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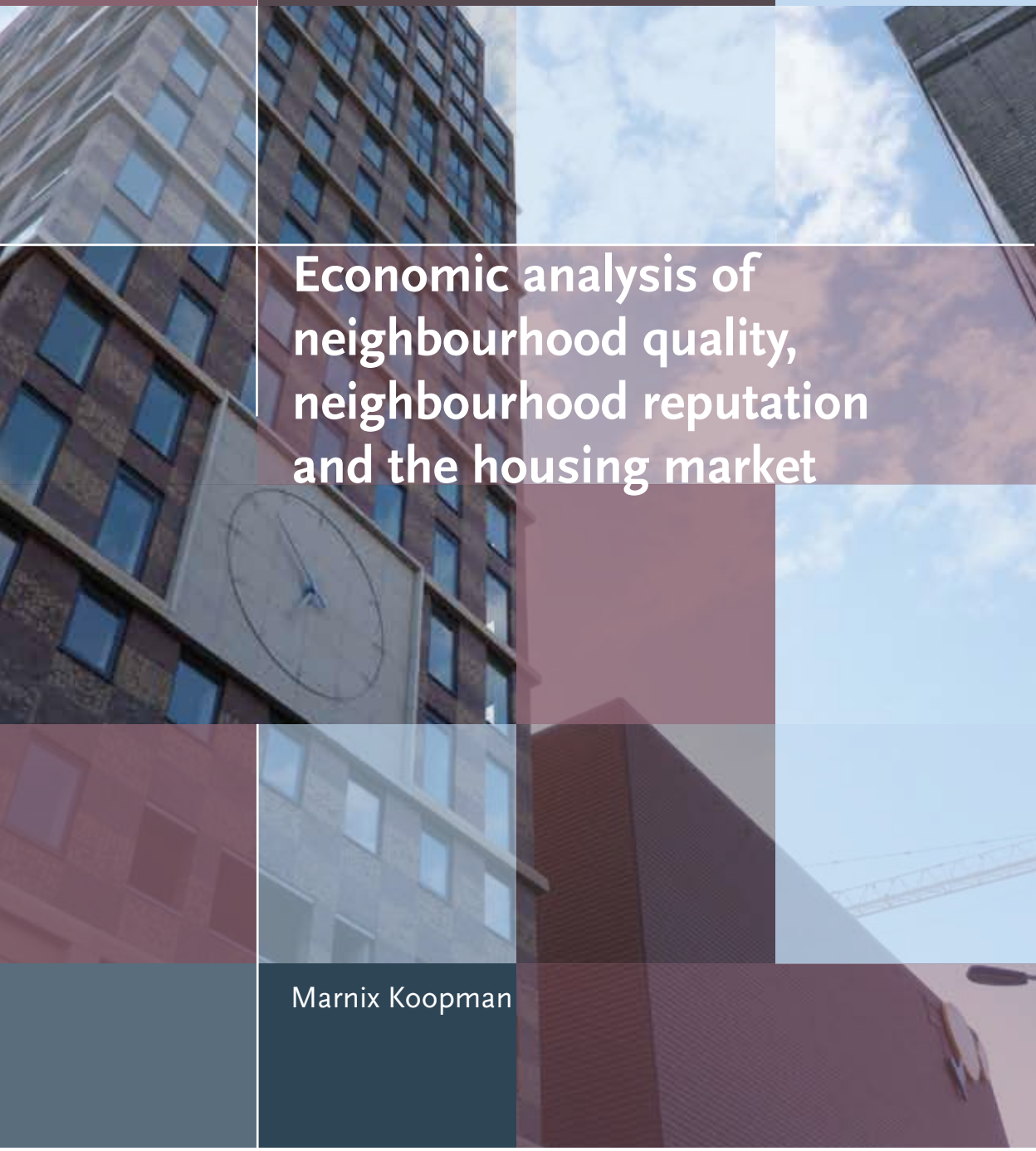

Economic analysis of neighbourhood quality, neighbourhood reputation and the housing market

Marnix Koopman

TU Delft Delft University of Technology

Challenge the future

Economic analysis of neighbourhood quality, neighbourhood reputation and the housing market

PROEFSCHRIFT

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Contents

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Rotterdam, January 2012

1 Introduction

1.1 Background

Residents care about the appearance of the buildings and public spaces in their neighbourhoods, about the people who live there, about the proximity to shops, schools and parks, about access to work and about the absence of crime and other nuisances in the area. The quality of a neighbourhood, however, extends beyond the realm of daily living experiences. Neighbourhood quality plays an important role in the pursuits of developers, city officials, planners, realtors and researchers. In order for their construction projects to succeed, developers must understand the types of locations and amenities that are most valued by buyers. City officials sometimes view the upgrading of neighbourhoods as a way of combating various social ills. In order to realise this goal, however, the planners who prepare the upgrades must first learn about the aspects of neighbourhood quality that are missing. Realtors, who act as intermediaries between buyers and suppliers of dwellings, must assess the quality of the neighbourhood before assigning a list price to a vacant dwelling. Sociologists, geographers, economists and other scholars working in the wider field of urban studies are interested in the reasons why households relocate, why relocating households choose particular destinations and how the quality of the surrounding area figures into the price of a house.

The societal importance that is attached to neighbourhood quality and the attention that it is receiving within various scientific disciplines suggest a high level of understanding regarding the quality and value of neighbourhoods. Despite the importance of this topic, such is not the case. It is obviously preferable to have some access to jobs than to have no access at all; good schools are obviously preferable to bad schools, parks are seen as attractive landscape features and nearly everyone abhors crime. Nevertheless, when scholars try to assess the impact of neighbourhood quality on residential mobility or house prices, the task proves surprisingly difficult. While investments in infrastructure can sometimes improve the accessibility of neighbourhoods, the proximity of roads and railways can also depresses property values. While ethnic enclaves have become popular tourist attractions in some places, buyers in other places may view them as no-go areas. While high-density construction still takes place in inner-city areas, residents in the outskirts of a city often see such developments as an invasion of their privacy. Although efforts are invested in urban restructuring, many restructured neighbourhoods fail to attract more affluent households, possibly reverting to a state of decline.

This thesis is not intended to explain how best to improve the quality of a neighbourhood. Instead, I try to explain why it is so difficult to assess neighbourhood quality, and I try to identify strategies that households can adopt to overcome these difficulties. My explanation rests on the informational constraints that many households face during their search for a new home.

Space constrains households from obtaining detailed information on the quality of neighbourhoods other than the ones in which they are living. The circumstances that residents experience in their neighbourhoods each day do not correspond to the notion that households in other parts of the city have of these areas. While house-seekers may share the same information regarding the price (or rent), structural characteristics and location of dwellings through advertisements and inspection of vacancies, they must make individual efforts to learn about the quality of the surrounding areas.

Some house-seekers have intimate knowledge of particular neighbourhoods from their own experience or that of friends, relatives or colleagues. Others rely on hearsay, public statistics or media reports. The use of different sources of information may generate divergent opinions regarding the quality of a neighbourhood. The relationship between house prices (and rents) and neighbourhood quality depends on the accuracy of the information that buyers (and new tenants) have. Improvements in neighbourhood quality need not always attract more affluent households to the area, and such improvements do not automatically lead to increases in the price or rent, particularly if house-seekers are unaware of the improvements that have taken place. Likewise, areas can become less popular and house prices may decline, even if the quality of the neighbourhood has remained the same. To elaborate on this idea, I draw upon a broad pallet of scientific disciplines, including information economics, queuing theory, complexity and auction theory, sociology, social psychology and geography. The core of my research is based upon mainstream housing economics and, more specifically, the neoclassical school of thought.

1.2 Economic approach

The value of objects has always been a topic of major importance to economists. Within the dominant neoclassical branch of economics, value in the exchange of goods is given by the equilibrium price (or the equilibrium rent, if the good is leased). On a free market, no rational seller (or owner) would voluntarily enter an exchange in which the price (rent) is less than the user value – the value of the good if the owner were to retain possession of it. No rational buyer (lessee) would willingly accept an offer if the price (rent) exceeds the value that the buyer attaches to the good. Neoclassical economists further assume that sellers, owners, buyers and lessees are aware of the price, rent and user value of every bid or offer that is on the market. Exchanges take place among sellers (owners) and buyers (lessees) who cannot find another buyer (lessee) who bids more or another seller (owner) who offers the same good for a lower price (rent). Whenever a seller's (owner's) offer matches the buyer's (lessee's) bid, equilibrium is reached for that specific exchange of the

good. In the aggregate, all bids and offers are balanced by equilibrium prices and rents, so that the market as a whole clears.

The unlimited ability to rank all offers and bids and to select the best one out of the many alternatives means that agents' preferences are revealed in their individual and collective choices. The revealed preference models of housing economists have contributed to the understanding of land-use patterns (Alonso, 1964; Mills, 1967; Muth, 1969), residential mobility (McFadden, 1978; Nordvik, 2001), housing demand and housing supply (Poterba, 1984; DiPasquale and Wheaton, 1992 and 1994), tenure choice (Ioannides, 1999), maintenance levels (Arnott and Braid, 1997) and the determination of house prices and market rents (Colwell, 2002; Harding *et al*., 2003). Perhaps the single most important contribution of housing economics is the notion that house price or market rent can be explained by the attributes of the dwelling and neighbourhood alone (Rosen, 1974).

The value of the actual dwelling poses less of a problem to housing economists. Although tenants, homeowners and landlords may hold differing opinions regarding the user value of a dwelling, they largely agree on the sellers' and landlords' willingness to accept and the buyers' and tenants' willingness to pay for each attribute of the actual dwelling. Researchers find it more difficult to explain how attributes of the surrounding area influence choice behaviour, but less so in the case of a household's decision to leave its home. Although most push effects that neighbourhoods can have on households have been identified (e.g. Bartik *et al*., 1992), measurement problems can obscure the exact strength and range of the effects (Openshaw, 1984). The same attributes that cause neighbourhood push, however, explain less when they are considered as pull factors in the destination choices of house-seekers. An increase in neighbourhood quality makes an area more attractive, and this should (at least in the short term) increase housing demand, house prices and market rents. In practice, this seemingly obvious relationship is more obscure than neoclassical theory predicts it to be (Atkinson and Crocker, 1987; Kauko, 2002).

The main conceptual difference between the dwelling and the neighbourhood is obviously related to space. The dwelling's location is fixed in space and time, and the attributes of the actual dwelling collapse into this point. Neighbourhood quality is based on a 'bundle of spatially-based attributes associated with clusters of residences' (Galster, 2001), which can change their location in the course of time. Space has entered housing economics in two ways. First, the distance between the home and workplace, school and other key activity places is accompanied by travel costs, which must be incorporated into the value of the dwelling (Alonso, 1964). Second, advances in data collection and GIS technology have fuelled the development of methodologies that have improved the estimation of housing choices and prices or rents within a spatial context (Anselin, 1999). If anything, the methodological

advances have underlined the ambiguity of neighbourhood pull as opposed to neighbourhood push. My argument is that this ambiguity results from the subjectivity that is inherent in the assessment of neighbourhood quality. The perception of neighbourhood quality is defined by both the experience that a household has had there and, the distance between the home and the neighbourhood.

1.3 Informational asymmetry

Understanding why neighbourhood value can be so difficult to predict requires the realisation that space imposes informational limits on the knowledge that households have regarding the housing market. Existing tenants, homeowners or landlords know everything they need to know about circumstances in their own dwellings, streets, blocks and neighbourhoods. They should encounter few problems in assessing the user value of the neighbourhood and its attributes. Once they observe the sales price or rent of dwellings in the vicinity, they learn about the exchange value of their neighbourhood. These 'insiders' have a particular advantage over 'outsiders' in one domain. Residents experience those aspects of housing quality that are most prone to change, least tangible and hardest to observe. The socio-economic and demographic attributes in the area are lost on most outsiders, as are the quality and availability of shops, schools and other local services, all of which shape a large part of the living experience.

House-seekers lack experience with the places in which their new homes are located, for the simple reason that they live elsewhere. They have to know beforehand in which areas they are going to conduct their residential search. Both types of information – knowledge about the experience of living in a particular location and knowledge about where to find a particular location – come at a cost. By necessity, house-seekers restrict the space within which they search (Huff, 1986) and the amount of information that they collect on various locations. They are likely to forego better options because they looked in the wrong place (Wolpert, 1966), and they do not enter negotiations with the opposite party in the exchange on the same footing (Merlo and Ortalo-Magné, 2004). The less a house-seeker knows about the new neighbourhood, the greater is the risk that the buyer (or renter) will acquire a 'lemon' (Akerlof, 1970) – a dwelling whose user value falls well short of its price (or rent).

One risk-minimising strategy is to limit the search to neighbourhoods that have 'prestige' or 'status' (Kauko, 2007), and to shun neighbourhoods that are seen as 'ethnic' or 'poor' (Ellen, 2000). These labels are superficial 'brand names' or reputations (Bettman, 1979), which reveal something about the quality (or the persistence thereof) of the area as opposed to other places (Stigler, 1961). These labels, however, do not go into detail about the exact

causes of differences in quality. While inspection leaves little room for disagreement on the quality of the dwelling and most tangible attributes of the neighbourhood, disagreement may arise in the assessment of unobservable attributes of the neighbourhood. For lack of a better measure, some house-seekers equate such unobservable quality with the reputation of a neighbourhood. Others are able to improve upon this incomplete and possibly biased information. For example, social ties in the area can provide access to residents' inside view of the neighbourhood. The more that is known about the neighbourhood, the more the house-seeker's destination choice can converge on the fully informed choice of the archetypical neoclassical household.

The neoclassical assumption of full information does not account for the different perspectives that house-seekers have on neighbourhood quality. House-seekers are assumed to possess the same level of experience that residents gather in the course of time. Noting that this assumption appears untenable, several authors have introduced an informational asymmetry between the buyers and sellers of dwellings into search models (Pope, 2008; Droës and Hassink, 2009; Albrecht *et al.*, 2009; Díaz and Jerez, 2009; De Wit and Van der Klauw, 2010). Others have highlighted the incomplete transmission of information on the quality of offers in the preceding search stage (Wheaton, 1990, Arnott and Igarashi, 2000; Merlo and Ortalo-Magné, 2004). This research focuses on buyers' lack of knowledge regarding the user value of a dwelling prior to inspection, as well as on uncertainties regarding the bargaining power of the opposite party in the exchange. The propositions tested by these authors concern the division of the bargaining surplus – the difference between the list and sales price – and the time that the offer remains on the market.[1]

My study does not address disagreements among buyers and sellers regarding the price or rent of vacant dwellings, nor is time on the market important to the argument.[2] The most important elements in this study are the various notions that house-seekers have regarding the quality of an offer. In a theoretical paper that is related to my work, Berliant and Yu (2009) build informational constraints into a spatial equilibrium model for the housing market. They conclude that price reflects the buyer's willingness to pay, assuming that the buyer may not be fully informed about the quality of the offer upon making the purchase. Although less rigid in a theoretical sense, my work extends the work of Berliant and Yu by adding a spatial dimension to the informational asymmetry between the suppliers of dwellings and new tenants or buyers. The observable quality of a dwelling yields the same price (or rent) in my approach as in the full information equilibrium. In contrast, its unob-

1 The bargaining surplus is defined by the difference between the seller's reservation price and the buyer's maximum bid. Unlike their proxies (i.e. list and sales prices), these prices are not observed.

2 In my work, time is relevant, albeit it in a different context. Later in this study, it is shown that well-informed tenants or buyers can substitute gains in housing quality for shorter waiting times for their preferred dwellings.

servable quality receives a common exchange value across a geographical submarket, regardless of local differences in unobservable quality. Less-informed house-seekers can not distinguish between offers that are undervalued or overvalued on a geographical submarket of the housing market. Well-informed house-seekers, in turn, can use their informational advantage to select the offers that yield the best user value for their money on each submarket. As such, the less informed are left with offers that are more likely to be overpriced, thereby receiving less housing quality in return for their bids.

In this thesis, I try to answer two questions in order to determine whether the neglect of an informational asymmetry in the knowledge of unobservable quality of neighbourhoods is indeed a shortcoming of standard housing economics.

Is the posited knowledge gap between residents and uninformed house-seekers visible in their respective valuations of neighbourhoods on the social rental market?

If so, does this informational asymmetry carry over to the owner-occupied market as well? In other words, do neighbourhood reputations affect house prices?

1.4 Neighbourhood value

This thesis is an attempt to explain how various types of agents carry out their valuation of neighbourhoods and how their assessments (which could be erroneous) affect their housing choices. Valuation by residents serves as the benchmark. In accordance with neoclassical thought, existing tenants and homeowners are assumed to possess nearly full information on their home surroundings. I use a socio-psychological concept as a short-cut in order to measure insiders' user value of their surroundings: neighbourhood satisfaction or residents' subjective valuation of the quality of life experience (Speare, 1974). The second variable that is used to measure neighbourhood quality is house price or, to be more accurate, the assessment value of the dwelling. The price differential between identical but spatially separated dwellings reflects the assessments of outsiders (i.e. realtors and buyers) regarding differences in the quality of locations. When applied to exits in the social rental sector in the city of Rotterdam (Netherlands), low neighbourhood satisfaction and low house price are shown to be important push factors for tenants. Neighbourhood satisfaction reflects the push effect of the unobservable attributes of a neighbourhood on social tenants, and house price largely reflects the push effects of observable attributes.

Neighbourhood satisfaction and house price also figure into the selection of new homes by tenants on the same market. I extend the geographic account of the residential search process (Brown and Moore, 1970; Smith *et al.*, 1979;

Huff, 1986) to include the assessment of neighbourhoods by house-seeking tenants. Analysis of the destination choices of tenants answers one of the key questions of the thesis. Upon moving to a new home, many tenants are only partially aware of the quality of the surrounding neighbourhood. More than half of all new tenants did not consider the inside view of the neighbourhood held by existing tenants (as reflected in neighbourhood satisfaction) in their destination choices. Throughout the thesis, I assume that households display 'satisficing' behaviour (Simon, 1991). Like the archetypical neoclassical agent, satisficing agents act rationally, but when faced with informational, institutional or cognitive constraints they sometimes chose outcomes that are less than optimal from the viewpoint of neoclassical agents. Under this axiom, new tenants may overlook areas where the most preferred offers are found. But they must have realised that the use of inside information in neighbourhoods where they did search, would have resulted in gains in utility. The crude destination choices made by half of all tenants must therefore have been the result of their relative ignorance about certain aspects of neighbourhood quality.

The choice to focus on social tenants in the second part of this thesis was motivated by the ample availability of data on the Dutch social rental market. More importantly, the social rental sector provides an experimental setting for analysing the role of asymmetric information on the housing market. Although the owner-occupied market in the Netherlands is expanding, supply at the lower end of the market is dominated by not-for-profit associations, with a small portion of the stock in the hands of private landlords. Rent controls, which apply to privately owned stock as well, and discounts provided by the associations yield regulated rent levels that are usually below the market rent. The rent gap has little to do with the actual dwelling. The neighbourhood is most likely to be undervalued on the Dutch social rental market (Van Ommeren and Koopman, 2011). Because social stock remains available in attractive city neighbourhoods, relocating tenants are able to realise gains in utility without paying additional rent.

Another interesting feature of the Dutch social rental market is the transparency of the system with which dwellings are distributed. Information-gathering is associated with the efforts of tenants to learn about the quality of offers, rather than on their efforts to find the offers. Set against the high potential gains in place-utility and low costs of searching within the distribution system are excessive risks in the acceptance of an offer. Upon acceptance, a tenant must return to the end of the 'queue' for social rental dwellings and must remain in a possibly undesirable dwelling for several years. The high opportunity cost of selecting a lemon should create a strong incentive to gather information on the new neighbourhood. The Dutch social rental sector appears to be especially suited for house-seekers who are well informed about their new neighbourhoods. The pool of house-seekers is supplement-

ed by other house-seekers (e.g. inter-urban movers) who know little about the places in which their next homes are located.

The segmentation of the Dutch housing market is an additional complication. Transitions between the owner-occupied and rental segments are rare on both the supply and the demand side. Results obtained from the social rental market do not necessarily carry over to the owner-occupied market. As an alternative way of identifying a possible informational asymmetry on the owner-occupied market, the relationship between neighbourhood reputation and house price is investigated. Sellers in deprived areas have an incentive to overstate the user value of their offers by increasing the price. Poorly informed buyers may resort to neighbourhood reputation as a simple rule of thumb for assessing the unobservable quality of an offer. Because overpriced dwellings are believed to be scarcer in areas with good reputations, ill-informed buyers tend to be drawn to such areas. If the demand in an area is dominated by ill-informed buyers, the neighbourhood's 'name' should affect house prices in the same way that 'brand name' adds value to PCs (Pakes, 2003), consumer electronics (Holbrook, 1992) or cars (Baltas and Saridakis, 2010).

The analysis of spatial house-price patterns in Rotterdam answers the second key question of the thesis: neighbourhood reputation is a relevant factor in the appraisal of housing quality, and by assumption, the neighbourhood's name is priced accordingly on the owner-occupied market.

1.5 Purpose of the thesis

Housing economists could benefit from my approach, which assumes that addressing space in choice behaviour requires more than simply improving the methodology. In the same way that households optimise their choices in time, they optimise their choices across space. The design of spatial models for the housing market that go beyond a simple distance-based treatment of space is still in an early phase.[3] Constraints that space imposes on the search and choice behaviour of households can be integrated into existing models,

3 Spatial models for the housing market have not ventured far beyond the seminal work of Alonso (1964), Mills (1967) and Muth (1969), which generated the mono-centric city model, in which commuting time is linked to land rents. Some additions to this model are the inclusion of search and transaction costs (Rouwendal, 1998), issues of control over public services and economies of scale herein (Brasington, 2004), land-use regulation (Quigley and Raphael, 2005), non-residential land use (Rossi-Hansberg, 2004) and agglomeration benefits (Glaeser and Gottlieb, 2009). Attempts to relax the full information axiom in housing economics include search models (e.g. Wheaton, 1990) and the spatial equilibrium model of Berliant and Yu (2009). The development of spatial models for the housing market within the field of economics continues to lag behind the developments in other fields, as with simulation models in urban geography (see Benenson and Torrence, 2004) or regional planning models (see Van Oort *et al.*, 2005). One reason is that the choice problem has to be solved in space and time, which makes analytical solutions harder to obtain than iterative solutions (Maier, 1991)

or researchers could devise clever ways of working around these constraints.[4] In this thesis, I have opted for the second approach. Despite my original focus on households' perception of space, my work should not be seen as a complete overhaul of standard housing economics or its methodology. It is merely an attempt to identify the limits that space introduces into choice behaviour and to clarify how these limitations affect the estimation of revealed preference models for the housing market.

In my approach, spatial constraints lead to the use of incomplete information by some house-seekers. Models for the destination or residential location choices of households yield different results in estimation, depending upon the informational advantage (or disadvantage) that the sampled households have. Households with longer length of stay in a city and denser social networks, those who move over shorter distances and those who put more effort into gathering information should be able to make destination choices that approach the full information outcome of standard economic theory. The choices of less-informed households diverge from this optimal solution, as their perceptions of the range and strength of neighbourhood pull effects are less accurate than are those of well-informed households. The estimated pull effects of the 'soft' socio-economic or demographic neighbourhood variables in existing models of destination (and residential location) choice should be treated with particular scepticism, as the applications are based on indiscriminate samples of households, whose information can range from the exact inside view to superficial reputation.

Geographers and sociologists should not be surprised by the notion that households experience space in a subjective manner (Corpataux and Crevoisier, 2007). This thesis might nonetheless be of interest to such scholars, as it introduces them to the rigorous treatment that is the mainstay of housing economists. One contribution that this study makes to the wider field of urban studies is of a more practical nature. The area-specific effects that are used to control for unobserved attributes or spatial autocorrelation are more than simply a methodological tool (Bourassa *et al*., 2003, 2007). The area dummies can embody the value of a neighbourhood's 'name' as a separate quality characteristic of a dwelling. When observations are aggregated over arbitrarily defined areal units, the spatial variation inside each unit is lost. This 'modifiable areal unit problem' is thought to hinder the estimation of neighbourhood push and pull effects (Openshaw, 1984). In drawing upon reputation, howev-

4 Several contributions in the literature do consider heterogeneous choice behaviour by differentiating between unanticipated and anticipated moves (Kan, 1999), between forced or voluntary moves (Timmermans *et al*., 1996) or between high and low availability of suitable offers (De Palma *et al*., 2007). The methodology used in these applications (i.e. discrete choice models with random or fixed effects in the coefficients on explanatory variables) could be applied to the difference between well-informed and ill-informed movers, which is prevalent throughout this thesis.

er, households adopt the same aggregation bias. A simple area dummy could thus be better suited to explain the pull on households than are sophisticated measurements of neighbourhood attributes. My analysis also stresses the importance of addressing the circular relationship in house prices (or rent) and residential sorting.[5] Mere expectations can trigger the selective arrival of households, a corresponding rise or fall in the price, confirmation of the neighbourhood's good or bad name and further selective inflow to the area.

Planners, developers and professionals working on the broader issue of housing may be particularly interested in the final chapter of this thesis. In the epilogue, the results from the preceding chapters are used to reflect on the methodological issues mentioned above, as well as on several policy issues that concern the housing market in the Netherlands and, by extension, in other developed economies. Why does urban restructuring often fail to change the social makeup of an area, despite a marked increase in owner-occupation? Why does gentrification appear to emerge spontaneously, while purposeful attempts to gentrify an area often fail? What direction should the reforms of the Dutch social rental market preferably take? Given the emphasis on the societal benefits of mixed-income neighbourhoods, is it fair to state that some of the costs of residential integration have been neglected by researchers and policy-makers alike?

The answers that the standard economic treatment of the housing market would offer to these questions are by no means attenuated by the approach that I take in this thesis. The empirical results suggest that tenants exercise a fair degree of rationality in their decisions to leave their old homes and in their choices of new homes. Residential location and destination choices do however diverge from the outcomes predicted by neo-classical economists, as households face constraints in relocating and in gathering information during the search for a new home. Improving the flow of information to tenants and homeowners is likely to improve their housing choices to some extent. The analysis asserts that it is in the best interest of both homeowners and social tenants for governments and semi-governmental bodies to increase the freedom of choice on the housing market by lifting restrictions on the exact timing and destination of relocations.

5 Two-stage models that treat the pricing mechanism and residential sorting as related processes (Bayer *et al.*, 2004; Bayer and Ross, 2006) are better suited for addressing such 'endogeneity' than are standard house price models and destination or residential location choice models.

1.6 Outline of the thesis

In the first part of this thesis, I specify the theoretical framework upon which the five empirical chapters that follow are founded. Lay readers might want to skip the technical expositions in this chapter. The framework allows for the derivation of exit and destination choice models, aggregate demand for dwellings, bid for a vacant dwelling and hedonic house price equation. The space-imposed constraints on the ability to gather information on distant neighbourhoods are discussed and incorporated into this framework. The use of incomplete information yields several conjectures regarding the size and shape of the pull that the neighbourhood exerts on house-seekers. Several of these conjectures are validated in the regression analyses in Chapters 3 to 7. Regulation on the Dutch housing market is also addressed, as are the constraints that households face because of such regulation, as the revealed preference models of standard economics are primarily designed to explain housing choices on a free market.

The second part of this thesis addresses residential mobility on the social rental market. The section begins in Chapter 3, with an investigation of the exit choices of social tenants in Rotterdam. Scores for neighbourhood satisfaction are first 'kriged' in order to obtain the shared notion that all residents (including non-respondents) have of the quality of their surroundings.[6] The addition of this inside view to a discrete choice model of the likelihood to move yields an estimate of the neighbourhood's user value for residents. The assessment value of the dwelling is used as a proxy measure for house price. It controls for the observable quality of the neighbourhood and brings differences in the valuation of the neighbourhood on the social rented and owner-occupied segment of the market to the foreground. The discrepancy between the two factors (i.e. low willingness to pay of tenants for high-priced neighbourhoods) reveals inefficiencies that the social rental market introduces onto the owner-occupied market. The main purpose of the regression in Chapter 3, however, is to assess the strength and scale of neighbourhood push effects on the social rental market in Rotterdam.

In Chapters 4 and 5, I discuss the destination choices of tenants on the same housing market, although the regressions centre on their aggregate demand and individual bids for dwellings. A count model for the net number of responses to vacancies (a proxy for aggregate demand) is estimated in Chapter 4. This stated preference model tells whether tenants have extended their knowledge of the neighbourhood beyond its reputation. In Chapter 5, a revealed preference model for the waiting time for a dwelling (a proxy for the

6 Kriging is a geostatistical technique in which the values of observations are smoothed across the spatial plain, such that the unobserved value at another location can be interpolated from known values (Stein, 1999).

Figure 1.1 Reading guide

PART I Theoretical analysis		
Ch. 2	**Theory and conjectures**	
PART II Informational asymmetry on the social rental market		
	Topic	***Methodology***
Ch. 3	Exit choice	Discrete choice model for the likelihood of social tenants to move
Ch. 4	Destination choice: 'Do house-seeking tenants use incomplete information in their destination choice?'	Count model for the net response to social rental dwellings
Ch. 5		Duration model for the waiting time of the new tenant
PART III Informational asymmetry on the owner-occupied market		
	Topic	***Methodology***
Ch. 6	House prices: 'Do house-buyers use incomplete information in their destination choices, and how does this affect house prices?'	Hedonic price equation for boundary fixed-effects in house price
Ch. 7		Repeat sales equation for change in house price
Ch. 8	**Conclusions and policy implications**	

tenant's bid for the dwelling) identifies tenants who were either well or poorly informed about neighbourhoods. The main purpose of the regressions is to compare the strength and scale of the pull effects of the neighbourhood with those of the corresponding push effects on the same housing market. If the information that the average house-seeker has is less complete than that of residents, the neighbourhood pull effects cover an area that is likely to extend beyond the scale that residents have in mind. Furthermore, the inside view is likely to play a lesser role in the destination choices of ill-informed tenants than it does in the exit choices of residents. The results show that tenants who stood to lose little by selecting a lemon (e.g. because of their low rank in the distribution system or their prior homelessness) acted in ways that suggest that they knew less about their new neighbourhoods than did tenants who faced riskier destination choices.

The third part of the thesis focuses on the valuation of neighbourhoods by owner-occupiers. Hedonic house price and repeat sales models are the standard methodology for explaining price differentials, and I do not stray from this convention. An indirect method for proving that buyers make use of reputations is by detecting jumps in house prices near the administrative boundaries of neighbourhoods. Most neighbourhood attributes work in an isotropic fashion. Their push and pull effects exhibit a smooth pattern of decay across the spatial plain. Sudden jumps in price that occur near neighbourhood boundaries could be caused by changes in the name of the area. The boundary analysis in Chapter 6 reveals the occurrence of many price jumps

on the Rotterdam owner-occupied market that can be explained neither by improvements in housing quality nor by increases in owner-occupation. This constitutes proof by exclusion, as some unobserved aspect (e.g. assessors' bias) could have been responsible for the price hikes. Changes in house prices in an area due to annexation by an adjacent, affluent (and better reputed) neighbourhood provide additional proof of the role of reputation in value assessments and by assumption in price-setting. This more direct evidence of informational asymmetry on the owner-occupied market is offered in a case study in Chapter 7.

Part I Theoretical analysis

2 Space and the housing market

2.1 Introduction

Neoclassical housing economists have produced revealed preference models for nearly every conceivable relationship on the housing market. Although these models can be viewed in isolation, they are a part of a single, unified framework for the housing market. In this chapter, I show how the exit choices of residents, the bids that households make for vacant dwellings, the destination choices of house-seekers, the aggregate demand for dwellings and the hedonic house price equation can be derived from the neoclassical framework. This framework is built upon the assumption that households hold full information on every attribute of the dwelling and the surrounding neighbourhood. The empirical literature , however, contains several inconsistencies that suggest that many house-seekers have less than complete knowledge of the neighbourhood to which they move.

I argue that the knowledge that house-seekers possess ranges from the exact inside view of residents to the superficial reputation of the area. Poorly informed house-seekers are at a disadvantage relative to the suppliers of dwellings when assessing the quality of offers in distant neighbourhoods. The use of the neighbourhood reputation acts as both a simple rule of thumb for assessing neighbourhood quality and a strategy for overcoming the informational disadvantage. Later in this work, this process is illustrated by a simulation model in which the reputational bias in favour of or against an area produces the outcome that is implied by the area's reputation: areas with poor reputations become deprived over time, while areas that are deemed attractive become just that.

I begin by showing how the models that are estimated in the chapters that follow, can be derived from the neoclassical framework. I make an occasional reference to contributions that address some of the intricacies of the framework. I then discuss how the pull effects of the neighbourhood in destination choice models differ from the corresponding push effects in exit choice models. The difference between neighbourhood push and pull is argued to be the result of the use of incomplete information by some house-seekers. A simulation model and a housing transactions model illustrate how informational asymmetry between the participants in the exchange of dwellings affects residential sorting and the price-setting mechanism. According to the models, the use of neighbourhood reputations by tenants and buyers generates differences in residential mobility and spatial discontinuities in house prices or market rent. The validity of the conjectures on the choice behaviour of house-seekers and the spatial patterns in house prices are listed at the end of this chapter and tested in the regression analyses in the chapters that follow.

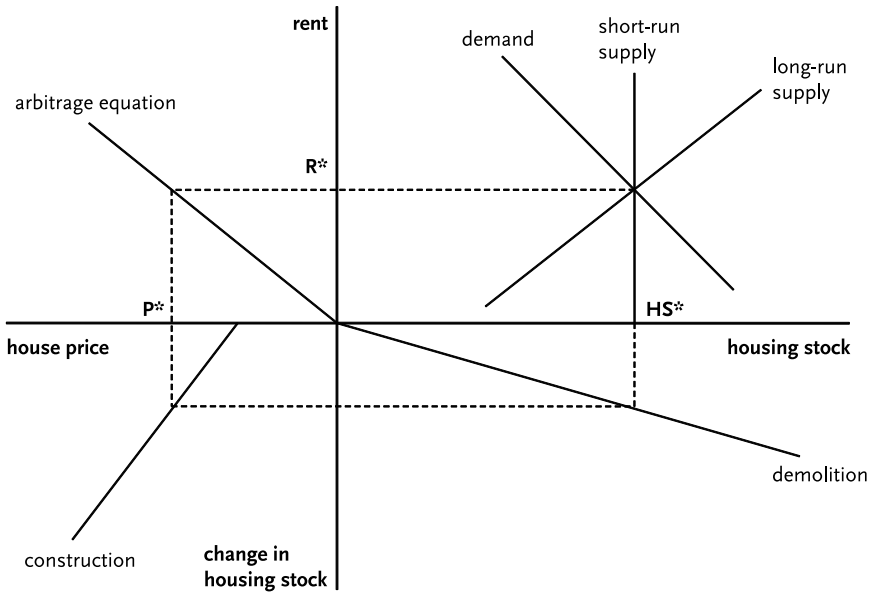
2.2 The neoclassical housing market

Full information, arbitrage and atomistic behaviour by self-interested agents are the cornerstones of neoclassical thinking (Stigler, 1961). Full information entails that utility-maximising households and profit-maximising producers can recognise, rank and value all offers and bids for goods on the market. Arbitrage, which refers to the unlimited ability to buy a good and sell it on a different market, guarantees that each offer or bid can be compared to other offers and bids, even if they are separated in space and time. Atomistic behaviour, in which households and producers act on their own accord, ensures that individual exchanges lead to an equilibrium in the aggregate. Taken together, these axioms are so strict that critics from both within and outside the realm of economics have stated that neoclassical economics deals with a utopian world (Simon, 1991; Weintraub, 2002). Although this criticism is essentially correct, it belittles the achievements and belies the meaning of neoclassical economics.

First, the neoclassical approach unifies individual choices and the aggregate outcome within a single framework that links the market to the rest of the economy. No other school of economic thought or field of study has been able to derive such an all-encompassing and concise description of choice behaviour from its axioms. Second, the critics are arguably too strict in their interpretation when stating that the neoclassical framework describes the real world. On most markets, at least one of the neoclassical axioms will not be met. Neo-classical economists describe what the outcome would be if their axioms did apply to the market. The discrepancy between the actual state and the idealised equilibrium helps to identify factors that impede the free exchange of goods. The framework, however, does not necessarily draw any normative conclusions regarding the need to remove the impediments when the free market outcome is deemed unacceptable from a non-economic standpoint. Finally, Neoclassicists have been reasonably successful in explaining choice behaviour in cases in which their axioms are only partially met. The regulated Dutch housing market, which is the subject of the empirical analysis in the second and third part of this thesis, presents such a case.

Although Mankiw and Weil (1989) laid some of the groundwork and Fisher (1992) reached a similar outcome independently, the neoclassical framework for the housing market is usually credited to DiPasquale and Wheaton (1992 and 1994). In their approach, prices and rents adjust in time and space to create long-run equilibrium between the supply of and demand for identical dwellings. On the supply side, landlords sell, buy or let property, constructors maintain, renovate or build dwellings and developers, who act as intermediaries, sell the dwellings in order to maximise their profits. On the demand side, utility-maximising households remain in or leave their current homes, select new homes from the available vacancies, shift from renting to owner-occupation (or vice versa) and commission constructors to maintain or reno-

Figure 2.1 Equilibrium on the housing market



Source: DiPasquale and Wheaton, 1992

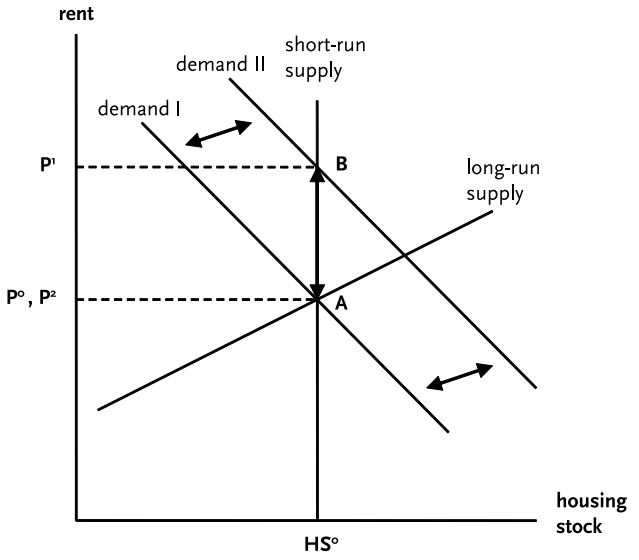
vate their homes.[7] Individual housing choices add up to the supply of and demand for dwellings. The equality of aggregate demand and supply yields the equilibrium stock, price and rent, which can be taken as given in the individual choices of suppliers and households.

The unlimited ability of landlords to change from letting to selling (or to buy property and let it out) equalises the profits from activities on the housing market and from holding other assets (upper-left quadrant in Figure 2.1; Poterba, 1984).[8] High prices or rent induce landlords and developers (if dwellings are sold directly to households) to order contractors to construct new dwellings (lower-left quadrant). The addition to the housing stock is the surplus of construction over demolition, the latter being a fixed depreciation rate on the existing stock (lower-right quadrant). Supply is fixed in the short run, due to the time lag in construction, but long-run supply is an upward-sloping function of the rent and price (upper-right quadrant). The aggregate demand on a housing submarket equals the number of households living in the sub-

7 Throughout this thesis, the household is considered as the unit of interest. For a discussion on the joint decision-making by members of the same household, see Molin (1999).

8 For landlords, the after-tax proceeds from the sale of a dwelling equal the discounted flow of rents minus taxes and the costs of control and maintenance. Arbitrage on the demand side entails that the rent equals the user costs of owner-occupation. The latter are defined as the sum of interest payments on mortgage debt, the costs of maintenance, repair and assurance, property taxes and the opportunity cost of holding the dwelling as an asset, minus subsidies and gains from the expected appreciation of the dwelling (Diewert, 2003).

Figure 2.2 Adjustment towards long-run equilibrium, without new construction



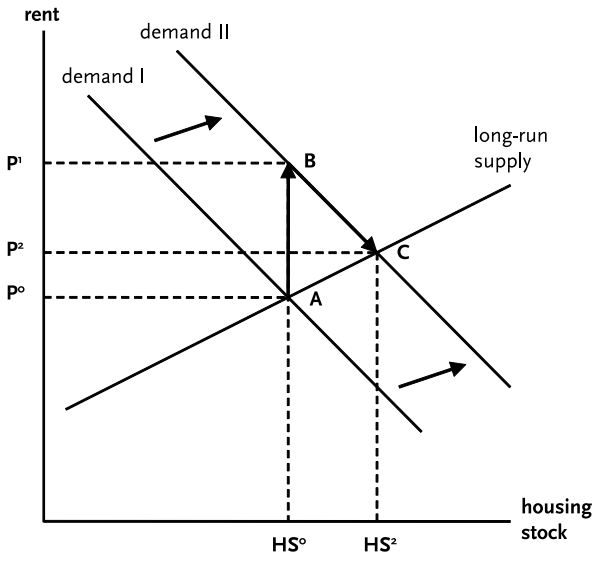
Source: DiPasquale and Wheaton, 1992

market, which can change due to household formation, mortality and changes in residential location demand (Maisel, 1963). Higher rents and prices make entry into the submarket more difficult and exits more likely, such that aggregate demand is a downward-sloping function of the rent (upper-right quadrant). Equilibrium conditions are given by the rent R* and price P* that equalise demand and supply at the stock level HS*.

Changing circumstances can make the current housing situation suboptimal. Suppose that large-scale demolition takes place in an area adjacent to the submarket depicted in Figure 2.1. This would increase the desire to enter the submarket and limit the ability to leave it. Excess demand generates a temporary disequilibrium in which the stock remains constant, but the price and rent increase. If the shift in demand is transitory (because dwellings are being rebuilt in the adjacent area), the market will return to the old equilibrium (trajectory A-B-A in Figure 2.2). If the shift in demand is permanent, higher price will lead to new construction. The stock will increase and a new equilibrium will emerge, in which the price and rent are higher than in the old equilibrium, but lower than in the disequilibrium (A-B-C in Figure 2.3). It is important to note that agents eventually learn what the long-run price, rent and stock are going to be. In applying this knowledge, agents guide the market towards the equilibrium, precisely because they are acting on full information and in an atomistic fashion.[9]

9 The time lag in construction may lead to a less-than-smooth adjustment process. If supply decisions are made before the new price is known, the market will oscillate towards the equilibrium (Kaldor, 1934). See also the discussion on overshooting.

Figure 2.3 Adjustment towards long-run equilibrium, with new construction



Source: DiPasquale and Wheaton, 1992

The framework presented in Figure 2.1 and its dynamics, as illustrated in Figure 2.2, tell only half of the story. It is not just supply that is fixed in the short run; rigid contract rents can make transitory vacancies more profitable than occupancy (Rosen and Smith, 1983). Some landlords will withhold dwellings from the market if they anticipate an increase in rent (Colwell, 2002). In a similar vein, owner-occupiers will withhold dwellings if they anticipate an increase in price (Poterba, 1984). The speculative actions of owner-occupiers and landlords can lead to a situation in which the vacancy rate – the share of the stock that is put on the market – drops below its 'natural' level: the level needed to accommodate house-seekers' search for an offer, landlords' search for tenants and sellers' search for buyers (Wheaton, 1990). Rents and prices tend to 'overshoot', even when their equilibrium values are common knowledge (De Leeuw and Ekanem, 1973). In general, the house price or market rent will be a non-linear function of the factors shaping the supply of and demand for housing. Aside from this non-linearity, the possibility of speculative behaviour does not alter the essence of the framework developed by DiPasquale and Wheaton (Collwell, 2002).

2.3 Introducing housing quality: hedonic house prices

Thus far, the framework has addressed only quantities: the supply of and demand for identical dwellings. It is physically impossible, however, for two dwellings to occupy the same location, if that location is defined in three-di-

mensional space. Dwelling can thus never be identical. Furthermore, households earn different levels of income and have idiosyncratic tastes for housing (Arnott, 1989). Any realistic model of the housing market should account for heterogeneity in both the stock and the preferences of households. Rosen (1974) found an elegant solution for comparing the prices of imperfectly substitutable goods on a market with heterogeneous agents. I have adapted his model slightly by identifying sellers as existing homeowners rather than as construction firms, bearing in mind that the Dutch housing market is quintessentially a 'stock market', in which the price of new construction is defined by transactions in the much larger existing stock (Boelhouwer *et al.*, 2006).

Let the quality of a dwelling be defined by the bundle of attributes z of the actual dwelling and the neighbourhood. The greater the quantity of an attribute, the better is the specification of dwelling. If a household enters the market for the first time, it spends its income y on housing – through the purchase of a dwelling with price *p(z)* – and on the consumption of other goods x. Homeowners remaining on the submarket have the option of remaining in their current home with specification ż and spending their entire income on other goods, or selling their dwelling at price *p(ż)* and buying a new one at price *p(z)*, while spending the remainder on other goods. Households must maximize their concave utility with respect to the housing bundle and other goods.[10] Prices of other goods are normalised to unity, such that the maximisation problem of a homeless person who becomes a first-time buyer reads as follows:

$$\text{(2.1a)} \quad Max_{x,z}\, U(x,z) \;\; s.t. \;\; y = p(z) + x$$

and that of a homeowner who decides to move as follows:

$$\text{(2.1b)} \quad Max_{x,z}\, U(x,z) \;\; s.t. \;\; y + p(\dot{z}) = p(z) + x$$

The solution to this problem is obtained by substituting *y-p(z)* or *y+p(ż)-p(z)* for *x* and taking the derivative of (2.1a) and (2.1b) with respect to z, and then setting it to zero:

$$\text{(2.2)} \quad \frac{\delta U(x,z)}{\delta p(z)} \frac{\delta p(z)}{\delta z} + \frac{\delta U(x,z)}{\delta z} = 0$$

The first-order condition in formula (2.2) states that housing consumption

10 Concavity means that the first derivative of the utility function is positive and the second derivative negative.

must be increased until the marginal utility of a higher housing consumption (second term) is offset by the marginal disutility from a lower consumption of other goods (first term). The first-order condition (and second-order condition, which is omitted for the sake of brevity) solves the optimal consumption path for the household. Along this path, the consumption of housing and of other goods decreases with house price, increases with income and, in the case of a seller, increases with the endowment from the sale of the old home. The household's bid function θ is defined as the expenditure on housing for every level of income at the highest attainable utility level u^*.

(2.3a) $$U(y-\theta, z) = u^*$$

(2.3b) $$U(y-\theta + p(\dot{z}), z) = u^*$$

The bid function is a concave function of the housing bundle z. A household is willing to pay more for higher housing quality, albeit at a decreasing rate: greater consumption of housing means less consumption of other goods. In equilibrium, the willingness to pay for the dwelling equals the price requested by the seller:

(2.4a) $$\theta(z, u^*, y) \equiv p(z)$$

(2.4b) $$\theta(z, u^*, y + p(\dot{z})) \equiv p(z)$$

In the model, all vacancies are filled instantaneously, as the number of households is assumed equal to the stock. Room for relocation is made by the exogenous exits from the submarket and the offers of homeowners who are exchanging dwellings.[11] Arbitrage ensures that sellers leaving the market can ask the same price as transferring homeowners. Sellers take the bid price for their offers as given, provided that it exceeds the endowment needed for a homeowner to consider a move in the first place (i.e. $p(\dot{z}) \geq \overline{p}$ where $\overline{p}$ is the price that makes him indifferent between staying or moving:
$U(y-\theta+\overline{p}, z) = U(y, \dot{z})$). In equilibrium, the value of the offer $\varphi(\dot{z})$ equals sales price for specification $\dot{z}$:

(2.5) $$\varphi(\dot{z}) \equiv p(\dot{z}) \text{ if } p(\dot{z}) \geq \overline{p}$$

By keeping all other attributes z^* in the housing bundle fixed, the quality of a dwelling can be defined by the quantity of attribute z_1. The response of buy-

11 In an inter-temporal model, vacancies are needed to allow for movements into and out of dwellings, making it necessary to solve for the 'natural' vacancy rate (1-N/HS) first (Wheaton, 1990).

ers and sellers to slight changes in housing quality is depicted in Figure 2.4. The bid functions θ_i and θ_j of two buyers are shown as dotted curves. In this example, household *i* has a lower income (or lesser taste for z_1) than does household *j*. Each household's bid is optimised at the point where the willingness to pay for the attribute equals its 'shadow price': the implicit exchange value on the market. The envelope $P(z_1,z^*)$ connects the bids for every quantity of z_1. The figure also shows the offers φ_m and φ_n, in which seller n is endowed with a higher-quality dwelling than seller m.[12]

Whenever the bid of a buyer matches a seller's offer, equilibrium is reached for that specific exchange of the attribute.[13]

The two-dimensional envelope depicted in Figure 2.4 exists in as many dimensions as there are housing attributes, plus one. The multi-dimensional envelope $P(z_1,z_2,\ldots z_K)$ is called the 'hedonic house price function': the schedule that balances the exchange of housing attributes. One important conclusion from Rosen's work is that the prices of heterogeneous dwellings can be combined into a single equation. The most common formulation for the hedonic house price equation is a log-linear transformation of house price:

$$(2.6)\quad Log(P) = \beta_0 + \sum_k \beta_k z_k + \sum_l \delta_l z_l (NBH)$$

where Log(P) denotes the logarithm of the price, β_0 is the constant term, β_k are the coefficients on each of the *K* attributes of the dwelling proper and δ_l are the coefficients on the *L* attributes of the neighbourhood. Housing preferences are embedded in the market's implicit valuation of each attribute, which is measured by the relevant coefficient in the equation. As such, the researcher need not observe the characteristics of individual buyers and sellers in order to estimate the model: all households must pay the same amount for an attribute, regardless of their idiosyncratic taste for housing, their income or wealth and their other characteristics.[14]

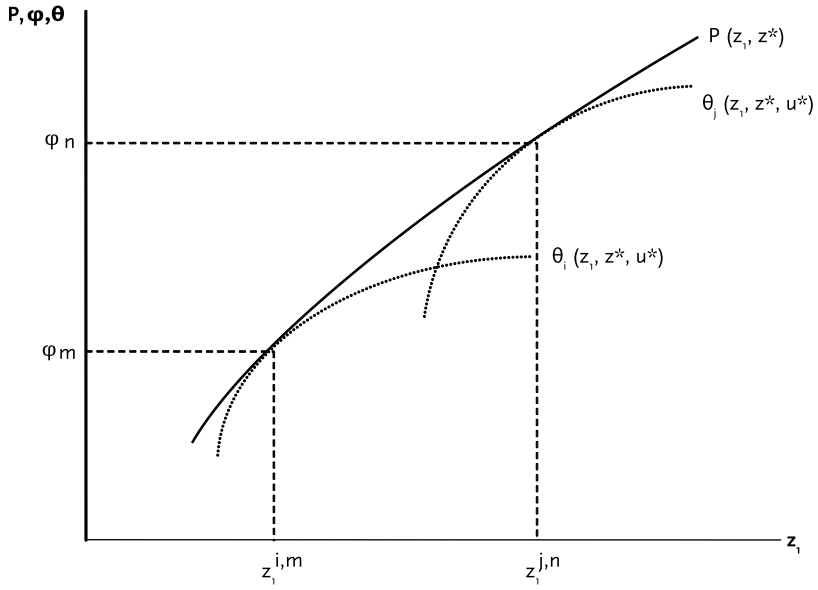
A bid function is estimated in an alternative setting (i.e. the social rental market) in Chapter 5. The waiting time for an offer is substituted there for

12 In Rosen's formulation, suppliers (i.e. firms) face increasing costs of construction. The offer curves will then be concave functions of housing quality rather than being the fixed points in Figure 2.4.

13 Matters on the housing market are more complicated than this. Buyers usually attach a higher user value to a good when they become the owners of it (Hanemann, 1991), the price equals the willingness to pay of the second bid in auction-type exchanges (Klemperer, 2003), and the sales price depends on the bargaining power of the seller relative to that of the buyer in negotiation-type exchanges (Albrecht *et al.*, 2009). In cases in which several identical dwellings are offered at once, all buyers except for the marginal buyer will bid less than their user value (Bayer and Ross, 2006).

14 This is yet another simplification of the actual pricing mechanism. Differences in search costs among buyers allow for the discriminatory pricing of dwellings with the same user value (Diamond, 1987). In Section 2.9, I discuss the role of informational asymmetries, which lead to the exact opposite case: a common price for offers with a different user value.

Figure 2.4 Hedonic price function



price; social tenants bid their registration time or duration of stay. A hedonic price function is estimated in Chapter 6. It underlies the analysis of the push effects and pull effects of the neighbourhood on social tenants in Chapters 3 to 5, whenever mention is made of the house price residual. The house price residual is defined as the share of the price that is explained by attributes other than those of the actual dwelling (i.e. $log(P)$-β_0-$\Sigma_k\beta_k z_k$). The house price residual conforms to the valuation of the neighbourhood by buyers and sellers, but it may contain other effects as well (see Chapter 6).

2.4 Housing demand and residential mobility

Rosen's work has led to an innovation in thinking about the housing market. The fact that a dwelling can be treated as a bundle of attributes, each of which has an equilibrium price, ensures that the optimality of the decision to buy or rent a dwelling carries over to the choice of specification of dwelling as well. This notion simplifies the construction of revealed preference models, as well as their interpretation. The aggregate demand for dwellings is derived in a manner similar to that of Rosen (1974). For convenience, I suppress the different notation for attributes of the actual dwelling and of the neighbourhood. Given that each attribute has an equilibrium price, expenditure on goods can be defined as follows for first-time buyers and homeowners:

(2.7a) $$e(p(z;nbh),y) = \sum_k p_k z_k(p(z),y) + x(p(z),y)$$

(2.7b) $$e(p(z),p(\dot{z}),y) = \sum_k p_k z_k(p(z),p(\dot{z}),y) + x(p(z),p(\dot{z}),y)$$

In these equations, z_k is the consumption of each of the *K* attributes of the dwelling and neighbourhood, p_k is the shadow price of attribute *k* and *x* is the consumption of other goods. For the sake of simplicity, I assume that households do not save, hence expenditure *e* equals income *y*. I further assume that dwellings differ in the quantity of z_1, while the other attributes z^* are the same. By using *x*=y-*p(z)* and taking the first derivative of household's utility at the optimal level u^* with respect to shadow price p_1, the amount of income needed to keep utility at a constant level follows from:

(2.8a)

$$\frac{\partial U(y-p(z),z_1(p(z),y),z^*)}{\partial p(z)}\frac{\partial p(z)}{\partial p_1}+\frac{\partial U(y-p(z),z_1(p(z),y),z^*)}{\partial y}\frac{\partial e(p(z),y)}{\partial p_1}=0$$

(2.8b)

$$\frac{\partial U(y-p(z)+p(\dot{z}),z_1(p(z),p(\dot{z}),y),z^*)}{\partial p(z_1,z^*)}\frac{\partial p(z)}{\partial p_1}+\frac{\partial U(y-p(z),z_1(p(z),p(\dot{z}),y),z^*)}{\partial y}\frac{\partial e(p(z),p(\dot{z}),y)}{\partial p_1}=0$$

The rise in income needed to keep the household on its optimal consumption path is equal to the quantity demanded of attribute z_1 (i.e. $\partial e(p(z);y)/\partial p_1 = z_1$ or $\partial e(p(z);y+p(\dot{z}))/\partial p_1 = z_1$). Formulas (2.8a) and (2.8b) can be rearranged to solve for housing consumption:[15]

(2.9a)

$$z_1=-\frac{\partial U(y-p(z),z_1(p(z),y),z^*)}{\partial p_1}\Bigg/\frac{\partial U(y-p(z),z_1(p(z),y),z^*)}{\partial y}$$

(2.9b)

$$z_1=-\frac{\partial U(y-p(z)+p(\dot{z}),z_1(p(z),y+p(\dot{z})),z^*)}{\partial p_1}\Bigg/\frac{\partial U(y-p(z)+p(\dot{z}),z_1(p(z),y+p(\dot{z})),z^*)}{\partial y}$$

The quantity demanded of attribute z_1, and by extension of overall housing quality, equals the drop in utility due to the rise in the attribute's shadow price, divided by the rise in utility due to the compensatory rise in income. This result could have been reached immediately by maximizing utility with respect to the attribute, subject to the constraints (2.7a) and (2.7b). The solutions in formulas (2.9a) and (2.9b) are better known as Roy's identity (Var-

15 The indirect effects of prices and income on utility (through z_1 and *x*) cancel each other out on the optimal consumption path.

ian, 1992). They can be extended to a situation in which all attributes are allowed to vary.[16] Individual housing demand depends on the shadow prices of the housing attributes, the price (or rent) of the dwelling and the characteristics of the household (Ioannides and Zabel, 2003).

Households' individual demand for housing must still be converted into the aggregate demand for dwellings. If the specification of dwelling is denoted as (z_1,z^*), then households who consume z_1 make up the target group for this specification. Let $n(z_1)$ denote the fraction of households who demand z_1. The aggregate demand for this type of dwelling is given by:[17]

$$D(z_1, z^*) = n(z_1(Max\{y, y + p(\dot{z})\}, p(z), p_1, hh), z^*))N \quad (2.10)$$

In this equation, N denotes the total number of households and hh the characteristics of the buyer that define his housing taste. Different combinations of hh and y can produce the same demand z_1. Again, one might allow the other attributes z^* to vary. In general, the demand for a specification of dwelling is a function of the house price, the shadow prices of the structural characteristics of the dwelling and the characteristics and income of the target group for this type of dwelling. A demand equation for social rented dwellings similar to equation (2.10) is estimated in Chapter 4.

An equilibrium relationship must now be defined in order to close the framework. Equilibrium prices are set in order for supply to meet demand for every specification of dwelling. For a small change in housing quality, the following identity holds:

(2.11)

$$S(\dot{z})dz = hs(z_1, z^*)HSd\dot{z}_1 \equiv n(z_1(Max\{y, y + p(\dot{z})\}, p(z), p_1, hh, z^*))Ndz_1$$

In this equation, $hs(\dot{z}_1,z^*)$ denotes the fraction of the housing stock HS whose specification conforms to a specific level of z_1. The equality of supply and demand in turn defines the equilibrium price and equilibrium shadow prices as functions of the housing attributes (through the supply side) and buyers' characteristics (through the demand side). The aggregate demand for and supply of dwellings can be derived by aggregating the above-stated identity over all values of z_1. This yields a quality-adjusted equivalent of the equilibrium relationship depicted in Figure 2.1.

16 As mentioned in Section 2.3, a higher taste for housing has the same effect on housing consumption as does higher income.

17 The identity (2.10) can also be derived in Rosen's (1974) original model. Rosen obtained the demand and supply curves by differentiation of the 'shadow prices' of housing attributes (i.e. the β_i and δ_i in Equation (2.6)).

With full information and no transaction costs, arbitrage ensures that equilibrium extends to locations. If two households are better off living at each other's location, then they can initiate a trade at prices that equal their willingness to pay for each other's dwelling. Prices are higher in areas where the willingness to pay is higher. In equilibrium, residential location demand – the sum of house-seekers relocating to an area and residents remaining in the area – equals the housing stock on each housing submarket.[18]

2.5 Exit choice and destination choice

All of the housing choices and the house price can ultimately be reduced to functions of the exogenous parameters, such as the specification of dwelling and household characteristics (Rosen, 1974). In this deterministic setting, households exit, stay or – in the special case of homeowners who are indifferent between the two choices – choose randomly between moving and staying. In a more realistic stochastic setting, households are more likely to move when the expected utility from moving exceeds the utility from staying. I assume a logistic distribution, so the probability of an exit by a homeowner can be written as follows (Koppelman and Wen, 1998):

(2.12)

$$\Pr\{U(y - p(z) + p(\dot{z}), z) \geq U(y, \dot{z})\} = \frac{e^{\{U(y-p(z)+p(\dot{z}),z)}}{e^{U(y-p(z)+p(\dot{z}),z)} + e^{U(y,\dot{z})}} = \frac{e^{U(y-p(z)+p(\dot{z}),z)-U(y,\dot{z})}}{1 + e^{U(y-p(z)+p(\dot{z}),z)-U(y,\dot{z})}}$$

In this equation, e^U stands for the exponential value of utility U.[19] In the absence of transaction costs, a move is more likely to occur when the expected utility from living in the new home exceeds the utility from staying in the old home. Identity (2.12) can be used to construct discrete choice models for exit, destination, residential location and tenure choices.

One consequence of the neoclassical axioms is that choices made in the past and choices that will be made in the future do not alter the optimality of choices made today.[20] The likelihood to move depends upon neither the outcome of the destination choice nor the parameters that govern it: the price

18 The number of households usually falls short of the stock, as some vacancies are needed to accommodate movements into and out of dwellings (Wheaton, 1990). On the regulated Dutch social rental market, however, demand usually exceeds the stock due to below-market rents.

19 Note that, when the utility of staying equals that of moving, the likelihood to move is one half.

20 The independence of irrelevant alternatives axiom (IIA) – if a choice is made from a subset of a larger set, then the same choice would have been made if a larger or smaller set were available to the consumer – underlies much of the reasoning in neoclassical economics (Sen, 1970). See also Footnote 21.

and attributes of the new home. One way of seeing this is by differentiating (2.12) with respect to the specification of the old home $\dot{z}$:

(2.13)

$$\partial\left(\frac{e^{U(y-p(z)+p(\dot{z}),z)}}{e^{U(y-p(z)+p(\dot{z}),z)}+e^{U(y,\dot{z})}}\right)\Big/\partial\dot{z}=\frac{e^{U(y-p(z)+p(\dot{z}),z)}e^{U(y,\dot{z})}}{\left(e^{U(y-p(z)+p(\dot{z}),z)}+e^{U(y,\dot{z})}\right)^{2}}*$$
$$\left[\left(\frac{\partial U(y-p(z)+p(\dot{z}),z)}{\partial z}-\frac{\partial U(y-p(z)+p(\dot{z}),z)}{\partial y}\frac{\partial p(z)}{\partial z}\right)\partial z\Big/\partial\dot{z}+\right.$$
$$\left.\left(\frac{\partial U(y-p(z)+p(\dot{z}),z)}{\partial p(\dot{z})}\frac{\partial p(\dot{z})}{\partial\dot{z}}-\frac{\partial U(y,\dot{z})}{\partial\dot{z}}\right)\right]$$

The first term within brackets on the right-hand side of equation (2.13) is the change in future consumption if the quality of the old home were to improve. This term is recognisable as the first-order condition in the maximization of *U* with respect to z. Hence, it equals zero. The household simply adjusts its future consumption following the change in specification of the old home ż, such that its utility remains at the highest possible level. The change in the likelihood to move depends on the second term within brackets: the increase in utility from the higher sales price of the old home, minus the opportunity costs of not staying in this dwelling. Differences in exit rates can be explained by characteristics of households, along with the price (or rent) and attributes of their current or abandoned homes.

A household's duration of stay depends upon the same factors that govern the exit choice (Goodman, 2003). Destination choice refers to the selection of a new home from amongst a number of suitable vacancies. Arguments similar to those stated above can be offered to prove that the destination choice depends upon household characteristics, along with the price (or rent) and attributes of the new home (McFadden, 1978).[21] The main difference between the exit choice model and the destination choice model is that the push effects on home-owners and existing tenants are opposite in sign to the pull effects on buyers and new tenants.

21 There are several reasons why the destination choice need not be independent of the price-quality relationship of the old dwelling or the alternatives that are on the market. Greater availability of a particular type of dwelling increases the odds of obtaining this dwelling type (Timmermans and Van Noortwijk, 1995). Buyer taxes make moving costs dependent upon the value of the new home, which can alter the likelihood to move (Van Ommeren and Van Leuvensteijn, 2005). The withdrawal of equity from the old home to re-mortgage the new one is yet another mechanism connecting exit and destination choices (Bridges *et al.*, 2004). In Chapter 5, I show how a good price-quality relationship of the old home causes tenants to be better informed, which leads to endogenous improvement in the price-quality relation of the new home.

One standard assumption in revealed preference modelling is that utility is separable in its elements. Utility in the exit choice model is written as a linear or quasi-linear function of price, housing attributes and household characteristics. I assume a logistic probability function. This leads to (McFadden, 1975):

(2.14)

$$\Pr\{U(exit) \geq U(stay)\} = \frac{\exp(\beta_0 + \sum \beta_k z_k + \beta_p p(z) + \sum \chi_l hh_l)}{1 + \exp(\beta_0 + \sum \beta_k z_k + \beta_p p(z) + \sum \chi_l hh_l)}$$

In this equation, z_k denotes the K attributes of the dwelling and neighbourhood, $p(z)$ the user costs (or rent) and hh_l the L household characteristics (including income or wealth).[22]

An exit model for social tenants similar to the one shown in equation (2.14) is estimated in Chapter 3, with rent replacing house price.

2.6 Search on the housing market

The revealed preference models discussed in the previous sections have been the subject of a large number of empirical studies. Some of these applications have tried to clarify the impact of neighbourhood quality on housing choices and house price. The attributes that define neighbourhood quality, and thereby a large part of the user and exchange value of the dwelling, can be classified under the broad headers of accessibility, amenities, physical, environmental, socio-economical and demographical features. Table 2.1 presents a non-exhaustive list of attributes that have been identified as determinants of house price and of the exit, residential location or destination choices. The listed variables can be thought of as the push factors and pull factors of the neighbourhood.

Three observations can be made upon surveying the empirical literature. First, some attributes may prove relevant on one housing market, while failing to produce significant estimates on another market and, when attributes are more universally valid, their coefficient values tend to have a wide spread (Atkinson and Crocker, 1987; Smith and Huang, 1995, Nelson, 2004). The task of measuring neighbourhood attributes and specifying their input in revealed preference models has proven more difficult than the task of defining the quality of the actual dwelling. Structural characteristics are in common use in advertisements, realtor's listings and residential surveys. Households are

22 Separability relies on the independence of the explanatory variables. This need not be guaranteed. In fact, residential sorting leads to interdependence between household characteristics, house type, location and the exit rate. This may cause problems such as endogeneity and heterogeneity. Throughout the regression analyses in Chapters 3 to 7, attention is paid to the possible or actual effects of these estimation problems.

Table 2.1 Neighbourhood push and pull factors

	Category	Attribute	Authors
House price	Accessibility	Travel times to CBD, workplace and other key-activity places	McMillen *et al.* (1992), DesRosiers *et al.* (2000)
		Access to public transport or major roads	Adair *et al.* (2000), So *et al.* (1997)
	Amenities	Shops	Sirpal (1994)
		Parks	Barnett (1985)
		Hospitals	Huh and Kwak (1997)
		Schools	Haurin and Brasington (1996)
	Physical/ land-use	Housing density	Kauko (2002)
		Dominant land use	Luttik (2000), Songa and Knaap (2004)
		Architectural style	Supplee-Smith and Moorhouse (1993)
		'Atmosphere' of area	Kauko (2007)
	Environmental	Railroads	Strand and Vågnes (2001)
		Highways	Mayeres *et al.* (1996), Theebe (2004)
		Airports	Espey and Lopez (2000)
	Socio-economic	Income of neighbours	Haurin and Brasington (2006)
		Education of neighbours	Gibbons (2003)
		Social renters as neighbours	Galster *et al.* (1999)
	Demographic	Ethnicity (or co-ethnicity) of neighbours	MacPherson and Sirmans (2001), Cervero and Duncan (2004),
		Crime	Schwartz *et al.* (2003)
		Nuisance and vandalism	Li and Brown (1980)
Exit choice	Accessibility	Travel time to workplace	WClark and Withers (1999)
	Amenities	Schools	Bartik *et al.* (1992)
		Public services, tax base	John *et al.* (1995)
	Physical/land-use	Dilapidation	Landale and Guest (1985)
	Socio-economic	Income of neighbours	Lahr and Gibbs (2002)
	Demographic	Lack of social ties	Landale and Guest (1985), Kan (2007)
		Crime	South and Crowder (1998)
		Ethnicity (or co-ethnicity) of neighbours	Lahr and Gibbs (2002)
Destination or residential location choice	Accessibility	Travel time to workplace	Anas and Chu (1984), Sermons and Koppelman (2001)
	Amenities	Schools	Kim *et al.* (2005)
		Public services, tax base	Dowding and John (1996)
	Physical/land-use	Population density	Kim *et al.* (2005)
	Socio-economic	Income of neighbours	Sermons and Koppelman (2001), Guo and Bhat (2007)
		Household type of neighbours	Sermons and Koppelman (2001), Guo and Bhat (2007)
		Owner-occupation	Guo and Bhat (2007)
	Demographic	Ethnicity (or co-ethnicity) of neighbours	Clark (1992), Ellen (2000), Waddell (2006)

trained to think of them as objective standards for housing quality, as is evident from the explanatory power of structural characteristics of the dwelling in residential satisfaction, residents' subjective valuation of their housing quality (Landale and Guest, 1985; Lu, 1998 and 1999).[23] In contrast, neighbourhood attributes have no uniform standard of measurement. Accessibility, land use and environmental features and amenities are cast into distance decay or gravity functions that produce densities, distances or travel times

23 Alternative approaches to modelling the relationship between attributes and housing quality that try to explain the ways in which households derive residential satisfaction from the structural characteristics include compositional models, conjoint models and decision nets (Timmermans *et al.*, 1994).

(Fotheringham, 1981).[24]

Statistics on socio-economic, physical and demographic features are provided by statistical agencies as means of observation within specific census tracts, postal code areas, administrative neighbourhoods or other administrative areal units.

Residents' perceptions of neighbourhood attributes need not have much in common with the way in which they are measured. Spatial displacement opens up the possibility that some households will not perceive a given attribute. Rivers, railways, open spaces and roads ensure that Euclidean distances are at best an approximation for the real use of space. Differences in modes of transport and the directional bias of households make travel times less reliable as predictors of accessibility (Cooke and Ross, 1999). Neighbourhood statistics are often stock measurements for flow variables, such that the attributes could have changed value by the time that their measurements are published. Furthermore, the statistics discard the spatial variation inside the areal unit over which they are aggregated, and the unit's artificial boundaries cut through the residential environment that some households experience (Openshaw, 1984). This 'modifiable areal unit problem' can affect the correlation between the statistic and the concept (i.e. neighbourhood quality) that it is intended to explain (Amrhein, 1995).

The attributes that shape neighbourhood quality can give rise to specification problems when they enter revealed preference models as explanatory variables. Complexity is inherent to all 'soft systems' that explain human choice behaviour in an uncertain environment (Stewart and Ayres, 2001). The socio-economic and demographic attributes that underlie the intangible, dynamic and largely unobservable social quality of an area may interact in a complex fashion (Marans and Rodgers, 1975). In an analysis of the Rotterdam owner-occupied market, Kauko (2002) showed that the effects of intangible (and some tangible) attributes on house prices change from one neighbourhood to the other. While the measurement and specification problems can obscure the strength and range of neighbourhood push and pull effects, they should affect the estimation of the exit choice and the destination choice in the same way. Measurement and specification problems do not explain why neighbourhood pull effects are more ambiguous than are the corresponding push effects.

A further comparison between the neighbourhood push and pull effects in residential mobility models reveals two further inconsistencies. As a rule, the pull effects of socio-economic and demographic attributes tend to be weaker than the corresponding push effects (Dowding and John, 1996; Newton, 1997).

24 Some geographers point out that households do not trade off housing quality for access to amenities or jobs, but that they ensure that the distance covered does not exceed a given threshold (Getis, 1969; Koenig, 1980).

In the most comprehensive destination choice model to date, some pull effects on the same attribute are present at more than one spatial level (Guo and Bhat, 2007).[25] According to some geographers, it is the search for vacancies that distinguishes the exit choice from the destination choice. In the geographical literature, it has been stated that households face access constraints with regard to information about the availability of vacancies. The cost of information-gathering leads to the adoption of spatial search strategies (Huff, 1986) and stopping rules in order to reduce the duration of search (Flowerdew, 1976). Among the search strategies, the area-based model assumes that households search for vacancies within a preferred geographical submarket (Smith *et al.*, 1979). The search space is defined by key-activity places in the anchor points model, and the availability of vacancies of the preferred type in the constrained choice model (Huff, 1986). The household selects the vacancy with the seemingly best price-quality relationship from within its limited choice set, abandoning better alternatives outside of the search space or dwellings that become available in the future (Wolpert, 1966).[26] The reason why geographers' search leads to a different outcome than the standard economic model is the less than complete information that households collect on the availability of vacancies. In my opinion, there should be little room for disagreement regarding the availability of vacancies if households have unlimited access to advertisements for and listings of vacancies.

The advertisement or listing of vacancies provides detailed information on the structural characteristics, price (or rent) and location of each dwelling. Once a suitable vacancy is found, inspection seems a necessary condition for acceptance (Barrett, 1973; Habib and Miller, 2005). After this visit, the household should have a reasonable idea of observable attributes, which include the actual dwelling, accessibility, amenities and services that cater to both insiders and outsiders, the physical features of the area and even less tangible aspects such as the area's atmosphere (Kauko, 2007). The most likely candidates for incompleteness then, are the amenities or services that cater to the local populace (e.g. local shops, primary schools) and, more importantly, the 'soft' socio-economical and demographic attributes that shape the intangible, dynamic and largely unobservable social quality of the area.[27]

Although the social quality of an area can be guessed through word of

25 The neighbourhood pull effects addressed in the study by Guo and Bhat have a range of 0.4 kilometres or more. This range extends far beyond the range of the surroundings that residents experience, which lie somewhere between 0.1 and 0.25 kilometres (Coulton *et al.*, 2001; Goetgeluk and Wassenberg, 2005).

26 In geographers' search, households display 'satisficing' instead of optimising behaviour. This means that the household selects the seemingly best option from amongst the known alternatives, although this choice may not be optimal with respect to its preferences (Simon, 1991).

27 Social quality has two dimensions: social fabric and social climate (Adriaanse, 2007). Social fabric relates to the area's demographic make-up, while social climate depends upon the frequency and nature of the social interactions amongst the residents.

mouth or statistics, it must be experienced rather than observed to obtain the full picture. Living experience ensures that residents learn who their neighbours are and how they interact with one another. This 'inside view' of residents probably comes closest to full information concerning the social and physical quality of the home surroundings. The spatial scale that residents have in mind for their surroundings is the block level, an area covered by a short walking distance from the home (Coulton *et al.*, 2001; Goetgeluk and Wassenberg, 2005).

The underlying demographic and socio-economic attributes remain hidden to the casual glance of outsiders. The quality of amenities and services that cater to the local populace may also go unobserved. As long as households do not observe all aspects of housing quality, they run the risk of buying or renting a lemon (Akerlof, 1970), a dwelling whose user value falls short of its price.

A house-seeker must trade off the costs of information-gathering about the quality of offers against the reduced risk of ending up with a lemon. Spatial search strategies do not simply reduce the costs of finding vacancies. They also limit the amount of information that needs to be collected on distant neighbourhoods. In adopting area-based or constrained choice strategies, house-seekers need only become familiar with areas inside their search spaces. House-seekers can save further costs by searching close to key-activity places or by using the quality of nearby areas that they know well as an estimate of neighbourhood quality elsewhere. With friends, family or acquaintances living in the area, house-seekers can obtain the inside view at a low cost. Indeed, many households search near their old homes (Barrett, 1976) and key-activity places (Huff, 1986; McHugh, 1984). The completeness of information that residents transmit to house-seekers depends on their credibility as witnesses and whether they withhold information (whether deliberately or by accident). Inter-urban movers often initiate repeat moves (Short, 1978) and tend to pay more for dwellings than intra-urban movers do (Lambson *et al.*, 2004), thereby revealing their lack of knowledge of the geographical submarket when they settled there.

The scarce empirical evidence on search behaviour thus points towards the density and extent of the social network, the distance of the move and previous experiences in the area as grounds for utility gains following a move. It is a small step to assume these gains are made through superior knowledge of the unobservable attributes of the neighbourhood, given that advertisements, listings and inspection of the vacant dwelling and its neighbourhood are open to all. House-seekers must choose between various sources of information in order to learn about the unobservable neighbourhood quality, if their own experience is lacking.

Own experience or reliable witnesses may yield a realistic picture of an area at the appropriate spatial scale. Statistics and the quality of nearby areas further aid house-seekers in their assessments of neighbourhoods when own

experience or witnesses are absent. Information on a spatial object (such as the home surroundings) is incomplete when the content of the information is corrupted or when the scale of the object to which it pertains is ill-defined (Egenhofer and Sharma, 1993). Statistics on a given neighbourhood attribute are usually incomplete for a number of reasons: the statistics need not correspond to the notion that residents have of the attribute; the statistics refer to a state in the past, their range usually extends beyond the home surroundings (i.e. the modifiable areal unit problem) and their range is fixed, while a fuzzy range is needed in order to cover the shifting contours of some of dynamic attributes (Openshaw, 1984; Peuquet, 2001). Extrapolation of the quality of a nearby area can lead to incomplete information, as the area might touch or even overlap with the home surroundings, although the two areas seldom match (Egenhofer and Sharma, 1993).

Incomplete information is not without merits. Statistics and extrapolation may provide a house-seeker with an accurate picture of the average quality of an area, the range of which covers part of the surroundings of the offer. Although this may lead to the overestimation or the underestimation of neighbourhood quality at the exact location, such errors are random and could even be negligible, if local differences in neighbourhood quality are small. The interpretation of statistics, however, requires some degree of sophistication, given that even trained researchers find this difficult. Other sources of information include the media, realtors and public opinion, all of which shape the common perception of the neighbourhood or, in other words, the neighbourhood reputation.

A reputation in economics, psychology or computational sciences is the anonymous, social evaluation of an object (Sabater and Sierra, 2005), which is used to minimize the costs of gathering information about its attributes (Weizsacker, 1980; Aberer *et al*., 2006). Reputations do not depend on isolated attributes, but on the composite 'brand', 'label' or 'name' of the object (Bettman, 1979). These labels reveal something about the persistence (or persistent lack) of quality of an object (Stigler, 1961). In sociology, a neighbourhood reputation is seen as the 'shared voice' about an area that is communicated in public opinion and the media (Suttles, 1972; Permentier, 2009).

Combining the two notions, neighbourhood reputation is defined here as the outsiders' view on the unobservable quality of the area (social or otherwise), taking heed of the fact that, unlike in the inside view, the anonymous evaluator (or evaluators) cannot be identified. Neighbourhood reputations relate to such labels as 'prestigious' (Semyonov and Kraus, 1982), 'pleasant' (Kauko, 2007), 'ethnic', 'working-class', 'middle-class' or 'unsafe'. These labels tell something about the way in which the general public views the social circumstances in an area and the socio-economic status of its inhabitants.

Neighbourhood reputations are determined by socio-economical and demographical attributes of the area rather than by its physical attributes. The

determinants of reputations seem almost self-explanatory: low income, high crime and an ethnic minority in the neighbourhood (Permentier *et al.*, 2011) or reported crime in the media (Kaliner, 2008). In a rare economic study on the subject, the effect of cleanup of polluted sites on house prices was examined (Messer *et al.*, 2006). The longer the cleanup was delayed, the greater the likelihood that prices did not return to levels at the date when pollution was first announced. The authors attributed this to the poor reputation of (formerly) polluted areas.

Neighbourhood reputations are a potential source of bias. If reputations are indeed 'simplified images expressed as sharp boundaries and exaggerated differences between neighbourhoods as noted by outsiders' as sociologists assert (Suttles, 1972; Permentier, 2009), then reputations are prone to the anchoring effect (i.e. putting too much weight on an isolated trait of a neighbourhood; Ellen, 2000) and distinction bias (i.e. exaggerating differences between neighbourhoods; Bell *et al.*, 2006) at the very least.

Sociologists have focused primarily on negative bias in the form of the stigmatisation (e.g. Forrest and Kearns, 1999; Hastings, 2004; Permentier, 2009; Wacquant, 2008). Exit rates are believed to be higher in stigmatized areas due to the 'third-party effect', the detrimental effect that stigma has on the well-being of residents (Tsfati and Cohen, 2003; Permentier *et al.*, 2008). Stigmas are maintained over a long period of time (Hastings, 2004). It is also possible for well-reputed neighbourhoods to be overrated. The presumed persistence of quality could have been overtaken by developments unknown to the outside world. The role of expectations in the construction of reputations means that neighbourhoods that are thought to be in decline are deemed less attractive, while the reputations of neighbourhoods that are believed to be in upturn are enhanced, even though actual circumstances need not confirm these expectations (Ellen, 2000). Gentrifying areas sometimes experience a sudden improvement in name (Ley; 1986, 1994).

The spatial scale of neighbourhood reputation depends upon outsiders' notions of a meaningful areal unit. In the Dutch context, this is usually the scale of the administrative neighbourhood. Media, realtors, statistical agencies, municipalities and public opinion agree on the size of neighbourhoods, as they have adopted the historical growth pattern of cities as a benchmark (Hortulanus, 1995). The successive ranking of competing neighbourhoods based on their respective reputations yields a 'neighbourhood hierarchy'. This hierarchy is unequivocal in the sense that, although a household may not know the reputation of all city neighbourhoods, the ranking of reputations that it does know conforms to the hierarchy (Hortulanus, 1995; Permentier, 2009). The hierarchy is non-binding, meaning that a household may be aware of a reputation without letting this knowledge influence its decision-making.

Quantitative sociological research has little to say on the question how neighbourhood reputations are constructed and maintained. The most defin-

itive answer given, relates to the spatial scale of reputations, that of the administrative neighbourhood. The key assumption is that outsiders perceive that the odds of buying (or renting) a lemon are smaller in administrative neighbourhoods that are reputed to be pleasant or in upturn, as these labels point towards the 'right type' of residents and residential environment.

Incomplete information is better than no information at all. This does not explain why house-seekers make use of reputations in their destination choices, if they are aware that the information can be biased. The next section reveals how the use of biased information in the destination choice is a viable alternative to the use of incomplete, unbiased information.

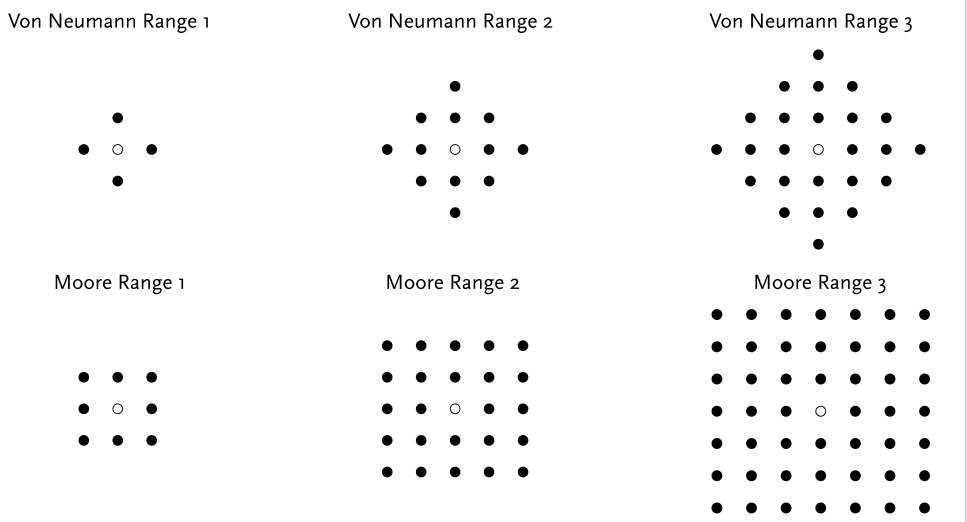
2.7 The meaning of neighbourhood reputations

Schelling's tipping model of segregation is arguably the most important contribution of computational modelling to the urban studies. This simulation model abstracts from the price and attributes of the dwelling and focuses on the role of the social distance to neighbours in residential mobility. The human predisposition toward affinity and sociability explains why similarities (or dissimilarities) in income, ethnicity, educational achievement or lifestyle act as push factors for residents and pull factors for house-seekers (Hawley, 1968). Many households aspire to reduce social distance to neighbours, due to sympathy for their own in-groups (Bogardus, 1926) or negative feelings towards out-groups (Durkheim, 1982). Households sort between areas according to shared norms and values, their wish to achieve a certain socio-economic status and their prejudices (South and Crowder, 1998; MacPherson and Sirmans, 2001; Gibbons, 2003; Cervero and Duncan, 2004; Guo and Bhat, 2007 and Clark and Fossett, 2008).[28]

In Schelling's simulation model, each agent belongs to a group. Agents are first assumed to hold complete information on the group membership of all other agents. In the initial state of the simulation, each agent randomly occupies a box on a two-dimensional grid. The agent's utility rises with the number of same-group neighbours. When the number of opposite-group neighbours exceeds a threshold, however, the agent becomes dissatisfied. In each run of the simulation, a dissatisfied agent is selected at random and allowed to move to a vacant box. In the next run of the simulation, another dissatisfied agent is selected. The simulation continues until the point that

28 Despite the vast literature on 'neighbourhood effects', including the effect of neighbours' housing consumption on residents' own consumption (Ioaniddes and Zabel, 2003), it is unclear whether the indirect benefits or costs of having the 'right' or 'wrong' type of neighbours (in terms of health, school achievement, access to labour market and participation in crime) are real, or whether they reflect socio-psychological beliefs and attitudes and their effects on residential sorting (Galster, 2001; Dietz, 2002; Durlauf, 2004).

Figure 2.5 Von Neumann and Moore neighbourhoods



Source: Weisstein, 2008

moves are unwanted, because all agents are satisfied, or further moves become impossible, because all desirable destinations have been taken.

Complete information

I follow the algorithm of Pollicott and Weiss (2001) in order to formalise Schelling's model. This algorithm surpasses others in its simplicity, without compromising Schelling's results. The agent's utility is calculated over a Von Neumann neighbourhood with a range of 1 under complete information (see Figure 2.5).[29] The two categories of agents are of equal size, with whites receiving label (l) 1 and blacks receiving label -1. Each agent occupies a box in a twenty-by-twenty grid containing 400 boxes, 10% of which are vacant (with label 0). A white agent will want to move if less than half of the neighbours are white, whereas a black agent will want to move if less than half of the neighbours are black.[30] The transition rule for the original version of the tipping model is presented by (Pollicott and Weiss, 2001; Weisstein, 2008):

29 The number of neighbours decreases to three on the edges of the grid and to two in the corners. The construction of a torus-like topology (i.e. a grid without edges) does not change the results (Fossett and Warren, 2005).

30 This 50/50 rule mimics real-life residential sorting behaviour in the US. White flight is triggered when the percentage of whites falls below 50 %, with whites tending to relocate to areas in which at least 70% of the residents are white (Laurie and Jaggi, 2003; Clark and Fossett, 2008).

(2.15)

$$\mathrm{U}(s_{ij}) = \sum l(s_{i+m,\,j+n}) \;\; \text{where } 0 < |m| + |n| \leq 1\} \text{ and } s_{ij} \in O$$

$$\text{if } l(s_{ij}) = 1 \Rightarrow \text{move to pq if } U(s_{ij}) < 0 \wedge U(s_{pq}) \geq 0$$

$$\text{stay if } U(s_{ij}) \geq 0 \vee U(s_{pq}) < 0 \;\; \text{for every } s_{pq} \in V$$

$$\text{if } l(s_{ij}) = -1 \Rightarrow \text{move to pq if } U(s_{ij}) > 0 \wedge U(s_{pq}) \leq 0$$

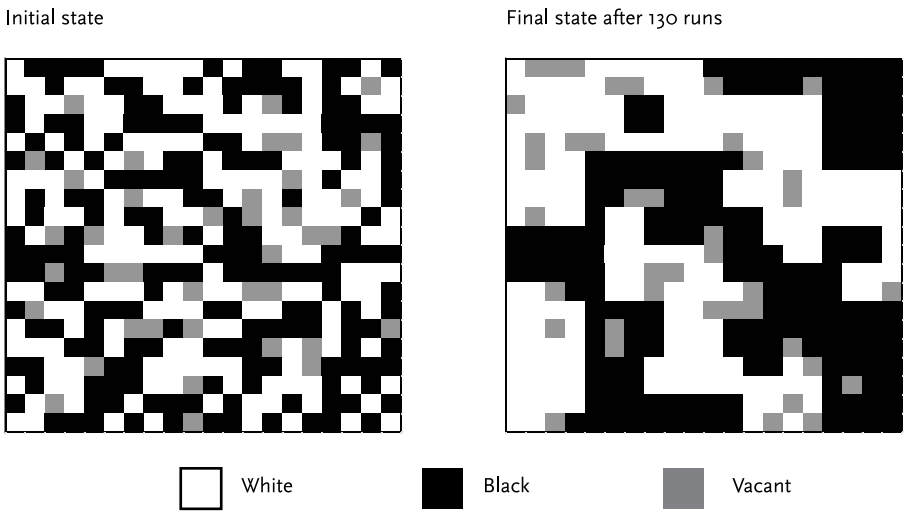
$$\text{stay if } U(s_{ij}) \leq 0 \vee U(s_{pq}) > 0 \;\; \text{for every } s_{pq} \in V$$

In this formula, s_{ij} denotes the box in row *i* and column *j* of the grid, which is a member of the set of occupied boxes *O*. If the white agent's utility, the sum of labels in the four adjacent boxes, is lower than zero, or if the black agent's utility exceeds zero, then the box s_{pq} in row p and column *q* is selected at random from the set of vacant boxes *V*. The utility in the vacant box must be equal to or higher than zero for a white agent to consider it as a suitable destination, and lower than or equal to zero for a black agent. The agent moves to an empty box, while its old box s_{ij} is vacated. A subsequent run is initiated in which another dissatisfied agent is allowed to move. The simulation continues until an equilibrium state is reached. Figure 2.6 presents a random configuration at the beginning of a simulation and the equilibrium at the end.

The final state of the simulation depicts what Schelling purported to show: discriminatory practices are not needed in order to explain residential segregation. Even though households are content to live in areas with a mixed population, their atomistic actions lead to segregation in the aggregate. The dynamics of the tipping model are well understood (Vinkovic and Kirman, 2006). Agents who live in mixed areas or in the border regions between black and white clusters are more likely to move. Their destinations are in regions that are more homogenous within the social fabric than their old locations were. The increased incidence of exits in mixed regions and the directional bias of movers fuel the segregated outcome. The direction of the first few moves has a large impact. Tipping can go either way: mixed areas become predominantly white or black, depending upon which type of agent first settles in the vacant box, thereby shifting the delicate balance between the groups (Meen and Meen, 2006).[31]

31 Schelling's outcome proves robust for a range of modifications; if one or both groups harbour same-group preferences (Fossett and Warren, 2005), if the grid is enlarged (Fossett and Warren, 2005), if there are three instead of two groups (Zhang, 2004), or when the number of empty boxes is increased (Vinkovic and Kirman, 2006), results stays the same. Another modification is the pricing of locations based on the vacancy rate in the area. This does not alter the outcome, as long as the increase in utility from having more same-group neighbours is not offset by the higher price paid for more popular locations (Zhang, 2004).

Figure 2.6 Tipping model within complete information

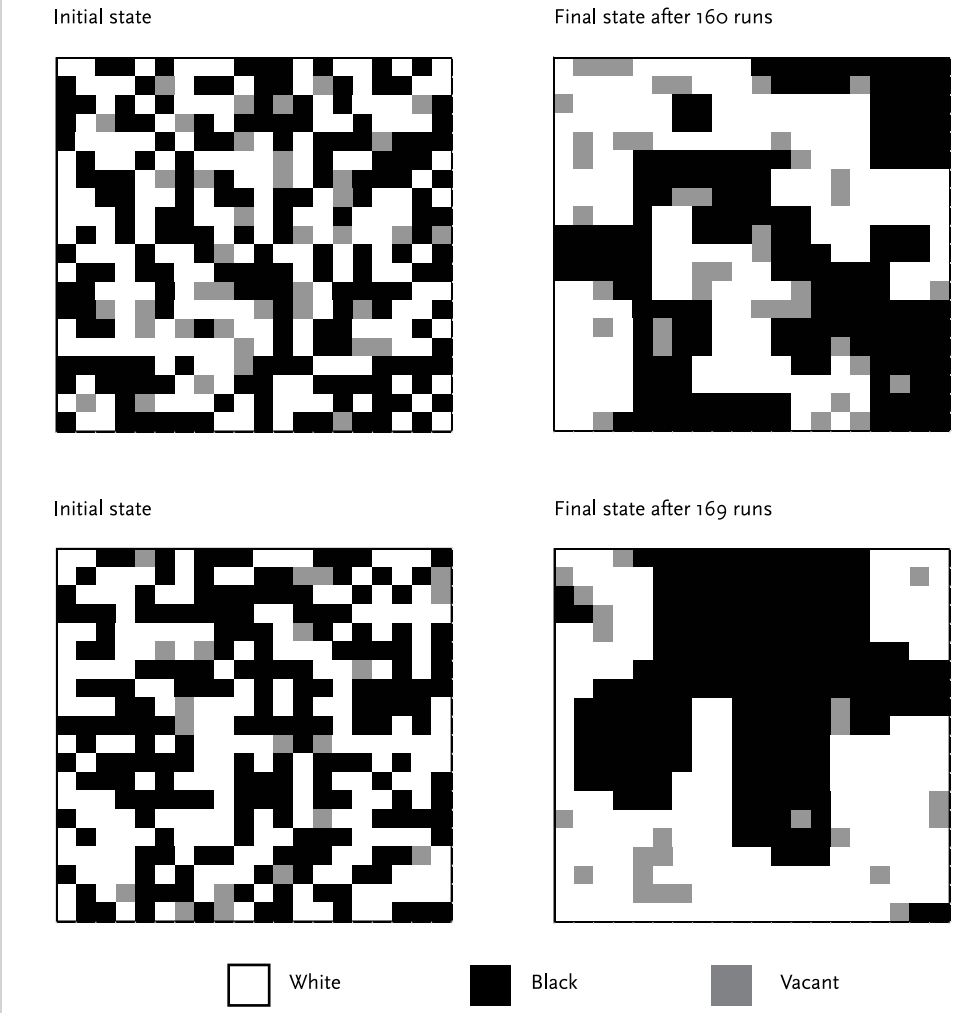


Schelling's model illustrates what standard economic analysis predicts as well: residential segregation is the expected outcome on a free housing market with complete information and zero transaction costs (Ekeland *et al.*, 2002).

Incomplete, unbiased information

House-seekers who cannot access inside information must rely on information that is incomplete by definition. One way of modelling incomplete, unbiased information is by increasing the range of the measurement of a spatial object beyond the range of the object itself (Egenhofer and Sharma, 1993). Expected utility in the tipping model is now calculated over a Von Neumann neighbourhood with a range of 3 and 24 neighbours (see Figure 2.6). The assessment can be either too high or too low for the neighbourhood around the vacant box. Because the overestimation or underestimation of utility is still a random figure, the information that agents use in their destination choices remains unbiased. The transition rule in this incomplete information regime reads as follows:

Figure 2.7 Tipping model with incomplete information



(2.16)

$$U(s_{ij}) = \sum l(s_{i+m,\,j+n}) \text{ where } 0 < |n| + |m| \leq 1 \text{ and } s_{ij} \in O$$

$$U(s_{pq}) = \sum l(s_{p+m,q+n}) \text{ where } 0 < |n| + |m| \leq 3\} \text{ and } s_{pq} \in V$$

$$\text{if } l(s_{ij}) = 1 \Rightarrow \text{ move to pq if } U(s_{ij}) < 0 \wedge U(s_{pq}) \geq 0$$

$$\text{stay if } U(s_{ij}) \geq 0 \vee U(s_{pq}) < 0 \text{ for every } s_{pq} \in V$$

$$\text{if } l(s_{ij}) = -1 \Rightarrow \text{ move to pq if } U(s_{ij}) > 0 \wedge U(s_{pq}) \leq 0$$

$$\text{stay if } U(s_{ij}) \leq 0 \vee U(s_{pq}) > 0 \text{ for every } s_{pq} \in V$$

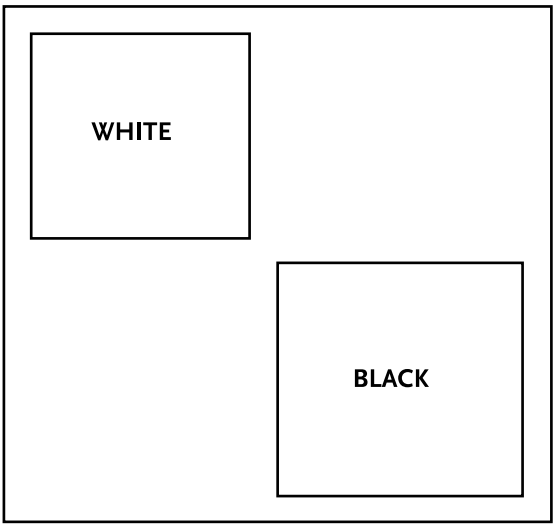
As illustrated in Figure 2.7, the use of incomplete, unbiased information has little or no effect on the outcome: the segregated clusters resurface. The main difference with the full information regime is that the number of runs in the simulation is increased, as some agents overestimate utility at the new location. Some of these agents initiate repeat moves, while their erroneous destination choices might trigger additional moves amongst the new neighbours. This result is not that surprising, as a thorough analysis of the work of Laurie and Jaggi (2003), who increased the vision of agents in both their exit and destination choices, revealed that, under reasonable assumptions, segregation is the expected outcome in the incomplete information regime (Fossett and Warren, 2005). With due caution, the conclusion states that the use of incomplete, unbiased information leads to random overestimation or underestimation of the quality of a location. Aside from increased turnover on the housing submarket, the sum effect on sorting is negligible, as moving households do not make mistakes all of the time, and even their mistakes can be mended in the course of time.[32]

Biased information

The use of neighbourhood reputations is the most likely cause of biased destination choices. It is modelled as a barrier or invitation to enter certain areas. In keeping with the previous analysis, the bias affects the behaviour of white agents. Two eight-by-eight areas (64 boxes) are designated as white or black (see Figure 2.8). In the 'white area', white agents will be willing to move to an empty box if the expected utility is equal to or greater than minus one. All empty boxes in the 'black area' will be avoided by white agents if the expected place utility is equal to or lower than one. White agents structurally overestimate utility in the white area and underestimate it in the black area. In all other regions, the choices of white agents, like those of black agents, are still made under the assumption of complete information. The transition rule is now given by:

32 The fact that inter-urban movers often initiate repeat moves (Short, 1978) corroborates this statement.

Figure 2.8 Designated areas



(2.17)

$$U(s_{ij}) = \sum l(s_{i+m,\,j+n}) \text{ where } 0 < |m| + |n| \le 1 \text{ and } s_{ij} \in O$$

$$U(s_{pq}) = \sum l(s_{p+m,q+n}) \text{ where } 0 < |m| + |n| \le 1 \text{ and } s_{pq} \in V = \{B;W;V - B - W\}$$

$$\text{if } l(s_{ij}) = 1 \Rightarrow \text{move to } s_{pq} \text{ if } U(s_{ij}) < 0 \wedge U(s_{pq}) \ge 1 \text{ if } s_{pq} \in B$$

$$\vee\, H(s_{pq}) \ge -1 \text{ if } s_{pq} \in W$$

$$\vee\, H(s_{pq}) \ge 0 \text{ if } s_{pq} \in V - W - B$$

$$\text{stay if } U(s_{ij}) \ge 0 \wedge H(s_{pq}) < 1 \text{ for all } s_{pq} \in B$$

$$\vee\, H(s_{pq}) < -1 \text{ for all } s_{pq} \in W$$

$$\vee\, H(s_{pq}) < 0 \text{ for all } s_{pq} \in V - W - B$$

$$\text{if } l(s_{ij}) = -1 \Rightarrow \text{move to } s_{pq} \text{ if } U(s_{ij}) > 0 \wedge U(s_{pq}) \le 0$$

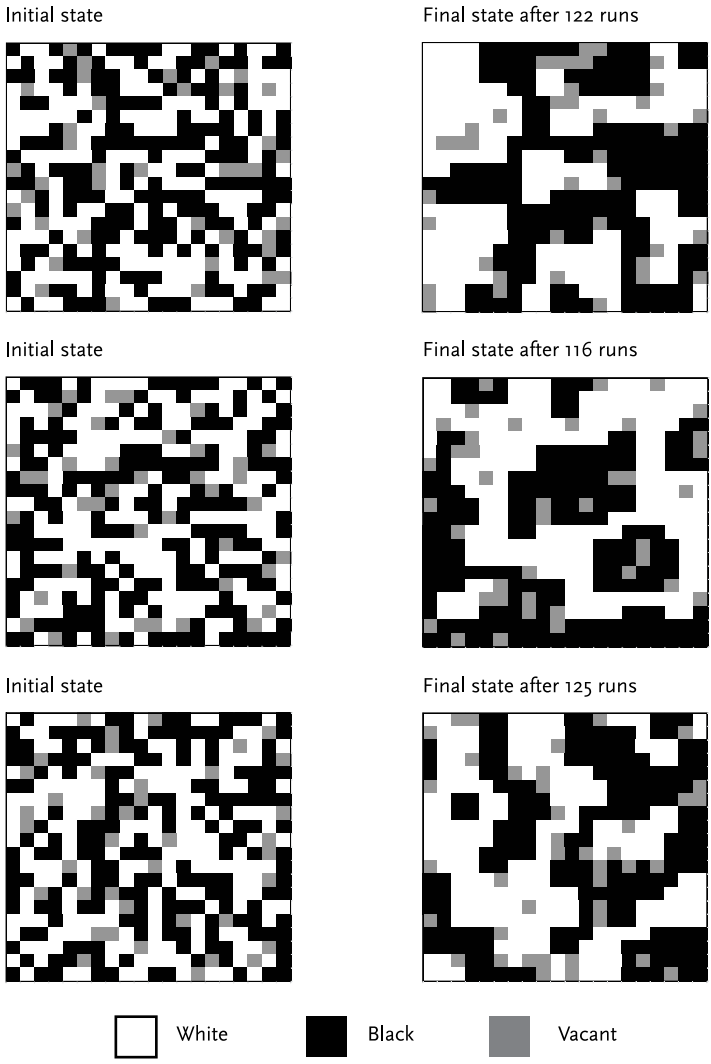
$$\text{stay if } U(s_{ij}) \le 0 \vee U(s_{pq}) > 0 \text{ for all } s_{pq}$$

B denotes the vacant locations in the black area, and W denotes the vacant locations in the white area.

A glance at the outcome of the simulation in Figure 2.9 clearly shows that the use of biased information leads to a directed form of tipping. Although tipping under complete information can go either way (Meen and Meen, 2006), the introduction of bias makes the white area turn predominantly white and the black area turn largely black.[33] White agents see an increase

33 The sum of labels in the white area in Figure 2.9 changes from 4 to 18, 0 to 19 and 0 to 12 in the simulations. The sum of labels in the black area is decreased from 3 to 2, 2 to -8 and 2 to -15.

Figure 2.9 Tipping model with biased information



in suitable destinations in the white area and a compensatory drop in suitable destinations in the black area. This increases white agents' likelihood of moving towards the white area, while they shun the black area. Black agents notice that vacancies are becoming scarcer in the white area, while opportunities to move to the black area increase, due to the directional bias of white agents.[34] Small white pockets inside the black area that require just one same-group neighbour to turn into a stable 'island' break up because no white agent is willing to fill this vacancy. In contrast, black islands in white areas can remain stable, as black residency in and entry into the white area

34 The introduction of bias among black agents would only reinforce segregation.

remains feasible. The reputation of an area thus lends a directional bias to the residential sorting of households.

The importance of the simulation in the biased information regime cannot be emphasised enough, as it provides a rationale for the use of reputations. Even though agents structurally overestimate utility at their destinations of choice, the subsequent moves of same-group agents ensure that utility conforms to their prior beliefs in the long run.[35] The reputation of an area as being in either upturn or downturn acts as a self-fulfilling prophecy.[36] The simulation proceeds in only one direction: from a random configuration to an equilibrium state. If some boxes are vacated in equilibrium, however, it is easy to see how reputations might also stabilise an area. Let group membership be defined by socio-economic status. When a high-income household moves, the likelihood that another high-income household will fill the vacancy is greater in a well-reputed area than it would be in an ill-reputed area. When a low-income household moves, its place is more likely to be filled by a high-income household in a well-reputed area and by a low-income household in an ill-reputed area. Pockets of prosperity in ill-reputed areas break up in the course of time, while pockets of poverty can be sustained in a well-reputed area, as long as poorer households are content to stay there and are not forced into selling their homes.

In a steady state, the neighbourhood reputation need not be biased at all: the average quality of the neighbourhood more or less conforms to the notion that outsiders have of it, although it may vary from one location to the other inside this area.[37] The reputational bias leads to the same efficient sorting between areas as in the unbiased, incomplete information regime, with the additional result that tipping can go in only one direction. The simulation thus demonstrates how biased reputations can be a viable alternative to the use of incomplete information in house-seekers' destination choices. In Schelling's own words (1960, p. 57), neighbourhood reputation yields a 'focal-point': a solution that seems natural to people in the absence of communication.[38] To paraphrase Schelling, a household with a high socio-economic status favours

35 A similar prediction was made by Yinger (1976) in a standard economic model.

36 A self-fulfilling prophecy is defined by the statement 'If men define situations as real, they are real in their consequences' (Thomas and Thomas, 1928, pp. 571).

37 This runs counter the idea in sociology that reputations are an unfair depiction of circumstances in the area. An area might still be stigmatised because of its physical isolation, such that moves to the area by uninformed households will be rare (Koopman, 2006).

38 Schelling (1960; p. 57) defines focal points as solutions 'for each person's expectation of what the other expects him to expect to be expected to do'. As an example, he specified a focal point for two strangers who are supposed to meet in a city on a given day: they meet at central station at noon. Another example involves the payoff for choosing the same colour when agents must choose between three cards of the same colour and one card of another colour. They naturally select the unique card. Schelling's focal point is a solution to the stag-hunt dilemma, as first described by Jean-Jacques Rousseau: two hunters must cooperate to kill a stag, but if a hare comes along, both of them are inclined to kill the hare for themselves (Skyrms, 2004).

prestigious and shuns ill-reputed areas, because it expects that other high-income households expect this household to expect that they will also move to the same area.

The simulation describes the basics of residential mobility on the Dutch social rental market, where group-membership is likely to be based on the life stage or ethnicity of tenants. As in the simulation model, the exit choices of social tenants are governed by near-complete information on their surroundings, while their destination choices are based upon expectations of the new neighbourhood. Although the regulated rent does depend upon the location of the dwelling, the rental increase corresponding to a rise in neighbourhood quality is very small. Gains in neighbourhood quality are largely translated into a rise in utility (Van Ommeren and Koopman, 2011). The similarity between the simulation and mobility in the social rental sector breaks down with the selection of a dissatisfied tenant. The selection procedure is based mainly on queuing: social tenants outbid one another based on either their duration of stay in another social rental dwelling or their registration time as a house-seeker. Schelling's results however, do not depend upon the order in which agents are selected to move.[39] The simulation shows how social tenants who are relatively ignorant about the quality of distant areas are drawn towards well-reputed neighbourhoods and that they shun ill-reputed neighbourhoods, even though (unbeknownst to them) the neighbourhood quality can be good in some places within ill-reputed neighbourhoods.

With several reservations, the simulation is also applicable to the Dutch owner-occupied market, where group membership is likely to be based on socio-economic status. One requirement is that the higher price paid for living in well-reputed areas does not deplete the gains in utility when moving there (Zhang, 2004). There are several reasons why buyers expect to make gains upon moving to a well-reputed neighbourhood. First, households do not increase their bids beyond what they think to gain from living in the area. Second, price reflects the willingness to pay of the marginal buyer, so that other buyers in the area still make gains in utility (Bayer and Ross, 2006).[40]

Another requirement is that the house price is not used as a signal for the unobservable quality of the offer. The plausibility of th requirement is discussed in the next section

39 The tolerance towards opposite-group neighbours governs the outcome of the simulation and not on the transition rule (Zhang, 2004). Integration occurs when agents are content with having less than 35 % same-group neighbours (Fossett and Warren, 2005).

40 The argument runs as follows: if identical dwellings are offered at once, the buyer must outbid the household that can afford to pay for the last dwelling in the batch. Buyers with income that is higher than that of the marginal buyer make gains in indirect utility (i.e. their consumer surplus).

2.8 Informational asymmetry on the owner-occupied market

The use of incomplete information in the destination choice can generate an informational asymmetry in the exchange of dwellings. The asymmetry between informed sellers and uninformed buyers entails that dwellings are priced based on the buyer's willingness to pay (Berliant and Yu, 2009). [41]

Poorly informed buyers may use the sales prices of similar type dwellings as an 'anchor' for the bid prices for their offers, the quality of which they do not fully observe (Northcraft and Neale, 1987; Genesove and Christopher, 2001). I assume that these buyers look for 'anchors' in the same neighbourhood, as the neighbourhood's name provides a simple rule of thumb by which the unobservable quality can be linked to a known exchange value. Suppliers have no incentive to reveal the user value of offers to poorly informed buyers, if the unobservable quality of their offer is worse than that of nearby vacancies (Merlo and Ortalo-Magné, 2004). Well-informed buyers have an incentive to go along with this 'cheating', because they can still select the offers that are underpriced. In this 'pooling equilibrium' (Rothschild and Stiglitz, 1976), the observable attributes are priced the same as they would be in the full information regime. The 'price tag' on the neighbourhood's name on the other hand, acts as a substitute for the exchange value of the unobservable quality of the area. No supplier offers less than the common price for the unobservable quality, while raising the price above this level leads to rejection, given that no information is conveyed to buyers by doing so.

I discussed two strategies that poorly informed house-seekers can use to overcome the asymmetry and avoid paying too much. First, they might rely on the neighbourhood's reputation. In the short run, they run the risk of selecting a dwelling that is overpriced. In the long run, however, their destination choice proves them right, as other ill-informed households of a similar socio-economic stratum move to the area as well. Second, house-seekers can learn about the user value of an offer at an endogenous cost. They may visit the area, invest in social ties or connect to various other sources of information (McLellan, 1977). The presence of well-informed and ill-informed house-seekers complicates matters for sellers. The offer of a dishonest seller may be rejected upon meeting up with an informed house-seeker.[42] The risk of re-

41 An existing homeowner will not offer a dwelling if its user value exceeds the sales price.

42 Rejection need not occur when the sales price can be lowered during negotiations (Díaz and Jerez, 2009). In a static model such as the one described here, however, the price of all lemons that are matched to informed buyers would have to be lowered. The quality of the remaining offers would then increase, and some dwellings would again be overpriced. The process of downward revisions continues until the point at which the quality of all offers is revealed, unless all informed buyers have been driven off of the market. A separating equilibrium is restored in the first case, while a segmented market emerges in the latter case, with a separating equilibrium in the segment that caters to informed buyers and a pooling equilibrium in the segment that caters to uninformed buyers.

jection could prevent sellers from overpricing offers. If no one is tempted to cheat, then the full information equilibrium is restored in what is called a 'separating equilibrium' in information economics (Spence, 1973). The price (or market rent) will then be the same as it would be in the full information equilibrium.

If the posited information gap between suppliers and at least some house-seekers is to be visible in the pull effects of the neighbourhood, then the house price or rent should not act as a signal for the unobservable quality of the area. Signalling is not a problem on the Dutch social rental market: the regulated rent is set with too little regard for neighbourhood quality (Van Ommeren and Koopman, 2011). Because signalling might be a problem for the house price models in Chapters 6 and 7, I must still show that there are feasible conditions under which a 'mixed equilibrium' exists (Rothschild and Stiglitz, 1976), in which all specifications of dwelling are priced the same, despite the fact that some buyers know the specification of an offer and reject it when its falls short of a desired level. A number of search models for the housing market are in existence that paint a realistic picture of the matching and negotiation process when sellers hold an informational advantage (Berliant and Yu, 2009; Díaz and Jerez, 2009; Albrecht *et al*., 2009). I use a simple housing transactions model in order to demonstrate the feasibility of a mixed equilibrium in which the price contains a reputational premium.

Pooling equilibrium

Assume that the house price is set by an ill-informed buyer's assessment of the unobservable attributes, such that all specifications of dwellings in the model presented in Section 2.3 are priced the same. Let p^* denote this pooled price. A homeowner (whose price-setting is followed by sellers who exit the submarket) can offer a dwelling for a price that is equal to the bid for the new home. The conditions for a move by a homeless person who becomes a first-time buyer and for a move by an existing homeowner are as follows:

$$E\{U(y-p^*;z)\} = \int U(y-p^*;z)\, f(z)dz \geq U(y;0) \quad \text{(2.18a)}$$

$$E\{U(y;z)\} = \int U(y;z)\, f(z)dz \geq U(y;\dot{z}) \quad \text{(2.18b)}$$

In these equations, y-p^* denotes the non-housing consumption and z denotes the housing consumption of a first-time buyer in formula (2.18a), while y and z denote housing and non-housing consumption of a transferring homeowner in (2.18b), and $\dot{z}$ denotes housing consumption if the homeowner decides to stay in the original dwelling. The function $f(z)$ is the (presumed) distribution of specifications on this particular submarket.

The integration of utility over z yields expected utility $E\{U\}$. The exits by homeowners who leave the submarket altogether and the exits by transfer-

ring homeowners define the pool of offers and thus the shape of the distribution function *f(z)*. The distribution function is skewed to the left in deprived and/or ill-reputed submarkets, as the average quality of offers is (deemed) lower in these areas.[43] According to formula (2.18a), a homeless person accepts an offer, if the expected utility from occupancy exceeds the utility from being homeless. Formula (2.18b) tells that the exchange of the old home for the new home prompts a move, as long as the homeowner expects to improve upon the specification of dwelling.[44] The homeowner is thus more likely to move when living in an inferior specification of dwelling or when homeowners who exit the submarket altogether lived in good specifications.

The house price equates the exits from the submarket with the entries by formerly homeless parties. The pooled price can be raised until the point at which the marginal first-time buyer's willingness to pay is exhausted. The remaining homeless are either forced to remain homeless or to move to a less attractive submarket. The pooled price is therefore lower in ill-reputed areas, as the marginal buyer's willingness to pay decreases with the expected quality of offers. The number of homeless who are willing to buy is also lower in ill-reputed areas, as the expected benefits of moving are lower in these areas. Finally, turnover is lower in ill-reputed areas, as fewer homeowners in the area expect to improve upon housing quality when they move. All in all, the model produces sensible results for the pooling equilibrium, thereby building confidence that equally sensible results can be obtained for the mixed equilibrium.

Mixed equilibrium

Now assume that (2.18a) holds for some of the homeless and that (2.18b) holds for at least one homeowner. The first assumption is a necessary condition for a mixed equilibrium to emerge: if none of the homeless are willing to move, then the pooled price remains undefined. The second assumption is superfluous, but it is imposed so that the behaviour of transferring homeowners can be studied. Buyers are now allowed to learn about the user value of offers. One way of doing this would be to introduce an endogenous cost of information-gathering or search cost c to the model (Fishman and Simhon, 2000). The buyer will incur the search cost and accept the offer if the user value (minus the search costs) is at least as high as the benefits from being homeless or staying in the old home. A further requirement is that buyers who enter the negotiations do not transmit information to other buyers, so

43 Suppose that the best and the worst specification are both available in two neighbourhoods. With the same upper and lower bound for z the average specification of dwelling *E{z}* must then be lower in the neighbourhood in which the fraction of inferior dwellings is higher (i.e. the ill-reputed neighbourhood).

44 I assume risk neutrality here. Under risk aversion, the average specification of the new home must be higher than the specification of the old home in order for a move to take place.

that their rejections go unobserved. An existing homeowner's move is made conditional upon the sale of the old home. If the homeowner rejects the offer of another seller, the earlier agreement with the buyer of the original offer becomes void, such that the homeowner is allowed to stay in the old home.[45]

The case in which all buyers remain ignorant due to excessive search costs is not of interest here: the pooled equilibrium is then reinstated. When all buyers are informed, the complete information equilibrium is restored. I am interested in a mixed equilibrium in which some buyers become informed, while others remain ignorant about the specification of offers. The condition for a first-time buyer to be informed reads as follows:

(2.19a)

$$\int_{\underline{z}} U(y - p^* - c; z)\, f(z)dz + \int^{\bar{z}} U(y - c;0)\, f(z)dz \geq \int U(y - p^*; z)\, f(z)dz$$

$$\bar{z} \text{ defined by } U(y - p^* - c; \bar{z}) = U(y - c;0)$$

The benefits of being informed (left-hand side of formula (2.19a)) decrease as search costs increase. Faced with moderate costs, a homeless person will become informed, provided that the expected utility from rejecting overpriced offers exceeds the utility from living in these lemons. This requires that the presumed fraction of lemons on the submarket (i.e. $F(z < \bar{z}) = \int^{\bar{z}} f(z)dz$) is sizeable enough for rejection to be considered as a viable strategy. The distribution function is skewed to the right in well-reputed areas. It is therefore less necessary for the homeless to inform themselves about the quality of well-reputed areas, as lemons are scarce in these areas. Now suppose that a fraction of the homeless (i.e. those with costs $0 \leq c \leq \overline{c}\ (y;p^*)$ where $\overline{c}\ (y;p^*)$ turns (2.19a) into a strict equality) is informed. The informational advantage then enables them to reject the lemons (i.e. all $z < \overline{z}$).

A transferring homeowner is randomly matched to a buyer in the model.[46] If this homeowner meets up with an ill-informed buyer, it will be possible to complete the exchange. This will not always be the case if the transferring homeowner is matched to an informed buyer. A well-informed homeless per-

45 In an alternative arrangement of the matching process, the homeowner is allowed to buy a new home and wait to see if the offer is accepted (Wheaton, 1990). In this case, homeowners run the risk of being stuck with two dwellings. In this arrangement, homeowners have no need to be informed. The ability to hold on to the (superior) old home insures against the acquisition of a lemon.

46 In a model with non-random matching, the informed house-seeker first sifts out the lemons prior to making a bid. Results stay the same as described in the text, with one notable difference. If too many buyers become informed, then the remaining offers are probably lemons. Uninformed buyers may then decide not to enter the market. The number of informed buyers must therefore remain below a given threshold in order to prevent a separating equilibrium in this arrangement.

son will reject an offer if occupancy does not improve upon homelessness. A well-informed homeowner will reject offers with specifications that are worse than that of the current home. The condition to be informed in the case of the homeowner who completes the exchange reads as follows:

(2.19b)

$$\int_{\dot{z}} U(y-c;z)\,f(z)dz + \int^{\dot{z}} U(y-c;\dot{z})\,f(z)dz \geq \int U(y;z)\,f(z)dz$$

Condition (2.19) states that the homeowner's utility from rejecting overvalued offers (all $z<\dot{z}$) must be higher than the expected utility from living in these lemons, if the homeowner is to become informed. Furthermore, the search costs should not be so high that the benefits from rejection are exhausted (i.e. $0\leq c\leq \overline{c}\ (y;\dot{z})$; where $\overline{c}\ (y;\dot{z})$ turns (2.19b) into a strict equality). The condition then specifies that the likelihood to move decreases on two counts when the homeowner lives in a good specification of dwelling: the gains from moving are smaller and the homeowner is more likely to be informed, thus becoming more likely to reject offers. As with the homeless, homeowners have no need to be informed when moving to well-reputed areas, as lemons are deemed scarce in these areas. The final result worth mentioning is that the exact cost $\overline{c}\ (y;\dot{z})$ that makes a homeowner indifferent between being informed or staying ignorant increases with the specification of the current home. The more that is at stake in the exchange of dwellings, the more can be gained from rejecting overpriced offers and hence the better informed a transferring homeowner should be.

The simulation model presented in Section 2.7 revealed that tenants who are ignorant about the quality of distant areas are drawn towards well-reputed neighbourhoods and that they shun ill-reputed neighbourhoods. Moves to ill-reputed neighbourhoods obviously do take place in cases in which tenants have few other options to obtain a dwelling or when the rent-quality relationship of the observable aspects of the dwelling and neighbourhood are sufficient. Table 2.2 summarises the results of the model for housing transactions in this section. It predicts an outcome for the owner-occupied market that is similar to the outcomes of the simulation discussed in the previous section. In the transaction model, however, the choice set is slightly richer than that included in the simulation model: some buyers are now able to acquire inside information, which allows them to reject the offers that are overpriced.

Buyers who cannot distinguish between offers that are underpriced or overpriced are similarly unlikely to move to ill-reputed areas voluntarily, and they also prefer to live in well-reputed areas. The main condition for the emergence of a mixed equilibrium in which the sellers of lemons cheat at the expense of ill-informed buyers is for the neighbourhood to have an interme-

Table 2.2 Reputation, information-gathering and type of move

		Neighbourhood reputation		
		Bad	**Intermediate**	**Good**
Search cost	Low	Involuntary move	Informed move	Uninformed move
	High	Involuntary move	Uninformed move	Uniformed move
Price equilibrium		Indeterminate	Separating/Mixed	Pooled

diate reputation. Ill-reputed neighbourhoods attract few voluntary movers, while no one sees much benefit in learning about the quality of neighbourhoods in which lemons are deemed scarce. Buyers of dwellings in neighbourhoods with intermediate reputations can exploit their informational advantage by accepting offers that are underpriced. [47]

Buyers who live in dwellings with a good price-quality relationship face greater risks in the exchange, thus having stronger incentives to become informed. Similar results should hold for tenants who must transfer from another social rental dwelling. On average, the destination choices of well-informed buyers and tenants will be superior to those of ill-informed buyers and tenants, who bid the same amount for the offers but who usually receive less user value in return

2.9 Conclusions

The theoretical analysis in this chapter can be summarised as follows. The transactions model presented in Section 2.8 demonstrated that a vacancy is considered a suitable destination when the quality of the surrounding area is sufficient. The main reason why households nonetheless move to ill-reputed areas is that they cannot obtain dwellings elsewhere or because the price-quality relationship of the observable aspects of housing quality is sufficient. Selecting destinations in well-reputed neighbourhoods is a worthwhile strategy for buyers or tenants who do not know the quality of the surrounding neighbourhood. The simulation model presented in Section 2.7 showed that house-seekers from a similar social-economic stratum perpetuate the social quality of a neighbourhood by moving there (or shunning it) as well. Neighbourhood reputation thus acts as a self-fulfilling prophecy: the social quality of well-reputed (ill-reputed) neighbourhoods remains high (low), as long as households with a higher (lower) social-economic status believe that the neighbourhood's name is well-founded and as long as they continue to move to (shun) the area.

Buyers and tenants who move over short distances, who search near key-activity places or who have social ties in the area retain inside information.[48] The inside information that they have of their surroundings is nonetheless of little use to them when moving to another neighbourhood. House-seekers who face considerable losses (in terms of utility, money or waiting time) up-

47 Comparable results were obtained by Chorus and Timmermans (2007) in a model for consumer choice under uncertainty. The authors concluded that the utility of acquiring information on a good is greater when the price-difference with other goods is small and when brand loyalty is low.

48 Moving entails a destruction of 'information capital'.

Figure 2.10 Conjectures

Conjecture	Derived in	Tested in
C1: The range of neighbourhood pull effects in the destination choices of households should be higher than the range of neighbourhood push-effects in their exit choices.	Section 2.6	Chapters 3 and 4
C2: Tenants (and owner-occupiers) who move over shorter distances should be able to realise greater gains in neighbourhood quality than do long-distance movers.	Section 2.8	Chapter 5
C3: Transferring tenants should be able to realise greater gains in neighbourhood quality than do first-time tenants, especially when they live in dwellings with a favourable price-quality relationship.	Section 2.8	Chapter 5
C4: The administrative boundaries of the neighbourhood may have an influence on house prices.	Sections 2.7 and 2.8	Chapter 6
C5: A name change of the neighbourhood may influence house prices.	Sections 2.7 and 2.8	Chapter 7

on making erroneous destination choices have stronger incentives to be informed about distant neighbourhoods.[49] As demonstrated in Section 2.8, one such group includes households who must exchange another dwelling with a good price-quality relationship. Short-distance movers and transferring households should therefore be better informed than long-distance movers and first-time buyers or tenants are. The acquisition of inside information allows them to discard the lemons among the offers. Ill-informed buyers and tenants pay the penalty: although they bid the same amount, they usually end up with offers that are overvalued on the social rental segment and overpriced on the owner-occupied segment of the housing market.

The informational asymmetry between residents and informed house-seekers on the one hand and ignorant house-seekers on the other hand gives rise to a set of conjectures, which are tested in the regression analyses in the coming chapters (see Figure 2.10).

First, the incomplete (and possibly biased) information held by the average house-seeker can be opposed to the inside view held by residents. Information on the neighbourhood can be incomplete when house-seekers adopt a spatial scale for the neighbourhood that is higher than the scale that residents have in mind for their surroundings. The estimated push effects of the neighbourhood in an exit choice model for social tenants in Rotterdam (Chap-

49 This constitutes another reason (see Footnote 21) for why the price-quality relationship of the old home might have an influence on the destination choice.

ter 3) are compared to the pull effects in the demand for social rental dwellings (Chapter 4). Residents should be well-informed, but some house-seekers might use information on too high a spatial scale i.e. neighbourhood reputations. The first conjecture then states that the pull that a neighbourhood exerts on house-seeking tenants must be acted out over a larger area than the corresponding push effect. The demand for dwellings is measured by the number of responses to offers on the social rental market (Chapter 4), thus making it a stated rather than a revealed housing choice. In order to compare the push effects with the pull effect of the neighbourhood in a revealed preference model, the same analysis is carried out for the small group of tenants who accepted the association's offer.

The pull of a neighbourhood on successful candidates in the Dutch social rental sector is analysed in Chapter 5, in the context of investigating the waiting time for a social rental dwelling. In accordance with the transaction model presented in Section 2.8, it is assumed that tenants who move over shorter distances are better informed, as are transferring tenants or tenants with a longer duration of stay and therefore a higher rank in the distribution system. The last two categories face higher risks when selecting an offer: transferring tenants must exchange another dwelling, while tenants with a longer duration of stay make a transfer and they abandon good housing opportunities in the near future. The purpose of this regression is to see how many new tenants were ignorant about the quality of the neighbourhoods to which they moved. If many tenants were unaware of the unobservable aspects of neighbourhood quality, then, with some reservations, an affirmative answer can be provided to the first question of this thesis: *'Is the posited knowledge gap between residents and uninformed house-seekers visible in their respective valuation of the neighbourhood on the social rental market?'*

Search costs are probably higher for owner-occupiers than they are for social tenants, due to the very low transactions costs in the Dutch distribution system for social rental dwellings. This does not imply that the incentives to be informed are higher among tenants than among owner-occupiers, as buyers face high opportunity costs when selecting a lemon. Buyers' taxes, realtors' fees, the cost of refinancing mortgage debt and moving costs make the resale of an unwanted dwelling a costly affair. The existence of an informational asymmetry on the social rental market in Rotterdam offers no guarantee for the existence of a similar asymmetry on the owner-occupied segment. It will be hard to prove that buyers use reputations without further knowledge of the way in which reputations are constructed and what the motives of buyers are behind their selection of a particular destination. A solution to this problem would be to investigate the posited relation between house price and neighbourhood reputation. Spatial patterns in house prices, or to be accurate the assessment value of dwellings, in Rotterdam, are investigated in the third part of the thesis in order to answer the second key question of this

thesis: '*does this informational asymmetry carry over to the owner-occupied market as well? In other words, do neighbourhood reputations affect house prices?*'

One necessary condition for the emergence of an informational asymmetry on the owner-occupied segment of the housing market is that the house price is not used as a signal for the unobservable quality of the area. All intra-neighbourhood differences in the unobservable quality should be neglected in the price. In this case, dwellings in well-reputed neighbourhoods receive a reputational premium in the house price, whereas dwellings in areas that are lower on the neighbourhood hierarchy receive a discount. When crossing the administrative boundaries of a neighbourhood, a sudden jump in house prices may be observed, which is unrelated to changes in the physical make-up of dwellings or the rate of tenure. The sorting of households between neighbourhoods according to the reputational bias could explain these discontinuities in price, especially when price hikes near neighbourhood boundaries are commonplace on the housing market. Second, a border adjustment may generate a sudden jump in the house prices, as the area has just changed its name. In Chapter 6, spatial house-price patterns in Rotterdam are investigated in order to detect jumps in the price near neighbourhood boundaries. The empirical part of this thesis concludes in Chapter 7, with a case study of the development of house prices in an area that was annexed by a more affluent neighbourhood.

Part II Informational asymmetry on the social rental market

3 The exit choices of social tenants[50]

3.1 Introduction

The quality of the neighbourhood plays an important role in a household's decision to leave its current home. A household's exit choice can be considered the one housing choice in which the full information axiom of standard economic theory is most likely to hold. Daily living experience ensures that residents' perceptions of their home surroundings come close to the fully informed view on the neighbourhood and its attributes that the archetypical neoclassical household is assumed to have as well. In this chapter, I analyse the exits and stays of tenants in order to obtain an estimate of this inside view on the neighbourhood within the context of the social rental market in Rotterdam.

The regression model for tenants' likelihood to move in 2002, 2003 and 2004 serves as the benchmark for the regressions that follow in Chapters 4 and 5. In the previous chapter, I argued that residents are likely to have highly accurate perceptions regarding the scale of the push effects of the neighbourhood, whereas house-seekers are likely to have a larger scale in mind. In the exit choice model presented in this chapter, the range of the push effects of neighbourhood attributes then acts as a minimum bound for the range of the pull effects in the destination choice models. In addition to having a superior notion of the scale of the neighbourhood, residents are in agreement about the size of the pull effects of neighbourhood attributes, while house-seekers differ in opinion regarding the size of the pull effects of at least some attributes.

Before presenting the regression, I introduce and discuss the two measures of neighbourhood quality that are used throughout the thesis: neighbourhood satisfaction and the assessment value of the dwelling as a proxy measure for house price. Each of these variables expresses a different aspect of neighbourhood quality: neighbourhood satisfaction reflects the neighbourhood's unobservable quality, while house price reflects its observable quality. The main advantage of using these composite measures is that it eliminates the necessity of measuring and specifying the underlying attributes of the neighbourhood. The size of the estimated push effect of neighbourhood satisfaction acts as an upper bound for the pull effect of the same variable in the destination choice models.

50 The analysis in this chapter is loosely based on Van Ommeren and Koopman (2011). The focus of that paper is different, however, as tenants' valuations of the neighbourhood are secondary to their valuations of the structural characteristics of their dwellings and the role of the housing association in maintaining the quality of its stock.

3.2 Neighbourhood push and the likelihood to move

The demand for dwellings of a certain size and type is related to the life stage and career of household members (Kendig, 1984; Mulder and Hooimeijer, 1999). Marriage, divorce, birth, old age, sickness, enrolment in higher education, entering the labour force or job changes are all life events that sometimes entail the necessity to relocate. A household's space requirements are coupled with a demand for other aspects of housing quality, as well as a shift in tenure, if the financial room allows it (Clark *et al.*, 1984; Boehm *et al.*, 1991). Given that long-term residents grow attached to their homes, a household's duration of stay acts as an impediment to moving (Henley, 1998). Attributes of the neighbourhood that have been cited as push factors include a lack of social ties (Landale and Guest, 1985; Kan, 2007), dilapidation (Landale and Guest, 1985), place detachment (Deane, 1990; Gustafson, 2001), high crime (South and Crowder, 1998), poor schools (Bartik *et al.*, 1992), high taxes and low public service levels (John *et al.*, 1995), social distance from neighbours (Lahr and Gibbs, 2002) and poor neighbourhood reputation (Permentier, 2009).[51]

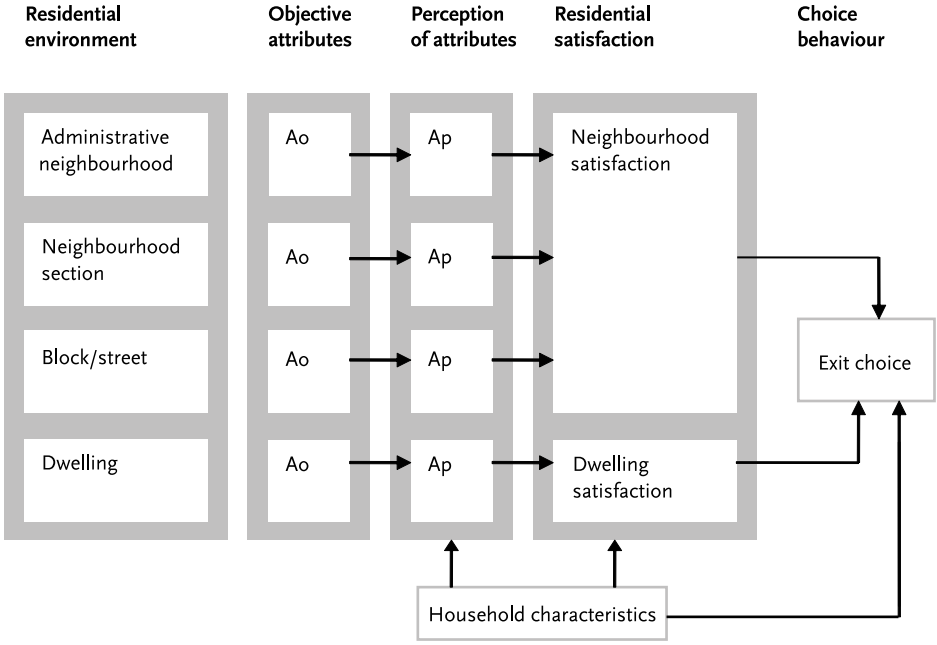
Figure 3.1 depicts the relationship between housing attributes and exit choice. A household perceives the attributes in various residential environments before starting to assess neighbourhood quality (i.e. neighbourhood satisfaction; Speare, 1974) and overall housing quality (i.e. residential satisfaction; Speare, 1974).[52] If neighbourhood satisfaction falls short of a desired level, residential stress can occur, possibly prompting the search for a new home (Wolpert, 1966; Brown and Moore, 1970). In the residential survey that is used throughout this thesis, half of the Rotterdam tenants who responded in 2004 stated that they would be willing to move within the next two years. In addition to overestimating their chances of obtaining a new home, the respondents provided reasons for the willingness to move that prove instructive.[53] Of all potential movers, 19.6% cited a desired change in tenure, 13.9% cited lower housing costs, 74% cited an improvement in the actual dwelling, 34.4% cited life events and 54.2% cited the quality of the neighbourhood. The share of po-

51 Permentier (2009) analyses exit choice according to the neighbourhood's reputation as perceived by residents, mentioning that this measure correlates strongly with its reputation as perceived by outsiders. As shown later in this chapter, it is far easier for social tenants to exit areas at the bottom of the neighbourhood hierarchy (which consist largely of social rental stock) than it is to leave more attractive neighbourhoods. It thus remains unclear whether the estimated push effects of reputations pertain to the 'third-party' effect that the stigmatisation of an area has on the well-being of residents (Tsfati and Cohen, 2003) or to the role of choice constraints.

52 The distinction between street or block level, neighbourhood section (the area that residents identify as common ground) and administrative neighbourhood (or borough) in Figure 3.1 is based on the work of Suttles (1972), which was verified empirically by Birch *et al.* (1979).

53 Only 5.4% of Rotterdam tenants seeking housing in 2005 managed to find social rental dwellings in that year. The minimum waiting time for a social rental dwelling was about four years for a first-time tenant (COS, 2006).

Figure 3.1 Exit choice



Source: adapted from Marans and Rodgers, 1975

tential movers referring exclusively to neighbourhood push factors (i.e. safety concerns, social circumstances and accessibility), however, was 3.9%. Poor neighbourhood quality is thus an important push factor, but only in combination with life events and a deficient rent-quality relationship of the dwelling. For this reason, the exit choice model should include the rent and structural characteristics of the dwelling and household characteristics as explanatory variables, in addition to measures that express neighbourhood quality.

Regression models for the exit choices of households include hazard rate models for duration of stay (Henley, 1998; Van der Vlist *et al.*, 2002), count models for exit rate (number of moves per dwelling within a given period) and discrete choice models for the dichotomous choice to stay or to move. Duration and count models make better use of information: they incorporate the date of the move or the number of moves that occur within a given period. On the other hand, discrete choice models are less demanding in terms of data collection, and they are easier to interpret. They suffice for the purpose of the regression in this chapter: the identification of the strength and range of neighbourhood push effects. The most easily interpreted discrete choice model is the logit model, which is given as (Gourieroux, 2000):

(3.1)

$$\Pr\{U(exit) \geq U(stay) \mid A\} = \frac{\exp(\beta_0 + \sum \beta_k z_k + \beta_r \log[r] + \sum \chi_l hh_l + \sum \delta_m NBH_m)}{1 + \exp(\beta_0 + \sum \beta_k z_k + \beta_r \log[r] + \sum \chi_l hh_l + \sum \delta_m NBH_m)}$$

The probability that a tenant will select a move from amongst the choice set A={stay; move} is a function of the *K* attributes of the actual dwelling z_k, the logarithm of the rent *log[r]*, the *L* household characteristics hh_l and the *M* neighbourhood variables NBH_m. An increase in one of the neighbourhood variables is expected to reduce the likelihood to move (δ_m<0). The equation inside the exponential function involves a trade-off between rent and neighbourhood quality (Van Ommeren and Koopman, 2011).[54] Differentiating the numerator in formula 3.1 with respect to the neighbourhood variable and setting this derivative to zero yields the tenant's willingness to pay for an increase in neighbourhood quality ($\partial r/\partial NBH_m$):

(3.2) $$MWP_{NBH} = -\frac{\delta_{NBH}}{\beta_{\log[r]}} r$$

A tenant's willingness to pay for an increase in neighbourhood quality is equal to the increase in rent needed to maintain the same likelihood to move. The average willingness to pay is an estimate of the user value of the neighbourhood for the existing tenant. This calculation returns in the next chapters.

The model (3.1) assumes that a tenant is able to move or stay. When investigating the Dutch social rental market, the role of choice constraints cannot be neglected. First, some tenants are forced to move out of their homes due to eviction, restructuring of their housing units or such life events as divorce, illness or old age. Second, some tenants find it hard to obtain another dwelling, due to their low rank in the distribution system. Finally, some tenants may be near the end of their housing careers. Because of the financial, personal, institutional or other constraints on moving, some tenants do not respond to small changes in housing quality. Tenants who live in the best dwellings in the most attractive areas find it especially hard to continue their housing careers within the social rental sector, and they may also be impeded from making a transition into owner-occupation.[55] The larger the number of choice-constrained tenants is, the weaker will be the neighbourhood's push effects on all tenants and, consequently, the lower will be the average willingness to pay for the neighbourhood.

54 The trade-off between rent and housing attributes is based on the work of Gronberg and Reed (1994), who estimated the marginal willingness to pay for skills from job-duration data.

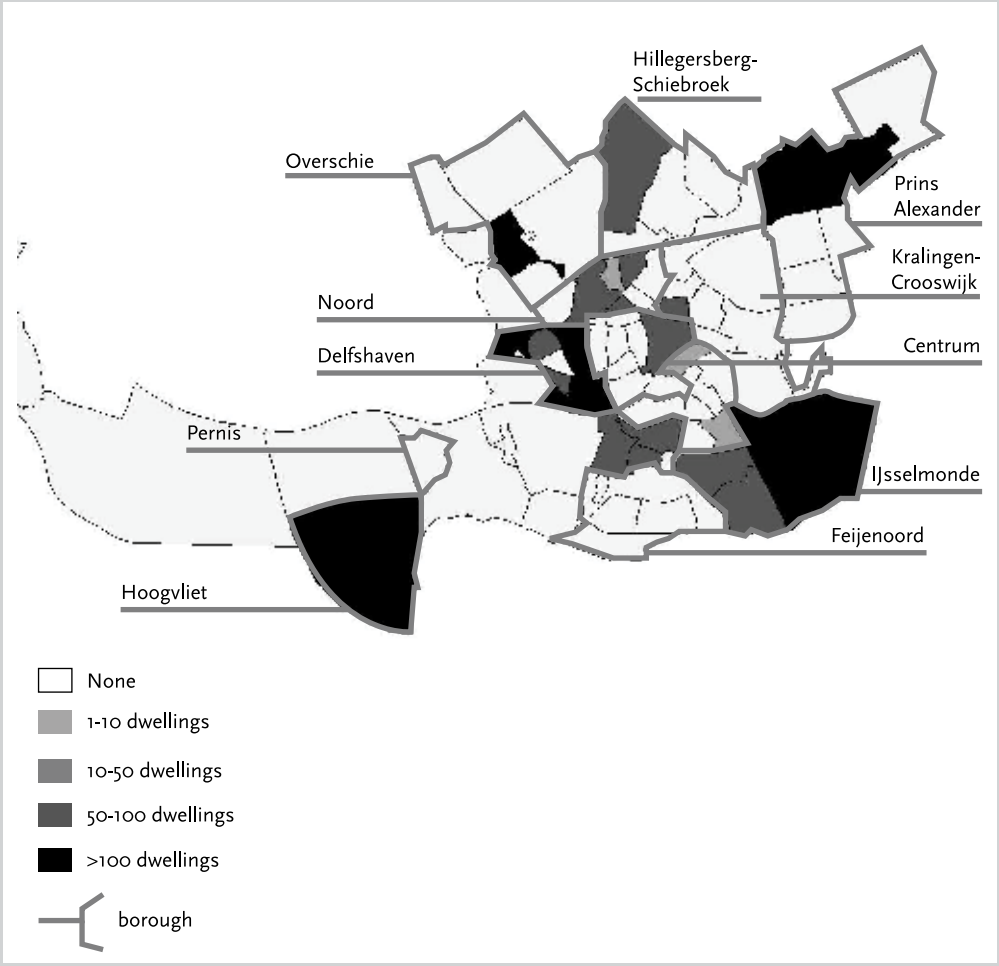
55 Accessibility remains a problem for first-time buyers on the Dutch owner-occupied market (Renes *et al.*, 2006; Neuteboom and Brounen, 2009).

Choice constraints are irrelevant to the discussion, as long as the regression is meant to clarify how neighbourhood quality affects the average exit rate on a particular housing market. However, I am interested in the push effects on tenants who have the option to move, as I later compare the strength and range of these effects to the pull effects on tenants facing a largely unconstrained destination choice. Tenant protection and the social task of the associations ensure that evictions are scarce in the Dutch social rental sector. The housing stock in the sample was not subject to restructuring. Following a divorce, the head of a household is allowed to stay in the dwelling. Involuntary moves due to an old age or illness and some involuntary stays due to a short duration of stay (a proxy for the tenant's rank in the distribution system) can limit the ability of some tenants to stay or move. This problem can be alleviated by extending the period in which a move is allowed to occur, as the constraints should become less binding as the tenant's duration of stay is lengthened. As a further precautionary measure, the sample could be limited to tenants below a certain age (thereby reducing the incidence of involuntary moves) and above a certain duration of stay (thereby reducing the incidence of involuntary stays).

3.3 Data

The port city of Rotterdam is the second largest city in the Netherlands, with an estimated population of 600,000 in the municipality in 2005. The population was distributed across 305,000 households in 285,000 dwellings. The share of social rented dwellings in the housing stock was 53%. With over 23,300 rental units and 3,500 dwellings in socially-bound ownership in 2005 Woonbron is one of the larger landlords on the Rotterdam market. The records of Woonbron in the years 2002 to 2005, tax assessment values in 1999 and 2003, a residential survey conducted in 2004 ('De Grote Woontest' [The Great Home Test]) and population register data from the municipal statistics office allow for a thorough analysis of the social rental market in Rotterdam. The association's records contain information on the structural characteristics and rent of 16,000 dwellings in 26 of the 73 largely residential neighbourhoods on a total of 89 neighbourhoods. This cross-section of the city's stock includes dwellings in ten administrative neighbourhoods in four administrative boroughs, where the association owns a sizeable fraction of the stock (see Figure 3.2). In Rotterdam, boroughs consist of from one up to nine administrative neighbourhoods. The remainder of property is dispersed over 16 neighbourhoods. Some neighbourhoods rank in the top ten of the deprivation index for Rotterdam, which was first published in 2008 (COS, 2008). Nearly 98% of Woonbron's property, however, was situated in ten neighbourhoods that ranked from place 14 to 53 on a total of 64 ranks in the index (from 1 – most

Figure 3.2 Rental stock of Woonbron Rotterdam



Source: Arcview 3.0 ESRI ©; Centraal Bureau voor de Statistiek / Topografische Dienst Kadaster

deprived – to 64 – least deprived).

The number of moves per dwelling and the date at which each move occurred are observed from the association's records for three years. These observations are linked to the age, duration of stay and eligibility for rental subsidies of tenants and population register data on household type at the beginning of 2002. [56]

This yields 9,600 observations of household characteristics, housing attributes and the occurrence of exits in 2002, 2003 or 2004.

The structural characteristics of a dwelling include the number of rooms,

56 Woonbron uses a two-tiered rental system. All households are eligible for social rental dwellings, even if their income is high. Households who are ineligible for rent subsidy pay the maximum rent, while other tenants receive a discount on the rent. Ineligibility for rent subsidy in 2005 are single households with an annual income higher than € 18,700 and households with an income higher than € 25,075. Less than 2% of Woonbron's tenants fell into the high income category (see Table 3.3).

the building period, five different categories of house size, three different house types, the presence of a lift and the maintenance label. A high label for maintenance indicates that the property was in prime condition, while a low label indicates that it was destined for renovation or demolition in the near future. The rent and assessment value of each dwelling are also observed.

The use of neighbourhood variables may lead to the measurement and specification problems that were discussed in Section 2.6. Returning to Figure 3.1, it becomes clear that direct valuation of neighbourhood quality by insiders and outsiders circumvents these measurement and specification problems.

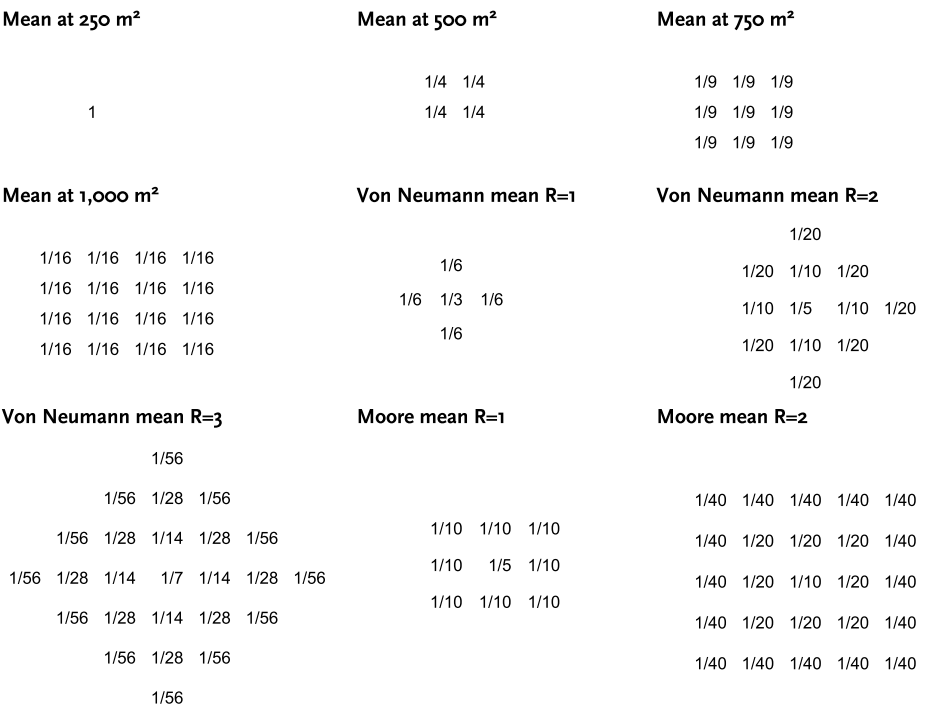
Before discussing the outsiders' valuation of the location in the form of the house price residual, I address the experiences of residents with regard to the quality of life in the neighbourhood. A residential survey ('De Grote Woontest' [The Great Home Test]), which was conducted in early 2004 under the commission of the municipalities and the associations in the wider metropolitan region, contains neighbourhood satisfaction scores from 9,000 households in Rotterdam. Due to considerations of privacy, responses could not be identified as coming from either tenants or non-tenants of Woonbron. The seven response options for the question 'How do you rate your neighbourhood?' ranged from 'extremely dissatisfied' to 'extremely satisfied', with an average score between neutral and mildly satisfied. While it could be argued that respondents may have interpreted the term 'neighbourhood' to mean their administrative neighbourhood rather than their surroundings, statistical evidence proves otherwise. As shown in Table 3.1, most of the spatial variation in the 9,000 adjusted satisfaction scores (see below) occurs within 66 administrative neighbourhood. Spatial dependency is high as well; Moran's I scores are highest for the four nearest neighbours (I=0.34), indicating that the scores are largely correlated with nearby observations.[57]

The scores of individual respondents must be transformed into a measure of the shared experience of the quality of a neighbourhood. To obtain the notion that all residents (including non-respondents) have of neighbourhood quality, the individual scores are first regressed on the characteristics of each respondent. Details of the linear regression on the survey scores are shown in the appendix titled Additional results.[58]

57 Moran's I is a measure of spatial autocorrelation that ranges from -1 (complete negative autocorrelation) and 1 (complete positive autocorrelation), with a value of 0 meaning no correlation whatsoever. The figure declines rapidly as the number of nearest neighbours increases.

58 Ordinal scores should really be estimated by means of an ordinal regression, for instance a multinomial logit model (Lu, 1999). The reason to use a linear regression lies in the fact that the scores are adjusted and 'kriged' (see below) to obtain an estimate of average neighbourhood satisfaction in 250 m² areas. Predicted scores from an ordinal model are less sensitive to changes in household characteristics. This leads to loss of information, especially when the number of scores in an area is low. See Permentier *et al.* (2011) for a similar approach taken. The robust estimation (using White's heteroskedasticity-consistent error terms) of the linear model and the multinomial logit model are shown in the appendix. Estimation results turn out very similar.

Figure 3.3 Kriging weights for representations of neighbourhood satisfaction



The influence of relevant household characteristics (e.g. family type, tenure, age and duration of stay) is first eliminated from the scores. The adjusted scores tell how a specific household (a non-pensioner, single, aged below 35 or above 65, with medium to lower education and a home-owner) rated his environment, given the type of dwelling that he lived in.

In an effort to remove the remaining idiosyncratic bias in the adjusted scores, a kriging procedure is applied (see Footnote 10 and Figure 3.3).[59] Nine different representations of neighbourhood satisfaction are obtained, starting with an average of the scores within a box of 250 m^2 (2,700 ft^2) and ending

59 First, a two-dimensional grid is constructed with boxes of 250 m2. The average value of the adjusted satisfaction scores is calculated for each box. The average per box is used to calculate weighted and unweighted averages with various ranges (see Figure 2.7). The spatial weights on the local average are based on a linear decay function, in which observations within a range carry double the weight of observations within the next range, such that all of the weights sum to one (see Figure 3.3). Adjustments are made when observations are missing in neighbouring boxes, as illustrated for the Von Neumann neighbourhood with range 1 in the lower panel of Figure 3.3.

Table 3.1 Within and between-neighbourhood variance in neighbourhood variables

	Sum of Squares (SoS)	SoS within neighbourhoods	SoS between neighbourhoods
Neighbourhood satisfaction	872.12	715.05 (82.0%)	158.07 (18.1%)
House price residual	391.82	198.36 (50.6%)	195.53 (49.9%)

* The percentages in the third and fourth row of the table do not sum to one hundred due to the linear calculation of the variance for a (non-linear) logarithmic transformation of house price.

with a weighted average that covers twenty-five boxes, or an area of 1.6 km^2 (0.4 mi^2). One of the nine representations should capture the inside view on the area. The inside view contains the residents' assessment of the area's social climate and the quality and availability of amenities that cater to the local populace. The various representations are tested for their relevance in the exit choice model in this chapter. Their relevance in the destination choice models is tested in Chapters 4 and 5.

Some attributes could be irrelevant to the inside view but still relevant to the exit choice. House price (or house price residual) is used to control for the remaining push effects of neighbourhood attributes. Municipalities in the Netherlands fund themselves in part by levying property taxes based on a percentage of the assessment value (or WOZ value) of the dwelling.[60] Assessment values in early 1999 and 2003 were provided by the municipal tax office, along with some structural characteristics of the entire Rotterdam housing stock (over 285,000 dwellings). Because several identical dwellings were appraised simultaneously, the data is limited to 106,000 unique assessments. A discussion on the suitability of the assessment value as a proxy measure for house price is postponed until Chapter 6. For now, the reader should bear in mind that I am talking about the assessment value whenever I mention house price.

The house price residual is the fraction of the price that is dependent upon the location of the dwelling (Bayer and Ross, 2006). It is obtained by means of a hedonic house price regression on the type, size and age of the dwelling and neighbourhood-fixed effects. A robust estimation of a hedonic house price regression for Woonbron's stock in 2003 is shown in the appendix. The sum of the neighbourhood dummy and the disturbance term for each observation in the estimated price equation is defined as the house price residual. This residual can contain the effects of measurement errors in the structural characteristics, misspecification bias and the value of structural characteristics that are observed by buyers but not by the researcher. It is assumed that the effects of the missing variables and the measurement errors are randomly distributed across the housing market, such that the house price residual acts as an estimate of the location's assessment by outsiders (i.e. realtors and buyers). This measure has the additional benefit of eliminating the necessity of identifying or specifying the underlying attributes of the neighbourhood in order to obtain a working measure for the observable aspects of neighbourhood quality.

If an informational asymmetry exists on the owner-occupied market, then the house price residual will be equal to the exchange value of observable

60 WOZ or 'Waardering Onroerende Zaken' is the value of immovable property.

Table 3.2 Correlation between neighbourhood statistics in 2003

	Spearman's Rho			
	House price residual	**Household income**	**% Owner-occupation**	**Neighbourhood satisfaction**
House price residual	1	0.723*	0.528*	0.707*
Household income		1	0.702*	0.745*
% Owner-occupied stock			1	0.535*
Neighbourhood satisfaction				1

* Indicates significance at 1%-level (two-tailed).
N=66

Source: Rotterdam Municipal Statistics Office

neighbourhood quality, possibly supplemented by estimation and misspecification bias and a reputational premium. Evidence of the close relationship between the house price residual and neighbourhood reputation is presented in Table 3.1. About half of the variance in the 16,000 observations on the residual is due to differences between 26 administrative neighbourhoods, the scale at which reputations are manifested. If the correlation between the house price residual and the representation of neighbourhood satisfaction is investigated, then Pearson's correlation coefficient turns out small and negative for representations with a low range, but it increases to 0.4 when satisfaction is averaged at the administrative neighbourhood level.

To further investigate the relation between house price residual and neighbourhood satisfaction at the administrative neighbourhood level, a non-parametric test is carried out for the correlation between these measures and two commonly used statistics for the social quality and socio-economic status of the neighbourhood: average household income and the share of owner-occupied dwellings in the stock. The test for uniformity in the ranking of 66 administrative neighbourhoods in Rotterdam is shown in Table 3.2.[61] The ranking of neighbourhoods based on house price residual and neighbourhood satisfaction is apparently similar, as is ranking based on income or owner-occupation. The analysis in Chapters 6 and 7 tells that house price probably contains a premium for each administrative neighbourhood, such that the push and pull effects of the price in residential mobility models may be the result of tenants' desire to improve upon their socio-economic status or the fact that they associate high socio-economic status with neighbourhoods in which the quality of living is good.

Outlier analysis for the dataset in Table 3.3 reveals that some dwellings carried an excessive rent and that a few dwellings had very high prices. All dwellings with rents above € 800 per month and prices above € 250,000 are excluded from the estimation, leaving 9,537 observations. Based on these observations, a total of 1,933 dwellings (or 6.8% on a yearly basis) were vacated in 2002, 2003 and 2004. Choice constraints were not so severe as to prevent tenants with low rankings in the distribution system from moving or to prevent the elderly from staying. The exit rate among tenants with a low duration of stay is higher than average (23.4% for tenants with a duration less than 20

61 The house price residual is calculated in Table 3.2 with the same data used in Chapter 6. Data on income and owner-occupation is provided by the municipal statistics office.

Table 3.3 Descriptive statistics

		Mean	Median	Maximum	Minimum	Std. dev.
Exits		0.20	0	1	0	0.40
Number of rooms	One	0.02	0	1	0	0.13
	Two	0.15	0	1	0	0.36
	Three	0.41	0	1	0	0.49
	Four	0.28	0	1	0	0.45
	Five or more	0.15	0	1	0	0.35
Building period	Before 1945	0.21	0	1	0	0.41
	Between 1945 and 1975	0.36	0	1	0	0.48
	Between 1975 and 1990	0.38	0	1	0	0.48
	After 1990	0.04	0	1	0	0.20
	Unknown	0.01	0	1	0	0.10
House size	Less than 50 m²	0.20	0	1	0	0.40
	Between 50 and 60 m²	0.26	0	1	0	0.44
	Between 60 and 75 m²	0.37	0	1	0	0.48
	Between 75 and 90 m²	0.14	0	1	0	0.35
	More than 90 m²	0.02	0	1	0	0.14
House type	Single-family	0.21	0	1	0	0.41
	Downstairs apartment	0.14	0	1	0	0.35
	Upstairs apartment with lift	0.23	0	1	0	0.42
	Upstairs apartment, no lift	0.41	0	1	0	0.49
Maintenance label	High	0.06	0	1	0	0.23
	Middle	0.86	1	1	0	0.35
	Low	0.07	0	1	0	0.26
	Unknown	0.01	0	1	0	0.11
Rent in Euros per month		371.33	365	2,344	78	95.92
House price in Euros		115,605	115,000	340,000	37,000	30,092
Neighbourhood satisfaction	250 m²	4.30	4.27	5.28	3.75	0.24
	500 m²	4.35	4.36	5.28	3.86	0.19
	750 m²	4.35	4.34	5.28	3.92	0.19
	1.000 m²	4.34	4.38	5.28	3.92	0.18
	Moore range 1	4.37	4.39	4.87	3.94	0.20
	Moore range 2	4.38	4.43	4.89	4.00	0.18
	Von Neumann range 1	4.35	4.36	4.93	3.88	0.20
	Von Neumann range 2	4.37	4.39	4.91	3.92	0.19
	Von Neumann range 3	4.38	4.41	4.89	3.94	0.18
Household characteristics	High income	0.02	0	1	0	0.13
	Age of head in years	55.49	53.00	119.00	22.00	16.89
	Duration of stay in months	119.54	91.00	705.00	1.00	103.75
	Single household	0.41	0	1	0	0.49
	Single parent household	0.20	0	1	0	0.40
	Couple with children	0.11	0	1	0	0.31
	Couple without children	0.18	0	1	0	0.38
	Other households	0.10	0	1	0	0.30

months). The exit rate among tenants older than 70 years of age is only marginally higher than the average (22.8%). There is thus no immediate need to restrict the sample any further based on the tenant characteristics.

Most dwellings lie within one of the ten neighbourhoods that are covered by the neighbourhood-fixed effects. The value of neighbourhood satisfaction ranges from 4 (a neutral view) to 5 (a mildly satisfied view). Although the sample does contain some disadvantaged areas with scores of less than 4, most observations lie within areas that can best be described as the middle to upper-middle range of the social rental market and the lower-middle to mid-

Table 3.4 Logit model for the likelihood of social tenants in Rotterdam to move in 2002, 2003 and 2004

		Model I		Model II		Model III	
		coefficient	z statistic	coefficient	z statistic	coefficient	z statistic
Constant		-23.11	-13.52	-2.92	-1.06	-3.37	-1.11
Number of rooms	Two	-1.76	-8.99	-1.36	-6.71	-1.35	-6.57
	Three	-2.26	-10.70	-1.70	-7.53	-1.69	-7.14
	Four	-2.77	-11.36	-2.15	-8.34	-2.30	-8.32
	Five or more	-2.85	-9.76	-2.20	-7.17	-2.49	-7.13
Building period	Between 1945 and 1975	-0.21	-2.14	-0.24	-2.50	-0.20	-1.88
	Between 1975 and 1990	-0.62	-7.11	-0.61	-7.13	-0.55	-6.09
	After 1990	-1.60	-8.14	-1.36	-6.84	-1.29	-6.30
House size	Between 50 and 60 m^2	-1.10	-9.90	-0.86	-7.37	-0.90	-6.92
	Between 60 and 75 m^2	-1.52	-10.32	-1.11	-7.13	-1.11	-6.44
	Between 75 and 90 m^2	-1.92	-9.02	-1.41	-6.35	-0.97	-3.92
	More than 90 m^2	-2.70	-7.53	-2.10	-5.73	-1.86	-4.36
House type	Single-family	-1.12	-8.74	-0.72	-5.23	-	-
	Upstairs apartment with lift	-0.35	-3.24	-0.30	-2.72	-0.25	-2.29
	Upstairs apartment no lift	0.44	4.89	0.31	3.35	0.31	3.37
Maintenance	Middle	0.09	0.84	0.01	0.12	0.02	0.17
	High	0.22	1.25	0.17	0.98	0.07	0.34
Log of net rent		5.33	17.06	5.64	17.37	5.42	15.30
Log of house price		-	-	-1.86	-8.41	-1.69	-7.21
Neighbourhood satisfaction	Von Neumann range 1	-1.41	-4.56	-0.77	-4.85	-0.82	-4.86
	Moore range 2	0.97	2.88	-	-	-	-
Household characteristics	High income	0.58	2.86	0.63	3.13	0.48	2.21
	Log of age of head	-1.11	-8.63	-1.05	-8.12	-1.04	-7.21
	Log of duration of stay	0.17	5.27	0.18	5.66	0.19	5.41
	Single household	-0.20	-2.11	-0.24	-2.44	-0.40	-3.73
	Single parent household	-0.72	-6.92	-0.71	-6.77	-0.81	-7.06
	Couple with children	-0.56	-4.62	-0.53	-4.35	-0.60	-4.19
	Couple without children	-0.21	-1.96	-0.24	-2.26	-0.31	-2.62
McFadden R^2			0.11		0.12		0.12
Standard error of regression			0.37		0.37		0.39
Log Likelihood			-4,139.62		-4,105.97		-3,859,4
N			9,369		9,369		7,342

dle range of the entire housing market.[62] The sample thus covers neighbourhoods that are located largely in the middle of the neighbourhood hierarchy. The scope of the sample is important in the investigation of the destination choices of tenants, as discussed in Chapters 4 and 5. An intermediate to good reputation is a prerequisite for the presence of ill-informed, voluntary movers on a geographical submarket (see Section 2.8).

3.4 The likelihood of social tenants to move

The results of the estimation of a logit model for social tenants' likelihood to move in Rotterdam in 2002, 2003 and 2004 are presented in Table 3.4. This and all other regressions in the thesis are performed using the EViews 5 software package of the Quantitative Micro Software Corporation. The base mod-

62 Satisfaction scores greater than 5 (satisfied) can be found only in the most prestigious owner-occupied neighbourhoods of the city, and in the garden villages which are poor, but very stable and popular white working-class areas. These outliers are not included in the dataset.

el includes the dwelling's structural characteristics and rent, as well as tenant characteristics as explanatory variables. The frame of reference in the model is a fictitious single-room downstairs apartment, built before 1945 with a size of less than 50 m^2 and a low level of maintenance, inhabited by a low-income household that could not be identified as members of one of the dominant household types. White's heteroskedasticity-consistent estimation is applied to control for heterogeneity in the model (White, 1980).

The estimation outcome for the base model makes sense. Likelihood to stay proves greater for larger, newer, less expensive and better-maintained dwellings. Moves occurred less frequently in single-family dwellings and more frequently in upstairs than in downstairs apartments. The observed tenant characteristics yield sensible results. Likelihood to move decreases with age, as older tenants are nearer the end of their housing careers (Henley, 1998). Likelihood to move increases with duration of stay, not so much because tenants became less attached to their homes in the course of time as because longer duration of stay led to a higher rank in the distribution system for social rental dwellings. The occurrence of life events may have triggered additional moves as the duration of stay lengthened. Households with children moved less frequently than households without children. As expected, the small group of high-income tenants that should have been able to make a transition in tenure had a higher likelihood to move.

In Model I, the local averages for neighbourhood satisfaction are tested one by one, in order to identify the best representation (in terms of its z statistic) for the inside view on the neighbourhood. The second best representation is then added to the model to test whether both representations are significant. If both are significant, the third best representation is added to the model. If not, the third best representation is substituted for the second best representation. The procedure continues up until the point that all representations have been tested for their relevance.

The averages for neighbourhood satisfaction that are calculated for the boxes of 250, 500, 750 and 1,000 m^2 are inferior to the locally weighted averages that cover the same ranges. Of all the representations, the average based on a Von Neumann neighbourhood with range 1 and a Moore neighbourhood with range 2 (see Figure 3.3) both prove significant. The first average covers an area of five boxes of just 250 m^2, with one third of the value defined by the box in which the observation falls and the other two thirds defined by the four adjacent boxes. The low scale of this measure (0.3 km^2) conforms to the residential environment of the block level. The average based on a Moore neighbourhood with range 2 covers a range of 625 metres in the northern, eastern, southern and western direction or an area of 1.6 km^2 (see Figure 3.3). This scale conforms to the administrative neighbourhood for smaller neighbourhoods and to entire neighbourhood sections for larger neighbourhoods.

Model II appends model I with the logarithm of the price of the dwelling,

which is assumed to control for observable neighbourhood quality. Later in this chapter, it is shown that house price and house price residual are perfect substitutes for one another in the estimation.. The use of house price in the model compares the neighbourhood's user value for owner-occupiers and for social tenants.[63]

The inclusion of house price annuls the explanatory power of neighbourhood satisfaction based on a Moore neighbourhood; the latter measure has a coefficient value of 0.36 with a z statistic of 1.0. It is subsequently dropped from model II. None of the other representations of neighbourhood satisfaction, apart from the average based on a Von Neumann neighbourhood with range 1, proves significant. House price is able to control for most inter-neighbourhood differences in living quality. Neighbourhood satisfaction captures the push effects operating at the block level. This is probably due to those aspects of the neighbourhood that are known only to insiders. The low spatial scale confirms the stylised fact that residents' living experience takes place within a short walking distance of their home (Coulton *et al.*, 2001; Goetgeluk and Wassenberg, 2005).[64]

The inclusion of house price also reduces the coefficients for some structural characteristics. One explanation is that price controls for unobserved attributes of the actual dwelling, the effects of which would otherwise enter the coefficients for larger and/or single-family dwellings. A more compelling explanation lies in the effects of residential sorting. Families opt for single-family dwellings, while younger couples tend to live in apartments closer to the city centre (Kendig, 1984). Single-family dwellings in the dataset are located in attractive areas: Pearson's correlation coefficient for neighbourhood satisfaction and single-family dwellings is 0.30, as compared to -0.23 for upstairs apartments. Continuous house price is better suited to control for the influence of sorting between areas on the exit rate than is the dichotomous house-type variable. The estimated coefficient in the model might therefore slightly overestimate the actual push effect of house price.

The estimated coefficient on neighbourhood satisfaction in Model II is -0.77 and the coefficient on the price is -1.86. Table 3.3 tells that an increase of one point (4.93-3.92) was the maximum attainable rise in the inside view. Tenants were prepared to pay an additional € 51.20 (i.e. 0.77/5.64*371.33*1.01; see also formula (3.2)) on an average rent of € 371.33 per month (or 13.8%) for

63 The rent is higher than tenants' housing costs due to rent subsidies, while the subsidisation of interest payments on mortgage debt inflates the house price and hence the user costs of the owner-occupied dwelling. These problems are circumvented by expressing both rent and house price as logarithms.

64 The estimation results are in line with research on neighbourhood satisfaction. Hipp (2010) showed that neighbourhood satisfaction is mainly dependent upon attributes that work at a low spatial scale. Lee *et al.* (1994) found that neighbourhood satisfaction is an important factor in exit choice, although it does not contain all of the push effects of the neighbourhood.

the maximum increase in the quality of life. If house price had increased by 1%, then social tenants would have been willing to pay an additional 0.33% (1.86/5.64) of rent. This low figure reveals that the societal costs of investing in neighbourhoods are high. Each neighbourhood investment that raised the price level by € 1 increased the consumer surplus of tenants by a mere € 0.33. This is an indication of the misallocation of dwellings across the various segments of the Dutch housing market. The introduction of social rental stock on a geographical submarket limits supply in the lower ranges of the owner-occupied segment. The displacement of some low-income and middle-income buyers (others may still enter the social rental market) pushes up the average income of buyers and thus their willingness to pay for the neighbourhood.[65] Model II is able to explain 282 of 1.861 exits (15,1%) and 7.337 of 7.508 stays (97,7%), which explains its poor fit (R^2=0.12). The low predictive power puts some perspective on the ability to model choice behaviour of social tenants: an awful lot of exits remains unexplained.

Robustness analysis

The following question concerns whether the outcome of model II is affected by estimation problems. Sorting between areas leads to interdependence between house type, location and household characteristics, and, potentially more seriously, between the explanatory variables and the error terms. Despite a correlation between the explanatory variables, coefficients remain unbiased, as long as all relevant characteristics and attributes are used as explanatory variables. Unobserved variables which affect sorting, can create omitted variable bias. Omitted variable bias is a special form of endogeneity in which the explanatory variables (including the coefficients of interest: the neighbourhood push effects) and error terms are correlated. Endogeneity can inflate the value and significance levels of the coefficients of interest in the model: the neighbourhood push-effects.

Sorting may create another endogenous relationship between the dependent and explanatory variables in the model. For example, the exit rate is usually lower and residential location demand is higher in attractive areas. Stable demand can become a neighbourhood-quality characteristic in its own right. This further reduces the exit rate, increases demand and causes an endogenous rise in neighbourhood quality (Bartik, 1987). The opposite (i.e. endogeneity concealing a causal relation) is true when there is a negative feedback

65 In urban studies, the term 'displacement' is usually used to refer to the exit of low-income households from gentrifying areas. (Marcuse, 1986). The displacement of high-income households has been the subject of studies that examine the externalities of zoning policies in the US (Glaeser and Gyourko, 2002) and the Netherlands (Vermeulen, 2008; Dekkers, 2010). Part of the difference in willingness to pay may be due to the agglomeration benefits of having high-income neighbours (Glaeser and Gottlieb, 2009). Other explanations for the gap in willingness of tenants and of owner-occupiers to pay are choice constraints for tenants, agglomeration benefits of having other owner-occupiers as neighbours or a difference in housing taste between tenants and owner-occupiers.

at work.

Endogeneity poses less of a problem in the relationship between house price and exit choice. Because price represents an assessment by outsiders (i.e. realtors' appraisals), the dependent variable (i.e. exit choices of insiders) need not feed back into the price. A low exit rate in one year, however, would likely lead to higher satisfaction scores in the next year and a further endogenous fall in the exit rate in the same year. Furthermore, areas that experience high exit rates in one year usually experience higher rates in the next year as well. Two-stage estimation with instrumental variables can be used to counter endogeneity (Bowden and Turkington, 1984). The instruments that substitute for neighbourhood satisfaction in the model must be able to explain satisfaction, but they should be unrelated to the exit choice. This poses a serious problem in the selection of instruments: the definition of neighbourhood push effects entails that these are attributes which cause neighbourhood dissatisfaction and lead to moves.[66] Something can be salvaged by investigating the average exit rate in the years 2002, 2003 and 2004 in the 175 boxes of 250 m^2 in the dataset. Pearson's correlation coefficient tells that spatial exit rates in 2002 and 2003 were strongly correlated to one another (r=0.80), but that exit rates in 2004 were largely independent from rates in 2002 and 2003 (respectively r=0.06 and r=0.09). Model II is estimated solely for 2004, thereby allowing a lag in the response of the exit choice to neighbourhood satisfaction which was measured at the beginning of 2004. Results from this model indicate that the pull effects of neighbourhood satisfaction and house price are the same as they were in the three-year period, although tenants' sensitivity to rent was slightly higher. The coefficient on rent (7.20 with a t-value of 13.8) remains within the upper bound of the coefficient shown in Table 3.4.

In an attempt to control for omitted variable bias, several statistics from the residential survey are first averaged over clusters of 250 m^2 and then appended to model II. These variables include the share of different household types among all households, the share of different house types, the share of ethnic households, the share of low and high income categories and the share of unemployed or inactive households in the area. The share of single-parent households and inactive households in the area do (negatively) affect the exit rate in model II. They do not affect the estimates of the coefficients or the willingness to pay for a one-point increase in neighbourhood satisfaction of a doubling of the price by much (14.1% and 32.0% respectively).

The analysis of the disturbances in Model II reveals the presence of spatial autocorrelation: Moran's I is 0.19. The localised Moran's I scores indicate that

66 This calls into question the use of neighbourhood satisfaction as an 'intervening' variable in revealed preference models for the exit choice (see for instance Speare, 1974; Landale and Guest, 1985 and Lu, 1998).

most autocorrelation is due to scattered observations in the 16 neighbourhoods where Woonbron owns little stock.[67] Exits were rare in these isolated cases. Spatial autocorrelation, dependency of the error term in the model on error terms of nearby observations, leads to inflated significance levels (Anselin, 1999). Spatially correlated disturbances are caused by spatial dependencies in the exit rate (e.g. copycat moving), the effects of spatially correlated, omitted variables (Dean and Lawless, 1989) or spatial heterogeneity (Anselin, 1999). With regard to the latter, heavier constraints on moving in some areas can lead to spatial dependency in the exit rate. White's estimation method controls for heterogeneity, but this ensures that the average push on all tenants is estimated accurately. The push on tenants facing an unconstrained exit choice may be higher. I address the issue of heterogeneity later on in this section.

The second model is first estimated without the scattered observations in 16 neighbourhoods and with neighbourhood-fixed effects for the remaining 10 neighbourhoods. The area dummies control for push effects that are manifest at the administrative neighbourhood level and beyond (e.g. changes in supply in nearby areas or the 'third-party effect'). They are a crude but effective way of addressing spatial autocorrelation (Bourassa *et al.*, 2003 and 2007).

The results for the structural characteristics are similar as those reported in Table 3.4, but Moran's I drops to 0.09. The reduction in spatial autocorrelation results in a willingness to pay of 13,9% of rent for a one-point increase in neighbourhood satisfaction and of 37,9% of rent for a doubling of the price.

In the third robustness check, the house price residual is used instead of house price as an explanatory variable, in order to prove that the latter does more than control for the unobserved attributes of the actual dwelling. The same structural characteristics that are used in the exit choice model, explain the difference between house price and the house price residual (see the appendix). Hence, the estimation of the model with the house price residual instead of price does not change the results presented in Table 3.4.

In addition to addressing endogeneity and spatial autocorrelation, it is important to address the problem of heterogeneity. Coefficients may change their value with each location, a problem known as 'spatial heterogeneity' (Anselin, 1999). A model with fixed coefficients is then a valid description of behaviour on a geographical submarket, but not elsewhere (Bourassa *et al.*, 2003). The most likely cause of heterogeneity is the spatial clustering of households that are unable to move. Geometrically weighted regressions and state-space models handle spatial heterogeneity quite well (Brunsdon *et al.*, 2002; Francke and Vos, 2004). I opt for another solution to this problem.

A preliminary regression is conducted for the logarithm of duration of stay

67 All of the spatial statistics are calculated with the Geoda software package designed by Luc Anselin.

on tenant characteristics, structural characteristics, rent, neighbourhood variables and neighbourhood-fixed effects. The age of the head of household proved the main force behind duration of stay, but duration also proved higher among tenants living in single-family dwellings in areas with high satisfaction scores.[68] Change in duration of stay (i.e. likelihood of moving within a given year) is affected by house price, although price proves irrelevant for duration of stay.[69] The most important outcome of the regression, however, is that moving was indeed more difficult for older, long-term residents living in attractive areas, especially for those living in areas in which the most sought-after house type (i.e. single-family dwelling) was more prevalent.

For further analysis, the sample is split according to neighbourhood satisfaction and house type. This creates subsamples of 5,915 observations in areas with satisfaction scores lower than 4.4 and 3,454 observations in areas with scores equal to or higher than 4.4. Two more subsamples are created which contain 2,027 observations involving single-family dwellings and 7,342 observations involving apartments. In the estimation for the disadvantaged areas, the coefficients for rent, neighbourhood satisfaction and house price are the same as they are for the entire sample, but neighbourhood satisfaction is insignificant. With regard to tenants living in attractive areas, there is no evidence that neighbourhood satisfaction has a push effect. This result should not be given too much weight, however, as much of the correlation between neighbourhood satisfaction and exit choice is eliminated by splitting the sample in half according to satisfaction. A compensatory increase is visible in the push effect of house price. Tenants living in attractive areas were willing to pay 46,1% of rent for a doubling of the house price.

Similar results are obtained when estimating the third model for the various house types. A loss in the explanatory power of neighbourhood satisfaction in the model with tenants in single-family dwellings is compensated by a stronger push effect of price. Tenants living in single-family dwellings were willing to pay 62,1% of rent for a doubling of the price. Other aspects of housing quality proved less important to tenants in single-family dwellings, while their sensitivity to rent was comparatively strong. Rent remains as a choice criterion for tenants who are unable to improve upon their current housing quality.

Tenants living in apartments responded in the same way to changes in housing quality as did tenants in the entire sample. The results of the estimation for apartments is shown as model III in Table 3.2. The estimates lead to a willingness to pay of 15,1% of rent for a one-point increase in neighbourhood satisfaction and 31.2% of rent for a doubling of the house price.

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68 A one-point increase in neighbourhood satisfaction increased the average duration of stay by 37%.

69 This counter-intuitive result can be explained by the fact that high-priced neighbourhoods in the dataset are dominated by new construction. The average duration of stay in younger residential areas had perhaps just caught up with duration of stay in established residential areas at the time during which the sample was drawn.

The results presented above could lead to the erroneous conclusion that tenants living in single-family dwellings placed less weight on the quality of their actual dwellings and neighbourhood than did tenants living in apartments. Tenants in single-family dwellings did place more weight on rent; if they had wanted to, they could have settled for less expensive dwellings in less attractive areas. The fact that they remained in more expensive dwellings indicates that the lower willingness to pay observed among tenants in single-family dwellings must have been due to some factor other than indifference with regard to housing quality. The most plausible explanation is that they found it difficult to continue their housing careers within or outside of the social rental sector. Their unwillingness or inability to improve upon their dwellings could explain their insensitivity towards changes in housing quality.[70] The willingness to pay of tenants living in apartments is a better benchmark for the assessment of neighbourhood quality than is the willingness to pay of tenants in the much scarcer single-family dwellings.

3.5 Conclusions

The main result of this chapter relates to the validity of neighbourhood satisfaction and the assessment value as measures of neighbourhood quality. The assessment value is a proxy measure for house price and it proved a suitable control variable for the observable quality of the neighbourhood, thus allowing a reasonably accurate estimation of the inside view. The size of the push effect of house price is approximately equal to about one-third of the rent for a doubling of the house price. The inside view is best portrayed by a weighted average for neighbourhood satisfaction with a range that conforms to the block level. In the model, neighbourhood satisfaction appears to capture the unobservable quality of the neighbourhood. The strength of the push effect of this inside view is equal to about 15% of the rent for the maximum attainable increase in the quality of life. The range on this push factor, which covers an area of 0.3 km^2, serves as the minimum bound for the range of the pull effect of the inside view. In the following chapter, the estimated range and size of the push effect of neighbourhood satisfaction, as discussed in this chapter, are compared to the range and size of the pull effects of neighbourhood satisfaction in two types of destination choice models. A word of caution seems appropriate; the low predictive power of the model reveals that social tenants' moving behaviour is surprisingly difficult to explain.

70 First-generation rent controls – the freezing of the contract rent during the rental period (Arnott, 1989) – might reduce willingness to move among long-term residents as well. The tenant's duration of stay controls for this effect in the model.

4 The demand for social rental dwellings

4.1 Introduction

Once a household has expressed the willingness to move, the search for a new home can commence. Households do not merely face constraints on moving that impede their ability to exit their current homes (e.g. financial constraints or a tight housing market). They also face constraints once they are able to move and trying to find new homes. In the search for a new home, a household must first gather information on the availability of suitable vacancies and then on the quality of the vacancies that are on offer. In Chapter 2, I argued that the main source of uncertainty in the assessment of a vacancy lies in the unobservable quality of the neighbourhood. The observable quality of a neighbourhood can be assessed upon the inspection of an offer, whereas house-seeking tenants must make an individual effort to learn more about the unobservable quality of a neighbourhood.

House-seekers who rely on different sources of information about the quality of distant neighbourhoods are assumed to hold different notions on the scale of the neighbourhood and on the strength of some of its pull effects. In this chapter, I examine the response to offers on the social rental market in Rotterdam (a proxy measure for the aggregate demand for dwellings), in order to see whether different notions materialise in the choice behaviour of house-seeking tenants. I then compare the estimated size and range of the pull effects of the neighbourhood in this stated preference model with that of the push effects in the exit choice model discussed in Chapter 3. In particular, neighbourhood satisfaction should be less relevant in the destination choices than it is in the exit choices of tenants. The comparison of the push and pull of the neighbourhood should indicate the average house-seeking tenant's disadvantage relative to an existing tenant, with regard to having knowledge of the neighbourhood.

4.2 Neighbourhood pull and housing demand

On a free market, the demand for and supply of dwellings are either in equilibrium or adjusting towards an equilibrium state. On a regulated market, the controlled rent is usually too low to clear the market, such that excess demand emerges (Arnott, 1989). Landlords who ask rent that is below the market level must find ways to allocate dwellings among tenants. Three allocation mechanisms exist on the social rental market in Rotterdam. Some of the dwellings are offered directly to particular target groups.[71] Most of the dwell-

71 In 2005, 22% of the vacancies on the social rental market in Rotterdam were offered directly to specific tenants (COS, 2006). This includes tenants living in areas that were undergoing restructuring, tenants who had

ings are offered through regular channels, predominantly on the internet, although the offers are also advertised in a freely distributed paper. After registering as a house-seeker, the tenant has access to the offers of all the associations in the wider metropolitan region. On the internet search site, the tenant must first state preferences regarding rent, house type, number of rooms and administrative borough. Once a preliminary choice set is available, additional detail is provided regarding the quality, rent, location and eligibility requirements of each offer. In any two-week period, a registered house-seeker may respond to a maximum of three offers.

Two allocation mechanisms are set in motion once the subscription period closes. The order of invitation in the queuing system depends upon the tenant's duration of stay in another social rental dwelling or the time that has elapsed since registering as a house-seeker. Requirements regarding income, age and household size are set for offers of a certain size and rent range in order to ensure that the elderly, low-income households and families with children stand a better chance of obtaining accommodations.[72] In 2002, Woonbron (the association on whose housing stock the analysis in Chapters 3, 4 and 5 is based) created an experimental lottery for some of its vacancies, in order to increase the success rate for first-time tenants. In this system, the candidate's rank is based on a random draw in the lottery. With the exception of apartments in assisted living facilities, no further eligibility requirements exist in the lottery. House-seekers can exercise one, two or three options on the same offer in the lottery, or on three different offers in the queuing system. House-seekers who subscribe to an offer are invited by the association to inspect the dwelling, based on their rank in the queue or the draw in the lottery. Acceptance of the offer makes the registration time of a first-time tenant or duration of stay of a transferring tenant void, thereby returning the candidate to the back of the queue for social rental dwellings.

Rejection of an offer either by the association or by the candidate is a common occurrence. Of the 1,806 offers made by Woonbron in 2002, 2003 and 2004, only 1.5% were accepted by the first candidate in line.[73] Rejection by the association occurs if the candidate does not meet the eligibility requirements or does not show up for inspection. Invited candidates are free to reject offers if they are disappointed with them upon inspection. Upon obtaining a dwelling (either within or outside of the distribution system), the candidate forfeits all other options. Given the high incidence of rejections, many house-seekers

experienced threats made against them and asylum-seekers, former psychiatric patients or homeless people who were granted accommodations in connection with the social task of the association.

72 In 2005, 78% of all social rental vacancies in Rotterdam were offered through regular channels (i.e. the internet site and the free paper), 29% carried eligibility requirements and 49 % carried no requirements at all (COS, 2006).

73 The average number of rejections for an offer in the sample was 17, while the highest number of rejections for an offer was 149 before a candidate accepted the offer.

seemed to have used their responses strategically. Invitations serve as a signal to candidates that they can upgrade their choices of specification in the next period. Tenants who are not invited learn that they must wait longer for the same specification of dwelling or downgrade their choices of specification in the next period, if they wish to obtain accommodation on short notice.

The response then, is a stated housing choice rather than a revealed housing choice for candidates who reject an offer. Unlike sociologists, statisticians, psychologists or environmental economists, who make frequent use of survey data in their research, many economists question the merit of stated choice analysis. One criticism is that a stated choice is subject to idiosyncratic bias and highly dependent upon the survey design (Diamond and Hausman, 1994). Large samples are likely to reduce the bias in the response, and measurement problems call for a better survey design or post-survey adjustments to the survey scores. A more serious objection is that a stated choice does not involve a real commitment on the part of the respondent.[74] The neoclassical framework discussed in Chapter 2 is not concerned with choices that are non-binding, although this does not mean that the response to the offer cannot be fit into the framework.[75] A model of net response to offers can still be derived with the aid of several assumptions concerning the unobserved search and choice behaviour of tenants.

Assume that all offers are made in the queuing system.[76] Homeless tenants extend their period of homelessness, while existing tenants extend their duration of stay in the old home up until the point *d* in time, at which they are better off living in the new home (Van der Vlist, 2001). A tenant will accept any offer that is made at time *d*, if the improvement in utility in the next period outweighs the expected losses in utility in the coming periods due to the abandonment of future housing opportunities:

(4.1a)

$$U(y-r_d;z_d)-U(y;0)>\sum_{t=d+1}^{I}(1+\rho)^{-t+d}\{U(y-r_{d+1};z_{d+1})-U(y-r_d;z_d)\}$$

(4.1b)

$$U(y-r_d;z_d)-U(y-r_0;z_0)>\sum_{t=d+1}^{T}(1+\rho)^{-t+d}\{U(y-r_{d+1};z_{d+1})-U(y-r_d;z_d)\}$$

In these equations, z_t is the specification of dwelling that is occupied from

74 The discrepancy between stated and revealed choices is most evident in willingness to move when confronted with exit choice. De Groot *et al.* (2011) found that a third of households that stated that they were willing to move actually did move within the next two years.

75 Attempts to provide theoretical underpinnings for stated choices include McFadden (1986) for dichotomous choices in general and Timmermans *et al.* (1994) and Earnhart (2002) for housing choices in particular.

76 A similar outcome is expected in the lottery, for reasons that become clear in Chapter 5.

time t onward, r_t is the rent of this dwelling, ρ is the discount rate ($0<\rho<1$) and *T* is the final period that the tenant will spend in the new dwelling. The likelihood of acceptance increases in the rent-quality relationship of the offer and decreases in the rent-quality relationship of future offers. Invitations serve as signals to candidates that their high ranking in the distribution system will allow access to better offers in the next period (i.e. $z_{d+1}>z_d$ and/or $r_{d+1}<r_d$). Some high-ranking candidates reject offers because the value of future housing opportunities over current offers is positive. In some cases, however, candidates are ranked so low that conditions (2.18a) or (2.18b) do indeed hold. The important result is that all candidates who are next in line would have to accept the offer as well, as the value of future housing opportunities is lower for them than it is for the winning candidate. The net response to an offer (i.e. the number of responses minus the number of rejections) must be closely associated with tenants' demand for this type of dwelling.

Three factors can create a gap between the net response to and the demand for a social rental dwelling. First, tenants can exercise options on three different dwellings in the queuing system or on one, two or three dwellings in the lottery. Second, if two identical dwellings arrive on the market at the same time, then the odds of obtaining this type of dwelling are also doubled (Timmermans and Van Noortwijk, 1995). In theory, this makes the net response to an offer equal to three times the demand for the dwelling, divided by the number of offers that have the same specification (i.e. number of arrivals) as the dwelling in question.[77] A less trivial reason for the gap between the net response to and demand for the offer involves the role of unobserved choice behaviour. Some house-seekers might be interested in an offer, but they could be absent during the subscription period. Uninvited candidates may also have rejected an offer (or be rejected by the association), even if they had been invited. Neither the non-response of absentees nor the implicit rejections of the uninvited candidates are observed. The difference between the two figures – the implicit rejections and non-response work in the opposite direction – is treated as a random process in order to arrive at a workable model.[78]

In Chapter 2, the demand for dwellings was derived. Demand depends upon the attributes of the actual dwelling and neighbourhood, housing costs and the characteristics of households that make up the target group for the specification of dwelling. Keeping all other attributes z^* fixed, the demand for a social rental dwelling with specification $(z1,z^*)$ can be formulated as follows:

$$(4.2)\quad D(z_1, z^*) = n(z_1(y, r, hh), z^*))N$$

77 Rational tenants are likely to exercise all three options, as the additional costs of a second and third response (possibly for the same offer) are negligible once the first option has been exercised.

78 This means that a particular target group is no more or no less inclined to respond to an offer and no more or no less likely to reject an offer than is any other target group.

In this equation, *N* stands for the number of house-seeking tenants, *hh* for the characteristics that define tenants' housing taste, *y* for tenants' income and/or wealth and *r* for the rent of the dwelling. The fraction of tenants *n* demanding specification (z_1,z^*) rises with the quality of the dwelling (z_1) and falls with the rent. The target group n^*N can contain tenants who are heterogeneous in their characteristics and preferences. The tenant characteristics in relationship (4.2) should not be viewed as features of any individual candidate, but as an exogenous demand shift parameter that expresses the taste of the target group as a whole.

The net response *NR* to an offer with specification (*z*,*r*) is equal to three times the demand for this type of dwelling, divided by the number of identical dwellings arriving on the market γ, plus a term u_t, which represents the sum effect of the implicit rejections and non-response:

(4.3)

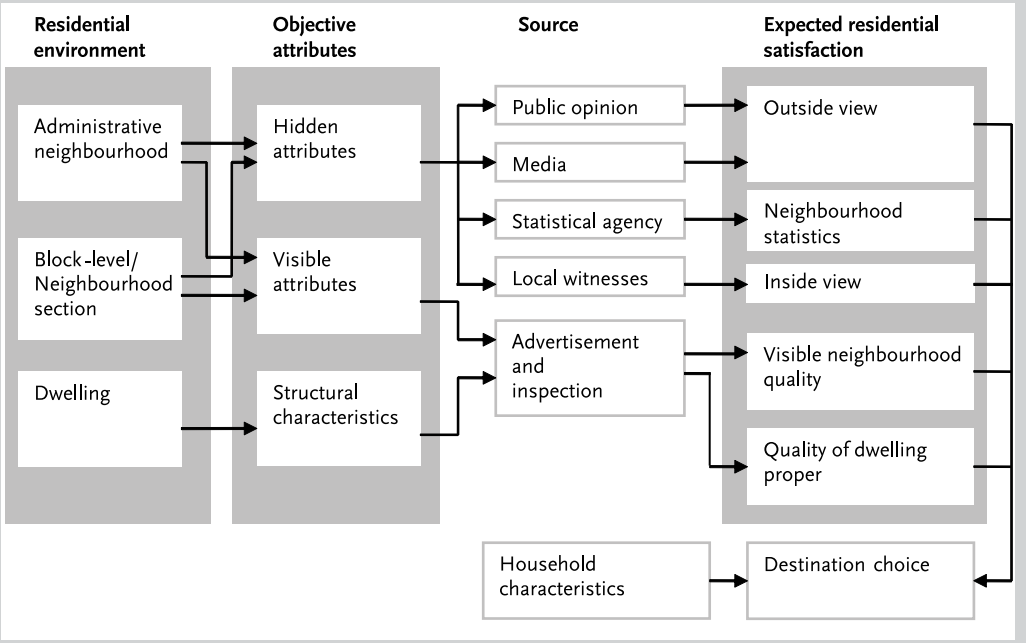
$$NR(z;NBH;r;\Phi;\gamma) = 3 * n(z;NBH;r;\Phi) * N / \gamma(z;NBH) + u_t$$

Net response rises with the availability and quality of attributes of the actual dwelling z and neighbourhood *NBH* and drops when the rent *r* increases. The demand shift parameteρ Φ captures the taste of the target group. The number of arrivals γ can act as an exogenous supply shift parameter, but it might vary with the specification of dwelling. Given that popular dwellings in areas with a better quality of life tend to be scarce, the number of arrivals for these types of dwellings is likely to be lower. The shape of the term ut can only be guessed. It is possible that the absolute difference between implicit rejections and non-response increases with the number of net responses. This leads to heterogeneity in the model.

Event data (e.g. net response) are best estimated with a count model. Among the different count models, the negative binomial model allows for a non-linear relationship between the dependent variable and the explanatory variables, and it allows for heteroskedastic disturbances due to heterogeneity or other reasons.[79] The model uses structural characteristics and the logarithm of rent as explanatory variables, in addition to several institutional variables addressing the peculiarities of the distribution system. Structur-

79 The mean value of the event variable y_i in the negative binomial count model is given by $E\{y_i\}=\lambda_i=exp(\alpha+\beta x_i)$, where $\alpha+\beta x_i$ is the estimated equation. The variance is $V\{y_i\}= \sigma^2\lambda_i$. The shape parameter $\kappa=log(\sigma^2)$ reveals the degree of dispersion of the disturbances compared to the mean. The data are underdispersed for values of κ that keep the variance below the mean, while higher values of κ refer to data that are overdispersed (Long, 1997). Underdispersion is preferable in this context, as it indicates that there is little positive spatial autocorrelation due to (spatial or non-spatial) heterogeneity (Haining *et al.*, 2009).

Figure 4.1 Destination choice



al characteristics include the primary choice criteria on the search-site (e.g. house type and number of rooms), secondary choice criteria (e.g. the size and building period of the dwelling, and the maintenance level), which can be observed upon inspection. Institutional variables include the year in which the dwelling was offered as a measure of general market pressure, a dummy term which tells whether the offer was made within the queuing system or within the lottery, and two dummies for the eligibility requirements for the dwelling.

The role of neighbourhood quality in the destination choice is illustrated in Figure 4.1. House-seekers have the same information on the rent, structural characteristics and location of the dwelling through the advertisement, but they must rely on external sources in order to learn about the quality of the neighbourhood. The outside view on the area, which is embodied by the house price residual, costs nothing to obtain and should be known by all. Inspection yields additional information on the observable aspects of neighbourhood quality. Inspecting the dwelling prior to the response might not pay off, however, given that most respondents will not be invited by the association. Tenants who acquire more detailed information on the neighbourhood through their own experience, local witnesses or the use of neighbourhood statistics nonetheless run the risk that this information is incomplete. Incompleteness may be due to the aggregation of information over a range that extends beyond the surroundings of the offer. If house-seeking tenants use incomplete information in responding to offers, then the range of the estimated pull effects of the neighbourhood must exceed the range of the corresponding push effects in their exit choices. Furthermore, neighbourhood satisfaction (the inside view) should play a minor role in the destination choices of most house-seeking tenants.

The regression is thus meant to shed light on the strength and range of the pull effect of neighbourhood satisfaction. Endogeneity should pose few problems in this particular estimation. The response to offers is probably higher in areas with a good living quality. With regard to the stability of the area, however, it makes little difference whether one or 500 tenants are standing in line, as long as one of them accepts the offer. The decision to respond can hardly be considered a constrained choice; a response is cheap and easy to make, and rejection is always an option. Tenants might still feel constrained in advance if they know that their rank is insufficient to obtain the type of dwelling that they actually prefer. Some low-ranking tenants may decide to wait, while others – presumably first-time tenants; see conditions (4.1a) and (4.1b) – can lower their standards to secure accommodations on short notice. The latter rational choice strategy could influence the estimation outcome, as hard-pressed tenants are more inclined to respond to offers that are attainable on short notice than they are to wait for offers that they actually prefer. This problem is discussed at the end of this chapter.

The unobserved non-response and implicit rejections can lead to heterogeneity in the model if they are correlated with the number of responses. Another cause of heterogeneity is linked to the dispersion of the observations across the city (see Figure 3.2). The boroughs in the sample differ in quality, reputation and social make-up.[80] The relation between net response and neighbourhood quality may change from one housing submarket to the other, as the target group in each area can be different as well. The estimation method (i.e. Huber-White's heteroskedasticity-consistent standard errors) controls for heterogeneity. This ensures that the average pull effects on all tenants are estimated accurately, although it might still lead to a misrepresentation of the pull effect on each separate submarket. Rather than resorting to a spline regression (Poirier, 1973) or a threshold model (Hansen, 2000), both of which allow for structural changes in the coefficients of the neighbourhood variables with every submarket, I opt for a simple solution for addressing spatial heterogeneity in the robustness analysis: separate regressions for subsamples of observations below and above a given threshold in neighbourhood satisfaction.

80 Although it is of a reasonable quality, the northwestern borough of Prins Alexander is known as a 'white bulwark' (Van der Zwaard, 2005), whereas the disadvantaged neighbourhoods in the western borough of Delfshaven house primarily ethnic minorities. The southeastern borough of IJsselmonde is neutral in most respects, although the city's entire south bank has a worse reputation than does the north bank.

Table 4.1 Descriptive statistics

		Mean	Median	Maximum	Minimum	Std. dev.
Response		153.38	118	858	1	130.43
Rejection		17.18	13	141	0	16.28
Number of rooms	One	0.06	0	1	0	0.24
	Two	0.24	0	1	0	0.43
	Three	0.38	0	1	0	0.49
	Four	0.21	0	1	0	0.40
	Five or more	0.11	0	1	0	0.31
Building period	Built before 1945	0.15	0	1	0	0.36
	Between 1945 and 1975	0.38	0	1	0	0.49
	Between 1975 and 1990	0.44	0	1	0	0.50
	After 1990	0.02	0	1	0	0.15
House size	Less than 50 m²	0.31	0	1	0	0.46
	Between 50 and 60 m²	0.30	0	1	0	0.46
	Between 60 and 75 m²	0.25	0	1	0	0.44
	Between 75 and 90 m²	0.12	0	1	0	0.33
	More than 90 m²	0.01	0	1	0	0.10
House type	Single-family	0.13	0	1	0	0.33
	Downstairs apartment	0.13	0	1	0	0.34
	Upstairs apartment with lift	0.45	0	1	0	0.50
	Upstairs apartment no lift	0.29	0	1	0	0.45
Maintenance label	High	0.07	0	1	0	0.26
	Middle	0.85	1	1	0	0.36
	Low	0.08	0	1	0	0.28
Rent in Euros per month		377.85	375	756	153	92.87
House price in Euros		105,257	100,000	197,000	37,000	30,961
Neighbourhood satisfaction	250 m²	4.31	4.31	5.28	3.75	0.23
	500 m²	4.35	4.37	5.28	3.86	0.18
	750 m²	4.35	4.35	5.28	3.96	0.19
	1.000 m²	4.35	4.38	5.28	4.03	0.18
	Moore range 1	4.39	4.39	4.87	3.96	0.20
	Moore range 2	4.40	4.44	4.89	4.00	0.18
	Von Neumann range 1	4.36	4.37	4.93	3.92	0.20
	Von Neumann range 2	4.39	4.41	4.91	3.98	0.19
	Von Neumann range 3	4.39	4.42	4.89	4.01	0.19
Lottery system		0.61	1	1	0	0.49
Physical accessibility	Three stars	0.03	0	1	0	0.15
	Four stars	0.19	0	1	0	0.39
Year	2002	0.21				
	2003	0.34				
	2004	0.46				
Percentage of moves in neighbourhood per year		0.09	0.08	0.15	0.04	0.03

N=1,794

4.3 Data

The data used in the estimation of the net response to offers in Rotterdam were taken from the record of the Woonbron association (see Table 4.1). The offers made by Woonbron in 2002, 2003 and 2004 are first cleansed of offers made directly to tenants. This leaves a total of 1,794 observations, 61% of which were offered through the lottery system. The vacant dwellings were situated in ten administrative neighbourhoods in four different boroughs of the city. In addition to the number of responses to and rejections of each offer, the dataset contains the structural characteristic of the dwelling (house size,

number of rooms, building period, house type, presence of a lift and maintenance label), rent in 2002 and the assessment value as a proxy measure for the house price in 2003. The observations concerning house price fall short of those on the other variables, thus leaving 1,673 observations in the estimation with price.

Institutional variables include the year of the offer, a dummy term for the distribution system (1 for the lottery, 0 for the queuing system) and dummies for the physical accessibility of the dwelling. In Rotterdam, stars are assigned to social rental dwellings in order to indicate how well the dwelling is adapted to the needs of the elderly and disabled. Dwellings with a three or four stars carried additional eligibility requirements regarding age and/or disability status. High star labels could be expected to lower the net response to offers, due to the reduction in the number of eligible candidates. The dataset from the association's records is appended by nine different representations of the locally weighted averages for neighbourhood satisfaction. Finally, the average turnover (i.e. the share of moving households) in each administrative neighbourhood and year is listed. The latter variable has been calculated from population register data from the municipal statistics office. The turnover rate is intended as a control for exogenous shifts in supply (i.e. changes in the arrival rate of dwellings) within the area.

4.4 Net response to social rental dwellings

The results of a robust estimation of a negative binomial count model for the net response to offers on the social rental market in Rotterdam in 2002, 2003 and 2004 are listed in Table 4.2. The referential category is a single-room downstairs apartment, built before 1945 with a size of less than 50 m^2 and a low level of maintenance. The estimation of the base model shows that the primary choice criteria (number of rooms, house type, rent and borough of the offer) played a decisive role in the net response to offers. Large single-family dwellings with low rents proved most popular among tenants. A comparison with Table 3.4 tells that the ratio's of the coefficients on number of rooms and house types with the coefficient on rent are similar for the exit choice and destination choice model, but that this correspondence does not apply to all structural characteristics. Secondary choice criteria (e.g. house size and age) proved unimportant.[81] Tenants discarded poorly maintained dwellings and dwellings in disadvantaged neighbourhoods more often, possi-

81 The negative sign on the coefficient on dwellings larger than 90 m2 should not be given too much weight. Only 17 observations fell into this category, including five offers with a net response lower than 50 and one observation that had a net response of one (14 responses and 13 rejections).

Table 4.2 Negative binomial count model for the net response to social rented dwellings in Rotterdam in 2002, 2003 and 2004

		Model I		Model II	
		coeff.	z-value	coeff.	z-value
Constant		15.86	16.84	10.01	6.26
Number of rooms	Two	0.67	8.47	0.54	6.59
	Three	1.12	9.81	0.96	8.16
	Four	1.56	11.63	1.42	10.20
	Five or more	1.55	8.87	1.39	7.78
Building period	Between 1945 and 1975	-0.06	-0.94	-0.10	-1.37
	Between 1975 and 1990	-0.33	-6.42	-0.34	-6.56
	After 1990	-0.45	-2.90	-0.58	-3.83
House size	Between 50 and 60 m²	0.13	1.60	0.04	0.47
	Between 60 and 75 m²	0.13	1.30	-0.04	-0.36
	Between 75 and 90 m²	0.11	0.85	-0.05	-0.35
	More than 90 m²	-0.28	-1.51	-0.48	-2.57
House type	Single-family	0.69	8.70	0.57	6.81
	Upstairs apartment with lift	-0.05	-0.97	-0.27	-3.76
	Upstairs apartment no lift	-0.23	-3.34	0.01	0.12
Maintenance label	Middle	0.40	5.16	0.41	5.23
	High	0.58	5.58	0.57	5.37
Logarithm of net rent		-2.25	-14.13	-2.41	-14.56
Year	2003	0.02	0.35	0.02	0.34
	2004	-0.13	-2.17	-0.12	-2.03
Accessibility	Three stars	-1.60	-10.02	-1.57	-9.82
	Four stars	-0.70	-9.75	-0.66	-9.06
Lottery		0.31	6.41	0.31	6.32
Logarithm of house price		-	-	0.58	4.80
Neighbourhood satisfaction	Moore range 2	0,20	1,76	0.29	2.45
Shape parameter		-0,67	-19,57	-0.68	-19.63
Borough fixed effects		No		No	
R^2		0.27		0.27	
Standard error of regression		109.02		108.69	
Log Likelihood		-10,228.9		-10,160.6	
N		1,797		1,673	

bly as a result of rejection upon inspection. As expected, dwellings designated for the elderly and infirm obtained fewer responses, while the net response in the lottery was higher than it was in the queuing system. On average, 42 more candidates responded to dwellings in the lottery (0.31*(153.38-17.18); see also Table 4.1). The shape parameter proves highly significant, thereby justifying the decision to use a negative binomial count model.[82]

The inside view on the neighbourhood is introduced in Model I. The best representation is calculated over a five-by-five Moore neighbourhood which conforms to the administrative neighbourhood for smaller neighbourhoods and to entire neighbourhood sections for larger ones. It is, however, just insignificant; there is a 93% probability that it is different from zero. The large scale (about 2.5 times the range and five times the size of the inside view in the exit choice model) reinforces the conjecture that most house-seekers held incomplete information on the neighbourhood when they responded to offers. This raises the possibility that neighbourhood satisfaction controls for

82 The alternative for the negative binomial count model, the Poisson count model, assumes that the mean value of the event variable is equal to its variance (Gourieroux, 2000).

Model III		Deprived areas Model IVa		Attractive areas Model IVb	
coeff.	z-value	coeff.	z-value	coeff.	z-value
13.11	6.76	17.87	7.67	1.97	0.71
0.55	6.32	0.77	4.80	0.51	5.11
1.09	8.61	1.06	5.54	1.15	6.53
1.58	10.86	1.50	7.01	1.61	7.56
1.69	9.10	1.36	5.41	1.63	6.08
0.09	0.92	0.06	0.59	0.46	2.64
-0.23	-3.42	-0.31	-4.57	0.13	0.72
-0.63	-3.79	-0.36	-2.17	0.07	0.15
0.01	0.06	0.26	2.15	-0.31	-2.24
-0.09	-0.87	0.26	1.85	-0.50	-2.82
-0.18	-1.28	0.46	2.51	-0.62	-2.87
-0.40	-2.02	-0.06	-0.26	-0.84	-3.01
0.70	7.66	0.72	4.03	0.59	5.07
-0.37	-4.80	-0.43	-4.31	-0.28	-2.62
-0.02	-0.29	-0.07	-1.06	0.04	0.55
0.42	4.82	0.25	2.72	0.85	5.48
0.54	4.62	0.32	1.59	0.96	5.65
-5.03	-12.43	-2.51	-11.67	-2.31	-8.68
-0.01	-0.15	0.13	1.64	-0.13	-1.45
-0.15	-2.38	-0.06	-0.82	-0.21	-2.44
-1.48	-8.41	-1.41	-8.04	-0.70	-7.09
-0.53	-7.00	-0.40	-3.07	-	-
0.33	6.58	0.20	3.07	0.48	7.04
0.12	0.76	0.20	1.33	0.82	3.69
0.48	2.31	-0.43	-1.73	1.15	3.66
-0.70	-19.32	-0.78	-15.71	-0.65	-13.48
Yes		No		No	
0.32		0.17		0.34	
105.45		110.97		108.94	
-9,501,7		-4,949.0		-5,174.7	
1,673		876		902	

aspects of neighbourhood quality in this model other than those for which it controlled in the exit choice model. Attributes that are known only to insiders must be acted out inside the administrative neighbourhood; otherwise, outsiders would be aware of them as well.

Model II introduces the natural logarithm of house price. The inclusion of the house price increases the value and significance of the coefficient for neighbourhood satisfaction. Based on the high scale for neighbourhood pull effects, both variables probably control for observable neighbourhood quality, whereas the largely unobservable quality of life at block level seemed to have little effect on the decision to respond. The inter-neighbourhood differences in the response rate are better explained when both variables are used in the estimation. The net response to offers depended on the primary choice criteria: the rent, number of rooms, house type and borough of the offer. Some tenants also took account of the dilapidation of the dwelling (an effect that is captured by the maintenance label) and the administrative neighbourhood or neighbourhood section in which the offer was made.

The estimated coefficient for price in model II yields a willingness to pay of 0.24% (0.58/2.41) for a percentage increase in the price. The willingness to pay for a one-point increase in neighbourhood satisfaction rises to € 45.47

(0.29/2.41*377.85), or 12% or rent.

This is about the same amount what existing tenants were willing to pay (14%, see Section 3.4). Despite the closeness of the willingness of residents and house-seekers to pay, the two figures should not be compared directly. Neighbourhood satisfaction probably explains inter-neighbourhood differences in net response to offers, whereas it controlled for intra-neighbourhood differences in the exit choice model. Apparently, some aspects of the observable quality of the neighbourhood that were not included in the push effect of neighbourhood satisfaction are now concealed in its pull effect.

Robustness analysis

The attributes of the neighbourhood whose range does not extend beyond the home surroundings seemed to have little or no effect on the decision to respond to offers. This raises the question of whether the model fails to capture the unobservable neighbourhood quality and its effect on the response. The pull effects of attributes that go unobserved by the researcher but are observed by tenants are likely to create large and spatially correlated disturbances in the estimation. The low rate of dispersion of the model (κ=-0,86, so exp(-0.68)=0.51<1) indicates that spatial autocorrelation is small (see also Footnote 78). The value of Moran's I of 0.11, however, shows that not all of the spatial variation in the net response is accounted for by the neighbourhood variables.

In the second robustness check, area-fixed effects are appended to model II. This is done in an attempt to reduce some of the spatial autocorrelation. Furthermore, it may reveal what aspects the neighbourhood variables are measuring. Estimation results are similar when borough-fixed or neighbourhood-fixed terms are used in the model. The results of the estimation of model II with borough-fixed effects is shown as model III in Table 4.2. Neighbourhood satisfaction retains its explanatory power, but house price is insignificant. Neighbourhood satisfaction explains differences in the net response at the scale of neighbourhoods and neighbourhood sections. Price mainly controls for the inter-borough differences in the number of response. Net response ranged from an average of 239 in the borough Overschie to 123 in the large southern borough of Groot-IJsselmonde. A t-test for the equality of the mean net response between boroughs is rejected for all but one comparison (i.e. between Delfsha-ven and Prins Alexander). The poor name of the southbank of the city seems to be reflected in both lower house prices and unpopularity on the social rental market.

In the third robustness check, the number of moving households each year as a percentage of all households in the neighbourhood is appended to the model, in an attempt to control for the arrivals of vacant dwellings on each geographical submarket. Contrary to expectations, the turnover rate proves irrelevant. The fact that vacancies were in short (or abundant) supply did not

lead to a higher (or lower) response to offers in the area. Without knowledge of tenants' motives for responding to offers, it is difficult to say whether they took account of local supply conditions or whether the turnover rate is an inadequate measure of the number of arrivals. After all, no distinction is made between moves in the social rental and owner-occupied segments of the market. In the absence of strategic response by tenants, changes in local supply are likely to have generated large, spatially correlated disturbances. The moderate spatial autocorrelation indicates that the arrival rate was either constant over the three-year period or that most tenants understood that supply affects the success rate. The variance in the arrival rate (see Table 4.1) makes the latter explanation more plausible than the former, although it remains an educated guess.[83]

The relationship between net response to offers and neighbourhood quality may have undergone a structural change if tenants shifted their focus away from attractive areas and towards disadvantaged areas (or vice versa). The use of different search areas by tenants with a different housing taste or different levels of awareness of neighbourhood quality may lead to spatial heterogeneity. In the final robustness check, the observations are split according to neighbourhood satisfaction scores. This produces a subsample of 876 observations with satisfaction scores less than 4.4 and a subsample of 902 observations with score of 4.4 and higher. The mean net response is identical in the subsamples.[84] The explanatory power of the neighbourhood variables is low in the estimation for the sample in the deprived areas (see Model IVa). Neighbourhood satisfaction has an unexpected, negative sign. The results are quite different for tenants who opted for offers in attractive areas. The estimation for areas with high satisfaction scores is listed as Model IVb in Table 4.2.[85] Tenants who responded to offers in attractive areas were willing to pay 0.36% for an percentage increase in house price. The willingness to pay for a one-point increase in neighbourhood satisfaction jumps to € 188.11 (or 49,8%) of monthly rent. The higher willingness to pay for neighbourhood satisfaction among tenants who responded to offers in attractive areas probably reflects their greater awareness of or greater sensitivity towards the observable quality of the neighbourhood. None of the other representations of neighbour-

83 The number of offers in each borough is listed on the opening page of the internet search site, while the paper lists the offers of each association in alphabetical order for each neighbourhood. This should reveal, at least to some extent, the areas in which the success rate is high and the areas in which it is low.

84 The hypothesis that net response differs between the subsamples can be rejected with a confidence level of 95% (t-value of 1.68). Three fourths of the observations in the first subsample are in Delfshaven, with the remainder in disadvantages sections of IJsselmonde and in Overschie. Nearly one third of the observations in the second subsample are in Prins Alexander, with close to two thirds in IJsselmonde and the remainder in Overschie (see Figure 3.2).

85 Because dwellings with a three-star label are rare in this particular subsample, this category is merged with the larger four-star category.

hood satisfaction adds explanatory power to Model IVb once the representation based on a Moore neighbourhood with range 2 is used. This makes clear that the majority of tenants who responded in attractive areas differentiated between administrative neighbourhoods or neighbourhood sections, but that they were either just as indifferent towards or unaware of the living quality in the surroundings of the offer as the other tenants were.

4.5 Conclusions

This chapter investigated net response to social rental dwellings in Rotterdam. Willingness to pay for the neighbourhood proved even higher among house-seeking tenants who responded to offers in attractive areas than it was among existing tenants. In contrast, the willingness to pay for the neighbourhood demonstrated by tenants searching in disadvantaged areas was negligible. The average house-seeking tenant valued the maximum attainable rise in neighbourhood satisfaction at about 12% of the rent, which is similar to the assessment of the average existing tenant. This figure increased to 50% for house-seeking tenants who opted for offers in attractive areas. Tenants were willing to pay about one-third of what owner-occupiers were willing to pay in order to live in the same area. It is nonetheless premature to draw conclusions from the comparison of the pull effects of the neighbourhood with the push effects discussed in Chapter 3. House price and neighbourhood satisfaction controlled for the observable aspects of neighbourhood quality in the count model, whereas most respondents apparently neglected the unobservable quality of the area, for reasons that are as of yet unclear.

One of the most striking results of this chapter is the high range of the neighbourhood pull effects. The spatial variation in net response occurred at the scale of the administrative neighbourhood or entire sections of larger neighbourhoods. This indicates that even within a highly transparent distribution system in which gains in neighbourhood quality can be substantial, few respondents took heed of differences in quality inside the administrative neighbourhood. This corroborates the first conjecture of Chapter 2, in which I stated that the range of neighbourhood pull effects must be higher than the range of the corresponding push effects. It remains unclear however, whether this difference in scale was the result of an informational disadvantage.

Tenants who responded to offers in unattractive areas (i.e. areas dominated by apartments) may have done so because they cared little about neighbourhood quality or because of a greater need for accommodation. The next chapter reveals that the waiting time for offers in unattractive areas was indeed shorter in 2005. Such strategic response behaviour could explain the observed sorting pattern as well: higher willingness to pay for neighbourhood quality triggers a response to offers in attractive areas, whereas lower willingness to

pay leads to a response to offers in more disadvantaged areas. The informational disadvantage of house-seeking tenants is not the only explanation for the estimation results in this chapter.

Furthermore, gathering additional information on neighbourhoods might not pay off, as the majority of candidates were not invited by the association anyway. Strategic choice behaviour and the non-binding nature of the response obscure the exact strength and range of the estimated pull effects. Only when the destination choice is revealed is it safe to make statements about tenants' preferences, the constraints they face or how well or ill-informed they are. Revealed destination choices were made by candidates who accepted offers. In the next chapter, I analyse the bids of successful candidates. This analysis is expected to reveal how useful the results of the stated choice model in this chapter were.

5 Waiting time for social rental dwellings

5.1 Introduction

In the previous chapter, analysis of the response to offers by social tenants in Rotterdam pointed at the fact that a large number of tenants did not seem to care about differences in quality within the administrative borough when they responded to offers. While most house-seeking tenants can afford to remain ignorant about the quality of distant neighbourhoods, successful candidates pay an immediate penalty for such a lack of information. With long queues for social rental dwellings, tenants are effectively forced to remain in the chosen dwelling for a number of years. Unlike the response to an offer by most tenants, the destination choice of a successful candidate is clearly a revealed housing choice.

In this chapter, I estimate a duration model of bids for vacant dwellings, in order to measure the pull that the neighbourhood exerted on successful candidates. The tenant's bid is closely associated with the waiting time for an offer. On the social rental market, the function of waiting time is similar to that of house price on the owner-occupied market. The purpose of the regression is to determine how many new tenants were aware of the circumstances in the neighbourhood. The notion that well-informed tenants have of the neighbourhood is expected to come close to the inside view of residents. In contrast, the pull on less-informed tenants is expected to exhibit the same pattern as seen in the previous chapter: a wide range on neighbourhood pull effects and weak pull effects for neighbourhood satisfaction.

5.2 Neighbourhood pull and waiting time

According to standard economic theory, households try to maximise their lifetime utility. A homeowner moves when the expected utility of living in the new home (when the costs of moving are taken into account) exceeds the utility of staying in the old home (Nordvik, 2001). The homeowner's duration of stay is dependent upon the same factors that govern the exit choice: the quality and user costs of the dwelling and the characteristics that define the homeowner's housing taste (Goodman, 2003). The conditions for a move by a first-time buyer are usually less stringent, as homelessness usually produces less utility than does occupancy of a dwelling. First-time buyers accept offers that allow them to continue along their optimal consumption paths (Van der Vlist, 2001). For both types of buyers, the waiting time for the new home is equal to the duration of the search, extended by the time spent negotiating with the seller. Negotiations end when the sales price equalises the buyer's bid to the seller's offer.

Duration of stay in the old home, waiting time for the new home and the bid for the new home acquire an entirely different meaning on the Dutch so-

cial rental market. Until 2005, tenants in Rotterdam could use their duration of stay in another social rental dwelling as a ranking device. This provided existing tenants with such an advantage over first-time tenants (who had to rely on their registration time) that the distribution system was transformed (COS, 2006). In 2002, the Woonbron association initiated a lottery for some of its offers, in which the candidates were drawn at random. In the queuing system that most other associations continue to use, duration of stay was reduced by one quarter in each half-year period from 2005 onwards, such that, by the middle of 2006, registration time counted as the sole allocation criterion.[86] Registration time or duration of stay (or a fraction thereof) acts as the tenant's bid for the offer. After accepting an offer, the winning candidate must re-register as a house-seeker, thereby voiding all accumulated registration time or duration of stay.

The decision to accept an offer is a revealed destination choice. Successful candidates prefer the offer to the many alternatives: other offers in the same period and their option on future offers in the queuing system. In the queuing system, the waiting time for a dwelling stands in a straightforward relationship to the net response to an offer. This relationship is an application of Little's Law from queuing theory. Little's Law states that a steady state queue is equal to the average arrival rate of customers, multiplied by the average time a customer spends in the queue (Hall, 1999; Adan and Resing, 2002).[87] The 'queue' for a social rental dwelling can be defined as net response minus the sum of implicit rejections and absentee response (see Section 4.2). Applying Little's Law, average time τ spent waiting for a dwelling with specification *(z, NBH)* and rent r equals the steady-state queue for this type of dwelling $(\gamma^{*}(NR\text{-}u_t))$, divided by the increase in the number of house-seekers in the target group during each period ψ, divided by three (the number of options that a tenant can exercise):

(5.1)

$$E\{\tau(z;NBH;r;\Phi;\psi)\} = E\{NR(z;NBH;r;\Phi;\gamma)\}/3\psi - E\{\gamma * u_t\}/3\psi$$

Waiting time for a dwelling (actual or expected) depends upon the same variables that govern demand for the dwelling: rent, housing attributes and demand shift parameter Φ, as well as the number of new house-seekers in each period (see identity (4.3)). The function of waiting time is similar to that of

86 During the first half of 2005, rank was based on 75% of the duration of stay for tenants living in a social rental dwelling, this changed to 50% in the second half of the year. Registration time acted as the ranking device for first-time tenants and for transferring tenants whose registration time exceeded (the fraction of) their duration of stay.

87 In steady-state, the number of customers who enter the queue is equal to the number of customers served.

house price on the owner-occupied market. The better the rent-quality relationship of an offer is, the more responses it will receive and the longer the tenant (who is in competition with other tenants) should be prepared to wait for it. Tenant characteristics and the rent and quality of the dwelling that the tenant leaves behind are irrelevant, as rank in the distribution system is defined solely by the tenant's registration time or duration of stay.

In a well-functioning distribution system, the bid of a successful candidate is equal to the waiting time for the dwelling. In the application of relationship (5.1), however, four problems arise. First, the arrival rate γ and the sum of implicit rejections and non-response u_t can not be observed. Second, the bid is a proxy for the waiting time for the dwelling. Third, the allocation criterion was in a process of transformation during the period of investigation. The fourth problem relates to the fact that the majority of offers was made in the lottery. I assume that the product of the arrival rate and the sum of implicit rejections and non-response is a random variable (i.e. $E\{\gamma^* u_t\}=0$). This assumption is in part validated by the irrelevance of the arrival rate for net response (see Section 4.4). With regard to the second problem, it is the waiting time of the candidate (i.e. the bid) that is observed and not the expected waiting time for the dwelling. Estimation in which the bid is substituted for the waiting time for the dwelling is feasible, as long as the expected value of the bid (taking heed of the transformation of the allocation criterion) is equal to the expected waiting time.[88] In reality, the bid can be either lower or higher than the waiting time for the dwelling.

The bid of the second candidate in line is leading for the waiting time for a dwelling (Klemperer, 2003); any duration of stay or registration time will do, as long as it is higher than that of the second candidate.[89]

At this point, I assume that tenants are more or less aware of their rank in the distribution system. The bidding process then has elements of an auction. Most auction designs (Vickrey auction, English auction and Dutch auction) lead to a price that is equal to the second-highest bid. Only in sealed-bid auctions (in which bidders are unaware of each others' bids) does the price conform to the willingness to pay of the highest bidder (Klemperer, 2003).

The winning candidate is not allowed to retain this surplus upon accepting the offer. When a tenant is first in line, it may take several periods before the desired specification is put on the market. The waiting time for the dwell-

88 If the measurement error in a dependent variable (i.e. the difference between the bid and the expected waiting time) is random, then the regression produces unbiased estimates (Greene, 1991).

89 At this point, I assume that tenants are more or less aware of their rank in the distribution system. The bidding process then has elements of an auction. Most auction designs (Vickrey auction, English auction and Dutch auction) lead to a price that is equal to the second-highest bid. Only in sealed-bid auctions (in which bidders are unaware of each others' bids) does the price conform to the willingness to pay of the highest bidder (Klemperer, 2003).

ing could then act as a lower bound on the bid. On the other hand, the transformation of the allocation criterion lowered all of the bids in the second half of the year.[90]

Because I am interested in the role of neighbourhood quality in lengthening or shortening the waiting time for a dwelling, it is necessary to find a way of controlling for the potential surplus or shortfall in the bid.

In an attempt to control for the surplus or shortfall in the bid, I assume that the expected value of the tenant's bid (θ) can be obtained by multiplying the waiting time by a factor *f*:

$$E\{\theta\} = f(hh;\Gamma) * E\{\tau(z;NBH;r;\Phi;\psi)\} \quad (5.2)$$

Factor *f* equates the expected waiting time with the expected bid. The instruments in *f* should ideally be correlated with the bid and independent of the waiting time for the dwelling. Waiting time depends upon rent, housing attributes and characteristics of the target group, but not on the tenant characteristics hh: each tenant must bid the same amount of time regardless of tenant characteristics. Among the various tenant characteristics, age is likely to be the best instrument. Because age was a good predictor for the duration of stay of residents (see Section 3.4), it must be correlated with the bid of a transferring tenant as well. It should also be a good predictor for the surplus or shortfall in the bid of a first-time tenant. The minimum age for registration is 18 years. Above this age threshold, age and registration time are identical. Age controls for the decline in the bids in the second half of the year, as well as for random 'overpaying' by individual candidates.[91]

Several institutional dummies Γ can be used as instruments as well. A dummy variable that distinguishes between first-time tenants and transferring tenants allows for a different degree of efficiency in the bidding of both categories of tenants. A dummy variable that distinguishes between the offers in the first and second halves of 2005 controls for any confusion that may have been created by the transformation of the allocation criterion. This dummy also controls for any increase or decrease in the arrival rate of house-seekers or any structural changes in the arrival of vacancies in the second half of the

90 Let two transferring tenants with respective durations of stay of three and four years and a first-time tenant with a registration time of two years vie for the same type of dwelling. One offer is made in each year. The first-time tenant must wait two years for a turn, such that the expected waiting time and bid amount to four years. Then suppose that the exchange value of the duration of stay is halved. The transferring tenant with a duration of stay of four years and the first-time tenant with a registration time of two years now have equal odds of winning. The expected value of their bids is equal to 2.5 years (the mean of two and three years), and the expected waiting times are 4.5 and 2.5 years, respectively. The transferring tenant with a duration of stay of three years has a waiting time of five years, such that this tenant's bid will be worth 3.5 years. The expected waiting time after the transformation is still four years, but the value of the bids has been reduced to 2.83 years.

91 Random 'underpaying' is obviously impossible, as an underpaying candidate would be passed over in the process

year. A positive coefficient for the institutional dummies or tenant characteristics (with the exception of tenant's age) reveals which categories of tenants 'overpaid', in the sense that their bids exceeded the bids of other tenants. Rational tenants must minimise the surplus of the bid (taking heed of the transformation of the allocation criterion) over waiting time. A surplus is indicative of overpaying, meaning that the tenant could have obtained a better offer in the same period or could have responded earlier to obtain the preferred type of dwelling.

The matter is further complicated by the fact that some offers were made in the queuing system and others were made in the lottery. The estimation of the count model in Chapter 4 showed that net response lengthened by about 30% in the lottery (see Table 4.2). Little's Law states that the expected waiting time for a dwelling should be the same, regardless of the distribution system. Tenants' ability to shift from the lottery to the queuing system, however, means that rational tenants select the lottery only if their rank is too low to obtain their desired specification of dwelling within the queuing system. In theory, the winner's bid in the lottery will then be a random draw between zero and the waiting time for the same offer in the queuing system. In practice, the bid in the lottery should be closer to the waiting time for the dwelling. As a precautionary measure, or to compensate for the costs of moving, tenants accumulate registration time or duration of stay before they become active house-seekers. The minimum bound on the bid in the lottery is likely to be higher than zero.

It is also conceivable that some tenants acted in a myopic fashion. Myopia entails that tenants respond in the same way to offers in the lottery as they would in the queuing system. The lottery was established three years prior to the period that is investigated here. Some tenants may have been unaware of the mixed distribution system. Tenants whose duration of stay or registration time was more than sufficient to obtain a dwelling in the queuing system, might still have participated in the lottery, if less than three desirable offers were available in the queuing system. It is therefore necessary to separate the tenants who could switch between the two distribution systems (and for whom Little's Law applies) from the tenants (presumably with low rankings) who participated in the lottery because it was their only option to obtain a dwelling. This can be achieved by dropping all bids of three years and under from the sample.[92] Another safeguard involves the use of a dummy term for offers that were made in the lottery. This dummy has a negative coefficient if the remaining candidates in the lottery had a lower average duration of stay

92 Only two first-time tenants with a registration time less than three years and four transferring tenants with a duration of stay less than six or 4.5 years (depending on the date of the offer) managed to obtain dwellings in the queuing system. The average bid of the remaining tenants in the lottery (i.e. those with bids higher than three years) is indistinguishable from the average bid in the queuing system (8.25 as compared to 8.27 years).

or registration time than did candidates in the queuing system.

The duration model attempts to measure the effect of neighbourhood quality on the waiting time for a dwelling, through the effect on the bids of successful candidates. Duration can be estimated with survival functions or hazard rates (i.e. the change in the survival function). I opt for a logarithmic transformation of the tenant's bid to linearise the model. The duration model of the bid for social rental dwellings reads as follows:

(5.3)

$$\log(\theta) = \beta_0 + \sum \beta_k z_k + \sum (\delta_l NBH_l) + \beta_r \log(r) + \sum \chi_m hh_m + \sum \phi_n \Gamma_n$$

The bid θ is a function of the waiting time for a dwelling (actual or expected), which is embodied by the structural characteristics of the dwelling *z*, the neighbourhood variables *NBH* and the rent *r*, as well as by the characteristics of the candidate and the institutional variables (Γ). The institutional variables include the dummy for offers in the lottery, the dummy distinguishing between first-time and transferring tenants and the dummy for offers made in the second half of 2005. A positive coefficient on any of the institutional dummies or tenant characteristics (excluding age) reveals which categories of tenants structurally overpaid for the offer.

Better housing quality and lower rent are expected to increase the waiting time for a dwelling. Tenants are also likely to realise that better neighbourhood quality increases their waiting time (i.e. $\delta_l > 0$). According to the conjectures at the end of Chapter 2, the bids of well-informed tenants are expected to reflect the gains in utility that accompanies knowledge of the inside view on the neighbourhood. These tenants might then substitute gains in housing quality for a shorter waiting time. Both choices have the same effect: reduction in the value of the bid. The pull that the neighbourhood exerts on well-informed tenants must be acted out at a scale similar to that of push effects on existing tenants. In contrast, ill-informed tenants must perceive the pull effects at a higher scale than residents do. While the coefficient for house price could be the same for both types of tenants, well-informed tenants are likely to pay more attention to neighbourhood satisfaction than ill-informed tenants are.

House-seekers are more likely to be informed when they face low costs of information-gathering or when the opportunity costs of selecting a lemon are high. According to some sociologists, long-distance moves destroy social capital, as the household's social ties are severed in the process (David *et al.*, 2008). The focus on information in this thesis leads to a different interpretation: moves destroy social capital, as they reduce the informational advantage that the household has as a resident. The inside view on the surroundings is of little use to the household if it is searching in distant neighbour-

hoods. Households who move over shorter distances retain inside information, as do households who move to areas that they or their witnesses know well. Although the tenant's place of origin and the presence of social ties in the area are unobserved, it is known whether the tenant moved within the administrative borough. A move within or outside the borough is used as a proxy for the distance of the move. Because tenants moving within the borough face lower costs of information-gathering, they should experience the pull effects of the neighbourhood at a low spatial scale.

Tenants who overestimate the quality of their new homes could initiate repeat moves (DaVanzo, 1983).[93] An erroneous destination choice is especially costly on the Dutch social rental market, as the tenant's rank in the queuing system is lost upon acceptance. The tenant must remain in an unwanted dwelling for at least several years. Transferring tenants with high duration of stay should be informed for a number of reasons. First, their rank is high and their destination choices are risky, due to the exchange of their old homes.[94] Second, tenants with high duration of stay tended to live in popular dwellings (see Section 3.4), which is likely to be associated with further increases in the opportunity costs of moving. Finally, duration of stay is a proxy for the length of stay in the city and thus for own experience with neighbourhoods and the extent and density of the network of local witnesses.

Some tenants may have accepted offers out of the need to obtain accommodations on short notice. According to the estimation presented in Chapter 4, strategic choice behaviour was more prevalent among first-time and low-ranking tenants, for whom selectivity is a luxury. On the other hand, tenants with high registration time or duration of stay have proven their ability to wait for the desired type of dwelling. The strategic destination choice of hard-pressed tenants could lead to insensitivity towards neighbourhood quality and a low estimate of the willingness to pay for the neighbourhood. This alternative explanation for the weak pull effect on first-time and low-ranking tenants is discussed and disproven in the robustness analysis later in this chapter. At any rate, excluding the bids of three years and less from the sample helps to reduce the number of hard-pressed tenants in the sample.

Ill-informed and well-informed tenants react differently to neighbourhood quality. One way of modelling the different response involves the use of random or fixed effects in the coefficients on explanatory variables (Kan, 1999). I opt for a simpler solution, splitting the sample into subsamples for tenants who moved within or outside of the administrative borough, transferring or first-time tenants and transferring tenants with a high duration of stay as op-

93 DaVanzo (1983) analysed migration between countries, finding that lengthening the stay in the host country led to the destruction of ties with the country of origin, thereby reducing the likelihood of return migration.

94 The value and quality of the old home may thus influence the destination choice (see Footnote 20).

posed to tenants who ranked lower in the distribution system.[95] The neighbourhood pull effects must be stronger in size and smaller in range for intra-borough movers, transferring tenants and tenants with high duration of stay than it is for inter-borough movers, first-time tenants and tenants with low duration of stay. Furthermore, the pull effects of neighbourhood satisfaction must be more relevant in the bids of intra-borough movers, tenants with a high duration of stay and transferring tenants than they are in the bids of other categories of tenants.

5.3 Data

The data used in the estimation of a duration model for the bids of social tenants in Rotterdam are drawn from about 600 offers that Woonbron made in 2005 (see Table 5.1). Dwellings that carried eligibility requirements regarding age or household size of the household are dropped from the sample, as are dwellings that have insufficient data on attributes or tenant characteristics. Structural characteristics include number of rooms, building period, house type and size, presence of a lift and the maintenance and star label of the dwelling. The data contain net rent, the assessment value as a proxy measure for the house price in 2003 and the nine representations of neighbourhood satisfaction in 2004. The data are supplemented by information on the intra-borough or inter-borough nature of the move, the date of the offer (i.e. the first or second half of 2005), the characteristics of the tenant and whether the offer was made in the lottery or in the queuing system.

The variables that define the dependent variable in the model are the tenant's duration of stay or registration time and the dummy that distinguishes between first-time and transferring tenants. The bid is calculated as the registration time for a first-time tenant and 75% of the duration of stay for a tenant living in another social rental dwelling in the first half of the year or 50% of his duration of stay in the second half of the year, provided that this fraction of the duration of stay exceeds the tenant's registration time. All bids of three years and under are dropped from the sample, leaving 516 observations that are used in the estimation. The logarithm of the bid is well-behaved: it has few outliers and its shape is similar to that of a normally distributed variable.[96] Tenant characteristics include the age of the head of the household,

95 Another solution would be to use a spline regression (Poirier, 1973), in which the coefficients undergo a structural change when the observation crosses a threshold in the distance of the move or in duration of stay. I decided against this approach, as the bid stands in a straightforward relationship to at least two of the criteria (i.e. registration time/duration of stay and first-time/transferring tenant) that act as thresholds.

96 The normality of the distribution of the bids is rejected with 96% certainty. The reason why the bid does not withstand the test for normality is that two intervals near the mean had no observations, while a large spike was

Table 5.1 Descriptive statistics

		Mean	Median	Maximum	Minimum	Std. dev.
Number of rooms	One	0.04	0	1	0	0.20
	Two	0.18	0	1	0	0.39
	Three	0.38	0	1	0	0.49
	Four	0.30	0	1	0	0.46
	Five or more	0.10	0	1	0	0.30
Building period	Before 1945	0.13	0	1	0	0.34
	Between 1945 and 1975	0.35	0	1	0	0.48
	Between 1975 and 1990	0.51	1	1	0	0.50
	After 1990	0.01	0	1	0	0.12
House size	Less than 50 m²	0.25	0	1	0	0.44
	Between 50 and 60 m²	0.26	0	1	0	0.44
	Between 60 and 75 m²	0.36	0	1	0	0.48
	Between 75 and 90 m²	0.12	0	1	0	0.32
	More than 90 m²	0.01	0	1	0	0.08
House type	Single-family dwelling	0.15	0	1	0	0.35
	Downstairs apartment	0.09	0	1	0	0.29
	Upstairs apartment with lift	0.30	0	1	0	0.46
	Upstairs apartment no lift	0.46	0	1	0	0.50
Maintenance label	High	0.08	0	1	0	0.27
	Middle	0.84	1	1	0	0.36
	Low	0.00	1	0	0.26	0.27
Rent in Euros per month		390.50	401.42	686.96	181.56	84.48
House price in Euros		106,940	105,500	187,000	37,000	29,313
Neighbourhood satisfaction	250 m²	4.30	4.30	5.28	3.75	0.22
	500 m²	4.35	4.38	5.28	3.89	0.17
	750 m²	4.35	4.35	5.28	3.99	0.18
	1.000 m²	4.35	4.38	5.28	4.03	0.18
	Moore range 1	4.40	4.41	4.87	4.00	0.20
	Moore range 2	4.41	4.45	4.89	4.00	0.19
	Von Neumann range 1	4.37	4.36	4.93	3.95	0.20
	Von Neumann range 2	4.39	4.41	4.91	4.00	0.20
	Von Neumann range 3	4.40	4.42	4.89	4.01	0.19
Institutional variables	Lottery system	0.91	1	1	0	0.28
	Second half of 2005	0.57	1	1	0	0.50
	Transferring tenant	0.47	0	1	0	0.50
	Move inside borough	0.45	0	1	0	0.50
Household characteristics	Duration of stay or registration time in years	10.94	9.60	32.98	3.05	5.21
	Log of tenant's bid	2.04	2.07	2.82	1.11	0.36
	Single	0.40	0	1	0	0.49
	Single parent	0.36	0	1	0	0.48
	Couple without children	0.11	0	1	0	0.32
	Couple with children	0.13	0	1	0	0.33
	Number of children	1.24	0	7	0	1.45
	Age of head of household	33.09	29	84	18	12.86
	Household income in Euros per year	17,558	15,578	106,285	500	10,120

N=516

household income, size of the household and household type.

Some households with dual earners had high incomes. Woonbron is one of the few housing associations that do not impose income requirements. Nevertheless, more than 96% of new tenants in the sample fell into the target

present at the mean. The erratic pattern in the distribution is probably the result of the low number of observations in the sample.

group for social rented housing, which the Dutch Ministry of Housing defined as households with a yearly income of less than € 33,000 in 2005. Compared to existing tenants, whose average age was 55 years (see Table 3.3), house-seeking tenants were young. The average age of a first-time tenant was 28 years. Nearly half of the first-time tenants were single, with single-parent families as the second largest category. Even transferring tenants were young compared to existing tenants. The average age of transferring tenants was 38, with single-parent families and couples with children as the largest categories. The observations are distributed over nine neighbourhoods in four boroughs of the city. The large southeastern borough of Groot-IJsselmonde (see Figure 3.2) accounts for nearly half of the observations in the sample.

5.4 Bids for social rental dwellings

Table 5.2 lists the outcome of a duration model of tenants' bids for social rental dwellings in Rotterdam in 2005 using White's method. Neither the size of the dwelling nor the maintenance label proves relevant. The model is further simplified by considering the fact that dwellings built before 1990 were valued the same and that the coefficients for dwellings with three, four and five or more rooms are indistinguishable from one another. These categories are merged in order to economise on degrees of freedom. The frame of reference in the model then becomes a single-room or double-room downstairs apartment that was built prior to 1990.

The only tenant characteristic of importance is the age of the tenant. The negative coefficient for the tenant's age indicates that the transformation of the allocation criteria led to the expected downward revision in all bids in the second half of the year. The tenant's age suffices as a control variable for the surplus in the bid, given that none of the other tenant characteristics or institutional dummies is significant.[97] No category of tenant overpaid: bids were not excessive in the second half of the year, and bids in the lottery (excluding bids of three years and under, as stated previously) were indistinguishable from bids in the queuing system. This is remarkable, since the vast majority of Woonbron's offers in 2005 was made inside the lottery. Violation of Little's Law should result in a large negative coefficient on bids made in the lottery. The base model uses a constant, dwellings with three rooms or more, dwellings built after 1990, house type, the logarithm of rent and the logarithm of age as explanatory variables. The overall fit of the model is very good, giv-

97 The coefficient for the dummy for transferring tenants has a value of 0.03 with a t-value of 1.12; the coefficient for offers made in the second half of the year has a value of -0.03 with a t-value of -1.01, and the coefficient for offers made in the lottery has a value of - 0.02 with a t-value of -0.76.

en the low numbers of observations and explanatory variables. As expected, tenants' bids proved higher for less expensive, larger, single-family dwellings. The negative coefficient on newer stock is puzzling. There are, however, just seven observations on dwellings built after 1990. Estimation without this variable does not change the estimates on the other variables.

In Model I, house price and neighbourhood satisfaction are added to the base model. Given that both neighbourhood variables were measured prior to 2005, endogeneity cannot be a problem. The best representation for neighbourhood satisfaction turns out to be the same measure that was used in the exit choice model discussed in Chapter 3: the average that is calculated over a Von Neumann neighbourhood with range 1. Representations with a higher range have similar coefficients (ranging from 0.22 to 0.24), but their significance levels are lower (t=3.7 at maximum, as opposed to 4.34 for the representation based on a Von Neumann neighbourhood with range 1). The low spatial scale on the selected measure reveals that, unlike the majority of house-seeking tenants, the winning candidates were well informed about their new neighbourhoods. Bids were indeed higher in more attractive areas. The coefficient of 0.26 leads to a willingness to pay for a one-point increase in neighbourhood satisfaction of € 88.29 (0.26/1.15*390.50) or 22.6% in monthly rent by new tenants. This figure is higher than the 12% that house-seeking tenants were willing to pay for a similar increase in quality (see Section 4.4). The coefficient of 0.61 for house price indicates that new tenants were willing to pay an average of 53% (0.61/1.15) of rent for a doubling of the house price.

In the next stage of the estimation, the sample of tenants is split into subsamples. In Models IIa and IIb, the sampling is based on the distance of the move. There are few differences between inter-borough and intra-borough movers, although tenants who stayed within the borough were slightly older, and the number of transferring tenants among this group was higher as well. The estimation indicates that the bids of intra-borough and of inter-borough movers were virtually identical. One conclusion might be that the distance of the move had little or no effect on tenants' efforts to inform themselves about the new neighbourhoods. The alternative is that the distinction between inter-borough and intra-borough moves is simply a poor measure for the distance of the move. Two of the four boroughs in the sample (Prins Alexander and Groot-IJsselmonde, see Figure 3.2) are very large, such that moves with these boroughs could have taken tenants over longer distances than was the case with moves between other boroughs.

The question of whether it made any difference whether the tenant exchanged another social rental dwelling is answered in Model III. Transferring tenants (who comprised 47% of all new tenants) were older than first-time tenants were (38.6 years vs. 28.6 years), and they opted more often for single-family dwellings (23% vs. 7% of all offers). The third model shows that first-time tenants paid less attention to the inside view than transferring tenants

Table 5.2 Duration model of bids for social rental dwellings in Rotterdam in 2005

		Model I		Model IIa Inter-borough move	
		coeff.	t-value	coeff.	t-value
Constant		1,31	1,58	1,28	1,16
Building period	After 1990	-0,24	-2,31	-0,03	-0,35
Number of rooms	Three or more	0,17	3,57	0,16	2,60
House type	Single-family	0,40	6,63	0,37	4,98
	Upstairs apartment with lift	-0,12	-2,42	-0,12	-1,99
	Upstairs apartment no lift	0,08	1,63	0,07	1,22
Log of net rent		-1,15	-11,47	-1,27	-9,89
Household characteristics	Log of age of head	-0,24	-6,24	-0,22	-4,24
Neighbourhood satisfaction	Von Neumann range 1	0,26	4,34	0,24	3,14
Log of house price		0,61	7,64	0,68	6,28
R^2		0,48		0,48	
Standard error of regression		0,26		0,26	
Log Likelihood		-36,2		-10,7	
N		516		282	

did. Transferring tenants were probably either better informed or more concerned with neighbourhood quality than first-time tenants were. The willingness to pay of transferring tenants for a one-point increase in neighbourhood satisfaction was 30.7% of the rent, while they were prepared to pay 59% of what owner-occupiers were prepared to pay to live in the same neighbourhood. First-time tenants were willing to pay less: 17% of rent for a one-point increase in neighbourhood satisfaction and an additional 47% of rent for a doubling of the house price.

The subsample used in Model IIIb is reduced further in Model IVb. The threshold is set at a duration of stay in another social rented dwelling of twelve years. . Transferring tenants with a high duration of stay (and hence a higher rank in the distribution system) were willing to pay an additional 42.0% of the rent for a one-point increase in satisfaction, while their willingness to pay for a 1% rise in the price was 0.63%. Given the high overlap of the subsample of lower-ranking tenants in model IVa with the sample of first-time tenants in model IIIa, it is not surprising that lower-ranking tenants seemed to pay less attention to differences in neighbourhood quality at the block level (i.e. a willingness to pay of 13% of rent), while they were willing to pay 47% of what owner-occupiers were willing to pay to live in the neighbourhood.

Neighbourhood satisfaction probably controls for the same aspects in the duration model as it did in the exit choice model: amenities and services that cater to residents only, as well as the socio-economical and demographic attributes. House price probably controls for the observable aspects of neighbourhood quality and perhaps for neighbourhood reputation as well. Based on the similarity in scale on the pull effects of the neighbourhood in Models IIIb and IVb with the push effects in the exit choice model discussed in Chapter 3, transferring tenants with a long duration of stay seemed to have the same intimate knowledge of the neighbourhood as existing tenants. In contrast, lower-ranking and first-time tenants either had less access to the inside view or were less partial to differences in neighbourhood quality. The 25% (≈0.42/1.00-0.16/1.21) of rent that high-ranking tenants as a group were willing

Model IIb Intra-borough move		Model IIIa First-time tenant		Model IIIb Transferring tenant		Model IVa Low bid		Model IVb High bid	
coeff.	t-value	coeff.	t-value	coeff.	t-value	coeff.	t-value	coeff.	t-value
0,34	0,26	2,09	2,14	0,60	0,41	2,54	2,46	-0,36	-0,24
-0,37	-3,41	-0,11	-1,04	-0,39	-2,64	-0,09	-1,14	-0,54	-3,80
0,16	2,19	0,18	3,04	0,15	2,04	0,18	3,04	0,15	2,04
0,43	4,11	0,44	5,25	0,29	3,04	0,40	5,23	0,41	4,00
-0,10	-1,09	-0,06	-1,02	-0,21	-2,43	-0,15	-2,47	-0,05	-0,62
0,12	1,40	0,13	2,63	-0,03	-0,38	0,04	0,72	0,14	1,82
-1,03	-6,45	-1,19	-8,91	-1,14	-7,80	-1,21	-9,53	-1,00	-6,09
-0,24	-3,96	-0,18	-3,61	-0,32	-5,39	-0,22	-5,14	-0,29	-4,06
0,31	3,25	0,20	2,53	0,35	3,93	0,16	2,02	0,42	4,53
0,61	5,32	0,56	5,71	0,67	5,22	0,57	5,44	0,63	4,62
0,49		0,43		0,54		0,47		0,52	
0,27		0,25		0,27		0,26		0,50	
-18,9		-4,9		-23,5		-17,7		-11,8	
234		272		244		320		196	

to pay more for an increase in satisfaction compared to low-ranking tenants, is an indication of the gains that their informational advantage brought. With an average bid of 7.7 years, this figure amounts to a reduction of two years and three months (or 25%) in waiting time for the desired type of dwelling. For low-ranking tenants, the loss incurred is closer to 20% (25/1.21) of their waiting time.

Robustness analysis

In the first robustness check, tenant characteristic are introduced into the third and fourth models as additional instruments. For example, the preference for single-family dwellings among transferring and high-ranking tenants could have led to a greater sensitivity towards the quality of life among this group. The only tenant characteristic to have any relevance, however, is the logarithm of the household income in the bids of transferring tenants (Model IIIb). Higher income led to a small increase in the bid.[98] This indicates that some idiosyncratic overpaying may have taken place among high-income tenants, but that no other category of tenants overpaid. More importantly, the coefficients for rent, structural characteristics and neighbourhood variables are unaffected by the inclusion of tenant characteristics.

In the next robustness checks, borough-fixed effects, neighbourhood fixed-effects and random effect are introduced to Models III and IV to address spatial autocorrelation. The use of borough-fixed effects reduces the explanatory power of house price in all models, although it is still significant in the model for first-time tenants and in the model for transferring tenants with a high duration of stay.[99] Borough-fixed effects make the pull of neighbourhood satisfaction on first-time tenants and on low-ranking tenants void. The coeffi-

98 Tenants with higher incomes may have overpaid because of their lower sensitivity to rent or because they were planning to make a transition to tenureship in the near future. The estimation presented in Chapter 3 revealed that their exit rate was also higher.

99 In the estimation of Models IIIa and IVb with borough-fixed effects the coefficient for price has a value of respectively 0.25 (t-value of 2.16) and 0.23 (t-value of 1.96).

cient on neighbourhood satisfaction remains closer to its value in the original model in the estimation with borough-fixed effects for transferring tenants (0.32 with a t-value of 2.46) and for high-ranking transferring tenants (0.29 with a t-value of 2.22). The use of neighbourhood-fixed effects presents problems in the estimation of models III and IV, because many neighbourhoods contain just a few clustered observations. Estimation for the larger sample in model II with neighbourhood fixed-effects, however, produces a significant estimate for the inside view (0,24 with t-value of 2,62).

Neighbourhood satisfaction retains its explanatory power when random effects are used for each of the 81 boxes of 250 m² in the sample in which an observation can fall. The coefficient on neighbourhood satisfaction changes to 0.35 (t=2.86) in model IIIb and to 0.42 (t=3.73) in model IVb. Neighbourhood satisfaction remains just significant in models IIIa (0.22 with t=1.79), but is insignificant in model IVa (0.12 with t=1.34) with random effects.

Unlike the push effect of price on existing tenants (as discussed in Chapter 3), which probably depended upon the observable quality of the neighbourhood, the pull effect of price on house-seeking tenants is probably associated with aspects of the neighbourhood (possibly including its reputation) that spread beyond the confines of the administrative neighbourhood.

Neighbourhood satisfaction captures the inside view and aspects that spread beyond the confines of the administrative neighbourhood. The use of fixed or random effects in estimation, however, does not annul its impact on the bids of transferring tenants in general and the bids of transferring tenants with a high rank in the distribution system in particular. Some of its explanatory power can be associated with their greater awareness of circumstances in the surroundings of the offers. Throughout the thesis, I assume that the weak pull effect of neighbourhood satisfaction on first-time and low-ranking tenants is the result of their ignorance about the living quality. One objection to this interpretation is that irrational or constrained choice behaviour may lead to the same outcome. First-time and low-ranking tenants may have ignored the living quality at the block level in their bids, even though they could have been aware of this information. This explanation, however, runs counter to another assumption that I make throughout the thesis, that of 'satisficing' behaviour (Simon, 1991). In this assumption, the choices of agents diverge from the optimum of standard economics, not because they act irrationally, but because they are choice-constrained or ill-informed. None of the evidence thus far pointed towards irrational behaviour among tenants. The apparent understanding of the transformation of the allocation criterion and the fact that no group of tenants structurally overpaid for bids point towards rational choice behaviour.

A more serious objection is that low-ranking and first-time tenants could have been in more pressing need of accommodations. This personal constraint could have made them less sensitive to neighbourhood quality, in the

same way that existing tenants living in the best type of dwellings proved less responsive to neighbourhood quality. One important piece of evidence casts doubt upon this otherwise plausible explanation. The destination choices of first-time and low-ranking tenants were different from those of transferring, high-ranking tenants in terms of desired house type (i.e. they preferred apartments to single-family dwellings), but not in terms of the desired location.[100] If first-time and low-ranking tenants managed to obtain offers in areas to which transferring tenants and high-ranking tenants moved as well, then they would have had to wait longer than their transferring and high-ranking counterparts did for the same type of offer. First-time and low-ranking tenants could have settled for lower quality in exchange for a move at a much earlier date. It is highly improbable that tenants refrained from responding and accepting offers that they desired when they were capable of obtaining the dwelling. The most plausible explanation for the relatively crude destination choices made by first-time and low-ranking tenants is that they faced higher search costs and lower opportunity costs than did the other categories of tenants.

5.5 Conclusions

The main result of the second part of this thesis is that many house-seekers on the social rental market adopted a much higher scale for the neighbourhood in their destination choices than existing tenants did in their exit choices. This was already evident from the count model of net response to dwellings (as discussed in Chapter 4), and it was confirmed by the duration model of the bids of first-time tenants and of tenants with low duration of stay (and hence a low ranking in the distribution system) in this chapter. The unobservable quality of the neighbourhood, which is captured by neighbourhood satisfaction, affected the destination choices of transferring tenants and especially those with a very high rank in the distribution system. The pull effect of neighbourhood satisfaction on these well-informed tenants was comparable in strength and scale to the push effect on existing tenants.

Ill-informed and well-informed tenants were in agreement over both the push and the pull effect of house price. On average, tenants were willing to

100 A t-test for the difference in the average satisfaction score for first-time and transferring tenants yields an insignificant value of 0.11, while a t-test for the difference in the average house price between the two groups yields 0.52. The differences between low-ranking tenants and tenants with a high duration of stay are even less pronounced: a t-value of 0.14 for neighbourhood satisfaction and 0.35 for the price. This result is interesting in its own right, as it indicates that efficient sorting between neighbourhoods (see Section 4.5) is a by-product of the choice of house type. The greater preference for single-family dwellings among high-ranking and transferring candidates guided them towards the most attractive neighbourhoods, from which they were less likely to leave (see Section 3.4).

pay 30% to 50% of the value that owner-occupiers had in mind to live in the neighbourhood. The price served primarily as a control variable for the observable quality of the neighbourhood, such that the pull effect of the inside view on the neighbourhood could be estimated with some confidence. The willingness to pay for the maximum rise in the quality-of-life experience (a one-point increase on a seven-point scale) ranged from little under 15% of the rent for existing tenants to 25-30% for transferring tenants and more than 40% for transferring tenants with a very high rank in the distribution system.[101] The pull of neighbourhood satisfaction on first-time and low-ranking tenants was acted out at the spatial scale of the administrative neighbourhood and beyond. Its pull effects on transferring and high-ranking tenants was acted out on the block level, probably as a reflection of the insiders' appraisal of the social climate and the availability and quality of local amenities and services.

The estimation thus seems to validate the first conjecture stated at the end of Chapter 2: first-time and low-ranking tenants did not seem to make use of the inside view in their destination choices. The inside view did prove relevant to tenants with high opportunity costs (i.e. transferring tenants with high duration of stay), which is in accordance with the third conjecture of Chapter 2. The pull effects of the neighbourhood on high-ranking, transferring tenants approached the push effects on existing tenants in range and even exceeded them in strength. No evidence could be offered, however, for the second conjecture of Chapter 2: the supposed informational advantage of short-distance movers over long-distance movers was not visible in the estimation outcome.

The size of the opportunity and search costs that tenants face is seen as the root cause of the informed destination choices of transferring, high-ranking tenants and the crude destination choices of low-ranking and first-time tenants. Irrationality and choice constraints can produce the same outcome, but some of the results ran counter these alternative explanations. This does not preclude the possibility that some tenants remained ill-informed because they cared neither about neighbourhood quality nor about the time that they had to wait. In my opinion, neither rank in the distribution system nor occupancy of another dwelling is likely to make a difference in the desire to obtain a dwelling in the shortest possible time. There is no reason why tenants should decide to wait if they cannot improve upon the rent-quality relationship of the dwelling.

Despite the results in the affirmative, a word of caution seems in order. The exit choices of tenants proved hard to predict and their destination choices

101 This difference might represent an estimate of the institutional, personal and financial constraints that existing tenants face in moving or of a difference in preferences among existing and house-seeking tenants.

seemed to be guided more by search criteria than by some aspects of housing quality (i.e. house size and age). Obviously, the structure of the social rental market shaped some of my results and it may even have been partly responsible for the validation of some of my conjectures. Estimation of the demand equation in Chapters 4 and bid function in Chapter 5 with a larger dataset, or estimation of a destination choice model (the pendant to the exit choice model) could provide a more definitive answer. Nevertheless, the evidence did not invalidate my answer to the question raised in the introduction: there seems to be a gap in knowledge about the quality of the neighbourhood between residents and house-seekers facing high opportunity costs for selecting a lemon on the one hand and house-seekers who face low opportunity costs on the other hand. More than half of all new tenants (i.e. those with a low rank in the distribution system and first-time tenants) were probably at an informational disadvantage.[102]

The research on the residential mobility of social tenants that has been discussed in the last three chapters has left one question unanswered. The pull effect of house price was acted out at the administrative neighbourhood level, which is the appropriate scale if house-seeking tenants are indeed guided by a reputational bias, as a result of their desire to avoid stigmatisation, to improve upon their residential status or because they equate the quality of an area with its reputation (see also Table 3.2). There is, however, no way of telling whether they actually relied on reputations without knowing the exact motives behind the selection of a particular destination. House price may have simply acted as a control variable for local supply conditions or for some other unobserved factor. The third part of this thesis is devoted to the owner-occupied segment of the Rotterdam housing market. This should determine whether house price contains a reputational premium and whether the larger scale and lower size of the pull effects of the neighbourhood on low-ranking and first-time tenants had something to do with their use of reputations in their destination choices.

102 Remember that tenants with bids under three years were dropped from the sample. These tenants, most of whom participated in the lottery, proved even less responsive to neighbourhood quality. Inclusion of this small group reduces the significance level of neighbourhood satisfaction from t=4.3 to t=2.6 in model II, without altering its value.

Part III Informational asymmetry on the owner-occupied market

6 Boundary effects in house price

6.1 Introduction

The analysis in the previous chapters has shown that most social tenants in Rotterdam were not as well-informed about the quality of the neighbourhoods to which they moved as the tenants who already lived there were. Only the group of tenants facing considerable losses in the case of erroneous destination choices, due to their high rank in the distribution system for social rental dwellings or the exchange of another dwelling, proved equally well-informed as residents. This corresponds to one of the key questions that I posed in the introduction: there seems to be gap in knowledge between residents and the average house-seeker, and this gap is visible in their respective valuations of the neighbourhood.

The average buyer in the same city could be equally poorly informed as the average tenant is about the neighbourhood. The use of incomplete information in the decision to buy a dwelling should become visible in spatial house price patterns. If neighbourhood reputations are used as a proxy for the unobservable quality of a neighbourhood, then house price must contain a reputational premium in each administrative neighbourhood. Price may then suddenly shift in value when crossing the administrative boundary of a neighbourhood, provided that the adjacent neighbourhoods are viewed in a different light by outsiders. In this chapter, I use a hedonic price analysis to identify a large number of cases on the Rotterdam owner-occupied market in which crossing a neighbourhood boundary led to a jump in the assessment values of dwellings.

6.2 Neighbourhood reputation and house price

While the structure of the owner-occupied market is more conventional than is that of the social rental market in the Netherlands, it is far from a free market. Restrictions are commonplace on the owner-occupied market. Local and provincial governments designate land for residential, industrial, environmental, commercial and recreational use. Targets are set (but not always achieved) for the number of social rental and owner-occupied dwellings that must be constructed in each municipality. Municipalities exchange the right to construct dwellings for the ownership of land, such that developers and associations who own plots of land are rewarded with a monopoly on construction. They cooperate with the municipality in public-private partnerships in the design, development and construction of dwellings. In this context, associations are treated favourably, as through the use of proceeds from the sale

of owner-occupied dwellings to finance future losses on the management of social rental dwellings.[103] The planning of new construction does not follow the maxims of profit-maximisation. In fact, housing supply in the Netherlands is almost completely dependent upon set targets, with the price elasticity of supply being close to zero (Vermeulen, 2008).[104] Planning has achieved some of the social targets set by the Dutch government, such as the conservation of open space, the restructuring of deprived neighbourhoods and the creation of mixed-income neighbourhoods. Restrictive planning is not the only type of government intervention that affects the owner-occupied market. The municipality takes the difference between the sales price of newly constructed dwellings and the construction costs and profit margin of the developer as a land-use tax.[105] Property taxes are levied on homeowners as a percentage of the assessment value of their dwellings. Buyers face an *ad valorem* buyer tax, which decreases mobility on both the housing and labour market (Van Ommeren and Van Leuvensteijn, 2005). In addition to being taxed in the housing domain, however, owner-occupiers are able to deduct interest payments on mortgage from their income taxes. This acts as a progressive subsidy on housing consumption.

The focus on mixed-income neighbourhoods, the quota set for new construction, the non-competitive stance taken by the parties involved in the construction of dwellings and the municipality's reliance on budgetary windfall gains have created a stock market on the owner-occupied market. New construction makes up a small fraction of the existing stock. The price of newly built dwellings is defined by the price of the existing stock, although construction can have an impact on the price in the case of large-scale development (Boelhouwer, 2003; Boelhouwer *et al.*, 2006). The low price-elasticity of supply means that the tax deduction for mortgage debt has little effect on construction. Combined with the relaxation of mortgage lending that took place in the 1990s, the tax deduction mainly produced an inflated house price level (Boelhouwer *et al.*, 2004). Restrictive planning practices may have added to this inflation by imposing a regulatory tax on the price of dwellings in urban areas (Dekkers, 2010).

The below-market rents, rent subsidies, buyer taxes and high prices make the transition to tenureship particularly difficult for middle-income tenants. The accessibility of owner-occupied dwellings has been troublesome for first-time buyers ever since the 1980s (Renes *et al.*, 2006; Neuteboom and Brounen,

103 In 2008, the value gap, the difference in value between letting out and the best alternative use (i.e. owner-occupation) (Hamnett and Randolph, 1986), on social rental dwellings was estimated at 28% (CFV, 2008).

104 The monopoly power shared by developers, associations and the municipality offers an alternative explanation for the low price-elasticity of Dutch housing supply.

105 According to some estimates, the price of newly constructed dwellings exceeds the construction costs and profits by a margin of 30% (NVB, 2009).

2009). The exit choice model discussed in Chapter 3 showed that tenants living in popular dwellings found it difficult to continue their housing careers within the social rental sector, and perhaps outside of it as well. Several associations, including Woonbron Rotterdam, responded to this problem by selling dwellings to their tenants (Gruis *et al.*, 2002), but this accounts for a small fraction of the total stock. The Dutch housing market is thus a segmented market, with few transitions taking place between the social rental segment and the owner-occupied segment on either the demand or the supply side.[106] Each segment has its own suppliers (sellers and developers vs. associations), allocation criterion (price vs. waiting time) and target groups (low-income tenants vs. high and middle-income owner-occupiers).[107]

The segmentation of the market makes it difficult to draw any inference from the results of the previous chapters. The existence of an informational asymmetry on the social rental segment is no guarantee for the existence of a similar asymmetry on the owner-occupied segment. There is no reason to assume that tenants and buyers act fundamentally different when conducting residential search. However, differences in the organisation of the market segments can influence the ability or need of house-seekers to gather information on the quality of offers. The fact that buyers use realtors' services indicates that they face higher search costs than social tenants do; these costs must be at least as high as the realtor's fee (Benjamin *et al.*, 2000). On the other hand, the opportunity costs of buying a lemon are fairly high. A repeat move is accompanied by a buyer tax that amounts 6% of the sales price, while realtor fees and the cost of refinancing mortgage debt increases the costs of moving by an additional 4-6% of the price (Van Ommeren and Van Leuvensteijn, 2005). The high opportunity costs of buying a home could explain the stylised fact that Dutch homeowners move less frequently than tenants do (Van Ommeren *et al.*, 2000; Van der Vlist, 2001).[108]

The lower willingness to move among Dutch homeowners suggests that an erroneous destination choice is costlier on the owner-occupied segment of the market, such that the incentives to be informed may be stronger among buyers than they are among tenants. The presence of ill-informed buyers is obviously a necessary condition for the inclusion of a reputational premium or downgrade in price, alongside the condition that house price is not used as a signal for the unobservable quality of the offer (see Section 2.8). Search models of the housing market provide some evidence that suggests the ex-

106 The rise in income levels, low real interest rates and relaxation of mortgage-lending criteria ensured that middle-income households still had access to the owner-occupied market in the long run (Renes *et al.*, 2006).

107 For example, in the dataset analysed in Chapter 5, less than 2% of the tenants were ineligible for rent subsidies.

108 Larger home investments and stronger place attachment (Poterba, 1984; Henley, 1998) may also explain the lower willingness to move among home-owners as compared to tenants.

istence of informational asymmetries (and thus the presence of ill-informed buyers) on the Dutch owner-occupied market (Droës and Hassink, 2009; De Wit and Van der Klaauw, 2010).

Advances in the collection of transaction data have enabled the testing of search models that explain the outcome of negotiations over sales price between buyers and sellers.[109] Most search models assume that sellers hold inside information that cannot be transmitted to buyers. In a 'thin' market, sellers of dwellings with a good price-quality relationship lower the list price in order to attract buyers, who are more than willing to accept a good offer once they have inspected it (Merlo and Ortalo-Magné, 2004). Sellers may also post a lower list price in order to reduce the offer's time on the market, as well as the costs associated with temporarily holding two dwellings (Díaz and Jerez, 2009). On the other hand, sellers who can afford to extend the time on the market can increase the list price as a signal to 'bargain-hunters' that any surplus in the negotiations is likely to accrue to the sellers (Albrecht *et al.*, 2009). Within the Dutch context, applications of search models have shown that list price reductions shorten an offer's time on the market (De Wit and Van der Klauw, 2010) and that 'strong' sellers (i.e. sellers with lower loan-to-income ratios) post higher list prices, but that these sellers are also less accurate in assessing the exchange value of dwellings (Droës en Hassink, 2009).[110]

Informational asymmetries between sellers and buyers thus do exist on the Dutch owner-occupied market. The focus in the search models is on the division of the bargaining surplus between well-informed sellers and ill-informed buyers. The difference between the list and sales price can be large in some instances, but the mark-up on the sales price was only 5% for the one fourth of all offers whose prices had been reduced during negotiations (De Wit and Van der Klauw, 2010).[111] Once a buyer enters negotiations, efforts to learn about the bargaining power of the opposite party do not constitute a vain en-

109 From their earliest usage by Courant (1978), who focused on residential segregation, search models have been used to explain stylised facts that have eluded the explanatory power of standard housing economics. This includes the role of realtors as intermediaries (Yinger; 1981), cyclical movements in house prices and vacancy rates (Wheaton, 1990), differences in the time on the market of identical dwellings (Genovese and Mayer, 1997), the relation between employment search and residential search (Rouwendal, 1998) and the rationale behind the use of rent controls (Arnott and Igarashi, 2000). Other applications of informational asymmetries on the housing market include bank lending when the likelihood of default on mortgage debt is unknown (Brueckner, 2000), landlords' decision to let when tenants' duration of stay is unknown (Ben-Shahar, 2001), tenants' decision to rent when the service expenditure is unknown (James, 2008), buying and selling when faced with the seasonal 'greenness' of property (Nagler and Osgood, 2006), and the mentioning of externalities from flood zones or airports in disclosure reports (Pope, 2008).

110 Similar results were obtained in a standard regression analysis by Hoeberichts *et al.* (2008). The authors further showed that the more unique a dwelling is, the higher is its list price and the longer the time on the market, as sellers must first ascertain the exchange value of the offer.

111 The actual surplus depends upon the seller's unobserved reservation price and the buyer's unobserved maximum bid, rather than on the observed list price and sales price. The list price is the upper bound of the reservation price, whereas the sales price increases with the maximum bid (Haurin *et al.*, 2010), such that the difference between the list price and sales price constitutes a proxy for the surplus.

deavour, but the case for gathering information in the preceding search stage is much stronger. The duration model discussed in Chapter 5 revealed that tenants with intimate knowledge of the new neighbourhood can realise gains of 30% of rent in terms of housing quality or waiting time.[112]

Based on these results, one may assume that it is more important for buyers to learn about the unobservable quality of an offer than it is for them to know about the characteristics of the opposite party in the exchange.

Berliant and Yu (2009) incorporated a similar belief into a spatial equilibrium model of the housing market. They theorised that an equilibrium can emerge in which the price of the dwelling need not reflect all available information on its quality. Search costs prevent buyers from being fully informed about the quality of distant offers. Households that are aware of the quality of an offer need not be interested, and the actual buyer need not be informed. If the market is made up of geographical submarkets, the circumstances in one submarket do not feed into the price on another submarket. The equilibrium price then reflects the buyer's ex ante assessment of the offer's user value. The difference between this view and the price equilibrium specified in the neoclassical framework is that some buyers now overestimate the user value of the offer and overpay for their new homes.

In Chapter 2, I extended Berliant and Yu's argument by claiming the existence of a spatial dimension in the informational asymmetry. Differences in the unobservable quality of a neighbourhood are known only to insiders and well-informed house-seekers. Ill-informed house-seekers can use the price of similar dwellings on the same submarket as an anchor for their bids. The owners of dwellings that lie in the worst parts of a submarket imitate the list price of superior offers on the same submarket (Merlo and Ortalo-Magné, 2004). The owners of dwellings in the more attractive spots are forced to lower their list prices in order to attract buyers if they cannot signal the superior quality of their offers.[113] In the aggregate, well-informed buyers benefit from the presence of ill-informed buyers, as it enables them to select the offers that are underpriced on a geographical submarket. This induces them to remain silent about the user value of offers so that ill-informed buyers never learn about the actual user value, unless they buy the dwelling and start to live in it. It is thus theoretically possible that differences in the quality of locations are not revealed in the house price. In this way, price offers an ac-

112 List-price reductions raise the selling rate by 83% and lower the rate of withdrawal by 44%, such that the time on the market can be substantially reduced (De Wit and Van der Klauw, 2010). These considerations refer to the incentives of sellers and not those of buyers.

113 Signalling can occur if extending the offer's time on the market is costlier to the owners of lemons. The owners of superior offers can then increase the list price as a signal to buyers (Díaz and Jerez, 2009). This solution for lifting the informational asymmetry seems farfetched. The user costs of temporarily holding two dwellings will be larger for the owners of better and thus more expensive dwellings, especially when interest on mortgage debt on a second dwelling is not tax-deductible, as is the case in the Netherlands.

curate image of the user value of the observable aspects of housing quality, whereas the unobservable aspects are valued the same across the geographical submarket.

The name of a neighbourhood helps house-seekers to divide geographical submarkets into smaller units; it is by far the simplest way to designate locations. One may assume that the house price residual – the fraction of the price that depends upon the quality of the location (Bayer and Ross, 2006) – and by extension the price contains a reputational premium in each administrative neighbourhood. Half of the spatial variation in the house price residual occurred at or beyond the level of the administrative neighbourhood (see Table 3.1). The pull effect of the price on social tenants displayed a range that is compatible with the same scale (see Section 5.4). This suggests a correspondence between outsiders' notions of neighbourhood quality and house price. Furthermore, price has all of the characteristics of a reputation-based measure (see Stigler, 1961; Bettman, 1979 and Sabater and Sierra, 2005). It is a single-valued measure set by anonymous parties, and it lends itself to the comparison of identical dwellings at different locations. At the same time, price is non-binding: informed buyers can relocate to ill-reputed (and hence low-priced) areas if they know that the living quality is good there.

The main problem in testing for a reputational premium in house price is that reputation is a social construct.[114] Reputations are based on general traits that help outsiders to set a specific neighbourhood apart from 'competing neighbourhoods' (Hortulanus, 1995).[115] For example, the crime rate is able to capture a trait such as 'unsafe', thus making it possible to differentiate one or two high-crime areas from other neighbourhoods, although it does not differentiate between neighbourhoods in which the crime rate is low. There is also no attribute that captures such ambiguous traits as 'prestigious' (Semyonov and Kraus, 1982) or 'pleasant' (Kauko, 2007). Statistics on determinants of neighbourhood reputations, such as crime rates, average income or the share of ethnic households and owner-occupation in the area, are continuous, while reputations are based on ranks. The ranking of neighbourhoods based on perceived differences in traits produces a 'neighbourhood hierarchy' (Hortulanus, 1995; Permentier, 2009). A strong correlation between this hierarchy and the ranking based on the average house price residual would be direct evidence for the role of reputations in the destination choices of buyers.[116] The exami-

114 Social constructs are categories that exist because people tacitly agree to act as if they exist (Pinker, 2002).

115 In an extensive analysis of house prices in Rotterdam, Kauko (2002) showed that the effects of most of the intangible attributes of a neighbourhood (and even some tangible attributes, such as housing density) on the house price can change from one neighbourhood to the other.

116 The ranking of neighbourhoods based on the notions of outsiders (i.e. residents of other neighbourhoods and realtors) has been used by sociologists. This hierarchy played a role in the quality-of-life experiences (Semyonov and Kraus, 1982) and exit choices of residents (Permentier, 2009). Circumstantial evidence for the role of reputations in the price can also be found in the literature on housing market segmentation. For example, Bour-

nation of spatial patterns in the price is the next-best solution to prove that buyers use reputations when no hierarchy is available to the researcher.

In an innovative approach first considered by Black (1999) and extended by Bayer *et al.* (2007), the effect of school quality on house prices was derived from the coefficients for area-fixed effects in a hedonic house price equation. The attractive feature of this approach is that it allows the direct comparison of the house price residual at different locations, in much the same way that sellers and buyers can compare areas by using differences in the price of identical dwellings. House price is first regressed on the structural characteristics of the dwelling and a large number of area-fixed effects. The area-fixed effects measure the average house price residual in the area. They also control for spatial dependencies in the missing variables, measurement errors in the dependent or explanatory variables, spatial heterogeneity and autocorrelation (Bourassa *et al.*, 2007). Although this complicates the interpretation of the coefficients, the difference between the coefficients contains relevant information. Bias in the house price residual, which is due to spatial autocorrelation or spatial heterogeneity, changes gradually across the spatial plain. The difference between the coefficients of adjacent area dummies is then an approximation of the difference in price between the areas, provided that each dummy covers an area that is small enough, such that the built-in bias is very similar in both areas.

Most attributes of a neighbourhood work in an isotropic fashion: accessibility, amenities and environmental features are distance-based, such that the change in value from one area to the adjacent area is small and gradual. Three aspects of neighbourhood quality can make a discrete change in space: the social fabric of the area, housing quality (e.g. dominant house type, building period, architectural style) and neighbourhood reputation. The social fabric is produced by the occupants of dwellings, and it can change from one housing block to the other. The social climate, however, which is the product of the social fabric, is not confined to the same range: circumstances in one area affect the quality of nearby areas. Likewise, housing quality usually affects the physical quality of nearby areas through spillover effects (e.g. the view of the area). An abrupt change in the socio-economic, demographic or physical attributes of an area leads to a smooth adjustment in the house price residual. A sudden jump in the residual when crossing a neighbourhood boundary is probably the result of a change in the name of the area. The difference in the coefficients for the area-fixed effects on opposite sides of the border can be used to test for the presence of a reputational premium in house price.

First, a hedonic house price regression is conducted for all observations

assa *et al.* (2003 and 2007) found that submarkets, as defined by realtors, explain spatial house price patterns quite well. See Islam and Asami (2009) for an overview of the literature on housing market segmentation.

that lie within a specified distance of the administrative boundaries. The structural characteristics of the dwelling are appended with boundary fixed-effects, which divide each border zone into equal-sized segments by varying the range on the fixed-effects. Boundary-to-neighbourhood-fixed effects with a range similar to that of the boundary-fixed effects are appended to the model, but only on one side of the border. The coefficients for the neighbourhood-fixed and neighbourhood-to-boundary-fixed effects describe the spatial decay process that the house price residual follows near the border. I illustrate the approach below. The hedonic price equation (2.6) is adapted as follows:

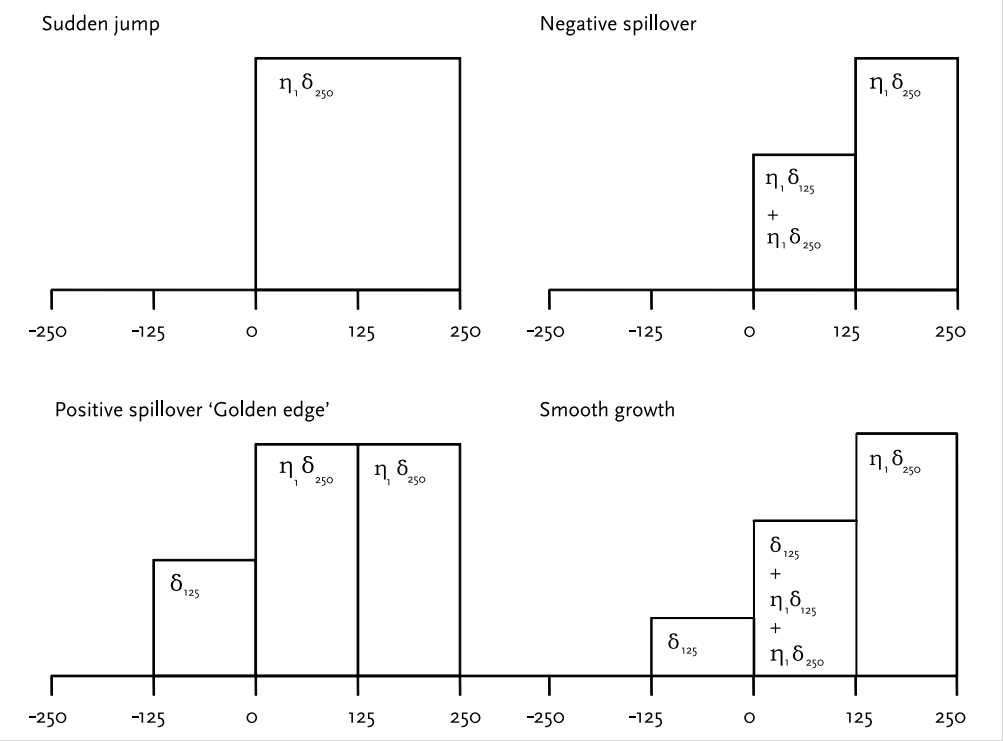
$$(6.1) \quad Log(P^l) = \sum_k \beta_k z_k + \sum_m \sum_q \delta^l_m \eta_q \Delta^l_m$$

In this equation, P^l stands for the house price in border area l, z_k for the K attributes of the dwelling proper and $\eta_q \Delta_l$ for the boundary-fixed and boundary-to-neighbourhood-fixed effects at M different bandwidths near one of the L ($L=\Sigma l$) administrative borders. The dummy η_q can take on two values: η_q has the value 1 if Δ^l denotes a boundary-fixed effect, while η_q takes on the value 1 or 0 (depending on which side of the border the observation lies) if Δ^l stands for a boundary-to-neighbourhood fixed effect. For the sake of simplicity, I assume that the interaction term η_q is set to 1 in the high-priced neighbourhood.[117] The coefficients δ_m measure the percentage increase in price within each segment. The number of area dummies depends upon the number of zones L and range M. In the regression analysis, the bandwidths are set at 250 and 125 metres from each border. The total number of area-fixed effects is thus equal to 2*2*L (i.e. two ranges, two area fixed-effects on either side of L boundary zones).

Each panel of Figure 6.1 depicts four relevant patterns in the house price residual within a distance of 250 metres from the neighbourhood boundary. The coefficient for the boundary-fixed effect at a range of 250 metres (δ_{250}) defines the average house price residual in the segment at a distance of 250 to 125 metres from the border in the low-priced neighbourhood. It is set to zero in the figures for the sake of convenience. The sum of the coefficients on both boundary-fixed effects (δ_{250}+ δ_{125}) yields the average house price residual in the low-priced neighbourhood within a distance of 125 metres from the border. The average house price residual in the segment at a distance of 250 to 125 metres on the high-priced side is defined by the sum of the coefficients on the boundary-fixed and the boundary-to-neighbourhood-fixed effect at the range of 250 metres (δ_{250}+ $\eta_1\delta_{250}$). Finally, the average house price

117 This is merely a matter of convention.

Figure 6.1 Boundary-fixed and boundary-to-neighbourhood-fixed effects



residual in the high-priced area within a distance of 125 metres from the border is given by the sum of the coefficients on all four area-fixed effects (δ_{250}+ δ_{125}+ $\eta_1\delta_{250}$+$\eta_1\delta_{125}$).

The upper left panel depicts the sudden jump in the house price residual that can be expected when a reputational premium is present. In order to conclude that the reputation of the area on the right side (i.e. the more expensive side) of the boundary is better than that of the area on the left, then the coefficient for the boundary-to-neighbourhood fixed effect at the range of 250 metres $\eta_1\delta_{250}$ should have a positive and significant value:

$$(6.2a) \quad t = \frac{\eta_1\delta_{250}}{\sigma_{250}} > 1.96$$

Condition (6.2a) is a necessary but insufficient condition for identifying a jump in the house price residual; the quality of an area may influence the circumstances in the adjacent area through spillovers. The upper right panel of Figure 6.1 depicts a negative spillover effect that emanates from the low-

priced neighbourhood. This situation is compatible with a jump in the house price residual, as long as the fall in the house price residual due to the spillover effect does not exceed the jump in the residual due to an improvement in neighbourhood name:[118]

$$(6.2b) \quad t = \frac{(\eta_1\delta_{250} + \eta_1\delta_{125}) + (\eta_1\delta_{125})}{\sqrt{\sqrt{(\sigma^{\eta 1}_{250})^2 + (\sigma^{\eta 1}_{125})^2} * \sigma^{\eta 1}_{125}}} > 1.96$$

The opposite case, a spillover from the high-priced neighbourhood or 'golden edge' on the low-priced neighbourhood, means that the coefficient on the boundary-fixed effect at the low bandwidth level is both positive and significant. This case is depicted in the lower left panel of Figure 6.1, where it should be noted that the boundary-to-neighbourhood and the boundary-to-neighbourhood fixed effect at the range of 125 metres cancel each other out (i.e. $\delta_{125} = -\eta_1\delta_{125}$). A 'golden edge' is compatible with a jump in the house price residual at the border, as long as the positive spillover effect does not exceed the jump in the residual:

$$(6.2c) \quad t = \frac{(\eta_1\delta_{250} + \eta_1\delta_{125}) - \delta_{125}}{\sqrt{\sqrt{(\sigma^{\eta 1}_{250})^2 + (\sigma^{\eta 1}_{125})^2} * \sigma_{125}}} > 1.96$$

A number of cases are conceivable in which the above conditions are not met. First, the house price residual need not make a jump if the two neighbourhoods are indistinguishable in terms of their reputation and composition. Second, either one of the spillover effects could be equal to or larger than the jump in the house price residual, such that conditions (6.2b) and/or (6.2c) do not hold. The case in which both spillover effects are larger than the jump in the house price residual is depicted in the lower right panel of Figure 6.1. This is the pattern that is predicted by the standard economic literature on house prices: the isotropic effects of neighbourhood attributes define the price of the location, such that the house price residual follows a smooth growth pattern (Gelfand *et al.*, 2004).[119]

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118 Conditions (6.2b) and (6.2c) are approximations in the sense that it neglects the covariance term between the coefficients on the neighbourhood-to-boundary fixed terms. The covariance terms are very small compared to the variance in the coefficients on the area dummies.

119 House price can follow an anisotropic instead of an isotropic pattern; the gradient might be steeper in some directions, such that the growth or decay is not uniform in all directions (Gillen *et al.*, 2001). Physical barriers, zoning restrictions and tax rate differentials have been cited in the literature as other causes f discontinuities in

The hedonic price model discussed in this chapter contains a small number of structural characteristics. The estimate of the house price residual is biased, if the unobserved structural characteristics are spatially correlated. Another ground for bias is the lack of controls for the spillover effects of the structural characteristics (i.e. the view of the area), which capture the effect that the quality of a dwelling has on the price of adjacent dwellings.[120] Aside from the effects of missing variables, a change in social fabric may also lead to changes in neighbourhood quality, especially when actual or potential buyers in the area happen to be well-informed. Cases with spillovers across the border must therefore be treated with caution, as they are indicative of (non-reputational) bias in the house price residual. Several additional checks are employed to ensure that the observed jumps in the house price residual are not caused by the specification of the model.

Sudden jumps in the house price residual must occur near many neighbourhood boundaries if the administrative neighbourhood is in common use as a subdivision of a geographical submarket. The set of border zones in which jumps occur should exclude cases in which the border is 'hard' (i.e. running along a physical demarcation line). Externalities from open spaces, railway, roads or rivers have an independent effect on house price (Mayeres *et al.*, 1996; Strand and Vågnes, 2001; Theebe, 2004), which is difficult to disentangle from a reputational premium. A final requirement is that institutional causes for residential sorting must not be confused with reputational bias. The set of border zones should not contain cases in which the low-priced side of the border consists entirely of rental stock (whether social or private), while the high-priced side is exclusively owner-occupied. The administrative boundary of a neighbourhood acts as a social demarcation line that status-driven buyers seldom cross, even when suitable dwellings can be found on the opposite (poorer) side of the border.

6.3 Data

The municipal tax offices in the Netherlands assess the value of real estate in their respective municipality at regular intervals. Automated appraisals have become more commonplace, but real estate in Rotterdam was appraised by realtors in the period that I investigate. Realtors assessed the unobserved market value of each property, remaining as close as possible to its sales price at the date of the appraisal. The assessed market value was either based on the sales price of the object or on own discretion and objective criteria (the

house prices (Glaeser and Gyourko, 2002; Bayer *et al.*, 2003). The latter explanations do not apply to the Rotterdam market, however, for reasons that are discussed in this chapter and in Chapter 7.

120 In house price models, these effects are usually controlled for by spatial lags (Anselin, 1999).

Figure 6.2 Selected neighbourhoods in Rotterdam

Source: Geoda, Luc Anselin, 1998; Centraal Bureau voor de Statistiek/Topografische dienst Kadaster, 2004

type of object, its size, age and 'market area'). In the latter case, three comparable sales in the vicinity of the object had to be listed. The assessed market value was discounted back to its assumed value at a fixed date, to arrive at uniform assessment values for all property.

Appraisals tend toward the centre of the distribution of sales price (Cornia and Slade, 2005). The assessment values of more expensive dwellings are usually deflated (Clapp, 1990). The assessment values of social rental dwellings were directly or indirectly based upon the sales of nearby owner-occupied dwellings, so their appraisals may be inflated. The negative impact of social housing in the vicinity is neglected in the appraisal when sales occur in owner-occupied sections of the neighbourhood. Changes in the assessment value in the Netherlands are however, virtually indistinguishable from changes in the sales price (De Vries *et al.*, 2007), thereby justifying the use of the assessment value as a proxy measure for the house price as long as it expressed in logarithmic form to some extent (Kochin and Parks, 2005).[121]

The assessment value and characteristics of 285,000 objects in 1999 and 2003 were provided by the municipal tax office in Rotterdam. These are the same house price data that were used in Chapters 3 to 5. Dwellings with

121 The capitalization of property taxes in the house price and the assessment value is another source of assessor's bias (Clapp, 1990). Yet another source of bias involves the use of conservative estimates by the municipal tax office in order to avoid litigation by taxpayers.

Table 6.1 Descriptive statistics

Houses			Mean	Median	Maximum	Minimum	Std. dev.
House price in 2003			134,199	115,000	747,000	50,500	79,115
Age of dwelling in years			64.91	72	183	1	32.71
Size of dwelling in square metres			91.43	83	1,370	12	39.28
House type share	Single-family	Detached	0.01	0	1	0	0.07
		Semi-detached	0.01	0	1	0	0.11
		Terraced corner	0.04	0	1	0	0.20
		Terraced other	0.08	0	1	0	0.27
	Multi-family	Gallery flat with lift	0.05	0	1	0	0.22
		Gallery flat without lift	0.02	0	1	0	0.15
		Maisonette with lift	0.01	0	1	0	0.08
		Maisonette without lift	0.04	0	1	0	0.19
		Apartment corner	0.03	0	1	0	0.18
		Apartment other	0.36	0	1	0	0.48
		Portico with lift	0.04	0	1	0	0.19
		Portico without lift	0.32	0	1	0	0.46
House-type index			2.68	2	8	1	1.36
N= 40,291							
Households							
Household income category			3.45	3.25	8	1	1.35
Educational achievement			5.84	6	8	1	1.61
Owner-occupied share			0.25	0	1	0	0.41
Rental share			0.75	1	1	0	0.41
Adjusted neighbourhood satisfaction			4.31	4.28	5.70	3.41	0.43
N=19,082							

missing data and identical dwellings that were assessed as a batch are dropped from the sample, leaving 106,000 unique assessments. The next step is to eliminate observations located in villages, rural areas or non-residential areas (e.g. near the airport, recreational and industrial sites and port areas). The dwellings are geo-coded, such that the distance to the nearest administrative boundary can be calculated. All observations falling within a range of 250 metres of a boundary are retained, thus leaving observations in 49 of the 89 administrative neighbourhoods in Rotterdam in 2003 (see Figure 6.2).[122]

Not all border zones in the selected neighbourhoods contain enough observations to conduct the price analysis. The New Meuse and Rotte rivers cut directly through the city, and parks, lakes, railroads and highways create largely uninhibited areas near many boundaries. It is ultimately possible to identify 45 zones that have sufficient observations within a 250 metres distance of their borders. None of these zones exhibits a complete separation of rental stock on one side of the border and owner-occupied stock on the opposite side. This leaves about 40,000 observations in the border zones, after the elimination of dwellings with very low (i.e. less than € 50,000 in 2003) and very high (i.e. greater than € 750,000) prices. The statistics for the remaining observations are listed in Table 6.1. The dataset contains the price in 2003, along with the age, size and type of dwelling. The high maximum for house size is due to the fact that outdoors facilities are treated as part of the object in the appraisal. The house-type index is derived from the hedonic price equation in

122 The town of Rozenburg to the southwest of Rotterdam was annexed in 2010, thereby adding two more neighbourhoods to the municipality.

the next section.

Also listed are 19,000 non-unique observations of the income, educational achievement, tenureship and neighbourhood satisfaction (adjusted for respondent characteristics; see Section 3.3) of households living in the border zones in 2004, which are taken from a survey conducted among 9,000 households in 5,800 six-digit postal code areas. The survey scores are averaged over a six-digit postal code area and then appended to the observations of dwellings in 4,100 six-digit postal code areas. Despite the aggregation over the postal code area, the variance in the income, education, tenureship and satisfaction remains large. Three fourths of the scores are taken from tenants, which is the same share comprised by rental stock in the entire stock in Rotterdam in 2003. The average household income of € 2,033 per month in 2004 (Source: COS, Rotterdam Municipal Statistics Office) falls within the survey's median income category.[123] This provides some level of confidence that the adjusted survey scores, which are later used to investigate the role of the social fabric (income and education) and social climate (neighbourhood satisfaction) in the estimate of the house price residual, as well as the role of institutional causes for sorting (owner-occupation), present an unbiased sample of border-zone residents and their characteristics.

6.4 Boundary analysis

Hedonic house price equation

In the preliminary stage of the analysis, a hedonic house price regression is conducted for more than 40,000 dwellings with the logarithm of the house price in 2003 as the dependent variable and twelve different house types (with apartments as the reference category), the age and age squared, the size and size squared of the dwelling and boundary-fixed and boundary-to-neighbourhood fixed effects as explanatory variables. The outcome of the regression is listed in Table 6.2. It has a decent fit, given the low number of structural characteristics in the model. Newer dwellings were more expensive than older ones were. This relationship is reversed at an age of 192 years (0.73/0.83*100), but the dataset contains no dwellings with such a high age. House price increased with the size of the dwelling, albeit at a declining rate.

The coefficients for the house types make sense. They are used later as input for the house-type index, which is used in the investigation of the role

123 The eight income categories are as follows: less than € 775, € 775–€ 1,090, € 1,090–€ 1,590, € 1,590–€ 2,770, € 2,770–€ 3,500, € 3,500–€ 5,000, € 5,000–€ 7,500 and greater than € 7,500 per month. The categories for educational achievement range from elementary school, lower secondary, medium secondary, medium tertiary, higher secondary and higher tertiary education (i.e. college-level) and university-level. Neighbourhood satisfaction scores are set along a seven-point scale ranging from extremely dissatisfied to extremely satisfied.

Table 6.2 Hedonic house price equation for Rotterdam in 2003

			Coefficient	t-value	House-type index
Age/100			-0.73	-45.7	-
Age²/10,000			0.38	28,9	-
Size/100			0.95	20.6	-
Size²/10,000			-0.08	-5.03	-
House type share	Single-family	Detached	0.55	22.4	8
		Semi-detached	0.50	36.5	7
		Terraced corner	0.32	51.2	6
		Terraced other	0.22	37.7	5
	Multi-family	Gallery flat with lift	0.04	6.07	3
		Gallery flat without lift	-0.03	-5.87	1
		Maisonette with lift	0.12	9.49	4
		Maisonette without lift	0.04	9.87	3
		Apartment corner	0.00	0,20	2
		Apartment other	-	-	2
		Portico with lift	0.23	32,6	5
		Portico without lift	0.00	2.08	2
Boundary-fixed effects			Yes	Yes	-
Boundary-to-neighbourhood-fixed effects			Yes	Yes	-
Log Likelihood=18,116					
R^2=0.87					
N=40,219					

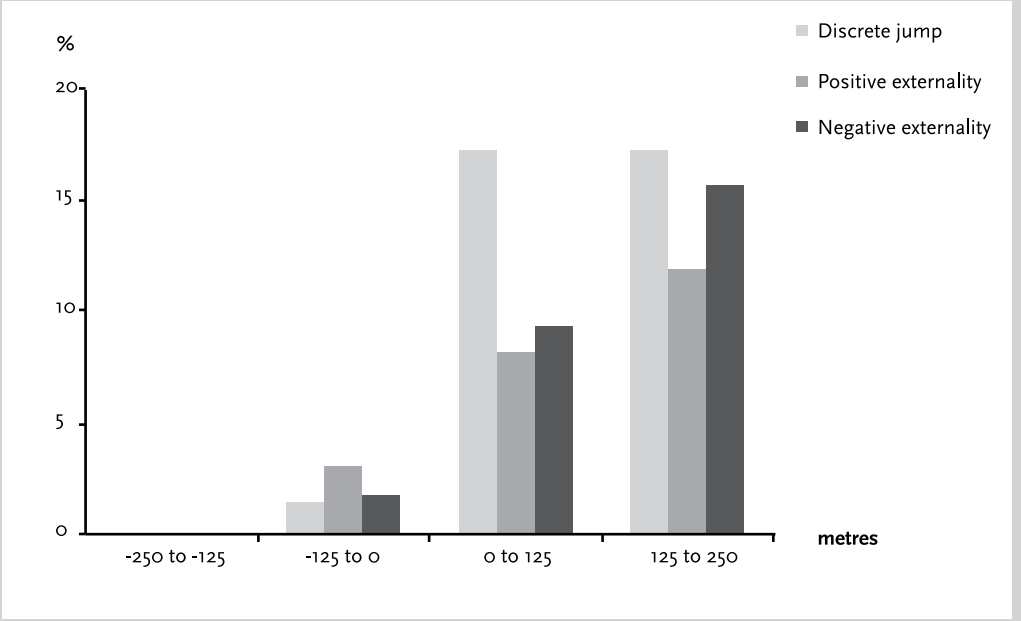
played by the physical quality of dwellings in jumps in house price. A simple t-test is applied to the coefficients to ascertain whether some of the house types can be grouped together. The three most expensive types of single-family dwelling remain separate categories, while the non-corner terraced dwelling can be grouped with the most expensive multi-family dwelling, a portico flat with a lift. The seven remaining types of multi-family dwellings can be reduced to four categories.[124] The house-type index ranges in value from 1 for the least expensive category (a gallery flat without a lift) to 8 for the most expensive category (a detached single-family dwelling). The main purpose of the regression, however, is to estimate the coefficients for the area-fixed effects, which serve as the building blocks for the boundary analysis presented in the remainder of this chapter.

Spatial patterns in the house price residual

The 180 coefficients for the area-fixed effects in the hedonic house price equation are now used to investigate spatial patterns in the average house price residual on the Rotterdam housing market. The value of the coefficient at a distance of 250 to 125 metres from the border on the low-priced side is first normalised to zero. The increase in the house price residual in the three remaining border segments is then derived from the sum of the coefficients on the area-fixed effects. The values for each segment are averaged based on the observed pattern in the house price residual. The grouping of the segments is defined by formulas (6.2a), (6.2b) and (6.2c), as depicted in Figure 6.1. Table 6.3 lists the average value of the house price residual in each segment for the four identified sets of border zones.

124 Although porticos without a lift are more expensive than apartments are, the difference is so small (0.005% of the house price) that these categories are grouped together.

Figure 6.3 Change in the average house price residual near 34 neighbourhood boundaries in Rotterdam in 2003



Of the 45 border zones, 11 exhibit a pattern in the house price residual that is incompatible with a reputational premium. The house price residual remains constant in six cases, while smooth growth is visible in five cases. The last set includes two border zones in the administrative borough of the city centre, which can thus be seen as a single geographical submarket. Interestingly, this set includes three of the four borders that divide neighbourhoods with the same name, but with a different prefix (i.e. north/south, east/west and new/old). Buyers apparently fail to distinguish between neighbourhoods with the same name. The one exception is the Kralingen area just east of the city centre, the eastern side of which is considered one of the most prestigious neighbourhoods in Rotterdam, while the western side is in the lower to middle layer of the neighbourhood hierarchy. This border zone is part of the set within which a discrete jump in the house price residual is visible.

The house price residual thus makes a significant jump in three fourths of the 45 border zones. A sudden jump is visible in 22 zones, a positive spillover from the high-priced to the low-priced side of the border in nine zones, while three zones display a negative spillover. As illustrated in Figure 6.3, cases with positive or negative spillovers are characterised by a smooth growth of the residual, despite the fact that the size of the jump near the border exceeds the size of the spillover effect. While these cases might still be compatible with a reputational premium in the house price, the remainder of the analysis focuses on the 22 zones in which the house price residual jumps beyond any doubt. The average jump in the house price residual for this group of border zones is 17% (see the third row and seventh column of Table 6.3), with a mini-

Table 6.3 Average house price residual in 45 border zones in Rotterdam in 2003

Category	N	-125 to 0 metres	0 to 125 metres	125 to 250 metres
Sudden jump	22	0.015	0.174	0.172
Jump with positive spillover	9	0.032	0.084	0.120
Jump with negative spillover	3	0.019	0.095	0.158
Subtotal	34	0.020	0.143	0.157
No jump	11	0.012	0.031	0.069
Total	45	0.018	0.116	0.136

mum value of 5% and a maximum value of 38%.[125]

Spatial patterns in the physical quality of dwellings

The next step is an investigation of the role of the physical quality of dwellings in jumps in house price. The missing structural characteristics and spatial lags in the model may have inflated the estimates of the house price residual and the inter-neighbourhood differences in the residual. The average house price residual, age and size of the dwelling and average house-type index are first regressed on boundary-fixed and boundary-to-neighbourhood-fixed effects in the 45 border zones. In the regressions with age and size as the dependent variable, which undergo a logarithmic transformation, the coefficients measure the percentage change in their value. Given that the house-type index is a dimensionless measure, the change in the coefficient is more relevant than the size. The means reported in Table 6.4 are obtained by averaging the sum of the coefficients for the area-fixed effects in each segment for the four sets of border zones. In Figure 6.4, these figures have been converted into percentage increases.[126] The resulting spatial patterns in the average age, size and house type in each area can be compared to the patterns in the house price residual shown in Table 6.3 and Figure 6.4.

The information reported in the third row of Table 6.4 suggests that the physical quality of dwellings plays some role in the observed discontinuities in the house price residual. The age of dwellings is higher on the high-priced side of the border, whereas the housing stock in that area is composed of slightly less popular house types. The most important structural characteristic (house size), however, is on average 7% higher on the more expensive side of the border. The size of dwellings is probably related to the physical quality of the area, given that larger dwellings are usually found in neighbourhoods with better architectural quality and more or better amenities. House size could also serve as a proxy for unobserved structural characteristics (e.g. number of rooms and presence of a garden or bath). It is reasonable to assume that the estimated jumps in the house price residual are inflated, due to the missing variables in the model. At best, however, the large size of

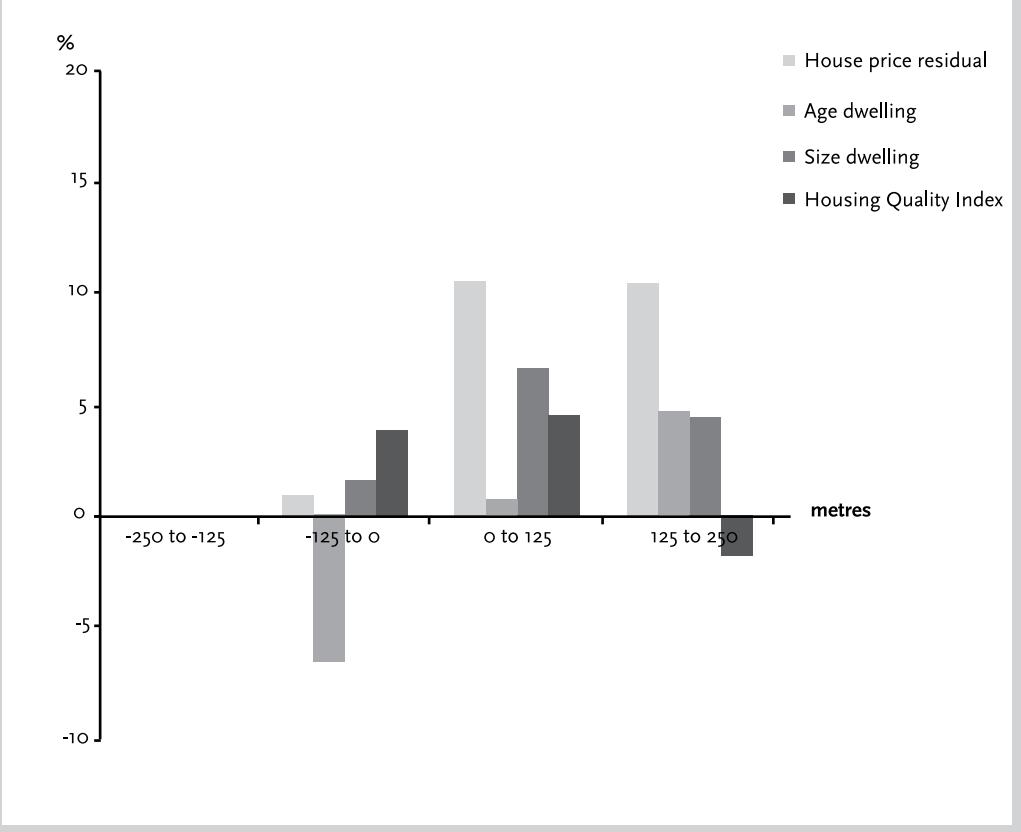
125 Differences between the neighbourhoods in the 22 selected zones amounted to an 8% increase in owner-occupation in the area, a 17% rise in average household income and an increase of 0.3 in average neighbourhood satisfaction, on a scale from 1 to 7 in 2003 (source: COS, Rotterdam Municipal Statistics Office).

126 The percentage rise in the house price index in Figure 6.4 is obtained by dividing the figures in Table 6.4 by the average value of the house price index from Table 6.1.

Table 6.4 Average physical quality in 45 border zones in Rotterdam in 2003

	Log age of dwelling			Log size of dwelling			House-type index		
Category	**-125 to 0**	**0 to 125**	**125 to 250**	**-125 to 0**	**0 to 125**	**125 to 250**	**-125 to 0**	**0 to 125**	**125 to 250**
Sudden jump	-0.11	0.01	0.08	0.03	0.11	0.07	0.17	0.19	-0.08
Jump with positive spillover	0.06	0.41	0.09	0.02	-0.08	0.01	-0.19	-0.43	0.15
Jump with negative spillover	-0.05	0.00	-0.13	-0.02	0.08	0.09	0.09	0.62	0.53
Subtotal	-0.06	0.12	0.06	0.02	0.06	0.06	0.06	0.07	0.03
No jump	-0.11	-0.02	-0.27	0.14	0.06	0.12	0.26	0.72	1.08
Total	-0.07	0.08	-0.02	0.05	0.06	0.07	0.11	0.23	0.29

Figure 6.4 Change in the average house price residual and physical quality near 22 neighbourhood boundaries in Rotterdam in 2003



dwellings on the high-priced side of the border can account for only a fraction of the observed jumps in the residual.

First, an increase in the size of dwellings occurred in only 11 of the 22 selected border zones. Average house size remained the same in nine cases, while it was even smaller on the high-priced side in two cases. The increase in house size is thus simply not general enough to explain all of the jumps in the house price residual. Second, the increase in size is not large enough

Table 6.5 Average social quality in 45 border zones in Rotterdam in 2003

	Income category			Owner-occupation			Neighbourhood satisfaction		
Category	**-125 to 0**	**0 to 125**	**125 to 250**	**-125 to 0**	**0 to 125**	**125 to 250**	**-125 to 0**	**0 to 125**	**125 to 250**
Sudden jump	0.22	0.60	0.41	0.07	0.18	0.15	0.11	0.04	0.12
Jump with positive spillover	0.05	0.10	-0.06	0.04	0.02	-0.01	-0.03	-0.12	0.05
Jump with negative spillover	-0.15	0.45	0.74	-0.03	0.07	0.22	-0.07	0.11	-0.14
Subtotal	0.14	0.45	0.31	0.05	0.13	0.11	0.06	0.00	0.08
No jump	0.11	0.14	0.13	-0.04	-0.06	-0.11	0.07	0.03	0.05
Total	0.13	0.38	0.27	0.03	0.08	0.06	0.06	0.01	0.07

to account for an average jump of 17% in the house price residual. The zones in which the residual did not jump can be investigated in order to develop an idea of the remaining bias in the estimate of the residual. The increase of the average house price residual was 7% in the 11 cases in which the residual remained constant or experienced a smooth growth, while average house size increased by 12% in these cases (see the seventh column of Table 6.4). Based on this relationship, a 7% increase in house size in the 22 zones of interest may have led to an additional jump of about 4% in the residual (i.e. 7/12*7%). This figure indicates that the larger stock on the expensive side of the border could have accounted for one fourth of the 17% average rise in the house price residual at best.

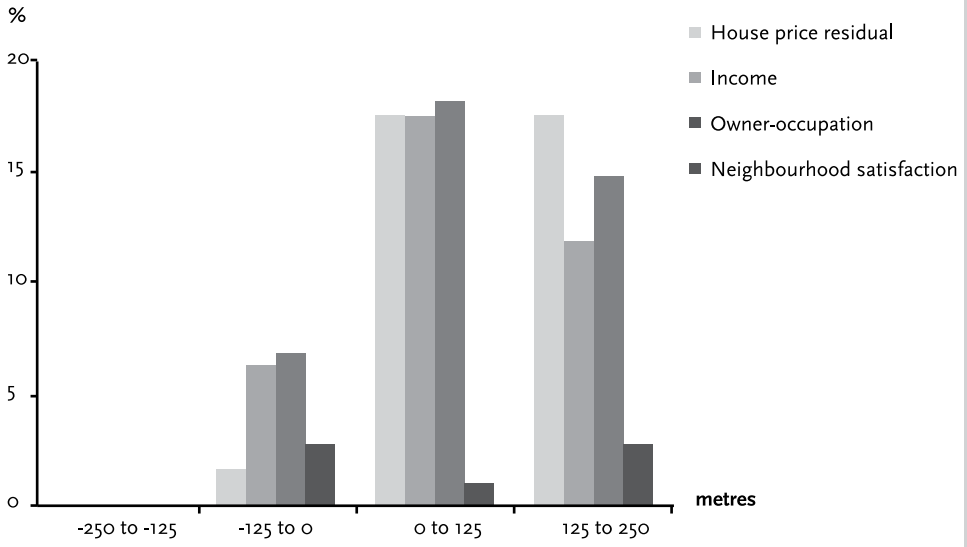
Roughly 75% of the jumps in the average house price residual in the 22 border zones remains unexplained. The improvement in physical quality is neither general nor large enough to explain the jumps in house price when crossing neighbourhood boundaries. Another noteworthy result in Table 6.4 relates to the nine cases in which a positive spillover is visible. The quality of the structural characteristics within a distance of 125 metres of the border was even better on the low-priced side of the border than it was on the high-priced side. This suggests a possible explanation for a 'golden edge' on a deprived neighbourhood. The much better price-quality relationship of dwellings on the low-priced side might attract some well-to-do buyers who would otherwise opt for dwellings in the adjacent, poorer neighbourhood. They can still make use of the amenities on the expensive side of the border, while profiting from the better price-quality relationship of the visible aspects of the dwelling and neighbourhood by living on the poorer side.

Spatial patterns in the social quality of the neighbourhood

The sorting of owner-occupiers of different socio-economic strata between areas is known to be associated with the price of locations (Bayer and Ross, 2006). The neighbourhood boundary must act as the social demarcation line if owner-occupiers are guided by a reputational bias in their destination choices. The social fabric, which is measured by the average income of responding households, should exhibit a pattern that is roughly similar to that of the house price residual.[127] In turn, the social climate must exhibit a smoother pattern of decay or growth across the border if it spills over to adjacent are-

127 The educational achievement of residents was also incorporated into the analysis, but it failed to deliver conclusive results. The erratic spatial distribution of students is probably responsible for this outcome.

Figure 6.5 Change in the average house price residual and social quality near 22 neighbourhood boundaries in Rotterdam in 2003



as. Earlier in this thesis, neighbourhood satisfaction has been shown to capture the inside view on the area quite well; it therefore seems an appropriate measure for the social climate of an area.[128] The change in owner-occupation is used to examine the role of institutional constraints in the estimate of the house price residual. The spatial patterns in the survey scores reported in Table 6.5 are once again obtained by regressing each of the scores on the area-fixed effects and then averaging the coefficients in the regression for each segment and for the four sets of border zones.

Judging from the small changes in neighbourhood satisfaction, the social climate hardly changes at all when crossing the administrative border. Residents' perceptions of their surroundings are related to the assessment of the overall neighbourhood by outsiders (see Table 3.2), but the differences in living quality within the neighbourhood seem to be lost on most buyers. This is another indication that buyers consider the neighbourhood at large and not the surroundings of the offer. Differences in income and owner-occupation on opposite sides of the border, which could be due to sorting between neighbourhoods, are larger than the local differences on either side of the border. As expected, household income follows the same pattern as the house price residual (see also Figure 6.5). A small but gradual change in income is visible in cases in which the residual does not jump, while the spillovers in the house price residual are also visible in the income variable. More important-

128 This has been verified empirically by Hipp (2010), who showed that the socio-economic status of the micro-neighbourhood has a much stronger impact on the satisfaction of residents with their neighbourhoods than does the status of the macro-neighbourhood or the physical features of the area.

ly, a sudden jump in the house price residual is accompanied by a marked increase in income. Looking more closely at the individual cases, household income makes a small drop in just four out of the 22 selected zones, but these happen to be the same zones in which the residual makes a modest jump (from 4% to 8%). The general picture is thus that households of different socio-economic strata are indeed sorting between administrative neighbourhoods in the cases in which the house price residual is seen to make a sudden jump.

It is still too early to conclude that the sorting between neighbourhoods is based solely on a reputational bias among buyers. Table 6.5 lists the average changes in owner-occupation in the 22 selected border zones. The share of tenants and home-owners is a proxy measure for the division between social rental and privately owned stock, which is far more relevant in the Dutch context.[129] The 15% increase in owner-occupation in the 22 zones suggests an institutional cause for sorting between neighbourhoods.[130] A higher share of social rental stock on one side of the border inevitably leads to lower income levels and lower house prices in that area, due to the low income of tenants, regardless of the existence of a reputational bias among buyers. The role of the ownership structure in the area in the estimate of the house price residual warrants closer examination, as does the role of the physical quality of the area.

Unexplained jumps in the house price

In a further examination of the spatial patterns in the house price residual, which extends beyond the procedure specified by Bayer *et al.* (2007), two regressions are conducted for the 22 zones of interest. In the first regression, the average house price residual in each border segment and zone is regressed on the average house-type index, size and age of the dwelling and the average income, educational achievement, neighbourhood satisfaction and tenureship of households within the same segment. This regression for 66 observations (i.e. three segments in 22 zones) indicates the contribution of physical quality and tenureship to the house price residual, thereby explaining the absence of area-fixed effects in the model.[131] The second regression uses the average income category in each border segment as a dependent var-

129 The marginalised private rental stock in the Netherlands caters to low-income households that are unable to obtain social rental dwellings on short notice, as well as to ex-pats and 'the new middle classes' on the opposite side of the neighbourhood hierarchy.

130 Of the total housing stock in Rotterdam in 2003, 20% consisted of private rentals, 55% consisted of social rentals and 23% consisted of owner-occupied dwellings (Source: Municipal Statistics Office). The tenureship of the remaining 2% consisted of either private rental or owner-occupied dwellings.

131 The approach is analytically similar to appending the hedonic house price equation with a spatial lag for the structural characteristics and local averages for owner education, income, education and neighbourhood satisfaction.

Table 6.6 Regression for average house price residual and average household income in 22 border zones in Rotterdam in 2003

		House price residual		Income category	
		Coefficient	t-value	Coefficient	t-value
House price residual		-	-	0.75	1.09
Housing quality	Age of dwelling	-0.01	-0.37	0.03	0.19
	Size of dwelling	0.40	3.13	0.91	1.27
	House-type index	-0.07	-3.42	0.03	0.26
Social fabric	Income category	0.02	0.95	-	-
	Education category	0.01	0.44	-	-
Social climate	Neighbourhood satisfaction	-0.01	-0.21	0.30	1.14
Tenureship	Owner-occupation	0.26	3.43	1.42	3.60
R^2			0.48		0.58
N=66					

iable, with the house price residual, the house-type index, the size and age of the dwelling and neighbourhood satisfaction as explanatory variables. This regression indicates whether sorting between neighbourhoods is due solely to differences in the tenureship rate and physical quality of dwellings or whether it is also due to a reputational bias.

Despite the simplicity of the models presented in Table 6.6 and despite the low number of observations, the overall fit is good and the estimated coefficients are revealing. The outcome of the regression for income shows that tenureship is an important determinant of sorting. The importance of tenureship is mirrored in the regression for the house price residual. A 15% rise in owner-occupation on the high-priced side of the border leads to a 3.9% rise in the house price residual (i.e. 0.15*0.26).

Less expensive house types tend to lie on the high-priced side, although the decrease in housing quality may actually lead to an increase in the price level in that area. The higher prevalence of small single-family dwellings in the social rental sector explains this counter-intuitive result. The decrease of 0.08 in the house-type index and the 7% increase in house size (see Table 6.4) on the high-priced side leads to an increase of 3.4% in the house price residual (i.e. 0.08*0.07+0.07*0.40).[132] This suggests that just over 40% of the 17% average jump in the house price residual (i.e. (3.9+3.2)/17.2) in the 22 zones is the result of bias due to the poor specification of the model, while roughly 60% remains unexplained.

6.5 Conclusions

The boundary analysis in this chapter is intended to prove that a reputational premium in house price can be made visible. A change in neighbourhood name should lead to an abrupt change in both the social fabric of the area and the average house-price level. House prices did jump in half the inhabited border zones on the Rotterdam market in 2003, even upon discarding the one fourth of the cases with positive or negative spill-overs. The prices jumped an average of 17% across the neighbourhood borders in these zones, where roughly 60% could not be explained by either an improvement in the

132 Note the similarity with the estimate in Section 6.4

physical quality of the area or a higher rate of owner-occupation. If the cases with spill-overs across neighbourhood borders are included as well, then the average house price residual jumped by 16% in three fourths of all inhabited border zones. These results validate the fourth conjecture stated at the end of Chapter 2. The administrative boundaries of neighbourhoods (and by extension, the neighbourhood name) may have an impact on house price and on sorting between neighbourhoods on the Dutch owner-occupied market.

Several shortcomings associated with the approach that I took, could cast some doubt on the results. First, the specification of the models in this chapter was arguably too simple. The estimate of the house price residual could have been improved to some extent by including additional structural characteristics in the hedonic price equation, but these data were unavailable. Second, the impact of the tenure-ship rate and the physical quality of the area on the house price residual could be larger than the 40% mentioned in the text if more sophisticated measures of various neighbourhood attributes are appended to the model. For example, the level of owner-occupation serves as a proxy for the more relevant division between social rental and privately owned stock. Realtors on the other hand, could have underrated the jumps near boundaries where differences in tenure ship were present. Finally, aspects that were not investigated may have been at least partly responsible for at least some of the jumps in the house price residual. For example, local supply conditions are neglected in the model.

Most importantly, the analysis is based on assessment values rather than on actual sales prices. Some of the jumps in the house price residual could have been the result of realtors' definitions of 'market areas'. Jumps in the assessment values come naturally, if market areas are associated with administrative neighbourhoods. Notwithstanding this objection, there are few people who understand the housing market better than realtors (Yinger, 1981; Levitt and Syverson, 2008). Their role as middlemen of the housing market entails that they act as 'informed outsiders'. Neighbourhood reputations are shaped by outsiders' perceived (and possibly exaggerated) differences between neighbourhoods. As such, possible assessor's bias feeds back into list prices and eventually into sales prices, unless buyers are well-informed.

The fit of the hedonic house price equation and the models for average income and the house price residual in the border zones are good. It thus seems improbable that a better specification of the models in this chapter would have improved the estimate of the house price residual to such an extent that the jumps in the residual could be explained away by the missing variables. The fact that jumps in the house price residual are so common on the housing market also indicates the presence of a structural reason for the observed discontinuities in house price, regardless of assessors' bias. The explanation that I offer here, the price-tag on the neighbourhood name, need not be the only reason for the observed patterns in the residual, but it does provide the

most feasible and viable explanation.

Analysis of the spatial patterns in sales prices near the administrative boundaries of neighbourhoods could give a more definitive answer to the question that I raised. More evidence for the role of reputations in the pricing mechanism can be offered in cases in which it is known that neighbourhood quality was left unchanged, while the name of the area changed abruptly. One such case is the subject of the next section, in which I investigate the annexation of a neighbourhood section by an adjacent, more affluent and thus better-reputed neighbourhood.

7 Boundary change and house prices

7.1 Introduction

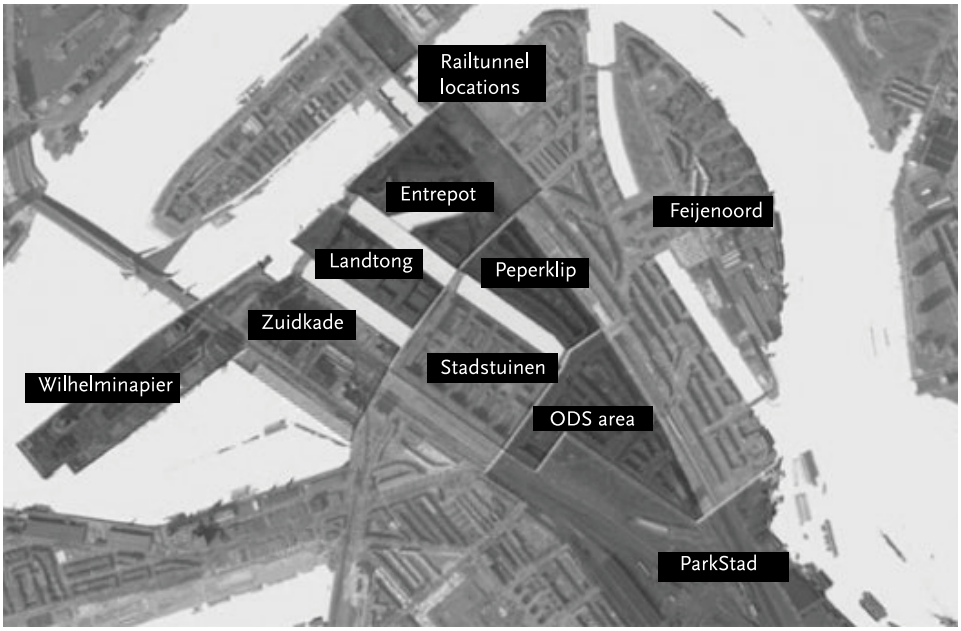
The hedonic price analysis presented in the previous chapter revealed that house price makes a jump near the boundary of the administrative neighbourhood in three fourths of all the inhabited border zones in Rotterdam. These jumps in price could not be explained entirely by changes in neighbourhood quality. Abrupt jumps are observed in half of the investigated border zones, thus corroborating the fourth conjecture stated at the end of Chapter 2: house price seems to contain a reputational premium (or downgrade) in each administrative neighbourhood. This evidence remains circumstantial, however, in the sense that some unobserved factor could have been at least partially responsible for the discontinuities observed in house prices.

A jump in house price that is the sole result of a change in the name of an area would offer much stronger evidence to support the conjecture that a neighbourhood's name carries a price tag. This administrative action leaves no traces behind in the area, with the exception of a change in neighbourhood name in the advertisement and listing of vacant dwellings. In this chapter, I use a repeat sales model to examine price changes in a section of a neighbourhood in Rotterdam that was annexed by an adjacent, better reputed neighbourhood. If house price does contain a reputational premium, then the name change should have resulted in a sudden change in price. Furthermore, owner-occupiers living in the area should have anticipated this price hike well in advance, due to their informational advantage as residents, relative to buyers from outside of the area.

7.2 Boundary change and repeat sales

The role that administrative boundaries of municipalities, boroughs and neighbourhoods play in explaining residential mobility and house prices was first analysed by political economists. Tiebout (1956) saw 'voting with your feet' as an alternative to voting in elections on the level of taxation and public spending within a legal jurisdiction (Ross and Yinger, 1999). Local taxes also affect the cost of living (Dowding and John, 1996), while the quality of policing or school quality directly affects neighbourhood quality (Nechyba and Strauss, 1998; Bayer *et al.*, 2007). Zoning restrictions can also be tighter or looser depending upon the jurisdiction. In some cases, administrative divisions do affect supply and house prices (Glaeser and Gyourko, 2002). Unlike the situation in the US and the UK, the division of Dutch cities into administrative boroughs and neighbourhoods has few real consequences. Local taxes are based on a head-of-household rate or a percentage of the property value. Public services are mainly administered at the national, municipal or individual level. Although boroughs do have some leeway in public spending, the lev-

Figure 7.1 Kop van Zuid-Entrepot and Feijenoord



Source: Informatiecentrum Kop van Zuid

el of spending is comparatively low.[133]

The administrative neighbourhoods within a borough are used primarily for the aggregation of neighbourhood statistics and the designation of places in the advertisements of vacancies, media reports and the public opinion. The boundaries of municipalities are regularly redefined as a result of mergers or dissolutions, but adjustments in the boundaries of administrative neighbourhoods are rare. In one case in Rotterdam, urban redevelopment led to an adjustment of a neighbourhood boundary. The growth of container shipping in the second half of the 20th century led to the obsolescence of older ports near the city centre. One such area lay just south of the city centre, across the New Meuse river. The Kop van Zuid (Southern head) neighbourhood was built in stages during the 1990s, and it consisted of privately owned stock. From its humble start in 1995 with only 24 dwellings, it had grown into a neighbourhood with 3,700 dwellings by 2003. East of this neighbourhood is the neighbourhood of Feijenoord, which remains one of the city's most disadvantaged neighbourhoods. In 1997, the city council decided that Kop van Zuid would be transferred from the city centre to the same borough as Feijenoord and that all sections of Feijenoord to the west of a railway tunnel would be a part of the new Kop van Zuid-Entrepot neighbourhood at the turn of the millennium. These westernmost sections include two social housing estates in the Peper-

133 The sum of the annual budgets of all fourteen boroughs in Rotterdam in 2009 was about 10% of the city council's annual budget.

klip and ODS-Gebied, as well as the Entrepot section and a number of dwellings in the Landtong, which are a combination of owner-occupied and private rental housing (see Figure 7.1).[134]

The annexation of the westernmost sections of Feijenoord by the Kop van Zuid-Entrepot neighbourhood provides an experimental setting for analysing the role of a reputational premium in house price. Feijenoord is an impoverished neighbourhood with the largest share of social rental housing in Rotterdam (95% of the stock in 2003, source: COS Municipal Statistics Office). The Kop van Zuid neighbourhood had been a success from its inception; it soon became the most affluent neighbourhood on the entire Southbank. In 2003, the difference in the house price residual between the two neighbourhoods was 33%, the second largest price differential between adjacent neighbourhoods on the housing market.[135] In the same year, the average household income in the Kop van Zuid-Entrepot neighbourhood was 35% higher than it was in Feijenoord, and neighbourhood satisfaction score was also 0.75 higher (on a seven-point scale). If the name of a neighbourhood adds to the house price, then the annexation of the Entrepot section by Kop van Zuid should have led to a marked increase in the price of dwellings within that area. This annexation must have increased the value of social rental stock in the Peperklip and ODS-gebied as well, given that the only available measure for the value of this stock (i.e. assessment value) is directly or indirectly based on the sales prices of comparable dwellings in the vicinity.[136]

The standard method for analysing changes in house price at two different moments in time is the repeat sales method (Bailey *et al.*, 1963). The following equation is estimated (Clapp and Giaccotto, 1998):

$$(7.1)\quad Log(P^t) - Log(P^{t-1}) = \beta_0^t - \beta_0^{t-1} + \sum(\delta_l^t - \delta_l^{t-1})NBH_l^t$$

The change in the logarithm of house price is the sum of the overall price hike in the area (captured by the change in the constant term) and the change in neighbourhood value. In this equation, the neighbourhood variables NBHl are defined as area-fixed effects. A clever definition of the area dummies allows for a direct test for the effect of the name change on the exchange value of the area.

The Dutch Central Statistics Office (CBS) regularly classifies all six-digit postal code areas into administrative neighbourhoods. The classifications for the years 1999 and 2003 are known for all the dwellings in the dataset.

134 The Peperklip is a famous design by the Dutch architect Carel Weeber, which was completed in 1982.

135 This border was among the cases with negative spillover effects, as discussed in Chapter 6, due to the presence of the two large social housing estates (ODS-gebied and Peperklip) in the annexed area.

136 Transaction data for Feijenoord are scarce, due to the large share of social rental stock.

The dataset is split into three subsamples: observations that were already a part of the Kop van Zuid neighbourhood in 1999, observations that remained a part of Feijenoord during the period 1999-2003 and observations that were first a part of Feijenoord in 1999 and then changed to the Kop van Zuid-Entrepot in 2003.[137]

A further division in the sample of the annexed area is made for dwellings that were built before the year in which the annexation was announced and dwellings that were constructed in 1997, 1998 and 1999. Sellers and buyers of the post-1997 construction were likely to have sold and bought their dwellings at post-annexation prices. Each subsample receives an area dummy, with the value 1 if the observation fell into the annexed area and building period in question and 0 elsewhere. The change in the coefficient for the dummy for older stock in the annexed area of Feijenoord is expected to be positive and significant (i.e. $\delta t-\delta t-1>0$ with a t-value greater than 1.96). The test ascertains whether the change in coefficient value of the older stock in the annexed sections is greater than the change in coefficient value of the younger stock in the same sections and of the stock in Kop van Zuid and Feijenoord.

This test further reveals whether any increase in price was due to the name change or whether it was due to improvements in neighbourhood quality (e.g. better amenities). An improvement in neighbourhood quality should lead to a price increase for all the stock. The majority of residents in the westernmost sections of Feijenoord remained in their dwellings during the annexation, such that the change in social fabric is negligible.[138] No changes occurred in the physical make-up of the annexed area either, other than the fact that construction was taking place and amenities were being established in the area adjacent to Kop van Zuid.

Feijenoord and Kop van Zuid are distinctly different areas, hence the evolution of prices could have been different. An area dummy is used for observations that were part of Kop van Zuid in 1999 in order to control for differences in the increase in price between both areas. Prices of single-family dwellings and apartments may have evolved differently as well. With seven observations on single-family dwelling in Feijenoord, a dummy for this house type is likely to act as an area-fixed effect. The model is therefore estimated twice: once for the entire sample and once for apartments only. The date

137 Dwellings in the Kop van Zuid-Entrepot neighbourhood that were built after 1999 are obviously dropped from the sample.

138 A total of 233 transactions occurred for the 1,235 privately owned dwellings (including the stock constructed between 1995 and 1999) in the annexed sections between 1999 and 2003, 30 of which involved repeated sales (source: Dutch Land Registry Office). This indicates that 83.5% of all owner-occupiers in the annexed region in 1999 were still living there in 2003, which corresponds to an annual exit rate of just 4.1%, which is low compared to the exit rate in other parts of the city (see Tables 3.3 and 4.1). Figures for the exit rate in the social rental sector could not be obtained, but it seems unlikely that these figures were much higher in the annexed sections than they were in the social rental stock elsewhere, given the comparatively high neighbourhood satisfaction scores in this area.

Table 7.1 Descriptive statistics

			Mean	Median	Maximum	Minimum	Std. Dev.
House price in 1999			88,028	75,555	323,091	9,075	52,305
House price in 2003			138,782	116,000	464,000	27,000	80,440
Age of dwelling in years			48.9	21	121	0	46.6
Size of dwelling in square metres			91.8	87	1,370	22	42.9
House type	Single-family	Terraced corner	0.03	0	1	0	0.16
		Terraced other	0.03	0	1	0	0.18
	Multy-family	Gallery flat with lift	0.13	0	1	0	0.33
		Gallery flat without lift	0.03	0	1	0	0.18
		Maisonette with lift	0.07	0	1	0	0.25
		Maisonette without lift	0.06	0	1	0	0.23
		Apartment corner	0.12	0	1	0	0.33
		Portico with lift	0.05	0	1	0	0.22
		Portico without lift	0.48	0	1	0	0.50

N=1,608

of the first appraisal falls after the announcement date of the annexation. As such, the test ascertains whether the name change of the area led to a slow rise in house prices, as the only other economic study on this subject asserts (Messer *et al.*, 2006), or whether prices adjusted immediately or not at all (i.e. coefficient is zero).

7.3 Data

Table 7.1 lists data on the price, age, size and type of 1,600 dwellings in the neighbourhoods of Feijenoord and Kop van Zuid-Entrepot on a sum total of 5,900 dwellings in 1999. House prices in 1999 and 2003 are based on the assessment values of the municipal tax office (the same dataset that was used in the previous chapter). The prices are first cleansed of non-unique assessments, largely serving to reduce the number of observations in the social housing estates in Feijenoord proper and the annexed sections of Feijenoord. The variance in the price, size and age of dwellings is large compared to that of the housing stock in the rest of the city (see Table 6.1). This is the result of the considerable difference in quality between the two neighbourhoods. The 224 dwellings that were already a part of Kop van Zuid in 1999 had an average house price of € 148,000 in the same year, as compared to an average price of € 62,000 for the 1,002 dwellings in Feijenoord proper. In 1999, the median age of dwellings in Kop van Zuid was one year, as compared to 89 years in Feijenoord proper. The observations in the annexed sections of Feijenoord consist of 382 dwellings, the quality of which was superior to that of the rest of the neighbourhood. Of these dwellings, 245 were built before 1997 and 137 dwellings were built during and after this year. The average house price in 1999 was € 120,000 in the annexed sections, about 94% higher than it was in Feijenoord proper.

Table 7.2 Repeat sales model for Kop van Zuid-Entrepot and Feijenoord in 1999-2003

		Model I		Model II		Model II	
		Coeff	t-value	Coeff	t-value	Coeff	t-value
Constant		0.20	65.71	0.20	68.57	0,19	52,93
Kop van Zuid in 1999		-0,02	-2.72	-0.02	-2.94	-0.02	-1,33
Feijenoord in 1999/Kop van Zuid-	Built before 1997	-0,02	0.92	0.00	0.12	-0.02	-1,58
Entrepot in 2003	Built after 1997	0.06	7.48	0.08	9.48	0,06	6,38
Random effects							
R^2		0.06		0.07		0,21	
Standard error of regression		0.091		0.093		0.039	
Log Likelihood		1,581.2		1,454.0			
N		1,608		1,511		1,511	

7.4 Repeat sales equation

A repeat sales equation is now estimated for the change in house price between 2003 and 1999 in the Kop van Zuid-Entrepot and Feijenoord neighbourhoods. The percentage change in house price of over 1,600 dwellings is regressed on a constant and the area-fixed effects.

The outcome of the first model in Table 7.2 shows that Feijenoord experienced an annual price hike of 4.7% (i.e. $100*(1.20^{¼}-1)$). The model further shows that the price gap between the stock in Feijenoord proper and the original Kop van Zuid neighbourhood was reduced by a slim margin. Prices of the older stock in the annexed sections of Feijenoord, however, increased by about 6%. In the second model, observations on single-family dwellings are not used in the estimation. This model reveals that older apartments in the annexed sections of Feijenoord experienced a price hike of 8%. Social landlords and owner-occupiers who owned stock in Feijenoord and found themselves owning property in the Kop van Zuid-Entrepot neighbourhood experienced an increase in house value. Owner-occupiers and landlords who bought new construction that was going to be a part of Kop van Zuid-Entrepot anyway, paid the same price as buyers who were already living in Kop van Zuid.

The near complete coverage of dwellings in the area makes it inevitable that error terms are spatially correlated. The second model is estimated with random effects for each of the 151 six-digit postal code areas in the sample in order to control for spatial autocorrelation. This reduces the estimate of the price hike of the older apartments in the annexed section of Feijenoord to 6%.

7.5 Conclusions

The third part of this thesis was devoted to the identification of the reputational premium in house price. The hedonic price analysis presented in Chapter 6 revealed that unexplained jumps in the house price residual near the administrative boundaries of neighbourhoods are common in Rotterdam. The boundary analysis left several doubts regarding the role of neighbourhood name in the price-setting mechanism. The repeat sales model discussed in this chapter analysed a case in which a residential area was annexed by an

adjacent, more affluent and better-reputed neighbourhood. Older dwellings that had originally been part of a disadvantaged neighbourhood and were later annexed by a more affluent neighbourhood experienced an average price increase of 6 to 8%. These dwellings were located in neighbourhood sections that experienced neither new construction nor a marked change in social fabric. Improvements in the physical quality of the area do not explain the price increase, as the improvement should have affected the price of both the newer dwellings and the older dwellings.

The evidence in this and the previous chapter corroborates the fourth and fifth conjecture stated at the end of Chapter 2. Neighbourhood name is a relevant element of housing quality, and it is priced accordingly on the owner-occupied market. The name of a neighbourhood is linked to its reputation, which was defined earlier as the notion that ill-informed outsiders have of the unobservable (mainly social) quality of the neighbourhood. The proof of a reputational premium in house price indicates that the pull effect of the price on social tenants in the count model discussed in Chapter 4 and the duration model discussed in Chapter 5 could have been a reflection of social tenants' bias towards certain neighbourhoods. Buyers and social tenants in Rotterdam seem to share a similar preference for (or dislike of) neighbourhoods based on the name of the area (see also Table 3.2). The second key question of this thesis can thus now be answered in the affirmative: the informational asymmetry on the social rental market carries over to the owner-occupied market; neighbourhood reputation has a price tag.

8 Summary and discussion

8.1 Summary

The full information axiom in the neoclassical economic literature for the housing market predicts that house-seeking tenants and buyers are just as well-informed as residents are about the circumstances in the neighbourhood. The pull effects of the neighbourhood on house-seekers should be more or less of the same size and range as the corresponding push effects on residents. The same attributes of the neighbourhood that explain residential mobility should also be able to explain house price. In reality, assessing the role of neighbourhood quality in the exit choices of residents poses less of a problem than assessing its role in the destination choices of house-seekers. Some pull effects of the neighbourhood prove relevant on one housing market, but then fail to explain residential mobility on another market. Furthermore, neighbourhood attributes that are known to affect house prices in one area fail to make an impact on the price in other areas on the same housing market (Atkinson and Crocker, 1987; Kauko, 2002).

The assumption that new tenants and buyers are well informed about the neighbourhoods to which they would like to move is abandoned in (among other contributions) search models for the housing market. This recent addition to the housing market literature states that most buyers and new tenants are at an informational disadvantage relative to the suppliers of dwellings (Wheaton, 1990; Merlo and Ortalo-Magné, 2004; Albrecht *et al*., 2009). Buyers and new tenants can lift the informational asymmetry by acquiring more information on the quality of vacancies. Another strand of literature has incorporated a similar belief into an equilibrium model of the housing market (Berliant and Yu, 2009). In this model, the equilibrium price is equal to the amount that a buyer is willing to pay for the dwelling, but ill-informed buyers may overestimate the user value of a dwelling and therefore overpay for it. I extended upon this body of literature and geographical search theories (Brown and Moore, 1970; McLellan, 1977; Smith *et al*., 1979; Huff, 1986) by assuming that there is a spatial dimension to the informational asymmetry between some house-seekers and the suppliers of dwellings.

Residents know all there is to know about circumstances in the home surroundings through their own experience. House-seekers learn about the availability and quality of vacancies through advertisements and through the inspection of the actual dwelling and neighbourhood. Several aspects of neighbourhood quality may still go unobserved. Who the new neighbours are and how they interact with one another remains hidden to a visitor's casual glance over the area. The availability and quality of local amenities and services may also go unnoticed. House-seekers can adopt several strategies to overcome their informational disadvantage. Geographical search theories assume that residential search takes place within a limited space, and house-seekers thus need to become acquainted with only a few areas. House-

seekers can save further costs by searching in their own neighbourhoods, in neighbourhoods where their family and friends live or on their way to work. These strategies reduce the risk of ending up with a lemon (Akerlof, 1970), a dwelling whose user value falls short of its price. Not all house-seekers are in a position to obtain detailed information on their final destinations.

Ill-informed house-seekers can always fall back upon neighbourhood reputation as a risk-reducing strategy. Sociologists have defined the reputation or name of a neighbourhood as the common view on the social circumstances in an area, which enables outsiders to make a simple (albeit not always correct) distinction between places and their inhabitants (Suttles, 1972). The agent-based simulation discussed in Chapter 2 revealed that reputations act as a simple rule of thumb in the destination choices of house-seekers. Given that a neighbourhood with a poor reputation is less likely to attract affluent households, it will be very hard to improve the social make-up of an ill-reputed area. A neighbourhood whose name does improve inevitably starts to attract more affluent households. Reputations thus act as self-fulfilling prophecies: the social quality of the area adapts to the neighbourhood's name. The use of reputations ensures that the destination choices of ill-informed buyers and tenants will prove right in the long run.

The second part of the thesis focuses on the social rental market in Rotterdam in order to test whether many tenants face informational constraints when searching for new homes. The spatial scale of reputations – which, in the case of the Netherlands, is the administrative neighbourhood (Hortulanus, 1995) – acts as a benchmark. If tenants use reputations in their destination choices, then they are likely to care less about differences in living quality within each neighbourhood than they do about the choice between neighbourhoods. In contrast, well-informed tenants are likely to be able to find the best (and thus undervalued) destinations, even in ill-reputed neighbourhoods. If a similar informational asymmetry exists on the owner-occupied market, then buyers' reputational bias should be visible in spatial house price patterns. This study predicts that price is likely to make an abrupt change when crossing the border to another neighbourhood whose reputation is better or worse than that of the adjacent neighbourhood.

The exit choices of tenants of a not-for-profit housing association in Rotterdam are investigated in Chapter 3. Two measures of neighbourhood quality suffice to explain spatial differences in the exit rate. A neighbourhood satisfaction score from a residential survey measures the quality of the neighbourhood as experienced by residents. House price reflects the value that outsiders to the area attach to the actual dwelling and, more importantly, to its location. Tenants' stated demand for social rental dwellings is investigated in Chapter 4. Demand is measured by the number of tenants who responded to the association's vacancies. On average, house-seekers are likely to be less informed about the quality of the neighbourhood than residents are. House-

seeking tenants do not pay as much attention to neighbourhood satisfaction, while it is likely to be a relevant push factor on existing tenants,. This conjecture was confirmed in the estimation outcome of a count model of the response to vacancies Chapter 4 in contrast to the outcome of an exit choice model in Chapter 3.

A responding tenant makes no commitment to live in the dwelling; rejection is always an option. Candidates who accept an offer do commit themselves: they lose their rank in the queuing system for social rental dwellings, meaning that they must stay in the dwelling for a number of years. The main result of a revealed preference model of the waiting time for social rental dwellings, as presented in Chapter 5, is that half of all new tenants knew little about the living quality near their new homes. The other half proved equally well informed as residents: the pull effect of neighbourhood satisfaction on these tenants was similar in scale – and even larger in size – than was the corresponding push effect on residents. Tenants with a low rank in the distribution system and first-time tenants proved less informed than high-ranking and transferring tenants. High-ranking tenants face high opportunity costs; they must forfeit good, future housing opportunities. Transferring tenants also face risky destination choices; they must exchange one dwelling for another. The maximum loss in utility that a poorly informed tenant could suffer amount to 25% of the rent or 20% reduction in the waiting time for the dwelling. The analysis of residential mobility on the social rental market thus answers one of the key questions of this thesis: there is a gap in knowledge between residents and at least some house-seekers, and this gap can be revealed in their respective valuations of the neighbourhood.

The analysis of the social rental market, which is the focus of the second part of the thesis, is followed by the analysis of spatial house price patterns. The purpose of this analysis is to prove that house price contains a reputational premium in each neighbourhood. This is predicted by a housing transactions model, presented in Chapter 2. The spatial pattern in house prices near the administrative boundaries of neighbourhoods in Rotterdam is investigated in Chapter 6. House prices jumped in three fourths of all of the investigated cases when crossing neighbourhood border, while abrupt jumps were visible in half of the cases. Prices were an average of 17% higher on the expensive side of the border. Roughly 60% of the difference in price can be explained by improvements in physical quality or an increase in owner-occupation, such that house price could be 10% higher or lower, depending upon which side of the virtual border the dwelling was located. The annexation of a neighbourhood section by an adjacent, more affluent neighbourhood is investigated in Chapter 7. The name change of the area led to an increase of 6 to 8% in the price of the older stock, even though no apparent changes took place in either the built environment or the social make-up of the area. Households that bought newly constructed dwellings in the same area during

and after the year in which the annexation was first stated anticipated the name change and were forced to pay this reputational premium in advance.

The house-price analysis of the owner-occupied market in Rotterdam answers the second key question of the thesis: there is an informational asymmetry between informed sellers and uninformed buyers, which can be revealed in spatial patterns of house prices. The evidence that I offered in Chapters 3 through 7 supports most of the conjectures that were derived in Chapter 2. One valid point of criticism, however, is that some of the evidence remains circumstantial. Alternative explanations can be offered for the residential mobility outcome as well. Likewise, a reputational premium may not be the only explanation for the patterns observed in house prices. Nevertheless, the empirical results are clearly at odds with the full information axiom, which predicts an optimal outcome for each tenant's destination choice and the smooth adjustment of house prices across the borders of neighbourhoods. The use of neighbourhood reputations provides a viable, although possibly not the only, explanation for the empirical results.

8.2 Methodological insights

The outcome of the models of exit and destination choices, as discussed in Chapters 3, 4 and 5, confirmed that households need not always face a free housing choice. The size and scale of the estimated push and pull effects of the neighbourhood depended upon the informational, financial, institutional or personal constraints that individual households were facing.[139] Nested choice models that distinguish between forced or voluntary moves (Timmermans *et al.*, 1996), planned or unexpected moves (Kan, 1999) and a high or low possibility of obtaining a new home (De Palma *et al.*, 2007) are better suited to estimating the effects of neighbourhood quality (or housing quality) on the exit or destination choices of households, as these models distinguish between households according to their ability to move. As an alternative, researchers could resort to a simple discrete choice model, as I have done, by limiting the sample to households facing a free housing choice. The analysis in the second part of the thesis considers the relative distance of the move and the presence of social ties in the new neighbourhood as selection criteria for moving households that are better informed and less choice-constrained.

The agent-based simulation model of the housing market, as presented in Chapter 2, reveals that the relation between house price, the sorting of households between neighbourhood and the quality of neighbourhoods is very

139 It has long been noted in the theoretical literature on residential mobility that the decision to move is a far more complex process than the revealed choice models assert (Priemus, 1986).

complex. Several authors (e.g. Bayer and Ross, 2006) have already gone beyond this simple approach, treating the destination choice and the determination of house price as an integrated, endogenous process. This endogeneity might even go a step further, however, as the use of reputations entails that mere expectations about future developments within a neighbourhood can trigger an increase (or decrease) in price, the selective arrival of households, improvement (or deterioration) in neighbourhood quality and a further rise in the price. The coefficients for socio-economic and demographic attributes of the neighbourhood in house price models have little meaning if the models fail to consider the endogenous relationship between house price and residential sorting.

The methodological insights that I have offered thus far strengthen the case for more advanced modelling practices. One result could simplify matters for housing market researchers. The aggregation of statistics on neighbourhood attributes over an areal unit with arbitrary boundaries can lead to the Modifiable Areal Unit Problem (Openshaw, 1984). The spatial variation within this unit is lost, possibly affecting the estimated correlation between an attribute and the process that it sets out to explain. Households however, adopt the same aggregation bias when they make use of reputations or statistics on the neighbourhood in their destination choices. A simple neighbourhood mean for socio-economic or demographic attributes (e.g. the mean income level in the neighbourhood) may actually prove superior to advanced specifications and measurements of the same attributes as an explanatory variable in destination choice or house price models.

8.3 Policy insights

National and local governments and not-for-profit housing associations intervene in many ways on the Dutch housing market. For example, millions of euros are spent each year to improve the social and physical quality of neighbourhoods, even though the measurement of the societal impact of these neighbourhood investments is still in its infancy. One important contribution of this thesis is the derivation of two monetary proxies that can be used to compute the Societal Returns on Investments for tenants in the cost-benefit analysis of neighbourhood investments. The estimated push or pull effects of house price and neighbourhood satisfaction were converted into the willingness to pay of tenants, which also serves as an approximation of the tenants' valuation of the neighbourhood. Suppose that investments take place that increase the average house price and neighbourhood satisfaction. by 1% This would yield a direct estimate for the benefits to owner-occupiers, while the benefits for tenants can be derived from the estimated willingness to pay of tenants for an increase in the price. The 1% increase in price is equivalent

to an increase of 0.3-0.5% in the rent depending on the type of tenant. In turn, the 1% increase in neighbourhood satisfaction amounts to an increase in the willingness to pay on the part of tenants, equivalent to 1% of the rent.

The creation of mixed-income neighbourhoods is one of the key targets of the Dutch housing policies. Neighbourhoods that are a combination of social rental and owner-occupied stock have various benefits for low-income residents, while middle-income residents benefit by being allowed to continue their housing careers in their old neighbourhood.[140] The same policy has been adopted in the UK, although the results have been less than satisfying. While the policy proved successful in the tight London housing market, it failed to produce the desired outcome (i.e. a durable increase in the price level) in social housing estates in other cities (Silverman *et al.*, 2005). The agent-based simulation discussed in Chapter 2 suggests that this outcome is not that surprising. A moderate desire to live among one's peers is sufficient to produce the sorting of households between areas according to income (Schelling, 1969; Ekeland *et al.*, 2002). The use of reputations reinforces segregation, because buyers are aware that the successful resale of the new home is contingent upon a lasting improvement in neighbourhood name.

Government-sponsored gentrification of disadvantaged areas through the small-scale construction of owner-occupied dwellings and the piecemeal sale of social rental stock can also be hampered by a neighbourhood's poor name. Policymakers appear to have only limited awareness that gentrification is more of a bottom-up than a top-down process. A possible trajectory for gentrification runs as follows.[141] After the initial stage, in which a small group of 'pioneers' prepares the area for further development (Ley, 1986), the dissemination of the improvement in living conditions changes the public's expectations of the neighbourhood. The improved reputation sets off a chain reaction in which affluent households flock to the area, hereby co-producing the environment to which the reputation was pointing in the first place. To force this type of process from the top down, governments and associations should not stop at social and physical investments. Reputation management might play a pivotal role in the upward trajectory of a neighbourhood. The target group for the owner-occupied dwellings must be made aware that the unobservable features of the neighbourhood (e.g. the social circumstances and quality of amenities) are indeed changing for the better.

This gives the impression that the increased level of owner-occupation in

140 Doubts have been raised concerning the alleged benefits of income-mixing in the Netherlands (Van Eijk, 2010).

141 It is worth noting that the Dutch policy of income-mixing is also incompatible with the competing supply-side view on gentrification (Smith, 1987). Because the rent gap in disadvantaged neighbourhoods is much lower than it is in affluent neighbourhoods, associations are more inclined to sell their stock in disadvantaged neighbourhoods, and governments are more prone to develop owner-occupied dwellings in these areas.

formerly disadvantaged neighbourhoods in the Netherlands is due to three reasons: the tightness of the owner-occupied market in most cities, the location of neighbourhoods as spill-over areas for the city centre and a marked improvement in the neighbourhood's name.[142] Without these favourable conditions, the owner-occupied stock in ill-reputed neighbourhoods cannot compete with the stock in well-reputed areas, as dwellings must be resold at some later date. Nevertheless, several recipes are available for the successful mixing of households. The simulation model discussed in Chapter 2 has shown that small pockets of prosperity in poorer neighbourhoods may not be viable in the long run, but that small pockets of poverty inside affluent neighbourhoods can be stable as long as the small share of social rental stock does not affect the neighbourhood's good name.[143] Finally, a 'golden edge' can be created on the fringes of disadvantaged neighbourhoods that border on more affluent neighbourhoods. A prerequisite for the creation of this micro-spill-over area is that the quality of the housing stock in the 'golden edge' is superior to the quality of the stock on the affluent side of the border.

The discussion in the previous chapters may have startled some non-Dutch readers, upon reading about the scope and scale of government interventions on the Dutch housing market. The high costs of the housing policy and the ambivalent results of some of the policies have prompted a discussion in political and scientific circles about the best ways to reform the Dutch housing market.[144] Two major inefficiencies of the social rental sector have been identified in the literature that lead to potentially high welfare costs. First, below-market rent has created excess demand in most urban areas, which has reduced the competiveness of the private rental sector and hence the supply of dwellings in the mid-price segment of the housing market. Second, rent controls are accompanied by the inefficient allocation of dwellings among tenants due to the absence of a pricing mechanism. The results presented in Chapters 4, 5 and 6, however, suggest that the second inefficiency is less important: social tenants do sort between dwellings and areas based on their willingness to pay for a particular house type and neighbourhood, whether they intend to do this or not.[145] In addition, however, the welfare costs of two further inefficiencies could outweigh the costs of undersupply: choice con-

142 Gentrifying neighbourhoods that attract a relatively large number of short-distance movers need not rely on an improvement in reputation, as most movers to the area will be well-informed.

143 The use of vouchers for social tenants under Section 8 of the US Housing and Community Development Act applies the same rationale. Evidence suggests that this 'stealthy' way of relocating low-income households does not reduce the price level in affluent areas (Galster *et al.*, 1999).

144 For example, see Besseling *et al.* (2008).

145 In this context, I should distinguish between the sorting of households between house types and between neighbourhoods. Previous research has shown that sorting between house types can be inefficient, with many small households tending to live in large dwellings and many large households living in small dwellings (Rouwendal, 1989 and 1990).

straints faced by existing tenants and the inefficient allocation of dwellings across the various segments of the housing market.

The exit choice model discussed in Chapter 3 has shown that residents living in the most popular house type (single-family dwellings) in attractive areas were indifferent to most aspects of housing quality. This is likely due to these tenants reaching the end of their housing career within the social rented sector. The wide gap in the user costs of renting and owner-occupation, however, effectively ends their entire housing career. A move into tenureship usually results in a reduction in housing quality, due to the low availability of owner-occupied dwellings for middle income households in most Dutch cities (Renes *et al*., 2006). Below-market rents, rent subsidies, ad valorem buyers' taxes and inflated price levels (due to the tax deduction on mortgage debt) work together to maintain the gap in user costs. One proposal is to link the regulated rent to the price of the dwelling, so that neighbourhood quality and high demand are better reflected in the rent and the gap in user costs can be reduced (Besseling *et al*., 2008). As the analysis has shown, however, tenants were not willing to pay the full amount of what owner-occupiers are willing to pay in order to live in an area. A stepwise increase of the rent in popular areas should reveal the tenants' actual willingness to pay for their neighbourhood, as choice restrictions are relaxed.

The low willingness to pay for the neighbourhood among social tenants relative to owner-occupiers (as mentioned earlier, 30-50% of additional rent for a doubling of house price) is indicative of an overlooked inefficiency: the misallocation of dwellings across the owner-occupied and social rental segments of the Dutch housing market (Van Ommeren and Koopman, 2011). Assigning social rental stock to low-income households in attractive areas and cities leads to the displacement of some middle-income buyers from the housing market. The higher average income of the remaining owner-occupiers increases the average willingness to pay for the dwelling and hence the average price. Social rental stock may thus depress house values in the immediate vicinity while inflating the average price level on the housing market by limiting supply to middle-income buyers. The gap in the willingness to pay of social tenants and buyers suggests that the greatest gains from the liberalisation of the Dutch housing market lie in the sale of social rental stock to middle-income households and the construction of owner-occupied dwellings for the same target group.

The latter observation is reminiscent of Milton Friedman's adage: 'there's no such thing as a free lunch'. Two of the social targets of Dutch housing policy – 'affordable housing for low-income households' and 'a sufficient supply of dwellings for first-time buyers and transferring households' – appear to be incompatible. As low-income households take possession of dwellings in attractive areas, first-time buyers and transferring tenants are frustrated in their desire to start or to continue their housing careers. On the other hand,

social rental stock in attractive neighbourhoods may be the best recipe for a durable mix of households, although the financial costs (e.g. higher land value) and welfare costs (e.g. displacement of middle-income households) are comparatively high in these areas. The question that the government should address concerns which groups on the housing market deserve support and at what cost to society. Regardless of the choice that is made in this trade-off, Dutch policymakers should consider the potentially high welfare costs associated with income-mixing on the housing market before presenting it as a means of combating the social ills of society.

The most important insight of the thesis however, is that the use of neighbourhood reputations can lead to different outcomes for the destination choices of households and for house price. These exceptions to the rule can seriously impede the effectiveness of housing policies. Efforts to incorporate informational asymmetries into housing economics and the insight that it produces for policy analysis could gain further impetus from the improved data collection drawing upon internet search sites for vacancies. Researchers need no longer rely solely on revealed housing choices, but can use this new type of data to learn more about the residential search process. Such future research could reveal the relative correctness of the assumption that neighbourhood reputations play an important role in housing choices.

Samenvatting en discussie

Economische analyse van buurtkwaliteit, buurtreputatie en de woningmarkt

Marnix Koopman

Samenvatting

De Neoklassieke economische literatuur over de huizenmarkt neemt aan dat kopers en huurders goed geïnformeerd zijn over de omstandigheden in hun nieuwe woonomgeving, wanneer zij hier naartoe verhuizen. In de modellen die verhuisbewegingen en prijsvorming op de woningmarkt moeten verklaren, wordt de kwaliteit van de woonomgeving meestal benaderd door buurtkenmerken. De invloed van zo'n kenmerk op het besluit om ergens te vertrekken moet dan ongeveer even groot zijn als de invloed ervan op het besluit tot vestiging elders. De kenmerken die deze verhuisbeweging beïnvloeden, moeten ook terugkeren in modellen die de huizenprijs verklaren. In de praktijk blijkt dat sommige buurtkenmerken op de ene woningmarkt wel van invloed zijn op de vestigingskeuze, maar op een andere woningmarkt weer niet. Zelfs op dezelfde woningmarkt kan een kenmerk in de ene buurt de prijs wel, maar in een ander buurt niet beïnvloeden. De gebruikte verhuismodellen zijn verder beter in staat om de invloed van de woonomgeving op de beslissing te vertrekken te verklaren, dan om de invloed ervan op het besluit zich ergens te vestigen te verklaren.

De aanname dat kopers en nieuwe huurders even goed geïnformeerd zijn over de kwaliteit van de woning of woonomgeving als verkopers en zittende huurders is losgelaten in onder andere zoektheorieën voor de woningmarkt. Deze theorievorming toont aan dat kopers een informatieachterstand bezitten ten opzichte van verkopers en dat zij door het verzamelen van informatie beter voor de dag komen in de onderhandelingen over de prijs (zie o.a. De Wit en Van der Klauw, 2010). Binnen de ruimtelijke economie heeft de gedachte postgevat dat de prijs van een woning gelijk is aan het bedrag dat de koper wenst te betalen voor de woning, los van de vraag of de koper goed op de hoogte is van de gebruikswaarde van deze woning (Berliant en Yu, 2009). In het eerste deel van dit proefschrift wordt voortgeborduurd op bovenstaande theorievorming en zoektheorieën uit de sociale geografie, door aan de informatieachterstand van huizenzoekers een ruimtelijke dimensie te verbinden.

Een zittende bewoner weet uit eigen ervaring hoe de omstandigheden in zijn woonomgeving zijn. Huizenzoekers kunnen zich door advertenties van het woningaanbod en een bezoek aan de buurt op de hoogte stellen van de prijs of huur en zichtbare woning- en buurtkenmerken. Maar hoe de sociale samenhang in de buurt is, hoe interacties met toekomstige buren en buurt-

bewoners verlopen en wat de meerwaarde van kleinschalige voorzieningen in de buurt is, blijft verborgen. Huizenzoekers kunnen op meerdere manieren de informatieachterstand ten opzichte van bewoners verminderen. Het inperken van de zoekruimte tot plekken die men goed kent, zoals de eigen buurt of buurten waar bekenden wonen, staat centraal in zoektheorieën uit de sociale geografie (zie Brown en Moore, 1970; Smith *et al*., 1979 en Huff, 1986). De zoekstrategieën leiden ertoe dat de risico's van een verkeerde vestigingskeuze, in de zin dat de gebruikswaarde van de woning lager uitvalt dan de prijs of huur ervan, beperkt worden. Niet iedere huizenzoeker is in de omstandigheid dat hij voldoende informatie kan verzamelen over de grotendeels onzichtbare sociale kwaliteit van zijn nieuwe buurt.

Een slecht geïnformeerde huizenzoeker kan altijd nog zijn toevlucht nemen tot de naam of reputatie van de buurt. Buurtreputaties zijn volgens sociologen breed gedeelde opvattingen over de sociale omstandigheden in een buurt, die buitenstaanders in staat stellen een simpel (maar niet altijd even correct) onderscheid tussen buurten en hun bewoners te maken (Suttles, 1972; Permentier, 2009). Een simulatiemodel in hoofdstuk 2 laat zien dat de buurtreputatie ook als een simpele vuistregel werkt, die slecht geïnformeerde huizenzoekers in staat stelt om de risico's van een verkeerde vestigingskeuze zoveel mogelijk te beperken. Een buurt met een slechte naam zal geen nieuwe bewoners van een beter allooi aantrekken, zodat de sociale omstandigheden daar net zo slecht blijven als de naam van de buurt al voorspelde. Een buurt waarvan gedacht wordt dat hij in de lift zit, zal als vanzelf een beter slag bewoner aantrekken. De reputatie wordt zo een 'selffulfilling prophecy': de kwaliteit van een buurt voegt zich op den duur naar de reputatie.

Om te toetsen of veel kopers en nieuwe huurders slecht geïnformeerd zijn over hun nieuwe woonomgeving, wordt in het tweede deel van dit proefschrift onderzocht of het gebruik van buurtreputaties door woningzoekenden op de Rotterdamse sociale huurmarkt zichtbaar kan worden gemaakt. De ruimtelijke schaal van reputaties, die van de administratieve buurt, vormt hier het aanknopingspunt. Als huurders zich laten leiden door reputaties in hun vestigingskeuze, dan dienen zij geen acht te nemen van de verschillen in sociale kwaliteit binnen een buurt, terwijl zij juist veel waarde hechten aan de keuze tussen buurten. Goed geïnformeerde woningzoekenden moeten in staat zijn om de beste locaties te vinden, zelfs in buurten die slecht bekend staan. Op de koopmarkt zal de prijs van de locatie – gegeven de zichtbare verschillen in omgevingskwaliteit – binnen een buurt vrij constant moeten zijn, terwijl het prijsverschil tussen buurten – als gevolg van een verschil in reputatie – soms sterk zal kunnen oplopen.

In hoofdstuk 3 wordt stilgestaan bij de verhuisbeslissing van zittende huurders van corporatie Woonbron Rotterdam. Twee maatstaven, een rapportcijfer voor de buurttevredenheid als maat voor de (voornamelijk sociale) kwaliteit van de buurt zoals bewoners die ervaren en de huizenprijs als maat voor de

(voornamelijk fysieke) kwaliteit van de buurt zoals buitenstaanders (NB kopers) die ervaren, blijken afdoende om de invloed van de woonomgeving op de verhuisbeslissing te verklaren. In hoofdstuk 4 wordt het aantal reacties van woningzoekenden op het vrijgekomen woningaanbod onderzocht. De relatief slecht geïnformeerde woningzoekende huurders dienen zich in verhouding tot goed geïnformeerde, zittende huurders minder te laten leiden door de sociale kwaliteit van de buurt, aangezien de meeste van hen hiervan niet op de hoogte kunnen zijn. Dit vermoeden werd bevestigd in een telmodel voor de reactiegraad op vrijgekomen sociale huurwoningen in hoofdstuk 4.

De reactie op een vrijgekomen woning is echter een vrijblijvende keuze, waaraan nauwelijks kosten zijn gebonden. De winnende kandidaten ondervinden wel de consequenties van hun keuze, omdat zij achteraan de rij voor een nieuwe huurwoning moeten aansluiten. Uit een duurmodel voor de wachttijd op een huurwoning in hoofdstuk 5 blijkt dat de helft van de nieuwe huurders wel lette op de buurt waarin de woning stond, maar geen notie nam van de kwaliteitsverschillen binnen deze buurt. Zij weken daarin af van huurders met een hogere woon- of inschrijfduur – wat tevens hun rang in de woonruimteverdeling bepaalt – die hierdoor meer risico liepen in hun vestigingskeuze, aangezien zij hun opties op een betere, toekomstige woning inleveren. Doorstromers moeten hun oude woning inleveren, wat meer risico's met zich meebrengt dan de meer vrijblijvende keuze die starters maken. Huurders met een langere woon- of inschrijvingsduur en doorstromers bleken wel even goed op de hoogte te zijn van de lokale omstandigheden als zittende huurders. De maximale afname aan woonkwaliteit als gevolg van een slechtere locatiekeuze door starters en woningzoekenden met een lage rang ten opzichte van doorstromers en woningzoekenden met een hoge rang in de woonruimteverdeling bedroeg 25% van de huur, een bedrag dat volgens de geschatte relatie tussen wachttijd en de huren equivalent is aan een verkorting van de wachttijd op een sociale huurwoning met 20%.

De analyse van de verhuisbewegingen op de Rotterdamse sociale huurmarkt wordt gevolgd door de analyse van woningprijzen in Rotterdam in het derde deel van het proefschrift. Het doel ervan is om aan te tonen dat de naam (of reputatie) van de buurt in de woningprijs verwerkt zit; een uitkomst die voorspeld is door een model voor transacties op de koopmarkt in hoofdstuk 2. In hoofdstuk 6 is het verloop van de huizenprijs aan de grenzen van Rotterdamse buurten onderzocht. Het gebruik van buurtreputaties moet leiden tot een reputatiepremie in de prijs. In driekwart van de gevallen bleek dat de prijs inderdaad een sprong maakte wanneer een buurtgrens overschreden werd en in de helft van de gevallen was zelfs sprake van een abrupte sprong. De prijs in de ene buurt lag gemiddeld 17% hoger dan in de naastliggende buurt. Veranderingen in de woningkwaliteit en de verhouding huur/koop kunnen 40% van dit prijsverschil verklaren. Een huis was dus gemiddeld 10% meer of minder waard, afhankelijk van de vraag aan welke kant van de

buurtgrens het stond. In hoofdstuk 7 is de prijsontwikkeling in een buurtdeel van Feijenoord onderzocht, dat later geannexeerd werd door de Kop van Zuid. De naamsverandering van het buurtdeel leidde tot een prijsstijging van oudere woningen met 10%, zonder dat er veranderingen in de bebouwde omgeving of bevolkingssamenstelling optraden. De verkopers en kopers van woningen in dit buurtdeel die gebouwd zijn nadat de annexatie bekend was gemaakt, reageerden blijkbaar op de naamswijziging en verwerkten de reputatiepremie van 6% tot 8% in de woningprijs.

De bewijslast in hoofdstukken 3 tot en met 7 stemt overeen met de gevolgtrekkingen uit de theorievorming in hoofdstuk 2. Maar men mag hier als bezwaar aantekenen dat de bewijslast tamelijk indirect is. Bij gebrek aan kennis omtrent de exacte motieven die woningzoekenden hebben om zich ergens te vestigen, wordt verondersteld dat een informatieachterstand de basis legt voor het negeren van de kwaliteitsverschillen binnen de buurt. Andere verklaringen (keuzerestricties, irrationeel keuzegedrag, desinteresse in de woonomgeving) lijken minder waarschijnlijk, maar dit bewijst nog steeds niet dat er geen alternatieve, betere verklaring denkbaar is voor de patronen in de verhuisbeweging. Het feit dat een buurtgrens van invloed is op de huizenprijs, suggereert wel dat er een prijskaartje aan de naam van een buurt hangt, maar ook hier kan bijvoorbeeld de woningtaxatie een rol gespeeld hebben.

Sommige uitkomsten in het proefschrift staan dus haaks op de aannames uit de economische woningmarktliteratuur wanneer uitgegaan wordt van volledige informatievoorziening. Woningzoekenden dienen volgens deze literatuur te snappen dat zij voordeel halen uit een goede kennis van hun nieuwe woonomgeving. Het negeren van deze informatie in de uitkomsten in dit proefschrift strookt niet met rationeel gedrag. Huizenprijzen op hun beurt dienen geen plotselinge sprong te maken bij 'zachte' buurtgrenzen, maar zich geleidelijk aan te passen aan de veranderingen in de woonomgeving. Het gebruik van reputaties door kopers en huurders als alternatief voor volledige informatievoorziening levert een aannemelijke, maar wellicht niet de enige verklaring op voor het geobserveerde keuzegedrag van woningzoekenden en de ruimtelijke patronen in de huizenprijs.

Methodologische inzichten

Uit de modellen voor de vertrek- en vestigingskeuze in hoofdstukken 4, 5 en 6 blijkt dat de ene verhuizing de andere niet is. De invloed van kenmerken van de buurt op het vertrek of de vestiging van een huishouden wordt niet alleen bepaald door de keuzerestricties die het individuele huishouden ondervindt (Priemus, 1986), maar ook door de informatieachterstand die het bezit. Verhuismodellen die een expliciet onderscheid maken tussen huishoudens op basis van een gedwongen of vrijwillige verhuizing (Timmermans *et al*., 1996), een geplande of onverwachte verhuizing (Kan, 1999), en de krapte of ruimte van de woningmarkt ten tijde van de verhuizing (De Palma *et al*., 2007),

zijn niet zozeer een methodologisch hoogstandje, als wel een noodzakelijke voorwaarde om iets zinnigs te kunnen zeggen over de invloed van buurtkenmerken op de verhuisbeslissing. Als alternatief voor deze 'geneste' modellen kan de onderzoeker zijn analyse beperken tot een groep van huishoudens die geen keuzerestricties ondervindt. De uitkomsten geven aan dat een onderscheid tussen huishoudens op basis van de afgelegde afstand van de verhuizing en de aan- of afwezigheid van vrienden en bekenden in de nieuwe buurt eveneens relevante criteria zijn om zo'n onderscheid aan te brengen.

Een simulatiemodel voor de woningmarkt in hoofdstuk 2 toont aan dat de relatie tussen de huizenprijs, vestigingskeuze en buurtkwaliteit bizarre vormen kan aannemen. Sommige auteurs (bijv. Bayer en Ross, 2006) zagen in dat er een vicieuze cirkel bestaat tussen prijzen, vestigingskeuze en buurtkwaliteit, zodat zij de prijsvorming en vestigingskeuze als een geïntegreerde keuze zijn gaan modelleren. Wanneer een huishouden met een hoog inkomen door het hoge prijspeil vermoedt dat huishoudens met een hoog inkomen zich naar deze plek begeven, wordt de buurt vanzelf een aantrekkelijke vestigingsplek. Deze endogeniteit – de wederkerige relatie tussen afhankelijke en onafhankelijke variabelen in het model – kan nog een stap verder gaan dan bovenstaande auteurs veronderstelden. Enkel verwachtingen omtrent de vestiging van andere huishoudens – welke mede gebaseerd zijn op de buurtreputatie – kunnen er al toe leiden dat prijzen veranderen.

Waar bovenstaande inzichten de noodzaak tot geavanceerde modellering van de woningmarkt onderschrijven, vloeit er ook een uitkomst voort uit het proefschrift die tot een versimpeling van de modellen kan leiden. Statistieken voor buurtkenmerken worden vaak geaggregeerd op het niveau van postcodegebieden of administratieve buurten. Hierdoor verliezen de statistieken aan zeggingskracht, omdat het verschil in kwaliteit binnen deze gebieden verloren gaat. Dit zogenaamde Modifiable Areal Unit Problem (Openshaw, 1984) hoeft echter minder problemen te veroorzaken in de woningmarktmodellen dan de gangbare literatuur veronderstelt. Als kopers of huurders zich verlaten op buurtreputaties, hanteren zij exact dezelfde ruimtelijke schaal voor de buurtkenmerken als de statistische diensten die de statistieken leveren. Buurtstatistieken voor sociaaleconomische en demografische kenmerken (bijv. het gemiddelde inkomen in een buurt of postcodegebied) kunnen dezelfde of wellicht een betere verklaringskracht bezitten dan geavanceerde maatstaven voor dezelfde kenmerken.

Beleidsmatige inzichten

De aanleiding voor dit proefschrift was de beleidsmatige vraag of wijkinvesteringen van corporaties bijdragen aan de woningwaarde. Op deze vraag valt niet altijd een antwoord te geven, omdat de perceptie van een buurt (NB via reputaties) en de daadwerkelijke buurtkwaliteit weliswaar samenhangen, maar er geen één-op-één relatie tussen bestaat. Een betere buurtkwaliteit

hoeft niet per se tot een naamsverbetering en prijsstijging te leiden. Recent onderzoek is wel in staat geweest om de effecten van zichtbare, fysieke investeringen, zoals de aankoop van panden door corporaties, nieuwbouw en de verkoop van sociale huurwoningen, op een maatstaf voor leefbaarheid te ramen (Marlet *et al*., 2009).[146] De regressieanalyses in het proefschrift leveren enkele kengetallen op die in maatschappelijke kosten-batenanalyses gebruikt zouden kunnen worden om de effecten van investeringen op de huursector te ramen. Voor cijfers voor leefbaarheid of buurttevredenheid op een zevenpuntsschaal geldt dat een één-punts-verbetering een toename van het woongenot van huurders bewerkstelligt, wat een bedrag van ongeveer 15% van hun huur vertegenwoordigt. Sociale of fysieke investeringen die de leefbaarheid in een buurt met 1% doen toenemen, dragen dus bij tot een verhoging van het woongenot van huurders, welke door hen gewaardeerd wordt als ongeveer 1% van hun gezamenlijke huursom. Voor eigenaar-bewoners levert de waardestijging van hun woning een indicatie op voor het effect van investeringen op hun woongenot. Een stijging van de gemiddelde prijs van koopwoningen in de wijk met 1% als gevolg van wijkinvesteringen zal het woongenot van een huurder doen toenemen met een bedrag dat equivalent is aan 0,3% tot 0,5% van de huur.

Een van de doelen die overheidsinterventies op de woningmarkt rechtvaardigen, is de creatie van wijken die een mix zijn van sociale woningbouw en koopwoningen. Uit wijkmenging vloeien maatschappelijke baten voort voor lage inkomensgroepen, terwijl middeninkomens de wooncarrière in eigen buurt kunnen vervolgen.[147] Hoewel eerdere ervaringen met gemengd bouwen in het V.K. tegenvielen, is het mengen van sociale woningbouw en eigen woningbezit een speerpunt geworden van het beleid in Nederland.[148] De simulatie in hoofdstuk 2 suggereert dat het succes van wijkmenging aan veel voorwaarden verbonden is. Ten eerste geldt dat op een vrije woningmarkt een lichte voorkeur om tussen gelijkgestemden te wonen al voldoende is om huishoudens te doen segregeren op basis van hun inkomen en maatschappelijke status (Schelling, 1969; Ekeland *et al*., 2002). Het gebruik van reputaties leidt tot een versterking van deze tendens, zelfs op een sterk gereguleerde woning-

146 De invloed van sociale investeringen kon niet geraamd worden door de auteurs vanwege meetproblemen en het feit dat de inzet van de corporatie juist verhoogd wordt als de leefbaarheid in het geding is. Als voorbeeld namen de auteurs de verkoop van sociale huurwoningen die 4% van de totale voorraad in een wijk vertegenwoordigden in ogenschouw. Dit zou tot een verbetering van de leefbaarheid met 0,6% leiden, wat een gemiddelde prijsstijging van € 10.000 per woning opleverde of 8% van de prijs, bij een gemiddelde WOZ-waarde van € 124.000 in 2004.

147 Zie Van Dam *et al.* (2010) voor een overzicht van mogelijke baten en Van Eijk (2010) voor een recente kritiek op wijkmenging.

148 In het V.K. bleek dat met uitzondering van de krappe Londense woningmarkt, de bevordering van eigenwoningbezit in voormalige sociale huurcomplexen nauwelijks bewoners van buiten de wijk aantrok (Silverman *et al.*, 2005). Deze uitkomst kan worden verklaard uit het belang van reputaties in het vestigingsgedrag van woningzoekenden van buiten de buurt.

markt als de Nederlandse. Ten tweede geldt dat gentrificatie, de verbetering van een buurt door de toestroom van hogere inkomensgroepen, zo zijn eigen dynamiek kent, die lastig van bovenaf afgedwongen kan worden. Als een wijk een betere naam verkrijgt, wordt ze vanzelf een aantrekkelijke vestigingsplek voor eigenaarbewoners en particuliere huurders met een hoger inkomen. Maar om zelf via investeringen gentrificatie tot stand te brengen, dienen buitenstaanders op de een of andere manier overtuigd te raken van de betere reputatie en leefomstandigheden in de wijk.

De indruk ontstaat dat de verkoop van nieuwbouwwoningen en bestaande huurwoningen in achterstandswijken vooral tot stand is gekomen door de krapte op stedelijke woningmarkten en een in potentie aantrekkelijke ligging van de betreffende buurt, bijvoorbeeld vlak bij het centrum. In het laatste geval kan de slechte naam omzeild worden, omdat potentiële bewoners regelmatig door de buurt komen. Zonder deze gunstige randvoorwaarden kunnen koopwoningen op lange termijn niet concurreren met woningen in meer aantrekkelijke buurten, omdat kopers weten dat hun woning in de toekomst weer doorverkocht moet worden aan een ongeïnformeerde buitenstaander. Tegelijkertijd levert het proefschrift enkele aanknopingspunten op voor menging die wel succesvol kan zijn. Allereerst bleek uit de simulatie in hoofdstuk 2 dat 'eilanden' van sociale woningbouw in welvarende wijken duurzamer zijn dan de tegengestelde situatie, zolang de reputatie van het gebied niet ondermijnd wordt. De populariteit onder kopers kan dan onaangetast blijven. De analyse in hoofdstuk 6 leverde nog een recept op om eigenwoningbezit in een achterstandswijk te bevorderen. De creatie van een 'gouden rand' op plekken waar de achterstandsbuurt grenst aan een aantrekkelijke buurt lijkt eveneens kansrijk. Een voorwaarde voor het ontstaan van zo'n overloopgebied is dat de woningkwaliteit uitstijgt boven de kwaliteit in de meer welvarende buurt. Kopers kunnen dan profiteren van de voorzieningen in de welvarende wijk, terwijl zij een goede en relatief goedkope woning in de achterstandswijk betrekken. Ten slotte moet nog gewezen worden op het belang van reputatiemanagement of 'branding'. Transformaties die gepaard gaan met een imagoverbetering van de buurt kunnen een broodnodige impuls geven aan de wijkverbetering.

De hervorming van de Nederlandse woningmarkt is stevig op de politieke agenda gezet (o.a. VROM-raad, 2007; Besseling *et al.*, 2008). Er zou sprake zijn van een inefficiënte allocatie van sociale huurwoningen en een tekortschietend aanbod van private huur- en middeldure koopwoningen die hoge welvaartsverliezen met zich meebrengen. De koppeling van huren aan WOZ-waarden is als beleidsmaatregel voorgesteld om deze verstoringen te beperken. Allereerst mag worden opgemerkt dat de inefficiënte allocatie van woningen onder huurders niet direct zichtbaar werd in mijn analyse: huurders met een hogere betalingsbereidheid voor de buurt kwamen vaker op de aantrekkelijke plekken terecht, omdat zij nu eenmaal bereid waren om langer te

wachten op een woning.[149]

De uitkomsten in hoofdstuk 3 laten zien dat de één-op-één relatie tussen de WOZ-waarde en de huur geen recht doet aan de waardering die zittende huurders aan de woonomgeving schonken. Voor iedere euro die een koper bereid was te betalen voor de locatie, was een sociale huurder bereid om 30 tot 50 eurocent aan extra huur neer te leggen. Een deel van dit waarderingsverschil kan te wijten zijn aan een inefficiënte allocatie van woningen tussen de marktsegmenten (zie hieronder) of keuzerestricties, maar een ander deel kan voortkomen uit afwijkende woonvoorkeuren. Sociale huurders profiteren bijvoorbeeld minder dan eigenaarbewoners van het hogere voorzieningenniveau dat meer welvarende buren met zich meebrengen. De één-op-één koppeling van huren aan de WOZ-waarde om een fictieve markthuur te simuleren, lijkt in de overgangsfase naar een geliberaliseerde huurmarkt ongewenst. Een stapsgewijze verhoging van huren in schaarstegebieden zal duidelijk maken wat de echte bereidheid van huurders is om te betalen voor hun woonomgeving, als keuzerestricties langzaam verdwijnen.

De uitkomsten in hoofdstukken 3, 4 en 5 wijzen op twee problemen in de sociale huursector, die wellicht grotere welvaartsliezen opleveren dan een tekortschietend aanbod of de misallocatie van woningen onder huurders. Het gaat om de slechte (niet-fysieke) bereikbaarheid van koopwoningen en de gevolgen ervan voor de doorstroming en de verkeerde allocatie van woningen tussen het huur- en koopsegment. Uit hoofdstuk 3 blijkt dat bewoners van de betere sociale huurwoningen (doorgaans eengezinswoningen) een relatief lage bereidheid tonen om voor de woning- en omgevingkwaliteit te betalen. Dit hangt wellicht samen met een gebrek aan keuzemogelijkheden, omdat zij aan het einde van hun wooncarrière zijn beland. In veel steden is te weinig aanbod van geschikte koopwoningen voor lage en middeninkomensgroepen om de kloof tussen sociale huur en koop te dichten (Renes *et al.*, 2006). De verkoop van sociale huurwoningen (al dan niet in maatschappelijk gebonden eigendom), de afschaffing van de overdrachtsbelasting, huurdifferentiatie, meer ruimte voor private verhuur en afschaffing van de hypotheekrenteaftrek zal niet alleen het financiële gat tussen koop en huur dichten, maar – met uitzondering uiteraard van de verkoop van sociale huurwoningen aan zittende huurders – neemt ook een belangrijke belemmering voor doorstroming op de sociale huurmarkt weg.

De lagere waardering die sociale huurders schenken aan de woonomgeving ten opzichte van kopers is mede het gevolg van een misallocatie van woningen tussen de huur- en koopsector (Van Ommeren en Koopman, 2011). De toewijzing van sociale huurwoningen aan lage inkomensgroepen verdringt een

149 Dit laat onverlet dat kleine huishoudens in te grote woningen kunnen wonen of vice versa, iets wat al twintig jaar geleden geconstateerd is voor de Amsterdamse sociale huurmarkt (Rouwendal, 1989 and 1990).

deel van de middeninkomensgroepen van de stedelijke woningmarkt – een ander deel gaat goedkoop scheefwonen – zodat het inkomenspeil van de overgebleven kopers en de gemiddelde huizenprijs stijgt in vergelijking tot de uitkomst op de vrije woningmarkt. Sociale woningbouw drukt weliswaar de woningprijs in de directe omgeving, maar heeft op de woningmarkt als geheel juist een prijsopdrijvend effect, omdat hiermee een deel van de koopvraag van de markt verdrongen wordt. Er ontstaan dan additionele welvaartsverliezen, omdat de verdrongen middeninkomensgroepen moeten wonen op plekken die niet hun eerste keus zouden zijn, terwijl men in principe bereid is om meer te betalen voor de woning dan de sociale huurders die op de betreffende markt kunnen blijven. Een tweede strategie voor potentiële kopers is dat zij in de sociale huursector goedkoop gaan scheefwonen. Het grote verschil in de bereidheid te betalen voor de buurt tussen sociale huurders en kopers suggereert dat de grootste welvaartswinst die uit de liberalisering van de woningmarkt te halen valt, ligt in het vertrek van lage inkomensgroepen uit en de komst van middeninkomensgroepen naar de meer gewilde (en dus duurdere) wijken en steden.

De laatste observatie sluit naadloos aan bij het adagium van Milton Friedman: “there’s no such thing as a free lunch”. ‘Een betaalbare woonruimte voor mensen met een laag inkomen’ en ‘voldoende woningen voor starters en doorstromers’ staan als sociale doelen op gespannen voet met elkaar. Als lage inkomensgroepen via sociale huur aantrekkelijke locaties innemen, worden starters op de koopmarkt en doorstromers op de huurmarkt belemmerd in hun woonkeuze. Eenzelfde afweging geldt voor wijkmenging. Menging door sociale woningbouw in meer aantrekkelijke buurten is waarschijnlijk duurzamer dan menging via de bevordering van eigenwoningbezit in achterstandswijken, maar gaat gepaard aan hogere stichtingskosten bij nieuwbouw en hogere welvaartsverliezen – die neerslaan bij starters en middeninkomensgroepen – in de bestaande voorraad. Welke groepen op de woningmarkt de meeste overheidssteun verdienen en of wijkmenging in de huidige vorm moet worden voortgezet, zal uiteindelijk een politieke afweging zijn. Maar voor een juiste afweging is het noodzakelijk dat beleidsmakers de maatschappelijke kosten die integratie op inkomen met zich meebrengen niet langer negeren, maar eveneens meenemen in de politieke afweging.

Het voornaamste inzicht uit het proefschrift is dat het gebruik van buurtreputaties tot veranderingen in voorspellingen omtrent de locatiekeuze van huishoudens en prijsvorming op de huizenmarkt leidt. Dit betekent dat beleidsvoorstellen verkeerd kunnen uitpakken in díe uitzonderingssituaties waar de informatieachterstand van huishoudens een rol van betekenis speelt. Vervolgonderzoek zal moeten uitwijzen hoe groot de rol van perceptie in de verhuisbewegingen en woningprijzen eigenlijk is. Gedetailleerde informatie over het zoekgedrag van kopers zoals deze op woningzoeksites als Funda en Jaap geregistreerd worden kan hierbij helpen. De informatieverstrekking over

buurten op deze sites zou de buurtreputatie in de toekomst minder belangrijk kunnen maken, maar deze informatie kan op zijn weer beurt weer tot 'selffulfilling prophecies' omtrent de aantrekkelijkheid van bepaalde locaties leiden. Gunstige informatie over een buurt, ongeacht de vraag of deze informatie correct is of niet, kan het beeld van een buurt doen kantelen en tot prijsstijgingen leiden.

Appendix Additional results

Table A1 Residential satisfaction in Rotterdam in 2004

			Linear model		Multinominal logit	
			coeff	t-value	coeff	z-statistic
Constant			4.99	43.65		
Household characteristics	Household type	Shared household	-0.46	-3.48	-0.54	-3.70
		Single parent household	-0.38	-5.44	-0.43	-5.24
		Couple with children	-0.24	-4.55	-0.17	-2.93
		Couple without children	-0.46	-3.48	-0.26	-4.11
	Tenant		-0.55	-12.68	-0.67	-12.31
	Age	Between 35 and 44 years	0.23	4.13	0.32	4.64
		Between 45 and 54 years	0.30	4.15	0.42	4.61
		Between 55 and 64 years	0.31	2.41	0.38	2.31
	Education	Higher education	0.18	4.43	0.24	4.74
	Occupation	Pensioner	0.22	1.95	0.26	1.80
	Duration of stay	Between 2 to 5 years	-0.27	-5.32	-0.31	-5.05
		Between 5 to 10 years	-0.27	-4.80	-0.30	-4.48
		Between 10 to 20 years	-0.43	-6.99	-0.50	-6.86
		More than 20 years	-0.53	-7.03	-0.65	-7.14
	House type	Single-family dwelling	0.37	6.80	0.46	6.88
		Apartment without lift	-0.23	-5.06	-0.24	-4.58
Neighbourhood fixed effects			Yes		Yes	
Cut-off points	1 to 2				-3.45	-23.71
	2 to 3				-2.55	-17.89
	3 to 4				-1.81	-12.85
	4 to 5				-0.75	-5.37
	5 to 6				0.41	2.94
	6 to 7				2.38	16.13
R^2			0.24			
Standard error of regression			1,49			
Log Likelihood			-12,970.6		-12,256.9	
N			7,163		7,163	

Table A2 Hedonic house price model for Rotterdam in 2004

		Coefficient	t-value
Constant		10.99	925.20
Number of rooms	Two	0.30	28.86
	Three	0.41	38.18
	Four	0.47	41.92
	Five or more	0.50	41.61
Building period	Between 1945 and 1975	-0.03	-5.43
	Between 1975 and 1990	0.12	22.84
	After 1990	0.16	31.40
House size	Between 50 and 60 m2	0.09	24.02
	Between 60 and 75 m2	0.20	39.44
	Between 75 and 90 m2	0.25	41.46
	More than 90 m2	0.31	29.91
House type	Single-family	0.24	59.36
	Upstairs apartment with lift	0.03	7.84
	Upstairs apartment. no lift	-0.09	-27.33
Maintenance	Middle	0.01	3.02
	High	0.05	10.54
Neighbourhood fixed effects	Yes		
McFadden R^2		0.86	
Standard error of regression		0.103	
Log Likelihood		13,935.4	
N		16,824	

Glossary of terms

Agglomeration benefits	Benefits that households (or firms) derive from close proximity to one another due to economies of scale or network effects
Anchoring	Using the known value of a dwelling or location (or one of its attributes) to value another dwelling or location (or the same dwelling or location)
Anchoring effect	Putting too much weight on a single attribute of the dwelling or neighbourhood during anchoring
Arrival rate of offers	Rate at which new offers become available on the market
Arrival rate of tenants	Rate at which house seekers enter the distribution system for social rented dwellings
Assessment value	Assessed market value of a dwelling
Assessors' bias	Structural overestimation or underestimation of house price in the assessment of its market value
Bargaining surplus	Difference between list price and sales price of a dwelling
Biased information	Incomplete information on a dwelling or neighbourhood that leads to structural overestimation or underestimation of their respective value
Bid	Payment that is offered for a dwelling by a potential buyer or tenant
Complete information	Full knowledge of a dwelling and its neighbourhood and the characteristics of market participants interested in it
Destination choice	Decision to settle at a new location
Directional bias	Preference for moving or searching in one direction as opposed to other directions
Distinction bias	Exaggerating differences between neighbourhoods
Duration of stay	Time spent living in the current dwelling
Endogeneity	Correlation between explanatory variable and error term in a model due to measurement and specification errors, feedback effects, omitted variable bias or spatial autocorrelation
Exchange value	Value of dwelling in an exchange
Exit choice	Decision to leave one's current dwelling
Exit rate	Share of exits as a fraction of the total stock in an area within a fixed period of time
Full or perfect information	Complete information with additional knowledge of other market participants' (current and future) actions
Gentrification	Up-scaling of formerly deprived, usually inner-city neighbourhoods

Heterogeneity	Structural differences in the choice behaviour of market participants, for instance participants living in different areas
House price residual	Portion of house price that can be attributed to the neighbourhood as opposed to the actual dwelling
Housing quality	The quality of the dwelling and its neighbourhood
Incomplete information	Insufficient knowledge of a dwelling or neighbour hood or the characteristics of market participants interested in it
Informational asymmetry	When one party in an exchange has superior information
Isotropic	Equal in all directions
Kriging	A geo-statistical technique in which known values at dispersed locations are connected; used for in stance in elevation maps
'Lemon'	An overvalued dwelling
List price	Price at which a dwelling is advertised
Market area	Area with a similar price for the location, used in the appraisal of house prices
Market rent	Rent on a free housing market
Market value	Approximation of the price of the dwelling if it is not for sale
Mixed equilibrium	Equilibrium in which some sellers and buyers are equally well informed while some buyers are poorly informed
Modifiable areal unit problem	Statistical bias due to poor measurement of the range of an area or of the spatial effects on one of its attributes
Neighbourhood hierarchy	Rank of neighbourhoods in a city based on their re - spective reputations
Neighbourhood quality	Objective quality of attributes in the neighbourhood
Neighbourhood satisfaction	Residents' subjective valuation of the quality of life experience in own neighbourhood
Neighbourhood reputation	Evaluation of social circumstances in an area and its inhabitants by anonymous outsiders to the area
Offer	Payment that is requested for a dwelling by the seller
Omitted variable bias	Bias resulting from missing, causal factors in the model; this leads to compensation through over- or underestimation of other, observed factors in the model
Opportunity costs	Costs associated with not choosing an alternative option
Place-utility	Utility that is derived from the neighbourhood

Pooling equilibrium	Equilibrium in which sellers are better informed than buyers
Pull effect	Attractive force that causes households to settle in a location
Push effect	Repulsive force that causes households to move away from a location
Quality of life	General well-being of households
Red-lining	Restriction on mortgage lending in (usually de prived) areas as opposed to restrictions on lending to individuals
Random effects	Same means but different variances
Regulated rent	Rent set by (semi-)governmental bodies
Residential search	Search for a vacant dwelling
Residential location choice	Decision to stay on one's home (as opposed to the exit choice) or decision to settle in a new home
Residential satisfaction	Residents' subjective valuation of the quality of life experience in their dwelling and neighbourhood
Sales price	Price at which the dwelling is sold
Search costs	Costs associated with information-gathering during residential search
Search space	Bounded area in which residential search takes place
Separating equilibrium	Equilibrium in which all market participants (buyers and sellers) have the same information
Signaling	Using a signal (e.g. price) to change from a pooling equilibrium towards a separating equilibrium
Social network	Social structure made up out of individuals who are tied
Social ties	Interpersonal ties to friends, family, colleagues and acquaintances
Sorting	Process by which households of a specific group cluster together as opposed to mixing
Spatial autocorrelation	Dependency of error terms in a model on error terms of nearby observations
Stock market	Housing market who's prices are defined by the existing stock as opposed to newly constructed stock
Stopping rule	Decision rule when to stop searching for a dwelling
Stigmatisation	Negative bias attributed to an area or the persons living there
Tenure choice	Decision to buy or rent a home
Third-party effect	Letting other people's opinion about oneself or one's place of residence influence one's own behaviour
Transaction costs	Deadweight costs associated with exchange (e.g.

	moving costs or buyers' taxes)
Urban restructuring	Policy-induced up-scaling of neighbourhoods as opposed to 'spontaneous' gentrification
User value	The value of a good to the owner
Vacancy rate	Share of vacant dwellings in the total stock within a fixed period of time
Waiting time	Time spent waiting until a vacant dwelling is available
Willingness to accept	Minimum amount that a seller is willing to receive for a good
Willingness to pay	Maximum amount that a buyer is willing to pay for a good

List of symbols

z	housing consumption in general or in the new home
y	household income
$p(z)$	house price in general or price of the new home
U	utility
$\dot{z}$	current housing consumption
$p(\dot{z})$	price of the current home
u^*	utility on optimal consumption path
$\theta(z,y,p)$	bid function
$\phi(z,y,p)$	offer function
$e(z,y,p)$	expenditure function
$D(z)$	aggregate demand for dwellings
$n(z)$	fraction of households demanding z
N	number of households
$S(z)$	supply of dwellings
hh	household characteristics
HS	housing stock
p^*	pooled house price
c	information cost
r	rent or Pearson's correlation coefficient (defined in the text)
NBH	neighbourhood variables
ρ	discount rate
Φ	demand shift parameter
τ	waiting time for dwelling
NR	net response to offers
γ	arrivals of offers
ψ	arrivals of house-seekers
κ	dispersal rate
d	duration of stay
f	surplus (or shortfall) in bid
Γ	institutional variables
Δ	boundary-fixed effect
$\eta_l\Delta$	neighbourhood-to-boundary fixed effect

List of tables and figures

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Marnix Koopman (1970) was born in Oosterhout and raised in the nearby village of Terheijden. He obtained his Masters degree at the Faculty of Economics and Business of the University of Amsterdam in 2001. He worked as a researcher at the Economic Institute for the Construction industry (EIB) in Amsterdam, before he became a PhD student in the field of strategic housing stock policy and technical management at OTB Research Institute for the Built Environment at Delft University of Technology in 2005. He joined the Netherlands Environmental Assessment Agency as a researcher in 2010.

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