelling an amenity, i.e. his marginal valuation of open space is high, only if it is located nearby and if open space is scarce in the area. In this case, the presence of open space is capitalized into housing prices, as shown for different natural amenities in various hedonic studies (Baranzini and Schaerer, 2011, Geoghegan et al., 1997, Nilsson, 2014). Since such research shows that households care very much about the landscape around them, we calculated amenity variables for the surroundings of res-

idential areas of a municipality using INSEE's 2013 *données carroyées sur la population* (population raster data). Settlement areas are in general significantly smaller compared to the overall municipal area, especially for mountain municipalities. Other amenities, such as air quality and climate, may only slightly vary across territories (Earnhart, 2002, Graves et al., 1988). Grenoble urban region, however, shows particular variations in environmental amenities in terms of altitude, terrain morphology, exposition, view sheds, land use and land cover.

To account for effects of the mountain environment, we consider altitude an important location factor for households in the region. It is proxied by the average elevation of the settlement area. Local climate, temperature and land use are strongly dependent on altitude in the Alps and mountain areas in general (Baetzing, 2003). Altitude has shaped seasonal activity and residential patterns for centuries, and still is a major transportation constraint and determinant of settlement limits (due to climate and especially snow conditions). Considered a negative location factor in the past, elevation is today considered as a variable that contributes to quality of life of certain population groups: significant reductions of temperature in summer months, of air pollution linked to human activity in summer (transport, industry) and notably in winter months (added effects from heating and temperature inversion) (Glorioso, 2006). Constraints arising from altitude, such as long commutes, snowfall, harsh climate and lack of comfort have been weakened in the last decades due to advances in transport, housing and communications technologies (Moss and Glorioso, 2012). The last decades have seen a *résidentialisation* (Comité du Massif des Alpes, 2013) of peri-urban mountain territories in the Alps (Perlik, 2006), especially by wealthier population groups (Perlik, 2011). An maximum altitude for permanent settlement remains, however, and local stakeholders assume that the optimal altitude for residence may potentially lie between 600 and 900 metres a.s.l. (Interview PNR Chartreuse employee 2012).

In addition to these tangible attributes of elevation, research on amenity migration and local experts suggest less tangible - subjective and sometimes even spiritual - factors that might attract households to elevated locations: households are in search of a tranquil environment to raise children (Interview PNR Chartreuse employee 2012), a mountain idyll and lifestyle and being closer to an authentic mountain culture (Moss, 2006). This is consistent with a vast amount of findings in sociological, rural and happiness studies that households seek rural and natural residential environments and these environments improve their subjective well-being (Brereton et al., 2008, MacKerron and Mourato, 2013, Van Dam et al., 2002). Moreover, there might be a feeling of superiority and domination linked to a location above the urbanized valley, especially on the steep

Table 4.3 – Municipality attributes

Statistic	N	Mean	St. Dev.	Min	Max
# primary residences ^a	224	1,252.9	5,258.2	58	75,227
# houses ^a	224	495.0	482.8	53.0	2,640.0
# flats ^a	224	757.9	5,025.3	0.000	72,587.0
Travel time to Grenoble (min) ^{b,c,d}	224	31.8	14.7	0.0	64.8
Housing price (average, in €) ^e	224	1,986.6	542.8	893.1	3,628.2
% executive hh ^a	224	10.6	7.7	0.0	34.6
% blue-collar hh ^a	224	20.6	6.7	2.5	35.4
% white-collar hh ^a	224	7.3	3.7	0.0	27.5
% non-active hh ^a	224	5.5	3.2	0.0	22.8
% young hh ^a	224	6.1	3.7	0.8	27.8
% old hh ^a	224	32.6	6.4	12.1	45.1
% foreign hh ^a	224	3.1	2.5	0.0	13.3
% couple with children ^a	224	42.5	7.4	19.0	60.6
Job growth ^a	224	10.5	88.9	−349.7	454.8
Housing construction ^f	224	5.6	3.2	0.4	19.0
# of rooms (average) ^a	224	4.4	0.4	3.0	5.0
% social housing ^a	224	0.1	0.1	0.0	0.4
Infrastructure (ha,surrounding) ^{g,h}	224	53.4	121.4	0	965
Travel time to service centre (min) ^{b,c,d,i}	224	7.7	4.8	0.0	20.9
Travel time to other urban centre (min) ^{b,c,d,j}	224	27.9	14.8	0.0	68.9
Travel time to sub-centres (min) ^{a,b,c,d}	224	13.8	10.2	0.0	55.2
Public transport ^k	224	0.1	0.3	0	1
% recreational area (surrounding) ^{g,h}	224	0.4	1.1	0.01	7.4
Altitude (m) ^{d,h}	224	480.1	236.4	211.5	1,226.6
Sun exposure ^{d,h}	224	2,865.6	181.4	2,288.0	3,256.4
Viewshed (ha) ^{c,d}	224	9,160.6	7,468.8	208.8	38,002.8
% forest area (surrounding) ^{g,h}	224	36.2	18.9	0.01	87.1
% nature area (surrounding) ^{g,h}	224	2.1	4.5	0.01	28.9
% water area (surrounding) ^{g,h}	224	1.7	2.9	0.01	17.9
Household demand ^a	224	294.3	1,254.9	7.9	17,863.5
Housing supply ^a	224	294.3	1,308.3	3.9	18,613.6

Sources: own data compilation and calculations with ArcGIS 10.1, R 3.2 (R Core Team, 2013) and PostgreSQL 9.3/PostGIS 1.5, based on: ^aINSEE 1999 population census, ^bIGN Route500, ^cIGN GéoFla 2009 (centroids), ^dCopernicus data and information funded by the European Union - EU-DEM layers, ^ePERVAL (aggregated data provided by Grenoble urban planning agency AURG), ^fSITADEL2, ^gEEA 2000 Corine land cover data, ^hINSEE 2013 population raster data, ⁱINSEE 2003 service areas, ^jINSEE 2000 functional urban areas, ^kOwn data entry.

foothills with views on the agglomeration (Interview PNR Chartreuse employee 2012). We assume that different population groups value these aspects of altitude differently.

A second feature of mountain environments are varying exposition and sun exposure for different locations, linked to the local morphology and the ruggedness of terrain. Research in environmental psychology shows that people generally prefer sunny and bright environments (Beute and de Kort, 2013). The study area provides diverse locations with regard to exposition and sun exposure. Sun exposure is proxied by solar radiation, calculated for the settlement area using GIS³⁵ and a high resolution Digital elevation model (DEM) and then averaged on municipality level. Third, views from home are a location attribute that is valued by households, shown e.g. in hedonic price studies (Baranzini and Schaerer, 2011, Cavailhès et al., 2009). Viewshed size and composition might also play a role in residential location choice decisions. We calculated viewshed size and composition using GIS³⁶, the DEM and CORINE land cover data.

A dummy variable indicates whether a municipality is located within the perimeter of a PNR. The PNR variable is a proxy for effects from (i) local strategies that valorise environmental quality and amenities e.g. tourism, (ii) the political will to preserve natural and the built environment and (iii) for specific park services that address tourists and residents, e.g. environmental education activities (Cremer-Schulte and Dissart, 2013). Last, amenity studies frequently proxy open space with specific land use and land cover categories. For instance, urban economic theory suggests that in peri-urban areas, agriculture produces amenities (cultural landscape preservation, forestry) which are valued by households (Cavailhès et al., 2004). Research highlights three possibilities for constructing open space variables (Magliocca et al., 2012): (i) dummy variables for presence/absence in a specific range around the house, (ii) distance from home to open space or (iii) surface area of different types of land use in a specified buffer zone. Here, we calculated shares of specific categories within a buffer zone of 1 km around the municipality's settlement area. Applying such a buffer limits the effect of land cover amenities to those accessible from the settlement area. A vast amount of additional structural and amenity variables has been calculated but rejected from this presentation due to collinearity issues (e.g. pollution data, topographic variation, urban density, equitability indices of land cover, see section 4.5).

³⁵ ArcGIS solar radiation tool, spatial analyst (toolbox).

³⁶ ArcGIS viewshed tool, spatial analyst (toolbox).

4.3.3 Planning scenarios: method & variables

In the scenario analysis, we compare the effects of different planning scenarios on residential demand distribution. More specifically, we are interested in the effects of the SCoT planning policy versus (vs.) continued planning trends, and vs. effects of more radical planning policies. The approach is inspired by counterfactual simulation approaches (Bayer and McMillan, 2012, Bruch and Mare, 2012), in which differences in outcomes between counterfactual policy-on and policy-off situations are compared. In our case, however, a valid policy-off situation is unobserved. We only observe the current 2008 distribution of households (hereafter *initial* distribution) which we use for comparison.

As another means of comparison, we predict residential demand for a control scenario (*control* (0)) which reflects the municipality state in 2008: moving households choose their new location based on 2008 municipality characteristics (see table 4.6 for details). A comparison with the simulation results of the control scenario gives an indication of the net effect that derives from one of the four main planning scenarios.

We create planning scenarios by making counterfactual changes to municipality characteristics and household preferences, for which we predict new demand distributions. The initial household population is kept stable for our scenarios, and reacts differently to the scenario changes. The 2008 migration data set is the only one which provides information on place of residence of a household on municipality level and allows us to integrate preferences regarding local attachment and migration costs. We select five distinct planning scenarios that we translated to scenario variables, namely

- 1) a ‘business as usual’ scenario describing continued trends in planning and transport policies (hereafter *BAU*), based on the extrapolation of recent trends (1990-2008),
- 2) a SCoT policy scenario (hereafter *SCoT*, unobserved) translating the objectives of the territorial cohesion scheme (Agence d’urbanisme de la région urbaine grenobloise (AURG), 2012),
- 3) a mountain sanctuarisation scenario (hereafter *SANCT*, unobserved) describing planning and transport policies that favour the preservation of mountain areas, based on the foresight study *Montagne 2040* (The 2040 Mountain prospective) by the Rhône-Alpes region (CESER Rhône-Alpes, 2013), and
- 4) a mountain innovation scenario (*MOUNTI*, unobserved) describing planning and transport policies that favour mountain development, also based on the 2040 Mountain prospective (CESER Rhône-Alpes, 2013).

Since the SCoT strategic plan is a holistic planning vision, i.e. it sets objectives in housing, transport, employment and urban quality, different sector policies within the SCoT scenario might counteract others and generate opposing effects on residential demand. We thus split up the SCoT scenario in four additional, sectoral scenarios: exclusive policy changes in dwelling construction (labeled *housing (2a)*), in accessibility (*access (2b1)*), in road travel time (*extend (2b2)*) and in urban amenities (*urbams (2c)*).

Scenario variables

In a next step, we identify key variables from the location choice model that are likely to undergo changes in the different scenarios. We do not select all dimensions of variables for these changes: we keep natural amenities stable. Natural amenities are generally understood to be non-producible (Green, 2001). Changes in their distribution cannot occur in the short run, or are simply hardly practicable without considerable effort (altitude, view). We also keep stable service accessibility across scenarios. Globally, service centres have a good to moderate accessibility from all municipalities.

Housing prices and neighbourhood composition are endogenous in the model and change with regard to prices and demand of specific household groups in the iterative procedure. 2008 data are taken as starting values for the neighbourhood composition variables, and average 2006-2012 data for the housing prices. The remaining dimensions and their variables (see table 4.4), namely housing, transport, employment growth and urban amenities, are likely to undergo changes due to regional and local planning and transport policy. The maps in figures 4.5 and 4.6 show the spatial distribution of the selected scenario variables.

Municipality classifications

To predict the residential patterns, we adjust these scenario variables on municipality level. To avoid changing attributes of all 224 municipalities individually, we use three different intra-regional perimeters and a municipality classification. First, the SCoT perimeter covers 199 municipalities in our data set; 25 municipalities of the functional urban area (30 % threshold) are situated outside this planning perimeter. Second, the SCoT identifies planning sectors that correspond to seven *bassins de proximité* (service catchment areas) (Agence d'urbanisme de la région urbaine grenobloise (AURG), 2012, p. 21). These are smaller territorial entities that have some own functional autonomy and challenges with regard to urban planning. They constitute a crucial level to implement the SCoT strategic objectives. The sectors differ substantially with regard to size,

Table 4.4 – Dimensions & variables susceptible to change

Dimension	Variable	Description (unit)
Housing	# flats	Number of flats
	# houses	Number of houses
	% social housing	Share of social housing (%)
	Construction	Average number of dwellings constructed (per year and per 1,000 persons)
	# rooms	Average number of rooms in dwellings
Transport	Travel time to Grenoble centre	Average travel time to the centre (min)
	Travel time to closest urban centre (other)	Average travel time to the closest urban centre beyond Grenoble agglomeration (min)
	Travel time to closest employment sub-centre	Average travel time to the closest employment sub-centre beyond Grenoble agglomeration (min)
	Public transport dummy	Municipality has railway/tramway station (dummy)
Employment	Employment growth	Employment growth (number of jobs per 1,000 persons)
Urban amenities	Grenoble dummy	Urban amenities of the central municipality (dummy)
	Grey urban area	Commercial zones, infrastructure and harmful land use area in settlement surrounding (ha)
	Share of recreational area	Share of recreational area in settlement surrounding (%)

Source: own table

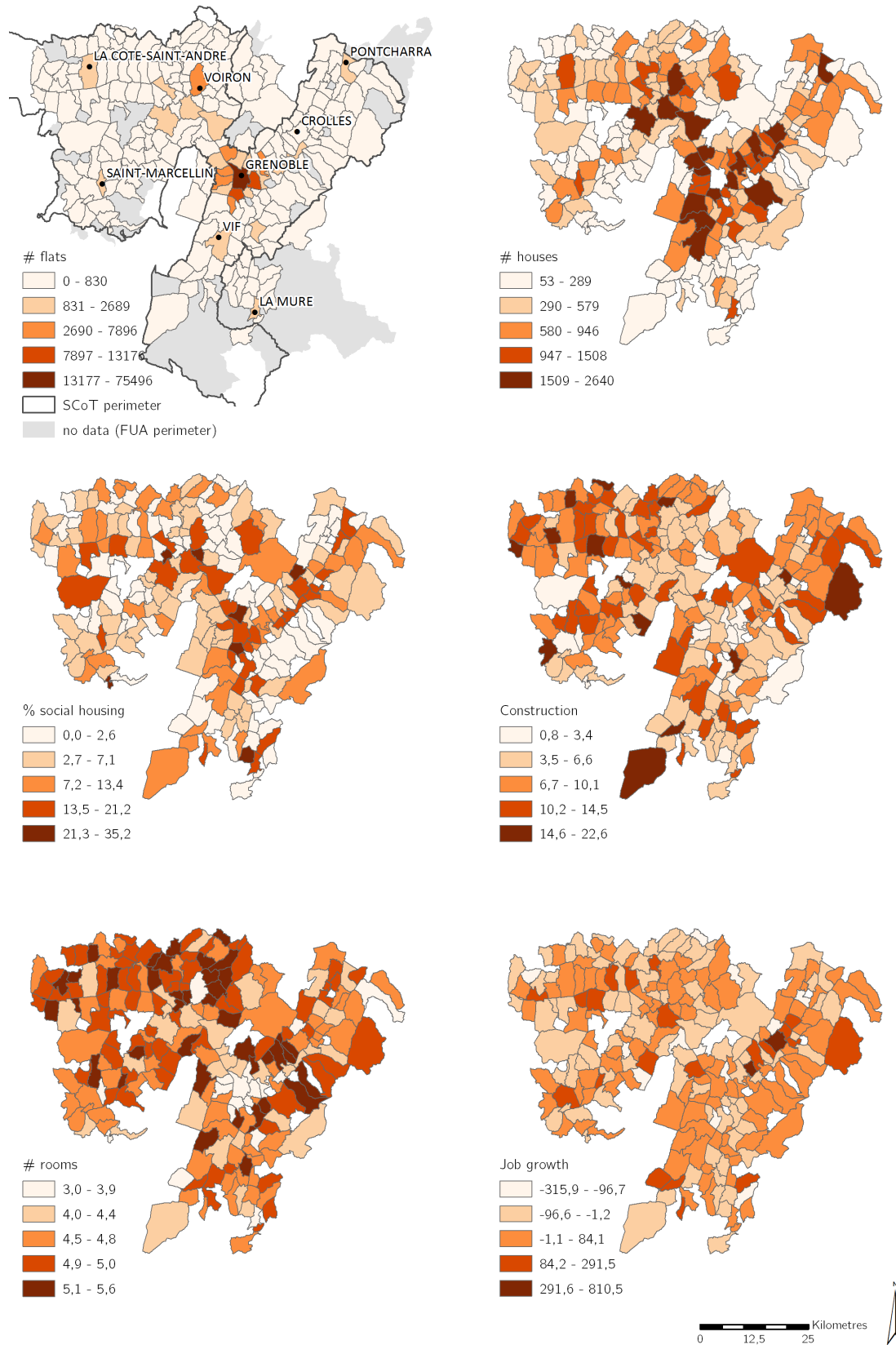


Figure 4.5 – Scenario variables (1)

Source: own illustration based on ()

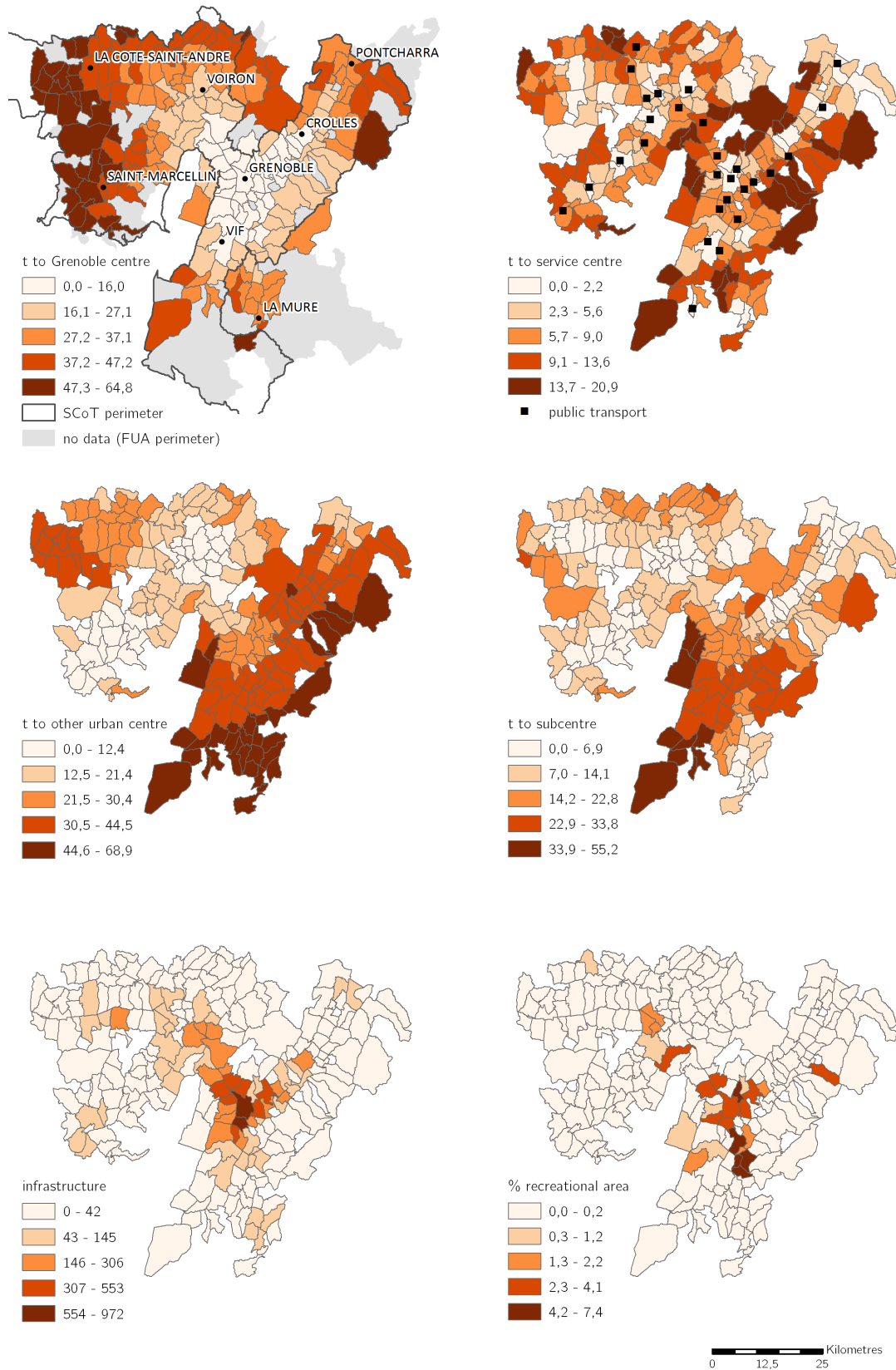


Figure 4.6 – Scenario variables (2)

Source: own illustration based on ()

population number, accessibility and landscape features (see table 4.5 and map 4.7).³⁷

Third, the SCoT classifies municipalities according to their role as central places in an urban hierarchy (*armature urbaine hiérarchisée* (urban centre hierarchy) (Agence d'urbanisme de la région urbaine grenobloise (AURG), 2012)). This classification is another means to structure the urban area and identify centres for future development. Future development aims are defined along this hierarchy in order to foster employment and population concentration in strategic locations. The classification is based on the presence of employment, service facilities and retail distribution, but also on future development objectives as aspired by local elected representatives. The SCoT describes the functions of the different centres as follows:

- (a) Urban centre (*ville centre*: Grenoble, Voiron, Saint Marcellin): Voiron and its surrounding municipalities is considered a second centre of gravity in the region, a counterbalance to the agglomeration. Saint Marcellin, a smaller urban centre situated downstream the Isère river, is the main centrality of the south Gresivaudan and shall act as a relay between urban dynamics in Grenoble and the Rhône-valley.
- (b) Primary centre (*pôle principal*): Bigger towns that structure a population catchment area, either of sufficient population size or located at sufficient distance from the urban centres. They provide a high level of functions: services, retail and employment, the latter potentially in industrial or commercial areas of regional importance.
- (c) Support centre (*pôle d'appui*): Smaller than primary centres, these towns guarantee some autonomy for daily and weekly needs with a diversified offer in services and retail. They come to reinforce higher level centres.
- (d) Secondary centre (*pôle secondaire*): Municipalities (< 2,000 inhabitants) of larger population whose demographic development was not accompanied by a development in service and retail supply. Also, small towns (*bourgs*) that provide a basic level of retail and service supply for the close surrounding areas.
- (e) Local centre (*pôle local*): Small and scarcely populated municipalities, which often lack basic retail and services.³⁸

³⁷The sectors of the SCoT do not cover all municipalities of our study area. Notably, some mountain territories under metropolitan influence are not comprised in the SCoT: isolated municipalities have been affected to the closest sector (Gresivaudan, Sud-Grenoblois, Bievre-Valloire, Sud-Gresivaudan); 3 new geographical sectors have been created for municipalities lying in mountain ranges beyond the SCoT: the Matheysine territory in the south-east, the Vercors range in the south and the Chartreuse range in the north of the agglomeration.

³⁸Another category, neglected here, concerns the tourism dimension. A municipality is considered a

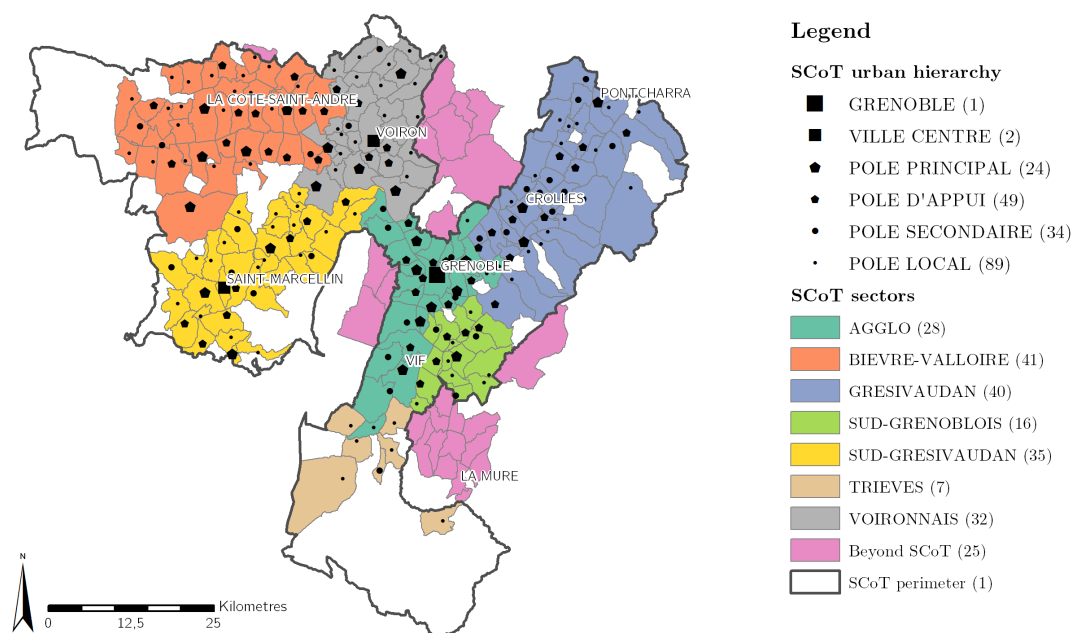


Figure 4.7 – SCoT classifications of municipalities

EP SCoT RUG (2013)

The map in figure 4.7 shows the geographical distribution of sectors and central places in the region.

An element relevant to urban planning and territorial structuring in the region is the presence of PNR. Older than the SCoT, parts of the protected areas of the Chartreuse (PNR created in 1995) and Vercors (1973) have strong functional linkages with the agglomeration, but are not covered by the SCOT.³⁹ Their charter can make dispositions concerning land development and construction. There is, however, some debate on whether or not PNRs have, in practice, a constraining impact on urban development. Table 4.5 presents two PNR delimitations: the first considers municipalities comprised entirely in the two current parks. In the second, we anticipate the creation of a third PNR in the Belledonne range which is currently in preparation (concerning 17 municipalities entirely comprised, see Espace Belledonne (2015)).

tourism centre (*pôle touristique*) if its current or future accommodation capacity requires a higher level of service and commercial supply than would be needed only for the resident population.

³⁹Some municipalities do, however. This discrepancy is due to political negotiations on intermunicipal level. A specificity of the PNR is that a municipality can only be partially concerned by the PNR perimeter. This is especially the case for municipalities in proximity of urban zones. In our case, especially municipalities of the Chartreuse park are concerned, whose major settlement areas are located in the valley but municipal limits stretch uphill in the park area. We excluded those municipalities as

Table 4.5 – Overview on municipality typologies in 2008

Class	N	# households	Household growth (%) ^{a,b}	Share of households (%)	Travel time to centre (min) ^b
^c Agglomération Grenobloise	28	179,661	8.1	57.2	9.3
Bièvre-Valloire	41	19,894	22.5	6.3	46.3
Grésivaudan	40	36,229	18.9	11.5	27.1
Sud-Grenoblois	16	12,338	12.5	3.9	17.8
Sud-Grésivaudan	35	15,888	19.2	5.1	43.2
Trièves	7	1,461	28.8	0.5	36.5
Voironnais	32	35,997	15.3	11.5	31.2
^d Grenoble	1	79,648	5.9	25.3	0.0
Urban centres	2	13,311	13.4	4.2	34.6
Primary centres	24	95,759	11.4	30.5	26.5
Support centres	49	67,550	14.7	21.5	25.8
Secondary centres	34	23,676	18.0	7.5	28.1
Local centres	89	21,525	21.6	6.9	37.8
^e Cœur de l'agglomération	14	158,159	7.4	50.3	5.3
^f PNR	31	12,419	18.9	4.0	35.1
SCoT	199	301,468	11.8	95.9	
Non-SCoT	25	12,756	15.6	4.1	
Total	224	314,224	12	100.0	

Notes: ^a1999-2008 period, ^bvariable average, ^cSCoT sectors, ^dSCoT urban hierarchy (Agence d'urbanisme de la région grenobloise (Urban planning agency of the Grenoble region) (AURG) 2012), ^eSCoT core urban area delimitation (AURG 2012), ^fFPNRF 2010. Source: Own calculations based on INSEE RP 1999 & 2008.

Scenarios in detail

We apply changes to the scenario variables according to observed development trends, quantitative planning objectives notably of the SCoT, qualitative information from foresight studies and own hypotheses that we develop for each scenario. The control scenario and the BAU (1) and SCoT (2) scenarios are at least partially based on available quantitative data and quantified objectives. By contrast, scenarios 3 (SANCT) and 4 (MOUNTI) are essentially based on qualitative information. We develop hypotheses which we quantify in order to translate them to the scenario variables. The following paragraphs give a detailed overview on the qualitative scenario, hypothesis and quantification on variable level for all scenarios. Table 4.6 gives a general overview on variable changes.

Scenario 0: control scenario where prediction is based on 2008 data (control)

Our control scenario reflects the state of the scenario variables in 2008, the chronologically accurate situation of municipalities on which the moving population reacts in the location decisions. All of the scenario variables in the dimensions housing, employment and urban amenities take the values observed in 2008 for each municipality. There are no changes in transport variables.

Scenario 1: Business as usual & continued trends (BAU)

In the business as usual (BAU) planning scenario, trends in spatial development and planning continue for another ten years in the whole region. Municipalities which exhibited high construction rates or employment growth over the last decade will keep this dynamism. More specifically, we extrapolated trends from 1999 to 2008 (2006 for land cover) for the housing and land cover variables. We also extrapolated average growth rates (employment growth and construction) using the average over the two prior periods (1990-1999 and 1999-2008).

We account for an increased traffic congestion, seen as a rising location choice constraint over the last decade, by extending travel times to peripheral sectors (by 10 % for the Voironnais, Grésivaudan and Sud-Grenoblois, and by 20 % for Bièvre-Valloire, Sud-Grésivaudan and the mountain sectors Chartreuse, Matheysine, Vercors and Trièves). Public transport provision has increased over the last decade. New tramway lines were inaugurated in 2006 and 2014, and new bus express lines have been introduced in the last years. Both increase competitiveness of public transport, at least in the agglomeration.

park policy has only minor impacts on these peripheral territories (from a park point of view).

We take note of this development by adding several municipalities as public transport hubs. The public transport dummy takes the value 1 for the following municipalities: Seyssinet, Seyssins, Saint Martin-le-Vinoux, Saint-Egrève, Fontanil-Cornillon (all new tramway), Lancey (new station), Montbonnot Saint-Martin, Bernin, Lumbin, Vizille, Champ-près-Froges, Domène, Meylan, Crolles (all new express bus).

Table 4.6 – Scenarios in brief

	BAU (1) Trends continued	SCoT (2) SCoT objectives	SANCT (3) Sanctuarisation	MOUNTI (4) Mountain innovation	Control (0) 2008 data
# flats / # houses	1999-2008 trends continued	based on construction and sector objectives for individual housing	based on construction with lower sector shares of individual housing	based on construction with lower sector shares of individual housing as in SCoT	2008 data
% social housing	1999-2008 trends continued	sector objectives translated to municipalities	no development in PNR, rest as in SCoT		2008 data
Construction	1990-2008 trends continued	construction objectives achieved	low in PNR, moderate in other mountain areas, high in other sectors	as in SANCT, but PNR also moderate	2008 data
# of rooms	calculated based on new construction	calculated based on new construction	calculated based on new construction	calculated based on new construction	2008 data
^a <i>T</i> Grenoble (min)	extension of travel time from peripheral sectors (north-east and north-west, 10-20 %)	extension of travel time from peripheral sectors (all, 33 %) + public transport competitiveness + ^b <i>generic travel time coefficient · 0.5</i>	as in SCoT + extension of travel time to PNR and mountain municipalities (50 %) + public transport competitiveness also from tourism hubs + <i>generic travel time coefficient · 0.5</i>	public transport competitiveness also from tourism hubs and their surroundings	no change
<i>T</i> other centres (min)	no change	extension of travel time (33 %) + inter-city connectivity along Sillon alpin and Lyon railway lines	as in SCoT + extension of travel time to PNR and mountain municipalities (50 %) + inter-city connectivity along Sillon alpin and Lyon railway lines	inter-city connectivity along Sillon alpin and Lyon railway lines	no change
<i>T</i> empl. sub-centres (min)	no change	<i>generic travel time coefficient · 0.5</i>	<i>generic travel time coefficient · 0.5</i>	no change	no change
Public transport	new public transport hubs: new tramway E and express buses	as in BAU	as in BAU + tourism hubs	as in BAU + tourism hubs	no change
Employment growth	1990-2008 trends continued	decentralized growth objectives	shift towards less congested sectors (67 %)	shift to peripheral sectors (83 %)	2008 data
Grenoble	no change	increased attractiveness: <i>Grenoble coefficient for children × 0.5</i>	no change	no change	no change
Infrastructure (ha)	1999-2008 trends continued	concentration in urban centres	shift to less congested sectors (70 %)	shift to peripheral sectors (80 %)	2008 data
% recreational area	1999-2008 trends continued	increase in urban green in dense areas	as in SCoT	as in SCoT	2008 data
Place attachment	no change	no change	no change	<i>generic same municipality coefficient · 0.5 and generic migration distance coefficient · 0.5</i>	no change

Notes: ^atravel time by road, ^ball changes to household preferences (location choice model parameters) in italics.

Scenario 2: Objectives of the strategic plan for 10 years (SCoT)

The principal aims of the SCoT strategic plan are to limit urban sprawl, improve traffic conditions, re-balance polarized employment distribution and to re-orient urban development to more central locations. The SCoT is comprehensive with the aim to reconcile urban development and the protection of the high-quality natural environment, thereby improving quality of life in the whole region.

For the SCoT municipalities, we adjusted quantified objectives of the SCoT document to the scenario variables. This approach concerned notably SCoT objectives for housing construction according to sectors and types of municipalities in the central place hierarchy. For objectives outlined at sector level or at even larger scales (social housing, share of individual housing in construction, new surface of commercial zones, employment growth), we made appropriate hypotheses on the distribution of development according to current distributions across sectors and the central place hierarchy.

For employment growth, we expect 30,000 new jobs in the region over the period of 10 years, corresponding to a recent and continuing average job growth of 0.7 % per year which is similar to the SCoT. In order to counterbalance employment polarisation, one third of the development in employment shall take place in the agglomeration, two thirds in the peripheral sectors. We attribute employment growth to a municipality based on the geographical sector, and apply a procedure that generates a weighted growth value based on recent growth (weight 60 %) and an employment/active population ratio (40 %). The higher the recent growth, and the lower the employment ratio, the higher the employment growth rate. By doing so, we take into account recent local economic dynamics and the political will to create jobs predominantly in areas where the employment ratio is lower.

We also simulate desired conditions in transport and accessibility, i.e. extended travel times by road. We increase travel times to the centre for municipalities of peripheral sectors by 33 %. There are no new public transport hubs (same as in BAU), but being a hub and being located close to a hub has an effect on the travel time to the center of a municipality: travel times from the hubs to the center are reduced by 25 %. By doing so, we introduce a competitive public transport offer between transport hubs and the center of the agglomeration. We also model a change of transport behaviour for the overall population: if road travel time to the centre from a municipality that is close to a hub (< 10 min) is longer than the sum of the new public transport travel time plus the road travel time to this hub, the new travel time to the center of that municipality is the shorter public transport option. Similarly, travel times to other urban centres reduce for municipalities along the Sillon alpin railway axis and the Rives/Bièvre axis,

and potentially for their surrounding municipalities.

With regard to sector objectives in the SCoT, we generate new commercial zones (grey infrastructure variable) in the main urban centres and important sub-centres, i.e. city centres, primary centres and support centres. For the Metro, Grenoble accounts for 10 % of the developed area (of a total of 150 ha) and the rest is equally distributed across the remaining sub-centres. To simulate an urban greening in dense areas, we raise the share of recreational area in surroundings to the observed maximum of the data set (7.5 %) for eight municipalities in which population density is high (> 175 inhabitants per ha) and urban green area per habitant is lower than the French average (< 30 m²).

Last, we make the hypothesis that the SCoT density and decentralized concentration policy will go in hand with incentives, which contribute to changes in the residential preferences of households. The preferences will tend to shorter travel times to the center, e.g. through a rise in commuting or fuel costs. Similarly, the city centre will have a greater attractiveness for families. We model these changes by reductions of 50 % in the generic coefficients (those for the reference category) for travel time to the centre, to local employment sub-centres and in the Grenoble dummy (interaction with couples with kids; no differentiated changes in preferences among household categories).

SCoT sectoral scenarios 2a, 2b1, 2b2 and 2c: sectoral policy objectives

The 4 sectoral scenarios reflect exclusive sectoral policy changes of the SCoT in housing, transport and urban amenities for the municipalities of the planning perimeter (see also table 4.4). The *housing (2a)* scenario reflects only changes in construction and development of shares of individual and social housing. Transportation in the SCoT scenario develops according to three hypotheses: an extension of travel times, an improvement of public transport provision and changing preferences towards shorter travel times. Accordingly, two sub-scenarios explore differentiated, potentially opposing policy effects: one reflecting overall changes in accessibility (labeled **access (2b1)**), and a second reflecting only an increase in road travel time to peripheral locations (labeled **extend (2b2)**). In both transport scenarios, we keep the SCoT values for employment creation stable according to the SCoT. The third sectoral scenario only reflects the SCoT changes in urban amenities (labeled **urbams (2c)**), i.e. in grey infrastructure, recreational areas and the preferences of households with children for Grenoble.

Scenario 3: Mountain sanctuarisation (SANCT)

Inspired by the third scenario of the 2040 Mountain prospective (see CESER Rhône-Alpes (2013)), the mountain sanctuarisation scenario assumes a reinforced preservation

of mountain areas from urbanisation. In this scenario, new environmental legislation as a response to continued urbanisation, loss of biodiversity and climate change reinforces the protection status of mountainous and natural areas, especially in the PNRs. Mountain areas are kept free from further residential and tourism development. Urbanized areas in the valleys and plains are densified and economic activities concentrate almost exclusively in more accessible areas, creating more congestion. Except for some mountain resorts which are linked by competitive modes of transport (e.g. cable cars), accessibility of the mountain territories decreases due to higher fuel prices and less maintenance of mountain roads.

Since no quantified objectives are provided by the 2040 Mountain prospective, changes to the scenario variables rely on recent evolutions and hypotheses. In addition to the geographical sectors and urban typology, we consider also the PNR. Besides the Chartreuse and Vercors PNR, we assume that a Belledonne PNR has been created which is currently in preparation (Espace Belledonne, 2015).

In terms of housing, we attribute different construction objectives for valleys and the mountains: PNR municipalities including Belledonne only add 1 dwelling unit per year and per 1,000 inhabitants, the mountainous sectors Matheysine and Trièves add 4 units, all other non-mountain sectors add 8 (for small centres, i.e. local centres, secondary centres) or and 10 units (for large centres, i.e. urban centres, primary centres and support centres).⁴⁰ Desired shares of built individual houses reflect densification: in the PNR, Trièves and Matheysine 70 % of built units are individual housing, only 5 % in the agglomeration, Voironnais and Gresivaudan, and 40 % in Bièvre-Valloire, Sud-Grenoblois and Sud-Gresivaudan. With regard to social housing, no development occurs in the parks, whereas development in other areas follows the SCoT objectives (increases in central locations for 6 years): the agglomeration, Voironnais and Gresivaudan +2 %, Bièvre-Valloire, Sud-Grenoblois, Sud-Gresivaudan and smaller centres from former group +1 %, and Trièves and Matheysine +0.7 %.

For employment growth, total expected employment for the area is the same than in the SCoT scenario. What changes is the overall distribution of employment across sectors, more oriented towards Bièvre-Valloire, Sud-Gresivaudan and the Voironnais, as land availability and accessibility (Rhône-Valley transport axis) are higher in these sectors. Employment creation is distributed as follows: agglomeration 5,000 jobs, growth sectors 20,000 jobs, all other sectors and park municipalities 5,000 jobs. More detailed distribution within the agglomeration: Grenoble 20 % of jobs, primary centres 45 %, oth-

⁴⁰To account for randomness in local planning decisions, we draw random numbers from a normal distribution with the indicated values as means and standard deviations of 1.

ers 35 %. In the other sectors: urban centres and primary centres 50 % of jobs, support and secondary centres 40 %, all others 10 %. We create weighted growth values based on recent growth (70 % weight) and an employment/active population ratio (30 %). Local economic dynamics are thus more important than political will to re-balance employment distribution.

Similar to the SCoT, the scenario expects an overall increase in travel times to the center, notably from mountain territories: we increase travel times to the centre for peripheral municipalities⁴¹ of the PNR and mountain sectors Trièves and Matheysine by 50 %. For other peripheral municipalities, the SCoT data is applied. We model competitive means of transport to mountain resorts by adding them to the list of public transport hubs from the SCoT scenario. We also add tourism-oriented municipalities: Les Adrets, Lans-en-Vercors, La Mure, Saint-Hilaire-du-Touvet, Saint-Martin d'Uriage, Saint-Nizier-du-Moucherotte and Le Sappey-en-Chartreuse. Similar than in the SCoT scenario, being a hub and being located close to a hub has an effect on the travel time to the center of a municipality (travel time reduction of 25 % for hubs and those municipalities close to hubs for which public transport travel time is shorter). Travel times to other urban centres change the same way than in the SCoT, whereas travel times increase stronger for park municipalities (same than for Grenoble travel time).

According to employment dynamics, we simulate development of new commercial zones and infrastructure predominantly in the growth sectors. We assume the same amount of developed land (540 ha), with 20 % of the amount of land developed in the agglomeration, 30 % in the Voironnais, 40 % in the Bièvre-Valloire and Sud-Gresivaudan 40 %, and 10 % in the PNR and other sector municipalities. Sector shares are then distributed to urban, primary and support centres according to the municipality's share of population and employment intensity⁴². Urban green area develops in the same way than in the SCoT.

Similar to the SCoT, we also suppose in this scenario that preferences will tend to shorter travel and commuting times, also affected by increased congestion and fuel costs. We model these changes by reductions of 50 % in the generic coefficients for travel time to the centre and to local employment sub-centres.

Scenario 4: Mountain innovation (MOUNTI)

The mountain innovation scenario is inspired by the fourth scenario of the 2040 Mountain prospective (see CESER Rhône-Alpes (2013)). It builds upon a radical economic

⁴¹those for which travel time to the centre > 10 min.

⁴² $Urban\ intensity = Population + Employment$

and societal change that is triggered both by technological advances in transport and communication as well as by quality of life considerations which gain centre stage in individuals' preferences. According to this scenario, life and work in the mountains becomes more attractive than in the urbanised zones due to density, frequency of heatwaves in summer, pollution and congestion, especially for vulnerable and higher educated population groups. This change drives new residential and economic development in mountain territories; both households and firms choose to locate at higher altitudes, facilitated by teleworking, advanced communication technologies, use of renewable energies and transport investments. Metropolitan functions and services are more dispersed and accessible across the territory. Instead of regulation, new legislative dispositions and incentives help lure economic activity to the mountain territories and reinforce their economic dynamism. Regional and land use planning, however, regulate urbanisation in the mountain areas in order to preserve the territories from urban sprawl and banalisation.

Similar to the third scenario, we anticipate the creation of a Belledonne PNR. Housing construction is equal to scenario 3 except for PNR where it is less restrictive: construction in PNR municipalities including Belledonne is around 4 dwellings per year and per 1,000 inhabitants.⁴³ Shares of built individual houses are same than in scenario 3, and social housing shares increase in the PNR by the same rate than in the other mountain sectors (0.7 %).

For employment growth, only the distribution of employment differs from scenario 3. We assume that 5 out of 6 new jobs will be created in peripheral sectors (25,000 jobs of 30,000), and there, at least half of it in smaller urban centres. Employment creation amounts to 5,000 in the agglomeration, accordingly. More specifically, distribution within the agglomeration is as follows: Grenoble 10 %, primary centres 30 %, others 60 %; in the peripheral sectors: urban centres and primary centres 50 %, support and secondary centres 40 %, others 10 %. Weights of recent growth and the employment/active population ratio are the same than in scenario 3 (70 % vs. 30 %).

Scenario 4 does not assume an extension of travel times by road. Competitiveness of public transport is modeled as in scenario 3 (25 % reduction), also including the tourism-oriented municipalities and their surroundings, and using the same three variables: both Grenoble and other urban centres accessibilities, and the public transport dummy. Consistent with the employment dynamics, we distribute the greater part of new developments of commercial zones and infrastructure (540 ha) in peripheral sectors (80 %), and only 20 % in the agglomeration. These shares are then also distributed

⁴³As in scenario 3, we draw random numbers from a normal distribution with the indicated values as means and standard deviations of 1.

across municipality types according to urban intensity (see scenario 3).

According to the employment dynamics, we simulate development of new commercial zones and infrastructure predominantly in the growth sectors. We assume the same amount of developed land (540 ha), with 20 % developed in the agglomeration, 30 % in the Voironnais, 40 % in the Bièvre-Valloire, Sud-Gresivaudan and PNR and 10 % in other sector municipalities. Sector shares are distributed to urban centres and primary centres (10 %), support and secondary centres (30 %), and other centres (60 %), according to urban intensity. Urban green area develops as in the SCoT.

Finally, we assume no changes in preferences with regard to travel times, but to place attachment. Migration distance and stay in the same municipality variables are proxies for local social networks, migration costs and for potential other reasons explaining place attachment, e.g. proximity to work. In scenario 4, households become more mobile by reducing the generic coefficients of the two variables by 50 %.

4.3.4 Scenario analysis

In order to analyse the scenarios in terms of outcomes for residential demand patterns, we calculate overall residential demand using the sampling weights of households and the probabilities predicted for each household - municipality observation (sample enumeration). We dispose of two residential demand patterns for each scenario: the demand of moving households and the overall household demand (movers + stayers).⁴⁴ In our analysis of residential patterns, we analyse the entire population distributions including moving and staying households.

We use different methods to compare scenario outcomes in terms of residential demand distributions. We notably employ mapping of residential demand for the overall household population and specific household groups on municipality level and calculate descriptive statistics for demand distributions and housing prices for different municipality groups and types. We also use statistical indices that measure three dimensions of demand distribution: (i) concentration (or dispersion) of demand, (ii) segregation of demand and (iii) demand development in mountain territories. Population dispersion and segregation relate to mismanagement of urbanisation and rising income inequality that is translated to space, both major risks for our contemporary society (World Economic Forum, 2013). Demand concentration emphasises the quantitative dimension of the distribution of demand (dispersion vs. containment), and relates more widely to

⁴⁴The statistical differences between residential demand patterns of movers are by nature greater than those for total population patterns. We test statistical significance of differences between the two distributions with one sample *t*-tests. They test the hypothesis that two populations have equal means. See section 4.5 in the annex of this chapter.

the challenges such as urban sprawl, land consumption and landscape fragmentation (see e.g. Antrop (2004), European Environmental Agency (2006), Wissen Hayek et al. (2011)). Demand segregation emphasises the qualitative dimension of the distribution of demand, i.e. sorting of population groups according to various demographic and economic characteristics that challenge social cohesion (Smets and Salman, 2008). The third dimension, the development of demand in mountain territories, addresses specifically the concentration of demand in peri-urban mountain areas (Giraut, 2009, Perlik, 2006, 2011). Here, we were specifically interested in the distributions of the young, the old and households with children (life-cycle effects) on the one hand, and executive and blue-collar worker households (income effects) on the other hand. We chose indices that are able to measure population concentration, centralization and different dimensions of segregation (see e.g. Apparicio (2000), Duncan and Duncan (1955a), Duncan (1957), Massey and Denton (1988), Otterstrom and Shumway (2003), Reardon and Firebaugh (2002), Sparks (2014), Tivadar et al. (2015) on the measurement and calculation of such indices).

We compare the resulting statistics and indices firstly between the main scenarios (1) to (4) and the initial household distribution (distribution before the move), and secondly between the four sectoral SCoT scenarios (2a) to (2c). We may also compare the residential demand patterns of the different scenarios to the predicted pattern of a control scenario (0). The simulation results also include the simulated housing prices at each iteration and at convergence (equilibrium price). We provide descriptive statistics for groups of municipalities to give indications on changes in price levels due to planning and transport policy changes.

Concentration indices

Population concentration across countries and metropolitan regions has been, among other indices, frequently investigated by Gini measures (Campante and Do, 2010, Henderson, 2009). Although a measure of inequality, the Gini coefficient can, when applied to a population distribution, provide information on the levels of concentration and dispersion across spatial units. Derived from the Lorenz curve, it is mapped using cumulative shares of population and spatial units. A Gini coefficient of zero expresses perfect equality in population distribution, i.e. all spatial units have the same population. A Gini coefficient of one expresses maximal inequality in population numbers across spatial units, i.e. one spatial unit concentrates the whole population.

The Gini coefficient is well-suited to analyse the population concentration over uniform space and without spatial interactions. It is less useful if we want to measure

concentration around a specific geographical area, e.g. an urban centre with its neighbouring entities (Campante and Do, 2010). Inspired from economic research in development studies that uses measures of urban primacy (Henderson, 2009), our second measure of urban concentration, hereafter referred to as *Grenoble primacy*, is the share of the Grenoble urban centre (sum of population in Grenoble municipality + suburbs) in the overall urban population of the region (sum of population in urban, primary and support centres).⁴⁵

As a third measure, we use the Hoover index of urban population concentration that considers density (see Duncan (1957), Otterstrom and Shumway (2003), Shumway and Otterstrom (2001)). It is defined

$$H = \frac{1}{2} \sum_{i=1}^n \left| \frac{t_i}{T} - \frac{a_i}{A} \right|, \quad (4.10)$$

where H is the Hoover index, t_i and a_i are population and land area in spatial unit i in n spatial units, and T and A are population and land area of the entire study area. For the calculation of indices and densities for the concentration measures, we use the area of inhabited zones obtained from Insee's population raster data (200 x 200 m cells > 5 inhabitants). The index takes the value 0 if each area had the same share of land and population, and 1 if the whole population lived in only one area. The Hoover index can be interpreted as the share of the total population that would have to move in order to create the same density in all spatial units n .

A fourth measure relating to population concentration considers the distance from the urban centre, which is Grenoble in our case. We calculate the absolute centralisation index ACE (Duncan and Duncan, 1955b) for the overall population distribution, using

$$ACE = \left(\sum_{i=2}^n T_{i-1} A_i \right) - \left(\sum_{i=2}^n T_i A_{i-1} \right), \quad (4.11)$$

where T_i is the cumulative share of population in spatial unit i (ratio between population in spatial unit i and cumulative population in spatial units 1 to i , ordered in ascending order by distance to the centre), and A_i is the cumulative share of the area of the municipality (same calculation). The centralisation index is an adaptation of Duncan's segregation index. It measures the share of the overall population that would have to move in order to create same densities across all spatial units around the centre. Its value is negative if population is concentrated in the periphery of the study area, and

⁴⁵ A measure being the share of the urban centre population in the overall population, as mentioned in Tivadar et al. (2015), would be less precise.

positive in the opposite case.

Segregation indices

There is substantial literature on the development and calculation of measures of residential segregation (see e.g. Apparicio (2000), Apparicio et al. (2008), Duncan and Duncan (1955a), Massey and Denton (1988), Reardon and Firebaugh (2002), Tivadar et al. (2015)). Typically, literature considers five dimensions along which segregation unfolds: evenness, exposure, concentration, clustering and centralisation (Massey and Denton, 1988).⁴⁶ For each dimension, three types of indices exist: one-group indices that compare a group's distribution to the rest of the population, inter-group indices that compare a group's distribution to other groups, and multi-group indices that measure the spatial distribution of several groups at once (Apparicio, 2000, Bertrand et al., 2010).

Evenness, or unevenness respectively, is the most common dimension in which segregation is measured (Musterd, 2005). It refers to under- and over-representations of one or more population groups across spatial units. The more uneven a group is distributed across an urban area composed of various spatial units, the more segregated it is. Among its measures, Duncan and Duncan's segregation index *SI* (Duncan and Duncan, 1955a) is one of the most popular indices. Its formula is given by

$$SI = \frac{1}{2} \sum_{i=1}^n \left| \frac{x_i}{X} - \frac{t_i - x_i}{T - X} \right|, \quad (4.12)$$

where x_i is the population of a specific population group in spatial unit i , t_i is the total population in the same spatial unit, and X and T are the group and total populations of the study area. Varying between 0 for complete evenness and 1 for complete segregation, the *SI* value indicates the proportion of the population that would have to move to another spatial unit in order to create a completely even distribution of the considered group relative to the rest of the population.

Similarly, the inter-group version of this index, Duncan's dissimilarity index *DI* (Duncan and Duncan, 1955a), measures the segregation between two population groups X and Y . The index is denoted

$$DI = \frac{1}{2} \sum_{i=1}^n \left| \frac{x_i}{X} - \frac{y_i}{Y} \right|, \quad (4.13)$$

⁴⁶See Apparicio (2000) for a brief history of indices and for a graphical representation of the five dimensions. See Tivadar et al. (2015) for a recent online tool to analyse segregation and spatial inequalities that makes use of a large array of indices.

with notation as above, and y_i and Y representing a second group's population in i and total population. There is also a generalisation of Duncan's dissimilarity index for multiple groups (Massey and Denton, 1988, Reardon and Firebaugh, 2002, Sakoda, 1981). It expresses segregation (unevenness) of multiple groups in a single dissimilarity index, ID_{multi} , denoted as

$$ID_{multi} = \frac{1}{2TI_{Simpson}} \sum_{k=1}^K \sum_{i=1}^n (t|x_i^k - X^k|, \quad (4.14)$$

with notation as above, and $I_{Simpson}$ as Simpson's interaction index⁴⁷ for the entire population.

According to urban economic theory and notably the mono-centric model, access to the city centre is a major factor in residential sorting of households. We explore centralisation of different household groups. The measure is the same than in equation 4.11 for the overall population.

For the analysis of the scenarios, we calculate these indices for different household groups. We consider executive and blue-collar households since (i) they are the most segregated socio-professional groups in the region and (ii) also the wealthiest and the poorest socio-professional category. An executive status is a proxy for high income and education. We further use three households groups that are proxies for three distinct life-cycle stages which affect location decision-making: young singles, couples with kids and old households (young and old retirees, empty-nesters).

Demand in mountain areas

In order to give indications on how the demand for mountain areas changes in each scenario, we calculate shares of total demand for mountain areas and for its composition, i.e. demand from different household groups. We consider the same household groups as in the segregation indices: executive and blue-collar households, young singles, old households and couples with kids.

We determine municipalities in mountain territories by two simple attributes: average altitude of settlement in a municipality and location of a municipality in one of the

⁴⁷Simpson's interaction index (Simpson, 1949) measures the probability that two randomly drawn individuals do not belong to the same group. It is denoted

$$I_{Simpson} = \sum_{k=1}^K X^k(1 - X^k), \quad (4.15)$$

where X^k is the overall population of group k of a total of K groups in the study area.

three mountain ranges Chartreuse, Vercors and Belledonne. We group municipalities into three altitude classes. We are less interested in valley municipalities below 600 m, but in municipalities situated between 600 m and 900 m and those located above 900 m above sea level. The former group refers to locations in foothills, where living conditions are less negatively affected by harsh climate. Above 900 m, these effects are stronger and the environment is less convenient for living (interview PNR Chartreuse employee). To determine location in one of the mountain ranges, we use the PNR dummy variable defined above.⁴⁸

⁴⁸We consider the interior of the mountain ranges and exclude accessible foothills

4.4 Results & discussion

4.4.1 Estimation results

The selection of variables for the final model specifications of our mobility, choice of dwelling type, location choice and housing price models reflects a trade-off between findings from economic theory and empirical studies, statistical robustness and parsimony. We selected the final specifications based on overall goodness of fit measures, statistical hypothesis testing for single variables, and by considering potential problems and violations of model hypotheses such as collinearity and endogeneity.

Decision to move & dwelling type choice

Table 4.7 presents the coefficient estimates for the logistic regressions of the decision to move and dwelling type choice. The two binomial logit models are estimated with the *logit.survey* function from the R *Zelig* package (Carnes, 2012, Imai et al., 2012) to account for survey weights in the data (see section 4.3.1).⁴⁹ Both models show moderate to good fits, the dwelling type choice model performing much better than the mobility model (McFadden's pseudo- R^2 of .38 and .27, respectively). This difference in explanatory power points at limitations in modeling the mobility decision with the available data. Notably, life-cycle and social status changes are unobserved in our cross-section data.

Although we use a rather simple model specification with mainly socio-demographic variables of the household in both models, the findings for the two models are generally consistent with theoretical considerations and empirical findings in the literature. The reference household in both models is a french home-owning household with a head aged 35 years, which is not a couple with children and whose head is active but neither executive, nor blue-collar nor white-collar.

Model 1, describing **the decision to move**, shows that social status, here captured by dummies for households with executive, blue- or white-collar heads and non-active

⁴⁹The *glm* function is the standard R procedure for fitting generalized linear models via maximum likelihood (R Core Team, 2013). However, *glm* does not correctly account for survey weights present in our population census dataset. The *Zelig* package (Imai et al., 2012) provides a model to estimate binomial logit models that correctly account for such weights, via survey-weighted logistic regression (Carnes, 2012) using maximum pseudo-likelihood estimation (MPLE). Basically, coefficient estimates of *glm* and *logit.survey* are similar, but standard errors of the former are wrong due to an incorrect consideration of survey weights. *logit.survey* allows for different kinds of survey weights, e.g. probability and sampling weights. Comparing the estimations of the two functions in both decision contexts, we find that coefficients and significance levels vary only slightly (see additional notes section 4.5). Predicted probabilities from the two models are similar. Since these are fitted using maximum pseudo-likelihood estimation (MPLE), no standard goodness of fit measures such as pseudo- R^2 are provided. We use the estimations from the standard *glm* function for an indication of the goodness of fit of the two models.

Table 4.7 – Estimation results for binomial logit models: decision to move & dwelling type choice

	move <i>survey-weighted</i> <i>logistic</i> (1)	house <i>survey-weighted</i> <i>logistic</i> (2)
Executive	0.060* (0.028)	0.082 (0.052)
White-collar worker	0.005 (0.033)	−0.402*** (0.067)
Blue-collar worker	−0.110*** (0.029)	−0.150** (0.055)
Non-active	−0.407*** (0.056)	−0.539*** (0.118)
Private tenant	0.908*** (0.027)	−1.570*** (0.048)
Social housing tenant	0.223*** (0.029)	−2.857*** (0.081)
Age	−0.080*** (0.001)	0.027*** (0.002)
Age ²	0.001*** (0.00004)	−0.001*** (0.0001)
Couple with children	−0.146*** (0.022)	1.176*** (0.042)
Foreign	0.201*** (0.042)	−0.539*** (0.092)
Prev. loc. suburbs	−0.040 (0.025)	1.347*** (0.058)
Prev. loc. peri-urban	−0.238*** (0.028)	2.830*** (0.063)
Constant	−1.502*** (0.029)	−1.259*** (0.062)
Observations	81,916	25,980
^a Log Likelihood	−37,287.390	−9,280.674
^a McFadden's R ²	0.271	0.375

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$, ^afrom standard models fitted with MLE (see additional notes section 4.5).

households, has a significant impact on mobility. Whereas executives appear to be slightly more mobile than the reference household (positive coefficient significant at 5 %), being a blue-collar household and especially a non-active household (almost 4 times the effect of blue-collar worker) decreases the probability to leave the current dwelling (both significant at 0.1 %), all other things being equal. As expected, being a tenant has a strong positive effect on mobility versus owning, and this effect is stronger for private tenants than for social housing tenants (both significant at 0.1 %).

Age and household composition have a strong influence on residential mobility: consistent with literature, young adults are the most mobile group, and mobility decreases with age. There is, however, a slight tendency to more mobility at higher ages, as shown by the highly significant coefficient for age-squared. Unsurprisingly, being a couple with children decreases the probability to move from the current dwelling. These findings are also consistent with literature: mid-range and older households and couples with children are more anchored to their current dwellings, have more constraints to make a move, and have successfully adjusted their housing consumption to a demand that remains stable for a longer period of life. In retiree or higher ages, however, households might consider moving again in order to adjust to new needs, i.e. a move to an agreeable area when entering retiree age or a move back to areas with higher density of services once personal mobility declines. In our model, the age effect on the propensity to move is positive for the period from 20 to 50, with a maximum around the youngest age and a minimum at 89, after which the negative effect of age slightly decreases. Foreign households show a higher propensity to move, all other things being equal.

Last, previous location of a household matters for mobility: the coefficients of the dummy variable indicating whether a household lived in the centre, in a sub- or peri-urban municipality before show some significance. Residing in a peri-urban municipality has a significant negative impact on mobility. Having previously resided in a suburb has a significant positive impact on mobility, but only in the *glm* model (see section 4.5). We might argue that households in the peri-urban zone are more satisfied with their current dwelling, or put differently, that households located in more urbanized areas have higher stress levels due to density, noise and pollution that influence mobility behaviour positively. The negative and highly significant constant shows that initially, all households have a negative effect on propensity to move.

The estimation results for model 2, **the decision of the dwelling type** between flat and house, similarly confirm the significant influence of social status, related to income, and life-cycle stage of a household. We do not find an effect of having an executive head on the household's propensity to choose a house in the survey-weighted regression

model, although the sign is positive (the *glm* estimate is significant at 10 %). By contrast, all other lower social status dummies have a highly significant negative impact on the probability to choose a house, strongest for white-collar workers and non-actives. This finding shows that not all social categories can to the same extent realise the dream of a house, all other things being equal (life-cycle stage, age, household composition and location).

As expected, being a tenant reduces significantly the probability to choose a house. Indeed, houses are usually acquired as private property and houses for rent represent only a small share of this housing market segment. Contrary to what we found for the decision to move, the probability of choosing a house increases with age, whereas there is a maximum at some point after which probability to choose a house decreases with age. More specifically, the age effect is positive for the period from 38 to 64, with a maximum around the age of 51.

We also find a strong positive and significant effect of the couple with children dummy variable; and a negative influence of having a foreign household head (potentially related to income or preferences). Finally, the probability of choosing a house is higher if a household was living in lower density areas before, especially in peri-urban areas (twice the effect size than those for suburban areas). This finding might be an expression of the lived experiences of the built environment of a household that may influence housing preferences and dwelling type choice. Finally, we find again a negative and highly significant constant. It shows that initially, all households have a negative effect on the propensity to choose a house.

Housing price model

The results of our hedonic regression models are presented in table 4.8. The semi-log specification yielded the best results with regard to several specification tests. With an R^2 of 0.8, the simple OLS has a very good overall fit. We found evidence for the presence of spatial autocorrelation in both the error terms of the OLS model and the dependent variable housing price (Moran's I value 0.794, significant at 0.1 %). We tested for spatial effects with several k nearest neighbour spatial weights matrices (3-5 neighbours). The best results were obtained with the five nearest neighbour weights matrix.⁵⁰ According to the Lagrangre multiplier tests (significant robust LM lag, not significant robust LM error), the spatial lag model is the appropriate spatial hedonic model specification.

Table 4.8 provides the estimation results for this model next to the OLS estimation. The more negative Akaike information criterion (AIC) value for the second model shows

⁵⁰For more details see subsection 4.5 of this chapter.

that the spatial autoregressive model has more explanatory power; the spatial autoregressive coefficient ρ is highly significant and positive (see Likelihood ratio (LR) test and Wald test). High housing prices in a municipality are partially explained by high housing prices in neighbouring municipalities. After correcting for spatial autocorrelation with the spatial lag model, a non-significant Moran's I value of the residuals indicates that the model accounts for a great portion of spatial autocorrelation and that remaining spatial interactions are negligible (Moran's I value 0.05, p-value 0.82).

Global and single statistical tests validate the linear model assumptions (Peña and Slate, 2006).⁵¹ Skewness and kurtosis problems have been corrected by removing eight significant observations from the estimation. The semi-log specification was confirmed. The non-significant Breusch-Pagan test indicates an acceptable level of heteroskedasticity. As reported by the Variance inflation factors (VIFs), multicollinearity between municipality characteristics is not a serious issue for our model. Correlation coefficients are very high between the variables demand and supply, and between travel time to the centre and its squared version that both enter the model. The reported VIFs do not consider the coefficients for demand and supply, and consider the standardised version of travel time to the centre.

Coefficient signs, magnitudes and significance levels are similar for the two models. Coefficient magnitudes reduce especially for the travel time to the center and share of executive variables in the spatial lag model. Only two variables change significance levels between the two models: squared travel time to the centre losing its 10 % significance and elevation gaining a 10 % significance.

The coefficients for the structural variables of models 1 and 2 have the expected signs, and are consistent with theory and empirical findings. The higher the local demand, the higher the average housing price in a municipality; and the higher the local supply, the lower the average price. In both models, the coefficients are not exactly opposed. As de Palma et al. (2005, p. 79) note for a similar model, there is no exact opposition due to the presence of other explanatory variables which are more correlated with demand than with supply. In addition, average housing prices are higher in municipalities the closer they are located to the agglomeration centre (the CBD, see e.g. Ahlfeldt (2011)), the larger their share of executive households (both a proxy for the presence of high-income groups and local public services, see e.g. Banzhaf and Walsh (2008), Cavailhès (2005))⁵², and the higher the recent dwelling construction (construction activity as a

⁵¹See Peña and Slate (2006) for details on the R *gvlma* function. See section 4.5 for the final results of the global and single tests.

⁵²We only do include the share of executive households as a proxy for socio-demographic composition. Other variables, such as the shares of couples with children or blue- and white-collar workers were found

Table 4.8 – Estimation results for housing price models

	Mean price per m ²	
	<i>OLS</i>	<i>spatial autoregressive</i>
	(1)	(2)
Demand	0.367* (0.150)	0.349* (0.138)
Supply	−0.361* (0.144)	−0.342** (0.133)
Travel time center	−0.873*** (0.156)	−0.530*** (0.156)
Travel time center ²	0.236 (0.135)	0.104 (0.125)
% executives	1.015*** (0.139)	0.791*** (0.134)
Housing construction	0.015*** (0.003)	0.013*** (0.003)
Elevation	−0.004 (0.004)	−0.006 (0.003)
View	0.004*** (0.001)	0.004*** (0.001)
Constant	7.743*** (0.049)	5.318*** (0.480)
ρ		0.307*** (0.061)
Observations	216	216
R ²	0.834	
Adjusted R ²	0.828	
Nagelkerke pseudo-R ²		0.822
Log Likelihood	180.188	191.512
Wald Test		25.365*** (df = 1)
LR Test		22.647*** (df = 1)
σ^2		0.010
Akaike Inf. Crit.	−340.376	−361.024
Breusch-Pagan	7.941	
Mean VIF (max VIF) ^a	1.624 (2.131)	
LM ^b error	12.113***	
LM error (robust)	0.130	
LM lag	25.327***	
LM lag (robust)	13.343***	
LM residuals		0.004

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$, ^aWithout VIFs for demand and supply,

^bLagrange Multiplier. For readability, the variables have been scaled before estimation.

proxy for dynamics in the economic context, for restrictiveness of local planning policy and the availability of recent dwellings, see e.g. Cavailhès (2005), Jaeger and Plantinga (2007)).

Regarding the non-linear effect of travel time to the center, the positive coefficient for the squared version indicates the presence of a maximum for the negative effect on price, after which the negative effect on travel time decreases again. The maximum resulting from the estimated coefficients lies at 111 minutes. This finding might indicate a flattening of the housing price gradient at large distances. On the first scatter plot in figure 4.14 in section 4.5, the local polynomial regression line illustrates this flattening. One could also assume that the finding might also point at the influence of the proximity of other urban centres on prices. Controlling for the travel times to other urban centres and employment sub-centres has not yielded significant coefficients and has not significantly improved the model. For our average housing price data, these findings validate the assumption of a mono-centric urban region. The squared version of travel time to the center, however, is only significant in the OLS regression.

In our model at municipality scale, two variables capture the influence of environmental amenities on housing prices. As expected and consistent with empirical findings, view has a positive effect on housing prices (Baranzini and Schaerer, 2011, Cavailhès et al., 2009, Nilsson, 2014, Wu et al., 2004). A larger viewshed, i.e. the size of the area seen from the center of a municipality, increases housing prices for this municipality. By contrast and all other things being equal, a higher average altitude decreases housing prices in the municipality (only significant at 10 % in model 2). Different non-linear specifications for the altitude variable have been tested (squared and natural log, and decomposition into a set of dummy variables), none of which proved to be statistically superior to the linear version. An explanation for this could be that altitude captures distance effects that are not fully controlled for in our travel time to the CBD variable.⁵³ Such additional distance effects could relate to more difficult road and traffic conditions given altitude, road sinuosity and slope, especially in winter months.

Negative effects of altitude on housing prices are at first glance not consistent with some empirical findings. There is evidence for situations in which elevation of a location increases housing prices, especially in predominantly urban housing markets (Nilsson, 2014, Wu et al., 2004). Given the scale and scope of our housing price data (comprising urban and rural territories), such altitude effects in local housing markets are probably

either not significant or too correlated with the executives' share; for instance, correlation with blue-collar worker share is .65).

⁵³Correlation with travel time to the center is low. See second plot in figure 4.14 in section 4.5).

masked and not identifiable in our data⁵⁴. The positive coefficient of the viewshed variable, however, might capture some of these more local effects. Correlation between these two variables is low and the largest viewsheds are indeed found for municipalities between 300 and 500 meters altitude.⁵⁵

Location choice model

Table 4.9 presents the estimation results for the residential location choice models. Both location choice models, the conditional logit and the nested logit model, were estimated using the *mlogit* package (Croissant, 2013). To select the final model specification, we took into account bi-variate correlations between explanatory variables, and traded-off a large number of intermediate models with the help of collinearity measures, likelihood ratio tests and hypothesis testing for individual parameter estimates. We chose the most significant set of explanatory variables for the model specification.

Model 1 presents the simple CL model, model 2 shows the results for the nested logit (NL) model with a nesting structure based on the four zones of the functional urban area: Grenoble municipality as the CBD, suburbs, peri-urban areas and extended peri-urban areas. The pseudo- R^2 measures indicate that both models fit the data excellently (McFadden's around .52 and Estrella's around .93). Almost all of the variables of the two models are statistically significant, indicating that all proxies for location factors play a role in the residential location choice. The coefficients of both models show in general similar magnitudes, signs and significance levels. Variations in significance between the coefficients of the two models concern travel time to the centre (more significant in the NL), housing prices (highly significant only in the NL), and some natural amenity coefficients (increases of significance in the NL).

Collinearity between the explanatory variables does not cause a major problem in our final model specification, as indicated by the low mean value of the VIFs (3.3). Higher VIFs concern the already known correlations between some of our control variables, notably the associations between travel time to the centre (27.2), its squared version (12.8), housing prices (7.2), number of flats (7.0), the Grenoble dummy (7.0) and average number of rooms per dwelling (7.9).

The NL model is slightly superior to the CL model, as indicated by the inferior AIC, the smaller log-likelihood (yielding slightly higher pseudo- R^2 s) and the highly significant coefficients of the inclusive values for the four nests.⁵⁶ Since no inclusive value is

⁵⁴Or, in our study region, demand in the whole population for such locations is lower than e.g. in warmer climates; the mountains attract only specific demand, less or not capitalized into prices.

⁵⁵See also sixth plot in figure 4.14.

⁵⁶The R package *mlogit* allows us to identify the inclusive values for all nests, including the degenerate

greater than one, our presumed nesting pattern of alternatives is valid. According to the parameters of the inclusive values, the highest within-nest correlation in unobserved factors across alternatives is observed for the extended peri-urban area (.29, which is a moderate correlation). The inclusive value for the peri-urban nest is statistically not significant from one, indicating no correlation in unobserved factors among alternatives in this nest. For the suburbs, we find a low correlation of .04, which is nonetheless statistically different from one. The Grenoble inclusive value estimate is difficult to interpret as it is a degenerate nest (Croissant, 2012).

Table 4.9 – Estimation results for location choice models

	Conditional logit	Nested logit
	(1)	(2)
# flats (log) x flat	0.832 (0.012)***	0.887 (0.010)***
# houses (log) x house	0.580 (0.029)***	0.631 (0.020)***
Grenoble	−0.038 (0.052)	0.295 (0.075)***
Grenoble x executive	0.358 (0.074)***	0.476 (0.088)***
Grenoble x young	0.262 (0.100)**	0.562 (0.109)***
Grenoble x couple with children	−0.374 (0.080)***	−0.512 (0.095)***

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nest with only one alternative (Grenoble). However, this is only possible by estimating the unscaled version of the nested logit model with generic variable (Croissant, 2012), in which the inclusive value parameter for the degenerate nest is difficult to interpret in terms of dissimilarity. Heiss (2002) calls this the non-normalized nested logit (NNNL) and discusses its difference with the standard nested multinomial logit derived from utility maximisation (which he calls a RUMNL model). He states that the inclusive values estimated with the NNNL do not relate to the concept of dissimilarity, since “[t]hey simply relax the constraint of equal scaling of the generic variable coefficient across nests” (Heiss, 2002, p. 243).

Table 4.9 – continued from previous page

	Conditional logit (1)	Nested logit (2)
migration distance	−0.823 (0.014) ^{***}	−0.887 (0.012) ^{***}
migration distance x executive	0.068 (0.026) ^{**}	0.089 (0.021) ^{***}
migration distance x white collar	−0.141 (0.022) ^{***}	−0.150 (0.018) ^{***}
migration distance x blue collar	−0.147 (0.019) ^{***}	−0.149 (0.015) ^{***}
migration distance x non-active	0.179 (0.038) ^{***}	0.134 (0.036) ^{***}
migration distance x couple with children	−0.102 (0.022) ^{***}	−0.095 (0.016) ^{***}
same municipality	1.503 (0.032) ^{***}	1.591 (0.029) ^{***}
same municipality x executive	−0.158 (0.057) ^{**}	−0.116 (0.051) [*]
same municipality x non-active	0.616 (0.099) ^{***}	0.563 (0.093) ^{***}
same municipality x young	−0.383 (0.061) ^{***}	−0.331 (0.055) ^{***}
same municipality x old	0.562 (0.055) ^{***}	0.545 (0.050) ^{***}
same municipality x couple with children	0.388 (0.048) ^{***}	0.330 (0.042) ^{***}
travel time centre	2.968 (0.244) ^{***}	2.212 (0.207) ^{***}
travel time centre x executive	−1.185 (0.237) ^{***}	−1.107 (0.221) ^{***}
travel time centre x white collar	0.314 (0.154) [*]	0.366 (0.140) ^{**}
travel time centre x blue collar	0.341 (0.181) [*]	0.784 (0.162) ^{***}
travel time centre x non-active	−0.598 (0.307) [*]	−0.856 (0.328) ^{**}
travel time centre x young	−1.287 (0.230) ^{***}	−1.148 (0.231) ^{***}
travel time centre x old	1.230 (0.183) ^{***}	1.344 (0.175) ^{***}
travel time centre x couple with children	1.188 (0.165) ^{***}	1.168 (0.149) ^{***}
travel time centre ²	−1.038 (0.220) ^{***}	−0.651 (0.223) ^{**}
housing price (log)	−0.173 (0.129)	−1.059 (0.035) ^{***}
price residuals	0.272 (0.176)	1.243 (0.109) ^{***}
travel time service centre	−0.256 (0.179)	0.006 (0.157)
travel time other urban centre x executive	−0.275 (0.174)	−0.297 (0.147) [*]
travel time other urban centre x couple with children	−0.328 (0.118) ^{**}	−0.323 (0.102) ^{**}
travel time sub-centre	0.658 (0.099) ^{***}	0.546 (0.089) ^{***}
travel time sub-centre x executive	−0.510 (0.241) [*]	−0.438 (0.203) [*]
public transport x pubtrans	0.679 (0.064) ^{***}	0.623 (0.063) ^{***}

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Table 4.9 – continued from previous page

	Conditional logit (1)	Nested logit (2)
housing construction	0.015 (0.005)**	0.030 (0.003)***
% social housing	−0.335 (0.159)*	−0.642 (0.142)***
% social housing x couple with children	1.125 (0.244)***	0.819 (0.207)***
# of rooms	0.211 (0.045)***	0.339 (0.037)***
# of rooms x couple with children	0.319 (0.063)***	0.121 (0.037)***
% executives x executive	1.956 (0.339)***	2.815 (0.299)***
% blue collars x blue collar	2.764 (0.350)***	1.743 (0.295)***
% young x young	4.036 (0.516)***	4.007 (0.502)***
% foreign households x foreign	5.337 (0.982)***	3.230 (1.017)**
employment growth x executive	0.006 (0.002)**	0.003 (0.002)
employment growth x white collar	0.008 (0.002)***	0.008 (0.002)***
employment growth x blue collar	0.002 (0.002)	0.000 (0.002)
infrastructure x non-active	0.123 (0.016)***	0.129 (0.020)***
% recreational area x children	2.798 (1.048)**	1.797 (0.965)
altitude x executive	0.090 (0.023)***	0.080 (0.020)***
altitude x blue collar	0.050 (0.018)**	0.017 (0.014)
altitude x young	0.078 (0.027)**	0.076 (0.026)**
altitude x old	−0.044 (0.023)	−0.057 (0.019)**
altitude x couple with children	−0.040 (0.017)*	−0.041 (0.015)**
% forest area x executive	0.274 (0.193)	0.284 (0.165)
% forest area x young	0.556 (0.268)*	0.561 (0.228)*
% forest area x old	−0.299 (0.194)	−0.366 (0.176)*
% forest area x couple with children	0.185 (0.134)	0.058 (0.114)
% nature area x executive	−3.439 (1.038)***	−3.602 (0.899)***
% nature area x couple with children	1.975 (0.654)**	1.856 (0.542)***
% water area x couple with children	2.219 (0.631)***	1.867 (0.542)***
IV Grenoble		0.797 (0.011)***
IV suburbs		0.961 (0.014)***
IV peri-urban		1.001 (0.024)***
IV extended peri-urban		0.712 (0.018)***

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Table 4.9 – continued from previous page

	Conditional logit	Nested logit
	(1)	(2)
# Observations	65931	65931
# Alternatives	224	224
AIC	115425	115057
Mean VIF (max VIF)	3.337 (27.210)	
Log Likelihood	−57651	−57463
Log Likelihood at 0	−118759	−118759
LR-test statistic	122214	122590
McFadden	0.515	0.516
McFadden (adj.)	0.514	0.516
Estrella	0.926	0.927
Estrella (adj.)	0.926	0.927

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$

Since both models fit similarly well and the only the CL model leads to convergence in our modelling procedure, we use this model for scenario prediction. The results are presented according to seven blocks of variables, namely scaling variables, local attachment/migration costs, travel time to the CBD, transport and other accessibilities, housing prices, housing, social composition and employment growth, and urban and natural (dis)amenities.

The first block of variables shows the effects of our two correction terms, which are simultaneously proxies for the choice of dwelling type by the households (interaction terms) and the municipality size effect (similar to the works of Ben-Akiva and Bowman (1998), Chiappori et al. (2014)). Both are highly significant and positive. Households prefer to choose locations with a higher supply of dwellings in the researched market segment (house vs. flat). Recall that the Grenoble dummy captures the outstanding position of the central municipality in our data set regarding its size (number of dwellings, population, employment), density, public services such as University facilities as well as urban modern amenities such as restaurants, bars and nightlife and cultural and built amenities and heritage (similar use of a dummy variable in de Palma et al. (2007b)). In the CL model, the variable shows only significant coefficients when interacted with certain household characteristics. In the nested model, the generic variable has a positive and highly significant coefficient. Whereas executive households and young singles have

a preference for the city municipality, households with children prefer to locate in other municipalities than the Grenoble municipality. These findings are consistent with different theoretical and empirical findings that explain sub- and peri-urbanisation tendencies and show families' preference to locate in lower density areas (Cavailhès et al., 2004, Van Duijn and Rouwendal, 2013). By contrast, research has shown the preference of young singles and higher income households in European city centres, valuing the presence of an appealing built environment and cultural and modern amenities (Van Duijn and Rouwendal, 2013).

The second block of variables, controlling for local attachment and migration costs, shows preferences for staying in the same municipality and for migration to municipalities farther away. As expected, we find highly significant coefficients indicating that in general, households prefer to stay in the same municipality or to move to a municipality nearby. These findings are consistent with other empirical studies in France and elsewhere (de Palma et al., 2007b, Schirmer et al., 2014, Zondag and Pieters, 2005). We go a step further and presume systematic heterogeneity in preferences across household groups with regard to these two variables. The highly significant interaction terms indicate the presence of such heterogeneity, namely that executives and young singles are less attached to their previous municipality, and that executives and non-actives are likely to move farther away. Old households, non-actives and couples with children are more attached to their municipality, and the latter have a higher preference for moving to locations nearby than the overall population, contrary to the non-actives. The two variables are proxies for social and financial migration costs. They show the spatial inertia underlying the location decisions of heterogeneous households.⁵⁷ For instance, couples with children might stay close to their previous location due to school enrollment of their child(ren) and the location of two workplaces.

The third group of variables relates to the hypotheses of the mono-centric model of urban economic theory. We control for commuting time to the workplace, here proxied by travel time to the CBD (travel time to Grenoble municipality without congestion), and housing prices. Against our expectations, the coefficient for the variable travel time to the center is highly significant and positive for the reference category. It attests a general preference in the household population to locate in municipalities farther away from the center. The interaction terms reveal that young singles and to a lesser extent executive households and non-actives (only significant at 10 %) prefer to locate closer to the centre. These effects remain, however, positive. Old households, couples with children and to a lesser extent working households (blue collar significant at 10 %, white

⁵⁷and also the limited information on housing opportunities in areas much farther away.

collar at 5 %) prefer to locate even farther away than those of the reference category.

We also control for a non-linear relationship between utility and travel time via the squared version of the travel time to the centre variable. The highly significant and negative coefficient indicates that the effect on probability to choose a municipality increases with travel time until a maximum, an optimal distance (around 85 minutes, for executives around 51 minutes), and decreases afterwards.

The positive parameter estimates for the travel time variable run against urban economic theory of household location (mono-centric model), in which households choose their location based on a trade-off between commuting time and land consumption. Utility is supposed to decrease with distance from the center for all households due to rising commuting costs. We cannot interpret our travel time variable in this way since other effects are likely to be captured by this variable. This inconsistency might be due to collinearity (housing prices, model scale or inaccuracy of measurement⁵⁸) and biased estimates, which result from omitted variables that make proximity to the city centre unattractive, notably disamenities such as air pollution, crime, noise and the urban heat island effect. The estimates for the travel time variable incorporate unobserved location factors which explain general preferences for locations farther from the city centre. For prediction in the scenarios, biased coefficients are generally not considered a problem. Scenario changes in travel time as a means to simulate rising or falling commuting costs, and the interpretation of resulting predictions in this regard, are, however, problematic.

We also control for the effect of housing prices on location choice. Due to their high correlation with travel time to the centre (Pearson's r is .82), housing prices enter the model only for control, without interaction terms and with the price residuals from the 2-step control function method to control for price endogeneity. The price coefficient is not significant but has a negative sign, indicating, as expected and consistent with literature, that prices have in general a negative impact on the probability to choose a location valid for all households. The price residuals from the control function method have a positive sign and are not significant, i.e. the unobserved elements correlated with price have a positive influence on the price coefficient. Controlling for endogeneity, the price coefficient is thus more negative. The nested version of our model reinforces the finding of price effects: both coefficients keep the expected signs, but increase in size and become highly significant. The coefficient might thus be insignificant due to collinearity and heterogeneity of price effects among households, i.e. it is a mean value which we use to control for the effect of housing prices. The estimates might still be biased due to

⁵⁸The proxy travel time to the CBD does not capture well the utility a household derives from locating close to work.

remaining price endogeneity and use of average prices aggregated from both house and flat price data.

The fourth block of variables concerns further measures of transport and accessibility. We expect all households to prefer to locate in proximity to municipalities that provide an intermediate level of services. The coefficient has an expected negative sign but is not significant. Shortest travel time to other urban centres than Grenoble, i.e. Lyon, Chambéry, Voiron or Saint-Marcellin, enters the specification with interactions for executive households and couples with children. We suppose that these household types value better access to another urban centre than the dominating one due to access to a second employment market for the couple.⁵⁹ Both interaction terms are negative, and the effect is slightly stronger for couples with children. The executive interaction is only significant in the nested version (at 5 %). Families are more sensitive to travel times to another urban centre.

We also control for the effects of travel time to the closest employment sub-centre, defined as a municipality situated at least 15 minutes away from the central municipality, and having at least 1,000 jobs and a jobs/active population ratio >0.9 . The coefficient is positive and highly significant for the reference category, and far less positive and significantly different at 5 % for executive households. Finally, the coefficient for the public transport dummy (for municipalities having access to railway or tramway networks) show a significant positive value for the interaction with households who actually use public transport to go to work. The migration data does not provide us with data on general transport behaviour. We only observe the mode the households uses once they arrived in the new municipality, i.e. in 2008. In our model, we thus make the hypothesis that there is a general mode preference in transport behaviour which is constant over time for the majority of the household population. According to hypotheses put forward in transportation studies (Wee, 2009), households self-select into municipalities depending also on which transport mode they prefer. Put differently, we expect households to anticipate their journey to work mode decision in the location choice process.

The fifth block concerns variables describing housing supply, all significant at least at 5 %. Housing construction, measured in dwellings started per year and per 1,000 inhabitants, has a significant and positive effect on all households' probability to choose a location. In general, households avoid locations with higher percentages of social housing and prefer those with larger average dwelling size. The coefficients for the interaction terms of couples with children are significant and show that these households prefer locations with higher social housing shares and, as expected, larger dwellings.

⁵⁹ 65 % of executive households live as couples with or without children.

Despite our expectations of heterogeneous preferences for the housing good, especially for dwelling size and social housing, we find that generic variables suffice in our case.⁶⁰

The sixth block of variables presents the coefficients for variables of the social environment and employment dynamics. Each of the four social environment variables is an interaction term between the share of a socio-demographic group in the population of a municipality and a dummy variable, indicating whether the household belongs to this group or not. As expected, we find positive and highly significant social environment effects for executives, blue-collar workers, young singles and foreign households.⁶¹ All of these categories prefer to locate in areas where shares of their group are higher in the local population. This effect is strongest for young singles and foreigners, around twice as strong as for the two socio-professional groups. These findings relate to (economic) segregation literature that explains sorting mechanisms by income (Bayer and McMillan, 2012, Guyon, 2012, Schmidheiny, 2006), life-cycle stage (Bailey, 2012, Dawkins, 2004, Détang-Dessendre et al., 2008) and race and ethnic group (Bayer et al., 2014, Dawkins, 2004), but also to public economic literature where households vote with their feet for bundles of local public goods and services (Banzhaf and Walsh, 2008, Bayer and McMillan, 2012, Tiebout, 1956). Since there is a high correlation between average income per household and shares of executives, the sorting effect observed for executives can also be interpreted as a form of income segregation.

The last three coefficients show effects of employment growth on three groups of the active population, translating the hypothesis that positive job dynamics attract especially households with active heads. The variable is highly significant for executives and white-collar workers, and not significant from zero for blue-collar workers.⁶²

The last group of variables comprises effects of urban and natural (dis)amenities. With regard to urban (dis)amenities, the grey amenity variable (size of large urban infrastructure, landfills and commercial zones in the surrounding of the settlement area of a given municipality) enters the specification interacted with non-active households. The coefficient is highly positive, indicating an attraction of non-actives to these zones.

⁶⁰Note, however, that the results for the dwelling size variable are dependent on the presence of the two correcting terms that control for the size of the house and flat sub-markets. They also capture the preferences for larger (house) and smaller (flat) dwellings through interaction terms. If we consider a simple correction term for municipality size (log of population or number of dwellings), the coefficients of other interactions with the dwelling size variable become significant and increase in size.

⁶¹In alternative specifications not reported here, we did not find significant coefficients for social environment interactions for non-actives and white-collar workers. We also assume that couples with children do not cluster *per se*, since the group is heterogeneous with regard to other characteristics such as income, race and age.

⁶²Employment growth without interaction was not significant in alternative specifications not reported here

According to literature, urban green areas are in particular valued by households with children. Here, the share of urban green areas in surrounding enters the specification only in an interaction term: we find that couples with children prefer municipalities with higher shares of urban green (significant at 1 %).

The remaining variables present the estimation results for natural amenity variables, namely altitude, forest, nature area and water area in surrounding area. In order to reduce collinearity, only interaction terms entered the specification. The altitude coefficients are all significant. For executives (largest coefficient), young singles and blue-collar households, a higher altitude of settlement area (of a municipality) increases the probability of choosing a municipality. By contrast, older households and families prefer municipalities at lower altitudes (significant at 10 % and 5 %, respectively). Finally, effects of natural land use shares in the surrounding of the settlement area have the following effects: we find positive effects of forest area in the surrounding on executives (only significant in the NL model), young singles (at 5 %) and couples with children (not significant), and a negative impact on old households (only significant in the NL model). Executives seem to avoid municipalities with large natural areas in the settlement surrounding, whereas couples with children prefer these locations (both significant at 1 %). The coefficient of the interaction of couples with children with water areas is highly significant and positive, stating that couples with children prefer to locate in municipalities where water areas are present in the surrounding area.

4.4.2 Scenario results

We analyse the effects of the main and sectoral scenarios on residential demand by comparing their outcomes using mapping, descriptive statistics, concentration and segregation indices. We compare these predicted outcomes to the outcomes of the control scenario (0).⁶³ Since all scenarios including the control scenario (0) are based on simulations, differences between their predicted distributions only relate to changes in scenario variables and household preferences.

We used the final CL specification in our iterative simulation procedure to predict new demand distributions for the different planning policy scenarios. This specification without interaction terms for the housing price variable but with endogeneity correction was the only one that yielded a negative coefficient for housing prices (not significant in the CL model). Alternative CL specifications yielded significant positive coefficients for price, especially for the reference category, executives and old households, even when corrected for price endogeneity. For prediction, collinearity and biased price coefficients

⁶³For mapping, we compare the predicted outcomes to the initial household distribution in 2008.

are generally considered unproblematic (Guevara and Ben-Akiva, 2006). In our iterative modeling procedure, however, positive price effects on demand would reinforce themselves, thereby concentrating demand under continuously rising prices in a few municipalities. Similarly, using the NL model in the iterative procedure did not lead to convergence of demand and price.

4.4.2.1 Effects of the main scenarios on residential demand distribution

Effects on residential demand distribution: mapping

The maps in figure 4.8 show absolute (a) and relative changes (b) in household demand in the study region municipalities for the main scenarios (1) to (4) compared to the initial household distribution in 2008. All four scenarios show a significant redistribution of residential demand due to changes in variables and household preferences. As expected, we find greater absolute changes for more populated municipalities, and greater relative changes for less populated municipalities.

Regarding the main scenarios and absolute changes, we find a dispersal of households in the ‘business as usual’ scenario (map 1a). Continued trends in planning and transport policies would lead to further demand dispersal to accessible peripheral and mountain territories in the region. There are notable residential demand losses for central locations of the agglomeration and moderate to high gains in peripheral locations, in valleys and in mountain areas. Some municipalities in the upper and lower Grésivaudan sectors, the area around Voiron and the Bièvre plain stand out.

When regarding the SCoT pattern of demand (map 2a), this process is obviously attenuated. Grenoble and some other municipalities of the agglomeration show population gains, whereas peripheral municipalities grow to a lesser extent or even shrink (See municipalities in the Vercors, Chartreuse, Belledonne, lower Grésivaudan and Bièvre-Valloire sectors). Voiron and its surrounding have an even stronger attraction. The SCoT also reinforces the demand discrepancy between municipalities on the right and left banks of the Isère in the upper Grésivaudan valley close to Grenoble: demand presents relatively higher gains on the right bank and losses on the left bank.

In the ‘sancturisation’ scenario (map 3a), household population losses particularly concern the main mountain areas (Belledonne, Chartreuse, Vercors). Similar to the SCoT, the population becomes more concentrated in the central agglomeration and, additionally, in the upper Grésivaudan valley, in the plain south of the agglomeration (around Vif) and north of Voiron.

Finally, the ‘mountain innovation’ scenario (map 4a) accentuates the demand dis-

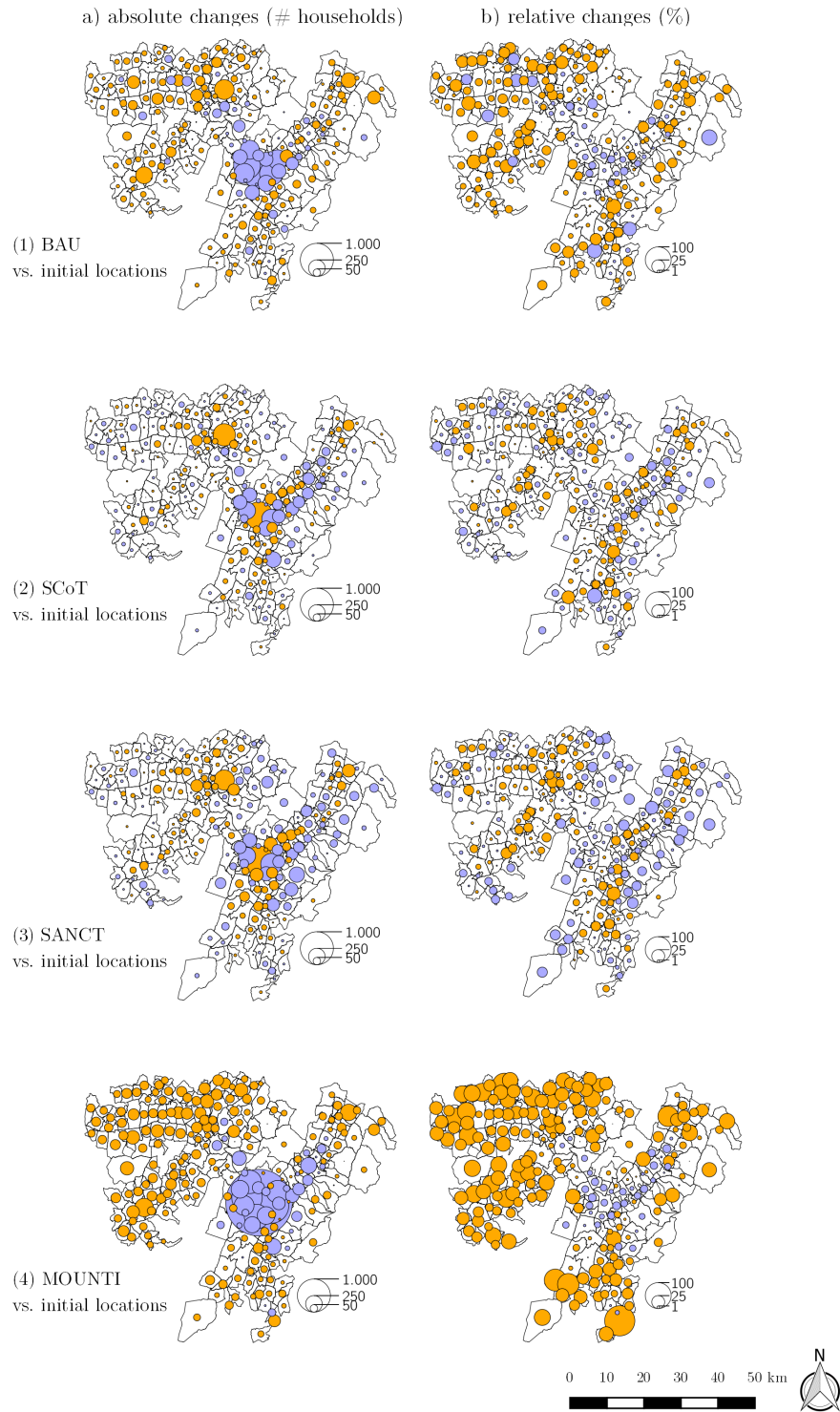


Figure 4.8 – Main scenario effects on total demand distribution: absolute and relative changes to initial locations

Note: dark red = totals, orange ≥ 0 , blue < 0 .

Source: own simulations, IGN BDcarto 2011 for administrative boundaries.

persal observed in the BAU scenario. Grenoble and other municipalities of the agglomeration loose a large amount of their inhabitants (Grenoble on its own loses > 4,000 households), which move to peri-urban areas. Growing territories are especially the Matheysine, Trièves and the upper Gresivaudan valley. Strongest growth is found for the lower Gresivaudan and the Bièvre-Valloire sectors. The three main mountain ranges grow only moderately compared to the former territories.

More detail is provided by the maps showing the relative changes (second column of figure 4.8). Whereas the BAU scenario (map 1b) yields high growth rates of > 20 % in peripheral areas as opposed to notable negative growth rates in the suburbs of the agglomeration, the growth patterns resulting from the SCoT scenario (map 2b) are more balanced: besides the presence of the same growth centres in the periphery, positive and negative growth rates are generally smaller. Map 3b shows the relative growth rates associated with the SANCT scenario. It emphasizes the decline of residential demand in PNR municipalities in the three mountain ranges (negative growth rates around 10-20 %) and high growth rates in neighbouring municipalities. Contrary to this, the MOUNTI scenario (map 4b) causes the strongest growth rates at the very outskirts of the functional urban area, notably in the Trièves, Matheysine, Bièvre-Valloire and Saint-Marcellin territories. At the same time, agglomeration municipalities show negative growth rates (ranging from -5 to -15 %).

Effects on residential demand distribution: territories & classes of municipalities

Table 4.10 provides simulation results for territories and types of municipalities. We use five different classifications of the region's 224 municipalities for interpretation: the FUA typology, the urban centre hierarchy, planning sectors (adapted), SCoT and PNR perimeters. The table gives the observed household distribution in 2008 and the predicted control (0) scenario distribution (based on 2008 data) in absolute values. Recall that effects of the main planning scenarios (1) to (4) are provided as percentage changes from the control scenario (0) outcomes.

Generally speaking, the predictions in the table show that current and continuing trends in planning and transport policy cause sustained peri-urbanisation processes in the region. The BAU scenario has a stronger impact on peri-urbanisation than the control scenario (0), as it extends its trends (absolute difference in percentage changes of +0.8 % for peri-urban areas, +1.4 % for remote areas, -0.8 % for the agglomeration). As expected, the effects of the 'mountain innovation' scenario (4), which alleviates mobility and reinforces decentralization of employment and habitat, create a far superior growth in peri-urban and remote areas than the BAU scenario. Three peripheral sectors present

double-digit demand increases⁶⁴. Compared to the control scenario (0), predicted demand in central locations drops by 6 % in Grenoble, by 2 % in the suburbs and by 4 % in the agglomeration. In the scenarios (1) and (4), almost all the peripheral planning sectors show increases in predicted residential demand. Whereas the demand within the SCoT perimeter slightly decreases, it increases in the 25 municipalities situated beyond the SCoT, again with highest increases for the MOUNTI scenario.

By contrast, SCoT and SANCT scenarios seem in general to be capable of curbing and partially reversing peri-urbanisation. Compared to the control scenario (0), residential demand grows in Grenoble and in the suburbs, and also in the agglomeration (+2.3 % and +2.5 %, respectively). Whereas the SCoT scenario (2) shows tendencies of both sustained peri-urbanisation (stable demand in Voironnais and slight decline in the urban centres) and re-urbanisation (in the agglomeration), the SANCT scenario (3) changes indicate a stronger re-concentration of demand in Grenoble urban area (stronger growth in the suburbs) and more generally the SCoT perimeter. In terms of planning sectors, only two sectors show positive evolutions in demand in the two scenarios that confine peripheral growth, notably the Voironnais and the agglomeration.

The effects for demand in regional nature parks are consistent with these results: demand in the Chartreuse and Vercors PNRs rises by ca. 6.2 % in the MOUNTI scenario and stays stable in the BAU; SCoT and SANCT scenarios decrease demand by 3.8 % and 13.8 %. Effects are stronger in the Belledonne range than in the Chartreuse and Vercors PNRs, except for the MOUNTI scenario in which predicted demand remains stable compared to the BAU.

Some of the classes of municipalities show similar effects on residential demand across all scenarios. This is especially the case for the typology of urban centres. In general, demand is likely to stabilize or decrease in all scenarios in the two urban centres Voiron and Saint-Marcellin. In the same vein, demand rises in the municipalities of the Voironnais.

Effects on residential demand distribution: concentration indices

The concentration indices in table 4.11 globally confirm the results of the detailed demand evolution for municipality groups. The Gini index indicates a strong inequality in initial population distribution and in predicted residential demand for the control scenario (slightly lower).

This inequality reduces moderately for the BAU scenario, and strongly for the MOUNTI scenario, due to peri-urbanisation that re-balances the distribution of de-

⁶⁴Bièvre-Valloire, Sud-Grésivaudan and Trièves

Table 4.10 – Main scenarios: demand changes for territories & classes of municipalities

Group	N	Observed (2008)	Control (0)	BAU (1)	SCoT (2)	SANCT (3)	MOUNTI (4)
^a Grenoble	1	59,084	58,292	-0.8	+2.6	+2.8	-6.0
Suburbs	50	122,691	119,983	-0.3	+1.6	+2.3	-2.0
Peri-urban	114	55,694	57,558	+0.8	-3.3	-4.4	+5.2
Remote	59	28,562	30,199	+1.4	-5.3	-6.2	+9.6
^b Urban centres	2	11,471	12,056	+0.6	-0.3	-1.0	-2.6
Primary centres	24	83,701	82,468	-0.0	+0.1	+0.7	-2.3
Support centres	49	60,014	59,215	+0.8	-0.1	+0.8	+2.3
Secondary centres	34	21,220	21,633	+0.2	-0.6	-1.4	+2.9
Local centres	89	19,468	20,878	+0.0	-4.1	-6.2	+15.8
^c Agglo. Grenobloise	28	146,688	142,923	-0.8	+2.3	+2.5	-4.0
Bièvre-Valloire	42	17,923	18,804	+1.6	-4.8	-3.3	+13.8
Chartreuse	7	3,986	4,080	-0.9	-3.4	-10.9	+3.1
Grésivaudan	40	32,130	32,810	+1.3	-2.8	-3.6	-0.5
Matheysine	13	5,151	5,352	-1.1	-4.3	-4.2	+4.5
Sud-Grenoblois	17	11,740	12,018	+0.6	-2.7	-2.8	-0.2
Sud-Grésivaudan	35	14,056	14,698	+2.2	-3.6	-3.3	+12.0
Trièves	7	1,218	1,364	-0.4	-10.3	-11.5	+15.4
Vercors	3	1,319	1,395	+1.1	-7.2	-17.6	-1.7
Voironnais	32	31,820	32,586	+0.1	+0.0	+0.5	+3.1
SCoT	199	254,959	254,541	+0.0	+0.2	+0.4	-0.2
Non-SCoT	25	11,072	11,490	-0.6	-4.5	-8.3	+3.5
^d PNR	31	10,837	11,215	-0.1	-3.8	-13.8	+6.2
PNR Belledonne	17	9,129	9,517	+1.0	-5.2	-14.8	-0.0
Non-PNR	176	246,064	245,299	-0.0	+0.4	+1.2	-0.3

Notes: Values for scenarios (0) to (4) are based on simulations, changes in scenarios (1) to (4) are percentage changes to the control scenario (0), ^aFUA typology, ^bmunicipality typology (Grenoble (urban centre) and non-SCoT municipalities not included since listed elsewhere in the table), ^cadapted SCoT planning sector classification (including non-SCoT municipalities), ^dPNR perimeter (only municipalities comprised entirely).

mand. This effect is positive for the SCoT scenario and SANCT scenarios that increase the concentration of household demand. These results are confirmed by Hoover's concentration index; an increase in H reflects an increased concentration: dispersal occurs in the BAU and MOUNTI scenarios, but not in scenarios that impose greater constraints on peripheral development (SCoT, SANCT).

The centralisation index calculated for overall demand predictions details these findings: there are indeed strong decreases in centralisation of demand for the two less confining scenarios (1) and (4). Centralisation increases for SCoT and SANCT scenarios. The Grenoble primacy index also points in this direction. The share of residential demand in the central urban area, with 85 % a high value, shows increases for the two confining planning scenarios SCoT and SANCT (1.2 %), and decreases for BAU and MOUNTI scenarios.

Table 4.11 – Main scenarios: concentration indices

Indices	Observed (2008)	Control (0)	BAU (1)	SCoT (2)	SANCT (3)	MOUNTI (4)
<i>Gini</i>	0.700	0.689	-0.2	+1.3	+1.7	-4.2
<i>H</i>	0.408	0.396	-0.6	+2.3	+2.8	-6.4
<i>ACE</i>	0.455	0.437	-1.0	+3.8	+4.2	-8.0
<i>Grenoble primacy</i>	84.834	84.080	-0.5	+1.2	+1.2	-1.3

Notes: Values for scenarios (0) to (4) are based on simulations, changes in scenarios (1) to (4) are percentage changes to the control scenario (0).

4.4.2.2 Effects of the main scenarios on residential demand segregation

Effects on residential demand segregation: mapping

The maps in figure 4.9 provide growth rates of specific household groups caused by the four scenarios. For reasons of space, we focus here on the distribution of demand of three particular population groups: executive households, blue-collar worker households and couples with children.

Typically the most centralised group, executive households continue to demand housing in accessible mountain areas but also peripheral locations in the BAU (map 1a). The Grenoble municipality and the inner suburbs show negative growth rates of executive demand. The MOUNTI scenario (map 4a) shows a similar but accentuated demand pattern, in which agglomeration and valley municipalities forfeit executive household demand. Here, executive households prefer peripheral hilly and mountain territories.

Both SCoT and SANCT scenarios (maps 2a and 3a) show a slight re-centralisation of executives with small positive growth rates in the centre and inner suburbs. It is important to note that some mountain municipalities keep their demand dynamics in terms of executive households in both scenarios.

Across all main scenarios, the demand of blue-collar worker households increases its concentration especially in areas where their municipal shares are already high. This concerns especially industrial areas south of Grenoble (Sud-Grenoblois, Matheysine), the upper Gresivaudan valley, and to a lesser extent areas in the Voironnais, lower Gresivaudan and in the Bièvre sector. In these latter sectors, demand increases stronger in the BAU and especially in the MOUNTI scenarios (maps 1b and 4b); SCoT and SANCT stronger increase the demand of this group in the more central locations and the Matheysine (maps 2b and 3b).

Couples with children, typically less centralised, avoid locations of the agglomeration except for the municipalities in the close Grésivaudan valley north-east of Grenoble. In the BAU (map 1c) and SCoT scenarios, higher demand growth rates are also present in the three close mountain ranges Chartreuse, Vercors and Belledonne. Similar to the growth patterns for the overall household population, the dispersion of the demand of households with children is less pronounced for the SCoT (map 2c) and especially the SANCT scenario (map 3c). In the latter, households face notably restrictions to move to mountain areas. MOUNTI scenario (map 4c) effects for households with children show a strong abandonment of the three major Alpine valleys⁶⁵.

Effects on residential demand segregation: segregation indices

Scenario effects on social status and life-cycle segregation are analysed with single-group, inter-group and multi-group indices for evenness and centralisation. As above, table 4.12 presents calculated indices in absolute values for the observed household distribution in 2008 and the control scenario (0). Recall that we cannot interpret differences between these two situations in terms of effects of the control scenario due to prediction inaccuracy of the model. The similar magnitude of calculated indices is, however, an indication that the model has good predictive power. The last four columns of the table present variations of the scenarios (1) to (4) from the control scenario in percentage changes. The scenario changes in segregation indices can be compared to each other, since the household population remains the same across scenarios.

⁶⁵The familiar *Y grenoblois*, the settlement structure of the urban region. Including the agglomeration, both banks of the Isère river in the upper and lower Gresivaudan up to Voiron, and the southern Romanche and Drac valleys.



Figure 4.9 – Main scenario effects on household groups: relative changes to initial locations

Note: dark red = totals, orange ≥ 0 , blue < 0 .

Source: own simulations, IGN BDcarto 2011 for administrative boundaries.

Observed and predicted indices show segregation patterns with regard to socio-professional status of the household head. Single-group Duncan segregation indices show a moderate unevenness (.20) in the distributions of executives and blue-collar workers at the outset. Executive households are more segregated than blue-collar worker households (absolute difference of + 3 percentage points). Both groups are highly segregated from each other (see also section 4.3.2): inter-group dissimilarity is .34. Considering all socio-professional categories, the composite dissimilarity index indicates a more moderate segregation between the socio-professional groups (.15). With regard to centralisation and as expected, executive households appear to be far more centralised (.57) than blue-collar worker households (.35, least centralised group).

Table 4.12 – Main scenarios: segregation indices

Indice	Group	Observed (2008)	Control (0)	BAU (1)	SCoT (2)	SANCT (3)	MOUNTI (4)
SI_{Duncan}	Exec.	0.222	0.210	+0.8	+2.3	+1.9	-10.4
	Blue-c.	0.190	0.188	+0.8	-0.1	+0.4	-8.7
	Young	0.360	0.379	-0.7	+3.1	+4.8	-6.4
	Old	0.072	0.063	+2.0	+3.8	+5.5	+12.2
	With children	0.169	0.183	+0.1	-4.4	-4.2	-2.8
ID_{Duncan}	Exec./Blue-c.	0.342	0.332	+0.8	+1.4	+1.5	-10.0
	Young/Old	0.356	0.374	-1.1	+4.4	+5.3	-9.2
ID_{multi}	SPC	0.147	0.143	+0.1	+1.3	+1.4	-9.0
	Age	0.099	0.097	+1.6	-1.1	+0.6	+6.6
ACE	Exec.	0.567	0.539	-0.5	+5.4	+6.0	-10.8
	Blue-c.	0.345	0.318	-2.1	+6.4	+7.0	-12.2
	Young	0.697	0.735	-0.3	+5.6	+5.9	-1.6
	Old	0.445	0.434	-0.5	+1.1	+1.3	-4.0
	With children	0.382	0.345	-1.7	+6.2	+6.9	-14.4

Notes: Values for scenarios (0) to (4) are based on simulations, changes in scenarios (1) to (4) are percentage changes to the control scenario (0).

Compared to the predicted demand patterns for the control scenario, unevenness in the distribution of socio-professional categories increases for scenarios (1), (2) and (3) (especially for executive and blue-collar worker households). Increases are strongest for the SCoT and SANCT scenarios, and there especially for the single-group index of executive households (+2.3 % and +1.9 % respectively). Executive - blue-collar worker household dissimilarity and the multi-group index show increases between 1.3 % and 1.5 %. Blue-collar worker household segregation remains stable in the SCoT scenario

(-0.1 %) and slightly increases in the SANCT scenario (+0.4 %). In the BAU scenario, segregation between these socio-professional groups increases more slightly.

Only in the ‘mountain innovation’ scenario (4), unevenness decreases compared to the control scenario (0): the indices present much stronger percentage changes for the four indices of socio-professional groups. Unevenness in the distribution of executive households decreases stronger (-10.4 %) than for blue-collar worker households (-8.7 %). Segregation between these groups decreases by 10 %, and by 9 % between all considered socio-professional categories. The strong increase in evenness is probably due to the reduction of migration constraints in this scenario.

The scenarios have varying effects on the centralisation of blue-collar worker households: whereas centralisation increases strongly for SCoT and SANCT scenarios (+6.4 % and +7.0 %), it decreases slightly in the BAU scenario (-2.1 %) and very strongly in the MOUNTI scenario (-12.2 %). The effects on centralisation of executive household demand show a similar pattern, with generally lower effects. The trend and mountain innovation scenarios attract executive and blue-collar household demand to less centralised areas, whereas SCoT and SANCT scenarios achieve a positive effect on centralisation of this demand.

With regard to life-cycle segregation, we particularly look at the segregation of three household groups: young singles, couples with children and old households. Young singles are the most segregated group in our sample with regard to unevenness and centralisation of their distribution: 36 % of young singles would have to move in order to achieve the same share in all municipalities; the centralisation index of the young is by far the highest (.70)(observed distributions). By contrast, the distribution of old households is fairly even (.07), and the group is not very centralised, as expected (.45). Young - old inter-group dissimilarity is even higher than that of executive and blue-collar worker households (.36). Couples with children show a moderate level of segregation (.17), with a low level of centralisation, also as expected (.38). Multi-group segregation between all age classes is moderate (0.1).

The strongest effects on segregation of young and old household result from the SCoT, SANCT and MOUNTI scenarios. For young singles, scenario effects decrease segregation slightly in the BAU (-0.7 %) and strongly in the MOUNTI scenario (-6.4 %); and they increase segregation in the SCoT and SANCT scenarios (+3.8 % and +5.5 %). This goes in hand with similar patterns in centralisation of this group: for the young, the confining scenarios SCoT and SANCT have a strong positive effect on the centralisation of demand (around 5.6 % increase), ca. four times the size of the negative effect from the MOUNTI scenario (-1.6 %).

By contrast, segregation of old households grows in all scenarios, strongest for scenarios (3) and (4) (+5.5 % and +12.2 % respectively). Effects on centralisation show a similar pattern than for the young, with slighter increases resulting from the SCoT and SANCT and a stronger decrease for the ‘mountain innovation’ scenario. The young - old households inter-group dissimilarity index similarly shows decreases in segregation for the scenarios (1) and (4), -1.1 % and -9.2 %, and increases for the two confining scenarios SCoT and SANCT, where the effects of the latter are slightly stronger (+5.3 %).

With regard to the multi-group dissimilarity index for all considered age groups (young singles, middle-aged and old households), there is an opposition with the above findings. The index shows that segregation between age group demand increases in all scenarios except for the SCoT, with the largest increase for the MOUNTI scenario (+6.6 %). The opposition is likely to be due to segregation levels of the middle age group (not reported here), which is the largest age group and potentially outweighs decreasing segregation levels of the young and old groups⁶⁶.

Finally, segregation of demand of couples with children decreases in almost all scenarios. This effect is strongest for sustained planning trends in the confining SCoT and SANCT scenarios (-4 %). In the BAU scenario, segregation remains almost stable (+0.1 %). The scenario effects on centralisation on this group are comparable in signs and magnitude to the blue-collar workers: slight decrease of centralisation in the trend scenario (1), high increases through SCoT and SANCT policies (+6 %), and largest decrease in centralisation due to the changes in the MOUNTI scenario (-14.4 %).

In a nutshell, our predictions suggest that policies that constrain peripheral growth and foster densification seem to sustain and potentially engender higher levels of income and age segregation. Segregation of households with children, however, is lower in these scenarios. Constraining development and promoting density policy lead to a higher centralisation of residential demand of all household groups. Trend and mountain innovation scenarios have a decentralisation effect on demand - with strongest effects on executive and blue-collar worker households and couples with children - and a positive effect on social mix.

4.4.2.3 Effects of main scenarios on residential demand in mountain areas

We are interested in the scenario effects on overall demand for mountain areas as well as in its composition, i.e. the demand from various household groups.

A relatively small part of the urban region’s household population lives in mountainous areas. Table 4.13 shows that 7.5 % of the household population live in the 48

⁶⁶The group’s *SI* index is fairly low (0.03).

municipalities of the three mountain ranges Chartreuse, Vercors and Belledonne (*ca.* 20,700 households, PNR delimitation); 4.3 % (*ca.* 11,300 households) live in municipalities with an average altitude between 600 and 900 m a.s.l. (25 municipalities); and only 2.4 % (*ca.* 6,400 households) have their residence in settlements above 900 m a.s.l. (23 municipalities).

Group shares indicate the share of specific groups in the population of the three mountain ranges. For instance, the mountain population is composed by 17.3 % of executive and 14.3 % of blue-collar worker households. Old households and couples with children both make up 38 % of the mountain population, indicating that almost 4 out of 5 households in the mountains is either old or a family with children⁶⁷. By contrast, young households make up a very small portion of the mountain population (1.5%), since they are concentrated in central locations in the valley.

The four main scenarios alter the residential demand in mountain areas quite differently (see table 4.13). We find only slight changes for the BAU scenario ($< \pm 0.5$ %) compared to the control scenario (0). If we compare control and BAU scenario distribution to the observed distribution in 2008 (leaving aside potential bias), we see a general increase in mountain residential demand. Whereas young singles and old households leave these territories, executive and blue-collar worker households and households with children continue to demand these areas.

Comparing the BAU scenario to our control, changes in global demand are higher in the mountain ranges but lower at higher elevations. Demand increases for executives, the young and households with children. Slightly more old households tend to leave the mountain territories. Globally, in continued trend scenarios, we would expect increases in demand and slight changes in the mountain population towards a wealthier population (proxied by executives) and a larger share of couples with children.

For the two opposing planning policy scenarios that specifically aim at preserving vs. developing the mountain territories, we find expected changes to residential demand. The ‘sanctuarisation’ scenario (3) leads to stark decreases in demand in municipalities located above 900 m (-12.3 %). Demand decreases by 11 % in locations between 600 and 900 m, and by 14.3 % in all municipalities of the main mountain ranges (*ca.* 2,900 households). Demand specifically decreases for executives, the young, blue-collar worker households and households with kids. The demand share of older households increases by 11 %; that of executive households decreases twice as strongly as that of blue-collar worker households. The SANCT scenario effects provoke a decrease in demand for mountain municipalities of young and highly-educated households, which might lead to

⁶⁷Not exclusive categories.

Table 4.13 – Main scenarios: effects on demand in mountain areas

Shares (%)	Observed 2008	Control (0)	BAU (1)	SCoT (2)	SANCT (3)	MOUNTI (4)
Households in ^a ‘mountain’ municip.	7.51	7.79	+0.4	-4.4	-14.3	+3.4
Households in municip. ^b > 600 m	4.25	4.47	-0.3	-4.8	-11.0	+2.8
Households in municip. ^c > 900 m	2.43	2.54	-0.6	-6.6	-12.3	+6.0
Group in ^a mountain pop.						
executives	17.30	17.97	+0.4	-4.8	-8.6	+6.8
blue-collar workers	14.26	14.52	+0.0	-0.0	-4.4	-0.5
young	1.68	1.47	+0.3	-21.6	-51.4	+17.0
old	38.62	38.00	-0.3	+3.6	+11.0	-2.8
couples with children	37.71	38.89	+0.1	-1.0	-2.5	+0.6

Notes: Values for scenarios (0) to (4) are based on simulations, changes in scenarios (1) to (4) are percentage changes to the control scenario (0), ^a48 municipalities located in the PNRs of Chartreuse and Vercors and the PNR project Belledonne, ^b25 municipalities situated between 600 and 900 m a.s.l., ^c23 municipalities situated above 900 m a.s.l.

aging and a loss of human capital in these areas. Also, there is less demand from couples with children in the mountain ranges (-2.5 %).

Orienting planning objectives in the opposite direction, innovation and employment creation in the ‘mountain innovation’ scenario (4) lead to strong increases of residential demand in the mountains (+3.4 %, i.e. *ca.* 700 households for three mountain ranges). The demand for municipalities above 600 m rises by 2.8 %, that for municipalities above 900 m by 6.0 %. Especially executives and young households increase their share in overall demand for mountain municipalities (equivalent to +250 executive and +50 young households). The demand share of old households decreases by 2.8 %; that of blue-collar worker households and couples with kids remains stable. In the MOUNTI scenario, the population preferring mountain areas as residential location becomes wealthier and younger.

The SCoT scenario (2) has similar but more attenuated influences on household residential demand for mountain areas to the ‘sanctuarisation’ scenario (3). For the elevation zones, the demand share decreases by half the percentage values of the SANCT scenario (-4.8 % and -6.6 % respectively). In the main mountain ranges, overall residential demand decreases by 4.4 % (*ca.* 900 households). Except for the old households which show an increase of demand share (+3.6 %, *ca.* 280 households), demand shares decrease for executive households, young singles and also couples with children (180, 65, and 80 households, respectively). The demand share of blue-collar worker households

remains stable in the SCoT scenario, similar to the BAU. In the SCoT scenario, residential demand in mountain areas is likely to loose demand from young and executive households, whereas demand shares especially of old households increase in mountain municipalities.

Globally, we see that the residential demand of executives, the young and the old in mountain areas tends to react stronger to planning scenarios than the demand of blue-collar workers and couples with children since the former groups are more mobile than the latter.

4.4.2.4 Effects of sectoral planning scenarios

In order to disentangle sectoral policy effects on demand distribution within the SCoT scenario, we use the same result measures as for the main scenarios. We compare these outcomes also to the outcomes of the control scenario (0).⁶⁸ Together, the changes in demand due to sectoral changes make up the overall effect of the SCoT scenario.

Effects on residential demand distribution: mapping

The maps in figure 4.10 show absolute (a) and relative changes (b) in household demand in the study region municipalities for the four sectoral scenarios (2a) to (2c) compared to the initial household distribution in 2008. All four sectoral scenarios show a redistribution of residential demand, whereas the pattern for scenarios 2a, 2b2 and 2c show strong similarities.

The two maps for scenario (2a) show the changes to the initial household distribution that are due to the application of the SCoT housing objectives. There are strong positive changes in absolute demand for smaller centres like Voiron, Saint Marcellin and Pontcharra and their surrounding municipalities. Demand decreases also in peripheral rural and mountain municipalities. Grenoble agglomeration, its suburbs and some valley municipalities (on the left bank of the Isère in the Gresivaudan, Voreppe area) partially register strong decreases in residential demand.

The maps for scenarios (2b1) and (2b2) provide information on the changes that are due to the two transport policy scenarios. For the road travel time extension scenario only (extend), the maps show a similar pattern but larger absolute changes both in the shrinking and growing municipalities than in the housing scenario. As seen from our residential location choice model, households prefer to locate farther away from the agglomeration and from secondary job centres.

⁶⁸Again for mapping, we compare outcomes to the initial household distribution in 2008.

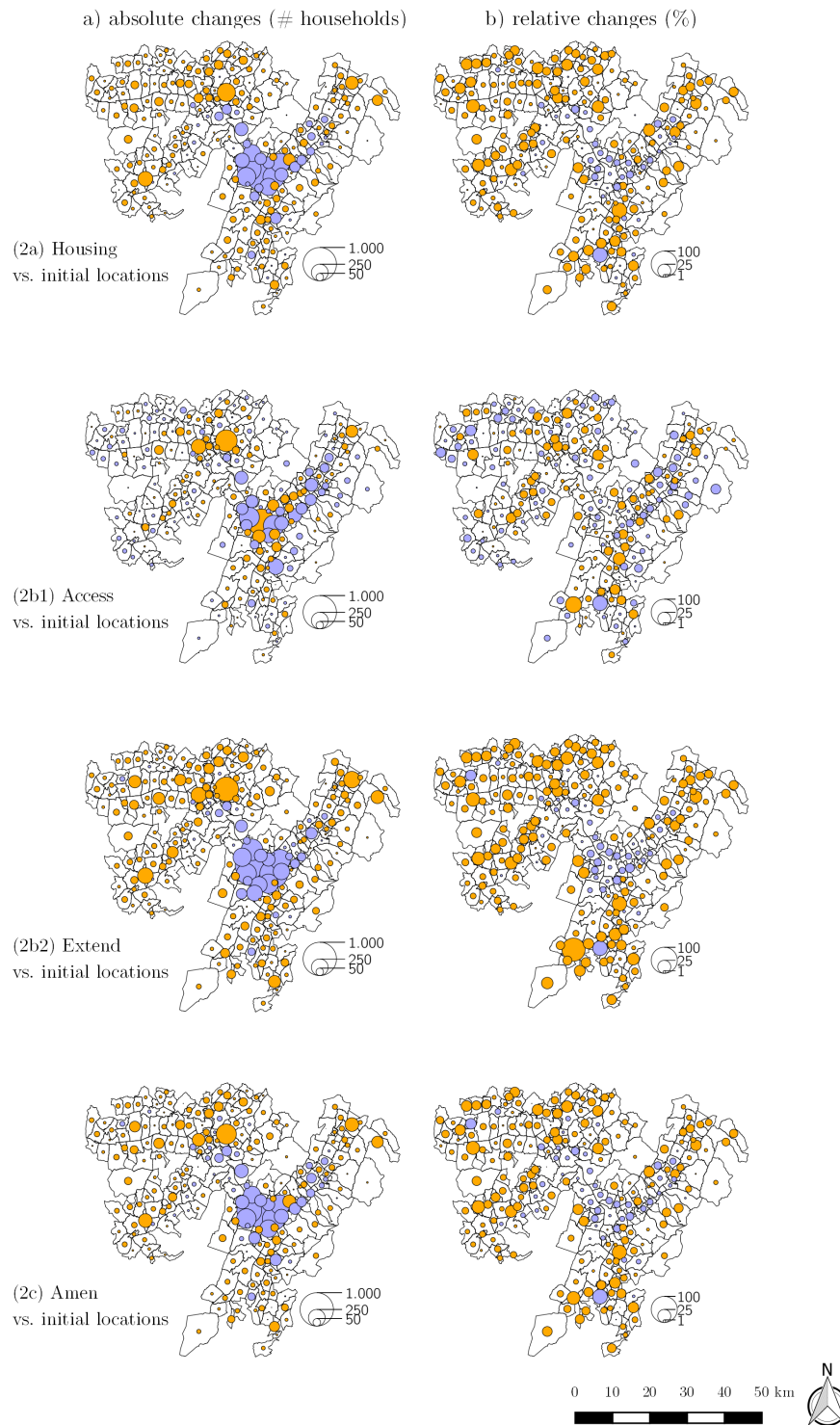


Figure 4.10 – Sectoral scenario effects on total demand distribution: absolute and relative changes to initial locations

Note: dark red = totals, orange ≥ 0 , blue < 0 .

Source: own simulations, IGN BDcarto 2011 for administrative boundaries.

Contrary to this, the maps for scenario (2b1) show the full transport and employment scenario effect, which reduces notably demand increases in small peripheral municipalities (e.g. Bièvre, lower Gresivaudan, Belledonne, Chartreuse, Vercors, Trièves, Matheysine). Grenoble municipality, some municipalities of the close suburbs and close municipalities on the right bank of the Isère register increases in demand. Residential demand concentrates along the major public transport axes (notably around stations of the *Sillon alpin* railway). But also some municipalities in the mountain ranges still show demand increases. There is a great similarity between this map and map of the global SCoT scenario effects, suggesting that this sectoral dimension is the predominant one in SCoT policy.

Finally, the maps of scenario (2c) show the demand changes when only urban amenity policy effects are applied and the rest of the variables remains stable. The resulting pattern is very similar to the pattern obtained from the housing policy scenario (2a), which suggests similar effects of urban amenity changes on residential demand.

Effects on residential demand distribution: territories, classes of municipalities & concentration indices

Tables 4.14 and 4.15 show that the sectoral scenarios have differentiated effects on the distribution of residential demand. They depict effects on demand share for classes of municipalities and territories in our region and on concentration indices. Both present percentage changes for each sectoral scenario compared to the control scenario, and provides the overall SCoT effects for comparison.

In general, variable changes in the two transport scenarios (2b1, 2b2) have larger effects on demand distribution and concentration than changes related to the ‘housing’ and ‘urban amenities’ scenarios (2a, 2c). The ‘access’ scenario shows effects that confirm the suggestion made in the mapping section above: the (2b1) effects on demand are globally very similar to the directions and magnitudes of those calculated for the SCoT. Both tables also highlight the non-linearity and non-additionality of the sectoral scenario effects: percentage changes of the sectoral scenarios do not sum up to the overall SCoT effect.

In more detail, the housing scenario reflects the objectives of construction stipulated by the SCoT in terms of house and flat construction and social housing share. Scenario changes also affect total number of houses and flats in a municipality and average dwelling size. Exclusive changes to these variables towards SCoT objectives (2a) contribute to continued peri-urbanisation of demand (compared to the control scenario): predicted demand decreases in Grenoble, other urban centres and the agglomeration, whereas it

increases for peripheral sectors and PNR. Concentration and centralisation indices do also decrease (see table 4.15). In our simulations, construction objectives alone do not contribute to a desired rise in residential demand in Grenoble and its suburbs. Demand distribution between the SCoT perimeter and the area beyond it remains stable.

Among all sectoral scenarios, exclusive changes to urban amenities (2c) have the lowest effects on residential demand distribution and concentration. Demand in Grenoble increases slightly (+0.3%) and remains stable for the agglomeration. Demand also slightly increases in some sectors and territories beyond the SCoT perimeter (see table 4.14). Effects on concentration indices are negligible: the values confirm that changes to urban amenities have no notable effect on demand distribution ($< 0.05\%$).⁶⁹

Scenario (2b2) originally had the intention to simulate the situation of increased commuting costs via extensions in travel time to the urban centre. From a planning perspective, such measures should contribute to a re-concentration of residential demand. However, given the biased coefficient for this variable (see above), such scenario development is problematic. By increasing travel times to the centre, we mechanically increase the effect of unobserved location factors and household preferences that benefit locations in the periphery. Therefore, scenario (2b2) is another continued trends scenario that favours dispersal of residential demand and hence its peri-urbanisation: both concentration and centralisation decrease (Hoover and ACE indices decrease by 1.6 % and 2.1 % respectively). Especially peri-urban and remote areas, local centres, mountain territories (PNR, sectors of Chartreuse, Matheysine, Trièves and Vercors) and areas beyond the SCoT perimeter attract demand, to the detriment of Grenoble and its suburbs.

The ‘access’ scenario - the full transport policy objectives of the SCoT - shows effects on demand that are globally very similar to SCoT effects themselves. This scenario seems to contribute heavily to the observed re-concentration process engendered by the SCoT. The concentration indices in table 4.15 confirm this finding. Recall that scenario (2b1) represents a situation in which road travel times to the centre are extended for peripheral locations, public transport competitiveness to various transport hubs is improved⁷⁰ and household preferences to locate farther away from the centre (and secondary employment centres) are reduced by 50 %. Given the results for scenario (2b2), a re-centralisation of demand in the ‘access’ scenario (2b1) can only arise from a change in households’ sensitivity to travel time.

⁶⁹The Corine land cover data set lacks detail with regard to the scale of our analysis. It considers only continuous areas larger than 25 ha.

⁷⁰Reduction of travel time from transport nodes and partially from their surroundings

Table 4.14 – Sectoral scenarios: demand changes for territories & classes of municipalities

Group	N	SCoT effect		SCoT sectoral scenario effects			
		Control (0)	SCoT (2)	housing (2a)	access (2b1)	extend (2b2)	urbams (2c)
^a Grenoble	1	58,292	+2.6	-0.4	+2.5	-1.0	+0.3
Suburbs	50	119,983	+1.6	+0.0	+1.5	-1.1	-0.2
Peri-urban	114	57,558	-3.3	+0.4	-3.1	+2.2	+0.0
Remote	59	30,199	-5.3	-0.1	-5.0	+2.1	+0.1
^b Urban centres	2	12,056	-0.3	-0.5	-0.7	+1.7	-0.2
Primary centres	24	82,468	+0.1	-0.3	+0.2	-0.6	-0.2
Support centres	49	59,215	-0.1	+0.3	-0.0	-0.2	-0.2
Secondary centres	34	21,633	-0.6	+0.7	-0.8	+0.8	-0.1
Local centres	89	20,878	-4.1	+1.3	-4.8	+2.0	-0.1
^c Agglo. Grenoble	28	142,923	+2.3	-0.1	+2.2	-1.5	+0.0
Bièvre-Valloire	42	18,804	-4.8	+0.2	-4.7	+2.0	-0.1
Chartreuse	7	4,080	-3.4	+0.3	-2.1	+3.5	+1.5
Grésivaudan	40	32,810	-2.8	+0.3	-2.7	+0.8	-0.1
Matheysine	13	5,352	-4.3	-0.7	-3.4	+2.7	+0.3
Sud-Grenoblois	17	12,018	-2.7	+0.4	-2.7	+1.7	-0.2
Sud-Grésivaudan	35	14,698	-3.6	+0.2	-3.5	+1.9	-0.1
Trièves	7	1,364	-10.3	-0.2	-10.0	+3.9	-0.2
Vercors	3	1,395	-7.2	+1.5	-5.7	+6.4	+3.3
Voironnais	32	32,586	+0.0	-0.1	-0.1	+1.9	-0.2
SCoT	199	254,541	+0.2	+0.0	+0.2	-0.2	-0.0
Non-SCoT	25	11,490	-4.5	-0.1	-3.4	+3.5	+1.1
^d PNR	31	11,215	-3.8	+0.7	-3.3	+3.7	+0.9
PNR Belledonne	17	9,517	-5.2	+0.3	-5.3	+2.0	-0.1
Non-PNR	176	245,299	+0.4	-0.0	+0.4	-0.2	-0.0

Notes: Values for scenarios (0) to (2c) are based on simulations, changes in scenarios (2) to (2c) are percentage changes to the control scenario (0), ^aFUA typology, ^bmunicipality typology (Grenoble (urban centre) and non-SCoT municipalities not included since listed elsewhere in the table), ^cadapted SCoT planning sector classification (including non-SCoT municipalities), ^dPNR perimeter (only municipalities comprised entirely).

Table 4.15 – SCoT & sectoral scenarios: concentration indices

Indice	SCoT effect		SCoT sectoral scenario effects			
	Control (0)	SCoT (2)	housing (2a)	access (2b1)	extend (2b2)	urbams (2c)
<i>Gini</i>	0.689	+1.3	-0.3	+1.4	-0.8	-0.0
<i>H</i>	0.396	+2.3	-0.4	+2.3	-1.6	+0.0
<i>ACE</i>	0.437	+3.8	-0.1	+3.7	-2.1	+0.0
<i>Grenoble primacy</i>	84.080	+1.2	+0.1	+1.1	-0.6	+0.0

Notes: Values for scenarios (0) to (2c) are based on simulations, changes in scenarios (2) to (2c) are percentage changes to the control scenario (0).

Effects on residential demand segregation

Table 4.16 shows that transport scenarios have stronger effects on segregation than housing or urban amenity scenarios. Again, effects of the ‘access’ scenario (2b1) show similar signs and comparable magnitudes to the SCoT effects. The other sectoral scenarios contribute to a much lesser extent to the SCoT effects.

Two exceptions between the scenarios ‘access’ and ‘SCOT’ can be observed: for couples with children (segregation index -0.1 %) and age groups (multi-group index -0.9 %), indices remain stable although the SCoT scenario causes decreases. The *SI* indices for executive households and young singles as well as the two- and multi-group *ID* indices show even higher effects on segregation than the SCoT. Centralisation has slightly lower effects than the SCoT for blue-collar worker households and couples with children.

The ‘housing’ scenario (2a) has only slight effects on evenness and almost none on centralisation of our household groups: unevenness generally decreases due to scenario changes in housing variables, with greatest effects on couples with children (-1.3 %), the young (-0.9 %) and blue-collar worker households (-0.7 %). The multi-group dissimilarity decreases by 0.8 % for the five socio-professional groups.

Similar to the effects on demand distribution, there are only slight changes in segregation due to the urban amenity scenario. These changes vary across population groups: whereas segregation of demand increases for old households (+1.3 %) and slightly for executive households (+0.3 %), it decreases notably for the young, couples with children and young - old dissimilarity (all around -0.9 %). Effects on centralisation are negligible, with the largest effect of +0.3 % for couples with kids that is most probably due to a gain of attractiveness of the Grenoble municipality.

Table 4.16 – Sectoral scenarios: segregation indices

Indice	Group	SCoT effect		SCoT sectoral scenario effects			
		Control (1)	SCoT (2)	housing (2a)	access (2b1)	extend (2b2)	urbans (2c)
SI_{Duncan}	Exec.	0.210	+2.3	-0.5	+2.9	+0.6	+0.3
	Blue-c.	0.188	-0.1	-0.7	+0.5	+1.3	-0.3
	Young	0.379	+3.1	-0.9	+5.3	+0.5	-0.9
	Old	0.063	+3.8	+0.1	+2.7	+0.1	+1.3
	With children	0.183	-4.4	-1.3	-0.1	+1.4	-0.9
ID_{Duncan}	Exec./Blue-c.	0.332	+1.4	-0.6	+2.0	+1.0	-0.0
	Young/Old	0.374	+4.4	-1.0	+5.9	-0.2	-0.8
ID_{multi}	SPC	0.143	+1.3	-0.8	+2.0	-0.4	+0.1
	Age	0.097	-1.1	-0.1	+0.1	+1.0	-0.4
ACE	Exec.	0.539	+5.4	-0.2	+5.1	-1.2	+0.1
	Blue-c.	0.318	+6.4	-0.2	+5.9	-5.0	+0.0
	Young	0.735	+5.6	-0.1	+5.9	+0.0	-0.2
	Old	0.434	+1.1	-0.0	+1.1	-1.1	-0.0
	With children	0.345	+6.2	-0.1	+5.2	-4.3	+0.3

Notes: Values for scenarios (0) to (2c) are based on simulations, changes in scenarios (2) to (2c) are percentage changes to the control scenario (0).

Finally, the extension in travel times scenario (2b2), increasing preferences for peripheral locations, has partially opposing effects to the SCoT and the ‘access’ scenario (2b1). It generally leads to slightly higher segregation among population groups than the control scenario, and to lower centralisation. Differences to the SCoT are notably an increasing segregation of blue-collar worker households and couples with children, and lower positive effects on the other groups. Travel time extension leads to a notable increase in segregation between all age groups, probably due to an effect on the largest group of middle-agers (as there is no effect on young - old dissimilarity). Contrary to the SCoT, centralisation of all households decreases (except for the young whose index remains stable compared to the control (0)), strongest for the least centralised groups: blue-collar worker households (-5.0 %) and couples with children (-4.3 %).

Effects on residential demand in mountain areas

For completeness, we briefly describe the effects of the sectoral scenarios on residential demand in mountain areas. In three out of four cases, the shares in the overall residential demand for mountain areas increase in comparison to the control scenario (0): slightly for the housing and urban amenities scenarios (except for higher altitudes in, (2a)), and much stronger for the extend scenario ((2b2), for all classes). The ‘access’ scenario (2b1) shows the known similarity to the SCoT scenario.

With regard to composition changes of the demand for mountain municipalities, the effects of the housing and urban amenities scenarios are also similar: their ‘mountain demand’ shows higher shares of young singles, and only slightly higher shares of executive and blue-collar worker households (+0.1 % to +0.3 %). In both scenarios, demand from older households and couples with kids decreases, albeit slightly.

In the extend (2b2) scenario, demand for mountain municipalities increases for blue-collar worker households and couples with children, which is not surprising since these groups prefer locations farther away from the centre; but ‘mountain demand’ also increases for the young. By contrast the demand shares of old households and executives decrease.

Again, the access scenario (2b1) is the dominant sectoral scenario at work. The composition of demand in mountain municipalities changes notably for executives (-4.3 %), the young (-23.9 %) and old households (+3.4 %). Globally, the ‘access’ scenario is somewhat more attenuated than the SCoT scenario, with lower decreases in demand of executive households and couples with kids, but a larger decrease for young singles (large change percentage due to small value).

Table 4.17 – Sectoral scenarios: evolution of mountain population

Indice	SCoT effect		SCoT sectoral scenario effects			
	Control (0)	SCoT (2)	housing (2a)	access (2b1)	extend (2b2)	urbams (2c)
Households in ^a ‘mountain’ municip.	7.79	-4.4	+0.5	-4.2	+2.9	+0.4
Households in municip. ^b > 600 m	4.47	-4.8	+0.0	-4.4	+2.9	+0.1
Households in municip. ^c > 900 m	2.54	-6.6	-0.1	-5.8	+3.6	+0.7
Group in ^a mountain pop.						
executives	17.97	-4.8	+0.1	-4.3	-0.4	+0.0
blue-collar workers	14.52	-0.0	+0.3	-0.0	+1.7	+0.2
young	1.47	-21.6	+4.4	-23.9	+0.3	+3.1
old	38.00	+3.6	-0.4	+3.4	-1.6	-0.3
couples with children	38.89	-1.0	-0.4	-0.2	+0.5	-0.2

Notes: Values for scenarios (0) to (2c) are based on simulations, changes in scenarios (2) to (2c) are percentage changes to the control scenario (0), ^a48 municipalities located in the PNRs of Chartreuse and Vercors and the PNR project Belledonne, ^b25 municipalities situated between 600 and 900 m a.s.l., ^c23 municipalities situated above 900 m a.s.l.

4.4.3 Summary of results

With regard to household behaviour and the housing market in the urban region of Grenoble, we find expected systematic differentiation in housing-related decisions according to demographic and socio-economic household attributes. Both residential mobility and location choice models reveal such sorting mechanisms across the urban-peri-urban space. We also find that the mountain environment contributes to peri-urbanisation and to residential sorting, notably via the capitalisation of mountain amenities into housing prices and systematic heterogeneity in preferences across households based on socio-professional status (also related to income and education) and life-cycle stage.

More specifically, our estimation results showed

- (i) a general preference of households for space, peripheral locations and mountain amenities over central city access.
- (ii) the presence of differentiated household decisions of residential mobility and dwelling type based on socio-professional status, while controlling for age, household composition and housing tenure.
- (iii) the presence of differentiated effects of mountain amenities on households' location choices, here especially altitude, forests and semi-natural lands, and notably with regard to socio-professional status, age and household composition.

- (iv) an impact of the mountain environment on local housing markets: View (from municipality centre) is positively associated with housing prices (all other factors being equal).

The analysis of simulated residential demand patterns for our main scenarios showed that

- (i) continued trends in planning and transport policies would sustain and potentially reinforce peri-urbanisation to rural and mountain areas in the region, also beyond the SCoT perimeter.
- (ii) confining scenarios such as the SCoT or a ‘mountain sanctuarisation’ policy appear in general to be capable of curbing and potentially reversing the peri-urbanisation process.
- (iii) a ‘mountain innovation’ policy - relating to a change of paradigm in planning and economic development policies, technological change and decreased mobility constraints - would actively promote population growth in rural and mountain territories.
- (iv) policies that constrain peripheral growth and increase urban density seem to sustain and engender higher levels of segregation by socio-professional status and age. Segregation of households with children, however, is lower in these scenarios as the demand of these households concentrates less on the periphery.
- (v) segregation on municipality level is intrinsically linked to centralisation in our region: higher centralisation engenders higher levels of socio-spatial fragmentation.

For our quantified translation of the regional SCoT planning policy and its sectoral scenarios, the analysis showed that

- (i) such policy may reach its objective to confine dispersion of residential demand and possibly prevent further sprawl. Compared to the control and trend scenarios, predicted residential demand patterns for the SCoT policy are more centralised and concentrated in the agglomeration and around the secondary center of Voiron. This re-concentration of demand benefits the agglomeration and disadvantages peripheral rural and mountain sectors - within and beyond the SCoT perimeter.
- (ii) a re-centralisation of demand can lead to problems of housing affordability, especially in case of inelastic supply.

- (iii) the policy, by increasing centralisation of all population groups, is likely to increase segregation (unevenness) by socio-professional status and, more strongly, by age.
- (iv) the policy is able to prevent mountain territories in the region from high residential pressure. It stabilises demand at moderate altitudes (600 to 900 m a.s.l.) and leads to a slight decrease in demand for higher elevations (> 900 m). Some accessible mountain municipalities maintain a high demand especially from executive households.
- (v) the above effects are an overlay of partially opposed sectoral policy effects, notably from housing, and transport and urban amenity policies.
- (vi) increasing building densities in central areas alone does not lead to a re-centralisation of demand in the same areas. Neither housing construction objectives nor improvements in urban quality reach the magnitude of the effect of changes to transport and accessibility, and specifically preferences. Without changes in household behaviour (notably in preferences for peripheral space and a rural living environment), the overall trend of peri-urbanisation is likely to continue. Changes in household behaviour could be triggered by rising commuting costs (or time), an increase in supply of affordable family housing and a general increase in urban quality of life.

Finally, with regard to the development of residential demand in mountain municipalities, we find that

- (i) those scenarios building upon continued trends or mountain development tend to increase demand in mountain areas and to recompose demand towards younger and wealthier population groups and couples with children.
- (ii) confining planning scenarios tend to decrease demand for mountain municipalities especially of young and highly-educated households, which might lead to aging and a loss of human capital in these areas.

4.4.4 Discussion & implications for planning

Effects of the mountain environment on household location choices

The findings for natural amenity effects on location choices in our model are in general consistent with findings in literature. Some results, however, are counter-intuitive.

Amenity studies in the Alps and other areas frequently highlight the attractiveness of mountain ranges and more remote areas for retirees (Debarbieux et al., 2011, Perlik, 2006, 2011, Poudyal et al., 2008). Entering the retiree age, households become more footloose and are more likely to move to places with a perceived higher quality of life. Our estimation results do only partially confirm such trends in the 2001-2010 migration data for the study region. Old households seek remoteness in their location choices, but not necessarily higher elevated locations (= mountain amenities) or other amenities related to land use (not significant interactions with shares of natural (not reported) or forest areas). This inconsistency might be due the exclusive consideration of retirees who stayed within the urban region of Grenoble over this time period. Although an attractive rural periphery is included in the study region perimeter, it may not correspond the remote high amenity areas to which literature refers to, for instance more remote and warmer areas in the Southern Alps.

Moreover, literature suggests that couples with children have higher preferences for a mountainous environment than others seeking a pleasing environment to raise their children (Debarbieux et al., 2011, Perlik, 2006)⁷¹. But this household type seems to avoid higher elevated municipalities in our data. We suggest that, as stated above, couples with children are a heterogeneous group composed of higher and lower income classes, and younger and older ages. These households are not mountain migrants *per se*, but potentially a subgroup among them. We obtain information in this direction from the interaction with executives: 65 % of executive households are couples with or without children, and their coefficient is highly significant and positive. We can also pull the coefficients for executives and couples with children together⁷²: although the coefficient becomes smaller, the overall effect of altitude on the probability to choose a municipality remains positive; doing the same for blue-collar worker households almost annihilates the effect of altitude on these households. We thus find a preference of higher income couples with children for elevated locations.

A last inconsistency concerns a negative influence of the share of natural areas in the surrounding of the settlement on the location choices of executive households; a

⁷¹This finding is also confirmed by our interview material (Philippe Rannaud, urbaniste du Parc Naturel Régional de Chartreuse).

⁷²This is mathematically not exactly correct since both groups have households in common.

finding that contradicts the results above. Hedonic studies show that the presence of natural areas in the surrounding can be considered an amenity and can increase housing prices (Baranzini and Schaerer, 2011, Geoghegan et al., 1997). But, studies also show that the relationship between the share of natural land and perceived esthetic value is not linear, at least not everywhere (see Nilsson (2014)): in central urban areas, where nature is scarce, an increase in natural land has a higher marginal effect on housing prices (and potentially location choices) than in remote areas, where natural land is ubiquitous. In remote areas, ubiquity might only slightly increase or even decrease esthetic value of a landscape, due to lower land use diversity. For instance, research in landscape planning shows that land use diversity increases perceived esthetic value of a landscape (Geoghegan et al., 1997). A mountain setting essentially made up of rocky slopes decreases esthetic value and value for human habitat; the same is true for a valley with steep forested slopes, closing-up the landscape (see e.g. Baetzing (2003) on the esthetic value of Alpine landscapes). Esthetic perception might also vary across groups and individuals: research shows that in particular higher educated persons have preferences for landscape and land use diversity (Dramstad et al., 2006).

Scenario effects on residential demand distribution

The results of the main scenarios are consistent with our expectations with regard to effects on residential demand distribution. Based on the changes that have been made to scenario variables and household preferences for each scenario, our model predicts demand distributions that show distinct effects of confining, continued trend and development scenarios. Whereas the confining scenarios - the SANCT and to a lesser extent the SCoT - curb residential development at the periphery and lead to re-urbanisation of demand, the continued trend scenarios - the control and BAU scenarios - reflect contemporary trends in planning and cause further peri-urbanisation of residential demand. The latter trends are currently observed processes that planners expect to continue if no planning action intervenes. The ‘mountain innovation’ scenario - relating to a reversal of current economic development policies and favouring rural development - results in a demand reversal in favor of peri-urban and remote areas and triggers strong demand increases in rural and mountain municipalities.

More specifically, the simulation results underline the crucial influence of households’ preference for accessibility among the scenario effects (sensitivity to travel time, indirectly also to commuting costs). The travel time preference effect is the predominant factor in demand concentration in the SCoT and in the sectoral scenarios (2b1, 2b2), besides smaller positive influences from construction objectives and urban amenity en-

hancement (see table 4.14). In the control, BAU and MOUNTI scenarios households' utility of longer travel times/commutes remain unchanged. The effects of increased commuting costs are not measurable due to estimation bias. Here, travel time extension (BAU) and increased public transport competitiveness (MOUNTI) reinforce peri-urbanisation, but in reality, such effects would re-centralise demand. A reduction in households' utility of local attachment (MOUNTI), which can be interpreted as both a reduction in migration constraints⁷³ and an increase in overall accessibility, yields further dispersal and peripheral growth of demand.

These findings are consistent with empirical location choice literature (see e.g. Schirmer et al. (2014)) and with urban economic theory, especially the mono-centric framework (see e.g. Anas et al. (1998), Brueckner et al. (1999), Fujita (1989)). A major location factor for households is the trade off between land consumption and accessibility to the CBD, based on income and their opportunity costs of time. These costs are expressed in income-elasticity of the demand for land and commuting costs. The findings are also consistent with theoretical considerations of the feedback-cycle between spatial development (land use) and transport (Dieleman and Wegener, 2004, Wegener and Fürst, 1999): from an increase in accessibility⁷⁴ for a given location, research would expect a rise in residential demand and land prices, i.e. a faster development than in other locations. Whereas local improvements in accessibility would steer residential demand in specific directions, global accessibility improvements for the whole region will foster dispersal and sprawl, as seen in the MOUNTI scenario.

The effects of policy changes on demand concentration due to other variables such as housing construction, local employment growth, public transport availability and urban amenities cannot be identified separately given the rather general character of the scenario approach. The SCoT sectoral effects, however, indicate that these scenario variables play a subordinate role for the development of residential demand in our simulation approach. This result backs other empirical findings of location choice studies which highlight the outstanding and continued importance of classic location factors: housing prices (correlated with distance to the city) and quality of transport infrastructure (Frenkel et al., 2013, Lawton et al., 2013).

For instance, the housing objectives fixed for sectors and classes of municipalities are a major tool of the SCoT, which underline its relevance as a regulatory spatial planning document: construction objectives are more restrictive in peripheral sectors and for small municipalities, for which upper bounds are fixed, than for denser and more

⁷³Recall that local attachment variables also capture effects of access to work, since information on workplace is not available in our household data set.

⁷⁴Here generally to jobs, education, retail, leisure and public service facilities.

holds to locate in ‘desired’ areas for urban development. Since higher demand concentrations lead to higher housing prices in these areas, planning policies need to guarantee the provision of sufficient, high-quality and diversified housing supply that meets both a heterogeneous housing demand and households’ residential preferences. Here, notably the preferences (and need) for high-quality environments and proximity to nature should be taken into account (see results of the mountain environment above), both in the choice and urban design of areas for development. This is all the more important in contexts with strong environmental quality differentials. Since both (environmental) supply constraints and environmental quality are likely to increase demand and housing prices, these planning policies should be accompanied by appropriate measures that guarantee housing affordability for all population groups, also with regard to the social mix objective (see below). However, the results also point at the limits to planning: if residential and transport mode preferences of households are greater than generated costs (e.g. monetary, social, psychological) and incentives created by planning and transport policy, peri-urbanisation trends are likely to continue.

Scenario effects on segregation

Changes in segregation levels across our main scenarios are triggered by a combination of centralisation, mobility and sorting effects. These relate to segregation mechanisms highlighted in economic theory, namely the urban mono-centric model (in the European case à la Brueckner et al. (1999), richer households outbid others in the center), the effect of transport mode choice (Glaeser et al., 2008) and residential sorting according to local public goods (here proxied by share of executives) and social environment (presence of similar households). From a higher level of centralisation of household demand, we would expect a greater social mix among all household groups. Researchers and planners often uphold the argument that compact urban forms and urban density, besides environmental and energy advantages, also improve the social mix (Burton, 2001, Dieleman and Wegener, 2004, Holden and Norland, 2005). Dieleman and Wegener (2004) argue, from a land-use - transport interaction point of view, that a dispersed settlement structure relies on private and individual transport and consequently contributes to social differentiation. Bayer and McMillan (2012) show this empirically, using an equilibrium sorting model to create counterfactual simulations of residential stratification. Reducing households’ estimated dis-utility of commuting to work leads to notable increases in racial and educational segregation across census blocks, and to a lesser extent, to an increase in income segregation, given increasing commuting distances. They argue that households would find it easier to locate in neighbourhoods with similar households if

commuting mattered less.

Counterintuitively, we find that if commuting time to the centre mattered more (changes in preferences), segregation by age and socio-professional category would increase. An increase in centralisation of all groups does not positively affect social mix and can even be detrimental to it (except for couples with kids). We can explain this result by the effect of endogenous sorting, notably of young and executive households: given their already high centralisation at the outset, young singles and executive household demand shares rise even more in few central locations, and consequently, sorting is reinforced in the iterative procedure. For instance, the more there are executive households in central municipalities, the higher their shares, and the higher the effect of endogenous sorting (see relative changes in figure 4.8).

Also, the SCoT and SANCT scenarios make the distribution of households with children more even. In the model specification, we assume that there is no endogenous sorting for households with children due to the heterogeneity within this household group. At the outset, the group is weakly centralised and has strong preferences to locate farther away from the center than other groups. In the SCoT and SANCT scenarios they become more centralised and since there is no sorting effect, evenness in distribution across municipalities increases.

On the contrary, if households had less constraints on mobility (preferences to stay in the same municipality and for migration distance) and access to work - such as in the control, BAU and ‘mountain innovation’ scenarios - both socio-professional and age groups would tend to mix more across the urban region. Generally, the sorting effect would decrease due to lower centralisation and lower shares of the household groups in central locations; evenness would thus increase, except for old households. For the latter, a lower centralisation increases the already uneven distribution. The evolution of the segregation of a household group in the region thus depends on changes to mobility constraints, commuting preferences and its centralisation at the outset.

To sum up these elements, we add the general segregation effects to the overview in figure 4.12, given figure 4.11. Except for families, segregation of demand in our results increases with demand centralisation in the confining policies. Segregation reduces the most, as we saw, for the ‘mountain innovation’ scenario.

The scenario effects on demand segregation reveal contradictory effects between two central objectives of urban planning policy: limiting urban sprawl increases residential segregation. If individual preferences of certain households to locate in peri-urban areas as one segregation mechanism are limited by spatial planning, the same and other mechanisms might operate in denser urban environments, only at smaller spatial scales

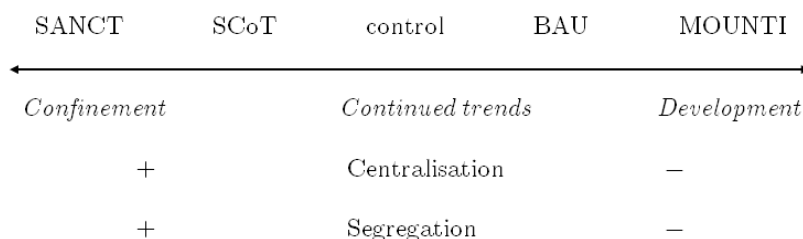


Figure 4.12 – Overview of main scenario effects: concentration & segregation

Source: own illustration.

(notably the neighbourhood level). This finding puts urban policy and decision-making in a dilemma, since they would have to trade off between the objectives of compact urban form and social mix. The pursuit of compact urban forms via increased population concentration demands for complementary measures that attenuate rising segregation levels. If we understand urban planning as an exercise limiting the pursuit of individual (residential) preferences in order to increase the common good (Klosterman, 1985), then density policies also need to account for social mix in compact and dense urban environments, notably via social housing policies and by improving housing affordability.

Scenario effects on residential demand in mountain areas

The major determinants of demand changes for mountain areas are also the accessibility and mobility effects. The confining planning policies increase centralisation and provoke an overall population loss in mountain municipalities, especially in less accessible locations such as the Chartreuse, Vercors and Belledonne ranges. Our scenarios show that such an exodus is likely to be accompanied by a brain drain and aging in the mountain territories: the mountains loose especially young singles and executive households, and the share of old households increases. Continued trends and notably a ‘mountain innovation’ policy would likely increase migration to higher altitudes, sustaining or even reinforcing peri-urbanization processes: first and foremost to accessible mountainous territories such as the Matheysine and the Trièves, and to a lesser extent to the Chartreuse, Vercors and Belledonne ranges.

In accordance with literature, we find that the mountains remain a preferred location for executive households and couples with children (given that 65 % of executive households are couples with or without children) in almost all scenarios. Qualitative research on location choices of families has shown that a major reason for settling in small communities, peri-urban, rural and mountain areas is raising children in a calm, secure and

high-quality natural environment (Gerber and Carpentier, 2013, Martin, 2012, Réseau des observatoires de l'agglomération Grenobloise, 2014). The scenario outcomes also give indications for the 'Alpine gentrification' hypothesis of Perlik (2011) in the estimation results⁷⁵ and in the trend and development scenarios. Permanent and temporary migrations of wealthy population groups to mountain locations contribute to rising housing prices and costs of living, and thereby decrease housing affordability for locals and potentially displace them (Ghose, 2004). In our results, the stark rise in executive household shares in the BAU and MOUNTI scenarios might point to such evolutions in accessible high-quality mountain areas.

The effects of the mountain environment highlighted above are relevant for urban and regional planning. If mountain areas have functional relationships with the urban centre notably via the provision of residential amenities, urban and transport planning should integrate these areas in strategies and policies in order to account for their specific effects. In our findings, we see notably that the residential demand of executives, the young and the old for mountain areas tends to react stronger to planning scenarios than the demand of blue-collar workers and couples with children. This is because the former groups are more mobile than the latter and potentially show higher preferences for this specific environment. Therefore, beyond the simple relation between accessibility and residential development of mountain areas (accelerated by the provided residential amenities) that we observe in the scenarios, planning and transport policies create incentives to which different household groups respond differently. Due to the specificity of mountain areas combining land scarcity, constraints in access and strong differentials in residential amenities, residential processes are even more sensitive to supply and transport shocks, both in terms of peri-urbanisation and tendencies of gentrification and segregation. This calls for a stronger integration of mountain areas in urban planning strategies of cities in and around the Alps, that explicitly considers and plans for positive and negative effects of such Alpine 'amenity migration' (Chipeniuk, 2004, Perlik, 2006, 2011).

Scenario effects on housing prices

The effects of the main scenarios on housing prices are in line with the prediction results of overall demand distribution. Table 4.18 depicts price predictions for the main scenarios for Grenoble, geographical sectors and the non-SCoT area.⁷⁶ Given the neglects of the

⁷⁵Blue-collar workers also have preferences for the mountain environment but less than executive households.

⁷⁶For the price predictions of the sectoral scenarios, see additional notes section 4.5.

supply side and housing sub-markets, predicted prices are only indicative.

The re-concentration and centralisation of demand in the SCoT make prices notably rise in central locations. In Grenoble, for an increase of 2.6 % in demand in the SCoT scenario compared to the control scenario (0), prices increase by around 72 % (to 5,082 €/m²). Prices also increase for the agglomeration (+3.3 %) and for the Sud-Grenoblois sector (+0.3 %), although overall demand decreases in the latter (-2.7 %). Strongest price declines of around 20 % due to the SCoT are observed for peripheral sectors such as Bièvre-Valloire, lower Grésivaudan, Trièves and Voironnais sectors.

The SANCT scenario globally reinforces the SCoT effects on prices instead for Voironnais, Matheysine and lower Grésivaudan sectors where effects are slightly lower, and the upper Grésivaudan, where prices rise. Housing prices almost double in Grenoble, and increase by 11.4 % in the agglomeration. In the ‘mountain innovation’ scenario, prices drop significantly in Grenoble municipality (-68.5 %), as expected. Prices rise in almost all peripheral sectors and also in the non-SCoT area, strongest in the upper Grésivaudan and Sud-Grenoblois sectors, and lowest in the agglomeration and the Voironnais. Only the Trièves and the Vercors sectors show decreases in prices in the MOUNTI scenario.

The few contradictory links between demand and price indicate that demand is not the only explanatory variable responsible for a rise in housing prices: our housing price model associates travel time to the center, higher construction rates (both scenario variables) and larger shares of executives in a municipality (endogenous variable in predictions) with higher housing prices. Those variables undergo changes in the scenarios, and besides influencing endogenous demand, they contribute to changes in housing prices. The price evolutions for the SCoT sectoral scenarios in section 4.5 make this more clear.

The predicted housing prices point towards expected drawbacks of confining urban policies such as SCoT or SANCT. The scenario results show that it is highly likely that such containment strategies, either implemented via construction restrictions in the periphery, increased commuting costs or incentives that incite households to locate in more central locations, make housing less affordable if supply is inelastic or if the development is not accompanied by social housing programmes. This finding is consistent with economic theory and empirical findings that generally find positive effects of density and urban containment measures on housing prices (Engle et al., 1992, Glaeser and Ward, 2009, Ihlanfeldt, 2007, Pogodzinski and Sass, 1990, Quigley and Rosenthal, 2005).

Table 4.18 – Changes in housing prices (median, in €): Main scenarios

	N	Observed (2008)	Control (0)	BAU (1)	SCoT (2)	SANCT (3)	MOUNTI (4)
Grenoble centre	1	2,959.55	2,771.73	-16.0	+83.4	+108.0	-68.5
Agglomération Grenobloise	28	2,774.01	2,771.81	-1.6	+3.3	+11.4	+1.4
Bièvre-Valloire	42	1,897.25	1,909.10	-15.3	-23.0	-18.0	+3.7
Chartreuse	7	1,921.78	1,976.88	-2.5	-16.8	-25.5	+1.0
Grésivaudan	40	2,568.91	2,571.57	-0.9	-2.3	+2.6	+7.9
Matheysine	13	1,846.05	1,874.88	-1.9	-14.4	-9.5	+4.2
Sud-Grenoblois	17	2,390.62	2,395.10	-0.7	+0.3	+2.3	+8.0
Sud-Grésivaudan	35	1,905.60	1,906.32	-12.6	-19.5	-16.1	+6.3
Trièves	7	2,095.70	2,097.15	-6.1	-21.8	-28.6	-2.8
Vercors	3	2,656.45	2,638.49	+0.6	-6.0	-14.4	-3.2
Voironnais	32	2,368.14	2,372.16	-4.6	-17.4	-12.6	+1.2
Non-SCoT	25	1,915.28	1,976.88	-6.5	-16.8	-14.2	+1.0

Notes: Values for scenarios (0) to (4) are based on simulations, changes in scenarios (1) to (4) are percentage changes to the control scenario (0).

Limits of analysis

Our estimation and scenario results rely on an approach that has various limits related to methodological choices and data availability.

Data & model scale

Limits arise notably due to constraints of the available household migration data. The household data only provides information on origin and destination of moves on municipality level. Several sources of bias arise from the municipality scale for our location choice and housing price models: omitted variable bias, aggregation bias, bias from perceptual influences and bias related to the Modifiable Aerial Unit Problem (MAUP) (de Palma et al., 2007a). Households typically make their location decision among dwelling units based on attributes of the dwelling and of the neighbourhood the unit is situated in.

Also, households are seen to perceive housing and neighbourhood attributes differently depending on spatial scale. Dependent on the size of the municipality, aggregate variables at municipality scale might not fully account for local variations in attributes, e.g. accessibility, urban form, neighbourhood composition and urban disamenities. Research has shown that environmental variable effects on housing prices (and location choices) are strongest in vicinity of a dwelling unit (Baranzini and Schaerer, 2011, Ge-

oghegan et al., 1997, Nilsson, 2014). Related to that, the MAUP problem states that model coefficient estimates are dependent on the scale at which the model is estimated, with better fits for greater scales (see e.g. de Palma et al. (2007a)). However, aggregate scales have been used in various studies of residential location choices (Ben-Akiva and Bowman, 1998, Dahlberg et al., 2012, Frenkel et al., 2013, Goffette-Nagot and Schaeffer, 2013, Nechyba and Strauss, 1998, Schmidheiny, 2006) and judged valid to represent intra-urban migration flows.

The model scale also causes collinearity issues between explanatory variables, the municipality attributes. A significant amount of information on municipalities is captured by more general variables (see section 4.5). Highly correlated variables were thus omitted; more sophisticated variables on accessibility, transport, public services, neighborhood attributes, education and more specific urban and natural amenities were not included in the model. The highest bi-variate correlation was observed for average municipal housing prices and travel time to the centre (Pearson's r is .82). The latter variable, proxying commuting time, also produces the known estimation bias, which result from omitted variables (work place location, disamenities).

Another limit arises from the nature of our data. The migration data reflects real household moves which were made based on preferences but also under social and economic constraints. Such so-called revealed preference data confounds preferences and constraints. Thus, model coefficients do not necessarily reflect the true household preferences, e.g. for the natural environment or for commuting (Biggiero and Pagliara, 2000, Cadwallader, 1992).

Modelling approach

Our modeling approach disregards important parts of the housing decision-making process and of the housing market (see also the neglect of supply constraints below). For reasons of simplicity, we do not consider tenure choice since this decision is also based on utility that arises from investment (housing as a store of value). We also do not model dwelling sub-markets with different price and demand equations. We do account for dwelling type choice: information on household choices enters representative utility in the location choice model via two correction terms, similar to the approach of Chiappori et al. (2014).

In our housing price model, we do not consider the effects of regulatory and physical constraints to urban development on prices. Empirical research has shown that these affect supply elasticities and thereby housing price levels (Irwin et al., 2012, Saiz, 2008). Natural amenities can exert both an amenity effect and a constraining effect,

both increasing housing prices but potentially offsetting each other (Irwin et al., 2012).

The estimation of the nested version confirms the presence of unobserved similarities across municipalities in the CL model, violating the IIA hypothesis. The NL model fits better, but does neither fully account for correlation among alternatives nor is it able to capture preference heterogeneity within household groups. Since only the CL model led to convergence of our iterative procedure (contrary to alternative CL models and the nested version), we used the standard model for scenario predictions.

Another problem is the potentially remaining housing price endogeneity, i.e. the estimation of an unbiased housing price coefficient. Since alternative CL specifications yielded significant positive coefficients for interactions of household attributes with price, the control function method did obviously not account for all of this endogeneity. In addition, the travel time to the center variable and its interaction terms are likely to capture price effects due to high correlation with the housing price variable. This leads to a biased coefficient for housing price: we cannot conclusively distinguish effects of prices and travel time to the centre.

Another source of endogeneity is residential sorting with regard to the socio-economic environment. We find that households belonging to a specific group choose areas with higher shares of this group. Endogenous sorting is considered an obstacle for econometric identification, since “neighborhood effects emanate from characteristics of neighborhoods that have been themselves objects of choice” (Ioannides and Others, 2008, p. 2). In such sorting, the characteristics of a household who chooses a neighbourhood are not independent of characteristics of those who have already chosen to reside in that neighbourhood. For the researcher, it is difficult to distinguish sorting effects from neighborhood effects.

In this analysis, we were on the one hand interested in the effects of natural amenity variables (with globally low correlations) and on the other hand on the predictive power of the model in order to establish scenarios. For prediction, collinearity and biased coefficients are generally considered unproblematic (Guevara and Ben-Akiva, 2006).

Supply constraints

Our housing price and residential location choice models neglect supply constraints. We do not explicitly consider regulatory and physical constraints to development in the housing price function (Irwin et al., 2012, Saiz, 2008). Households choose their location based on preferences without considering supply constraints in the location choice. In reality, however, households might not be able to choose the alternative which maximises their utility due to a constrained offer, forcing them to choose a second or even third-best alternative. More specifically, housing construction and the supply of flats and houses

only enter the residential demand and housing price functions. The location choice model with endogenous housing prices generates a pseudo-equilibrium in which prices do not fully clear the market, i.e. demand may exceed supply in some areas. Without explicitly taking account of capacity constraints in supply and adequately representing residential search processes, estimated coefficients are likely to be biased and supply restrictions arising from planning scenarios are not adequately modeled (see de Palma et al. (2007b), Kryvobokov et al. (2009)).

In economic housing studies, supply is usually considered rather inelastic, especially in urban core areas (strong regulation, city-cores are to a great extent already built, and reactions to a rising demand through construction is likely to occur with some inertia)(de Palma et al., 2007b). For Paris, de Palma et al. (2007b) assume that in the most desired locations, supply might not suffice to meet demand. There is, at least, some doubt about whether the assumption of perfect competition is true, i.e. that prices clear the housing market. In past works on the implementation of capacity constraints for discrete choice models of residential demand, de Palma et al. (2007b), de Palma and Rouwendal (1996) state that if the researcher does not control for effects of supply constraints, predictions of future demand due to exogenous changes to location characteristics will also be biased, making conclusions on costs and benefits of policy scenarios less valuable for decision makers. In their 1996 study using stated preference data, de Palma and Rouwendal (1996) find strong availability constraints for most dwelling types in the starkly regulated Dutch housing market. These findings imply that households who intent to move are willing to accept second best alternatives if they look for dwellings of types that have low availabilities.

This explains why the SCoT construction objectives do not impede dispersion of residential demand: although we observe slight increases in demand in the agglomeration compared to the BAU, demand increases also in some peripheral sectors. The sectoral ‘housing’ scenario leads to a notable demand increase in peri-urban and remote areas, which may exceed supply (existing and planned) and is thus unrealistic. The implementation of a search algorithm to model supply constraints, however, lies beyond the scope of this chapter.⁷⁷ For the estimation of model parameters, we assume that the problem of disequilibrium between supply and demand can be neglected. We estimate model parameters from revealed preference data (see above), i.e. household preferences are observed and describe behaviour under supply constraints and the predicted housing prices clear the market.

⁷⁷See Waddell (2000) and de Palma et al. (2007b) for solutions with market-clearing under supply constraints

Stable scenario population

In our scenario approach, the household population remains unchanged. We use the 2008 population data for scenario predictions and do neither account for in-migration and out-migration from the study region (closed city region) nor for natural change. However, future residential demand heavily depends on social and demographic changes such as aging, the evolution of household size (dependent on formation and dissolution due to divorce, mortality and birthrate) and migration; also, changes in socio-economic characteristics in the population (social mobility) affect dynamics of residential demand. Population dynamics might significantly effect peri-urbanisation and segregation processes.⁷⁸

In our case, however, there were no appropriate population projections available for the area. The demographic projections from Insee's Omphale tool (Institut National de la statistique et des études économiques (INSEE), 2009) give forecasts on aggregate level (sectors) for overall population and age classes based on different assumptions on the development of birth-rates, mortality and migrations. In this respect, the Omphale tool is another means to project population distributions, an alternative to our location choice model. Whereas our approach models individual household behaviour at micro-level, Omphale predicts population development from a macro-perspective. Combining our model with the Omphale data would have added an additional source of bias to the resulting scenario distributions. Furthermore, the Omphale projections do not provide information on social status of households.

A second option would have been to develop a demographic transition model. Integrated models for urban simulation account for population changes in specific sub-modules (e.g. the demographic transition model in *urbansim* (Waddell et al., 2003)). These sub-modules compare and adjust an internal household data set to (external) macroeconomic trends of population development. They automatically add and removes households (simulation of formation and dissolution) from the data set in order to comply with aggregate population dynamics (Waddell et al., 2003, p. 9). But here, the development of a demographic transition model lies also beyond the scope of this chapter.

Given these facts, we traded off a spatially detailed representation of the choice process with the 2008 data against a chronologically more accurate forecasting methodology, but without locations of households at municipality level. We use a detailed location choice model that considers initial locations of households at municipality level and thus accounts for local migration inertia: households globally prefer to stay in the same mu-

⁷⁸For a discussion on such effects on residential segregation, see Bailey (2012)

nicipality, and move predominantly only over short distances. In this regard, the model better represents and predicts changes in local populations, and better identifies the effects of important location factors linked to the individual household.

A single random population of movers and stayers

The dependence of the predicted demand distributions on a unique random draw of moving households is another limit. Dependent on probabilities to move, composition, characteristics and spatial distribution of stayer and mover populations might vary across random draws and might thus significantly affect predicted demand distributions. At a micro-scale, a mover's initial location influences his choice through the local attachment (same municipality) and migration distance variables.⁷⁹ Scenario effects, which are measured as differences between predicted demand distributions and indices, might therefore vary with random draws.

To test robustness of the scenario results, we may investigate the sensitivity of indices that we calculate for different random draw distributions of movers. Since a sensitivity analysis of the scenario predictions exceeds computational tractability, we tested the sensitivity of Duncan's *SI* for several groups of the initial mover and stayer distributions (see section 4.5 in the additional notes). Using simulation to create a large set of alternative mover distributions, we found that the indices on which our scenario results are based (model values) fall within the range of expected values. We also found, however, significant variation between mean values of the simulations and the model values. This means that the stayer and mover populations do indeed significantly vary in characteristics and spatial distributions across random draws. Consequently, absolute index values and absolute population distributions per municipality from predictions should be interpreted with care, e.g. if compared to observed values of the area or other urban contexts for reference.

We believe, however, that this methodological limit does not affect the robustness of our scenario results, i.e. the differences in predicted distributions between scenarios. They predominantly rely on the changes applied to the scenario variables, and not on the random draws. We would expect relative changes in scenarios to show similar signs and similar magnitudes if we re-drew a mover population randomly or applied a simulation procedure instead.

⁷⁹Similarly, predicted demand also depends on a unique random draw from the housing-type choice model. If a household chooses a house, he is more likely to locate in areas with many houses.

Scenario results

Our scenario results (differences between predicted distributions of scenarios to the control scenario) vary from percentage values < 1 to large double digit percentage changes (up to 30 %, even higher for price effects). However, we do not know whether these differences are statistically significant. Due to a unique predicted distribution for each scenario, we cannot apply statistical hypothesis testing to test whether distributions and indices are significantly different from each other (e.g. through t -tests). A possible approach to address this drawback would be simulation.⁸⁰ Here, such a simulation approach was simply not feasible due to the long computation time for simulation with the location choice model (with endogenous housing prices). In addition, prior work (see chapter 3) has shown that distributions based on sample enumeration are good approximations for distributions obtained from simulation.

It is also likely that we underestimate price effects in our scenario predictions, since we use of a generic housing price variable in our model specification (negative but not significant coefficient, see above): all households react similarly to changes in prices in our simulation procedure (see above) In reality, we would expect executive households to be less sensitive to a rise in prices than worker households, and consequently, we would expect income segregation results in the scenario predictions to be stronger; i.e. we underestimate income segregation.

Originally, one idea in scenario development has been to simulate effects of increased commuting costs, as desired e.g. in the SCoT (travel time extension). In our model, however, the travel time to the center variable captures unobserved location factors and preferences and is thus biased: it reflects more information than simply household preferences for commuting costs to the centre.⁸¹ Effects of unobserved factors combine with the ‘real’, negative effect of commuting time. Since the travel time coefficient is positive for all population groups, an extension of travel time to the centre increases demand in the periphery, which runs against economic theory. In urban economic terms, by manipulating travel time we mechanically increase preferences for locations in the periphery (by creating more ‘space’), which adds to continued trends of peri-urbanisation. For the results of the scenarios in which we aimed at simulating increased commuting costs, this problem leads to a general underestimation of the centralisation effect on residential demand. If we predicted demand in scenarios with an unbiased coefficient we would expect results in terms of centralisation and concentration to be even stronger, notably

⁸⁰Similar to the method in chapter 3, we could simulate k location choices for each household based on the predicted probabilities. This would yield a statistical distribution of k household distributions for each scenario.

⁸¹There is also a strong collinearity between travel time and housing price variables.

in the SCoT and SANCT scenarios.

Our results do not properly identify variables' single contributions to the simulated effects in our scenarios. The main scenarios are comprehensive, i.e. changes are made to various variables simultaneously and the resulting demand distributions are a result of overlain single effects (partially depicted by the sectoral scenarios). If we were interested in the effects of a single variable, re-running the prediction procedure with the only changes made to the variable of interest would be necessary.⁸² Finally and in more normative terms, even if scenario effects would be tested significant, we would not know whether levels and changes in indices are quantitatively critical. The interpretation of sprawl and segregation indices largely depends on ideology and perceptions (Musterd, 2005), and the question of what critical increases in sprawl or segregation are remains unclear.

⁸²Alternatively, we could first calculate elasticities that express the responsiveness of probabilities with regard to absolute changes in explanatory variables

4.5 Conclusion

In this chapter, we shed light on planning policy effects on processes of residential development in an Alpine urban region, notably peri-urbanisation and socio-spatial segregation. We developed a residential demand model for the urban region of Grenoble and used it to predict counterfactual demand distributions based on different urban planning and transport scenarios. The model, composed of the mobility decision, dwelling type choice and a location choice model with endogenous housing prices, was estimated on rich population census and geographical data for an extended functional urban perimeter composed of 224 municipalities. Our modelling approach allowed us to explore changes in residential demand patterns based on adjustments made to municipality attributes as well as to household preferences.

The four main scenarios were a continued trends scenario (business as usual), the comprehensive SCoT planning strategy approved for the region (SCoT) in 2012, and two planning scenarios which were inspired by a foresight study on mountain development in the region: a mountain sanctuarisation (= preservation) and a mountain innovation scenario. We also considered three sectoral scenarios that we derived from the SCoT, which expressed separate sectoral changes to housing supply, transportation and urban residential quality.⁸³ We analysed predicted total demand distributions and those of different household groups to explore potential planning effects on segregation. We used mapping, descriptive statistics, concentration and segregation indices. A focus was also laid on demand development in peri-urban and rural mountain areas.

The estimation results of our different econometric models are generally in line with economic theory and previous findings from residential mobility, location choice and hedonic housing price studies. As expected, mobility and house-choice propensities vary with regard to age, occupational status, housing tenure, socio-professional status and household composition and with regard to a household's location. Younger, wealthier, smaller and foreign households are found to be the most mobile. Housing prices are influenced by housing supply and household demand, travel time to the urban center, the local share of high-income households and recent housing construction. In the residential location choice model, we find effects of 'hard' location factors: households showed sensitivity to housing prices, socio-economic composition of the neighbourhood and local attachment (migration costs). There is a general preference for peripheral locations among households, and most of them tend to stay close to their initial locations.

We were notably interested in the effect of 'soft' peri-urban location factors, i.e.

⁸³Given the limits of the model, scenario 2b2 cannot be considered as a full-fledged sectoral scenario. It was used as a composant to explore in more detail the SCoT transport policy.

natural and mountain amenities, on location choices and housing prices. We found significant effects, especially for variables related to the mountain environment. Our housing price model showed, albeit using rather unsatisfactory variable measures at municipality scale, a positive effect of view and a negative effect of altitude of settlement on housing prices. In our location choice model, besides general preferences for peripheral areas, we found systematically varying preferences in the location choices with regard to altitude of settlement and shares of semi-natural areas: forest, near-natural and water. Especially younger and executive households show preferences for locations at higher altitudes, controlling for classical factors.

Eventually, our estimations do not account for the full effect of the mountain environment. We find highly significant sorting of executive households, which presents a problem of endogeneity: larger shares of executive households are already located in high-amenity areas that are also pricier and chosen by new incoming executive households. There is a strong correlation between executive shares in study municipalities over time: municipalities with high executive household shares in 1982 present even higher executive household shares today ($r = .74$, see section 4.5). Indeed, it is impossible to disentangle the effects of seeking *entre-soi*, bundles of local public goods and natural amenities that have attracted other executive households before. Therefore, the true natural amenity effects could be even greater.

Our estimation results thus support the hypothesis of selective migration to peri-urban areas of our study region based on preferences for the mountain environment. These preferences are related to a household's life-cycle stage and income level (correlated with education and socio-professional status). Similar to the literature (Hand et al., 2008, Kim et al., 2005, Lindberg et al., 1992), we find evidence for a life-cycle story of households in Alpine peri-urban areas: younger households (singles or couples without children) move to these areas in their late twenties or early thirties; they potentially seek health, security and space but also the 'rural idyll' (Benson and O'Reilly, 2009), the simple or the good life, getting back to the land and to nature; the mountains may also be seen as a 'good' setting to rear children far-off from the dense Alpine valleys. There, households stay put until they retire. By entering the retiree age, households become more sensitive to an easier access to transportation, health care and social services, and relocate at lower altitudes.

In addition, we find evidence for higher preferences for living at an altitude among higher income households (households with executive heads; 3 out of 5 of these households have children). This finding supports the hypothesis that natural amenities and here specifically mountain amenities are normal goods, i.e. their demand rises with in-

come. Beyond mobility lower constraints arising from higher disposable income, this finding points to systematic links between consumption preferences on the one hand and socio-economic characteristics of the individual on the other hand (Benson and O'Reilly, 2009). In addition, socio-economic characteristics might also be linked to socio-cultural characteristics, education and lived experiences of a household that influence landscape perceptions and lifestyle choices (Benson and O'Reilly, 2009). "The choice of destination, while also an intentional choice about how to live, is [...] the product of both structural constraints and individual agency." (Benson and O'Reilly, 2009, p. 6) We also find that individual and residential mobility, i.e. motorization (not reported) and income effects on migration costs, vary significantly across socio-economic groups, adding to these differentiated natural amenity preferences and observed sorting behaviour.

The observed mobility behaviour and selective migration of higher-income households to mountain locations contributes to peri-urbanisation and potentially segregation processes (see also chapter 3). Also, gentrification processes as suggested by Perlik (2011) might be triggered by selective migration but remain unobserved in our study.⁸⁴

Taking into account some additional data, however, we might argue that selective migration has differentiated effects on communities along the urban-rural continuum (similar to (Chi and Marcouiller, 2012)), potentially involving gentrification processes: long-standing high-income neighbourhoods (predominantly in the valley and in the foothills, see figures 4.16 and 4.18), where natural amenities and other location factors overlap and are fully capitalized into housing prices, continue to attract affluent households able to pay for these locations, thereby excluding others. These areas are less dynamic with regard to land use and income development (as a simple gentrification measure, see figure 4.18); here, larger shares of affluent households have been present for decades, i.e. gentrification has occurred earlier (see figure 4.16). Peri-urban areas in the foothills and mountains farther away from the center, where natural amenities are not yet fully capitalized into housing prices, started to attract high-income households in the recent decades due to rising housing prices in central locations and to transport shocks (e.g. A51 motorway construction in 1999 and 2007, respectively).⁸⁵

The highlighted effects of natural amenities on urban housing markets and selective migration can imply well-known market inefficiencies: longer average commutes (Wu and Plantinga, 2003), higher land and energy consumption, traffic congestion, socio-spatial

⁸⁴Our micro-economic methods and the lack of longitudinal data do not allow us to identify the displacement of population groups and the magnitude of such effect in different areas.

⁸⁵At the same time, low-amenity areas such as the left bank of the Isère (upper Grésivaudan), historically blue-collar worker communities, showed stronger positive changes in average household income, pointing to 'gentrification' and potentially increasing social mix (see figure 4.18).

stratification, social exclusion and increasing environmental inequality (Banzhaf and Walsh, 2008, Brulle and Pellow, 2006, Padilla et al., 2014). Notably, the capitalization of natural and mountain amenities into the housing market may lead to the exclusion of parts of the population from local benefits provided by these amenities: ecosystem services such as aesthetic value, recreation and proximity to nature that increase psychological restoration potential (Hartig and Staats, 2006), but also temperature and air-quality regulation, provision of raw materials and (own) food (De Groot et al., 2010, Larondelle and Haase, 2013). The ‘flight from blight’ of affluent and middle-classe households also contributes to concentration of poverty at its origin, typically central areas of (relatively) lower amenity value. Selective migration thereby creates adverse neighbourhood effects (Galster, 2012) which reduce individual opportunities and participation in society of the staying populations (labor market, education, politics and culture, see Musterd (2005)). From a rural and mountain development perspective, however, peri-urbanisation may be considered also beneficial: research has for a long time seen proximity to urban centres as an effective rural development strategy. Urban centres provide employment, which enables rural areas in the hinterland to retain and even attract new populations and human capital (Ali et al., 2011). Peri-urbanisation may increase sustainability of settlement in these areas and also their social mix, by decreasing the risks of depopulation, brain drain, aging and loss of public services.

Based on the changes that have been made to the municipal data and household preferences in the planning scenarios, our model predicts demand distributions that show clear distinctions between the effects of confining, continued trend and development scenarios. As expected, confining scenarios curb demand dispersion and reduce peri-urbanisation compared to our control; the mountain sanctuarisation scenario does this stronger than the SCoT planning policy. Such a re-centralisation of demand, however, may significantly increase housing prices. On the other hand, *laissez faire* and rural development policies would sustain and reinforce peri-urbanisation and decentralized growth of residential demand in rural and mountain areas. Confining policies generally sustain or even engender higher levels of segregation on municipality level compared to *laissez faire* policies.

With regard to the SCoT planning directive, the scenario results show that it reaches its objectives as an anti-sprawl policy: compared to the continued trend and control scenarios, predicted residential demand patterns for the SCoT are far more centralised and concentrated in Grenoble agglomeration and around the secondary center of Voiron. However, the scenario results also showed potentially increasing segregation levels due to such re-concentration of demand in the agglomeration. A desirable result in the

concentration dimension of demand development, i.e. a curb of peri-urbanisation, might be accompanied by a less desirable result in the segregation dimension. In the SCoT scenario, a density policy does not *per se* lead to the desired demand concentration: without a change in household preferences regarding housing affordability, commuting costs and natural amenities, peri-urbanisation is likely to continue.

These results strongly rely on the model estimations and on the changes made to transport variables in the scenarios, notably access to the center and household preferences towards access to the center. Other variables related to housing, employment growth and urban quality showed minor effects on residential location choices. These findings point at the limits of our approach. We do not consider supply constraints in housing price and location choice models that would force exceeding demand to relocate in other locations and prices to clear the market. Also, we used cross-section migration data at municipality level which provides limited spatial and temporal information on household behaviour. Without more sophisticated data, the model had to remain somewhat simplistic.

Whilst the results and their interpretation are hampered by these limits (see also section 4.4.4), we believe that our modelling and scenario approach delivers valuable insights on households' location choice behaviour in the study region and on the potential effects of different planning and transport policies on the distribution of aggregate residential demand.

The findings of this chapter have several implications for urban planning, in particular in Alpine urban regions. First, planning policies pursuing density and compact urban forms need to guarantee the provision of sufficient, high-quality and diversified housing supply that meets both a heterogeneous housing demand and households' residential preferences. Here, notably the preferences (and need) for high-quality environments and proximity to nature should be taken into account. Since both (environmental) supply constraints and environmental quality are likely to increase residential demand and housing prices in specific areas, planners should develop appropriate measures that guarantee housing affordability for all population groups. However, the results also point at a need to influence on changes in preferences by creating incentives for location and transport mode choice.

Second, the results call for a more comprehensive understanding of peri-urbanisation processes. Our results showed that peri-urbanisation is the outcome of selective migration of certain population groups. A migrant transforms the social composition of his origin and destination location, and affects segregation patterns. Both dimensions, peri-urbanisation and segregation, are therefore interlinked. Urban planning needs to

account for this interrelation by developing complementary measures to density policies that prevent rising segregation levels, e.g. social housing policies and regulation of the housing market.

Last, the results of this chapter show that natural amenities, and here specifically the mountain environment, are policy relevant (see also Hand et al. (2008)). Due to its specificity combining land scarcity, constraints in access and strong differentials in residential amenities, residential processes are even more sensitive to planning and transport shocks, both in terms of peri-urbanisation and tendencies of gentrification and segregation. For instance, we see notably that the residential demand of executives, the young and the old for mountain areas tends to react stronger to transport shocks. Our results thus call for a greater consideration of the links between natural features and urban residential processes by urban planning. More practically, if mountain areas have functional relationships with the urban centre, urban and transport planning should integrate these areas in strategies and planning practice in order to account for their specific effects. In order to counter adverse effects from amenity differentials, urban planning in Alpine urban regions should promote a more equal distribution of local living conditions, not only in urban planning strategies at regional scale but also in local land-use planning. This concerns also measures of nature protection: protected areas close to city regions can provide a high level of amenities, and households will be willing to pay more (or accept longer commutes) if they can live close to these amenities (Irwin and Bockstael, 2004, Wu and Plantinga, 2003). Open space and nature protection measures can thus produce adverse effects that run against the originally intended planning result (leap-frog development, income segregation). Here, the ‘ecosystem service approach’ could become a means to include natural amenities and environmental inequality into regional and local planning practice and decision-making via its assessment and valuation toolkits (De Groot et al., 2010). Overall, the findings of this chapter call for a stronger integration of mountain areas in urban planning strategies of cities in and around the Alps. They call for an urban planning that explicitly considers and plans for positive and negative effects of such Alpine ‘amenity migration’.

Annexe

Scatter plots and correlations

The following figures provide scatter plots and correlation coefficients for the data. The plots have been realized with several R packages. The *ggplot2* package (Wickham, 2009) provides advanced plotting functions to create graphs in the R environment. We add two regression curves to each scatter plot that describe the relationship between the variables X and Y : a simple linear regression line estimated with OLS, and a Local Regression Smoothing (LOESS) curve (locally weighted scatterplot smoothing). The latter is based on locally weighted polynomial regression (Cleveland et al., 1992), which consists in fitting a low-degree polynomial at each point of the data to a subset of the data, with independent variable values close to the point for which the dependent variable is being estimated. The major advantage of this method is that it is not necessary for the analyst to specify a global function to make a model fit the data, but only to fit segments of it (Wikipedia, 2015).

- Figure 4.13 depicts Pearson bivariate correlation coefficients for the main variables of our data set in a heat map: red for negative - green for positive correlation; darker values represent stronger correlation.
- Figure 4.14 shows correlations between important variables of the price models.
- Figure 4.15 shows a scatterplot of the mean house and apartment price data for 163 municipalities. There is strong correlation between the two variables.
- Figure 4.16 shows a scatterplot of the share of executive households in 1982 and in 1999 in the 224 study municipalities. There is strong correlation between the two variables.
- Figure 4.17 shows a scatterplot of the number of polluted days and mean elevation of settlement area of the 224 study municipalities. There is strong correlation between the two variables.
- Figure 4.18 presents two maps: the first depicts average household income per municipality in 2011 for 261 municipalities for which data was available. The second map depicts the changes in average household income per municipality for the period 2002 to 2011.

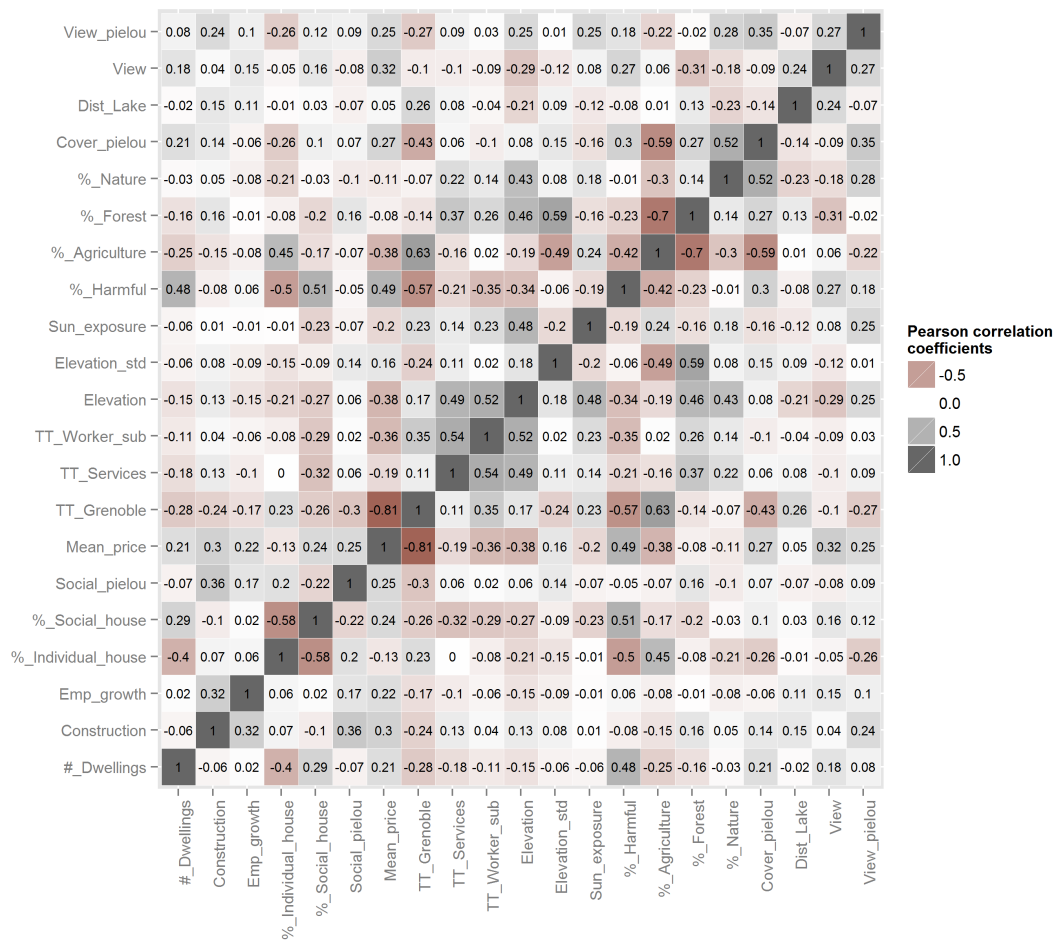


Figure 4.13 – Bivariate correlations: heat map of main variables

Source: see table 4.3, own illustration based on own calculations, N=224 municipalities.

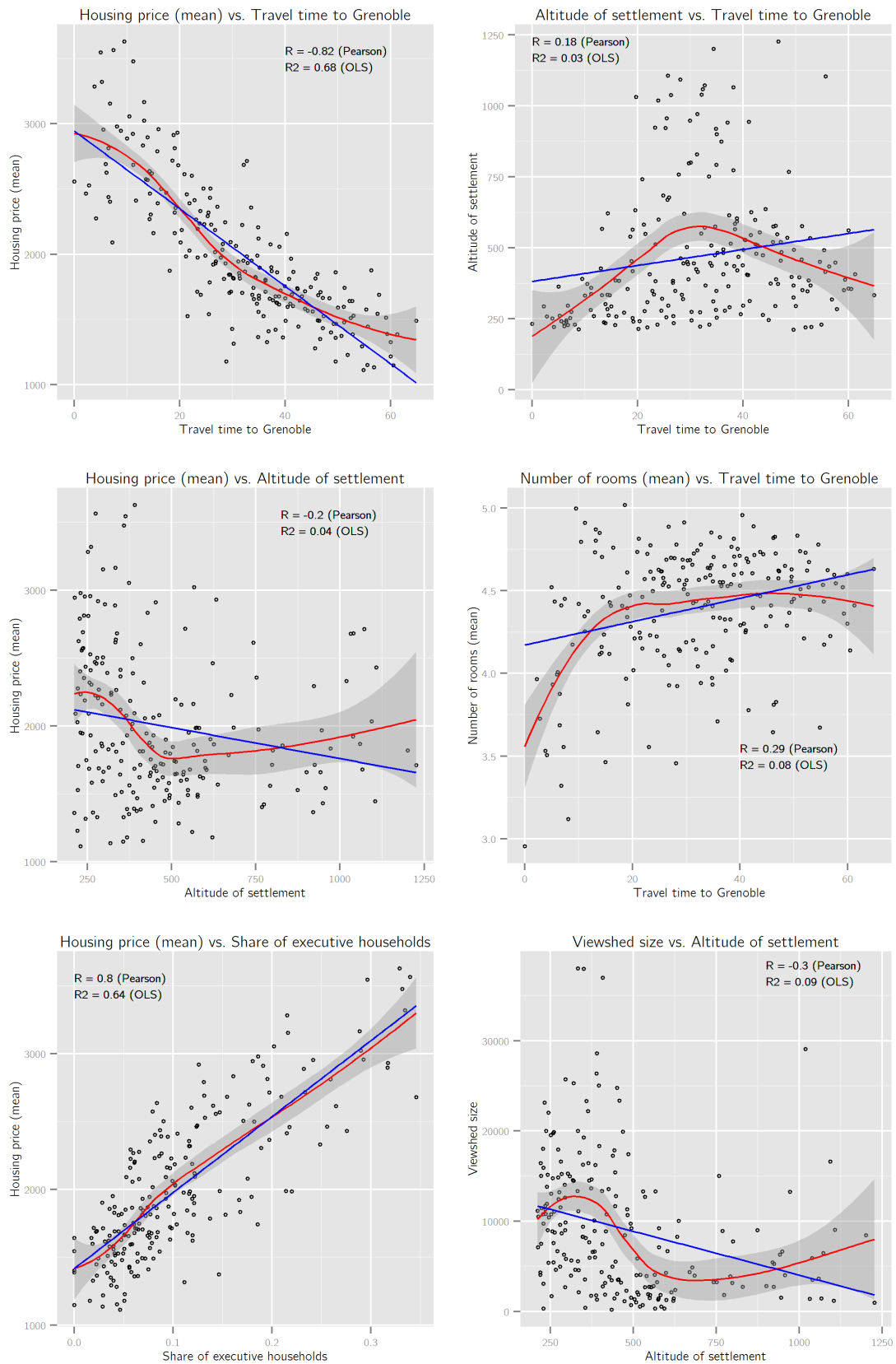


Figure 4.14 – Scatterplots of selected variables

Notes: blue curve for OLS regression, red curve for LOESS. *Sources:* see table 4.3, own illustration based on own calculations, N=224 municipalities.

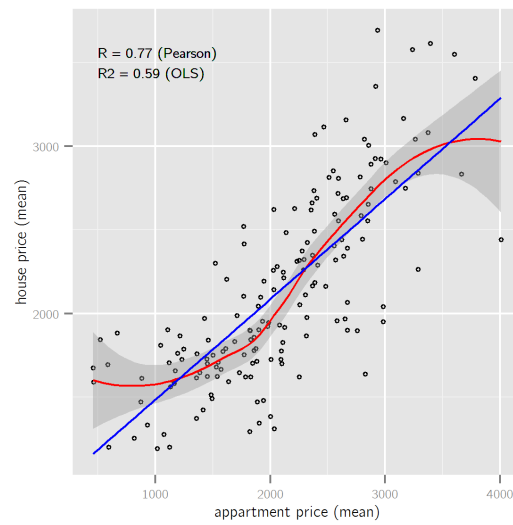


Figure 4.15 – Scatterplot: house vs. apartment prices

Notes: blue curve for OLS regression, red curve for LOESS. *Sources:* see table 4.3, own illustration based on own calculations, $N=163$ municipalities.

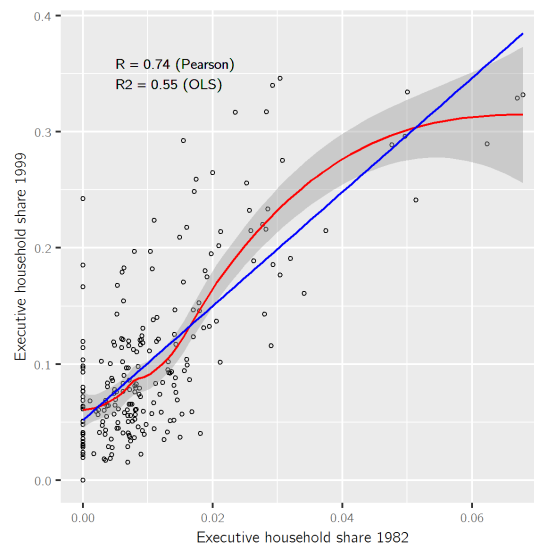


Figure 4.16 – Scatterplot: executive shares in 1982 vs. 1999

Source: see table 4.3, own illustration based on own calculations, $N=224$ municipalities.

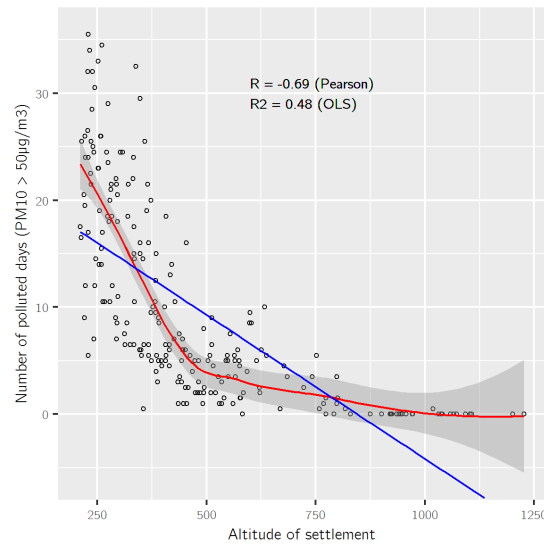


Figure 4.17 – Scatterplot: number of polluted days vs. elevation

Source: see table 4.3, own illustration based on own calculations, N=224 municipalities.

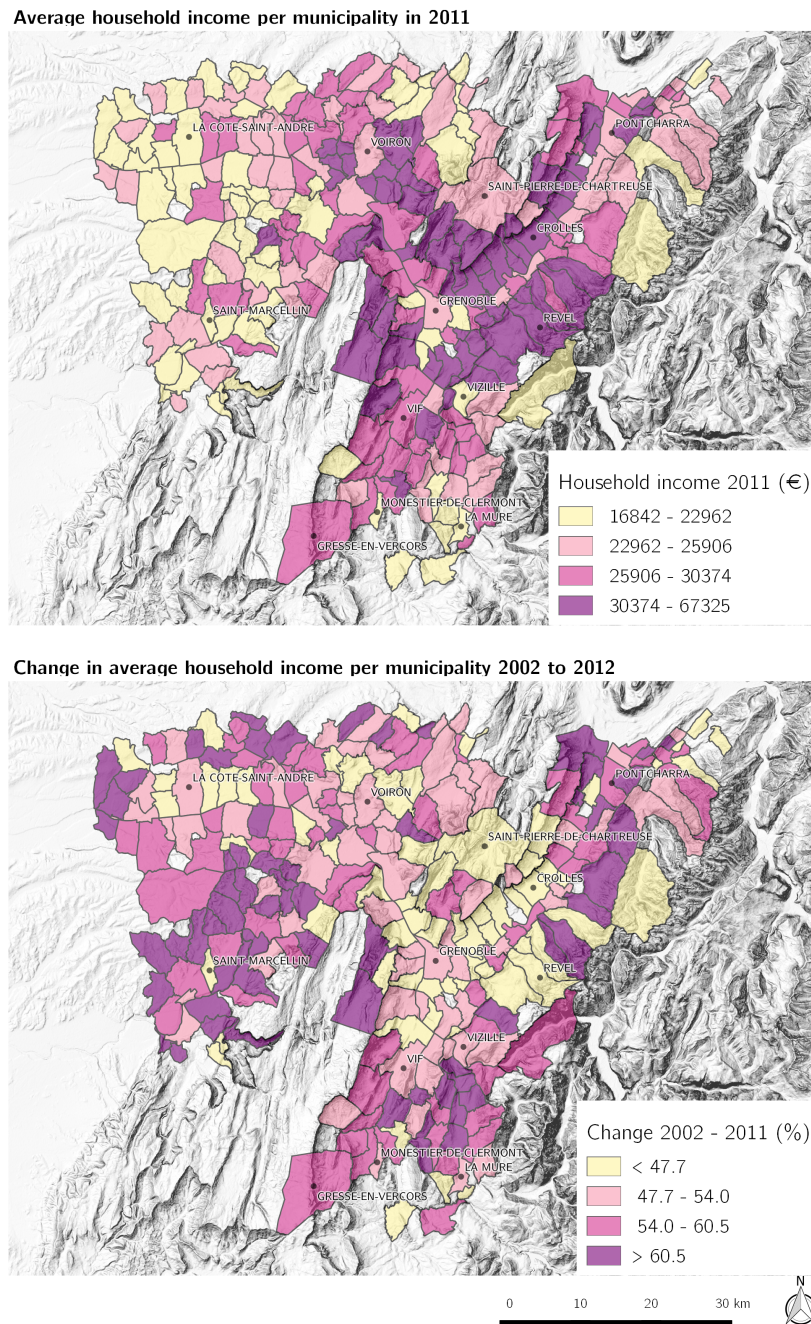


Figure 4.18 – Average household income per municipality and 2002-2011 change

Sources: Direction générale des Impôts - IRPP for income data, IGN BDcarto 2011 for administrative boundaries. Hillshade produced using Copernicus data and information funded by the European Union - EU-DEM layers.

Scaling of variables

In order to make coefficients more readable in the estimation table 4.9 we performed unit transformations on some of the variables, displayed in table 4.19. This ensures more coherence in coefficient magnitudes.

Table 4.19 – Scaling of variables for residential choice model display

Variable	Scaling operation
Demand	$[\times 10^{-3}]$
Supply	$[\times 10^{-3}]$
Migration distance	$[\times 10^{-1}] = km \times 10^{-1}$
Travel times	$[\times 60^{-1}] = h$
Infrastructure area	$[\times 10^{-2}] = km^2$
Employment growth	$[\times 9^{-1}] = \text{growth per year}$
Altitude	$[\times 10^{-2}] = hm$
Viewshed	$[\times 10^{-3}] = km^2 \times 10^{-3}$

Binomial logits: glm (R stats) versus logit.survey (R zelig)

Table 4.20 – Decision to move & dwelling type choice (logistic regression)

	move <i>logistic</i> (1)	house <i>logistic</i> (2)
Executive	0.059* (0.027)	0.086 (0.050)
White-collar worker	0.006 (0.030)	−0.388*** (0.064)
Blue-collar worker	−0.123*** (0.027)	−0.131* (0.053)
Non-active	−0.450*** (0.047)	−0.589*** (0.122)
Private tenant	0.868*** (0.024)	−1.491*** (0.045)
Social housing tenant	0.227*** (0.026)	−2.744*** (0.078)
Age	−0.077*** (0.001)	0.030*** (0.002)
Age ²	0.001*** (0.00004)	−0.001*** (0.0001)
Couple with children	−0.126*** (0.021)	1.174*** (0.041)
Foreign	0.217*** (0.037)	−0.493*** (0.090)
Prev. loc. suburbs	0.046* (0.022)	1.376*** (0.054)
Prev. loc. peri-urban	−0.156*** (0.026)	2.999*** (0.061)
Constant	−1.474*** (0.026)	−1.527*** (0.060)
Observations	81,916	25,980
Log Likelihood	−37,287.390	−9,280.674
Akaike Inf. Crit.	74,600.790	18,587.350
McFadden's R ²	0.271	0.375
ML (Cox-Snell) R ²	0.287	0.349
Cragg-Uhler(Nagelkerke) R ²	0.402	0.512

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$

Housing price model

Validation of linear model assumptions

The assumptions of the linear model (according to Kennedy (2003): misspecification, non-zero expected disturbance, nonspherical and uncorrelated disturbances, errors in variables/simultaneity, and number of observations) for our hedonic price function have been controlled and validated using global and single tests of skewness, kurtosis, link function and heteroscedasticity. We use the *gvlma* function in R from the package of the same name (Peña and Slate, 2006). It performs a global validation of linear model assumptions as well as single tests. Table 4.21 depicts the results of the *gvlma* function for our final model. Heteroskedasticity is no problem in our data. Skewness and kurtosis problems have been corrected by removing eight significant observations from the estimation. Prior model specifications (linear-linear, log-log) have been corrected by a semi-log specification (taking natural logarithm of housing prices) and by introducing travel time squared into the model. The results reveal that globally the linear model assumptions are met (see table 4.21).

Table 4.21 – Global validation of linear model assumptions

	Value	p-value	Decision
Global Stat	8.88	0.06	Assumptions acceptable.
Skewness	3.51	0.06	Assumptions acceptable.
Kurtosis	2.57	0.11	Assumptions acceptable.
Link Function	1.05	0.31	Assumptions acceptable.
Heteroscedasticity	1.75	0.19	Assumptions acceptable.

Spatial autocorrelation

Housing markets show spatial patterns that relate to spatial heterogeneity and spatial dependence. We presume spatial autocorrelation to be present in our municipal data and our housing price model, i.e. that either prices or municipal characteristics in proximity are more similar to each other than those from municipalities farer away (Anselin and Lozano-Gracia, 2008). Hedonic price research has shown that spatial autocorrelation of the error terms can be a serious issue in these models, causing inefficient estimates and biased standard errors (Waltert and Schlöpfer, 2010). In empirical studies, it has thus become common practice to account for spatial dependencies and interactions in hedonic price models (see e.g. Dumas et al. (2005), Nilsson (2014), Pouyanne et al. (2013), Won Kim et al. (2003)).

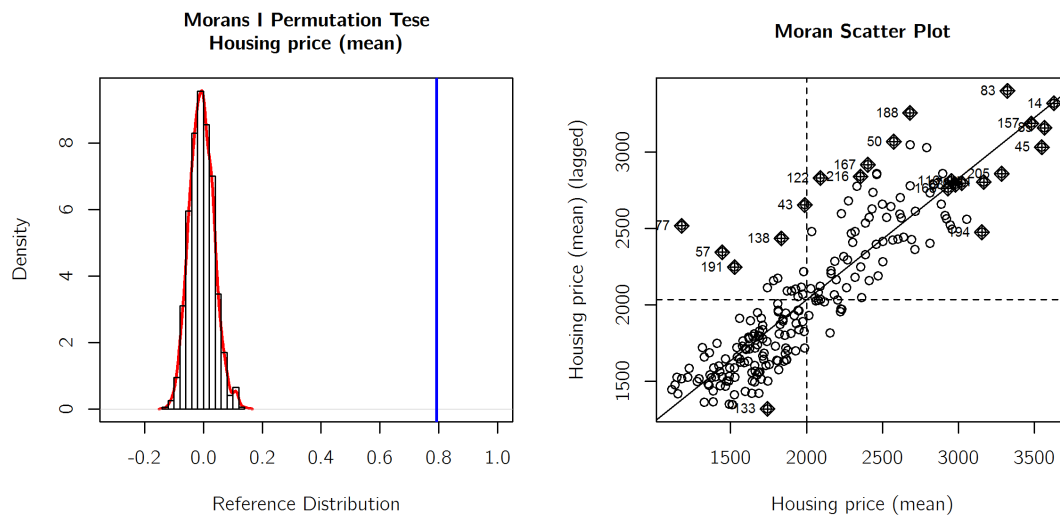


Figure 4.19 – Moran's I for housing price variable & Scatter Plot

R *spdep* output(Bivand et al., 2013, Bivand and Piras, 2015). Sources: see table 4.3.

We tested spatial autocorrelation in our data by computing Moran's I, a measure for spatial dependence widely used in empirical economics. We used the R package *spdep*(Bivand et al., 2013, Bivand and Piras, 2015) for the measurement of Moran's I and estimation of our spatial hedonic models. The exclusion of some municipalities for which price data was not available led to non-contiguous polygons (islands) in the geographical data. We thus decided to test for spatial dependence with three nearest neighbour weights files (3, 4 and 5 neighbours), bypassing problems of non-contiguity.⁸⁶ Figure 4.19 and table 4.22 show the results for the five nearest neighbour weights matrix. We find significant spatial autocorrelation for our average housing price variable on municipality level (Moran's I statistic standard deviate = 4.131, p-value 1.807e-05). Similarly, we find a significant Moran's I estimate for the residuals of the OLS regression (see table 4.22).

⁸⁶Clearly, further efforts to determine precisely the nature of spatial interactions in the data would have exceeded the scope of this analysis. We leave it to future work to test other specifications of spatial interactions, e.g. cut-offs or inverse distance weight matrices.

Table 4.22 – Moran's I for housing prices & price models

	Moran's I estimate	Expectation	p-value
Housing price	0.79	-0.00	0.00
OLS residuals	0.14	-0.02	0.00
LM test for residual autocorrelation	0.00		0.95

Note: Calculation based on a 5 nearest neighbours spatial weights matrix.

To decide on the nature of the spatial autoregressive model, we follow Anselin (2005), Anselin and Bera (1998) who developed specification tests for this context, namely lagrange multiplier tests. These tests provide information on the presence of spatial dependence in the data, and, if this is the case, whether a spatial lag or a spatial error model are more appropriate for estimation. There are two simple tests, testing for a) a missing spatially lagged dependent variable (Lagrange Multiplier (lag)) and b) for error dependence (Lagrange Multiplier (error)). In addition, these both have robust variants (Robust LM (lag) and Robust LM (error)), which test for error or lag misspecification considering the presence of the other misspecification, respectively (e.g., test for error dependence in the possible presence of a missing lagged dependent variable. Finally, an overall test (SARMA) combines the simple Lagrange Multiplier (error) with the robust LM (lag). Table 4.23 shows that in our case, both simple tests are significant. The robust test for the error specification is not significant, whereas the robust LM lag test remains highly significant while controlling for the presence of an error dependence. Since the lag model is also more appropriate from a theoretical point of view (representation of structural spatial interaction in the market), we choose a spatial lag model to estimate our spatial hedonic model.

Table 4.23 – Lagrange multiplier tests

	Statistic	Parameter	p-value
^a LM (error)	12.11	1.00	0.00
Robust LM (error)	0.13	1.00	0.72
LM (lag)	25.33	1.00	0.00
Robust LM (lag)	13.34	1.00	0.00
SARMA	25.46	2.00	0.00

Note: ^aLagrange Multiplier

Scenario data

Table 4.24 – Means of scenario-relevant variables for municipality classes in 2008^a

Class	N	# flats	# houses	% social housing	Construction	# of rooms	tt Grenoble centre	tt service centre	tt other urban centre	public transport	tt sub-centres	Job growth	infrastructure	recreational area
^b La Métro	28	5116.1	1207.2	10.7	5.7	4.2	9.3	7.2	28.4	0.4	20.4	-4.1	261.6	1.2
BIEVRE	41	85.6	397.4	6.0	9.5	4.9	46.3	7.1	26.4	0.1	10.1	17.6	23.0	0.1
GRESIV	40	243.3	655.8	7.5	8.0	4.7	27.1	7.9	35.5	0.1	10.1	52.0	30.0	0.1
SUD-GREN.	16	240.9	522.6	4.6	6.4	4.7	17.8	7.0	40.0	0.1	24.9	-11.8	45.1	1.7
SUD-GRESIV.	35	121.6	328.8	5.1	8.2	4.7	43.2	7.7	12.2	0.1	8.7	3.9	19.1	0.1
TRIEVES	7	40.4	166.8	6.1	8.6	4.5	36.5	9.8	58.2	0.1	42.0	23.6	0.0	0.0
VOIRON	32	449.9	659.3	6.0	7.4	4.9	31.2	6.9	12.7	0.2	10.7	6.8	38.4	0.1
^c GRENOBLE	1	75495.9	2823.5	15.3	4.4	3.0	0.0	0.0	23.0	1.0	16.0	7.9	972.0	3.0
Urban centre	2	4866.8	1694.9	19.1	3.1	3.7	34.6	0.0	0.0	1.0	0.0	14.5	102.5	0.0
Primary centre	24	2580.3	1354.9	16.5	6.5	4.2	26.5	3.5	22.8	0.6	10.9	40.0	195.8	0.9
Support centre	49	540.7	825.5	8.7	7.4	4.6	25.8	6.1	24.1	0.2	12.4	37.6	88.7	0.6
Secondary centre	34	114.5	575.1	6.3	8.3	4.8	28.1	7.5	27.1	0.1	13.5	-5.7	43.4	0.1
Local centre	89	19.6	221.7	2.7	8.3	4.9	37.8	9.5	28.1	0.0	15.6	4.2	4.4	0.2
^d Urban core	13	4538.4	1416.9	13.6	4.5	3.9	5.7	5.7	24.5	0.5	17.5	-12.7	366.6	2.1
Non-SCoT	25	135.0	374.2	6.8	8.6	4.7	33.4	9.9	43.2	0.0	14.6	-12.9	19.4	0.0
Non-core	211	586.1	518.5	6.3	8.1	4.7	33.4	7.8	28.1	0.1	13.6	13.6	37.0	0.2

Notes: ^a1999-2008 for growth variables; ^bfirst part of table according to the SCoT sectors, ^csecond part according to the SCoT urban hierarchy, ^dthird part according to the SCoT core urban area delimitation.

Additional results: spatial autocorrelation & spatial segregation indices

In order to test whether segregation levels (here evenness) are influenced by spatial interactions between municipalities, we test for spatial autocorrelation in the household distributions across scenarios. The results for the Moran's I tests indicate significant spatial autocorrelation for all household groups (see table 4.25). The effect is strongest for children, followed by blue-collar workers, old households and executives. The Moran's I value for the young is much lower, but still similarly significant. For all scenarios and population groups, spatial autocorrelation decreases, strongest for BAU and control scenarios.

Table 4.25 – Main scenarios: spatial autocorrelation in household group distributions

Group	Moran's I		Change (%)			
	Observed	Control	BAU	SCOT	SANCT	MOUNTI
Exec.	0.180***	0.170	+0.9	+2.1	+3.1	+5.6
Blue-c.	0.261***	0.252	-1.0	+0.6	+1.3	+1.7
Young	0.077***	0.061	+1.3	+10.8	+4.1	+25.0
Old	0.224***	0.217	-0.3	+0.4	+0.4	-0.6
With children	0.322***	0.317	-0.6	-1.6	+0.9	-2.7

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$. For all groups and all scenarios, Moran's I values remain significant at 0.001.

In order to consider spatial autocorrelation in the measuring of segregation, research has developed several of the existing segregation indices to take into account spatial interactions between neighbouring spatial units (notably evenness measures). The central idea is that spatial proximity between minority groups located in neighbouring spatial units provides opportunities for interaction. Segregation levels, here the dissimilarity value, should thus in reality be smaller; spatial interaction effects should be subtracted from the simple index. One of such indices is Wong's dissimilarity index DS (Wong, 1993), which considers length of common boundary and shape of neighbouring spatial units (by the proportion between perimeter and area). The index is calculated by

$$DS = D - \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n w_{ij} \left| \frac{x_i}{t_i} - \frac{x_j}{t_j} \right| \frac{(Per_i/A_i) + (Per_j/A_j)}{2max(Per/A)}, \quad (4.16)$$

$$w_{ij} = \frac{b_{ij}}{\sum_j b_{ij}}, \quad (4.17)$$

with notation as above, and D as Duncan's segregation or dissimilarity index (see equations 4.12 and 4.13, respectively), w_{ij} are elements of a distance matrix based on common

boundary length, b_{ij} is the common boundary length between spatial units i and j , and Per and A are perimeter and area of spatial units. Interpretation is similar to the Duncan indices.

Table 4.26 shows the comparison between the Duncan's aspatial segregation index and Wong's spatial segregation index. The table shows that globally, when taking into account spatial interactions between neighbours, the absolute dissimilarity level decreases (compare control and BAU levels for the two indices, see also the last column for percentage changes between the two indices calculated for the control scenario). Comparing changes in segregation levels between the control and the BAU scenario for the two indices, we see that there is little difference for relative changes as the spatial interaction remains stable over scenarios. For our scenario analysis, we thus consider the simpler and more commonly used Duncan index.

Table 4.26 – Main scenarios: Wong's SI vs. Duncan's SI

	SI_D^a			SI_W^b			SI_D vs. SI_W^c	
Group	Control	BAU	Change (%)	Control	BAU	Change (%)	Change (%)	
Exec.	0.210	0.211	+0.8	0.198	0.200	+0.8	-5.6	
Blue-c.	0.188	0.190	+0.8	0.177	0.178	+0.8	-6.1	
Young	0.379	0.377	-0.7	0.378	0.375	-0.7	-0.5	
Old	0.063	0.064	+2.0	0.051	0.051	+1.0	-19.3	
With children	0.183	0.184	+0.1	0.170	0.170	-0.2	-7.1	

Notes: ^aDuncan's SI , ^bWong's DI , ^cOnly for initial population. Differences for scenarios are similar.

Additional results: sectoral scenario effects on housing prices

Table 4.27 shows the predicted housing prices for the sectoral scenarios. Changes to the travel time to the center variable and commuting preferences, highly correlated to housing prices, play a predominant role in price evolutions in the SCoT scenario. In the 'housing' scenario (2a), housing prices decrease compared to the predicted prices in the control scenario, notably for peripheral sectors due to higher dispersal of demand.

As to the second transport scenario 'extend', an extension in travel time would generally make prices fall, especially in central locations. We would, however, expect the opposite. This result is due to the biased travel time coefficient. Contrary to this, increasing preferences for shorter travel times and additionally enhancing public transport competitiveness (access scenario) leads to a rise in prices in the agglomeration and a price drop in peripheral sectors - close to the price effects observed for the global SCoT scenario. The urban amenity changes from the SCoT have positive effects on

housing prices in the centre, due to the higher demand related to new urban green areas and growth of commercial zones in peripheral sectors.

Table 4.27 – Changes in housing prices (median, in €): SCoT & sectoral scenarios

Group	N	Observed (2008)	SCoT effect		SCoT sectoral scenario effects			
			Control (0)	SCoT (2)	housing (2a)	access (2b1)	extend (2b2)	urbams (2c)
Grenoble centre	1	2,959.55	2,771.73	+83.4	-3.8	+70.9	-20.5	+6.8
Agglo. Grenobloise	28	2,774.01	2,771.81	+3.3	-1.5	+3.3	-4.4	+0.1
Bièvre-Valloire	42	1,897.25	1,909.10	-23.0	-8.6	-16.1	-13.5	-0.6
Chartreuse	7	1,921.78	1,976.88	-16.8	-2.2	-16.2	-11.9	-2.8
Grésivaudan	40	2,568.91	2,571.57	-2.3	-0.5	+0.2	-7.6	-0.1
Matheysine	13	1,846.05	1,874.88	-14.4	-1.5	-14.3	-11.4	-1.5
Sud-Grenoblois	17	2,390.62	2,395.10	+0.3	-0.6	-0.8	-7.0	-0.2
Sud-Grésivaudan	35	1,905.60	1,906.32	-19.5	-5.2	-15.4	-12.2	-0.0
Trièves	7	2,095.70	2,097.15	-21.8	-9.1	-15.2	-12.8	-0.1
Vercors	3	2,656.45	2,638.49	-6.0	+2.3	-7.6	-9.0	+0.7
Voironnais	32	2,368.14	2,372.16	-17.4	-4.5	-11.4	-8.8	-0.2
Non-SCoT	25	1,915.28	1,976.88	-16.8	-4.1	-16.2	-13.0	-3.1

Notes: Values for scenarios (0) to (2c) are based on simulations, changes in scenarios (2) to (2c) are percentage changes to the control scenario (0).

Sensitivity analysis

A sensitivity analysis to test the robustness of the result measures for all scenario distributions using simulation exceeds in our case computational tractability.⁸⁷ What we can test is the sensitivity of result measures for the initial distributions of moving households and of staying households (initial and final).

In order to do so, we simulate a considerable number of mobility decisions for each household (999 random draws from a binomial distribution), based on predicted probabilities of the decision-to-move model. We then calculate concentration (*Hoover*), centralisation (*ACE*) and segregation indices (*SI*) for these simulated household distributions (segregation indices for executives, blue-collar-workers, other SPC, households with children, young singles and old households). To these 999 values for each of the k indices, we add the corresponding index value μ_{0k} as observed in the model's initial distributions

⁸⁷No available computer could calculate the outcome of such a simulation procedure in a reasonable amount of time. Other solutions, using slightly differing methods (e.g. combining probabilities) or script improvement to accelerate the procedure, lie beyond the scope of the chapter.

(single draw value or model value). We thus have eight indices with distributions of size $N = 999 + 1$.

To test for sensitivity of differences, we compare the means of the indices from simulations, \bar{x}_k , to the single model values and plot the initial model value against the overall distribution of N using a kernel density plot.⁸⁸ Thereby, we test whether a μ_{0k} value is located in the extremes of its simulated distribution and thus whether its value is unlikely.⁸⁹ We add margins for a two-tailed test: extreme values are either sufficiently small or sufficiently large, thus located beyond a threshold in the lower- or upper-tail of the distribution. In addition, we use standard one-sample t -tests to test the null hypothesis that the mean values of the eight indices from simulations, \bar{x}_k , are equal to the single draw values, μ_{0k} , used for modeling and the scenario analysis.

Table 4.28 – Sensitivity analysis: one-sample t -tests

	Index	Simulations (mean)	Single draw (value)	Variation (%)	t -value
Movers	Hoover	0.465	0.466	+0.3	-17.7
	ACE	0.515	0.516	+0.2	-12.4
	Exec.	0.228	0.224	-1.7	23.6
	Blue-c.	0.224	0.230	+2.7	-40.8
	Other SPC	0.099	0.103	+3.5	-26.2
	Young	0.332	0.330	-0.4	10.9
	Old	0.134	0.134	-0.6	3.1
	With children	0.233	0.233	-0.1	1.3
Stayers	Hoover	0.384	0.385	+0.0	-5.8
	ACE	0.429	0.429	-0.1	15.0
	Exec.	0.225	0.227	+0.9	-20.5
	Blue-c.	0.194	0.192	-0.9	15.9
	Other SPC	0.069	0.070	+0.9	-9.6
	Young	0.404	0.401	-0.7	5.0
	Old	0.094	0.094	-0.3	5.2
	With children	0.156	0.156	+0.2	-4.8

Source: own calculations.

Figures 4.20 and 4.21 show the eight indices, their distributions (grey areas), mean values (black lines) and single draw values (blue lines). The dotted lines indicate the 25th and the 975th value, respectively, delimiting extreme values that lie below 2.5 % and beyond 97.5 % in the distribution (two-tailed test with a significance level of 5 %).

⁸⁸The plotted probability density function is estimated using kernel density estimation (KDE), a non-parametric way to estimate the distribution of a random variable.

⁸⁹The null hypothesis H_0 will be rejected if the p-value of the test statistic is sufficiently extreme vs. the test statistic's sampling distribution.

The plots show that all single draw values lie within the range of ‘normal’ values (not extreme), and some lie even very close to the mean value of the simulations. However, the plots also show that the range of simulated index values is relatively large, especially for movers (due to smaller population size). For instance, we observe an absolute range of 0.02 between the two-tailed 5 % confidence limits for the *SI* value at the initial location of executive moving households. That is, to achieve evenness in their distribution, the share of executives that would have to relocate might vary by 2 absolute percentage points (ca. 300 households), depending on the randomly assigned mobility choice.

Finally, table 4.28 shows simulation means and single draw values for all indices, variations between them and the results of the one-sample *t*-tests. In general, the numbers confirm the low variation of our single draw values from the simulations means. They are stronger for the moving population, and in particular for the socio-professional categories (SPC) in both cases. Except for moving households with children, all the single draw values are statistically significantly different from the simulation means (significant at 5 % when *t*-value >1.96). Given these variations, absolute index values⁹⁰ should be interpreted with care, e.g. when compared to levels in other urban contexts for reference. Relative changes between scenarios, however, rely only marginally on initial population distributions.

⁹⁰and also absolute population distributions per municipality

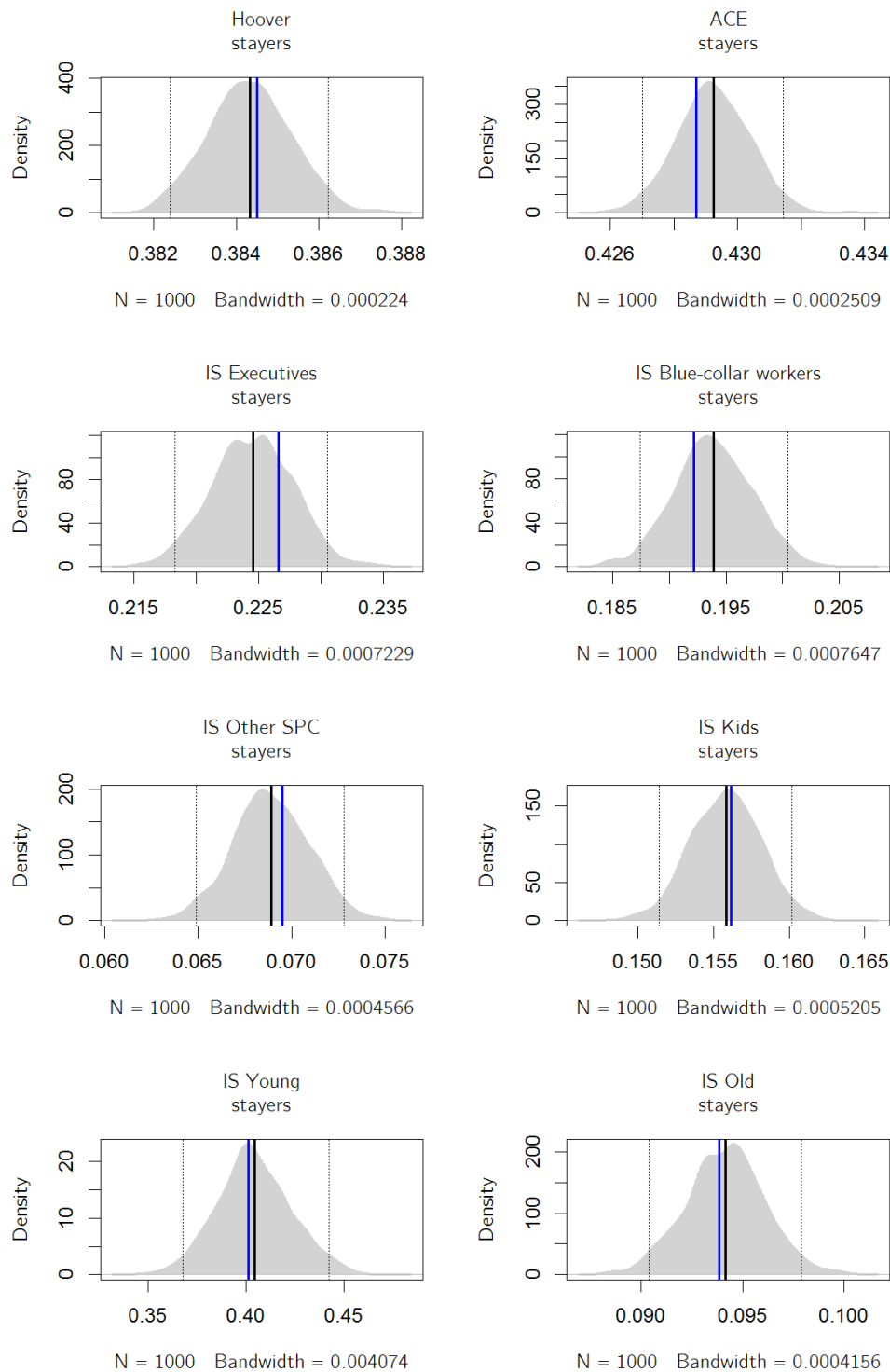


Figure 4.20 – Sensitivity analysis (stayers): index values from simulations vs. model value

Notes: grey area: kernel density curve for simulation values (999 draws) + model value (single draw value), black line: mean of the simulation value, blue line: model value, dotted lines: 25th and 975th values of distribution

Source: own simulations

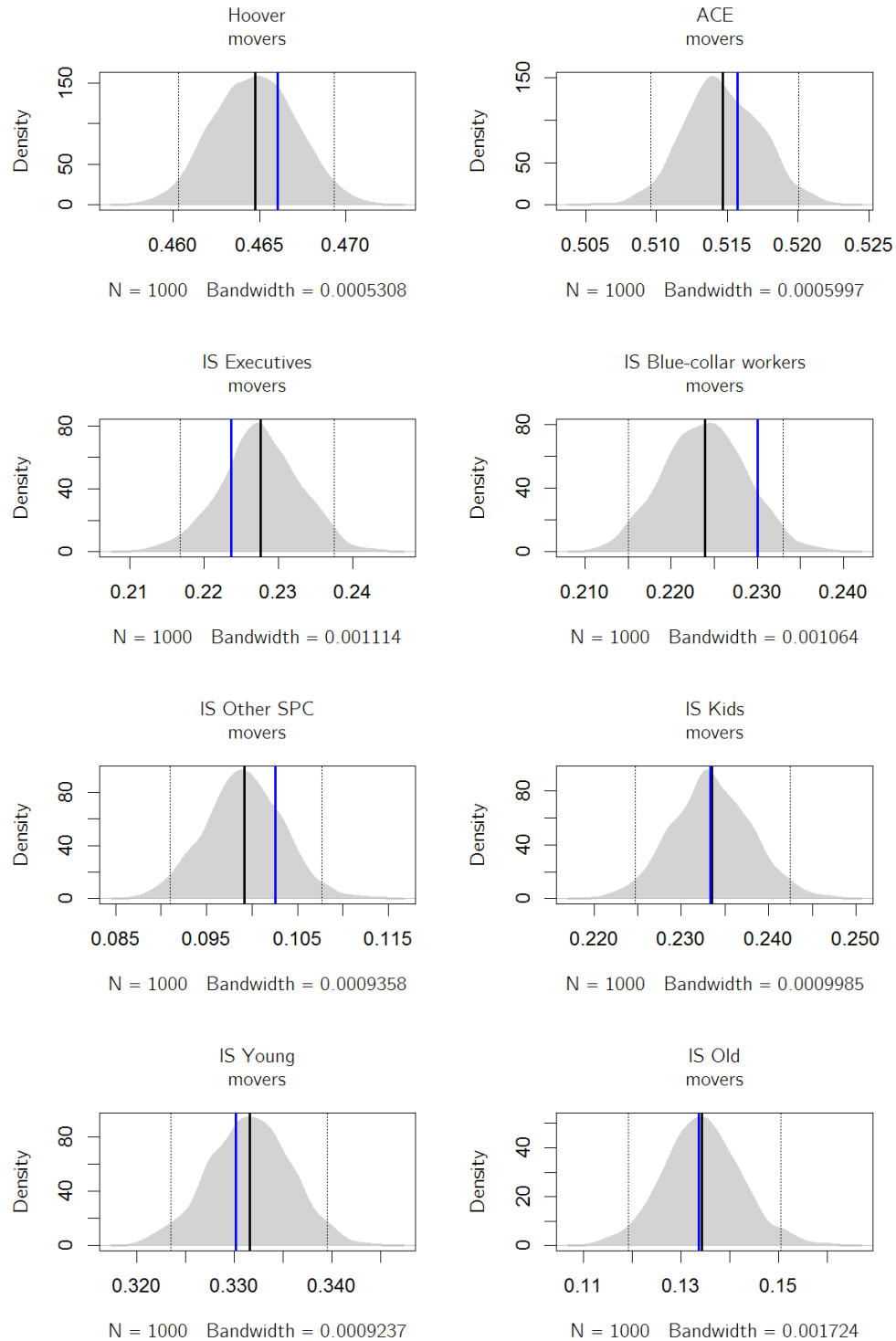


Figure 4.21 – Sensitivity analysis (movers): index values from simulations vs. model value

Notes: grey area: kernel density curve for simulation values (999 draws) + model value (single draw value), black line: mean of the simulation value, blue line: model value, dotted lines: 25th and 975th values of distribution

Source: own simulations

Chapter 5

Conclusion

“The good news is that we do not need to convince people about the usefulness of planning. Each person already does some planning. We do need to convince people why they should plan together for common problems tied to the place they inhabit.”

- Charles Hoch, 2016¹

IN this thesis, we have investigated urban planning and residential processes in the context of urban regions in the Alps. We used Grenoble urban region as unique and in-depth case study to highlight contemporary changes in urban planning practice and to analyse location choice behaviour of households. In particular, we have shed light on how individual households' residential decisions contribute to aggregate residential processes such as *peri-urbanisation* and *residential segregation* and how different urban and transport planning policies influence on these socio-spatial phenomena.

Throughout the thesis, we have taken both an urban planning perspective and an urban economics perspective. In the course of the research, the latter perspective has gained in importance compared to the work plan which was set out at the beginning of this doctoral work. At the very outset, the thesis aimed at analysing urban planning policies in the Alps and at investigating their effects on residential development patterns with econometric models and a scenario approach. The initial aim was to use tools from urban economics as a means to provide new insights for urban planning research and practice in Alpine urban regions. The thesis still reflects this initial aim (chapter 4), but has come to consider an additional research dimension: the effects of the mountain

¹Haselsberger (2016)

environment on households' location choices, and thereby on residential processes and patterns.

The interest for this problem arose while working on the specifications of the econometric models and reviewing the related economic literature. Indeed, urban economists show empirically effects of place-specific environmental features - natural amenities - on housing prices and location choices in different geographical contexts, and, at least theoretically, also on urban spatial structure. In addition, geographers and Alpine researchers argue for Alpine-specific migration patterns and make the case for an Alpine 'amenity migration' and an 'Alpine gentrification' linked to peri-urbanisation and processes of socio-spatial differentiation. However and to our knowledge, no study had analysed residential decisions and their determinants with econometric models in urban regions of the Alps before. These cities are less studied quantitatively due to their smaller size and quantity compared to larger urban regions outside the Alps. Therefore, this is where our thesis adds to the existing urban economics and location choice literature as well as to research on the Alps in the field of human geography and spatial economics.

The economic perspective

In the economic perspective of this thesis, we argued that preferences for the natural environment - and more precisely for natural amenities that are heterogeneously distributed, specifically in an Alpine context - play a role in residential decisions, in addition to classic location factors. They thereby affect residential processes and urban spatial patterns. The results of our discrete choice models, estimated from rich inter-municipal migration data, provided statistical evidence for influences of the mountain environment. In particular, preferences for natural amenities seem to contribute to peri-urbanisation: we found a general tendency of households to settle in peri-urban areas. We also identified significant effects of natural features such as altitude and open spaces close to residential zones on location choices of certain household groups - especially the young, highly educated households and families. The systematic differences in environmental preferences with regard to social status and life-cycle stage confirm the hypothesis of selective migration to mountain areas in the study region. In other words, peri-urbanisation - or the migration to close mountain areas in the Alps - influences socio-spatial composition of municipalities and neighbourhoods. The mountain environment - via household preferences - thus develops not only effects on the quantitative dimension of population distribution (concentration vs. dispersion), but also on its qualitative dimension (social mix vs. social segregation). The reader may want to note, however, that in the mod-

els considering preference heterogeneity within household groups, we found significant variation in environmental preferences in almost all groups of the population.

Now, if there are significant effects, *in which direction do they influence social segregation? Do natural amenities amplify or mitigate social segregation?* We investigated this question in a comparative study of Grenoble urban region and Marseille metropolitan area. The work, presented in chapter 3, benefited from synergies with another ongoing study of colleagues at Irstea on the topic of environmental inequality. The analysis was based on discrete choice models developed in the course of this thesis and counterfactual simulations that enabled us to simulate household distributions with and without natural amenities for the two regions. The results showed a significant role of preferences for natural amenities in social segregation dynamics in both geographic contexts. In Grenoble, these preferences amplified segregation with regard to household size, but attenuated segregation of socio-professional groups (and between them). We saw that in the counterfactual scenarios without household preferences for natural amenities, i.e. only considering household preferences for standard location factors, the segregation of high-income households and of retirees was significantly stronger than in the realistic scenario. We argued that the preferences for natural amenities do not spatially coincide with those for standard location factors, i.e. the effects of the amenity-driven segregation channel work against effects of the standard segregation channel. On the other hand, the systematically varying preferences of smaller and larger households in the two channels seem to coincide spatially, i.e. segregation is increased by natural amenities when considering households by their size. Here, mountain amenities in peri-urban zones seem to amplify the flight from central locations and segregation of families.

Although these results seem important for Alpine research, the comparison of the two very different study regions - a mountain and a coastal context - reveals that effects of environmental preferences on residential processes and in particular social segregation strongly depend on spatial context. Since we focused on Grenoble urban region in this thesis, the findings might not translate to other urban regions in the Alps as claimed in the research framework. Processes and levels of social segregation depend on many other factors than selective migration based on the spatial distributions of ‘soft’ and ‘hard’ location factors, for instance historic development of industries and socio-economic patterns, the level of social inequality, local tax regimes, social policies, demographic effects, disparities in education and finally social mobility. Our cross-section study and scenario design leave out longitudinal effects on socio-spatial differentiation. Moreover, statistical and data limitations hampered a more detailed econometric analysis with regard to model scale. The available migration data set from the French population census did

neither allow us to investigate moves and segregation between lower levels than the municipality, nor to consider more precise measures of natural amenities and other location factors. We believe, however, that this thesis provides new insights on residential processes in the Alps. It provides statistical evidence for previously established hypotheses on residential choices and highlights some key elements that could help research and urban planners in other Alpine and peri-Alpine urban regions to reflect on residential processes.

Residential stories of life-cycle, income and environmental preferences

According to the literature and the indices provided by our findings, we can deduce some elements of households' residential stories along the urban-rural continuum which might occur generally within Alpine urban regions. Residential decisions in these stories are influenced by a household's life-cycle stage, disposable income and environmental preferences. Besides a general heterogeneity in preferences for the natural environment, environmental preferences also vary over the life-cycle and with regard to income. We find that locations in the mountains are most attractive for young, high-income households and those in the family formation stage. However, we need to distinguish between mountain areas with regard to their attractiveness regarding classic location factors and residential dynamism.

Preferences for natural amenities are said to rise with income (Martínez-Alier, 1995). Inequality in household incomes results in higher demand for mountain amenities of richer households, which increases housing prices in high-amenity areas. They thereby limit the possibility of poorer households to locate in these areas. This process has also a spatial dimension. Capitalisation of natural amenities into housing prices is not homogeneous in an Alpine urban region: households do not pay the same price for scenic views on the mountains everywhere. In general, where these features are scarcer or where they overlap with other location factors that increase demand of richer households, e.g. in proximity to the urban centre, capitalisation is also stronger. This is especially the case in long established neighbourhoods in close Alpine foothills, which are less dynamic.

Interestingly, we find the largest average lot and dwelling sizes in the study area in these well-exposed, slightly elevated foothills with views on the surrounding mountain ranges. These areas are also those with the highest housing prices. We can thus make the hypothesis that housing in such a high-amenity settings is a luxury good and a positional good.² Such a location in the foothills and close mountain ranges may provide utility

²Luxury goods are goods for which demand rises more than proportionally than income rises, in contrast to necessity goods (demand increases less than proportionally than income rises). I.e., demand

not only through absolute consumption of natural amenities but also through relative consumption compared to the consumption by other households (see Frank (2005) on positional goods). Research shows that relative positions of households in society and social concerns matter in housing choice behaviour. For instance, Frank (2005) describes how increased spending on housing by high income households leads to shifts in the frame of reference of lower income groups, creating expenditure cascades that also increase spending on housing of the latter, thereby making them worse off. Greater income inequality is thus seen to cause higher housing prices, but also higher divorce rates and average commuting times (in the US) and thus reduced public welfare. Economic models but also public policies should thus account for such positional externalities in housing and residential development.

Contrary to long established neighbourhoods in close Alpine foothills, natural amenities are less capitalised into housing prices in peri-urban and remote areas farther away from the urban centre. There, mountain and natural amenities are more ubiquitous and housing demand especially from high-income households is generally lower. These areas, situated in the interior of mountain ranges and remoter valley and foothill locations, have become the preferred residence of the middle class over the last decade and still present a high dynamism.

Implications for policy-making

The results of the econometric analysis of inter-municipal migrations in the study area show that the natural environment and its effects on residential decisions and processes are important for spatial policy-making in Alpine urban regions. They increase average commutes, urban sprawl and traffic and can also reinforce segregation. In addition, considering environmental quality of the mountains as a common good, the pursuit of natural amenities by some households appears problematic since such behaviour excludes other households, creates social costs and thus reduces overall welfare. We might also postulate that the mountain environment has become a positional good in some Alpine contexts, and that linked positional externalities potentially contribute to overall welfare losses. Overall, our results call for a greater consideration of natural amenities and their effects on residential processes in Alpine urban planning. Moreover, potential effects of “conspicuous consumption” (Veblen, 1899) of mountain amenities on overall public

for luxury goods rises proportionally after basic needs are met. Positional goods are goods for which there is some absolute or socially imposed scarcity or which are subject to congestion and crowding through more extensive use (Hirsch, 1976). For positional goods, context is important: they are searched for because of their extrinsic value with regard to social recognition and status. Research shows that in a positional economy, households consume more than at the (economic) optimum (Frank, 2005).

welfare call also for a greater consideration in wider social policies.

Research perspectives: residential decisions

Beyond the results of our analysis, the economic literature shows that the mountain environment also has indirect effects on peri-urbanisation and urban sprawl. Certain features of the mountain environment such as altitude, slope and terrain ruggedness create scarcity effects which are likely to increase housing prices in an urban housing market. These potentially add to the amenity effects described in this work and make land and housing even pricier in specific locations, which again pushes households further away in the search of cheaper land for construction. Our study design was not appropriate to include such scarcity effects since we do not consider the supply side of the housing market. One research perspective would thus be to include the supply side in a migration or location choice model in order to investigate jointly amenity and scarcity effects and their magnitude.

For our estimations, we used revealed preference data and rather simple household categories to investigate residential preferences of households, especially for the mountain environment. Revealed preferences are, however, preferences expressed under constraints: the actual migration of a household is the result of the trade-off between different preferences for location factors. In addition, we use rather simple household groups and we do not have information on the ranking of location factors of individual households. A second future research perspective would thus be to back our econometric research with the analysis of qualitative and stated preference data, e.g. a survey of a representative sample of recent movers in the region combined with semi-structured interviews. We believe that such data, in the best case collected via a longitudinal study design and at the level of postal addresses (instead of municipalities), would enrich the research on this topic and significantly increase the knowledge on the effect of the mountain environment on residential processes.

The planning perspective

At the outset of this doctoral work, the aim was to analyse the effects of urban planning policies on residential development in different Alpine urban regions. Due to a shift of focus towards the econometric modelling work described above, an Alpine-wide perspective and comparative analysis of urban region planning moved beyond the scope of this

thesis.³

The first contribution of this thesis thus presented only a minor part of the research work conducted in this strand (see chapter 2). With regard to the econometric focus on Grenoble, however, this lack of opening and international comparison does not impede the general line of argumentation of this thesis. The chapter investigated the recent SCoT strategic planning episode and inserted it in the wider perspective of a paradigm change towards strategic spatial planning in urban regions in Europe. This change is accompanied by territorial re-scaling of spatial planning (and also public missions and services) towards larger spatial entities that comprise both urban and peri-urban areas. In addition, strategic spatial planning implies also a shift from government to governance, through which new arenas and scenes are created on which decision-makers and planners shape visions for urban spatial development.

Our contribution highlights that these governance arenas transform planning practice on the local level by providing room for the expression of power imbalances and the rolling-out of power plays, notably in relation to diverging development interests between urban, peri-urban and rural territories. The Grenoble case of strategic spatial planning showed moreover the importance of path-dependency when aiming at creating a common development vision and a climate of non-adversarial dialogue between territories and their actors. Given the complexity of the urban planning instruments, here specifically in the French case with many amendments in the last 15 years, the role of planners in sharing knowledge and mediating governance processes has become all the more important. However, through their greater technical knowledge on both instruments and urban processes compared especially to rural decision-makers, urban planners may themselves become proactive and influence decision- and policy-making in a region. Overall, strategic spatial planning can leave room for vested interests that might orient spatial and economic development in a region, thereby potentially undermining the urban planning objectives of public welfare and sustainability.

³Substantial work in this direction has nevertheless been accomplished. In the frame of the *resport* project and in collaboration with CIPRA France, contemporary planning systems (institutional and legislative frameworks) and practice were reviewed and investigated in different cities of the Alps. For this, two dozens interviews were carried out with researchers, urban planners and elected representatives in six cities during 2013: Bolzano, Genève, Grenoble, Innsbruck, Munich and Ljubljana. Until now, three publications (two scientific) appeared based on this material: the first contribution of this thesis on strategic spatial planning in Grenoble urban region (chapter 2), the research article on strategic spatial planning and territorial asymmetries in Grenoble and Greater Geneva (Bertrand et al., 2015), and the collection of factsheets on urban planning in Alpine city regions (Irstea Grenoble and CIPRA France, 2014).

Research perspectives: strategic spatial planning

To go further in this strand and enable processes of urban strategy-making to create shared visions and strategy-making, especially when they find direct expressions in formal planning instruments, it is important to deepen the understanding on how strategic spatial planning operates and is used: how are visions and plans made and who plans? In this regard, it seems relevant to focus on decision-makers, institutions and other stakeholders, their roles, backgrounds, mindsets and interests as well as their influence and power in planning processes. Especially in an Alpine context, our research revealed strong territorial identities that shape actors' behaviour in governance and decision-making processes. The question is whether such strong identities exist also in other urban regions of the Alps and whether they are stronger than in other territorial contexts. This question is also related to the study of residential decisions: economic literature describes the existence of exclusionary zoning as practiced by new inhabitants of peri-urban territories. By taking influence on local land use planning, these *neo-rurals* try to safeguard the environmental and landscape values that originally have been the reasons for their location choice. Such behaviour can, however, contribute to social exclusion and environmental inequality.

Finally, more research is needed on the diversity of strategic planning processes in Europe. Although causes, objectives and methods of planning are seen to converge across city regions in Europe, cultural and institutional differences might persist and result in varying outcomes of this renewed spatial planning. The analysis of interview data of the *resport* project could be a first step in this direction.

Effects of urban planning on residential processes

One of the main research questions concerned the effects of urban planning on residential processes and patterns (see chapter 4). Notably, we were interested in the potential outcomes of the SCoT strategic planning document in terms of residential demand, in comparison to continued trends and more radical planning scenarios. We tried to answer these questions by developing a residential demand model for the study region and used it to predict counterfactual demand distributions based on different and diverging planning scenarios. Our approach is original as it combines an econometric tool with a reflective perspective on contemporary strategic spatial planning. The quantitative simulation of outcomes of different comprehensive planning scenarios may help decision-makers and planners reflect on their work and its potential outcomes. It thus serves the contemporary idea of strategic spatial planning understood as “a socio-political project

centred on collective endeavours to shape place qualities to promote better trajectories than might otherwise occur.” (Patsy Healey in Haselsberger (2016))

The analysis of predicted demand distributions showed distinct and expected effects of four scenarios: continued trends, two confining scenarios (SCoT and ‘mountain sanctuarisation’) and a rural development scenario (‘mountain innovation’). We saw that the confining scenarios are able to curb dispersion of residential demand. In our simulations, the SCoT reaches its objectives as an anti-sprawl policy. Continued trends and rural development policies led, by contrast, to an increase in residential demand in peri-urban and mountain areas in the predictions. With regard to segregation, our main finding was that confining policies engender higher levels of segregation of residential demand. A density policy does thus not lead to an increase in social mix *per se* (at municipality scale). Our simulations showed that transport costs, housing prices and general household preferences to avoid the centre determine to a large extent the predicted demand distributions. Besides the aforementioned limits of our modelling approach, notably statistical and data limitations as well as the neglect of supply constraints, we believe that this contribution has delivered valuable insights on potential effects of different planning and transport policies in an Alpine urban region.

Our results imply that research and urban planning practice should consider peri-urbanisation and related processes more comprehensively. The quantitative dimension of population distribution is necessarily related to a qualitative dimension: residential mobility and migrations always cause local changes in human and social capital, financial resources and to diversity in origin and destination territories. In more general terms, urban planning should continue to focus on transport policies that create incentives for households to locate in ‘desired’ areas for urban development. In addition, it needs to provide sufficient, high-quality and diversified housing supply that meets both a heterogeneous housing demand and environmental preferences of households.

Research perspectives: urban planning effects

Our modelling approach was appropriate to predict and explore counterfactual residential demand patterns. We did not, however, consider the supply side of the housing market in our model, on which urban and land use planning exert direct influence. Constraints to housing development, imposed by the SCoT, could thus not be modelled adequately. Since the implementation of supply constraints in a residential choice model is costly, we left this methodological extension for potential future developments.

As we saw, residential processes are complex and depend on a variety of factors. A more direct and frequently used way to estimate urban planning effects is to analyse the

evolution of housing prices, e.g. with regression analysis. For this, economists regress location characteristics and planning variables on price. The literature review in chapter 4 has provided insights on such methods and planning effects, on which future research could build upon.

In order to go further into detail in such an analysis of the study region, the use of more detailed data on urban planning would be necessary. Even though the SCoT is a regulatory tool - construction objectives and ordinances regarding zoning have to be respected by lower-scale land use planning documents -, there might be some variation regarding the local implementation of the SCoT resolutions. The analysis and use of data of land use planning documents on the local level might be promising in this regard: there are different types of land use plans and zoning might vary across municipalities. In this respect, future research could investigate in-depth the emergence of local zoning regulations and their effects. Given the total number of 273 municipalities in the SCoT of Grenoble urban region, such analyses would need to concentrate on specific territories, though.

Alpine peri-urban areas: which way to choose?

Based on the knowledge acquired throughout the work on this thesis, we might put forward a desirable vision for the spatial and social development of Alpine peri-urban areas. These areas continue to be the most dynamic regarding residential development and land use change in the Alps. Number of research articles, official documents and strategic planning documents speak out for the spatial development vision - a *Leitbild* - of ‘decentralised concentration’ (see e.g. Spiekermann (1999)). It postulates decentralised growth around central places on different levels and demands for functional mix. This vision clearly runs against centralised growth management such as green belts or growth boundaries. As we discussed in this thesis, such regulatory instruments may have adverse impacts on residential development, fostering sprawl, leap-frog development and social segregation due to the creation of protected environmental amenities. But a desirable planning vision also has to speak out against *laissez-faire* policies (see e.g. Klosterman (1985)). The last 60 years of urban dispersion have shown that the free market produces sub-optimal social and ecological outcomes (Wilson et al., 2008) that compromise sustainability, quality of life and the common good.

In our view, the only sustainable planning policy vision for Alpine urban regions (but also for regions elsewhere) is one that promotes peri-urban growth at an appropriate pace, respecting the natural environment and building on endogenous resources,

not focusing on growth *per se*. Instead, such a vision integrates economic and social development objectives and also those for spatial planning (see e.g. Leber and Kunzmann (2006)). Spatial planning has to be thought within wider territorial development strategies, if possible in bottom-up processes, similar to the charters of French nature parks. Strategies in this direction cannot be developed at the scale of a city region, because the city region does not reflect the scale of social life of its inhabitants - urban quarters, towns and villages. In the light of the necessity to move towards a “reductive modernity” (Welzer, 2013)⁴, integrated development strategies have to consider territories that (i) have a critical mass for economic and social life and (ii) provide an identity and a feeling of belonging. Spatial planning, in this regard, is not about reducing the adverse effects of free market externalities but on shaping places and minds in order to provide a maximum of quality of life for the people. Planning should not be a reactive action of necessity, but a proactive action creating opportunity for the common good.

⁴In contrast to the present expansive modernity relying on extractivism which puts Earth’s systems at risk (Welzer, 2013).

Chapter 6

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Synthèse : Sur les liens entre les aménités naturelles, le développement résidentiel et la planification urbaine : enseignements d'une région urbaine alpine

CETTE thèse étudie la planification urbaine et les décisions résidentielles dans une région urbaine des Alpes européennes. Elle éclaire sur deux processus résidentiels qui conduisent le changement urbain contemporain et remettent en question la durabilité urbaine-rurale, en particulier dans les régions urbaines situées dans ou à proximité de montagnes : la périurbanisation et la ségrégation sociale. Les deux processus agissent contre les objectifs centraux de la planification urbaine, notamment la compacité du tissu urbain, la mixité fonctionnelle et la cohésion sociale.

Plus spécifiquement, la thèse analyse les effets de l'environnement de montagne et de la planification urbaine sur les processus résidentiels dans le contexte des régions urbaines alpines. Son objectif général est d'étudier comment et dans quelle mesure les flux et configurations résidentiels sont influencés par (i) l'environnement de montagne et (ii) les politiques de planification urbaine, notamment en matière de péri-urbanisation et de ségrégation sociale. La thèse vise donc à mieux comprendre les liens entre l'environnement de montagne, les politiques de planification urbaine et les processus résidentiels, et de fournir des informations et des recommandations pour la planification et la prise de décision dans des contextes urbains alpins. Pour cela, la thèse présente trois contri-

butions distinctes qui utilisent la région urbaine de Grenoble dans les Alpes françaises comme zone d'étude central. Les trois contributions ont des objectifs et des questions de recherche spécifiques.

La première contribution porte sur les changements dans la politique et pratique de la planification urbaine contemporaine. Partout en Europe, la planification urbaine s'adapte à la montée de l'incertitude, l'interdépendance spatiale et à la complexité en développant des processus de planification stratégique à grande échelle. Cette nouvelle planification se concentre sur des zones urbaines fonctionnelles qui sont composées par les territoires urbains et péri-urbains. Ces processus créent de nouvelles scènes de gouvernance et de prise de décision, mais qui laissent potentiellement la place pour des nouvelles définitions et des déséquilibres de pouvoir et de compétence. **Comment la politique de planification contemporaine répond aux défis régionaux dans les régions urbaines des Alpes ? Comment les nouveaux processus de planification stratégique transforment la planification et la prise de décision au niveau régional et local ? Quels effets découlent de ces processus pour la pratique de la planification locale, notamment dans les zones de montagne ?**

La deuxième contribution porte sur le lien entre l'environnement naturel, en particulier l'environnement de montagne, et les processus résidentiels. Elle estime que l'environnement alpin influence les processus résidentiels, notamment via les disparités spatiales significatives de la qualité de l'environnement entre le centre urbain et les zones péri-urbaines. Plus précisément, elle considère que - en plus des facteurs de localisation classiques tels que les prix des logements et l'accès au travail - les spécificités de l'environnement alpin - facteurs « doux » de localisation - influent sur les choix de localisation des ménages. Ces facteurs sont en particulier en lien avec la qualité de l'environnement habitable (Dinda, 2004), largement mis en avant dans les recherches sur les *aménités naturelles* (McGranahan, 1999, Moss, 2006, Power, 2005). Ces caractéristiques de l'environnement naturel sont spécifiques à un lieu et améliorent sa qualité de vie perçue. Leurs effets peuvent donc produire des flux et configurations résidentielles différenciées, à savoir en termes de dispersion et de ségrégation sociale.

La spécificité du cadre alpin pour le développement urbain est lié au cadre environnemental et à l'accessibilité. Ces deux facteurs font l'objet des disparités spatiales plus grandes entre les territoires (et au sein de ceux-ci) dans les zones de montagne, en comparaison aux régions urbaines dans la plaine. Nous faisons l'hypothèse que certains groupes de population pourraient être plus fortement attirés ou repoussés par ces facteurs de localisation, conduisant à des flux résidentiels sélectives. Ces flux affectent la distribution de la population non seulement quantitativement mais aussi qualitativement, à

savoir en ce qui concerne les caractéristiques socio-économiques des ménages migrants et de leurs destinations. Les questions de recherche de cette deuxième contribution sont donc : **Est-ce que l'environnement de montagne a une influence sur les choix de localisation résidentielle des ménages dans les régions urbaines alpines ? Si oui, en quoi consiste cette influence et dans quelle mesure s'exerce-t-elle ? Est-ce que l'environnement de montagne amplifie ou atténue les processus tels que la périurbanisation ou la ségrégation sociale ? Quelles conséquences résultent des résultats pour la planification urbaine dans les régions urbaines alpines ?**

Outre les effets de l'environnement de montagne, les politiques de planification urbaine ont non seulement une influence sur la structure spatiale urbaine et l'utilisations du sol, mais aussi sur les décisions résidentielles des ménages individuels. En agissant sur les facteurs de localisation « durs » et « doux » des quartiers et des territoires, la planification crée des incitations positives et négatives auxquels les ménages répondent dans leurs décisions de mobilité et leurs choix de localisation. De ce fait, la planification urbaine peut influencer sur les processus de périurbanisation et de ségrégation sociale qui sont au moins partiellement des résultats de la mobilité des ménages. Par conséquent, la troisième contribution de cette thèse considère que différents scénarios de la planification urbaine peuvent avoir des effets différenciés sur les processus résidentiels et les configurations qui en résultent. Elle vise à étudier le lien entre les politiques de planification et les processus et configurations résidentiels afin d'informer les planificateurs et les décideurs sur les résultats potentiels de leur politique en matière de développement résidentiel. Les questions de recherche associés sont : **Quels effets résultent des objectifs contemporains de planification urbaine en termes de processus et configurations résidentiels dans les régions urbaines alpines ? Quant aux politiques visant à contrecarrer l'étalement, sont-elles capables de freiner la périurbanisation ? Quels liens existent entre les effets de la planification sur la périurbanisation et la ségrégation sociale ? Et enfin, quelles recommandations peuvent être données pour la planification urbaine dans les régions urbaines alpines ?**

Perspective de recherche & méthodes

La recherche urbaine considère les villes et leurs régions comme des systèmes complexes, qui développent de bottom-up (Batty, 2012). Cette thèse se fonde sur cette idée. Dans sa perspective générale, la thèse considère que les processus et les configurations résidentiels sont des produits agrégés de millions de décisions individuelles et collectives des ménages,

des promoteurs et des planificateurs urbains. Les décisions résidentielles de ménages contribuent fortement à ces processus agrégés dans une région urbaine. Les processus de concentration (dispersion) et de ségrégation affectent la structure spatiale et sociale urbaines des quartiers, des territoires et de toute la région urbaine. Les configurations résidentielles établies affectent à leur tour les décisions résidentielles d'autres ménages.

En ce qui concerne la perspective de notre recherche, la thèse prend à la fois une perspective de planification et une perspective de l'économie urbaine. D'une part, la recherche contemporaine sur les système de planification se concentre sur les acteurs, les niveaux institutionnels, les échelles et leur articulation dans les processus du gouvernement et de la gouvernance. Cette recherche est généralement de nature qualitative et implique une approche centrée sur les acteurs pour étudier les processus et les pratiques de planification. D'autre part, la micro-économie appliquée mobilise des modèles économétriques pour expliquer quantitativement le comportement des consommateurs. Notamment, ces outils permettent à analyser comment et pourquoi les individus font des choix en s'appuyant sur le principe de maximisation d'utilité. Plus précisément, l'économie urbaine étudie les processus spatiaux, l'émergence de la structure urbaine et les décisions des ménages et des entreprises qui y contribuent.

Les méthodes mobilisées dans cette thèse reflètent ces deux perspectives : nous utilisons des méthodes de recherche qualitative pour analyser les changements dans la pratique contemporaine de la planification urbaine, notamment l'analyse documentaire et les entretiens semi-directifs. Afin d'explorer les liens entre l'environnement naturel, la planification urbaine et les processus résidentiels - l'objectif général de cette thèse -, nous faisons usage de la modélisation économétrique pour analyser le comportement résidentiel des ménages et les prix immobiliers, ainsi que de simuler des configurations résidentielles. Nous utilisons notamment le cadre (micro-économique) des choix discrets pour analyser les décisions des ménages quant à la mobilité résidentielle et aux choix de localisation. La théorie et les méthodes de ce cadre ont été développés par Daniel McFadden (McFadden, 1974). Les modèles de choix discrets sont largement utilisés dans la recherche et dans le cadre opérationnel de la modélisation urbaine.

Résumés des trois contributions

Dans les chapitres 2, 3 et 4, la thèse présente trois contributions distinctes qui peuvent être lus de façon indépendante.

Chapitre 2 : Planification territoriale stratégique & réajustement des échelles dans la région urbaine grenobloise

Dominik Cremer-Schulte

La planification urbaine dans les régions urbaines européennes présente des changements importants. Ce chapitre utilise le cadre du réajustement des échelles, de la planification territoriale stratégique et de l'émergence de nouveaux modes de gouvernance afin d'analyser les épisodes de planification stratégique dans la région urbaine de Grenoble (France) - notamment dans le cadre du schéma de cohérence territoriale de la région urbaine grenobloise (2012) adopté en 2012. Le chapitre vise à montrer comment les processus de planification stratégique au moyen de nouvelles scènes de gouvernance remettent en question les cultures locales de planification, notamment à travers la ré-configuration des périmètres de planification, des identités territoriales et les rôles des acteurs. Le chapitre montre en particulier l'importance de la dépendance du sentier de la planification territoriale stratégique, les effets des déséquilibres de pouvoir entre les acteurs locaux et le rôle important que jouent les planificateurs dans l'élaboration et la mise en oeuvre des politiques spatiales.

En analysant une récente épisode de planification territoriale stratégique dans la région grenobloise, nous explorons comment les nouveaux espaces de gouvernance tels que le SCoT influent sur la culture de la planification locale, et réussissent à élargir l'échelle de planification et de regrouper une grande quantité de territoires dans une stratégie collective. Le processus du SCoT a créé une scène de gouvernance pour les décideurs et les aménageurs, sur laquelle les stratégies territoriales et les objectifs de planification pour la région urbaine ont été collectivement discutés et définis (Healey, 2007). Le cas d'étude a souligné trois enseignements majeurs pour la planification territoriale et stratégique en région urbaine.

Tout d'abord, l'analyse souligne l'importance de la dépendance du chemin pour le climat et la culture de la planification territoriale à l'échelle de la région urbaine mais aussi à l'échelle locale, ici démontré pour un climat local de dialogue. Ce climat s'est toutefois développé au fil des décennies à travers des différents épisodes de planification stratégique, de la coopération inter-communale et de différents projets territoriaux. De

plus, le cas de Grenoble montre que la proximité géographique, le voisinage et des relations fonctionnelles qui relient les territoires sont bénéfiques pour un tel climat. Avec l'augmentation de la distance au centre de l'agglomération, les territoires sont également susceptibles d'être plus loin dans leur positionnement, comme c'est le cas pour certains territoires de montagne. Au fil des décennies, cependant, les processus de gouvernance autour des épisodes de planification stratégique semblent avoir lissé les positions conflictuelles et les clivages en termes de politique de planification et normes culturelles entre les territoires urbains et péri-urbains. Conformément à la littérature, ce constat souligne l'importance de la dépendance du sentier dans les processus de gouvernance et dans l'évolution des cultures de la planification locale et plus largement des politiques urbaines (Brenner and Theodore, 2002, Haughton et al., 2013, Nadin and Stead, 2008). Le cas de la région de Grenoble montre que les efforts de gouvernance dans la direction d'un dialogue non conflictuel peuvent ouvrir la porte à des efforts collectifs à grande échelle dans la planification urbaine.

Deuxièmement, l'analyse indique la présence potentielle des jeux de pouvoir, notamment entre les acteurs de l'agglomération et les représentants ruraux. Le chapitre met ainsi en lumière la façon dont les nouveaux espaces et processus de gouvernance pourraient être sensibles aux déséquilibres de pouvoir entre les acteurs politiques. Chercheurs en aménagement et en sociologie soutiennent l'hypothèse que les processus de gouvernance et les approches *bottom-up* peuvent laisser la place à de puissants intérêts et des personnalités influentes dans la coalition et la formation d'alliances (Allmendinger and Haughton, 2010, Harvey, 1989, Metzger, 2011). Dans l'exemple de ce chapitre, les clivages géographiques entre les territoires urbains et ruraux et en particulier les identités territoriales apparaissent sur la scène et les acteurs les perçoivent fortement. Sur la scène du SCoT, les acteurs urbains utilisent le positionnement stratégique des représentants influents pour influencer les acteurs et les réseaux existants. Des intérêts d'acteurs influant peuvent alors façonner une stratégie urbaine, un problème qui peut se produire lorsque les débats politiques sont déplacés à des espaces de gouvernance plus souples (Metzger, 2011).

Enfin, notre analyse attire l'attention sur le rôle des aménageurs et urbanistes dans les processus de gouvernance et de leur influence sur les décisions stratégiques. Quant à l'échelle et à la portée, leur champ d'action est devenu diversifié. Dans la théorie de la planification, les approches de planification collaborative ou de communication se réfèrent au rôle du planificateur comme l'un d'un médiateur objectif et neutre entre les différents acteurs et intérêts (Healey, 2007). Mais les planificateurs peuvent aujourd'hui jouer des rôles différents, en fonction du contexte (Briassoulis, 1999). Dans un contexte de plus

en plus présent de la planification technocratique, les agents de l'agence d'urbanisme ont pris le rôle d'informateurs, de diffuseurs et d'éducateurs en matière de réformes politiques et normes de planification au service des collectivités locales. Dans une certaine mesure, nous pourrions dire que la traditionnelle séparation entre la prise de décision politique et la partie opérationnelle de la planification a tendance d'être minée. Ce sont les urbanistes et aménageurs, dotés de plus grandes libertés, qui ont des connaissances techniques et des moyens d'influencer fortement l'élaboration et les décisions politiques. L'agence d'urbanisme agit, d'une certaine manière, comme un groupe de réflexion pour une politique territoriale plus large.

Dans l'ensemble, les leçons du cas du SCoT de Grenoble montrent la nécessité de réfléchir sur la façon dont les visions stratégiques, les cultures de planification et les identités territoriales sont façonnées par les différents acteurs sur de nouvelles scènes de gouvernance. Bien que le document se fonde sur une épisode particulière de la planification territoriale et stratégique en France, nous croyons qu'il présente des renseignements précieux sur la façon dont les acteurs locaux traduisent les récentes réformes de la politique urbaine à leurs territoires et quels inconvénients peuvent exister. Dans le contexte français, la réforme contemporaine de l'aménagement du territoire et une nouvelle vague de décentralisation renforcent considérablement la compétence de l'intercommunalité en matière de planification. L'échelle de la municipalité en tant que plus petite entité de l'administration est susceptible de perdre une grande partie de ses compétences en la matière à moyen terme. En fin de compte, la performance des processus de planification stratégique, notamment pour le développement durable, est fortement dépendante de la façon dont les acteurs locaux façonnent une culture collective de dialogue, de partenariat rural-urbain et de partage des responsabilités.

Chapitre 3 : Les aménités naturelles comme moteur de la ségrégation : indices dans les choix de localisation résidentielle dans deux régions métropolitaines françaises

Yves Schaeffer, *Dominik Cremer-Schulte*, Cosmina Tartiu, Mihai Tivadar

De nombreuses études en économie et en psychologie suggèrent que les ménages se soucient de l'environnement naturel de leurs lieux de vie. Ce chapitre examine le rôle joué par les aménités naturelles dans la formation des configurations résidentielles ségréguées.

La recherche sur la ségrégation résidentielle est nécessaire pour mieux comprendre ses mécanismes et sa résolution par le biais de politiques publiques. Des études ont mis en évidence plusieurs facteurs susceptibles d'influer sur la ségrégation. Dans la littérature économique, la ségrégation résidentielle est considérée surtout comme le résultat des migrations sélectives des ménages dans une région urbaine en fonction de leurs préférences de localisation, qui diffèrent en fonction de leurs attributs socio-démographiques et ethniques. Les cadres explicatifs les plus influents sont des modèles de type Tiebout, les modèles économiques urbains et des modèles d'interaction sociale. Le travail important de Tiebout (1956) suggère que les ménages « votent avec leurs pieds » et choisissent la localisation qui maximise leur utilité en matière d'impôts et de biens publics locaux. L'association d'une inégale capacité à payer pour les biens publics, et des variations dans les préférences conduisent à la concentration des ménages similaires à travers les juridictions locales. Les modèles économiques urbains standards analysent les arbitrages des ménages entre deux principaux facteurs de localisation : l'accessibilité à l'emploi et la consommation en matière de logement (sol). La ségrégation par le revenu et la taille devrait se produire alors dans un motif de cercles concentriques autour d'un quartier central d'affaires (Fujita, 1989). Enfin, les modèles d'interaction sociale du type Schelling supposent un processus de ségrégation où la composition ethnique ou sociale du quartier entre dans la fonction d'utilité des ménages (Grauwin et al., 2012, Schelling, 1971).

Utilisant des renseignements de ces modèles théoriques, un vaste corpus d'études empiriques analyse des comportements résidentiels de localisation dans de nombreuses zones urbaines et métropolitaines à travers le monde. Sur la base de données de préférences déclarées ou révélées, et largement mobilisant les modèles de choix discrets (McFadden, 1978), les travaux confirment l'importance de ces facteurs dans les décisions de localisation. De plus, ces études fournissent des indices pour les différences dans les préférences de localisation entre différents groupes de population (Guo, 2004, Schirmer et al., 2014). En outre, des études récentes montrent l'impact de certains de ces facteurs sur la ségrégation socio-spatiale (Bayer and McMillan, 2012, Goffette-Nagot and Schaeffer, 2013).

Certaines études théoriques et empiriques s'interrogent sur le rôle de l'environnement naturel sur la ségrégation sociale. Par exemple, Banzhaf and Walsh (2008) étend un modèle du type Tiebout pour analyser les réactions des ménages aux changements de qualité de l'environnement local (pollution de l'air), tandis que (Wu, 2006) montre que les configurations de la ségrégation peuvent être mieux expliquée à l'aide d'un cadre économique urbain qui tient compte de la répartition spatiale des aménités naturelles, comme par exemple les éléments de surface (par exemple les parcs) et des éléments linéaires (par exemple les rivières). Les analyses de choix discrets (par exemple de Palma et al. (2007b), Van Duijn and Rouwendal (2013)) confirment que les facteurs du cadre de vie et les nuisances affectent les choix de localisation des ménages, considérant le choix d'une commune de résidence ou un cadre d'analyse plus fin. Cependant, à notre connaissance, il n'existe pas d'étude empirique qui lie explicitement les préférences pour les aménités naturelles des ménages avec les résultats en termes de ségrégation sociale et résidentielle.

Les questions de recherche spécifiques de ce chapitre sont les suivantes : (1) est-ce que les aménités naturelles ont-elles un effet significatif sur les processus de ségrégation résidentielle ? et si oui, (2) est-ce que cet effet renforce ou atténue les autres dynamiques de ségrégation stressés par l'économie urbaine, les modèles Tiebout ou encore ceux de l'interaction sociale ? Le chapitre étudie ces questions avec l'aide de la région urbaine de Grenoble et de la région métropolitaine côtière de Marseille. La localisation des deux régions fait qu'elles sont particulièrement dotées d'aménités naturelles : Grenoble dans les Alpes, et Marseille sur la côte méditerranéenne. Dans le chapitre nous nous concentrons particulièrement sur les aménités prétendument attractives : les aménités vertes (par exemple des zones forestières), des aménités bleues (par exemple des lacs) et des aménités spécifiques tels que la montagne (altitude) et le littoral. Nous étudions les mécanismes de ségrégation en fonction de la taille du ménage et le statut socio-professionnel.

Nous estimons des modèles de choix résidentiels à l'aide de grands échantillons de ménages dans ces deux régions métropolitaines. Les données sur la mobilité résidentielle provient du recensement de la population de 2008, fournies par l'Institut national de la statistique et des études économiques (Insee). La méthodologie est basée sur une approche en deux étapes adaptée de Goffette-Nagot and Schaeffer (2013). Dans la première étape, nous estimons des modèles logit conditionnels et mixtes (Train, 2009) pour les deux régions pour analyser les déterminants des choix de localisation des ménages. Nos variables explicatives comprennent des facteurs standards de localisation tels que l'accessibilité de l'emploi, les services publics locaux et les prix des logements ainsi que les variables pour décrire les aménités naturelles. La deuxième étape est une analyse contre-

factuelle de la ségrégation. Nous calculons les probabilités des choix de ménages en utilisant les modèles estimés dans la première étape (scénario réaliste), et des modèles partiels où les estimations correspondant aux préférences pour les aménités sont mis à zéro (scénario contrefactuel). Ensuite, des simulations de Monte Carlo des choix de localisation des ménages nous permettent de calculer les distributions des indices de ségrégation pour chaque scénario, et de comparer les modèles de ségrégation « avec » et « sans » préférences pour les aménités naturelles.

Les résultats du chapitre confirment que les préférences pour les aménités naturelles diffèrent de façon significative quant à la taille du ménage et son statut socio-professionnel. L'analyse contrefactuelle montre en plus que la recherche des aménités naturelles par les ménages a des répercussions significatives sur la ségrégation sociale. Elle contribue le plus souvent à renforcer la ségrégation, mais peut aussi être un facteur atténuant la ségrégation. La ségrégation résidentielle est notamment renforcée si les résultats socio-spatiales de la dimension de ségrégation « aménités naturelles » et ceux de la dimension « standard » coïncident, et atténuée sinon.

Chapitre 4 : *Etalement ou compacité* : Effets de scénarios de la planification urbaine dans une région urbaine alpine

Dominik Cremer-Schulte

Ce chapitre étudie l'influence de différentes politiques de planification urbaine sur les processus et configurations résidentiels. Nous développons un modèle de choix de localisation résidentielle pour la région urbaine de Grenoble pour i) étudier les déterminants des choix de localisation résidentielle dans la région et ii) analyser les résultats contre-factuels de différentes politiques de planification urbaine.

Par rapport à la littérature existante, ce chapitre apporte trois contributions. Tout d'abord, à notre connaissance, il présente la première étude économétrique des choix résidentiels utilisant des données individuelles désagrégées dans une région urbaine alpine. Les Alpes sont la chaîne de montagne la plus densément peuplée au monde, où deux tiers des 14 millions d'habitants habitent des territoires sous forte influence urbaine (Borsdorf, 2006, Perlik, 2001). Avec 680 000 habitants en 2012 (Insee), l'aire urbaine de Grenoble est de loin la plus grande région urbaine à l'intérieur des Alpes et affiche une dynamique de croissance : la zone urbaine fonctionnelle a accru de 90 000 habitants dans la période allant de 1990 à 2010, et 100 000 habitants de plus sont attendus jusqu'en 2030 (EP SCoT RUG, 2013). Des études antérieures ont mis en évidence l'importance de la migration et de la mobilité résidentielle dans les Alpes et leurs régions urbaines pour le développement urbain et les disparités spatiales (Bender and Kanitscheider, 2012, Camenisch and Debarbieux, 2011, Corrado, 2014, Perlik, 2006, 2011). Des études en géographie ont notamment analysés les migrations interrégionales en Suisse (Camenisch and Debarbieux, 2011) et les processus de péri-urbanisation à travers l'ensemble de l'arc alpin (Perlik, 2001). Des études en économie et en aménagement ont analysé les choix de localisation résidentielle et les marchés du logement dans les régions urbaines limitrophes des Alpes, à savoir dans le Grand Zurich (Bürgle, 2006, Schaerer, 2008, Schirmer et al., 2013), le Grand Lyon (Kryvobokov et al., 2009) et Genève (Schaerer, 2008). Une analyse quantitative des choix résidentiels et de ses déterminants dans un contexte géographique alpin manque, cependant, à ce jour.

Deuxièmement, les préférences des ménages pour des facteurs de localisation résidentielle « doux », contrairement aux facteurs classiques, ont gagné de plus en plus d'intérêt dans la recherche économique au cours des dernières décennies. Ces facteurs de localisation « doux » portent en particulier sur la qualité du cadre de vie en lien avec l'environnement naturel (Dinda, 2004) et les aménités naturelles (McGranahan, 1999, Moss, 2006). Ce gain d'intérêt doit être considérée dans le contexte de la poursuite de l'urbanisation

des sociétés (United Nations, 2014), l'augmentation du niveau de vie et la prolongation du temps de loisirs (Zasada, 2011). L'accent augmenté sur la santé, le bien-être et la qualité de vie individuelle ainsi que le renouveau de la demande de contact avec la nature y sont également liés (Hartig, 1993, Matsuoka and Kaplan, 2008). La recherche économique considère les aménités naturelles comme biens normaux, au moins dans les régions métropolitaines : la demande pour celles-ci augmente avec le revenu (Brueckner et al., 1999, Costa and Kahn, 2000, Deller et al., 2005, Dorfman et al., 2011, Hand et al., 2008, Knapp and Graves, 1989). Parce qu'elles sont spécifiques à un lieu, les ménages ne peuvent varier leurs quantité consommée en se délocalisant.

La théorie économique a mis en évidence les effets des aménités naturelles sur le développement territorial résidentiel et urbain, en particulier sur l'étalement urbain, l'étalement en « saut de grenouilles », mais aussi sur les tri spatial des revenus (voir par exemple Brueckner et al. (1999), Caruso et al. (2007), Cavailhès et al. (2004), Coisson et al. (2014), Wu (2006), Wu and Plantinga (2003)). Les études de prix hédoniques ont confirmé la capitalisation des aménités naturelles dans les prix des logements et fonciers (par exemple Baranzini et al. (2008), Baranzini and Schaerer (2011), Boyle and Kiel (2001), Cavailhès et al. (2009), Cheshire and Sheppard (1995), Nilsson (2014), Waltert and Schlöpfer (2010)), qui affectent ainsi les choix de localisation. Seules quelques études de choix de localisation ont, cependant, intégrés les aménités naturelles dans leurs modèles à ce jour. De plus, les régions de montagne, comme les régions côtières, peuvent fournir des aménités naturelles spécifiques à leurs habitants. Celles-ci sont liés à l'environnement de montagne, telles que l'altitude, la vue, l'ensoleillement et en général les zones proches de la nature (Moss, 2006). Dans les régions de montagne, la distribution des aménités naturelles est, au moins en théorie, plus inégale en comparaison avec une région dans la plaine : des localisations dans les collines et montagnes offrent des aménités naturelles spécifiques et ont des plus grandes chances dans les régions urbaines alpines à jouer un rôle dans les choix de localisation. Outre les facteurs classiques de localisation tels que l'accès au travail, les prix du logement et l'environnement socio-économique, les disparités dans la distribution d'aménités naturelles sont soupçonnées d'influencer de manière significative les choix de localisation des ménages.

Enfin, l'environnement de montagne impose des contraintes sur le développement urbain et sur l'accessibilité en raison de la topographie et de la rareté des terres disponibles pour le développement urbain. Dans le même temps, les Alpes sont un « hotspot » important de la biodiversité en Europe, possèdent des paysages culturels et naturels précieux qui se sont développées au cours des siècles (Debarbieux et al., 2011, European Environmental Agency (EEA), 2010), et présentent donc une forte proportion

de surface couverte par des espaces protégés. Pour les populations locales et régionales, l'environnement de montagne offre des fonctions et des services écosystémiques importants dont il est nécessaire de les maintenir et les distribuer de manière plus équitable. La combinaison d'une ressource foncière limitée et des aménités naturelles et résidentielles font que les régions urbaines alpines sont particulièrement sujettes à la périurbanisation (Perlik, 2001) et à l'étalement urbain. Le schéma de cohérence territoriale de la région urbaine grenobloise (SCoT) à l'horizon 2030 est un instrument de la planification urbaine à la fois stratégique et réglementaire. Ce document a été adopté en 2012 par 273 maires et est censé de contribuer considérablement à la réduction de l'étalement urbain, de promouvoir un développement urbain dense le long des axes de transport public et de renforcer la cohésion sociale dans la région jusqu'en 2030. Le modèle de choix résidentiels qui est développé par ce chapitre peut informer les aménageurs et décideurs sur les résultats potentiels de cette politique et d'autres scénarios d'aménagement alternatives pour la région urbaine.

Dans ce contexte, le but de ce dernier chapitre de thèse est double : (i) d'identifier les déterminants des choix de localisation des ménages et spécifier un modèle de choix résidentiels la région urbaine de Grenoble, et (ii) utiliser ce modèle pour tester les effets de scénarios différents de planification sur la répartition de la demande résidentielle. Nous nous intéressons d'une part aux effets du SCoT, et d'autre part aux effets de plusieurs scénarios de planification radicales et opposées dans différentes zones de la région, en particulier dans les zones de montagne. Les questions de recherche sont les suivantes :

- Quels sont les principaux déterminants des choix de localisation des ménages dans une région urbaine située dans un environnement alpin ?
- En supposant la validité du modèle de choix résidentiels spécifié et son pouvoir prédictif, comment les différents scénarios de planification et de politique des transports affectent-ils les processus résidentiels ? Quels sont les liens entre la répartition de la demande dans une dimension quantitative - concentration - et celle dans une dimension plus qualitative - segregation -, et enfin la demande en zone de montagne ?
- Quels effets résultent du SCoT comme outil réglementaire de planification, en particulier pour la péri-urbanisation et les prix de l'immobilier dans la région ? Quels mesures en termes de politiques spatiales conduisent les processus résidentiels le plus ?
- Comment influencent les politiques de planification et de transport plus radicales la demande résidentielle dans la région ?

Pour répondre à ces questions, le chapitre utilise des modèles de mobilité et de choix résidentiels avec des prix immobiliers endogènes afin de simuler et analyser les configurations de demande résidentielle pour les différents scénarios.

Pour répondre à ces questions, la méthodologie de ce chapitre suit trois étapes. Nous développons d'abord un modèle de choix de localisation résidentielle au niveau de la municipalité pour la région d'étude, en utilisant des modèles de choix discrets (McFadden, 1978, Train, 2009). Car le choix de localisation fait partie d'un processus de choix de logement plus large d'un ménage, nous spécifions des modèles supplémentaires pour représenter la mobilité résidentielle et le choix du type du logement. Pour l'analyse, nous utilisons des données du recensement de la population qui contient des informations désagrégées sur les ménages, notamment les migrations récentes au niveau communal ainsi que des données socio-démographiques. Différentes études ont modélisé de manière similaire des choix désagrégés pour des niveaux géographiques agrégés tels que les secteurs du recensement ou les communes (Ben-Akiva and Bowman, 1998, Dahlberg et al., 2012, de Palma et al., 2007a, Frenkel et al., 2013, Goffette-Nagot and Schaeffer, 2013, Nechyba and Strauss, 1998, Schmidheiny, 2006). En outre, le cadre du modèle considère l'endogénéité des prix de l'immobilier en mettant en interaction le modèle des choix discrets de la demande avec un modèle de prix.

Dans une deuxième étape, nous simulons des configurations de la demande résidentielle pour les différents scénarios contrefactuelle de planification. Plus précisément, nous sélectionnons quatre scénarios de planification urbaine et de transport intégré basé sur le SCoT et une étude prospectives existante pour la région d'étude : (1) un scénario tendanciel dit « BAU », (2) un scénario de planification « SCoT » qui reflète les objectifs du document stratégique 2030 pour la région urbaine, (3) un scénario mettant l'accent sur la préservation des territoires de montagne « SANCT », et (4) un scénario qui représente l'innovation et la croissance économique dans les territoires de montagne « MOUNTI ». Parce que nous nous intéressons aussi à l'apport de différents mesures de planification qui présente le SCoT, le SCoT scénario (2) est subdivisé dans quatre scénarios de politique sectorielle, reflétant les changements apportés par le SCoT dans les secteurs du logement (« housing »), le transport (« access » and « extend ») et par rapport aux aménités (urbaines et naturelles, « amen »). Ces scénarios sont quantifiés et traduits dans les variables du modèle pour simuler les distributions de la demande résidentielle pour chaque scénario. Dans certains scénarios, nous nous apportons aussi des changements dans les coefficients estimés pour simuler des changements systématiques dans les préférences des ménages pour les facteurs de localisation.

Dans une dernière étape, nous analysons et comparons les distributions de la demande

résidentielle simulées et les prix des logements des scénarios avec l'aide de la cartographie et des statistiques descriptives. Nous comparons les distributions de la demande résidentielle aussi à l'aide des indices de concentration de la population, de ségrégation et de développement de la demande dans les zones de montagne.

Les résultats de l'estimation pour le modèle de choix discrets montrent une préférence générale des ménages pour l'espace péri-urbain et ses aménités naturelles en comparaison avec l'accès à la ville centre. Les résultats de l'estimation du modèle de mobilité résidentielle et celui du type du logement révèlent, comme attendu, des variations systématiques dans les décisions des ménages en fonction de leurs caractéristiques démographiques et socio-économiques.

En contrôlant pour les différents facteurs de localisation classiques, nous trouvons que l'environnement de montagne semble contribuer à la péri-urbanisation et au tri résidentiel, notamment par la capitalisation des aménités naturelles et de montagne dans les prix des logements (vue), mais aussi par l'intermédiaire de l'hétérogénéité systématique des préférences des ménages pour celles-ci en fonction de leurs caractéristiques démographiques (âge, composition du ménage) et socio-économiques (revenus, éducation).

L'analyse des distributions simulées de la demande résidentielle pour les scénarios de planification montre qu'une évolution tendancielle des politiques de planification et de transport soutiendrait et potentiellement renforcerait la périurbanisation dans les zones rurales et de montagne dans la région. Des politiques de planification plus contraignantes en matière de développement urbain péri-urbain telles que le SCoT apparaissent en général d'être capable de freiner et potentiellement inverser le processus de péri-urbanisation. Une re-centralisation de la demande, cependant, peut conduire à des hausses des prix au centre. Les politiques qui limitent la croissance périphérique et augmentent la densité urbaine semblent par ailleurs soutenir et potentiellement accroître les niveaux de ségrégation quant aux catégories socio-professionnelles et à l'âge. En revanche, la ségrégation des ménages avec enfants a tendance à être plus faible dans ces scénarios.

Dans nos scénarios, les politiques de planification qui augmentent la densité dans les zones centrales ne conduisent pas à elles-seules à une re-centralisation de la demande résidentielle. Ni les objectifs de construction de logements, ni l'amélioration de la qualité urbaine atteignent l'ampleur des effets des changements pour le transport et l'accessibilité, notamment ceux causés par les changements des préférences des ménages. Sans changements dans les préférences, la tendance générale de la péri-urbanisation est susceptible de se poursuivre. Une politique d'innovation dans les zones de montagne - relative à un changement de paradigme dans les politiques de planification et de développement

économique ainsi que des changements technologiques qui apportent une diminution des contraintes de mobilité - serait capable d'activement promouvoir la croissance de la population dans les territoires ruraux et de montagne.

Les résultats quant à la prédominance des effets des changements dans les variables de transport soulignent les limites de notre approche. Nous ne considérons pas les contraintes de l'offre dans nos modèles. Dans un modèle avec de telles contraintes, le modèle forcerait la demande dépassant de déménager dans d'autres localisations et les prix équilibreraient le marché. En outre, nous utilisons des données de migration en coupe, à l'échelle communale qui fournissent des informations spatiales et temporelles limitées sur les choix résidentiels des ménages. Sans données plus sophistiquées, le modèle doit rester quelque peu simpliste.

Principaux enseignements

Etant donné les indices fournis par nos résultats et la littérature, nous pouvons déduire certains éléments de trajectoires résidentielles des ménages qui pourraient se produire d'une manière générale dans les régions urbaines alpines. Les décisions résidentielles sont influencés par la situation du ménage dans son cycle de vie, son revenu disponible et ses préférences environnementales. Outre une hétérogénéité dans les préférences, les préférences pour les aménités naturelles varient au cours du cycle de vie et en matière de revenus. Nous constatons que les localisations en montagne sont plus attrayantes pour les jeunes, les ménages à revenu élevé et ceux à l'étape de formation de famille. Cependant, nous devons distinguer entre les zones de montagne et leur attractivité en prenant en compte leurs facteurs de localisation classiques qui déterminent largement leur dynamisme résidentiel.

Les préférences pour les aménités naturelles sont soupçonner d'augmenter avec le revenu (Martínez-Alier, 1995). L'inégalité dans les revenus des ménages résulte dans une demande plus élevée pour les aménités de la part des ménages les plus riches, ce qui augmente les prix des logements dans les zones de haute qualité environnementale. Cela limite la possibilité de ménages les plus pauvres de se localiser dans ces zones. Ce processus a également une dimension spatiale. La capitalisation des aménités naturelles dans les prix immobiliers n'est pas homogène dans une région urbaine alpine : les ménages ne paient pas le même prix pour une vue panoramique sur les montagnes dans les alentours. En général, lorsque ces caractéristiques sont rares et où ils se combinent avec d'autres facteurs de localisation importante qui augmentent la demande des ménages, par exemple à proximité d'un centre urbain, la capitalisation est également plus forte.

Cela est particulièrement le cas dans les quartiers et communes établis depuis longtemps sur les coteaux des vallées, qui affichent un dynamisme modéré grâce aux prix élevés.

Contrairement à ces quartiers établis depuis longtemps, les aménités naturelles sont moins capitalisées dans les prix des logements dans les zones péri-urbaines et éloignées, loin du centre urbain. Là, le cadre de vie et les aménités naturelles ne sont guère rares et la demande de logements en particulier des ménages à revenu élevé est généralement plus faible. Ces zones, situées à l'intérieur des chaînes de montagnes et dans les vallées et piémonts éloignées, sont devenues la résidence préférée de la classe moyenne au cours de la dernière décennie et présentent aujourd'hui encore une forte dynamique.

Notre analyse des scénarios de planification montre que les coûts de transport, les prix des logements et les préférences générales des ménages pour éviter le centre urbain déterminent dans une large mesure les distributions de la demande résidentielle. Malgré les limites de notre approche de modélisation, nous pensons que les scénarios de planification ont fourni des renseignements précieux sur les effets potentiels des politiques de planification et de transport dans une région urbaine alpine.

Implications pour la planification urbaine

Les résultats de l'analyse économétrique des migrations intercommunales dans la zone d'étude montrent que l'environnement naturel et ses effets sur les décisions et les processus résidentiels sont importants pour la planification dans les régions urbaines alpines. Ils augmentent les temps de déplacement et l'étalement urbain et peuvent contribuer à la ségrégation sociale. En outre, en considérant la qualité environnementale des montagnes comme un bien commun, la recherche des aménités naturelles par certains ménages apparaît problématique, car de tels processus peuvent exclure d'autres ménages, engendrer des coûts sociaux et réduire ainsi le bien-être général. Nous pourrions aussi postuler que l'environnement de montagne est devenu un bien positionnel dans certains contextes alpins. Les externalités de position liés contribuent à leur tour à des pertes globales de bien-être social. Dans l'ensemble, nos résultats appellent à une meilleure prise en compte des aménités naturelles et leurs effets sur les processus résidentiels dans la planification urbaine.

Les résultats des scénarios impliquent que la recherche et la pratique de la planification urbaine devraient considérer la périurbanisation et ses processus connexes de façon plus complète. La dimension quantitative de la répartition de la population est nécessairement liée à une dimension qualitative : la mobilité résidentielle et les migrations provoquent des changements locaux en termes de capital humain, social et financier ainsi

que la diversité sociale dans les territoires d'origine et de destination. Etant donné les effets forts provenant des changements dans le transport, la planification urbaine devrait continuer à mettre l'accent sur ces politiques qui créent des incitations pour les ménages de se localiser dans les zones « souhaitables » pour le développement urbain. En outre, la planification devrait fournir une offre de logements suffisante, diversifiée et de haute qualité qui répond à la fois à une demande de logements hétérogène et aux préférences environnementales des ménages.

Perspectives de recherche

Au-delà des résultats de notre analyse, la littérature économique montre que l'environnement de montagne peut avoir également des effets indirects sur la péri-urbanisation et l'étalement urbain. Certaines caractéristiques de l'environnement de montagne telles que l'altitude, la pente et la morphologie du terrain créent des effets de rareté qui sont susceptibles d'augmenter les prix immobiliers dans un marché du logement urbain. Ceux-ci s'ajoutent potentiellement aux effets d'aménités décrites dans ce travail et rendent le foncier et le logement encore plus chers dans certaines localisations, et qui donc poussent les ménages à choisir des localisations encore plus loin dans la recherche de terrains abordables pour la construction. Nos choix méthodologiques n'étaient pas appropriés pour intégrer de tels effets de rareté puisque nous ne considérons pas l'offre sur le marché du logement. Une perspective de recherche serait donc d'inclure l'offre des logements dans un modèle de migration ou de choix de localisation afin d'étudier conjointement les effets d'aménités naturelles et de rareté, et leur ampleur.

Pour nos estimations, nous avons utilisé des données du type préférences révélées et des catégories de ménages assez basiques pour analyser les préférences résidentielles, en particulier pour l'environnement montagnard. Les préférences révélées sont, cependant, les préférences exprimées sous contraintes : en réalité, la migration d'un ménage est le résultat d'un compromis entre les préférences pour les différents facteurs de localisation. De plus, nous utilisons des sousgroupes de la population des ménages simples et nous ne disposons pas d'informations sur le classement des facteurs de localisation des ménages individuels. Une deuxième perspective de recherche serait donc de soutenir nos recherches économétriques à l'aide d'une analyse des données qualitatives, par exemple un sondage auprès d'un échantillon représentatif de déménageurs récents dans la région, potentiellement associé à des entretiens semi-directifs. Nous croyons que ce type de données, dans le meilleur des cas collectés dans une étude longitudinale et au niveau des adresses postales (au lieu des communes), permettrait d'enrichir la recherche sur ce sujet et d'augmenter

considérablement les connaissances sur les effets de l'environnement de montagne sur les processus résidentiels.

Notre approche de modélisation était appropriée pour simuler et explorer des configurations contrefactuelles de la demande résidentielle. Cependant, nous considérons pas l'offre sur le marché du logement dans notre modèle, sur laquelle la planification urbaine exerce une influence directe. Les contraintes pour le développement urbain, imposées par le SCoT, n'ont donc pas pu être modélisées de façon adéquate. Car la mise en œuvre des contraintes de l'offre dans un modèle de choix résidentiels est coûteux, nous avons laissé cette extension méthodologique pour les développements futurs.

Comme nous l'avons vu, des processus résidentiels sont complexes et dépendent d'une variété de facteurs. Une façon plus directe et fréquemment utilisée pour estimer les effets de la planification urbaine est d'analyser l'évolution des prix du logement, par exemple avec des analyses de régression. Pour cela, les économistes régressent les caractéristiques de la localisation et les variables de planification sur son prix. La revue de la littérature dans le chapitre 4 a fourni des informations sur les méthodes et les effets de la planification, sur laquelle les recherches futures pourraient s'appuyer.

Afin d'aller plus loin dans le détail dans une analyse de la région d'étude, l'utilisation des données plus détaillées sur la planification urbaine serait intéressante. Même si le SCoT est un outil réglementaire - ses objectifs et orientations doivent être respectés par les documents de planification des échelles inférieurs, à savoir notamment les plans locaux d'urbanisme (intercommunaux) -, il pourrait y avoir une certaine variation en ce qui concerne la mise en œuvre locale des objectifs du SCoT. L'utilisation des données des documents de planification à aux échelles intercommunales et communales pourrait être prometteuse à cet égard : il existe différents types de plans locaux qui varient selon le contexte local. Des recherches futures pourraient étudier en détail les effets de ces instruments ainsi que l'émergence de ces régulations, étant donné que les documents sont en partie le résultat des processus politiques locaux. Compte tenu d'un nombre total de 273 communes dans la zone du SCoT de Grenoble, ces analyses devraient se concentrer sur des territoires spécifiques.

Les territoires péri-urbains dans les Alpes : quel avenir ?

Sur la base des connaissances acquises tout au long de ce travail de thèse, nous pourrions avancer une vision souhaitable pour le développement urbain et social des zones périurbaines dans les Alpes. Ces zones continuent d'être parmi les plus dynamiques en termes de développement résidentiel et l'urbanisation. Un grand nombre d'articles de recherche, des documents officiels et documents de planification stratégique soutiennent une vision spécifique de l'aménagement du territoire - une *Leitbild* -, celle d'une « concentration décentralisée » (voir par exemple Spiekermann (1999)). Elle postule une croissance décentralisée autour des lieux centraux sur différents niveaux et exige de la mixité fonctionnelle. Cette vision va clairement contre une gestion de la croissance centralisée tels que les ceintures vertes ou les limites de croissance. Comme nous l'avons discuté dans cette thèse, ces instruments réglementaires peuvent avoir des effets néfastes sur le développement résidentiel, favorisant l'étalement urbain, le développement en « saut de grenouilles » et la fragmentation sociale-spatiale grâce en raison de la présence des espaces naturels ou semi-naturels protégés. Cependant, une vision de planification souhaitable doit également se prononcer contre des politiques du *laisser-faire* (voir par exemple Klosterman (1985)). Les 60 dernières années d'étalement urbain ont montré que le libre marché produit des résultats sociaux et écologiques sous-optimales (Wilson et al., 2008) qui mettent en cause la durabilité, la qualité de vie et le bien commun.

À notre avis, la seule vision de la politique d'aménagement durable pour les régions urbaines alpines (mais aussi pour des régions ailleurs) est celle qui favorise la croissance périurbaine à un rythme approprié, en respectant l'environnement naturel et en s'appuyant sur des ressources endogènes, ne pas se concentrant sur des objectifs de croissance. Une telle vision intègre les objectifs de développement économique et social, ainsi que ceux de l'aménagement du territoire (voir par exemple Leber and Kunzmann (2006)). L'aménagement du territoire doit être pensé dans les stratégies plus larges du développement territorial, un utilisant des processus bottom-up, comme par exemple dans les chartes des parcs naturels français. Ce type de stratégie ne peut être développées à l'échelle d'une région urbaine, parce que son périmètre ne correspond pas à l'échelle de la vie quotidienne de ses habitants - quartiers urbains, villes secondaires et villages. Compte tenu de la nécessité d'avancer vers une « modernité réductrice » (Welzer, 2013), des stratégies du développement intégré doivent prendre en considération les territoires qui (i) ont une masse critique pour la vie économique et sociale et (ii) offrent une identité territoriale et un sentiment d'appartenance. L'aménagement du territoire, dans cette perspective, ne consiste pas en réduisant les effets adverses des externalités du libre

marché, mais en façonnant les lieux et les esprits afin d'offrir un maximum de qualité de vie pour les habitants. L'aménagement du territoire ne doit pas être une action réactive née de la nécessité, mais une action proactive qui crée des opportunités pour le bien commun.

