Toward a better representation of housing demand : on the role of monetary and non-monetary costs in household residential strategies

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Toward a Better Representation of Housing Demand

On the role of monetary and non-monetary costs in household residential strategies

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Résumé

Cette thèse étudie les stratégies résidentielles des ménages par l'angle des budgets logement et transport, incluant débours monétaires et budgets temps et distance dans le cas du transport. Elle vise à mieux cerner le rôle des contraintes budgétaires dans les choix résidentiels, notamment pour mieux représenter ces derniers en modélisation appliquée.

Un état de l'art compare comment l'économie et les modèles d'interaction transport – usage du sol adressent la demande de logement. Ayant mis en évidence le manque de vision globale d'une part, et une tendance à une vision trop statistique et peu comportementaliste d'autre part, l'étude du rôle des budgets logement et transport tente de remédier à ces deux points.

Ceci comprend deux temps : un empirique, via l'étude des budgets transport et logement des ménages franciliens et des implications quant aux stratégies résidentielles, suivi de l'analyse théorique d'une limitation de la dépense de logement ou de logement et de transport.

Mots-clés : marché du logement, stratégies résidentielles, budget logement, budget transport, Île-de-France, économie urbaine, modélisation transport – usage du sol

Summary

This dissertation investigates household residential strategies using housing and transportation budgets, including outlays and daily travel time and distance in the case of transport. It aims to better understand the role of budget constraints in determining residential choices in order to obtain a clearer representation of these choices in applied modeling.

A state of the art compares how housing demand is represented and analyzed in economics with land-use transport interaction modeling. Considering the lack of a comprehensive perspective on the one side and a tendency toward a purely statistical as opposed to a behavioral perspective on the other, our analysis of the role of housing and transport budgets intends to remedy both shortcomings.

I examine housing and transport budgets in the Greater Paris Region and their implications for household residential strategies before evaluating the impact of limiting either housing or housing plus transport expenses using a theoretical model.

Keywords: housing market, residential strategies, transportation budget, housing budget, Greater Paris Region, urban economics, land-use transport interaction modeling

RÉSUMÉ DÉTAILLÉ

OUVERTURE

Des interactions entre transport et usage du sol

Le lien entre transport et usage du sol est un fait établi, ce probablement depuis l'origine même des systèmes de transport. Moins intuitive par contre est la considération que **cette relation est à double-sens**, le système de transport exerçant aussi une influence notable sur l'usage du sol, et notamment sur le marché du logement. L'impact de réseaux lourds de transports en commun ou d'autoroutes sur le développement urbain illustre parfaitement ce point, bien qu'en mesurer l'ampleur exacte recèle des difficultés techniques inattendues (Small et Verhoef 2007, pp.12-13).

Il existe désormais un *corpus* important de recherche concernant les interactions entre transport et usage du sol, dont l'origine remonte vraisemblablement aux travaux de von Thünen (1826). Celui-ci fut en effet le premier à traiter cette question dans un cadre économique formalisé. Plus d'un siècle plus tard, et parallèlement au développement de la **Nouvelle Économie Urbaine**, marqué entre autres par les apports d'Isard (1956), Alonso (1964), et de Muth (1969), les **modèles intégrés de transport et usage du sol** apparurent dans les années 1960, le modèle de Lowry en constituant sûrement le plus célèbre représentant (Lowry 1964). Aux débuts enthousiastes succédèrent un temps mort dans la recherche opérationnelle, auguré par le célèbre requiem de Lee (Lee 1973), et qui devait durer plusieurs années.

L'émergence de la problématique du **changement climatique** ainsi que de la **raréfaction des ressources pétrolières** a grandement contribué à renouveler l'intérêt académique en la matière, aiguillonné par une opinion publique de plus en plus sensible à la protection de l'environnement et par des politiques en quête de solutions durables en urbanisme et en transport. Les célèbres travaux de Newman et Kenworthy (1989) s'avérèrent primordiaux à cet égard, d'abord en posant la question de la forme urbaine, et en convainquant les ultimes sceptiques de l'intérêt de considérer conjointement les questions de transport et d'usage du sol plutôt que de concevoir et mener des politiques purement logement ou purement transport.

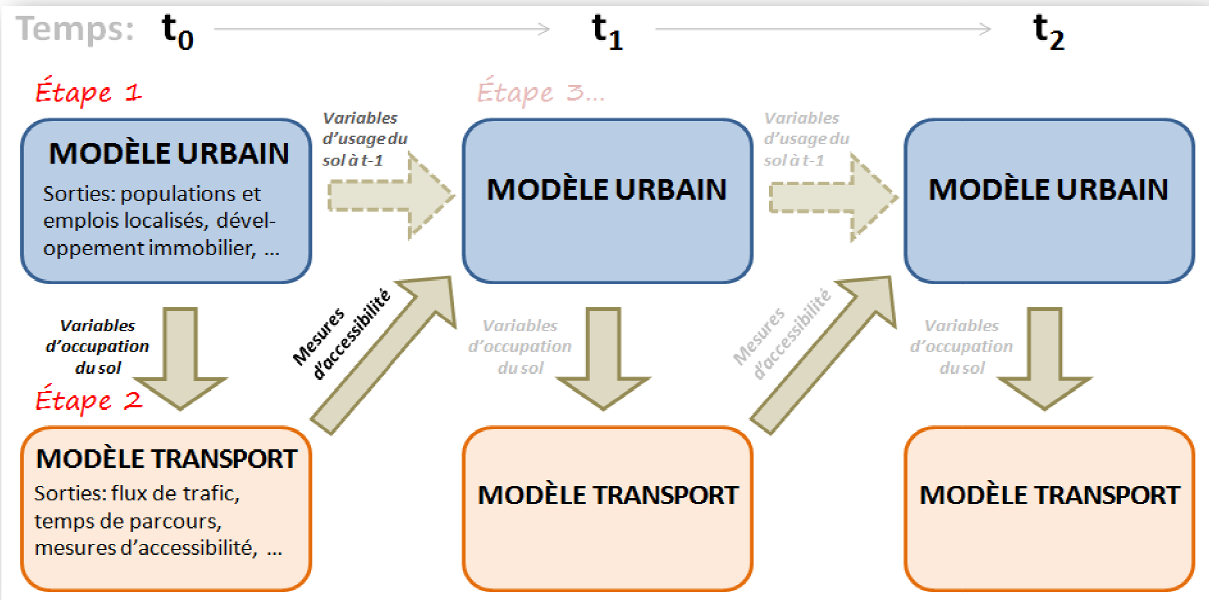
Pourquoi une modélisation intégrée?

Tentons de préciser les enjeux de la représentation des interactions entre transport et usage du sol en modélisation appliquée. Concernant le domaine du logement, il est clair que construire un programme de logements en zone dense ou à l'inverse en zone rurale, loin des centres d'emploi, n'aura pas le même impact en termes de distances parcourues. En outre, le projet peut générer de la congestion supplémentaire, ou à l'inverse favoriser l'emploi d'infrastructures sous-utilisées jusqu'à présent. En termes de politiques publiques, cela implique que **les éco-quartiers ne peuvent négliger la question des habitants et de leurs besoins de transport**, et de comment ceux-ci seront adressés.

Pour ce qui est du transport, la communauté académique a depuis longtemps souligné l'importance de tenir compte des interactions liant transport et usage du sol. Les modèles à quatre-étapes prennent l'occupation du sol comme une donnée exogène, hypothèse raisonnable à court terme. Cependant, **à long terme il devient impérieux de considérer les ajustements résidentiels et l'évolution de la localisation des emplois**, invalidant l'approche traditionnelle à quatre étapes (Putman 1983).

Pour résoudre cette difficulté majeure, la recherche sur la modélisation intégrée transport et usage du sol, dite **modélisation LUTI** pour Land Use–Transport Interaction, a progressivement repris, d'abord dans les pays anglo-saxons, puis dans l'ensemble des pays développés. Ceci donna lieu à de nombreuses classes de modèles, présentés dans la revue élaborée par David Simmonds Consultancy *et al.* (1999). Malgré des différences parfois fondamentales d'un point de vue tant méthodologique que conceptuel, une caractéristique commune à presque tous les modèles consiste en une **structure duale**. Celle-ci repose sur le couplage d'un modèle urbain et d'un modèle de transport, qui se répondent l'un à l'autre comme indiqué en figure suivante.

LE VA-ET-VIENT ENTRE LE MODÈLE URBAIN ET DE TRANSPORT DANS LA MODÉLISATION LUTI



Le modèle urbain est utilisé en premier, ses sorties en termes d'usage du sol servant comme données d'entrées pour le modèle transport. L'équilibre offre-demande de transport résultant est ensuite traditionnellement synthétisé par une ou plusieurs variables d'accessibilité, réinjectées dans le modèle urbain, mais seulement pour le prochain pas de temps. L'hypothèse sous jacente est que l'occupation du sol a une influence directe sur la demande de transport, tandis que les variables de transport ne rétroagissent sur le système d'occupation du sol qu'avec un certain délai.

Le modèle urbain est généralement subdivisé en un module de localisation des emplois et un autre représentant le marché du logement. La présente thèse se concentre sur ce dernier, et nous allons désormais rappeler quelques spécificités du marché du logement, et les difficultés qui s'ensuivent pour la modélisation appliquée.

Sept éléments faisant la spécificité du marché du logement

La spécificité du marché du logement fut rapidement reconnue par les économistes, sous-entendu que les théories micro- ou macroéconomique classiques s'appliqueraient, mais seulement dans une certaine mesure. Smith, Rosen, et Fallis (1988) énumèrent quatre caractéristiques fondamentales de ce marché :

- **durabilité;**
- **fixité spatiale;**
- **hétérogénéité**;
- l'**importance de l'action publique** dans le domaine du logement.

En sus de ces quatre premiers éléments, ajoutons les trois suivants :

- le **rôle majeur du logement dans le patrimoine des ménages**;
- les **dimensions non-économiques du logement**, y compris culturelle, sociale, ou psychologique;
- le rôle crucial que le logement exerce dans l'**accès aux services et aux populations**, *via* sa localisation. Cela inclut le voisinage, la problématique de la carte scolaire, …

Rappelons enfin quelques conséquences notoires des quatre premières caractéristiques. En premier lieu, la durabilité du logement a amené à une **approche duale** de ce marché. La première traite le logement comme un bien de consommation, auquel cas il est fait mention de **service de logement**, tandis que la seconde l'aborde comme un capital, le **stock de logement**, procurant des loyers et se dépréciant avec le temps (Olsen 1969). La durabilité entraîne aussi diverses technologies de production, incluant construction, maintenance, reconversion, et réhabilitation. L'ensemble du processus de construction est long, en particulier du fait de mesures de régulation, avec comme conséquence que **l'offre ne peut s'ajuster instantanément à la demande** (ceci valant également pour la réhabilitation). La relative **indivisibilité du logement** contribue aussi à rendre difficile l'ajustement de l'offre en cas de variations constatées de la demande.

Deuxièmement, l'hétérogénéité des logements donne lieu à des **coûts d'information**, un corollaire étant des asymétries d'information concernant la qualité du bien logement.[1] La fixité spatiale induit des **coûts de déménagement** (**monétaires ou non**). Enfin, l'action publique dans le domaine du logement va généralement de pair avec une forte taxation de ce bien, ceci se traduisant notamment par des **coûts de transaction**.

[1] Soulignons que des asymétries d'information ont aussi lieu au niveau des caractéristiques des agents économiques, tant dans la relation acheteur-vendeur que dans la relation propriétaire-locataire.

Les diverses spécificités du marché du logement soulèvent de multiples difficultés lors de sa modélisation. Jusqu'à présent, la recherche appliquée s'est principalement attelée à la représentation de la demande, et il n'existe pas encore de consensus sur la manière de modéliser l'offre de logement. Malgré ce manque manifeste, le présent travail se propose de traiter essentiellement de la demande de logement.

CONTEXTE, OBJECTIFS ET CHAMP DE LA THÈSE

La modélisation LUTI en France: un champ relativement vierge

Comme le suggère le titre, la capacité française d'ingénierie et d'expertise concernant la modélisation LUTI pâlit en comparaison de pays tels que les Etats-Unis ou le Royaume-Uni.[2] Trois éléments participent de ce retard :

- En France, l'aménagement du territoire relève de la régulation plus que du marché. Les personnes en charge de la planification tendent dès lors à se fier à des modèles classiques de transport, reposant sur des scénarios exogènes d'usage du sol, quand bien même cela empêche de considérer divers problèmes essentiels, tel que l'impact du transport sur les prix immobiliers et les choix résidentiels.
- Les divers acteurs français restent sceptiques quant à la capacité des modèles LUTI à représenter correctement le système d'occupation du sol. Notamment, la nature très orientée marché de ces modèles ne satisfait pas leur perception du marché du logement.
- Enfin et par-dessus tout, il y a actuellement un clair manque d'expérience concernant l'application de bases de données logement à la modélisation offre-demande. L'échec de la première tentative de mise en œuvre d'un modèle LUTI en France, consistant à calibrer TRANUS à l'aire métropolitaine lyonnaise, illustre ce point de façon éloquente (Du Crest 1999).

En vue de combler ce retard, ces dernières années donnèrent lieu à un **lancement de projets tous azimuts**, au risque de se chevaucher.[3] Pour la plupart, l'objectif est avant tout d'ordre opérationnel, à savoir le développement et la calibration d'un modèle LUTI. Les objectifs de recherche demeurent relativement secondaires en moyenne générale. Au nombre des exceptions, le projet ILOT tente actuellement de concilier l'économie urbaine et méthodes de microsimulation, et analyse les réponses du modèle résultant. De même, le projet SIMAURIF en région parisienne a abouti à plusieurs résultats ayant attrait à la théorie des choix discrets (De Palma, Picard, et Waddell 2007).

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[2] Les Etats-Unis ont acquis une longue expérience dans le domaine de l'utilisation de modèles LUTI, et de nombreuses *Metropolitan Planning Organizations* et agences étatiques possèdent de fait leur propre modèle, étant donné les recommandations strictes en termes de planification et d'analyse environnementale (Yen 1996). Dès l'année 2000, l'Agence américaine pour la Protection de l'Environnement avait déjà composé un guide permettant aux organismes impliqués dans la planification régionale de choisir leur propre modèle LUTI (EPA 2000). De même, plusieurs modèles LUTI ont déjà été calibrés et testés au Royaume-Uni (cf. David Simmonds Consultancy *et al.* 1999).

[3] Cf. PREDIT (2008) pour une revue concise mais quasi-exhaustive des projets LUTI actuels en France.

Objectif scientifique: mieux connaître le marché du logement pour mieux le modéliser

De nombreux champs disciplinaires traitent du marché du logement de manière plus ou moins directe: en sus de l'économie urbaine et de la modélisation appliquée précédemment évoquées, nous pourrions aussi mentionner la sociologie, la géographie, et ainsi de suite. La présente thèse s'inscrit d'abord dans la tradition de la **Nouvelle Économie Urbaine**. Par conséquent, le modèle monocentrique constitue un cadre analytique de référence, de manière plus ou moins importante suivant le sujet traité.[4] L'**économie du logement** et la **modélisation de la demande de transport** constituent les deux autres principales disciplines auxquelles ce travail fait appel.

Bien que cette recherche ait un lien marqué avec la **modélisation LUTI**, celle-ci constitue le point de mire plus que le cœur même de la thèse. Plus précisément, un objectif important sous-tendant ce travail est l'acquisition *in fine* d'une expertise suffisante pour **assister décideurs et ingénieurs planificateurs dans l'utilisation et l'analyse de modèles LUTI avec la distance critique nécessaire**. Cet objectif de long-terme est d'autant plus important que la modélisation LUTI est jeune en France. Cela implique un manque de familiarité avec ces techniques de modélisation, accompagnée d'une certaine tendance des non-initiés à une confiance excessive dans les dires des modélisateurs et un manque d'esprit critique, qui ne fait que refléter la forte complexité de ces modèles. Ceci vaut également au niveau international : plusieurs exercices ont été menés à ce niveau pour améliorer la compréhension des modèles LUTI, incluant le projet ISGLUTI, mais ceux-ci se sont essentiellement résumés à comparer les modèles existants entre eux.[5] Les rétro-simulations visant à tester et à valider un modèle demeurent choses rares. Enfin, bien que les modèles LUTI soient fréquemment rapprochés à l'économie urbaine, ceci est rarement étayé par une analyse comparative détaillée des deux.[6]

Précision des objectifs et du champ de la thèse

Compte tenu du contexte, l'heure semblait venue d' « ouvrir la boîte noire », impliquant de décortiquer la représentation du marché du logement en modélisation appliquée afin de mieux l'améliorer. Traiter toutes les facettes du marché du logement requerrait des années, et le champ est donc restreint à la **formation de la demande de logement**. Considérant le but ultérieur d'appliquer cette recherche à la modélisation LUTI, une attention particulière est prêtée à l'influence du transport sur le processus résidentiel.

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[4] Cf. Fujita (1989) pour une analyse poussée et rondement menée de ce modèle et de ses diverses extensions.

[5] Pour le projet ISGLUTI, voir Webster et al. (1988) concernant la phase 1, puis pour la phase 2 Echenique *et al.* (1990), Mackett (1990), Paulley et Webster (1990), Webster et Paulley (1991), et Wegener *et al.* (1991). Voir aussi plus récemment Wegener (2000) pour les derniers projets similaires.

[6] Voir Coulombel (2006) pour une première tentative dans cette direction.

Les contributions personnelles de cette thèse (i.e. excluant l'état de l'art) traitent ainsi du **rôle des budgets transport et logement dans les stratégies résidentielles des ménages**.

SYNTHÈSE DES PRINCIPAUX RÉSULTATS

Chapitre 0 : une introduction au marché du logement en France

Un chapitre ancillaire présente la situation française vis-à-vis du marché du logement. Celui-ci vise à munir le lecteur de tous les éléments nécessaires aux chapitres suivants. Du fait des nombreuses spécificités de ce marché, présentées en-sus, il convient en effet de situer le contexte français puis francilien avant d'étudier les stratégies résidentielles. Ceci permettra de surcroît au lecteur de déterminer dans quelle mesure les résultats seraient transférables à un autre contexte national ou régional.

Un **tableau du marché du logement au niveau national** ouvre ce chapitre. Après avoir établi l'importance du logement dans l'économie française, les éléments de contexte essentiels à la compréhension du fonctionnement de ce marché, incluant sa régulation et sa structure générale, sont fournis. Les principaux chiffres-clés sont ensuite reportés, via une description du stock de logement complétée par des éléments complémentaires sur une sélection de sujets (prix, construction, et mobilité résidentielle).

La seconde section pousse l'analyse un peu plus loin et acquiert de la perspective en « dézoomant » et « zoomant ». Ceci consiste en un premier lieu à **situer la France par rapport aux autres pays européens**, afin de déterminer quelles caractéristiques sont typiques de la France et lesquelles ne le sont pas. Inversement, le « zoom » examine les hétérogénéités internes à travers une **analyse régionale**. Ceci fournit l'opportunité de présenter l'Île-de-France, qui constitue l'aire d'étude du *Chapitre 2*.

Enfin, la dernière section procède à une **revue des bases de données en France**. Toutes les bases de données d'échelle nationale sont couvertes à notre connaissance, ainsi que celles dont le champ couvre l'ensemble de la région Île-de-France. Cette revue s'avérera utile lors du choix des bases de données pour le *Chapitre 2*.

Chapitre 1: la formation de la demande de logement, état de l'art

Après ces premiers éléments factuels, le *Chapitre 1* apporte des éléments scientifiques et méthodologiques. Dressant l'état de l'art concernant la formation de la demande de logement, il forme la pierre angulaire sur laquelle reposent les deux chapitres suivants. Ce chapitre comprend une fois de plus trois parties.

La première est dévouée à la **littérature économique** en rapport avec notre sujet. Celle-ci se structure autour de quatre thèmes :

- la mobilité résidentielle, c'est à dire la décision de déménager;
- la quantité de consommation de logement ;
- le choix des caractéristiques du logement ;
- le choix de localisation.

A notre connaissance, il n'existe pas à ce jour de théorie globale du marché du logement. Ceci signifie que tous les travaux ne couvrent que d'un à deux de ces quatre thèmes, voire trois dans le meilleur des cas. Pour chacun des thèmes, une revue des principaux travaux en la matière est fournie.

La partie suivante étudie la manière dont **la demande de logement est représentée dans trois modèles appliqués** pris comme représentatifs de leur catégorie, à savoir le modèle de Lowry, TRANUS, et UrbanSim. Pour cela, les différents modules résidentiels sont décortiqués, chaque composante inspectée, et le lien avec la littérature économique est établi quand cela s'avère pertinent.

La dernière partie fait le point sur les **études opérationnelles** en France, que nous définissons comme des travaux visant d'abord à des recommandations opérationnelles plus qu'à des objectifs de recherche (qui peuvent exister mais demeurent secondaires). Cela inclut l'évaluation des besoins de logement, des analyses statistiques du marché du logement (par fonctions d'enchères, AFC, etc.) et des approches basées sur la mobilité résidentielle.

Chapitre 2: une analyse spatiale des budgets transport et logement en région Île-de-France

Le *Chapitre 2* étudie les stratégies résidentielles des ménages franciliens à travers le prisme des budgets transport et logement. De fait, cette analyse ne prétend pas fournir plus qu'un éclairage partiel sur le processus complexe qu'est le choix résidentiel. Néanmoins, cette analyse s'avère fructueuse, dans la mesure où elle confirme plusieurs résultats d'études précédentes menées sur le même sujet, et en découvrent d'autres.

Les budgets comprennent des éléments monétaires, loyer ou mensualité du prêt dans le cas du logement, coûts complets dans le cas du transport, ainsi que deux budgets non monétaires en ce qui concerne le transport, le budget temps et le budget distance. La question d'un arbitrage entre dépense de transport et de logement est notamment discutée. La méthodologie d'évaluation repose sur l'utilisation combinée d'une enquête de mobilité quotidienne et de modèles d'affectation routier et de transport en communs, avec quand cela s'avère nécessaire l'utilisation de bases supplémentaires sur les prix et les dépenses des ménages.

Le premier résultat auquel aboutit l'analyse est que les **ménages allouent en moyenne une part relativement constante de leur revenu au logement**, cette part décroissant avec le niveau de revenu. La taille moyenne des logements augmente avec l'éloignement à Paris, reflétant la baisse des prix. Cependant, la taille des ménages augmentant aussi, au final **la surface moyenne par personne varie peu suivant la localisation**.

Deuxièmement, **le taux d'effort transport augmente fortement en s'éloignant de Paris**. Ceci traduit une plus forte motorisation ainsi qu'un plus grand usage de la voiture, permettant aux ménages de parcourir de plus longues distances pour un budget temps quotidien certes identique, mais au prix d'un budget transport dangereusement élevés. Encore une fois, les ménages à faible revenu paient relativement un plus lourd tribut.

L'ensemble des résultats obtenus m'amène à formuler l'hypothèse selon laquelle **les ménages chercheraient avant tout à atteindre un certain niveau de confort domestique** (de 33 m^2 par personne environ). Le transport servirait ainsi de variable d'adaptation pour atteindre cet objectif. Plus précisément, et à la lumière des résultats précédents, **les ménages choisiraient la meilleure localisation possible dans un rayon donné autour du ou des lieux de travail des membres du ménages, étant donné une contrainte de budget logement, mais quel que soit le coût de transport**. Ce rayon est fixé en termes de budget temps, d'où l'utilité, et à la fois la « malédiction », de la voiture.

Chapitre 3: faut-il mieux contraindre le taux d'effort logement ou logement plus transport? Une réponse monocentrique

Au vu des résultats du *Chapitre 2*, on pourrait s'inquiéter du niveau très élevé des taux d'effort H+T des ménages périurbains, et encore plus pour ceux vivant en zone rurale. Plusieurs chercheurs ont mis la faute sur la mesure limitant le taux d'effort logement (en vue de s'assurer la solvabilité des ménages). Celle-ci inciterait à s'éloigner du centre de l'agglomération pour profiter d'un immobilier plus accessible, mais au prix de budgets transport dangereusement élevés, le problème étant que ces derniers ne seraient pas suffisamment pris en compte lors de la recherche du logement. Pour prévenir cet effet, ces mêmes chercheurs prônent l'utilisation d'une contrainte portant à la fois sur le transport et le logement au lieu d'uniquement considérer la dépense de logement.

Ce chapitre **étudie et compare l'impact de ces deux mesures** sur les principales caractéristiques de l'agglomération, incluant la question du **bien-être**. L'analyse est menée dans le cadre du **modèle monocentrique** de l'économie urbaine. Après une première analyse dans le cas général, un modèle de référence est spécifié afin de mieux cerner les effets de chaque politique. Plusieurs extensions sont ensuite développées afin de confirmer les principaux résultats dans un cadre plus réaliste.

L'analyse théorique aboutit à trois résultats majeurs : premièrement, **limiter le taux d'effort logement augmente l'utilité des ménages** tant que la contrainte reste mesurée, fait rare étant donnée la nature contraignante de cette mesure. Deuxièmement, **les deux mesures réduisent l'étalement urbain,** disculpant la première des accusations à son encontre. Cependant, limiter le taux d'effort logement plus transport s'avère de fait plus efficace sur ce point, et **protège mieux la solvabilité des ménages** qu'une mesure limitant uniquement le taux d'effort logement. Ces différents résultats impliquent un **arbitrage entre étalement urbain, équité, et protection de la solvabilité des ménages** quant à savoir quelle mesure choisir.

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GENERAL INTRODUCTION

OVERTURE

On land-use and transport interactions

The connection between land-use and transportation is a widely acknowledged fact, dating back probably to the origins of transportation systems. Indeed, who would build roads in the desert? Slightly less intuitive however, is the consideration that the **relationship functions both ways**, in other words that the transportation system also exerts significant influence on land-use, and in particular on the housing market. The impact of highways or heavy transit systems on urban development marks the epitome of this phenomenon, although measuring the precise extent of this impact reveals considerable pitfalls (Small and Verhoef 2007, pp.12-13).

There is now a substantial history of academic research regarding land-use and transport interactions, and one might consider Von Thünen's works as its very foundation, being the first to address this issue in a standard economic setting (Von Thünen 1826). One century later and parallel to the progressive development of urban economics, punctuated by the contributions of Isard (1956), Alonso (1964), and Muth (1969) to cite only three, integrated models of transport and land-use started to develop in the 1960s, with Lowry's model as its most famous representative (Lowry 1964). However, the early enthusiasm gave way in the 70s to a long slumber of operational research in this field, foreseen by Lee's famous requiem (Lee 1973), and which lasted for several years. The recent issues of **climate change and dwindling oil resources** have largely contributed to renewing academic interest in this topic, fueled further by a public opinion increasingly keen to protect the environment and decision-makers looking for sustainable urban and transport solutions. The seminal work of Newman and Kenworthy (1989) has been central in this regard, first by setting the issue of the optimal urban form, and by convincing the last non-believers of the potential benefits of jointly considering land-use and transportation issues, instead of designing short-sighted policies.

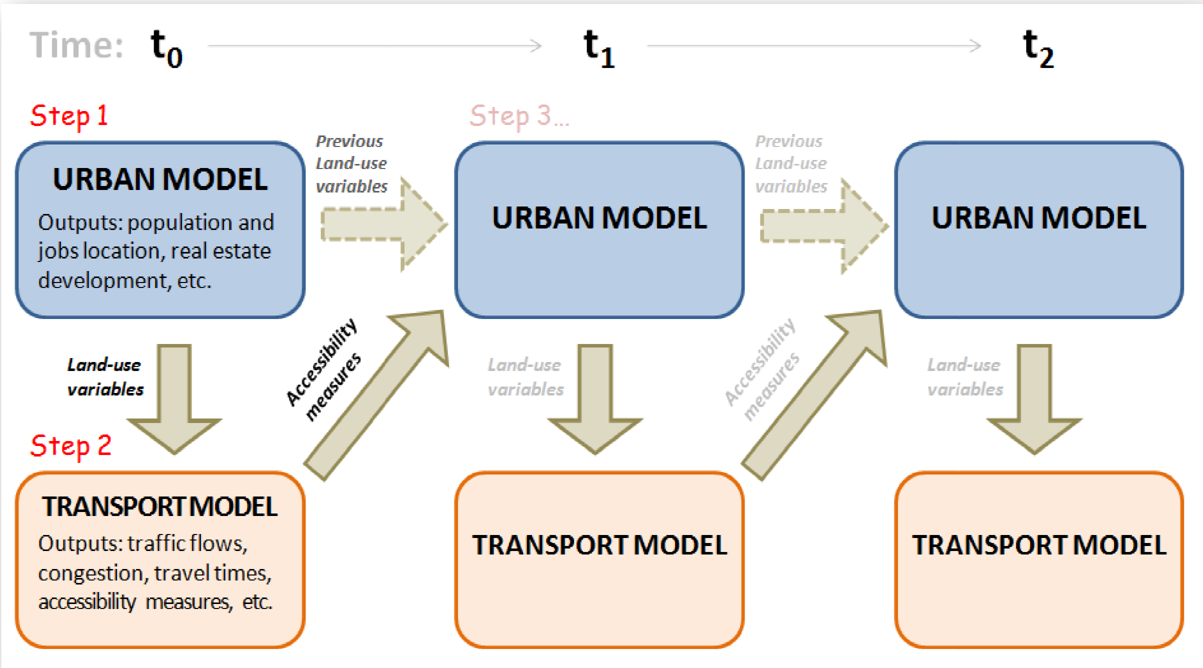
Why develop integrated models?

Let us try and be more specific about what is at stake in considering interactions between land-use and transportation in applied modeling. Regarding housing, it is clear that building a housing project in the core of the metropolis or within the rural area, far from the employment centers, will not have the same impact in terms of travelled distances. In addition, the project can lead to increased congestion, or on the other hand make better use of underused infrastructures. As far as public policies are concerned, this means that **sustainable neighborhoods cannot disregard the question of the travel needs of their inhabitants** and of how it will be dealt with.

With regard to transportation, the importance of taking into account interactions between residential choices and the transportation system has long been emphasized by the academic community. Traditional four-step models actually consider land-use variables as exogenous, and focus on how new infrastructures or transport policies succeed or fail in addressing the subsequent travel demand. Although the assumption of exogenous population and employment variables is correct in the short term, **in the long run one must consider residential adjustments and changes in employment location**, and traditional models become irrelevant (Putman 1983).

To overcome this major shortcoming, research on Land-Use Transport Interaction modeling, often referred to as LUTI modeling for short, has progressively resumed first in Anglo-Saxon countries, later to be followed by many other developed countries. This gave birth to several classes of models, presented, among others, in Coulombel (2006). Despite fundamental conceptual and/or methodological differences between these various models, a widely shared feature is a dual structure based on the coupling of an urban model and a transportation model, which typically interplay as shown on *Figure 1*.

FIGURE 1: ARTICULATION OF URBAN AND TRANSPORT MODELS IN LUTI MODELING



The urban model is run first, its land-use outputs serving as input variables for the transport model. The resulting transport equilibrium is then usually characterized by one or several measures of accessibility, which are fed back to the urban model (in addition to previous land-use variables), but only for the next time period. The underlying assumption is that while land-use has a direct influence on travel demand, transport variables have a lagged influence on the land-use system.

The urban model is generally divided further into an employment location sub-model and a housing market sub-model, often in interaction but still separate entities.[7] The present work focuses on the latter sub-model, and I will now present some of the specificities of the housing market, and the ensuing difficulties for housing modeling.

Seven reasons behind the specificity of the housing market

The housing market has soon been acknowledged by economists as a peculiar one, meaning that standard micro- and macroeconomics do apply, but to a limited extent. Smith, Rosen, and Fallis (1988) list four key special characteristics of this market:

- **durability**;
- **spatial fixity**;
- **heterogeneity**;
- **extensive involvement of governments** in housing and related input markets.

In addition to these, I suggest the three following elements:

- the **primary role** of housing within **household finance**;
- the **non-economic dimensions** to housing: cultural, social, and psychological;
- the major influence it exerts on the **access to services and populations**: this comprises the notion of neighborhood, the choice of schools, etc.

These last three items are partly linked to the previous ones: the paramountcy of housing for households, from both a financial or social point of view, has undoubtedly prompted the major involvement of governments in this matter. Similarly, the spatial fixity of housing is directly related to its strong influence upon the access to services, as well as in determining one's neighborhood. Notwithstanding, I reckon the last three elements to be critical in understanding residential strategies, which is why I have deliberately emphasized them.

Let us recall some noteworthy consequences of the first four characteristics. First of all, the durability of housing has led to a dual approach to this market. The first one treats housing as a consumption good, in which case one speaks of **housing services**, while the second one considers housing as a capital good, the **housing stock**, which yields rents and (usually) depreciates with time (Olsen 1969). A further consequence of durability is the fact that the production of housing stock involves various technologies, to wit: construction, maintenance, reconversion, and rehabilitation. The whole process of construction takes time, in particular due to regulation procedures, meaning that

[7] Spatial Input-Output models originating from the Martin Centre of the University of Cambridge, and primarily including TRANUS and MEPLAN (De la Barra 1989, Echenique *et al.* 1990), are one notorious exception, and achieve a much further level of integration than any other models. However, one can still exhibit the equation systems corresponding to residential choices, meaning that our approach remains cogent.

supply cannot adjust instantaneously to demand (this also is equally true for rehabilitation). The relative **indivisibility** of the housing good also contributes to hindering smooth adjustments of housing supply in case of variations in demand.

Secondly, dwelling heterogeneity leads to significant **information costs** which apply to both aspects of housing (consumption and capital). One corollary is the presence of information asymmetries regarding the quality of the housing good.[8] Spatial fixity entails **moving costs** (monetary as well as non-monetary ones). Last but not least, the extensive involvement of governments has usually gone together with substantial taxation, taking in particular the form of **transaction costs**.

The various specificities of the housing market raise numerous difficulties when trying to model it. As for now, applied modeling has rather concentrated on the representation of housing demand, and there is still little consensus over how to model housing supply. The present work does not aim to address this lack; it will instead focus on housing demand, many questions of which remain unaddressed. But before elaborating on the specific subject of this thesis, I shall present the context of my PhD, which will put the objectives in perspective.

CONTEXT, OBJECTIVES, AND SCOPE

LUTI modeling in France: growing seeds in the desert

As suggests the title of this subsection, the French engineering capacity and expertise regarding LUTI modeling pales in comparison to other countries such as the U.S. or the UK.[9] Three elements account for this scientific gap:

- In France, land-use planning is based on regulation rather than market-driven. Thus planners tend to retain classic transportation models with exogenous land-use scenarios, despite the fact that it precludes tackling several critical issues (e.g., the impact of transport on housing prices and residential choices).
- French actors remain skeptical about the ability of LUTI models to represent correctly the land-use system. In particular the market-oriented nature of these models does not match their perception of the housing market.

[8] Let us note that there are also information asymmetries regarding the characteristics of economic agents, occurring in the relationship buyer/seller as well as in the relationship landlord/tenant.

[9] LUTI modeling has an especially long history in the U.S., and various MPOs and State agencies run their own LUTI model due to the strict requirements regarding environmental and planning analysis (Yen 1996). As early as 2000, the U.S. Environmental Protection Agency had already composed a guide to help land-use planners and decision-makers pick their LUTI model (EPA 2000). Similarly, several LUTI models have already been calibrated and tested in the UK (David Simmonds Consultancy & Marcial Echenique and Partners Limited 1999).

- Most of all, there is a clear gap in experience concerning the application of housing databases to demand-supply modeling. The failure of the first attempt to develop a LUTI model in France, which consisted in applying TRANUS to the metropolitan area of Lyons, epitomizes this lack tellingly (Du Crest 1999).

To remedy this gap, **several research projects** were launched almost simultaneously in recent years, with the consecutive risks of overlap.[10] Most of them focus on their operational goal however, which is the development and calibration of a LUTI model, meaning that research objectives are often secondary. Among the few exceptions, the ILOT project currently endeavors to merge the monocentric model with micro-simulation techniques, and analyzes the response of the resulting model.[11] Similarly, the project SIMAURIF in the Greater Paris Region contributed to deepen the knowledge on residential choices and discrete choice theory (De Palma, Picard, and Waddell 2007).

Scientific context: bringing urban economics to applied modeling

Various fields of research are more or less directly concerned with the housing market: economics and applied modeling have already been cited, but one might also think of sociology, geography, and so on. The present dissertation is primarily rooted in **urban economics**. As a consequence, the monocentric city model logically represents a framework of reference, more or less preeminently depending on the chapters and the corresponding topics.[12] **Housing economics** and **transport modeling** are two other significant fields for this work.

Although this research has a strong connection to **urban and LUTI modeling**, it constitutes the focal point rather than the very core of the study. More specifically, an important motive underlying this work is to ultimately acquire enough expertise **to assist French land-use planners and decision makers in using and analyzing the results of LUTI models while maintaining a critical perspective**. This long-term goal is paramount since LUTI modeling is relatively new in France. This means that people are still unfamiliar with such modeling techniques, and tend to take anything one says for granted considering the complexity of these models. This remains true at an international level: while some rigorous and stimulating exercises were carried out to improve the understanding of these models, including the famous ISGLUTI project, this was mainly done by comparing them with each other.[13] Moreover, retro-simulations to

[10] Refer to PREDIT (2008) for a concise but comprehensive review of current LUTI projects in France.

[11] In a similar and stimulating direction, Mc Breen, Jensen, and Goffette-Nagot (2009) further explore the potentialities of micro-simulation in modeling the housing market.

[12] See Fujita (1989) for an excellent and thoroughgoing analysis of this model and several of its extensions.

[13] Webster *et al.* (1988) provides a thorough report on phase 1 of the ISGLUTI project. For results on phase 2, see Echenique *et al.* (1990), Mackett (1990), Paulley and Webster (1990), Webster and Paulley (1991), and Wegener *et al.* (1991). See also the more recent Wegener (2000) for new ISGLUTI-like projects.

test and validate a model remain extremely rare. Lastly, while LUTI models are often related to urban economics, this connection rarely involves carrying out a systemic comparative analysis.[14]

Setting the objectives, specifying the scope

Given the above context, it seemed time to pry open the black box, which meant analyzing and improving the current representation of the housing market in applied modeling. Addressing the housing market as a whole would require years of exertion though, and the scope was thus narrowed down to the **formation of housing demand**. Considering the ulterior goal of applying this research to LUTI modeling, special emphasis is placed on the influence of transport in the residential process. In particular, personal contributions (thus excluding the state of the art) specifically deal with the **role of housing and transport budgets in households' residential strategies**.

The use of the term "strategy" instead of "choice" is not fortuitous and should be clarified: it indicates that the residential decision is considered together with future transport decisions, mainly involving the issue of commuting. The term "strategy" seemed appropriate to stress the fact that there is not only one but a set of decisions, while the expression "residential choice" sets the focus on the outcome of the residential process. However, one should bear in mind that by "strategy" I do not mean the whole strategy of search, visits, offers, and so on.

Lastly, although a conspicuous thread ties the whole dissertation together, one should consider this thesis rather as a collection of works aiming toward a better understanding of the formation of housing demand, including how this knowledge could be transferred to applied modeling. Among other things, this explains the rather wide scope of the state of the art, as compared to the narrower one of the ensuing chapters.

NAVIGATING THROUGH THE DISSERTATION

The dissertation adopts a ternary structure which is supplemented by an ancillary chapter, accordingly dubbed *Chapter 0*. Privileging a fairly open composition, I moreover decided to write the various parts as **relatively independent chapters**. As a result, one can read them separately without being completely disoriented. This implies some repetitions, the extent of which remains however fairly limited. An extensive reading will still bear more fruits than reading the chapters separately in a holistic kind of way, and is therefore encouraged. A presentation of chapters 1+3 chapters follows.

[14] See Coulombel (2006) for a first endeavor in this direction.

Chapter 0 or all you need to know about the French housing market

The preliminary chapter is dedicated to the presentation of the French situation concerning housing. It intends to provide the reader with all the necessary elements of context for the ensuing chapters. Because of the many specificities of the housing market (see above), it is indeed important to identify the French situation before analyzing residential strategies; this will also to some extent allow the reader to determine whether results could be transposed to another situation or not.

This chapter consists of three sections. *Section I* provides a **national outline of the French housing market**. After assessing the importance of housing within the French economy, important elements of context are provided regarding operation, regulation, and the general structure of the market. Key figures are provided next, including a detailed description of the housing stock, completed by additional elements on selected key topics (prices, construction, and residential mobility).

Section II carries out this analysis a little further and acquires some perspective by "zooming out" and "zooming in". The former involves **situating France among European countries**, in order to evaluate which features are specific to France and which are not. Conversely, the "zooming in" probes internal heterogeneities through a **regional analysis**. This will provide the opportunity to present the Greater Paris Region, *Chapter 2*'s object of study.

Lastly, *section III* reviews the main **French housing databases**. All surveys and databases of national scale are covered, as well as those dedicated to the Greater Paris Region as a whole. This review will prove useful when choosing the relevant databases later on in *Chapter 2* and *3*, and when discussing whether the work carried out in *Chapter 2* could have been achieved through other means.

Chapter 1: the formation of housing demand, state of the art

Following these factual elements, *Chapter 1* brings scientific and methodological elements of context. It reviews the state of the art regarding the formation of housing demand, and will thus be the cornerstone upon which the next two chapters will rest. This chapter is again composed of three sections.

The first one is dedicated to **economic works** relevant to our study topic. I find that these may be structured around four main themes:

- residential mobility, that is the decision to move;
- the level of housing consumption;
- the choice of dwelling characteristics;
- the location choice.

To the best of my knowledge, there is currently no comprehensive economic theory of housing. This means that each work covers only one or two out of the four themes, up to three in the best of cases. An overview of the most influential works is provided for each of these four identified issues.[15]

The next section studies the **representation of housing demand in three applied models** as illustrative of their own categories, viz. Lowry's model, TRANUS, and UrbanSim. This involves breaking the residential sub-model asunder, scrutinizing each component, identifying the economic mechanisms that are represented, and drawing a comparison with the previously presented economic literature when relevant.

The last section reviews French "**operational studies**", defined as works primarily aiming at operational recommendations instead of fulfilling research objectives. This encompasses the evaluation of housing needs, statistical analyses (bid-rent, FCA, etc.), and mobility-based approaches.

Chapter 2: spatial analysis of household housing and transportation budgets in the Greater Paris Region

Chapter 2 studies household residential strategies in the Greater Paris Region through the prism of housing and transportation budgets. It is a prism indeed, and this analysis sheds only partial light onto the complex process that is the residential choice. Despite this limitation, the analysis proves fruitful, and various key results are either confirmed (in relation to previous studies on the same issue) or discovered.

Housing and transportation budgets encompass actual expenses as well as two key non-monetary costs in the case of transport: daily travel-times and distances travelled. In particular, the existence of a trade-off between housing and transportation expenses is discussed. The evaluation method combines the use of a travel survey and of transit and road traffic assignment models, completed by other databases when necessary.

The analysis shows that **households allow on average for a relatively constant share of their income to housing**. This share decreases with income, ranging from 19% for the upper tercile to 41% for the lower one. Home size rises with distance to the center of Paris, reflecting lower prices. However, household size rises at the same time, and all in all the **average surface area per person varies little with location**. Lastly, social renters bear lower burdens while enjoying similar levels of surface area per person.

Secondly, the **average transportation burden** (defined as the ratio between the transportation outlay and household income) **grows significantly with distance to the**

[15] Because works often tackle more than just one out of the four themes, cases of overlap may occur. They are kept to a minimum.

center of Paris, ranging from 8% to 21% for the most remote areas. This mirrors both an **increased motorization** and a **more intensive use of the car**, which allow households to travel longer distances for identical daily travel times, but at the price of dangerously high transportation costs. Once again, lower-income brackets average higher burdens.

These various findings lead me to the following hypothesis, that **the household primary objective is to reach a certain level of "housing comfort"** (33 m^2 per person or so), and that it allows for a constant share of its income to this objective. Transport serves as a variable of adaptation to reach this goal, in the sense that **households opt for the best location possible in a certain radius around the workplaces of employed household members, in the limit of their target housing budget but whatever the transportation cost**. This radius is set in terms of travel time, hence the use of the car to access to more housing opportunities, even though these are remote from employment centers and entail heavy transport expenses.

Chapter 3: Monocentric analysis of the impact of budget restrictions

Considering the results of *Chapter 2*, one might worry about the heavy H+T burdens faced by suburban households, and even more so for inhabitants of rural areas. Several researchers have blamed the policy capping the share of housing expenditure in the household budget, so as to secure the solvency of the household, for this situation. This policy supposedly induces people to get farther from the city center in search of cheaper housing prices, but with subsequent increased transport costs that are often disregarded during the home search process. To prevent this side effect, several researchers **have advocated the use of a constraint bearing on the total share of housing plus transportation rather than on housing alone**.

The present chapter analyzes and compares the impact of these two policies on the main features of the city, including a welfare analysis. The investigation is carried out within the standard **monocentric city model**. After a general analysis, an applied model is specified to capture the effects of each policy in straightforward formulae. In addition, several extensions are developed to confirm the findings in a more realistic setting.

The theoretical analysis leads to three main findings: first, **capping housing expenses can increase household utility**, a rare consequence for a constraining policy. Secondly, **both policies lead to reduced urban sprawl**, contrary to what is often asserted regarding the limitation of housing expenses. However, capping simultaneously housing and transport costs is indeed more effective in this regard. Lastly, the latter policy also protects household solvency more efficiently than policies only capping the housing expenditure. This implies a **trade-off between urban sprawl, equity issues, and the protection of household solvency** when choosing which policy to implement.

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Chapter 0
An Introduction to the French Housing Market

Structure, regulation, observation
Key facts and figures

I - NATIONAL OVERVIEW

This section provides an overview of the French housing market.[16] It includes:

- an initial appraisal of the place of housing within the French economy;
- basic notions on how the market is structured, regulation, etc.;
- a depiction of the housing stock and its occupancy;
- additional insights into other key issues, namely prices, mobility, and construction.

Considering the scope of this dissertation, emphasis is put on the demand side, and elements regarding housing supply are kept to a minimum.

A THE GROWING IMPORTANCE OF HOUSING WITHIN THE FRENCH ECONOMY

The National Housing Expenditure (NHE), which comprehends all housing related expenses, added up to **416 billion € in 2006** (*Figure 2*). It consists of three elements:

- **Capital expenses** made by all actors of the housing market, so as to increase their stock of housing capital (through acquisitions or home renovation)[17]. They represent on average around **one third** of the NHE.
- **Current expenses** incurred by households for the consumption of housing services (rents, utilities, home maintenance, etc.) amount to **two thirds** of the NHE.
- Financial flows are minor sources of expenses that could not be integrated within the first two categories.[18]

The NHE has grown at a sustained rate of +4.7% a year between 1991 and 2006, supported by a continual increase of current expenses. It represents a growing share of the French Gross Domestic Product, at 23% in 2006 as compared to 19% in 1985 (*Figure B*), to the point that several researchers mention decoupling.

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[16] First, let us recall that France is composed of:

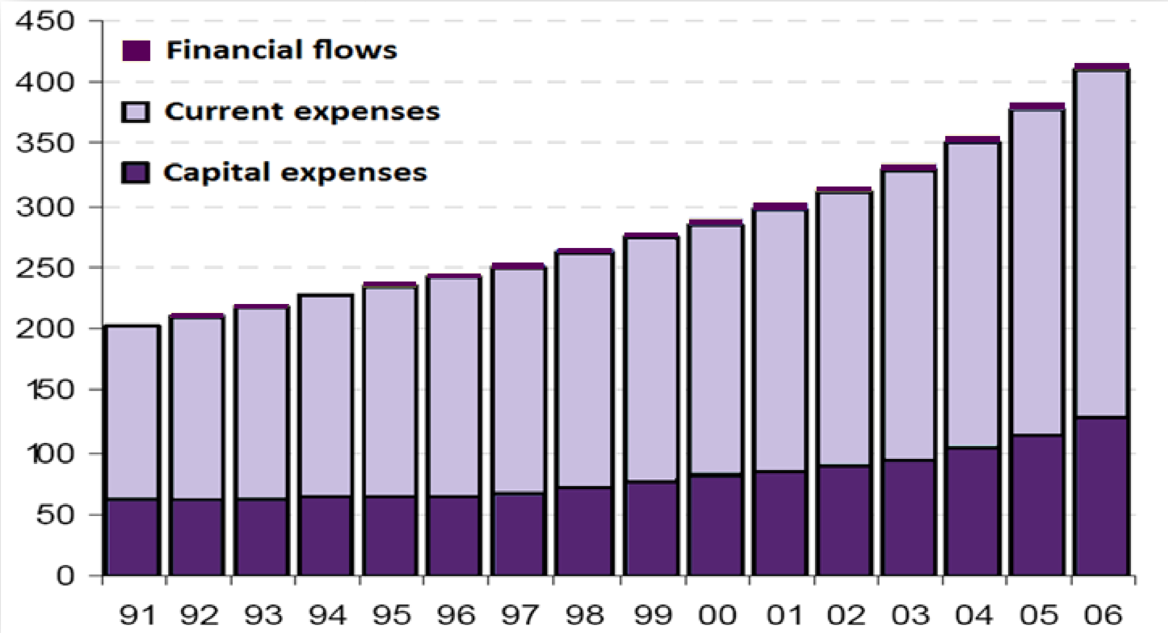
- a European part consisting of the mainland and neighboring islands (including Corsica). This part is called France *métropolitaine;*
- French-administered overseas territories referred to as DOM-TOM.

A map is provided in the appendix (*Figure A*). Because of their unique characteristics as well as data issues, DOM-TOM are not covered in this analysis unless specified by the mention France (whole) instead of France *métropolitaine*.

[17] National accounting distinguishes between maintenance (e.g., minor electrical, plumbing, or painting works) and renovation (e.g., adding a new room, substantial remodeling, repainting of the dwelling, etc.). The term "home improvements" is used to refer to both categories together.

[18] See DAEI/SES-P and DGUHC (2008) for more details on this topic.

FIGURE 2: THE RISE OF THE NATIONAL HOUSING EXPENDITURE ***(BILLIONS OF €)***

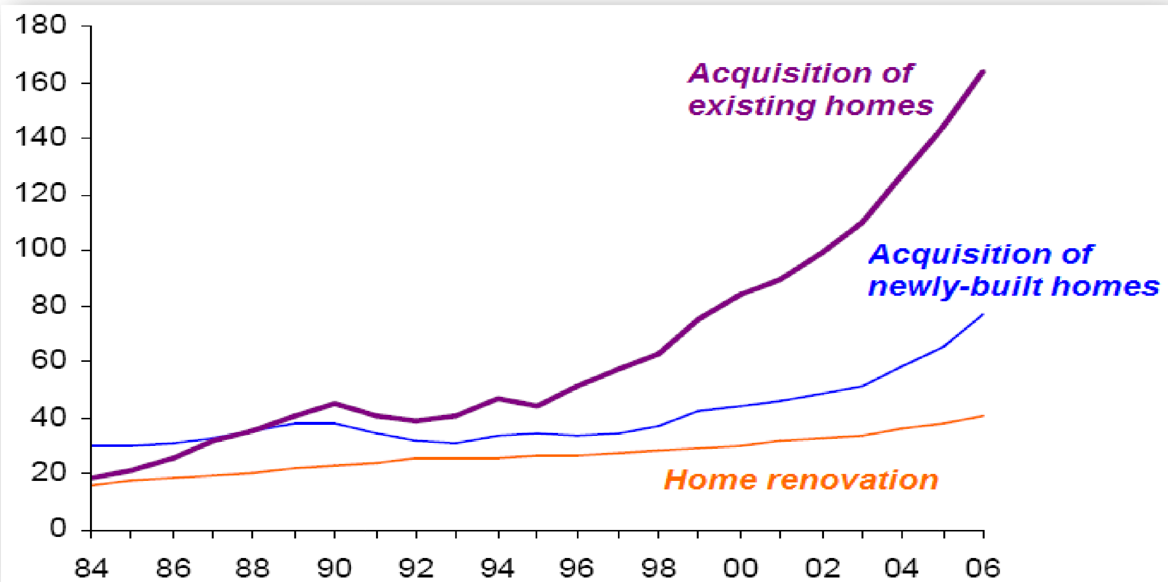


Scope: France (whole) *Source: French Housing Accounts, 2006*

A-1. Gross and net capital expenses

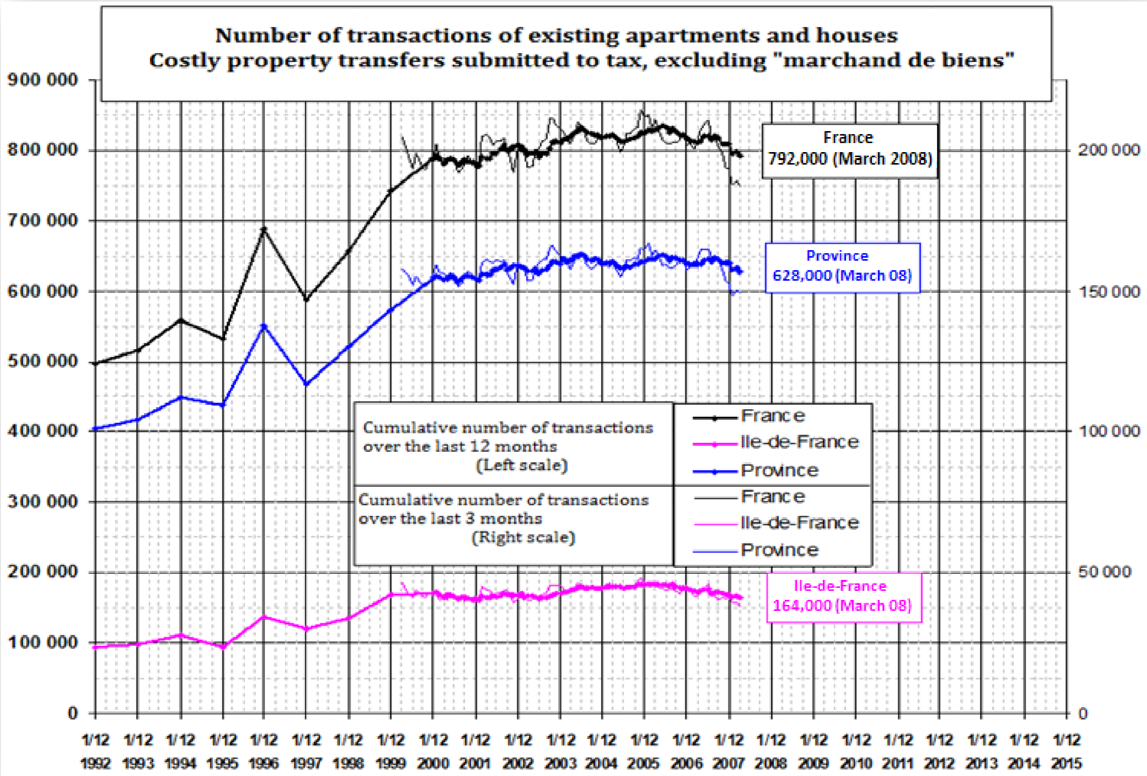
As previously stated, net capital expenses represent a sizable share of the NHE, one third to be precise. A more detailed analysis of gross capital expenses reveals a **surge in the volume of acquisitions of existing homes**, rising from 20 billion to more than 160 billion between 1984 and 2006 (*Figure 3*). The market for new homes also shows strong growth, rising from 30 to 80 billion during the same period.

FIGURE 3: TRENDS IN ACQUISITIONS AND HOME RENOVATION ***(BILLIONS OF €)***



Scope: France (whole) *Source: French Housing Accounts, 2006*

FIGURE 4: NUMBER OF TRANSACTIONS IN THE MARKET FOR EXISTING HOMES



Île-de-France = Greater Paris Region, Province = France *métropolitaine* - Greater Paris Region (→ *II - C*).

Scope: France *métropolitaine* *Source: Friggit (2008a)*

Despite this marked upward trend, the 1990-91 housing market crash triggered a drop in the volume of transactions which lasted for a few years, highlighting the highly **cyclical nature** of this market. After 1995, acquisitions of existing and new dwellings were on the rise again, especially the former as the number of transactions in the market for established housing increased from 498,000 in 1992 to **808,000 in 2007** (*Figure 4*).[19] Interestingly, from 2000 onward, the number of transactions has remained stable, which implies that the observed rise in the volume of acquisitions stems from a pure price effect. To conclude with the subject of existing homes, let us note that 2008 put an end to this situation: focusing on 3-month figures in *Figure 4*, one can discern a downturn at the end of 2007, foreshadowing the recent drop in transactions caused by the ongoing crisis.

A less known fact is that **home renovation** accounts for a **significant share of the new housing stock**, fluctuating between a third and a half of net capital expenses between 1984 and 2006. A similar order of magnitude was found for the U.S. market (Smith, Rosen, and Fallis 1988), indicating that home renovation often represents a

[19] While finding similar trends, Grépinet (2006) provides lower estimates, with 625,000 transactions in the market for existing homes and 400,000 as regards new homes for year 2005. Considering the sizable gap between the volume of new and existing dwellings displayed in *Figure 2*, Friggit's estimates seem more reliable.

serious alternative to a residential move when a household is dissatisfied with its current home. Unlike acquisitions, home renovations have been regularly increasing since 1984, and seem unaffected by market cycles.[20]

Only a small part of the purchases of existing homes is counted within net capital expenses, since transactions involving French parties on both sides (buyer and seller) do not affect the French housing stock. This explains why net capital expenses added up to only 116 billion € in 2005 for example (*Figure 2*), in spite of the rise in acquisitions of existing homes. As a consequence, home construction and renovation are the two main elements contributing to increase housing capital. Still, the volumes of acquisitions of existing and new homes are central to understanding the relative significance of each market, and both are noteworthy indicators.

A-2. Current expenses

Current housing expenses represent on average around two thirds of the NHE. They include all expenses related to the **consumption of housing services** (as opposed to housing capital investments), that is:

- rents in the case of tenants, imputed rents in the case of owner occupiers;[21]
- utilities (heating, electricity, water);
- other service charges and expenses: insurance, taxes, maintenance, moving costs, etc.

Although current housing expenses are highly volatile, their growth has usually outweighed the growth of disposable income, resulting in a **sharp upward trend** of the ratio of current expenses to household disposable income (*Figure 5*). In 2005, current expenses represented on average **22% of the household disposable income**, as compared to only 18% in 1985. This trend stems from a long term increase in rents (*Figure C*), as well as a recent rise in energy prices (Plateau 2006).

Fluctuations in current housing expenses seem to be in phase with real estate market cycles, also presented in *Figure C*: growth rates are higher during bullish periods than during bearish ones. This hardly comes as a surprise considering that rents account for almost 75% of current expenses (*Table* A), implying that the two variables are indeed strongly correlated.

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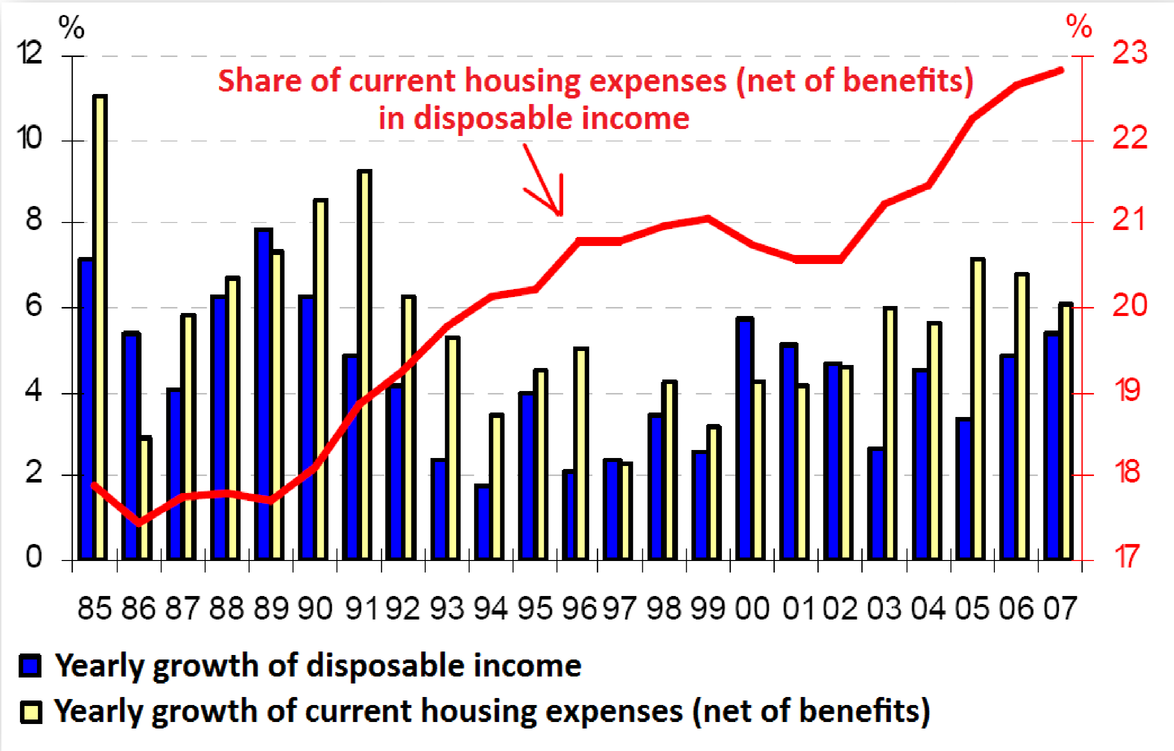
[20] Smith, Rosen, and Fallis (1988) find a similar pattern in the U.S. market. They argue that home improvement expenditure increases steadily because it has contra-cyclical features.

[21] Imputed rents are fictive rents that owner-occupiers would pay to themselves to live in their dwelling. They count as both an income source and an expense, thereby being neutral within the household budget. This artifice is used to put renters and owner occupiers on an equal footing. Imputed rents are assessed using a hedonic analysis of rental prices. A strong limitation of this method lies in the fact that the rental and property markets offer very different products (e.g., rural areas offer few rental dwellings). This means that they are hardly comparable to begin with, which raises issues as to the quality of the estimates.

FIGURE 5: CURRENT HOUSING EXPENSES VIS-A-VIS DISPOSABLE INCOME



Scope: France (whole) *Source: French Housing Accounts, 2007*

Let us stress that current housing expenses are but one indicator used in the analysis of housing consumption, and have various shortcomings:

- They do not correspond to actual expenses since they are based on the notion of imputed rents. Mortgage payments are logically excluded from the scope of current housing expenses, while they may represent a heavy burden for homebuyers.
- Following this line of thought, implicit subsidies stemming from the supply of subsidized rental housing should logically be taken into account. Indeed, current housing expenses intend to measure housing service consumption, and social housing is a source of distortion in this regard.
- **Imputed rents** account for as much as **two thirds of total rents** (*Table* A). Miscalculations would thus automatically lead to sizable errors in the measurement of current housing expenses. This proves problematic given that the estimation and use of imputed rents is fraught with several theoretical and practical pitfalls (Driant and Jacquot 2005).[22]

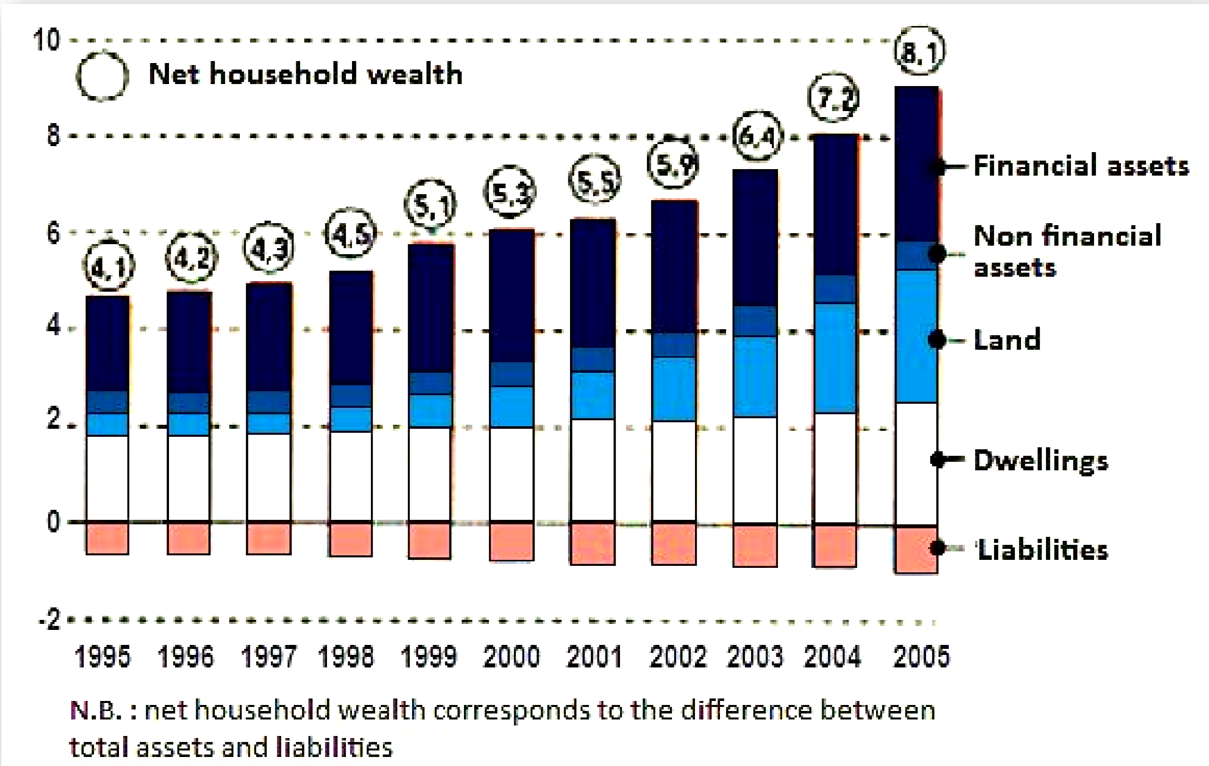
[22] Note that the estimation of implicit subsidies in the social sector is fraught with the same difficulties.

A-3. An increasing weight in the wealth of households

In addition to its important place in the French economy, housing plays a special role in the household finances. Buying a home is usually the most important decision in a household life with respect to its savings behavior and its capital accumulation strategy. When doing so, the household is committed to save a substantial share of its income, or otherwise risk foreclosure (unless not resorting to a mortgage). This form of commitment is important to low-income households, primarily through enforcing a savings discipline, and also because it is less sophisticated and complex than other products such as the stock market (Kain and Quigley 1972).

In 2005, real estate was the highest-valued item in household assets, accounting for about 60% of the 9 trillion Euros owned by households, as compared to only 45% in 1995 (*Figure 6*). Interestingly, this dominant position was achieved through the increase in the value of land assets: negligible in 1995, they were ten years later on their way of becoming the primary component of French household wealth. [23]

FIGURE 6: HOUSEHOLD ASSETS AND LIABILITIES ***(TRILLIONS OF €)***



Source: Donzel et al. (2008), based on National accounts, Insee

[23] This "land" item encompasses both vacant land and the land on which dwellings are built on.

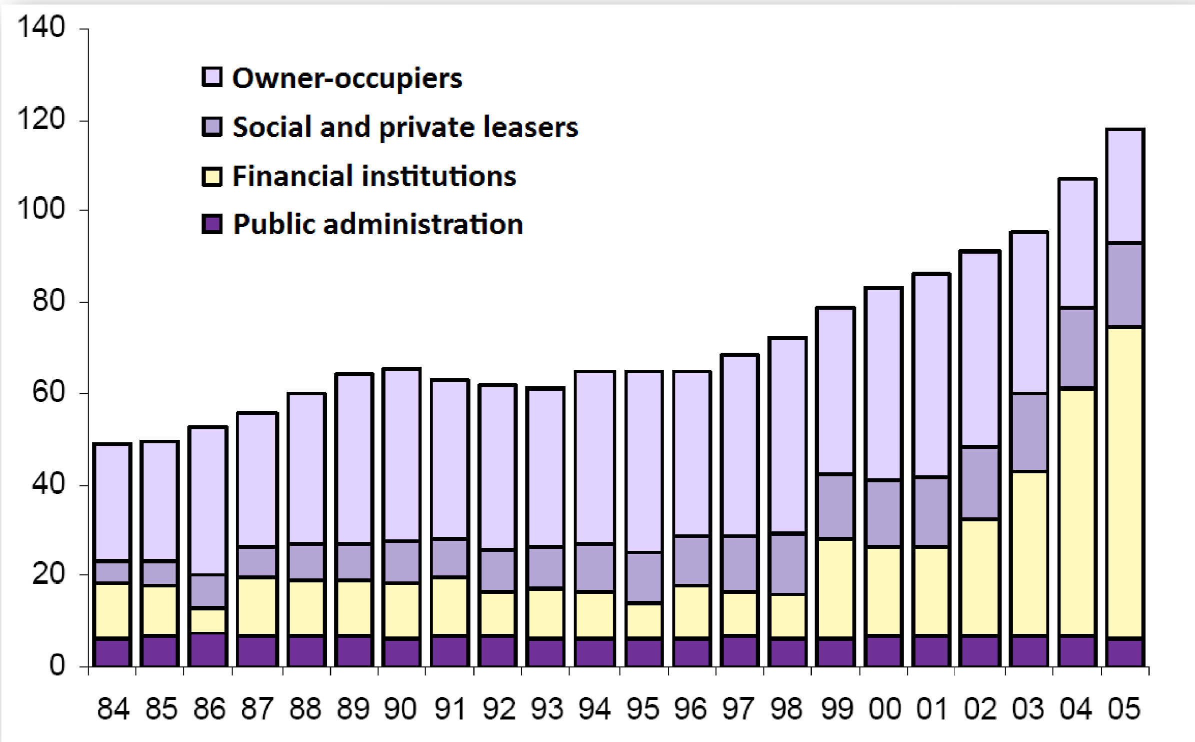
B THE FRENCH HOUSING MARKET: BASIC NOTIONS

The **great variety of actors** intervening at the different stages of the life of a dwelling constitutes a well-known difficulty when willing to study and/or model the housing market. The analysis of stakeholders in the funding of housing (*Figure 7*) provides a first overview of some of these actors.

While households occupying their own dwelling used to play a leading role in housing investment, their contribution has decreased over the last years due to a **massive use of credit,** hence the soar in expenses of financial institutions during the current decade. Social and private lessors also play a slightly increasing role. Lastly, expenses by public administrations have for their part remained steady for the last twenty years, in the vicinity of a mere five billion Euros.

These considerations bring us to the difference between the social and private housing sectors. This distinction is of great significance in France: the social sector is strongly regulated and has substantially lower rents than the free sector. Besides, the actors that finance each sector greatly differ. I shall first present the social market, then the private market. A short overview of housing benefits will complete this outline of the structure and operation of the French housing market (from a demand point of view).

FIGURE 7: EXPENSES CONTRIBUTING TO THE FUNDING OF HOUSING ***(BILLIONS OF €)***



Source: French Housing Accounts, 2005

B-1. The French social housing market

a) Definition of social housing

The distinction between the social and private rental sectors depends on the type of the landlord. Social rental units are owned by either an *Habitation à Loyer Modéré* (HLM) agency or another social lessor. Although the HLM sector represents by far the greatest share of the social sector, and thus constitutes the main provider of dwellings with regulated rents, its weight is dwindling: in 2005, **HLM units accounted for 77% of social rental dwellings**, as compared to 87% in 1985.

b) Institutional overview

Institutions managing subsidized rental accommodations are bodies specifically created for this purpose. They are broken down into two categories, the HLM sector and « other social lessors». These institutions are numerous, and greatly vary as regards the size of the managed housing stock, this whatever the considered type. Most of them operate locally, but a few institutions are of national scale (Grépinet 2006).

The HLM Sector

The HLM sector is further subdivided into three groups: public establishments, HLM companies, and cooperative companies.

Public establishments (the *Offices Publics*) are created by local authorities such as *communes*, *groupements de communes*, or *départements*, in order to provide their population with social housing. Two types of establishments used to coexist: the *Offices Publics d'Habitations à Loyer Modéré* (OPHLM) and the *Offices Publics d'Aménagement et de Construction* (OPAC). Following the law « *Engagement National pour le Logement* » (2006-07-13), they merged in 2007 under the name of *Offices Publics de l'Habitat* (OPH). They now share the same status, which is close to that of the former OPACs. [24] In 2007, there were 279 OPH, managing as many as 2.2 million dwellings and accommodating around 4.5 million people. [25]

The second group of HLM agencies consists of private companies named *Entreprises Sociales pour l'Habitat* (ESH, formerly known as the *Sociétés Anonymes d'HLM*). The ESH are subject to the legislation covering public limited companies and are non-profit organizations, although they are able to distribute dividends. They are created on the initiative of private companies, Chambers of Commerce, collectors of the

[24] OPHLMs were subject to public accounting rules and employed public servants. OPACs had a status closer to that of private companies with respect to accounting rules and the status of employees. Although both their missions and statuses differed according to law, their activities were actually quite similar, hence the merger.
[25] Source: http://www.offices-hlm.org/

1% logement (see below), mutualist organizations, and so on. There were 281 ESH at the end of 2007, which managed a total of around 2 million housing units and provided accommodation for 4.5 million people. [26]

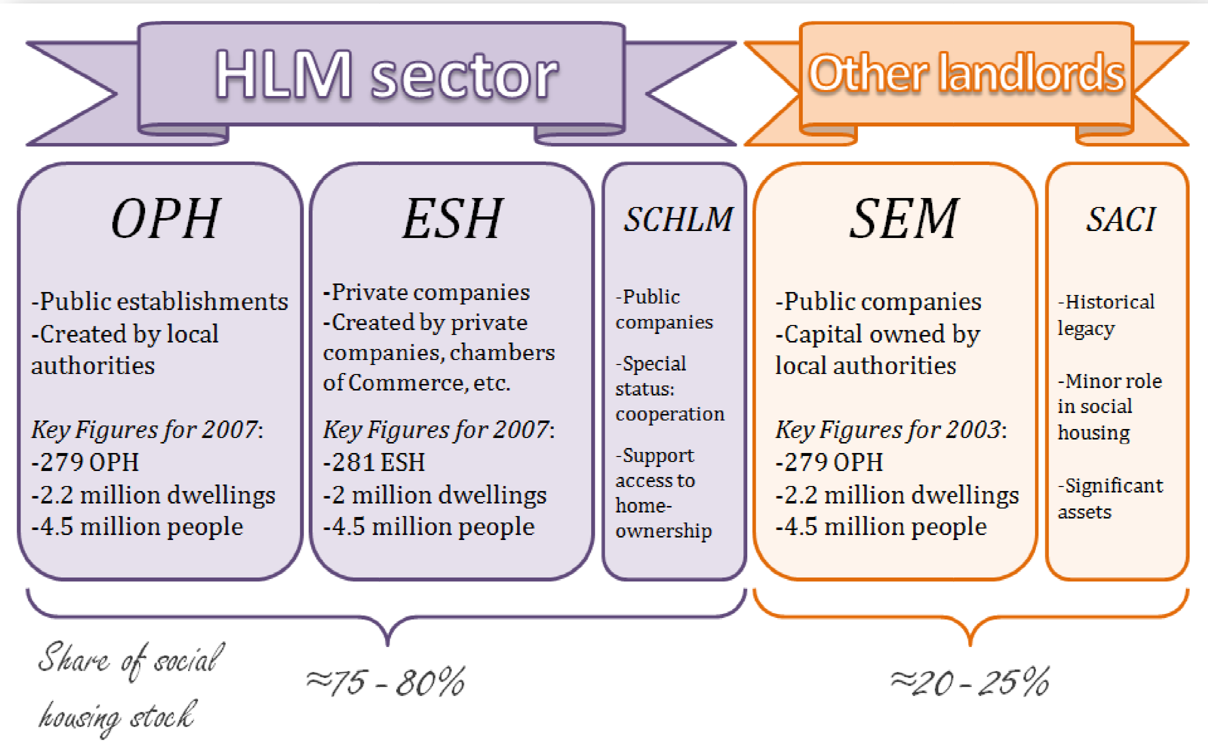
The last group plays a lesser role within the HLM sector. The *Sociétés Coopératives d'HLM* (SCHLM) are public companies the main goal of which is to facilitate access to home ownership for low-income households. They have a special status which makes them slightly more efficient than other HLM bodies for their designated purpose. They produced 5,700 housing units in 2007, 4,000 for the ownership sector and 1,700 for the social rental sector.[27] Such levels remain indeed relatively low in comparison to the total production of social dwellings, which reached 80,000 units in 2005.

Other social landlords

The two remaining types of institutions playing a role in the field of social housing are the *Sociétés d'Economie Mixte* (SEM) and the *Sociétés Anonymes de Crédit Immobilier* (SACI). These categories have regulated rent, but not the HLM status.

SACIs are essentially an historical legacy from the beginning of the 20th century and play little role in social housing nowadays. Yet their substantial assets arouse great interest among politicians who would like to use them to finance social housing policies.

FIGURE 8: INSTITUTIONAL STRUCTURE OF SOCIAL HOUSING



[26] Source: http://www.esh-fr.org/fede/frame_chiffres.htm
[27] Source: http://www.hlm.coop/, documents of the general assembly.

Lastly, SEMs are public companies the capital of which is owned in majority by local authorities. While the scope of their action is broader than social housing, SEMs are basically subject to the same rules as HLM bodies when operating in this field. There were 284 SEM in 2003, managing more than 500,000 social dwellings.

c) Social housing financing system

In France, social housing is mainly financed by the following parties and mechanisms:

- The State, on budgetary credits: investment is made under the form of a loan or of a *subvention à fonds perdus* (subsidy). As compensation, the prefect earns a preemptive right to 30% of social dwellings of the financed program, 5% (i.e. one sixth) being reserved for public servants.[28]
- Local governments play an increasing role in providing complementary funding to that of the State.
- Employers also take part in the home building effort through a financial contribution called the *1% Logement*. Collectors dedicated to this purpose raise these funds and use them under the form of loans or subsidies to support social housing and help low-income households achieve home-ownership.
- The *Caisse des Dépôts et Consignations* provides loans with preferential rates to social lessors thanks to its management of the *Livret A*, a riskless savings product widespread in France.[29]
- The *Caisses d'Allocations Familiales* (CAF) receive the contributions of employers for social insurance and are in charge of paying housing benefits (among other benefits).

d) The different products in social housing

Subsidized rental housing units are broken down into various categories, each one targeting a specific part of the population. The *Prêt Locatif à Usage Social* (PLUS) is the basic product: it represents the largest part of the social housing stock and serves as a reference for other products. The *Prêt Locatif Aidé d'Intégration* (PLAI) is oriented towards needy households, when the *Prêt Locatif Social* (PLS) is an intermediate product between the PLUS and the free market.[30]

This classification reflects the level of price ceilings and income ceilings. Price ceilings are set at the State level in accordance with the target population of each product, and are updated yearly. They also differ by zone to take into account regional income variations (*Table 1*).

---

[28] In France, a prefect (*préfet*) is the chief administrative official of a *département*.

[29] See http://fr.wikipedia.org/wiki/Livret_A#Des_pr.C3.AAts_au_logement_social for more on this topic.

[30] Other categories do exist, but are of lesser importance and thus not presented here.

TABLE 1: MONTHLY RENTAL PRICE CEILINGS IN € PER M² OF USEFUL SURFACE AREA, 2008

Product Type	Zone 1 bis	Zone 1	Zone 2	Zone 3
PLUS	6.17	5.81	5.1	4.73
PLAI	5.49	5.16	4.52	4.2
PLS	9.26	8.72	7.64	7.11

Useful surface area adds half the area of annexes (balconies, parking lots, basements, etc.) to the living surface area.

Zone 1bis: Inner Paris + adjacent cities

Zone 1: Paris metropolitan area - Zone 1bis

Zone 2: Île-de-France - (Zone 1 + 1bis) + metropolitan areas >100,000 inhabitants

Zone 3: remainder of France

Source: Circulaire UHC/DH2, 2008-07-04

Income ceilings are also set by the State and depend on household type, product type, and location. At the time of the application, they are compared to the household taxable income of year *n*-2 to determine whether the household is eligible for a social dwelling (**eligibility rule**). Once the file is accepted, the household may stay for as long as it wants in the dwelling, even if it were to exceed income ceilings.[31] This important rule is named ***droit au maintien***. *Table 2* provides income ceilings in the case of a PLUS housing unit. Income ceilings for PLAI and PLS units correspond to approximately 60% and 130% of PLUS ceilings, respectively.

In fact, eligibility rules are **barely selective**: in the Greater Paris Region, from 31% to 80% of households were eligible in 2007 depending on the type of social housing.[32]

TABLE 2: INCOME CEILINGS FOR PLUS HOUSING UNITS, 2009 ***(IN €)***

Household Type	Paris and adjacent cities	Remainder of the Île-de-France	Other regions
Single person	24,306	24,306	21,132
Couple, no children	36,326	36,326	28,220
Couple, 1 child	47,620	43,668	33,937
Couple, 2 children	56,855	52,304	40,968
Couple, 3 children	67,645	61,919	48,195
Couple, 4 children	76,119	69,677	54,314
** Extra household member*	*8,481	*7,764	*6,059

Source: Circulaire MLVU0829808C UP/FL3, 2008-12-30

31 If household income exceeds the income ceiling, an overcharge may be applied. However, this ***surloyer*** (literally over-rent) is often minor compared to the actual rent differential with the private market.

32 Collective (2008). The first figure corresponds to eligibility for a PLAI dwelling, while the figure of 80% indicates the share of households eligible for a PLS housing unit in the Greater Paris Region.

e) Rent regulation

Rents are regulated in the social sector, generally leading to **substantially lower prices than in the free sector**. The main line of thinking underlying the setting of rents is to reach the financial break-even point of the body managing the social housing program. Consequently, rents of social dwellings tend to reflect construction and financing costs rather than market conditions. The precise setting of rents is somewhat complex and depends on the type of financing chosen for a given HLM program. To put it simply, two types of dwellings are considered (Plateau 2006):

- Dwellings under convention with the State (92% of the HLM housing stock): rent is set by the HLM agency under the limitation of a price ceiling per m^2 (see above).
- Dwellings with no convention: rents are determined by applying a base price per m^2. The base price is set by the board of directors of the HLM agency.

Nowadays, the total cost of a social housing program is such that price ceilings represent a reference point in determining the minimum equity necessary to the financial equilibrium. Furthermore, the date of the signature of the convention determines the price ceiling.[33] As a result, price ceilings may vary substantially within a metropolitan area, inducing a **inharmonious system** plagued with abnormalities.[34]

Regarding adjustments over time, rent increases take into consideration maintenance, investment programs, but also the solvability of tenants, once again in order to reach the financial break-even point of social lessors. The Construction Cost Index (ICC in French) plays a central role in this issue: the variations of the 4-trimester averaged ICC dictate the evolution of ceiling prices as well as base prices.

f) Allocating social dwellings

The variety of actors contributing to the funding of social housing is mirrored by the **diversity of rationing mechanisms**. At the completion of a social housing program, new dwellings are assigned to three different contingents:

- One is under the prefect's responsibility. It represents 30% of the dwellings.
- One is under the responsibility of the city (20% of the dwellings).
- The remainder goes to the lessor, which often sells it to collectors of the *1% Logement*.

---

[33] Price ceilings are recalculated each year and take into account the level of construction costs. Consequently, the price ceiling of one given housing program initially depends on its date of construction. It then varies independently of other housing programs according to rules detailed further. However, because these rules roughly link the variation of price ceilings to the Construction Cost Index, all ceilings tend to move together and commensurately, thus perpetuating initial differences. This is why rent differentials based on the construction date of the housing program do not fade with time.

[34] A classic example is old buildings enjoying a particularly good location near the city center while presenting lower rents than newer and worse-located buildings.

Besides attributing social dwellings to public servants, the prefect has to use its contingent to provide low-income households with accommodation, especially those living in low-quality housing units. The mayor may freely dispose of his contingent within the limits of eligibility rules. Lastly, collectors of the *1% Logement* provide employees of contributing companies with social dwellings.

Several aspects contribute to the whole complexity of the rationing system:

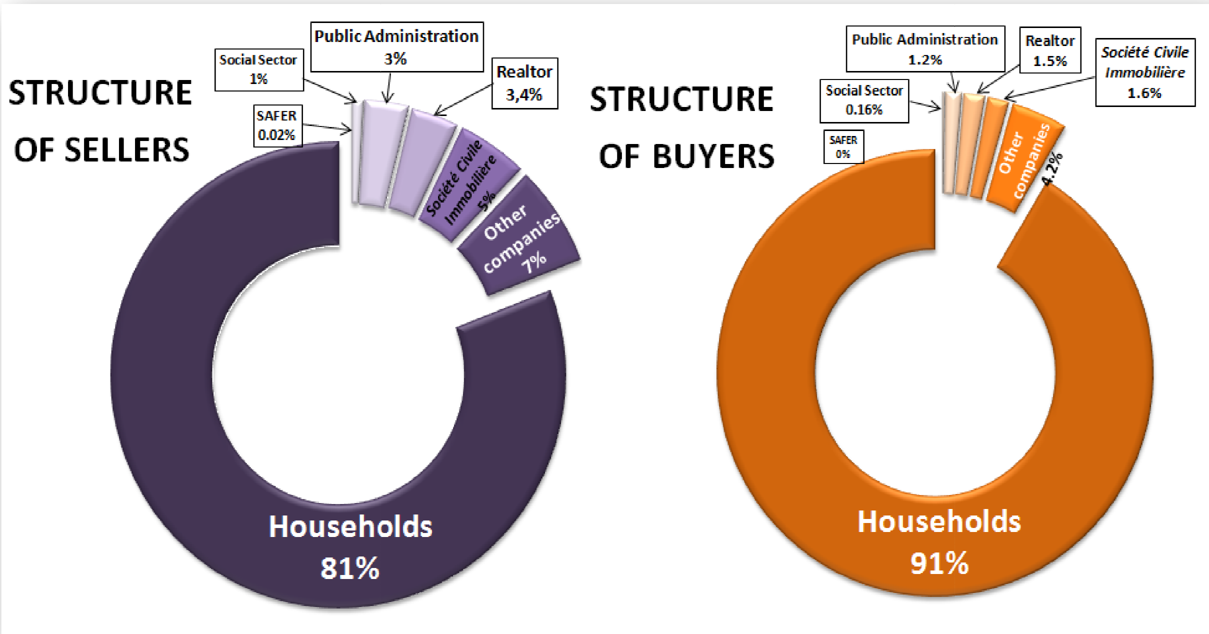
- Within each contingent, **no explicit allocation rule** such as First In First Out prevails.
- One household may apply in several cities and to several HLM agencies. Furthermore, demands are not centralized.
- **Demand far exceeds available supply**. A household waits on average 10 months after its first application before getting a social dwelling (Laferrère and Le Blanc 2006). And in the Greater Paris Region, there are approximately 374,000 candidates for 80,000 openings a year (Collective 2008)…

B-2. Presentation of the private market

a) Actors of the private market

Like the social sector, the private market is characterized by a vast range of actors. Yet, the analysis of the statuses of buyers and sellers taking part in real estate transactions underlines the paramount role of households in the property market (*Figure 9*).

FIGURE 9: TYPE OF BUYERS AND SELLERS IN REAL ESTATE TRANSACTIONS *(IN % OF SALES)*



Source: Donzel et al. (2008)

SAFERs are non-profit-making public companies supporting agricultural development through interventions on the land market. The *Sociétés Civiles Immobilières* (SCI) are civil companies dedicated to the management of housing holdings.[35]

There is a clear dissymmetry between the structure of buyers and sellers: logically, households act more often as buyers than as sellers, while it is the other way round for all other categories. Although households have unchallenged predominance on the property market as a whole, **other categories may exert a significant influence on local real estate markets**. This is especially true regarding real estate professionals, who tend to focus on localized and promising areas (Donzel *et al.* 2008).

To conclude on this point, let us note that it is **legacies and familial transfers** which prevail in terms of property transfers, and not costly real estate transactions (ibid.). This element further establishes the paramount influence of households in the property market.

Among agents intervening in the housing market not directly, but as intermediates or else, brokers and agents are to be singled out. These make information more readily available to potential home buyers or tenants, thereby playing a major role in reducing search costs and more generally market imperfections. Yet, brokers intervene in less than half (45%) of real estate transactions in France and sellers use sole mandates in only 10% of cases (Grépinet 2006). These relatively low figures most probably stem from prohibitive upfront fees, agent fees usually adding up to 6% of the transaction amount in France. In England or Ireland where commission rates are significantly lower (between 1.5 and 1.8%), realtors take part in as much as 90% of the transactions.

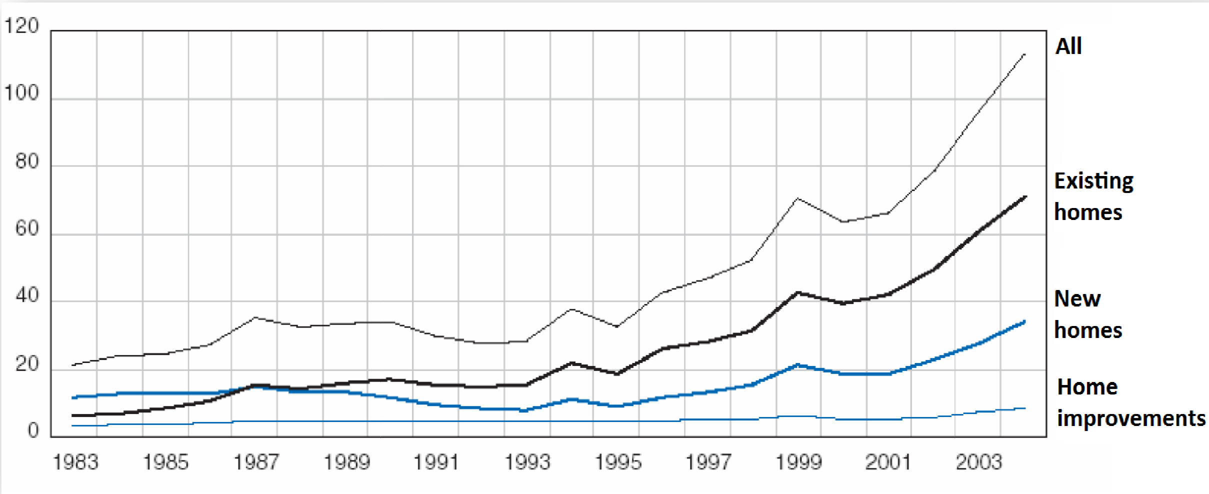
b) Home loans, borrowing constraints, and home ownership

As underlined before, a recent feature of the housing market is the tremendous growth of home loans. This phenomenon is mainly related to home acquisitions, credits for home improvements remaining at a relatively stable level (*Figure 10*). As a matter of fact, around **80% of home purchases are credit-based**. For the period 1998-2002, the exact repartition of acquisitions of new primary residences (first-time and former owners altogether) were broken down as follows (Daubresse 2003):

- 9% inheritances or donations;
- 13% “debtless purchases”;
- 78% mortgage-backed purchases (21% new dwellings + 57% existing ones).

[35] Contrary to the *marchands de bien* (real estate dealers), SCIs may not commit to trade. To put it simply, SCIs may purchase and rent dwellings, or even build and sell them, but may not purchase an existing home to resale it later. See http://www.sci-societecivileimmobiliere.com/generalitessci.html for more.

FIGURE 10: TRENDS IN NEW HOME LOANS ***(BILLIONS OF €)***



Source: ENA (2005), from SGFGAS, Banque de France

The dwelling price represents on average 3.1 years worth of income for recent home buyers (i.e. the last category), with a small premium in the case of a newly-built home (+0.4 years of income). The down payment amounts to around 33% of the total price, while monthly payments add up to 19% of the household income (*Table 3*).

The French banking system enforces **credit rationing** with rules similar to those prevailing in the US. In particular, the household must comply with a twofold constraint:

- The down payment must be greater than 20% of the home value.
- The net front ratio (yearly payment to yearly income) must not exceed 33%.[36]

TABLE 3: SUMMARY CHARACTERISTICS FOR RECENT HOMEBUYERS, 1998-2002

		Nb. of households (Thousands)	Average yearly income (€)	Dwelling price (€)	Dw. Price / income (years)	Total borrowed amount (€)	Down payment (% price)	Yearly payments (€)	Gross front ratio (%)	Net front ratio (%)
EXISTING HOMES	No subsidy	1 231	40 100	120 500	3.0	80 500	33.2	7 585	18.9	18.9
	Subsidized	165	22 350	78 500	3.5	58 000	26.1	5 245	23.5	16.2
	All	**1 396**	**38 000**	**115 500**	**3.0**	**78 000**	**32.5**	**7 300**	**19.2**	**18.7**
NEW HOMES	No subsidy	421	41 800	141 000	3.4	92 500	34.4	8 300	19.9	19.9
	Subsidized	90	24 600	100 000	4.0	80 000	20.0	6 200	25.3	18.5
	All	**511**	**38 900**	**134 000**	**3.4**	**90 000**	**32.8**	**7 900**	**20.5**	**19.7**
PROVINCE	Existing	1 084	34 800	101 000	2.9	71 000	29.7	6 700	19.2	18.6
	New	463	37 000	125 500	3.4	865 000	31.1	7 500	20.4	19.6
	All	**1 547**	**35 000**	**108 300**	**3.1**	**75 500**	**30.3**	**6 900**	**19.6**	**18.9**
GREATER PARIS REGION	Existing	313	49 000	166 500	3.4	101 000	39.3	9 500	19.4	19.2
	New	47	58 000	215 000	3.7	127 000	40.9	12 100	21.0	20.9
	All	**360**	**50 300**	**173 000**	**3.4**	**105 000**	**39.3**	**9 900**	**19.6**	**19.4**
	All	**1 907**	**38 200**	**120 500**	**3.1**	**81 000**	**32.8**	**7 500**	**19.6**	**19.0**
	All of subsidized	**255**	**23 200**	**86 000**	**3.7**	**65 000**	**24.4**	**5 580**	**24.1**	**17.0**

Source: Daubresse (2003), from 2002 Housing Survey, Insee

[36] The two figures of 20% and 33% are indicative and correspond to frequently observed practices.

The first constraint aims to limits moral hazard issues (that is, households filing for bankruptcy in case of negative equity), while the second would supposedly control the risk of housing default (cf. *Chapter 4*).

Lastly, home loans with fixed rates are largely predominant in France. They are similar in essence to **level payment mortgages**; in other words, they are designed with constant nominal flows of reimbursement. This specific feature is known to entail two consequences (Smith, Rosen, and Fallis 1988):

- the time profile of payments is not evened, and the housing burden of households usually decreases with time due to inflation and income gains;
- in case of increased/decreased inflation, the present value of future mortgage payments is unchanged, but the real burden is "tilted" forward/backward.

c) Rent regulation in the private sector

Even if it is often referred to as the free sector as opposed to the regulated social sector, the private rental market is still subject to regulation, in particular regarding the setting and increase of rents. Though less constrictive than in the social sector, this regulation aims to protect households from excessive rent increases, and in particular from "economic eviction". The main rules are as follows:

At the beginning of a lease: rents are freely set in the case of a new housing unit or of a unit that has undergone significant renovation; otherwise, the rent must conform to the average rent level observed in the neighborhood.

During the lease: rent increases are allowed as long as they do not exceed the yearly variation of a reference index. This reference index used to be the 4-quarter averaged ICC. It was replaced with the Rent Reference Index (*Indice de Référence des Loyers* or IRL) in 2006. The IRL is a weighted average of the Consumer Price Index (60%), the house works and maintenance cost index (20%), and the ICC (20%).

In case of lease renewal: a reassessment of the rent may only occur if the rent is blatantly underestimated. Even so, the rent increase is limited to half the difference with the average rent level observed in the neighborhood.

B-3. Housing benefits: AL and APL

Two main housing benefit schemes coexist in France:

- The *Allocation de Logement* (AL), which is further subdivided in the AL *Familiale* (ALF) and the AL *Sociale* (ALS);
- The Aide Personnalisée au Logement (APL);

In short, the APL is specific to a certain category of dwellings (those under a convention with the State), while the AL cover households eligible for benefits but not accommodated in those dwellings. The ALF chiefly targets families, and the ALS is dedicated to the remainder of the population.

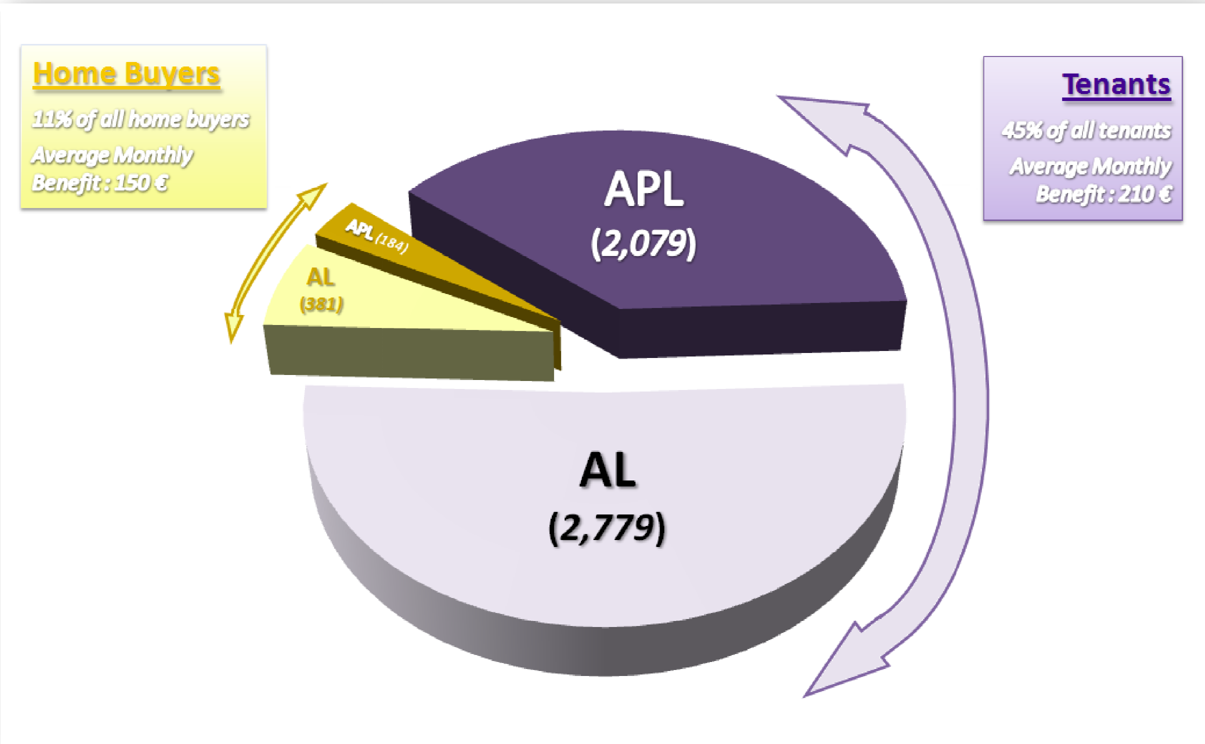
Eligibility is based on **income requirements** and both tenants and home buyers may apply. However, tenants profit the most from housing benefits, be it in number of recipients or with respect to average monthly benefit (*Figure 11*).

The benefit amount mainly depends on three elements:

- household income;
- household size;
- housing costs.

Location also has an influence, but only insomuch that it determines the maximum level of housing benefits. To be more specific, France is divided in several zones depending on the regional or local level of housing prices, each zone having its own maximum. Otherwise, the basic principle behind the setting of the benefit amount is to make households bear a lesser yet non negligible housing burden. This aims to limit moral hazard issues.

FIGURE 11: SUMMARY FIGURES FOR HOUSING BENEFITS IN FRANCE, 2007



Figures under parentheses in the pie denote the number of recipients (in thousands of households).

Source: French Housing Accounts, 2007

C THE FRENCH HOUSING STOCK AND ITS OCCUPANCY

C-1. Initial overview

In 2008, the French housing stock amounted to **32.8 million ordinary dwellings**,[37] including **27.6 million primary residences.** Both figures have steadily increased over the last twenty years, driven by both the population increase and the continual decrease in the number of persons per dwelling (*Table 4*). As a matter of fact, the occupancy rate has fallen from 2.73 in 1985 to **2.32 persons per dwelling in 2008**. Mainly two factors account for this trend: the ageing of the population and recent changes in lifestyle, in particular the increase of single-parent families (Grépinet 2006). This shift in household size is substantial:[38] it has caused the average growth rate of the housing stock to be more than twice the population growth rate for the period 1985-2008.

TABLE 4: THE FRENCH HOUSING STOCK AND ITS OCCUPANCY

	1985	1990	1995	2000	2005	2008	Yearly Growth Rate 85-08
Ordinary Dwellings *(Thousands)*	25,120	26,670	28,148	29,623	31,389	32,774	*1.2%*
Primary Residences	20,703	21,905	23,257	24,634	26,323	27,607	*1.3%*
Population	56,600	58,171	59,419	60,508	62,731	63,937	*0.5%*
Persons Per Dwelling *(Ratio)*	2.73	2.66	2.55	2.46	2.38	2.32	*-0.7%*

Scope: France (whole) *Source: Insee*

C-2. Tenure structure

Housing tenure generally provides a **segmentation of primary importance** in the analysis of real estate markets. First of all, home owners differ substantially from tenants in various aspects, be it with regard to residential mobility or in the way they look after their dwelling. The same goes between tenants of the social and private sector, the former displaying lower mobility rates and treating their housing unit with less care than the latter (SES-P and CERTU 2006).

---

[37] The scope of ordinary dwellings excludes some specific types of housing, such as residences for the elderly, traditional university residences, etc. These categories account for a minor share of the population (less than a million in 2005). They are not considered in the remainder of the analysis. See DAEI/SES-P and DGUHC (2008) for more details on the definition of ordinary dwellings and on non-ordinary dwellings.

[38] Let us note that the Insee has changed its **definition of a household** since 2005. From then on, a household is defined as a group of people sharing the **same dwelling** and a **common budget**. It is also referred to as an *unité de vie* (living unit). As a consequence, one dwelling unit may accommodate several households, which is the case with roommates. Such occurrences remain seldom though, and only marginally affect statistics. Therefore, the former definition, which identifies a household as people living in a same dwelling, will often be used for the sake of simplicity, unless specific issues that would require the new definition.

These differences in behavior result in a wide range of effects: Oswald (1997) relates high unemployment rates in Western Europe to the rise of home ownership, based on the lower flexibility of owner-occupiers. On the other hand, recent researches in the U.S. link several inner city problems, such as poorly maintained housing stocks, lack of social capital, substantial juvenile crime problems, and low quality schools, to low homeownership rates (Hilber 2005).

a) Detailed structure

In France, households are usually broken down into two main classes with two sub-categories each:

- Owner-occupiers: households owning and occupying their dwelling. They include:
  - home buyers, who are still in the process of paying back their mortgage;
  - outright owners, who own "completely" their dwelling.
- Tenants. They rent their dwelling from either:
  - the private sector;
  - the social sector.

A more detailed classification exists to take into account specific forms of tenure, branded under the label "Other forms of tenure" (*Table 5*). This encompasses:

- tenants of furnished dwellings;
- subtenants;
- tenant farmers;
- people being given free accommodation (students living in the studio of their parents, people being accommodated through their work, etc.).

TABLE 5: DETAILED TENURE STRUCTURE OF THE FRENCH HOUSING STOCK *(%)*

	1984	1988	1992	1996	2002	2006
Owner-occupiers	**50.7**	**53.6**	**53.8**	**54.3**	**56.0**	**57.2**
Outright owners	26.3	27.4	30.3	32.1	35.0	37.6
Home buyers	24.4	26.1	23.5	22.2	21.0	19.6
Tenants of unfurnished dwellings	**39.0**	**37.2**	**37.7**	**38.1**	**37.9**	**37.5**
HLM	14.6	15.0	15.3	15.7	15.6	15.7
Other social dwellings	1.9	2.0	1.8	1.9	1.6	1.4
1948 Law	3.5	2.5	2.0	1.4	1.0	1.0
Unregulated sector	19.0	17.7	18.6	19.1	19.7	19.4
Other forms of tenure	**10.4**	**9.1**	**8.4**	**7.6**	**6.1**	**5.3**
Furnished dwellings, subletting	1.9	1.5	1.5	1.6	1.6	1.7
Tenant farmers	0.6	0.4	0.2	0.2	0.3	0.0
Free accommodation	7.9	7.2	6.7	5.8	4.2	3.6

Scope: France *métropolitaine*

Source: Housing Surveys, Insee

The first two categories are for all practical purposes the closest to regular tenants of the private sector. Besides, they are a minor and relatively stable share of the housing stock. Tenant farmers are on the verge of being history, and might as well be classified as an endangered, if not yet extinct, species. The last category "Free accommodation" is the most problematic. Though dwindling, its weight in the housing stock remains sizable, and people belonging to this category do not pay any kind of rent. They are otherwise similar to regular tenants.

For the sake of simplicity, all specific forms of tenure are customarily regrouped with tenants of unfurnished dwellings in the unregulated sector to form the general category "tenants of the private sector". As mentioned above, **this regroupment is inconsequential, unless analyzing housing expenses**. In this specific case, people being given free accommodation should be addressed separately.

Lastly, the status "Tenant under the regimen of the 1948 law" is a relic from the first part of the 20th century, bound to disappear with time. Similarly to tenants of the social sector, those tenants enjoy lower rents and tenure security (*droit au maintien*). They are thus customarily grouped with social renters.

b) Simplified tenure structure

Considering that an ordinary dwelling may also be either a secondary residence or a vacant dwelling, *Table 6* provides a simplified structure of the French housing stock:

TABLE 6: BREAKDOWN OF THE HOUSING STOCK BY TENURE

		1985	1990	1995	2000	2007	
	Primary Residences	**82,4%**	**82,2%**	**82,7%**	**83,2%**	**84,0%**	↗
including	-Owner-occupiers	53%	55%	55%	56%	57%	↗
	outright owners	*28%*	*30%*	*32%*	*35%*	*38%*	↑
	home buyers	*25%*	*25%*	*22%*	*21%*	*19%*	↘
	-Tenants	47%	45%	45%	44%	43%	↘
	of the private sector	*31%*	*27%*	*26%*	*25%*	*24%*	↓
	of the social sector	*16%*	*18%*	*19%*	*19%*	*19%*	↗
	Second Homes	**10.1%**	**10.6%**	**10.2%**	**9.9%**	**9.9%**	→
	Vacant Dwellings	**7.6%**	**7.2%**	**7.1%**	**6.8%**	**5.9%**	↘

NB: here, the "social sector" includes dwellings owned by local authorities but not subject to regulated rent. It should thus rather be referred to as the "extended social sector". Dwellings owned by local authorities account for a minor share of the housing stock though (cf. *D-3*), which is why I kept the term "social sector" here for more simplicity.

Scope: France (whole) *Source: French Housing Accounts, 2007, from Insee*

All variables vary relatively slowly with time, highlighting the **strong inertia of the housing market**. Otherwise, the first salient feature of this table is that primary residences are more and more prominent within the housing stock. This stems from the **continual decrease of the vacancy rate**, when the proportion of second homes remains for its part fairly stable, in the vicinity of 10%. The very low vacancy rate in 2007 (5.9%) illustrates the particular tightness of the housing market during this period. [39] In point of fact, the structural imbalance between housing demand and new construction has led to:

- a decline in the stock of available dwellings;
- a drop in the rate of urban renewal, being a way to cope with the scarcity of housing.

In other words, the current level of vacancy is too low, being detrimental to the efficiency of the housing market and to the quality of the housing stock. And although a recent increase in vacancy has been observed, [40] indicating more slack in the housing market, there is strong basis for the fact that the current level of construction remains insufficient to sustainably relieve the housing market (Grépinet 2006).

Secondly, **owner-occupiers are more and more numerous**, accounting for 57% of all households in 2007, as compared to 53% in 1985. The drop in the share of home buyers likely foreruns a slow down, but recent pro-home ownership tax incentives could lure additional households into becoming home owners. The rise of ownership comes with a decline of the private rental sector, which has lost 7% in twenty-two years. Meanwhile, the share of social housing remains relatively stable.

c) Housing tenure and household size

The analysis of household size by tenure type reflects a classic phenomenon in housing markets: households usually first opt for tenancy, and then for homeownership later in the lifecycle (typically when births increase the demand for space and the stability of the household). A simple explanation of this tendency lies in the greater residential mobility of young households, and in the greater transaction and moving costs associated with home ownership. Considering these two facts, young households naturally lean towards tenancy (Smith, Rosen, and Fallis 1988, Hubert 2006). [41] Furthermore, home ownership

[39] Vacancy is but one indicator of market tightness. It must be analyzed with great care for the following reasons:

- There are various forms of vacancy, such as structural or frictional vacancy, which have different economic meanings (Robert and Plateau 2006).
- A minimum level of vacancy is generally needed for market efficiency purposes (Wheaton 1990).
- Spatial analysis must consider local characteristics of housing markets.

Despite these pitfalls, longitudinal analyses of vacancy prove less problematic, a decrease in the vacancy rate usually being the signal of a tightening market (Robert and Plateau 2006).

[40] Except in some areas including the Greater Paris Region, see once again Robert and Plateau (2006).

[41] Note that this is only part of the picture, and wealth accumulation (among other things) also plays a role in this phenomenon.

is becoming less and less affordable for low-income households, especially large ones, restricting them to the social sector. Putting these two elements together, this partly explains why **the private rental sector accommodates smaller households** than other tenure segments do (*Figure 12*). As a consequence, talking in terms of population instead of number of dwellings would slightly modify the shares indicated above of each tenure type. Lastly, the decrease in household size mentioned in *C-1* concerns all tenure segments alike (*Figure 12*). The sharper decline observed for the social sector between 2002 and 2006 has yet to be accounted for though.

FIGURE 12: NUMBER OF PEOPLE PER OCCUPIED DWELLING, BY HOUSING TENURE

Scope: France *métropolitaine* *Source: Housing Surveys, Insee*

C-3. Single- vs. multi-family housing

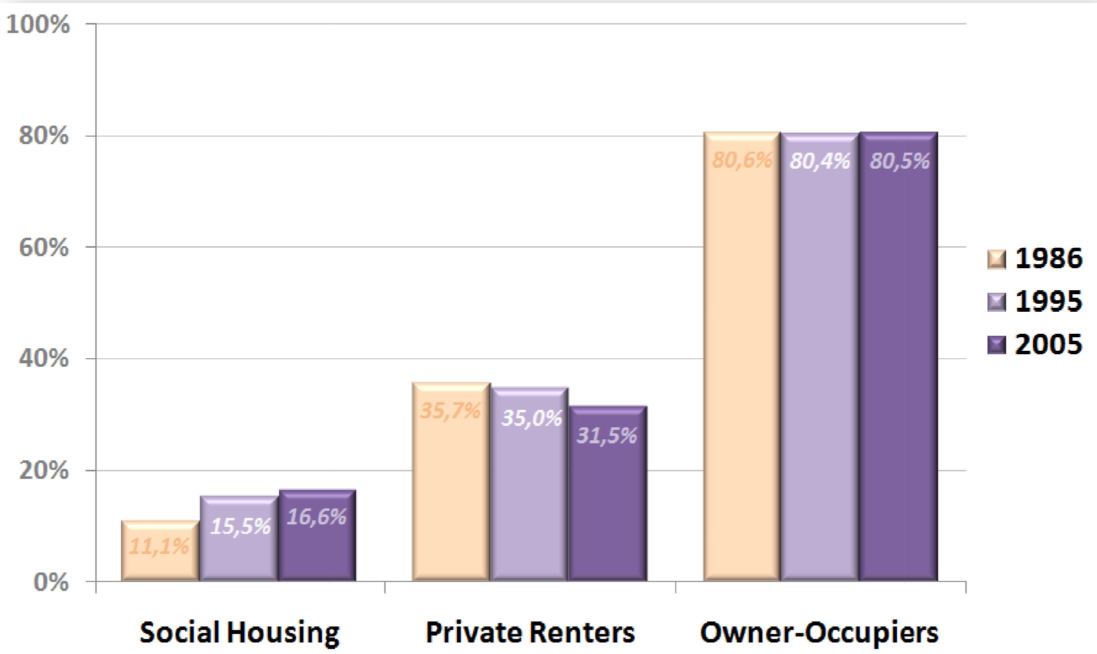
The distinction between single- and multi-family dwelling units constitutes another relevant criterion for the segmentation of the housing market.[42] From a demand point of view, single-family housing offers more flexibility to households regarding architectural choices, the possibility of future improvements, the general management of the dwelling, and so on (Hubert 2006, Coulson and Fisher 2009). This makes this housing type ideal for owner-occupiers, a fact corroborated in the French case (see below). Conversely, households willing to spend less time on maintenance will find multi-family housing more attractive. Detached dwellings also limit interactions with neighbors, which might be a decisive factor for households with specific lifestyle wishes. From a supply point of view, the choice of the housing type entails different land consumptions and financial costs (rather in favor of single-family housing for comparable dwellings in terms of surface area and quality, Castel 2005).

[42] In France, the classification of housing types rarely goes beyond the distinction single- vs. multi-family. This probably stems for the predominance of common housing types there, contrary to other countries such as the U.S. (cf. http://en.wikipedia.org/wiki/List_of_house_types for an illustration).

An initial analysis of the share of single-family units within the total housing stock brings to light a **cyclical pattern** between 1985 and 2007 (*Figure D*). Fluctuations seem to be in phase with real estate market cycles, indicating that households turn to multi-family housing during recession periods. This seemingly cyclical nature of the housing type distribution is challenged though by the fact that single-family housing has gained significant ground between 1973 and 1985, rising from 50 to 56% (Grépinet 2006). In any case, fluctuations have remained of slight amplitude for the last twenty years, with a share oscillating between 56 and 57%. This tends to indicate that the market is more mature, and thus stabilized.

As it is often the case in the housing market, the above aggregate figures conceal significant discrepancies across tenure types: owner-occupiers massively turn to single-family housing, while the rental market offers few detached accommodations, especially in the social sector (*Figure 13*). In sum, there is a **strong yet not perfect correlation between tenure and housing type**. Therefore, these two criteria provide a double axis of analysis that is regularly used in the study of local and national housing markets.

FIGURE 13 : SHARE OF SINGLE-FAMILY HOUSING ACCORDING TO TENURE



Source: French Housing Accounts, 2005

C-4. Home size and housing quality

For obvious reasons with respect to quality of life, dwelling size is a paramount factor in the home search process of the household. Single persons rarely opt for a 4-room apartment. Conversely, large families do not fit in a studio. This implies that the size of the dwelling represents another natural criterion for market segmentation.

a) Main measures of home size

Two indicators prevail in France to measure home size: the **surface area** and the **number of rooms**. Surface area is defined as the floor surface area of the dwelling, excluding walls, stairs, windows, etc., as well as areas with roof height under 1m80. It does not include balconies, cellars, parking lots, annexes... On the other hand, two measures coexist in France regarding the number of rooms, which raises uncalled for issues. The first one is used by realtors and in everyday life, and does not count kitchens, bathrooms, or toilets. For example, a house with two bedrooms, a living room, a kitchen, and a bathroom, is considered as a 3-room dwelling unit according to this measure. The Insee uses an alternate measure which includes kitchens larger than 12m^2. Although it is not a clearly established fact, several elements lead me to think that the first definition is probably the most useful when interpreting statistics.[43]

The two indicators show a **strong positive correlation**, but are obviously not equivalent since rooms vary in size from one dwelling to another. Besides, some households may give priority to the number of rooms (to have a separate room for the baby, a study room, etc.), and others to the home size. According to the work of Arenes, Elias, and Weiss (2005), the number of rooms is a better predictor of household size than surface area, which tends to indicate that most households give priority to the former over the latter. Because of these slight differences between the two variables, analyses at the micro level may use both simultaneously (e.g., Fauvet 2007). On the other hand, most aggregate studies pick only one out of the two variables to avoid colinearity issues. In this case, surface area is more frequently used. Lastly, the **surface area per person** is widely used as a **proxy for housing quality**.

b) Trends in home size and housing quality

Home size has steadily increased over the last thirty years: in 2006, the average home comprised 4 rooms for a total surface area of 92m^2, which are 0.4 rooms and 20m^2 more than in 1973 (*Table 7*).[44] Meanwhile, households have gotten smaller, resulting in an even larger increase of the two indicators measured per person. In 2006, one person lived on average in 40m^2 (+15m^2 compared to 1973) and used 1.8 rooms (+0.6).

[43] The second definition should logically prevail as the INSEE provides most housing statistics. Yet, the measure of the number of rooms is based on self-assessment, which may bring about two types of mistakes: confusion between the two definitions and wrong appraisal of the kitchen size. Adding the fact that kitchens are seldom larger than 12m^2, this is why I argue the first definition to be the most helpful when interpreting statistics.

[44] To be precise, the rise in home size results from an increase in the number of rooms, but from bigger rooms too. As a matter of fact, the average room size has been steadily increasing since 1973 for all categories of dwellings (1, 2, 3, 4, 5, and 6 rooms and more). See Grépinet (2006), p.32.

TABLE 7: INDICATORS OF HOME SIZE

	1973	1978	1984	1988	1992	1996	2002	2006	
Per Dwelling:									
Average size (m²)	72	77	82	85	86	88	90	92	⇗
Average nb. of rooms	3.6	3.7	3.8	3.9	4.0	4.0	4.0	4.0	⇗
Per Person:									
Average size (m²)	25	27	31	32	34	35	37	40	⇧
Average nb. of rooms	1.2	1.3	1.4	1.5	1.6	1.6	1.7	1.8	⇧

The indicators per person are actually computed in Jacquot (2007) as the ratio of the averages (average size / average household size). Because of under- and overcrowding issues in the housing stock, **the true means are greater than the displayed ratios**. I stuck to Jacquot's methodology when adding the 2006 figures for the sake of consistency. However, the question as to which computation method should be preferred remains an open issue.

Source: Jacquot (2007) + author's calculations, from Housing Surveys

Two factors account for this marked growth (Jacquot 2007):

- A higher quality of housing: the average home size per person has progressed in the last thirty years for all household types.
- A population structure effect: the ageing of the population drives both indicators up inasmuch as older households usually live in bigger dwellings.[45]

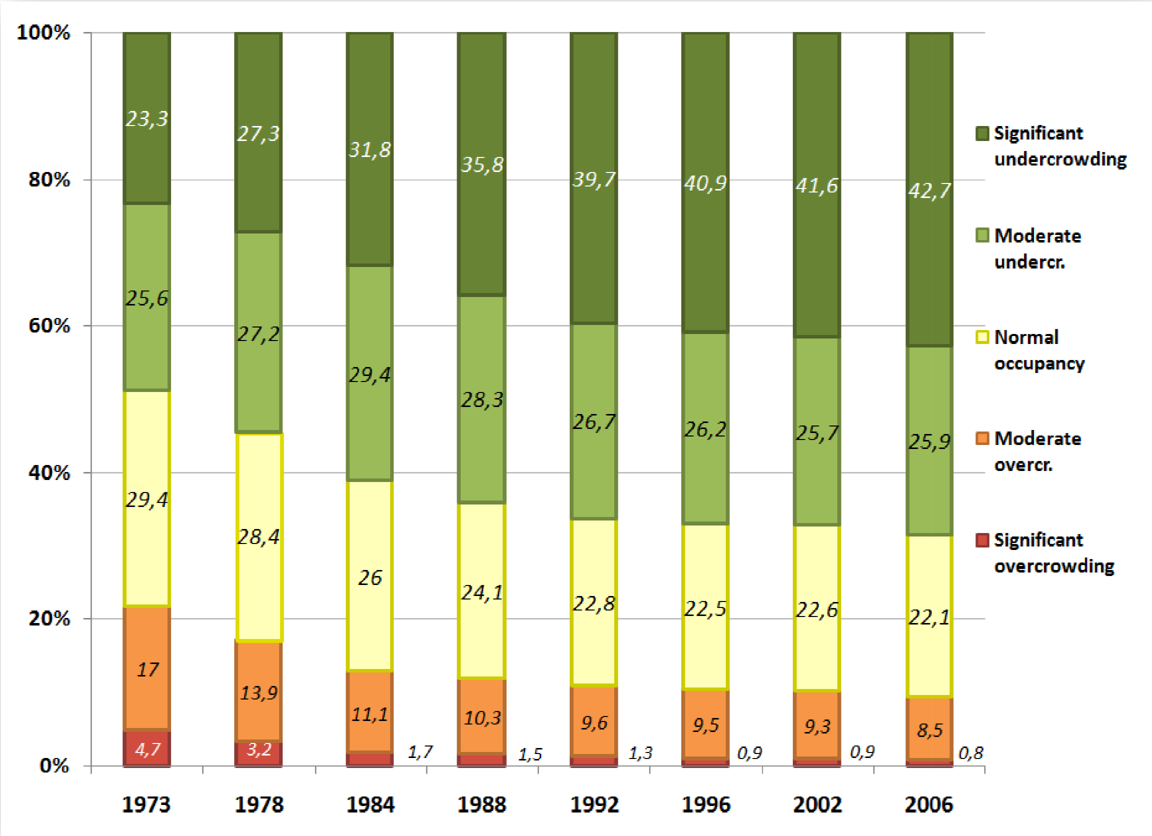
A crowding analysis of the French housing stock provides an indirect confirmation of the extent of this second effect (*Figure 14*).[46] As a matter of fact, the fall of overcrowding over the last thirty years has only resulted in an equivalent increase of significant undercrowding. The **allocation of the housing stock** is thus **far from optimal**. One element mitigates this point, namely the increase of divorces and separations. Indeed, both parents of a separated couple usually look for a sufficiently large home to accommodate their children when they are under their custody, which is one form of "necessary" undercrowding. The extent of this phenomenon remains limited though, and other "non-necessary" factors of undercrowding such as the ageing of the population preponderate as for now.

To conclude, let us mention some striking figures regarding the increase in housing quality: in 1954, only 10% of dwellings had sanitary equipment (ENA 2005). In 2006, they were 99% according to the Housing Survey.

[45] Older people tend to stay in the same dwelling as the one they lived in with their children. This habit leads to an increase of the average size per person when dependent children leave home.

[46] Crowding definitions derive from a methodology developed by the Insee. It assesses the need for space of the household given its composition. This method mainly considers the number of rooms, plus square footage when relevant. For more details refer to: http://www.inegalites.fr/spip.php?article508&id_mot=95.

FIGURE 14: CROWDING STRUCTURE OF THE FRENCH HOUSING STOCK, 1973-2006



Scope: France *métropolitaine* *Source: Housing Surveys, Insee*

C-5. Age distribution of the housing stock

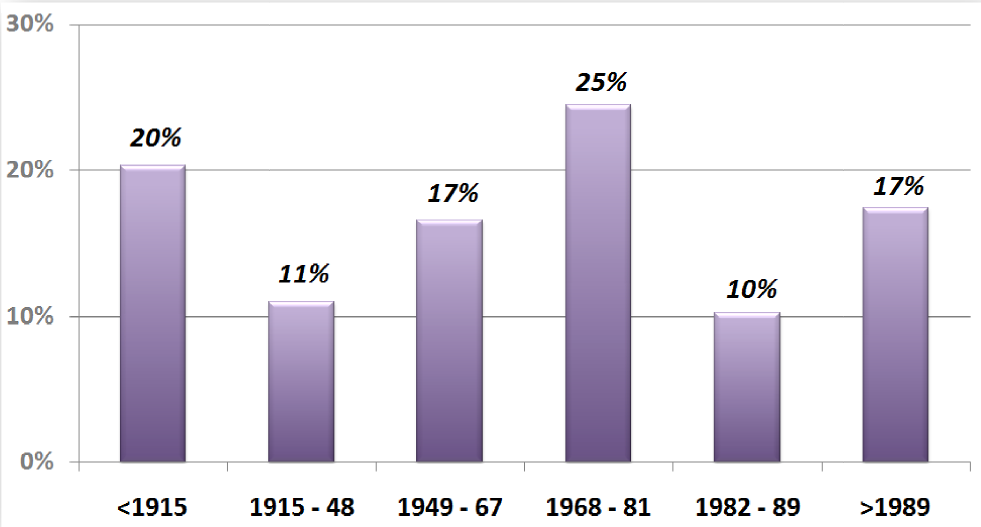
The age of the housing stock is important as regards private and public matters alike, for at least three reasons:

- Its link with housing quality: buildings and dwellings alike degrade with time. Moreover, living in a recent dwelling means getting the latest equipment. For all these reasons, households, rich ones first, tend to avoid neighborhoods with old housing stocks, leading to a pauperization of these areas and a lower quality of life (Brueckner and Rosenthal 2005).
- On the other hand, aged dwellings with sought-after architectural features may contribute to the attractiveness of the neighborhood.
- Lastly, it provides indications about the need for urban renewal, in the sense of demolitions/reconstructions.

The French housing stock can be divided into **three main blocks** (*Figure 15*):

- a first one constructed before 1948 ;
- a second one constructed between 1948 and 1975;
- a last one constructed after 1975.

FIGURE 15: DATE OF CONSTRUCTION OF THE HOUSING STOCK, 2006



Scope: France *métropolitaine* *Source: Housing Survey, Insee*

Almost half the stock dates from the "reconstruction period" (1949-1981) that followed World War II, which is, unlike all other periods, characterized by a prevalence of multi-family housing (*Table 8*). Considering the severe dearth of housing after the war, the government massively intervened by promoting industrialization of housing construction to allow for high levels of construction at moderate costs. This lead to huge buildings named *Grand Ensembles*, sometimes reaching several hundreds of housing units, which were eventually blamed for several of the current urban and social issues. *Table 8* also highlights the **key role of detached housing in the upward trend of home size**, when dwelling size decreases in the multi-family sector.[47]

TABLE 8: HOME SIZE ACCORDING TO DATE OF CONSTRUCTION AND HOUSING TYPE, 2002

		Average dwelling size (m²)		
Construction date	Share of single-family housing	Single-family	Multi-family	All
Before 1948	64.8 %	107.5	60.5	91.0
1949 - 1974	41.3 %	102.8	68.3	82.6
1975 - 1981	60.4 %	112.9	68.3	95.6
1982 - 1992	66.0 %	110.9	64.8	95.6
1993 - 1996	57.6 %	113.2	59.9	90.6
1997 - 2001	62.2 %	114.4	60.5	94.0
All	56.6 %	108.3	65.2	89.6

Scope: France *métropolitaine* *Source: Housing Survey, Insee*

[47] Two additional elements may have contributed to the striking growth of home size presented in *C-4.b)*: dwelling mergers, and an overrepresentation of small dwellings in demolitions. Lack of readily available data regarding these two issues makes any kind of test unlikely "in the near future".

C-6. Summary table and income analysis

Key statistics about the housing stock and its occupancy are summarized in *Table 9*. Some elements are even further detailed compared to what can be found in the above figures and tables, always confirming above statements. The date of construction is omitted though, and replaced by two important household characteristics: **income** and **length of tenure**. Income is a paramount factor in the housing market, and the only reason it was not addressed before is that data are currently presented from the point of view of dwellings rather than households. The reported income measure is the % of the PLUS income ceiling, which for reminder partly depends on household size as well as on location (→ *B-1.d)*). Length of tenure is directly linked to residential mobility, a topic further discussed in *D-2*.

The analysis of income distribution according to housing tenure brings several elements to light: [48]

- **Owner-occupiers are substantially richer than tenants** of the private sector (PS), who are themselves slightly richer than tenants of the social sector (SS).
- SS tenants display a higher median income level than PS ones.
- 10% of SS tenants earn a yearly income higher than the PLUS income ceiling.

The first point is well-known, and stems from the fact that the income distribution of owner-occupiers is unlike tenants skewed towards high-income values. Conversely, the second and third facts are a little more surprising, especially the second one. Actually, the social sector is renowned for accommodating low-income people, due to eligibility rules. Among the factors which might account for these points, let us note two complementary explanations:

- SS tenants are older than PS tenants, and income rises with age.
- When households get older, and thus richer, the substantial rent discount gives tenants of the social sector an incentive to stay, which they may do thanks to the *droit au maintien*.[49] On the other hand, private renters can now achieve home ownership, which they often do, explaining why there are less old/rich households in the private rental sector.

[48] The category "Others" is put aside as it would require a specific analysis.
[49] See Laferrère (2009).

TABLE 9: THE HOUSING STOCK AND ITS OCCUPANCY, SUMMARY STATISTICS, 2005

	Owner-occupiers	Social housing	Private renters	Others
Population (total)		61,137,056		
Number of households (total)		25,931,635		
by tenure	14,770,419	4,226,841	6,291,548	642,827
Dwelling characteristics				(primary residences only)
Dwelling type				
Multi-family	22.8%	85.5%	71.8%	45.5%
Single-family	77.2%	14.5%	28.2%	54.5%
Liveable surface area				
Mean	95,7	70,3	60,8	
< 35 m²	3%	8%	21%	
35 to 75 m²	26%	61%	51%	
75 m² and more	71%	32%	28%	
Household characteristics				
Household size				
Mean	2,5	2,3	1,9	
1	24%	35%	42%	
2	35%	24%	24%	
3	16%	15%	12%	
4 and 5	22%	18%	12%	
6 and more	2%	5%	2%	
Single-parent families	7%	20%	14%	
Overcrowding				
Significant (9m² per person)	0,8%	1,6%	2,2%	
Moderate (16 m² for 1st person, then 11m² per per	2,1%	4,2%	5,8%	
Age of head of the household				
Mean	58	48,4	44,2	53,8
<25	0,2%	3%	7%	2%
25-39	14%	30%	39%	25%
40-59	41%	39%	29%	37%
60-74	25%	15%	9%	13%
75 and more	19%	11%	8%	20%
Household income				
Situation relatively to Income Tax				
Non taxable	38,7%	68,1%	51,0%	54,3%
Income level				
Mean (in % of HLM ceiling income)	112,1	71,9	74,9	80,1
Median	89,2	64,3	62,5	64,2
Poor households (income <30% of HLM ceili	7%	26%	18%	0,171
Low-income households (30 to 60%)	19%	34%	26%	0,277
Modest households (60 to 100%)	33%	28%	29%	0,299
Middle-income households (100 to 130%)	0,171	0,061	0,098	0,11
Well-off households (130 to 150%)	7,2%	1,4%	3,3%	3,8%
Affluent households (>150%)	17,1%	1,5%	6,5%	7,9%
Length of tenure				
Less than a year	10%	18%	31%	
1 to 2 years	16%	24%	30%	
3 to 9 years	32%	36%	28%	
10 years and more	42%	22%	11%	

Scope: France métrop.; Others= free accomodation+tenant farmers *Source: ANAH (2008), from FILOCOM 2005*

D FURTHER INSIGHTS: PRICES, MOBILITY, CONSTRUCTION

Three elements complete this overview of the French housing market:

- housing prices,
- residential mobility,
- and lastly housing supply.

D-1. A marked rise in housing prices over the last decade…

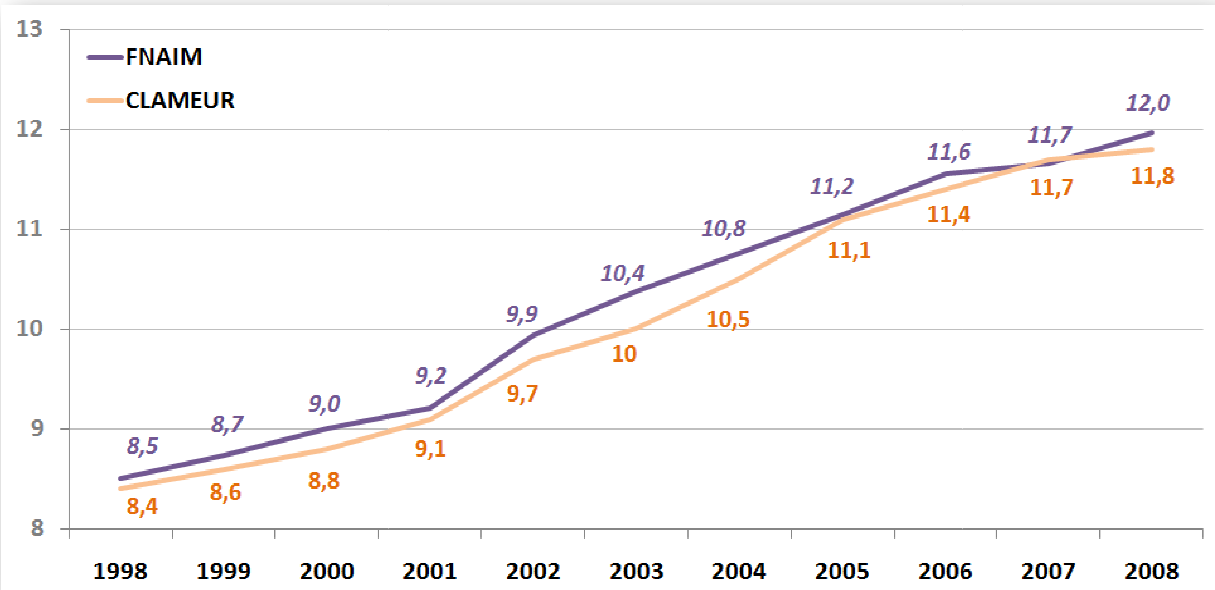
a) *Trends in housing prices*

Because housing prices depend heavily on the market segment considered, the use of several indexes is common in this field. Four common categories are presented here, namely the private rental market, social housing, and in the case of the property market new and existing homes. For each category, one or two representatives are selected among the various existing indexes, based on their prevalence. A more complete list of indexes on housing prices may be found in section *III*.

Private rental sector

Rents have markedly grown in the private rental market over the last decade, with an acceleration between 2001 and 2005, ensued by a relative slow down (*Figure 16*).[50]

FIGURE 16: AVERAGE RENT LEVEL IN THE PRIVATE SECTOR ***(€/M²)***



Scope: France *métropolitaine* *Source: CLAMEUR, FNAIM*

[50] Considering that the index of the Insee, which is based on the National Survey on Rents and Service Charges, has a trend extremely similar to that of the CLAMEUR index (ANAH 2008, p.19), **the three rent indexes, CLAMEUR, INSEE, and FNAIM, seem to be concurring**.

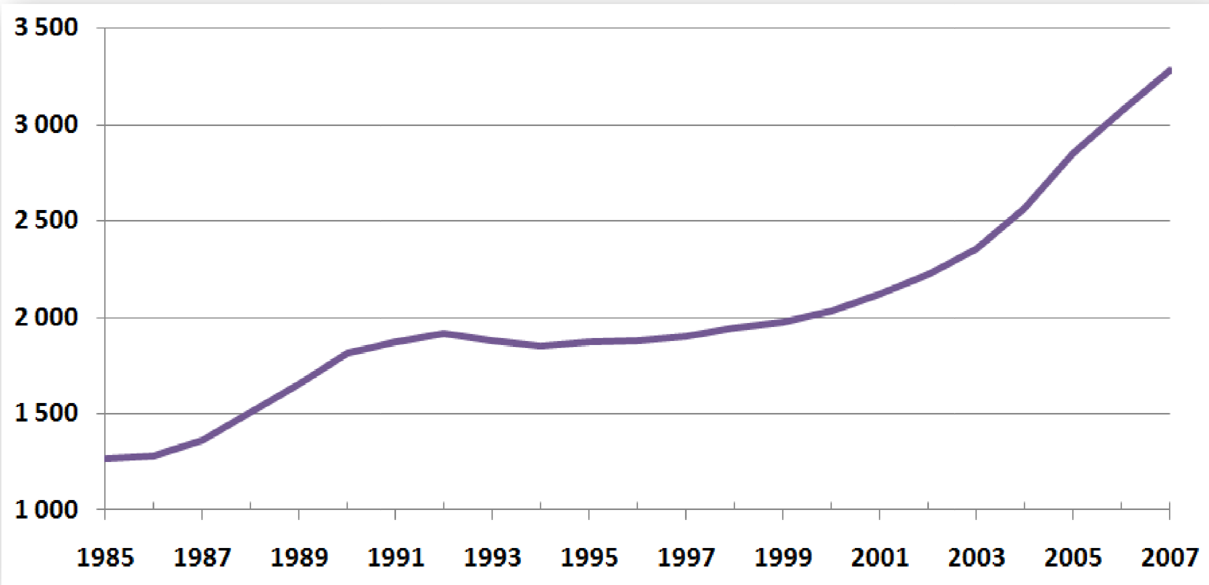
Social rental sector

Rental prices have increased at similar paces in the social and private sectors over the last twenty years (Plateau 2006), implying that the price differential remains unchanged in relative terms. In 2004, the average rent in the social sector was 4.8€/m², well below the free market level (10.5€/m² for the CLAMEUR index).

Property market, new homes

Sales prices of new multi-family dwelling units (*Figure 17*) show a similar trend to the one observed concerning new home acquisitions (→ *Figure 3*).[51] In other words, the two categories have coincident market cycles, which is intuitive as new and existing homes are two substitute goods. Between 1998 and 2008, a rise of 72% could be observed, far exceeding the one simultaneously occurring in the rental market (+40%).

FIGURE 17: AVERAGE SALE PRICE OF NEW MULTI-FAMILY DWELLING UNITS ***(€/M²)***



Scope: France *métropolitaine* *Source: ECLN, SOeS*

Property market, existing homes

This outline of housing prices concludes with the market for existing homes. A long-term analysis is proposed here, based on the use of a ratio dividing a housing price index by the household average gross disposable income.[52]

Besides the fact that the cyclical nature of the housing market is once again highlighted,

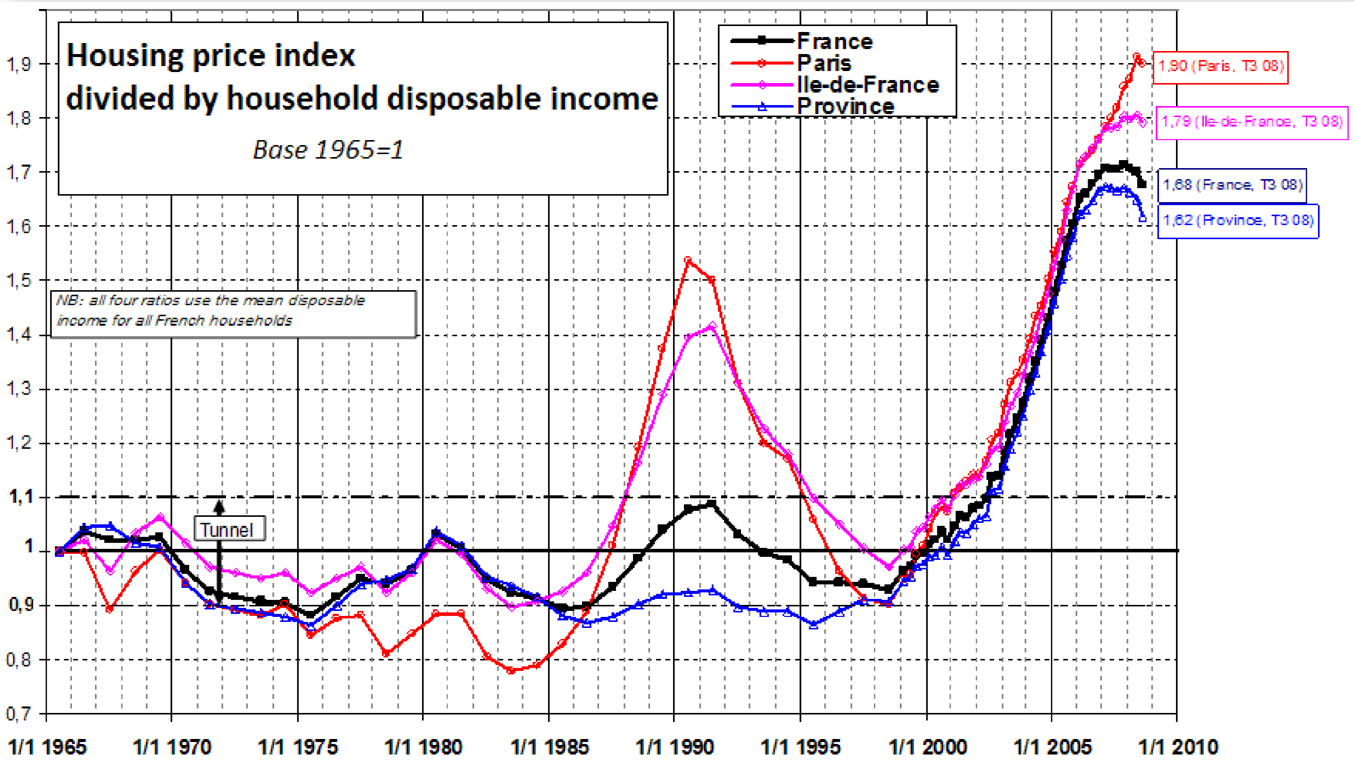
[51] Because the ECLN only gives the total price for detached housing units, the scope is restricted to multi-family housing in order to avoid dwelling size effects.

[52] Because this ratio should theoretically be stable over the long term, its use is particularly relevant here. See Sauvant (2004a) for a demonstration of this result.

the recent and pervasive increase in prices is salient (*Figure 18*). Indeed, fluctuations are even greater than during the previous real estate market cycle (1983-1998), and affect all parts of France *métropolitaine* alike, contrary to the previous upswing which was centered on Paris (Friggit 2001). From the trough of 1998 to the peak of 2008, the ratio housing price index to household disposable income has nearly doubled for all categories, Paris *intra-muros*, Île-de-France, *Province*, and France *métropolitaine* altogether.[53] In terms of real prices, this corresponds to a growth of +110% between 1998 and 2007, which is **more than four times the increase in the rental market** observed for the same period (+25%).[54]

Some relate the marked rise of prices to the proliferation of home loans. As a matter of fact, the two variables show remarkably similar trends (*Figure 19*). However, because causality is obviously two-way in this matter, hence endogeneity, more refined analyses are necessary to specify the links between the amount of home loans and the level of housing prices.

FIGURE 18: LONG-TERM ANALYSIS OF HOUSING PRICES, EXISTING HOMES

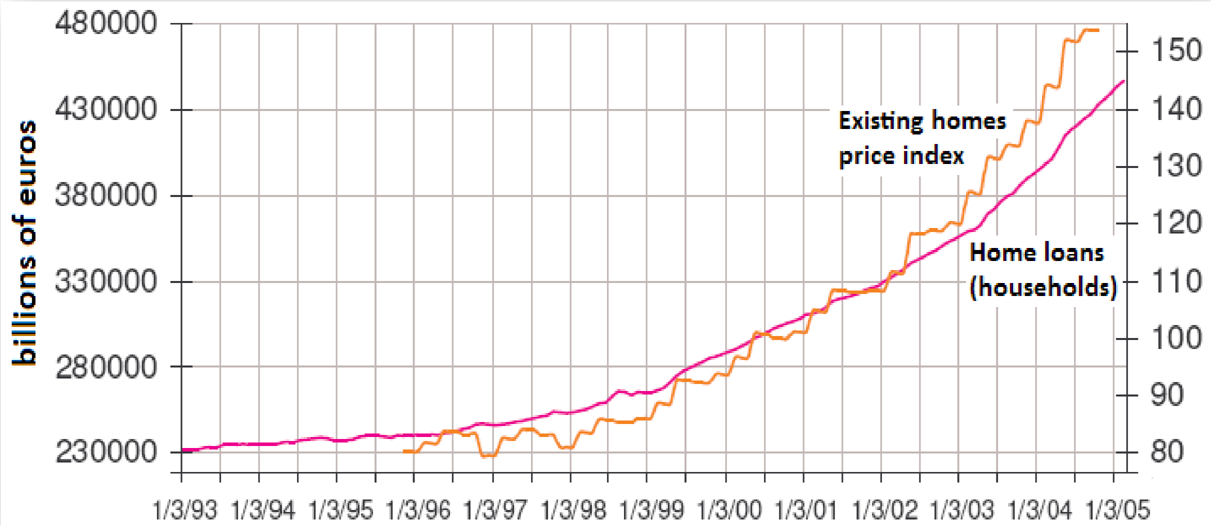


Scope: France *métropolitaine* *Source: Friggit (2009)*

[53] For reminder, the Île-de-France is the original French name of the Greater Paris Region. The term *Province* designates the remainder of the France *métropolitaine*.

[54] ANAH (2008), p.24.

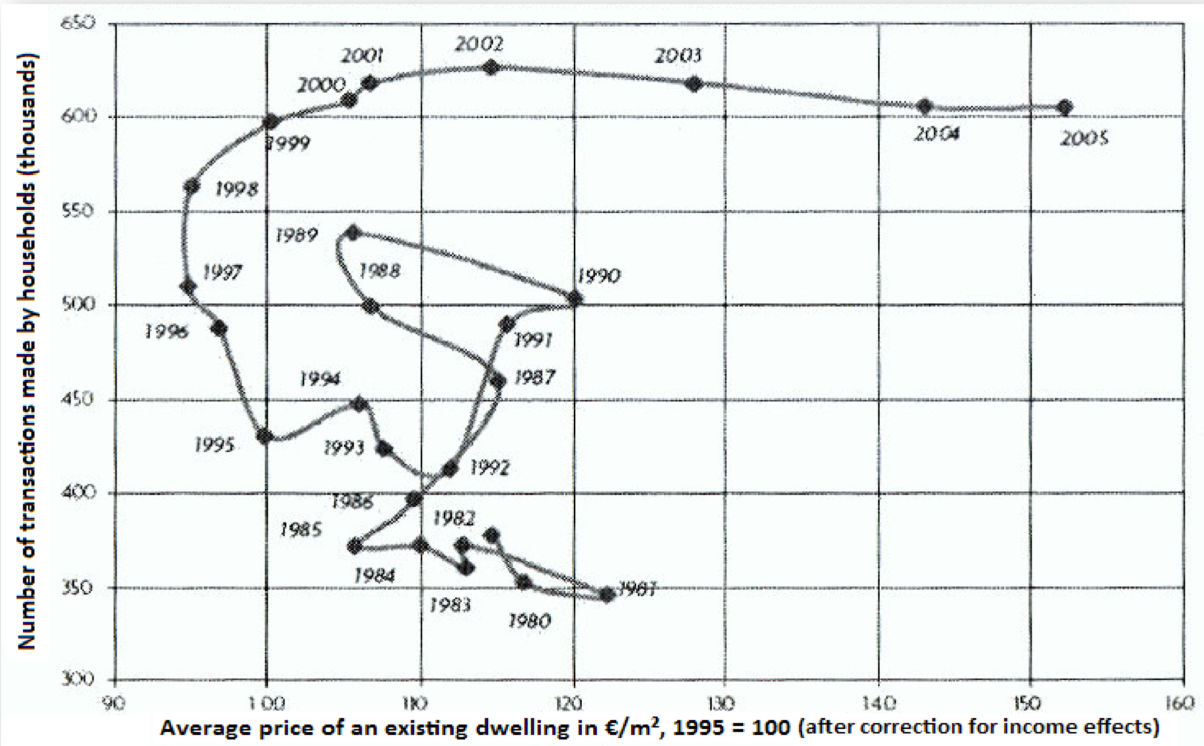
FIGURE 19: TRENDS IN HOUSING PRICES AND HOME LOANS



Source: ENA (2005), from Banque de France, INSEE

On the other hand, the relation between housing prices and market activity, as measured by the number of transactions, seems more complex, to the point that one can wonder if there is any connection at all (*Figure 20*).

FIGURE 20: A COMPARISON OF HOUSING PRICES AND MARKET ACTIVITY



Source: Grépinet (2006), from FNAIM (2005)

To conclude, let us first note that 2008 has triggered a fall in housing prices and in housing transactions (→ *Figure 4*) in France as in most of the world. The analysis has also shown substantial discrepancies between the capital city and the remainder of France,[55] providing a first example that space matters. This general issue is discussed at length in the next section. Lastly, let us further note that:

- The price differential between new and existing homes has remained stable over the last thirty years (Sauvant 2004b).
- Contrary to the rental sector, houses for sale are becoming more and more expensive than flats, be it for existing homes (*Figure G*) or new homes (*Figure H*).

b) The increasing share of housing in the household budget

Unsurprisingly, the rise in housing prices has affected household housing expense ratios, defined as the share of disposable income spent on housing. Starting from 1978, the **housing burden has markedly increased for all categories**,[56] until 1996 when few categories experienced a relative slowdown (*Table 10*).

Three other important facts are revealed by this table:

- Recent movers bear heavier burdens than other households. Rules regarding rent increases (→ *B-1.e)* and *B-2.c)*), which profit to long-standing tenants, and the specific design of home loans (→ *B-2.b)*), partly account for this point.[57]

TABLE 10: THE RELATIONSHIP BETWEEN HOUSING EXPENSE RATIOS AND TENURE

		1973	1978	1984	1988	1992	1996	2002	
HOME BUYERS	**Recent movers**	18.6	18.4	21.7	21.7	21.5	19.6	19.1	↗ ↘
	new dwellings	*18.8*	*18.7*	*23.6*	*25.2*	*23.2*	*22.2*	*19.8*	↗ ↘
	Other households	9.0	9.5	10.7	14.0	14.7	17.1	16.6	⬆
	All	**12.9**	**12.3**	**14.0**	**16.2**	**17.0**	**17.8**	**17.6**	↘ ⬆
TENANTS	**Recent movers**	11.5	10.7	11.7	14.4	16.1	17.9	18.0	↘ ⬆
	new dwellings	*11.6*	*10.6*	*11.7*	*15.8*	*18.8*	*18.7*	*17.9*	↘ ⬆ ↘
	Other households	8.6	7.8	9.1	11.3	12.2	14.0	14.8	↘ ⬆
	All	**10.0**	**9.1**	**10.3**	**12.8**	**14.3**	**16.0**	**16.4**	↘ ⬆

Scope: France *métropolitaine*

Source: Grépinet (2006), from Housing Surveys, INSEE

[55] Despite a common trend over the last years, housing prices are highly volatile in the case of Paris, while *Province* is overall less affected by market cycles. Intriguingly, while the order of the different peaks in 1990-91 highlights the classic phenomenon that market downturns are first observed in markets with greater volatility (Sauvant 2004b), the contrary occurs for the last peak, an unusual phenomenon which calls for a deeper analysis.

[56] Excluding outright owners, who are beyond the scope of this analysis.

[57] In the case of tenants, other economic rationales are often indicated to explain the link between rents and the length of tenure (see for instance Driant and Jacquot 2005):

- Because mobility costs often increase with the length of tenure (→ *Chapter 1, I – B-3.d)*), tenants might be willing to pay more and more to stay within the same dwelling.
- On the other hand, landlords are incentivized to give discounts to their "good" tenants to avoid vacancy.

Because rent regulation probably overrides such rationales, their importance remains dubious.

- Home buyers pay more than tenants, but the gap is decreasing over the years.
- Living in a new dwelling usually involves paying a slight premium.

c) Transaction costs

This part on housing prices concludes with orders of magnitude for transaction costs. Magnan and Plateau (2004) provide the following estimates in the case of the property market (excluding donations and inheritances):

TABLE 11: TRANSACTION COSTS FOR THE PROPERTY MARKET

in % of the housing price	New homes	Existing homes
Notary fees	2%	2.3%
Property transfer taxes	0.8%	5%
Broker and agent fees	8%	8%
Total	**11%**	**15%**

Source: Magnan and Plateau (2004)

The main difference between new and existing homes lies in the heavier taxation of the latter. In the rental market, broker fees usually amount to one to two months' rent. To avoid this significant expenditure, tenants and landlords may resort to peer-to-peer methods (which frequently happens in the property market, → *B-2.a)*).

Besides providing us with key figures, this short analysis of housing prices has highlighted **sizable differences between the various market segments**. Therefore, one should be careful to use an appropriate segmentation, in order not to miss composition effects when dealing with specific issues.

D-2. …accompanied by an increase in residential mobility…

In their analysis on the residential mobility of French households, Debrand and Taffin (2005) distinguish two measures of mobility: the moving rate for either all households, which they name the "**Moving in Rate**", or only for "permanent households", [58] in which case they use the term "**Mobility Rate**". Moving in rates are always higher than mobility rates, as they include newly formed households who automatically move into a new dwelling. In 2002, the two rates were respectively of **9.8% and 7.4%**, in sharp progression as compared to the housing market recession period (1991-1999), which featured a decline in mobility (*Table 12*).

[58] Permanent households at survey *n* are defined as the households whose head fulfills the two following conditions:

- He/she was either the head or the head's significant other of a household at survey *n-1.*
- He/she was living in a fixed dwelling at survey *n-1.*

TABLE 12: MOBILITY RATES AND MOVING IN RATES

Mobility Rates (in %)	1984	1988	1992	1996	2002
Owner occupiers	**4.6**	**4.5**	**3.6**	**3.4**	**4.5**
- Outright Owners	*1.6*	*1.9*	*1.5*	*1.1*	*1.5*
- Home Buyers	*8.6*	*7.6*	*6.5*	*7.2*	*10.3*
Tenants	**10.4**	**11.4**	**11.2**	**12.1**	**13.1**
- Social Sector	*9.8*	*10.6*	*8.9*	*9.2*	*9.9*
- Private Sector	*10.7*	*12*	*13.1*	*14.7*	*15.9*
Other Statuses	5.6	6.5	7	6.4	8.6
Mobility Rate	**6.6**	**6.8**	**6.2**	**6.4**	**7.4**

Moving in Rates (in %)	1984	1988	1992	1996	2002
Owner occupiers	**5.5**	**5.3**	**4.2**	**4.1**	**5.1**
- Outright Owners	*2.1*	*2.1*	*1.8*	*1.5*	*1.8*
- Home Buyers	*9.7*	*9.3*	*7.3*	*8.2*	*11.4*
Tenants	**14.6**	**15.7**	**15.8**	**16.5**	**17.4**
- Social Sector	*13.7*	*14.4*	*12.1*	*12.1*	*13*
- Private Sector	*15.2*	*16.6*	*18.5*	*20.1*	*21*
Other Statuses	9.6	11.2	12.1	11.7	15.3
Moving in Rate	**9**	**9.3**	**6.2**	**8.8**	**9.8**

"Other Statuses": → *C-2.a)*

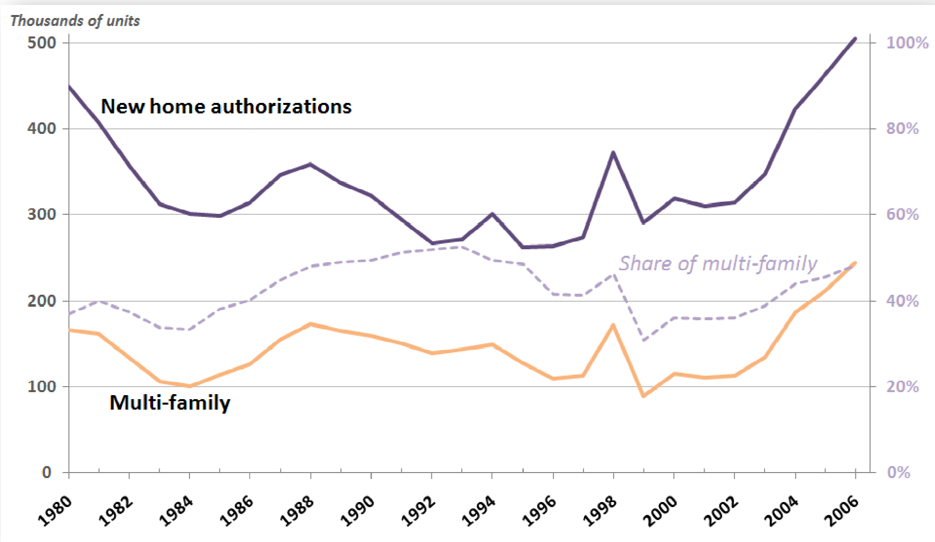
Scope: France *métropolitaine* *Source: Debrand and Taffin (2005), from Housing Surveys, Insee*

Tenure has a major influence on residential mobility, a point discussed in the next chapter. The different types of tenure are ranked in the following order, from lowest to highest mobility: outright owners, home buyers, social renters, and lastly private renters. The extent of the differences, with mobility rates ranging from a **factor 1 to 10 between outright owners and private renters**, urges the use of housing tenure when analyzing residential mobility. Let us also note that social renters have higher mobility rates than one might have expected.

D-3. …and in housing supply

Key figures relative to construction and to supply in general conclude this presentation of the housing market. In 2006, there were **505,000 authorizations for new homes**, a figure that has greatly increased since 1995 (*Figure 21*). A downturn should be observed for 2007 and the next few years though.

FIGURE 21: TRENDS IN CONSTRUCTION, 1980-2006



Scope: France *métropolitaine*, authorized dwellings *Source: SITADEL*

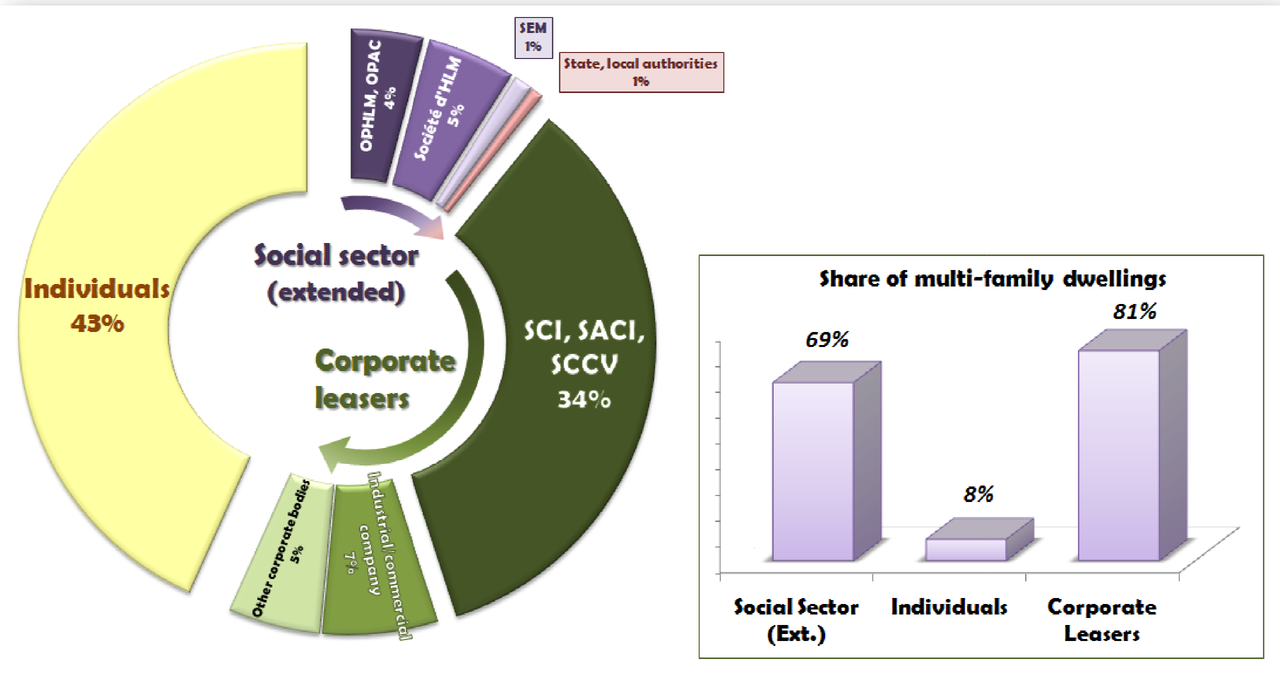
The share of attached housing within construction shows small fluctuations around a mean value of 40%. However, understanding how this share varies with time requires first turning to the structure of construction by "*maître d'ouvrage*".[59]

There are various kinds of *maître d'ouvrage* in France, which are divided into **three main categories** (*Figure 22*):

- individuals;
- the "extended" social sector, which consists of the social sector plus public lessors, namely the State and local authorities;
- corporate lessors, which encompass SCI, SACI, SCCV, industrial and commercial companies, and other corporate bodies.

The term "extended" social sector refers to the fact that dwellings built by the State or by local authorities do not necessarily have regulated rent. Nevertheless, because of the nature of these lessors, they are customarily regrouped with the social sector. This category is specific to the analysis of construction and to the French Housing Accounts (→ *C-2.b)*). As regards corporate lessors, SCI have already been presented in *B-2.a)*. SACI, also presented before in *B-1.b)*, have most of their current activity in the private sector, which is why they are now under this banner. Lastly, SCCV (*Société Civile de Construction-Vente*) are a special form of SCI for real estate developers only.

FIGURE 22: CONSTRUCTION BY *MAÎTRE D'OUVRAGE*, 2006



Scope: France *métropolitaine*, authorized dwellings

Source: SITADEL

[59] The "*maître d'ouvrage*" is a specific term in French law designing the client (more or less). It is mainly used for construction.

In 2006, corporate leasers were the main actor in the construction market, accounting for 46% of new authorized dwellings, closely followed by individuals (43%). The social sector only accounts for 11% of all construction, well below the objective of 20% often brandished by public authorities.[60] Each "maître d'ouvrage" has its own housing type of predilection, to wit, multi-family housing in the case of corporate and social lessors, and detached housing for individuals.

Because the share of multi-family housing barely varies with time whatever the considered group, the composition of construction in terms of housing type primarily depends on the fluctuations in the structure by "maître d'ouvrage" (*Figure I*). All shares are fairly volatile, but some regularity exists:

- Individuals represent between 40 and 60% of construction.
- The social sector represents between 10 and 20% of authorized dwellings, and has remained at a low level for the last few years.
- On the other hand, the share of private leasers, usually between 30 and 40%, has gained significant ground in the recent years, reaching 46% in 2006.

Construction is not the only way to increase the supply of housing. Actually, dwellings may undergo transformations, the three main types of which are:

- destruction/demolitions, in which case dwellings disappear from the housing stock;
- mergers/divisions, which modify the number of dwellings while leaving the overall surface area unchanged;
- transformation into non-residential floorspace (and contrariwise): this operation decreases (raises) both the number of dwellings and the overall residential floorspace.

Although figures relative to this topic are seldom and mainly based on guesstimation, Grépinet (2006) provides orders of magnitude for these phenomena:

TABLE 13: TRANSFORMATION OF DWELLINGS

Flows of dwellings *(thousands)*	1994 - 95	95-96	96-97	97-98	98-99	1999 - 2000	2000 - 01	
Dwelling divisions	23	18	20	21	23	20	19	↘↗↘
Transformation of non-resid. floorspace into dwellings	29	27	25	22	25	21	20	↘
Reverse transformation	-35	-32	-32	-32	-31	-32	-32	↘➡
Destruction - demolitions	-22	-20	-21	-22	-20	-22	-25	➡↘
Mergers	-28	-26	-24	-23	-23	-25	-23	↘➡

Source: Grépinet (2006), from Insee's Housing Division

[60] The objective of 20% refers to the housing stock, not to construction. Notwithstanding, the share of social dwellings within total construction should obviously reach 20% at equilibrium…

II – SPACE AND SCALE MATTER! : A EUROPEAN, AND REGIONAL ANALYSIS

The housing market is often singled out as a unique one, for space and scale play a major role in its operation. Housing conditions differ greatly from one country to another and even from one metropolitan area to another. Yet, local housing markets are interconnected in some way, the strength of the link usually depending on the distance separating them. Understanding this complex mix of interactions and idiosyncrasies constitutes one of the most challenging issues in housing market analysis.

The objective of this section is twofold:

- to highlight the **influence of space and scale**, firstly from a theoretical point of view ($\rightarrow A$), then through actual facts through an international then regional analysis, carried out in subsections B and C, respectively;
- to provide **key figures** enabling to situate:
  - France on the European scene ($\rightarrow B$);
  - the Greater Paris Region in the French regional landscape ($\rightarrow C$).

This section does not aim to elaborate on the role of space and scale in a theoretical way. Rather, subsection A provides a few elements as to why those are critical issues in housing market analysis and details the choice of scales. B and C illustrate this point first in the case of France, then of the Greater Paris Region (being our study area → *Chapter 2*). The role of space is studied in greater detail in the theoretical review (→ *Chapter 1*).

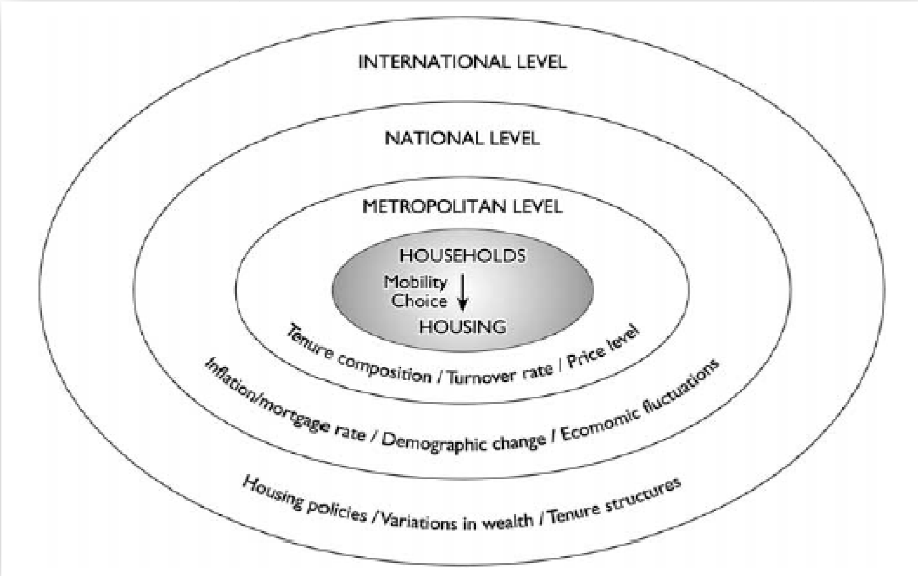
A ON THE ROLE OF SPACE AND SCALE

Space plays a central role in housing markets in various regards:

- at the geographical level: location with respect to rivers and other natural resources, landscape, climate, etc.;
- at the urban geographical level: location relatively to other towns, regions, etc.;
- through socio-economic variables: via spatial variations in employment, wages, income, crime rates, local taxes, and so on.

Moreover, **the relevant scale** (international, national, regional, metropolitan, or local) **depends on the issue at stake**. For instance, the influence of mortgage rates on housing prices is usually studied at the national level. On the other hand, the housing - employment balance is usually examined at the metropolitan or local scale.

FIGURE 23: RESIDENTIAL RELOCATION AND ITS EMBEDDEDNESS IN THREE GEOGRAPHICAL SCALES



Source: Dieleman et al. (2000)

Dieleman *et al.* (2000) develop this point further, and try to identify the circumstances which seem most important for molding the mobility process according to the scale of analysis. Their findings are encapsulated in the following diagram, which illustrates at which scale each of the main factors operates.

In the case of France, an additional level must be introduced. It is the regional level, which is often used for economic, administrative, or public policy considerations. France *métropolitaine* is divided into 22 *Régions* (*Figure M*), which could be roughly compared to small states if one were to refer to the U.S., or to *Länder* as far as Germany is concerned. Indeed, regions have played an increasing role in economic and transport policies since the 1980s, a period that marks the starts of various waves of devolution. This is less the case for land-use policies, which remain the privilege of mayors. Nevertheless, this situation might change as *Régions* take more and more interest in housing, resulting in regional planning exercises or the funding of various housing programs. The regional level is therefore added to the three scales identified by Dieleman *et al.* (2000), and logically finds it place between the metropolitan and the national level. The Greater Paris Region will obviously be of special interest to us. However, before looking further into this issue, I shall review housing markets in the European Union, which will allow us to situate France among European countries.

B HOUSING MARKETS IN THE EUROPEAN UNION

Each national housing market has its own specific features, reflecting the variety of geographic situations, socioeconomic contexts, and housing policies (Strassmann 1991).

As a result, models and study methodologies cannot be directly transposed from one country to another. This is especially true when comparing Europe to the United States: the latter is well-known for the low level of federal regulation in the housing market (meaning that standard economic theory of competitive markets does apply), while most European governments enact a more extensive regulation (Anas and Cho, 1985).[61] In point of fact, there are marked differences even among European countries as I will show later on. Some points of convergence still exist between national markets, which added to European integration, progressively lead towards a *rapprochement* of national housing policies (Grépinet 2006).

This subsection underlines this mix of heterogeneities and common trends, and situates France on the European scene through an overview of European national housing markets. Data issues are also discussed.

B-1. Data available at the European level

Housing data at the European level are available from several international or European organizations, chiefly including Eurostat, the Housing Ministers Meeting of the European Union, the Royal Institution of Chartered Surveyors (RICS), and the Organization for Economic Co-operation and Development (OECD). They mostly consist of a **recollection of national data**, sometimes completed with some harmonizing procedures. The report "Housing Statistics in the European Union" (Italian Housing Federation 2006), made every one-two years for the Housing Ministers Meeting, is to the best of my knowledge the most noteworthy and exhaustive work in this regard. It endeavors to provide comparable data for the member countries of the European Union on the following themes: general data, quality of the housing stock, availability and affordability of the housing stock, and the role of public policies. Other sources exist, but have significantly fewer data at their disposal.

Dedicated surveys collect additional data directly at the European scale: in particular, the European Union Statistics on Income and Living Conditions (EU-SILC), which superseded the European Community Household Panel (ECHP), provides interesting cross-sectional and longitudinal multidimensional micro-data relative to the housing market.

The combination of all the above sources offers a good overview of the European housing market. However, they mostly provide **aggregate and standardized figures** under the form of reports, rarely extensive datasets. Furthermore, the reported statistics often suffer from a **comparability issue**, since the various national housing surveys do

[61] Strassmann (2001) provides an informative discussion on how these contrasting institutional contexts fostered dissimilar ways of thinking and modeling housing markets.

not use the same methodology, and are not carried out the same year to boot.[62] This would likely not be the case **would housing be a competence of the European Union**. European surveys allow for interesting works at both the micro and macro levels (e.g., Gobillon 2001 or Hoekstra 2009), but have major limitations: they cover a limited amount of topics, the small size of their samples (2,000 to 6,000 households per country for the ECHP) make them unfit for analyses at finer scales than the national one, and they were found to produce dubious results for some well-known aggregate statistics such as tenure distribution (Hoekstra 2009). In the end, national databases are most likely the most reliable and exhaustive sources for in-depth analyses of the European housing market, at least for now.

B-2. Outlining European housing markets

National housing markets of member countries of the European Union are now outlined using a selection of indicators relative to the housing stock and its occupancy, tenure structure, housing supply, and housing prices. Because this part only purports to give an overview of the European housing market, methodological issues underlined in the report "Housing Statistics in the European Union" were not addressed.

a) European housing stocks and their occupancy

The first group of indicators describing national housing stocks includes the number of dwellings per 1,000 inhabitants (*Figure 24*, *Table B* for time series), the average household size (*Table 14*), and vacancy rates (*Table C*). As these variables strongly interact with each other,[63] they are analyzed together, hence the regroupment.

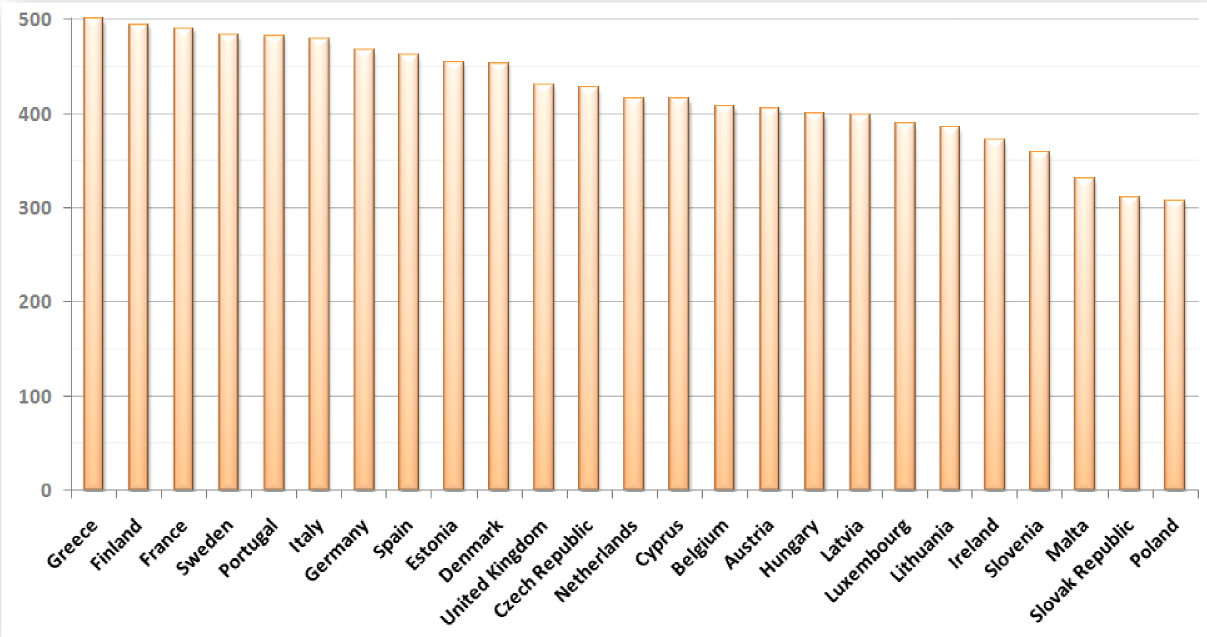
An initial analysis of this group of indicators brings to light **sizable dispersion in the relative size of housing stocks**: in 2004, France had the highest level of housing supply among the European Union with 513 dwellings per 1,000 inhabitants, as compared to only 314 for Poland (*Table B*). Several factors contribute to this substantial gap between France and Poland, and more generally to the overall heterogeneity:

- **Household size varies greatly** among countries, which is the case regarding France and Poland: Poland ranks second with an average size of 3.1 in 2004, while France is among the last quarter with a substantially lower level (2.3 in the same year).

[62] This is especially striking in the report "Housing Statistics in the European Union" (Italian Housing Federation 2006). This report emphasizes methodological hurdles, which sometimes lead to hardly comparable data between countries. The vacancy analysis (later in this subsection) provides a perfect illustration of this point.

[63] E.g., the average household size directly influences the relative size of the housing stock (number of dwellings per 1,000 inhabitants). Conversely, the relative size may influence the phenomena of cohabitation and "de-cohabitation". Insufficient levels of housing construction might for instance induce larger household sizes, as children wait longer to leave the family home or share apartments as coping strategies.

FIGURE 24: NUMBER OF HOUSING UNITS PER 1,000 INHABITANTS, 2000*



*Year 2000 is presented instead of year 2004 because of missing data for 2004.

Source: Housing Statistics in the European Union 2005/2006

- Secondly, the **heterogeneity of vacancy rates** adds to the volatility of the relative sizes of housing stocks. Some countries show virtually no vacancy (e.g., Latvia has a vacancy rate as low as 0.3%) when others such as Greece supposedly have a quarter or a third of their housing stock vacant. France (6.1% in 2004) and Poland (5.3% in 2002) have relatively low levels in this regard. The disturbingly high vacancy rates mentioned previously illustrate well the substantial methodological differences that exist between European countries; in this specific case, some countries count second homes as vacant dwellings, hence significantly higher vacancy rates.
- Lastly, second homes (when not counted among vacant dwellings) increase the relative size of the housing stock, which accounts for the first place of France in 2004 as regards the relative size of its housing stock. [64]

In spite of these disparities, almost all European countries share one common trend: a marked **decrease in household size** over the last decades. This downward trend has logically contributed to an increase in the number of dwellings (*Table B*). I do not seek to explain the diminution of household size here, due to the wide range of potential causes (fewer children, ageing of the population, increase in the number of single-parent families, and so on). However, this phenomenon certainly highlights that behind a sheer heterogeneity at first glance, European national housing markets actually share some common underlying mechanisms.

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[64] I do not have figures corresponding to this matter, but other countries such as Denmark, with levels of vacancy similar to France and smaller households, would logically rank above France were it not the case.

TABLE 14: AVERAGE NUMBER OF PERSONS PER OCCUPIED DWELLING

	1980	1985	1990	1995	2000*	2004	Variation**
Poland	3.6	3.4	3.4	3.3	3.2	3.1	-14%
Ireland	3.8	3.5	3.4	3.3	3.0	2.9	-24%
Malta	3.0	3.4	na	3.2	3.0	na	0%
Slovak Republic	3.1	na	3.0	na	3.0	3.2	3%
Spain	3.9	na	3.3	3.0	3.0	na	-23%
Portugal	3.0	na	3.2	na	2.9	na	-3%
Greece	3.2	na	3.0	2.9	2.8	na	-13%
Slovenia	3.0	na	2.8	2.8	2.8	2.4	-20%
Cyprus	na	3.4	3.0	2.7	2.6	na	-24%
Czech Republic	2.9	na	2.8	na	2.6	na	-10%
Italy	3.2	3.0	2.8	na	2.6	na	-19%
Latvia	3.2	na	2.8	2.7	2.6	2.0	-38%
Lithuania	na	3.3	3.2	3.0	2.6	2.7	-18%
Luxembourg	2.8	na	2.7	na	2.6	2.6	-7%
Estonia	2.8	na	2.4	2.6	2.5	na	-11%
Hungary	3.1	2.8	na	2.6	2.5	2.5	-19%
Austria	2.8	2.4	2.6	2.6	2.4	2.4	-14%
Belgium	2.6	2.6	2.6	2.6	2.4	2.0	-23%
France	2.8	2.7	2.6	2.5	2.4	2.3	-18%
Netherlands	2.9	2.7	2.6	2.5	2.4	2.4	-17%
United Kingdom	2.7	2.6	2.5	2.4	2.3	na	-15%
Finland	2.6	na	2.4	2.3	2.2	2.1	-19%
Germany	2.5	2.4	2.4	2.3	2.2	2.2	-12%
Denmark	2.4	2.3	2.1	2.1	2.1	2.0	-17%
Sweden	2.3	2.2	2.1	2.1	2.1	2.1	-9%

*: Sorting year

**: Variation is computed between last and first year with available data. Any comparison is to take this element into account.

Source: Housing Statistics in the European Union 2005/2006

This concurrence of heterogeneity and common patterns also characterizes the second group of indicators, consisting of the floor areas per dwelling and per person (*Table 15*). On the one hand, European countries differ greatly with respect to the current level of both indicators. On the other hand, in almost all countries recent homes are larger than existing ones. Besides, exceptions are gathered among the countries with already the highest levels of useful floor area per person. Considering the simultaneous decline in household size, this growth in dwelling size entails a **gain in housing quality**.

TABLE 15: AVERAGE USEFUL FLOOR AREA PER DWELLING AND PER PERSON

		DWELLING				PERSON
	Year	Total dwelling stock (m²/dwelling)	Year	Dwellings completed (m²/dwelling)	Year	Occupied dwelling stock (m²/person)*
Denmark	2005	113.1	2005	107.0	2005	52.4
Luxembourg	2001	125,0	2001	120.2	2001	49.0
Sweden	2005	91.5	2005	94.0	2005	44.5
United Kingdom	2001	86.9	1981-2001	82.7	2001	44.0
Netherlands	2000	98.0	2000	115.5	2000	41.0
Germany	2002	89.7	2003	113.9	2002	40.1
Austria	2003	93.9	2002	101.0	2003	38.3
France	2002	89.7	2004	111.0	2002	37.5
Italy	2001	96.0	2003	76.5	2001	36.5
Finland	2002	77.0	2003	90.2	2002	36.3
Ireland	2003	104.0	2003	105.0	2002	35.0
Malta	2002	106.4	-	na	2002	34.3
Spain	2001	90.0	2003	100.6	2001	31.3
Slovenia	2004	75.6	2004	108.7	2004	30.9
Greece	2001	81.3	2001	124.6	2001	30.6
Czech Republic	2001	76.3	2005	100.7	2001	28.7
Hungary	2001	75.0	2002	94.1	2001	28.0
Estonia	2003	60.2	2003	89.1	2003	27.7
Slovak Republic	2001	56.1	2004	131.7	2001	26.0
Latvia	2003	55.4	2004	92.1	2003	23.9
Lithuania	2003	60.6	2003	106.2	2003	23.0
Poland	2004	69.0	2004	107.5	2004	22.9
Belgium	2001	81.3	2005	105.0	-	na
Cyprus	-	na	2002	197.6	-	na
Portugal	2001	83.0	2003	88.9	-	na

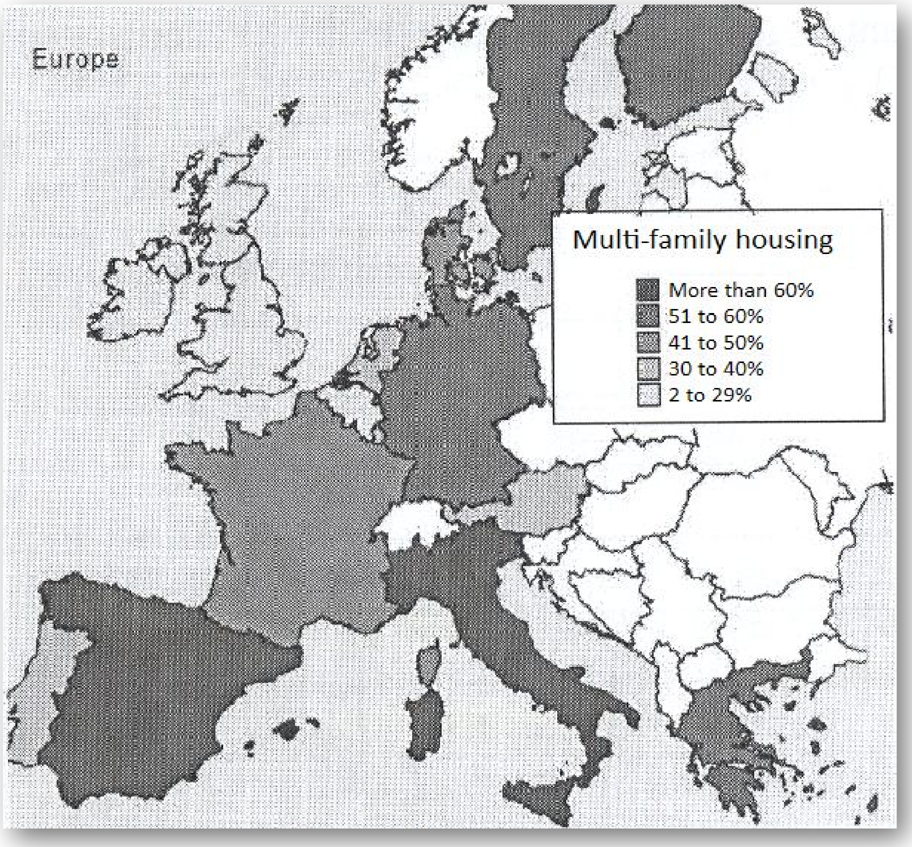
AU, **CZ**, **FR**: Primary residences only; **UK**: England only.

*: Sorting variable

Source: Housing Statistics in the European Union 2005/2006

The analysis of the share of multi-family housing concludes this presentation of European housing stocks. It offers **counterintuitive results**: low-density countries such as Sweden or Finland have a fair amount of multi-family housing, whereas detached housing prevails in high-density countries such as the United Kingdom, Belgium, or the Netherlands (*Figure 25*).

FIGURE 25: MULTI-FAMILY HOUSING IN EUROPE, 2000



Source: Grépinet (2006)

b) Tenure structure

The analysis of tenure structure could logically find its place in the above description of the housing stock. Yet, I present it separately to emphasize two elements which are intertwined: methodological issues and national specificities.

On the difficulty of defining housing tenure

Giving a general definition of the various forms of housing tenure proves particularly arduous in practice, especially regarding social housing (Ruonavaara 1993). There is actually no such thing as a European agreement on the definition of social housing, and each country uses its own. True, the distinction private vs. social sector is usually drawn based on the characteristics of the landlord (i.e. local authorities, housing associations, and so on, are usually associated to the social sector). But such a boundary line can be misleading for countries such as Germany where private individuals play an important role in providing rental dwellings with non-profit rents.

Hoekstra (2009) provides an interesting insight into this matter in the European context: he successfully tests Kemeny's typology and shows the **coexistence of dualist and integrated rental systems** in Europe. Dualist rental systems are defined by a clear separation between the private and social sectors, the latter acting as a safety net for low-income households.[65] Three features typically distinguish countries enforcing such systems: a high level of home ownership, and lower rents as well as lower housing quality in the social sector, and "residualization" (concentration of low-income groups in a specific tenure sector). On the other hand, governments of countries with integrated rental systems promote competition between the private and social sectors in order to "strike a balance between economic and social priorities" (Kemeny 1995, p.11). These countries typically have large rental sectors, and the rent differential between the social and private sector is usually small. Residualization is also kept to a minimum.

The coexistence of these two types of rental systems, among other things, makes it necessary to take into account **national specificities**. This holds true for analyses as well as modeling attempts. A housing model designed for the French housing market, with its specific rules concerning social housing, would most likely be unsuitable for another European country, unless performing the appropriate modifications.

The prevalence of homeownership in Europe

An initial analysis of tenure structure corroborates Kemeny's typology (*Table 16*): **homeownership prevails in all countries but Germany and Sweden**, two typical cases of integrated rental systems quoted by Kemeny (1995). The degree of prevalence varies from one country to another, though: in Estonia, homeownership is virtually the only option (96% of home owners in 2004), when several countries including France (a dualist system in Kemeny's typology) have more than a third of their housing stock dedicated to tenancy.

When compared to other countries, France does not display an especially high level of social housing units, be it as a share of the rental stock or of the whole housing stock alike. Once more, these two indicators are highly variable, reflecting the variety of national housing policies. The Czech and Slovak Republics have the highest share of social housing units within their rental markets (80% in 2004), but it is the Netherlands (an integrated rental system according to Kemeny) who rank first when comparing levels to the whole housing stock (34% in 2004).

Analyzing the dynamics of tenure structure does not bring to light any conspicuous pattern among European countries (*Table D*). **Rise in home ownership** is observed for several, including France, but does not constitute a rule.

[65] See Hoekstra (2009) for more precise definitions of dualist and integrated rental systems.

TABLE 16: BREAKDOWN OF HOUSING STOCK BY TENURE
+ SOCIAL HOUSING AS % OF TOTAL (TS) OR RENTAL DWELLING STOCK (RS)

	Year	R	OO	CO	O	Year	% of TS	% of RS
Austria	*2004*	41	51	na	9	*2000*	23	52
Belgium	*2004*	31	68	na	2	*2004*	7	24
Cyprus	*2000*	14	68	na	18		na	na
Czech Republic	*2000*	29	47	17	7	*2004*	20	80
Denmark	*2004*	38	49	7	6	*2004*	19	42
Estonia	*2004*	4	96	0	0	*2004*	4	40
Finland	*2004*	33	63	0	4	*2004*	18	52
France	*2004*	40	57	0	3	*2004*	17	40
Germany	*2004*	55	45	na	0	*2004*	6	12
Greece	*2004*	20	74	na	6	*2004*	0	0
Hungary	*2004*	6	93	na	1	*2004*	3	48
Ireland	*2004*	21	79	na	na	*2004*	8	38
Italy	*2004*	19	73	0	9	*2004*	5	24
Latvia	*2004*	19	77	4	na	*2004*	1	2
Lithuania	*2000*	7	91	na	na		na	na
Luxembourg	*2004*	29	68	na	3		na	na
Malta	*2004*	26	70	na	4		na	na
Netherlands	*2004*	44	56	na	0	*2004*	34	77
Poland	*2004*	25	57	18	0	*2004*	12	47
Portugal	*2000*	21	75	na	4	*2000*	na	21
Slovak Republic	*2004*	5	85	7	3	*2004*	4	80
Slovenia	*2004*	9	84	na	7	*2004*	6	73
Spain	*2004*	11	82	na	7	*1990*	2	21
Sweden	*2004*	45	38	17	0	*2004*	18	46
United Kingdom	*2004*	31	69	na	0	*2004*	20	65

Year = last year with available data. R = Rent, OO = Owner Occupied, CO = Cooperative and O = Other.

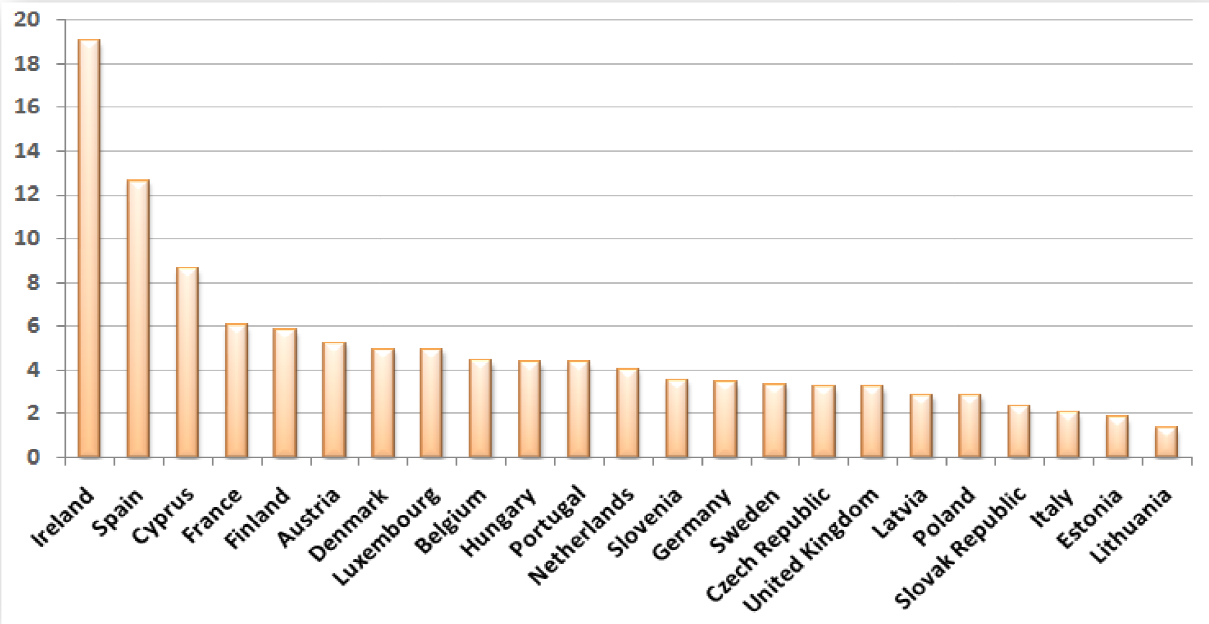
Other includes **BE**: (rent) free dwellings; **ES**: vacant or unknown dwellings; **FR**: tenancy of a furnished unit, subtenancy, and free housing; **FI**: empty dwellings; **IT**: free right of user.

Source: Housing Statistics in the European Union 2005/2006

c) Housing supply

The number of completed dwellings per 1,000 inhabitants is a good indicator of the home building effort of a country. While Ireland, Spain, and to a lesser extent Cyprus, are singled out by their outstanding levels of home construction, the remaining countries show relatively similar figures, with levels around three to five dwellings per thousand inhabitants (*Figure 26*).

FIGURE 26: COMPLETED DWELLINGS PER 1,000 INHABITANTS, 2004

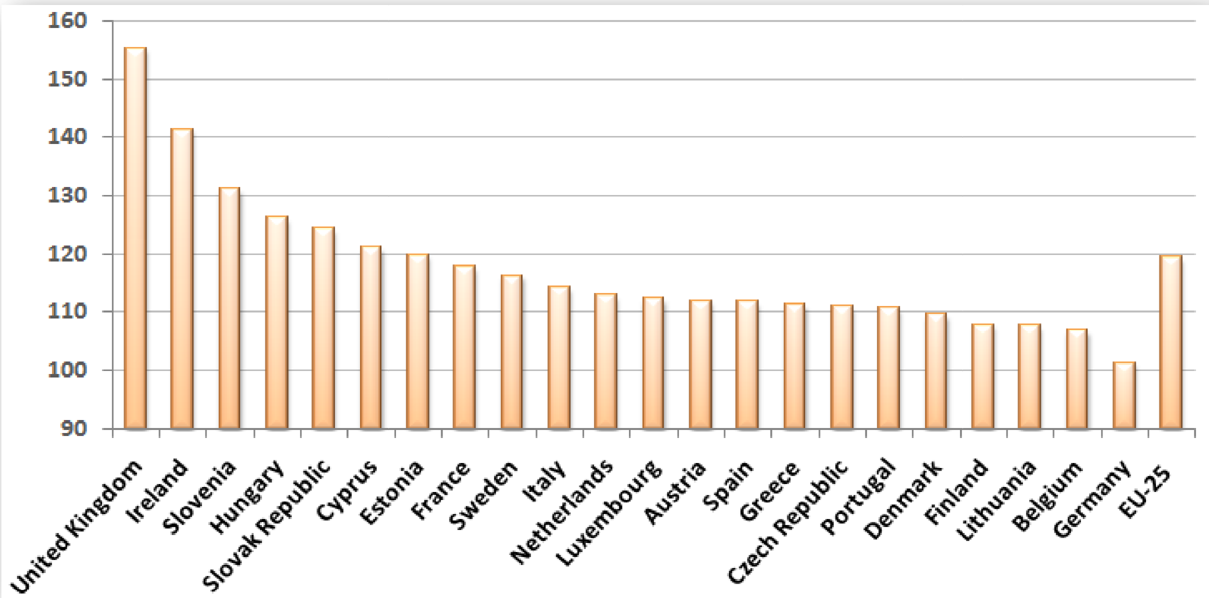


AU, **CY**: Data for 2002; **LI**, **PT**, **UK**: Data for 2003; **GR**, **MA**: no available data for recent years

Source: Housing Statistics in the European Union

As regards construction costs, let us first note that these usually increase with time, be it only because of inflation. Keeping this point in mind, between 2000 and 2004, indexes of construction costs have risen in all European countries, especially in the United Kingdom and in Ireland where they have grown as fast as 11.6% a year (*Figure 27*). In 2004, the French construction cost index had gained 18% over the last four years, rising at a similar pace than the European average (19%).

FIGURE 27: CONSTRUCTION COST INDEX, RESIDENTIAL BUILDINGS, 2004 (2000=100)



LV, **MA**, **PO**: no data available

Source: Housing Statistics in the European Union 2005/2006

d) Housing prices and housing consumption/expense ratios

Two indicators are presented in regard to housing prices:

- The average annual rent for the rental market (*Table 17*);
- The average price of a dwelling for the property market (*Table E*).

The latter index, though informative, is marred with various inconsistencies, and brings to light the limits of available European data. Keeping this element in mind, in 2004 France was the most expensive country with respect to housing (among countries with available data), with an average price of 2,500€/m^2.

The indicators for the rental market prove more reliable, and underline once again **sizable discrepancies across Europe**, with rents ranging from a factor 1 to 10 for the free market (Lithuania 1.12€/m^2 vs. Ireland 12€/m^2) and 1 to 100 for the regulated market (Lithuania 0.06€/m^2 vs. Sweden 5.66€/m^2).[66] The ratio of rents between the regulated and the free market also varies greatly: nearing 1 for Sweden (being a sign of an integrated rental system), it is close to null for Ireland (indicating this time a dualist rental system). However, the existence of housing benefits in several countries undermines any direct comparison of rents, especially in the case of social housing.

TABLE 17: AVERAGE YEARLY RENT AND AVERAGE SIZE OF RENTAL DWELLINGS, 2004

	FREE MARKET		REGULATED MARKET	
	Average rent* (thousands of €)	Average size (m^2)	Average rent (thousands of €)	Average size (m^2)
Ireland	12.0	na	1.87	na
Netherlands	9.2	85	4.3	74
United Kingdom	8.89	na	3.93	na
Luxembourg	8.12	90	4.01	88
Cyprus	6.12	121	na	na
Sweden	5.99	66	5.66	66
France	5.8	68	4.17	71
Denmark	5.7	80	na	na
Austria	5.0	68	4.3	72
Germany	4.9	70	na	na
Italy	3.69	na	0.96	75
Greece	3.0	72	na	na
Malta	2.21-8.28	45-120	na	na
Czech Republic	1.28	51	0.67	63
Lithuania	1.12	61	0.06	44
Latvia	0.88	86	na	52
Belgium	na	na	2.4	na
Estonia	na	na	1.3	45

*: Sorting variable.

ES, **FI**, **HU**, **PO**, **PT**, **SK**, **SL**: no available data

Source: Housing Statistics in the European Union, 2005/2006

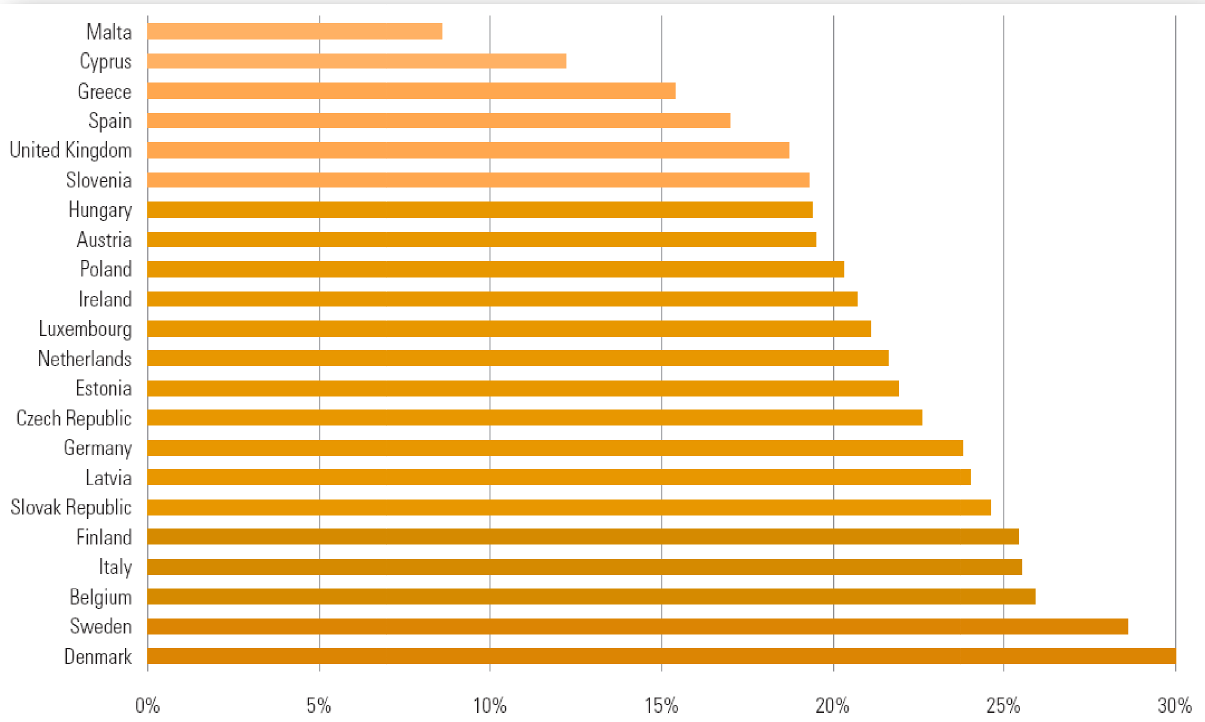
[66] Such a high figure might indicate a data entry error regarding Lithuania, but this fact could not be ascertained.

To conclude on housing prices, even the growth of rental prices shows strong variations among European countries, no specific pattern being manifest at first glance (*Figure* J). As regards France, for the period 1996-2004 rents have progressed slower than the European average (+1.6 as compared to +2.4% a year).

The housing consumption ratio, defined as the ratio housing consumption on total consumption, provides an interesting alternative to classic housing price indexes. Being a relative weight, it is not affected by income or price differences between countries, making this indicator more readily comparable.[67] Note that the notion of housing consumption corresponds almost exactly to that of current expenses presented in *I - A-2*; in particular, it is different from actual expenses because of imputed rents.

Except for Malta and Cyprus, **housing accounts for a significant share of overall consumption** in Europe, with ratios between 15 and 30% (*Figure 28*). Variations across countries are noteworthy, yet mitigated compared to the previous price indexes, hence corroborating the usefulness of ratio-type indicators. In 2003, the average housing burden of a French household reached 24.1%,[68] situating France among the countries with the highest levels of housing consumption.

FIGURE 28: HOUSING CONSUMPTION AS A SHARE OF TOTAL HOUSEHOLD CONSUMPTION, 2004



Source: Housing Statistics in the European Union, 2005/2006

[67] I simply mean by this that multiplying prices and incomes by a same factor k would leave this ratio unchanged. Obviously, the specific economic characteristics of a country (housing prices compared to consumption prices, income level, housing policies, etc.) exert a strong influence on this variable.
[68] No data was available for 2004 at the time of the report.

B-3. The European housing market: a complex system

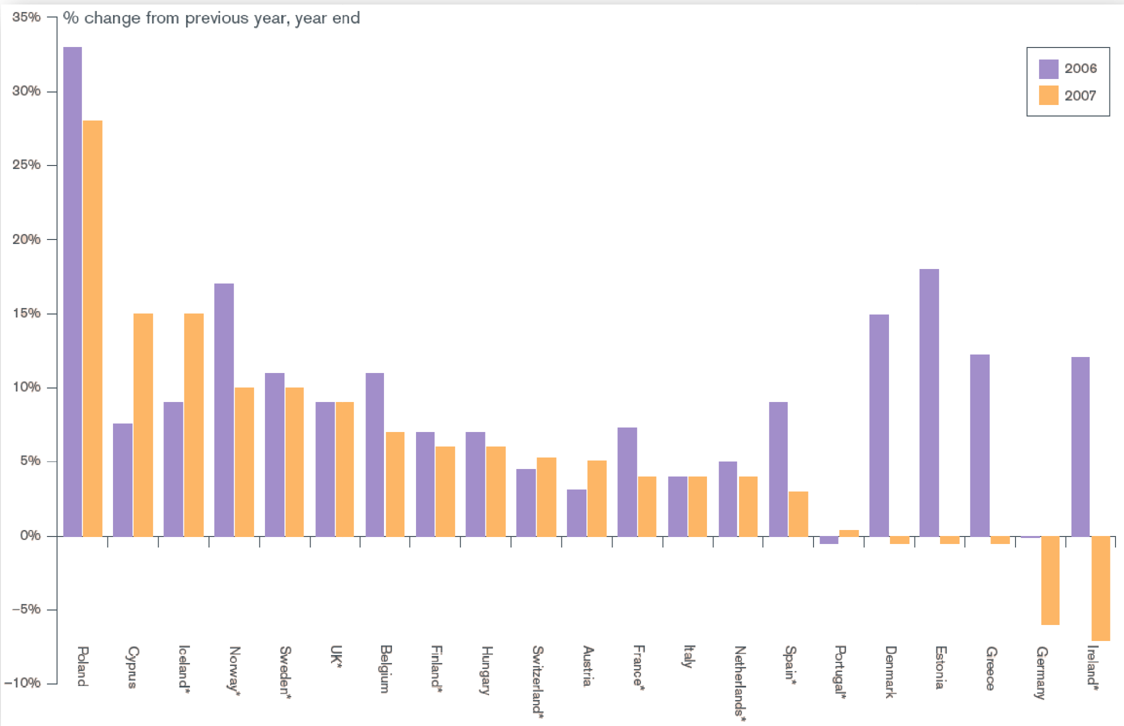
Following this overview of national markets, and before undertaking the regional analysis, I wish to emphasize once again a significant difficulty, which is the extreme complexity of the European housing market as a whole. Indeed, national housing markets are partly in interaction (through financial markets to begin with), [69] but may also develop idiosyncratic responses to shocks due to their specificities.

a) A system displaying strong idiosyncrasies

To develop and assert this last point, let us start by analyzing recent housing price variations across Europe. *Figure 29* shows an overall upward trend, especially in 2006. Yet, in 2007, when housing prices keep on rising in most countries, they stagnate in Greece or Denmark. They even regress in Ireland and Germany, thereby indicating a turn in the real estate market cycles of these countries. Therefore, one can already housing prices can vary quite differently from one country to another.

One might object that economic conditions vary across countries. Withal, a longer term analysis shows that even when facing a similar context, that is one of a lasting rise in real housing prices, European national markets reacted in very heterogeneous ways as regards house building (*Table 18*).

FIGURE 29: HOUSING PRICE INFLATION IN EUROPE



Source: RICS (2008)

[69] Obviously, interactions may also occur at a regional or local scale, between territories located near borders.

TABLE 18: THE RESPONSIVENESS OF HOUSING SUPPLY TO HOUSE PRICE RISES

% change 1996-2006	Ireland	UK	Sweden	Spain	France	Denmark	Netherlands	Finland	Germany
Real house prices	188	118	107	102	99	96	88	85	-14
House building	177	12	128	187	58	131	-19	63	-55

Source: RICS (2008)

b) The issue of foreign-owned second homes

Foreign-owned second homes provide another illustration of the complexity of the linkage between European housing markets. [70] For the time being, foreign housing investment remains somewhat marginal: e.g., only 7% of French second homes were foreign-owned in 2003. Yet, foreigners tend to gather in specific areas within a country (see for instance *Figure L*). And since secondary residents, especially foreign ones, usually consume more than ordinary residents during their stay in their second home, they are a noteworthy source of income for regions (Calzada, Le Blanc, and Vandendriessche, 2004). The significance of this issue should thus be assessed when working at the local level, because of its potential consequences on local development on the one side, and on housing prices and potential eviction effects on the other side.

C FRENCH REGIONAL HOUSING MARKETS

French regions differ greatly in various aspects, economic, cultural, and political, to mention only three. Unsurprisingly, regional housing markets are no exception to this rule, and all following analyses will confirm it. Yet, the **level of dissimilarity** between regions, and in particular the **specific situation of the Greater Paris Region** (GPR, its true name being Île-de-France) [71], are of great interest, and constitute the object of this subsection. These two issues represent one part of this subsection each. Salient facts regarding the **role of location within the metropolitan area** are exposed in between, and shed additional light on the role of space.

[70] Not surprisingly bordering countries usually play the most significant role in this matter. In the French case, UK, Switzerland and Italy stand for more than half of the foreign-owned second homes (*Figure K*).

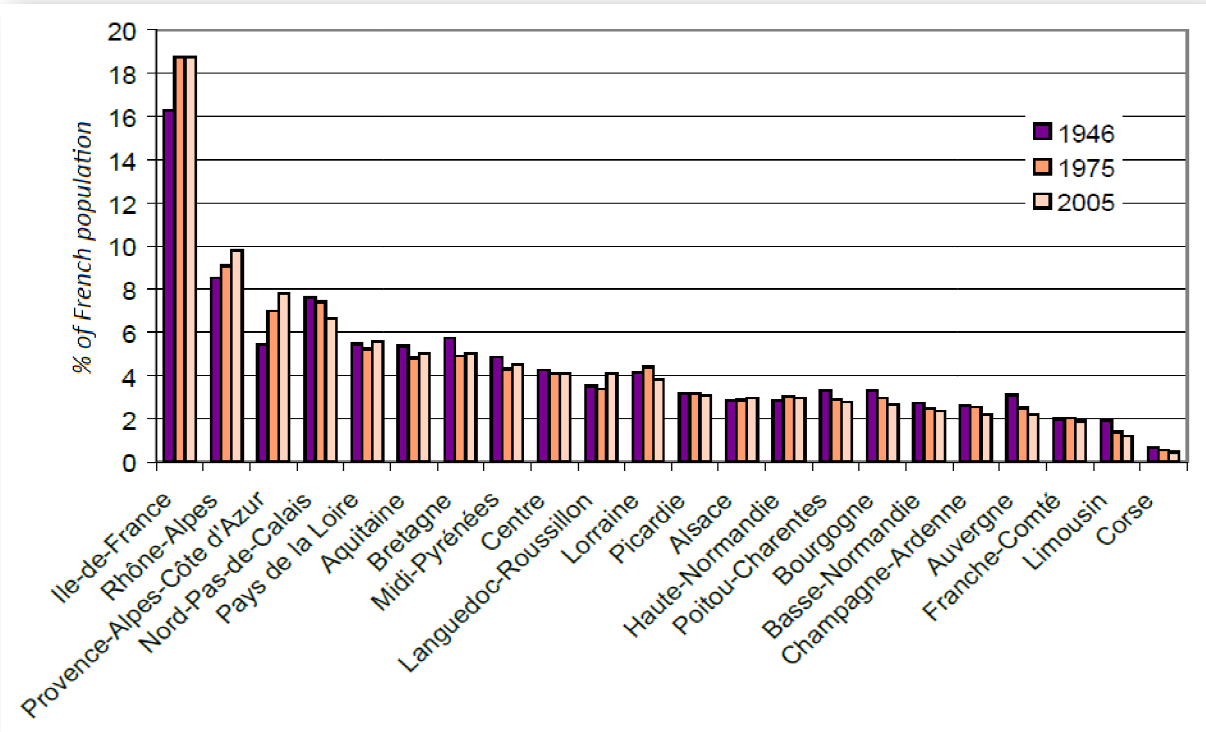
[71] "Île-de-France" is the French name of a large administrative district including Paris and its 7 surrounding *départements* (cf. *Figure N*). Because its limits are determined by administrative boundaries, the Île-de-France slightly differs from the metropolitan area of Paris. For disambiguation purposes, I use the term "Greater Paris Region" as a synonym of "Île-de-France", since the former might be more evocative for non-French readers. The term "Paris Metropolitan Area" refers to the metropolitan area of Paris as defined by the INSEE. Let us note that French works often use the two in an interchangeable way, at the risk of the above mentioned ambiguity.

C-1. France: a country with marked regional discrepancies

As mentioned above, French regions differ in various aspects, including population. In point of fact, France shows an **increasingly high level of localization**: the first three most populated regions, namely the Greater Paris Region, the Rhône-Alpes region, and the Provence-Alpes-Côte d'Azur (PACA region),[72] have accounted for nearly half (48.4%) the French population growth between 1946 and 2005 (*Figure 30*). In 2005, they represented altogether more than a third of the total population. At first glance, the hierarchy of regions seems otherwise relatively stable, although the Greater Paris Region does stand out even more since 1975.

Let us carry the analysis a step further. In his diagnosis of the French housing market, the very first feature emphasized by Grépinet (2006) regarding French regions is the **heterogeneity of growth rates**, a fact already noticeable in *Figure 30*. Each region has its own speed of growth, dictated by the rhythm of migration, births, and mortality. This leads to contrasted situations (*Figure 31*), some regions experiencing fast growth, when others are lagging behind (or even dwindling as far as the Champagne-Ardennes region is concerned).

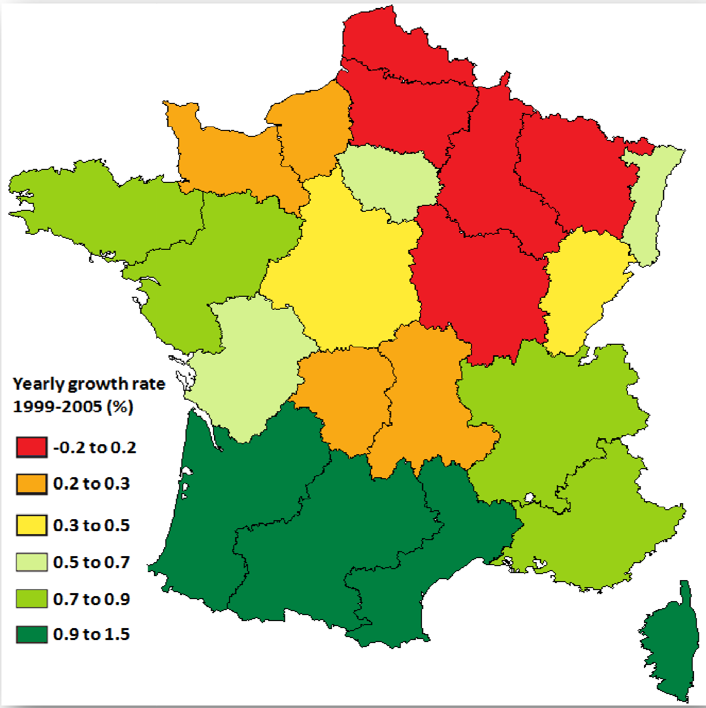
FIGURE 30: LONG-TERM TRENDS IN FRENCH REGIONAL POPULATIONS



Source: Donzel et al.(2008), from Insee

[72] The last two being the region where the city of Lyons is located and the South Eastern region that includes the French Riviera, respectively (→ *Figure M*).

FIGURE 31: REGIONAL POPULATION GROWTH RATES, 1999-2005



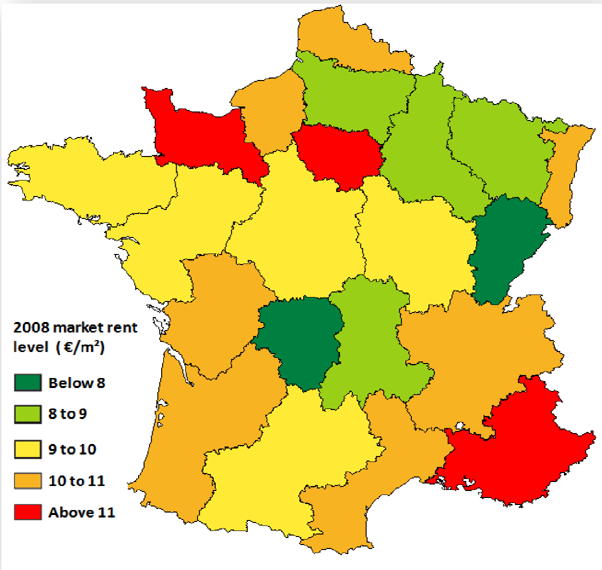
Source: Insee

This fact calls for a first comment: **housing needs vary from one region to another**, depending on the attractiveness of the region (as measured by its migration rate)[73] and its "dynamism" (measured by its natural population growth rate). Furthermore, because dwellings are fixed and cannot be "moved" at will, the overall housing need cannot be computed as the simple sum of regional needs.[74] Consequently, evaluations should be based on specific regional analyses rather than on national projections. Lastly, let us note that growth rates are as heterogeneous within regions as they are across regions, increasing the **necessity of local analysis** for robust results (Grépinet 2006).

The analysis of population growth rates highlights geographical patterns, **growth being fastest in coastal and south-western regions** (*Figure 31*). This fact is not haphazard and reflects a trend observed in various countries. It may partly be explained by the ageing of the population and the ensuing migration of retired households towards regions with specific climates. In the long term, this tendency might cause longstanding upheavals in the hierarchy of French regions. In fact, the sturdy growth of the PACA region and the concurrent decline of the Nord-Pas-de-Calais region (→ *Figure 30*) are likely harbingers of such changes, mitigating the above statement about a seemingly stable regional hierarchy.

[73] Second homes are another noteworthy source of spatial heterogeneity regarding housing needs (*Figure 0*), which is also directly related to the attractiveness of the area.
[74] I come back to this point in *Chapter 1*, section *III*.

FIGURE 32: REGIONAL LEVELS OF MARKET RENTS, 2008

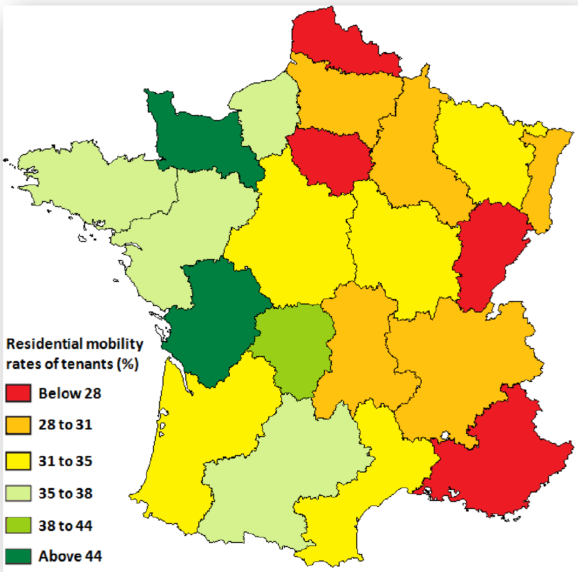


Source : CLAMEUR

Housing prices also vary to a great extent among regional markets, a point illustrated in *Figure 32* in the case of the free rental sector. In 2008, average rental prices ranged from 6.8 €/m^2 for the Franche-Comté to 17.2 €/m^2 for the GPR. The latter stands out as a very expensive region in this regard: most regions situate themselves in the vicinity of 10 €/m^2, and the second most expensive region in terms of rents, namely the PACA region, only reaches 12 €/m^2.

The analysis of residential mobility rates of private renters highlights once more sizable differences across regions (*Figure 33*). The most and least mobile areas, being the Poitou-Charentes region (44.8%) and the PACA region (25.3%), respectively, are almost separated by a factor 2. The GPR ranks just above the latter, with a rate of 25.5%.

FIGURE 33: YEARLY RESIDENTIAL MOBILITY RATES OF PRIVATE RENTERS

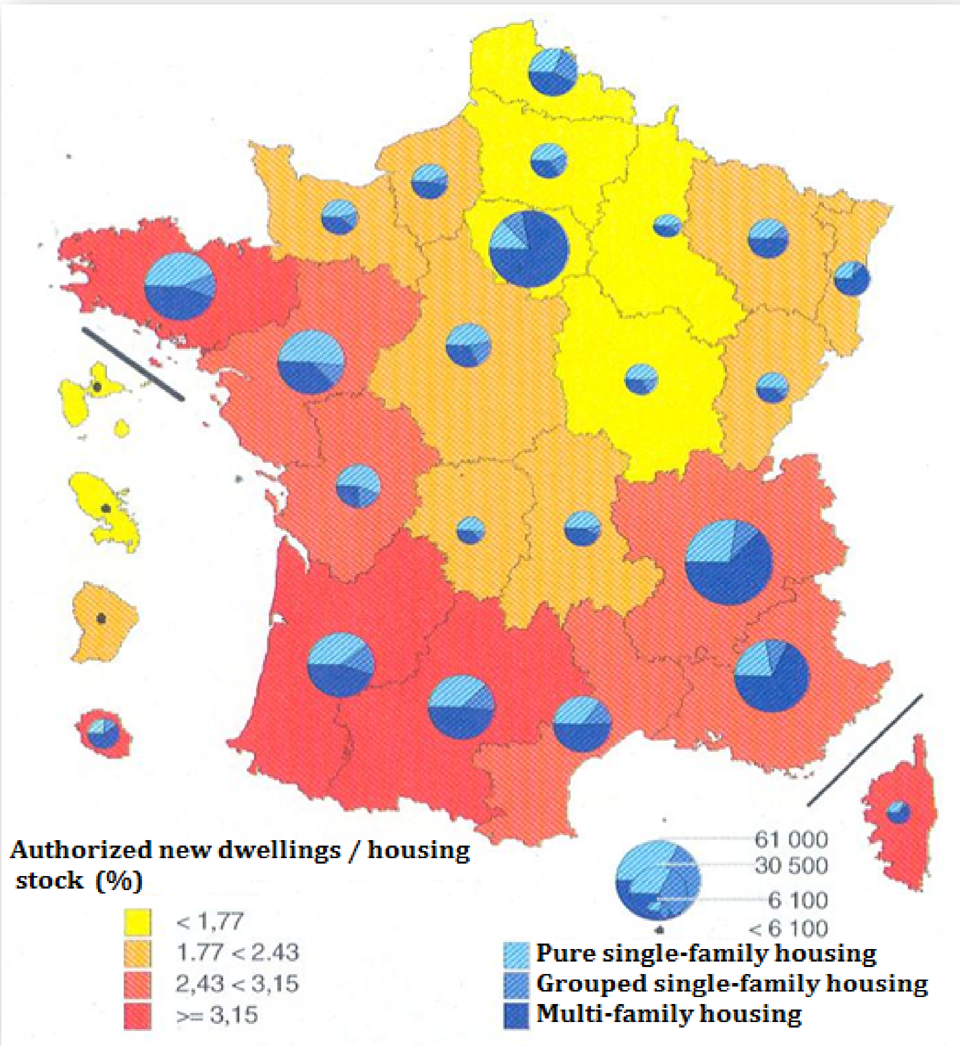


Source : CLAMEUR

This outline of regional housing markets concludes with a glance at housing supply. The analysis of new home building brings two points to light (*Figure 34*). First, measuring construction in absolute (circle size) or relative terms (background color) leads to completely different regional rankings, taking us back to the space/scale issue. Secondly, the distribution of housing type varies greatly among regions. Multi-family housing prevails in expensive regions (including the GPR), which is probably not a coincidence.[75]

Besides confirming the influence of space, here at the regional scale, this brief analysis has singled out the Greater Paris Region, and to a lesser extent the PACA region. Both feature high housing prices, lower residential mobility, and a predominance of attached housing in construction. These three elements are signs of tight housing markets, a point which is confirmed for the GPR in *C-3*. But before that, let us further discuss the role of space and scale.

FIGURE 34: AUTHORIZED NEW DWELLINGS BY HOUSING TYPE



Source: Sitadel, Filocom 2005, and Census 2006

[75] This trend likely stems from high land prices, making multi-family housing the most profitable form of construction.

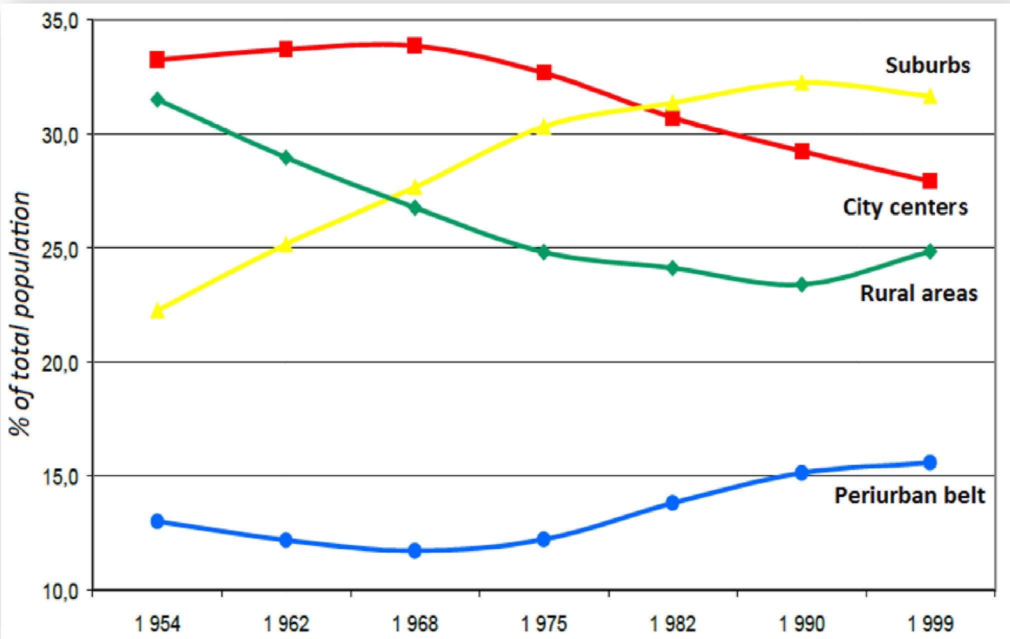
C-2. Additional facts on the role of space and scale

a) The influence of the location within the metropolitan area

For the last few years, the scourge named urban sprawl has been on everybody's lips, spurring countless works and debates regarding the genuineness of this phenomenon, the underlying reasons, how to counter it, and so on. While not purporting to come to a conclusion nor shed new light on this issue, I shall still report some noteworthy trends in the spatial patterns of urban growth in France.

First of all, one established fact is that **suburbs and outskirts of metropolitan areas absorb a more and more important share of the population growth**. The weight of city centers has been declining for nearly forty years now, people migrating first to the suburbs, then to the outskirts when suburbs eventually reached their limits (*Figure 35*).[76] The year 1990 even sets a milestone in the history of French urban development as the **end of "rural exodus"**. From this census onward, population growth has resumed in rural areas. Two factors are often quoted to account for this recent trend: a renewed yearning for rural lifestyles, and the pervasive growth of land prices in denser parts of metropolitan areas.

FIGURE 35: TRENDS IN THE SPATIAL DISTRIBUTION OF FRENCH POPULATION



In French lexicon, the corresponding categories are *villes-centre*, *banlieues*, *couronnes périurbaines*, and *Autres* (*villes multipolarisées* + *rural*). These terms were translated to the closest corresponding notions.

Source: Donzel et al. (2008)

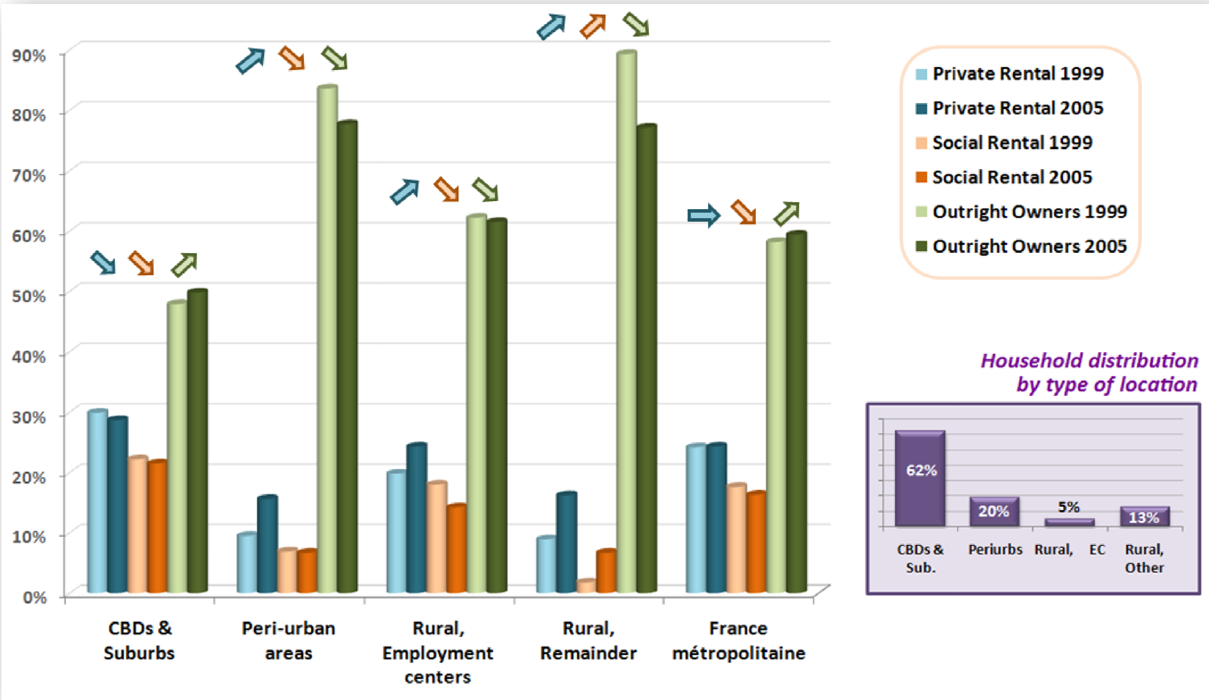
76 Recent analyses of the 2006 Census confirm these trends: while population grows for all categories in absolute terms, growth rates remain lower in city centers and in suburbs (Laganier and Vienne 2009, Baccaïni and Sémecurbe, 2009).

Location within the metropolitan area also exerts a primary influence on tenure. Rental housing is mostly localized in downtowns, suburbs, and smaller employment centers of rural areas (*Figure 36*). Conversely, city outskirts and rural areas teem with single-family houses.

Despite this overwhelming trend, between 1999 and 2005 the private rental sector still grew in all locations but Central Business Districts (CBDs) and suburbs, where it slightly shrank. However, because this last category accounts for more than 60% of the total housing stock, these opposite trends countervailed each other, hence a stable share of private rental dwellings at the national level.[77] The social sector shrank everywhere, except in the "remainder of the rural area" quite surprisingly. Conversely, home ownership decreased everywhere but in the densest zones of agglomerations.

Last but not least, **land prices are strongly connected to location**: the price of building land markedly decreases with distance to CBD (*Figure 37*), as predicted by the monocentric model of urban economics (→ *Chapter 1*, section *I*). As a consequence, and considering that construction costs are in comparison little affected by location, one might expect housing prices to vary accordingly.

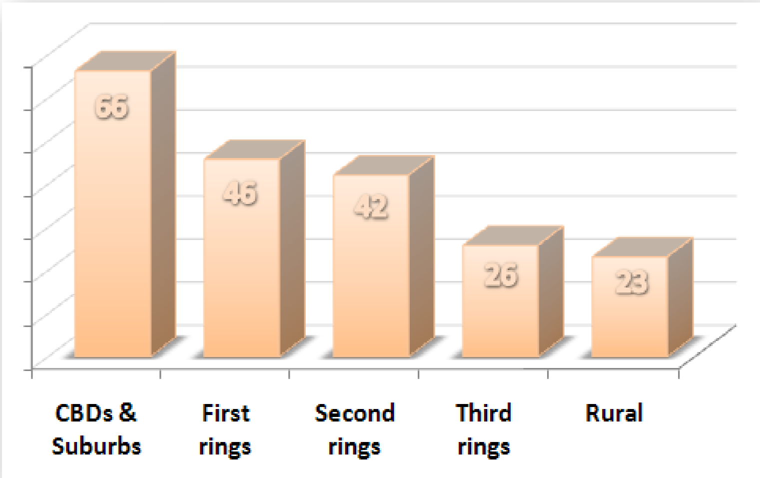
FIGURE 36: DISTRIBUTION OF HOUSING TENURE ACCORDING TO LOCATION WITHIN THE METROPOLITAN AREA



Source: Based on ANAH (2008), itself using FILOCOM 2005

77 The successive tax incentives have played a major role in the development of private rental supply far from the densest areas, stimulating extensive construction regardless of potential demand. This caused the misfortune of a lot of small investors, who were promised easy money and found themselves with an empty dwelling on their hands.

FIGURE 37: AVERAGE PRICE OF BUILDING LAND WITH RESPECT TO LOCATION *(€/M²)*

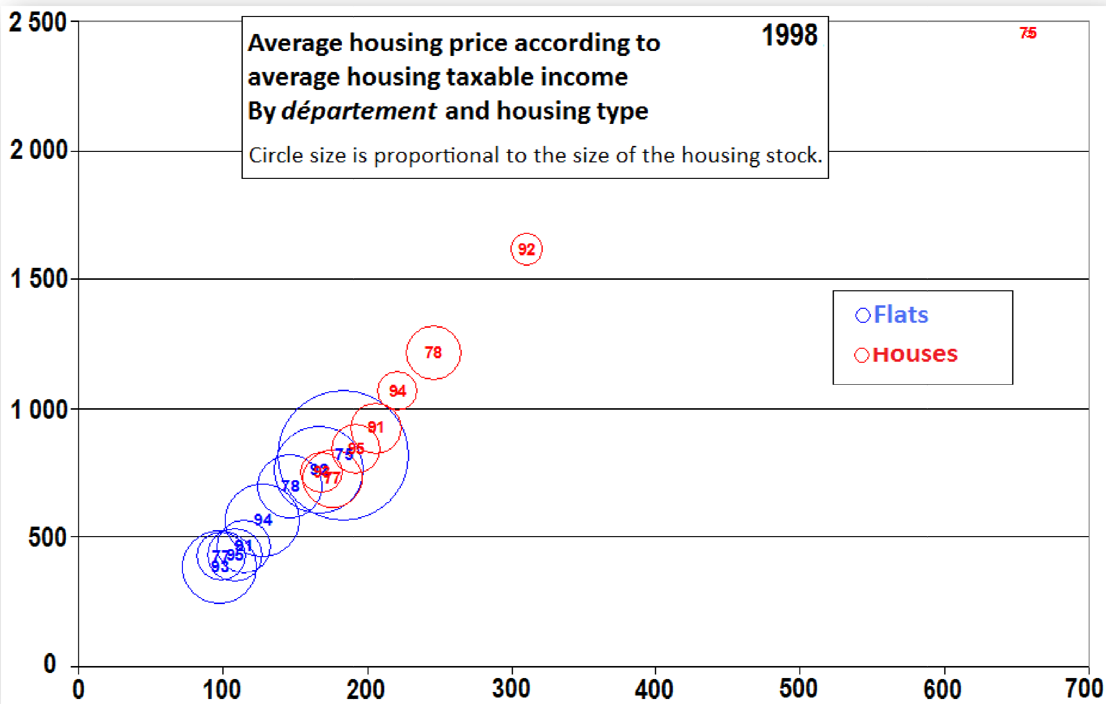


Source: Donzel et al. (2008)

b) Does scale really matter? Housing price and household income

Housing being the archetype of a "local market", one could wonder about the relevance of analyses at large scales (i.e. regional, national, etc.). Yet, some regularity does exist in the complex world of housing: for instance, from the regional down to the city scale**,** a **strong correlation links housing prices and average household income**, the regularity of which seemed worthy to be noted (*Figure* P). Even when accounting for housing type, this relationship remains (*Figure 38*), except for one singular point: houses in Paris (which are actually extremely rare).

FIGURE 38: THE LINK BETWEEN HOUSING PRICE AND INCOME



Source: Friggit (2001)

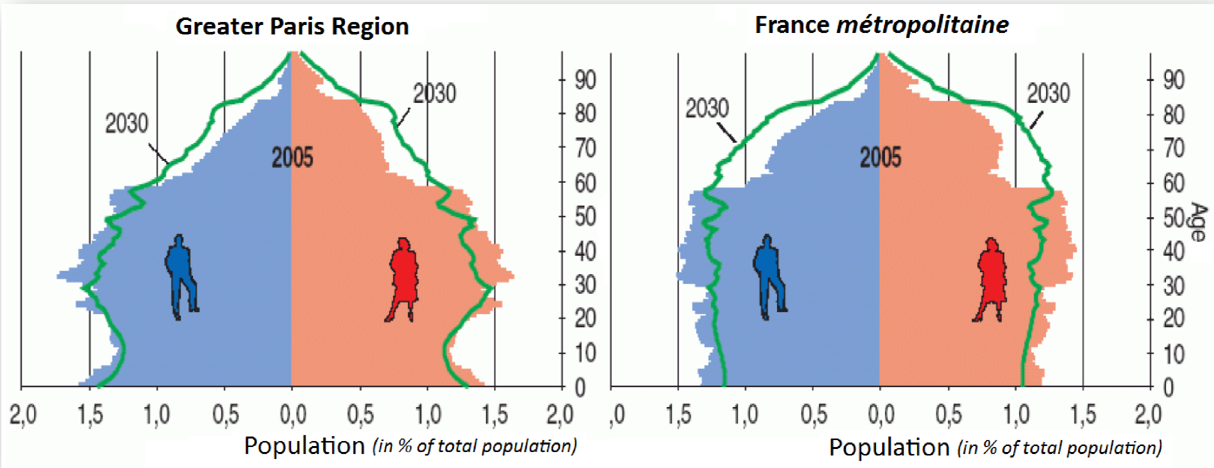
C-3. The Greater Paris Region: a structurally tight housing market

I shall now proceed to a more thorough characterization of the housing market of the Greater Paris Region. After an initial overview, I first establish that the housing market is indeed tight, and then provides some elements of diagnosis.

a) A balanced housing market tenure-wise, mainly composed of prime-aged workers

In 2005, the population of the Greater Paris Region (GPR) added up to 11.4 million people, accounting for 18% of the total French population. It is mainly composed of **prime-aged workers**, with relatively few old households and, to a lesser extent, children aged 8 to 18 as compared to the national average (*Figure 39*).[78]

FIGURE 39: POPULATION PYRAMIDS, GPR *VIS-À-VIS* FRANCE *MÉTROPOLITAINE*



Source: Collective (2008), based on Insee

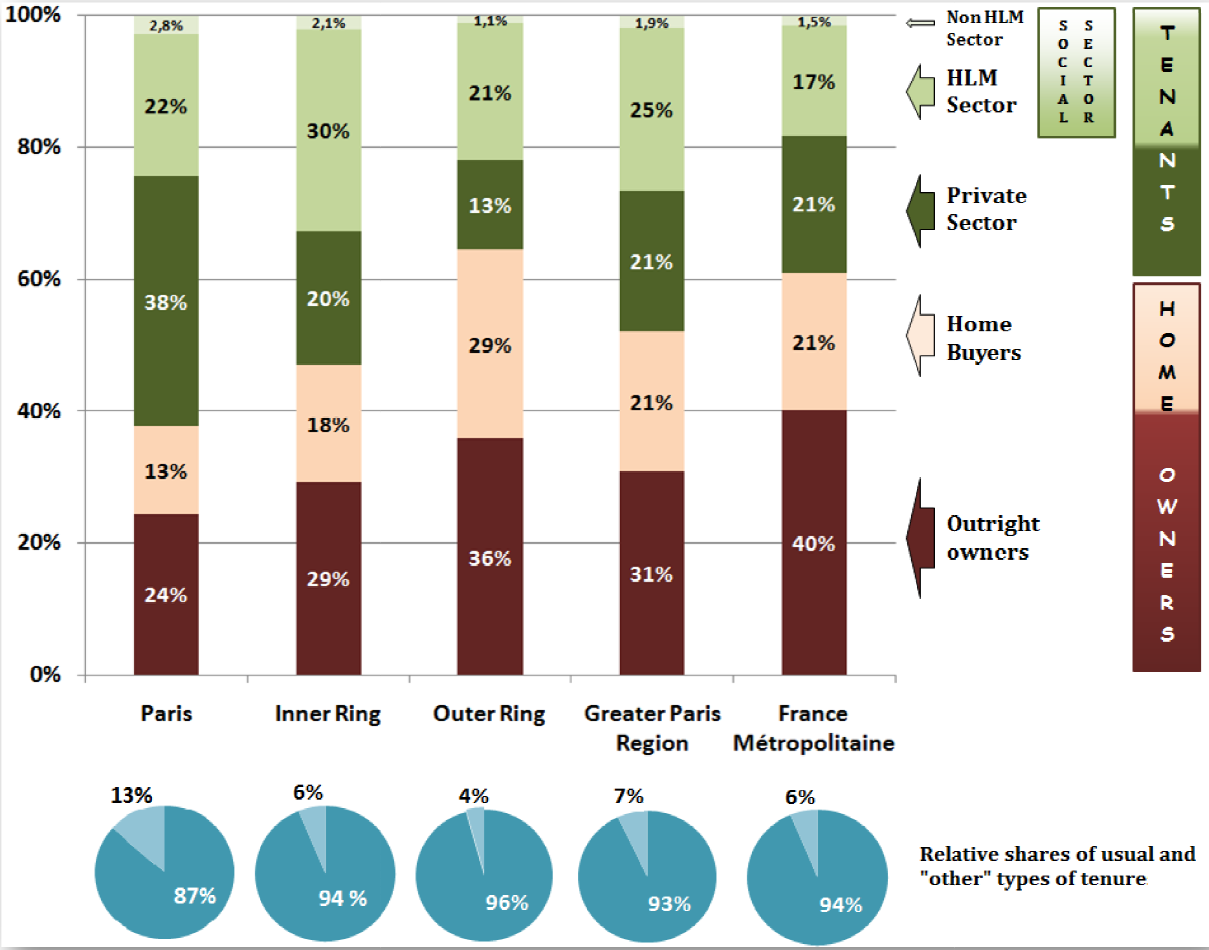
This population structure, while raising concerns about the consequential income leak for the region (Collective 2008),[79] also sheds light on the distribution of housing tenure in the GPR. As a matter of fact, putting aside the category "Other", the Greater Paris Region comprises fewer outright owners and more social tenants than the French average (*Figure 40*).

[78] There are three reasons to think that this under-representation of children and elderly people is partly related to the tightness of the housing market in the GPR, although not tested here:

- Households with attendant children might want to migrate out of the region in search of more affordable housing considering their increased need for surface area;
- The expensiveness of housing might reduce fecundity;
- Older households with modest retirement pensions might also leave the region due to the high housing prices and cost of living.

[79] Since retired households have both a basic income (that is, coming from outside the territory) and a high propensity to consume, they usually give a strong boost to the local economy (cf. Davezies 2001). Therefore, their migration outside the GPR constitutes a significant income loss for the GPR. Furthermore, real estate gains often flow out of Île-de-France, adding to this income leak.

FIGURE 40: TENURE STRUCTURE OF THE HOUSING STOCK OF THE GPR, 2002



"Other" types of tenure (→ *I - C-2*) are not considered in the above column. *Source: Housing Survey, 2002*

The low rate of home ownership may be related to the under-representation of older households in the Greater Paris Region, who typically belong to the "Outright Owners" category. The second point stems from pro-active policies in favor of social housing. These are a response to the relatively more uncomfortable situation of low-income households in the GPR as compared to the rest of France, which induces a strong need for affordable housing (Collective 2008).

All these elements result in a **well-balanced distribution of housing tenure**, each type representing one quarter or so of the "Usual Tenure" category (all types but the category "Other"). Moreover, the spatial distribution of tenure corroborates the fact that rental dwellings are localized in the densest parts of the metropolitan area.

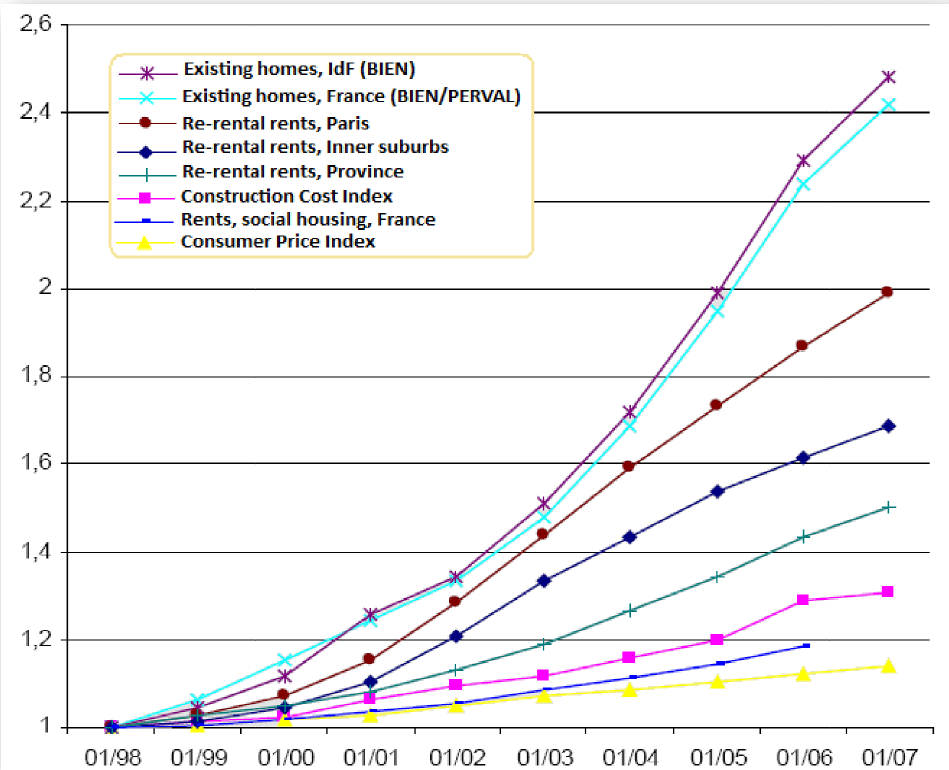
b) A tight housing market?

Housing prices: sizable differences in prices, with faster growth in rental

The fact that the housing market of the Greater Paris Region is a tight one was mentioned several times, but never clearly established. To confirm this point, let us start by examining housing prices. The analysis of regional rental prices (→ *Figure 32*) has provided us with a first piece of evidence. A complementary analysis of various housing price indexes proves conclusive in establishing this point (*Figure 41*). Between 1998 and 2007, re-rental prices have grown faster in the Greater Paris Region than in *Province*,[80] especially in Paris. In other words, the gap has widened over the last years, and no sign has yet indicated that this trend might change. In 2006, re-rental prices reached 17.7€/m² in Paris, 13€/m² in the inner suburbs, and only 7.9€/m² in *Province*.

Price variations in the second-hand housing market seem more homogeneous across France. In particular, the curves of the GPR and of France nearly coincide for the period 1998-2007. Still, a prior long-term analysis (→ *Figure 18*) has emphasized that the GPR, and especially Paris, are more volatile.[81] This greater sensitivity to market cycles tends to confirm a tighter situation in the GPR. Besides, the difference in housing prices remains large between the two areas. At the beginning of year 2008, the average price for an existing flat reached **4650 €/m² in the GPR** (and even as high as **6430 €/m² for inner Paris**), as compared to **2420 €/m² for the rest of France**. In other words, there is a factor 2 between *Province* and the GPR (3 with inner Paris).

FIGURE 41: TRENDS IN HOUSING PRICES AND REFERENCE INDEXES



BIEN / PERVAL: refer to description in section *III*. *Sources: INSEE, BIEN/PERVAL, EPLS*

[80] For reminder *Province* = France *métropolitaine* - Greater Paris Region.
[81] See Sauvant (2004b) for a discussion on this issue.

The case of housing burdens: mitigating circumstances?

Startlingly, **the gap is considerably reduced when comparing housing burdens**. In 2002, the share of net housing expenses within the income of tenants reached 17.9% in the case of the GPR and 16.7% for France. In the case of home buyers, the ratios were 29.1 and 27.8% in 2004, respectively. Two factors could explain this fact:

- An income effect: households would be richer in the GPR than in France.
- A dwelling size effect: households would opt for smaller dwellings in the GPR.

Despite this point, the share of private tenants who, albeit recipients of housing benefits, spend more than 40% of their income of housing, is remarkably higher in the Greater Paris Region, especially in Paris, than everywhere else in France (*Figure Q*).

Income and housing tenure both turn out to have a major influence on the housing burden (*Table 19*):

- The lower the income, the higher the burden.
- Tenants of the private sector pay relatively more than owners with a mortgage, and even more than tenants of the social sector.

This said, housing expense ratios have steadily increased in all areas and in all market segments in recent years.[82] Together with the fact that the housing price indexes for the private market (rental and ownership alike) have grown faster than the CPI for the last decade (*Figure 41*), it is clear that at the beginning of 2008, the housing market is still tight, at the national level and even more so in the Greater Paris Region.

TABLE 19: HOUSING EXPENSE RATIOS FOR THE GREATER PARIS REGION, 2002

	TENURE				
Income Level	Other	Private renters	Social renters	Recent owners	All
Very Low	10.3	32.6	14.6	25.2	20.7
Low	7.3	26.0	15.1	22.3	17.7
Average	6.0	21.0	12.9	20.4	15.1
High	3.7	16.7	12.8	15.1	12.1
All	6.8	24.1	13.9	20.7	16.4

Source: Collective (2008), based on Housing Survey, 2002

[82] Collective (2008), and DAEI/SES-P and DGUHC (2007).

Residential mobility: a tight market after all

Besides housing prices and housing burdens, two additional elements highlight the tightness of the housing market in the Greater Paris Region:

- The **vacancy rate**, which was 8.1% in 1999, reached a **6.3% low in 2004**. There were still no signs of improvement in 2006, unlike several other French areas (Robert and Plateau 2006).
- Residential mobility of private renters is relatively low compared to the French average (→ *Figure 33*).

When these two arguments might seem feeble separately, put together they provide a strong basis for the fact that current housing market conditions in the GPR do hamper the residential mobility of households.

c) Diagnosis

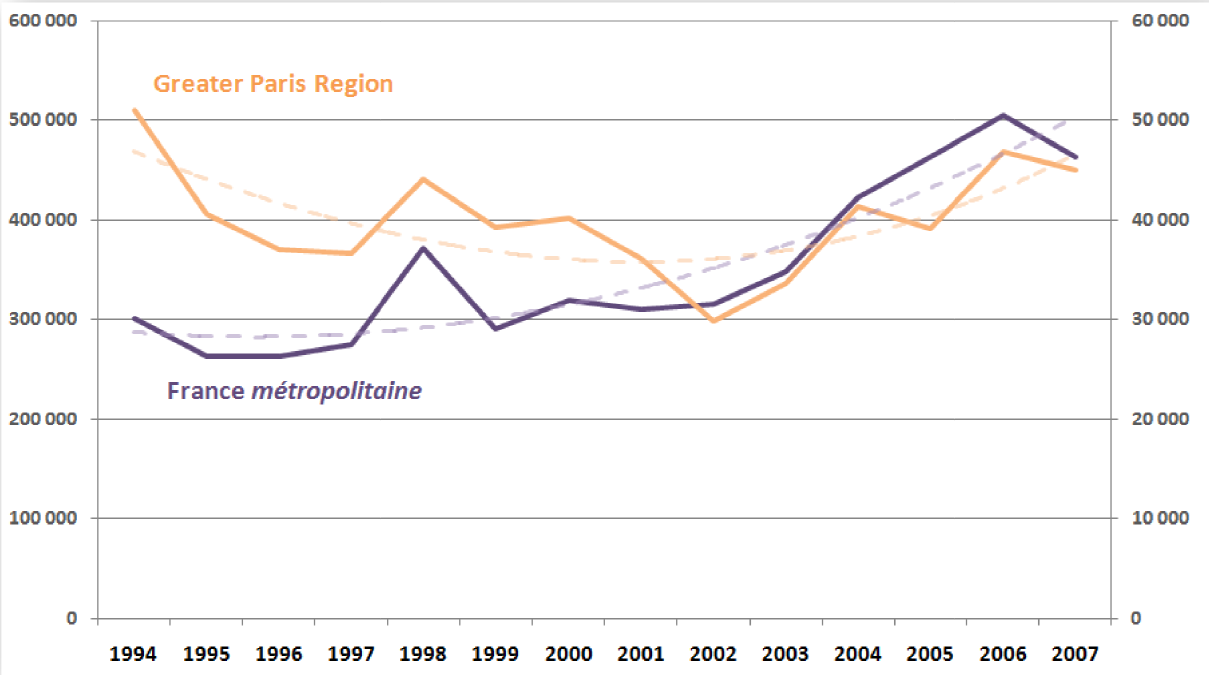
The strenuous situation of the Greater Paris Region results from **insufficient levels of housing construction in relation to demand, which remains strong in this region**. Malthusian local policies and high land prices both account for the low levels of new housing supply.

On the demand side, the high level of prices has barely relieved the housing market, demand remaining structurally high. And the regular decrease in household size has only added fuel to the fire. Between 1992 and 2001, the Greater Paris Region had gained 362,000 new households, one third of which resulting from the drop in household size. For the period 2005-2014, the IAU-IdF expects a growth of 39,000 households a year. [83] Considering the need for urban renewal and the replenishment of the stock of vacant units, housing needs would approximately add up to **60,000 new units a year** for the period 2005-2014 (Groupe Experts Logement du SDRIF 2006).

On the supply side, housing construction in the Greater Paris Region is quite irregular, though it hovers in the vicinity of **30,000-50,000 housing units a year**. First showing a marked downward trend for the period 1990-2002 (Collective 2008), it has picked up since then, recovering +50% between 2002 and 2007 (*Figure 42*). This contrasts with the national situation, which presents a more steady growth over the same period. In 2007, the level of home building in the GPR, with about 45,000 units, remained well below the stated objective of 60,000 units despite the recent upturn. Moreover, a drop in construction should be observed for at least the next two years due to the ongoing housing market crisis. In sum, actual construction is still far behind the objectives, and these will likely remain out of reach unless enforcing proactive policies.

[83] The IAU Île-de-France is a regional think-tank working on the issues of land-use and transportation planning.

FIGURE 42: COMPARISON OF RECENT TRENDS IN HOUSING CONSTRUCTION IN FRANCE AND IN THE GREATER PARIS REGION *(NUMBER OF AUTHORIZED DWELLINGS)*



Source: SITADEL

Considering the insufficient level of home building with respect to demand, vacancy has dropped and prices have skyrocketed, especially in Paris. Precisely accounting for the structurally low level of construction would require substantial analysis, but let us still mention two important factors:

- Several cities have carried on **Malthusian housing policies**, voluntarily not participating in the home building effort. As a result, in recent years construction has been constrained as well as more spatially concentrated.
- **Land is getting scarcer and scarcer** in the GPR, in particular readily building land, [84] and this in spite of very high land prices.[85] The combination of these two hindrances puts a great burden on housing construction.

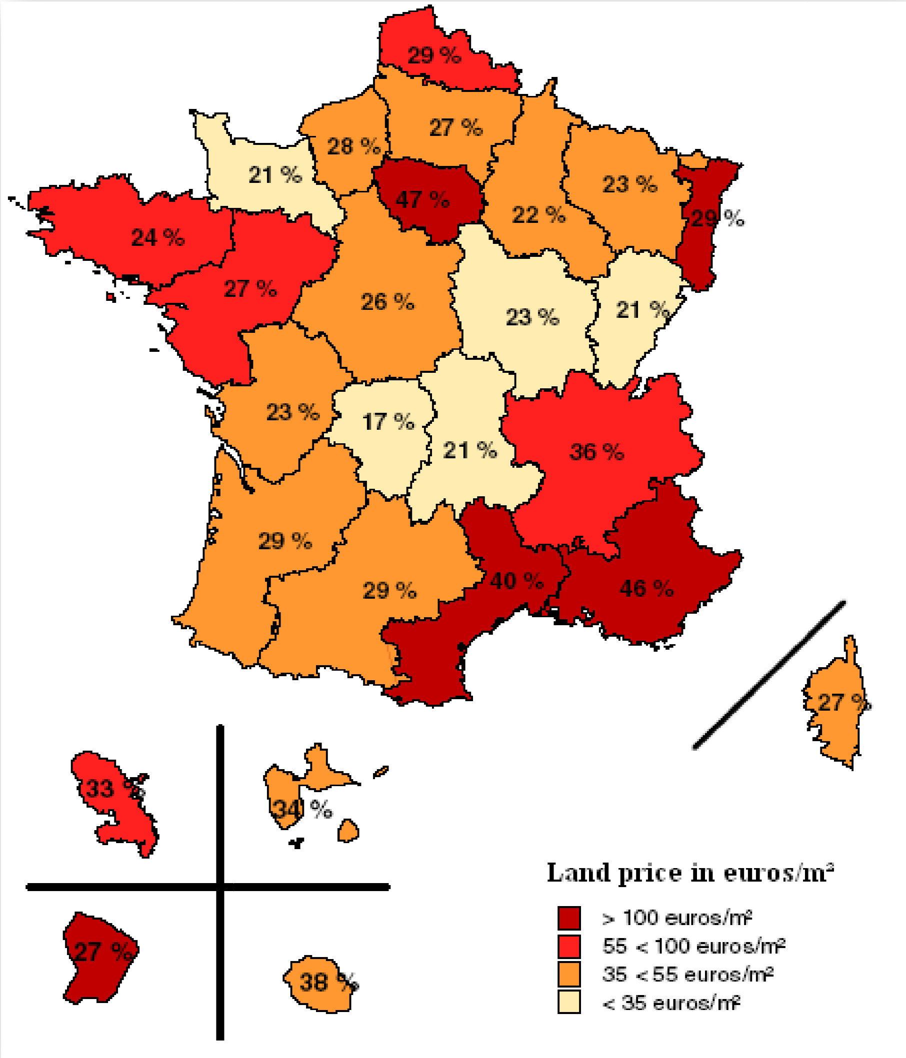
A short analysis of land prices and burdens in France strongly supports the second argument. It confirms the singular situation of the Greater Paris Region in regard to land prices, as it features (*Figure 43*):

- The highest land prices: 245 €/m^2 on average for 2006, as compared to only 127 €/m^2 for the PACA which once again ranks 2nd;
- And thus the highest land burdens, despite considerably smaller lots compared to other regions. In 2006, land represented on average 47% of the overall housing price.

[84] Groupe Experts Logement du SDRIF (2006), Collective (2008).

[85] One might have expected such high prices to entice mayors into allocating more land for urban use, but manifestly such is not the case.

FIGURE 43: LAND PRICES AND LAND BURDENS IN 2006, BY REGION



Percentages correspond to land burdens, i.e. the average shares of land prices within total housing prices.

Source: SES-P (2007)

To conclude, let us proceed to a brief recapitulation. This section has started by underlining the role of space and scale at a theoretical level, noting at the same time the importance of *Régions* in France with regard to housing market analysis. Then, it has provided key figures and elements of reference, allowing us to situate:

- France on the European scene as a typical dualist country, with relatively high housing prices (and burdens) as well as a moderate level of ownership (in comparison to dualist countries) though;
- The Greater Paris Region as a very specific regional housing market in France, as regards its importance as well as its currently especially tight situation.

The next section will conclude this introduction to the French housing market on a completely different topic: the observation system and the issue of databases.

III - SURVEY OF FRENCH HOUSING DATABASES

The choice of database is a key issue in empirical works. It determines which analyses may or may not be done, and conditions further methodological choices. As far as the housing market is concerned, databases on this topic are numerous in France, and often overlap. This is when a review proves useful, which is the object of the present section. As we will see, some cases of overlap do arise, but are less of an issue when the research topic is specified enough.[86] This is why I will essentially outline housing databases, lingering on fine details only when necessary. A more extensive description of all databases presented or mentioned in this survey may be found in *Supplement 1*, under the form of **fact sheets**.

The review of existing databases establishes the housing stock and its occupancy as the best covered subject. Conversely, urban renewal (or urban regeneration)[87] is the topic for which data is the scarcest. This last point, added to the simultaneous lack of data on home improvements, proves detrimental to the general knowledge of housing supply, which otherwise profits from detailed and reliable databases on construction. Residential mobility and housing expenses are properly addressed at the national and regional levels, less so at the local level. As regards housing prices, databases on this topic are not lacking in number, but most present more or less substantial shortcomings. At first glance, the topic of vacancy also seems to be correctly covered, but because it remains a collateral result of housing surveys, its measurement is still up to debate.

The present section carries out a survey of French housing databases structured around the five following topics: the housing stock and its occupancy (including the issue of vacancy), housing supply, housing prices, comprehensive surveys, and lastly miscellaneous surveys.[88] Though not purporting to exhaustiveness, the survey reviews **all major databases on housing** in France and/or the Greater Paris Region. It reports key topics covered by each database, as well as the main kinds of study they allow. Strong points and major drawbacks are emphasized. Cases of overlaps are also discussed. The section concludes with a **reminder chart** which encapsulates the contents of the surveyed databases, ensued by a discussion on the adequacy of the current French observation system as regards housing.

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[86] Carrying through a survey and managing a database are both costly. Surveys and databases are designed to address issues not covered by other data sources, or at least have specificities which differentiate them from the rest. Logically, the choice of a database should therefore be deterministic in most cases. Fortunately, this basic fact prevails for French housing surveys and databases, with few exceptions that are discussed further.

[87] The term “urban renewal” refers here to the transformation or demolition of housing units.

[88] This seemingly simple classification of housing surveys aims to rapidly delineate potential candidates given a study topic. Though somewhat coarse, it has been effective this far.

A THE HOUSING STOCK AND ITS OCCUPANCY

Census and FILOCOM are the two primary databases as far as the French housing stock and its occupancy are concerned.[89] Besides these, four other databases shed additional light, although on narrower topics. The pair EPLS/OPS focuses exclusively on social housing. Though not primarily designed for housing analysis, the Employment Survey has the edge of frequently reporting information on a dwelling panel. Lastly, the EDF database provides quarterly indicators on vacancy and residential mobility.

A-1. Census (*Recensement Général de la Population*)

Census is central to the analysis of the housing stock and its occupancy, even though its recent overhaul might have lessened its reliability, and thus usefulness. It used to provide at regular time intervals (every seven years or so) an exhaustive picture of the formal housing sector and of its occupiers. Since 2004, it is called *Recensement Rénové* (Renovated Census), a decision which betokens in-depth methodological changes as census is now **carried out yearly**. This allows more frequent releases of the main indicators (population, occupancy of the housing stock, etc.), but at the collateral cost of **forsaking the exhaustiveness** of the former version, even though it was generally considered its foremost quality. The sampling, similar to a cyclical one, is designed to enable the reconstruction of most of the housing stock (about 70% of it) by combining five successive surveys. Notwithstanding, two shortcomings seriously undermine this method: first of all, combining yearly cross-sections entails various pitfalls as changes occur over the years. Secondly, the sampling rate varies greatly according to city population, and merely reaches 40% for the largest ones. Since the change in data collection dates only from 2004, the extent of these issues is still unknown for now.

Dwelling characteristics reported in Census are profuse and cover housing type, dwelling size, date of construction, and some elements of housing quality. In the case of attached housing, additional variables provide a description of the building. Household- and individual-level characteristics are also rife, and encompass household structure, demographic variables (age, sex, nationality), and socioeconomic status (including economic activity). Besides ethnicity which remains a sensitive topic in France, a major lack lies in the **absence of income**. Otherwise, additional elements include the usual commuting mode, as well as the previous home five years before the day of the survey. This last item allows analyzing residential mobility up to a certain extent (variables relative to this topic remain limited).

Census is commonly used to estimate all **main aggregates** on the housing stock and its

[89] The Housing Survey also plays a great role in this matter. It is presented later among comprehensive surveys.

occupiers.[90] Because the survey covers all dwellings, it is a gilt-edge source to tackle the issues of vacancy and second homes. Another classic use of this source lies in the computation of **local indicators of neighborhood composition**. Lastly, Census is sometimes used to estimate discrete choice models of residential location.

Since 1968, the Insee has been regularly updating an **individual panel** by matching the successive Census files.[91] Named *Échantillon Démographique Permanent* (Permanent Demographic Sample), this panel follows about 4% of the French population. Abiding by the setting up of the Renovated Census, the EDP is undergoing changes to address the subsequent attrition problems that will affect the sample. It could receive some major improvements to boot: possible matches with fiscal and social databases are under consideration, which would remedy the absence of income variables in Census.

A-2. FILOCOM (*Fichier des Logements par Communes*)

The FILOCOM database is set up by the French tax collection agency (*Direction Générale des Finances Publiques*), which matches various tax files relative to income, property, and local taxes (*taxe d'habitation*). FILOCOM assists the French Department of Housing and Urban Development in the design, implementation, and assessment of housing policies. It is updated biennially, and draws an **exhaustive picture** of the housing stock, with two minor limitations: analysis is currently limited to France *métropolitaine*, and only dwellings subject to the *taxe d'habitation* are adequately covered.[92] The recent sampling of Census has undoubtedly **enhanced the value of FILOCOM**, being now the only database to cover the French housing stock exhaustively. Rules regarding confidentiality and the use of implemented geographic variables are less restrictive to boot, allowing **analyses at the local level**.

Overall, the spectrum of housing-related topics covered by FILOCOM is almost identical to Census. Dwelling and household characteristics are scarcer though, especially household ones. Yet, FILOCOM holds one crucial edge over Census: household **income measures**. To be thorough, additional pieces of information include owner characteristics, and the year of the last property transfer.

Unlike Census, observational units are dwellings, not households.[93] This enables

[90] The role of Census in this matter is anything but trifling: Census-based population estimates are used to assess financial endowments of French local authorities (municipalities, *départements*, and *régions*), and serve as a reference for numerous laws. The recent choice of practicing sampling is thus extremely controversial.
[91] See Couet (2006) and Lollivier (2009).
[92] See *Supplement 1* for more precision on these two points.
[93] By saying that I simply wish to emphasize that one can track a dwelling through sequent FILOCOM files, but not a household (yet). Were **household identifiers** to be introduced (which are easy to implement but raise confidentiality issues), FILOCOM would prove an incredibly **powerful database to study residential mobility**. In the case of Census, the distinction household/dwelling could seem irrelevant regarding the observational unit, as the absence of

longitudinal analyses at the dwelling level. On the other hand, the absence of household identifier results in a twofold limitation: it blurs the distinction between a residential move and a change in household structure, and prevents tracking the previous location of recent movers. The fact that FILOCOM is a **fiscal source** aggravates the former point, household identification being based on fiscal considerations, not on actual dwellers.

To conclude, let us recapitulate the main analyses that may be undertaken with FILOCOM, while taking this opportunity to carry out a brief comparative analysis:

- While Census and Housing Surveys are usually still preferred to FILOCOM to compute the main figures and characteristics of the housing stock and its occupancy (at least for the time being), [94] FILOCOM is better suited for **cyclical analysis**, especially of **vacancy,** given its exhaustive, frequent, and regular nature.
- **Local analysis of neighborhood composition** is a given considering the contents of the database, and profit from income measures otherwise absent in Census.[95]
- Unlike Census, analyses of residential mobility are fraught with difficulty, for the reasons mentioned above. As a result, turnover rates are not perfectly accurate, and discrete choice models cannot be estimated (yet).
- Lastly, one can study variations in characteristics of occupiers over time.

A-3. EPLS (*Enquête sur le Parc Locatif Social*) - OPS (*Enquête sur l'Occupation du Parc Social et son évolution*)

The EPLS is a yearly survey which devotes itself to the exhaustive description of the **social housing stock**. The observational unit is the "housing program", which is defined as a set of dwellings characterized by similar conditions in terms of construction and management. This includes the date of construction, the type of funding, the administrator, and the fact of being located within a same city. All these elements are reported in the database, which also details a few dwelling characteristics for each housing program: dwelling type, number of dwellings broken down by the number of rooms, total square footage of the housing program, and average rent per m^2. Lastly, the EPLS provides some elements on residential mobility and vacancy.

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identifier of any kind prevents *de facto* matches between successive surveys. Yet, because some questions are asked about the previous home location, a kind of household follow-up is possible.

[94] A systematic analysis of differences between FILOCOM and Census/Housing Surveys regarding the estimation of the main aggregates (population, housing stock by tenure, etc.) has yet to be undertaken to the best of my knowledge. A report from the ANAH (2008) indicates concurring results at the national scale, but few substantial discrepancies at the local scale. A technical report from the CETE Nord-Picardie (2001) carries through an informative comparative analysis of Census and FILOCOM, variable by variable, but unfortunately with no statistics of any kind to support it. Lastly, Friggit (2007) compared FILOCOM to mainly the Housing Survey, SITADEL, and BIEN/PERVAL, but restrained his scope to a limited number of aggregates. Overall, he finds concurring estimates, except for a slight over-representation of small houses in FILOCOM.

[95] See Filippi *et al.* (2007) for an illustration of the potentialities of FILOCOM for such purposes.

The OPS complements the EPLS and provides every three years a description of **households accommodated in social housing units**. This encompasses demographic characteristics (household structure, age), economic characteristics (activity, income), and housing benefit recipiency. A focus can be made on recent movers, and information on vacancy is also included. Unlike the EPLS, the OPS is not exhaustive on its scope, but its coverage rate (in number of dwellings surveyed) still neared 87% in 2006.

Both surveys offer fairly **aggregate data** and thus cannot be used for disaggregate analyses. Spatial resolution is at best the city level for the EPLS, and is even less precise in the case of the OPS. Moreover, one survey depicts the housing stock, the other one occupiers, but **none of them relates the two**, which is unfortunate.

Despite these drawbacks, these surveys may be used for the following purposes:

- separate descriptions of the housing stock or of its occupiers (EPLS/OPS);
- analysis of vacancy (EPLS & OPS);
- level of rents in the regulated sector (EPLS);
- estimation of residential mobility rates (EPLS).

In sum, the EPLS and the OPS are mainly descriptive surveys, hence of little help in understanding the mechanisms of the housing market. Their interest lies elsewhere: first, they are intended for social housing, unlike other surveys which may omit issues specific to this sector (e.g., the *conventionnement*). Consequently, they prove particularly relevant when describing the social housing stock or its occupancy. Secondly, because they are both exhaustive (or near-exhaustive) and reliable, they may be used as **alternate sources** to double-check results for the above items (rents, vacancy, etc.). [96]

A-4. Employment Survey (*Enquête Emploi*)

Although the employment survey primarily aims to deliver quarterly statistics on jobs and unemployment, it is also a useful source in regard to various housing topics. Each term, a **panel of around 38,000 dwellings** is surveyed, then one sixth of it exits the sample and is renewed (meaning that a dwelling stays in the panel for six consecutive terms). The scope comprehends all ordinary dwellings, excluding people living in communities (1 million people or so, → *I - C-1*).

Household and individual characteristics include the standard socio-demographic variables and extensive information regarding economic activity (employment situation, unemployment spells, job search, etc.). On the other hand, dwelling characteristics are scarce, especially since 2003: while dwelling type, tenure, and dwelling size all used to be available, tenure is now the only remaining variable in the currently released version.

[96] However, one should heed methodological differences between the various surveys when doing so.

By following a dwelling panel, the Enquête Emploi allows:

- characterizing the housing stock and its occupancy;
- analyzing residential mobility;
- longitudinal analyses of dwelling occupancy and of successive profiles of occupiers;
- roughly estimating dwelling transformations (demolitions, mergers, etc.).

Let us note that Census, FILOCOM, and the Housing Survey, are usually more reliable sources as far as the first three items are concerned, the Employment Survey featuring few dwelling characteristics and a small sample size. It proves useful for either the last point or to study short-term trends in the first three items, nonetheless.

A-5. The EDF Database

The EDF file owes its name to the eponymous company, which is the main provider of electricity in France. As a matter of consequence, the primary purpose of this database is not directly related to housing, which is why pieces of information on this topic are scant. However, because moving in or moving out usually involves the signature or the termination of an electricity contract, this source proves useful for the following intents:

- analysis of vacancy;
- estimation of residential turnover;
- rough estimation of new home supply.

Being quasi-exhaustive on the French housing stock, quarterly updated, and providing data at the city level, it is suited for **cyclical analysis**, especially of **vacancy**. [97] On the other hand, the few household characteristics limit the scope of potential studies.

B HOUSING SUPPLY

Information on housing supply is structured around two main topics:

- **New home construction**: SITADEL provides levels of housing construction, while the EPRLN monitors costs. Lastly, the quarterly survey on prospects for real estate development reports short term prospects for both of these elements.
- **Home improvements**: data regarding this issue are meager. As a point of fact, OPERA is to the best of my knowledge the only database dedicated to this topic. [98]

B-1. SITADEL (*Système d'Information et de Traitement Automatisé*

[97] For a good illustration of a cyclical analysis of vacancy based on the EDF database, see Robert and Plateau (2006). Analyses of residential mobility based on this database prove slightly less promising as one can only estimate turnover rates (and nothing about the reason behind mobility, destination, and so on).

[98] Few other databases besides OPERA provide some information on home improvements, such as the Housing Survey. They do not focus on housing supply though, and are presented later in the review.

des Données Elémentaires sur les Logements et les locaux)

The SITADEL statistical application was developed to monitor **trends in construction** of housing and business floorspace (for commercial, industrial, or administrative use). As far as housing is concerned, it provides quarterly time series with respect to authorizations to build and construction starts in France *métropolitaine*, measured in number of dwelling units as well as total residential floor space. It is **exhaustive** on the scope of new homes.

Data may be further disaggregated according to the following variables: location (down to the city level), dwelling type, number of rooms, type of financing, purpose (owner occupancy, rental sector, sale), and *maître d'ouvrage* (client).

SITADEL provides relatively **aggregate data**, and is mainly intended to release indicators of new home construction at the national or regional level. It could possibly be used at a finer scale to monitor local trends in housing supply.

B-2. EPRLN (*Enquête sur le Prix de Revient du Logement Neuf*)

The calculation of the Construction Cost Index (ICC) is based on the use of the EPRLN. This mandatory quarterly survey covers a small sample of new housing programs (around 320 programs randomly picked up among the SITADEL database), and collects information on the various cost items of a construction program, including the acquisition of land. This survey is for internal use only, hence not detailed here.

B-3. *Enquête trimestrielle de conjoncture dans la construction immobilière*

The *Enquête trimestrielle de conjoncture dans la construction immobilière* (Quarterly survey on prospects for real estate development) provides **short term prospects** with regard to real estate development in France *métropolitaine*. Each term, a quick survey is carried out among a thousand real estate developers, and gathers information on various issues: the demand for new homes broken down by purpose (owner-occupiers or rental sector), stocks of unsold dwellings, sales prices, land prices, and buyers' financial means. Because of the small sample size and of its limited contents, the survey essentially gives rough indicators of short-term trends in real estate development at the national level, and has no usefulness whatsoever for microeconomic analyses.

B-4. OPERA (*Outil de Pilotage et d'Échange du Réseau* ANAH)

OPERA is a statistical application used to prepare, manage, and monitor claims for the subsidies deliver by the National Agency for a Better Quality of Housing (*Agence*

Nationale pour l'Amélioration de l'Habitat, hence the acronym ANAH).[99] These subsidies are for the sole dwellings aged fifteen years or more and owned by private lessors (owner-occupiers and landlords alike). Furthermore, only works specifically aiming to **improve the quality of the dwelling** are eligible for subsidies, excluding maintenance and home extensions. Within this scope, OPERA lists all claims exhaustively.

The following information may be found in OPERA, available by file:[100] number and average size of subsidized dwellings, total amount of subsidies, overall cost of home improvements, and number of dwellings agreeing to be subject to regulated rents (*loyer conventionné* or *intermédiaire*) after completion of home improvements.

The scope and contents of OPERA allow one to compute several aggregates, from the national down to the city level, on works undertaken to improve dwelling quality in the private sector. Though an interesting source in this regard, **it largely fails at providing an exhaustive picture of home improvements** given its restrictive scope.

C HOUSING PRICES

At first glance, France has a good number of surveys and databases on housing prices,[101] at the risk of redundancy. Yet, the **quality and availability of information is far from being beyond reproach** (Sénat 2007). This is especially true regarding new homes: current databases do provide average price levels for this category, which allows comparisons with existing housing units to a certain extent, but they prove unfit for microeconomic analyses. Likewise, most databases on existing homes are managed by private sources, are not exhaustive, and present various shortcomings, whereas **public sources**, which could remedy most of these issues, are **currently underused**. In sum, saying that there is room for improvement is merely an understatement.

BIEN and PERVAL are the two main databases when willing to undertake an economic analysis of housing prices in France, but they only cover property transfers. On the exact same scope and using related information channels, one can also mention the defunct EXISTAN, and the fiscal databases FIDJI and OEIL. Then, the FNAIM and CLAMEUR files are both professional databases managed by real estate agencies. CLAMEUR focuses on the private rental market. The FNAIM has a wider purview,

[99] ANAH subsidies have completely replaced the *Prime d'Amélioration à l'Habitat* (PAH) since 2002. A database exists for this former subsidy, and is presented in *Supplement 1*.

[100] Because claims may be grouped together when occurring within a single building, the observational unit is the file, and unfortunately not the dwelling unit.

[101] The notion of price is ambiguous in the field of housing: it might either refer to the sale price of the durable good, or to the rent, which measures the price of housing services. The term "housing prices" is used here in its broad acceptance and embraces both notions unless the context indicates otherwise: e.g., the BIEN database focusing on property transfers, the housing price should be understood as the sale price.

comprehending property transfers in addition to rentals. The national survey on rents and service charges monitors trends in these two items for both the free and regulated sector. The OLAP does the same, but only for the private sector of the Paris metropolitan area. Lastly, the ECLN provides some key aggregates regarding the commercialization of new homes.

C-1. BIEN – PERVAL

BIEN (*Base d'Informations Économiques Notariales*) and PERVAL are twin databases: almost identical in nature, the former covers the Greater Paris Region, the latter the remainder of France. Both register **real estate transactions** giving birth to a notarial deed, hence a restriction in their scope to **existing homes**,[102] plus part of new homes.[103] Not exhaustive, notaries being free to contribute or not in feeding them with recent deeds, they rely on the well-understood interest of their members (the more complete the base, the more useful it is to them), or simply good will. Overall, the **coverage rate is beyond satisfactory**, especially in the GPR, although it may drop below 40% in some specific areas. In June 2006, the following estimates were given for the coverage rate over the last twelve-month period: 63% for the whole of France, 80% for the Greater Paris Region, 56% for Province, and only 19% for DOM-TOM and 36% for Corsica (Sénat 2007). The fact that the *de facto* sampling seems to be exempt from any systematical bias adds to the quality and usefulness of those databases (David et *al.* 2002).

Both files teem with housing characteristics, starting with the price and date of the transaction. The geographic coordinates of the dwelling, its size (square footage, number of rooms), date of construction, and a few elements on housing quality (bathrooms, elevator, standing, etc.), are also reported. Unlike Census, "annexes" in a comprehensive sense (parking lot, garden, balconies, and indeed annexes) are taken into account up to a certain extent, giving an edge for the analysis of detached units. Nevertheless, several variables have substantial non-response rates, inducing various rectification works from the Insee to fill those blanks whenever possible.

On the other hand, characteristics of sellers and buyers are few, and suffer from heavy non-response rates. This dispels any possibility of analysis at the household level (such as analyses of residential choice), and dampens the quality of hedonic analyses based on these variables. Bid-rent analysis would also prove difficult.

Considering their design, BIEN and PERVAL perfectly fit the data requirements of

[102] The term "existing home" is used here in its the fiscal acceptance, which comprehends dwellings undergoing their second property transfer, as well as dwellings sold for the first time but aged five years or older.

[103] Homes built by individuals on their own land (with or without the assistance of building professionals) do not give birth to a notarial deed, hence escaping the scope of these databases. Contrarily, homes built by real estate developers and sold to individuals are included in the database as they involve a notarial deed.

hedonic analyses (they actually represent the mainstream data sources in this regard, that is, within their scope). As a result, one can compute **housing price indexes**, be it at the national level or at the local level to measure the affordability of a neighborhood.[104]

C-2. EXISTAN (*EXploitation de l'Information Statistique sur les Transactions dans l'Ancien et le Neuf*)

EXISTAN was an unfruitful attempt to develop a permanent and reliable system to monitor housing prices. It merely lasted from 1993 to 2000, later to be replaced by BIEN and PERVAL which ultimately came to prevail as the primary databases on housing prices. Although its contents were very close to BIEN and PERVAL, EXISTAN differed from them in two aspects:

- It was based on fiscal files, therefore drawing its sample from an exhaustive source;
- but it had a substantially lower sampling rate.

In sum, EXISTAN basically allows the same analyses as BIEN/PERVAL, but with old data and fewer transactions (implying less precision and a lower spatial resolution).

C-3. FIDJI (*Fichier Informatisé de la Documentation Juridique sur les Immeubles*)

The FIDJI database is managed by fiscal services (the *Conservations des hypothèques* to be specific), which enter all notarial deeds transmitted to them. Similar to BIEN and PERVAL for all practical purposes, it is **exhaustive** to boot as all property transfers must be reported to fiscal services for taxation purposes. This exhaustiveness could turn FIDJI into a reference public database on housing prices. However, because it is currently designed for administrative use only, and thus omits several key variables including dwelling characteristics, it is currently far from being usable for research purposes.

C-4. OEIL (*Observatoire des Evaluations Immobilières Locales*)

OEIL is also a fiscal database dedicated to the needs of the *service des Domaines*. Created in 1993, its primary purpose is to provide them with a benchmark of housing prices and to assist them in the **appraisal of housing properties**. It combines a database, which is once again based on extracts from notarial deeds (relative to property transfers), to an efficient search engine. Because it is even more designed for fiscal purposes than FIDJI, and uses specific notions, OEIL does not appear as a propitious tool for research, at least under its current form. Besides, unlike FIDJI, the database is filled neither regularly nor exhaustively, depending on the interests and motivation of local fiscal services.

[104] Indexes of housing prices are estimated by the INSEE and may be found on www.insee.fr.

C-5. The FNAIM database

The *Fédération Nationale de l'Immobilier* (FNAIM, translating as Real Estate National Federation) keeps a substantial database on housing prices to date. This database has been recording housing sales since 1995 and rental acts in the free sector since 1990, and covers the whole of France. Regarding home sales, existing homes are once more the largest part of the database. At the beginning of 2009, the FNAIM database comprised around 800,000 sales and 700,000 rental acts. Internal analyses of this database are published on a monthly basis, and feature **sale and rental price indexes**.[105]

The contents of the file are fairly similar to BIEN and PERVAL, especially as regards housing characteristics, with maybe two extra features:[106] the financial situation of the buyer/tenant, and the number of applications received by the FNAIM for the dwelling.

The FNAIM database has both pros and cons in comparison to other sources, in particular BIEN/PERVAL. Starting with the cons, the data collection method entails **two potential biases**: one, the scope is restricted to transactions and rentals involving the intermediation of a real estate agent, two, the real estate agent necessarily belongs to the FNAIM network, the representativeness of which among the body of real estate agents is unsettled.[107] Furthermore, the FNAIM file has **less observations than the pair BIEN/PERVAL** regarding sales of existing homes, contrary to the hoodwinking claims of the FNAIM.[108] On the other hand, the FNAIM source has one sure advantage, and another one which has yet to be ascertained. The sure one rests on the size and quality of its rental database, only matched by CLAMEUR to the best of my knowledge. The other one is the probably greater quality of data in general (as realtors should have all the necessary information at their disposal), and in the extra variables (if actually present).

In brief, the FNAIM database could allow the same analyses as BIEN and PERVAL, and maybe even a little more thanks to the extra variables, but it is unfortunately unavailable to non-members (*a priori*).

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105 Indexes are computed for houses, apartments, and both together. The FNAIM indexes clearly represent an alternative to the ones released by the INSEE or CLAMEUR. See French Senate (2007) for a first endeavor of a comparative analysis, focusing on the case of price indexes for existing homes.

106 Elements present in FNAIM (2009) lead me to think that such variables are available. Unfortunately, I could not get a confirmation from the FNAIM on this point.

107 The extent of these two potential biases is currently unclear, mainly because the FNAIM is a private party, and has no incentive whatsoever to claim the limitations of its database or of its network. A first comparison attempted by Friggit (2008b) brings to light discrepancies with other sources, which tends to imply that the FNAIM sampling is indeed biased.

108 The FNAIM claims that its database covers around one third of real estate transactions (FNAIM 2009). According to estimates provided by Jacques Friggit in the French Housing Accounts of 2005, the actual coverage rate would rather be between 15 and 20%. In addition, for the current decade, a simple comparison of yearly figures of new entries shows that BIEN and PERVAL have on average registered each year three to four times the number of transactions registered by the FNAIM database.

C-6. CLAMEUR (*Connaître les Loyers et Analyser les Marchés sur les Espaces Urbains et Ruraux*)

CLAMEUR (which literally translates as "Knowing Rents and Analyzing Markets on Urban and Rural Areas") results from the merger of the various observatories of all its members, which include both private and public parties: Anah, Bouygues Immobilier, DHUP, SeLoger.com, etc. This "meta-observatory" allows the precise measurement of market rents in all France *métropolitaine* but Corsica. The gathered information also enables one to tackle additional topics such as residential mobility, vacancy, the quality of dwellings put on the market, and home improvements, providing a **fine overview of the private rental sector**. Started in 1999, CLAMEUR contained 900,000 references at the beginning of 2009, with a current inflow of 140,000 new entries a year.

As to be expected for this kind of database, dwelling characteristics are bountiful and similar in nature to those available in BIEN or PERVAL. No household characteristics are available to the best of my knowledge. On the other hand, it includes some unusual variables such as the rent and length of tenure of the former tenant, and a few elements on vacancy, residential mobility, and home improvements made during a vacancy spell.

Based on its contents, CLAMEUR allows the following elements:

- Indexes of market rents (including re-rental prices), residential mobility, home maintenance and improvements, and of the comfort and quality of the private rental supply and stock, are released yearly by CLAMEUR.
- hedonic analysis;
- analysis of the setting of "re-rental rents";[109]
- analysis of vacancy, subject to the extent and quality of data regarding this matter.

Regarding residential mobility, CLAMEUR seems propitious to provide frequent updates on trends in the private rental sector, but unfit for microeconomic analysis. Similarly, the usefulness of home improvement variables remains dubious, or limited at the best.

C-7. *Enquête nationale sur les loyers et charges*

The national survey on rents and service charges monitors the trends in these two items. Its scope is thus obviously restricted to the rental sector. The survey is carried out quarterly among a **panel of around 5,000 dwellings** located in France *métropolitaine*, one fifth of the sample being replaced each term. It is primarily intended for the computation of a national index of housing rents, which is later integrated in the Consumer Price Index established by the Insee. The small sample size implies that the survey is best used at the national scale.

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[109] I.e. the rent for homes having recently undergone a lease termination, followed by a new lease signature.

Detailed information on rents and service charges are included indeed, as well as household characteristics (including income and demo-socio-economic variables), lease conditions, housing benefits, and dwelling characteristics.

Based on the above elements, the survey may be used for the following purposes:

- computing the index of rents and service charges;
- analysis of housing expenditure and expense ratio;
- Hedonic analysis might yield interesting results given the frequent updating of the database. In particular, one could **test the stability of implicit prices**. Availability of dwelling and neighborhood characteristics should be carefully examined though to assess beforehand the relevance of such a study.

C-8. *Enquête Loyers de l'OLAP* (*Observatoire des Loyers de l'Agglomération Parisienne*)

The OLAP also runs a survey which monitors trends in rental prices, but only for Paris and its suburbs, plus eleven cities in *Province*. It is fairly similar in content and design to the national survey on rents and service charges, at the risk of redundancy. Consequently, one could use the database to undertake the same analyses as mentioned above for the agglomeration of Paris. Unfortunately, this database is seldom disclosed to other researchers.

C-9. ECLN (*Enquête sur la Commercialisation des Logements Neufs*)

The ECLN is a spin-off of SITADEL that follows the **commercialization of new homes** in the market for individuals. Based on a quarterly survey carried out among property developers, it is exhaustive on its scope, which comprehends all housing programs of more than five dwelling units that are to be sold to individuals. Like SITADEL, the ECLN provides relatively **aggregate data**, and is thus ill-adapted to local or disaggregate analyses. On the other hand, it is perfectly suited for studies at the national, regional, or city level.

Available items include flows (number of dwellings put up for sale, number of reservations), stocks (total number of dwellings available for sale), and sales prices, which may all be broken down according to the control variables present in SITADEL.

The ECLN allows three main kinds of studies:

- Analysis of new home prices on either a unit or per m^2 basis. Once more, the aggregate nature of the ECLN precludes any kind of microanalysis (including hedonic ones).
- tracking stocks and flows of new home supply;
- monitoring the economic sector of home building.

D COMPREHENSIVE SURVEYS

This subsection covers five general-purpose surveys which may be used for a wide range of purposes, hence their name. The first and foremost one is the Housing Survey, which provides extensive information on housing conditions and residential mobility at the national and regional levels. Then comes the pair comprising the ECHP and the EU-SILC, which are actually the only genuine household panels dealing with housing in France. Lastly, the EGT and ENT are two interesting sources for integrated land use – transport analyses in the Greater Paris Region and in France *métropolitaine*, respectively.

D-1. Housing Survey (*Enquête Logement*)

The Housing Survey is undoubtedly the **foremost French survey on housing**. Carried out by the Insee every four or six years, it covers an especially broad panel of topics. Formerly restricted to France *métropolitaine*, it has now been extended to French overseas territories. In 2006, five regional extensions (including the Greater Paris Region) and several local ones completed the national sample, for a grand total of 42,701 dwellings for 42,963 households.[110] Unfortunately, **detailed location variables are removed** to protect confidentiality, leaving only rough indicators of location (the *tranches d'unité urbaine*), and precluding any kind of local analysis.

The database comprehends most variables present in Census, plus multitudinous pieces of information specific to housing. Dwelling characteristics are the object of special care, with various elements relative to quality (objective and subjective), and in the case of houses a description of the lot and improvements. The household financial situation is also reported in great detail: available variables encompass household income, housing expenses (rents, monthly loan payments, service charges, utilities, home improvements, taxes, etc.), a precise description of home loans (in the case of home buyers), and solvency. On a minor note, the household real estate patrimony is listed (if applicable, the reason for a vacant dwelling is included), but no other elements on household wealth are included. To top it all, residential mobility is described at great length, and various issues are tackled: number of moves, reasons for moving, characteristics of the previous dwelling, and prospects on future residential mobility. Lastly, three additional elements may be found in the Housing Survey: neighborhood quality, the enumeration and description of recent home improvements, and the situation of children living outside the family home.

[110] Starting from the 2006 edition of the Housing Survey, one dwelling may now accommodate several *unités de vie* (living units). The definition of a "living unit" is based on the notion of separate budgets, → *I - C-1*.

The profusion of information available in the Housing Survey enables at least the following kinds of study:

- extensive description of the housing stock and of its occupancy;
- analysis of housing expenses, including the computation of expense ratios;
- financial snapshots and acquisition behavior of owner-occupiers;
- analysis of residential mobility rates for the various market segments;
- estimation of discrete choice models of residential location;
- hedonic or bid-rent analysis of the rental and property markets.

D-2. The ECHP (European Community Household Panel) and the EU-SILC (European Union - Statistics on Income and Living Conditions)

The ECHP and its successor, the EU-SILC, are both panels developed on the initiative of the European Union to cover a wide range of social and economic issues. Though data collection is carried out at the national level, a single and specific methodology was designed to ensure **data comparability** between participating countries. The sample is generally medium-sized, and essentially allows for analyses at the **national scale**. In France, the ECHP rounded up around 7,000 households, while the EU-SILC analyzes a slightly larger sample of approximately 10,000 households.

These panels are primarily intended to analyze income and living conditions (as indicated by the SILC acronym), but the broad compass of available information makes them an equally interesting source for housing in general. Besides standard socio-, demo-, and economic characteristics of the households and of their members, the ECHP and the EU-SILC include information about housing conditions, residential mobility, rents, and income (including housing benefits).

The main advantage of the ECHP/EU-SILC over any other French database lies in them being **household panels**. This allows one to develop unique longitudinal analyses, which are especially potent when dealing with residential mobility. In fact, the ECHP and the EU-SILC are currently the only sources enabling to finely track living and financial conditions before and after a residential move. As a result, one can scrutinize underlying reasons behind a move, reasons which are in some of the editions even directly stated thanks to dedicated questions.[111] On the other hand, the **modest sample size** turns out to be a limitation for otherwise promising analyses of residential mobility, as it prevents focusing on a given metropolitan area.

[111] The Housing Survey nearly achieves such a feat, but only regarding living conditions: it does not report the former financial situation before the residential move. Besides, it is not a panel, and former living conditions are based on households' statements regarding their residential history. Similarly, an individual-based panel does exist for Census, but it is not a genuine panel in its design and operation (it is reconstructed thanks to the Census files), and it does not cover the household financial situation yet.

A short list of potential works based on these panels includes:

- studying residential mobility at the micro-level. Estimation of discrete choice models of tenure choice, housing type, or else, are a given.
- analysis of housing expenditure and of housing expense ratios.

D-3. EGT (*Enquête Globale de Transport*)

The *Enquête Globale de Transport* (literally Comprehensive Survey on Transportation) is a travel survey dedicated to the Greater Paris Region (GPR), [112] which was put into place to help remedy the substantial transportation issues specific to this area. Its primary purpose is the description of daily travel behaviors of households living in the GPR. Additional questions are asked to a subsample of households in order to cover week-end mobility. Because it includes various housing characteristics, the EGT allows for an **integrated analysis of land use and transportation** in the Greater Paris Region. In addition, new questions were recently introduced with respect to housing expenses, giving another edge to this survey. For the 2001-2002 edition (being the latest one), the sample comprises around 10,500 households, which represents approximately 23,000 individuals. The sample size allows the use of a relatively fine spatial resolution for most analyses, but proves too scant to work at a local scale.

Four tiers of variables comprise the EGT:

- Household characteristics: size, structure, income, dwelling characteristics (square footage bracket, type, tenure), housing expenses (rent or mortgage payments only), previous location, and motorization plus description of owned vehicles.
- Individual characteristics: demographic (age, sex) and socioeconomic.
- Trip characteristics: origin, destination, time of departure and of arrival, number of “legs”,[113] primary transport mode, etc.
- Leg characteristics: each elementary link is featured by elements similar to those used for trips.

The combination of these variables enables the following analyses:

- description of the housing stock of the GPR and of its occupancy;
- analysis of residential mobility, including estimation of discrete choice models;
- integrated analysis of housing and transportation budgets, which may also include non-monetary transport-related components such as travel-times (→ *Chapter 2*).

The EGT should be regarded as an alternative source to Census or the regional extension of the Housing Survey regarding the first two items, as well as for the analysis of housing

[112] Other transport-oriented household surveys are carried out in *Province*, and may be of interest for reasons similar to those exposed here. They are not presented here considering our scope, but are reported in *Supplement 1*. Besides, they do not represent a regular source of information, and are usually one-shot instances.
[113] A trip is composed by a succession of “legs”, each leg corresponding to a single transportation mode.

expense ratios. Housing and residential mobility are not thoroughly recorded in the EGT, and the reliability of various variables, firstly income and housing expenses, is questionable. On the other hand the EGT has the advantage of including transport variables.

D-4. ENT (*Enquête Nationale de Transport*)

To put it simply, the *Enquête Nationale de Transport* (National Survey on Transportation) is the **national counterpart of the EGT**, and is for all practical purposes similar in content. However, it covers daily and vacation travel, and is actually the only survey to report household travel behaviors to such an extent, at a national scale to boot. Carried out irregularly (around every ten years), its latest edition dates from 2007-2008. The scope is restricted to France *métropolitaine*, with several regional extensions for the latest edition, including once again the Greater Paris Region. The 2007-2008 sample amounts to 20,220 households, one half of them corresponding to regional extensions.

Because it is so close in content to the EGT, all above remarks hold, in particular regarding possible uses of the ENT. Regional analyses are subject to the existence of a regional extension, otherwise analyses should be carried out at the national scale.

E MISCELLANEOUS

This subsection presents miscellaneous surveys, databases, and sources of information. Among them, the French Housing Accounts provide an excellent overview of the French housing market, and include all key aggregates. The Family Budget Survey and Epicaf allow disaggregate analyses of household housing expenses and burdens. Lastly, the *Observatoire Crédit Logement / CSA* provides an excellent overview of the credit market and of home buyers' financing conditions.

E-1. Key aggregates: French Housing Accounts (*Compte du Logement*)

Not a database *per se*, the French Housing Accounts are yearly reports on the economic environment as regards housing, which aim to provide more extensive information than the rough outline given by national accounts. To do so, they recollect all the main **macroeconomic data relative to the housing market**, covering the whole of France, and constitute a **first-rate source** in this regard. The following themes are meticulously treated in the reports:

- the housing stock and its occupancy;
- the place of housing within the French Economy;
- current expenses, investment, and real estate activity;

- profitability of the supply of housing services;
- public intervention in the housing market.

To top it all, several time series are available in the appendix, including among other things the main aggregates of the housing stock or the national housing expenditure. On the other hand, disaggregate studies are *de facto* excluded.

E-2. Home loans: *Observatoire* Crédit Logement / CSA

The *Observatoire* Crédit Logement / CSA is dedicated to the **observation of financing conditions for home buyers** in France. Every month, Crédit Logement reviews more than 25,000 operations, and discards non-classic types of loans (revolving loans, mixed loans, etc.) for a final sample of about 16,000 operations a month. For each transaction, several variables are recorded, including household characteristics (income, age and economic activity of the head of the household), characteristics of the loan (size, nominal interest rate, length), and the price of the real estate transaction. All data are available at the regional level.

The database chiefly allows for the following kind of studies:

- analysis of the credit market and of financing conditions for households;
- computation of housing expenses and burdens for recent home buyers.

A suitable tool for aggregate analyses of the credit market, the absence of detailed household and dwelling characteristics, including location, make the *Observatoire Crédit Logement / CSA* unfit for micro-economic studies.

E-3. Housing expenses: Family Budget Survey (*Enquête Budget de Famille*)

Carried out every five years or so by the Insee, the Family Budget Survey is primarily intended to scrutinize **household expenses** so as to be able to reconstruct their entire accountancy. For these ends, the survey provides a thorough reporting of all expenditures, monetary resources (wages, benefits, etc.), and costless consumptions.[114] By doing so, it turns out to be a powerful database to track, decompose, and analyze housing expenses. Indeed, one can carry out a comprehensive analysis of housing expenses, by choosing to include or not service charges, housing benefits, and so on. Gross and net housing expense ratios may also be computed. However, due to a **limited sampling ratio**, figures are only representative at a scale close to the regional one.

E-4. Housing expenses: Epicaf

Created in 1995, Epicaf is the name of the database managed by the *Caisses d'Allocations*

[114] This includes the consumption of housing services by owner-occupiers, allowing the estimation of imputed rents.

Familiales (CAF), which are the agencies in charge of providing various public benefits, including housing benefits. It provides an exhaustive record of CAF subsidy recipients. Updated every year, it contains numerous household and dwelling characteristics, in particular those relative to income, benefits indeed, and housing expenses. Because the household address is known, **local analysis** of living conditions of recipients is possible after data anonymization. On the other hand, the database must be handled with care considering quality issues for some of the variables, and **methodological pitfalls** inherent to the scope definition, which fluctuates in accordance with regulation.

All things considered, Epicaf turns out to be a rich source of micro-data to analyze **housing conditions of low-income households**, including their gross and net housing expenses ratios, as long as one keeps in mind its specific scope and the above caveats.

F RECAPITULATING THE MAIN FINDINGS

First of all, this overview of French housing databases has highlighted that data sources are numerous and cover a wide panel of topics. Moreover, this review not purporting to be exhaustive, one may come upon additional surveys or databases.[115]

Among all key topics, the **housing stock and its occupancy** was shown to be the **best covered** one, mainly thanks to the triptych Census, FILOCOM, and Housing Surveys. FILOCOM ensures a frequent follow-up, regularly completed by the more extensive descriptions provided by Census and Housing Surveys. The recent overhaul of Census is thus uncalled for, at least in regard to housing: it creates a doublet and relinquishes an exhaustive source instead of taking advantage of potential synergies with FILOCOM.

Conversely, **home demolitions and improvements** are currently **insufficiently covered** by the French observation system. The French Housing Accounts do fulfill their role in this regard, but only at a national scale. Other sources such as FILOCOM or OPERA give but a rough outline of these issues. As a result, analyzing variations in housing supply at a local or regional level would require changes in the French statistical system regarding those two specific points. On the other hand, SITADEL does a great job in recording new home construction. To conclude on the topic of the housing stock, various sources provide information on vacancy, but because it remains a collateral result of the various surveys, its measurement is still up to debate. A quick comparison of vacancy rates stresses discrepancies between the various sources, significant in level but less so in trends (ANAH 2008, Robert and Plateau 2006).

[115] In point of fact, some regions have developed a housing observatory of their own. While these mostly use existing databases, they sometimes undertake specific surveys, or even manage to match various files together by making data suppliers cooperate.

Second only to the housing stock/occupiers data in terms of quality, the coverage of housing prices (including rents) capitalizes on many databases. This abundance of databases might even be questioned, for several cases of overlap or redundancy are conspicuous, starting with the co-existence of the National Survey on Rents and Service Charges, CLAMEUR, Housing Surveys, and the OLAP to boot. Yet, one might deplore the **absence of an exhaustive and reliable public data source**, whereas this situation could be remedied as far as costly property transfers are concerned by the use of fiscal sources (assuming substantial changes in the current data collection system though). Ideally, BIEN, PERVAL, FIDJI and OEIL could be merged into a single tool.

Last but not least, residential mobility and housing expenses are well addressed at the national or regional scale, primarily thanks to the Housing Surveys, but less so at the local scale. As regards residential mobility, FILOCOM could easily and efficiently remedy this gap were household identifiers to be implemented. As far as only housing expenses are concerned, the issue is less problematic since one could easily reconstruct those expenses thanks to the vast amount of housing price databases. More concerning is the fact that there is still insufficient knowledge regarding the trade-off between housing and transportation budgets. [116] The Family Budget Survey provides first elements in this regard, but provides no information on travel behaviors, and has too few observations for local analysis. The EGT could fulfill this role for the Greater Paris Region, assuming that income and housing expenses were better informed in the next surveys.

A table encapsulating the main characteristics of each database concludes this section (*Table 20*). The more "+" there are, the better the description of the corresponding item. A "-" indicates scant information. A "?" means that the presence of information regarding this item could not be confirmed. No sign means that the database does not cover this topic at all. Lastly, notes provide some information on the scope, and additional remarks.

[116] True, several studies provide figures on this topic (→ *Chapter 2*), but none of them analyses the variability of expenses across households, and only report average figures instead. Because variability could come along with a fairly share of households nearing financial distress, this issue is obviously far from trifling.

TABLE 20: SUMMARY TABLE OF MAIN DATABASE CHARACTERISTICS

	Dwelling Char.	Household Char.	Vacancy	Residential Mobility	Housing Prices	Housing Expenses	Supply	Transport	Notes
CENSUS (RGP)	++	++	++	++				-	Formerly exhaustive Now based on sampling
EDP	++	++		+++				-	Individual Panel
FILOCOM	++	++	++	+			-		Exhaustive
EPLS	+		++	+	+		++		Social housing Exhaustive
OPS		++	+						Social housing Almost exhaustive
EMPLOYMENT SURVEY	-	++	+	+			+		Dwelling panel
EDF			++	+			+		Almost exhaustive
SITADEL	+						++		New homes
ICC - EPRLN							++		New homes
ENQUÊTE CONJ. CONSTRUCTION					+		+		New homes
OPERA	+	+					+		Home improvements
BIEN / PERVAL	++	-/+			++				Property transfers
EXISTAN	++	-/+			++				Property transfers 1993-2000 only
FIDJI	-				++				Property transfers Almost exhaustive
OEIL	++				++				Property transfers
FNAIM	++	?			++				Property transfers + Private rental sector
CLAMEUR	++		+/++	+	++		-/+		Private rental sector
ENQUÊTE NAT. LOYERS/CHARGES	++	++			++	++			Rental sector
OLAP	++	++			++	++			Rental sector, Agglomeration of Paris
ECLN	+		+		+		++		New homes
ENL	+++	++		+++	++	++	+		Primary residences
ECHP/EU-SILC	++	++		++	+	++		+	Household panel + Avail. data varies with surveys
EGT	++	++		+	-	+		++	Travel survey Greater Paris Region
ENT	++	++		+	-	+		++	Travel survey
HOUSING ACCOUNTS	++	+	++		+	++	++		Macroeco. data only
OBSERVATOIRE CL/CSA		+			++	++			Home loans
FAMILY BUDGET	++	++				++		+	Consumer expenditure survey
EPICAF	?	++			+	++			CAF recipients only

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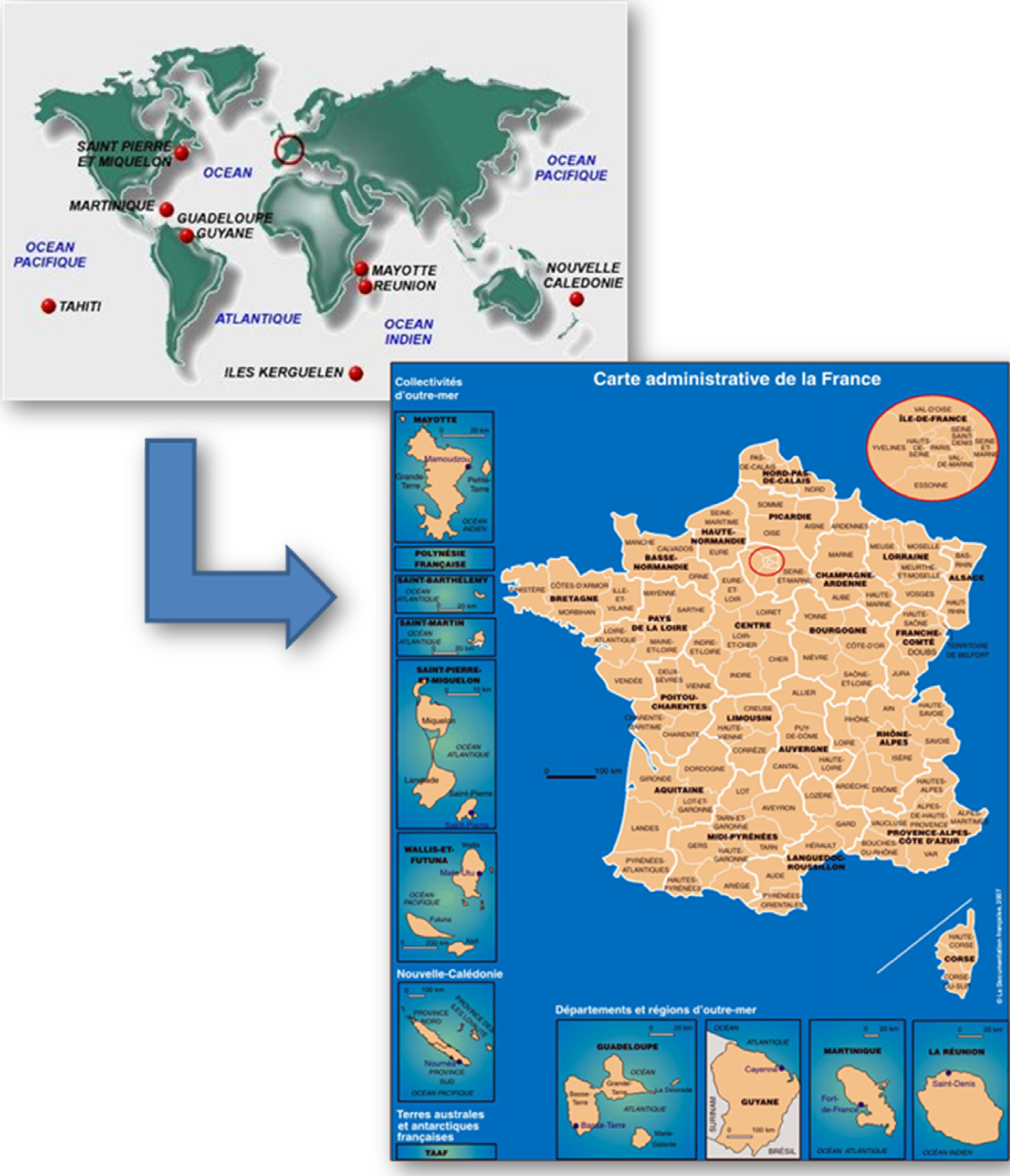
ANNEX A: ADDITIONAL FIGURES AND CHARTS

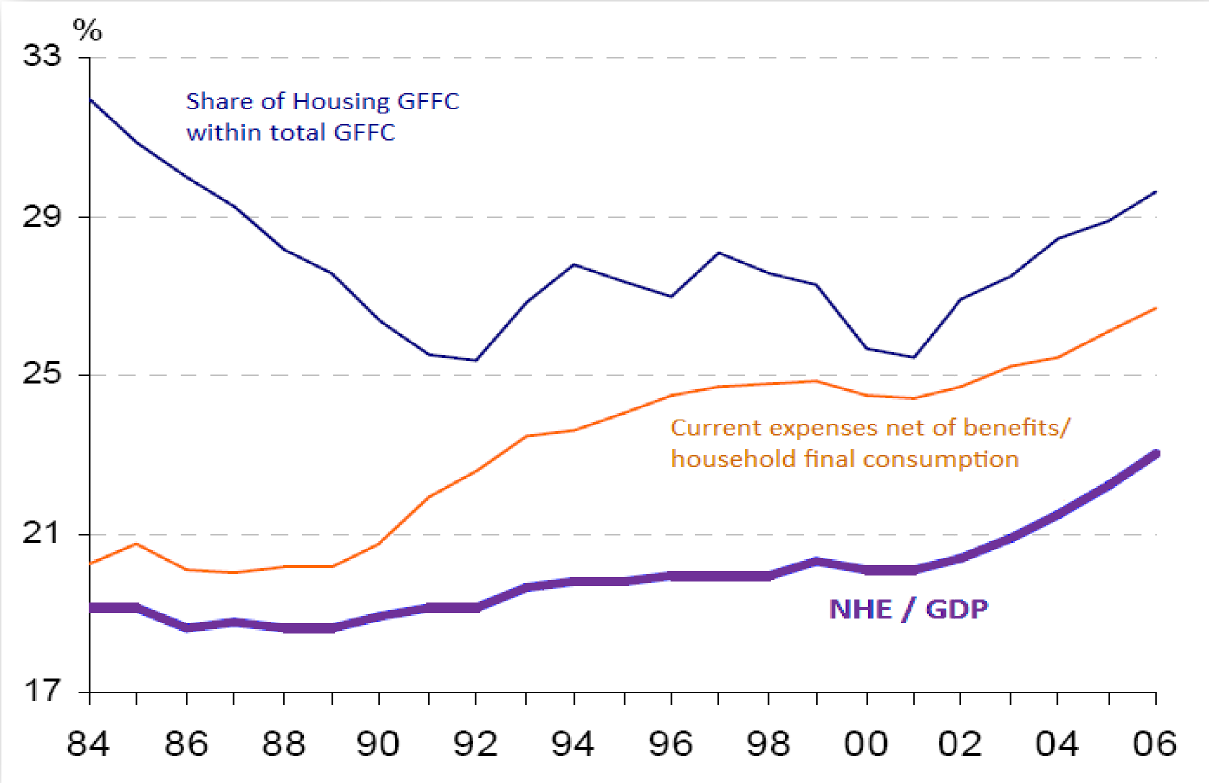
INTRODUCING THE FRENCH HOUSING MARKET

FIGURE A: MAP OF FRANCE, INCLUDING OVERSEAS TERRITORIES



Source: Various, Internet

FIGURE B: THE GROWING SHARE OF NATIONAL HOUSING EXPENDITURE WITHIN FRENCH GDP

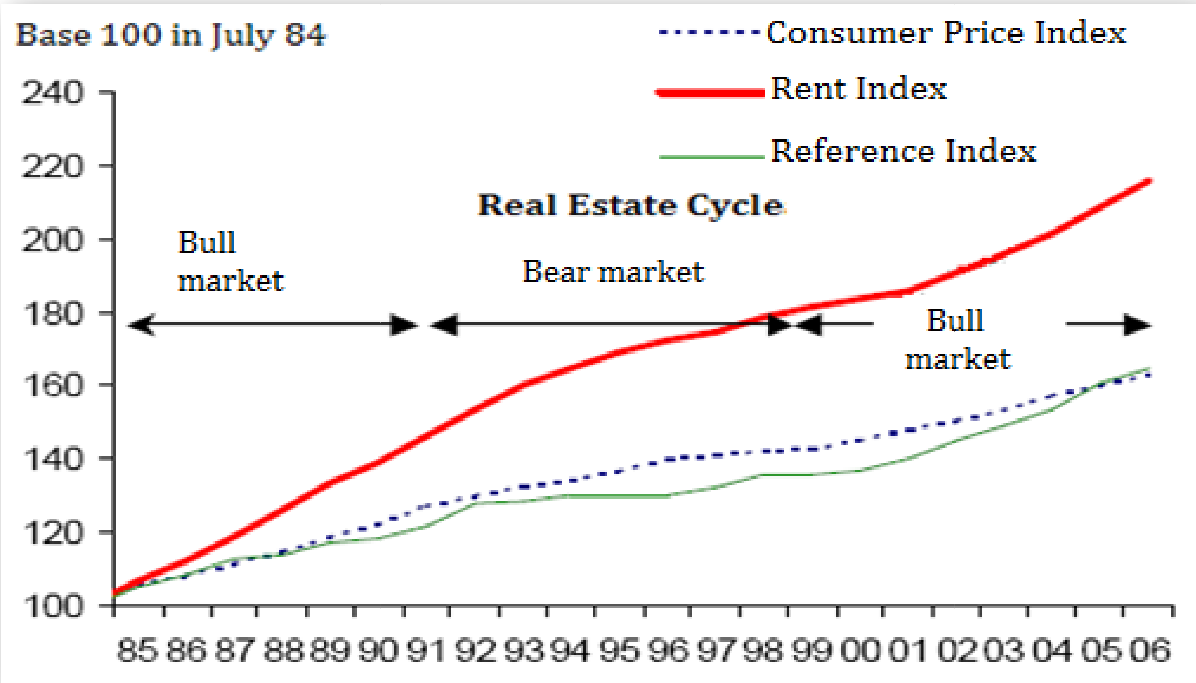


GFFC = Gross Formation of Fixed Capital

Scope: France (whole)

Source :French Housing Accounts, 2006

FIGURE C: RENTS, REFERENCE INDEXES, AND REAL ESTATE MARKET CYCLES



Reference index: refer to section *I* part *B-2* for definition

Source : French Housing Accounts, 2006

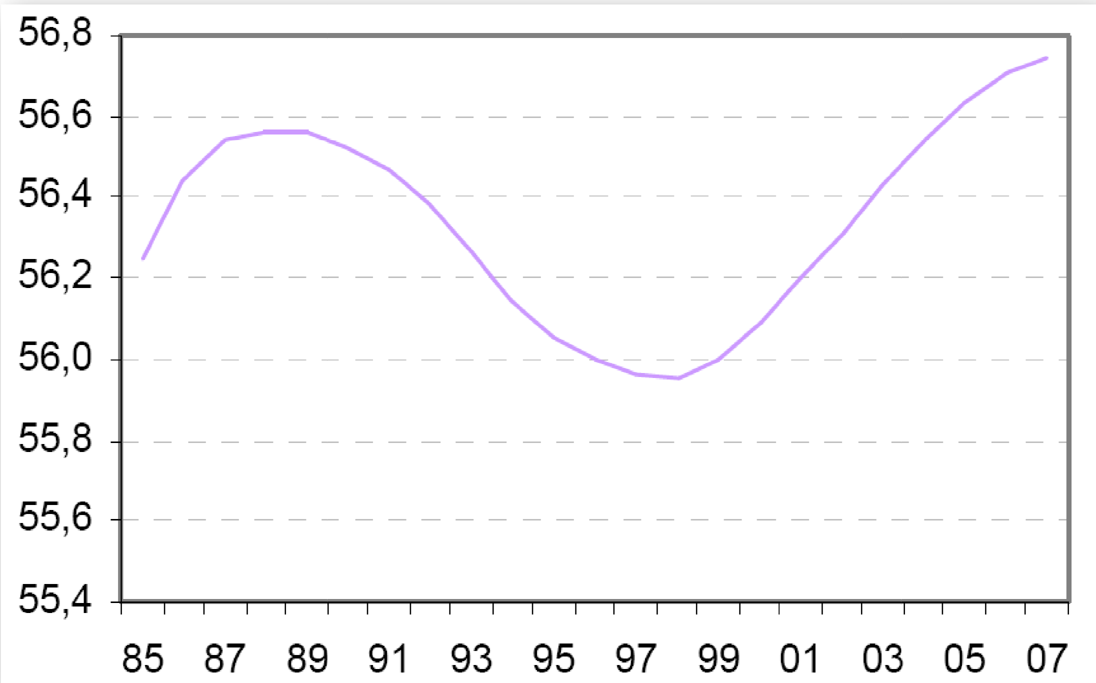
TABLE A : DETAIL OF CURRENT HOUSING EXPENSES ***(BILLIONS OF €)***

		2007
RENTS	**Primary Residences**	**178.5**
	Owner occupiers	120.2
	Tenants, including:	58.3
	- Landlord = Individual	*36.2*
	- HLM Sector	*15.4*
	Secondary Residences	**17.8**
OTHERS	**Energy and water**	**43.6**
	Other Charges	**26.9**

Scope: France (whole)

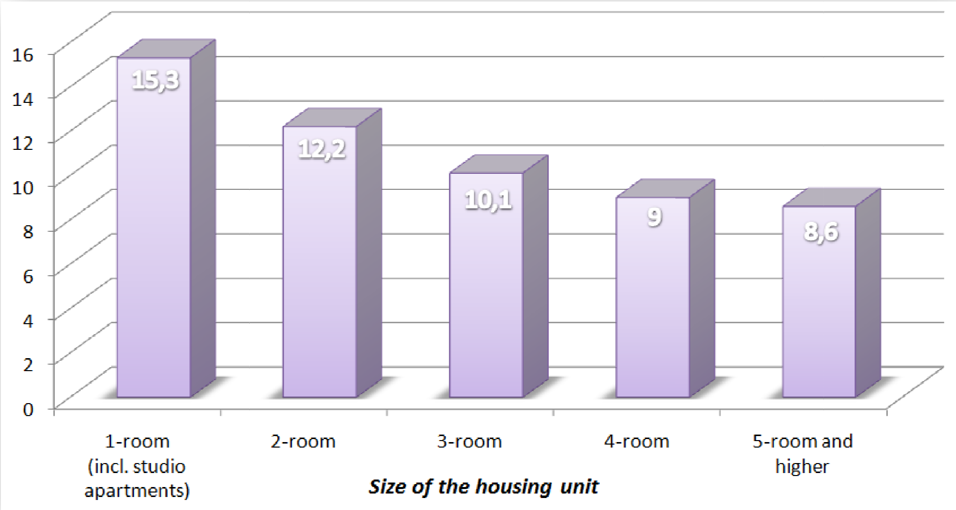
Source : French Housing Accounts, 2007

FIGURE D: SHARE OF SINGLE-FAMILY DWELLINGS, 1985-2007 ***(IN %)***



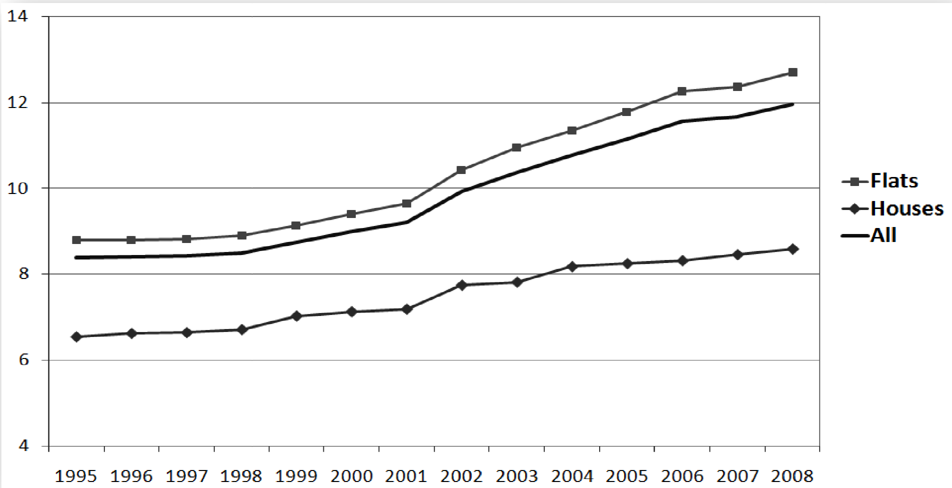
Source: French Housing Accounts, 2007

FIGURE E: INFLUENCE OF DWELLING SIZE ON MARKET RENTS *(€/M²)*



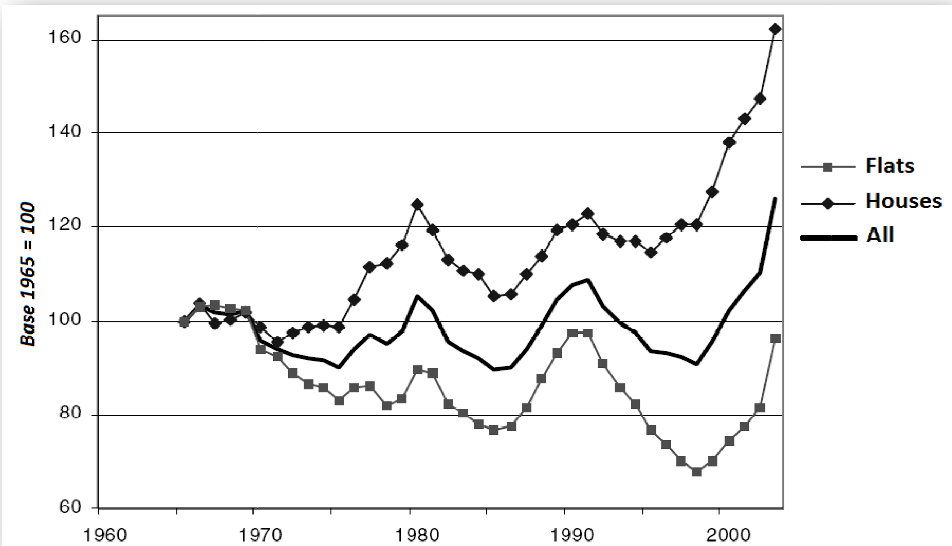
Source: CLAMEUR

FIGURE F: TRENDS IN MARKET RENTS ACCORDING TO HOUSING TYPE *(€/M²)*



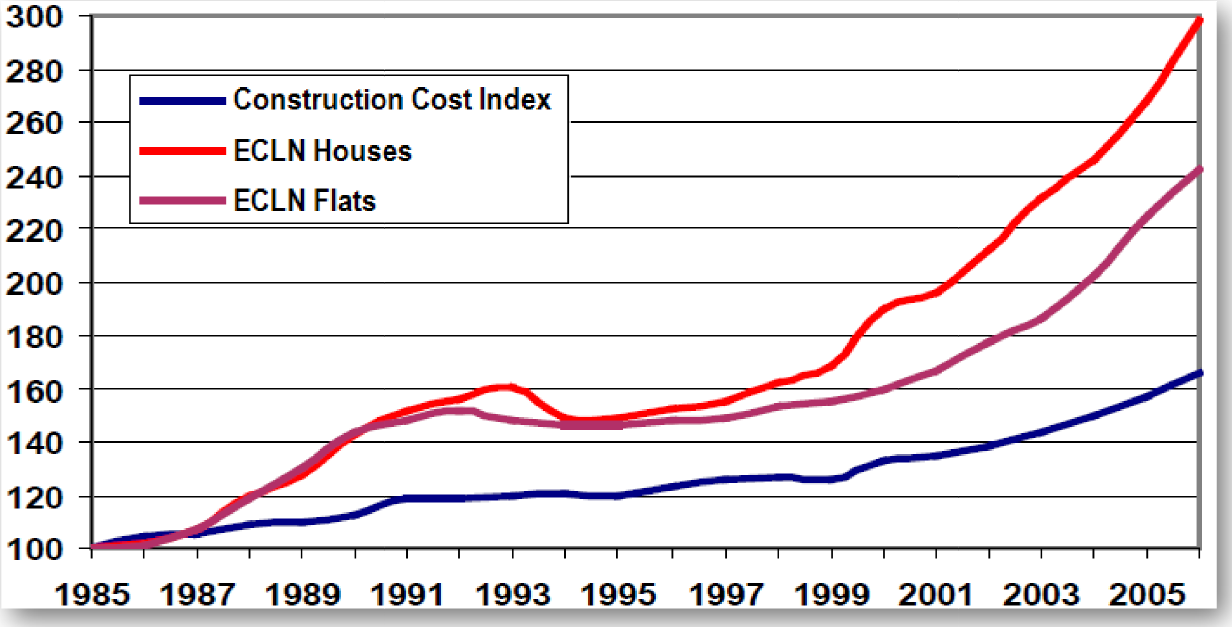
Source : FNAIM

FIGURE G: (HOUSING PRICE / DISPOSABLE INCOME) RATIOS ACCORDING TO HOUSING TYPE



Source : Sauvant (2004b)

FIGURE H: TRENDS IN HOUSING PRICES, NEW HOMES



Source: ECLN, SOeS

FIGURE I: BREAKDOWN OF CONSTRUCTION BY *MAÎTRE D'OUVRAGE* (CLIENT)

Scope: France *métropolitaine*, number of authorized dwellings

Source: SITADEL

European overview

TABLE B: NUMBER OF HOUSING UNITS PER 1,000 INHABITANTS

	1980	1985	1990	1995	2000	2004	Average yearly growth*
Austria	402	415	380	391	405	421	0.2%
Belgium	387	374	390	390	407	409	0.2%
Cyprus	297	337	374	391	415	na	1.7%
Czech Republic	366	na	396	na	427	438	0.8%
Denmark	435	418	437	449	453	456	0.2%
Estonia	352	na	411	427	454	463	1.1%
Finland	398	382	450	465	494	503	1.0%
France	436	449	464	478	490	513	0.7%
Germany	412	425	425	439	467	477	0.6%
Greece	410	na	454	na	500	na	1.0%
Hungary	331	362	372	390	399	423	1.0%
Ireland	265	278	292	345	371	400	1.7%
Italy	388	na	404	441	479	na	1.1%
Latvia	305	na	358	386	398	391	1.0%
Lithuania	na	296	313	345	385	na	1.8%
Luxembourg	344	na	298	365	389	391	0.5%
Malta	297	294	na	321	331	na	0.5%
Netherlands	343	365	393	405	416	422	0.9%
Poland	274	286	289	298	307	314	0.6%
Portugal	349	382	na	na	482	na	1.6%
Slovak Republic	283	na	307	na	310	318	0.5%
Slovenia	na	na	na	344	358	408	1.9%
Spain	390	413	440	454	462	na	0.9%
Sweden	442	463	471	479	483	486	0.4%
United Kingdom	382	385	407	420	430	na	0.6%

*: Computed between last and first year with available data

Source: Housing Statistics in the European Union, 2005/2006

TABLE C: VACANT CONVENTIONAL DWELLINGS

	Early to mid-1990s	%	Latest available year	%
Austria	-	na	-	na
Belgium	-	na	-	na
Cyprus	1992	21.5	2001	24.1
Czech Republic	1991	9.1	2001	12.3
Denmark	1995	4.5	2005	6.3
Estonia	1995	11.0	2002	10.9
Finland	1995	6.9	2004	8.8
France	1996	7.6	2004	6.1
Germany	1993	2.9	2002	8.2
Greece	1991	31.9	2001	33.2
Hungary	1996	5.6	2005	5.1
Ireland	1991	10.2	2002	12.0
Italy	1991	21.3	2001	20.7
Latvia	1195	2.1	2005	0.3
Lithuania	-	na	2001	3.7
Luxembourg	1991	4.4	2001	2.3
Malta	1995	23.0	-	na
Netherlands	1990	2.3	2002	2.2
Poland	-	na	2002	5.3
Portugal	1991	10.5	2001	10.6
Slovak Republic	1991	9.3	2001	11.6
Slovenia	1991	3.9	2002	10.1
Spain	1991	21.1	2004	21.9
Sweden	1995	3.3	2005	1.7
United Kingdom	1995	4.0	2002	3.4

In principle,second homes should be excluded. In practice, some countries may include them.

CY: conventional dwellings that are not occupied as primary residences. This includes vacant dwellings, second homes, and homes waiting for demolition.

GR: includes second, vacant, and abandoned homes.

SE: dwellings ready to be rented. Scope: rental multi-family housing.

Source: Housing Statistics in the European Union, 2005/2006

TABLE D: OCCUPIED HOUSING STOCK BY TENURE

	1980				1990				2000				2004				Variations (between last and first years			
	R	OO	CO	O	R	OO	CO	O	R	OO	CO	O	R	OO	CO	O	R	OO	CO	O
Austria	43	52	na	5	41	55	na	4	41	52	na	7	41	51	na	9	↘	→	na	↗
Belgium	38	59	na	3	33	67	na	0	32	68	na	0	31	68	na	2	↘	↗	na	→
Cyprus	16	61	na	23	13	64	na	23	14	68	na	18	na	na	na	na	→	↗	na	↘
Czech Republic	40	40	13	7	40	38	19	3	29	47	17	7	na	na	na	na	↓	↗	↗	→
Denmark	43	55	1	1	40	54	5	1	39	52	7	2	38	49	7	6	↘	↘	↗	→
Estonia	na	na	na	na	na	na	na	na	na	na	na	na	4	96	0	0	na	na	na	na
Finland	30	63	0	7	25	72	0	3	32	64	0	4	33	63	0	4	↗	→	na	↘
France	41	47	na	12	39	54	na	7	39	55	na	7	40	57	na	3	→	↑	na	↓
Germany	61	39	na	0	52	48	na	0	na	na	na	na	55	45	na	0	↘	↗	na	na
Greece	27	70	na	3	20	76	na	4	20	74	na	6	20	74	na	6	↘	↗	na	↗
Hungary	29	71	na	0	26	74	na	0	7	92	na	1	6	93	na	1	↓	↑	na	→
Ireland	24	76	na	0	18	79	na	3	na	na	na	na	21	79	na	na	↘	↗	na	na
Italy	36	59	-	5	25	68	-	6	20	71	-	9	19	73	-	9	↓	↑	-	↗
Latvia	na	na	na	na	79	21	na	0	30	70	0	0	19	77	4	na	↓	↑	↗	na
Lithuania	na	na	na	na	na	na	na	na	7	91	na	na	na	na	na	na	na	na	na	na
Luxembourg	39	60	na	1	30	64	na	6	26	70	na	4	29	68	na	3	↓	↗	na	→
Malta	na	na	na	na	na	na	na	na	22	74	-	4	26	70	na	4	↗	↘	na	→
Netherlands	58	42	na	0	55	45	na	0	47	53	na	0	44	56	na	0	↓	↑	na	na
Poland	na	na	na	na	na	na	na	na	26	55	19	0	25	57	18	0	→	→	→	na
Portugal	39	52	na	5	28	67	na	5	21	75	na	4	na	na	na	na	↓	↑	na	→
Slovak Republic	na	na	na	na	28	49	22	1	9	74	15	2	5	85	7	3	↓	↑	↓	→
Slovenia	na	na	na	na	na	61	na	39	na	na	na	na	9	84	na	7	↑	↑	na	↓
Spain	21	73	na	6	15	78	na	7	10	84	na	6	11	82	na	7	↓	↑	na	→
Sweden	42	42	16	0	44	39	17	0	47	38	15	0	45	38	17	0	↗	↘	→	na
United Kingdom	42	58	na	0	35	65	na	0	31	69	na	0	31	69	na	0	↓	↑	na	na

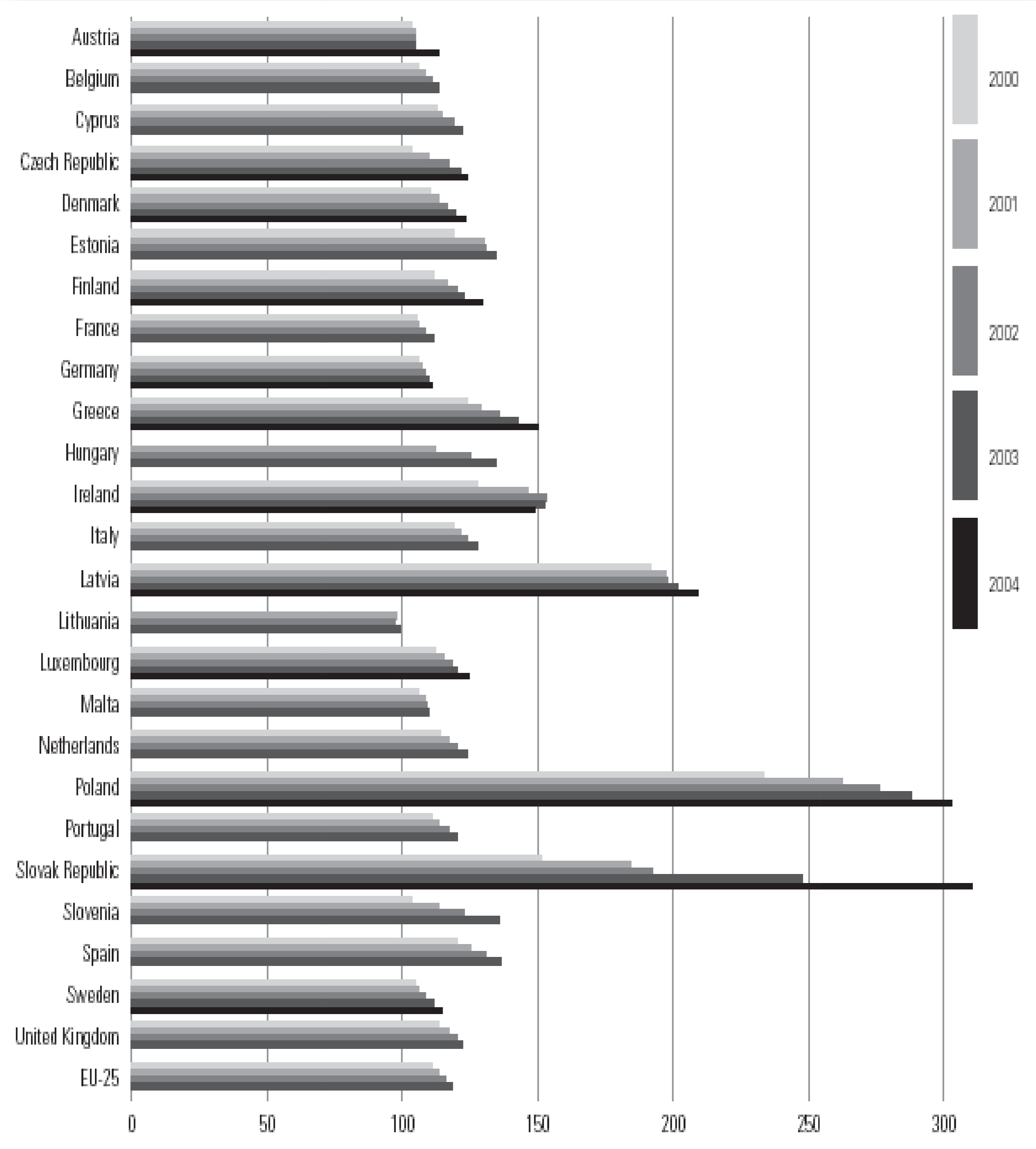
Source: Housing Statistics in the European Union, 2005/2006

TABLE E: AVERAGE PRICES FOR NEW AND EXISTING HOMES, 2004

	Existing homes			New homes		
	Average price (in k€)	Average price (€/m²)	Average size (m²)	Average price (in k€)	Average price (€/m²)	Average size (m²)
Austria	na	1,010	75	na	1,890	80
Belgium	101	169	na	na	na	na
Czech Republic	na	375	61	na	590	114
Estonia	120	na	59	200	na	62
Finland	na	1,600	77	na	na	93
France	na	2,500	70	na	2,500	na
Greece	na	2,020	100	na	2,206	97
Ireland	295	1,967	150	249	1,649	147
Italy	150	1,844	na	na	na	na
Latvia	120	na	52	300	na	86-93
Luxembourg	173	1,600	123	275	1,715	132
Malta	na	815 - 1,050	45 - 200	na	>1,050	45-200
Netherlands	257	2,360	109	269	2,340	115
Slovak Republic	na	na	na	na	na	132
Sweden	147	1,140	129	na	na	122
United Kingdom	256	na	na	na	na	na
Cyprus	na	na	na	na	na	na
Denmark	na	na	na	na	na	na
Germany	na	na	na	na	na	na
Hungary	na	na	na	na	na	na
Lithuania	na	na	na	na	na	na
Poland	na	na	na	na	na	na
Portugal	na	na	na	na	na	na
Slovenia	na	na	na	na	na	na
Spain	na	na	na	na	na	na

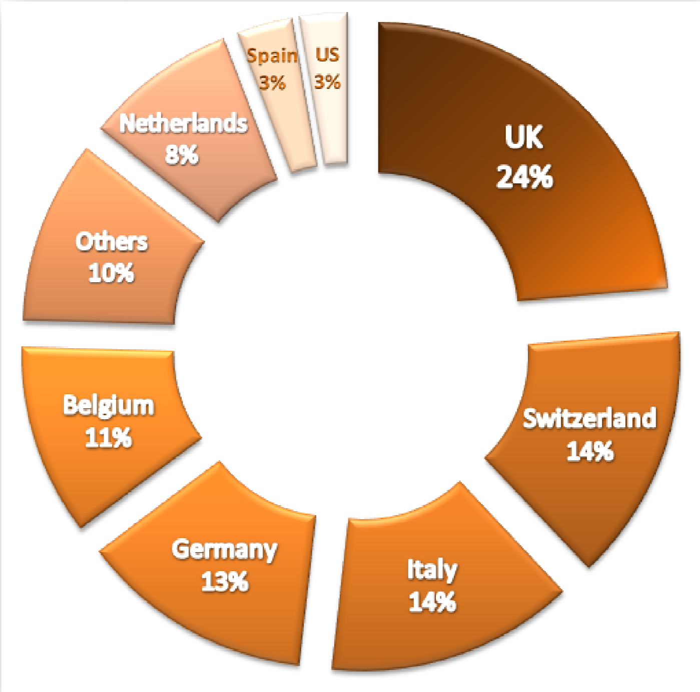
Source: Housing Statistics in the European Union 2005/2006

FIGURE J: TRENDS IN RENTAL PRICE INDEXES, ANNUAL AVERAGE, 1996 = 100



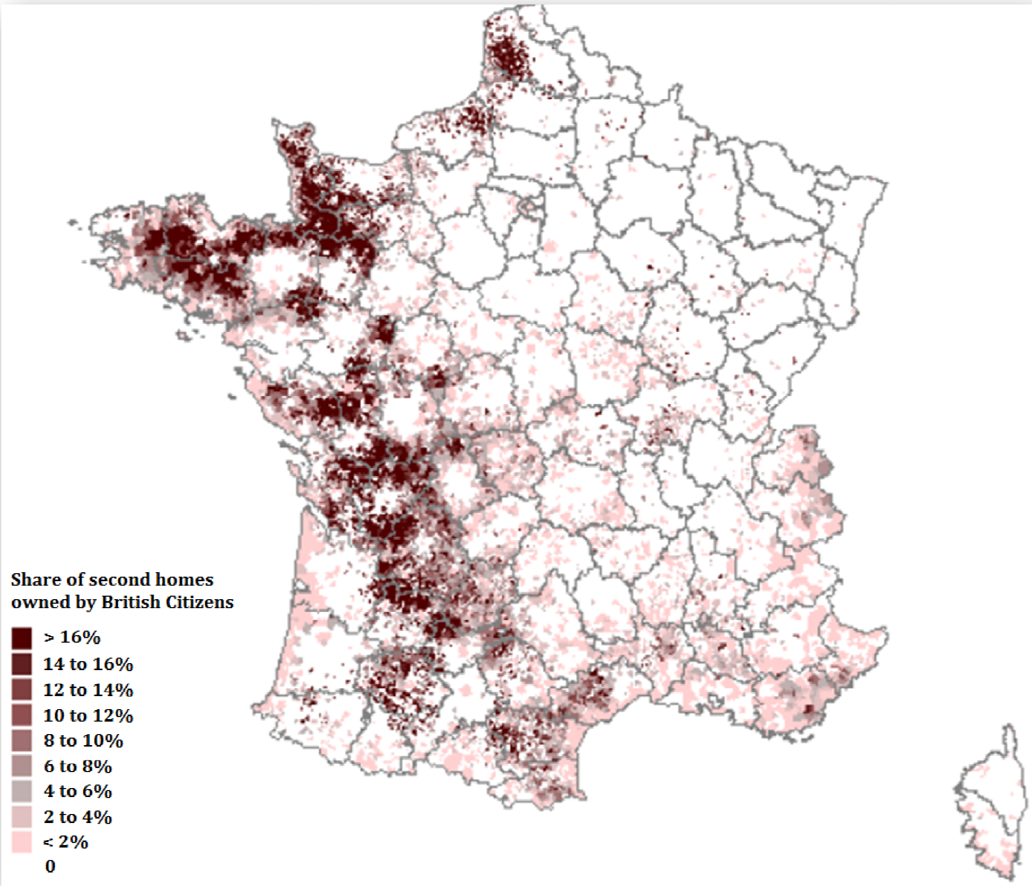
Source: Housing Statistics in the European Union 2005/2006

FIGURE K: FOREIGN OWNERSHIP OF SECOND HOMES IN FRANCE, 2003



Source: Insee

FIGURE L: THE LOCALIZATION OF BRITISH-OWNED SECOND HOMES



Source: Calzada, Le Blanc, and Vandendriessche (2004), from FILOCOM 2003

French regional housing markets

FIGURE M: A MAP OF FRENCH REGIONS

FIGURE N: THE GREATER PARIS REGION, INCLUDING PARIS AND ITS SURROUNDING *DÉPARTEMENTS*

Source: http://www.iledefrance.fr/

FIGURE O: STOCK AND CONSTRUCTION OF SECOND HOMES IN FRANCE *MÉTROPOLITAINE*

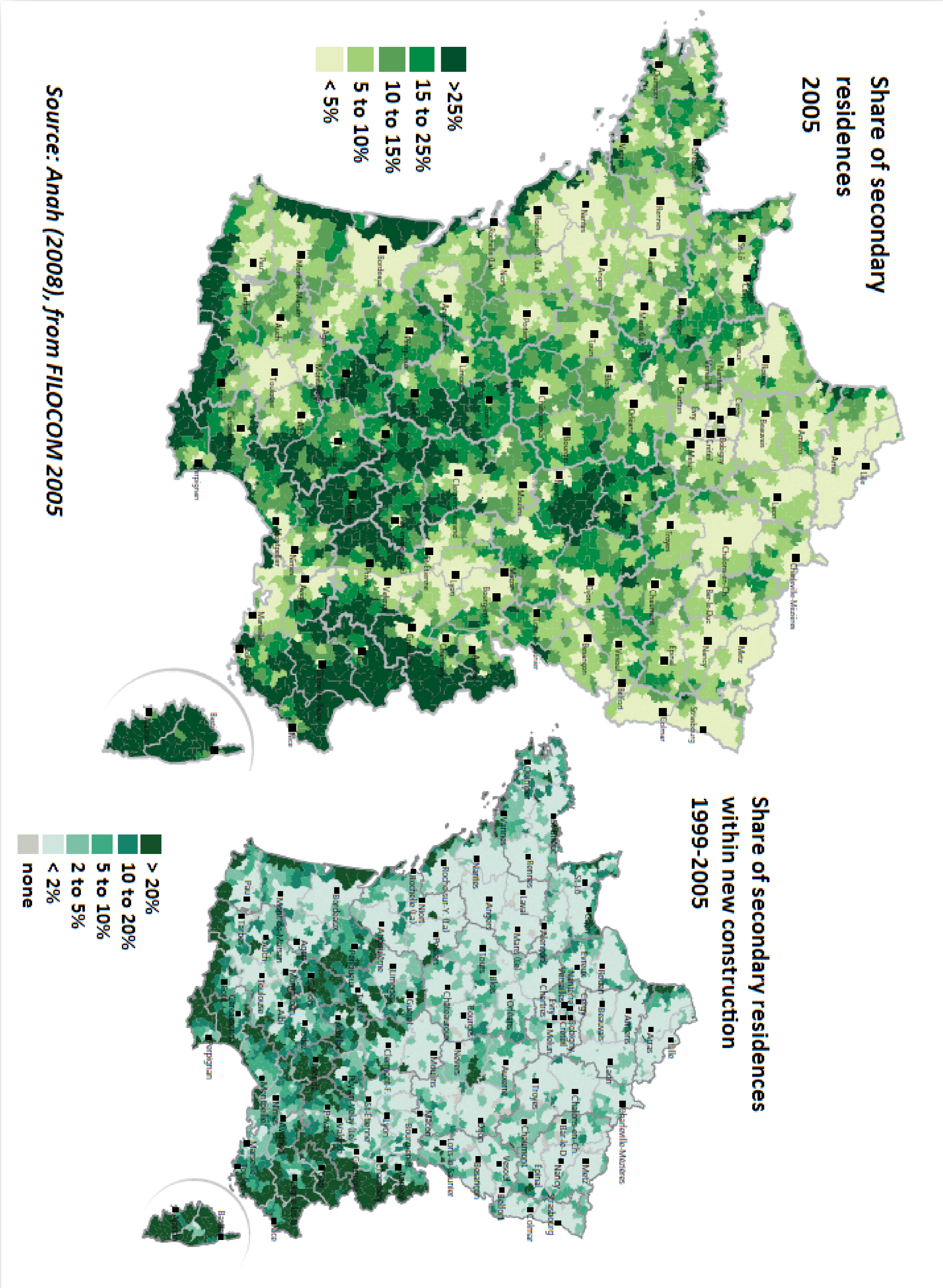
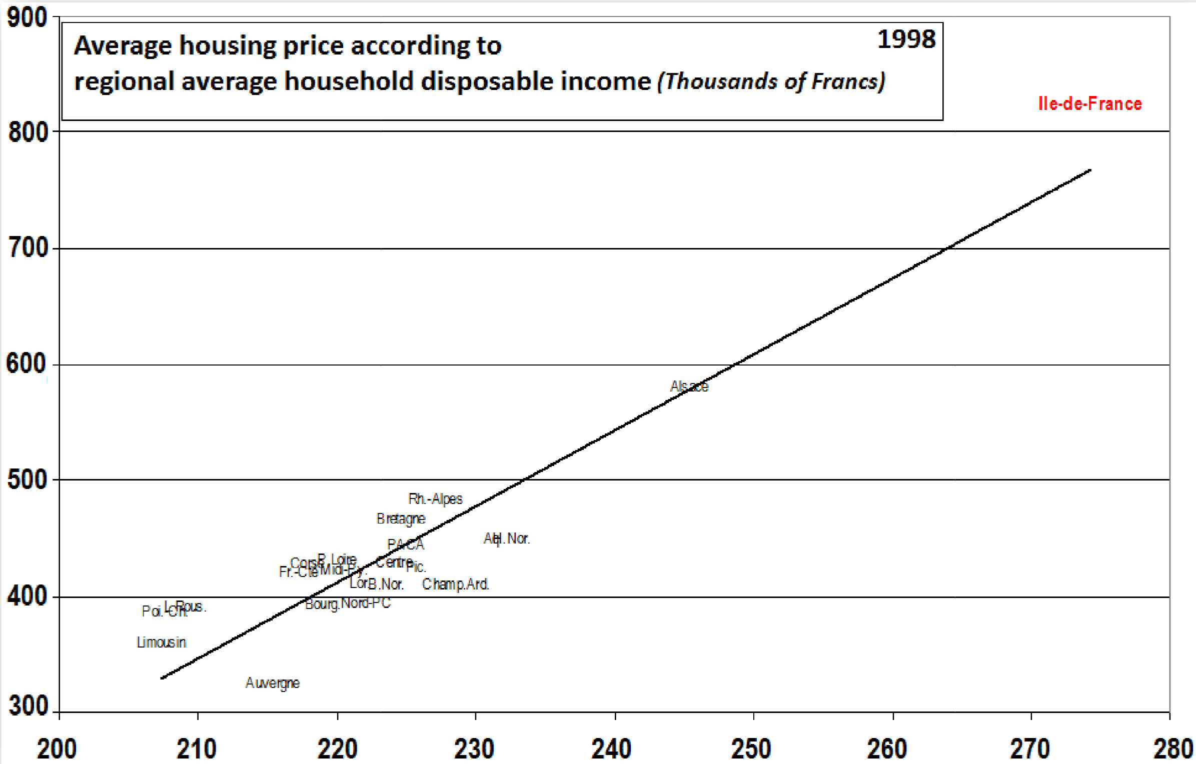
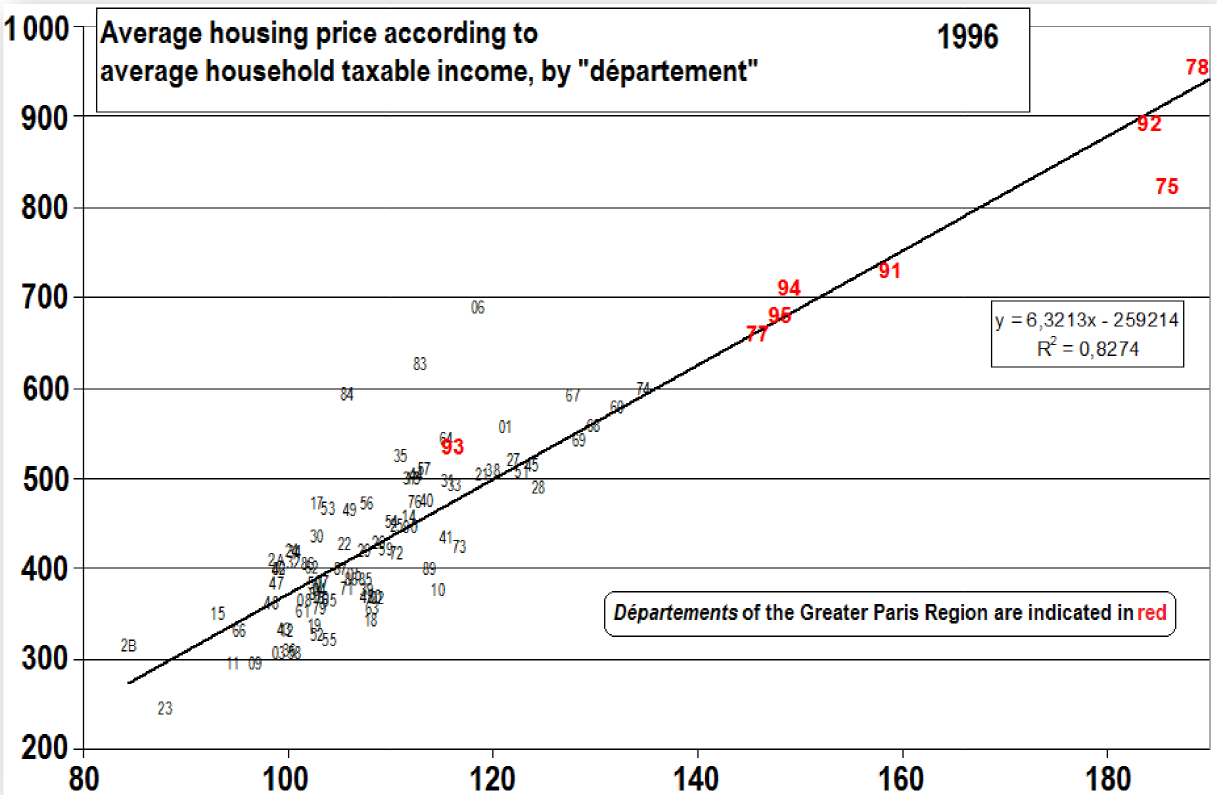
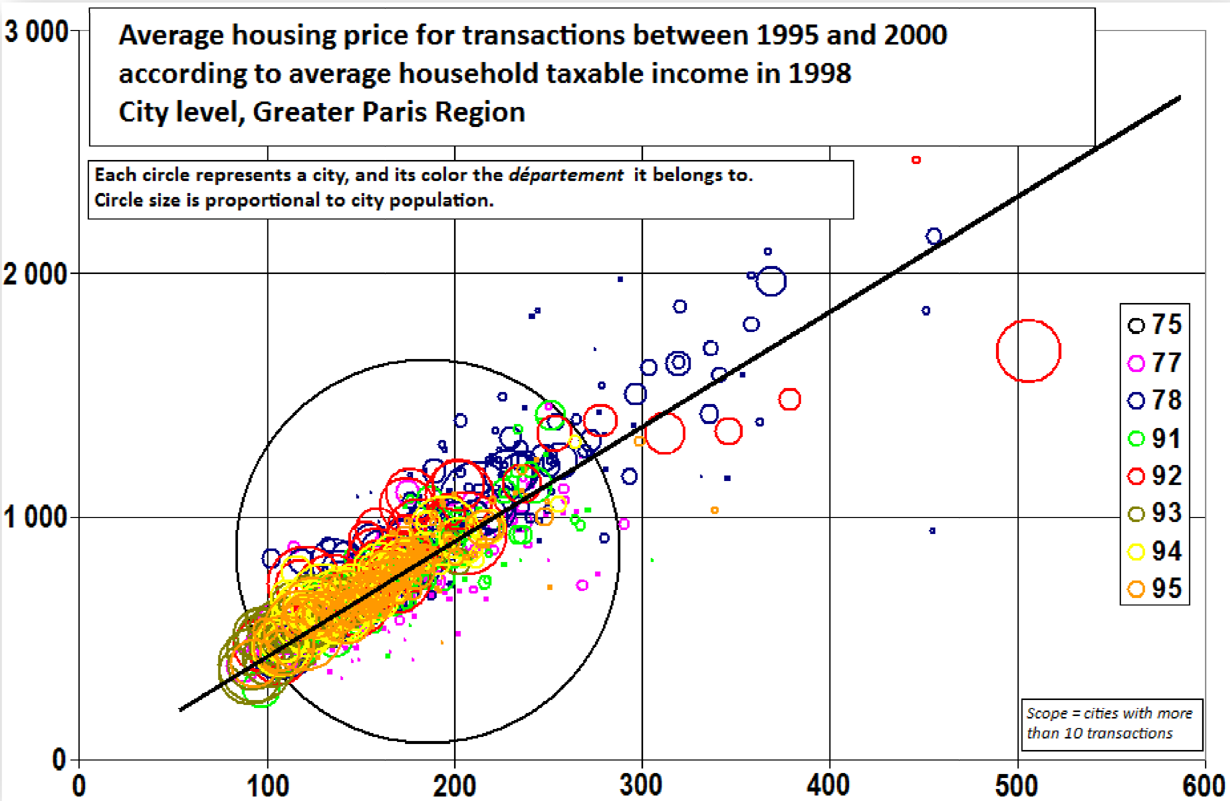
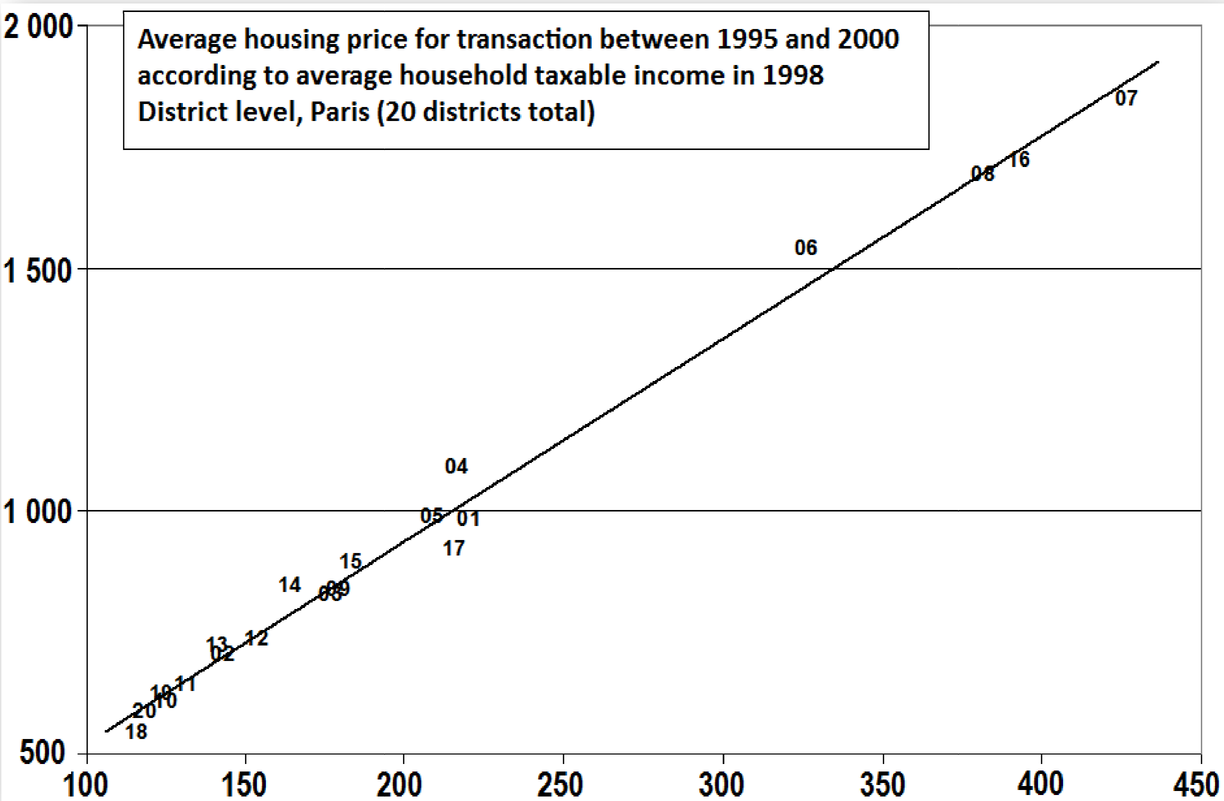


FIGURE P 1, 2, 3, AND 4: THE LINK BETWEEN HOUSING PRICE AND HOUSEHOLD INCOME



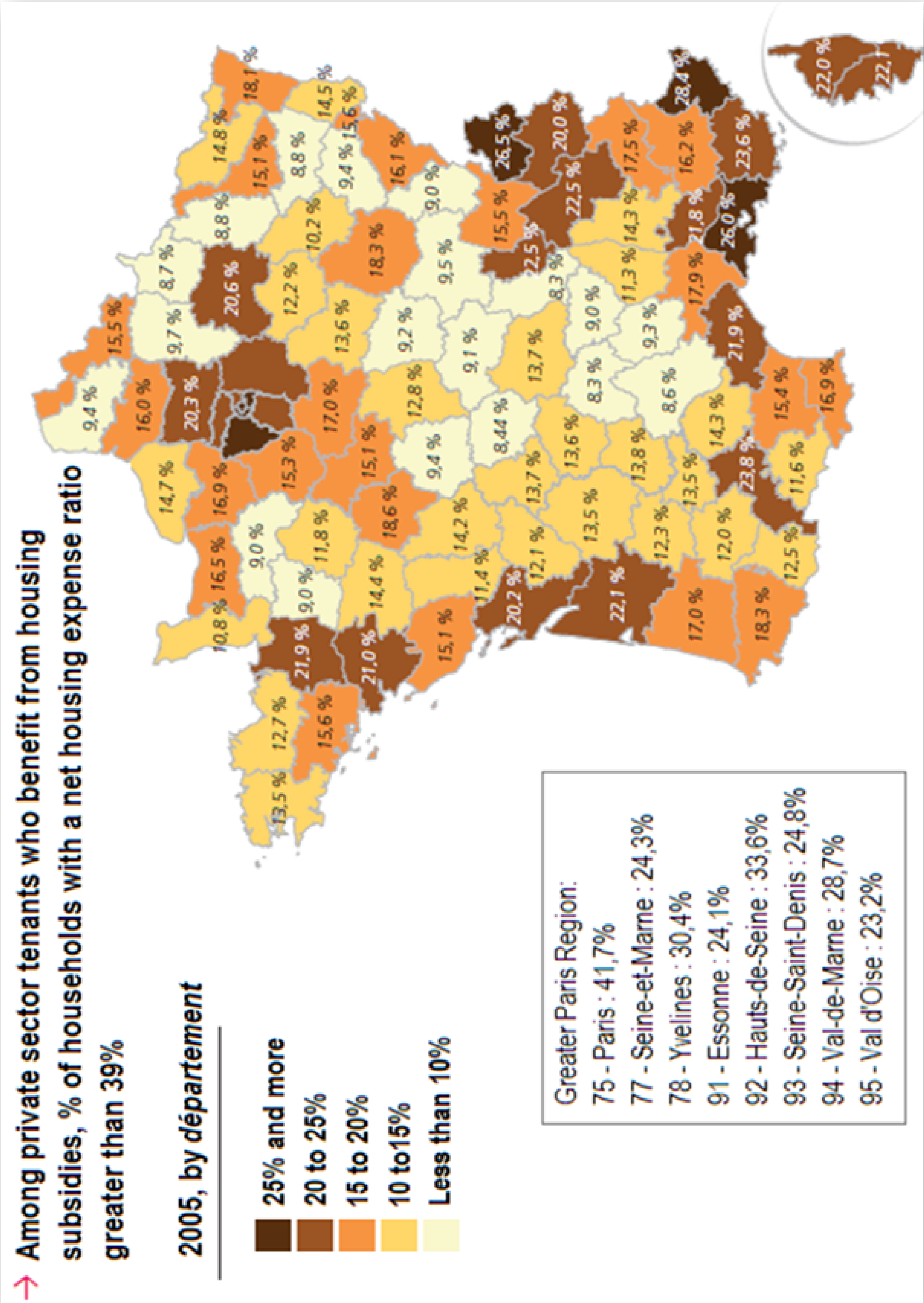






Source: Friggit (2001)

FIGURE Q: SHARE OF SUBSIDIZED PRIVATE RENTERS WITH HEAVY HOUSING BURDENS



Source: Anah (2008)

Chapter 1

The Formation of Housing Demand

State of the Art

An overview of the economic, applied, and operational literature

INTRODUCTION

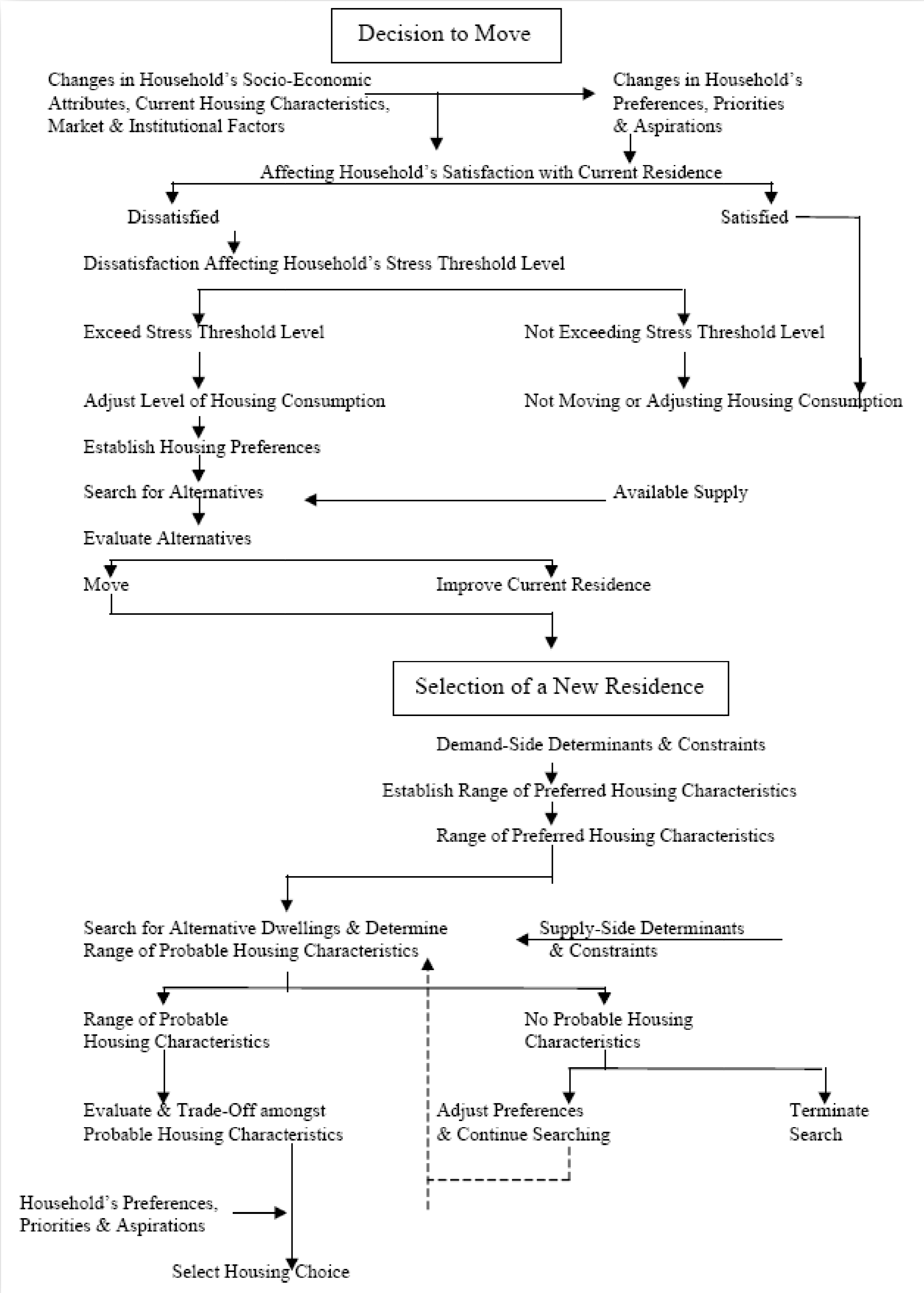
The formation of housing demand is a simple and at the same time extremely complex process. Simple in that one household equals one home (hopefully), and forecasting housing needs could seem straightforward on that account. However, the many specificities of the housing market (→ *General Introduction*) render the task drastically more complex than some basic balancing of housing supply with demographics.

To study housing demand and its formation, researchers have endeavored to **break down the individual process** into a succession of steps, each representing one elementary decision. Wong's suggestion, represented in *Figure 44*, illustrates the sheer difficulty of the task: the decision tree is dense, with a barely comprehensive structure, and includes numerous feedbacks to boot. Yet, this merely mirrors the extremely high level of complexity and singularity of the residential process, and I thus use Wong's attempt to break it down as a basis for the ensuing discussion.

As emphasized in the decision tree, the residential process is generally split into two main components: the **decision to move** and the **residential choice** *per se*. The first element logically seems to precede the other: one chooses a new residence because one wishes to move. Yet the very decision to move may directly depend on the existing alternatives. One might find his or her dream house while wandering along the streets, and decide to buy it and move in at once. Another might wait for the good bargain before moving. Furthermore, it represents an "everyday decision" insomuch that households are constantly assessing their satisfaction with their home as they experience living in it. Although one does not seriously consider the issue of whether or not to move each morning while having coffee, numerous events in the life-cycle provide an occasion to give it some thought, meaning that dynamic behaviors are probably at work.

This **two-step structure** is probably the most commonly shared assumption across all works presented here. Activity-based or discrete choice models of residential mobility typically place special emphasis on the decision to move, which results in either a move indeed (with the ensuing residential choice to be made), or an alternative action (usually to stay put and do nothing, home improvements sometimes constituting an option). On the other hand, long-term equilibrium models, e.g. the monocentric city model, often omit this decision by assuming that households do not wish to move at equilibrium and jump ahead to the residential choice. Aside from that, there is considerable variety in the way of dealing with the complexity of the residential process. Activity-based models presented in section *II* strive to represent more and more minutely the decision tree, even though behavioral economics still provide few findings on this specific matter.

FIGURE 44: A CONCEPTUAL MODEL OF THE HOUSEHOLD'S HOUSING DECISION-MAKING PROCESS



Source: Wong (2002)

Economic works break the whole process asunder and scrutinize it part by part. And in more operational and "down-to-earth" studies, the end generally justifies the means, meaning that any methodological choice works so long as it remains relevant.

The present chapter intends to review and, to some extent, compare the way housing demand is represented and studied in three different fields: urban and housing economics, applied modeling (including LUTI models), and lastly "operational studies".[1] It focuses on the **household perspective** (when possible)[2] and **economic mechanisms**. Market equilibrium mechanisms and especially the formation of housing prices do introduce indirect interactions between residential choices, but are not at the core of the analysis. They are however presented when relevant.

I shall start with an overview of the economic literature and endeavor to classify all of these works. This constitutes the object of *section I*. *Section II* analyzes how housing demand is represented in LUTI and urban models. Lastly, *section III* concludes this chapter by carrying out a survey of analytical methods used in operational studies.

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[1] I use the term "operational studies" to refer to works setting policy recommendations as their primary goal, as opposed to fulfilling research objectives (although these might be secondary objectives).

[2] In aggregate models, e.g. Lowry's model, individual behavior is not represented, households being only treated as a form of stock. Because there is no such thing as individual housing demand, only the main characteristics of aggregate demand are presented in this specific case. Otherwise, in all the works that I am aware of aggregate housing demand is obtained by directly summing individual/household demand functions, implying that no coordination between economic agents is considered at this stage. This justifies focusing on the sole household perspective. While this assumption seems relatively appropriate concerning the housing market, this would not be the case for specific markets, to wit internet instant messengers, where coordination among individuals is a key factor in the formation of demand.

I - HOUSING DEMAND ANALYSIS IN ECONOMICS: DIVIDE AND CONQUER

The housing market represents a specific field in economic research considering its many singularities, and various scientific reviews are dedicated to this topic, indeed. Within this literature, **housing demand is more frequently addressed than housing supply**. This is especially true in Europe where land-use regulation plays a major role, partly removing this matter from the market sphere.[1] Although this proves beneficial to my very own dissertation, applied models suffer from this lack to a great extent. The current representation of housing supply is actually far from satisfying, ranging from exogenous scenarios on the one side, to utterly complex endogenous formulations on the other side, as is the case in CATLAS (Anas and Duann 1985).

As far as housing demand is concerned, the economic literature breaks the residential process into small parts and examines them separately. Holistic approaches are seldom, maybe because researchers have acknowledged the high complexity of this process and concluded on the vanity of seeking one integrating approach when so much remains to be done. Regardless, **four key topics** may be identified in the literature:

- residential mobility;
- the level of housing consumption;
- the choice of dwelling characteristics;
- the location choice.

Dwelling characteristics should be understood as intrinsic ones, while the location choice comprehends the issue of location-based amenities. Most works tackle only one or two of these points, sometimes up to three. Addressing all four would surely get you a Nobel price though, as once again it has never been done to the best of my knowledge. Among those, the level of housing consumption is maybe the most recurring subject, sometimes being central in the analysis, sometimes as a co-product. Conversely, there is **a wall separating the issues of location and dwellings characteristics** in academic research, and the interplay between the two is still not fully understood (Hilber 2005). This might represent the most important lack as for now.

[1] Strassmann (2001) provides an interesting discussion about the existing gap between Americans and Europeans regarding their mental representation of the housing market and how this influences their research. Americans, having faith in the almighty power of the market (with some reason as their market is less regulated than the European one), rely on standard economics, while Europeans tend to focus on the micro-level and always stress the "*extreme complexity*" of the mobility process (Dieleman 2001). This might be the last clue in giving away the origin of yours truly.

One major issue seems missing when comparing to *Figure 44*: the home search.[2] The housing market being characterized by sheer product differentiation, information gathering is crucial yet costly at the same time. Visits, which are necessary to confirm stated characteristics as well as to get the whole picture, require time. As a consequence, households must develop search strategies which condition their residential decision. The way households devise such strategies should constitute a natural field of research. Yet, literature on this specific topic remains scant to the best of my knowledge; the issue of **home search** is thus **not considered in this review**.[3]

Bearing this limitation in mind, this section exposes the various contributions of theoretical and empirical economics with respect to the representation and analysis of **housing demand**, with a special attention to the **main microeconomic mechanisms** that are represented. Macroeconomic models, which appraise the general level of demand, supply, and housing prices, are considered beyond scope. Each of the four above topics is addressed one by one, starting with the issue of defining and measuring housing consumption. After this preamble, three more substantial subsections cover the topics of residential mobility, the selection of dwellings characteristics, and lastly the location choice.

A HOUSING SERVICES, OR HOW TO MEASURE HOUSING CONSUMPTION WITHOUT MEASURING IT

A significant issue when studying the housing market is that is characterized by **sheer heterogeneity**. Therefore, it substantially differs from standard markets, where the notions of price and quantity are well defined. Taking it to the extreme, one might argue that each housing unit is unique and has its own price. Such a standing is not convincing however, as it precludes any kind of analysis. It is also challenged by the fact that dwellings are substitutable between each other, at least to some extent.[4] In order to address the issue of heterogeneity, researchers have developed various frameworks which I am now going to expose, starting with likely the most used one, namely the notion of housing services.

[2] Some could argue maintenance to be another missing item in my list. I personally consider maintenance as one among several possible supply-side responses to the willingness to adjust one's housing consumption. This is why it does not appear in this short list.

[3] Some works do consider the search process to account for the phenomenon of vacancy (e.g., Wheaton 1990, Arnott and Igarashi 2000), but they seldom try to specify it, encapsulating the whole process in an effort variable. Among the rare works taking specific interest in the way households search their future home, let us cite the recent contribution of Chen, Lin, and Paaswell (2009).

[4] Once again, housing often involves a strong affective dimension as far as households are concerned, especially home owners, meaning that there is a limit to substitutability.

A-1. Housing services

The notion of **housing services** first appears in Muth (1960) in a study on the demand for non-farm housing, where the author develops a competitive theory of the housing market based on this very notion. Olsen (1969, p.613) proposes the following definition of housing services:

"*In order to view the housing market as one in which a homogeneous commodity is bought and sold, an unobservable theoretical entity called housing service is introduced. Each dwelling (or housing) unit is presumed to yield some quantity of this good during each time period. It is assumed to be the only thing in a dwelling unit to which consumers attach value. Consequently, in this theory there is no distinction between the quantity and quality of a dwelling unit as these terms are customarily used.*"

The strength and at the same time the most severe drawback of this notion is that it is a **theoretical entity**: housing services are **unobservable, thus immeasurable**. The same is equally true as regards the price of this commodity. Indeed, the only thing that one may observe is, in the case of tenancy, the monthly rent, which is equal to the product of housing services by their price. In this setting, the ratio of rents between two dwellings is also equal to the ratio of housing services. This provides an indirect way to measure housing services, but only in relative terms.

The strongest advantage of this notion is that it enables one to study the housing market with the **standard tools of micro-economic theory**. In this theoretical setting, housing services provide a measure of housing consumption by encapsulating all the characteristics of a dwelling, including its size, quality, as well as the issue of amenities. Olsen (1969) provides an excellent overview of the predictive power of this theory. Eventually, the notion of housing services was transferred to the monocentric city model, allowing for a better representation of housing supply as well as the introduction of the housing industry (Muth 1967). On the other hand, the price of housing services varies with distance to CBD in this context, making it even more difficult to achieve a mental representation of what this notion could mean in practice. If this was still not enough, a few recent works even assume that other elements besides housing services yield utility (for example amenities in the case of Brueckner, Thisse, and Zenou 1999).

This last element highlights the limitations of this theory. Because housing services are a pure conceptual entity, they often end up in being just a convenient way to provide housing with a consumption measure, at the risk of incoherency. In particular, housing services are often interpreted as a measure of dwelling size, thereby relinquishing the quality dimension. Furthermore, because it is not observable, it limits the explanatory power of this theory, as it is substantially harder to apply it in empirical studies.

A-2. Alternate approaches to measure housing consumption

Besides the notion of housing services, there are two main other ways to "measure" housing consumption. The first one is similar in essence to housing services, but considers that housing possesses **both a quantity and quality dimension**. This way of modeling housing is mainly used to tackle the issue of optimal maintenance decisions, being the reason why I will not dwell on this point (Smith, Rosen, and Fallis 1988).

The second one is based on the postulate that households value goods for their various characteristics (Becker 1965, Lancaster 1966, Muth 1966). In other words, each of these characteristics yields utility, and thus enters the utility function as an argument. Rosen (1974) has formally rendered this approach in the case of the housing market by "*setting out a model of demand, supply, and competitive market equilibrium*" (Smith, Rosen, and Fallis, *supra* p.37). In this framework, a housing unit is described through a **vector of *n* characteristics**. These may be intrinsic (dwelling size, age of construction) or extrinsic (average household income in the neighborhood, access to transit stations, and so on), as long as they are **objectively measurable**. As *C-3* discusses further the application of this theoretical framework to hedonic analysis, I will now tackle the issue of residential mobility.

B RESIDENTIAL MOBILITY, OR WHEN DO WE MOVE?

Stricto sensu, residential mobility is not a component of housing demand. As a matter of fact, a move is already the outcome of a meeting between supply and demand, which brings us back to the issue of stated vs. revealed preferences. And, to a more or less important extent, the same remark could be made concerning *subsections C* and *D*. This consideration is not trivial in the case of the housing market, some households being actually unable to move because appropriate supply does not exist in sufficient quantity. In other words, **residential mobility would be but the visible part of the iceberg**. Notwithstanding, there is considerable data and literature regarding actual residential mobility, much less so regarding the willingness to move, hence the choice of addressing the former rather than the latter.

This survey comprises four parts. First, a simple model is developed as a parable of residential mobility, providing an initial insight into this matter. After stressing next the difference between a move and a migration, the survey on residential mobility is resumed. A review dedicated to the phenomenon of migration concludes this subsection.

B-1. Residential mobility: an introduction

a) A parable of residential mobility: Homeworld

To introduce the topic of residential mobility, let us start by a simple tale. Imagine Mister M. who, right after his graduation, leaves home with a suitcase as sole luggage. Once arrived in the city of his choice, he gets a work downtown and decides to settle in a nearby gigantic hotel named Homeworld. Homeworld can provide him with any kind of place, from a luxurious villa with a lovely garden to the simplest room. M. has relatively simple tastes, taking the form of a Cobb-Douglas utility function:

$$U(h, z) = h^{\varepsilon} z^{1-\varepsilon}$$

where h denotes housing services ($\rightarrow A$), z is a composite good standing for all other goods in the economy, and ε a random variable taking values in $[0; 1]$. The value of ε may change at any moment, according to how much time M. plans to spend in his room, the weather, his mood, and so on.

b) Why do we move?

Let us start by assuming that M. can freely change rooms. In our rather simple model, M. would do so every time ε varies: this might be a simple bedroom when he worked late, another one when he feels like changing, or a deluxe villa for a week-end with friends. Transposed to the real world, **residential mobility is primarily a response to a change in housing needs** (Gobillon 2008). If one is satisfied with his location, home improvements are also an alternative. Otherwise, a residential move is the sole option. Moreover, if mobility was costless in all regards, one should expect people to constantly adjust their housing consumption, as happens in our tale. Lastly, a residential move can also be imposed by an outside constraint: non renewal of lease, accident at one's place, expropriation, etc.

c) When moving? The role of moving and transaction costs

Because all is not for the best in Homeworld, soon the manager finds that if M. were to stay in the same room, this would make his job easier. As a result, the clever manager enforces a fee for every room change, and as a counterpart adds a carrot to secure the loyalty of his clients: the longer one stays, the less he pays per day. Actually, M. does not mind these new rules for many reasons. Changing room takes time, he cannot leave his suitcase, he needs to get used to his new place, and he also has to tip the groom each time he carries his luggage to another room. Most of all, M. finds it stressful to constantly change places, and longs for stability. All these elements are as many deterrents to mobility, encapsulated in a disutility term δ when changing room.

Considering the new moving costs, M. stops changing room every day. More specifically, he goes and asks the manager for another place if and only if:

$$U(h^*, z^*) - U(h_0, z_0) > \delta$$

where (h^*, z^*) is the optimal bundle given the current value of ε, and (h_0, z_0) his current consumption. Considering that M. has a budget constraint giving z as a function of h and income, the above condition is tantamount to a (S, s) rule: a move occurs if and only if $h^* \notin [h_0 - m, h_0 + M]$, where m and M depend on ε and δ among other things.

In sum, the introduction of moving costs has the following consequences:

- Adjustments of housing consumption become punctual instead of continuous. [5]
- More specifically, **a move is triggered when the inadequacy between the current residence and the optimal one exceeds a stress threshold**.

This last rule was empirically validated by various works, including Dunn (2003) and Gobillon and Le Blanc (2008).

d) Planning or not planning?

An implicit yet crucial assumption behind the above moving rule is that M. is myopic. He does not know what the future holds for ε, the value of which may change at any time. Only under this assumption is the strategy described above optimal. This position is the one adopted by Venti and Wise (1984), who develop a model of residential mobility based on a **"disequilibrium" approach**. A move is triggered only when a disequilibrium term exceeds a certain threshold, which resets the value of this term to zero. On the other hand, the **"dynamic movement plan" approach** considers that households know their future to a certain extent. In this setting, the existence of moving and transaction costs leads the household to carefully plan its mobility. Amundsen (1985) shows that a disequilibrium measure can actually be at its largest just after a move has taken place, [6] a claim corroborated by the empirical findings of Edin and Englund (1991) in an analysis on recent movers.

Although this last element could seem to invalidate the "disequilibrium" approach, **the existence of unpredictable hazards** which may lead to forced moves **limits the household capacity to plan its residential mobility** (Nordvik 2001). More specifically, Nordvik finds in an endeavor to merge the two above approaches a result previously shown by Muth (1974) in a more simple setting, which states that "*the willingness to accept overconsumption or underconsumption early in a planned stay decreases with the probability that an exogenous move should take place*" (Nordvik *supra*, p.523). In sum, the truth would lie somewhere between the two approaches.

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[5] Note that one has to assume that the set of discontinuities of h^* has a measure equal to zero to obtain this result. In other words, ε cannot be excessively irregular (punctual jumps are ok though).

[6] Cf. Muth (1974) and Goodman (1995) on this point.

e) Some simple comparative statics

Let us derive a few more findings from our model. First, **moving and transaction costs** hinder mobility. Indeed, the greater δ, the higher the stress threshold, hence this result.[7] **Search costs**, including both time and money dedicated to the home search, logically have a similar impact (Wheaton 1990, Debrand and Taffin 2005). Secondly, because part of the monetary costs of moving do not vary much with income, high income households should display a higher propensity to move. Böheim and Taylor (1999) and Debrand and Taffin (2005) both confirm the **role of income** empirically, when Gobillon (2001) finds that it is the perception of one's own financial situation that affects mobility decisions rather than income itself. Lastly, the more ε varies (in frequency and/or in amplitude), the shorter M.'s expected length of stay in a given room will be. In other words, **the more frequently your housing needs (significantly) change, the more you move**. Versatile people or those having an aversion to stability should accordingly move more often than the others. Conversely, Kan (2003) shows risk aversion to reduce residential mobility, though to a modest extent. Still in this line of thought, changes in household structure will often trigger a residential move as they significantly change the value of h^*, a point that I discuss at length in *B-3.a)*.

B-2. Is it a move or a migration? Long- vs. short-distance mobility

a) On the importance of distance in residential mobility

Before proceeding further, it is paramount to acknowledge differences between short- and long-distance mobility. Indeed, motives underlying residential moves greatly differ between from one category to the other. **In long-distance residential mobility**, **the link to employment is primary**, the move being frequently coupled to a job change.[8] Such is not the case in short-distance mobility, to the point that Dieleman (2001, p. 253) states that "*it is generally supposed that the residential location can be chosen without reference to the location of the job, at least if the commuting distance is not too large*". To be more specific, the **adjustment of housing consumption** (including tenure, home size, and housing type) is usually the **primary motive behind a short-distance move** (Gobillon 2001).

[7] Refer once again to Amundsen (1985) for a demonstration of this point in a rigorous theoretical framework. Van Ommeren and Van Leuvensteijn (2005) validate this result empirically.

[8] Retirees and other inactive people represent a non negligible exception to this rule, but do not undermine our argument. In point of fact, one could easily substitute the notion of labor market by that of social network (mainly family for retirees). Because metropolitan areas define the natural space for daily travel practices, labor-and-housing markets roughly coincide with "social spaces" (in other words, metropolitans areas define who you can "easily" visit). Other exceptions include people taking advantage of rapid transit systems to live in different metropolitan areas than they work in; such instances are much less numerous, however.

This duality is partly reflected by the very structure of the economic literature. A specific literature exists on migration, including both theoretical and empirical works, when short-distance mobility is on the other hand more seldom considered alone.[9] In sum, the economic literature basically draws a distinction between migration and residential mobility as a whole, rather than between short- and long-distance mobility. Although there are sometimes cogent reasons to do so (e.g., when space is clearly not an issue it is relevant to consider all residential moves together), this undermines findings insomuch that the influence of various factors may vary depending on whether one considers long- or short-distance mobility (Gobillon 2001, Debrand and Taffin 2005, Kan 2007).

b) Defining the term "migration"

The fact that one can draw a line between long- and short-distance mobility is, as implied above, a widely acknowledged fact in the economic literature. There is still no clear consensus however over how to define this line precisely, resulting in a variety of considerations based on political jurisdictions, co-occurrence of a job change, and so on. In fact, the term "migration" itself is fraught with ambiguousness, and the economic literature abounds with multiple and inconsistent uses of this term (Zax 1994).[10]

Among all explicit as implicit suggestions, Zax offers to my view the best definition of migration when he says that "***a move is a migration when the worker leaves one housing-and-labor market to relocate in another***" (*ibid.*). This definition is more appropriate than others for it is grounded on the notion of regional markets, instead of, for instance, distance thresholds or administrative boundaries which might not reflect the reality of real estate markets. In operational terms, the closest translation of this definition would be the notion of residential **moves exiting a metropolitan area**.

The choice of placing the market at the center of the definition of a migration is motivated by the postulate that housing-and-labor markets are the natural framework of reference for job/housing decisions, as they are characterized by specific wage and housing price functions. The latter are the product of various factors, such as population, employment, local amenities, access to markets, and production technologies (among other things). In other words, **housing-and-labor markets would define expectations for wages and housing prices, setting the framework in which the household thinks and takes its residential decision, in conjunction with its job decision** (including keeping the same job). This links this definition to the works of urban

[9] The fact that there is a specific word for long-distance mobility, "migration", and none for short-distance mobility, is quite interesting in this regard.

[10] To the best of my knowledge, the situation has not changed much since then, and later works still remain unclear or inconsistent about this notion (e.g., Dieleman 2001, Gobillon 2001, Debrand and Taffin 2005).

economics,[11] as one must assume that housing-and-labor markets and their associated wage and housing price functions exist and are consistently defined. The monocentric city model actually represents the ideal analytical framework in this regard: it provides a theoretical basis to justify the existence of these wage and housing price functions and derive them. The situation could be more complex in case of polycentric metropolitan systems, however. Additionally, the issue of the interstitial space, namely the rural area, is not addressed by this definition at all. This might explain why politico-administrative divisions are still often preferred in practice. Regardless, Zax's proposal provides a clear and consistent basis to converge towards a uniform definition of migration, which would constitute a significant step forward in residential mobility analysis.

c) Few facts about short vs. long distance mobility

The empirical literature confirms and specifies the above statements. First, all works on residential mobility report or find that **long-distance moves are relatively infrequent** in comparison to short-distance ones. In the case of France, inter-regional mobility only accounted for 21% of all residential moves during the period 1999-2002 (Debrand and Taffin 2005). As mentioned above, long-distance mobility is also generally accompanied by a job change (Zax 1994). Conversely, **residential and workplace relocations are substitutes within a same region**, meaning that they are much more frequent alone than together (Linneman and Graves 1983, Zax 1991). Once again, this is consistent with the previous statements.

B-3. Residential mobility 2

Considering the fact that there is little literature dedicated to short-distance mobility, the reviews first keeps on addressing residential mobility as a whole. On the other hand, issues and factors specific to migration are presented separately in *B-4*.

a) The influence of life-cycle and household composition

Since the seminal work of Rossi (1955) which gave the initial impulse, there is now considerable history concerning the study of the influence of the life-cycle on residential mobility, and several regularities were observed across the globe. First, there is a strong relation between the propensity to move and the **stage in the life-cycle** of an individual. In all developed countries, young adults aged between 20 and 35 are by far the most mobile population segments, and residential mobility typically falls as one gets older.[12] Secondly, **changes in the personal, educational, or employment domains** are common triggers of a residential move (Dieleman, Clark, and Deurloo 2000). Among

[11] Note that this *rapprochement* is unequivocally supported (1994).
[12] See Long (1992) for an international analysis, Debrand and Taffin (2005) for French data.

other things, this encompasses leaving home, changes in household composition (e.g., getting married, birth of children, divorce), or getting a new job. Given that most of those triggering events are concentrated at the beginning of adulthood, this partly explains why mobility decreases with age. In addition, Dunn (2003) finds that the size of the (S, s) band is broader for older households, which implies that the **psychic cost of moving increases with age**. This provides another explanation to the lower propensity to move of this household category.

Considering what was just said, it seems pretty clear that **household composition** is to impact residential mobility in various ways. First, living as a couple automatically entails a move from either one or the two partners. On the other hand, an employed spouse hampers mobility (Böheim and Taylor 1999, Gobillon 2001, Debrand and Taffin 2005). If a move occurs anyway, the longer the distance, the higher the probability of the spouse becoming unemployed or inactive (Courgeau and Meron, 1995). The impact of children is relatively complex as they tend to increase mobility at first, but ultimately decrease it (Gobillon 2001). Indeed, once the family has settled in a sufficiently large and comfortable home, a residential move would cause the children to lose contact with most of their friends (Long 1972), and potential troubles to adapt to their new school might affect their future school results (Long 1975).

Household composition also influences the decision-making process itself. According to Molin (1999), households of more than one person tend to use two higher-order constructs to come to a joint statement of their residential preferences. More specifically, housing characteristics are divided into two main groups:

- Dwelling characteristics: the key considered elements are tenure, dwelling type, the number of rooms, and price or monthly rent.
- Location characteristics: households are mainly concerned with the type of neighborhood, the general accessibility to activity places (including workplaces, schools, etc.), and the frequency and proximity of public transit.

Although this provides first clues as to how families and more generally households take joint decisions, significant work remains to be done on this topic (Dieleman 2001).

b) Is commuting an issue?

The **influence of commuting** on residential mobility is **highly controversial**, and many antagonistic points of view coexist on this topic.[13] In new urban economics, commuting costs are central in the location choice (→ *D-1*). Thus, one might expect this variable to also exert a significant influence in the decision to move (for instance, if the commute

[13] Quigley and Weinberg (1977, p.54) had already noted in their time that "*there is no consensus on the effects of accessibility, workplace location, and workplace change on subsequent* [residential] *mobility*".

gets longer due to congestion, or in case of job change), an opinion shared by Zax (1994). On the other hand, Simmons concludes following a review of early literature on intra-urban mobility that "*all studies reject job location as an important reason for moving*" (Simmons 1968, p.637), although conceding that "*the place of employment may act as a constraint when it comes to selecting a dwelling*" (p.646). Indeed, it is quite obvious that commuting is at some point an issue, as one cannot live in one continent and work in another (at least not with our current technology). The question is thus: to what extent?

A key issue when studying the link between employment location and residential mobility is that when facing costly commute (be it in time or money), two options arise: **moving or quitting**. The existence of a strong connection between the two processes is a well-established fact, theoretically and empirically (Zax 1994, Böheim and Taylor 1999, Gobillon 2001). The disagreement lies in the precise nature of this interaction. Böheim and Taylor (1999) are probably the most radicals in this regard, as they find commuting time to exert no significant influence on residential mobility. When Zax and Kain (1991) conclude that the longer the commute, the less likely moves are and the more likely quits are, implying that households would mainly resort to the "quit" strategy, Van Ommeren *et al.* (1999) find in the same case that moves and quits are both more likely. In the case of workplace relocation, Zax and Kain show the probability of a residential move to increase significantly with the distance between the new workplace and the old residence (Zax and Kain 1996). In short, this brief overview has, if anything, underlined the current lack of consensus over this topic, meaning that this case is not closed yet.

c) Housing tenure

Housing tenure represents with age and household composition one of the dominant correlates of the propensity to move (Dieleman, Clark, and Deurloo 2000, Debrand and Taffin 2005). According to the first source, private renters are in general three to four times more likely to move than home owners. This ratio is relatively accurate in the case of France, where tenants of the private sector, and of the social sector to a lesser extent, are much more mobile than home owners (Debrand and Taffin 2005, see also *Chapter 0*, *subsection I – D-2*).

Several elements account for these differences. First, search costs and transaction costs are typically higher in the case of ownership.[14] In the case of the social sector, the fact of enjoying lower rent represents a disincentive to mobility, especially to the long-distance one (Debrand and Taffin 2005). There is also strong basis for **self-selection**, as

[14] Note that while the acquisition of a new home involves substantial search and transaction costs (Hubert 2006), this is also the case when willing to sell your former home (Coulson and Fisher 2009). In sum, home owners willing to move and buy a new residence are doubly handicapped. Concerning transaction costs in France, see *Chapter 0*, *subsection I – D-1*.

households with long expected lengths of stay tend to opt for ownership, and conversely (Haurin and Gill 2002). This phenomenon is related to the above indicated search and transaction costs, but also to the fact that ownership provides the greatest freedom as to how to maintain and improve your dwelling, especially in the case of detached housing. Households willing to invest in their dwelling would therefore logically buy instead of renting (Hubert 2006).

d) Additional factors

Length of housing tenure

The length of housing tenure is often cited as a deterrent to mobility. The rationale is that people **accumulate a specific type of capital with time spent in a given location**. This includes among other things the knowledge of the neighborhood, the development of a social network (Schwartz 1973, Kan 2007), or the investment in decorating and furnishing the dwelling. All these elements contribute to increase the costs of moving, monetary and non-monetary alike. In the case of the private rental sector, regulations favorable to tenants regarding rent increases, or similarly discounts given by landlords to avoid costly changes of tenants might also account for lower mobility (Hubert 1995).

As a consequence, most empirical works find the length of housing tenure to decrease the household propensity to move (Böheim and Taylor 1999, Gobillon 2001). Let us highlight two limitations though. First, the length of housing tenure might capture part of the effect of job tenure if this last variable is not considered in the regression, as these two variables are significantly correlated (Bartel 1979). This point could explain why Gobillon (2001) finds the length of housing tenure to have an influence on long-distance mobility but not on the short-distance one. Were it not for the argument of Bartel, this result would be difficult to account for. Secondly, it is quite likely that households have **idiosyncratic tastes for stability**. Given this postulate, some households are willing to move and change jobs frequently, while others long for the greatest possible stability as discussed in *B-1.e)*. Length of housing tenure would in this case be strongly correlated with the household type, resulting in biased estimates.

Borrowing constraints

Besides altering tenure structure (→ *C-1*), borrowing constraints also exert a significant influence on residential mobility. Indeed, those prevent part of potential moves toward the homeownership sector from occurring. The overall impact on residential turnover is not straightforward though, for at least three reasons:

- Constrained households may move within the rental sector instead. Consequently, lower mobility toward the ownership sector are compensated for by higher mobility toward the rental sector (Ioannides and Kan 1996).
- Borrowing constraints might merely delay the move.
- Residential turnover could rise through a structure effect, as borrowing constraints result in a higher share of tenants, who are the most mobile category (→ *c)*).

In spite of the first point, Zorn (1989) and Gobillon and Le Blanc (2008) both find that **borrowing constraints hinder mobility**. However, as it is not clear to which extent they address the last two issues in their model, their results remain subject to caution.

Unemployment

Unemployment is found to have **mixed effects** in the literature: at the individual level, unemployment experience increases the likelihood to proceed to a residential move, especially a migration (Pissarides and Wadsworth 1989, Debrand and Taffin 2005). Unemployed individuals have fewer incentives to stay and might expect better job opportunities in other regional labor markets. On the other hand, the overall unemployment level exerts a negative influence on mobility (Debrand and Taffin 2005). The effect is more significant for unemployed people, whom bad economic prospects discourage to move (Pissarides and Wadsworth 1989).

Government interventions

According to Strassmann (1991), government interventions have a "*strong side effect of **lowering residential mobility***". In an international analysis of residential mobility rates, he finds this element to be a better predictor of housing turnover than tenure structure. Notwithstanding, this has to be considered as a general rule, and specific policies might obviously facilitate residential mobility.

B-4. Theoretical and empirical analyses of migration

After presenting the main theoretical frameworks to study migration, including meso- and micro-models, a survey of the main determinants of migration is proposed based on an overview of the empirical literature.

a) Meso-models of migration and the constant utility principle

Although differing in various regards, most recent theoretical models of migration are based on the utility maximization principle. Under this assumption, households wish to settle in the region yielding the highest utility. Like potential differences create electric current between two points, **utility differences generate flows of households directed from low-utility to high-utility regions**. In this setting, a network of cities (or regions) is characterized at equilibrium by a constant utility for all mobile households.

A first and well-known application of this framework is the monocentric open-city model. This model basically assumes that the level of the city population adjusts itself to equate household utility with a national equilibrium level, which is exogenous.[15] The underlying mechanism is as described above: a higher population increases competition for land, thereby reducing utility and ultimately driving part of excess households away (and conversely). In sum, congestion acts as a back-pulling force ensuring the stability of the equilibrium. However, the constant utility principle is in this context an elegant way to close the model rather than a premise to study migration patterns.

The New Economic Geography, founded on the twofold keystone constituted by Krugman (1991, 1993), provides a more enlightening insight in this regard. It is a branch of neoclassical economics which aims to explain size differences between regions. The standard model takes place in a two–region setting, with either part or the whole population being mobile. Centripetal and centrifugal forces are modeled, and utility is *in fine* a function of regional population. In this general analytical framework, **migrating to the other region can be the result of agglomeration forces or on the opposite the consequence of excessive congestion or competition in the region of origin**. Once again, regional utilities are equal at equilibrium. Although several equilibrium patterns are possible (including a symmetric allocation), the only stable one would typically consist of a central region and a satellite one.[16] The strong appeal of this theory is that unlike the basic open-city monocentric model, where migration boils down to equating population across regions, it accounts for regional disparities: regions are more or less attractive, and this **attractiveness is at the core of migration patterns**.

A SIMPLE EXAMPLE OF A MODEL OF REGIONAL MIGRATION: ANAS (1992)

Anas (1992) offers a simple two–zone model which illustrates the above framework tellingly. In his model, an increase in population brings about an increase in per–capita output (*via* localization economies), but a decrease in per–capita land consumption. This results in an inverted U–shaped utility function $V(n_i)$, n_i standing for the population of city *i*. In addition, a dynamic adjustment mechanism operates migration from the lowest to the highest utility location. In Anas' model, the agglomeration force is thus the economies of scale, while the competition for land acts as a repulsive force.

[15] → *D-1* for a presentation of the monocentric model.

[16] The purpose of this subsection is not to present in detail the findings of the New Economic Geography, rather to focus on its contribution in accounting for the phenomenon of migration. This is why drastic simplifications are made. In particular, the role of the level of transportation costs in determining the stable equilibrium pattern (symmetric vs. asymmetric) is deliberately not addressed here. Similarly, while a classic issue is that of optimal city size, it is once again not exposed here. See Combes, Mayer, and Thisse (2008) for more on this topic.

b) The decision to migrate: an individual perspective

Parallel to the previous literature, another strand has focused on the decision to migrate from an individual perspective. The gist of this literature is to **identify the costs and benefits of migration**, and reflect upon how these two elements vary with individuals. An important though indirect contribution in this field is provided by Sjaastad (1962), who casts the migration issue into a basic allocation problem, resulting in migration being considered as an investment increasing the productivity of human resources. Migrating involves private costs on the one hand, including out of pocket moving expenses and the psychic costs of changing one's environment. On the other hand, monetary returns to migration take the form of a positive or negative increment to the stream of real earnings, the increment depending on the changes in nominal earnings, costs of employment, and prices. Although the private and public spheres are strongly intertwined in Sjaastad's work,[17] the **Cost-Benefit Analysis** clearly takes shape.

Following this line of thought, Puig (1981) carries the analysis further and models the migration decision as a **trade-off between future earnings and location preferences**. In addition, there is imperfect information, implying that individuals, who are risk-averse, base their decision on future expectations. A first consequence is that **information and risk-aversion both exert a significant influence on the migration decision**. Individuals are less reluctant to migrate when they know what they will get, even more so when they have strong risk aversion. Secondly, young households logically value discounted wages over a longer term than old households. As a result, the former are chiefly concerned by employment prospects (including real wage differentials), while they care less about the uncertainty about their future environment than old households for whom location preferences are paramount.

c) The main determinants of migration

While previous models provide a sound theoretical background to explain migratory movements, they are obviously unfit to derive structural models, since it is extremely hard, if possible at all, to measure the utility of living in one city compared to another. On the other hand, it is fairly easy to track flows of population between regions, and the empirical literature has thus focused on uncovering the main determinants of this variable, mainly using simple linear regressions (with possible sophistications).

[17] The issue of migration is *a priori* considered from a public perspective, the question being what is the best spatial allocation of human resources considering a starting position and the costs and benefits of migration. However, it is private considerations that *in fine* underlie the decision to migrate or not.

Let us briefly present **incentives and hurdles to migration** based on the survey made by Ghatak, Levine, and Price (1996) for a start. The main driving forces of migration that are identified are:

- **real wage differentials**;
- **unemployment differentials**;
- **attractive amenities** (public goods, climate,[18] etc.);

while the two main hurdles to migration are:

- the **costs of migration** (which may be pecuniary, social, etc.);
- **risk aversion** of potential migrants.

This short list is fairly consistent with the theory, and most elements previously cited appear. One can first note that the influence of various factors should vary by age bracket according to Puig (1981), nonetheless. Furthermore, several significant issues are omitted, including:

- **The role of information**: according to Wasmer and Zenou (2002), distance to job opportunities has a negative influence on information gathering. A first way to cope with this difficulty is to migrate first and search onsite, which implies that the migrant already has optimistic expectations about employment prospects. Otherwise, regions providing readily available information about job opportunities (good websites, national press, etc.) should be more attractive.
- **Educational attainment**: in the same line of thought, because better educated people can make easier use and analyze sophisticated sources of information, they should show a higher propensity to migrate. Another important factor in this regard is that as a general rule, the higher the qualification of a job, the higher the recruitment area (Schwartz 1973).
- **The presence of family or friends**: first, getting closer to one's family can be the primary motive of a migration, especially for older people (Gobillon 2001). Regardless, the presence of family or friends at the zone of destination mitigates the cost of migration, monetary (it provides solutions as to where to stay for the first few days) and psychic alike, and makes the job hunt from afar easier (Bauer, Epstein, and Gang 2000). Conversely, the development of a social network at the zone of origin is a hindrance to mobility as was discussed before, a hindrance which proves even more important in the case of migration (Kan 2007).
- **Job tenure**: as job tenure usually involves the acquisition of specific experience, status, and wage, one might expect it to have a negative influence on the propensity to migrate, a hypothesis corroborated by Bartel (1979).

[18] Cf. Rappaport (2007).

The last two factors cannot be readily considered in aggregate models. One would have to resort to disaggregate modeling (such as logit models) to take those into account. Lastly, most factors having an influence on residential mobility as a whole should logically have to some extent an influence on the propensity to migrate.

C CHOOSING DWELLING CHARACTERISTICS

As stressed in *General Introduction*, the housing market is characterized by the fact that it offers **heterogeneous goods**. In fact, each housing unit is unique to a certain extent. Because dwelling on this consideration precludes any kind of research, researchers have progressively endeavored to represent the heterogeneity of housing ($\rightarrow A$) and study it.

Concerning housing demand, this involves first determining which characteristics matter in the residential choice, and to what extent. There are two ways to tackle this issue, which are to use either stated preferences (e.g. Louviere 1979) or revealed preferences. Considering limitations inherent to the first method, including the paucity of data in France ($\rightarrow$ *Chapter 0*, *section III*), the review focuses on methods based on revealed preferences. Except for a few exceptions, including the tenure choice (thus dealt with separately in *C-1*) or the location choice (for which exist alternative theories exposed in *subsection D*), most works dealing with the choice of residential characteristics use either one of the two main theoretical frameworks, namely discrete choice theory and hedonic analysis. These two main strands are presented in *subsection C-2* and *C-3*, respectively.

C-1. The choice of housing tenure

a) Standard approaches to the tenure choice

The issue of tenure choice holds a specific place in housing economics, as it gives birth to a prolific literature. It may be divided into three main branches.

Housing: an asset like any other?

A first strand focuses on the notion of housing as a **financial investment**, and makes use of the standard tools of portfolio analysis. A housing unit is an asset, which is risky due to the uncertainty on future prices and potential rents. As cleverly highlighted by Kain and Quigley (1972), housing plays a specific role in the dynamics of wealth accumulation of low- and middle-income families for at least two reasons. First, other forms of investment such as the stock market "*require far more knowledge, sophistication and discipline*", and secondly "*low- and middle- income households have more leverage available in the real estate than in other investment markets*" (op. cit.). Consequently, **home equities have a dominant position in the asset portfolios of these income brackets**.

In a seminal work, Henderson and Ioannides (1983) have set the basis for the analysis of tenure choice and of the household investment behavior. Based on the consideration that partial-ownership arrangements are hardly feasible, the crux of their housing investment-consumption model is an **investment constraint** that requires home owners to own at least as much housing as they consume. While their model does not consider other risky assets besides housing, Brueckner (1997) has successfully filled this lack by carrying out the same reasoning in the presence of multiple risky assets. Flavin and Nakagawa (2008) study for their part the investment behavior of households in the presence of both durable (housing) and non-durable goods, as well as adjustment costs for the housing good.[19]

A "micro" approach to tenure decision

Another approach is presented and discussed in Kain and Quigley (1972), and more recently in Magnan and Plateau (2004). It bases the tenure decision on a meticulous **financial analysis of the different options**, using the standard indicators in this field. Typically, the costs of renting and owning are assessed on a yearly basis, according to a baseline investment plan for the ownership case (acquisition then reimbursement of the mortgage) which incorporates loan conditions. These costs are then used in an actuarial calculus taking various parameters into account, such as taxation, transaction costs, or expected length of tenure. Compared to the previous one, this approach is primarily intended to evaluate a small number of options, and sort them according to various financial indicators.

Statistical approaches

Lastly, a large body of literature has adopted a more neutral approach, based on sheer statistics with little economic founding,[20] to try and uncover the many variables exerting influence on the household decision. Probit or logit models are especially rife in this strand. At first, the stress was put on four categories of factors:

- **Household socio-economic characteristics**, which include race in the U.S. case.[21] Gyourko and Linneman (1996) underline for this country the growing influence of labor market conditions as compared to demographic factors such as marital status or family type.
- **Household life–cycle attributes**: in particular, the odds of ownership drastically rise as the head of the household gets older and the household gets bigger (Li 1977).

[19] Other works on this topic include Fu (1991), Flavin and Yamashita (2002), or Arrondel and Lefebvre (2001).
[20] I argue that this literature has little economic founding since it seldom seeks to explain why renting or owning yields different utilities for the various household categories.
[21] While this issue has largely been addressed in the U.S. (e.g., Kain and Quigley 1972, Li 1977, or Gyourko and Linneman, 1996), such works are less frequent in France since ethnicity remains a "hot topic".

- **Permanent income**, which was shown to be more reliable indicator than yearly income (Kain and Quigley 1972). Wealth also exerts significant influence on the tenure choice, in particular due to borrowing constraints (see below). Data on this topic are seldom available however, and few studies include this variable.
- The **relative cost of owning versus renting** (Hendershott and White 2000).

Later works have underlined other factors influencing tenure choice, such as:

- **Path dependence**: homeowners rarely revert to renting unless their household splits up (Michelson 1977).
- The **tax system** (Brueckner 1986): in the U.S., home ownership is usually less costly than renting due to tax exemptions on capital gains (Hendershott and White 2000).
- **Transaction costs** and expected length of stay (Haurin and Gill 2002).[22]
- **Borrowing constraints**: following the seminal works of Linneman and Wachter (1989) and Zorn (1989), this issue stimulated numerous papers, reviewed in Gobillon (2008). Because borrowing constraints may prevent households from choosing their optimal value of housing stock, it has a negative impact on the ownership rate.
- The **risk** carried by housing prices (Turner 2003), income (Diaz-Serrano 2005), or rents (Sinai and Souleles 2005). In the first two cases, risk reduces the odds of home ownership for risk-averse households. Inversely, uncertainty on rents increases them. When two of these elements carry uncertainty, risk insurance mechanisms may arise. This is the case when income is correlated with rents (Ortalo-Magné and Rady 2002) or housing prices (Davidoff 2006). In the latter (former) case, the propensity to home ownership (tenancy) increases because housing prices (rents) serve as an insurance mechanism against income shocks.

b) Limitations of standard approaches and unaddressed issues

Despite the significant advances made concerning the ins and outs of the tenure choice, four limitations must be highlighted.

Firstly, Gobillon (2008) illustrates in the case of borrowing constraints that some factors may have a more important impact in hindering residential mobility rather than in altering the household tenure decision (→ *B-3.d)*). Consequently, it is important to **consider the decision to move and the tenure choice simultaneously**.

Secondly, the choice of applying for **social housing** has yet to be properly addressed by this field of research. Most of the literature gives little attention to social housing,[23]

[22] As seen in *Chapter 0*, transaction costs are substantial in the French housing market. For reminder, in the second-hand property market, they represent 14% of the transaction amount in France, against 12% in the U.S. (Laferrère and Le Blanc 2006). In the rental market, they typically amount to one month worth of rent.

[23] Anas and Cho (1985) is one exception. However, being an extension of the applied model CATLAS to include the various forms of social housing in Sweden, it is closer to urban modeling than to housing economics.

and only considers owner-occupiers and private renters. As far as France is concerned, social housing is characterized by eligibility rules and a potentially long waiting period before the acceptance of the application ($\rightarrow$ *Chapter 0*, *subsection I – B*). Besides, while the household enjoys cheaper rents than in the unregulated market, it has to choose among a limited number of options, barring any precise pick of dwelling characteristics.[24] Lastly, social housing units are often located in lower quality environments. All these aspects differentiate social housing from the private rental market and render current models irrelevant, at least in the French context. Among the few works on this subject, Magnan and Plateau (2004) and Laferrère (2008) underline the low incentives for social tenants to move towards the property market considering the low level of rents they benefit from. But they fail to analyze how these households ended up in social housing in the first place.

Thirdly, there exist several other factors which may influence the household decision and are difficult to test in practice. This includes the role of ownership as an **edge against inflation** (Kain and Quigley 1972), or the freedom it provides as regards the way to accommodate, decorate, and do works in one's home (Hubert 2006, Coulson and Fisher 2009). Moreover, while most of the models are based on sound financial and economic mechanisms that affect the household decision, tenure choice may stem from less pragmatic reasons.[25] Households could excessively fear being homeless, especially after their retirement, which drives them to acquire their own home. Ownership also has an **affective dimension** in our societies based on consumption and indeed ownership, inclining individuals towards this form of tenure. Lastly, many households consider rents as "money wasted" in a simplistic but widespread way of thinking (since rents are but the counterpart of monthly payments of home loans). While the significance of these rationales has yet to be assessed, it is clear that the tenure choice is generally more than just the outcome of a complex financial analysis.

Lastly, **available housing supply** is seldom considered in the literature on tenure choice. This is detrimental to the quality of results inasmuch as household may opt for ownership because the rental market does not offer dwellings matching their needs (Taffin 1987). The **role of space** is another shortcoming, as stressed by Hilber (2005) when he claims that "*research about the role of location specific factors as determinants of the homeownership status of properties is a widely underdeveloped area*".[26]

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[24] That is unless you have connections with your city mayor…

[25] Le Blanc and Lagarenne (2004) argue that were it not the case, household portfolios would be more diversified than the way they are now. See also Magnan and Plateau (2004) on this point.

[26] While Hilber (2005) constitutes a noteworthy exception by tackling the role of various urban amenities on the home ownership rate, the analysis focuses on uncertainty issues (more precisely on the relationship between the neighborhood externality risk and housing price volatility, and its impact on the homeownership rate). The extent of neighborhood externality risks and their influence on housing prices have yet to be confirmed, however.

C-2. A disaggregate approach to the choice of dwelling characteristics: discrete choice theory

Following the pioneering work of Luce (1959), completed by the equally seminal one of McFadden (1973), the use of discrete choice theory has quickly spread to various fields of research, such as the analysis of travel demand (cf. Ben-Akiva and Lerman 1985). As far as housing demand is concerned, the early contributions of Quigley (1976), Lerman (1977), and McFadden (1978) have set the basis for the analysis of residential choices in this theoretical framework, which I am now going to present.[27]

a) Basic theoretical set-up

Discrete choice theory owes its name to the fact that it addresses the situation where an individual must choose among a **finite number of well-identified options**. Each of the *N* options yields a different utility, which is given in the case of option *i* by:

$$U_i = \overline{U}_i + \varepsilon_i \qquad (DC1)$$

where ε_i is a centered random variable and $\overline{U}_i$ the **strict** (or deterministic) **utility** of option *i*. Assuming a linear utility function, ($DC1$) can be rewritten as:

$$U_i = \sum_{k=1}^{K} \beta^k X_i^k + \varepsilon_i \qquad (DC2)$$

where $\left(X_i^k\right)_{k\in[1,K]}$ is the vector of the characteristics of option *i*, and $(\beta^k)_{k\in[1,K]}$ the set of parameters of the utility function measuring how individuals value each one of these. Given the assumption that individuals are rational and seek to maximize their utility, this leads to the following maximization problem:

$$\max_{i\in[1,N]} \overline{U}_i + \varepsilon_i \qquad (DC3)$$

When ε_i follows a **Gumbel** or **type I extreme value distribution** with variance σ^2, one can show that the probability π_i of choosing option *i* is:

$$\pi_i = \frac{e^{\theta \overline{U}_i}}{\sum_{j=1}^{N} e^{\theta \overline{U}_j}} \qquad (DC4)$$

where $\theta = \pi/\left(\sqrt{6}\sigma\right)$. This specific case is called the **multinomial logit model** (MNL). It is likely the most frequently used specification among those allowed by discrete choice theory. Let us note one last important finding, which is that the expected utility is given by the following formula, named log-sum:

$$\mathbb{E}\left(\max_{i\in[1,N]} U_i\right) = \frac{1}{\theta} ln \sum_{j=1}^{N} e^{\theta \overline{U}_j} \qquad (DC5)$$

[27] This subsection only intends to give an overview of discrete choice theory and focuses instead on applications to the housing market. For more on this topic, see the reference book by Anderson, de Palma, and Thisse (1992).

b) Assumptions and extensions

The MNL specification holds several assumptions which are discussed at length in Skaburskis (1999). Among these, the assumption that the random error terms $(\varepsilon_i)_{i\in[1,N]}$ are independent and identically distributed (i.i.d.) and follow a Gumbel distribution is probably the most often discussed. As a matter of fact, a corollary of this assumption is what Luce calls the "***independence from irrelevant alternatives***" (Luce 1959) or IIA, meaning that "*the relative odds of two alternatives are independent of the attributes, or even the availability, of any other alternative*" (Mc Fadden 1978).

Besides the IIA, another direct consequence of the above assumption is that the random error terms are uncorrelated. This point entails a serious shortcoming, first enounced by Debreu under the form of the **blue bus/red bus paradox** (Debreu 1960). Alternative specifications enable one to overcome this difficulty (e.g., nested models, network GEV models), but often at the cost of greater complexity.[28]

c) Application of discrete choice theory to the housing market

Discrete choice theory can be applied to a vast amount of issues, ranging from the sole choice of tenure (Li 1977) to the complete choice of all housing characteristics as is done in urban and LUTI modeling (→ *section II*). Besides this last specific case, it is generally used to **analyze the choice of a small number of characteristics**, for instance, tenure, tenure plus building type (Cho 1997), or the decision to move completed by the tenure choice (cf. Gobillon 2008).

A recurrent issue is to understand the process of the household residential choice. In particular, several researchers have **tested whether households establish a hierarchy between the various alternatives** by testing nested models against simple MNL models. Intriguingly, an initial overview of the literature reveals that MNL models fare better or as well as nested models (Tu 1994, Skaburkis 1999), which could stem from the limitations inherent to the nested formulation (Daly 1987). However, when alternatives are numerous, as it is the case in applied modeling, the assumption that the random error terms are uncorrelated is dubious at the least and should be thoroughly tested.

Lastly, let us note that discrete choice theory is often preferred to hedonic analysis to study individual choices, based on the claim that "*hedonic price functions provide limited information about consumer behavior*" (Cho 1997 based on Ellickson 1981). Notwithstanding, both methods provide meaningful insights into household residential preferences, and a more systematic comparative analysis of the two has yet to be done.[29]

[28] Cf. Garcia-Castello and Leurent (2007) for a recent review of the various specifications currently in use at the international level.

[29] See de Palma *et al.* (2009) for a first endeavor in this direction.

C-3. Picking a bundle of housing attributes: hedonic theory is the key

Following the seminal work of Rosen (1974) mentioned in subsection A, a large body of literature has tackled the issue of household preferences *via* the study of housing prices. The main premise of hedonic analysis is that households value goods for their various characteristics, and that the real estate market reflects these valuations through the formation of prices. The **housing attributes** can be intrinsic (number of rooms, home size, presence of a parking lot, etc.) or extrinsic (view, quality of the neighborhood, etc.).

Once again, this subsection only aims at a brief introduction to hedonic analysis. Presentation is mostly based on Cavailhès (2005), who offers a thoughtful survey of works on this topic.[30]

a) Basic theoretical set-up

In the framework of hedonic analysis, a household j with characteristics α_j maximizes a utility function including among its arguments the set of characteristics $H = (x_1, \dots, x_n)$ of the housing unit. This is formally translated as:

$$\begin{gathered} \max_{z,H} U(z, H, \alpha_j) \\ s.t.\ p(H) + p_z z = Y_j \end{gathered} \qquad (HP1)$$

where $p(H)$ is the price of the home, Y_j the household income, and z a composite good standing for all other goods in the economy. z can be taken as the *numéraire*, meaning that its price p_z can be arbitrarily set to 1 without affecting the results.

b) The two steps of the hedonic analysis

The hedonic analysis consists in **two successive steps**:

- The first one is the estimation of **implicit prices**, i.e. the function $p(H)$.
- The second one is to estimate for any given characteristic i the **demand function** $x_i(p, Y_j, \alpha_j)$.

The second step is extremely rarely performed, first because of its technical complexity, secondly because it involves specific data requirements (Cavailhès 2005). Yet, this step provides the most interesting results as far as household preferences are concerned, inasmuch as it gives the price and income elasticities of any housing characteristic.

While cases of naïve estimations of the hedonic price function are rife, the first step also involves **substantial methodological difficulties**, discussed at length in Sheppard (1999). In particular, the use of linear specifications for the function $p(H)$ is frequent, even though it is not methodologically sound due to endogeneity issues (Sheppard 1999).

[30] See also Sheppard (1999) for another excellent introduction to hedonic analysis, in English to boot.

c) Applications to the housing market and discussion

The scope of issues that may be tackled using the hedonic analysis is unbelievably vast. Any amenity can be examined as long as it is correctly reported in the chosen database, which has brought about the analysis of the impact of elements such as the view afforded by the location, the climate, or even the presence of jails in the neighborhood. Hedonic analysis also allows one to test one of the main predictions of the monocentric city model, which is the decrease of housing prices with distance to the CBD ($\rightarrow D$).[31]

Contrary to discrete choice models which are best used when dealing with a small number of options, the quality of a hedonic model is highly dependent on the level of detail, and more especially on the **inclusion of all relevant variables**. On the one hand, this leads toward a comprehensive analysis of the housing market, and the hedonic framework appears as a powerful approach to integrate all kind of housing attributes. On a more practical note, this has led to hardly comparable studies as each one has its own list of variables, which implies in turn extremely contrasted results. This point is well illustrated in Cavailhès (2005). Added to the fact that any form of misspecification, inconsistency in the data, or bad instrument can substantially undermine the quality of the estimation, this highlights all the difficulties associated with hedonic analysis.

D DETERMINANTS OF THE LOCATION CHOICE

Prior to the above works based on discrete choice theory or hedonic analysis, another section of the economic literature had already begun to investigate the location choice. These works generally disregard any intrinsic housing characteristics besides home size, and focus on the residential location and its connection with job location (*D-1* and *D-2*), segregation mechanisms (*D-3*), and all kinds of "location amenities" in general (*D-4*).

D-1. Tell me where you work, I will tell you where you live: the monocentric city model

The canonic model of urban economics, namely the **monocentric city model**, studies the **connection between employment and residential location**. The premise of this literature is that commuting is costly and thus affects the household residential choice. After exposing how this is modeled, borrowing the formalism developed in Fujita (1989), I present the main characteristics of housing demand in the monocentric urban model, and lastly discuss the assumptions and then the model in general.[32]

[31] See Deschamps (2008) for a good survey of this topic

[32] Presentation of the monocentric model owes much to Fujita (1989) and Fujita and Thisse (2003).

a) Theoretical set-up: the household maximization problem

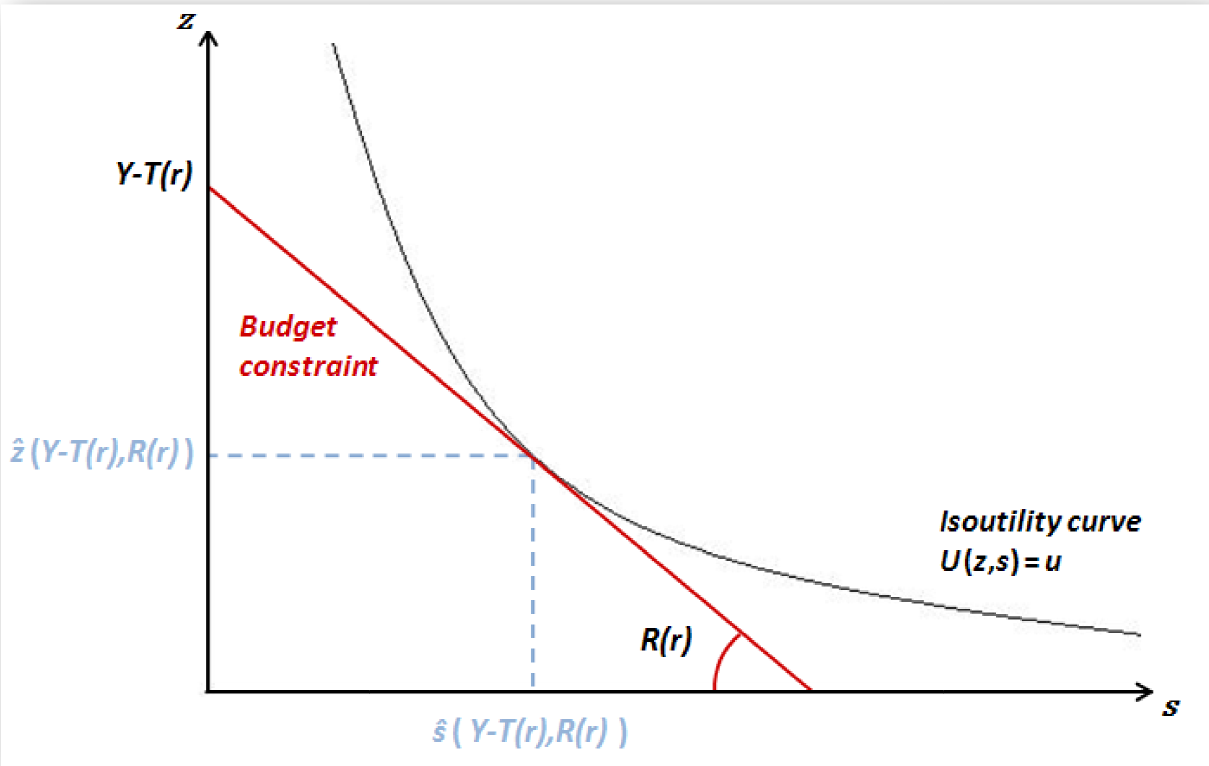
In the “basic” version of the monocentric model, as exposed in Fujita (1989, chapter 2), housing demand is actually a **demand for land**, households being assumed to build their own home. Demand is derived from the household utility maximization problem, which takes the following form:

$$\max_{z,s,r} U(z,s) \qquad (M1)$$
$$s.t.\ R(r)s + z + T(r) = Y$$

Given a location r, households proceed to a trade-off between two goods: **land**, s denoting land consumption or lot size, and a **composite consumer good** standing for all other goods in the economy, the consumption of which is measured by z. This composite good is taken as the *numéraire*. Relative income and relative land price at location r are denoted by Y and $R(r)$, respectively. In this simplified version of the monocentric model, **demand for accessibility** is encapsulated in the budget constraint, which incorporates a commuting cost $T(r)$ to the Central Business District (CBD).

When r is fixed, the household maximization problem is equivalent to the standard case of consumer theory. It can be solved graphically using the budget constraint line and indifference curves (*Figure 45*).

FIGURE 45: THE HOUSEHOLD MAXIMIZATION PROBLEM



At location r, household disposable income is $Y - T(r)$ and land rent $R(r)$. This leads to the red budget constraint line. Utility is maximized when the isoutility curve is tangent to the budget line, with the corresponding solution $(\hat{s},\hat{z})$.

Analytical derivation gives the Marshallian demand for land as a function of disposable income $Y - T(r)$ and land rent $R(r)$: [33]

$$\hat{s}\big(Y - T(r), R(r)\big) = \underset{\substack{z,s \\ R(r)s+z=Y-T(r)}}{\operatorname{argmax}} U(z,s) \tag{M2}$$

The household then chooses its location by maximizing the optimal utility solution to the previous problem over feasible locations. This is formally translated as:

$$\max_{r}\left\{\max_{\substack{z,s \\ R(r)s+z=Y-T(r)}} U(z,s)\right\} = \max_{r} V\big(Y - T(r), R(r)\big) \tag{M3}$$

where $V(Y,p)$ is the indirect utility function.

THE MONOCENTRIC CITY MODEL, A SHORT HISTORY

The paradigm of urban economics, namely the monocentric city model, aims to explain household residential choices in a metropolitan area through three main elements:

- a major spatial heterogeneity, materialized by a central point where all jobs are located, the **Central Business District**, and associated with isotropic **commuting costs**;
- a **trade-off** between three elements concerning the residential choice *per se*: **accessibility**, **space**, and a composite good;
- competition for land between city residents and the agricultural sector.

The monocentric city model originates from **Von Thünen's seminal work** on the location of agricultural activities in a plain, which he explains by the existence of a market place and the ensuing transportation costs (Von Thünen 1826). The market place, which is where farmers gather to sell their production, is assumed one to be unique, two to be in a fixed location. Transportation costs vary from one good to another and are borne by farmers.

The first main finding of the model is that activities the most sensitive to transport costs and the least land consuming are located near the market at the equilibrium land-use, when activities less sensitive to transport costs and requiring more land are located further. The second one is that **land rent decreases with distance to market place**. This stems from the increase of transport costs with distance which reduces farmers' capacity to pay for land.

Following the pioneering works of Isard (1956), Beckmann (1957), and Wingo (1961), **Alonso (1964)** developed the first monocentric city model integrating the same notion of bid rent curves as in Von Thünen's works. Various researchers have then greatly contributed to improve the monocentric city model, primarily Muth (1969), Mills (1972), and Fujita (1989), which is now a reference book concerning the theoretical aspects of the model.

[33] Disposable income generally refers to household income net of tax. The use of this term in this context makes sense insomuch that transport costs are an expense over which households hold no control (besides through the location choice).

b) Main characteristics of housing demand in the monocentric city model

Two elements characterize household housing demand in the monocentric model:

- **location**;
- **quantity** (here lot size).

Once more, the model simultaneously addresses two of the four main issues identified in introduction. The two elements are simultaneously determined, with the underlying assumption that households are **perfectly informed**. They consider all feasible options and select the optimal one in accordance with their utility function. On the other hand, the household decision to move and the choice of housing characteristics are seldom represented in this strand of literature. Few exceptions are presented further. However, the crux of the monocentric model lies in the formation of the equilibrium rent curve, which governs both location and lot size choices**.**

To provide more specific results about housing demand in the monocentric model, an additional assumption is necessary: the **normality of land.**[34] Given this assumption, one can show that land consumption $\hat{s}\big(Y - T(r), R(r)\big)$:

- decreases with transport costs;
- decreases with the level of land rent.[35]

The household location choice results from the trade-off between these two items. It is a trade-off, indeed, as at equilibrium land rents capitalize the accessibility of a location, and thus decrease with respect to distance to CBD (Fujita 1989).

To be thorough, let us point out one particular aspect concerning housing demand in the monocentric city model. Demand is continuous and not discrete, households being assumed to be of negligible size relatively to the whole population.[36]

[34] A good is said to be "normal" when the associated demand has a positive income elasticity. This assumption is supported empirically in the case of land/housing (Fujita 1989, pp.20-21).

[35] These two results may seem trite. Yet, one should bear in mind that they are contingent on the normality assumption, and that most of the subsequent analysis of the monocentric model stems from these simple results.

[36] This point gave birth to a rich debate between theoretical economists about whether the continuous monocentric city model is well founded or not. Several attempts were made to link the continuous model to the discrete one. There are two main approaches: on the one hand, some economists such as Papageorgiou and Pines (1990) propose a transformation that sets a correspondence between continuous and discrete models on a geometric basis. On the other hand, Asami, Fujita, and Smith (1990) study asymptotic distributions of discrete models and the question of convergence between these and continuous models. Berliant (1991) argues that despite these works, several issues are not addressed. In particular, land consumption is a surface in the discrete model, while it is a density in the continuous model (households consume infinitesimal parcels of land), leading to inconsistencies. To the best of my knowledge, this debate, stimulating but highly technical, remains unresolved at the present day.

c) Model assumptions: those that matter and those that do not

The monocentric city model makes various assumptions, being a simplistic yet powerful representation of reality. These are structured around key topics as a guideline for the following discussion. When an assumption is of small or moderate importance, it is explained why that is so. Otherwise, the review of the main model extensions ($\rightarrow$ *D-2*) highlights to what extent results depend on each of the remaining assumptions.

Transportation system

($T1$) The transportation network is assumed to be dense,

($T2$) and “unimodal”.

($T3$) Transport costs only include monetary costs,

($T4$) are isotropic,

($T5$) only determined by location,

($T6$) and increase with distance.

As far as ($T4$) and ($T6$) are concerned, the introduction of anisotropic or non-increasing transport costs should not be problematic as it merely induces a transformation of space.[37] The same holds true concerning ($T1$), which is mainly made for the sake of simplicity. ($T2$) should be understood as the fact that only one mode is available at each location. The existence of various modes throughout the city (e.g., public transit in the city center, car in the periphery) has no importance whatsoever for the model. The only thing that actually matters is the structure of transport costs. Given this point, ($T2$), ($T3$), and ($T5$) are all significant assumptions, and several extensions study how modifying them alters equilibrium patterns ($\rightarrow$ *D-2*).

Housing market

($H1$) Each household manages the construction of its house by itself. In other words, the housing industry is not represented.

($H2$) Only the private rental sector is represented.

($H3$) Land is owned either publicly or by absentee landlords.

($H4$) Dwellings are perfectly homogeneous.

This time, all assumptions are clearly important ($\rightarrow$ *D-2*).

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[37] Since transport costs are in $\mathbb{R}^+$, locations can be indexed by $t \geq 0$ instead of using polar coordinates (r, θ), where t is the transport cost to the CBD. In this setting, usual integrations are carried out over the set of feasible t. $T(r, \theta)$ must verify a few conditions, however, to ensure that $\int_{T(r,\theta)=t} L(r, \theta)$ exists and is finite for all $t \leq Y$.

Households

($HH1$) There is only one household type, meaning that households all share the same characteristics.

($HH2$) Households have homogeneous preferences, in the sense that their utility does not include a random component such as in random utility theory.

Once again, ($HH1$) and ($HH2$) are both important and are discussed in *D-2*.

Employment

($E1$) All jobs are located in the CBD,

($E2$) and there is only one type of job, yielding a fixed wage Y.

Idem.

Space

($S1$) There exists a CBD prior to the settlement of households.

($S2$) Space exerts influence on household residential decisions only *via* transport costs.

The preexistence of the CBD is paramount and secondary at the same time. Paramount inasmuch as it explains **why people gather in a city**. Without this spatial heterogeneity, agglomeration cannot occur based on Starrett's spatial impossibility theorem (1978).[38] Yet, it is **merely a way of explaining the existence and structure of transport costs**. When the transportation technology is not explicitly represented, it does not matter where employment is located and whether it is localized or not. The one important thing is that settling at distance r from a point named CBD entails the transport expense $T(r)$. Only if one wants to study specific transportation technologies (e.g., by considering congestion or various transport modes), does employment location become crucial. All in all, the CBD is generally an appropriate way to introduce transport costs in the model, no more, no less.

Regarding ($S2$), considering the role of location directly in the utility function greatly enhances the complexity of the problem, which is why utility is generally a function of z and s exclusively. The famous work of Brueckner, Thisse, and Zenou (1999) illustrates this point tellingly: the introduction of amenities in the utility function leads to multiple equilibriums, and findings remain relatively vague due to the analytical complexity.

[38] This issue has brought about a vast amount of literature inquiring into the origin of cities. In an attempt to overcome the assumption of a preexistent CBD, several works endogenize the formation of city centers using agglomeration mechanisms. See the reference book of Fujita and Thisse (2002 in English / 2003 in French), or more recently Mori (2006).

d) Discussion

As exposed above, housing demand, which encompasses location and land consumption, chiefly depends on the following factors in the standard monocentric city model:

- job accessibility through transport monetary costs;
- the relative land rental price (trade-off between land and the composite good).

The paradigm of urban economics thus lies in the **trade-off between accessibility and space**. The search for accessibility leads to higher population densities, whereas the yearning for residential space exerts the opposite effect.[39] In this simplified framework, **transport is central in influencing residential decisions**.

As a result, the monocentric city model is a powerful tool to understand how evolutions in the transportation system have shaped cities (e.g. Gin and Sonstelie 1992). Comparative statics, first performed by Wheaton (1974), also give interesting insights into the role of population and economic growth in urban sprawl. As a matter of fact, two predictions of the monocentric city model have led to intensive empirical testing. The first one is the capitalization of accessibility by real estate prices. The second one is the impact of various variables on the density curve (primarily the fact that it decreases with distance to CBD, but also the effect of population, income, and so on).[40]

D-2. Extensions of the monocentric city model

Because this was still not enough, many works proved the usefulness of the monocentric framework by extending the model to take other key economic mechanisms into account. Several major extensions are now outlined, structured according to the above guideline.

a) Transportation system

A first set of extensions has improved the representation of the transportation system and tested how it changes results. Two main issues are often addressed: the co-existence of various transport technologies, hence addressing (*T1*) and (*T2*), and congestion (*T5*).

A good representative of the first strand is provided by Anas and Moses (1979), who study the combination of a dense secondary transportation network with a primary network that is both sparse and radial (representing mass transit or expressways). They show that various urban forms can emerge at the equilibrium land-use depending on the characteristics of each network, and determine the areas of prevalence of each mode. The fundamentals of the model remain unchanged, however.

[39] This is in the case of transport technologies where cost increases with distance.

[40] Regarding the first point, I suggest the reader to refer to the recent work of Deschamps (2008). Otherwise, see Anas, Arnott, and Small (1998) for a brilliant discussion of the second point.

On the other hand, congestion adds a new consideration in residential strategies by introducing interaction between household location choices. This point is especially cogent in the case of new radial infrastructures. While these make remote locations attractive at first, due to affordable housing and good access to the CBD, households may ultimately regret their move when excess migration to the periphery results in high levels of congestion. One related issue is that of optimality based on this new externality (see Fujita 1989 or the recent contribution of De Palma *et al.* 2008).

Another important issue is that of daily travel-times and the **Value of Time (VoT)**. In the standard framework, time spent in transportation is beyond scope, while it is known to exert a significant influence on household residential decisions ($\rightarrow$ *Chapter 2*). The easiest way to overcome this difficulty is to replace the usual monetary cost by the **generalized cost of travel**, which incorporates a valuation of time spent in commuting. In this setup, transport costs depend on household income inasmuch as it determines the VoT (and the transport mode). The second method, more satisfactory and realistic, involves adding a **time budget constraint** to the household maximization problem.[41]

b) Employment

During the last two centuries, the development of new transport systems (mainly roads and railways) combined to lower transportation costs and increased speeds has fostered **job decentralization.**[42] Therefore, the assumption that all jobs are located in the CBD is somehow unrealistic nowadays. The monocentric urban model allows for job dispersion as long as employment conserves a circular symmetry and is less dispersed than residences, i.e. that any circle contains more jobs than houses (Solow 1973, White 1988). In this case, wages vary over location and offset differences in commuting costs.

In a different direction, a seminal work by Kain (1968) has given birth to a prolific literature on the issue of **spatial mismatch**. While this literature sheds significant light on this phenomenon from both a positive and normative point of view, it basically relies on the monocentric framework (sometimes replaced by a simplified two-zone model), introducing few new elements as far as residential strategies are concerned. This includes the role of distance to employment on available information (Wasmer and Zenou 2002) and the issue of redlining (Zenou and Boccard 2000).[43]

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[41] The first method implicitly assumes that income and monetized time are fungible, that is to say that leisure time can be considered as being equivalent to buying additional composite good z, which seems unrealistic. Moreover, severe difficulties arise when trying to determine the time endowment that must be added to income. The second method is exposed in Fujita 1989, pp.31-38.

[42] See Anas, Arnott, and Small (1998) about job decentralization in the U.S. and the decline of traditional CBDs.

[43] See Gobillon, Selod, and Zenou (2007) for an insightful review of literature on spatial mismatch.

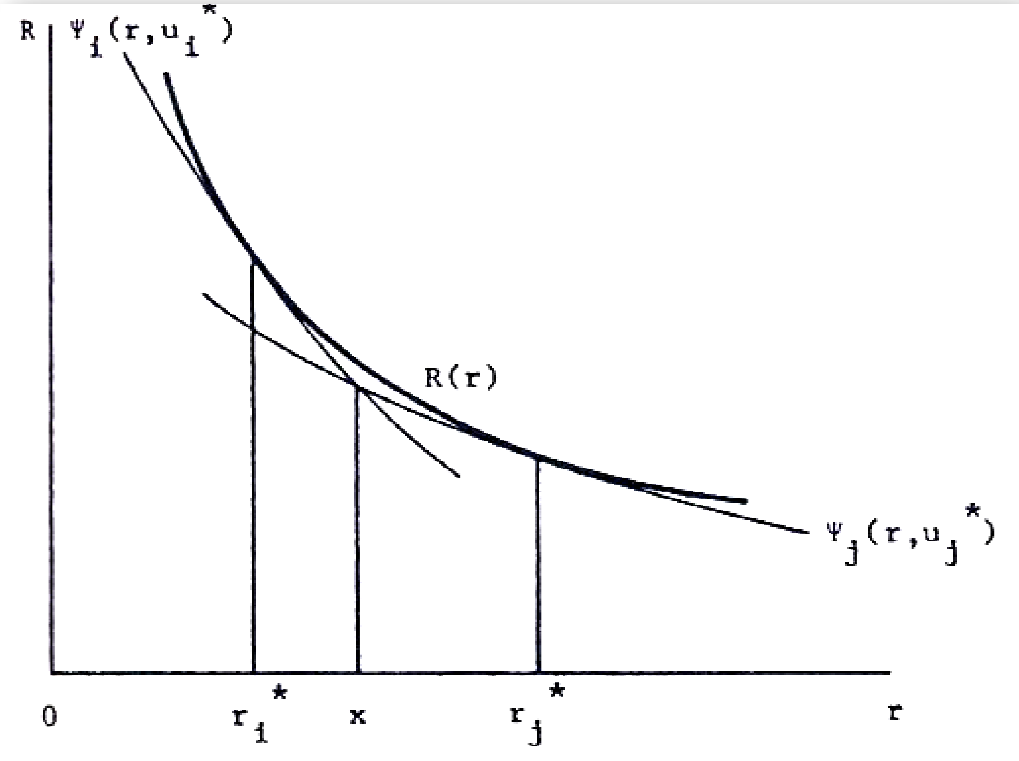
c) Towards a better representation of the household

A key extension concerning the representation of households lies in the introduction of **several income classes**. This extension, studied at length in Fujita (1989), is made easier by the notion of **bid rent curves**, which are now widely used in urban economics. Bid rent $\Psi_Y(r,u)$ is defined as the maximum land rent per surface unit that a household with income Y is willing to pay at location r, given a target utility u:

$$\Psi_Y(r,u) = \max_{z,s}\left\{\frac{Y-T(r)-z}{s}\middle|U(z,s)=u\right\} \qquad (M4)$$

Under standard assumptions, one can show that $\Psi_Y(r,u)$ decreases with both r and u. Furthermore, the **steepness** of the bid rent curve mirrors the willingness to live close to the CBD. In theory, low income households have steeper bid rent curves than rich ones inasmuch as they are more affected by transport costs, and thus locate closer to the CBD (*Figure 46*). [44] This result is frequently mentioned to account for the phenomenon of **income sorting** and the localization of low-income households in the city centers of U.S. metropolitan areas.

FIGURE 46: BID RENT CURVE AND EQUILIBRIUM LOCATION, RICH VS. POOR HOUSEHOLDS



The poor household is denoted by index i, the rich one by index j. For each household, the bid-rent curve must be tangent to the land rent curve at the optimal location. Because the bid-rent curve of the poor household is steeper than that of the rich one, the above figure illustrates why the former locates closer to the CBD than the latter.

Source: Fujita (1989)

[44] A demonstration of this result is provided in Fujita (1989), pp.28-29.

The hypothesis of a complete income sorting, as suggested by the previous result, is challenged by the observation that income actually varies to a substantial extent within neighborhoods (Ioannides 2004), a phenomenon named **income mixing**. Various theories have been developed to account for this point, which are thoroughly reviewed in Ortalo-Magné and Rady (2008).

Another extension of the monocentric model (Fujita 1989, based on Beckmann 1973) simultaneously considers the **household structure** (size plus the number of workers) and a time–budget constraint. Using the bid rent approach, one can show households with larger proportions of workers to locate closer to the CBD than the others, inasmuch as they are more affected by commuting costs. [45]

Lastly, Anas (1990) addresses the issue of **taste heterogeneity** using discrete choice theory. He shows taste heterogeneity to reduce the pressure in the housing market, which flattens bid rent curves and leads to larger cities. When the variance of the error term tends toward zero, the model converges towards the standard monocentric model.

d) Towards a better representation of the housing stock

While various works aim to improve the representation of the household to gain further understanding about the formation of housing demand, other authors pointed out the need for advances concerning the **representation of the housing stock**. In this regard, the introduction of the housing industry by Muth (1967, $\rightarrow$*A-1*) is a major improvement as it allows one model supply-based retroactions in the operation of the housing market. This modification does not modify the household location behavior, however.

An insightful extension of the monocentric urban model is proposed by Brueckner and Rosenthal (2006), who argue the **age of the housing stock** to be a decisive variable to understand the patterns of income sorting. In fact, this argument is not recent and is better known as the hypothesis of **filtering**, which has been extensively documented. [46] The basic idea is that as the quality of a building decreases with time, from an absolute as well as relative point of view inasmuch as new buildings are usually better equipped. As a result, income levels continue decreasing as new residents replace old ones, until the building is inhabited by only low-income households. When it occurs, urban renewal leads to gentrification and the eviction of the former inhabitants, allowing the cycle to start anew.

[45] Fujita (1989) shows this result in the case of a log–linear utility function and in the absence of nonwage revenues.
[46] See Olsen (1969) for an introduction to this notion.

e) Taxation

The introduction of taxation in the monocentric city model is likely one of the simplest extensions. Fujita (1989, pp.83-88) discusses distortions brought about by basic tax systems, which are flat rate or proportional taxations. Mainly, addition of taxes results in lower utility at equilibrium, lower housing demand and thus a smaller city.

D-3. Tell me who you are, I will tell you who you live with: models of segregation and social interaction

Alongside the development of the monocentric literature, research developed in a different direction to explore another important aspect of the residential decision, which is the **choice of neighborhood**. The issue of segregation in the U.S. has clearly been central in accounting for the development of this literature. Unlike the monocentric city model, the transport system is seldom represented and the choice of housing quantity is often overlooked. In other words, among the four main constituents of housing demand, the emphasis is wholly put on the location choice, and all other issues are disregarded. A presentation of three seminal works pertaining to this strand of literature as well as some of their extensions ensues.

a) Schelling's model of segregation

With his famous games taking place on either a line or a 2-dimensional chess board, Schelling (1969, 1971) provides a meaningful insight into the dynamics of settlement. He shows how very **specific patterns such as complete segregation can stem from decentralized decisions**, thereby indicating a form of auto-organization.

The model studies the impact of neighborhood composition on location choices. Two types of households are considered, differing only by their color (black or white). Individual housing demand is unitary,[47] and location is chosen on the sole basis of neighborhood composition. At each period, households assess whether they are satisfied with their current situation. If not, they move to the closest available and satisfactory location, until an equilibrium solution is reached. Schelling shows **complete segregation** to be the **typical outcome** of this game, individuals of the same group localizing in either one large district or a collection of clusters, which are the formal equivalent of "ghettos". The crux of the model is that even minor forms of aversion to the other group can ultimately lead to perfect segregation.[48]

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[47] One household equals one housing unit, with the underlying assumption of indivisibility of the housing good.
[48] In Schelling's original model, the rule stipulates that black (white) households do not want to live in white (black) ghettos. More specifically, if the share of neighbors of the other color exceeds a specified amount, households locate elsewhere. This means that households do exhibit some propensity to segregation, but still tolerate the other color to

This simple model proves powerful to explain the emergence of segregation in a relatively realistic dynamic setting. Furthermore, additional developments by Schelling shed light onto the emergence or not of ghettos upon the arrival of waves of immigrants. Past a certain threshold, segregation forces are set into motion, eventually giving birth to ghettos.[49] Although primarily applied to the analysis of racial segregation, Schelling's framework allows one to examine to a certain extent any kind of preferences in terms of neighborhood composition (social groups, income-based, and so on).

b) "Good neighbors": the Becker and Murphy model

Becker and Murphy (2000) study the impact of neighborhood composition and exogenous amenities on household location choices in a standard economic framework, based on the early work of Becker (1957). Unlike Schelling's model, system dynamics are not specified. On the other hand, the model features a basic representation of the housing market, and the analysis focuses on the market equilibrium resulting from the interaction of households' residential choices.

The model takes place in a two zone setting. Two types of households, named H and L, are to settle in one of the two zones, named A and B. The willingness to pay of type j household to be in zone i takes the following form:

$$V_{j|i} = V_{j|i}(h_i, a_i) \quad \begin{matrix} i \in (A, B) \\ j \in (H, L) \end{matrix} \qquad (BM1)$$

where h_i is the share of type H households in zone i and a_i the level of exogenous amenities in zone i. $V_{j|i}$ increases with both h_i and a_i. Contrary to the previous situation, **both household types seek the vicinity of one specific group** generating positive externalities, the H population.[50]

Let us disregard the issue of exogenous amenities for now, discussed further in *D-4*. In order to fix upon where to live, households maximize their surplus $P_i - V_{j|i}(h_i, a_i)$, where P_i is the price of a housing unit in zone i. As in Schelling's model, the residential choice boils down to the location choice, which depends exclusively on neighborhood composition. Housing demand is once again taken as unitary.

When a zone has a higher concentration of H than the other one, the fact that H individuals yield positive externalities results in an **agglomeration force** which attracts

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a more or less important extent. Emergence of perfect segregation under this context is likely Schelling's model most striking result. Further works have even showed that preference for racial mixing could still lead to high degrees of segregation when coupled to aversion to living in ghettos (Pancs and Vriend 2007).

[49] See the movie Gran Torino for a brilliant depiction of such a phenomenon in the U.S.

[50] This means that the presence of H individuals yields positive externalities for all households. One might think of rich households who attract high quality services and finance high levels of local public goods, or of well – educated and behaving communities with low levels of criminality.

all households and ultimately leads to higher housing prices. Two alternatives arise then. If the L group has a greater willingness to be near the H one than H individuals themselves do, the equilibrium outcome is **perfect mixing**.[51] In the opposite situation,[52] L individuals are excluded from the H ghetto, leading to **perfect segregation**. The silver lining is that the L group is compensated with lower housing prices in this last scenario, because of the **capitalization of the positive externality** by housing prices.

c) The Tiebout hypothesis

In his famous article "A Pure Theory of Local Expenditures" (Tiebout 1956), which originally aims to provide a non-political solution to the issue of free-riding in public economics, Tiebout proposes another economic mechanism explaining the phenomenon of segregation, and in particular income sorting. As previously, the analysis places the focus on the equilibrium rather than on dynamics, and the model intends to show the **role of the provision and financing of public services in residential choices**.

In the original version of the model, the metropolitan area is divided into various jurisdictions offering different levels of publics services at a variety of prices (tax rates). Individuals may settle in any community, with the additional assumptions of perfect mobility (i.e. no moving cost) and perfect information. The crux of the model is that **individuals have heterogeneous tastes for public services**. As a consequence, they look for communities that are in accordance with their tastes. Furthermore, the ability to pay for public services also varies across individuals as a result of income heterogeneity. The main finding of the model is that because residents can "**vote with their feet**", jurisdictions and residents will determine an equilibrium provision of local public goods in accord with residents' tastes, hence sorting population into optimum communities.

In direct line with the Tiebout hypothesis, the issue of **local taxation** is paramount in understanding household location choices, as suggest Nechyba and Walsh (2004). They argue that "*homogeneous suburban communities allow high-income households to escape redistributive central city taxation while improving the quality of public goods*" (Brueckner and Rosenthal 2006).

To conclude, let us note that the Tiebout model is most accurate in suburban areas with several independent communities. The cost of moving between communities tends to be lowest in these areas, and the set of possible choices is very diverse.

[51] Under this assumption, L individuals outbid H individuals in a zone with a high level of H population. Consequently, part of H individuals is forced to move to the other zone, evening the amount of H in each zone. This back-pulling force also ensures the stability of the equilibrium.
[52] E.g. when H individuals are endowed with a higher income and can thus pay more than L individuals to stay together.

D-4. The role of amenities

In a fashion similar to Schelling or Becker and Murphy, other economists, including Diamond (1980), Fujita (1989), and Brueckner, Thisse, and Zenou (1999), incorporate amenities into the utility function in an extended version of the monocentric city model. For the sake of brevity, the review focuses on this last work.

The standard monocentric city model is amended by integrating exogenous and endogenous amenities in the utility function, which thus becomes:

$$U = U(z, s, a, \bar{Y}) \qquad (AMEN1)$$

where a and $\bar{Y}$ measure the level of exogenous amenities and average income in the neighborhood, respectively. $\bar{Y}$ is taken as a proxy for the level of endogenous amenities. Households take a and $\bar{Y}$ as given (i.e. they exert no "market power") when choosing their location. In sum, the basic derivation of the household maximization problem remains unchanged in each location, but **the steepness of bid-rent curves is affected by the gradient of amenities**.

The introduction of amenities has a twofold impact, in a way fairly similar to what occurs in Becker and Murphy's model (2000):

- **Amenities raise the level of housing prices** inasmuch as households value them.
- **Spatial variations in the level of amenities may alter the equilibrium land-use**. In the present framework, if the bid-rent curve of rich households is affected to the point that it becomes steeper than that of poor households (because of high levels of amenities near the CBD), the standard pattern low-income households near the CBD, high-income ones in the suburbs, is reversed.

As stated by Brueckner, Thisse, and Zenou (1999, p.91), "*the virtue of the theory is that it ties location by income to a city's idiosyncratic characteristics. It thus* ***predicts a multiplicity of location patterns across cities****, consistent with real-world observation*". According to the authors, and based on the argument cited above, this theory explains why low-income households are localized in city centers in the U.S. when they are often evicted from these same areas in Europe, hence the title of the paper.

While this approach, very close to the one proposed by Becker and Murphy (2000), looks promising because of its seeming simplicity, it induces three major difficulties. The first one is that it greatly increases the complexity of the analytical derivation, which forces Brueckner, Thisse, and Zenou (1999) to remain relatively vague about the domain of validity of their findings. The second one is that the presence of endogenous amenities entails **multiple equilibriums**. Lastly, the issue of **how to measure amenities** in practice remains largely unanswered.

DEFINITION AND TYPOLOGY OF AMENITIES

Amenities are any tangible or intangible benefits of a property, especially those which raise the attractiveness or value of the property or contribute to its comfort or convenience. Customarily, two types of amenities are distinguished in the economic literature:

Exogenous amenities: amenities that are not influenced by current households' residential choices, such as historical monuments, landscape, and so on.[53]

Endogenous amenities: amenities depending on neighborhood composition (through the average income level, preferences for public goods, etc.). Typical examples of endogenous amenities are public facilities, services, or the level of criminality.

Note that **neighborhood composition** is already in itself an endogenous amenity. The fact that it is originally a specific field of research accounts for the choice of presenting models of segregation and social interaction separately. Withal, inasmuch as endogenous amenities are often measured by a proxy based on the composition or average income of the neighborhood, one could argue that there is a thin line between the two.

To conclude, let us also note that while various intrinsic housing attributes are considered as amenities in everyday language (e.g. a swimming pool), the economic literature restricts the use of the term "amenity" to **extrinsic housing attributes**.

[53] There is obviously a limit to the notion of exogeneity, the extent to which humans can alter their surroundings being unfathomable. This notion always refers to a set of assumptions, usually a scenario with no drastic change, no extraordinary event, and a timeframe limited to a few decades at the very most.

II - HOUSING IN APPLIED MODELING: FROM MECHANISTIC MODELS TO MICROSIMULATION

Urban and housing economics have proved more than helpful in identifying most of the economic forces at work in the housing market. Yet, many urban and transportation modelers soon argued that their representation of the housing market and their findings were hardly transferrable to applied modeling, for they were too stylized. [1] These practitioners, while aware and influenced by the economic literature, still chose to distance themselves from this field and began to develop models of their own.

The first noteworthy generation of applied models is traditionally attributed to Lowry (1964). His seminal model gave rise to countless extensions, presented for the most part in Batty (1976). Based on the nomenclature proposed in DSC *et al.* (1999) and represented in *Figure 47*, those were mostly static models: there is no notion of system dynamics, models only providing the long-term equilibrium. At some point static models were disparaged, and the most cited argument to account for this downfall states that **urban systems involving several processes with differing temporalities**, static models could not possibly be realistic. Be that as it may, it is rarely argued why this would preclude any form of long-term equilibrium or even make this notion irrelevant.[2] After Lowry, the second most influential contribution in this field was probably brought by Wilson (1974). His work led to a second wave of models, named entropic models because of their affiliation to statistical physics. Few years later, spatial-economics models made use of Lowry's and Wilson's findings and completed them by a more thorough description of the economic system based on Leontief's Input–Output framework. [3] However, entropic and spatial-economics models were soon found to be guilty of the same charge, implying that cross-sectional models could not possibly well represent the various temporalities of the urban system. [4] This last consideration resulted in the development of activity-based modeling, which focuses on "*the different processes of change which affect activities and the spaces they occupy; they are therefore the complete opposite of general equilibrium modeling*" (DSC *et al.* 1999). In particular, recent activity-based models often include micro-simulation techniques.

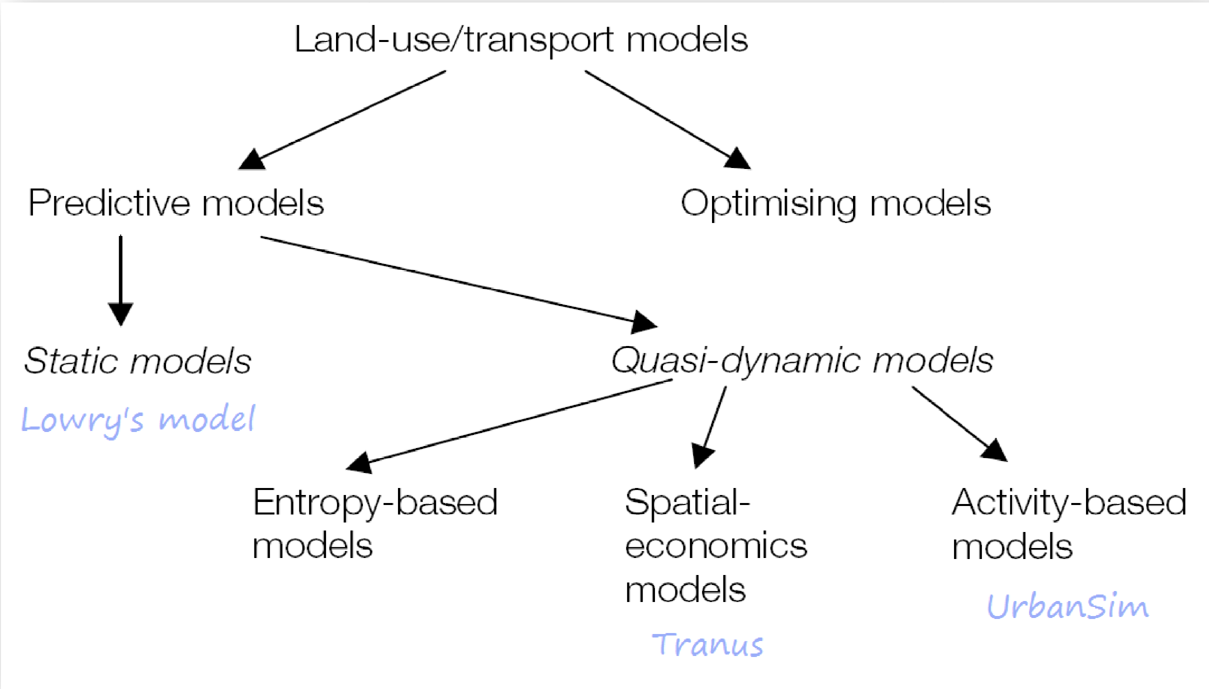
[1] The controversy over the relevance of the monocentric framework marks the epitome of this line of thought.

[2] PIRANDELLO, a LUTI model developed by Cofiroute and Vinci for the Greater Paris Region, constitutes a stimulating attempt at reinstating static modeling. A presentation of this model is available in *Supplement 2*. Note that I concur with DSC *et al.* (1999) on their discussion about the relevance of static models.

[3] See Leontief (1986) for an introduction to input-output economics.

[4] Cross-sectional models are calibrated on one time period, and predict the spatial distribution of all activity in each time period, rather than predicting changes from one time period to the next.

FIGURE 47: CLASSIFICATION OF LUTI MODELS



Quasi-dynamic models have a treatment of time, simplified into discrete periods, and at least some of the relationships within the model include lagged variables. This is different from the traditional economic meaning of "dynamic", which implies that economic agents may react in real time to changing conditions, hence the term "quasi-dynamic".

David Simmonds Consultancy & Marcial Echenique and Partners Limited (1999) + Author

This section intends to describe and analyze the representation of housing demand in applied modeling. **In no way does it purport to provide a review of these models**. There is a plethora of urban and LUTI models, meaning that it would be hardly possible to address all of them in a single review (if there was ever a point in doing so). Besides, there are already countless reviews of past and current LUTI models.[5] Instead, the focus is put on three specific models as good representatives of their own kind, namely the Garin-Lowry model, TRANUS, and UrbanSim. All along the following presentation and discussion, it is specified whenever possible which elements are common to all models in the category, and which are specific to the model under scrutiny.

Lastly, **the scope is purposely restricted to models with minimum economic founding**. While multi-agent programming, fractal models, and cellular automata are extremely fashionable,[6] I believe those to be of little interest for public policy analysis. Notwithstanding, comparing the explanatory powers of economic vs. non-economic models might constitute an interesting exercise, and possibly prove me wrong, but such is not the purpose of the present work.

[5] Among others, let us cite Wegener (2004) for a recent, quasi-exhaustive, but rather general review, and DSC *et al.* (1999) which includes detailed descriptions of various LUTI models in appendix. For French references, see Deymier and Nicolas (2005) for a well-handled review and PREDIT (2008) for current French projects.
[6] At least in France where we are several years late on this topic, as is usual regarding urban modeling.

A HOUSING DEMAND IN SPATIAL INTERACTION MODELS

The term "**spatial interaction model**" is borrowed to De la Barra: it encompasses static, entropy-based, and spatial-economics models, which have in common an at least partially **aggregate approach** of the problem (De la Barra 1989). In particular, the study area is divided into a finite number of zones, often of relatively large size and characterized by stock variables (e.g., population, jobs, housing stock, etc.). Transport costs are measured accordingly, that is from centroid to centroid. All these features are consistent with the fact that spatial interaction models are based on macro/meso–simulation (rather than on micro–simulation).

A-1. A first, mechanistic urban model: the Garin-Lowry model

Lowry's model (Lowry 1964) is considered first for a twofold reason: on chronological grounds, and also because it has been highly influential to LUTI modeling as a whole (being the reason why it was picked among all static models). However, considering the substantial improvements brought by Garin (1966), the modified Garin-Lowry (G-L) model is presented instead of the original one. [7] The mathematic formulation of housing demand is described first, followed by a discussion of its main characteristics. Lastly, the main extensions aiming to refine the representation of housing demand in the G-L model are reviewed. Given our study topic, the analysis focuses on housing demand; a general presentation of the model may be found at the end of this subsection.

a) Mathematic formulation of housing demand

The representation of housing demand in Garin-Lowry's model is based on the previous work of Hansen (1959). In this modeling framework, **housing demand stems from labor demand**, in a way similar to the monocentric model. To illustrate how the G-L model operates, let us consider E_i jobs located in zone i among the set of N zones forming the whole study area. These jobs induce in the model a demand for H residents, with $H = u.E_i$ and u being the population-to-employment ratio. Those H residents are then distributed spatially according to the following **gravity formulation**:

$$R_{ij} = (u.E_i)\frac{w_j e^{-\beta c_{ij}}}{\sum_{k=1}^{N} w_k e^{-\beta c_{ik}}} \qquad (G\text{-}L1)$$

where R_{ij} is the number of residents working in zone i and living in zone j, w_j the residential attractor weight of zone j, and c_{ij} the transport cost from zone i to zone j.

[7] Garin (1966) has greatly improved Lowry's work by casting the whole model in matrix notation and explicitly introducing the gravity formulation. Garin's formulation, with Lowry's zonal density constraints reintroduced, is known as the "modified Garin-Lowry model" (Berechman and Small 1988).

b) At first glance: a simple and aggregate representation of demand

In the modified Garin-Lowry model, **housing demand is only defined by its location**. Dwellings are not represented as the model only aims to forecast populations per zone. Furthermore, total population is directly obtained by multiplying total employment by u. In other words, there is no demographic model: the population forecast entirely relies on a regional forecast of basic employment external to the model (or inversely).

Another key characteristic is that housing demand is modeled at the aggregate level directly. The household as an economic agent is not represented. This merely reflects the gravity formulation, which is the expression of a mechanistic vision of the urban system. Still, one can note that $(G\text{-}L1)$ is similar to a multinomial logit formulation, implying that the G-L model might have a micro-economic foundation after all. While this is true to some extent (Anas 1983), discrete choice theory was to be developed only several years later. $(G\text{-}L1)$ should thus be interpreted in a macroscopic way: it is an **aggregate demand function reproducing macroscopic regularities** in the spatial distribution of households, nothing more, nothing less.

c) On second thought: an opportune extension of the monocentric framework....

Housing demand in zone j deriving from jobs located in zone i depends:

- negatively on transport cost c_{ij} from zone i to zone j;
- positively on the residential attractor weight w_j.

The first feature enables the model to **represent the space-accessibility trade-off** of urban economics to some extent. β, which represents sensitivity to transport costs, may actually be related to the slope of the bid rent curve: the higher β, the more sensitive households are to transport costs and the closer they locate to jobs. Furthermore, while the G-L model assumes a strong regularity in the spatial distribution of households relatively to employment (via an exponential density function), such regularity seems to be backed by data when taking into account multiple employment centers (Anas, Arnot, and Small 1999, pp.22-23). Indeed, another strong asset of the G-L model is that it may represent and deal with **multiple job centers** in a simple and efficient way, thereby extending the monocentric model in a more realistic setting.

Lastly, the fact of weighting exponential terms by the set of attractors $(w_k)_{k\in[1,N]}$ allows overcoming the famous "blue bus/red bus" paradox described in Debreu (1960). In point of fact, the additive formulation ensures that housing demand is independent of zoning, implying that splitting a zone into two does not artificially raise demand in the original zone. However, the attractors (w_k) must be extensive variables and transport costs only marginally affected by the split for this property to be true. The latter point involves that the zoning system should be consistent with the transportation network.

d) … still showing clear limitations

On the other hand, one first important drawback of the G-L's framework is that the location procedure is relevant for working households only, whereas unemployed and inactive households account for a sizable share of the population. Furthermore, the **space-accessibility trade-off is basically the only mechanism represented**, and several elements discussed in section *I* of this chapter are not taken into consideration, viz. amenities, taxation, and so on.

Another issue lies in the set of factors $(w_k)_{k\in[1,N]}$. These have no economic founding, and are a pure byproduct of the model (they are first given as inputs then adjusted to meet residential density constraints). More generally, one must bear in mind that as mentioned above, **the Garin-Lowry model has little economic foundation**, and is a relatively mechanistic location model. In particular, there is no representation of the housing market, including housing stocks, prices, and so on.

e) Extensions of Lowry's model

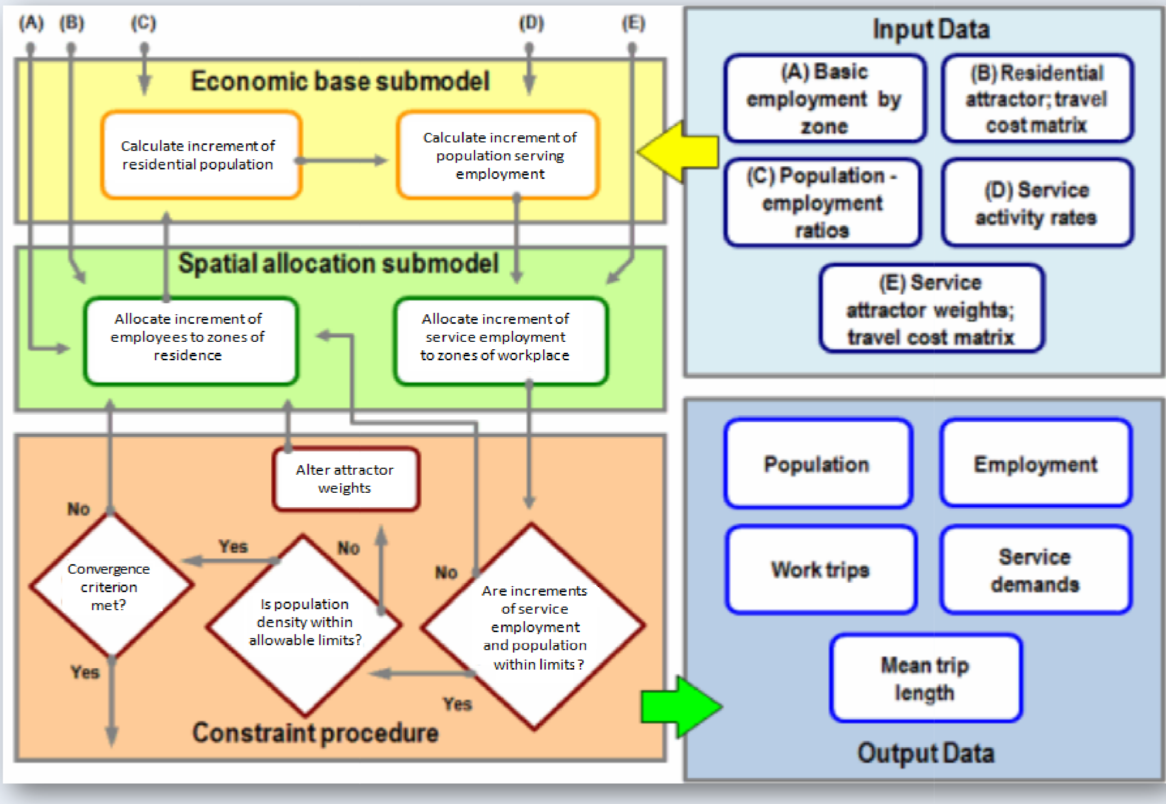
Though simplistic, the representation of housing demand in Lowry's original model was shown to possess several desirable features. This partly explains why the model was so influential, spawning myriads of extensions in a way strangely similar to the monocentric city model. The modular architecture also had its importance in the success of the model by allowing practitioners to easily develop extensions, like adding new sub–models, refining existing ones, and so on.

The first major improvement relative to the representation of housing demand is the fact of Crecine (1964), who stratifies population into several socio-economic classes so as to increase the explanatory power of the model. Extensions including alternate forms of demand ensued, including Wilson (1974) who proposes a unitary demand for housing (i.e. one household = one dwelling unit), or Baxter and Williams (1973, 1975) who introduce demand for floorspace. Another development of special interest to our topic consists in the addition of a household budget constraint by Wilson (1974), which states that housing plus transportation expenses cannot exceed a maximum for each income group, housing prices being exogenously given.

THE MODIFIED GARIN-LOWRY MODEL: BASIC PRINCIPLES

The Garin-Lowry model is an early LUTI model based on **economic base theory**. It aims to determine the location of populations and services relatively to the distribution of basic employment, which is an input of the model. It uses a **gravity location model** for these ends: this implies that it merely reproduces regularities of the urban system observed at the macro level. It is not based on any micro-economic foundation in the first place, leading Anas to say that Lowry's original model is “not economic but physicalistic in nature”.

FIGURE 48: GRAPHIC REPRESENTATION OF THE MODIFIED GARIN-LOWRY MODEL



Hint: start in (A) and (B) then follow the arrows Source: http://people.hofstra.edu

The model follows an **aggregate and iterative approach**: zones are characterized by the number of basic jobs, service jobs, and residents. Furthermore, one job is undistinguishable from another except for location (this also holds true for residents). Based on the exogenous distribution of basic jobs, people are located throughout the region according to a gravity formulation so as to meet the induced labor demand. This first set of people generates a demand for services, ultimately creating service jobs that locate themselves around residents so as to answer this induced demand. From there, service jobs requiring workers, an additional wave of residents is created and located, once more inducing an extra demand for services, and so on until convergence (hence the iterative approach, one wave corresponding to one step).

A-2. TRANUS: towards a more standard representation of the housing market

Considering the lack of micro-economic foundation of both static and entropic models, spatial-economics models aim to provide a better description of the regional economy, using a **spatial general equilibrium framework**. In MEPLAN and TRANUS, which are probably the most famous spatial-economics models, the representation of the housing market is embedded in an Input–Output structure which formalizes the links between the various economic activities. On the other hand, the pair CATLAS/METROSIM only represents the real estate and transportation markets.[8] Notwithstanding, it is most likely the most achieved model as far as its micro-economic foundation is concerned. Because MEPLAN and TRANUS were much more successful in Europe and are similar in design to boot, TRANUS was eventually chosen to represent spatial-economics models. As previously, a general overview of TRANUS is provided at the end of the subsection, which otherwise focuses on the representation of housing demand.

a) Mathematic formulation of housing demand

As in Garin-Lowry's mode (and the monocentric city model), **housing demand mainly stems from labor demand** in TRANUS.[9] Jobs located in zone i generate a demand for working households, who are stratified by income. For the sake of simplicity, let us focus on one income class. Households choose their residential location according to the following **multinomial logit formulation**:

$$\begin{cases} P_{ij} = \dfrac{\left(A_j^t\right)^{\alpha} e^{-\beta \widetilde{U}_{ij}}}{\sum_k \left(A_k^t\right)^{\alpha} e^{-\beta \widetilde{U}_{ik}}} \\ \widetilde{U}_{ij} = \dfrac{U_{ij}}{\left(\min\limits_k U_{ik}\right)^{\theta}} \\ U_{ij} = \lambda\left(p_j + h_j\right) + t_{ij} \end{cases}$$

where P_{ij} represents the probability to settle in zone j and $\widetilde{U}_{ij}$ is a scaled residential disutility based on average housing price p_j, shadow price h_j, and commuting cost t_{ij} between zone i and zone j.[10] The term t_{ij} may correspond to any form of transport cost:

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[8] METROSIM is the upgraded version of CATLAS; both were developed by Alex Anas. Descriptions may be found in Anas and Duann (1985) and Anas and Arnott (1993). For a presentation of MEPLAN, see Echenique *et al.* (1990). Abraham (1998) also provides an interesting systematic comparison of MEPLAN with several other economic and LUTI models. For TRANUS, see De la Barra (1989) and Coulombel (2006).

[9] I say « mainly » because the relatively open structure of TRANUS allows one to model any kind of activities, e.g., inactive people who would locate within the study area according to user-specified rules. Withal, all the main mechanisms presented for working households would still hold.

[10] Shadow prices are constant terms that are introduced for operational purposes and allow to equate modeled prices with observed prices. They are consequently overlooked in the remainder of the discussion.

monetary, generalized, travel-time, and so on. A_j^t is an attractor weight for zone j at time t, based on lagged measures of population and income composition of the same zone.

After the location choice, the household selects the size and type of its dwelling. This is modeled with an **aggregate demand function** taking the following form:

$$D_j^{h,t} = X_j^t . s_j^h \left[Mini^h + (Maxi^h - Mini^h)e^{-\delta^h p_j^h}\right]$$

where $D_j^{h,t}$ is the demand for residential floorspace of type h in zone j and at period t, X_j^t measures the total housing demand for the same zone, s_j^h the degree of substitutability of housing type h, p_j^h the average price of type h in j, and lastly $Mini^h$ and $Maxi^h$ denote the minimum and maximum dwelling size for type h.

b) A micro-economically founded yet aggregate demand function

Unlike Lowry's model, TRANUS is **micro–economically founded**, making intensive use of **discrete choice theory** and its multinomial logit models. In particular, the residential process is articulated around the following two-step structure:

- The household first chooses its location by maximizing a utility function.
- Then an aggregate demand function encapsulates the choice of dwelling type and size.

Although TRANUS explicitly represents the household as an economic agent, in the end it still has **a fairly aggregate treatment of demand**. Spatial allocation of households is achieved by directly multiplying zonal employment by zonal shares P_{ij}, and not through micro-simulation (e.g., with a Monte-Carlo process). Likewise, quantities of residential floorspace broken down by housing type are based on aggregate demand functions.

c) The return of the space-accessibility trade-off

As in Lowry's model, basically the location choice only takes the **space-accessibility trade–off** into consideration, with the same limitations as before. Here "accessibility" is measured by the cost of commuting, and the housing price is chosen instead of dwelling size. The "disutility function" would thus more correctly be referred to as an indirect disutility function. Otherwise, the chosen formulation is closest to the monocentric one as compared to other kinds of LUTI models (Coulombel 2006). However, the fom of the utility function and the absence of a budget constraint involve some drawbacks (ibid).

To try and be more specific, two parameters play an important role in the household location choice:

- β measures the **relative importance of the disutility term**. A households with a large β behaves as a "disutility minimizer", when one with a low value of β tends to locate according to attractor weights.

- λ measures the **household sensitivity to housing prices**. Again, it may be related to the steepness of the bid–rent curve, as low-λ households seek low transportation costs, while high-λ households preferentially settle in zones offering cheap housing.

Attractor weights $\left(A_j^t\right)$ are similar in nature to those present in the G-L model, entailing the same remark regarding housing demand and independence to zoning (→ *A-1.c)*). However, unlike in the G-L model, the functional form of A_j^t has to be specified then calibrated. It is usually a linear function of lagged measures of population and income composition, which tends to reproduce the previous spatial distribution of activities. Though introduced in the first place as a way to induce viscosity in the system dynamics, these attractors may also be **interpreted as a proxy measure of amenities**, making zones more or less attractive depending on exogenous amenities (*via* a constant term) and endogenous ones (*via* the lagged measure of income composition, among others). Withal, the actual calculation of A_j^t has **no solid economic foundation** as it once again merely results from the model calibration.

d) The choice of housing characteristics

Once the location problem solved, households "opt" for both housing type and size. I say "opt" since as implied above, the individual choice is not explicitly represented. Instead, floorspace quantities per dwelling type are provided by a standard macro-economic demand function. It features the following own-price elasticity for type h:

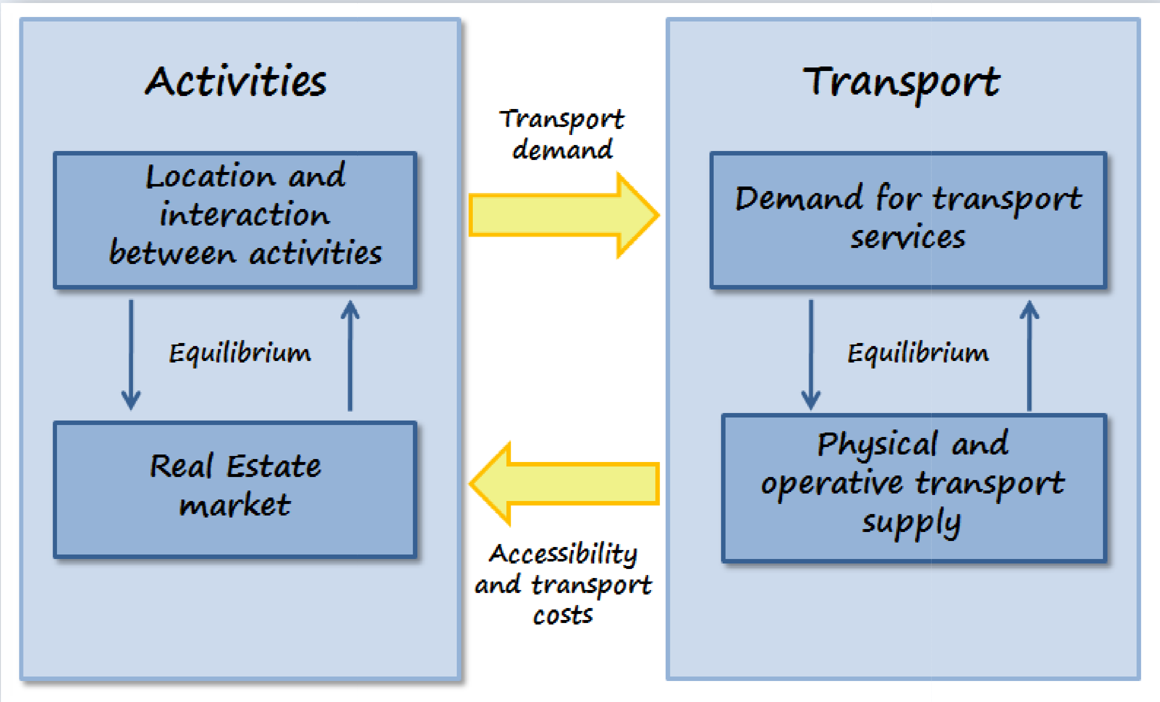
$$\varepsilon^h = -\delta^h \frac{(Maxi^h - Mini^h)e^{-\delta^h p_j^h}}{Mini^h + (Maxi^h - Mini^h)e^{-\delta^h p_j^h}} p_j^h < 0$$

All in all, the relatively flexible architecture of TRANUS enables one to represent the **heterogeneity of preferences** with respect to housing type and dwelling size between and within each household class (by adjusting the various parameters δ^h, s_j^h, $Maxi^h$...). The impact of the mixture of aggregate and disaggregate formulations on the precision of the model has yet to be verified, though. To conclude, let us emphasize that this choice of a flexible architecture involves a **heavy and complex estimation process**, which ultimately led to the failure of the calibration of TRANUS to the metropolitan area of Lyons (Du Crest 1999).

GENERAL PRESENTATION OF TRANUS

TRANUS is a LUTI model which belongs to the family of spatial-economics models. It is built on a modular architecture as is often done since Garin-Lowry's model, being composed of an **activity model** and a **transport model** that interact with each other as shown on *Figure 49*.

FIGURE 49: THE DUAL STRUCTURE OF TRANUS



Source: Author, based on TRANUS website, http://www.modelistica.com/

The transport model feeds the activity model with measures of accessibility and transport costs. The activity model, which is in turn used to determine travel demand, is based on an **input – output structure**. The economy is divided into activities representing:

- standard goods: manufactured goods, services, and so on;
- households;
- built/un-built surfaces: mainly residential/non residential floorspace and building land.

The input–output framework aims to model the linkage between these various activities. For instance, producing a car requires goods (to wit, tires, glass, metal sheets, etc.), floorspace for the production site, and workers, who in turn need a place to live, and so on. Basically, this specific set-up is a generalization of Garin-Lowry's formalism to all economic activities. In particular, it follows the same **iterative structure**, with an exogenous and an induced demand. However, the exact formalism of TRANUS is relatively complex. A more thorough presentation of the model, including its formalism, may be found in Coulombel (2006).

B HOUSING DEMAND IN ACTIVITY-BASED MODELS

Aiming to improve the representation of the housing market, which is clearly limited in static and entropic models, spatial economics models have opted for a more standard economic framework, but which led them to focus on the notion of market equilibrium. As a result, several researchers questioned the ability of these models to correctly take into account the **various temporalities of urban processes**. Their "original doubt" gave birth to quasi–dynamic **activity-based models**. These models have the following characteristics (DSC *et al.* 1999):

- Their primary goal is to analyze processes of change linked to economic activities and the space they occupy.
- Economy, activities, and demography are often modeled at a very detailed level. The same is equally true concerning relocation decisions.
- The partition of the study area is typically very refined, with zones often the size of a block.

From there, activity-based models can be divided further between those based on micro-simulation and those that are not. Famous examples of the latter category include DELTA, developed by David Simmonds and Consultancy, and UrbanSim, developed by Paul Waddell. Micro-simulation models, which explicitly represent each individual, are more recent and have consequently less history of actual application. Among others, let us cite the stimulating ILUTE project for the Greater Toronto Area (Salvini and Miller 2005) and the model RAMBLAS (Veldhuisen *et al.*, 2000) for the Netherlands. While I do draw the distinction, one should bear in mind that only a thin line separates the two categories, which mainly involves the level of precision. Otherwise, these models are quite alike as regards their general spirit and their structure.

Considering the fact that most activity-based models are based on the same structure, only differentiating themselves by more or less substantial refinements, and that UrbanSim is currently in use in France,[11] UrbanSim is chosen to represent activity-based models.

[11] Current endeavors to develop activity-based models in France include the projects SIMAURIF and SIMBAD, both based on UrbanSim, and MOBISIM, a "new" model showing striking resemblance with this same model. Cf. PREDIT (2008) for an outline of these projects.

B-1. UrbanSim: aiming for a more realistic representation of the residential process

Once again, I first describe the formation of housing demand, followed by a critical analysis of the model concerning this specific matter. An overview of UrbanSim as a whole is to be found at the end of this subsection.

a) *The two-step formation of housing demand*

UrbanSim models the residential process in two steps: the evaluation of housing needs and the residential choice *per se*. Unlike previously, the mathematic formulation is not reported as it is less relevant in this specific case.

Step 1: Determining housing needs

The first step determines "**aspatial housing demand**", also referred to as housing needs. More specifically, this step aims to list households looking for a home, implying that demand is not located at this stage, hence the term "aspatial". In UrbanSim, aspatial housing demand at period *t* consists of:

- newly formed households;
- preexisting households who have decided to move.

Establishing the first household set is the very purpose of the demographic transition sub–model. It determines the variations in each stock of households, who are stratified by type (size, head of household's age, income, etc.). The user must provide the sub-model with external demographic projections though, which must at least include trends relative to the total population of the study area. The sub–model can take into account more refined projections (e.g., by household type). Otherwise, a constant demographic structure is assumed by default.

The mobility sub–model generates the second household set. It assumes constant residential mobility rates for each household type, which are estimated on an historical basis. Within each subset (based on the stratification by household type), the required number of moving households is randomly, uniformly drawn from the whole population. The combination of newly created and moving households forms the list of households looking for a home.

Step 2: The residential choice

Once aspatial demand determined, households on the list of movers make their choice one after the other among the set of vacant dwellings. The dwelling choice is modeled by a **multinomial logit model** (MNL) applied to a **sample of options**, randomly and uniformly drawn within the whole set of vacant dwellings.[12] Usual choice variables may be regrouped into three main categories (Waddell *et al.* 2003):

- Housing characteristics: price, development type (density, land-use mix), housing age.
- Urban design-scale (local accessibility): neighborhood land-use mix and density, employment level of the neighborhood.
- Regional accessibility: accessibility to populations and to services, travel time to the CBD and to the nearest airport.

Although this list is the standard set of variables used to estimate the location model, the user can easily replace it with his own list, meaning that UrbanSim offers a relatively flexible structure in this regard.

b) A marginalist approach to housing demand

The primary characteristic of activity-based models is that at each period, they only treat **"marginal housing demand"**. Unlike all other LUTI models, activity-based models focus on the fraction of households who decide to be active on the housing market at a given period. In UrbanSim, those are newly created households and "movers".

Let us consider more carefully these two sets of households. As regards newly created households, one can note that the demographic model is external to UrbanSim. This precludes any retroaction from the housing market onto the general demographic structure or onto household composition, which is a first shortcoming.[13] As far as the second household set is concerned, it is based on the strong assumption of a constant share of movers within each household type, who are randomly picked to boot. This implies that **no economic consideration underlies the decision to move**.[14]

c) A two-step decision tree

A second key characteristic of activity-based models is the **independence between the decision to move and the residential choice**, which constitute the two and only steps of the decision tree. In comparison to *Figure 44*, the tree has been rather pruned... The separation of these two decisions is blatant in the architecture of UrbanSim (*Figure 50*). The demographic transition and mobility sub–models deal with the decision to move and the location choice sub–model with the residential choice. This postulate might

[12] Estimation of the MNL can be carried out in a stratified way (one estimation per household type) or on the whole household set by introducing interaction terms when necessary, this last option being most often used.

[13] Among other things, housing prices could exert an influence on household size (e.g., as children wait longer to leave the family home or share apartments as coping strategies.) or on the number of children.

[14] Waddell (200x) did test endogenizing the decision to move based on utilitarian considerations, but found the test to be unsuccessful in the sense that it did not improve the explanatory power of the model. Notwithstanding, I think that this matter should be investigated more thoroughly in order to understand and take into account **spatial variations in household residential mobility**. Among other things, this could include the influence of a decrease in accessibility or in neighborhood quality on the household decision to move.

seem crude, as it drastically reduces interactions between demand and supply. Indeed, separating the two issues is tantamount to considering that households decide whether to move or not without considering the current available supply. The validity of this assumption should therefore be investigated.

d) The residential choice: multinomial logit models, again and again

The residential choice is deeply rooted in discrete choice theory, once again relying on the use of multinomial logit models, which ensures micro-economic consistency. Unlike TRANUS, the utility function includes several variables however, the choice of which was strongly influenced by the economic literature described in *section I*. This encompasses market conditions (price), dwelling characteristics (size, age), and lastly neighborhood characteristics (including various measures of accessibility). The presence of price and transport variables allows UrbanSim to represent the **space–accessibility trade–off**, while the accessibility to population term enables taking into account some forms of amenities, and thereby modeling segregation to some extent.[15]

Unlike previous models, the **quality of the neighborhood** is considered through "urban design-scale" variables, namely land-use mix, density, and employment level. Concerning the first one, Waddell *et al.* (2003) find households to prefer residential or mixed neighborhoods to industrial ones, in accordance with intuition. On the other hand, the choice of the last two variables seems controversial. First, employment levels might be strongly correlated with regional measures of accessibility, as well as with density. This last variable might also lead to endogeneity issues. To conclude on this point, let us note that the mean housing age of the cell is another way of measuring the quality of the neighborhood, and allows representing the well-known phenomenon of filtering.

Lastly, **heterogeneity of preferences** may be modeled through the interaction of dwelling characteristic variables with household type variables, allowing one to take into account economic mechanisms such as the normality of the housing good, or more simply the influence of household composition on the residential choice.

e) Current shortcomings

Despite clear improvements with respect to the representation of the residential choice, several shortcomings remain. The first one has to do with the utility function, which includes the housing price in addition to dwelling and neighborhood characteristics. As a consequence, **it is unclear whether this is a direct or indirect utility function**. Besides, the housing price should capitalize most of the amenities, meaning that such a

[15] Refer to Coulombel (2006) for a longer discussion about the choice of variables and potential issues.

formulation necessarily involves endogeneity issues (unless assuming that prices substantially diverge from their equilibrium value).

Secondly, the choice of a multinomial model implies that there is no correlation between alternatives. In plain words, there is **no structuring or prioritizing of choices** (such as can be found for instance in nested logit models). Numerous empirical works challenge this assumption in the case of the housing market.[16] As a matter of fact, it seems quite obvious that one can establish a hierarchy among all the decisions variables included in the location choice model. The number of rooms, the type of tenure, and the housing type are usually a more important factor than the travel time to the airport.

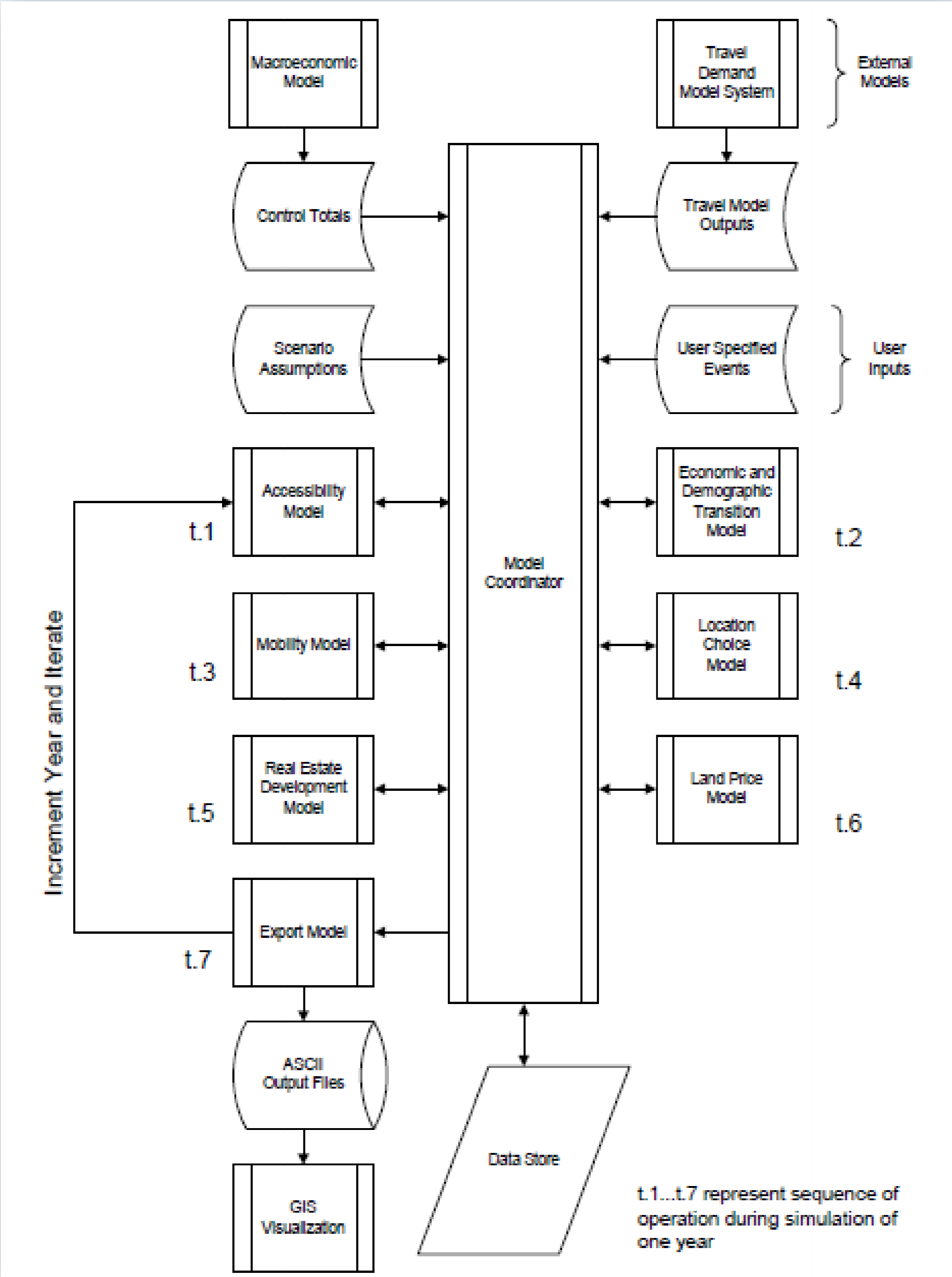
Lastly, the choice of sampling alternatives reflects the premise that households are imperfectly informed of the available supply in the housing market. Though cogent this postulate might seem, the issue lies in the sampling method itself. The subset of alternatives is randomly and uniformly drawn from the whole set of vacant dwellings, **disregarding any strategic consideration in the search process** of the household. Furthermore, this might occasion a residential utility loss for the household compared to its previous location. While this point is not necessarily problematic when considering constrained moves (change of workplace, end of lease, etc.), it is so when the motive underlying the move is the very increase of one's quality of life.

[16] To cite only one, Gobillon (2001) reports that 76% of households making a short-distance move state that the primary purpose behind this move is linked to one or a combination of the three factors indicated further, that is, home size, housing tenure, or housing type; results are based on the ECHP survey.

GENERAL PRESENTATION OF URBANSIM

UrbanSim is an open source urban model developed by Paul Waddell, formerly from the Washington University of Seattle. It aims to represent the dynamics of residential location and employment, using realistic processes of relocation. A model coordinator is at its core, serving as a conductor for the collection of sub–models numbered from t.1 to t.7:

FIGURE 50: MODULAR ARCHITECTURE OF URBANSIM



Source: Waddell et al. (2003)

This modular architecture is a typical feature of activity-based models, and allows the developer to make the model increasingly complex.

External models and inputs:

The model coordinator is connected to the external models and fed with user inputs:

- The macroeconomic model determines employment trends for the study period.
- The transportation model establishes the impedance matrix, which includes composite costs of transport, levels of congestion, and so on.
- The user may input scenarios (e.g., transportation or land-use policies) and specific events (e.g., development of an industrial project in an area).

Overview of the sub – models:

t.1 **Accessibility model**: this sub-model transforms the outputs of the transport model into accessibility measures, broken down by car ownership, and directly usable by UrbanSim.

t.2 **Economic and Demographic Transition Model**: population and employment trends are simulated by this sub–model, based on user inputs and the external macroeconomic model. In particular, this sub-model manages the creation and destruction of households.

t.3 **Mobility Model**: determines which existing households and firms are willing to relocate within the study area at a given period.

t.4 **Location Choice Model**: simulates household residential choices and firm location choices.

t.5 **Real Estate Development Model**: represents land developers' decisions with respect to the construction of new homes, commercial zones, or the redevelopment of specific zones.

t.6 **Land Price Model**: determines at each period the various real-estate prices in each cell (land, housing, office floorspace, etc.).

C A CRITICAL ANALYSIS OF THE STATE OF THE ART

C-1. The hegemony of discrete choice theory

Keeping the scope of the analysis in mind (→ *introduction* of subsection), a first striking trend is that **urban modeling constantly aims toward a better representation of the housing market**, be it regarding the demand or supply side (although a massive amount of work remains to be done concerning supply). Micro-economic founding has become a key concern when developing a LUTI model, leading to explicit representations of the household as an economic agent and of the residential process.

Secondly, as far as I know, **all the latest models rely on discrete choice theory**; multinomial logit models are especially rife in this field. Although this theoretical setting seems fitting for the housing market, it is founded on the central assumption of a utility-maximizing household. As discussed in the general introduction, the housing market has many specificities, including the affective dimension a home has for households, or the difficulty of getting accurate information about the various dwelling attributes (intrinsic and extrinsic) prior to actually moving in. Furthermore, the residential choice may sometimes be made with a sense of urgency (end of a lease, etc.). All these elements **challenge the postulate of utility maximization** to some extent. An interesting ongoing research in this field investigates the relevancy of applying prospect theory to the residential choice so as to improve the representation of the household behavior. [17]

C-2. The residential process: still simple decision trees

In most models so far, the decision tree of the residential process is relatively basic. It typically involves only two successive decisions: in the case of "micro-oriented" models (i.e. activity-based models), the decision to move precedes the residential choice, whereas "macro-oriented" models represent first the location choice, then the dwelling choice. [18] Moreover, the two decisions are usually modeled independently. For activity-based models, the ensuing shortcomings were discussed in *B-1.c)*. For "macro-oriented" models, this two-step structure boils down to considering that the location choice is paramount, while the residential choice only comes next. In other words: "location, location, location". At first, this could seem oversimplistic. However, zones are typically large in macro-oriented models, meaning that one will generally find a relatively diverse housing stock in his zone, and thus an appropriate match. As a result, this assumption might not be so off the point after all, but should still be appropriately tested.

[17] See Bilal *et al.* (2009).

[18] Note that some "macro-oriented" models do not represent the dwelling choice at all, e.g., the Garin-Lowry model and several entropic models.

What drawbacks do such simple decision trees involve for activity-based models? First, maintenance or home improvements are not considered as an option. As a consequence, residential mobility is likely overestimated in times of recession or high housing prices. Secondly, the home search process is seldom modeled. [19] Although this probably affects the system dynamics rather than the long term equilibrium,[20] the specific impact of not representing this process has yet to be assessed. **The most problematic point is likely the independence between the decision to move and the residential choice *per se***, as it is clear that households behave strategically in the housing market, unless being forced to move with no forewarning.

C-3. The decision to move: a neglected area in applied modeling

The **decision to move** is undoubtedly **the most neglected aspect** in the residential process, most models putting much more emphasis on the location choice. This point is not trivial, for it is not quite clear why the transportation system would have a stronger influence on residential choices than on residential mobility, which is the very implicit assumption behind this choice of priorities. Quasi-dynamic macro-oriented models have quite an awkward standing in this regard, as they waver between a long-term equilibrium approach and the need to represent some dynamics. Fulfilling this latter task is usually entrusted to attractor weights, which would miraculously set the path between the successive equilibriums. Activity-based models do not fare much better in this regard, and there is still but little interest in applied modeling as to why people move,[21] or in the influence of changing conditions (in accessibility, neighborhood quality...) in this regard. [22]

C-4. The location choice: monocentric after all?

The above analysis has emphasized the influence of urban and housing economics on applied modeling. Indeed, and this holds especially true for activity-based models, the use of discrete choice theory allows for flexible specifications of the utility function; as a result, **one can easily incorporate the latest findings from the economic literature**, which is constantly evolving. Scientific reviews such as *Urban Studies* include numerous works addressing the residential choice based on discrete choice theory, and modelers can draw on this whole body of literature to specify their model.

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[19] Search behaviors have been investigated by the ILUTE model (Bilal *et al.* 2009).
[20] If one assumes that the home search process becomes more efficient with time as households learn more about their environment, in the end these would find the relevant alternatives.
[21] Once again, ILUTE constitutes one noteworthy exception.
[22] If your neighborhood becomes congested as a result of a public policy drastically reducing road capacity to promote an already congested public transit system, to the point that all you can hear at peak hour is cars honking because they want to move forward, you might want to leave, right?

Among economic works, the **monocentric model holds a certain place** as it is a systematic reference for LUTI models. Most models actually put strong emphasis on the space-accessibility trade-off, sometimes being the one and only location principle for households. Except for the last extreme case, this seems befitting as LUTI models aim to represent interactions between transport and land-use, which is the very purpose of the monocentric framework. Notwithstanding, this raises an important issue, that is **which of actual commuting time or accessibility is the most relevant decision variable** as far as household residential strategies are concerned. In all LUTI models of my knowledge, the modeling framework determines the choice. When a workplace is explicitly assigned to households, the commuting time is used, otherwise an accessibility measure is chosen instead. It is rarely argued which measure should be preferred and resulting caveats.

In addition to the above elements, several issues continue to undermine the current representation of the household residential choice. First, financial considerations are left out of the picture. Among other things, the **role of expectations** with respect to future housing prices and the prospect of a capital gain are not represented. Following this line of thought, the tenure choice includes no strategic consideration such as discussed in the economic literature (e.g., as a way to insure oneself against inflation, → *I - C-1.a)*). Secondly, and this will end the list, **the introduction of the housing price as a way to compensate for the missing budget constraint seems highly controversial** in regard to the twofold issue of incoherency and endogeneity (→ *B-1.e)*).

III - AN OVERVIEW OF FRENCH OPERATIONAL STUDIES ON THE HOUSING MARKET

This section intends to complete the two previous sections by presenting "operational studies", which I define as works setting policy recommendations as their primary goal, as opposed to fulfilling research objectives. Those may come as secondary objectives, though. In other words, operational studies are the more "down-to-earth" ones, aiming at concrete knowledge or results instead of looking for the truth of the housing market. Once again, there is no exact line separating "academic works" on the one side and "operational studies" on the other side. Besides, by no means do I intend to establish a hierarchy between the two. However, one might rephrase my definition of operational studies by the notion of "**technical works**" (indeed, they often involve fairly advanced scientific methods, see *B-1* for instance), as opposed to works aiming to uncover new economic mechanisms or to evaluate policies in a rigorous framework for instance.

As a matter of fact, operational studies have a twofold interest for this review: they often use **specific techniques**, which could prove relevant when representing housing demand, and also tackle some issues otherwise little covered by the academic literature. This section mainly reviews French operational studies, hence the title. A few foreign studies or methods are reported, however.

A ESTIMATING HOUSING NEEDS

A major issue for local authorities is to **evaluate housing needs**, in the short like in the long term. This is a prerequisite for land-use planning, and of course a crucial matter to struggle against homelessness and bad housing. Several methods, some standard, others more experimental, were developed to answer the expectations of local authorities. The problem is generally broken down into three smaller questions:

- What is the current situation?
- What are the prospects regarding the future?
- Where are the needs located?

Each question involves specific tools and methods. Question 2 is in this regard the most developed topic, and the notion of potential housing demand provides a now relatively standardized answer to this problem. On the other hand, questions 1 and 3 usually involve more experimental approaches. I am now going to present some of these tools and methods, with a special focus on those applied in France.

A-1. Looking in the future: potential housing demand

a) Definition

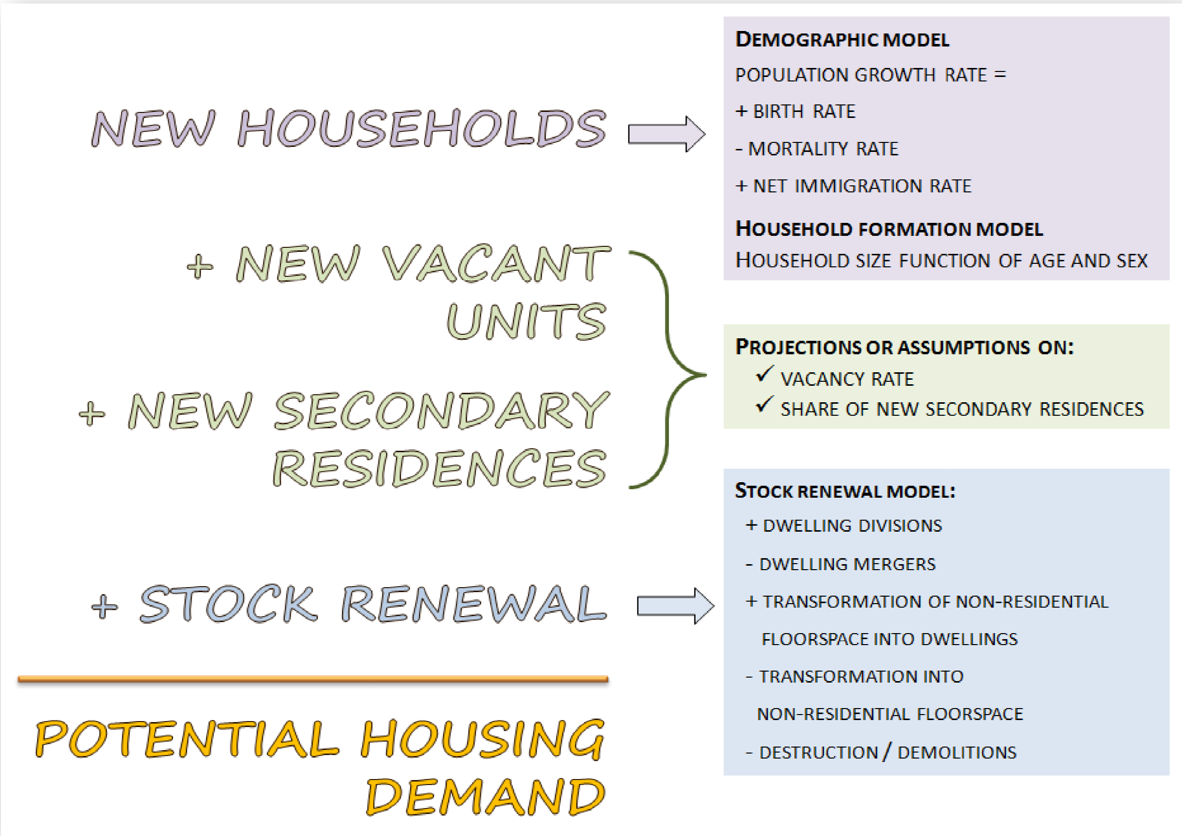
In France, potential housing demand is defined as the **flow of new home construction compatible with the forecasted growth in household population**. [1] This definition stresses the fact that both the demand and supply-side are considered in the projection. The annual increase in the number of households is a central issue, but other factors such as the replacement of units lost from the housing stock and the allowance for a normal level of vacant units are also taken into account.

b) Methodology

The methodology comprises three main steps (*Figure 51*):

- forecasting the yearly growth in household population, which gives the corresponding increase in primary residences;
- projecting the number of vacant dwellings and of secondary residences;
- estimation of the housing deficit (or surplus) associated to stock renewal.

FIGURE 51: POTENTIAL HOUSING DEMAND, METHODOLOGY



[1] Definition may slightly vary from one country to another depending on whether factors relative to the housing stock (renewal, vacancy…) are taken into account or not (e.g., Canada Housing and Mortgage Corporation 1992).

Step one usually involves the combination of a mechanistic demographic model simulating births, deaths, migration, and population ageing on the one side, and of assumptions on household size on the other side. The latter are themselves the sum of underlying assumptions regarding the cohabitation behavior of the French population. Step two rarely goes beyond simple linear extrapolations, *idem* for step three. In addition, a sensitivity analysis is generally carried out to test the influence of various parameters and the robustness of the results.

c) Discussion

In sum, the estimation of potential housing demand is chiefly grounded on **mechanistic considerations** (including the way it is broken down as well as the demographic model) combined to **simplistic work assumptions** (linearity/constancy of various variables).[2] To justify these methodological choices, Jacquot (2007) argues that taking macro-economic conditions into account would be fraught with difficulty, if only because there is no consensus over their impact on the cohabitation behavior. Indeed, introducing a macro-economic feedback is feasible but almost nonsensical: macro-economic forecasts are so imprecise that adding this extra layer could hardly improve the accuracy and robustness of the estimates, and at the subsequent cost of a much greater complexity. Regardless, it seems necessary to have minimum knowledge and guidance on macro-economic mechanisms, and know for instance if faster or slower economic growth tends to increase or shrink potential housing demand in the short-, middle-, and long-term.

Besides this first point, Grépinet (2006) expresses strong criticism against current works on potential demand for two reasons. First, he argues that usual scenarios are overly optimistic and greatly minimize the need for stock renewal.[3] The second charge is that **the methodology does not take regional and local contexts into account**. Indeed, one of its underlying assumptions is that new households are willing to settle in any vacant dwelling, whatever the location. Yet, it seems clear that households' location wishes should not be disregarded, if only in terms of metropolitan area or region. This is why many people advocate the use of regional approaches. In such a framework, national aggregate demand only adds up regional housing deficits, while regional surpluses are considered as "wasted".[4]

[2] The methodology is basically the same in every country and translates the fundamental equation in *Figure 8*. However, based on SES-P and CERTU (2006), it seems that Dutch and German studies have achieved a higher level of refinement in this regard, especially the Dutch model PRIMOS which seemingly includes numerous macro-economic feedbacks.

[3] Projections by the INSEE count on an average pace of 30,000 new dwellings a year to balance building obsolescence, which boils down to assuming an average longevity of 1,000 years for a building…

[4] In mathematical terms, this corresponds to summing the positive parts of regional potential housing demands instead of doing the algebraic sum (a positive demand standing for a shortage of dwellings, and conversely).

Lastly, let us stress that **potential housing demand disregards current housing deficits**. Jacquot (2007) argues that this matter should be dealt with separately to avoid confusion, a quite agreeable opinion as long as one bears this disjunction in mind.

A-2. A normative approach to current housing needs

Bosvieux, Coloos, Mouillart, and Taffin (BCMT 2001) offer a first attempt at addressing this last lack. They aim to determine how many households were not correctly housed at that time in the Greater Paris Region, and to translate it into construction needs.

a) Defining a norm for unfit housing

The first and major issue is how to determine that a dwelling does not fit the household needs. BCMT (2001) proposes a normative approach so as to easily translate this notion of "**suitable housing**" in operational terms, based on a **twofold criterion**:

- "Good housing": this notion encompasses standards of comfort, crowding, and home size.
- "Affordable housing": the housing expense ratio must not be greater than 35% and the remaining income must be superior to a minimal amount.

Only households answering both criterions are considered as properly housed.

b) Methodology

Given this definition, the methodology is once again composed of three steps:

- appraising the number of households falling in either one of the above categories;
- evaluating the capacity of the current housing stock to answer these needs;
- deducing the need for new housing.

Step 2 reveals substantial methodological difficulties, as one has to judge to what extent the model can relocate households to improve the situation. Considering that a complete relocation is hardly reasonable, BCMT (2001) opts for a partial one (only households in situation of unfit housing may be relocated) including spatial constraints (they must be relocated sufficiently close to where they currently live).

c) Discussion

BCMT (2001) provides a promising approach to estimate current housing needs. In particular, it proposes a clear definition of unfit housing, with explicit thresholds which may constitute a basis for discussion and possible criticism. Their notion of "affordable housing" involves some issues though, as there is no regard to the cause underlying this situation. For instance, a high housing expense ratio might result from temporary conditions such as an unemployment spell, or be willingly accepted in exchange for better housing quality. Step 2 should also be further investigated considering the substantial difficulties behind this matter.

A-3. Locating housing needs

The issue of locating housing needs is likely the one for which **standard methodology is most lacking**. To the best of my knowledge and as far as France is concerned, the methodology used in each study varies greatly depending on the issue at hand, as well as on whether the study aims to realism or to fulfilling political or regulatory objectives. The technical report made to prepare the latest version of the land-use planning document for the Greater Paris Region (Groupe Experts Logement du SDRIF 2006) illustrates this diversity of approaches tellingly. Notwithstanding, one can identify four recurring elements in the methodology of these studies:

- The estimation of the total amount of housing needs relies on **demographic trends**, generally given by an external demographic model (→ *A-1*). Some studies even use forecasts at a small spatial scale, implying that needs are already partly located.
- **Recent trends in construction** are usually taken as an indicator of the attractiveness of the area, as well as the predisposition of the mayor to allow population expansion in his city (as a point of fact, several mayors may carry on Malthusian policies as a form of political strategy, Charmes 2009).
- the issue of **current and potential building land**;
- **social housing objectives**, which mainly include the target level of 20% per city as defined by French law.

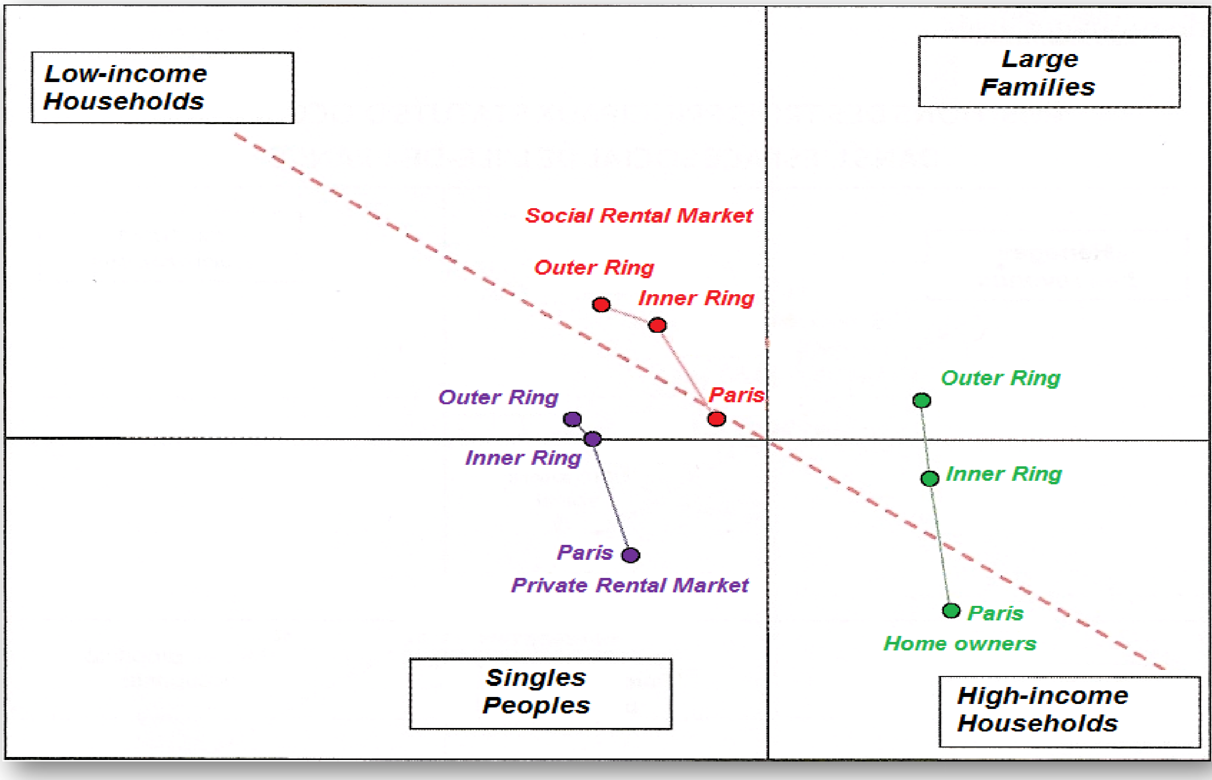
B HOUSING MARKET ANALYSIS, STATIC APPROACHES

B-1. Profiling neighborhoods using Factorial Correspondence Analysis

The development of Factorial Correspondence Analysis (FCA) by Jean-Paul Benzécri has greatly contributed to improving the analysis of local housing markets. Using this method, one can easily characterize any type of aggregate of the housing market, such as neighborhoods, segments of the housing market, and so on.

First applied in France to draw a "social map" of the country (Tabard 1993), or set "social profiles" of the various segments of the housing market (Lévy 1995), researchers soon combined the three dimensions of the holy triptych Household – Housing – Location. This led to **profiles of neighborhoods encompassing elements relative to both the housing market and its occupancy**. A good example of such an accomplishment is provided by Filippi, Funès, Nabos, and Tutin (FFNT 2007), who examine the housing market of the Greater Paris Region through this analytical prism (*Figure 52*). Note that a Hierarchical Ascendant Classification (HAC) judiciously completes a FCA, using it to create **cogent typologies**.

FIGURE 52: A REPRESENTATION OF TENURE SEGMENTS IN THE SOCIAL SPACE OF THE GPR



Source: Filippi, Funès, Nabos, and Tutin (2007), based on FILOCOM 1999

B-2. The link between housing prices and residential choices

a) An increasing number of hedonic studies

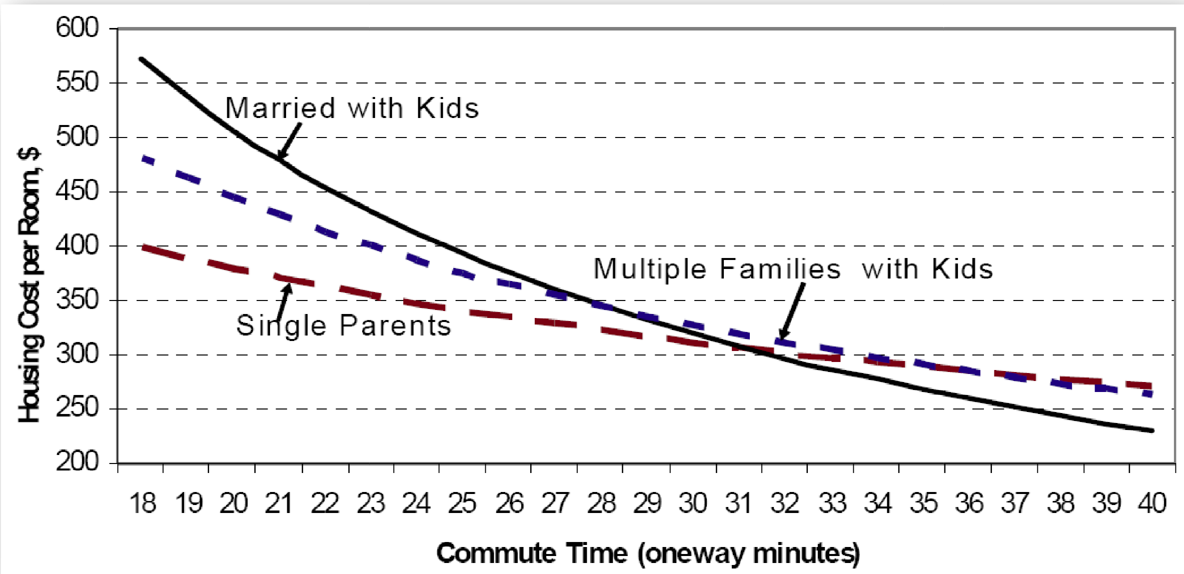
Hedonic analysis has become **more and more standard**, which is the reason why it is also reported within "operational studies". Studies seldom go farther than the first stage (estimation of implicit prices), however. As discussed in *I - C-3*, the methodology reveals considerable pitfalls, which are addressed to an extent greatly varying depending on the study. Accordingly, results should be always received with caution. To cite only three, Donzel *et al.* (2001), Christel (2004), and Fauvet (2007) provide good examples of how hedonic analysis has spread, with once again the above methodological caveat.

b) Bid-rent analysis

When hedonic analysis endeavors to assess how much households value each of the multitudinous housing characteristics, intrinsic or extrinsic alike, bid-rent analysis focuses on the **competition between various household classes for housing**. It is similar to hedonic analysis inasmuch as it predicts the housing price based on various characteristics. It considers that various household types compete for housing, however, which is eventually attributed to the highest bidder. The underlying postulate is that **each household type has its own valuation of housing characteristics**, as a result of differing income, household structure, and so on. These differences in valuation strongly influence the outcome of the competition for housing, thus accounting for the relative spatial locations of each household type. This approach directly stems from the works of "New Urban Economics" (→ *I - D-1*), and as a matter of fact, the issue of how bid-rent curves are affected by transport variables is often central in these works. *Figure 53* illustrates this point in the case of a study carried out by Cervero *et al.* (2006) in seven U.S. metropolitan areas.

In France, Jayet (2004) has been the first to achieve the estimation of bid rend functions in a study on the *Pays de Brest* (located in the far west of France). It is indeed an achievement as bid-rent analysis reveals considerable methodological difficulties, due to the non-observation of the bid-rent functions of the "losers of the auction". To address this difficulty, Jayet analyses housing prices using a **generalized Tobit model**. This rigorous analytical framework has then been reapplied to the Greater Paris Region (FFNT 2007). A degenerate form of bid-rent analysis involves the use of an hedonic analysis with appropriate interaction terms (Cervero *et al.* 2006). This ultimately leads to some inconsistency. Talking about the relatively flat "bid-rent curve" of single parents, Cervero *et al.*(2006, p.22) state that this is "an indication that they face more constraints and have fewer choices", in total contradiction with the very assumption that the housing market is at equilibrium in hedonic analysis (Rosen 1974).

FIGURE 53: TYPICAL OUTPUT OF BID-RENT ANALYSIS



This figure illustrates for various household types the influence of commute time on housing costs. Married households with kids average higher (lower) costs than other households at central (remote) locations. This tends to indicate that they are especially sensitive to the issue of commute time, and thus preferentially settle in central locations.

Source: Cervero et al. (2006)

c) Analysis of household housing and transportation budgets

I only mention these studies here, for they provide a snapshot of the housing market through the analysis of housing and transportation budgets. The reader will find a more thorough presentation of these works in *Chapter 2*.

C MOBILITY-BASED APPROACHES

C-1. Vacancy chains

The concept of **vacancy chain** provides a powerful analytical framework to undertake a **comprehensive evaluation of the impact of a housing project**. It studies chain reactions following the appearance of a vacant dwelling (through construction, a leave, or death), and gives information about the "household residential careers" as well as the linkage between the various segments of the housing stock (Driant 2003).

A vacancy chain is defined as the set of moves consecutive to the initial vacancy, until termination of the chain. Termination occurs when the last move does not trigger a vacancy within the study area. A chain is characterized by its length and by the cause of its termination (creation of a new household, household coming from outside the study area, demolition of the last dwelling, etc.). The simplest example is a newly built studio inhabited by a student leaving the family home. In this case, chain length is one and termination is caused by the creation of a new household. Because it is often difficult to observe the whole chain, unless having access to very specific surveys, modeling techniques are developed and make use of partial observations.

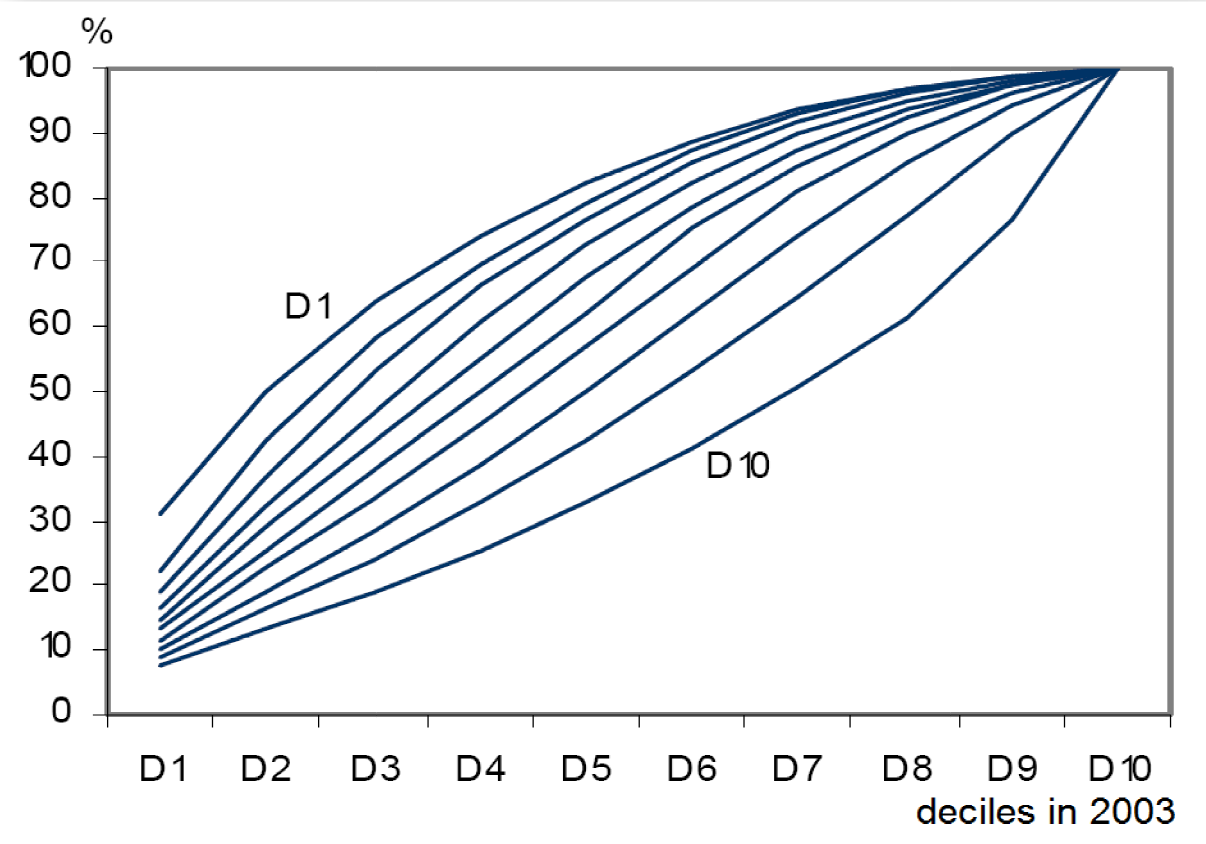
Vacancy chains provide worthy information concerning household residential careers and the connection between the various segments of the housing stock. Yet, their major interest relatively to other approaches is when proceeding to the evaluation of a housing project. Indeed, a new housing project proves useful in accommodating households, which is a direct benefit, but as part of these households will vacate dwellings, this will allow other households to move in dwellings that better fit their needs, and so on. In sum, **vacancy chains allow taking into account direct and indirect benefits of a housing project.**[5]

[5] Refer to Driant (2003) for a list of French studies based on this methodology.

C-2. Variations in profiles of occupiers

Studies examining variations in profile of occupiers conclude this analysis of French operational studies. Thanks to the existence of dwelling panels in France, and primarily FILOCOM (→ *Chapter 0, section III*), one can study how household characteristics vary between the former and new occupier. While these studies do not make use of specific techniques, one typical output is provided in *Figure 54*.

FIGURE 54: VARIATIONS IN HOUSEHOLD INCOME FOLLOWING A CHANGE OF TENANT



The *x* axis represents the income of newcomers in 2005. Each curve corresponds to a set of housing units which were formerly occupied by a household of the indicated decile. For instance, curve D1 is for housing units formerly occupied by households who were among the 10% poorest in France in 2003. All incomes seem to be measured in terms of 2003 deciles according to the legend, although this point is not quite clear in the study. Regardless, curve D1 should be read as follows: for housing units formerly occupied by households of the first decile in 2003 and that observed at least one change of tenant between 2003 and 2005, at the beginning of 2005 32% of the new tenants belonged to the first income decile as defined by the income distribution of 2003, 50% belong to either one of the first two deciles, and so on.

Scope: Private rental sector, France *métropolitaine* *Source: Even and Robert (2008)*

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Chapter 2

Residential Strategies in the Greater Paris Region

An insight through the prism of household housing and transportation budgets

Abstract

This chapter studies housing and transport budgets in the Greater Paris Region, thereby shedding light on household residential strategies. The evaluation method combines the use of a travel survey and of transit and road traffic assignment models, completed by databases on prices and household expenses when necessary.

The analysis leads to two main findings. First, households allow on average for a relatively constant share of their income to housing, which decreases with income. Home size increases with distance to CBD, reflecting lower prices. However, household size rises at the same time, and all in all the average surface area per person varies little with location.

Secondly, the average transportation expense ratio grows significantly with distance to the center of Paris. This mirrors both an increased motorization and a more intensive use of the car, which enable households to travel longer distances for identical daily travel times, but at the price of dangerously high transport costs. Once again, lower-income brackets average higher burdens.

These various findings lead me to the following hypothesis, that the household primary objective is to reach a certain level of "housing comfort" (33 m^2 per person or so). Transport serves as a variable of adaptation to reach this goal, inasmuch as households select the best location in a certain radius around the workplaces of household members, given a target housing budget but whatever the transport cost. The radius is set in terms of travel time, hence the usefulness, and yet a "curse" at the same time, of the car.

Keywords: residential strategies, housing/transportation trade–off, housing budget, transportation expenses, housing market, Greater Paris Region.

INTRODUCTION

Increasing concerns about global warming and the rise in energy prices have significantly galvanized public and academic interest in land-use planning, and especially in the connection between land-use and transport. In most developed countries, past transport policies, chiefly relying on car use, have actually been major catalysts of urban sprawl, a phenomenon which is widely regarded as problematic nowadays, because of the alleged environmental impact and lower energy efficiency of this sparse urban form.[1]

To address these various concerns, the linkage between the transport system and residential choices has been studied by an ever increasing body of literature, which may be split into two strands. The first one consists of economic studies. In particular, the question of whether distance to the Central Business District (CBD) has an influence on real estate prices, as affirmed by urban economic theory, has largely been addressed by this literature.[2] However, most of the research in this field is devoted to either real estate prices or density, while the household point of view is considered only sparingly. The second strand comprises works based on Land Use – Transport Interaction (LUTI) modeling.[3] These have significantly contributed to the general understanding of the links operating at the micro-level between transportation supply and residential choices. They are mostly based on discrete choice theory, however. This involves assumptions about the very form of the connection, thereby conditioning results.[4]

This study bridges those two strands by **examining the interplay between residential choices and the supply of transport services using household housing and transportation budgets**. These budgets encompass actual expenses as well as two key non-monetary costs in the case of transport: daily travel times and distances. I do not purport to develop a model of residential choice as often done in the LUTI literature. Instead, I focus on improving the understanding of the role of transportation as a variable of adaptation in the location strategies of households. In particular, building on Polacchini and Orfeuil's work (1998), I seek to determine whether households proceed to a trade-off between housing and transport costs.

To do so, this chapter undertakes a spatial analysis of housing and transport budgets in the Greater Paris Region. The relative share of each budget item in the household income will be of specific interest, as well as the relationship between the two shares (if any).

[1] In fact, the debate on the optimal urban form with respect to energy consumption still carries on. A comprehensive analysis involves a vast number of elements in addition to the sole matter of transportation, to wit land development, housing, or heating, greatly adding to the complexity of this matter.

[2] See Anas, Arnott, and Small (1998) for an extremely stimulating introduction to this field of research.

[3] To cite only three, the reader might want to refer to PLUME (PLanning and Urban Mobility in Europe, Clifford *et al.* 2005), SCATTER, another European project (Gayda *et al.* 2003), and SIMAURIF in France (Nguyen-Luong *et al.* 2007).

[4] → *Chapter 1, section I.*

Although not at the very core of the analysis, non-monetary transport costs will prove useful in better identifying residential strategies. Concerning methodological aspects, several key factors are controlled, including income and housing tenure.

The analysis leads to two main findings. First, **households allow on average for a relatively constant share of their income to housing**. This share decreases with income, ranging from 19% for the upper tercile to 41% for the lower one. Home size increases with distance to the center of Paris, reflecting lower prices. However, household size rises at the same time, and all in all the **average surface area per person varies little with location**. Lastly, social renters bear lower burdens while enjoying similar levels of surface area per person.

Secondly, the **average transportation burden** (defined as the ratio between the transportation outlay and household income) **grows significantly with distance to the center of Paris**, ranging from 8% to 21% for the most remote areas. This mirrors both an **increased motorization** and a **more intensive use of the car**, which allow households to travel longer distances for identical daily travel times, but at the price of dangerously high transportation costs. Once again, lower-income brackets average higher burdens, with 14% for the lower tercile as compared to 9% for the upper tercile.

These various findings lead me to the following hypothesis, that **the household primary objective is to reach a certain level of "housing comfort"** (33 m^2 per person or so), and that it allows for a constant share of its income to this objective. Transport serves as a variable of adaptation to reach this goal, in the sense that **households opt for the best location possible in a certain radius around the workplaces of employed household members, in the limit of their target housing budget but whatever the transportation cost**. This radius is set in terms of travel time, hence the use of the car to access to more housing opportunities, even though these are remote from employment centers and entail heavy transport expenses.

Chapter 2 is divided into five sections. *Section I* presents the context of the study, starting with an outline of the study area, namely the Greater Paris Region, followed by an overview of the relevant literature on our topic. *Section II* reviews the methodology and databases. Then, *section III* elaborates on the estimation of transportation budgets and analyses first estimation results, while *section IV* does the same, but for housing. Lastly, *section V* undertakes the spatial analysis of household expense ratios, and a conclusion ensues.

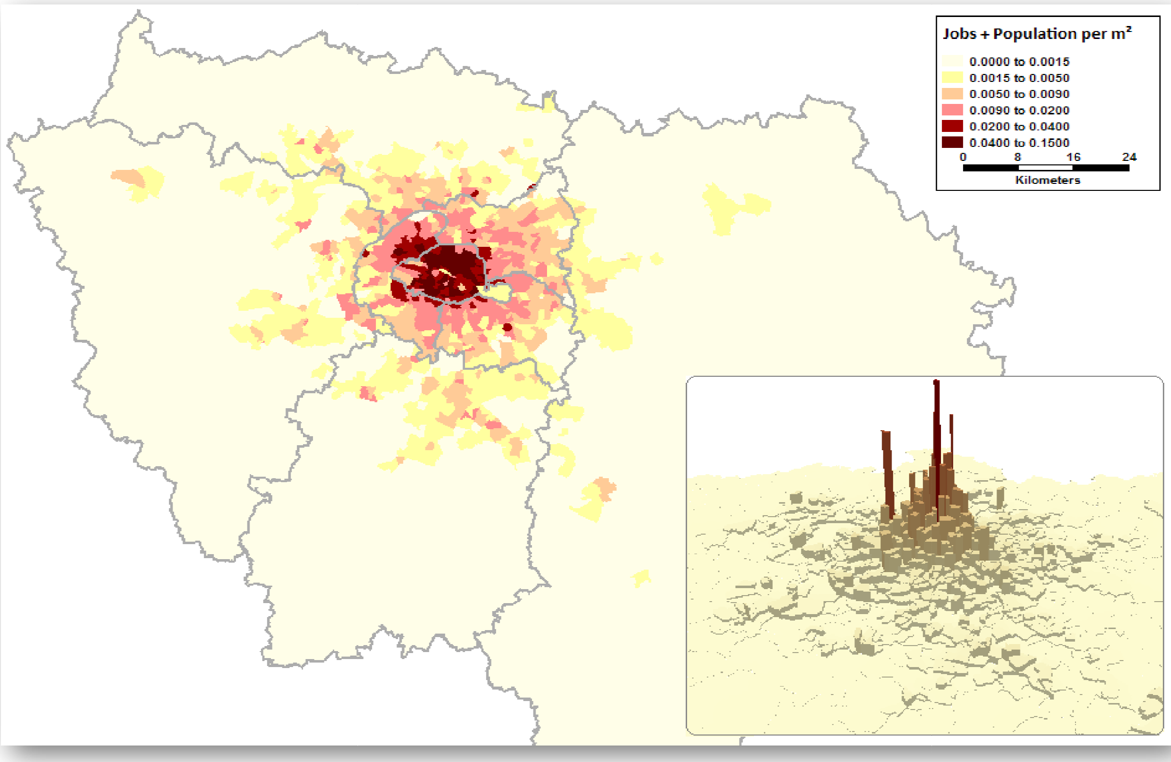
I - CONTEXT OF THE STUDY

A THE GREATER PARIS REGION, A MONOCENTRIC STRUCTURE ?

The *région Île-de-France*, translated as Greater Paris Region (GPR),[1] is composed of Paris *intra-muros* and its seven neighboring *départements* (infra-regional political districts). The latter surround the capital city in two concentric rings, shown in *Figure R* (*Annex A*). In 1999, 4.5 million households were living in the GPR, adding up to 10.9 million people, including around 2 million inhabitants for Paris *intra-muros*.[2]

The Greater Paris Region is characterized by a significant localization of human activities in and around Paris (*Figure 55*). This resembles a **monocentric structure**, an hypothesis corroborated by the conspicuously radial transport system. As far as the road network is concerned, the main axes form a spider web centered on Paris (*Figure S*). Similarly, the subway and regional railway map highlights the overwhelmingly radial structure of the public transit network (*Figure T*).

FIGURE 55: HUMAN ACTIVITY DENSITY IN THE GREATER PARIS REGION, 1999



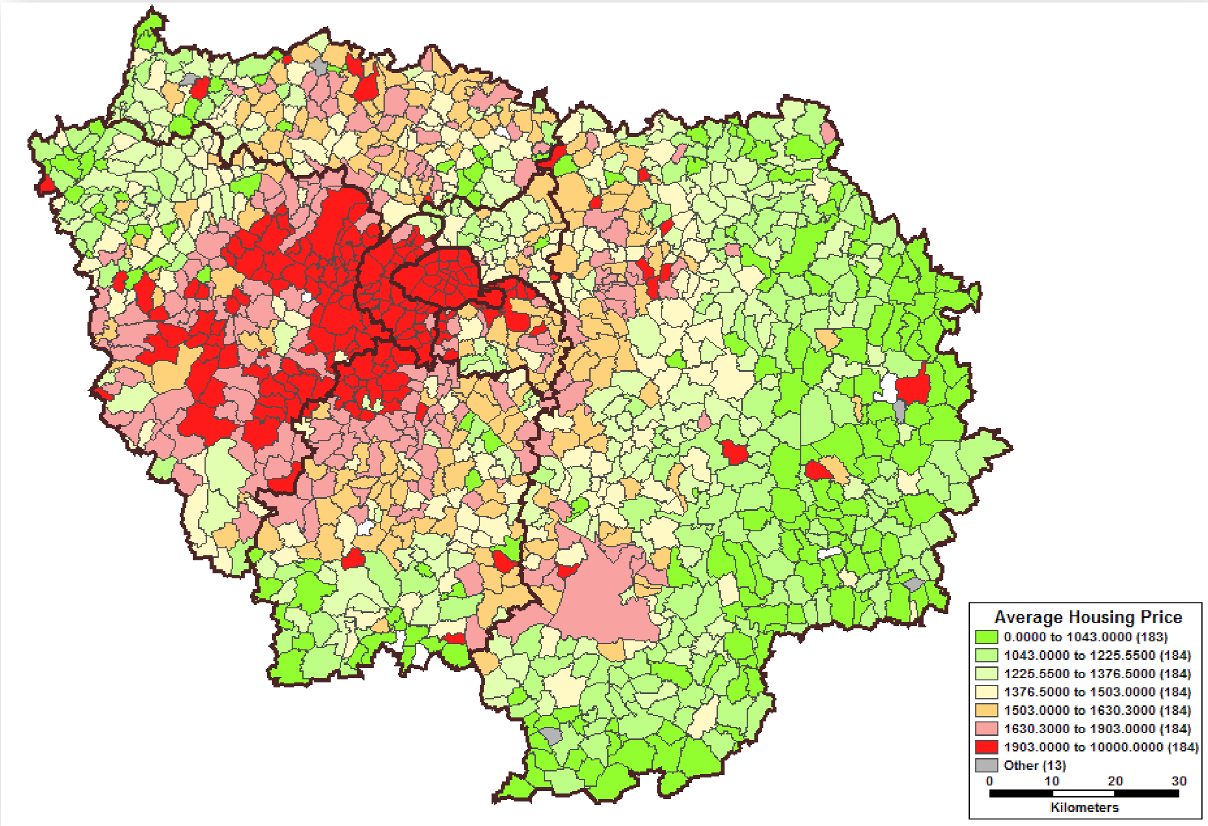
Human activity density = (population+employment)/built surface *Source: Census, 1999*

[1] Because the administrative region slightly differs from the metropolitan area (defined by statistical means), I have chosen the translation Greater Paris Region for disambiguation purposes, even though “Paris Metropolitan Area” might have been more evocative to native English speakers (→ *Chapter 0, subsection II – C*).
[2] Source: Census.

Although these various points strongly back the monocentric hypothesis, other elements come to mitigate this assertion. Firstly, there is sizable income sorting across the region, which does not present any simple spatial pattern (*Figure U*). The overrepresentation of high-income households in the western part of the GPR and of low-income households in the Seine-Saint Denis (*département* north-east of Paris) are two famous examples of this spatial heterogeneity of income, which difficultly fit the monocentric hypothesis. Similarly, local housing prices are anisotropic inasmuch as they reproduce variations in income (*Figure 56*).[3]

In sum, the monocentric assumption fits in the strict acceptance of the **localization of activities** in a (large) CBD, which roughly consists of inner Paris and part of its vicinity (primarily La Défense). On the other hand, the **isotropic hypothesis is rejected**.

FIGURE 56: LOCAL HOUSING PRICE INDEXES IN THE GREATER PARIS REGION, 2001-02 ***(€/M²)***



Indexes are here simply defined as the average prices per square meter for real-estate transactions occurring in 2001-02, and only purport to provide a rough indication of the level of housing prices. Averages are computed at the city level.

Source: BIEN database

[3] → *Chapter 0, point II – C-2.b).*

B WHAT LITERATURE ON OUR TOPIC ?

Main findings of urban economic theory

Numerous economic studies, theoretical and empirical alike, have tried to uncover the main determinants of location choices. All conclude that models can hardly represent the sheer diversity of individual behaviors, itself stemming from the heterogeneity of household preferences *vis-à-vis* urban and housing services. Notwithstanding, several theoretical results were found, and then empirically tested for most of them. They can be schematically structured around four mechanisms.[4]

a) The trade-off between accessibility and space

In urban economic theory, the model of the monocentric city, deriving from the seminal work of Von Thünen (1826), and owing much to the contributions of Alonso (1964), Mills (1967), and Muth (1969), tackles the issue of the residential location choice within a simplified framework.[5] Space is represented by a homogeneous plain, and all jobs are located in a specific point called the Central Business District (CBD). When choosing its residential location, the household maximizes its utility subject to a budget constraint. This entails a trade-off between the cost of commuting (increasing with distance to CBD) and the level of housing prices. The model predicts that housing prices decrease when distance to CBD increases as a result of equilibrium mechanisms, also leading to a decrease in density, two stylized facts regularly tested in the empirical literature. Another stylized fact, though less often tested, has spread as "common knowledge": the **sum of housing and transportation expenses** is a **space-invariant**. While this relationship encapsulates the trade-off between housing price and transport expense tellingly, most people forget about the **underlying assumption of constant lot size**, though central to this result.

b) Income sorting

Following the development of the monocentric city model, the phenomenon of income sorting was studied at great length.[6] To summarize the main theoretical findings, if the elasticity of transportation costs is greater than that of housing demand, high-income households prefer central locations while low-income households settle in the suburbs, and *vice versa*. At first, this result seemed appealing to account for the widely observed phenomenon of income sorting. Yet, some empirical studies soon argued that this could hardly be the case as the two elasticities were very close (e.g., Wheaton 1977). Besides,

[4] Note that *B-1* basically consists in a recapitulation of part of the theoretical review carried out in *Chapter 1*, section *I*. Thus, readers having perused this section might want to skip this part and jump directly to *B-2*.

[5] Refer to Fujita (1989) or Huriot and Thisse (2000) for a thorough analysis of this model and its extensions.

[6] See Ortalo-Magné and Rady (2008) for an introduction to this topic and to income mixing, a more recent research topic directly complementary to this issue but not presented here.

many questioned whether the inversion of spatial patterns between American and European cities could be explained by this only mechanism.

c) The trade-off between space and amenities

In an attempt to solve this last puzzle, Brueckner, Thisse, and Zenou (1999), among others, introduce the "space-amenity trade-off". [7] They amend the standard monocentric city model by considering amenities in the household utility function. As a consequence, amenities raise housing prices in locations well-endowed in this regard. A trade-off ensues between lot size and the level of amenities, which superimposes to the previous space-accessibility trade-off. This extended model can lead to **contrasted results** in terms of land-use equilibriums. Depending on whether amenities are regarded as more important in the city center (cultural and social amenities) or in the periphery (space, landscape, reduction in the harmful effects of vicinity), the model predictions vary accordingly. This provides an account of the differences between European cities, which are typically endowed with important cultural amenities in the historic center, and more recent American cities which have lower gradients of amenities. This literature does not indicate yet how to measure such amenities though.

d) Urban segregation

Lastly, urban segregation has spawned countless theoretical and empirical works, to wit, the famous Schelling model (1969) or Becker and Murphy (2000). In short, neighborhood externalities as well as social and cultural attitudes build the urban environment and spontaneously give birth to the localization of homogeneous social or ethnic groups. Two mechanisms further fuel this phenomenon. Firstly, the localization of lower-income households decreases the capacity of financing public services in the corresponding areas, making them even less attractive. Furthermore, stigmatization of specific areas (the so-called "redlining") increases the rate of unemployment, poverty, and so on, once more harming the attractiveness of those zones. Last but not least, residential mobility being weaker for lower-income brackets, urban segregation is characterized by phenomena of hysteresis and irreversibility. [8]

e) Urban economics: case closed?

Despite all these achievements, various questions remain unaddressed. How the trade-off between space and accessibility impacts household housing and transportation expenses is one of these (unless making the unrealistic assumption of constant lot-size). Besides, empirical economic literature describing with the necessary care household

[7] Cf. Diamond (1980) and Fujita (1989).

[8] Let us point out that income sorting is indeed one of the many aspects of urban segregation. However, it involves specific economic mechanisms, hence a separate presentation. In point of fact, one speaks of "passive segregation" in the case of the leading theories on income sorting outlined above, inasmuch as segregation stems from neutral market mechanisms and does not reflect any specific attitude toward other social groups.

residential strategies in a metropolitan area remains scant. Many specific issues have been explored, but most works seldom try to render the whole picture. Obviously, exceptions exist, and some studies have attempted to identify residential strategies in the case of the Greater Paris Region. A presentation of these works follows.

B-2. Existing works concerning the Greater Paris Region

Using the classification developed in the introduction, I first examine works based on LUTI modeling, and then those closer to the urban economic literature.

a) Current LUTI models for the Greater Paris Region

The IAURIF and THEMA, a research team from the University of Cergy-Pontoise, have engaged since June 2003 a research project on the interactions between land-use and transportation, with at its core the development of a model for the Greater Paris Region. This LUTI model, dubbed SIMAURIF, is based on three existing "submodels": [9]

- UrbanSim, an open-source urban model created by Paul Waddell from Washington University, Seattle;
- METROPOLIS, a dynamic road assignment model developed by André de Palma, a former member of THEMA;
- the IAURIF model as far as the graph networks, the Origin-Destination matrices of travel demand, and the transit assignment model are concerned.

This project has achieved significant advances, being in particular the first functional LUTI model for the GPR (Nguyen-Luong *et al.* 2004, 2007). Its purpose, however, is mainly operational. It follows that the description of household residential strategies is a little crude, the model focusing on the economic assessment of transportation policies.

Another LUTI model, codenamed PIRANDELLO, is currently under development by Cofiroute, a major company in the road industry. Like SIMAURIF, the primary purpose of the project is the economic assessment of land-use and transportation policies, and its contribution to the analysis of residential strategies is consequently limited. [10]

b) Analyzing household housing and transportation expenses

In another direction that has greatly influenced my approach, Polacchini and Orfeuil (1999) probe the relationship between transport and residential choices in the GPR using housing and transportation expense ratios. [11] In their study, the housing outlay is restricted to either the monthly rent or the home loan monthly payment depending on household tenure. [12] Transportation costs are estimated using the *Enquête Globale de*

[9] Those "submodels" are actually models *per se*, and are still in use in stand-alone settings, hence the quotes.
[10] A thorough presentation of PIRANDELLO may be found in *Supplement 2*.
[11] The expense ratio is the amount spent on a given good divided by household income. In the remainder of the text, it is also referred to as "burden" (e.g., the housing burden).
[12] The scope only includes home buyers and private renters, being the only categories for which data was both

Transport 1991, a survey on daily travel behaviors within the GPR (→ *II - B-1*). Lastly, the study area is divided into nine zones with decreasing levels of housing prices. The authors find the **housing expense ratio to be approximately constant**, whatever the zone of residence. Daily travel-times are also roughly constant within the whole region. On the other hand, distances travelled grow markedly from the most expensive zones to the least expensive ones, that is, from core to periphery. As a result, the **transportation expense ratio strongly increases**, nearing the housing burden in the most remote zones. All in all, the authors find some fungibility between transportation (T) and housing (H) expenses in central zones, but a rising H+T burden as one goes further into the outskirts. Besides, from core to periphery, household size rises while average income decreases, which entails a fall in the average income per consumption unit; on average, **the "choice of remoteness" is rather the fact of low- and middle-income families**. Therefore, regulations capping housing expenses at a certain fraction of income seize only one part of the phenomenon. They may even prove counterproductive inasmuch as they drive modest households towards zones with affordable housing prices, but high H+T costs, ultimately endangering their financial condition.

Berri (2007) confirms most of these findings using expenditure data from the Family Budget Surveys (*Enquêtes Budget des Familles*) of 1978-79, 1984-85, 1989 and 1994-95. This sequence of four surveys allows an analysis on more than fifteen years, during which car motorization intensified, housing prices fluctuated, and urban sprawl spread. In spite of a coarse spatial resolution (only three zones are used), the author reaches the same conclusions as Polacchini and Orfeuil (1999).

A similar analysis is carried out for the U.S. by Cervero *et al.* (2006), who seek to understand in what way the trade-offs of "working families" of 7 American metropolitan areas (Atlanta, Chicago, Dallas, New York City, Los Angeles, the San Francisco Bay Area, Baltimore-Washington) differ from those of "upper-income families". [13]

available and reliable.

[13] In sum, the authors find that the higher their income, the more American households spend on transportation and on housing. In relative terms, income rises faster than expenses, hence an overall H+T burden decreasing with income. Otherwise, the two groups (working and upper-income families) use the car in similar proportions and also average similar commuting times, although they occupy quite distinct types of work, in different locations to boot. The authors conclude that the poorest do not have as many choices as the wealthiest, especially regarding housing: choices being always a matter of income, the richest can make much more advantageous trade-offs in terms of quality and affordability.

II - METHODOLOGY AND DATA

A GENERAL METHODOLOGY

A-1. Choosing the database

Housing and transportation remain two relatively separate cultures in France, with few coordinated instruments of observation. Transport surveys are mostly oriented towards travel patterns, leaving little place to transportation costs, and even less so to housing.[1] Inversely, housing surveys seldom include questions on household travel needs stemming from to the residential choice and the associated costs. Though surprising it may seem, this merely reflects the diversity of stakeholders in the Greater Paris Region concerning transport and housing, which hinders any attempt at a concerted collection of data.

This "sectored way" of operating and the resulting lack of comprehensive data are largely accountable for most methodological choices and limitations of this study. Based on the previous review of French housing databases (→ *Chapter 0*, section *III*), it turns out that only two allow an **integrated analysis of housing and transportation budgets** at the household level: the Family Budget Survey and the *Enquête Globale de Transport* (EGT). As already mentioned, Berri (2007) carries out an integrated analysis based on the Family Budget Survey. Despite interesting results, it suffers from serious drawbacks, such as a limited sample size (hence a coarse spatial resolution) and little information on household travel patterns. On the other hand, the EGT allows for a more "complete" estimation of transportation budgets, which includes daily travel-times and distances travelled in addition to transportation costs. Moreover, a consequence of Polacchini and Orfeuil's study has been to enrich the 2001-2002 edition with additional information relative to housing characteristics and expenses. This allows me to overcome one major limitation of Polacchini and Orfeuil (1999): the authors use separate databases when estimating housing and transportation expenditures, which forces them to relinquish the disaggregate analysis to focus on zonal means.

Considering all these points, the **EGT 2001-2002** is chosen as the main database for this study. A more complete description of this database may be found further in *B-1* (see also *Chapter 0*, *section III*), after specifying few additional methodological points.

[1] To mitigate this critic, let us note that trip surveys usually involve time-consuming interviews and a long list of questions. This makes it harder to introduce questions that do not seem to be directly related to the survey topic and which purpose might not be understood by the respondent.

A-2. Scope of the study

The analysis focuses on **home buyers and tenants** (of the private and social sectors). Because no housing costs could be computed for outright owners, they are excluded from the sample, *idem* for households with free accommodation (→ section *IV*).

As regards housing and transportation budgets, the scope of each item is specified in sections *III* and *IV*, respectively. In short, monetary costs are comprehensive in the case of transport, but only include rents or monthly loan payments concerning housing. Furthermore, transportation costs, monetary and non-monetary alike, are restricted to **daily travels** (thus excluding vacation travels).

Given the rates of non-responses and nonsensical answers, especially concerning the new housing characteristics (→ *B-1*), we must remain cautious: this work should be considered as exploratory, and needs more data and double-checking to produce final and robust results.

A-3. The IAURIF zones

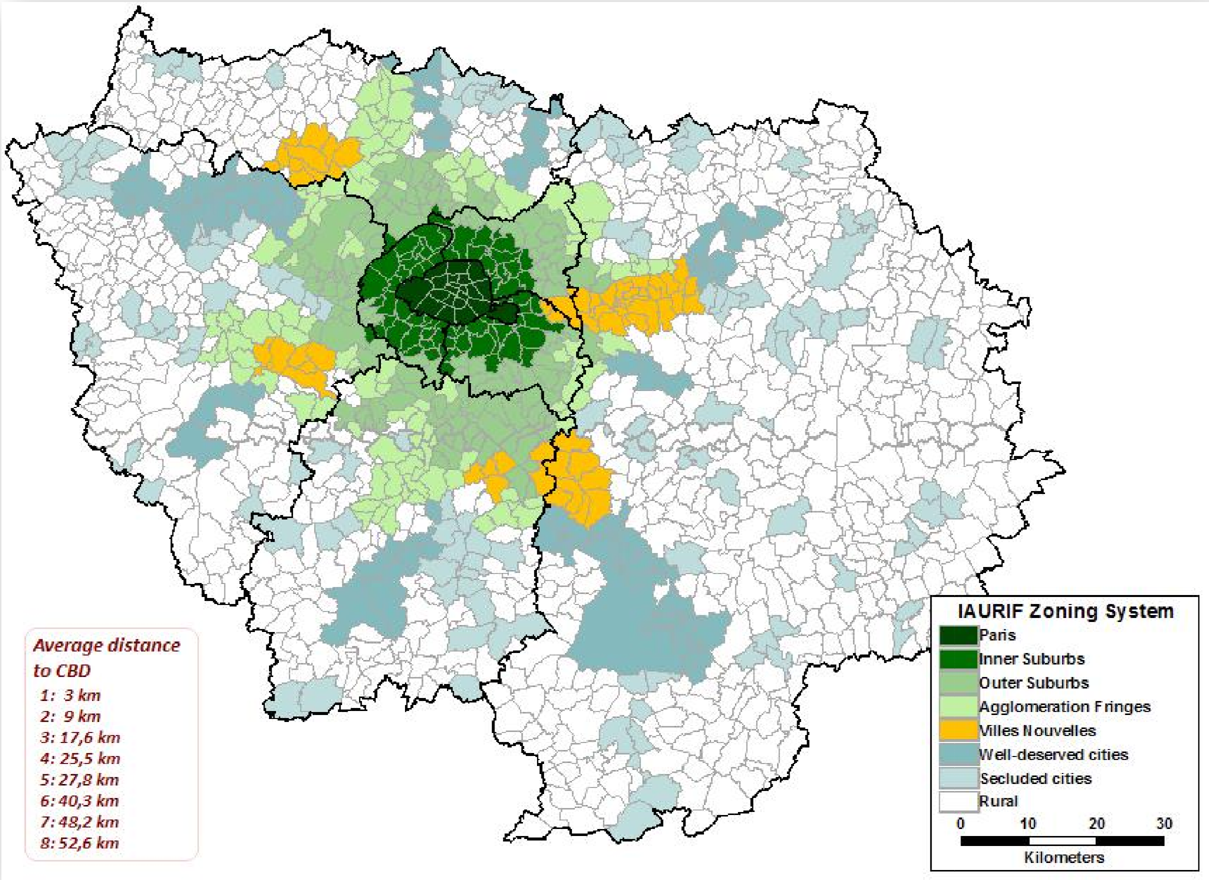
Considering the many specificities of the Greater Paris Region, the IAURIF (*Institut d'Aménagement et d'Urbanisme de la Région Île-de-France*) [2] has partitioned space in eight zones especially **intended for the analysis of transport-related issues** (*Figure 57*). All cities belonging to a same zone have similar levels of road accessibility (be it to the CBD, to employment, etc.) and of transit services.

A priori, this partition of the GPR has no reason to be relevant for the housing part of our analysis. It does not take housing prices into consideration, while they were shown to vary considerably and with non-simple geographical patterns (→ *I - A*). It presents **several desirable features**, nonetheless. First, average distance to CBD increases with the zone number, an interesting property considering the key role of this variable in urban economic theory. Secondly, the partition takes into account a specificity of the GPR, the *Villes Nouvelles*. [3] Those are a set of cities developed in the second half of the 20th century intended to act as secondary centers in the metropolitan area, and foster job and population decentralization. Although quite far from Paris (the average distance to the center of Paris is 28 km), the *Villes Nouvelles* enjoy a good access to the capital thanks to highways and heavy rail transit services. Lastly, the IAURIF zones provided good results to boot, validating our choice *a posteriori*.

[2] Note that the IAURIF has recently changed its name and is now called IAU (sometimes IAU - IdF).

[3] There exist *Villes Nouvelles* in other regions, but neither as numerous nor as important as in the GPR.

FIGURE 57: THE PARTITION OF THE GREATER PARIS REGION IN 8 ZONES



Zones are numbered as follows: 1 = Paris, 2 = Inner Suburbs, …, 8 = Rural.
Here, the CBD is assumed to coincide with the geographic center of Paris.

Source: IAURIF

B TRAVEL AND TRANSPORT-RELATED DATABASES

This study uses three kinds of travel and transport-related databases:

- a household travel survey, central to the analysis;
- travel demand/supply databases;
- lastly, databases on transportation prices and on household expenditures.

B-1. The *Enquête Globale de Transport*, a travel survey for the GPR

a) Presentation

The reconstruction and analysis of household travel behaviors is entirely based on the *Enquête Globale de Transport* (EGT, literally Comprehensive Transportation Survey), which may consequently be considered as the principal database for this work. Carried out by the *Direction Régionale de l'Equipement en Île-de-France* (DREIF), the EGT reports the travel behaviors of households living in the Greater Paris Region. The 2001-2002 survey is its fifth edition, meaning that the methodology is sound and proof-tested.

The EGT comprises two forms, one for weekdays and one for the week-end. The former reports all trips made by the household during one day of the week, this day varying randomly from one household to another. The database also includes several household, individual, and housing characteristics. **10,478 households** have answered the weekday survey, for a total of 23,656 individuals. In number of households, this corresponds to a **sampling ratio of 0.23%**. One third of surveyed households were asked to answer the week-end form and provide information about their trips on both Saturday and Sunday. The week-end survey differs from the week day survey in this regard (i.e., it covers two days instead of one), and is also less detailed in content.

b) Data quality, filtering, and correction procedures

A preliminary analysis of data quality of the EGT has identified three significant issues in relation to our study topic:

- missing household income;
- non-response rate and data quality concerning housing expenses;
- incoherencies and missing information at the trip level, or in the trip chaining.

Regarding the two first items, the whole household is removed from the sample in case of missing information.[4] Otherwise, a few minor correction procedures were carried out on housing expenses, using the database established by Hourdez and presented below. These are described in *Annex B*.

As far as trips are concerned, various correction procedures helped reduce the amount of nonsensical data. Cases of missing data are seldom, and are generally dealt with using all the other information at our disposal to try and deduct them. Once again, all these elements are presented in *Annex B* and *Annex C*.

Given the exclusion from the sample of outright owners and households with free accommodation, as well as households for which income or housing expense is missing, the final sample size is of **5,462 households**.

B-2. Additional transportation databases

In addition to the EGT, databases relative to transportation supply and travel demand are used for the road traffic and transit assignment models.[5] The public transit supply database includes the transit network, transit services with their main characteristics (including vehicle headway by transit line for the peak period), and a simplified tariff system. The road traffic assignment model uses **four O-D matrixes of travel demand**

[4] Standard estimation procedures do exist for these variables, but cannot be carried out with the EGT. In the case of missing income, the EGT provides age and employment data, but unfortunately no measure of educational attainment. Similarly, the absence of indicator of housing quality undermines from the start any attempt to estimate missing rents. Missing monthly payments would obviously be even more difficult to estimate.

[5] Those databases are gracefully provided by the DREIF. They were completed and revised primarily by Thierno Aw (LVMT), as well as by Vincent Breteau (LVMT) and the author.

(morning peak hour, evening peak hour, in-between period, and the remainder) and a network of 28,478 road segments.

The evaluation of transport expenses requires the combination of various sources. A report of the RATP (Garcia Castello 2006) provides the prices of passes and tickets for year 2001.[6] Fuel expenses are estimated with the fuel consumption model COPERT3, adjusted to the GPR using a survey carried out by the Energy Observatory (*Observatoire de l'Énergie* 2003). Fixed costs and variable costs besides fuel expenditure are estimated using the 2001 Family Budget Survey (Cérani and Camus 2004). This leads to the formulation of two working assumptions (→ *III - B-3.b)*). Lastly, I draw on miscellaneous sources to validate the estimation of fixed and variable costs as well as the two working assumptions.

C HOUSING DATABASES

As explained in *A-1*, the choice of the EGT as the main source for both the transport and housing side of the analysis aims to examine possible trade-offs at the household level. As far as housing is concerned, the EGT reports home location using a 300m x 300m grid. Dwelling characteristics include home size, housing type (single-family or multi-family), and tenure. When applicable, the database provides the monthly rent or loan payment.

Because housing expense variables were only recently introduced, one could fear a lack of reliability. I thus use a database on housing prices established by Hourdez (2005) to control the quality of data. For each city of the Greater Paris Region, this database gives the average housing price per m^2 according to tenure and dwelling size, based on a recollection of data drawing on various sources (real estate agencies, newspapers, etc.). Though probably not panacea, this database remains a satisfactory tool to control data quality in the EGT. In addition, reliable local price indexes of housing prices, including property transfers and rents, might exist, but have yet to be claimed. Otherwise, computing such indexes would require the combination of various sources unless using the FNAIM database.[7]

[6] The RATP is the main provider of transit services in the Greater Paris Region.
[7] To be convinced of this point, → *Chapter 0, section III*.

III - ESTIMATING TRANSPORTATION BUDGETS

After specifying the scope of transportation budgets (A), I present the main variables of analysis and how they were estimated (B). First results are then commented, giving an initial insight into household residential strategies in the Greater Paris Region (C).

A SPECIFYING THE SCOPE

A-1. What kind of travel is considered?

Transport-related mobility can be divided into two components: daily and "holidaily" travel, the latter referring to all trips made on vacation (to, from, and on-site). Although both are significant in terms of distances as well as associated costs, [1] I assume vacation travel to exert no influence on the residential choice, based on three considerations:

- Vacation travel varies greatly from year to year for many households, and future projects of vacation are seldom known beyond the few months to come.
- This mobility is not recurrent, hence not perceived with the same acuteness that one's day-to-day commute.
- Changing location within a given metropolitan area would generally have but a minor impact on the overall travel (in terms of distance, cost, etc.).

The scope is consequently restricted to costs associated with **daily travel**. Because the EGT does not explicitly distinguish between daily and non-daily travel, I identify daily travel as **trips staying within the Greater Paris Region**. Albeit not perfect (e.g. the case of people working outside the GPR), for all practical purposes this methodological choice only marginally affects the sample size (it concerns 0.97% of trip observations).

A-2. Does money do it all?

Transportation budgets include monetary costs and two non-monetary items, namely, **transportation expenses**, **daily travel times,** and **daily distances travelled.** Indeed, one generally considers during his home search in how much time he will get to work, the distance, and the associated cost, at least roughly speaking. This is why I argue these three elements to be significant decision variables in the household residential strategy. Following results corroborate this assertion *a posteriori*.

[1] CHIFFRES OU REF SUR MOB. VACANCE

A-3. A comprehensive assessment of monetary expenses

The household transportation expenditure is broken down into three main budget items:

- Private vehicle: this item encompasses fixed and variable costs of cars, commercial vehicles, and two-wheeled vehicles.
- Parking: rental/ownership of a parking lot, purchase of parking tickets and passes.[2]
- Public transit: passes and tickets.

Regarding private vehicles, variable costs comprehend fuel, maintenance, and accessories. Fixed costs cover the acquisition of the vehicle plus insurance costs.

Choosing to assess the transportation expenditure on a comprehensive basis is not straightforward, especially for car-users. As far as regular transit users are concerned, these generally purchase monthly or yearly passes, and thus know what they spend monthly on transportation. Such is not the case for car-users, and except for fuel and insurance, other costs are more difficult to appraise on a monthly basis.[3] Furthermore, fixed costs have an impact on residential choices only inasmuch as people consider that having a car is a choice and not a given.[4] I shall disregard this last consideration for now, and will come back to this issue in conclusion in light of previous results.

B ESTIMATION METHODOLOGY

B-1. General considerations

The variables of interest are presented and analyzed as follows:

- Household expenses are assessed on a monthly basis.
- Non-monetary budgets are provided on a daily and per individual basis.

The choice of presenting monthly/daily and household/individual figures is not neutral. It stems from the assumption that most people think in these terms.[5] Similarly, various measures of non-monetary costs can be relevant *a priori*: the average over the whole household (egalitarian decision), over employed members only (job-based decision), or considering only the head of the household (patriarchy/matriarchy). This study reports the first and the last measure, the second one not being tested.

As regards the estimation methodology *per se*, all estimates are based on one-day observations for weekdays, and partial observations for week-ends (some households are surveyed, others are not), which is a **clear yet unavoidable limitation** of the study. As far as weekdays are concerned, this implies that the day of observation is assumed to

[2] If the parking lot is owned, an "imputed rent" is used to put owners and tenants of parking lots on equal footing.
[3] At least, it needs minimum education and willingness to do so.
[4] It is at least a choice in the sense one can move to a place with access to transit and thus spare a car if he wants to.
[5] This working assumption has yet to be validated, however.

correctly represent the household "average weekday".[6] The methodology used for week-ends is relatively similar in essence. However, because only a third of households answer the week-end survey, non-respondent households are assigned mean values based on a typology taking household type, location, and motorization into account.

B-2. Estimation of travel times and distances travelled

In comparison to previous works (→ *I - B-2.b)*), one novelty of my approach lies in the **use of transit and road traffic assignment models** to estimate non-monetary budgets, instead of using stated times and crow-fly distances available in the EGT.

More specifically, the origin and destination of each "leg" constituting the trip is extracted from the database, as well as the transportation mode and time of departure. For walks, crow-fly distances are amended by a curvature factor, and walking times are computed using three age-based classes of speed. For car-based (transit-based) legs, the origin and destination are assigned to the corresponding zones (nearest stops) of the road traffic (transit) assignment model. Travel times and distances travelled are then extracted from the corresponding impedance matrix according to the time of departure. Both assignment models are run with TransCAD, a transport-oriented GIS.[7]

This approach has a threefold advantage:

- replacing crow-fly distances with **actual network distances**;
- **improving the estimation of fuel consumption**, which is made road segment by road segment instead of applying an average speed to the whole trip;
- developing an **alternate measure of travel-time** more robust to statement errors. This estimation method also prevents the measure from being affected by specific and thus non-recurring events faced by the respondent on the surveyed day, such as unusual congestion, road works, and so on.

Given that the EGT teems with incoherencies as far as stated travel-times are concerned, this last point is a promising improvement for future works that will use this database. In addition, it seems relevant not to consider "specific events" when addressing the issue of residential strategies. Indeed, households are not likely to take these into account when choosing their home.

[6] To put it bluntly, travel times and distances are based on this day only. Similarly, monetary costs (for weekdays) are obtained by multiplying the sum of all expenses estimated for this day by the average number of weekdays per month. Fixed costs are not affected by this shortcoming though (except for those of private vehicles under the H1 hypothesis, → *B-3.b)*).

[7] See *Annex C* for a more thorough description of the methodology, including correction procedures.

B-3. Estimation of monetary costs

a) Transit

Estimation of monetary costs is straightforward in the case of transit, since the medium used to travel (ticket or pass) is fairly well reported. When the individual owns a pass, the corresponding cost is imputed. If a ticket is used instead, a tariff equation estimated by the RATP is preferred to the overly complex actual tariff grid. This equation was shown to be accurate.[8] In case of connection, the corresponding tariff rules are applied.

b) Private vehicles

Fuel expenditure is an output of the road traffic assignment model, which integrates the **fuel consumption model COPERT3**. Two working assumptions are tested with regard to fixed and remaining variable costs. The H1 hypothesis considers that fixed costs are in fact variable costs, perfectly correlated with fuel consumption.[9] The coefficient relating fuel expenditure to the comprehensive cost is guesstimated using results of the Family Budget Survey concerning the GPR. Inversely, H2 assumes fixed costs to be indeed fixed and not to vary with yearly mileage. Moreover, each household bears the same fixed cost per vehicle, whatever the age, brand, or power of the actual vehicle.[10] Variable costs are for their part perfectly correlated to fuel expenditure. The corresponding coefficient is again guesstimated using the Family Budget Survey. Considering the design of the EGT and the fact that H1 and H2 yielded similar results in terms of spatial trends, **H2 was eventually chosen.**[11]

c) Parking

Parking costs are first estimated at the individual level, and then aggregated at the household one. The EGT provides detailed information on parking, including where the vehicle is parked, for how long, and the type of parking used. All these elements are used to compute the parking cost, using either an hourly cost (tickets) or a fixed cost (rental /ownership), both varying with the zone and type of parking.[12] The cost of parking is **borne by the driver**, thus disregarding the possibility of splitting it with passengers (e.g. in case of car-pooling). Lastly, if the trip triggering the parking is made for business purposes, a 50% discount is applied to represent company coverage.

[8] Agenais-Guegen (2008).
[9] I chose to relate fixed costs to fuel consumption instead of mileage because the Family Budget Survey only includes the first two variables, and not mileage.
[10] Three categories are distinguished though: cars and commercial vehicles, two-wheeled motorized vehicles, and bikes.
[11] The EGT covers only one weekday for each household (and sometimes one week-end). If one does not use his car on the surveyed day, H1 yields a null private vehicle budget, which is obviously erroneous. The H2 assumption is not perfectly satisfying either, but this major drawback of H1 made me lean towards H2. A short comparison of results under both assumptions is provided in *Annex C*. Once again, the truth likely lies somewhere in the middle.
[12] If the car is parked on public roads with a resident tariff, a daily cost is used as this system is a "pay per day".

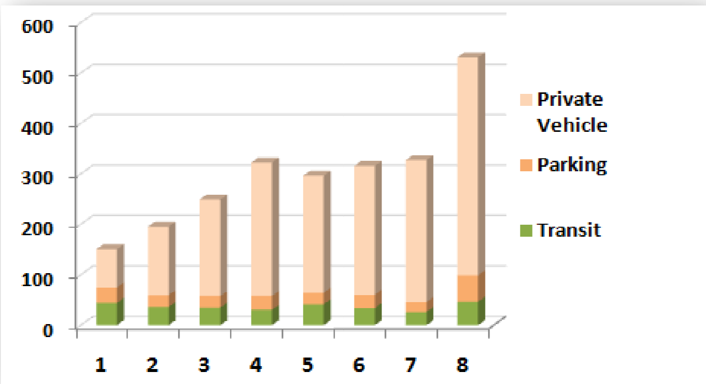
C FIRST ESTIMATION RESULTS

C-1. The preponderant weight of private vehicles in the household transportation expenditure

The analysis of household transportation expenses highlights a **sharp increasing trend with respect to location**, except for a slip at the fifth zone, the *Villes Nouvelles* (*Table 21*). The use of private vehicles accounts for 73% of household transportation expenses on average, far ahead of public transit (15%) and parking (12%). While these last two budget items are relatively stable,[13] private vehicle costs are highly sensitive to location, hence the upward trend. **The increase in motorization** as one gets farther from the CBD explains part of the picture, but variable costs are significant as well, and are even greater than fixed costs for the last two zones (*Table F*).

TABLE 21: BREAKDOWN OF HOUSEHOLD TRANSPORTATION EXPENDITURE *(IN €)*

IAURIF Location	Private Vehicle	Parking	Transit	Total Transport Expenditure	*Motorization Level (Nb of cars)*
Paris	76	30	44	151	0.48
Inner Suburbs	136	24	36	195	0.81
Outer Suburbs	191	23	35	249	1.07
Agglomeration fringes	265	28	30	322	1.40
Villes Nouvelles	232	23	41	296	1.20
Well-deserved Cities	255	26	34	316	1.28
Secluded Cities	281	20	26	327	1.29
Rural	432	53	46	531	1.90
All	164	26	38	228	0.91



Source: Author's estimation based on EGT 2001-2002

Scope: tenants & home buyers

[13] One can discern a moderate influence of location, however. In the case of transit expenses, it is easily interpretable as the spikes observed for Paris and *Villes Nouvelles* mirror the important supply of transit services in these zones. On the other hand, the high level of transit expenses in the rural area highlights the high prices one faces when willing to access central zones from there. Parking costs being more complex to interpret, I do not endeavor to do so here.

C-2. A rise in distances travelled mainly the fact of car-owners

To account for this last phenomenon, let us examine average daily distances travelled for weekdays. [14] The analysis reveals two major facts (*Figure 58*, *Table G* for detailed figures):

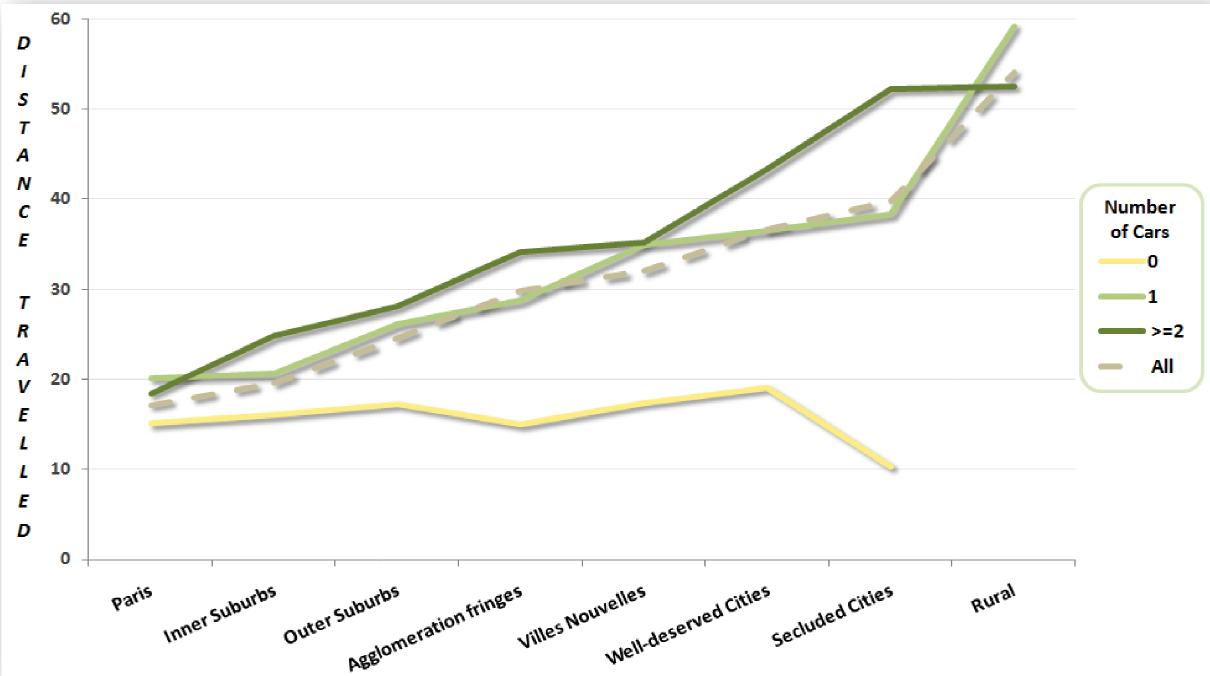
- **Distances travelled rise with location**.
- This marked increase is essentially **the fact of motorized households**.

Distances travelled grow markedly with distance to CBD, being almost three times as important in the rural area as in Paris. This upward trend is more blatant in the case of car-owners, however, who also travel longer distances than non-equipped households.

As regards other possible factors, income has an influence on distances travelled, but only inasmuch as it is correlated with **economic activity**, which seems to be the predominant factor here. [15] Unemployed and inactive households average the shortest distances, and dual-earner households the longest ones (*Figure V*). Heads of household also travel longer distances than the average household member (+6 km on average). The impact of housing tenure on the daily distance travelled by the head of household was also tested. Overall, **housing tenure has little influence**, **except for home buyers** who average longer distances than the rest (*Figure W*).

FIGURE 58: HOUSEHOLD DAILY DISTANCES TRAVELLED ACCORDING TO MOTORIZATION

(KM PER HOUSEHOLD MEMBER)



Note that points with less than 10 observations are never reprensented.

Scope: weekdays only, tenants & home buyers *Source: Author's estimation based on EGT 2001-2002*

[14] Weekday travel patterns are largely shaped by commuting, hence more regular than week-end ones. They are thus more readily interpretable, and also weigh more in terms of expenses, which is why the analysis focuses on this measure.
[15] While this point was not tested with due econometric methods, cross-tabulations provide strong basis for it.

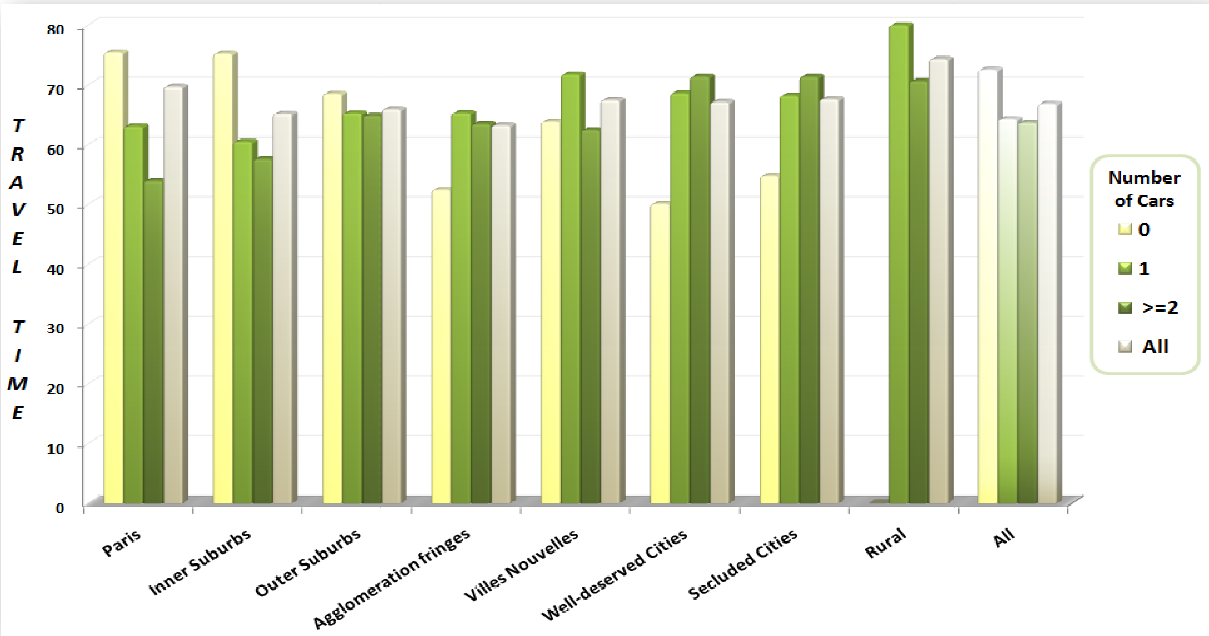
This sharp upward trend in distances travelled by car-owners explains both the extent and spatial patterns of expenditures linked to private vehicles. It remains unclear why car-owners make longer trips than transit users, however. This is when the analysis of travel-times proves enlightening.

C-3. Zahavi's law, or the curse of speed

Household daily travel times vary little with location in comparison to distances travelled, with a mean 67 minutes spent in transport per weekday and per household member (*Figure 59*, *Table G* for detailed figures). This result is especially striking for car-owners, at the sole exception of the spike observed for rural households with one car. Volatility is slightly greater in the case of transit users, and varies in accordance to the level of transit services.[16] The relative constancy of daily travel times does bode well, as "**Zahavi's law**" is known to apply to the Greater Paris Region.[17]

Further analysis confirms the findings of *C-2*. The influence of income on travel times is mild,[18] while it is **more pronounced in the case of economic activity** (*Figure X*). Similarly, **heads of household spend more time** in transportation than the "average household member" (+6 minutes on average). Lastly, the analysis of the impact of tenure on the daily travel time of the head of household corroborates the fact that home buyers are willing to dedicate more time to transport than the rest (*Figure Y*).

FIGURE 59: HOUSEHOLD DAILY TRAVEL TIMES ACCORDING TO HOUSEHOLD MOTORIZATION
(MINUTES PER HOUSEHOLD MEMBER)



Scope: weekdays only, tenants & home buyers

Source: Authors' estimation based on EGT 2001-2002

[16] Once again, except for rural households with no car, who only represent 3 observations…
[17] For reminder, "Zahavi's law" makes the conjecture of constant daily travel-times, be it throughout time or across space.
[18] The lower tercile averages 6 minutes less than the middle one, which in turn averages 3 minutes less than the upper one.

C-4. A first insight into residential strategies

Based on the above analysis, we can develop a first hypothesis with regard to household residential strategies, which is that households **choose the best available home within a 30-40 minutes radius from their working place**. Let us elaborate.

First, the relative **constancy of daily travel-times** tends to corroborate the fact that individuals have an underlying notion of a "**maximum daily travel-time**", which would be a reference point during their home search. Under this assumption, the fact that heads of home buyer households spend slightly more time in transportation than the others highlights the specific place that ownership holds in French households' hearts. To achieve the "dream" of ownership, and given very high housing prices in the GPR, households consent to sacrifice a little of their daily spare time to access better housing opportunities. In this regard, the fact that outright owners spend less time in transport is in accordance with the review of the economic literature. As a matter of fact, a twofold interpretation can be provided in light of *Chapter 1*, *I-B-3.b)*:

- When the opportunity arises, home owners try to get jobs closer to their residence (cf. Zax and Kain 1991).
- Conversely, home owners with high commuting times might at some point no longer stand it, hence showing a higher propensity to move (cf. Van Ommeren *et al.* 1999).

The analysis of distances travelled confirms this hypothesis. The **greater speeds** allowed by the car have not been converted in an equivalent gain of time, but on the contrary in **longer distances travelled**, hence the "**curse of speed**". Higher speeds only serve to access better opportunities (including housing ones), and thereby contribute to urban sprawl.

Let us stress, however, that this does not imply that one wishes to be as close to this "maximum daily travel-time" as possible. Travel times are quite volatile across households, even though the methodology used in this study prevents me from properly addressing this point (→ *footnote* [6]). Besides, the fact that lower commuting times seem to entail higher travel times concerning other purposes (such as leisure) implies that **households would surely minimize their commuting time and distance if they could** (given their residential preferences). Among the possible factors that could influence the actual commuting time and distance of the head of household, let us note:

- Income: the role of income is highly ambiguous. Higher income gives access to more opportunities, but may also drive households to settle far from CBD (→ *Chapter 1*, *I-D*). Similarly, a too low income substantially constrains the household residential choice, which is likely to increase the commuting time, but it also limits distances travelled insomuch as using the car might be too costly for the household.
- the household value-of-time;
- available supply at the time of the home search, which is mainly the fact of chance.

All the elements could be tested in time. They would have been tested here were it not for time constraints, as well as the limitations inherent to the EGT mentioned above.

Lastly, let us underline that if **income** could have an influence on commute variables, it was found to exert **no significant influence on total travel times and distances** when correcting for household economic activity (by opposing employed households to unemployed and inactive ones).

IV - ESTIMATING HOUSING EXPENSES

As in the previous section, I first identify the scope of housing expenses (A), then expose the evaluation method (B), and lastly present first estimation results (C).

A SPECIFYING THE SCOPE

A-1. Which expense items are considered and which are not?

The housing expenditure is calculated at the household level. It is the **rent** in the case of private and social renters, or the **monthly loan payment** in the case of home buyers. Those are in fact the only available data concerning housing outlays. Expenses related to home maintenance, renovation, insurance, and so on, are not reported in the EGT. In other words, the database gives no information about housing costs as far as outright owners are concerned. This is why they are not considered in this study (this being equally true for people being given free accommodation).

A first limitation of the EGT concerns **utilities and service charges.** It is unclear in the case of tenants whether these include this expense item or not when stating the rent. Based on *Chapter 0*, *Table A*, service charges account for around 10% of the total housing expenditure, and energy and water for 20%. Similarly, **local tax** (*taxe d'habitation*), plus **land tax** (*taxe foncière*) in the case of home buyers, is another substantial expense item not reported in the database. It undermines results inasmuch as they vary with location. These taxes could thus exert an influence in household residential choices, probably limited though as they weigh little in comparison to the rent or the total housing price. Given the information available in the EGT, it is theoretically possible to estimate them, which could be the object of a further work to improve the quality of the results.

Lastly, the **down-payment** is not known in the case of home buyers, and thus not considered. This is an important limitation seeing that the down-payment is significant (40% of the housing price on average in the GPR, *Chapter 0*, *I – B-2.b)*), and varies greatly from one household to another (first-time owners typically making a smaller one).

A-2. Actual expenses or imputed rents?

This last consideration raises the issue of **whether to consider actual expenses** or **imputed rents**. This choice is in fact not trivial at all. Actual expenses are observable, readily interpretable, but vary greatly depending on the acquisition and financing strategy. Down-payments and cash acquisition are massive sources of irregularities to boot, this consideration holding equally true be it in the case of home or car ownership. Conversely, imputed rents provide a more stable accounting framework, but are not observable and much more complex to manipulate and understand as they set aside the issue of financing and of the cost of the loan. In the end, the choice was that of actual expenses in the case of housing (that is the rent or the monthly loan payment), and that of "total cost" in the case of transport. Besides pragmatism, the underlying idea is that cars have typically shorter life spans than buildings, and are thus amortized.

A-3. What about housing benefits?

As presented in *Chapter 0*, *I–B-3*, there exist housing benefits for low-income households in France, based on the dual system AL – APL. Unfortunately, **this issue is not covered by the EGT**, despite its substantial effect of alleviating the housing burden of this income category. This represents a possible source of overestimation of the housing expenditure. Furthermore, though it is likely that most households have declared their gross housing expense, some may have already deduced these benefits. This renders almost impossible any attempt to perform to a correction procedure.

Berri (2006) casts an interesting light on this issue, as **he compares gross and net housing expense ratios** (*supra*, pp.43-44). The difference is the greatest for low-income tenants, social and private alike (from 4 to 5% on average in 1994). On the other hand, it is barely sizable for all other categories, including low-income home-buyers (only 1.3%). This shortcoming of the EGT database thus **mostly affects results concerning low-income tenants**, and that the extent of the error should be less than 5%.

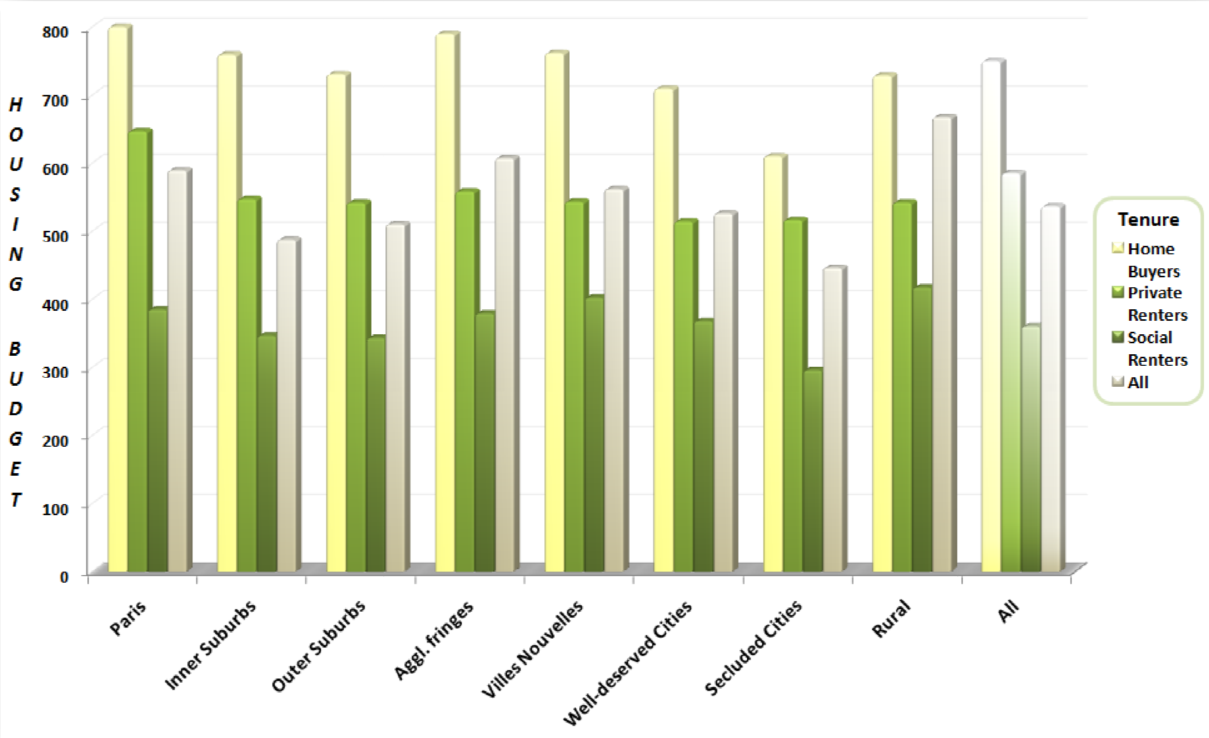
B ESTIMATION METHODOLOGY

The estimation of the housing expenditure is straightforward as this element is directly reported in the database. Correction procedures are indicated in *Annex B*.

C FIRST ESTIMATION RESULTS

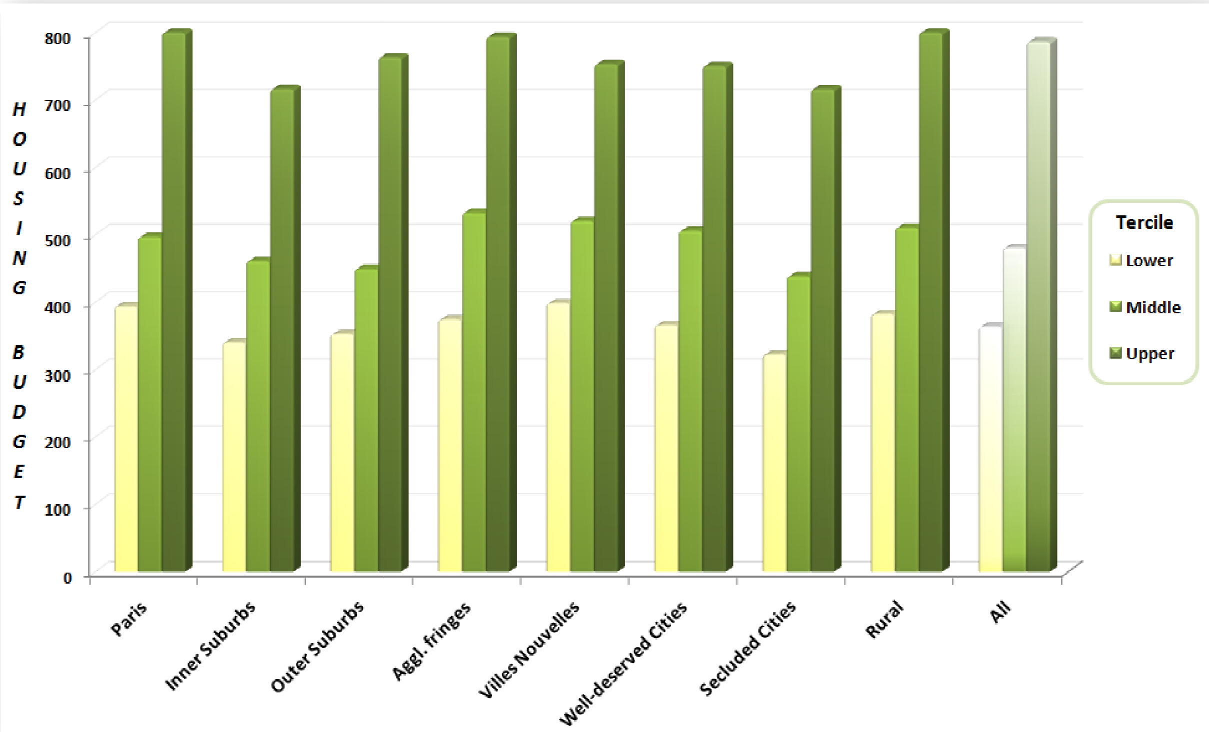
Whereas an initial analysis of the average housing expenditure highlights some volatility with respect to location, variations are mitigated when controlling for tenure (*Figure 60*). Results are in accordance with intuition: home buyers average higher housing expenses than private renters (750€ against 585€, *Table H*), who in turn have significantly higher rents than social sector tenants (360€ on average). Paris and secluded cities are singled out to some extent, the first one featuring high levels of outlay in the unregulated market, which stem from very high housing prices in this area (→ *Figure 56*), and the second one a small fall in the housing expenditure of home buyers.

FIGURE 60: AVERAGE HOUSING EXPENDITURE ACCORDING TO HOUSING TENURE



Source: Author's estimation based on EGT 2001-2002

FIGURE 61: AVERAGE HOUSING EXPENDITURE ACCORDING TO INCOME TERCILE



Scope: tenants & home buyers

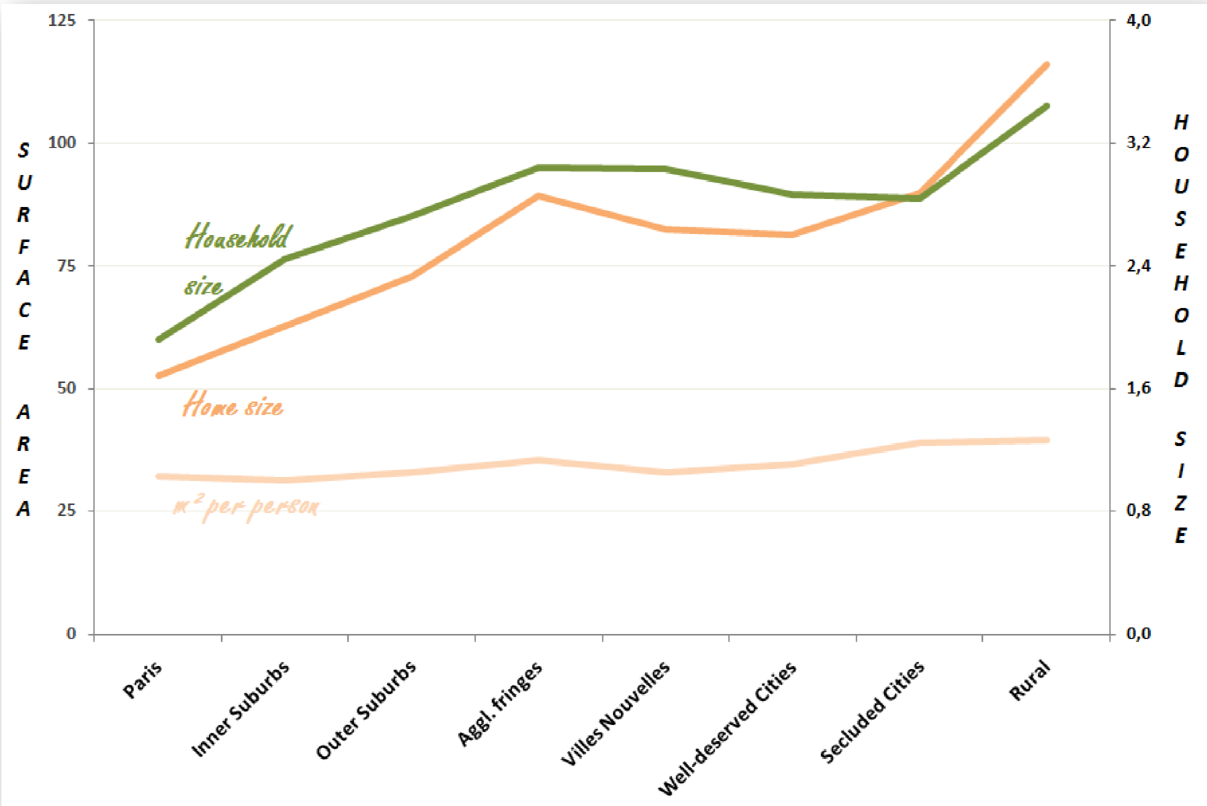
Source: Author's estimation based on EGT 2001-2002

The analysis by income tercile reveals an even higher regularity of housing expenses (*Figure 61*). These barely vary with location, averaging 364, 480, and 787€ for the lower, middle, and upper tercile, respectively (*Table I*).

These relatively stable housing expenses conceal a **significant rise in home size** as one gets further from Paris, coincident with an **increase in household size** (*Figure 62*). All in all, this results in an **almost constant number of m² per person** (on average). Considering the relative decrease in housing prices with distance to CBD (→ *Figure 56*), this gives an important insight into household residential strategies. In order to reach an average level of 33m² per person, **households get increasingly further in the GPR as the household gets bigger**, in response to the lack of affordable housing supply in the central parts of this area.

Controlling for household income leads to similar spatial patterns, but reveals that wealthier households have bigger homes, indeed (*Table J*). Yet, and quite surprisingly, **the average level of m² per person is roughly constant whatever the household income and the location**. The same holds equally true for tenure: home buyers have bigger homes than social renters, who in turn have bigger homes than private renters, but controlling for household size highlights similar situations (*Table K*).

FIGURE 62: AVERAGE HOME AND HOUSEHOLD SIZE



Scope: tenants & home buyers *Source: Author's estimation based on EGT 2001-2002*

V - HOUSING AND TRANSPORTATION BURDENS AND HOUSEHOLD RESIDENTIAL STRATEGIES

This section undertakes the spatial analysis of household housing and transportation burdens. This will allow me to specify residential strategies in the Greater Paris Region, in particular by tackling the question of the housing – transportation trade–off.

The housing and transportation burdens are obtained by dividing the corresponding amount by the household income. As this last variable is only known by class in the EGT, some assumptions are made concerning the income distribution to estimate the average of each class. Those are presented in *Annex B*.

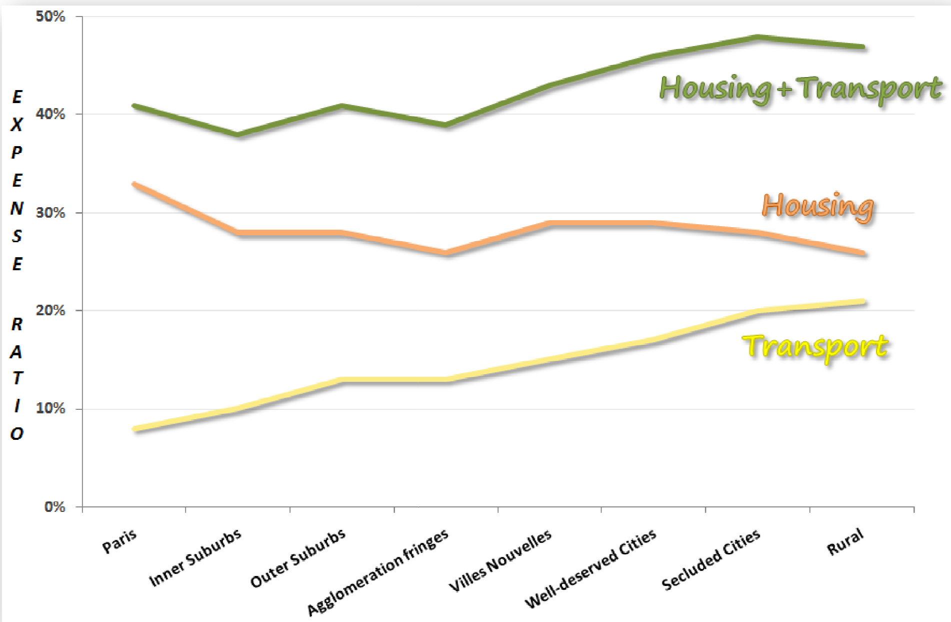
A AT FIRST SIGHT: A TRADE–OFF ONLY IN CENTRAL AREAS

An initial analysis highlights that the housing plus transportation (H+T) burden is stable at first then rises in the last zones (*Figure 63*). This stems from two countervailing trends:

- the **transportation burden markedly increases with distance to CBD**;
- the **housing burden**, although more irregular, has a **slight decreasing trend**.

The first point is not surprising considering preliminary results obtained in *section III*. Similarly, the downward trend of the housing expense ratio is the outcome of a regular housing expenditure and of an increase in household income.

FIGURE 63: HOUSING AND TRANSPORTATION BURDENS IN THE GREATER PARIS REGION



H	T	H+T	N
33%	8%	41%	1020
28%	10%	38%	1558
28%	13%	41%	1303
26%	13%	39%	418
29%	15%	43%	448
29%	17%	46%	475
28%	20%	48%	106
26%	21%	47%	134
29%	12%	41%	5462

Scope: tenants & home buyers

Source: Author's estimation based on EGT 2001-2002

In central zones, the relatively stable H+T share, hovering in the vicinity of 40%, tends to indicate that **a trade–off occurs between housing and transportation expenditures**. Starting from *Villes Nouvelles*, the trade-off wears off, leaving place to a **rising H+T burden**. However, one must bear in mind the possible influence of tenure and income composition, which I am now going to investigate.

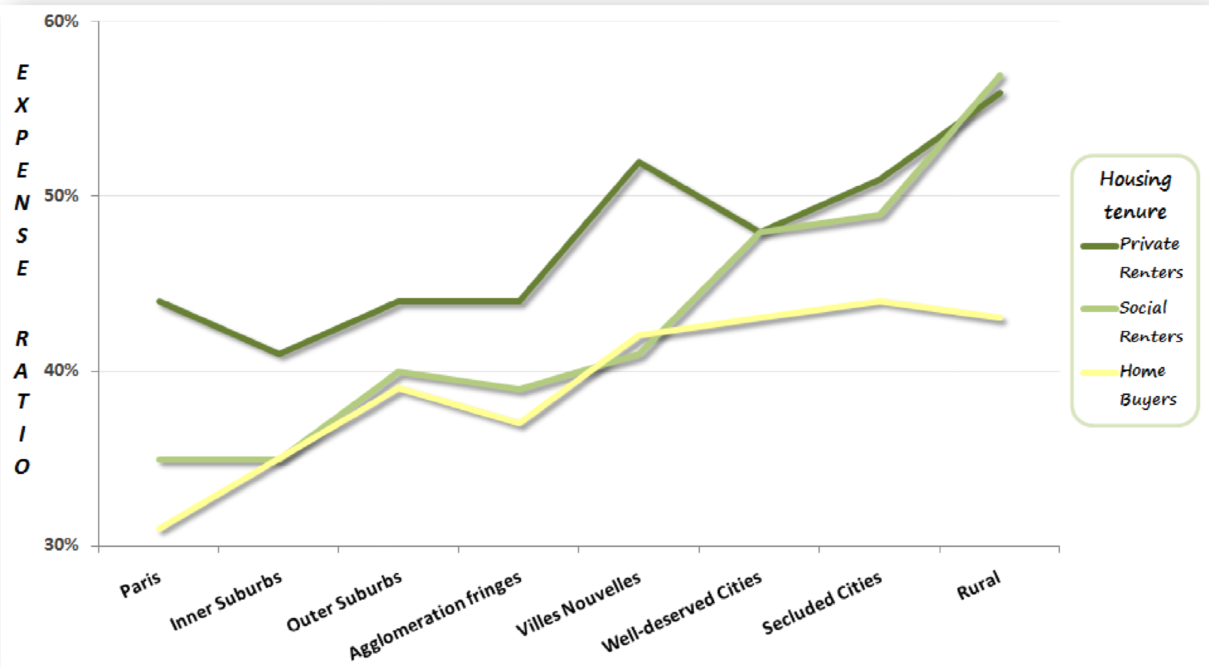
B THE ROLE OF HOUSING TENURE

The analysis of tenure yields surprising results. While the three categories have in each location similar levels of transportation burden, private renters bear higher housing burdens than social renters, who in turn dedicate a slightly higher share of their income to housing than home buyers. Considering the former results of *section IV*, this indicates a **significant income composition effect**. As a result, private renters have the highest H+T burdens, and home buyers the lowest ones, especially in the last zones (*Figure 64*).

Controlling by tenure also uncovers **more marked upward trends** concerning H+T burdens, except for private renters, which mitigates the previous statement about the housing – transportation trade-off in central zones.

All in all, this analysis has highlighted that housing tenure and household income both exert significant influence on housing and transportation burdens. **Not controlling for these two factors simultaneously therefore entails possible misinterpretations**. The following subsection remedies this lack.

FIGURE 64: HOUSING AND TRANSPORTATION BURDENS ACCORDING TO TENURE



Source: Author's estimation based on EGT 2001-2002

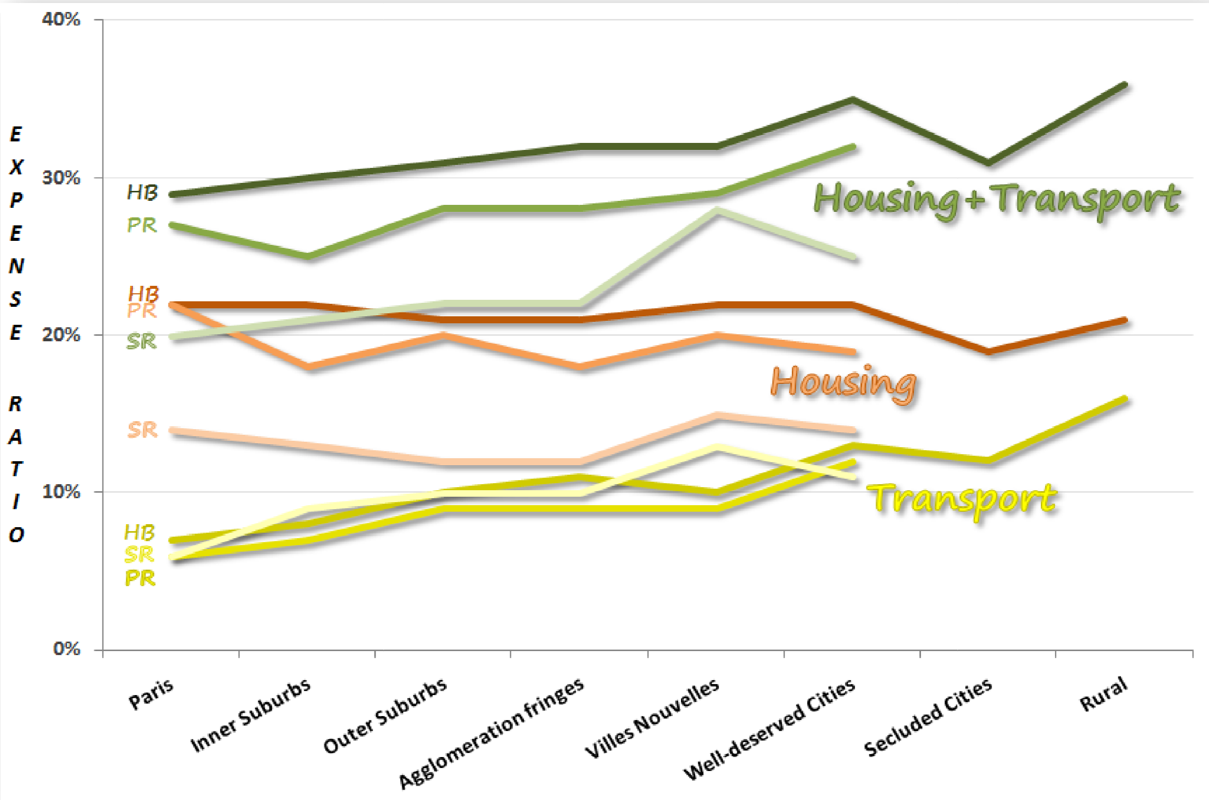
C CONTROLLING FOR INCOME

C-1. The case of high-income households

Controlling for income leads to clearer results, thereby highlighting the role of income composition in previous findings. In the case of upper tercile households, **the share of income allocated to housing varies little whatever the distance to CBD** (*Figure 65)*. Social renters average lower levels, however (13% against 20% for private renters and 21% and homebuyers, *Table L*).[1] Therefore, **H+T burdens grow with distance to CBD, borne by the rise of transportation burdens** (except for a few singular points).

All in all, households lucky enough to be accommodated in social housing have significantly lower H+T burdens than other households in the same tercile. This is partly compensated by the fact that private sector tenants and home buyers live in larger homes (+3.5 and +6m^2 as compared to social renters, respectively). This difference in home size also probably accounts for the slightly higher H+T burdens of home buyers as compared to private sector tenants.

FIGURE 65: HOUSING &TRANSPORTATION BURDENS BY TENURE, UPPER TERCILE



HB=Home Buyer; PR=Private Renter; SR=Social Renter *Source: Author's estimation based on EGT 2001-2002*

[1] Unexpectedly, social tenants account for 18% of upper tercile households, which stems from the "*droit au maintien*" (tenure security, → *Chapter 0, I – B-1*).

C-2. Middle income households: the cost of "remoteness" starts to loom

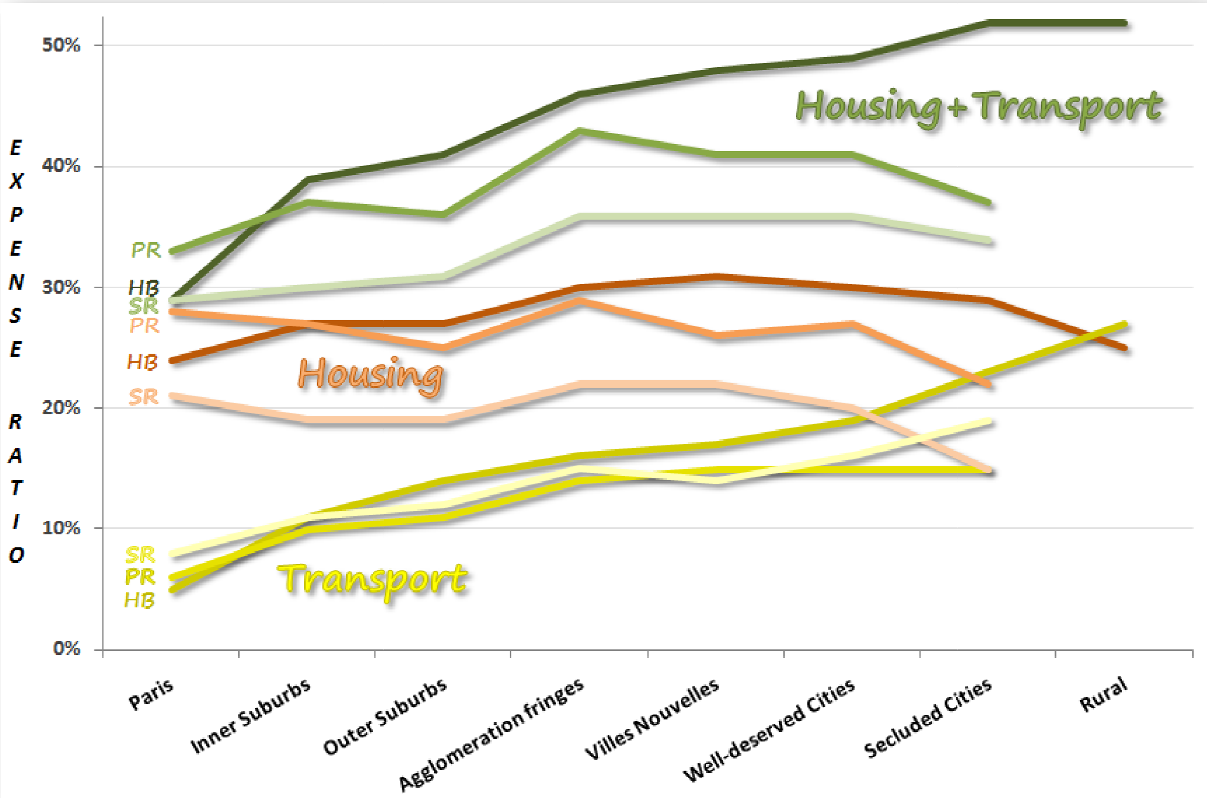
Although the analysis of housing and transport burdens of middle-income households leads to **results almost identical to the previous case**, two elements differ:

- burdens are uniformly higher;
- the slope of the curve of the transportation burden is steeper.

As a result, **H+T burdens grow more markedly** with distance to CBD, especially in the case of home buyers. Besides, the supply of rental housing is limited in the last zones (*Table M*). The constancy, or even slight decrease, of H+T burdens of tenants living in these areas has thus a limited meaning.

Once again, **households seem to give prominence to housing in their residential choices**, with a planned housing budget. Large households who need to settle far from the CBD to fulfill their need for space thus experience the rise in transportation burdens to its fullest, and bear heavy H+T burdens. This point is especially true for home buyers, for whom there is a difference as high as 20% between Paris and the most remote zones. In addition, these have the highest burdens (except for Paris) for only +3m^2 per person on average.

FIGURE 66: HOUSING & TRANSPORTATION BURDENS BY TENURE, MIDDLE TERCILE



HB=Home Buyer; PR=Private Renter; SR=Social Renter *Source: Author's estimation based on EGT 2001-2002*

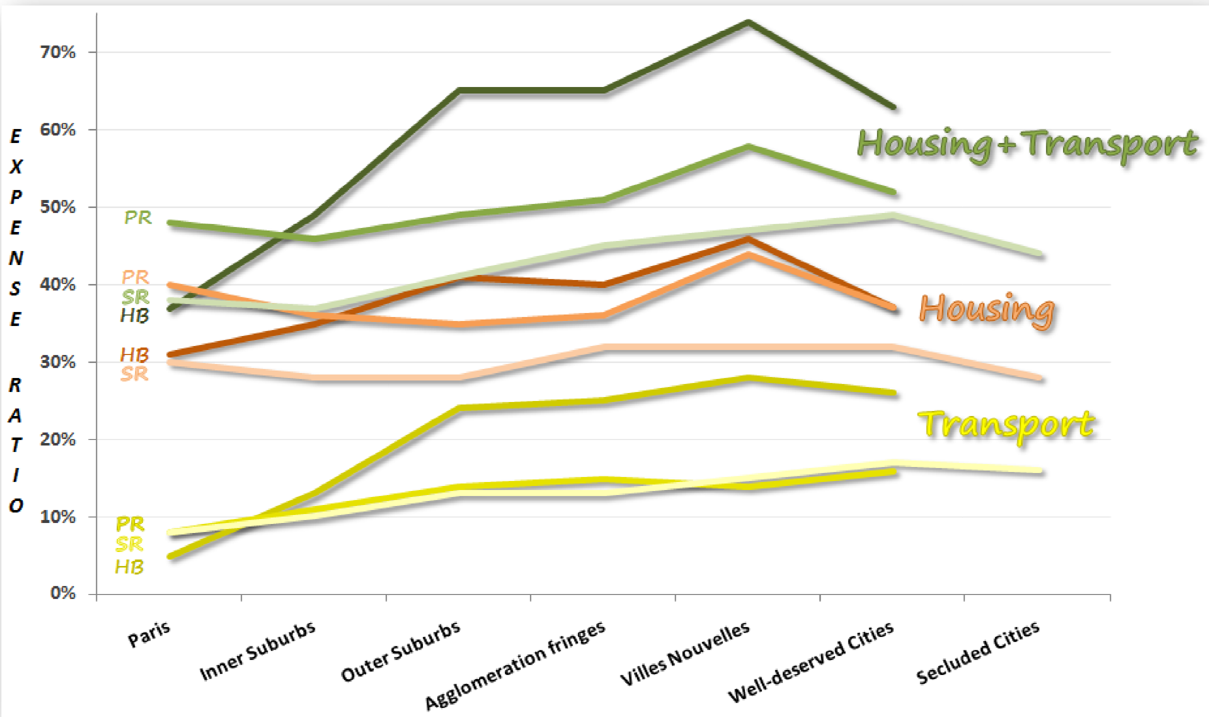
C-3. Low income households: when the dream of home ownership turns into a nightmare

As underlined in *IV - A-3*, the analysis of lower-income brackets is fraught with difficulty, housing benefits not being reported when they prove central in improving their solvency. Furthermore, the fact that household income is given by income bracket is also more of an issue for these categories (→ *Annex B*). This leads to highly volatile curves (*Figure Z*), as well as overly high H+T burdens (*Table N*). To address this issue, the analysis focuses on the upper half of the lower tercile (i.e. the second sextile).[2]

The analysis leads to exactly the **same findings** as in the case of the middle tercile, except these are **even more pronounced** (*Figure 67*). Tenants allow for a constant share of their income to housing, except in Paris and *Villes Nouvelles*, where private renters bear slightly higher burdens due to high prices (→ *Figure 56*). On the other hand, home buyers bear increasingly high housing burdens as they settle farther from Paris, due to a rise in household size which is more marked than for tenants (private sector ones especially).

All in all, **H+T burdens increase with distance to CBD for all tenure segments, even more so for home buyers**, hence the dream of homeownership turning into a nightmare. Well-deserved cities and secluded ones are an exception to this rule, their remoteness maintaining low levels of housing prices in these zones, at least for now.

FIGURE 67: HOUSING & TRANSPORTATION BURDENS BY TENURE, LOWER TERCILE, UPPER HALF



[2] Note that housing expense ratios are still likely to be overestimated. This should not undermine spatial considerations, however, inasmuch as housing benefits vary little with location within the GPR (→ *Chapter 0*, section *I–B-3*).

CONCLUSION

RESIDENTIAL STRATEGIES IN THE GREATER PARIS REGION: A HYPOTHESIS

The evaluation of housing and transportation budgets, including monetary and non-monetary items, has yielded several important findings which shed light on residential strategies in the Greater Paris Region.

This leads me to formulate the hypothesis that the issue of transport is second to that of housing for households, in the sense that they use the former as a variable of adaptation to fulfill their housing needs. More specifically, I propose the hypothesis that **the household primary objective is to reach a certain level of "housing comfort"**, which is around $33m^2$ per person. **Households allow for a fixed share of their income to this objective,** this share decreasing with income and ranging from 20% for the upper tercile to 40% for the upper half of the lower tercile (in the unregulated market). Social housing allows households to enjoy substantially lower housing burdens. In the case of home buyers, the housing burden slightly increases with distance to CBD, stemming from a marked increase in household size as compared to tenant households. **Households then choose their location based on their target housing budget**. This drives large households to settle far from the metropolitan center.

Given this initial description of residential strategies, the role of transportation is to allow households to proceed to their daily activities under a travel-time constraint, which is of 70 minutes approximately. **As one gets farther from the center of the GPR, households make an increasing use of the car**, which enables them to travel longer distances for identical travel-time budgets. However, this involves a tremendous rise in transportation expenses, insofar as one might wonder whether households are fully aware of the extent of these costs (their assessment not being straightforward for car users). This rise in transportation costs is even more pronounced in the case of home buyers, who seem to locate in neighborhoods with low level of transit services. This last point is likely related to the prevalence of single-family housing in the property market, which proves a substantial obstacle to transit.

ASSESSMENT

This study has provided the occasion to develop an innovative methodology to estimate housing and transportation budgets, monetary like non–monetary ones, comprising:

- an integrated approach of housing and transportation, thanks to the new variables available in the *Enquête Globale de Transport*. Relating housing and transportation data at such a precise spatial level is quite uncommon in French studies, and enables me to compute the housing plus transportation expenditure at the household level.
- the use of transit and road traffic assignment models to estimate daily travel-times and distances travelled. This methodological choice has a twofold advantage. The first one is to compute network distances instead of crowfly ones. The second one is to provide more reliable measures of daily travel-times. The methodology has proved promising in this last regard, but further analysis and calibration must be carried on.

Despite these achievements, results must be taken cautiously as two validations could not be properly made:

- housing expenditures, using an alternate data source (e.g. the *Enquête Logement*);
- validation of the assignment of fixed costs of private vehicles with a more extensive household expenditure dataset.

AREAS OF DEVELOPMENT

While this study has shed significant light on residential strategies in the Greater Paris Region, the next logical step would consist in developing a model of residential choice, using the acquired knowledge. Doing so would be beneficial in two ways:

- consolidating and validating the findings of this study;
- having a better understanding of residential dynamics.

Further research will be carried on in this direction. Nevertheless, despite the prolific literature on the topic, several substantial difficulties await us, especially concerning the modeling of prices and real estate development.

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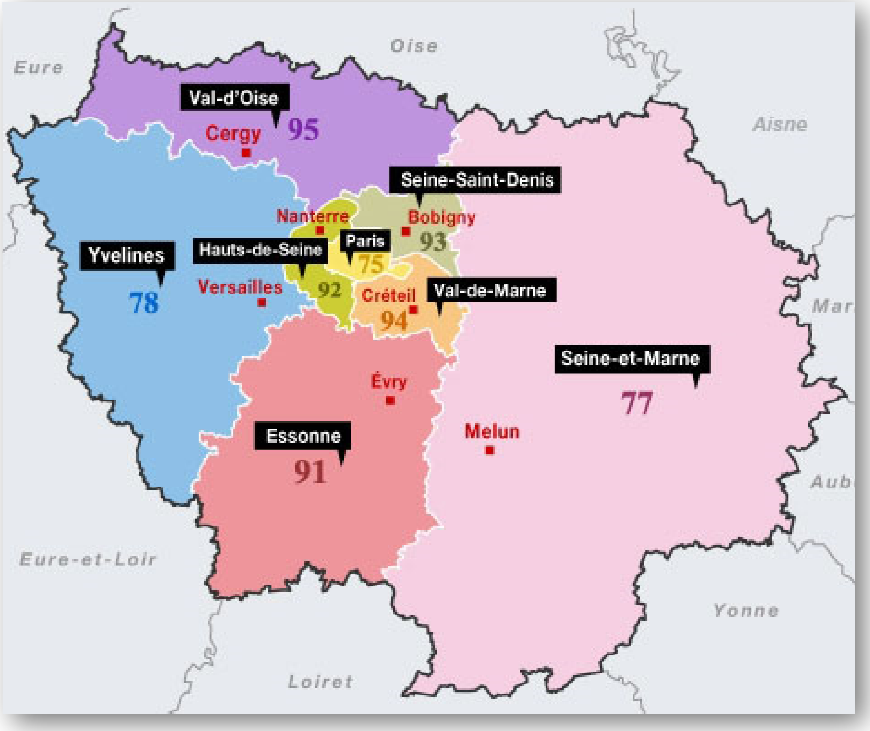
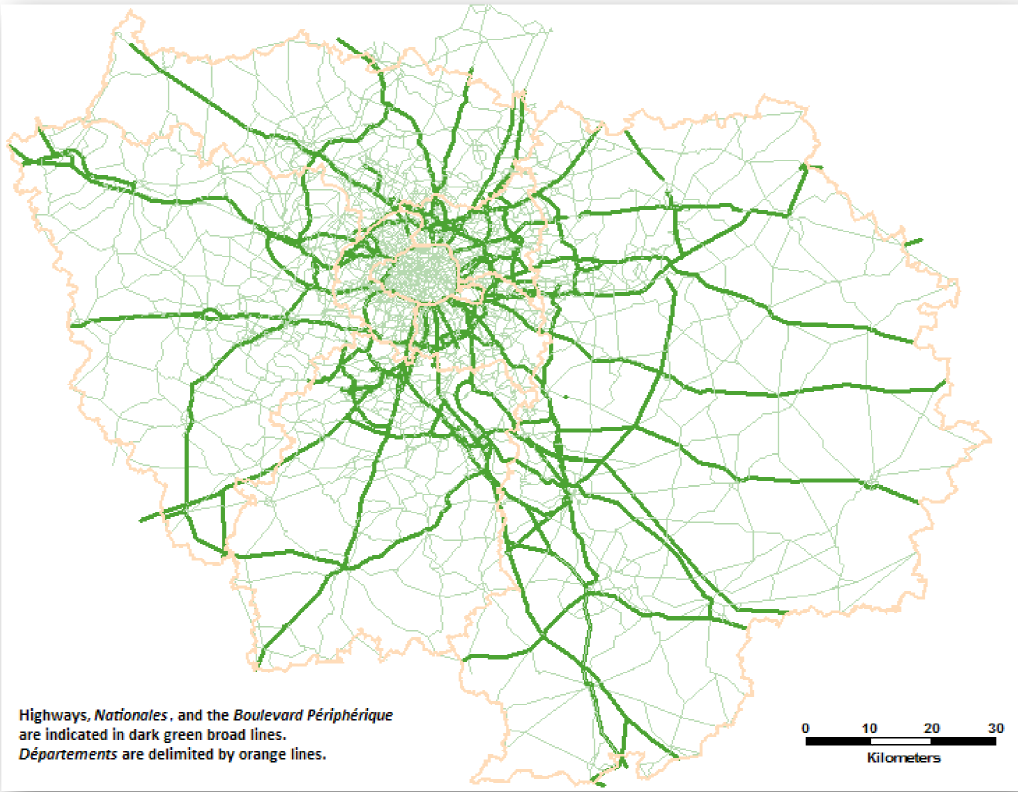
ANNEX A - ADDITIONAL FIGURES AND CHARTS

FIGURE R: ADMINISTRATIVE DIVISION IN *DÉPARTEMENTS* OF THE GREATER PARIS REGION



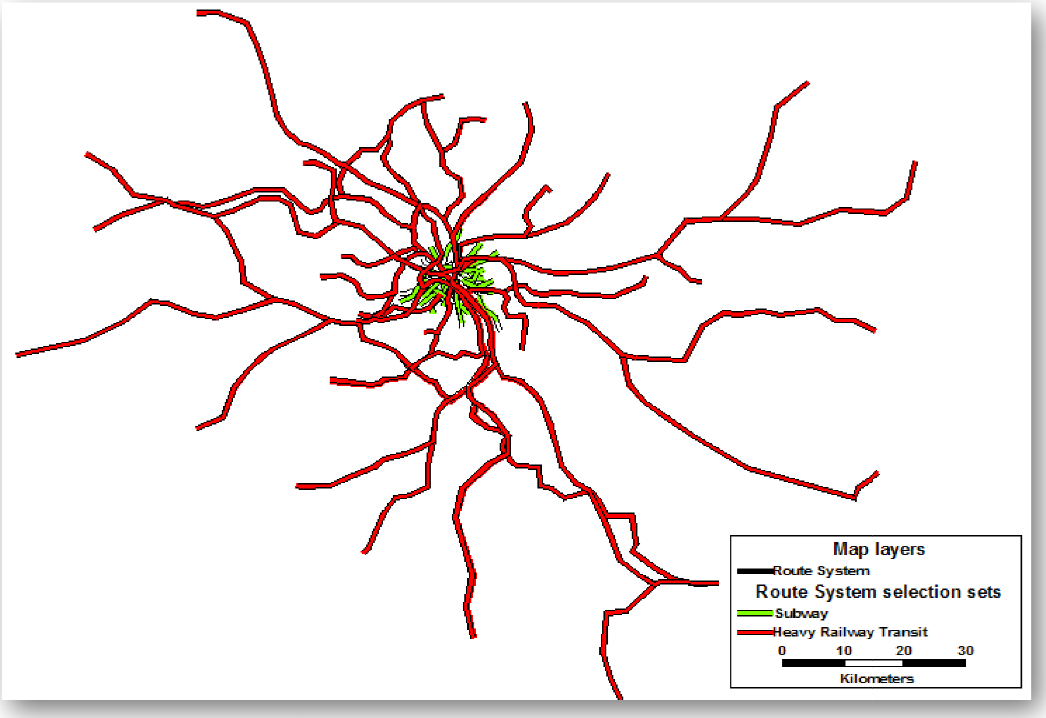
Source: http://www.iledefrance.fr/

FIGURE S: PRIMARY ROAD NETWORK OF THE GREATER PARIS REGION



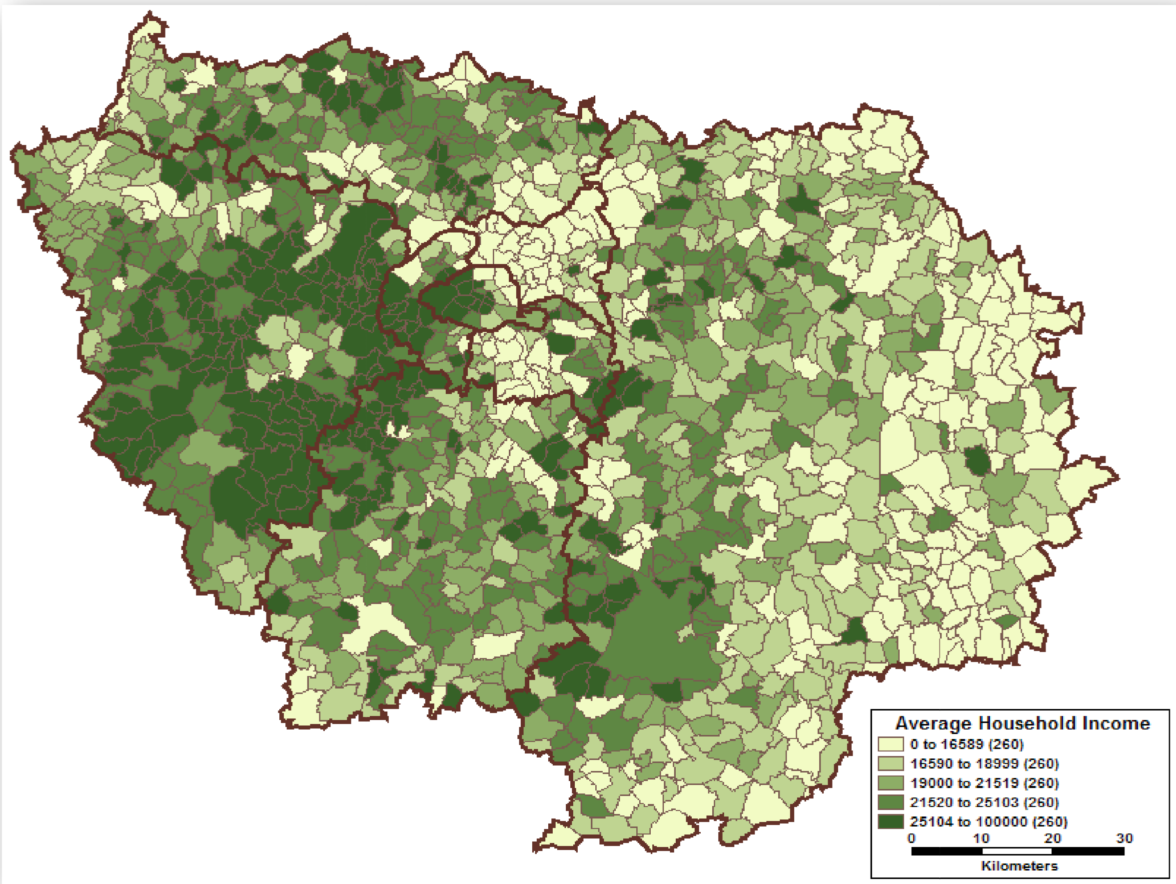
Source: DREIF

FIGURE T: REGIONAL RAILWAY AND PARIS SUBWAY NETWORKS



Source: DREIF

FIGURE U: AVERAGE HOUSEHOLD INCOME BY CITY, 2001



Source:DGI

TABLE F: DETAILED STRUCTURE OF HOUSEHOLD TRANSPORTATION OUTLAYS *(IN €)*

IAURIF Location	*PRIVATE VEHICLES* Variable Costs	Fixed Costs	Parking	*TRANSIT* Tickets	Passes
Paris	25.0	51.0	30.4	22.2	22.0
Inner Suburbs	50.5	85.2	23.6	15.3	20.9
Outer Suburbs	78.7	112.7	22.8	14.2	20.9
Agglomeration fringes	115.3	149.2	27.6	14.2	16.2
Villes Nouvelles	105.5	126.3	23.0	15.7	25.7
Well-deserved Cities	119.0	136.1	26.3	13.4	20.8
Secluded Cities	145.0	136.4	19.6	13.3	13.0
Rural	225.1	207.0	52.6	30.2	16.3
All	67.8	96.3	26.0	16.8	21.0

Scope: tenants & home buyers *Source: Author's estimation based on EGT 2001-2002*

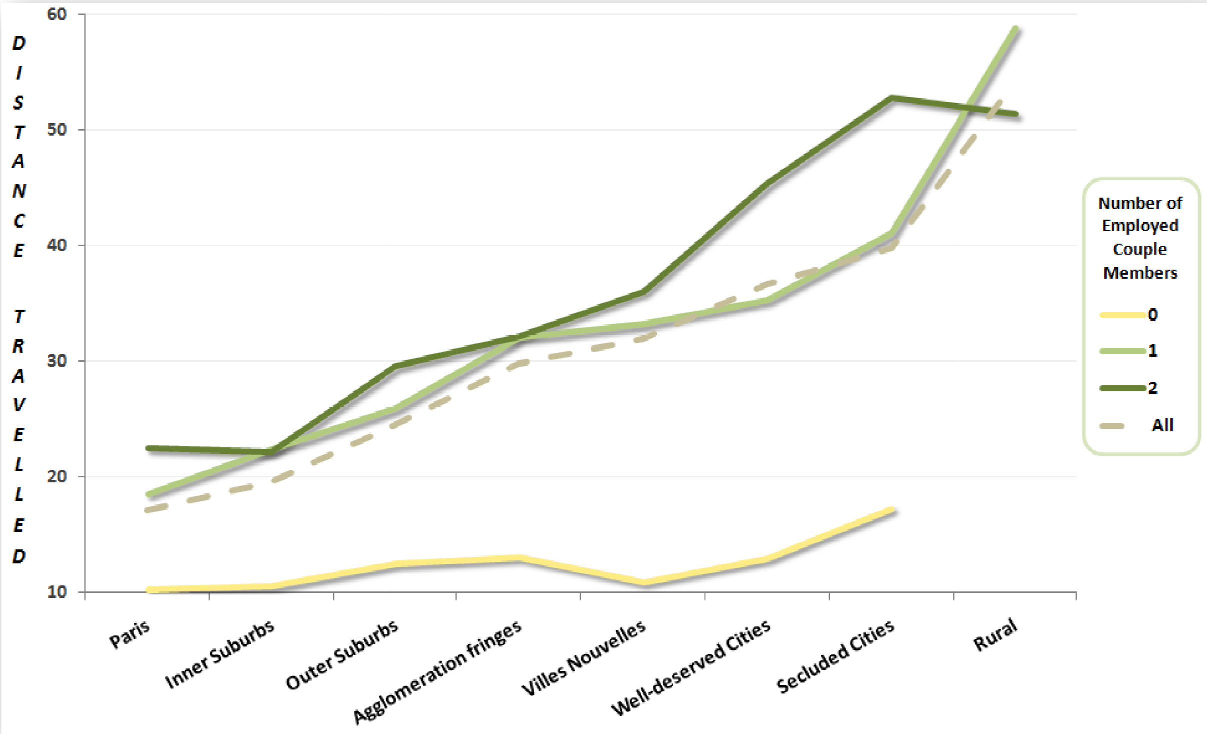
TABLE G: HOUSEHOLD AVERAGE DAILY TRAVEL-TIME AND DISTANCE TRAVELLED, WEEKDAYS (*PER HOUSEHOLD MEMBER*)

IAURIF Location	Distance Travelled *(km)* NB. OF CARS 0	1	>=2	ALL	Travel Time *(min.)* NB. OF CARS 0	1	>=2	ALL	*Nb. of observations* NB. OF CARS 0	1	>=2	ALL
Paris	15.1	20.3	18.5	17.2	75	63	54	70	*575*	*393*	*393*	*1020*
Inner Suburbs	16.0	20.6	24.8	19.6	75	60	58	65	*521*	*792*	*792*	*1558*
Outer Suburbs	17.2	26.2	28.1	24.6	69	65	65	66	*296*	*656*	*656*	*1303*
Aggl. fringes	15.0	28.8	34.2	29.9	52	65	63	63	*38*	*189*	*189*	*418*
Villes Nouvelles	17.4	35.0	35.2	32.0	64	72	62	67	*70*	*229*	*229*	*448*
Well-deserved Cities	19.1	36.5	43.3	36.7	50	69	71	67	*58*	*225*	*225*	*475*
Secluded Cities	10.3	38.4	52.2	39.8	55	68	71	68	*13*	*53*	*53*	*106*
Rural	46.4	59.3	52.6	54.1	80	84	71	74	*3*	*36*	*36*	*134*
All	15.9	25.4	32.6	23.8	73	64	64	67	*1,574*	*2,573*	*2,573*	*5,462*

Scope: weekdays, tenants & home buyers *Source: Author's estimation based on EGT 2001-2002*

FIGURE V: HOUSEHOLD DAILY DISTANCE TRAVELLED ACCORDING TO COUPLE ECONOMIC ACTIVITY

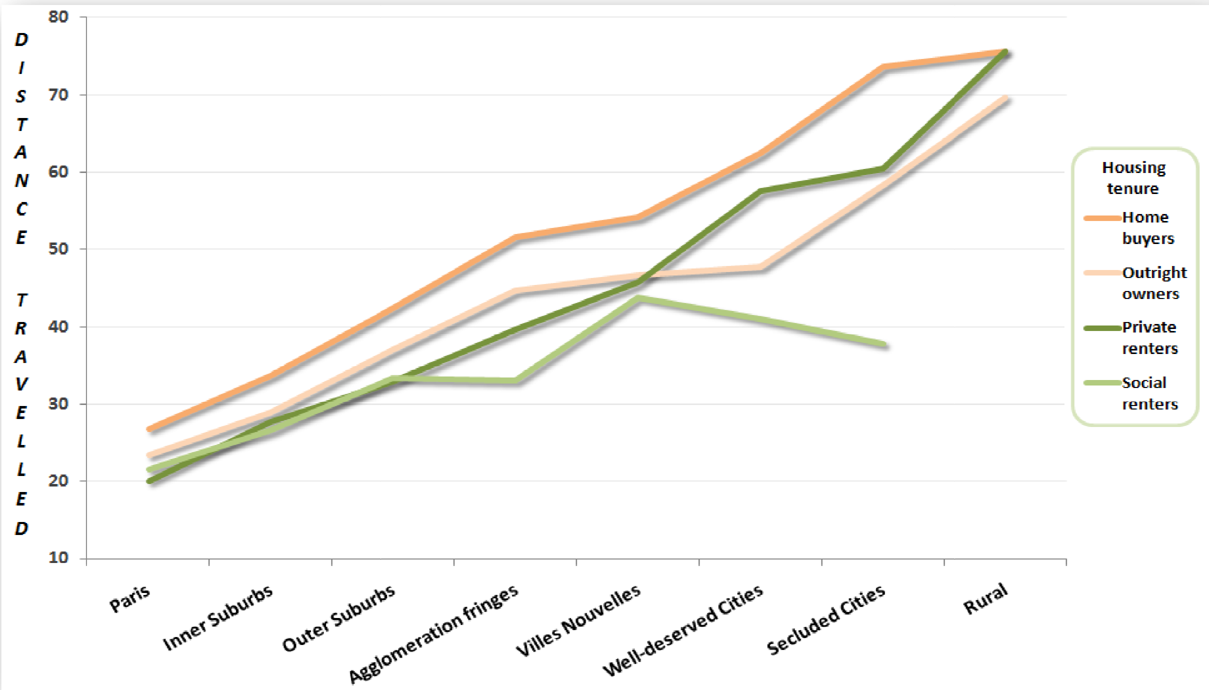
(IN KM PER HOUSEHOLD MEMBER)



Scope: weekdays, tenants & home buyers *Source: Author's estimation based on EGT 2001-2002*

FIGURE W: DAILY DISTANCE TRAVELLED BY HEAD OF HOUSEHOLD ACCORDING TO TENURE

(IN KM)

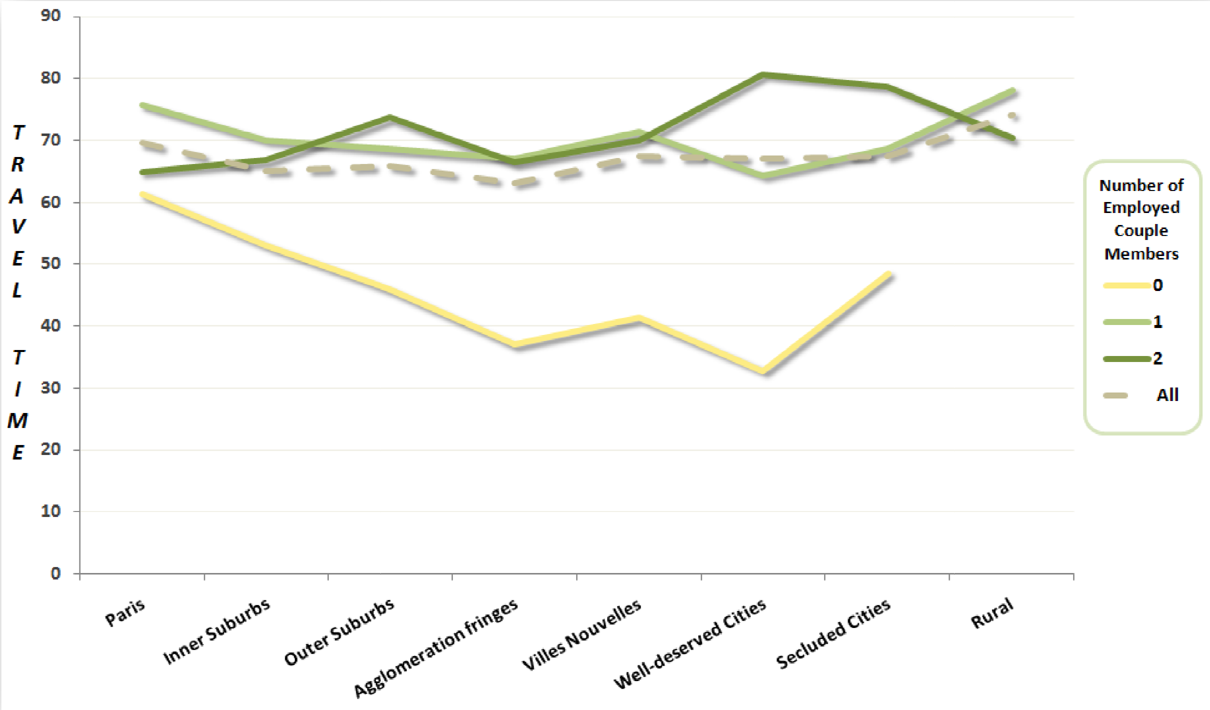


Scope: weekdays, head of household, tenants & home owners. At least one couple member employed (inactive households being overrepresented among outright owners due to retirees, they are removed for better comparability).

Source: Author's estimation based on EGT 2001-2002

FIGURE X: HOUSEHOLD DAILY TRAVEL TIME ACCORDING TO COUPLE ECONOMIC ACTIVITY

(IN MINUTES PER HOUSEHOLD MEMBER)

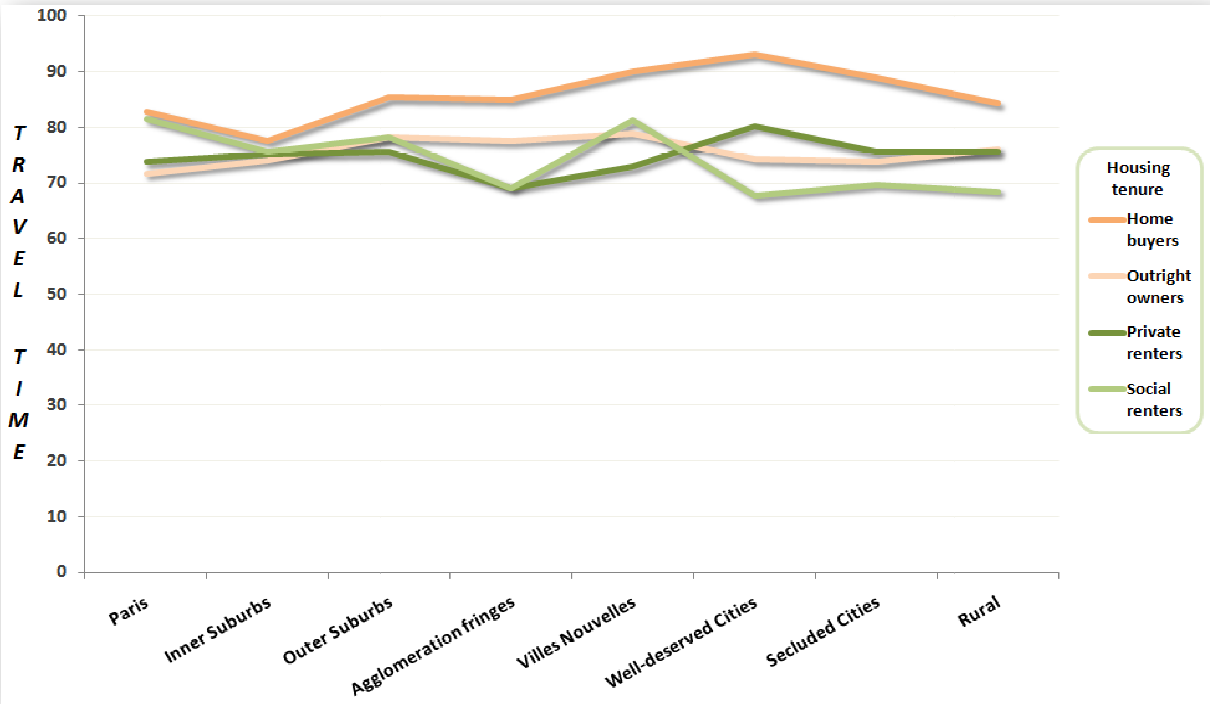


Scope: weekdays, tenants & home buyers.

Source: Author's estimation based on EGT 2001-2002

FIGURE Y: DAILY TRAVEL TIME OF HEAD OF HOUSEHOLD ACCORDING TO HOUSING TENURE

(IN MINUTES)



Scope: weekdays, head of household, tenants & home owners. At least one couple member employed.

Source: Author's estimation based on EGT 2001-2002

TABLE H: AVERAGE HOUSING EXPENDITURE ACCORDING TO TENURE

IAURIF Location	TENURE						ALL	
	HOME BUYERS		SOCIAL RENTERS		PRIVATE RENTERS			
	Housing Budget (€)	Nb. of obs.	Housing Budget (€)	Nb. of obs.	Housing Budget (€)	Nb. of obs.	Housing Budget (€)	Nb. of obs.
Paris	801	90	385	279	647	651	589	1020
Inner Suburbs	759	231	346	707	547	620	487	1558
Outer Suburbs	730	362	343	531	542	410	510	1303
Agglomeration fringes	790	198	379	123	558	97	607	418
Villes Nouvelles	762	183	402	193	543	72	562	448
Well-deserved Cities	709	194	368	186	514	95	526	475
Secluded Cities	610	30	296	44	516	32	446	106
Rural	728	97	417	10	542	27	667	134
All	750	1385	360	2073	585	2004	536	5462

Source: Author's estimation based on EGT 2001-2002

TABLE I: AVERAGE HOUSING EXPENDITURE ACCORDING TO TERCILE

IAURIF Location	TERCILE					
	LOWER		MIDDLE		UPPER	
	Housing Budget (€)	Nb. of obs.	Housing Budget (€)	Nb. of obs.	Housing Budget (€)	Nb. of obs.
Paris	394	389	497	278	890	353
Inner Suburbs	340	622	461	452	716	484
Outer Suburbs	353	492	449	389	763	422
Agglomeration fringes	374	106	533	121	794	191
Villes Nouvelles	398	129	520	167	753	152
Well-deserved Cities	366	165	506	160	750	150
Secluded Cities	322	44	438	39	716	23
Rural	382	29	510	28	831	77
All	364	1976	480	1634	787	1852

Scope: tenants & home buyers

Source: Author's estimation based on EGT 2001-2002

TABLE J: AVERAGE HOUSEHOLD (HH) AND HOME SIZE ACCORDING TO TENURE

IAURIF Location	HOUSING TENURE												ALL			
	HOME BUYERS				SOCIAL RENTERS				PRIVATE RENTERS							
	Home Size (m^2)	HH Size	m^2 per person	N	Home Size (m^2)	HH Size	m^2 per person	N	Home Size (m^2)	HH Size	m^2 per person	N	Home Size (m^2)	HH Size	m^2 per person	N
Paris	62	2,1	34,3	90	55	2,0	33,7	279	51	1,9	31,1	651	53	1,9	32,1	1020
Inner Suburbs	75	2,7	32,3	231	66	2,6	32,7	707	55	2,2	29,6	620	63	2,5	31,4	1558
Outer Suburbs	92	3,3	32,4	362	69	2,7	34,3	531	62	2,3	32,0	410	73	2,7	33,1	1303
Agglomeration fringes	109	3,5	36,0	198	74	2,8	33,5	123	73	2,4	36,8	97	89	3,0	35,4	418
Villes Nouvelles	102	3,3	36,3	183	72	3,0	30,7	193	65	2,4	32,2	72	82	3,0	33,0	448
Well-deserved Cities	102	3,4	35,6	194	71	2,8	33,8	186	66	2,2	35,0	95	81	2,9	34,7	475
Secluded Cities	113	3,7	35,0	30	83	2,5	44,7	44	80	2,6	34,1	32	90	2,8	38,9	106
Rural	129	3,7	39,7	97	106	3,3	49,2	10	78	2,5	36,3	27	116	3,4	39,6	134
All	93	3,1	34,4	1385	66	2,6	33,5	2073	56	2,1	31,3	2004	68	2,5	32,8	5462

Source: Author's estimation based on EGT 2001-2002

TABLE K: AVERAGE HOUSEHOLD (HH) AND HOME SIZE ACCORDING TO HOUSEHOLD INCOME

IAURIF Location	*INCOME TERCILE*												*ALL*			
	LOWER				*MIDDLE*				*UPPER*							
	Home Size (m^2)	*HH Size*	*m^2 per person*	*N*	*Home Size (m^2)*	*HH Size*	*m^2 per person*	*N*	*Home Size (m^2)*	*HH Size*	*m^2 per person*	*N*	*Home Size (m^2)*	*HH Size*	*m^2 per person*	*N*
Paris	43	1,6	31,8	*389*	48	1,8	31,7	*278*	68	2,4	32,7	*353*	53	1,9	32,1	*1020*
Inner Suburbs	54	2,1	33,6	*622*	62	2,6	29,5	*452*	76	2,8	30,2	*484*	63	2,5	31,4	*1558*
Outer Suburbs	60	2,2	35,9	*492*	71	3,0	29,3	*389*	91	3,1	33,2	*422*	73	2,7	33,1	*1303*
Agglomeration fringes	67	2,3	38,6	*106*	81	3,0	32,9	*121*	108	3,5	35,2	*191*	89	3,0	35,4	*418*
Villes Nouvelles	68	2,6	34,1	*129*	80	3,1	31,9	*167*	98	3,4	33,3	*152*	82	3,0	33,0	*448*
Well-deserved Cities	66	2,3	38,2	*165*	80	3,2	30,2	*160*	103	3,3	35,4	*150*	81	2,9	34,7	*475*
Secluded Cities	81	2,3	46,5	*44*	91	3,2	32,0	*39*	106	3,2	35,3	*23*	90	2,8	38,9	*106*
Rural	88	2,7	41,4	*29*	105	3,5	38,5	*28*	131	3,7	39,3	*77*	116	3,4	39,6	*134*
All	55	2,0	34,5	*1976*	66	2,6	30,6	*1634*	85	2,9	32,8	*1852*	68	2,5	32,8	*5462*

Scope: tenants & home buyers

Source: Author's estimation based on EGT 2001-2002

TABLE L: HOUSING AND TRANSPORTATION BURDENS BY TENURE, UPPER TERCILE

IAURIF Location	UPPER TERCILE											
	HOME BUYERS				SOCIAL RENTERS				PRIVATE RENTERS			
	H	T	H+T	N	H	T	H+T	N	H	T	H+T	N
Paris	22%	7%	29%	58	14%	6%	20%	58	22%	6%	27%	237
Inner Suburbs	22%	8%	30%	143	13%	9%	21%	124	18%	7%	25%	217
Outer Suburbs	21%	10%	31%	223	12%	10%	22%	71	20%	9%	28%	128
Agglomeration fringes	21%	11%	32%	143	12%	10%	22%	16	18%	9%	28%	32
Villes Nouvelles	22%	10%	32%	100	15%	13%	28%	32	20%	9%	29%	20
Well-deserved Cities	22%	13%	35%	102	14%	11%	25%	19	19%	12%	32%	29
Secluded Cities	19%	12%	31%	15	14%	21%	36%	1	19%	11%	29%	7
Rural	21%	16%	36%	68	13%	11%	24%	1	23%	16%	39%	8
All	21%	10%	32%	852	13%	9%	22%	322	20%	7%	27%	678

TABLE M: HOUSING AND TRANSPORTATION BURDENS BY TENURE, MIDDLE TERCILE

IAURIF Location	MIDDLE TERCILE											
	HOME BUYERS				SOCIAL RENTERS				PRIVATE RENTERS			
	H	T	H+T	N	H	T	H+T	N	H	T	H+T	N
Paris	24%	5%	29%	19	21%	8%	29%	82	28%	6%	33%	177
Inner Suburbs	27%	11%	39%	60	19%	11%	30%	219	27%	10%	37%	173
Outer Suburbs	27%	14%	41%	92	19%	12%	31%	173	25%	11%	36%	124
Agglomeration fringes	30%	16%	46%	47	22%	15%	36%	48	29%	14%	43%	26
Villes Nouvelles	31%	17%	48%	67	22%	14%	36%	75	26%	15%	41%	25
Well-deserved Cities	30%	19%	49%	75	20%	16%	36%	60	27%	15%	41%	25
Secluded Cities	29%	23%	52%	12	15%	19%	34%	14	22%	15%	37%	13
Rural	25%	27%	52%	19	25%	44%	69%	1	27%	16%	43%	8
All	28%	15%	43%	391	20%	12%	32%	672	27%	9%	36%	571

TABLE N: HOUSING AND TRANSPORTATION BURDENS BY TENURE, LOWER TERCILE

IAURIF Location	LOWER TERCILE											
	HOME BUYERS				SOCIAL RENTERS				PRIVATE RENTERS			
	H	T	H+T	N	H	T	H+T	N	H	T	H+T	N
Paris	35%	5%	40%	13	36%	8%	44%	139	57%	11%	69%	237
Inner Suburbs	37%	13%	51%	28	33%	10%	43%	364	45%	13%	57%	230
Outer Suburbs	40%	31%	71%	47	35%	15%	50%	287	45%	16%	62%	158
Agglomeration fringes	40%	25%	65%	8	32%	15%	46%	59	42%	17%	59%	39
Villes Nouvelles	44%	40%	84%	16	35%	15%	50%	86	61%	17%	77%	27
Well-deserved Cities	37%	27%	64%	17	38%	21%	59%	107	42%	21%	63%	41
Secluded Cities	29%	45%	74%	3	37%	19%	56%	29	42%	35%	77%	12
Rural	29%	46%	75%	10	36%	22%	58%	8	46%	32%	78%	11
All	38%	25%	63%	142	35%	13%	47%	1079	50%	14%	64%	755

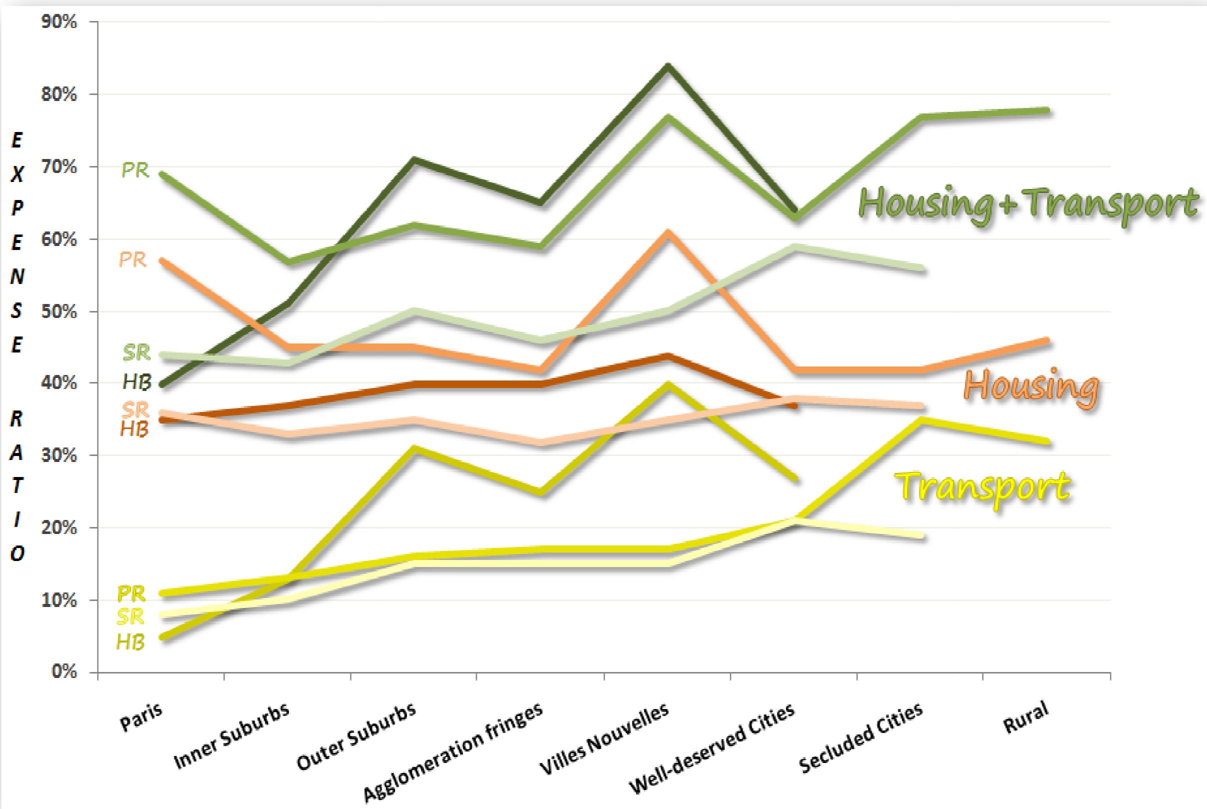
Source: Author's estimation based on EGT 2001-2002

TABLE O: HOUSING AND TRANSPORT BURDENS BY TENURE, LOWER TERCILE, UPPER HALF

IAURIF Location	LOWER TERCILE, UPPER HALF											
	HOME BUYERS				SOCIAL RENTERS				PRIVATE RENTERS			
	H	T	H+T	*N*	H	T	H+T	*N*	H	T	H+T	*N*
Paris	31%	5%	37%	*11*	30%	8%	38%	*96*	40%	8%	48%	*160*
Inner Suburbs	35%	13%	49%	*24*	28%	10%	37%	*287*	36%	11%	46%	*170*
Outer Suburbs	41%	24%	65%	*38*	28%	13%	41%	*218*	35%	14%	49%	*122*
Agglomeration fringes	40%	25%	65%	*8*	32%	13%	45%	*52*	36%	15%	51%	*35*
Villes Nouvelles	46%	28%	74%	*14*	32%	15%	47%	*81*	44%	14%	58%	*20*
Well-deserved Cities	37%	26%	63%	*15*	32%	17%	49%	*86*	37%	16%	52%	*36*
Secluded Cities	58%	39%	97%	*1*	28%	16%	44%	*19*	35%	30%	65%	*9*
Rural	31%	38%	68%	*8*	36%	22%	58%	*8*	39%	31%	70%	*6*
All	38%	20%	58%	*119*	29%	12%	41%	*847*	37%	11%	49%	*558*

Source: Author's estimation based on EGT 2001-2002

FIGURE Z: HOUSING AND TRANSPORTATION BURDENS BY TENURE, LOWER TERCILE



Source: Author's estimation based on EGT 2001-2002

Chapter 3

Impact of Budget Restrictions on Residential Choices

A monocentric analysis

Abstract

Capping the share of housing expenditure in the household budget is a widespread measure to protect household solvency. Yet, it has often been criticized. It supposedly induces people to get farther from the city center in search of cheaper housing prices, but with subsequent increased transport costs that are often disregarded during the home search process. To prevent this side effect, several researchers have advocated the use of a constraint bearing on the total share of housing plus transportation rather than on housing alone.

The present chapter analyzes and compares the impact of these two policies on the main features of the city, including a welfare analysis. The investigation is carried out within the standard monocentric city model. After a general analysis, an applied model is specified to capture the effects of each policy in straightforward formulae. In addition, several extensions are developed to confirm the findings in a more realistic setting.

The theoretical analysis leads to three main findings: first, capping housing expenses can increase household utility, a rare consequence for a constraining policy. Secondly, both policies lead to reduced urban sprawl, contrary to what is often asserted concerning the limitation of housing expenses. However, capping simultaneously housing and transport costs is indeed more effective in this regard. Lastly, the latter policy also protects household solvency more efficiently than policies only capping the housing expenditure. This implies a trade-off between urban sprawl, equity issues, and the protection of household solvency when choosing which policy to implement.

Keywords: urban economics, budget constraint, monocentric city model, housing expenses, transportation expenses, housing policy, location efficient mortgage

INTRODUCTION

During the 2008 surge in oil prices, concerns rose about household “solvency”, which I define here as the ability of the household to meet all its expenses.[1] This issue was especially tangible in tight housing markets, where households must already cope with substantial housing costs. And while the subsequent fall has relieved households’ budgets, concerns remain since oil prices are bound to rise again sooner or later.

Under such circumstances, the relevance of capping housing expenditure at a given fraction of the household income, measure which had already been questioned in the past, has become even more controversial. This practice is actually common in several countries in order to preserve household solvency. In France, it is enforced in two ways:

- Monthly payments for home loans are capped at one third of household income;[2]
- When applying to rent a home, candidates must earn at least three times the rent.[3]

While capping housing expenses does seem to secure household solvency, it is often blamed for two related harms: fostering urban sprawl, and endangering the very solvency of suburban households. According to its detractors, this policy spurs households to settle far from the employment centers in search of low housing prices. Such is the case in the Greater Paris Region, whose central part direly lacks affordable housing supply. This induces new homeowners to settle farther and farther in the suburbs, thereby contributing to urban sprawl (Polacchini and Orfeuil 1999). Moreover, because suburban households make the most intensive use of the car, they expose themselves to significant transport expenses, which, combined to the cost of housing, jeopardize the household budget.

To prevent those side effects, some researchers have advocated the use of a joint budget constraint for homebuyers, that is to say capping housing plus transportation expenses instead of housing expenses only.[4] Their aim is twofold:

- to increase public awareness of the extent of transportation costs implied by suburban and exurban lifestyles;
- making near transit locations more affordable by increasing home loan size for households willing to locate in such areas, based on future savings on transportation.

[1] This definition therefore encapsulates the usual notion of solvency as the ability of the household to meet its financial obligations on time, in particular mortgages.
[2] The ratio is slightly lower in the U.S., being around 28% according to Duca and Rosenthal (1994).
[3] This ratio corresponds to a widespread practice in the Greater Paris Region, where some landlords may even require up to four times the rent. Income requirements may be less strict in other parts of France.
[4] See Hare (1995) and Polacchini and Orfeuil (1999).

This idea has been put into practice in the U.S. under the name of "Location Efficient Mortgage".[5] Its implementation is currently limited to a few metropolitan areas though.

There is considerable economic literature regarding the assessment of land-use regulatory policies (cf. Bertaud and Brueckner 2005, Brueckner 2006). Yet, it remains pretty silent regarding the two types of policies mentioned above (capping housing or housing plus transport expenses). These policies are likely to have significant repercussions on land-use and on welfare though, given that they constrain household residential choices. I propose to remedy this lack by analyzing both policies within the classic framework of urban economics, i.e. the monocentric model. Focus is set on spatial and welfare effects. In particular, the issue of housing default is set aside, though acknowledged as being the primary reason for the policies under scrutiny.[6]

Theoretical analysis leads to three major findings. First, **both policies reduce urban sprawl**, refuting the previous assertion concerning the limitation of housing expenses. The second one, even more surprising, is that **they leave household utility unaffected, or even increase it**. Capping housing expenses entails positive welfare effects for households, whereas capping the sum of housing and transportation expenses proves more efficient in containing urban sprawl. A central element underlying these results is that both policies lead to an **implicit transfer from landlords to households.** However, by limiting urban sprawl, these policies are more than mere tax substitutes. Lastly, I show capping the sum of housing and transport costs to be more efficient when willing to improve household solvency.

Chapter 3 is structured as follows: section *I* presents the context and scope of the study. Section *II* studies in a general setting the policy limiting the housing expense ratio (named Constrained Housing Expense or CHE policy), while section *III* addresses the one capping the joint share of housing and transportation (hence named CH+T policy).[7] Considering the limitations inherent to the general analysis, section *IV* pushes the investigation further in the case of a linear city. Section *V* provides a complementary discussion, including welfare considerations and a comparative analysis. Various extensions are then tested in section *VI*, which confirm findings in a more realistic setting. Lastly, some policy recommendations are offered in conclusion.

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[5] See www.locationefficiency.com for more on the LEM project, based on research by the Center for Neighborhood Technology and the Surface Transportation Policy Project (in particular Haas *et al.*, 2006).

[6] In other words, I assume the question of default and the impact on the equilibrium land use to be orthogonal issues. The question at hand is thus: taking these policies as a given, what are their consequences on land use and welfare, including city size, density, etc.?

[7] For the remainder of the text, I will use the terms "burden" or "expense ratio" interchangeably to refer to the fraction of income spent on a given budget item. The housing expense ratio is also sometimes referred to as the front ratio.

CONTEXT AND SCOPE OF THE STUDY

As stressed in the introduction, the economic assessment of CHE or CH+T policies has yet to be carried out, at least in a spatial setting. Although filling this gap would already be of academic interest, three questions are central in motivating the present study:

1. Does the CHE policy concern a significant number of households?
2. Is the impact on residential choices sizable?
3. Do spatial variations of transport costs loom large in front of the housing burden?

Should one of the answers be no, the practical interest of the study would be greatly compromised.

Three strands of works help answer these questions and address the matter at hand. The first one, by probing housing and transportation burdens, provides indirect yet conclusive evidence for the significant extent of CHE policies in France and in the U.S. Lower-income households are also shown to be the first affected by CHE and CH+T measures. A survey of existing works on CHE and CH+T policies is carried out next. Lastly, I present the analytical framework, namely the monocentric model, and specify at the same time the scope of the study.

PROBING INTO HOUSING AND TRANSPORT BURDENS

By providing estimates of housing and transport expenditures, Polacchini and Orfeuil (1999), Berri (2007), and *Chapter 2* bring first pieces of answer to questions *1* and *2* in the case of the Greater Paris Region (GPR). Using different methodologies and not considering the same years, all works draw similar conclusions regarding housing and transport burdens in the GPR:

- The **front ratio is fairly stable over space**, and is close to the maximum allowed by the CHE policy. Polacchini and Orfeuil (1999) find that in 1991 homebuyers bore an average burden of 32%, as compared to 26% for private renters. Keeping the same categories, *Chapter 2* finds for 2001 25% and 34% respectively, while Berri (2007) finds the lowest estimates with 28% and 22% in 1994.[1]
- Conversely, the **transport burden markedly increases with distance** to the Central Business District (CBD), as a result of a greater car modal share in the suburbs, as well as suburban households making longer trips. In 2001, expense ratios were found to range from 8% for inner Paris to 21% in remote parts of the GPR (→ *Chapter 2*).

[1] Relative positions in the real estate cycle partly account for observed differences.

As a result, all works find that **the total H+T burden substantially rises with distance**.

Interestingly, Haas *et al.* (2006) reach similar conclusions in the case of the U.S. despite notorious differences with Europe regarding urban structure. Scrutinizing 28 metropolitan areas, they find the housing expense ratio to be significantly less sensitive to location than the transport expense ratio, the latter strongly increasing with distance to the nearest employment center. For instance, the average front ratio of households with yearly income between 35,000 and 50,000 $ varies between 23 and 26% depending on location within the metropolitan area, as compared to 16 to 26% in the case of the transportation burden.

INFERRING THE EXTENT OF THE CHE POLICY

The above findings naturally lead to the following conclusions:

- The near constancy of the housing burden within a given metropolitan area, combined to its closeness to the theoretical upper bound, is likely the result of the CHE policy.
- Given this constancy, heavier transportation expenditures jeopardize the budgets of suburban and exurban households. In point of fact, spending more than half one's income on housing and transport only is not uncommon anymore when living there.

Let us further discuss these two statements which, albeit intuitive, are not straightforward. Two elements come to corroborate the first point. First, housing burdens are volatile even within households of a same zone. Ergo, an average housing burden close to the theoretical upper bound likely conceals a sizable number of constrained households. Besides, having a front ratio below the cap does not imply that one was not constrained by the CHE policy when choosing his current home.[2] In other words, the number of households with housing burdens at or above the theoretical cap is probably a lower bound of the number of households concerned by the CHE policy.[3]

To be thorough, the first statement should be mitigated by underlining the key role of income in the discussed analyses. All works accounting for this variable (viz. *Chapter 2*, Haas *et al.* 2006) highlight the **marked decrease of both the housing and**

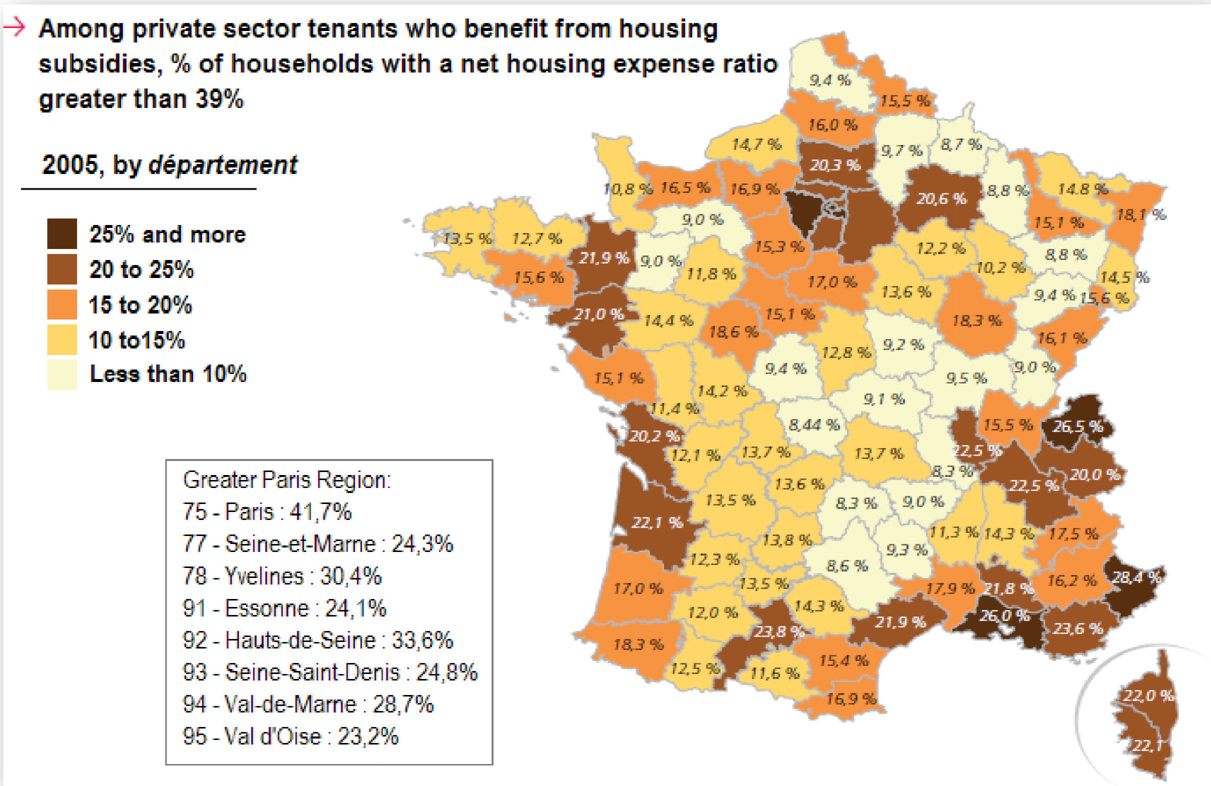
[2] Income generally rises along the household life-cycle until retirement, through inflation, job promotions, etc. In this case, since nominal mortgage payments are held constant over time (→ *Chapter 0*), the housing burden gradually decreases. When the household has eventually paid back its loan, its burden drops even more. Because rent increases are regulated (→ *Chapter 0*), a similar phenomenon occurs in the rental market. As a result, **the housing burden usually abates until the household's next residential move**. Counterexamples mainly involve specific conditions such as a renegotiation of the lease, flexible interest rate mortgage products, an adverse event on the job market (e.g., unemployment spell), and so on.

[3] Households may have housing burdens above the theoretical ceiling since the CHE policy is not enforced dynamically, but in a one-shot fashion (the capping is effective at the time of the residential choice only).

transportation expense ratios with income. [4] Since households in the lower income bracket are more likely to face a heavy H+T burden than wealthier ones, they are also more prone to be bound by CHE and CH+T policies.

Gobillon and Le Blanc (2008) provide valuable elements to come to a conclusion with regard to the extent of the CHE policy. In their study on the effects of borrowing constraints, they estimate that 53% of private renters would be constrained were they to opt for home ownership. [5] The share of virtually constrained households is logically lower for home owners (home buyers and outright owners altogether), but still amounts to 20% of this category. Putting all elements together, the significant extent of the CHE policy is clearly established in the case of new home buyers. And in the case of tenancy, *Figure 68* speaks for itself.

FIGURE 68 : SHARE OF SUBSIDIZED PRIVATE RENTERS WITH HEAVY HOUSING BURDENS



Source: ANAH (2008)

Now let us consider statement two, which might seem odd at first thought: a sound economic reasoning would object that rational and perfectly informed households

[4] Controlling by income leaves the spatial patterns of expense ratios unaltered, though.

[5] More precisely, they develop an econometric model which estimates how many households would face borrowing constraints considering their current wealth and income. This is done by predicting the price of the dwelling that the household would be willing to purchase, were it to buy a new one now. Two types of borrowing constraints are considered: the income-based one, which is at the core of our study, and the upfront payment constraint. The income constraint is found to prevail in most cases, corroborating the significance of the CHE policy.

choose the housing/transportation bundle that befits them. High H+T burdens would stem from an optimizing behavior and be willingly borne by suburban households, even if this burden were to outweigh half their income. At least three arguments challenge this line of thinking:

- In presence of sticky prices,[6] households already settled near the city center (the "insiders") might stay to benefit from low transport costs, pushing new households ("outsiders") towards the outskirts. These would enjoy lower housing prices indeed, but that would still not compensate for the extra incurred transportation costs. In this setting, stickiness slows the upward adjustment of housing prices in the central part of the metropolitan area, making insiders better-off than outsiders.
- Households might not be perfectly informed of transport costs. As far as car-owners are concerned, the coexistence of fixed and variable costs, the issue of maintenance, the cost of credit, and the possibility of selling the car to get a new one, all contribute to hide the true cost of car ownership. Besides, many households do not consider fixed costs in the equation. They consider the fact that they need a car for granted, and compare the cost of transit to the variable cost of private transportation. Yet, they could save on one less car were they to locate in transit-friendly areas. The volatility of fuel prices might also be misunderstood or poorly taken into account.
- Lastly, the fact that laws and public policies protect financially distressed households might lead to a moral hazard issue, and to households not sufficiently protecting themselves from bankruptcy (from a social welfare optimizing point of view).

EXISTING LITERATURE ON THE STUDY TOPIC

While there is little work on the regulation of housing expenses in the rental market,[7] the effects of borrowing constraints on housing demand have largely been documented by the economic literature. These works, described at great length in a survey by Gobillon (2008), study the household decision to move and the subsequent tenure choice. They are based on a standard economic framework, households choosing the tenure and housing consumption that maximize their utility. Moving or transaction costs are generally introduced to induce punctual housing adjustments instead of continuous ones. These adjustments, based on a $[s, S]$ rule, take the form of a residential move.[8]

[6] The way several countries regulate rent increases strongly supports the assumption of sticky prices in the housing market. In France, a standard lease lasts for 3 years, and rent increases during the lease are bordered by a national index (→ *Chapter 0*, section *I*). This implies that the assumption of sticky prices is valid as long as no change of tenant occurs.

[7] Note that the regulation of housing expenses, which operates at the household level, differs from rent control, enforced at the dwelling level through rental price ceilings, and for which exists a vast economic literature.

[8] Home improvements as a form of stock adjustment are seldom considered in this strand of literature.

When such a move occurs, the household chooses between renting and owning according to the current and future prices of the two options, and then selects its housing consumption. Because borrowing constraints may prevent households from choosing their optimal quantity of housing consumption, they have the twofold impact of making tenancy more attractive and hindering residential mobility. The latter effect would even prevail according to Zorn (1989) and Gobillon and Le Blanc (2008).

This strand of literature has shed substantial light on the household behavior under borrowing constraints. It has also collected enough evidence to positively answer to above question *2*.[9] It displays two major shortcomings though. Most works do not consider the housing supply side, thus equilibrium mechanisms. In particular, the feedback of borrowing constraints on housing prices is usually overlooked. The "aspatiality" is another limitation of most works on this topic, as well as of the few works specifically addressing the issue of location efficient mortgages.[10] Indeed, since housing prices vary within the metropolitan area, borrowing constraints are likely to alter the household location choice. According to Hare (1995), what he calls "clunker mortgages" would even be central in accounting for urban sprawl.

THEORETICAL FRAMEWORK AND SCOPE OF THE STUDY

Why a monocentric city model?

Based on above considerations, fully understanding the effects of CHE and CH+T policies requires considering the role of space and of equilibrium mechanisms. This guides us towards a third strand of the economic literature, namely urban economics. This field has scrutinized various forms of regulation including restrictions on city size, lot size, and building-height, using the urban monocentric city model. This model is an especially fitting tool for such purposes because of **its ability to represent both the demand and supply side of the housing market**, and **within a spatial framework** to boot. Recent contributions of Bertaud and Brueckner (2005) and Brueckner (2006) give a good overview of this literature. Considering these elements and the issue at stake, the choice of the monocentric model turned out to be a given.

[9] Once again I refer the reader to Gobillon (2008) for conclusive evidence on this issue.
[10] E.g., Blackman and Krupnick (2001).

OUTLINING THE MONOCENTRIC CITY MODEL

In the version of the monocentric city model that I am going to use, directly inspired from Fujita (1989), households with income Y maximize their utility $U(z,s)$ through a trade-off between two goods, subject to a budget constraint. The two goods are land (s representing land consumption or lot size) and a composite good denoted by z which stands for all other goods. The household behavior is represented by the following maximization problem:

$$\max_{z,s,r} U(z,s)\ s.t. R(r)s + z + T(r) = Y$$

r is the distance to the Central Business District (CBD), $R(r)$ stands for the relative land rent, z is the *numéraire* good, and transport costs are denoted by $T(r)$. Since locating farther from the CBD entails higher transportation costs, households make a trade-off between accessibility and housing prices when choosing their location. The crux of the model lies in the endogeneity of housing prices, which vary according to the law of supply and demand. At equilibrium, prices reflect the "spatial comparative advantage" of a given location.

Scope and limitations of the study

The choice of the monocentric model involves several assumptions which I am now going to discuss, thereby specifying the scope of the present study.

Transportation network

Several key assumptions are made regarding the transportation system:

(H1) The transport network is assumed to be "unimodal" and dense.

(H2) Transport costs include monetary costs only.

(H3) They are isotropic,

(H4) are wholly determined by location,

(H5) and increase with distance.

Among these, (H2) is the most natural for two reasons. Firstly on grounds of coherence, as only monetary costs enter the scope of the HE and H+T constraints. Besides, neither location nor household income has a significant impact on daily travel-times in the Greater Paris Region (→ *Chapter 2*). Plugging a time constraint into the location choice would thus be neutral in first approximation. [11] (H3) is merely made for simplicity. It

[11] The issue would be more complex if one assumes time saved on commuting by locating near the CBD, and dedicated to leisure purposes for instance, raises household utility by giving access to better leisure opportunities.

could be overcome, but at the cost of a much greater complexity. (H5) is a standard assumption in a monocentric framework. It was checked in the case of the GPR (*ibid.*).

Now let us turn to (H1) and (H4). Although transport expenditure slightly increases with income, this feature is overlooked for the sake of simplicity. Besides this point, the **strongest assumption** is probably that of **"unimodality"**. Within the present stylized model, this assumption does not necessarily mean one single mode throughout the city. It rather implies that one location equals one given amount of transportation costs, whatever the household characteristics. This could be transit costs near the CBD and car costs in the suburbs, without affecting the validity of the model. However, households may not choose between various modes at a given location. In sum, the "unimodality" assumption can be reformulated as the fact that travel behaviors are solely determined by location. This is not too far from truth, especially in the GPR: walking and transit prevail among people living in the densest areas, while the car often represents the only sensible option for suburban households. Some recent findings by Haas *et al.* (2006) corroborate this postulate: they establish transportation costs to be driven more by neighborhood characteristics than by household type or income.

Representation of the housing market

As regards the housing market, the main assumptions are as follows:

(H1) Each household manages the construction of its house by itself. In other words, the housing industry is not represented.

(H2) Only the private rental sector is represented.

(H3) Dwellings are perfectly homogeneous.

A corollary of (H1) is "land equals housing", and land rents and housing prices are actually equivalent in this basic version of the monocentric model. This assumption could be problematic since it implies that **housing supply is almost inelastic.**[12] As a result, supply-based retroactions following the implementation of CHE or CH+T policies are likely underestimated. An extension developed in section *VI* elaborates on this issue. It shows that while the main results hold true, those retroactions do indeed mitigate the impact of both policies.

(H2) could seem a limitation, as CHE and CH+T policies are likely to alter both the household moving and tenure decisions. Because I focus on land-use equilibrium and on spatial impacts, I send the reader back to the existing literature on this specific matter.[13]

[12] Because there is outside competition for land (modeled by the agricultural sector), city size may vary, hence elasticity of housing supply. However, housing supply does not vary within the city boundaries.

[13] The underlying assumption is that spatial impacts on the one hand, and moving and tenure related issues on the other hand, may be treated separately. I reckon that such is the case for long-term analyses. In the short run, CHE and

On the other hand, (H3) is relatively unimportant in our context. It might be detrimental to the analysis of very specific segregation mechanisms. However, the opportunity of introducing dwelling heterogeneity remains doubtful in regard to the matter at hand.

Description of households

Lastly, two key assumptions underlie the description of households in the model:

(H1) There is only one household type, meaning that households all share the same characteristics.

(H2) Households have homogeneous preferences, in the sense that their utility does not include a random component such as in random utility theory.

Once again, (H1) is likely the most problematic assumption. Indeed, the major influence of income on both the housing and transport burdens was underlined in subsection *0*. Because low-income groups are more prone to be affected by CHE and CH+T policies, **specific segregation and equity issues may arise**. A single household type model cannot take these phenomena into account, meaning that a model with two income classes, or even better a continuous income distribution, would ultimately be preferable. (H2) is for its part rather inconsequential in the current context, though heterogeneous preferences might explain why the housing burden may vary within a similar income class, with the ensuing consequences.

CH+T policies are likely to have spatially differentiated impacts on residential mobility rates, through their influence on housing prices.

THE CHE MODEL

This section starts by introducing the Constrained Housing Expense (CHE) model. First results regarding the impact of CHE policies are presented next, in the general case with a single household type.

THE MODEL

Throughout this section, utility function U and transport cost function T are assumed to comply with the following:

- $U(z,s)$ is concave, strictly increasing with z and s, and well-behaved. [1]
- Transportation costs $T(r)$ grow with distance r to the CBD.

Amending the monocentric model

CHE policies consisting in capping the ratio housing expenditure to household income, they are represented by amending the monocentric model with the following constraint:

$$R(r)s \leq (1-\alpha)Y \qquad (E1)$$

where $\alpha \in [0;1]$ is the minimum fraction of income remaining after meeting housing expenses. [2] Consequently, **the higher α, the tighter the constraint** is for households. Two special cases arise:

- $\alpha = 0$ yields the original unconstrained model.
- $\alpha = 1$ leads to a null housing expense, precluding any decentralized equilibrium.

Rewriting and reinterpreting the constraint

Considering the household budget constraint $R(r)s + z + T(r) = Y$, $(E1)$ is equivalent to the following constraint, which will prove easier to handle:

$$z \geq \alpha Y - T(r) \qquad (E2)$$

An economic interpretation of $(E2)$ arises if one sees the consumption of the z good as a **proxy for solvency**. Indeed, z is equal to the income remaining after paying for housing and commuting. Like housing, commuting entails a “compulsory” expense, in the sense that it must be sustained in order to work and earn one’s paycheck. In addition, this budget item cannot be easily adapted according to events faced by the household, as this

[1] Cf. definition in Fujita (1989), p.99.

[2] The monocentric model is a single-period equilibrium model. Saving and borrowing behaviors are not represented, meaning that α<0 is irrelevant.

would usually imply a job change. Secondly, the commuting cost is directly tied to the residential choice, meaning that housing and commuting form a bundle to some extent. Adding the fact that there are other compulsory expenses besides housing and transport (food, health care, and so on), meaning that a low level of z greatly enhances the risk of housing default, all these elements give credit to interpreting z as a measure of solvency. Given this remark, $(E2)$ states that a minimum level of solvency is required from households, and that this level decreases with transport costs. Reformulated this way, the solvency requirement seems relatively odd and inappropriate, a fact that will be confirmed and discussed in section IV.

By substituting $(E1)$ by $(E2)$, the household maximization problem becomes:

$$\max_{z,s,r} U(z,s) \;\; s.t. \begin{cases} z + R(r)s + T(r) = Y \\ z \geq \alpha Y - T(r) \end{cases} \qquad (E3)$$

Notation

The following notations are used throughout the section:

- A $\sim$ superscript refers to the CHE model, as opposed to the unconstrained one (for which no symbol is used).
- Parameter α may be included as an argument for comparative statics purposes.
- $S(z,u)$ and $Z(s,u)$ are the solutions of $U(z,s) = u$ in s and z respectively.
- r_{max} represents the farthest feasible location, defined by: $T(r_{max}) = Y$.

I also define two specific subsets of $[0; r_{max}]$, noting $z(r,u)$ the solution of the bid-max program for the unconstrained model (see below):

- $E_A(u,\alpha) = \{r : \; z(r,u) < \alpha Y - T(r)\}$ is the strictly binding zone, defined as the set of locations where the Lagrange multiplier associated to $(E2)$ is strictly positive.
- $E_I(u,\alpha) = \bar{E}_A(u,\alpha)$ is the nonbinding zone,[3] and $\breve{E}_I(u,\alpha)$ its open subset.

The bid-max problem

The household bid-rent function

Bid-rent functions are defined as the maximum land rent (per surface unit) a household can pay given a target utility u and its "disposable" income $Y - T(r)$:

$$\tilde{\Psi}(r,u) = \max_{z,s} \left\{ \frac{Y - T(r) - z}{s} \;\middle|\; \begin{array}{l} U(z,s) = u \\ z \geq \alpha Y - T(r) \end{array} \right\} \qquad (CHE\ model)$$

$$\Psi(r,u) = \max_{z,s} \left\{ \frac{Y - T(r) - z}{s} \;\middle|\; U(z,s) = u \right\} \qquad (unconstrained\ model)$$

[3] Thus the complementary of $E_A(u,\alpha)$, which is also the zone where the constraint is Inactive.

Solutions to the maximization problem are noted $(z(r,u), s(r,u))$ for the unconstrained case, and $(\tilde{z}(r,u), \tilde{s}(r,u))$ for the constrained one.

Properties of bid-max variables

Let us first remind the main properties of $\mathrm{s}(r,u)$, $\mathrm{z}(r,u)$, and $\Psi(r,u)$:

- $\mathrm{s}(r,u)$ increases with *r* and *u*;
- $\Psi(r,u)$ decreases with *r* and *u*;
- $\mathrm{z}(r,u)$ decreases with *r* (no specific result regarding the influence of *u*).

The solution of the constrained maximization problem verifies the following property (proof in *Annex B*):

property 1

$$\begin{cases} \tilde{\mathrm{z}}(r,u) = \max[\mathrm{z}(r,u), \alpha Y - T(r)] \\ \tilde{\mathrm{s}}(r,u) = \min[\mathrm{s}(r,u), S(\alpha Y - T(r), u)] \\ \widetilde{\Psi}(r,u) = \min[\Psi(r,u), (1-\alpha)Y/\tilde{\mathrm{s}}(r,u)] \end{cases} \tag{E4}$$

A direct consequence of property 1 is that $\forall(r,u)$, $\tilde{\mathrm{z}}(r,u) \geq \mathrm{z}(r,u)$, $\tilde{\mathrm{s}}(r,u) \leq \mathrm{s}(r,u)$, and $\widetilde{\Psi}(r,u) \leq \Psi(r,u)$. In plain words, capping housing expenditures reduces: [4]

- the lot size which is bid for;
- the ability to pay for land (per land unit).

Furthermore, ((*E5*)) implies that:

- $\tilde{\mathrm{s}}(r,u,\alpha)$ increases with *r* and *u*, but decreases with α;
- $\widetilde{\Psi}(r,u,\alpha)$ decreases with *r*, *u*, and α;
- $\tilde{\mathrm{z}}(r,u,\alpha)$ decreases with *r* and increases with α.

The fact that $\tilde{\mathrm{s}}$, $\tilde{\mathrm{z}}$, and $\widetilde{\Psi}$ have the **same variation properties** as s, z, and Ψ with respect to r and u will prove central in demonstrating the existence and uniqueness of the equilibrium land use. As regards the role of α, tightening the constraint lowers the maximum authorized level of housing expenditure, which drives households to purchase smaller lots, decrease their bid rent, and consume more of the z good.

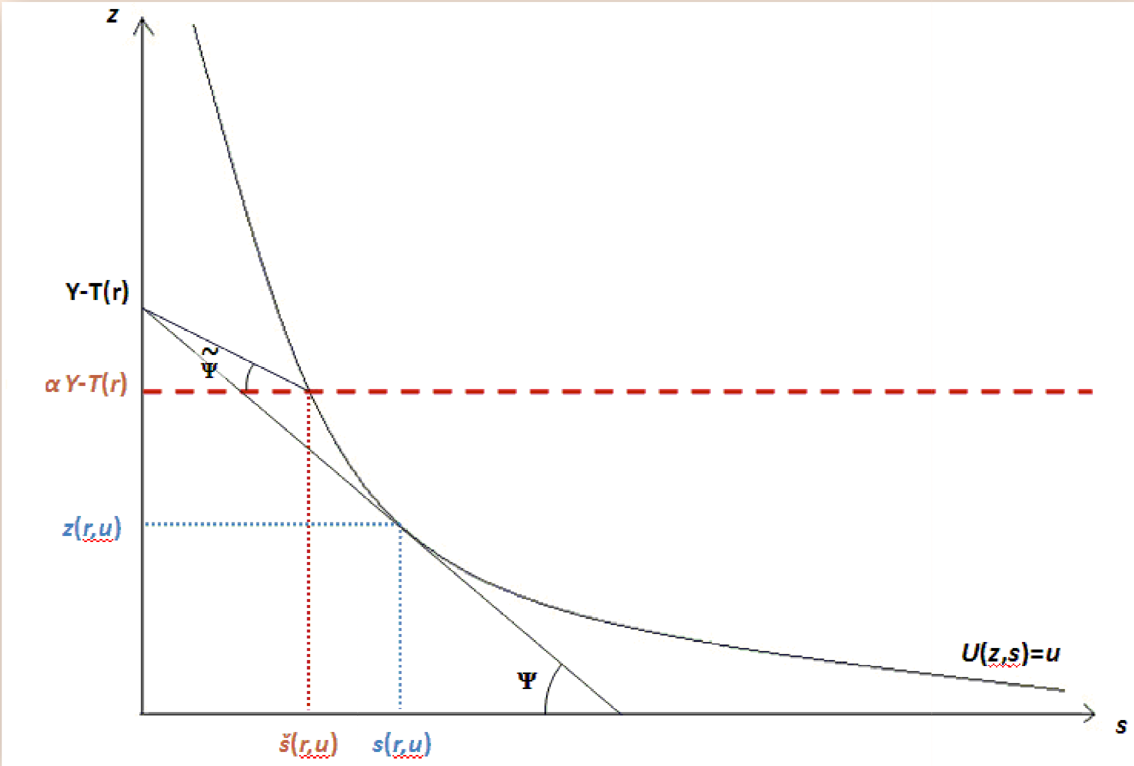
Additional results relative to $\widetilde{\Psi}_r(r,u,\alpha)$ and to the characterization of the binding zone $E_A(u,\alpha)$ are reported in *Annex C*.

[4] This is for a given utility level. Because the CHE constraint alters the equilibrium utility of the city, we will see that CHE policies may ultimately lead to larger lots than in the unconstrained city.

INTERPRETING THE BID-MAX PROBLEM

Figure 69 provides an economic (and graphic) interpretation of the bid-max problem:

FIGURE 69: THE BID-MAX PROBLEM, UNCONSTRAINED CASE AND CHE MODEL



The household starts by considering consumption options yielding target utility u, that is, all bundles (s, z) located on the isoutility curve $U(z, s){=}u$. Within this set, the household seeks to maximize its bidding power, equal to its willingness to pay per land unit. This bid-rent $(Y - T(r) - z)/s$ is the slope of the "budget line" joining the points $(0, Y\text{-}T(r))$ and (s, z).[5]

In the unconstrained case, bid-rent maximization leads to the tangent budget line and to the solution $\Psi(r, u) = \{Y - T(r) - z(r, u)\}/s(r, u)$.

In the constrained case, the set of feasible choices is restricted to the quarter-plane $s \geq 0$ and $z \geq \alpha Y - T(r)$. This corresponds to the area above the dashed horizontal line. If $z(r, u) < \alpha Y - T(r)$, the unconstrained solution violates the constraint (as in *Figure 69*). Otherwise, the unconstrained solution holds. If the constraint is indeed violated, constrained maximization leads to $\widetilde{\Psi}(r, u) < \Psi(r, u)$. It is also crystal clear that $\tilde{z}(r, u) > z(r, u)$, implying $\tilde{s}(r, u) < s(r, u)$ (since the isoutility curve decreases).

5 Let us recall that the bid rent program consists in looking for the maximal land rent a household can afford given a target utility u and its disposable income $Y\text{-}T(r)$. Contrary to the classic microeconomic framework where the price is set, the "price" is here an output of the maximization problem.

THE CASE WITH SINGLE HOUSEHOLD TYPE

This subsection investigates the standard framework of a closed city with absentee landlords. It is inhabited by households of a single type, with income Y and utility function $U(z,s)$. After demonstrating the existence and uniqueness of the equilibrium land use in the CHE model, I shall perform comparative statics and compare the CHE equilibrium to the unconstrained one.

For the remainder of the text, N denotes the number of households. I also assume positive land supply $L(r) > 0$ for all $r > 0$.

Existence and uniqueness of the CHE equilibrium

Following Fujita (1989), establishing the existence and uniqueness of the equilibrium in the case of the CHE model is equivalent to proving that there exists a single couple $(\tilde{u}, \tilde{r_f})$ that verifies the following system:

$$\begin{cases} \tilde{\Psi}(\tilde{r_f}, \tilde{u}) = R_A \\ \displaystyle\int_0^{\tilde{r}_f} \frac{L(r)}{\tilde{s}(r,\tilde{u})} dr = N \end{cases} \qquad (E5)$$

The first equality is the boundary condition that determines the city edge: at $\tilde{r_f}$ bid rent equates the opportunity cost of land R_A. The second equality represents the population constraint: integrating density within the city boundaries yields total population N.[6]

proposition 1

The CHE monocentric model with single household type admits a unique equilibrium.

PROOF

Similarly to Fujita (1989), I first consider the outer boundary function $\tilde{b}(u)$ defined by $\int_0^{\tilde{b}(u)} \frac{L(r)}{\tilde{s}(r,\tilde{u})} dr = N$. $\tilde{b}(u)$ is the city size given a target utility u. Because $\tilde{s}(r,u)$ has the same required features as $s(r,u)$, that is to say it decreases with u, tends toward $+\infty$ when $u \to +\infty$ and toward 0 when $u \to -\infty$, one could proceed similarly to Fujita and show that $\tilde{b}(u)$ is defined on an interval $]-\infty, u_{max}]$. Moreover, $\tilde{b}(u)$ strictly increases with respect to u, and ranges from 0 to r_{max} when u ranges from $-\infty$ to u_{max}.
Then I consider $\tilde{R}_E(x) = \tilde{\Psi}(x, \tilde{U}(x))$ where $\tilde{U}(x) = \tilde{b}^{-1}(x)$ for $x \in [0, r_{max}[$. $\tilde{R}_E(x)$ is the land rent at the edge of a city the utility of which was chosen to yield the required size *x*. As $\tilde{b}(u)$ is an increasing function, so is $\tilde{U}(x)$, implying that $\tilde{R}_E$ strictly decreases with *x*

[6] Density $n(r)$ is obtained by dividing available land supply $L(r)$ by land consumption per household $\tilde{s}(r,\tilde{u})$.

(remember that $\widetilde{\Psi}(r,u)$ decreases with both r and u). Considering that $\tilde{R}_E(r_{max}) = 0$ and $\tilde{R}_E(x) \xrightarrow[x\to 0^+]{} +\infty$, the equation $\tilde{R}_E(x) = R_A$ admits one and only solution $\widetilde{r_f}$. Finally, taking $\tilde{u} = \widetilde{U}(\widetilde{r_f})$, it is easy to check that $(\tilde{u}, \widetilde{r_f})$ satisfies (*E5*).

Comparative statics in the general case

Let us now study the influence of the constraint parameter α on the equilibrium city.

City Size

Quite intuitively, **CHE policies reduce city size**:

proposition 2

The size $\widetilde{r_f}(\alpha)$ of the CHE city decreases with α.

PROOF

Taking $0 \le \alpha_1 \le \alpha_2 \le 1$, let us first show that the first constrained boundary rent curve is above the second one, in other words: $\tilde{R}_E(x,\alpha_1) \ge \tilde{R}_E(x,\alpha_2)$

As $\forall(r,u)\ \tilde{s}(r,u,\alpha_1) \ge \tilde{s}(r,u,\alpha_2)$, then $\int_0^x \frac{L(r)}{\tilde{s}(r,u,\alpha_1)} dr \le \int_0^x \frac{L(r)}{\tilde{s}(r,u,\alpha_2)} dr$. Therefore, $\int_0^{\tilde{b}(u,\alpha_1)} \frac{L(r)}{\tilde{s}(r,u,\alpha_1)} dr = \int_0^{\tilde{b}(u,\alpha_2)} \frac{L(r)}{\tilde{s}(r,u,\alpha_2)} dr = N$ implies $\tilde{b}(u,\alpha_1) \ge \tilde{b}(u,\alpha_2)$. This, in turn, implies that the inverse functions are in reversed order, i.e. $\widetilde{U}(x,\alpha_1) \le \widetilde{U}(x,\alpha_2)$.

Using the inequality $\forall(r,u)\ \widetilde{\Psi}(r,u,\alpha_1) \ge \widetilde{\Psi}(r,u,\alpha_2)$, we have:

$$\widetilde{\Psi}(x,\widetilde{U}(u,\alpha_1),\alpha_1) \ge \widetilde{\Psi}(x,\widetilde{U}(u,\alpha_2),\alpha_1) \ge \widetilde{\Psi}(x,\widetilde{U}(u,\alpha_2),\alpha_2)$$

$\Rightarrow \tilde{R}_E(x,\alpha_1) \ge \tilde{R}_E(x,\alpha_2)$, which is the claimed property. Considering this, proposition 2 is straightforward as $\tilde{R}_E(\tilde{r}_f(\alpha_1),\alpha_1) = \tilde{R}_E(\tilde{r}_f(\alpha_2),\alpha_2) = R_A$.

An interpretation of this result is provided below in *0*. Otherwise, given that $\alpha = 0$ yields the unconstrained model, proposition 2 implies that CHE cities are always smaller than unregulated ones.

Equilibrium utility

The HE constraint induces **two countervailing effects** that alter the equilibrium utility:

- Being constrained in their choices, households achieve at all locations a lower utility than when unconstrained (for a given land rent curve),
- but capping the housing expenditure has a depressing impact on bid rents, hence on equilibrium land rents, which raises household utility through an income effect.

Depending on the relative magnitude of these forces, the resulting utility level is higher or lower than in the unconstrained city. I show in section *IV* that both cases are actually possible. On the other hand, **both forces tend to reduce city size,** explaining why the impact on city size is unambiguous. This point is clear as far as the first force is concerned. The second one does so by increasing the relative competitiveness of the agricultural sector. Coming back to the matter of utility, the next proposition solves part of the indetermination:

proposition 3

For any couple (α_1, α_2) with $\alpha_1 < \alpha_2$, if households located at the edge of the α_1 city spend less than $(1\text{-}\alpha_2)Y$ *on housing (i.e.* $\tilde{r}_f(\alpha_1) \notin E_A(\tilde{u}(\alpha_1), \alpha_2)$*), then equilibrium utility is greater in the α_2 city than in the α_1 city.*

PROOF

Let us consider a household living at the edge $\tilde{r}_f(\alpha_1)$. The following relations hold:

$\widetilde{\Psi}\big(\tilde{r}_f(\alpha_1), \tilde{u}(\alpha_1), \alpha_1\big) = \widetilde{\Psi}\big(\tilde{r}_f(\alpha_1), \tilde{u}(\alpha_1), \alpha_2\big)$: from $\tilde{r}_f(\alpha_1) \in E_I(\tilde{u}(\alpha_1), \alpha_2)$

$\widetilde{\Psi}\big(\tilde{r}_f(\alpha_1), \tilde{u}(\alpha_1), \alpha_1\big) = \widetilde{\Psi}\big(\tilde{r}_f(\alpha_2), \tilde{u}(\alpha_2), \alpha_2\big) = R_A$: boundary conditions

$\widetilde{\Psi}(\tilde{r}_f(\alpha_1), \tilde{u}(\alpha_2), \alpha_2) \leq \widetilde{\Psi}(\tilde{r}_f(\alpha_2), \tilde{u}(\alpha_2), \alpha_2)$: due to $\tilde{r}_f(\alpha_1) \geq \tilde{r}_f(\alpha_2)$

Combining all these relations gives $\widetilde{\Psi}(\tilde{r}_f(\alpha_1), \tilde{u}(\alpha_2), \alpha_2) \leq \widetilde{\Psi}(\tilde{r}_f(\alpha_1), \tilde{u}(\alpha_1), \alpha_2)$, which implies $\tilde{u}(\alpha_2) \geq \tilde{u}(\alpha_1)$.

In other words, when suburban households have the financial means to maintain their level of housing consumption, increasing α improves the overall household well-being. When so, tightening the constraint affects people living in the most expensive areas, i.e. near the CBD, and those only. **This transfers housing demand towards the suburbs**, urging landlords to greatly **lower rents near the CBD**, hence the increase in utility. On the other hand, if the constraint is so strong that all households are affected, the "suburban migration" strategy disappears. This mitigates the above effect, resulting in an indetermination with regard to the utility outcome.

When setting $\alpha_1 = 0$, proposition 3 gives a sufficient (but not necessary) condition for utility to be greater in the CHE city than in the unconstrained one. In particular, enforcing a moderate constraint, to wit $\alpha \leq 1 - R_A s\big(r_f, u_{eq}\big)/Y$,[7] always raises utility.

Housing expenses and total differential land rent

Determining the influence of α on the total housing expenditure proves complex, because raising α may lower utility, thereby potentially increasing housing expenses in the non binding zone. In most cases total housing expenditure decreases with α though, *idem* for total differential land rent (see additional results in *Appendix C*).[8]

[7] u_{eq} being the equilibrium utility in the unconstrained case.

[8] Counterexamples would be rare and would involve atypical utility functions (see comment after proposition B in *Appendix C*). Furthermore, there is strong support (but no definite proof at this stage) for the fact that total differential land rent would also decrease with α for "regular" utility functions.

THE CH+T MODEL

This section examines an alternative policy consisting in capping the total share of housing and transport within the household budget (instead of housing only). As in the previous section, I first present the model, and then study the impact on the equilibrium land use in the general case with a single household type.

Considering the similarities between the CH+T (Constrained Housing + Transport expenditure) and CHE models, various proofs are shortened or even omitted. More detailed results regarding the CH+T model may once more be found in *Appendix C*.

THE MODEL

Amending the monocentric model

The monocentric model is this time amended by introducing the following constraint:

$$R(r)s + T(r) \leq (1 - \mu)Y \tag{E6}$$

The sum of housing and transport costs is capped at a fraction $(1 - \mu)$ of the household income Y, or alternatively μ is the minimum level of solvency. Indeed, $(E6)$ can be rewritten as:

$$z \geq \mu Y \tag{E7}$$

Unlike CHE policies, CH+T policies enforce an **homogeneous solvency requirement**, meaning that it is the same for all households, whatever their location. Otherwise, $\mu = 0$ is once again tantamount to the unconstrained model, and $\mu = 1$ leads to a null housing expense, precluding any form of decentralized equilibrium.

Modification of bid-max variables

Enforcing a CH+T policy entails the same effects as a CHE-type policy:

- constraining households' choices as regards lot size (it actually sets a *de facto* minimum density) [1];
- lowering prices by limiting the household capacity to pay.

In particular, all properties found for bid-max variables in the CHE model remain true. However, unlike the CHE policy, the H+T constraint **firstly concerns households in the suburban area**, starting from the city edge (→ *Appendix C*). The tighter the constraint,

[1] This stems from the fact that $z \geq \mu Y$ implies at the equilibrium land use $\hat{s}(r, \hat{u}) \leq S(\mu Y, \hat{u})$.

the more households are affected, until the whole city is actually constrained. This property is intuitive. Housing being cheaper in the suburbs, people living there consume more of the housing good and less of the composite one (substitution effect). They are logically the first ones affected by a measure forcefully raising z good consumption.

THE CASE WITH SINGLE HOUSEHOLD TYPE

Existence and uniqueness of the CH+T equilibrium

Considering the similarities between the CH+T and CHE models, one can easily adapt proof of proposition 1 and show that the CH+T land use equilibrium exists and is unique.

Comparative statics

As underlined above, the H+T constraint generates the **same two antagonistic forces** that interfere with equilibrium utility:

- it forces households to make sub-optimal choices, hence lowering utility,
- but it generates a "discount" on housing prices beneficial to households.

Unlike the CHE policy, there is *a priori* no specific case where one can predict the outcome regarding utility. The same goes for total housing expenses and total differential land rent. The only specific property of the equilibrium in the general case is that **city size decreases with μ**, which stems from the minimum density enforcement (once again, one can easily adapt proof of proposition 2 to show this result).

APPLICATION TO A LINEAR CITY

Considering the limitations of the general analysis, I develop a special case consisting in a linear city, that is, $L(r) = 1$, with linear transportation costs $T(r) = ar$. This city accommodates N households with income Y and a log-linear utility function $U(z, s) = 1/2 \log z + 1/2 \log s$. The aim of this relatively simple specification is twofold:

- enabling the **analytical derivation** of the equilibrium land use while keeping some parameters flexible (α, a, etc.). This allows me one to illustrate results from the two previous sections, two to carry out the analysis further regarding the impact of CHE and CH+T policies.
- developing a **reference framework** to confront CHE and CH+T policies, a direct comparison not being feasible in the general case.

Subsection *0* deals with the CHE linear city model, subsection *0* with the CH+T model. The two subsections are structured identically: the derivation of the equilibrium city is carried out first, ensued by comparative statics.

THE CHE LINEAR CITY MODEL

Derivation of the equilibrium land use

After establishing the binding zone (*0*), I derive the various variables of interest, viz. bid-max variables, utility level, and city size (*0*).

Determining the binding zone

The log-linear utility function proves particularly convenient to handle thanks to its property of allocating fixed fractions of the disposable income to each budget item. [1] Here $z(r, u) = 1/2(Y - ar)$, implying that the HE constraint is strictly binding when:

$$r < r_{bind}(\alpha) = (2\alpha - 1)\,\frac{Y}{a} \qquad (E8)$$

This leads to two possible cases:

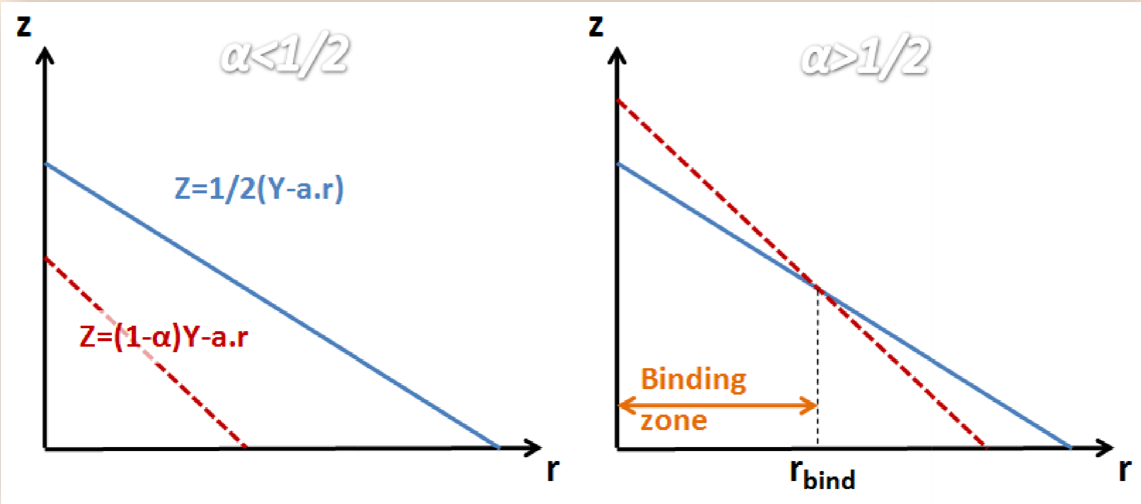
- If $\alpha \leq 1/2$ the HE constraint is too weak and thus never binding. The CHE model is equivalent to the unconstrained model.
- If $\alpha > 1/2$, only households located before $r_{bind}(\alpha)$ are affected by the HE constraint.

[1] For reminder, in the case of a log-linear utility function $U(x, y) = \beta \log x + (1 - \beta) \log y$, the household allocates a fraction β of its disposable income to the x good, and the remaining fraction *1-*β to the y good.

ILLUSTRATING THE NOTION OF BINDING ZONE

The two alternatives are illustrated in *Figure 70*, which plots $z(r,u)$ and the HE constraint:

FIGURE 70 : BINDINGS ZONES FOR α < 1/2 AND α > 1/2



Given its preferences specified by the linear city model, a household wants to spend half its disposable income Y-$T(r)$ on housing, and the other half on the composite good. If $\alpha \leq 1/2$ the constraint is never violated, which is illustrated by the fact that $z(r,u)$ remains above the dashed constraint line. On the other hand, if $\alpha > 1/2$ the constraint is binding for locations close to the CBD, and those only. Indeed, in the unconstrained case, the growth of transport costs leads households to spend less and less money on housing as they settle farther and farther from the CBD, hence a declining housing expense ratio. In $r_{bind}(\alpha)$ the ratio reaches exactly 1-α, meaning that the constraint is not binding anymore.

Characterization of the equilibrium

Solving the bid-max maximization problem yields the following formulae:

$$r \leq r_{bind}(\alpha) \begin{cases} \tilde{z}(r,u) = \alpha Y - ar \\ \tilde{s}(r,u) = e^{2u} / \tilde{z}(r,u) \\ \tilde{\Psi}(r,u) = e^{-2u}(1-\alpha)Y(\alpha Y - ar) \end{cases} \qquad r \geq r_{bind}(\alpha) \begin{cases} \tilde{z}(r,u) = (Y - ar)/2 \\ \tilde{s}(r,u) = e^{2u} / \tilde{z}(r,u) \\ \tilde{\Psi}(r,u) = e^{-2u}(Y - ar)^2 / 4 \end{cases} \qquad (E9)$$

Figure 71 illustrates these solutions for what will constitute the **reference model**, characterized by the following parameter settings: $N = 10$, $Y = 80$, $a = 8$, and $R_A = 20$. Remaining parameters are set at $\alpha = 0.80$ and $u = 21.21$, being the equilibrium utility of the CHE model for the chosen settings. This leads to $r_{max} = 10$ and $r_{bind}(\alpha) = 6$.

FIGURE 71A: CONSUMPTION CHOICES IN THE UNCONSTRAINED (U) AND CHE MODELS

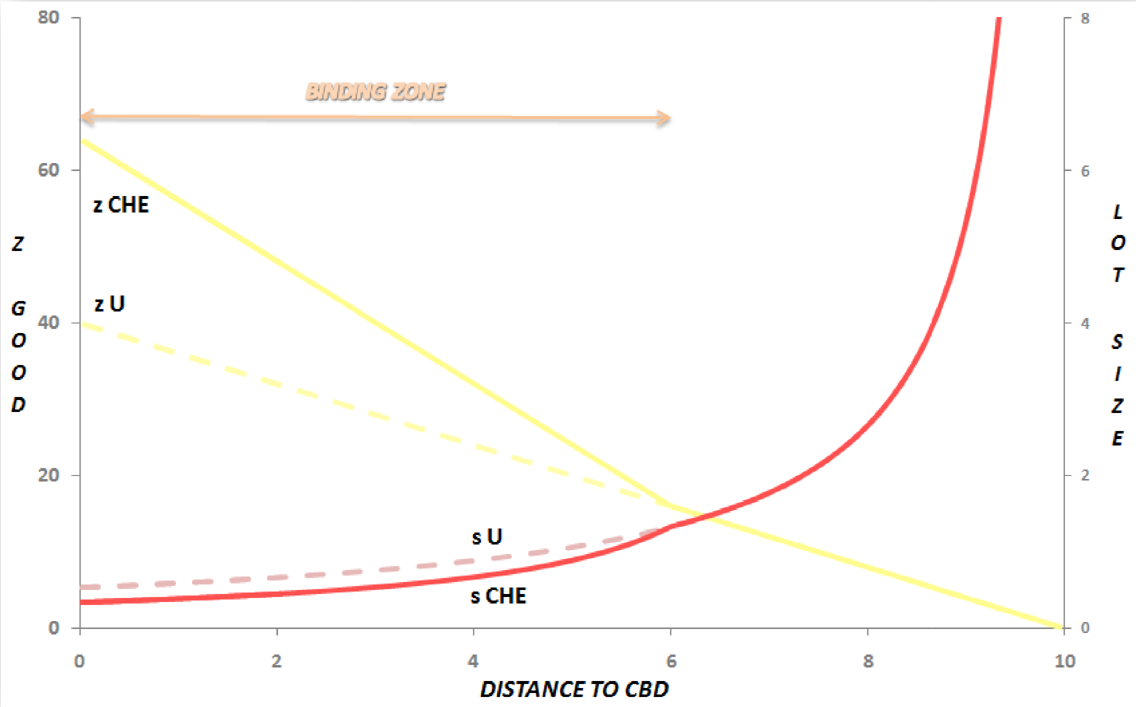
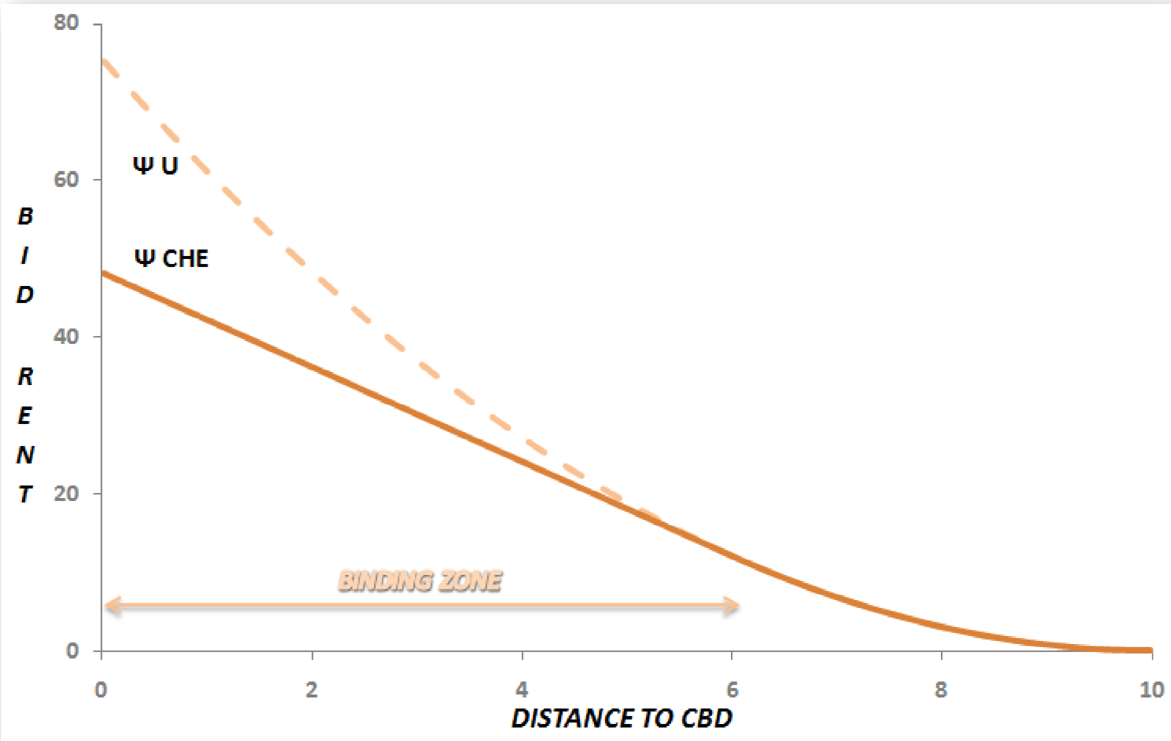


FIGURE 71B: BID RENT FUNCTIONS



As indicated in section *II*, given a target utility, **the HE constraint reduces both lot size and bid rent inside the binding zone**, while raising the consumption of the composite good. Outside the binding zone, the HE constraint is innocuous.

We are now ready to characterize the equilibrium.

proposition 4

In the CHE linear city, the equilibrium land use is characterized as follows:

	$0 \leq \alpha \leq 1/2$ UNCONSTRAINED	$1/2 \leq \alpha \leq \alpha_{cr}$ MODERATE CONSTRAINT	$\alpha_{cr} \leq \alpha \leq 1$ STRONG CONSTRAINT
$e^{2\tilde{u}}$	$\frac{1}{4}\frac{Y^2}{aN+R_A}$	$\frac{1+(2\alpha-1)^2}{4}\frac{Y^2}{aN+R_A}$	$\frac{\alpha^2 Y^2}{\sqrt{a^2N^2+\left(\frac{\alpha}{1-\alpha}\right)^2 {R_A}^2}+aN}$
$\tilde{r}_f$	$\frac{Y}{a}\left(1-\sqrt{\frac{R_A}{aN+R_A}}\right)$	$\frac{Y}{a}\left(1-\sqrt{1+(2\alpha-1)^2}\sqrt{\frac{R_A}{aN+R_A}}\right)$	$\frac{Y}{a}\left\{1-(1-\alpha)\left(1+\sqrt{\left(\frac{aN}{R_A}\right)^2+\left(\frac{\alpha}{1-\alpha}\right)^2}-\frac{aN}{R_A}\right)\right\}$

where $\alpha_{cr} = 1 - \left(1 + \sqrt{\frac{2aN}{R_A}}\right)^{-1}$.

Calculations, detailed in *Appendix B*, are based on the distinction of the following cases:

- $\alpha \leq 1/2$ yields the unconstrained model.
- If $\alpha \in [1/2, \alpha_{cr}]$, the edge of the city is beyond $r_{bind}(\alpha)$.
- If $\alpha \geq \alpha_{cr}$, the whole city is affected by the HE constraint.

Comparative statics

Because closed-form solutions exist for $(\tilde{u}, \tilde{r}_f)$, we can now study in depth the influence of α on the main variables of interest, namely utility, city size and density, the composition of the household budget, and landlord surplus. All proofs of the following properties are sent back to *Appendix B*.

Utility

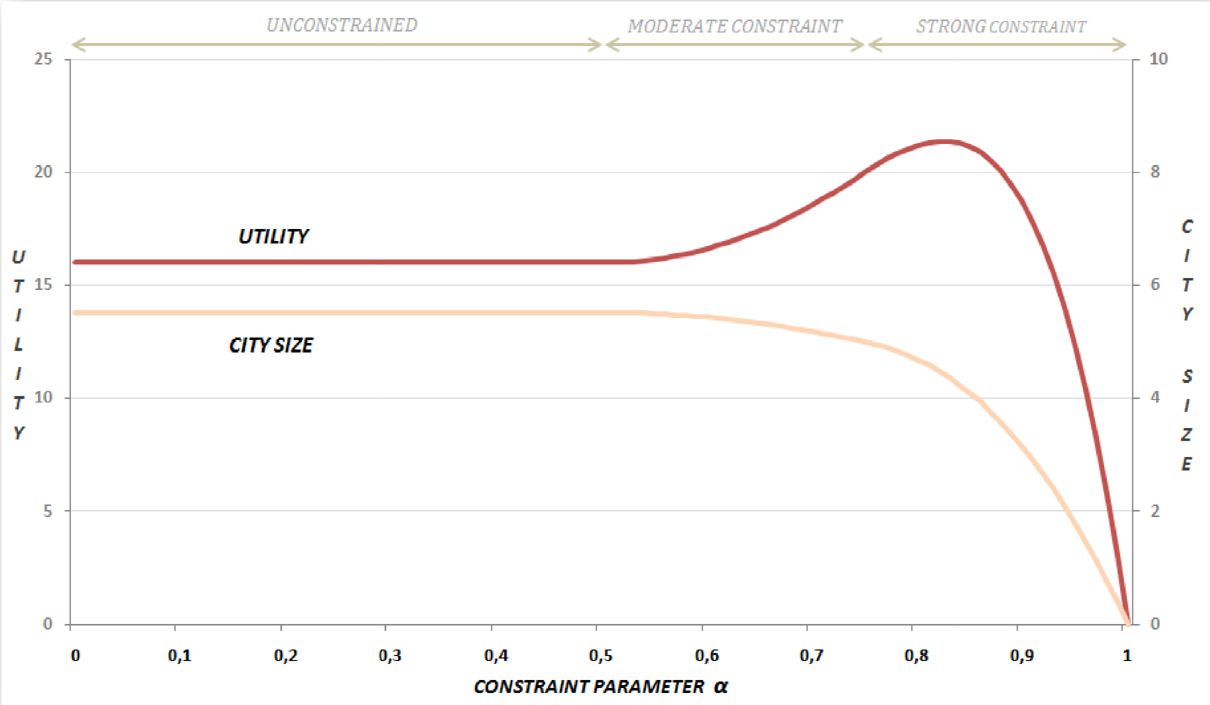
property 2

For any set $(N, Y, R_A > 0, \alpha)$*, the equilibrium utility* $\tilde{u}(\alpha)$ *of the CHE city is constant on* $[0; 1/2]$*, then strictly increases on* $[1/2; \alpha_{cr}]$*. It is maximal for* $\alpha_{max} > \alpha_{cr}$*. In addition,* $\tilde{u}(\alpha) \xrightarrow[\alpha \to 1^-]{} -\infty$.

If $R_A = 0$*,* $\tilde{u}(\alpha)$ *strictly increases on* $[1/2; 1[$.

Proof directly stems from proposition 4. Before interpreting this property, let us first take a look at *Figure 72*. It depicts $e^{2\tilde{u}(\alpha)}$ for the reference model, which for reminder corresponds to $N = 10$, $Y = 80$, $a = 8$, and $R_A = 20$; for these settings $\alpha_{cr} = 0.75$.

FIGURE 72 : UTILITY LEVEL AND SIZE OF THE CHE LINEAR CITY



One can check that $0.824 \approx \alpha_{max} > \alpha_{cr} = 0.75$, which is in accordance with property 2.

Property 2 perfectly illustrates proposition 3. Whenever the city edge is beyond the binding zone (i.e. $\tilde{r}_f(\alpha) \geq r_{bind}(\alpha)$, being equivalent to $\alpha \leq \alpha_{cr}$), utility is higher in the CHE city than in the unconstrained one. On the other hand, if the whole city is constrained, raising α proves worthwhile at first, but quickly utility falls. In other words, **when outside competition for land** (represented by R_A) **is mild**, **the constraint put on household choices is more than compensated for by lower prices** in the binding zone, which result from less fierce competition for land. This raises household utility. Conversely, **when household competitiveness becomes too weak in comparison to the agricultural sector, the reduction of city size is exacerbated and utility falls.** Obviously if $R_A = 0$ this last phenomenon never happens, being the reason why utility only rises in this case.

City Size and Density

Unlike utility, raising α always reduces city size (proposition 2). In the linear city model, city size decreases past $\alpha = 0.5$, and the fall accelerates for $\alpha > \alpha_{max}$, to wit when the HE constraint weighs too heavy and benefits to the agricultural sector (*Figure 72*).

Reduction of city size occurs in two different ways, depending on the value of α:

- As long as utility rises, higher densities near the CBD overweigh lower ones in the suburbs.

- Then, when utility decreases, density uniformly expands throughout the city.

Note that both situations lead to a **steeper density curve**. These various points are illustrated in *Figure AA* (→ *Appendix A*).

Household budget composition

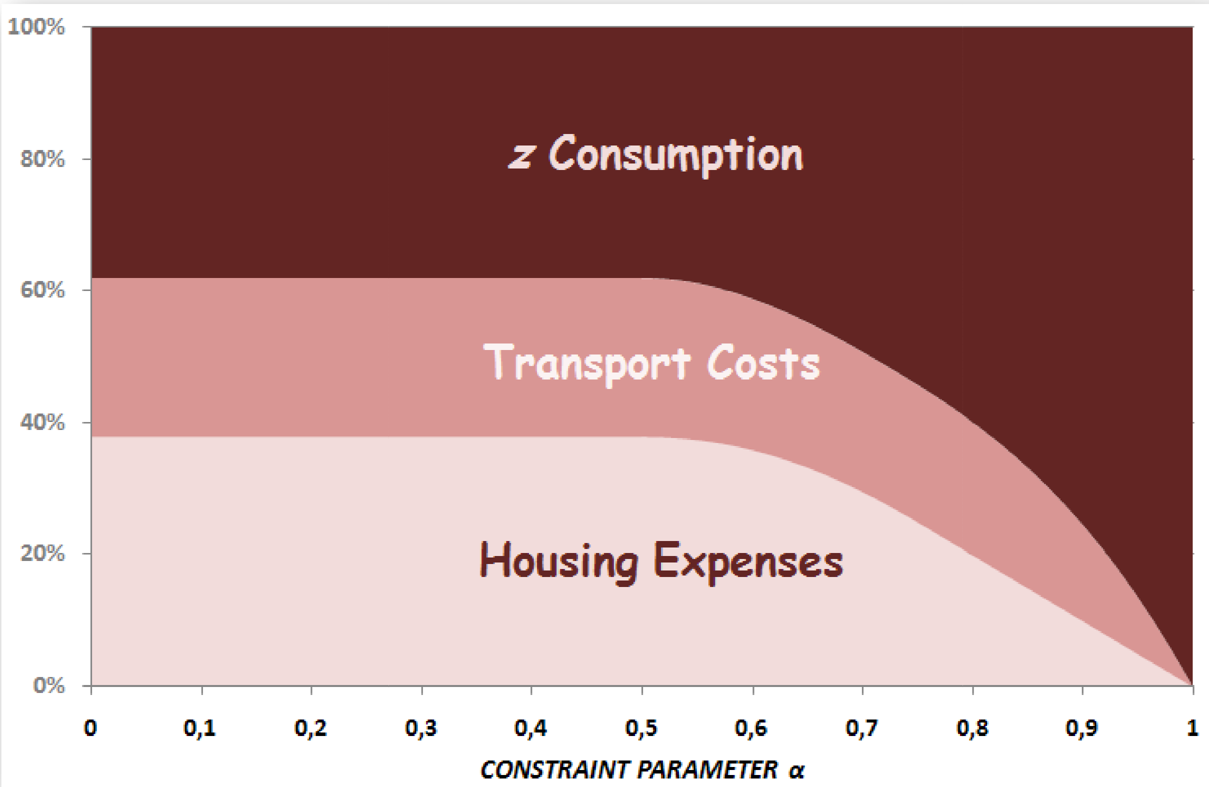
Given that HE policies are primarily designed to protect household solvency, one key issue is their impact on the average composition of the household budget:

property 3

The average housing and transport expense ratios both decrease with α, resulting in an increasing consumption of the z good.

This property is illustrated for the reference model (*Figure 73*). Low values of α (from 0.5 to 0.6) barely reduce housing and transport burdens, since few households fall within the scope of the CHE policy. As α keeps on rising, total housing expenditure decreases more sharply whereas total transport costs are still moderately affected, until $\alpha = \alpha_{max}$. On this interval, the impact bears on prices rather than on lot sizes (cf. *0*). Beyond α_{max}, it is the opposite that happens, triggering a drop in city size as well as in housing and transportation burdens.

FIGURE 73: INFLUENCE OF α ON AVERAGE HOUSEHOLD BUDGET COMPOSITION



Considering property 3, it seems clear that raising α improves solvency. However, a further analysis of the distribution of z among households mitigates this view.

property 4

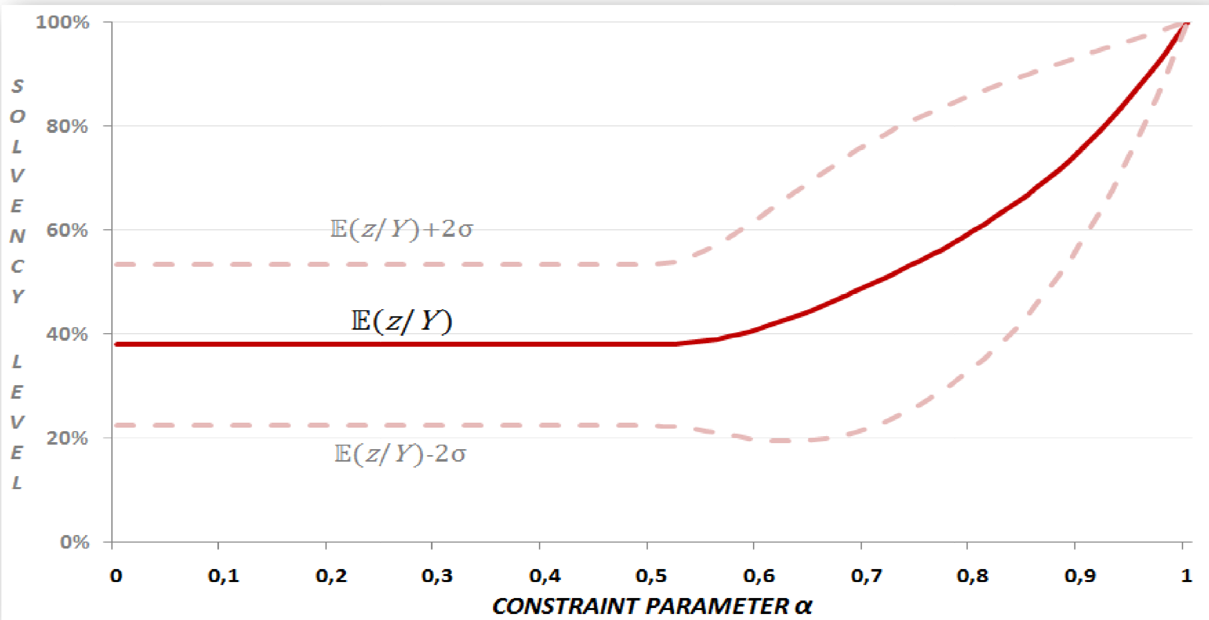
For any set $(N, Y, R_A > 0, \alpha)$, $Var(z)$ increases then decreases with α. In addition, $Var(z) \xrightarrow[\alpha \to 1^-]{} 0$.

If $R_A = 0$, $Var(z)$ increases with α.

In other words, though raising α improves household solvency on average, at first it "flattens" the distribution of solvency. This magnifies disparities between households at the beginning and at the end of the distribution (*Figure 74*). Indeed, the constraint first affects households living near the CBD, who are already those with the highest level of z. In sum, **CHE policies are off the point as far the protection of solvency is concerned**, at least for moderate values of α (and in the simplified setting of the model). When the constraint is so strong that the whole city becomes constrained, the situation improves for all households, hence a declining $Var(z)$.

Variations of $\sqrt{Var(z)}$ are represented once more in the case of the reference model (*Figure BB*). At the maximum, the relative gain as compared to the unconstrained situation is sizable, highlighting the inadequacy of this policy as regards solvency issues.

FIGURE 74: AVERAGE SOLVENCY AND CONFIDENCE INTERVAL AT 95%, REFERENCE MODEL



Assuming a normal distribution, the confidence interval at 95% is approximately the interval [$\mathbb{E}$(z/Y)-2σ ; $\mathbb{E}$(z/Y)+2σ], where σ is the standard deviation of the distribution of z/Y. Note that z/Y does not actually follow a normal distribution. However, this interval remains illustrative in first approximation.

Landlord surplus

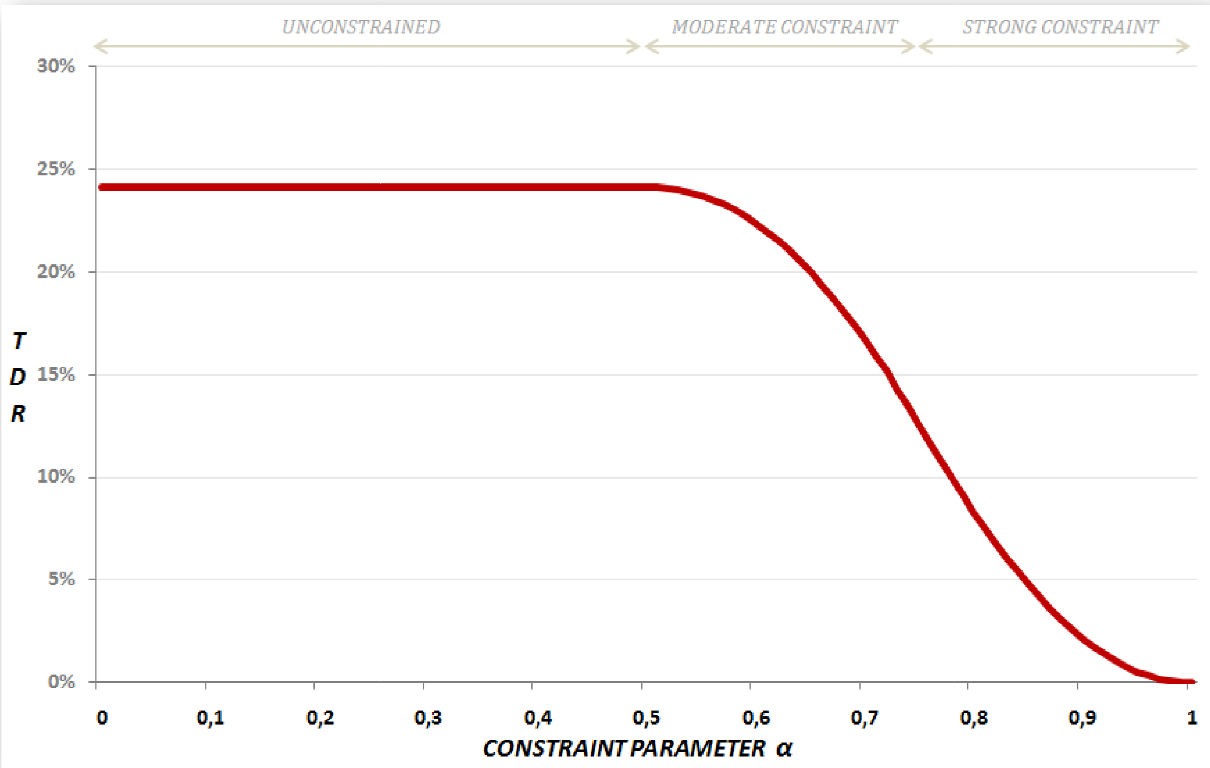
property 5

Total differential land rent decreases with α.

As discussed in *0* and in *Appendix C*, this property is mathematically not trivial as total housing expenditure and city size both decrease with α.[2] It can be proved by deriving the explicit formula provided in *Appendix B*. It is relatively intuitive from an economic point of view, however: CHE policies constraining housing demand, they are bound to decrease landlord profits.

In the reference model, the TDR falls increasingly fast at first, until reaching the inflexion point $\alpha = \alpha_{cr}$. From there onward, it decreases more slowly until reaching 0 when α tends toward 1 (*Figure 75*). This inflexion in $\alpha = \alpha_{cr}$ echoes the discussion made in *0*. Indeed, landlords sustain greater and greater losses for as long as the "suburban migration" strategy is possible, but this phenomenon is lessened when the whole city is constrained.

FIGURE 75 : INFLUENCE OF α ON TDR ***(IN % OF TOTAL INCOME)***



[2] For reminder, TDR = Total Housing Expenditure – R_A* City Size, hence the indetermination.

THE CH+T LINEAR CITY MODEL

Derivation of the equilibrium city

The same steps are carried out to derive the equilibrium land use.

Determining the binding zone

Given the log-linear utility function, the H+T constraint is strictly binding when:

$$r > r_{bind}(\mu) = (1 - 2\mu)\frac{Y}{a} \qquad (E10)$$

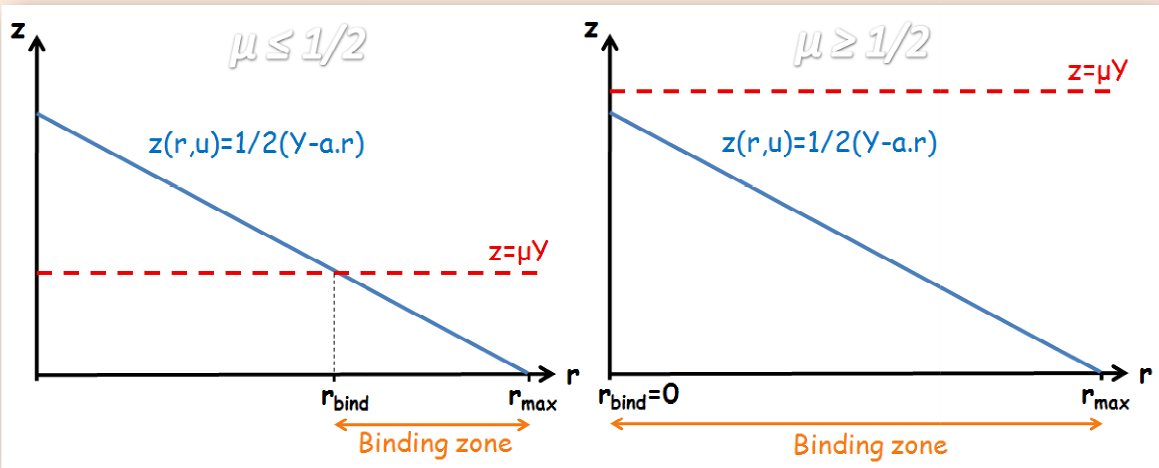
Hence two possibilities:

- If $\mu > 1/2$ the constraint is always binding.
- If $\mu \leq 1/2$, only households located beyond $r_{bind}(\mu)$ are bound by the H+T constraint.

ILLUSTRATING THE NOTION OF BINDING ZONE

Once again, the two alternatives are illustrated in *Figure 76*. The unconstrained solution is drawn in plain blue, the H+T constraint in dashed red. Only households beyond r_{bind} (if any) are constrained. As the constraint gets tighter (by raising μ), the dashed red line rises, more and more households are affected, until μ=1/2, which is when the entire city is constrained.

FIGURE 76: ILLUSTRATION OF THE BINDING ZONE WHEN $\mu \leq 1/2$ AND $\mu \geq 1/2$



Characterization of the equilibrium

Solving the bid-max problem yields the following equations:

$$r \leq r_{bind}(\mu) \begin{cases} \hat{z}(r,u) = (Y - ar)/2 \\ \hat{s}(r,u) = e^{2u} / \hat{z}(r,u) \\ \hat{\Psi}(r,u) = e^{-2u}(Y - ar)^2 / 4 \end{cases} \qquad r \geq r_{bind}(\mu) \begin{cases} \hat{z}(r,u) = \mu Y \\ \hat{s}(r,u) = e^{2u} / \hat{z}(r,u) \\ \hat{\Psi}(r,u) = e^{-2u} \mu Y \left\{(1-\mu)Y - ar\right\} \end{cases} \qquad (E11)$$

Figure 77 illustrates (*E11*) in the case of the reference model. In addition, I choose μ=0.3 and $u = 16$, entailing $\hat{r}_{max} = 7$ and $r_{bind} = 4$.[3]

FIGURE 77A: CONSUMPTION CHOICES IN THE UNCONSTRAINED (U) AND CH+T MODELS

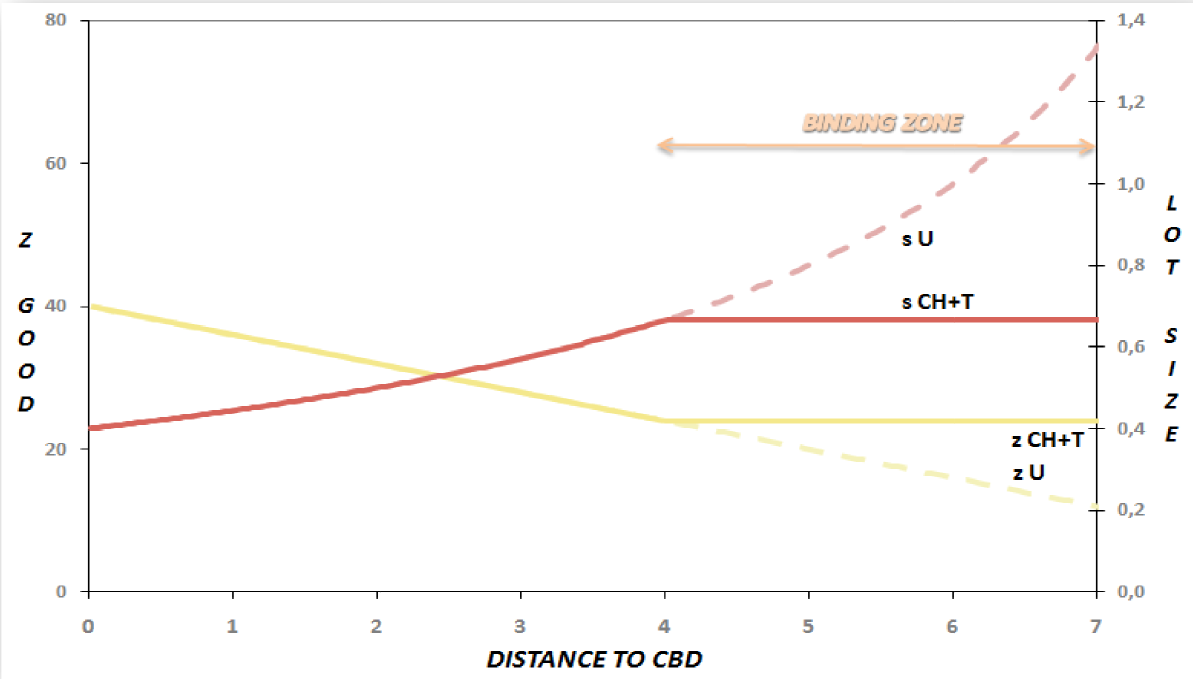
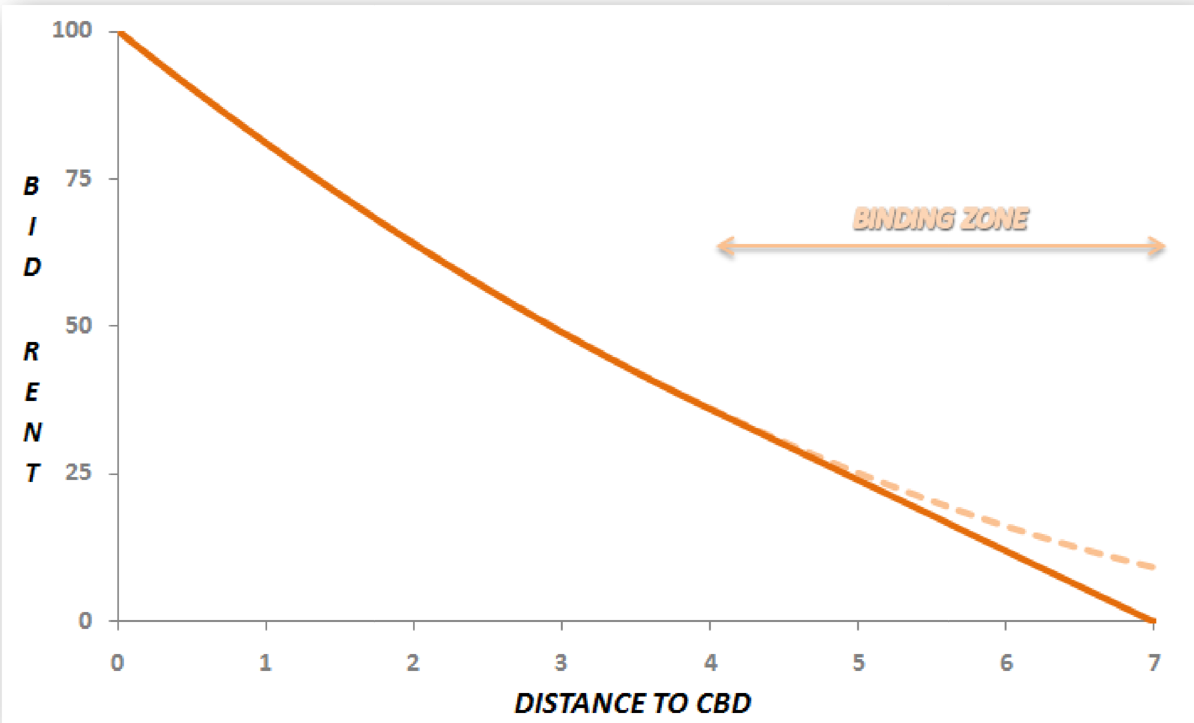


FIGURE 77B: BID RENT FUNCTIONS



[3] $u = 16$ is the equilibrium utility of the CH+T reference model with $\mu = 0.3$. Otherwise, we should have $r_{max}=\frac{Y}{a}=10$, but because the H+T constraint implies $T(r) \leq 0.7 * Y$, $r > 7$ is not feasible and $\hat{r}_{max} = 7$.

For $r \le r_{bind}$ the H+T constraint is not binding, and consumption choices are identical in the constrained and unconstrained case. When $r > r_{bind}$, the constraint becomes active, leading to constant choices of lot size and z good consumption, and smaller bid rents.

Using ($E11$), we can now derive the equilibrium utility and city size:

proposition 5

In the CH+T linear city, the equilibrium is characterized as follows:

	$\mu \le \mu_{cr}$ UNCONSTRAINED	$\mu_{cr} \le \mu \le 1/2$ MODERATE CONSTRAINT	$\mu \ge 1/2$ STRONG CONSTRAINT
$e^{2\hat{u}}$	$\frac{1}{4}\frac{Y^2}{aN + R_A}$	$\frac{1}{4}\frac{Y^2}{aN + R_A}$	$\mu(1-\mu)\frac{Y^2}{aN + R_A}$
$\hat{r}_f$	$\frac{Y}{a}\left(1\text{-}\sqrt{\frac{R_A}{aN + R_A}}\right)$	$\frac{Y}{a}\left(1\text{-}\frac{1}{2}\left(\frac{\mu}{\mu_{cr}}+\frac{\mu_{cr}}{\mu}\right)\sqrt{\frac{R_A}{aN+R_A}}\right)$	$(1-\mu)\frac{Y}{a}\frac{aN}{aN + R_A}$

where $\mu_{cr} = \frac{1}{2}\sqrt{\frac{R_A}{aN+R_A}}$.

Calculations are once again based on the distinction of three cases ($\rightarrow$ *Appendix B*):

- $\mu \le \mu_{cr}$ yields the unconstrained model.
- If $\mu \ge 1/2$, $r_{bind}(\mu) = 0$: the H+T constraint is active for the whole city.
- $\mu \in [\mu_{cr}; 1/2]$ is the intermediate scenario where the constraint is only binding in the periphery of the city.

Comparative statics

Utility

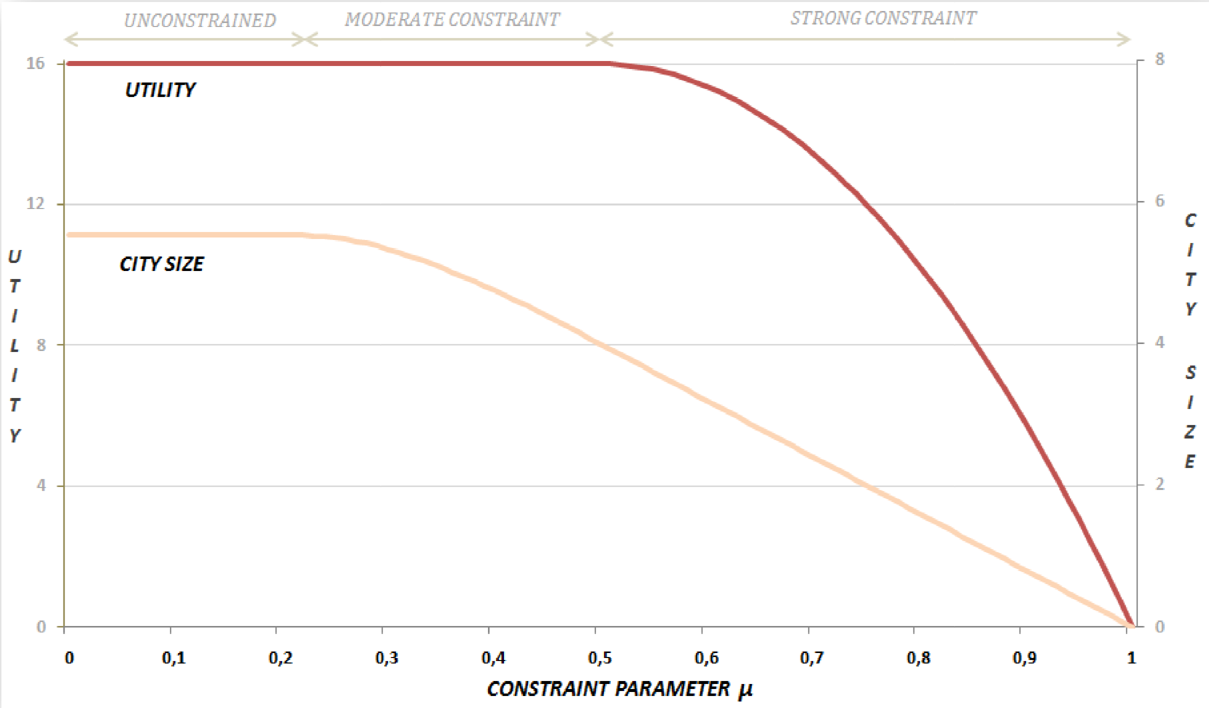
property 6

The equilibrium utility $\hat{u}(\mu)$ of the CH+T linear city remains constant for $\mu \le 1/2$ then strictly decreases.

Compared to proposition 5, property 6 seems hollow at first. Yet, it states that when $\mu \in [\mu_{cr}; 1/2]$, the “discount” on housing prices perfectly compensates suburbanites for the smaller lot sizes. In sum, **the CH+T policy is “funded” by suburban landlords**. On the other hand, the good accessibility of the central part of the city (i.e. the low transport costs) allows the situation to remain unchanged in this place. Actually, this is precisely the reason why the constraint weighs so heavily on housing prices in the suburbs. **Suburban landlords are forced into lowering rents to avoid the “suburban flight”.** It is the exact reverse of what happens in the CHE case. However, if $\mu \ge 1/2$ the city center becomes also affected by the CH+T policy and cannot be used as a “withdrawal strategy” anymore. As a result, utility falls.

Figure 78 plots $e^{2\hat{u}(\mu)}$ in the case of the reference model (with $\mu_{cr} = 0.224$):

FIGURE 78 : UTILITY LEVEL AND SIZE OF THE CH+T LINEAR CITY



City Size and Density

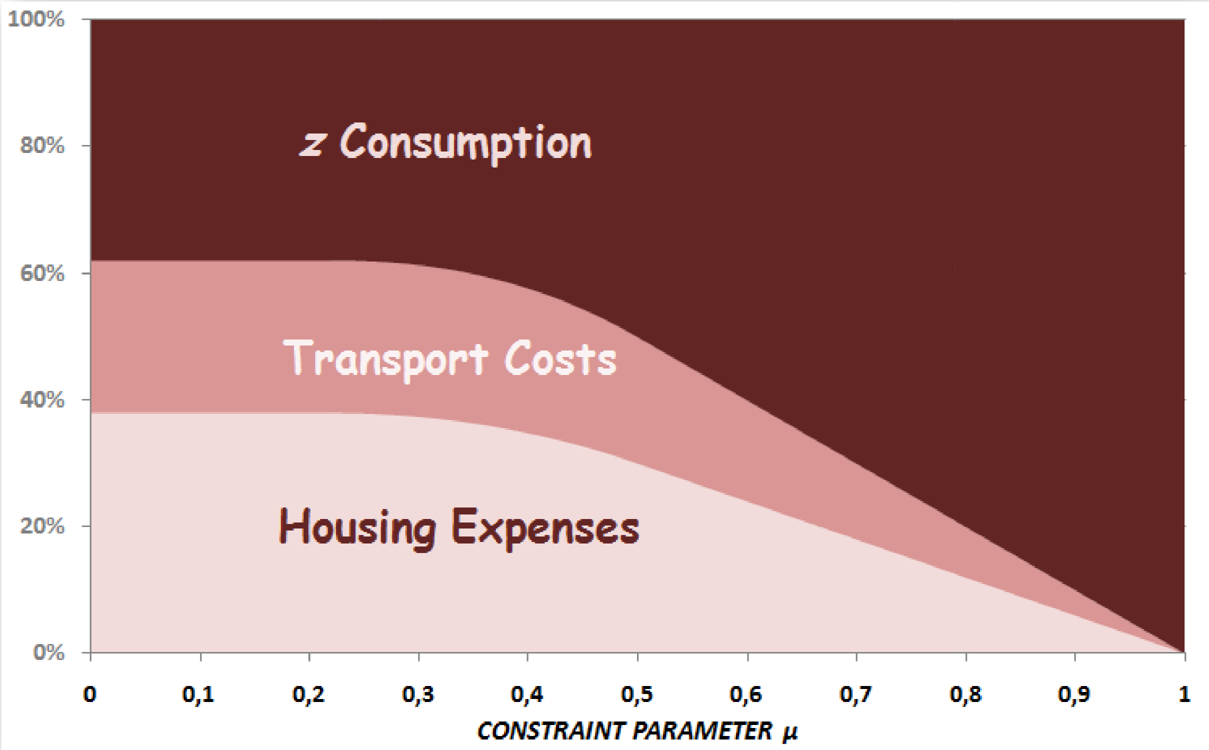
City size always decreases with μ whatever the choice of parameters ($\to$ *0*). In the case of the reference model, starting from μ_{cr} (before, the constraint is innocuous), the effects of the CH+T policy are barely sizable at first (*Figure 78*). However, quickly city size decreases, demonstrating the efficiency of this policy to contain urban sprawl as compared to the CHE one. When $\mu \geq 1/2$, city size decreases linearly.

Like its CHE counterpart, the CH+T policy alters the density curve. However, this time it sets *de facto* a **minimum density level**, thereby **flattening the density curve** (*Figure CC*). The density constraint affects either part or the whole city depending on $\mu \leq$ or $\geq 1/2$, explaining the linear pattern of city size in the latter case.

Household budget composition

Similarly to the CHE policy, the CH+T policy causes both household housing and transport outlays to diminish (which is indeed the very goal of this policy).

FIGURE 79: INFLUENCE OF μ ON THE COMPOSITION OF THE HOUSEHOLD BUDGET



property 7

The average housing and transportation budgets both decrease with μ, while the mean consumption of the composite good increases.

In the reference model, when the H+T constraint becomes active ($\mu \geq \mu_{cr}$), total housing and transportation expenditures both start decreasing (*Figure 79*). Moreover, the two items decrease commensurately, whereas in the CHE case the fall was more accentuated for the total housing expense. This directly stems from the form of the H+T constraint. When μ exceeds $1/2$, the decrease in both items is accentuated and becomes linear.[4]

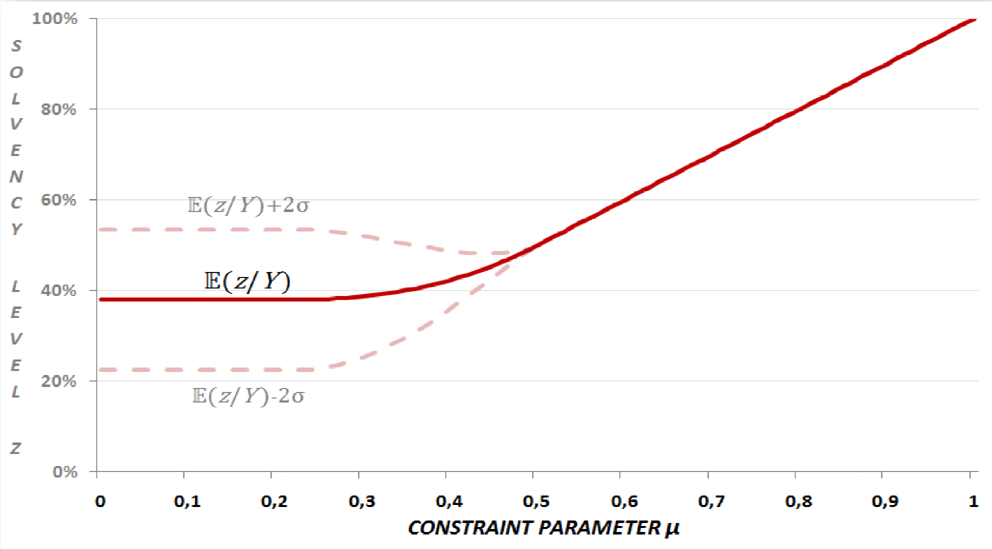
property 8

$Var(z)$ decreases with μ.

Unlike CHE policies, CH+T policies firstly concern suburban households, who have the lowest levels of solvency. Therefore, CH+T policies improve the average solvency of households while **homogenizing the default risk within the city** (*Figure 80*). In this sense, they seem far more adequate than CHE policies regarding this specific matter. When μ reaches $1/2$, the whole city becomes constrained and consumption choices are identical throughout the city, which is why standard deviation becomes null (*Figure DD*).

[4] Linearity is in this case a byproduct of constant lot sizes and linearity of city size.

FIGURE 80 : AVERAGE SOLVENCY AND CONFIDENCE INTERVAL AT 95%, REFERENCE MODEL



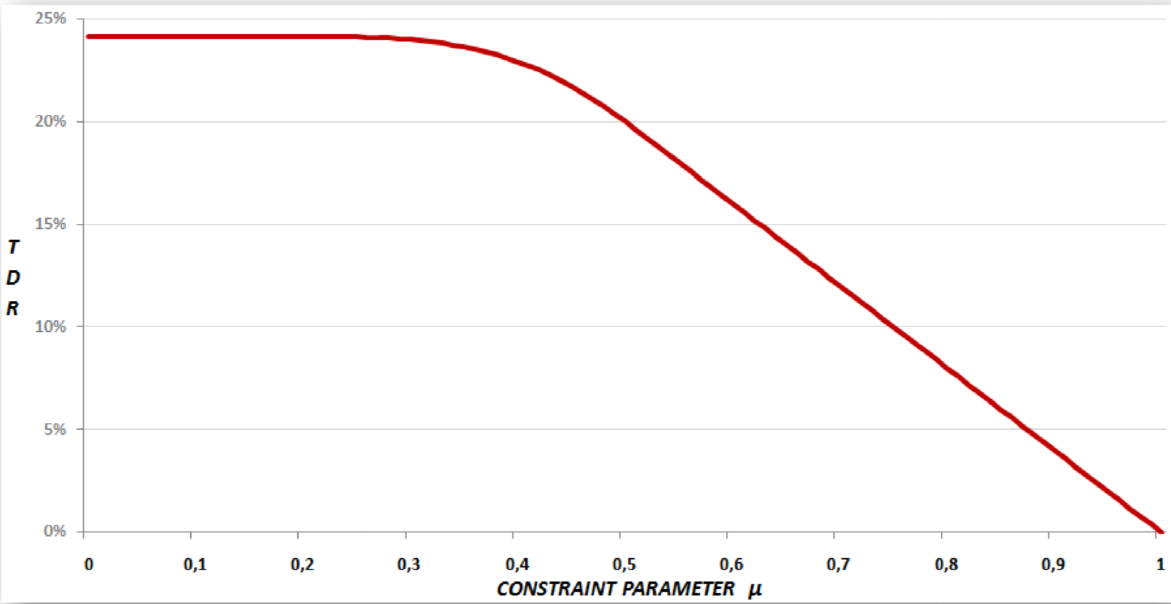
Landlord surplus

property 9

Total differential land rent decreases with μ.

As previously, the formula to derive so as to prove property 9 is provided in *Appendix B*. In the case of the reference model, TDR decreases smoothly at first (as compared to CHE policies), then linearly when $\mu \geq 1/2$ (*Figure 81*). This tends to indicate that CH+T policies are less detrimental to landlords than CHE ones, a point which is confirmed in the next section.

FIGURE 81 : INFLUENCE OF μ ON THE TDR IN THE CH+T LINEAR CITY ***(IN % OF TOTAL INCOME)***



DISCUSSION

CHE AND CH+T POLICIES: A WIN-WIN SITUATION?

In sum, capping the housing expense ratio or the H+T expense ratio entails the same result: it distorts household residential choices and reduces housing prices. However, the significance of each effect varies depending on the policy, resulting in contrasting outcomes. In addition, CHE and CH+T policies do not affect the same households first. Despite these differences, **both policies reduce urban sprawl while leaving utility unaffected or even increasing it** (as compared to the unconstrained situation).

This last element may seem puzzling: how can a constraint decrease city size while not being detrimental to utility, and even beneficial in the case of CHE policies? Would this imply that the unconstrained equilibrium is not efficient? Of course it is not the case, as the unconstrained land use equilibrium was indeed shown to be efficient. The answer lies in the decrease in landlord surplus. By reducing housing demand, both policies spur landlords to lower rents, causing an **implicit transfer from landlords to households.** It is this very redistribution which maintains or raises the utility level compared to the unconstrained situation with absentee landlords.

Based on the analysis of the Herbert-Stevens model, we know the utility of the closed-city model to be maximized in the case of public ownership (Fujita 1989). No other allocation, and in particular any outcome of CHE measures, can outperform public ownership on utility grounds. However, CHE policies are currently widely enforced and accepted, unlike public ownership of land. They are thus an interesting alternative to contain urban sprawl and at the same time improve household well-being, though being clearly detrimental to landlords. CH+T policies are for their part better suited to address urban sprawl and solvency issues, and are also less detrimental to landlords.

MEASURING THE INEFFICIENCY

The previous discussion naturally raises the issue of efficiency. As it is implied above, **CHE and CH+T policies are not efficient**. Indeed, lump-sum transfers from landlords to households are the only efficient policies in the monocentric model (*ibid*). For any CHE or CH+T policy, it is therefore possible to determine a lump-sum transfer G_0 so that:

- the CHE/CHT policy and the unconstrained situation with lump-sum transfer G_0 from landlords to households would yield the same utility level,
- and landlord surplus of the CHE/CHT policy would be outperformed.

The corresponding allocation is called the "**efficient equivalent**".

The issue of efficiency solved, the next one is that of the "**distance to efficiency**". Because the differences in the household consumption choices vary in each location between the CHE/CH+T allocation and its efficient equivalent, defining this distance is not trifling. I choose to focus on **landlord surplus**, considering that efficiency is based in the first place on utility for households and total differential land rent for landlords.

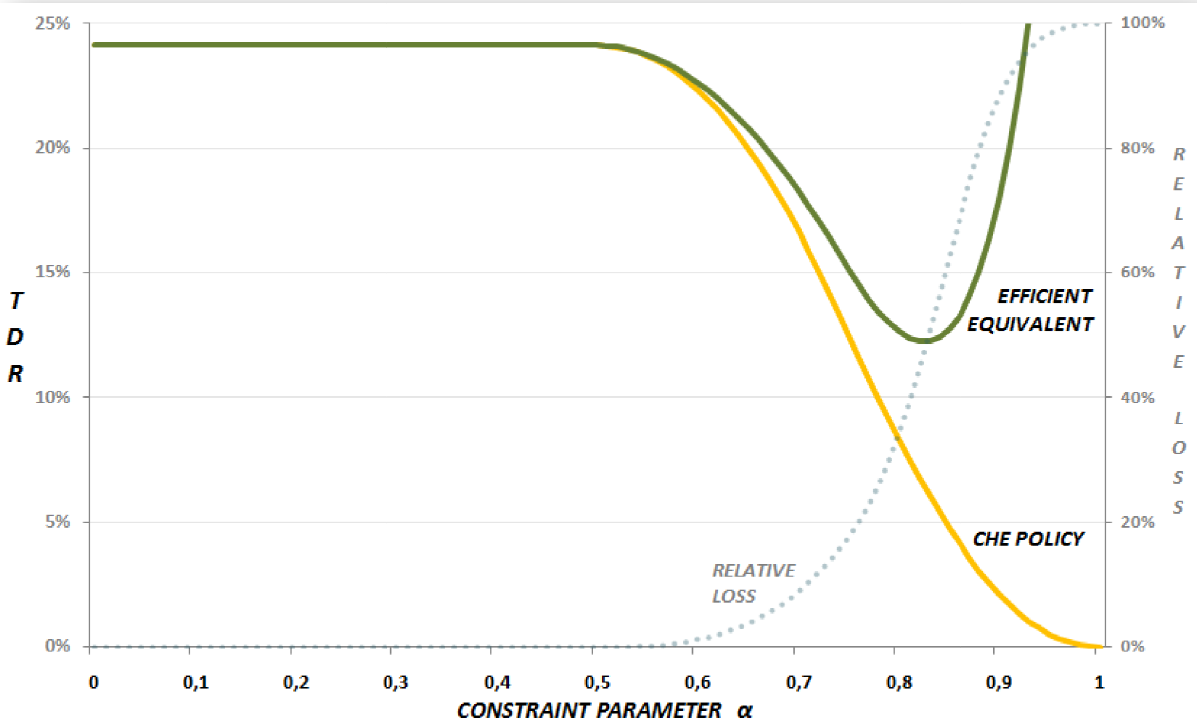
Analysis in the case of CHE policies

To effectively measure distance to efficiency, one has to determine first for each value of α the lump-sum transfer $G_0(\alpha)$ that yields the same utility, that is:

$$\max_{\substack{z,s,r \\ R(r)s+z+T(r)=Y+\frac{G_0(\alpha)}{N}}} U(z,s) = \widetilde{U}(\alpha)$$

Then, the landlord surplus of the efficient equivalent, i.e. $TDR\left(Y+\frac{G_0(\alpha)}{N}\right)-G_0(\alpha)$, is compared to $\widetilde{TDR}(\alpha)$.[1] Once again, the analysis focuses on the reference model as an epitome of what would happen for any choice of parameter settings.

FIGURE 82 : LANDLORD SURPLUS, CHE POLICY VS. EFFICIENT EQUIVALENT



Surpluses are measured as a share of total gross income (before the lump-sum transfer), i.e. in % of NY.

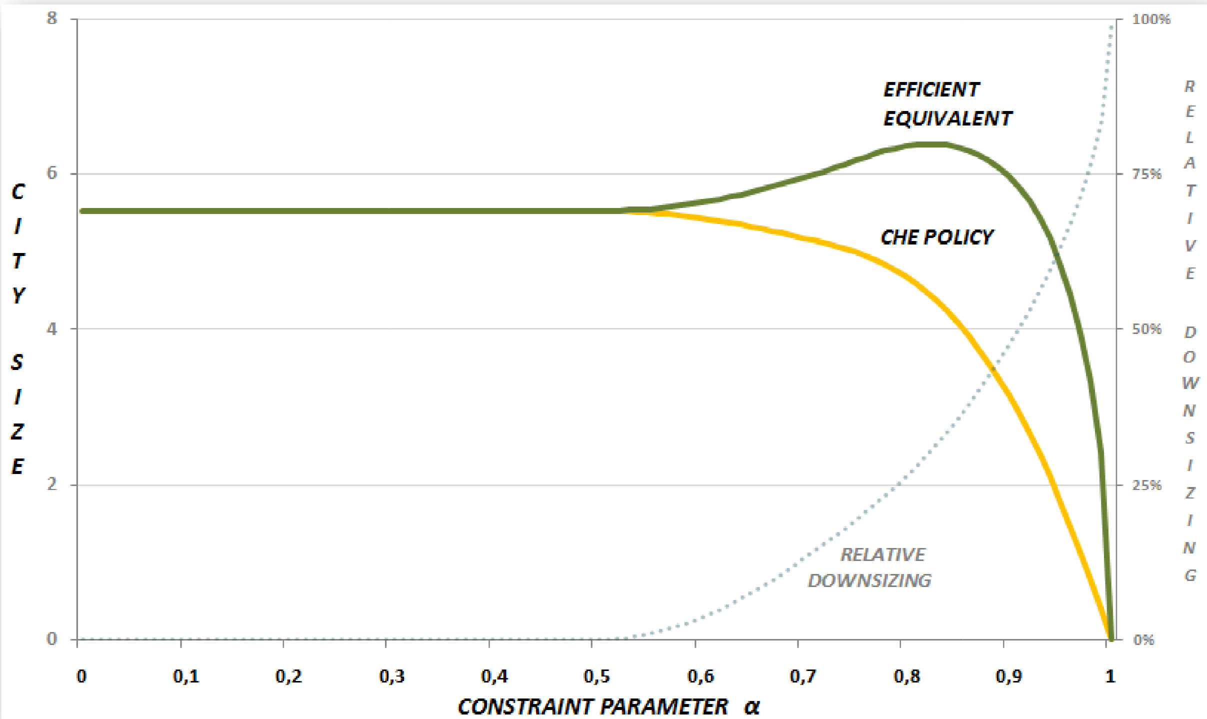
Relative loss corresponds to the ratio $1-\frac{\widetilde{\mathrm{TDR}}(\alpha)}{\mathrm{TDR}\left(\mathrm{Y}+\frac{G_0(\alpha)}{\mathrm{N}}\right)-G_0(\alpha)}$.

[1] In this case, a ~ is added to the notation TDR for disambiguation purposes.

Overall, it appears that **distance to efficiency increases with α** (*Figure 82*). The difference in surplus remains limited at first, but soars when $\alpha \geq \alpha_{max}$, i.e. when $\widetilde{U}(\alpha)$ decreases. CHE policies are then too distortionary, leading to significant inefficiency.

A comparative analysis of city sizes uncovers that the "inefficiency" of CHE policies is directly related to the containment of urban sprawl (*Figure 83*). As a matter of fact, the major difference between a CHE policy and its efficient equivalent is that although both involve a transfer, implicit or explicit, from landlords to households, the former forces households to purchase smaller dwellings than optimal. Households thus need a higher compensation to reach the same utility level as in the efficient equivalent. On the other hand, housing consumption is strongly reduced, whereas with efficient transfers higher utility comes with larger city size. In sum, by compensating households for choosing smaller dwellings, **landlords subsidize the reduction of city size**.

FIGURE 83: CITY SIZE, CHE POLICY VS. EFFICIENT EQUIVALENT

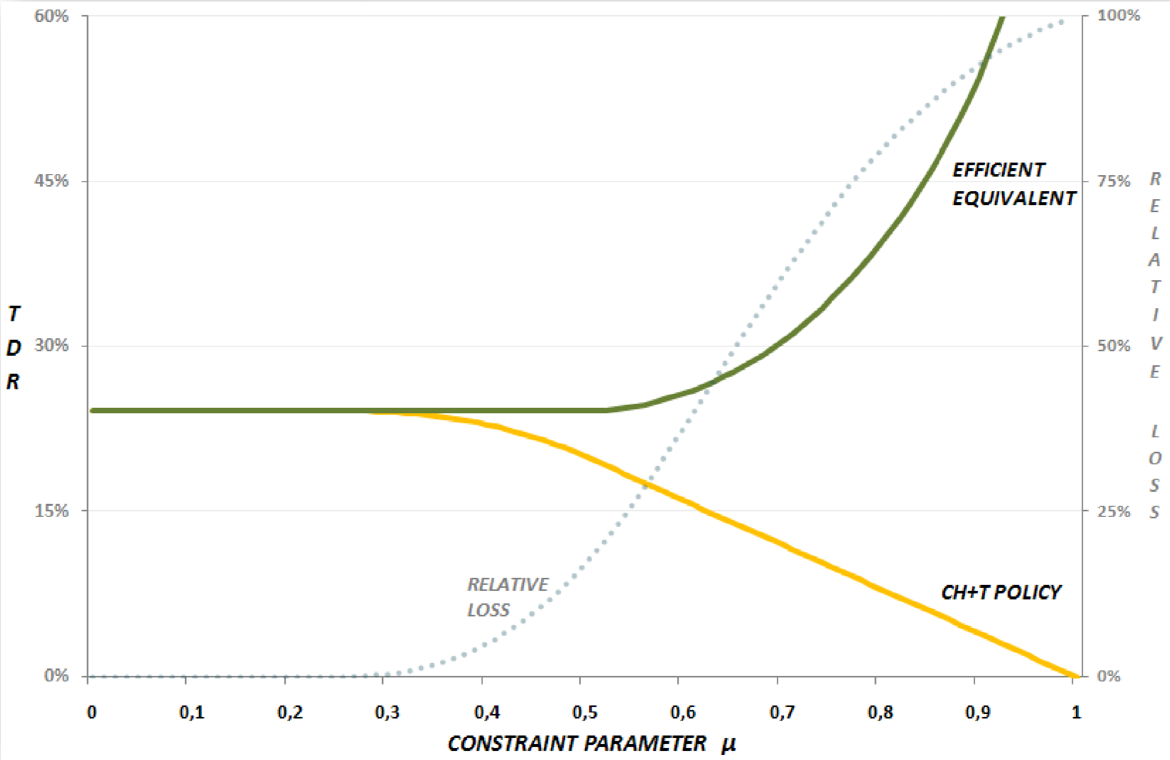


The curve "Relative downsizing" plots the ratio of city sizes (CHE/efficient).

Analysis in the case of CH+T policies

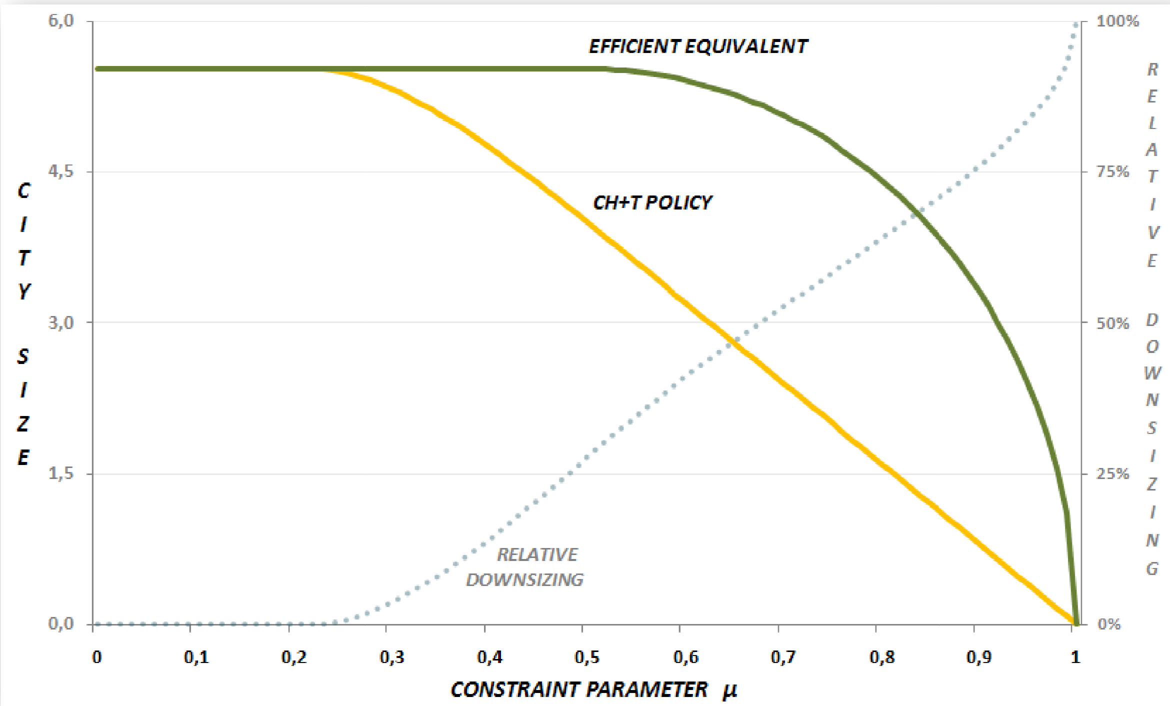
The same analyses are carried out in the case of the reference model. As previously, **inefficiency grows with μ** (*Figure 84*). As utility remains constant then decreases in the CH+T case, conversely TDR remains constant then increases for the efficient equivalent. When μ tends toward 1, utility drops to -∞, which in the efficient equivalent corresponds to transferring the whole of households' incomes to landlords.

FIGURE 84: LANDLORD SURPLUS, CH+T POLICY VS. EFFICIENT EQUIVALENT



The analysis of city size leads to the same interpretation as in the CHE case: the **"inefficiency" of CH+T policies allows the reduction of urban sprawl**. Moreover, the relative "downsizing" increases with μ, mirroring the increasing relative loss (*Figure 85*).

FIGURE 85: CITY SIZE, CH+T POLICY VS. EFFICIENT EQUIVALENT

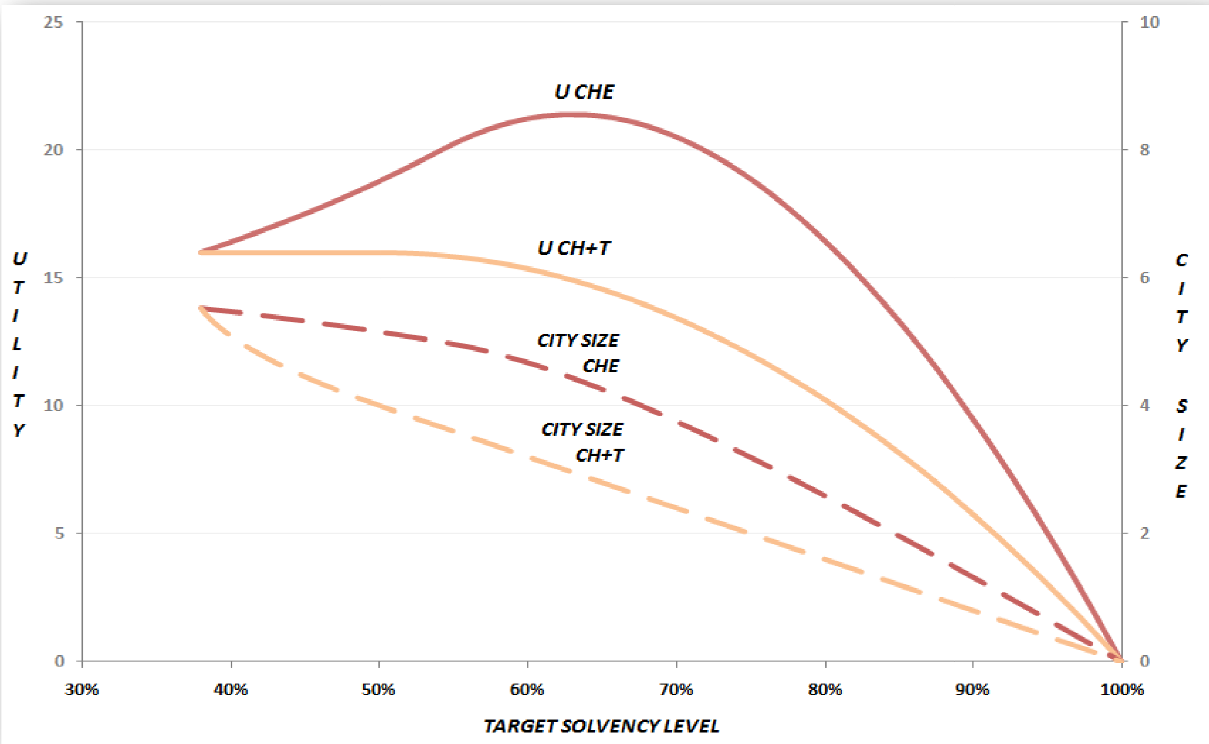


WHICH POLICY TO CHOOSE?

This subsection compares the impact for a city implementing either a CHE or a CH+T policy. Because the constraint parameters α and μ are not directly comparable, an **auxiliary measure** must be introduced, which must be common to both models and meaningful as well. This led me to the choice of the **average level of solvency**, defined as the average share of income remaining after paying for housing and transportation.[2] In both cases, increasing household solvency means raising the value of the constraint parameter, until reaching the maximum level of 100% for a value of α or μ equal to 1. Since α or $\mu = 0$ both yield the unconstrained model, the average level of solvency of the unconstrained reference model is the common starting point.

The comparative analysis first shows **CHE policies to always provide a greater utility than CH+T ones**, whatever the target solvency level, but at the subsequent cost of **greater urban expansion** (*Figure 86*). Moreover, while both policies contain urban sprawl, **CHE policies steepen the density curve whereas CH+T policies flatten it**.

FIGURE 86 : COMPARISON OF UTILITY AND SIZE OF THE CHE AND CH+T CITIES



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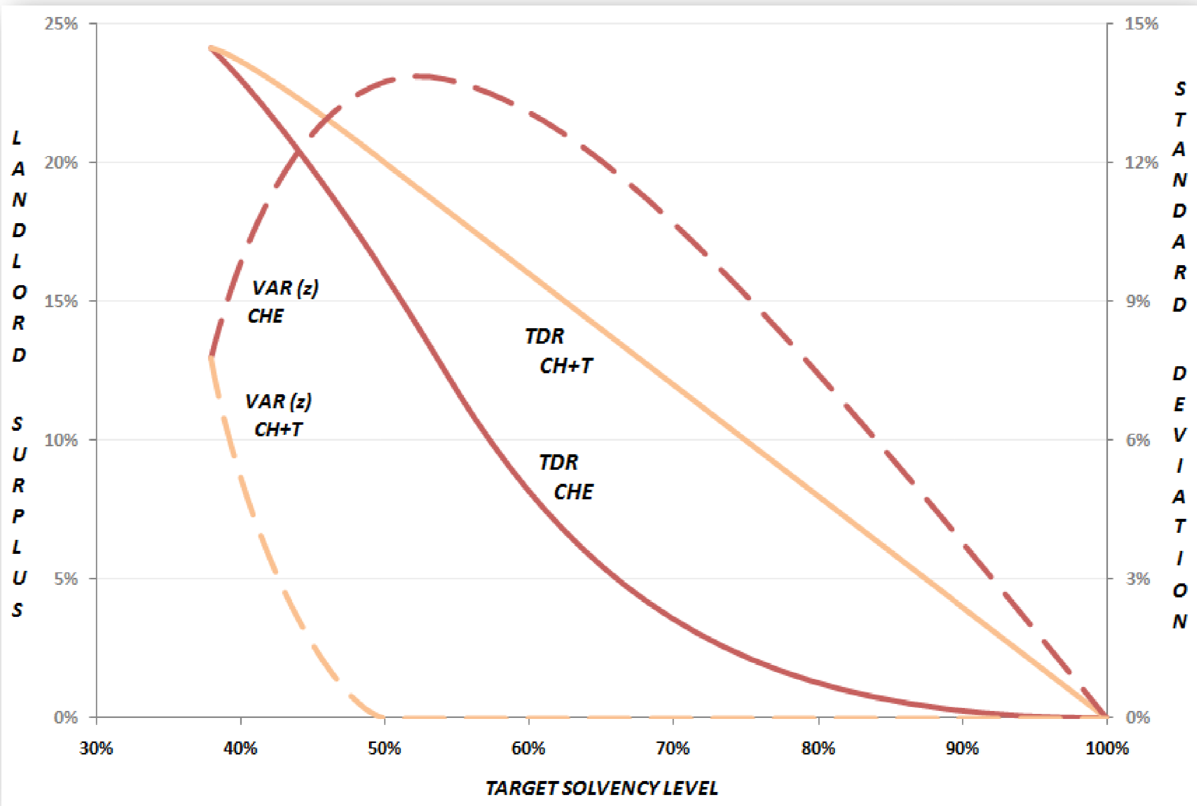
[2] In other words, I perform a scaling from α to $\lambda_{HE}(\alpha) = \int_0^{\widetilde{r_f}} n(r)\tilde{z}(r,\tilde{u}(\alpha))dr\,/NY$, *idem* for μ. Obviously $\lambda_{HE}(x) \neq \lambda_{H+T}(x)$. This measure provides a good common proxy for the intensity of the constraint. In addition, the primary aim of CHE and CH+T policies is to secure solvency, making this measure meaningful. Correspondence between constraint parameters and target solvency level (λ) is illustrated in *Figure E*.

Secondly, CH+T policies are less detrimental to landlords than CHE ones (*Figure 87*). In sum, **the "cost" of the policy is more equally shared between households and landowners in CH+T policies**. By adding transport costs to the residential equation, households can cope with the constraint by reducing their housing consumption, but also by moving closer to the CBD. This second possibility mitigates the impact on housing prices.

Lastly, **CH+T measures are more relevant to protect household solvency than CHE ones** (*Figure 87*). For a same target solvency level, CH+T policies greatly reduce $Var(z)$, meaning that households are close to this level. Conversely, the distribution of z is more spread with CHE measures, meaning that a sizable share of households still present a substantial risk of housing default (relatively to the target value).

To sum it up, the linear city model suggests that moderate CHE policies are beneficial to households, detrimental to landlords, reduce city size (and thus transport costs), and somehow improve household solvency. On the other hand, CH+T measures make a better tool to struggle against urban sprawl and solvency issues, and are less costly to landlords. Since the model does not consider externalities such as pollution or congestion, nor oil scarcity, a CH+T measure might prove a better choice than a CHE one depending on the local authorities' objectives, and this in spite of utility considerations.

FIGURE 87 : COMPARISON OF TDR AND VAR(Z) FOR CHE AND CH+T CITIES



CHE/CH+T VS. AL/APL

Parallel to CHE measures, a system of housing benefit was created in France to improve the solvency and well-being of modest households. Consisting of two complementary schemes, the *Allocation de Logement* (AL) and *Aide Personnalisée au Logement* (APL), the main characteristics of this system are as follows:[3]

- Eligibility is based on income requirements.
- Benefit amount depends on household income, household size, and housing costs (monthly rent or monthly payments in the case of home buyers);
- Benefits are capped, the maximum varying with location (France is divided in several zones that take the level of housing prices into account).

As noted above, housing benefits were primarily intended to decrease the housing burden of low-income households. Yet, a known drawback of benefit schemes is that **when supply is inelastic, the whole benefit of the policy is transferred to suppliers**. Unfortunately, the French housing market might well fit in this case, and Fack (2005) indeed showed that most of APL/AL end up in the landlords' pockets, who have thus all the reason to be pleased by such a policy.

Let us examine the APL/AL system in the light of the monocentric framework. Two simplifications are made:[4]

- The benefit amount is given by a function $f(h)$ which strictly increases then is constant for $h \geq h_0$, where h is the amount $R(r)s$ of housing expenses.
- No income requirement is considered.

Given this specification, one can show that the relative impact on the boundary rent curve fades with distance, that is, $R_E^{APL}(x)/R_E(x)$ decreases with x and tends toward 1. To prove this point, let us first note that the housing expenditure does not vary with utility in our linear city model, and is equal to $1/2\big(Y - T(x)\big)$ at location x. As a result, the farther a household is located, the less benefit it receives. Secondly, the household housing consumption at the city edge $s\big(x, U(x)\big)$ increases with x.[5] Combining these two elements yields the desired property, which will soon prove useful.

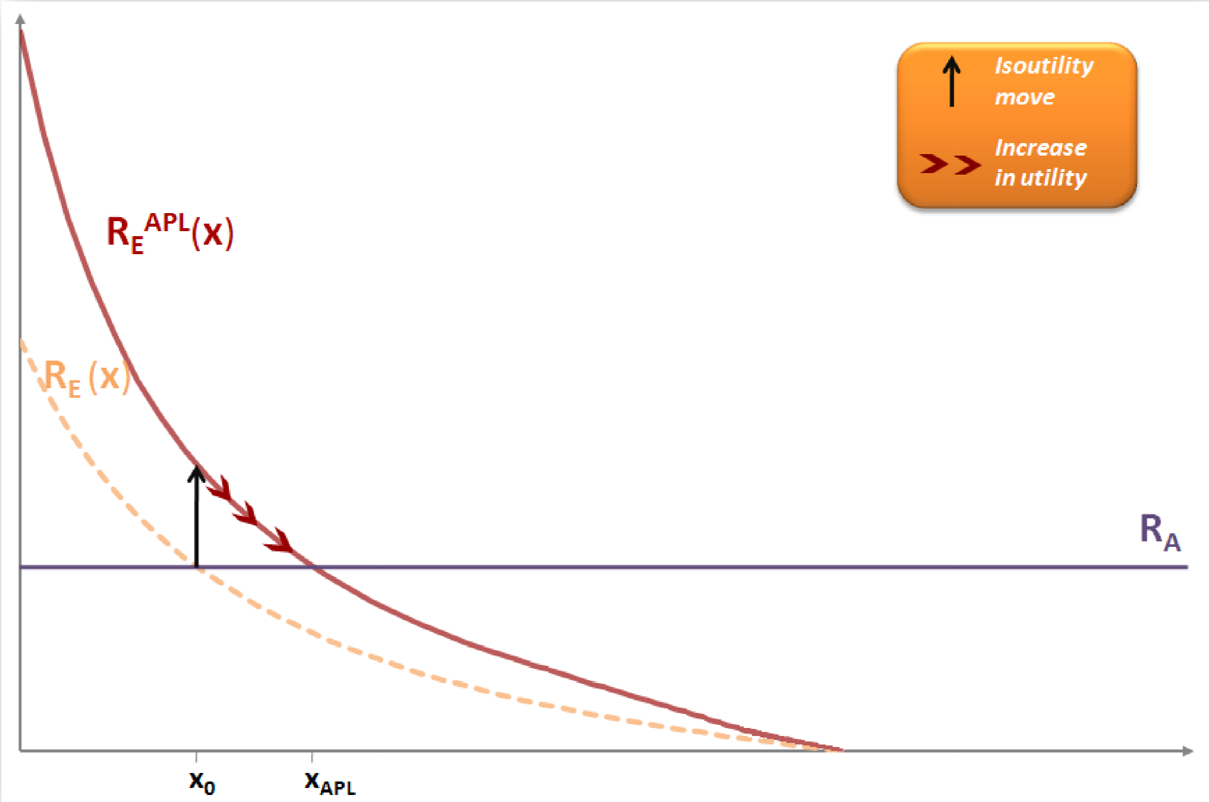
In our linear city, **implementing a housing benefit system raises household utility**, a phenomenon illustrated and explained in *Figure 88*. However, the above consideration entails that **the greater the city size, the lower the impact on utility**, as supply expands less. Considering the size of the Greater Paris Region, this tale may well

[3] → *Chapter 0*, section *I* for more details on this point.

[4] A more detailed and realistic analysis would require representing various income classes. While this could be the object of a future work (cf. C*onclusion*), this is not the object here, and I only purport to provide an initial insight.

[5] Remember that $s(r, u)$ increases with r and u, and that $U(x)$ increases with x.

FIGURE 88: IMPACT OF THE HOUSING BENEFIT SYSTEM ON THE EQUILIBRIUM LAND-USE



Starting from the former equilibrium $(u = U(x_0),\ r_f = x_0)$, we introduce the housing benefit system. This leads to the new boundary rent curve $R_E^{APL}(x)$. Under the housing benefit system, landlords "mimic" the benefit scheme, but "negatively". To be specific, housing prices rise so that benefits being deduced, the household is left as before. This gives birth to the isoutility move represented by the black arrow. However, the rise in housing prices leads landlords located beyond x to enter the "competition for households", hence the move along the boundary rent curve and the resulting increase in utility.

be consistent with the results of Fack (2005). Furthermore, assuming that utility does indeed barely increase, the equilibrium rent curve would progressively internalize housing benefits, meaning that **the impact on the housing burden would be marginal** in the end.

What happens if we were to represent the housing industry to be even more realistic? As discussed above, housing benefits increase profitability in every location, but the relative gain decreases with distance. As a consequence, one **density would rise** throughout the city, two the density curve **would steepen**. This additional expansion of housing supply through a density effect would further increase household utility, but again insomuch that supply is elastic.

In sum, housing benefit schemes might not be as good as they come to decrease the housing burden of low-income households, and **CHE or CH+T policies** could prove to be **better alternatives in the long run**, the choice between the two depending on whether one focuses on household well-being or on household solvency.

EXTENSIONS

When discussing the scope of the study (→ *0*), the absence of the housing industry was underlined as being a major limitation, because it does not allow for supply-based retroactions. In addition, the linear city model studied in section *IV* has two drawbacks: the assumption of a linear city is not realistic, and the elasticity terms of the log-linear utility function are both set to ½.

To address these various shortcomings, a more sophisticated model is developed featuring a **housing industry** *à la* Muth, a **2-dimensional city**, and a **more general utility function** $U(z,s)= \beta \log z + (1- \beta) \log s$. This section primarily aims to ascertain whether the main findings remain valid under these new specifications. The influence of two newly-introduced parameters, namely β and land elasticity γ, is also explored.

Subsection *0* presents the extended model and the methodology applied to the ensuing analysis. To disentangle the roles of the various modifications, each issue is then analyzed incrementally in subsection *0*.

MODEL AND METHODOLOGY

The disk-shaped city model *à la* Muth

The extended model features the following upgrades:

- Land supply is now given by $L(r) = 2k\pi r$, corresponding to a discoid city. [1]
- The specification of the utility function allows for any constant value of elasticity, i.e. $U(z,s) = \beta \log z + (1 - \beta) \log s$;
- A housing industry produces housing services q following a standard Cobb-Douglas production function $F(K,L) = K^{\gamma} L^{1-\gamma}$, using capital K and land L as inputs. Human labor is not represented. Cost of capital is r_k. Similarly to land, the price of housing services varies with location and is noted $R_H(r)$.

This new specification entails far more complex calculations and relatively cumbersome formulae. Furthermore, **no closed form** exists neither for $(\tilde{u}, \tilde{r}_f)$ nor for $(\hat{u}, \hat{r}_f)$, making comparative statics tedious, and compelling to a numerical analysis. These elements, combined to the fact that the main results are overall relatively unaffected by these modifications, motivated the choice of a linear city model in the main analysis.

[1] This specification is often referred to as the "pie-shaped city" case. Personally, I advise the reader to just consider that supply is reduced in every location by a factor *k*, a fraction *1-k* being used for other purposes.

Methodology

Derivation of equilibrium land-use conditions under CHE and CH+T measures are provided in *Appendix C*. Given that no closed-form solution exists for these equations, I developed Visual Basic routines based on the native solver of Excel 2007 to find the roots of the corresponding systems.[2]

The ensuing analysis focuses on the reference model.[3] A general analysis would have been preferable, but was not feasible given the complexity of the extended model. Parameter sensitivity was tested and results were found to be robust, which inclines me to say that the below results may be reckoned as general.

Lastly, in most of the comparative statics that follow, changing the value of the parameter of interest modifies the **baseline**, defined by the land-use equilibrium of the unconstrained situation (α=0 or μ=0). For example, modifying β in the utility function alters equilibrium utility levels, and in particular that of the unconstrained situation, all other things being equal. To erase this artifact, **variations relatively to the baseline** replace absolute values when relevant.

VALIDATION OF RESULTS IN A MORE REALISTIC SET-UP

The three improvements to the basic model are studied incrementally, starting with the modification of $L(r)$, then the introduction of a flexible elasticity β in the utility function, and lastly the representation of the housing industry.

From a linear to a discoid city

Though considering a disk-shaped city instead of a linear one does not change the fundamentals of the model, **it does alter the relative distribution of land supply**. When $L(r) = 2k\pi r$, corresponding to the 2-dimensional case with circular symmetry (equal infinitesimal amount of supply kdr in each point), suburban areas are endowed with more supply than central areas in relative terms as compared to the linear case, which might affect the results.

To make the comparison easier between the linear and the two-dimensional case, k is chosen so as to equal equilibrium utility in both cases' baselines. This calibration gives k=0.065984, which yields e^{2u}=16 for α=0 and μ=0 in the 2-dimensional setting. This way, it matches the equilibrium utility of the reference model for the unconstrained linear city (→ *Figure 72*).

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[2] Though neither the most efficient nor fastest solver, Excel proved largely sufficient plus convenient to use.

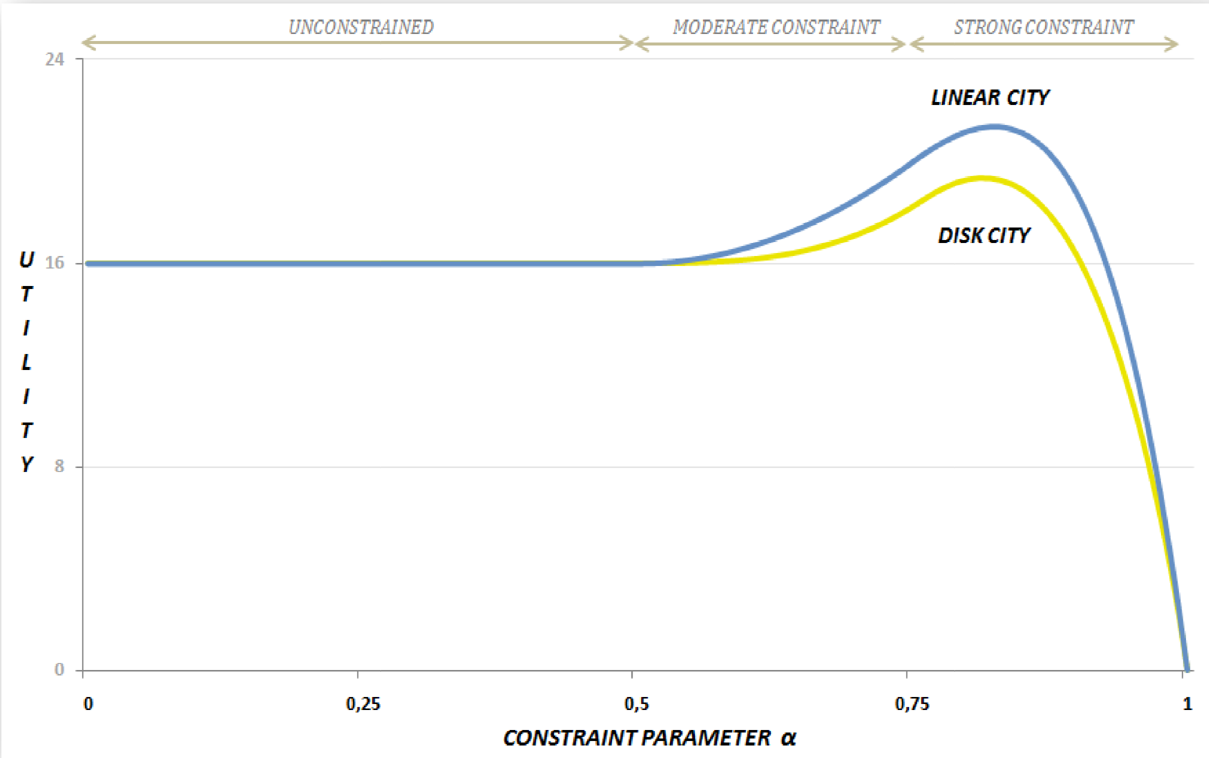
[3] For reminder, this model features the following parameter settings: $N = 10$, $Y = 80$, $a = 8$, and $R_A = 20$.

The CHE case

Given this adjustment, it turns out that considering a disk-shaped city instead of a linear one does not alter the general shape of the equilibrium utility curve in the CHE case. However, it does **reduce the impact of the policy** (*Figure 89*). This may be naturally explained, as land supply is scarcer near the CBD in the 2-dimensional case, thereby reducing the extent of the downward pressure on housing prices.

The impact on land-use is more complex. An initial analysis shows that city size decreases less rapidly in the 2-dimensional context (*Figure FF*). However, land supply is commensurate with $\tilde{r}_f$ in the linear case, whereas it is with $\tilde{r}_f{}^2$ in the 2-dimensional setting. To take this point into account, an additional analysis with respect to the relative decrease in urban land area is provided (also in *Figure FF*). Unlike previously, two situations arise: reduction in urban land area is greatest in the linear city for low values of α, but greatest in the disk-shaped city for high values of α.[4]

FIGURE 89: LINEAR VS. DISK-SHAPED CITY, CHE CASE



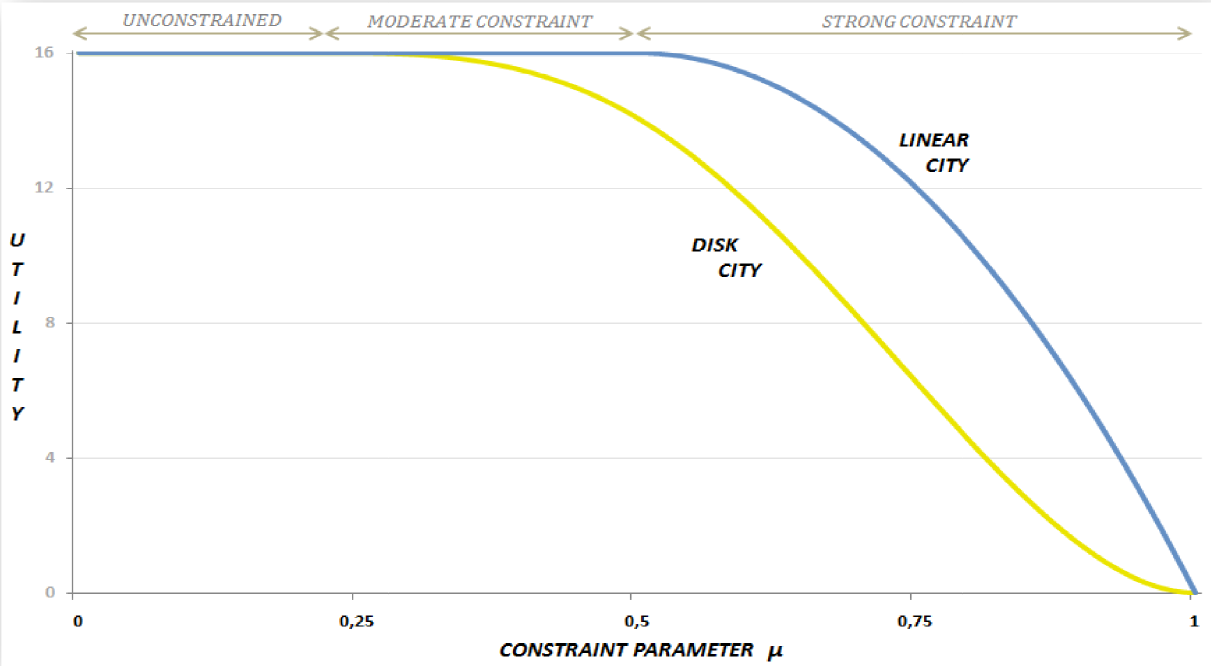
For this analysis as well as all following ones, e^{2u} is represented instead of the nominal utility u, for better lisibility as well as coherency with respect to the linear case.

[4] This inversion probably mirrors two antagonistic elements: in the 2-dimensional setting, housing prices decrease less in the vicinity of the CBD than in the linear case (since utility is smaller), resulting in smaller lot sizes. On the other hand, land supply is scarcer near the CBD, meaning that fewer households are affected. Depending on the value of α, the former or the latter effect would prevail. This point was not clearly established though.

The CH+T case

The main findings of the linear model remain once again mostly unaffected. However, this time **the impact is amplified** in the 2-dimensional setting as regards utility as well as urban land area (*Figure 90*, *Figure GG*). This is actually fairly intuitive as CH+T policies firstly affect suburbanites, more numerous in disk-shaped cities (in relative terms).

FIGURE 90: LINEAR VS. DISK-SHAPED CITY, CH+T CASE



Introducing a flexible elasticity in the utility function

The second tested extension allows for a flexible elasticity β in the utility function, which becomes $U(z,s) = \beta \log z + (1-\beta) \log s$. Otherwise, the city remains 2-dimensional and the same value of k is kept.

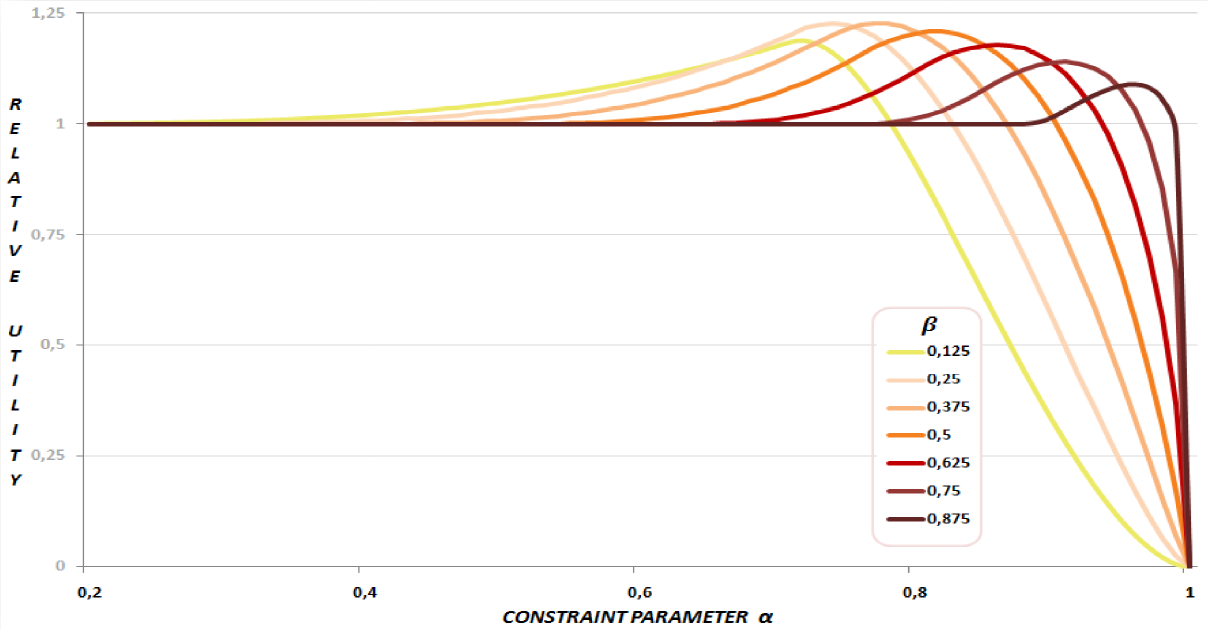
The CHE case

The analysis of the influence of β on the equilibrium utility curve brings three points to light (*Figure 91*):

- utility curves have shapes similar to the linear case;
- α_{max} increases with β;
- the gain relatively to the baseline $(e^{2\tilde{u}(\alpha_{max})}/e^{2\tilde{u}(0)})$ increases then decreases with β.

The first observation is not surprising considering proposition 3, and the fact that changing the value of β would not fundamentally modify economic forces at work, but rather their magnitude. Point 2 is also intuitive since raising β shifts the curve to the right. The last element is on the other hand puzzling, and still unaccounted for.

FIGURE 91 : INFLUENCE OF β ON EQUILIBRIUM UTILITY CURVES, CHE CASE

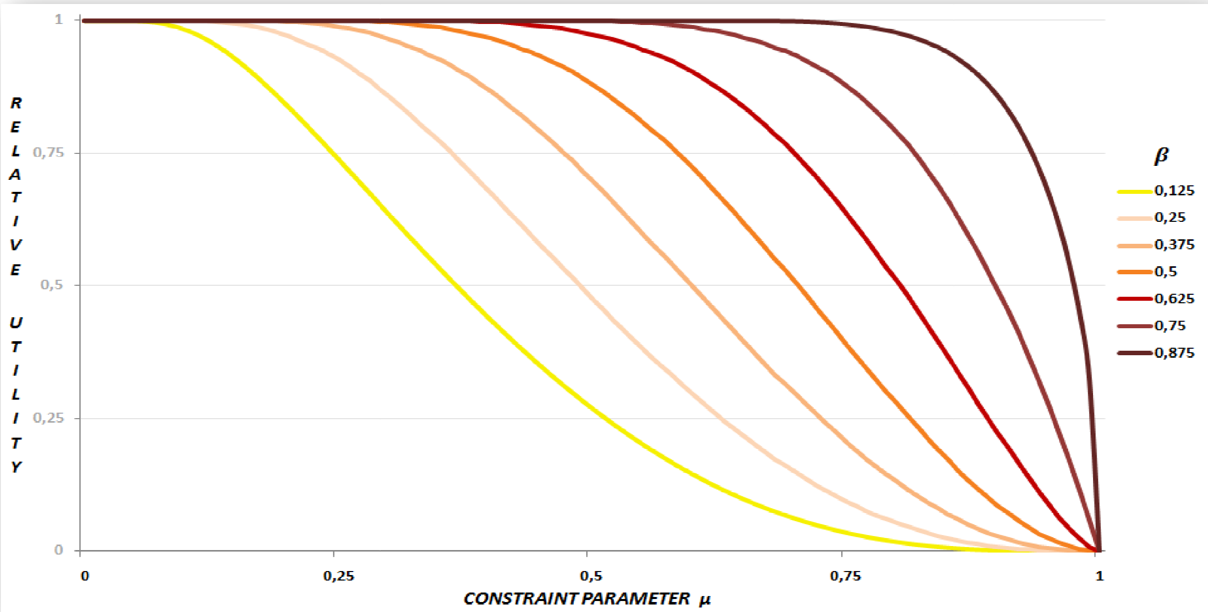


City size analysis corroborates the hypothesis that the **disk-shaped city case with flexible elasticity remains similar in essence to the linear case**. City size curves show the same ternary pattern of constancy, moderate decrease, and the fall (*Figure HH*). The greater β, the later city size starts decreasing with α, which is fairly straightforward.

The CH+T case

Unlike the previous case, nothing special can be noticed besides the fact that moving β shifts the curve accordingly (and that the main findings of the linear model hold).

FIGURE 92: INFLUENCE OF β ON EQUILIBRIUM UTILITY CURVES, CH+T CASE



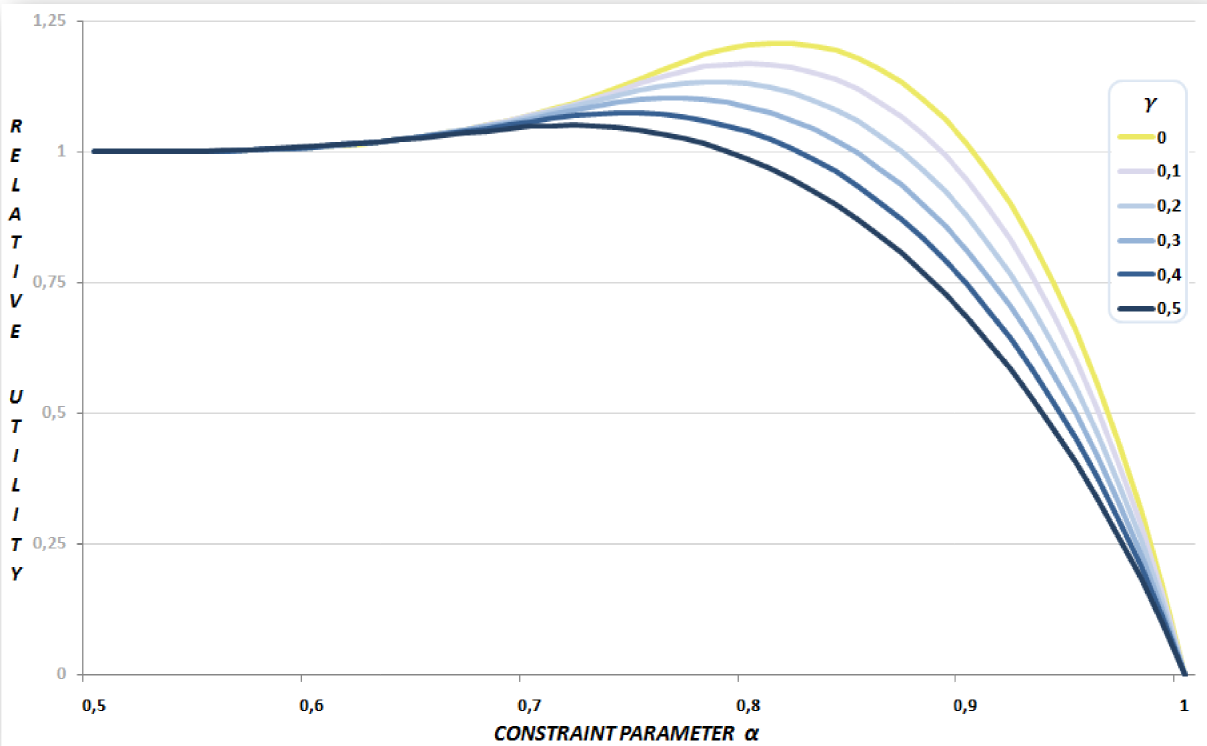
The housing industry and supply-based retroactions

The last extension intends to represent the housing industry, in the line with Muth's works (Muth 1969). Cost of capital is arbitrarily set to $r_k = 50$ in the following analyses (the choice of the value does not significantly affect results). The city remains disk-shaped with the setting $k = 0.065984$. Furthermore, β is reset to its default value ½, which will make the comparative analysis easier.

The CHE case

Once more, the representation of the housing industry does not invalidate the main findings of the linear city model. However, it does mitigate the impact of CHE measures. As γ grows, the maximum of the equilibrium utility curve decreases and shifts to the left. In other words, α_{max} and $\tilde{u}(\alpha_{max})$ both decrease with γ (*Figure 93*). This phenomenon may easily be understood: the housing industry reacts to demand variations accordingly, **inducing a supply-based retroaction that smoothes the impact of demand-based measures**. Here, CHE policies reduce housing prices, in particular near the CBD. Profits of the housing sector are consequently cut down, resulting in lower densities, especially in the central part of the city, and counteracting the downward pressure on prices. This has the twofold impact of lowering utility, and reducing city size (*Figure JJ*).

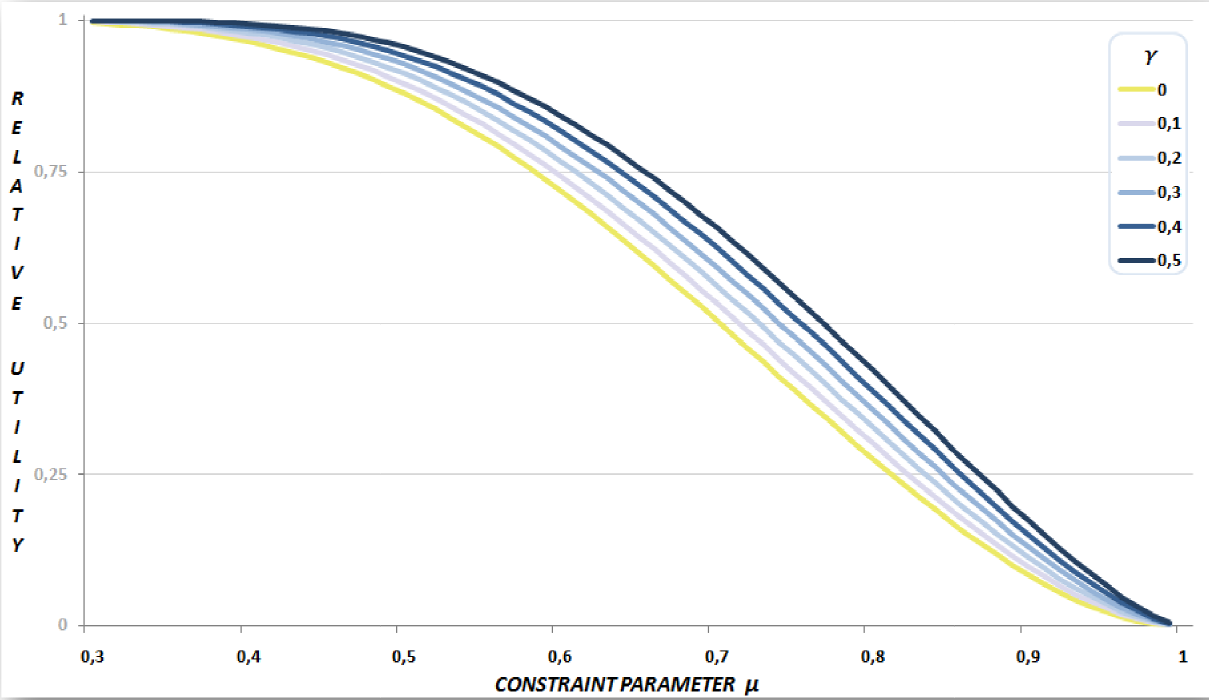
FIGURE 93: INFLUENCE OF γ ON EQUILIBRIUM UTILITY CURVES, CHE CASE



The CH+T case

The same phenomenon occurs in the CH+T case, the housing industry acting as a buffer and mitigating the impact of the measure. As a consequence, utility and city size both increase with γ, and seem to slowly converge toward the baseline (*Figure 94*, *Figure KK*).

FIGURE 94: INFLUENCE OF γ ON EQUILIBRIUM UTILITY CURVES, CH+T CASE



CONCLUSION

MAIN FINDINGS

Let us first recapitulate the main theoretical findings of this chapter:

- First, CHE and CH+T policies alike set **two economic forces** in motion: a reduction in the consumption of housing services (and of transportation for CH+T measures) and a downward pressure on housing prices.
- Secondly, as both forces decrease city size, **both policies reduce urban sprawl**. However, the two forces exert opposite effects on the household utility level, resulting in contrasting outcomes with regard to utility. Under plausible assumptions described in this chapter, **moderate CHE policies improve household well-being**, when **moderate CH+T policies are neutral** in this regard.
- Thirdly, CH+T policies are more appropriate to protect household solvency than CHE ones. The former raise the average level of solvency and homogenize the underlying distribution at the same time, whereas the latter focus on solvent households first.
- Lastly, CHE and CH+T measures not being efficient, they both involve a **hidden cost**. CHE policies essentially make landlords bear this cost, while CH+T policies impose a lesser burden on landlords. In all cases, **landlords are undoubtedly the great losers** of such measures.

IMPLEMENTING CHE OR CH+T POLICIES

A significant issue which has yet to be addressed is **how to implement these policies**. CHE measures are already enforced in France as well as in various other countries (→ *Introduction*). Therefore, one would only have to adapt the current regulation to change the level of α. The public acceptability of raising α, that is, to increase the constraint, remains dubious though. At first thought, understood when not taking equilibrium mechanisms into account, such a measure would seem detrimental to households. On the other hand, lowering α, i.e., alleviating the constraint, would be relatively easy. Considering this difficulty, **two alternatives** arise as substitutes of CHE measures:

- taxing the consumption of housing services, and restituting the subsequent revenue under the form of a lump-sum transfer equally shared among households;
- increasing income tax to subsidize the consumption of the z good.

As far as CH+T policies are concerned, the **LEM initiative** appears as a simple and efficient way to enforce such measures (→ *Introduction*). In addition, being based on incentives (get a bigger loan if you move in transit-friendly areas) and not on coercion, its acceptability is pretty well ensured. In the case of the private rental sector, income requirements could be relaxed in transit-friendly areas, or alternatively **the State could put up bond for households willing to locate in those areas**, and not for others.

Maybe the biggest problem of all would be the **impact on the housing industry**. While landlords in the Greater Paris Region enjoy a comfortable situation considering the long-term upward trend in housing prices and the structural lack of housing supply, there is indeed major need for new home construction. As the profitability of the housing industry is already burdened by the colossal cost of building land in the GPR, one should heed this issue when implementing CHE or CH+T policies.

FURTHER DEVELOPMENTS

A new tale for income sorting?

The theoretical framework developed in this chapter, including the basic model and its extensions, was shown to make an appropriate tool to study CHE and CH+T policies in a spatial equilibrium setting. Notwithstanding, several limitations were reported in *0*, **the most problematic of all being that of a single income class** ($\rightarrow c)$, same part). Since households allow a decreasing share of their earnings for housing as their income rises, low-income households are more likely to be constrained by CHE or CH+T policies than high-income ones. Consequently, two issues might arise:

- **Equity issues**: in a situation where affluent households would be less affected by the enforced policy (be it CHE or CH+T), these might exploit the decreased competiveness of more modest households to claim most of the benefits associated to the decrease of housing prices. It is not clear whether both income classes would still benefit from the policy, even in disproportionate ways, or if low-income households might even find themselves worse-off than before the measure due to this possibility of hold-up.
- The **reswitching phenomenon**: similarly, the previous context might alter spatial patterns of low- and high-income households, as a result of CHE and CH+T policies steepening bid-rent curves of low-income households primarily. In particular, part or all of high-income households could move near the CBD and evict low-income ones, meaning that configurations such as high-income, low-income, high-income (from core to periphery), would become a possibility. This gives another account of the reverse spatial patterns between European and American cities, at least for countries enforcing such policies (cf. Brueckner, Thisse, and Zenou 1999).

A preliminary analysis was carried out in a 2-income class setting, and was found to include the reswitching phenomenon as a possible equilibrium. Welfare analysis proves relatively complex however, and is still under way.

Empirical application to the Greater Paris Region

Another logical follow-through of this chapter would be to **test and apply theoretical findings to the Greater Paris Region**. As a matter of fact it is an especially fitting region for doing so, as it features very high housing prices (→ *Chapter 0*) and a strict regulation (→ *Introduction*). Consequently, as far as France is concerned, CHE measures should have the greatest extent there.

To perform this test, the 2006 edition of the Housing Survey is probably the best data source, as it includes detailed data regarding housing expenses, household income, and location (with troublesome confidentiality rules though). Furthermore, it has a quite satisfying sample size for a regional analysis (→ presentation in *Chapter 0*, section *III*). The EGT would have been an even better alternative considering the presence of transport variables, were it not for the insufficient data quality regarding housing expenditure and household income (→ *Chapter 2*). Similarly, the Family Budget Survey, another potential candidate, does not have enough observations for a spatial analysis in the GPR. Withal, **combining the 2006 Housing Survey with the results of *Chapter 2*** could surely lead to conclusive results as regards the relevance of applying the present theoretical framework to the Greater Paris Region.

ACKNOWLEDGMENTS

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ANNEX A - FIGURES

APPLICATION TO A LINEAR CITY

FIGURE AA: INFLUENCE OF α ON DENSITY, CHE LINEAR CITY MODEL

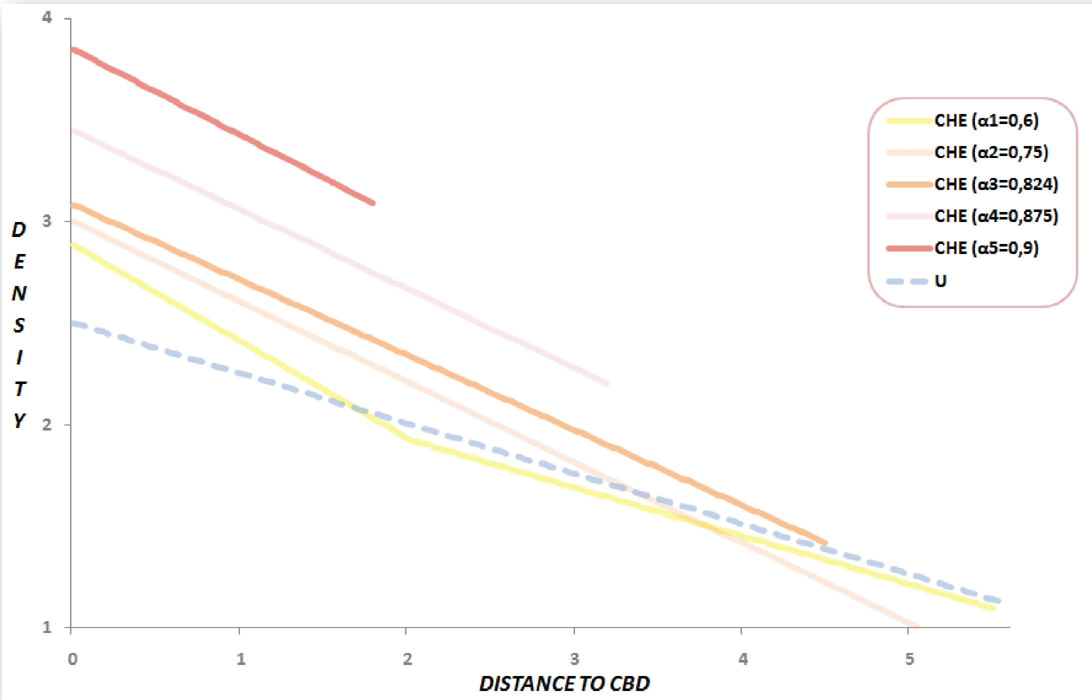


FIGURE BB: STANDARD DEVIATION OF THE *Z* GOOD CONSUMPTION *(IN % OF INCOME)*

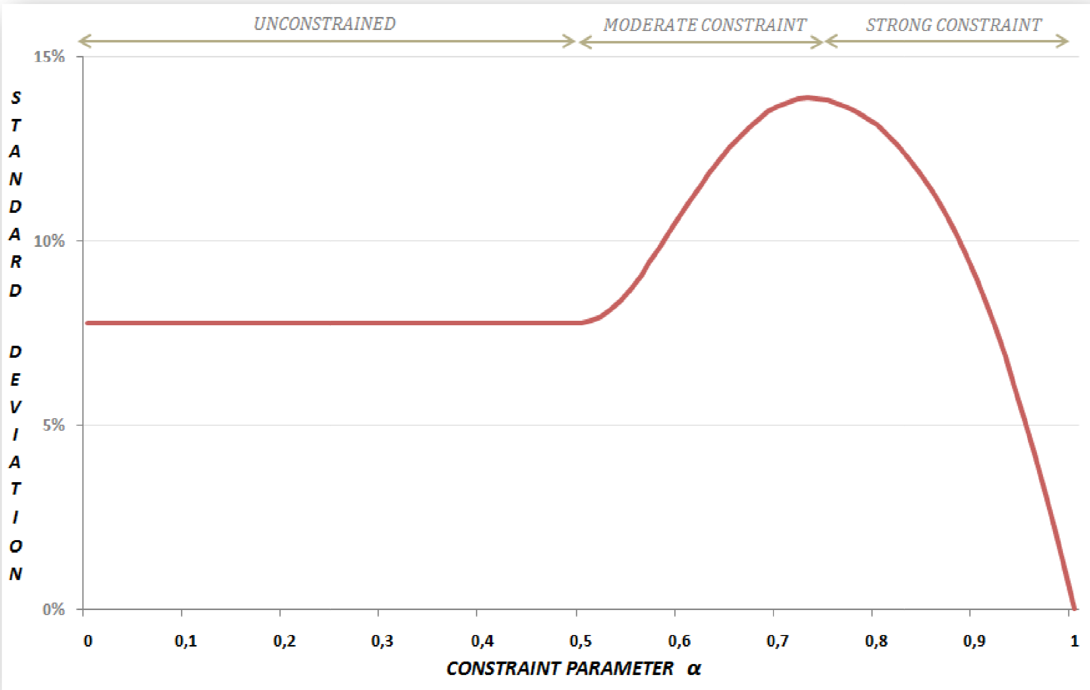


FIGURE CC: INFLUENCE OF μ ON EQUILIBRIUM DENSITY, CH+T LINEAR CITY MODEL

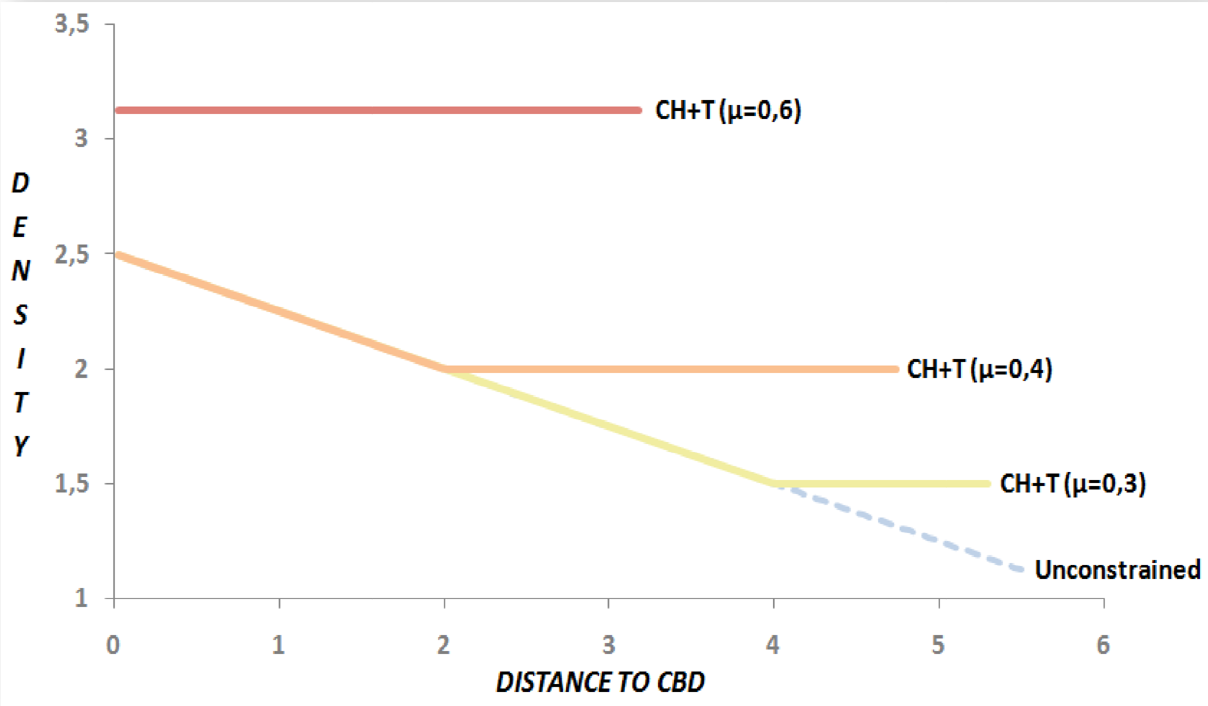
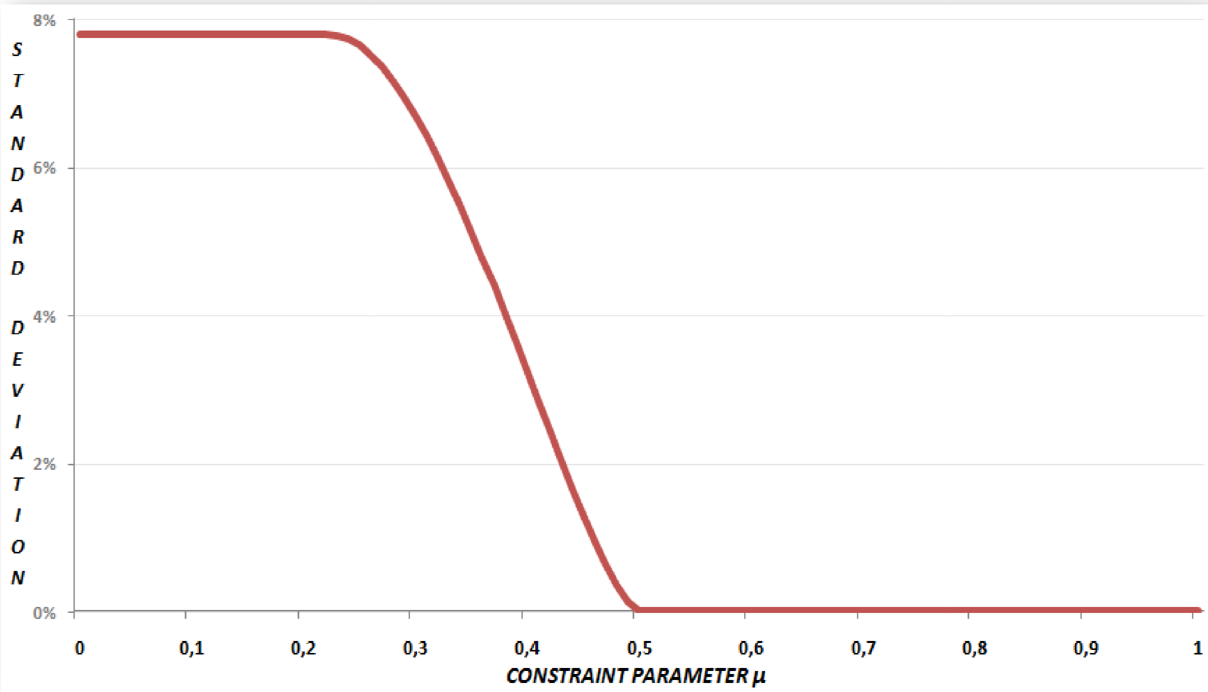
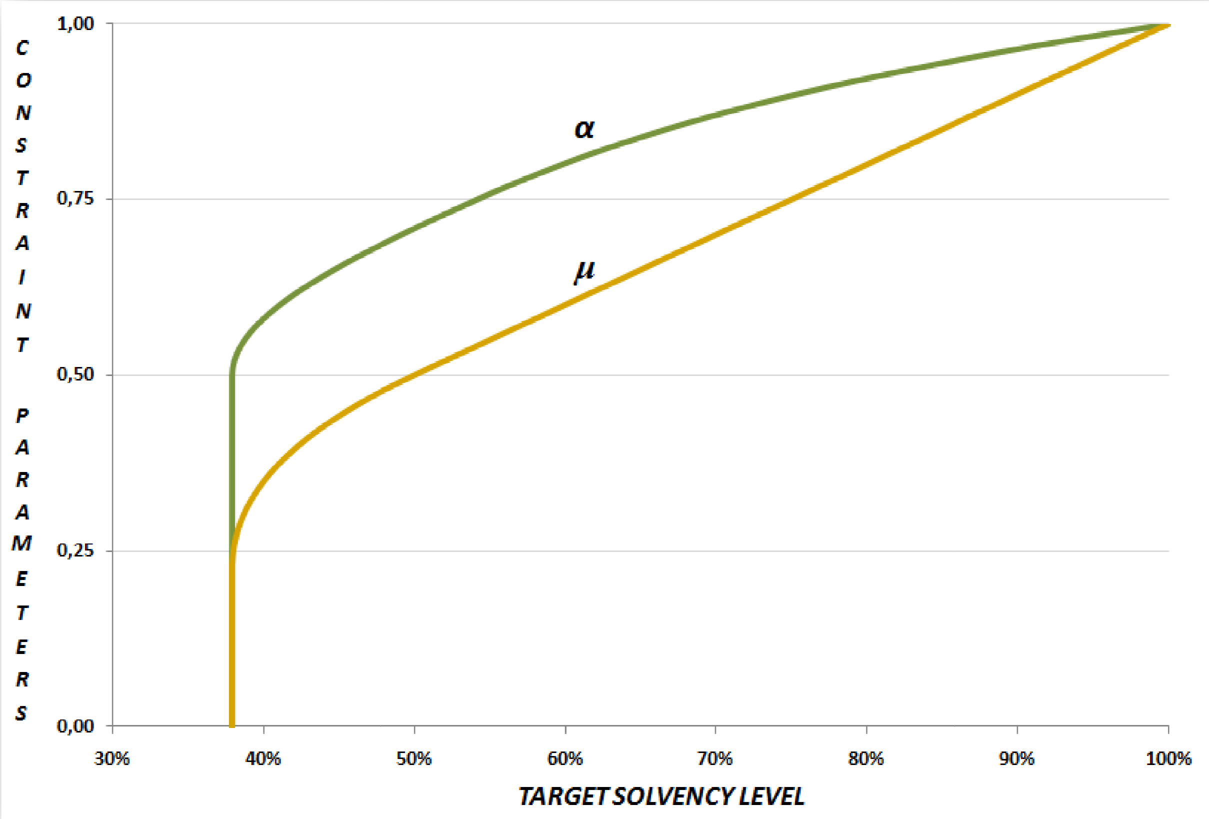


FIGURE DD: STANDARD DEVIATION OF THE Z GOOD CONSUMPTION *(IN % OF INCOME)*



DISCUSSION

FIGURE EE: CORRESPONDENCE TARGET SOLVENCY LEVEL ↔ CONSTRAINT PARAMETERS

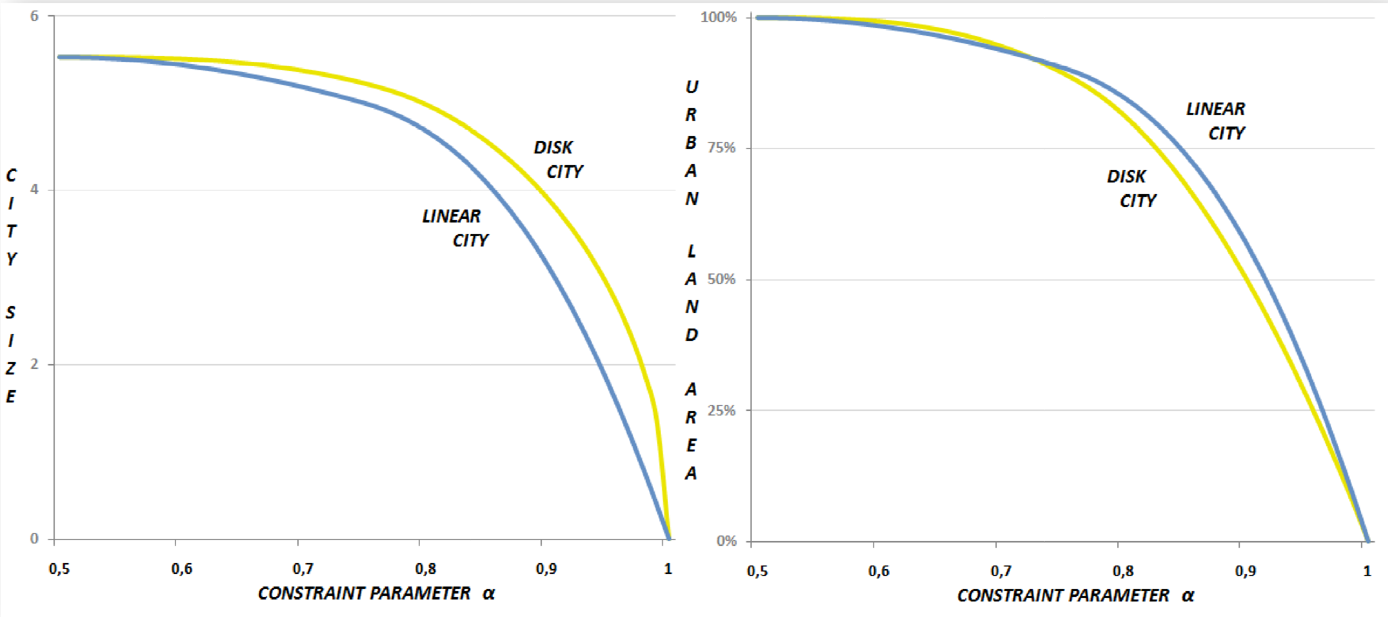


This figure should be read as follows: a target solvency level of 50% corresponds to an implicit value of μ equal to 0.5 in the CH+T reference model, and to an implicit value of α equal to 0.71 in the CHE reference model.

EXTENSIONS

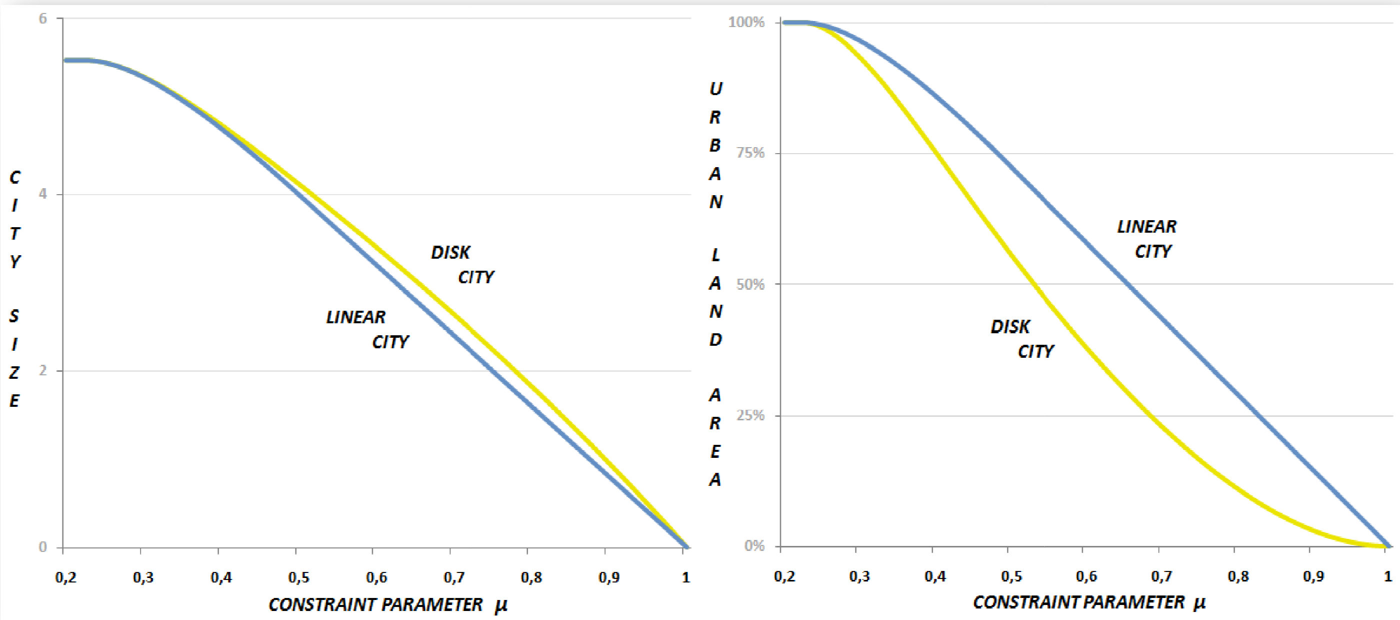
Linear vs. disk-shaped city

FIGURE FF: IMPACT OF CHE POLICIES ON CITY SIZE AND LAND SUPPLY
LINEAR VS. DISK-SHAPED CASE



For better lisibility, all curves start at $\alpha = 0.5$. $\alpha \leq 0.5$ being equivalent to the unconstrained case, all variables are constant on this interval. It is thus not represented for improved lisibility.

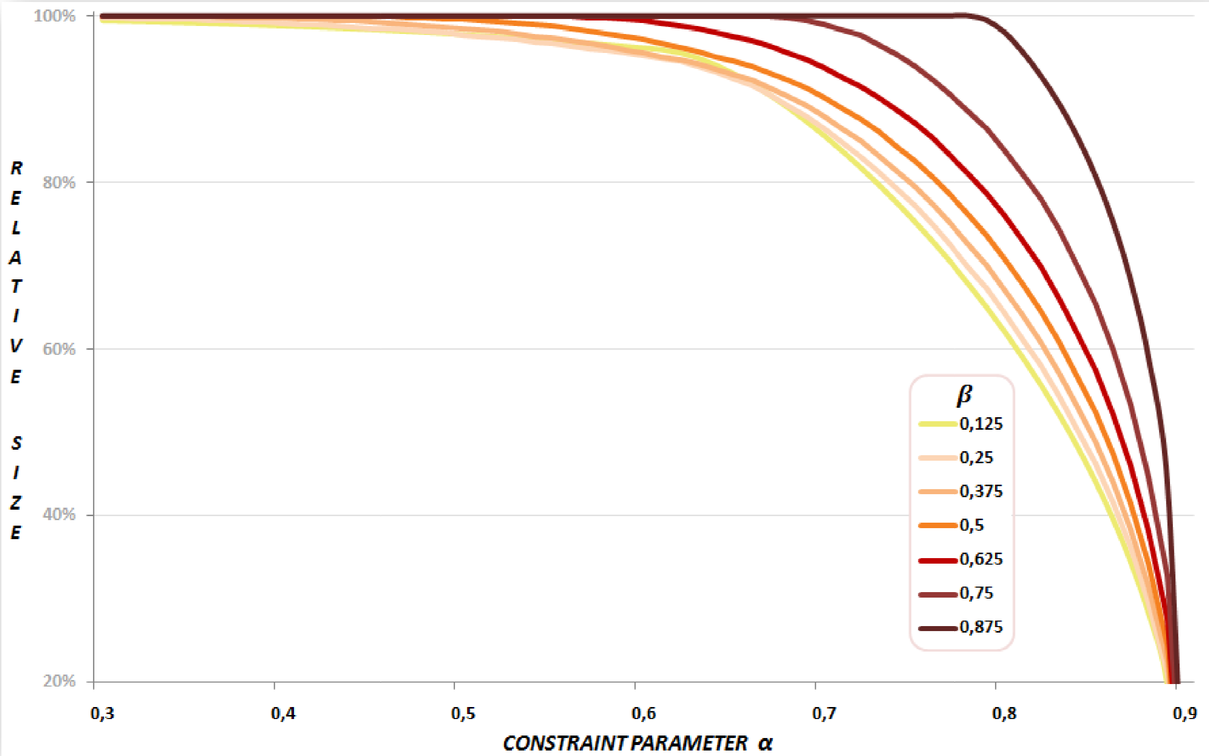
FIGURE GG: IMPACT OF CH+T POLICIES ON CITY SIZE AND LAND SUPPLY
LINEAR VS. DISK-SHAPED CASE



Idem, curves start at $\mu = 0.2$.

Flexible elasticity of substitution

FIGURE HH: INFLUENCE OF β ON CITY SIZE CURVES, CHE CASE



Curves are confounded for $\alpha \leq 0.3$ (being equal or almost equal to 1), idem for $\alpha \geq 0.9$ (falling toward 0).

FIGURE II: INFLUENCE OF β ON CITY SIZE CURVES, CH+T CASE

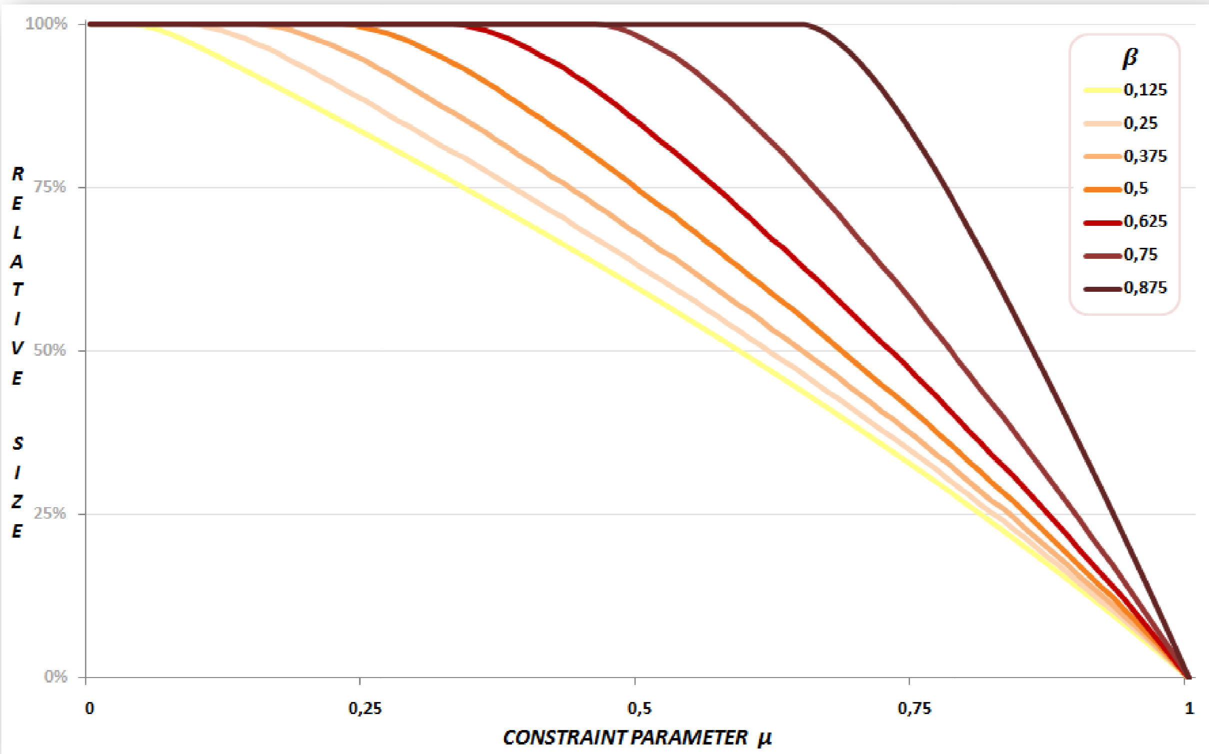
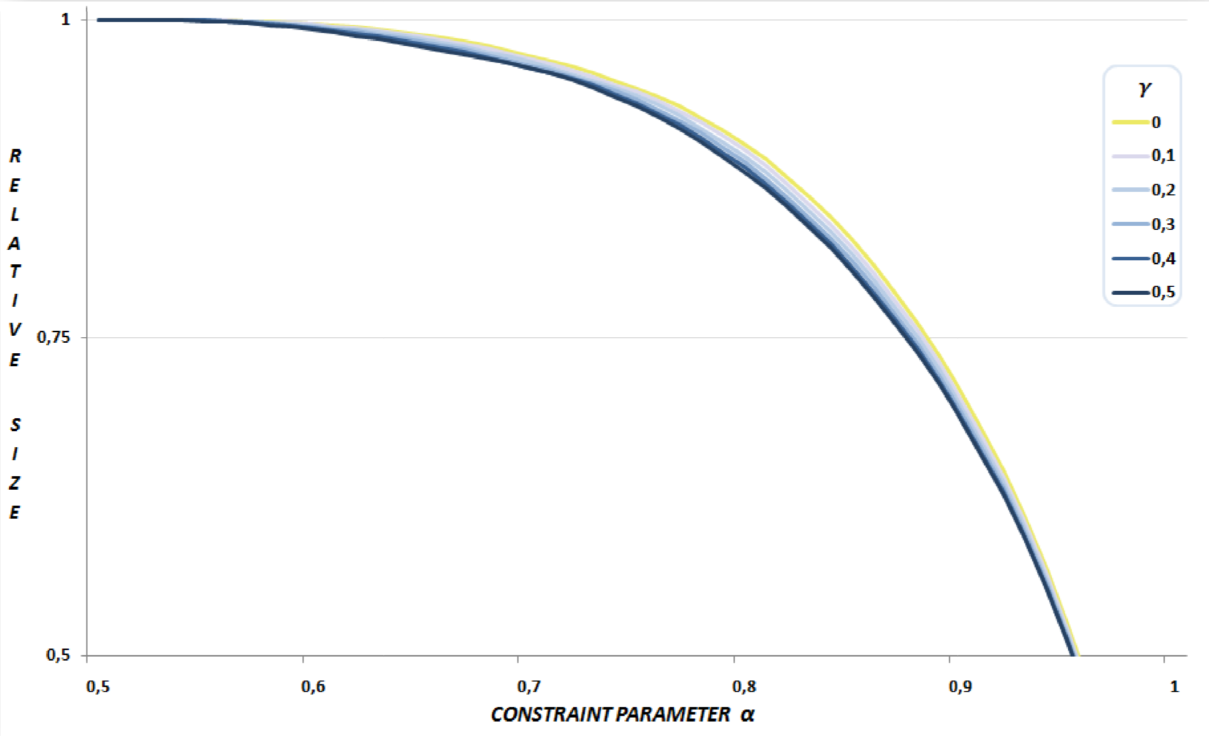
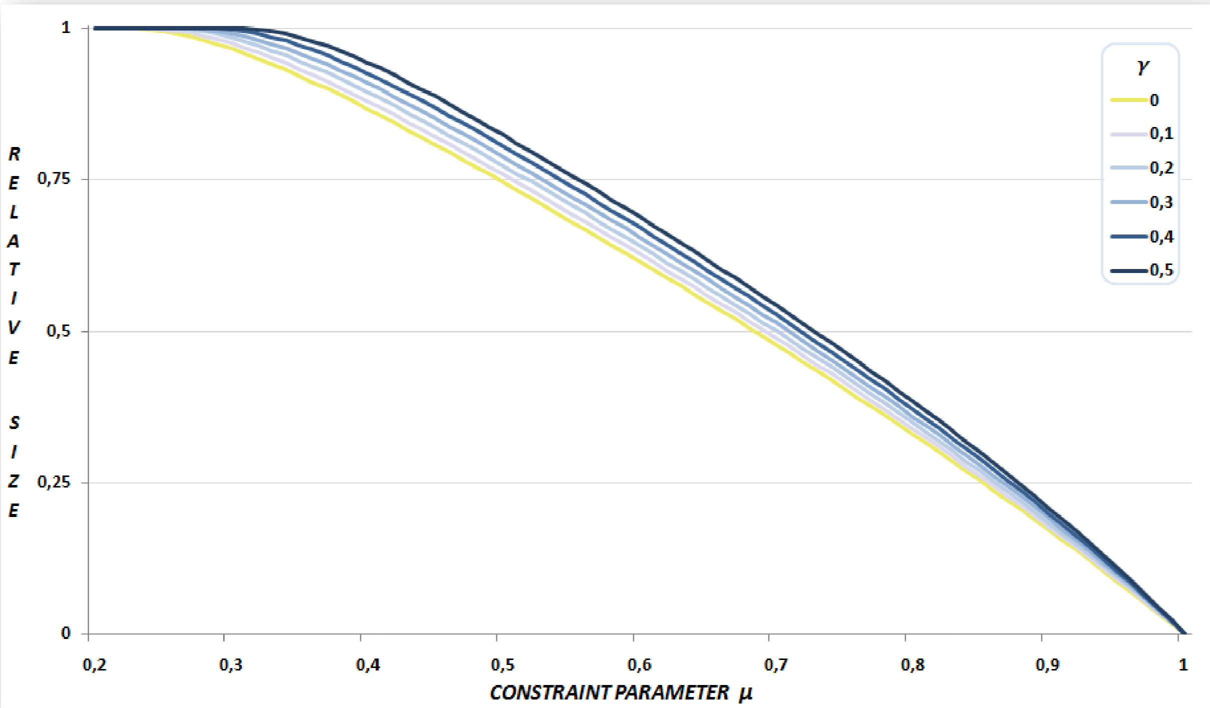


FIGURE JJ: INFLUENCE OF γ ON CITY SIZE CURVES, CHE CASE



Once again, please heed axes ranges, optimized for better lisibility. For values of α greater than 0.96 approximately (i.e. below what is represented), curves are almost confounded.

FIGURE KK: INFLUENCE OF γ ON CITY SIZE CURVES, CH+T CASE



Idem.

ANNEX B - PROOFS

THE CHE MODEL

PROOF OF PROPERTY 1

Demonstration of property 1 is straightforward:

- If $z(r,u) \geq \alpha Y - T(r)$ the CHE and unconstrained models yield identical solutions for the bid-max program, and $\tilde{z}(r,u) = z(r,u)$.
- If $z(r,u) < \alpha Y - T(r)$, the constraint (*E2*) is binding and $\tilde{z}(r,u) = \alpha Y - T(r)$.

This may be rewritten as $\tilde{z}(r,u) = max[z(r,u), \alpha Y - T(r)]$. From here, $\tilde{s}(r,u) = min[s(r,u), S(\alpha Y - T(r), u)]$ and $\tilde{\Psi}(r,u) = min[\Psi(r,u), (1-\alpha)Y/\tilde{s}(r,u)]$ are trivial considering that either we are faced with the unconstrained case or (*E2*) is binding.

APPLICATION TO A LINEAR CITY

The CHE linear city model

PROOF OF PROPOSITION 4

If $\alpha \leq 1/2$, we are faced with the unconstrained model. Since it can be treated as the special case $\alpha = 1/2$, I will not dwell on this matter.

This leaves $\alpha \geq 1/2$. Let us start by assuming that the whole city is constrained, which corresponds to $\tilde{r}_f(\alpha) \leq r_{bind}(\alpha)$. Using (*E9*), equilibrium conditions are given by:

$$e^{-2\tilde{u}}(1-\alpha)Y(\alpha Y - a\tilde{r}_f) = R_A \qquad \text{: boundary condition}$$

$$N = \int_0^{\tilde{r}_f} \frac{L(r)}{\tilde{s}(r,\tilde{u})} dr \qquad \text{: population constraint}$$

The population constraint can be restated as:

$$N = \int_0^{\tilde{r}_f} e^{-2\tilde{u}}\,(\alpha Y - ar)dr = \frac{e^{-2\tilde{u}}}{2a}\left[-(\alpha Y - ar)^2\right]_0^{\tilde{r}_f} = \frac{e^{-2\tilde{u}}}{2a}\left\{\alpha^2Y^2 - \left(\alpha Y - a\tilde{r}_f\right)^2\right\}$$

Using the boundary condition and noting $\tilde{Y} = e^{2\tilde{u}}$, we have:

$$N = \frac{1}{2a\tilde{Y}}\left\{\alpha^2Y^2 - \left(\frac{R_A\tilde{Y}}{(1-\alpha)Y}\right)^2\right\} \Leftrightarrow \frac{{R_A}^2}{(1-\alpha)^2Y^2}\tilde{Y}^2 + 2aN\tilde{Y} - \alpha^2Y^2 = 0$$

Since $\tilde{Y} > 0$, the only suitable solution to this 2nd degree equation is:

$$\tilde{Y} = \frac{(1-\alpha)^2Y^2}{{R_A}^2}\left(\sqrt{a^2N^2 + \left(\frac{\alpha}{1-\alpha}\right)^2{R_A}^2} - aN\right) = \frac{\alpha^2Y^2}{\sqrt{a^2N^2 + \left(\frac{\alpha}{1-\alpha}\right)^2{R_A}^2} + aN}$$

Lastly, substituting $\tilde{Y}$ in the boundary condition gives:

$$\tilde{r}_f = \frac{Y}{a}\left\{\alpha - (1-\alpha)\left(\sqrt{\left(\frac{aN}{R_A}\right)^2 + \left(\frac{\alpha}{1-\alpha}\right)^2} - \frac{aN}{R_A}\right)\right\}$$

Let us check the domain of validity of this solution, i.e. the set of α for which the assumption $\tilde{r}_f(\alpha) \leq r_{bind}(\alpha)$ is true:

$$\tilde{r}_f(\alpha) \leq r_{bind}(\alpha) \Leftrightarrow \sqrt{\left(\frac{aN}{R_A}\right)^2 + \left(\frac{\alpha}{1-\alpha}\right)^2} - \frac{aN}{R_A} \geq 1 \Leftrightarrow \alpha \geq 1 - \frac{1}{1+\sqrt{1+\frac{2aN}{R_A}}}$$

This corresponds to our condition $\alpha \ \geq \ \alpha_{cr}$.

Let us now assume $\tilde{r}_f(\alpha) \geq r_{bind}(\alpha)$. Equilibrium conditions become:

$$e^{-2\tilde{u}}\left(Y - a\tilde{r}_f\right)^2/4 = R_A \qquad \text{: boundary condition}$$

$$N = \int_0^{r_{bind}} \frac{L(r)}{\tilde{s}(r,\tilde{u})}dr + \int_{r_{bind}}^{\tilde{r}_f} \frac{-L(r)\tilde{\Psi}_r}{T'(r)}dr \qquad \text{: population constraint}^1$$

As previously, the population condition can be restated as follows:

$$N = \frac{1}{2a\tilde{Y}}\{\alpha^2Y^2 - (\alpha Y - ar_{bind})^2\} + \frac{\tilde{\Psi}(r_{bind},\tilde{u}) - R_A}{a}$$

Finally, using $\tilde{\Psi}(r_{bind},\tilde{u}) = (Y - ar_{bind})^2/4\tilde{Y}$ and $ar_{bind} = (2\alpha - 1)Y$ yields:

$$\tilde{Y} = \{(\alpha - 1/2)^2 + 1/4\}\frac{Y^2}{aN + R_A}$$

$$\tilde{r}_f = \frac{Y}{a}\left(1 - \sqrt{(2\alpha-1)^2+1}\sqrt{\frac{R_A}{aN+R_A}}\right)$$

We double-check the domain of validity of the assumption $\tilde{r}_f \geq r_{bind}$:

$$\frac{Y}{a}\left(1\text{-}\sqrt{(2\alpha\text{-}1)^2+1}\sqrt{\frac{R_A}{aN+R_A}}\right) \geq (2\alpha\text{-}1)\frac{Y}{a} \Leftrightarrow 2\text{-}2\alpha \geq \sqrt{(2\alpha\text{-}1)^2+1}\sqrt{\frac{R_A}{aN+R_A}}$$

$$\Leftrightarrow 4aN(1-\alpha)^2 + 4R_A(1-\alpha) - 2R_A \geq 0 \Leftrightarrow \alpha \leq 1 - \frac{1}{1+\sqrt{1+\frac{2aN}{R_A}}}$$

This is indeed equivalent to $\alpha \ \leq \ \alpha_{cr}$.

[1] In the unbinding zone $\tilde{\Psi}_r = -\frac{T'(r)}{\tilde{s}(r,\tilde{u})}$.

PROOF OF PROPERTY 2

Proof of property 2 revolves around the use of proposition 4. Let us start by considering the case $R_A > 0$. Continuity of $\tilde{u}(\alpha)$ is ensured inside each interval given that all formulae are continuous functions, and it is easily checked in $\alpha = \alpha_{cr}$. For $\alpha = 1$, $\widetilde{\Psi}(r,u) = 0$ implies $\tilde{u}(1) = -\infty$ (no equilibrium) since $R_A > 0$. It is easy to show that $\tilde{u}(\alpha) \xrightarrow[\alpha \to 1^-]{} -\infty$, so in this acceptance $\tilde{u}(\alpha)$ is continuous on $[1/2; 1]$.

Now, still according to proposition 4:

$$\alpha \in [1/2; \alpha_{cr}] \Rightarrow e^{2\tilde{u}} = \{(\alpha - 1/2)^2 + 1/4\}\frac{Y^2}{aN + R_A}$$

$\tilde{u}(\alpha)$ strictly increases on $[1/2;\ \alpha_{cr}]$, where $\alpha_{cr} \in]1/2; 1[$. Since $\tilde{u}(\alpha)$ is continuous on $[1/2;\ 1]$, there exists $\alpha_{max} \geq \alpha_{cr}$ for which $\tilde{u}(\alpha)$ is maximal.

Showing $\alpha_{max} > \alpha_{cr}$ is not straightforward, for determining the sign of $d\tilde{Y}(\alpha)/d\alpha$ turns out to be quite tedious. In particular, solving $d\tilde{Y}(\alpha)/d\alpha = 0$ cannot be achieved analytically. However, one can show that $\left(d\tilde{Y}(\alpha)/d\alpha\right)_{\alpha=\alpha_{cr}} > 0$. To do so, first derive the 2nd degree equation checked by $\tilde{Y}(\alpha)$ on $[\ \alpha_{cr}; 1]$, and from there, substituting α_{cr} by its value does the deal.

In the special case $R_A = 0$, the city edge is always located in the farthest feasible location $r_{max} = Y/a$. Considering the definition of α_{cr}, $\alpha_{cr} = 1$ ensues, meaning that $e^{2\tilde{u}} = \{(\alpha - 1/2)^2 + 1/4\}\frac{Y^2}{aN+R_A}$ holds true on [1/2;1[. $\tilde{u}$ is consequently maximal when α tends toward one, with the following limit:

$$\lim_{\alpha \to 1^-} \tilde{u}(\alpha) = lnY - 1/2ln(2aN)$$

Since no equilibrium occurs when $\alpha = 1$, the exact maximum cannot be reached through a classic decentralized equilibrium.

PROOF OF PROPERTY 3, 4 & 5

The following table provides the expressions of H, T, and Z, denoting total expenditure for the housing, transportation, and composite good, respectively. Total differential land rent TDR is obtained by subtracting the opportunity cost of the land covered by the city to H. Lastly, $Var(z)$ is computed as $\mathbb{E}(z^2) - \mathbb{E}(z)^2$.

Properties 3, 4, and 5 can then be established by deriving the adequate formulae.

	$1/2 \leq \alpha \leq \alpha_{cr}$ MODERATE CONSTRAINT	$\alpha_{cr} \leq \alpha \leq 1$ STRONG CONSTRAINT
H	$\left\{\alpha^2 + \frac{(1-\alpha)^2}{3}\right\} \frac{(1-\alpha)Y^3}{2a\tilde{Y}} - \frac{R_A(Y - a\tilde{r}_f)}{3a}$	$N(1-\alpha)Y$
T	$NY - H - Z$	$N\alpha Y - Z$
Z	$\{\alpha^3 + (1-\alpha)^3\}\frac{Y^3}{3a\tilde{Y}} - \frac{R_A(Y - a\tilde{r}_f)}{3a}$	$\frac{(\alpha Y)^3 - \left(\alpha Y - a\tilde{r}_f\right)^3}{3a\tilde{Y}}$
Var(z)	$\frac{(\alpha Y)^4 + \left((1-\alpha)Y\right)^4}{4aN\tilde{Y}} - \frac{R_A{}^2\tilde{Y}}{2aN} - \left(\frac{Z}{N}\right)^2$	$\frac{(\alpha Y)^4 - \left(\alpha Y - a\tilde{r}_f\right)^4}{4aN\tilde{Y}} - \left(\frac{Z}{N}\right)^2$
TDR	$H - R_A\tilde{r}_f$	$H - R_A\tilde{r}_f$

The case $\alpha \leq 1/2$ is tantamount to $\alpha = 1/2$ in the "moderate constraint" case.

The CH+T linear city model

PROOF OF PROPOSITION 5

Let us start by assuming $\hat{r}_f \geq r_{bind}(\mu) \geq 0$: the H+T constraint is active everywhere except within radius $r_{bind}(\mu)$. Equilibrium conditions are:

$e^{-2\hat{u}}\mu Y\left((1-\mu)Y - a\hat{r}_f\right) = R_A$: boundary condition

$N = \int_0^{\hat{r}_f} \frac{L(r)}{\hat{s}(r,\hat{u})} dr$: population constraint

Using $\widehat{\Psi}_r(r,u) = -\frac{T\prime(r)}{\hat{s}(r,u)}$, the population constraint may be rewritten as:

$$N = \frac{\widehat{\Psi}(0,\hat{u}) - R_A}{a} \Rightarrow e^{2\hat{u}} = \frac{1}{4}\frac{Y^2}{aN + R_A}$$

Plugging this into the boundary condition thus gives:

$$\hat{r}_f = \frac{Y}{a}\left(1 - \mu - \frac{1}{4\mu}\frac{R_A}{aN + R_A}\right)$$

Let us determine the domain of validity of this solution. First, $r_{Bind}(\mu) \geq 0$ is equivalent to $\mu \leq 1/2$. $\hat{r}_f \geq r_{Bind}(\mu)$ is for its part equivalent to the following condition:

$$\frac{Y}{a}\left(1 - \mu - \frac{1}{4\mu}\frac{R_A}{aN + R_A}\right) \geq (1 - 2\mu)\frac{Y}{a} \Leftrightarrow \mu \geq \frac{1}{2}\sqrt{\frac{R_A}{aN + R_A}} = \mu_{cr}$$

Finally, one can easily rewrite the $\hat{r}_f$ formula as $\hat{r}_f = \frac{Y}{a}\left(1 - \frac{1}{2}\left(\frac{\mu}{\mu_{cr}} + \frac{\mu_{cr}}{\mu}\right)\sqrt{\frac{R_A}{aN+R_A}}\right)$, which is the required result.

The case $0 \leq \mu \leq \mu_{cr}$, tantamount to the unconstrained model, may be addressed by choosing $\mu = \mu_{cr}$ in above formulae.

This leaves only the case $\mu \geq 1/2$, corresponding to a city entirely constrained by the H+T capping, and characterized by the following equilibrium conditions:

$$e^{-2\hat{u}}\mu Y\left((1-\mu)Y - a\hat{r}_f\right) = R_A \qquad \text{: boundary condition}$$

$$N = \int_0^{\hat{r}_f} \frac{L(r)}{\hat{s}(r,\hat{u})}dr = \hat{r}_f \mu Y e^{-2\hat{u}} \qquad \text{: population constraint}$$

Plugging the population constraint into the boundary condition yields:

$$\frac{(1-\mu)Y - a\hat{r}_f}{R_A} = \frac{\hat{r}_f}{N} \Leftrightarrow \hat{r}_f = (1-\mu)\frac{Y}{a}\frac{aN}{aN+R_A}$$

Hence (population constraint): $\hat{u} = \mu(1-\mu)\frac{Y^2}{aN+R_A}$

PROOF OF PROPERTY 7, 8, AND 9

Once again, the following table provides all the necessary formulae to show the various results, which is each time achieved by deriving the corresponding formula.

	$\mu_{cr} \leq \mu \leq 1/2$ *MODERATE CONSTRAINT*	$\mu \geq 1/2$ *STRONG CONSTRAINT*
H	$(1-2\mu^3)\frac{Y^3}{12a\hat{Y}} - \frac{R_A}{2a}\{(1-\mu)Y - a\hat{r}_f\}$	$N\left\{(1-\mu)Y - \frac{a\hat{r}_f}{2}\right\}$
T	$(1-2\mu)^3\frac{Y^3}{2a\hat{Y}} + \frac{\mu Y a\hat{r}_f{}^2}{2\hat{Y}}$	$N\frac{a\hat{r}_f}{2}$
Z	$\left\{\frac{1}{12} + \frac{4}{3}\mu^3 - \mu^2\left(1 - \frac{a\hat{r}_f}{Y}\right)\right\}\frac{Y^3}{a\hat{Y}}$	$N\mu Y$
Var(z)	$\left\{\frac{1}{32} - \mu^3\left(1 - \frac{a\hat{r}_f}{Y}\right) + \frac{3}{2}\mu^4\right\}\frac{Y^4}{aN\hat{Y}} - \left(\frac{Z}{N}\right)^2$	0
TDR	$H - R_A\hat{r}_f$	$N\frac{a\hat{r}_f}{2}$

ANNEX C - FURTHER ANALYSIS AND RESULTS

THE CHE MODEL

Additional results relative to the spatial variations of $\tilde{\Psi}(r,u)$ and to the characterization of the binding zone $E_A(u,\alpha)$ complete the analysis of the CHE model in the general case.

The amended relation for the bid-rent function

Property A gives the partial derivative of $\tilde{\Psi}(r,u)$ with respect to r:

property A

$$\tilde{\Psi}_{\mathrm{r}}(r,u) = -\frac{T'(r)}{\tilde{s}(r,u)}\frac{\tilde{\Psi}(r,u)}{\Psi^*(r,u)} \qquad (E12)$$

where $\Psi^*(r,u) = -\frac{\partial Z}{\partial s}(\tilde{s}(r,u),\mathrm{u}) = \left\{-\frac{\partial S(\tilde{z}(r,u),\mathrm{u})}{\partial z}\right\}^{-1}$.

PROOF

There are three possible cases: $r \in \breve{E}_I(u)$, $r \in E_A(u)$, and $r \in E_I(u) - \breve{E}_I(u)$.

If $r \in \breve{E}_I(u)$ we are faced with the unconstrained model. Application of the envelop theorem gives (Fujita 1989, equation 2.27):

$$\tilde{\Psi}_r(r,u) = -\frac{T'(\mathrm{r})}{\tilde{s}(r,u)} = -\frac{T'(r)}{\tilde{s}(r,u)}\frac{\tilde{\Psi}(r,u)}{\Psi^*(r,u)}$$

since $\tilde{\Psi}(r,u) = \Psi(r,u) = \Psi^*(r,u)$ on $E_I(u)$.

If $r \in E_A(u)$, (*E2*) is binding. Partial derivation of $\tilde{\Psi}(r,u) = (1-\alpha)Y/\tilde{s}(r,u)$ gives:

$$\tilde{\Psi}_r(r,u) = -\frac{(1-\alpha)Y}{\tilde{s}(r,u)^2}\frac{\partial\tilde{s}(r,u)}{\partial r} = -\frac{(1-\alpha)Y}{\tilde{s}(r,u)^2}\frac{\partial\tilde{z}(r,u)}{\partial r}\frac{\partial S(\tilde{z}(r,u),u)}{\partial z} = \frac{(1-\alpha)Y}{\tilde{s}(r,u)^2}T'(r)\frac{-1}{\Psi^*(r,u)}$$

Using again $\tilde{\Psi}(r,u) = (1-\alpha)Y/\tilde{s}(r,u)$, we eventually have:

$$\tilde{\Psi}_r(r,u) = -\frac{T'(r)}{\tilde{s}(r,u)}\frac{\tilde{\Psi}(r,u)}{\Psi^*(r,u)}$$

where $\Psi^*(r,u)$ is the land rent that rationalizes the choice of $(\tilde{z}(r,u),\tilde{s}(r,u))$ in the classic household consumer program under target utility u. When (*E2*) is strictly binding, bid rents are ranked in the following order: $\tilde{\Psi}(r,u) < \Psi(r,u) < \Psi^*(r,u)$.[2] *Figure* 69 provides a graphic interpretation of $\Psi^*(r,u)$: it is the absolute slope of the isoutility curve in $(\tilde{s}(r,u),\tilde{z}(r,u))$.

The last case $r \in E_I(u) - \breve{E}_I(u)$ can be dealt with based on continuity considerations.

[2] $\Psi(r,u) < \Psi^*(r,u)$ stems from the fact that $-\partial Z(s,u)/\partial s$ decreases with s.

The standard equation $\Psi_r(r,u) = -T'(r)/s(r,u)$ is amended by a factor $\widetilde{\Psi}(r,u)/\Psi^*(r,u)$ varying between 0 and 1, 1 being the unconstrained case. Considering the above comment on $\Psi^*(r,u)$, the more binding the HE constraint, the lower the distortion factor is.

Characterizing the binding zone

The analysis of the CHE model naturally raises the question of the specification of the binding zone, that is, the set of locations where households effectively have to limit their housing expenditure. Unfortunately, the monocentric city model gives no answer in the general case. As a matter of fact, **two economic forces counteract each other**. When a household gets farther from the city center, its housing consumption rises whereas equilibrium land rent decreases, hence indetermination regarding housing expenditure. Depending on household preferences, the binding zone can actually take many forms, such as a disk starting from the CBD, a ring starting from the city edge, or even a collection of scattered rings.

Despite this difficulty, various properties can be established. First, because $E_A(u)$ can be defined as $\{r: z(r,u) + T(r) - \alpha Y < 0\}$, the continuity of $z(r,u) + T(r) - \alpha Y$ ensures that $E_A(u)$ is an open subset of $[0; r_{max}]$. Likewise, $E_I(u)$ is a closed subset of $[0; r_{max}]$. Secondly, the constraint is never binding beyond a certain distance (defined by $T(r) = \alpha Y$), since remaining income becomes too low for households to violate the HE constraint. Lastly, proposition A gives a utility-based condition under which the binding zone has the shape of a disk.

proposition A

$$\forall s > 0, -\frac{Z_{ss}(s,u)s}{Z_s(s,u)} > 1 \Rightarrow E_A(u) \text{ is either empty or of the form } [0; r_{bind}(u)[.$$

PROOF

Let us first derive the unconstrained equilibrium housing expenditure with respect to *r*:

$$\frac{\partial\big(R(r)s(r,u)\big)}{\partial r} = -T'(r) + R(r)\frac{\partial s(r,u)}{\partial r} \qquad (E13)$$

Noting s_{Hicks} the compensated demand for land,[3] we have the following relationships:

- $\dfrac{\partial s(r,u)}{\partial r} = \dfrac{\partial s_{Hicks}(R(r),u)}{\partial r} = -\dfrac{T'^{(r)}}{s(r,u)}\dfrac{\partial s_{Hicks}}{\partial R}$
- $\dfrac{\partial s_{Hicks}(R(r),u)}{\partial R} = -\dfrac{1}{Z_{ss}(s(r,u),u)}$
- $R(r) = -Z_s(s(r,u),u)$

[3] Defined as the argmax $s_{Hicks}(R,u)$ of $\min_{z,s} z + Rs \ s.t. U(z,s) = u$.

Hence:

$$\frac{\partial\big(R(r)s(r,u)\big)}{\partial r} = -T'(r)\left\{1 + \frac{Z_s(s(r,u),u)}{Z_{ss}(s(r,u),u)}\right\} \qquad (E14)$$

Because $\forall s > 0$, $\frac{Z_s(s(r,u),u)}{Z_{ss}(s(r,u),u)} > 1 \Rightarrow \frac{\partial(R(r)s(r,u))}{\partial r} < 0$, proposition A is clear.

In the case of a log-linear utility function, that is, $U(z,s) = \gamma \log z + \beta \log s$, we have $-Z_{ss}(s,u)s/Z_s(s,u) = (\gamma+\beta)/\gamma > 1$, meaning that proposition A applies. All these elements tend to corroborate the **prevalence of disk-shaped binding zones**, except for very specific utility functions.

Comparative statics: the case of housing expenses

Analyzing the influence of α on total housing expenditure is actually not straightforward. Because raising α may lower utility, it can also possibly increase the housing costs of unconstrained households. Notwithstanding, proposition B indicates two instances when raising α unambiguously diminishes total housing expenses (= total land rent), and in one case total differential land rent (TDR).

For reminder, TDR is the sum of household housing expenses, to which has been deducted the opportunity cost of land:

$$TDR(\alpha) = \int_0^{\tilde{r}_f(\alpha)} L(r)\big(\widetilde{\Psi}(r,\alpha) - R_A\big)dr \qquad (E15)$$

proposition B

For any pair $\alpha_1<\alpha_2$ complying with $\tilde{u}(\alpha_1) \le \tilde{u}(\alpha_2)$, the overall amount $H(\alpha_1)$ of housing expenses in the α_1 city is greater than $H(\alpha_2)$. Similarly, $TDR(\alpha_1) \ge TDR(\alpha_2)$. Otherwise, if the α_1 city is entirely constrained, then $H(\alpha_1) > H(\alpha_2)$.

PROOF

Let us start with case one. $\tilde{u}(\alpha_1) \le \tilde{u}(\alpha_2) \Rightarrow \forall r\ \widetilde{\Psi}(r,\tilde{u}(\alpha_1),\alpha_1) \ge \widetilde{\Psi}(r,\tilde{u}(\alpha_2),\alpha_2)$ as $\widetilde{\Psi}$ decreases with both *u* and *α*. Moreover, $\tilde{r}_f(\alpha_1) \ge \tilde{r}_f(\alpha_2)$ (proposition 2), hence:

$$H(\alpha_1) = \int_0^{\tilde{r}_f(\alpha_1)} L(r)\widetilde{\Psi}(r,\alpha_1)dr \ge \int_0^{\tilde{r}_f(\alpha_2)} L(r)\widetilde{\Psi}(r,\alpha_2)dr = H(\alpha_2)$$

Considering that $\widetilde{\Psi}(r,\alpha_1) - R_A \ge \widetilde{\Psi}(r,\alpha_2) - R_A$, we also have $TDR(\alpha_1) \ge TDR(\alpha_2)$.

In the second case, all households are constrained in the α_1 city, hence in the α_2 city too. Therefore $H(\alpha_i) = N(1-\alpha_i)Y$ for $i = (1,2)$, and $H(\alpha_1) > H(\alpha_2)$. On the other hand, in $TDR(\alpha) = N(1-\alpha)Y - R_A \int_0^{\tilde{r}_f(\alpha)} L(r)dr$, both terms of the subtraction decrease with α, resulting in an indetermination regarding the sign of $TDR(\alpha_1) - TDR(\alpha_2)$.

Based on proposition B, one can note that raising α would rarely increase housing costs. To be more specific, under the conditions where proposition A applies, which are met for most utility functions, equilibrium utility starts by rising, and cannot fall unless the city is entirely constrained (based on proposition 3). Thus, application of proposition B implies that for "regular" utility functions, total housing expenditure decreases with α.

THE CH+T MODEL

Basic elements relative to the CH+T model are presented here, in analogy to *0*.

Bid rent function of the household

This time a "^" denotes the CH+T model. $\widehat{\Psi}(r,u)$ is defined as follows:

$$\widehat{\Psi}(r,u) = \max_{z,s}\left\{\frac{Y - T(r) - z}{s}\middle| \begin{array}{l} U(z,s) = u \\ z \geq \mu Y \end{array}\right\}$$

Once again, deriving the CH+T bid-rent maximization problem leads to the following solution:

property B

$$\begin{cases} \hat{z}(r,u) = \max[z(r,u), \mu Y] \\ \hat{s}(r,u) = \min[s(r,u), S(\mu Y, u)] \\ \widehat{\Psi}(r,u) = \min[\Psi(r,u), \{(1-\mu)Y - T(r)\}/\hat{s}(r,u)] \end{cases} \qquad (E16)$$

Determining the binding and feasible zones

Unlike the CHE case, characterizing the binding zone is simple: if not empty, this zone is a ring located in the outer suburbs, possibly encompassing the whole city. Property C reformulates this assertion, using notations similar to those exposed in section *II*.

property C

$E_A(u)$ is an interval of the form $]r_{bind}(u), r_{max}[$.

PROOF

This directly stems from the fact that $z(r,u)$ decreases with r. However, nothing can be said about variations of $r_{bind}(u)$ with u, for $z_u(r,u)$ is of indefinite sign.

In addition, the introduction of the H+T constraint alters the set of feasible locations, i.e. the set of locations where the household maximization problem has a solution. Indeed, if $T(r) > (1-\mu)Y$, the H+T constraint is automatically violated, implying that the farthest feasible location drops from r_{max} to $\hat{r}_{max}(\mu)$ defined by $T(\hat{r}_{max}(\mu)) = (1-\mu)Y$.

Properties of bid-max variables

Bid-max variables display exactly the same properties as in the CHE case. On the other hand, the standard relationship for Ψ_r holds if one uses new lot sizes:

property D

If $r \in [0, \hat{r}_{max}(\mu)]$ *then*:

$$\widehat{\Psi}_r(r,u) = -\frac{T'(r)}{\hat{s}(r,u)} \tag{E17}$$

PROOF

If $r \in \breve{E}_I(u) = [0, r_{bind}(u)[$ we are faced with the unconstrained model, see property A.

If $r \in]r_{bind}(u), \hat{r}_{max}]$, the H+T constraint is binding $\Rightarrow$ $\widehat{\Psi}(r,u)$=$\{(1$-$\mu)Y$-$T(r)\}/\hat{s}(r,u)$.

In addition, inside the binding zone $\frac{\partial \hat{s}(r,u)}{\partial r} = 0$. Derivation of $\widehat{\Psi}(r,u)$ thus gives:

$$\widehat{\Psi}_r(r,u) = -\frac{T'(r)}{\hat{s}(r,u)}$$

To end the demonstration, we can easily check that the relation holds in $r = r_{bind}(u)$ by showing that left-side and right-side derivatives are equal in this point.

Although we obtain the standard equation for $\widehat{\Psi}_r(r,u)$, one must keep in mind that unconstrained and constrained bid-max lot sizes differ inside the binding zone, with $\hat{s}(r,u) < s(r,u)$. Consequently, H+T policies steepen the bid-rent function.

EXTENSION: THE DISK-SHAPED CITY *À LA* MUTH

This part is dedicated to the derivation of equilibrium conditions for the discoid city including a housing industry *à la* Muth. For reminder, it features $L(r) = 2k\pi r$, $U(z,s) = \beta \log z + (1-\beta) \log s$, and $F(K,L) = K^\gamma L^{1-\gamma}$. It is dubbed Disctown for short. Calculations are skipped for the most part (they are relatively tedious), and the focus is put on the main steps leading to the final equilibrium conditions.[4]

Disctown under CHE measures

Derivation of equilibrium conditions now includes four steps: determining the binding zone, solving one the bid-max maximization problem, two the housing industry profit maximization problem, and lastly establishing equilibrium conditions.

[4] Detailed calculation steps are available on request.

Binding zone

In Disctown, the binding zone of the HE constraint is defined as follows:

$$r \leq r_{bind}(\alpha) = \frac{\alpha - \beta}{1 - \beta}\frac{Y}{a} \tag{E18}$$

Similarly to the linear city, the binding zone is a disk, which is not empty if and only if $\alpha \geq \beta$. Otherwise, the HE constraint is too weak and therefore effectless.

Bid-max variables

Solving the household bid-max maximization problem leads to the following formulae:

$$\begin{aligned}
r \leq r_{bind}(\alpha) &\begin{cases} \tilde{z}(r,u) = \alpha Y - ar \\ \tilde{s}(r,u) = e^{u/(1-\beta)}(\alpha Y - ar)^{-\beta/(1-\beta)} \\ \tilde{\Psi}(r,u) = e^{-u/(1-\beta)}(1-\alpha)Y(\alpha Y - ar)^{\beta/(1-\beta)} \end{cases} \\
r \geq r_{bind}(\alpha) &\begin{cases} \tilde{z}(r,u) = \beta(Y - ar) \\ \tilde{s}(r,u) = e^{u/(1-\beta)}\beta^{-\beta/(1-\beta)}(Y - ar)^{-\beta/(1-\beta)} \\ \tilde{\Psi}(r,u) = e^{-u/(1-\beta)}\beta^{\beta/(1-\beta)}(1-\beta)(Y - ar)^{1/(1-\beta)} \end{cases}
\end{aligned} \tag{E19}$$

The housing industry

The profit of the housing industry in developing land in location r is given by:

$$\Pi(K,L) = R_H(r)F(K,L) - r_K K - R(r)L \tag{E20}$$

Profit maximization involves the following first-order condition:

$$\left(\frac{K}{L}\right)^{\gamma} = \left\{\frac{\gamma R_H(r)}{r_K}\right\}^{\frac{\gamma}{\gamma'}} \tag{E21}$$

with $\gamma' = 1 - \gamma$. Furthermore, because of free-entry and perfect competition, the profit of the housing industry is null in every location, hence the additional condition:

$$R(r) = \gamma'\gamma^{\frac{\gamma}{\gamma'}}\frac{R_H(r)^{\frac{1}{\gamma'}}}{r_K^{\frac{\gamma}{\gamma'}}} \tag{E22}$$

The equilibrium land-use

In presence of the housing industry, equilibrium conditions become:

$$\begin{cases} \tilde{\Psi}(\tilde{r}_f, \tilde{u}) = R_H(\tilde{r}_f) \\ \int_0^{\tilde{r}_f} \frac{L(r)}{\tilde{s}(r,\tilde{u})} dr = N \end{cases} \tag{E23}$$

However, calculations are much more complex than in the linear city. In most cases, no closed-form solutions may be exhibited.

To be more specific, let us consider the two cases $\alpha \leq \alpha_{cr}$ and $\alpha \geq \alpha_{cr}$, starting with the latter.[5] For a wholly constrained city, equilibrium conditions become:

$$\begin{cases} \tilde{r}_f = \dfrac{\alpha Y - \tilde{Y}}{a} \\ \dfrac{\tilde{Y}^{2+K}}{2+K} - \alpha\dfrac{Y\tilde{Y}^{1+K}}{1+K} - \dfrac{a^2N}{2k\pi R_A}\gamma'\alpha' Y\tilde{Y}^K + \dfrac{(\alpha Y)^{2+K}}{(1+K)(2+K)} = 0 \end{cases} \tag{E24}$$

with $\tilde{Y}^{\frac{\beta}{\beta'}} = \frac{r_K{}^{\gamma}R_A{}^{\gamma'}}{\gamma^{\gamma}\gamma'^{\gamma'}\alpha' Y}e^{\frac{\tilde{u}}{\beta'}}$ as the main unknown, $\beta' = 1 - \beta$, and $K = \frac{\beta}{\beta'\gamma'}$. The form of the equation to solve in $\tilde{Y}$ involves only rare cases of closed-form solutions. One instance is the case $K = 1$, which yields a 3rd degree equation (cubic).

If $\alpha \leq \alpha_{cr}$, only the central part of the city is constrained, entailing the following equilibrium conditions:

$$\begin{cases} \tilde{r}_f = \dfrac{Y - \tilde{Y}}{a} \\ \left(\dfrac{\beta'\gamma' a^2 N}{2k\pi R_A} + \dfrac{Y}{1+K'}\right)\tilde{Y}^{1+K'} - \dfrac{\tilde{Y}^{2+K'}}{2+K'} = Y^{2+K'}\left\{\dfrac{1}{1+K'}\left(\dfrac{\alpha'}{\beta'}\right)^{1+K'} - \dfrac{1}{2+K'}\left(\dfrac{\alpha'}{\beta'}\right)^{2+K'} \dots \right. \\ \left. \dots + \beta^2\left[\dfrac{1}{(1+K)(2+K)}\left(\dfrac{\alpha}{\beta}\right)^{2+K}\left(\dfrac{\alpha'}{\beta'}\right)^{\frac{\gamma}{\gamma'}} + \dfrac{1}{2+K}\left(\dfrac{\alpha'}{\beta'}\right)^{2+K'} - \dfrac{1}{1+K}\left(\dfrac{\alpha}{\beta}\right)\left(\dfrac{\alpha'}{\beta'}\right)^{1+K'}\right]\right\} \end{cases} \tag{E25}$$

with $\tilde{Y} = \left(\frac{r_K{}^{\gamma}R_A{}^{\gamma'}}{\gamma^{\gamma}\gamma'^{\gamma'}}\right)^{\beta'}\frac{e^{\tilde{u}}}{\beta^{\beta}\beta'^{\beta'}}$, and $K' = \frac{\beta}{\beta'\gamma'} + \frac{\gamma}{\gamma'} = K + \frac{\gamma}{\gamma'}$. Closed-form solutions are also few, and once again include $K' = 1$ as a cubic. In all other situations, one has to resort to numerical analysis to find the roots of the above system.

Disctown under CH+T measures

The approach is analogous to the CHE case.

Binding zone

Similarly to the linear case, the binding zone is either a ring or the whole city:

$$r \geq r_{bind}(\mu) = \frac{\beta - \mu}{\beta}\frac{Y}{a} \tag{E26}$$

If $\mu \geq \beta$, $r_{bind}(\mu) \leq 0$, which means that the CH+T policy affects the whole city. Otherwise, only suburban households are concerned (if any).

[5] Beware that the formula $\alpha_{cr} = 1 - \left(1 + \sqrt{\frac{2aN}{R_A}}\right)^{-1}$ is only valid for the linear case. I use here the general definition of α_{cr} as the value separating the entirely constrained case from the partly constrained one. Once again, computation of α_{cr} proves especially tedious and is not reported here.

Bid-max variables

Solving the bid-max maximization problem leads to following formulae:

$$
\begin{array}{ll}
r \le r_{bind}(\mu) & \begin{cases} \hat{z}(r,u) = \beta(Y - ar) \\ \hat{s}(r,u) = e^{u/(1-\beta)}\beta^{-\beta/(1-\beta)}(Y-ar)^{-\beta/(1-\beta)} \\ \hat{\Psi}(r,u) = e^{-u/(1-\beta)}\beta^{\beta/(1-\beta)}(1-\beta)(Y-ar)^{1/(1-\beta)} \end{cases} \\
r \ge r_{bind}(\mu) & \begin{cases} \hat{z}(r,u) = \mu Y \\ \hat{s}(r,u) = e^{u/(1-\beta)}(\mu Y)^{-\beta/(1-\beta)} \\ \hat{\Psi}(r,u) = e^{-u/(1-\beta)}(\mu Y)^{\beta/(1-\beta)}\left((1-\mu)Y - ar\right) \end{cases}
\end{array}
\tag{E27}
$$

The housing industry

Derivation is identical to the CHE case.

The equilibrium land-use

Like in the linear model, two cases arise. If $\mu \ge \mu_{cr}$, the whole city is constrained, which eventually leads to the following equilibrium conditions:

$$
\begin{cases} \hat{r}_f = \dfrac{\mu' Y - \hat{Y}}{a} \\ \dfrac{1}{1+\gamma'}\hat{Y} + \dfrac{\gamma'}{1+\gamma'}\mu'^{1+\frac{1}{\gamma'}}Y^{1+\frac{1}{\gamma'}}\hat{Y}^{-\frac{1}{\gamma'}} = \dfrac{a^2 N}{2k\pi R_A} + \mu' Y \end{cases}
\tag{E28}
$$

where $\hat{Y} = \frac{r_K{}^{\gamma} R_A{}^{\gamma'}}{\gamma^{\gamma}\gamma'^{\gamma'}}\frac{e^{\hat{u}/\beta'}}{(\mu Y)^{\beta/\beta'}}$ and $\mu' = 1 - \mu$. When $\mu' = 1$ (no housing industry), the system can be rewritten as $\pi R_A \hat{r}_f{}^2 + aN\hat{r}_f = (1-\mu)NY$, which is readily interpretable: housing plus transportation costs equate the maximum authorized budget per household times household population.[6]

If $\mu \le \mu_{cr}$, only suburban households are constrained. This yields the following equilibrium conditions:

$$
\begin{cases} \hat{r}_f = \dfrac{\mu' Y - \hat{Y}}{a} \\ \dfrac{Y^{1+\frac{1}{\gamma'}}}{\hat{Y}^{-\frac{1}{\gamma'}}}\left\{\dfrac{\beta'^{K'-K}}{\gamma'}\left(\dfrac{\beta}{\mu}\right)^{K}\left[\dfrac{1}{(1+K')(2+K')} + \dfrac{\left(\frac{\mu}{\beta}\right)^{2+K'}}{2+K'} - \dfrac{\left(\frac{\mu}{\beta}\right)^{1+K'}}{1+K'}\right] + \mu'\left(\dfrac{\mu\beta'}{\beta}\right)^{\frac{1}{\gamma'}} - \dfrac{\left(\frac{\mu\beta'}{\beta}\right)^{1+\frac{1}{\gamma'}}}{1+\gamma'}\right\} \ldots \\ \ldots + \dfrac{\hat{Y}}{1+\gamma'} = \dfrac{a^2 N}{2k\pi R_A} + \mu' Y \end{cases}
\tag{E29}
$$

where $\hat{Y} = \frac{r_K{}^{\gamma} R_A{}^{\gamma'}}{\gamma^{\gamma}\gamma'^{\gamma'}}\frac{e^{\hat{u}/\beta'}}{(\mu Y)^{\beta/\beta'}}$.

---

[6] Indeed, because lot size is constant in this case, total housing plus transport costs are given by the sum of the opportunity cost of land and of the quantity $aN\hat{r}_f$, which encompasses transport costs and total differential land rent.

GENERAL CONCLUSION

EXPOSITION (AMBIVALENCE)

Housing demand in economics: looking for the superstring

Housing has given birth to an extremely rich body of literature in economics, a part of which, the one dealing with housing demand, has been reviewed in *Chapter 1*, *section I*. This specific section of the housing economic literature covers a **wide range of topics**, including for instance the decision to move, the choice of housing tenure, or segregation. Specific theoretical frameworks exist for each one of these issues, sometimes completed by a dedicated econometric literature as is the case with hedonic analysis.

Research in housing economics is far from its completion, however, inasmuch as there is nothing near a unifying theory tying all works together. As discussed in *Chapter 1*, one can identify **four key topics** in the literature (omitting the **home search process**):

- **residential mobility**;
- the **level of housing consumption**;
- the **choice of dwelling characteristics**;
- the **location choice**.

Then, one can easily notice that **no theory covers all these topics** at the present day. The monocentric city model focuses on location and the choice of housing quantity, and disregards the three other items. Hedonic analysis addresses from two to three elements depending on the extent to which location is considered. And one could go on and on with all remaining theories. In sum, each of the theoretical frameworks is generally a powerful analytical tool in itself, but with a restricted scope.

In addition, models of urban economics are often **criticized for lacking in realism** as compared to the alleged complexity of urban systems. The recurrent debate about the validity of the monocentric city model in current metropolitan areas, in which job decentralization has mitigated the importance of traditional Central Business Districts, marks the epitome of a fracture between theorists on the one side, and practitioners and politicians on the other side, little convinced about this radically simplified framework. True, the relevance of economic models does not have to be questioned insomuch that simplification is the very essence of modeling. If one wants to establish that a model is irrelevant, he must first show to what extent the simplification conditions the findings. Notwithstanding, at the present day it is clear that the urban economic literature can only provide but very general answers to land-use planners. In particular, the economic evaluation of a housing project is outside the scope of this field, seeing that it requires to probe issues ranging from a micro scale (e.g. the economic impact on the neighborhood) to a macro one (e.g., vacancy chains, impact on regional traffic and road congestion).

Housing in applied modeling: through the looking-glass

Among economic analytical frameworks, discrete choice theory should be singled out, however. It is arguably the more comprehensive and flexible theory, and thus the most apt to address the usual criticisms. In point of fact, this theory has rapidly become **omnipresent in applied modeling**, which now makes extensive use of multinomial logit models and their kinds (TRANUS and UrbanSim both illustrate this point tellingly).

Considering limitations inherent to standard economic models, LUTI models have endeavored to minutely describe the urban system, so as to allow a comprehensive evaluation of land-use and transport policies. Moreover, these models now aim to be able to assess policies ranging from large-scale ones to housing projects of moderate size, making them a "must have" tool for land-use planners.

In reaction to the strong criticism against mechanistic models such as the Garin-Lowry one, LUTI models have continuously **strived for more economic founding** and a **realistic representation of the whole residential process**. To achieve this goal, they have converged toward the following triptych:

- **micro-simulation**;
- **reductionism**;
- **discrete choice theory**.

Discrete choice theory is often assumed to be the guarantee of a sound micro-economic approach. Similarly, microsimulation supposedly ensures the realism of the model, *idem* for the breakdown of the residential process into a succession of elementary steps.

These points call for necessary caveats. Firstly, while the last two features appeal to the individualism of democratic societies and the limitation of the human mind to deal with organized complexity, the cogency of these choices has yet to be clearly established. It is frequently implied that the joint use of micro-simulation, cutting-edge econometric techniques, and a detailed representation of the residential process is bound to fare better than aggregate models. Yet the **descriptive, explanatory, and predictive powers of recent models are seldom tested or discussed**. In a way, dogma and technicism have taken over science in applied modeling. Secondly, the choice of discrete choice theory has fostered a complete reliance on econometrics. The counterpart is that most applied models do not have an underlying theory to support their representation of the residential process. Once again, economic forces have progressively and paradoxically been replaced by a mechanistic and statistical vision.

To my view, the way toward an improved representation of housing demand in applied modeling passes by a return to basics. Among other things, this involves a **better consideration of the budget constraint in the household maximization problem**.

FROM H&T BUDGET ITEMS TO RESIDENTIAL STRATEGIES, AN EMPIRICAL THEN THEORETICAL ANALYSIS (CLIMAX)

This dissertation has first intended to shed light on the role of various budget items in household residential strategies. It has then studied the impact of constraining two of these items, more specifically to cap either the H(ousing) or H+T(ransportation) burden. I am now going to summarize the main findings.

The role of housing and transport budgets in residential strategies: the case of the Greater Paris Region

Chapter 2 has investigated household residential strategies in the Greater Paris Region through the prism of housing and transportation budgets. The analysis has first shown that **households allow on average for a relatively constant share of their income to housing**. This share decreases with income, ranging from 19% for the upper tercile to 41% for the lower one. Home size rises with distance to the center of Paris, reflecting lower prices. However, household size rises at the same time, and all in all the **average surface area per person varies little with location**. Lastly, social renters bear lower burdens while enjoying similar levels of surface area per person.

Secondly, the **average transportation burden** (defined as the ratio between the transportation outlay and household income) **grows significantly with distance to the center of Paris**, ranging from 8% to 21% for the most remote areas. This mirrors both an **increased motorization** and a **more intensive use of the car**, which allow households to travel longer distances for identical daily travel times, but at the price of dangerously high transportation costs. Once again, lower-income brackets average higher burdens.

These various findings have lead me to formulate the following hypothesis, that **the household primary objective is to reach a certain level of "housing comfort"** (33m^2 per person or so), and that it allows for a constant share of its income to do so. Transport serves as a variable of adaptation to reach this goal, in the sense that **households opt for the best location possible in a certain radius around the workplaces of employed household members, in the limit of their target housing budget but whatever the transportation cost**. This radius is set in terms of travel time, hence the use of the car to access to more housing opportunities, even though these are remote from employment centers and entail heavy transport expenses.

Capping the housing burden vs. the housing + transportation burden, or the choice between a redistributive and a land-use policy

In the light of the results of *Chapter 2*, one might naturally wonder about the sustainability of living in remote areas of the GPR, considering the heavy H+T burden that it implies. Considering also the various claims that the policy capping the housing expense ratio is the main culprit in this case, I have endeavored to unravel this question by the use of an appropriate theoretical framework, namely the **monocentric city model**. This choice is especially cogent in this context as it allows me to consider the three key issues:

- the impact of the additional budget constraint on household consumption choices;
- how this impact varies with location;
- the reaction of supply and the effect on housing prices.

The theoretical analysis has first shown that each of the two considered measures, i.e. capping the H or H+T burden, induces the **same two economic forces**:

- a reduction in the consumption of housing services;
- a decrease in housing prices.

These two forces **do not operate in the same way** depending on the policy, however, leading to **contrasted outcomes**. These can be summarized as follows:

- The CHE policy places the focus on the second economic force, that is, the decrease in housing prices. Furthermore, it firstly concerns areas and households near the CBD. As long as the constraint remains reasonable, utility rises as a result of an important redistribution from central landlords to households, while city size moderately shrinks. Lastly, household solvency improves on average, but at the cost of an increase of in the inequality in front of the risk of housing default.
- Conversely, the CH+T policy gives prominence to the first economic force, that is, the reduction in housing consumption. Besides, it chiefly concerns suburban households. Therefore, and once more as long as the constraint remains reasonable, city size greatly decreases while leaving household utility unaffected. Furthermore, household solvency improves starting from households being the most at risk, resulting in a much greater efficiency of the policy in this regard.

On the other hand, when the constraint gets too strong, household utility and city size fall in both cases.

All in all, **the choice between the two policies involves a trade-off** between urban sprawl, equity issues, and the protection of household solvency when choosing which policy to implement. Lastly, this analysis has offered the occasion to discuss the **relevance of French housing benefit policies**, and has established the CH+T policy to be an interesting alternative to the current system.

RESOLUTION

Because there is fortunately no such thing as a perfect dissertation, the present work calls for numerous improvements and further developments. To my view, here are the main limitations of each chapter (except for *Chapter 0*):

- The extremely wide scope of *Chapter 1* has led to very concise presentations in some cases. This is especially true concerning discrete choice theory and hedonic analysis, which ideally would require a more extensive review. On the other hand, I hope to have brought a useful classification of the economic literature, which could serve as a superstructure for further reviews.
- The chief limitation of *Chapter 2* consists in the database itself. While the *Enquête Globale de Transport 2001-2002* has several merits, its design entails some limitations, the first and foremost one being that it provides information for only one weekday. Its use in disaggregate analyses is therefore fraught with difficulty, especially when considering the issue of transport expenses. Secondly, the quality of housing and household income data is another source of difficulty.
- *Chapter 3* has two major limitations. As it has already been mentioned, the first one is that there is a single household class, as the introduction of various household classes leads to a drastically higher complexity. This precludes the analysis of equity issues, although central in this matter. Hopefully, further work will remedy this first lack. Otherwise, the model must be empirically validated to confirm the relevance of the proposed measures. An evaluation of the number of households that could enter the scope of a reasonable CH+T policy (for example, limiting the H+T burden to 40-50%), which can be achieved using the housing survey, would constitute a good start.

In the longer term, this work is intended to be transferred and used in applied modeling. This will mean confronting one major difficulty, however, which was already underlined by Masson (2000): the limitation of the current French observation system as far as housing is concerned, an element highlighted in *Chapter 0*. Despite promising databases, e.g., the Housing Survey or FILOCOM, all fail to meet the requirements of LUTI modeling, in particular because of the distance separating the worlds of housing and transport. This will be my last vow, that this dissertation has convinced all readers of the necessity of considering these two issues together, and of all the change that this implies.

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