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Sorting based on Urban Heritage and Income: Evidence from the Amsterdam Metropolitan Area

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Sorting based on Urban Heritage and Income: Evidence from the Amsterdam Metropolitan Area

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Sorting based on urban heritage and income: Evidence from the Amsterdam metropolitan area

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Abstract. Urban heritage is often concentrated in conservation areas with a protected status. Previous research argues that urban heritage attracts especially higher educated households who are likely to have higher incomes. The presence of these households may have a further impact on the attractiveness of the neighborhoods concerned, for instance through endogenous amenities like better shops or schools. If this is the case for high income households, conservation areas will have a further impact on the area's attractiveness through the demographic composition of the residential area. In this paper we investigate the interaction between the preference for urban heritage – as an exogenous amenity – and the preference for areas with a high concentration of high income households – as an endogenous amenity. We develop a logit-based sorting model in which different income groups interact and estimate it for the Amsterdam metropolitan area. Results show that all employed households highly value conservation areas and prefer to live in areas with a high concentration of high income households. We investigate the impact of urban heritage on house prices and welfare through counterfactual simulations. The disappearance of urban heritage would result in a substantially more suburbanized location pattern of the high income households in the Amsterdam metropolitan area, and to lower welfare for all income groups.

Key words: Location choice, urban heritage, sorting models, discrete choice, heterogeneous household preferences, welfare analysis

JEL classifications: R2, J1, Z1

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1 Introduction

Urban amenities are closely related to the current urban revival. The decentralization of employment, the improved possibilities for communication and the secular decrease in transport costs have weakened the strength of traditional forces behind the concentration of economic activities. Since the amenities that make a city attractive for consumers, such as shops, theatres and restaurants remain localized 'consumer city' (Glaeser et al., 2001) becomes more important. Moreover, Brueckner et al. (1999) suggest that the presence of urban amenities is an important driver of the location of rich and poor households in an urban area. In their theory, the demand for these amenities is highly income elastic. This implies that the rich will tend to locate in the city center when it is amenity-rich, while they will otherwise prefer the suburbs where land is much cheaper. In their theoretical model, amenities are taken as exogenous as is plausible for historic city centers. Other urban amenities, like shops, restaurants and theatres, are affected by the composition of the population in a neighborhood. Through this route, urban heritage may have a further impact on the attractiveness of neighborhoods. To the extent that this effect is positive, this secondary effect of the exogenous amenities reinforces their primary impact.

The economic literature on heritage has mainly focused on the impact of designation of monuments and conservation areas. See Navrud and Ready (2002), Noonan (2003) for surveys of the early literature. Examples are Coulson and Leichenko (2001), Coulson and Lahr (2005), and more recently Been et al. (2014), Ahlfeldt et al. (2015) and Koster and Rouwendal (2015). Recently there has been an increasing interest on cultural heritage in a wider urban economic context (Van Duijn and Rouwendal (2013), Falck et al. (2015); Sheppard, 2015).

The relative location of high and low income households is an important issue in urban economics (see, for instance Wheaton (1977)). The monocentric model, which is the workhorse of this literature, suggests that ratio of the income elasticity of the demand for housing and that of the value of commuting time is the driving force of the spatial distribution of incomes in urban areas. If the value of time is roughly proportional to the wage (and hence income) and the income elasticity of housing demand is less than 1, as much of the literature suggests, the model predicts that the rich should live in the city center. Since many cities (in the US as well as elsewhere) do not confirm this prediction, other factors must be important. One possibility is the durability of housing which tends to make older housing, which is often overrepresented in the central city, less suitable for high income households.¹ However, old houses are not necessarily inferior. For instance, in many

¹ See Bond and Coulson (1989) for an example of this 'filtering' literature and Rosenthal (2008) and Brueckner and Rosenthal (200.) for a recent contribution.

European cities ancient buildings – the canal houses in Amsterdam are a clear example – are regarded as highly attractive urban heritage and are often inhabited by high income people.² This observation suggests that, under appropriate conditions, old housing may in fact contribute to the concentration of high income households in city centers.

Bayer et al. (2007) have documented for the San Francisco Bay Area that the attractiveness of neighborhoods for specific groups of households is influenced substantially by the presence of particular household groups.³ The pattern they observe confirms the sociological principle of ‘homophily’ – similarity breeds connection (see for instance, McPherson et al., 2001). There are several possible mechanisms behind this phenomenon. One is that households belonging to a particular group like to meet similar households and such interaction is facilitated by physical proximity. Another is that households with similar characteristics like the same type of amenities, such as schools, shops and restaurants with particular characteristics, and that these tend to emerge close to the concentrations of these households through the market or other allocation mechanisms as is suggested by the literature on Tiebout sorting.⁴ The preference of households to live in neighborhoods where similar households are located interacts with the exogenous amenities and may therefore reinforce their impact. In other words, an overrepresentation of high income households in conservation areas will have a further impact on the area’s attractiveness through preferences for demographic composition.

To investigate these issues, we develop and estimate a residential sorting model in which urban heritage – indicated by conservation areas – has a direct impact on the residential choice behavior of households, while we also incorporate preferences for demographic composition similar to Bayer et al. (2007) that may cause an additional impact of this amenity on neighborhood attractiveness for particular groups. Our model is of the ‘horizontal,’ logit-based type (see Kuminoff et al., 2013). This family of sorting models is closely related to the Berry, Levinsohn, and Pakes (1995) (BLP) model which is a workhorse model in industrial organization and was first applied to study residential sorting by Bayer and his co-authors.⁵

An important restriction on the unobserved characteristics of the choice alternatives that, to the best of our knowledge, is imposed in all applications of BLP-type models is that they are evaluated identically by all actors. Since heterogeneity in the evaluation of all observed characteristics is an important issue in this framework, and is generally found to be important in

² Lazrak et al. (2014) find in a hedonic analysis on Dutch data that the prices of houses listed as monuments 15-20% higher than those of otherwise comparable houses.

³ The classical references for these sorting effects are Schelling (1971, 1978).

⁴ See Tiebout (1956) and Epple et al. (1984) for seminal contributions.

⁵ See Bayer, McMillan & Rueben (2004), Bayer & Timmins (2005; 2007), and Bayer & McMillan (2012).

empirical work, this asymmetry is potentially restrictive. Below we generalize the BLP framework to a setup that allows a partial relaxation of this assumption.

We find that households in all income groups attach a large value to urban heritage in their neighborhood, which we measure as the area that is part of a conservation area. The values we find are much larger than those reported in Van Duijn and Rouwendal (2013) who take the much larger municipalities as their spatial units of analysis.⁶ Our results also suggest that all households prefer to live in neighborhoods with a high share of high incomes. Although we don't find large differences in willingness to pay for urban heritage by income, a counterfactual simulation suggests that without urban heritage the location pattern of the high income households would be substantially different from what it is now, with significant concentrations of this group in some suburban locales, a pattern that is reminiscent of location patterns in U.S. metropolitan areas.

This paper unfolds as follows. In Section 2, we discuss the methodology concerning the residential sorting model and the introduction of spatial elements in the model. The data on household and neighborhood characteristics, as well as some descriptive statistics are discussed in Section 3. Section 4 is devoted to the estimation results. The implications of these results are discussed in Section 5. The multiplier effect is investigated in Section 6. Section 7 summarizes and concludes.

2 The location choice model

2.1 The first stage

As indicated in the introduction, our methodology follows BLP who addressed a number of important issues in discrete choice models of market demand. A main innovation of that paper was that the possible presence of unobserved characteristics of the choice alternatives was dealt with explicitly. This clarified an endogeneity issue associated with the price variable that had long plagued the estimation of logit models of market demand. BLP showed that, under appropriate assumptions, the endogeneity could be dealt with by including alternative-specific constants representing the average utility attached to the alternatives in the logit model. These alternative-

⁶ Van Duijn and Rouwendal (2013) also develop a sorting model and estimate it on Dutch data, but there are a number of important differences with the present paper. They apply the model to all municipalities in the Netherlands, whereas we focus on the Amsterdam metropolitan area and use much smaller spatial units. They use survey data whereas the present paper uses administrative data. They do not consider the role of demographic composition, which is arguably less important at the municipal level, whereas this is a main focus of this paper. Moreover, they maintain the assumption that unobserved neighborhood characteristics have the same value for all households.

specific constants include the impact of the unobserved characteristics as well as the endogenous price and they are analyzed further in a second estimation step using methods for linear equations.⁷

We assume that each consumer i ($i=1\dots I$) has preferences over n neighborhoods ($n=1\dots N$). These preferences refer to neighborhood characteristics that are not all observed by the researcher. Two observed characteristics that are of special importance are the neighborhood housing price, p_j , and the share of households belonging to a particular group in the neighborhood population, σ_j . We denote the other observed characteristics as a vector x and unobserved characteristics as a scalar ξ . Moreover we allow for idiosyncratic differences in preferences over alternatives ϵ . Finally, we assume that each consumer belongs to a group g ($g=1\dots G$) and that members of the same group have similar preferences. More specifically, we assume that the coefficients in the utility function referring to the price, the share of the special group and the unobserved neighborhood characteristics are identical for all members of a given group, while we allow the coefficients for the other neighborhood characteristics to be individual-specific. We specify the utility function for household i as:

$$\begin{aligned} u_j^i &= \left[\alpha^{g(i)} \ln p_j + \beta^{g(i)} \sigma_j + \bar{\gamma}^{g(i)} x_j + \xi_j^{g(i)} \right] + \left[(\gamma^i - \bar{\gamma}^{g(i)}) x_j \right] + \epsilon_j^i \\ &= \delta_j^{g(i)} + \varepsilon_j^i + \epsilon_j^i, \end{aligned} \tag{1}$$

where $g(i)$ denotes the group to which household i belongs, and $\delta_j^{g(i)}$ and ε_j^i in the second line are the first and second terms in square brackets, respectively, in the first line.

When $G=1$, our specification of the utility function is the conventional one in which δ_j equals the average utility attached to alternative j in the population and ε_j^i is the deviation of the deterministic part of the utility from the average. The obvious disadvantage of this specification is that it does not allow for heterogeneity in the evaluation of the endogenous variables p_j and σ_j and in the unobserved characteristics ξ_j . Although some researchers include such variables in the deviation from the average ε_j^i , a drawback is that the coefficients of this term have to be estimated in the first step where the endogeneity of these variables cannot be addressed. Opinions on the importance of this issue differ, but it seems desirable to avoid it if possible.

For $G>1$ some heterogeneity in the evaluation of endogenous and unobserved characteristics is allowed: heterogeneity across the groups is possible, but within each group homogeneity is still required. This may be regarded as a modest generalization of the conventional specification, but a potentially important one. For instance, in the setting of this paper it allows us

⁷ See Berry (1995) and BLP for further discussion. In these papers the price of the choice alternatives does not occur in the first (logit) stage of the estimation procedure.

to estimate different coefficients for the housing price and the share of the special group without evoking the concerns about endogeneity that are associated with introducing these variables in the first stage of the estimation procedure.

To estimate the model, we start with estimating G logit models with alternative-specific constants. For each of these models the sum of the estimated probabilities $\pi_j^i, i \in g$ that alternative j will be chosen by consumers in the group, divided by the total number of consumers in the group, B^g , equals the observed share of households in that group choosing alternative j , which we denote as s_j^g ⁸:

$$\frac{\sum_{i:g(i)=h} \pi_j^i}{B^g} = s_j^g, \quad (2)$$

which implies that the contraction mapping technique can be used. It follows also that, for the total population we have that the sum of the estimated probabilities that alternative j will be chosen divided by the total population equal to observed share of the total population that chooses j :

$$\frac{\sum_i \pi_j^i}{B} = \sum_g B^g s_j^g = s_j. \quad (3)$$

This property will be used when computing the instrument for the price in the second stage.

Before moving to a discussion of that stage it is useful to observe that the procedure just proposed requires the presence of enough observations of actors belonging to each of the groups to be able to estimate the model. At the very least, there should be one observation of each group choosing each alternative, but in practice one would like to have more. This is not always an innocuous requirement. For instance, low and high income households may be strongly overrepresented in some parts of urban areas and strongly underrepresented in others. Extreme sorting would therefore invalidate the procedure just outlined. However, apart from this requirement, no additional assumptions seem to be necessary to enable this method to work.

2.2 The second stage

The second stage consists of G linear regressions:

$$\delta_j^g = \alpha^g \ln p_j + \beta^g \sigma_j + \bar{\gamma}^g x_j + \xi_j^g, \quad g = 1 \dots G, \quad (4)$$

where δ_j^g denotes the alternative specific constant for neighborhood j that has been estimated in the logit model referring to group g . The unobserved characteristics as evaluated by the various groups are the error terms in these equations. Since they may be correlated with the price and the share of high income households, these variables have to be instrumented.

⁸ This is a property of maximum likelihood estimation of the logit model as was shown by McFadden (1974).

While BLP instrumented the price with characteristics of competing alternatives, Bayer and his co-authors introduced an alternative approach. Its basic idea is to combine the exogenous information about the choice alternatives and the structure of the sorting model to construct counterfactual prices that are independent of the unobserved heterogeneity and endogenous characteristics of the choice alternatives. Bayer and Timmins (2007) show that a similar procedure can be used when the demographic composition of a neighborhood – which is determined by choices made by the households – affects its attractiveness.

More specific, Bayer, McMillan and Rueben (2004), to which we refer for further discussion, proposed to construct *“an instrument for the housing price by solving for the vector of prices that would clear the market when only exogenous features of houses and neighborhoods are included in the utility function. This instrument captures the portion of housing price variation attributable to the distribution of the exogenous features of houses and neighborhoods throughout the region, summarizing this information in a single variable”* (Bayer, McMillan and Rueben, 2004, p. 19). Below, we follow their approach, and apply it also to the share of high income households. That is, we remove the ξ 's from the expressions of the choice probabilities and compute the prices that would equilibrate the market, using the equilibrium conditions $\sum_i \hat{\pi}_j^i / B = s_j$, where $\hat{\pi}_j^i$ denotes the choice probabilities from which the impact of unobserved neighborhood characteristics has been removed. In these choice probabilities the shares σ_j are still the observed ones. We now replace them by the shares that would be predicted by the choice probabilities $\hat{\pi}_j^i$ at the prices we have just computed. This implies that these prices do no longer reflect a counterfactual equilibrium, so we recomputed them. Then we compute the predicted shares σ_j again, et cetera, until convergence is reached. The computed prices and the associated predicted shares are our instruments. Note that we compute a counterfactual equilibrium for the whole market, not for each group separately. We thus use the same instruments in the second stage regressions for all the groups.⁹

2.3 Other issues

In this subsection we deal with some remaining issues in the specification of our model. One is the specification of the heterogeneity in the evaluation of neighborhood characteristics by households belonging to the same group. A second concerns the possibility that some characteristics may have an impact that transcends the boundaries of the neighborhood in which they are located. And finally we discuss the computation of a welfare measure to compare different equilibria.

⁹ Note that the computation of the instrument requires knowledge of the parameters in (7) and for that reason Bayer, McMillan and Rueben (2004) propose an iterative procedure that we adopt here. See Bayer, McMillan and Rueben (2004), p. 19-20.

We specify the terms $(\gamma^i - \bar{\gamma}^g)$ that reflect the heterogeneity in the valuation of the neighborhood characteristics x as linear functions of the household characteristics z . We use a subscript k for neighborhood characteristics, $k = 1 \dots K$. For households belonging to an arbitrary group g we postulate:

$$(\gamma^i - \bar{\gamma}^g) x_j \quad (= \sum_{k=1}^K (\gamma_k^i - \bar{\gamma}_k^g) x_{j,k}) = \sum_{k=1}^K (\gamma_{k,l}^g \sum_{l=1}^L (z_l^i - \bar{z}_l^g)) x_{j,k}, \quad (5)$$

where z_l^i denotes the value of characteristic l ($l=1 \dots L$) for household i and \bar{z}_l^g the average value of this characteristic in group g . The $\gamma_{k,l}^g$'s are the coefficients to be estimated. This follows the papers by Bayer and his co-authors referenced earlier.

Since our neighborhoods are relatively small, it is probable that their attractiveness is determined in part by amenities in other neighborhoods in the proximity. For instance, having the ancient Amsterdam city center within walking distance may still be experienced as an attractive property of a neighborhood, even though it does not belong itself to that center. We therefore allow for the possibility that some neighborhood characteristics are indicators of amenities in different, but close-by, neighborhoods. More specifically, if amenity k does in neighborhood j affect the well-being of the inhabitants of surrounding neighborhoods as well, we define characteristic k' of a such a neighborhood j' as a distance-weighted average of amenity k in other neighborhoods:

$$x_{j',k'} = \sum_{j \in C_{j'}} e^{-\varphi_{k'} d_{j,j'}} x_{j,k}, \quad (6)$$

where $C_{j'}$ is the set of neighborhoods in the proximity of j' . This 'potential' formulation was also employed by Van Duijn and Rouwendal (2013) who used the much larger municipality as their spatial unit of analysis. Clearly, $x_{j',k'}$ in (6) can be interpreted as a spatial lag of $x_{j,k}$ with exponential weights.^{10,11}

The standard welfare measure associated with discrete choice models is the change in the so-called logsum, the natural logarithm of the denominator of the logit choice probability formula.¹² It is well known that this measure is only exact when utility is linear in income.¹³ In the model used in this paper the housing price plays a crucial role and it is useful to express the welfare consequences of changes in market circumstances (that may result from policy changes) in terms of equivalent changes in the housing price in all areas. However, utility is nonlinear in this price, since it is included after a logarithmic transformation. This implies that the computation of a

¹⁰ We only use the spatial lag for exogenous neighborhood characteristics.

¹¹ The distance decay coefficient, φ , is set at 0.2. The function is therefore exponentially decreasing and weights are going towards zero when distance increases (weight < 0.1 if distance is 5 km). The cutoff point is set at 5km.

¹² Small and Rosen (1981), McFadden (1981).

¹³ See McFadden (1999). There is a close parallel with the Marshallian consumer surplus which is an exact measure of welfare only when utility is quasi linear. Dagsvik and Karlstrom (2005) and De Palma and Kilani (2003) show that compensating variation can be computed by a one-dimensional integral.

compensating change in the housing price is not a straightforward issue. We now show that if we do not use an amount of money, but a relative change in all housing prices as our welfare indicator, computation is still easy. Our starting point is the utility function:

$$u_j^i = \alpha^i \ln p_j^s + \beta^i \sigma_j^s + \gamma^i x_j^s + \xi_j^i + \epsilon_j^i, \quad (7)$$

where the superfix $s = \{0, 1\}$ is introduced to distinguish the situations before and after the change.

The logsum in situation s gives the expected maximum utility of the consumer:

$$\text{logsum}^s = \ln \left(\sum_j e^{\alpha^i \ln p_j^s + \beta^i \sigma_j^s + \gamma^i x_j^s + \xi_j^i} \right). \quad (8)$$

Our welfare measure k is the fraction with which the housing prices in all choice alternatives have to change to make the expected maximum utility in situation 1 equal to that in situation 0. That is, k is defined implicitly by the following equation:

$$\text{logsum}^0 = \ln \left(\sum_j e^{\alpha^i \ln k p_j^1 + \beta^i \sigma_j^1 + \gamma^i x_j^1 + \xi_j^i} \right). \quad (9)$$

This equation can be solved as:

$$k = \exp \left\{ \frac{\text{logsum}^0 - \text{logsum}^1}{\alpha} \right\}. \quad (10)$$

This is the simple logsum measure, although it does now refer to a multiplication factor (or, equivalently, to the associated percentage change in house prices) rather than to an amount of money.

3 Data and descriptive statistics

3.1 Urban conservation areas

We estimate the model for the Amsterdam metropolitan area. The historic city center of Amsterdam and its canal belt are world-famous and have almost completely been listed as World Heritage by UNESCO in 2010. The center has many urban amenities like shops, restaurants, theatres, and has a cosmopolitan atmosphere which is regarded by many as very attractive. It is also a very popular residential area with high house prices. The ancient canal houses are still highly appreciated for residential purposes and only affordable by the rich.

In the Netherlands, the parts of urban areas that are regarded as being exceptionally valuable are listed as national conservation areas¹⁴ by the Netherlands Agency for Cultural Heritage,¹⁵ for their architectural and historic value. Apart from the historic city center several other parts of the Amsterdam metropolitan area have been given the status of a conservation area. The US equivalents of these conservation areas are the historic areas listed on the National Register

¹⁴ In Dutch: *Beschermde stadsgezichten*.

¹⁵ In Dutch *Rijksdienst voor het Cultureel Erfgoed* It is part of the Ministry of Education, Culture and Science.

of Historic Places under the authority of the National Park Service.¹⁶ The UK equivalents of listed buildings – determined on a national level – and conservation areas – designated by lower tier authorities – are listed by the Secretary of State for Culture, Media and Sport and based on the Planning Act 1990.

If the preferences of the households coincide (at least to a substantial extent) with the expert judgments that are behind the listing as conservation areas, one should expect that they are more attractive than non-listed areas. If the households that choose to live there are predominantly rich, they become overrepresented in these areas and if the composition of the neighborhood population is one of its relevant attributes for location choice, this will have a further impact on the housing market equilibrium in the area. Ignoring this effect when it is present may lead to biased estimates of the coefficients of a sorting model as the omitted variable is probably correlated with neighborhood characteristics that are included like urban heritage and house prices. The main purpose of our empirical work is to disentangle the effects of the urban heritage *per se* and that of the related sorting by income.

3.2 The Amsterdam metropolitan area

The study area consists of the municipality of Amsterdam and a number of surrounding municipalities. The spatial unit we use is that of the neighborhood¹⁷ which is considerably smaller than a municipality. On average, around 1800 households live in a single neighborhood. Comparing this to the average of the Netherlands, 630 households per neighborhood, it is clear that our study area focuses on the higher populated (urban) areas. In the study area there are 330 neighborhoods in 13 municipalities. We drop neighborhoods with none or only a few houses. These are mainly agricultural¹⁸ and industrial areas, such as Centrale Markt, Westelijk Havengebied and Bedrijventerrein Sloterdijk. Second, to keep the number of choice alternatives manageable and to focus on Amsterdam we aggregate most neighborhoods outside the Amsterdam municipality to the municipality level. This leaves us with 85 choice alternatives. Figure A.1 in Appendix A shows a map of the resulting areas. Below, we will still refer to these 85 choice alternatives as neighborhoods.

The boundaries of our (aggregated) neighborhoods do not always coincide with those of the conservation areas. We use the size of the area inside the boundaries of a neighborhood that belongs to a conservation area as an indicator of the amount of urban heritage in that

¹⁶ The National Park Service is a government office of the United States Department of the Interior. Note that the criteria of designation to become a conservation area could differ between countries.

¹⁷ In Dutch: *Buurt*. This is an administrative unit which does not only refer to residential areas.

¹⁸ Tight spatial planning in the Netherlands has resulted in the preservation of agricultural areas close to large cities. The 'Green Heart' of the Randstad is the primary example, but also to the north of Amsterdam the polder landscape is protected.

neighborhood. For instance, the historic city center of Amsterdam is large, 679 hectare (6.79 km²),¹⁹ and contains the canals, many gabled houses and numerous other monuments. There are ten neighborhoods that cover a part of it. The one with the largest part of the Amsterdam historic city center is *Nieuwmarkt en Lastage* (1.03 km²).

Figure 3 shows the share of the high income households, defined as the top 25% high income households, per neighborhood in the study area. The left panel refers to all households and it suggests that the rich are underrepresented in the city center. Although this may give the impression that Amsterdam is more similar to American cities than one would have expected, the background is entirely different. Housing policy in the Netherlands has for a long time emphasized the construction of social housing, especially in the large cities. Even in the center of Amsterdam, the share of social housing in the total stock is large, and since this sector is only accessible to low-income households, this has a substantial impact on the share of high income households in our study area.²⁰ It is therefore also of interest to look at the share of high income households in the owner-occupied sector only, and this is what panel b) of Figure 3 does. Now the picture is different, and the share of high income households in some of the central area neighborhoods is higher than the surrounding neighborhoods.

As will be clear from this discussion, the owner-occupied and rental sectors of the Dutch housing market differ much. While the market mechanism determines allocation in the former part, rent control and the associated excess demand and queuing are dominant in the latter.²¹ We will take this difference into account when estimating the sorting model by treating rental and owner-occupied housing in a neighborhood as separate choice alternatives. This implies that the choice set has 170 alternatives: renting or owning in each of the 85 neighborhoods.

¹⁹ The average size of conservation areas in the Netherlands is around 75 hectare (0.75 km²).

²⁰ The social rental sector in Amsterdam covers approximately 50% of the housing stock – compared to the average of 35% in the Netherlands. Rents in the social sector are controlled according to a national system that links maximum possible rents to the number of quality points. The system ignores the typically large differences in house prices that are associated with urban location. As a consequence, houses with similar structural characteristics have similar rents everywhere in the Netherlands, which implies that social housing is especially cheap in the large urban areas like Amsterdam.

²¹ The allocation system for public housing is based on choice-based lettings. The private rental sector in the Netherlands is negligibly small.

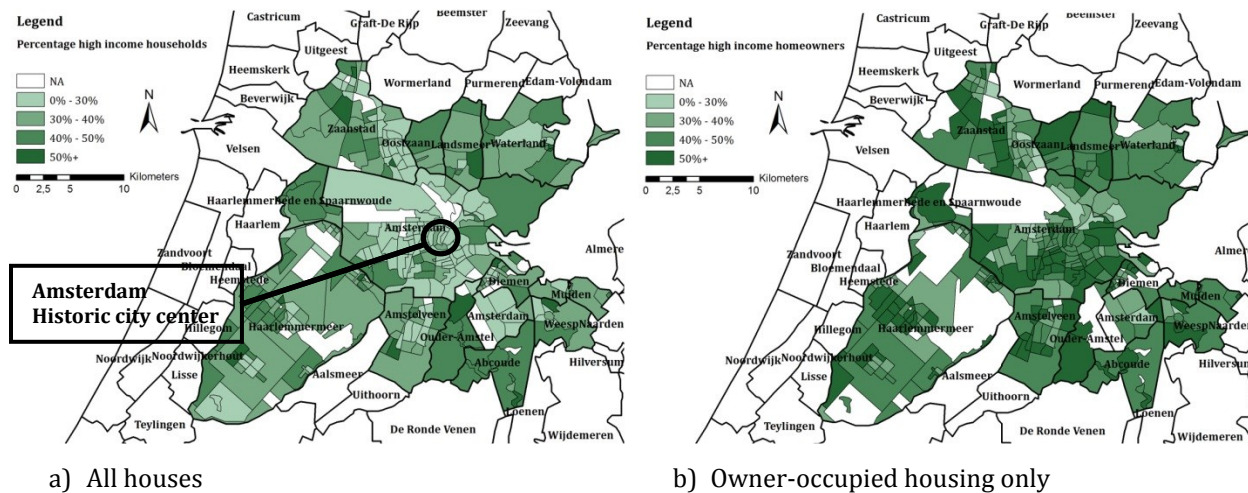


Figure 1. Distribution of high income households and high income homeowners in the Amsterdam area. Note: The figures are based on households within the highest income quartile (top 25%). Source: CBS (2008)

3.3 Data

To estimate the sorting model we need information about households and neighborhoods. Administrative data on households was provided by Statistics Netherlands (CBS). The information refers to 2008 and contains approximately 600,000 households spread over the study area. We select households with at least one employed member and divide this population into three groups of equal size on the basis of income: high, middle and low income. For computational reasons, we take a random sample of these remaining 329,701 households based on the number of observations per choice alternative. For each choice alternative which contains 100 or more of each income group we take a random sample. This leaves us with a sample where we observe a minimum of 30 households from each income group per choice alternative. In total the sample contains 86,663 households, which is 26% of the households' population where at least one member is employed.²²

Table 1 shows an overview of the household and neighborhood characteristics. Household characteristics include income,²³ housing tenure, composition of the household – whether the individuals within the household are a couple and whether the household has children under the age of 18 – age and neighborhood of residence. An important limitation of the CBS data is that they do not contain information about education levels. This is well known to be an important variable as it appears that especially young higher educated people appreciate urban heritage and the associated urban amenities. Although income and education are in general strongly correlated, this

²² This means that we have a choice-based sample. We use weighted maximum likelihood to deal with this characteristic (see Manski and Lerman, 1977). We used this sampling technique a few times to make sure that our results are robust.

²³ Statistics Netherlands provides information on gross primary household income.

is less true for the younger households. Neighborhood characteristics include, apart from the conservation area, the price of a standard house, the share of high income households in the population of the neighborhood, distance to the nearest concentration of 100,000 jobs, distance to the nearest intercity train station, size of nature and water, and the average age of the housing stock. The price of a standard house is a hedonic price index based on transaction data from the Dutch Association of Real Estate Agents (NVM). We construct the index on the basis of a straightforward log-linear hedonic price regression that includes neighborhood dummies. This index gives the price of an owner-occupied house with a given bundle of characteristics. This enables us to compare prices within neighborhoods. The average of these prices is around 230 000 euro.

Table 1. Descriptive statistics household and choice alternative characteristics

Variables	Data source	Mean	SD	Min.	Max.
Household characteristics (N=329701)					
Gross primary household income (in €)	CBS (2008)	66454	57889	-	-
Couples	CBS (2008)	0.53	0.50		
Household with children (-18)	CBS (2008)	0.32	0.47		
Age of head of the household	CBS (2008)	42	11	-	-
Choice alternative characteristics (J=85)					
Conservation areas (km ²)	RCE (2012)	0.0991	0.2428	0	1.029
Percentage high income households (%)	CBS (2008)	32.56	12.35	-	-
Price of standard house (in €)	NVM (2009)	231042	56273	144981	372550
Distance to the nearest concentration of 100,000 jobs (km)	PBL (2005)	5.93	3.06	0.82	14.78
Distance to the nearest IC train station (km)	PBL (2005)	3.39	2.68	0.60	13.02
Nature (km ²)	CBS (2008)	0.94	1.36	0	7.63
Water (km ²)	CBS (2008)	0.68	1.02	0	4.65
Age of the housing stock	BAG (2010)	62	32	5	175

Note: Some values are hidden (-) because of confidentiality. See Figure A.1 of Appendix A for a complete picture of the 85 choice alternatives.

4 Estimation results

This section reports and discusses the results of the two estimation steps of the sorting model for neighborhoods in the Amsterdam area. Because allocation of housing in the rental sector deviates from the market mechanism, we cannot regard the observed choices in this segment of the market as revealing the household's preferences in the same way as this occurs in a market setting. We have therefore estimated separate sets of coefficients for the owner-occupied and rental sectors and will only report estimation results of the former below.²⁴

²⁴ The same procedure was used in Van Duijn and Rouwendal (2013).

4.1 First step estimation results

The first step of our residential sorting model involves the estimation of an MNL model for each of the three income groups. The utility function was discussed above (see Equations 1 and 5) so the utility that household i of group g attaches to alternative j is:

$$u_j^i = \delta_j^g + \sum_{k=1}^K (\gamma_{k,l}^g \sum_{l=1}^L (z_l^i - \bar{z}_l^g)) x_{j,k}. \quad (11)$$

We estimate the alternative-specific constants δ_j^g as well as the coefficients $\gamma_{k,l}^g$ for the cross-products of the demeaned household characteristics and some neighborhood attributes. As discussed before, we do not include the possibly endogenous variables housing price and the share of high income households in the MNL model. Their impact will be absorbed by the δ_j^g 's. Also, separate sets of coefficients were estimated for alternatives referring to rental and owner-occupied housing.

Table 2 reports the estimated coefficients, $\gamma_{k,l}^g$, for the owner-occupied market and the three income groups. Since the household characteristics have a mean zero ($z_l^i - \bar{z}_l^g$), the cross coefficients can be interpreted as deviations from the mean utility of the group. The table shows a relatively large number of significant coefficients, indicating that there is non-negligible heterogeneity in tastes within the three income groups. For instance, results show that high income couples have a lower preference to live within conservation areas than the average high income household. Older high income households seem to have a higher preference to live within conservation areas than the average high income household. For high income households with children the effect is negative but not significantly different from zero. Note that the significant effect of couples on conservation areas disappears for the middle and low income households. This implies that especially high income singles have a positive and significant higher preference to live within conservation areas compared to the average high income household.

Table 2. First step results for homeowners: Deviations from mean indirect utility

Neighborhood characteristics	Household characteristics					
	High income households					
	Couple		With children (-18)		Age	
Conservation areas (km2)	-0.404***	0.090	-0.145	0.091	0.057***	0.004
Conservation areas in surrounding neighborhoods	-0.117***	0.033	-0.060**	0.026	-0.010***	0.001
Distance to the nearest concentration of 100,000 jobs (km)	0.007	0.013	0.075***	0.010	0.005***	4.95E-04
Distance to the nearest intercity station (km)	0.092***	0.017	-0.033***	0.012	-0.002***	0.001
Nature (km2)	-0.023	0.022	0.066***	0.016	0.005***	0.001
Nature in surrounding neighborhoods	-0.062***	0.017	-0.032**	0.014	-0.001*	0.001
Water (km2)	0.125***	0.032	-0.015	0.022	0.004***	0.001
Water in surrounding neighborhoods	0.035*	0.021	-0.001	0.016	0.003***	0.001
Age of the neighborhood	-0.002**	0.001	0.001	0.001	1.43E-04***	4.16E-05
Log-likelihood	-133928					
	Middle income households					
	Couple		With children (-18)		Age	
Conservation areas (km2)	-0.049	0.118	-0.167	0.142	0.055***	0.005
Conservation areas in surrounding neighborhoods	-0.140***	0.035	-0.146***	0.037	8.15E-05	0.001
Distance to the nearest concentration of 100,000 jobs (km)	-0.007	0.013	0.023*	0.014	0.003***	0.001
Distance to the nearest intercity station (km)	0.089***	0.016	0.030*	0.016	0.001	0.001
Nature (km2)	0.000	0.023	0.024	0.024	0.006***	0.001
Nature in surrounding neighborhoods	-0.064***	0.019	-0.040*	0.021	0.003***	0.001
Water (km2)	0.096***	0.031	0.000	0.031	0.004***	0.001
Water in surrounding neighborhoods	0.027	0.020	0.068***	0.021	-0.003***	0.001
Age of the neighborhood	0.002	0.001	-0.003**	0.001	-1.78E-05	5.04E-05
Log-likelihood	-137213					
	Low income households					
	Couple		With children (-18)		Age	
Conservation areas (km2)	-0.069	0.145	-0.271	0.169	0.050***	0.005
Conservation areas in surrounding neighborhoods	-0.134***	0.046	-0.019	0.050	3.37E-04	0.002
Distance to the nearest concentration of 100,000 jobs (km)	0.007	0.018	0.025	0.019	0.001*	0.001
Distance to the nearest intercity station (km)	-0.006	0.022	0.030	0.023	0.003***	0.001
Nature (km2)	-0.019	0.029	0.025	0.032	0.004***	0.001
Nature in surrounding neighborhoods	-0.077***	0.026	0.006	0.029	0.003***	0.001
Water (km2)	0.069*	0.041	0.059	0.044	0.006***	0.002
Water in surrounding neighborhoods	-0.006	0.028	0.004	0.031	-0.003**	0.001
Age of the neighborhood	0.002	0.002	-0.005***	0.002	1.68E-04***	6.02E-05
Log-likelihood	-135997					

Note: Parameter estimates are used to calculate the deviations from the mean indirect utility with all variables normalized to have mean zero. Significance at 90%, 95% and 99% level are, respectively, indicated as *, **, and ***. The first step results for renters can be found in Table B.1 of Appendix B. The regression results based on other specifications can be obtained from the author.

4.2 Second step estimation results

The second step of the residential sorting model consists of three 2SLS estimation based on Equation 4. The dependent variable is the vector of mean indirect utilities for each income group δ_j^g . We deal with endogeneity of the housing price and the share of high income households through instrumental variables as discussed in Section 2.2. The instrument for house prices is computed as the equilibrium housing price that would prevail in the absence of unobserved heterogeneity. The instrument for the concentration of high income households is computed as the equilibrium concentration of high income households that would prevail in the absence of

unobserved heterogeneity after adjusting for the equilibrium housing price (see section 2.2). We test for weak instruments by using a Wald F statistic based on the Kleibergen-Paap rk statistic (Kleibergen and Paap, 2006). We find an F-statistic of 19.2 which informs us that the instruments are not weak.

The results for each income group are reported in Table 3. The coefficients in each group have the same sign. As expected, the price coefficient is negative and strongly significant. The share of high income households and the conservation area both have positive and significant coefficients. All households appear to appreciate living close to high income households. This deviates from the results of Bayer et al. (2007) who found that lower income groups prefer to live in areas with a lower share of high incomes (and hence a larger share of lower incomes). Our results thus do not confirm the homophily hypothesis.

Other neighborhood characteristics are also important for the location choice of households. The positive and significant effect for the spatial lag of the conservation area shows that spatially lagged exogenous variables are important to include in location choice models. This suggests that households do not only enjoy the characteristics from their own neighborhood but also from surrounding neighborhoods. The coefficients for the distance to the nearest concentration of 100,000 jobs and for the distance to the nearest intercity train station show a negative but insignificant effect. This is not too surprising as the Amsterdam area can be regarded as one labor market with good accessibility to public transport. For nature we find the expected positive signs of the estimated coefficients, but they are not significant. For water, we find inconclusive results for the main effect but a negative and highly significant effect for its spatial lag. Both amenities are relatively abundantly present in the suburban areas constructed in the postwar period that are less appreciated and we therefore suspect that these variables pick up the presence of the associated negative amenities.²⁵ The age of the housing stock should be expected to absorb this effect to some extent as well, and has a positive sign, indicating that older neighborhoods are in general more appreciated. This is in contrast to most US city centers where poor families seem to occupy old homes (Rosenthal, 2008).

²⁵ In their hedonic price analysis Rouwendal and Van der Straaten (2008) also found that the green areas in the suburban quarters of Amsterdam to have no impact on house prices.

Table 3. Second step results for homeowners: Decomposition of mean indirect utilities

	High income households		Middle income households		Low income households	
	co	se	co	se	co	se
Standard house price (in ln euros)	-10.021***	2.018	-10.764***	1.906	-10.185***	1.924
High income households (%)	0.116***	0.019	0.086***	0.018	0.075***	0.018
Historic city center (km ²)	1.352**	0.533	1.219**	0.524	1.350**	0.545
Historic city center in surrounding neighborhoods	0.775***	0.212	0.761***	0.202	0.713***	0.199
Distance to the nearest concentration of 100,000 jobs (km)	-0.091	0.056	-0.102*	0.055	-0.079	0.056
Distance to the nearest intercity station (km)	-0.079	0.079	-0.072	0.076	-0.116	0.080
Nature (km ²)	0.131	0.179	0.123	0.172	0.130	0.172
Nature in surrounding neighborhoods	0.152*	0.092	0.126	0.091	0.099	0.092
Water (km ²)	0.024	0.167	-0.002	0.157	0.011	0.159
Water in surrounding neighborhoods	-0.260***	0.094	-0.262***	0.089	-0.242***	0.088
Age of the neighborhood	0.013*	0.008	0.013*	0.008	0.016**	0.008
Constant	117.526***	23.901	128.760***	22.548	122.080***	22.761
Price instrumented	yes		yes		yes	
High income households instrumented	yes		yes		yes	
Observations	85		85		85	
First stage F-statistic	19.2		19.2		19.2	

Note: Significance at 90%, 95% and 99% level are indicated as *, **, and ***, respectively. The regression results of our sensitivity analyses can be obtained from the authors.

Some sensitivity analyses have been done by including and excluding many other variables, such as the number of monuments, age of the housing stock squared, and population density. The results have a negligible effect on the marginal willingness-to-pay figures that will be presented in the following section.

5 Implications

In this section, we consider the implications of our estimation results reported in Section 4. The sorting model allows us to calculate the marginal willingness-to-pay (MWTP) of each type of household that we included in the analysis. These figures give a clear overview of the impact of different neighborhood characteristics on the location choice of heterogeneous households with respect to the price of a standard house. Furthermore, the sorting model also allows us to do a counterfactual analysis. The general equilibrium property, where housing demand has to match the housing supply, enables us to show how prices of a standard house change when we change one of the neighborhood or household characteristics.²⁶ We report changes in the price of a standard house for several areas within the Amsterdam metropolitan area if there were no differences in the availability of conservation areas among all neighborhoods in the Amsterdam area.²⁷

²⁶ Note that our model does only explain relative house prices. We therefore assume that the average house price remains unchanged in counterfactual simulations.

²⁷ Similar interpretations are the change in prices if there would be no conservation areas in the Amsterdam area or if all households would not value conservation areas.

5.1 Marginal willingness-to-pay

The estimation results reported in Section 4 enable us to calculate the MWTP of heterogeneous households for neighborhood characteristics (see Appendix C for technical details). This allows us to compare the MWTP between the income groups and neighborhoods. Column 1 of Table 4 reports the average MWTP of the three income groups. For the high income group the figures represent the MWTP of the average high income household. Columns 2 through 4 report the deviations from the average of each income group for couples, households with children and age.

The mean MWTP – in terms of higher prices for a standard house – for an additional percentage point of high income households in their neighborhood is largest for high income households (€2,666 for a percentage point increase). As we discussed above, we did not allow for differences in the MWTP within the three income groups to prevent endogeneity issues. The differences between the groups that we find are small. Low income households are still willing to pay around €1,700 to live in a neighborhood with a 1% higher share of high income households.

The MWTP of an average high income household for living inside conservation areas is large and significant (€31,183 for an additional km² in conservation area). This implies that the average high income household, that has to pay €31,181 extra for a house in an area with an extra square kilometer of conservation area in their neighborhood, still reaches the same utility as when living in an otherwise equal neighborhood without this amenity.²⁸ The figures for the other income groups are somewhat lower but of the same order of magnitude. The figures are much higher than those reported in Van Duijn and Rouwendal (2013) who used much larger spatial units. Their results refer to living in the municipality Amsterdam instead of another municipality, whereas the results reported here allow us to differentiate between various neighborhoods within the municipality Amsterdam. The results thus show that there is substantial heterogeneity within the municipal boundaries, as seems plausible.

Living not inside but close to conservation areas is also regarded as positive and significant. The mean MWTP is highest for high income households (€9,637). This number can be interpreted as the value attached to an extra square kilometer of conservation area in surrounding neighborhoods – where the distance between adjacent neighborhoods is 1km (the average distance between the cores of neighborhoods in the Amsterdam area is somewhat lower than 1 km) – that the average household is willing to pay in terms of the price for a standard house.

The interpretation of the mean MWTP figures of the other neighborhood characteristics is similar. Deviations from the mean of each group are shown in Columns 2 through 4 of Table 4. Their

²⁸ Note that the *ceteris paribus* condition involved refers also to the random part of the utility function.

interpretation can be clarified as follows: If a household belongs to the high income group, and is a couple with children under 18 while the age of the head of the household is equal to the average in this group, their MWTP for an additional square kilometer of conservation area is €3,963 ($= -1986 + -1977$) lower than the average high income household. This MWTP is around 10% lower than that of the average high income household.

These results show that there is large heterogeneity between different types of households. On average, high income couples seem to prefer areas outside the historic center and further from the intercity station where the housing stock is younger compared to the average high income household. Middle income couples seem only to prefer to live further from the intercity station and in areas with water compared to the average middle income household. Low income couples seem to not differ that much from the average low income households. High income households with young children prefer to live in neighborhoods outside conservation areas with more green, further away from the labor market but close to an intercity station compared to the average high income household. Middle and low income households with young children prefer younger neighborhoods compared to the average household of that group. The age component seems to play a large role as well. Note that we did not include retired households in the sample so the positive deviations from the mean for living in conservation areas is not surprising. Depending to the income group, households where the head of the household is 10 years older than the average, their MWTP for living in conservation areas increases with around €11,000 to €13,000 in terms of house prices (which is around a 35% increase from the mean MWTP). The same positive, but slightly smaller, numbers are found for the presence of nature and water. This suggests that older households who are still working have a higher preference to reside in areas within conservation areas with preferably a lot of green and water compared to younger households.

Some of the effects we find are not monotone in income. Low income households are sometimes more similar to high incomes households than medium income households. This may be related to our lack of information about education that was noted earlier and the attractiveness of Amsterdam for highly educated young people, who often do not (yet) have a high income. More general it may have to do with the attractiveness that a cosmopolitan city like Amsterdam has on specific groups of people who like the special atmosphere of the city although living there does not enable them to reach a particularly high income.

Table 4. Marginal willingness to pay results

High income households	Average household	Deviations from the mean		
		Couple	Household has children (-18)	Age (+10 years)
High income households (+%)	2666 ***			
Historic city center (+km2)	31183 ***	-1986 ***	-1977	13068 ***
Historic city center in surrounding neighborhoods	9637 ***	-310 ***	-440 **	-1231 ***
Distance to the nearest concentration of 100,000 jobs (+km)	-2101	34	1024 ***	1041 ***
Distance to the nearest intercity station (+km)	-1822	453 ***	-453 ***	-515 ***
Nature (+km2)	3029	-114	901 ***	1101 ***
Nature in surrounding neighborhoods	1890 *	-165 ***	-236 **	-152 *
Water (+km2)	555	614 ***	-205	941 ***
Water in surrounding neighborhoods	-3233 ***	93 *	-5	324 ***
Age of the neighborhood (+year)	304 **	-12 **	13	33 ***
Middle income households				
High income households (%)	1837 ***			
Historic city center (km2)	26168 ***	-534	-2511	11843 ***
Historic city center in surrounding neighborhoods	8810 ***	-821 ***	-1182 ***	9
Distance to the nearest concentration of 100,000 jobs (+km)	-2195 *	-73	344 *	543 ***
Distance to the nearest intercity station (km)	-1555	964 ***	453 *	194
Nature (km2)	2633	-3	367	1358 ***
Nature in surrounding neighborhoods	1455	-377 ***	-324 *	397 ***
Water (km2)	-42	1047 ***	-3	836 ***
Water in surrounding neighborhoods	-3032 ***	159	552 ***	-324 ***
Age of the neighborhood (+year)	289 **	21	-44 **	-4
Low income households				
High income households (%)	1705 ***			
Historic city center (km2)	30618 ***	-1064	-4596	11244 ***
Historic city center in surrounding neighborhoods	8718 ***	-1115 ***	-173	41
Distance to the nearest concentration of 100,000 jobs (+km)	-1788	110	432	272 *
Distance to the nearest intercity station (km)	-2630	-87	506	704 ***
Nature (km2)	2958	-296	422	875 ***
Nature in surrounding neighborhoods	1211	-641 ***	58	364 ***
Water (km2)	254	1066 *	998	1413 ***
Water in surrounding neighborhoods	-2959 ***	-53	38	-336 **
Age of the neighborhood (+year)	356 **	33	-83 ***	38 ***

Note: The values are in euros. Significance at 90%, 95% and 99% level are, respectively, indicated as *, **, and ***. The significance levels of Column 2 to 4 (deviations from the mean) are based on the first step estimation procedure of the residential sorting model.

5.2 Impact on house prices

The sorting model suggests that house prices react to changes in amenities. The general equilibrium property of the sorting model allows us to estimate the changes in house prices when the number of neighborhood amenities change. We have carried out a counterfactual simulation in which we compute the price of a standard house that would prevail if there were no differences in the availability of conservation areas in each neighborhood in the Amsterdam area. We set conservation areas at zero in all neighborhoods.²⁹ Evidently, the spatial spillovers of conservation areas will also disappear but all other neighborhood characteristics remain unchanged.

²⁹ Results will not change if we set the variable at any other value, e.g. the average over all neighborhoods. The important thing is that there are no differences in this amenity between the neighborhoods.

We use the following procedure. First, we compute the new price equilibrium while keeping the shares of high income households constant in the demand equations.³⁰ At this price equilibrium the share of high income households will differ from what they were originally. The second step is to adjust these shares and re-compute the price equilibrium. This procedure is continued until the shares of high income households do no longer change. In each step the house prices are scaled so to keep the average housing price equal to its value in the situation where urban heritage was present.³¹

Table 5 reports the results of the simulation where we set the conservation areas at zero in all neighborhoods. For a better overview of the effects we aggregate the choice alternatives to the district³² level for Amsterdam and to the municipal level for the other neighborhoods. Column 1 reports the average price of a standard house – determined by a simple hedonic model with neighborhood fixed effects. Column 2 reports the adjusted price of a standard house after we set the conservation areas at zero in all neighborhoods. This is the counterfactual price that would prevail if there was no urban heritage after the adjustment of the share of high income households. Column 3 reports the difference between Column 1 and 2. As expected, the central areas of Amsterdam become much cheaper, while the price in suburban districts of Amsterdam and the surrounding municipalities increases. The standard house prices in the rich Amsterdam districts which are within or close to the historic city center decrease the most. Note that the district *Amsterdam Stadsdeel Zuid* is outside of the historic city center but, because of the large spatial spillover effects of the historic city center, house prices in this neighborhood will also decrease. The gap between the price of a standard house in Amsterdam and elsewhere decreases. However, the prices in the city center will still be larger than in most other areas in Amsterdam due to the attractive central location close to the Central station and the accessibility to the job market.

³⁰ The price equilibrium computed in this way is unique (see e.g. Rouwendal, 1990).

³¹ The procedure used by Bayer and McMillan (2012) is identical.

³² In Dutch: *Wijk of stadsdeel*. This is an administrative unit which is between the neighborhood and municipal level.

Table 5. Counterfactual simulation: Set the conservation areas at zero in all neighborhoods

Municipalities	Districts	Standardized house price (in €)	Predicted house price (in €)	Difference in prices	High income households (in %)	Predicted high income households (in %)
Abcoude		237154	349149	111995	59.0	80.0
Amstelveen		227539	283357	55818	45.3	48.4
Amsterdam						
	Stadsdeel Centrum	310047	223399	-86648	32.1	24.2
	Stadsdeel Noord	183164	190361	7197	24.7	22.5
	Stadsdeel West	249824	214506	-35318	23.5	18.6
	Stadsdeel Nieuw-West	183086	215425	32339	27.5	28.7
	Stadsdeel Zuid	296512	271588	-24924	37.2	35.1
	Stadsdeel Oost	232712	221535	-11177	29.5	28.8
	Stadsdeel Zuidoost	156902	190791	33889	20.2	19.3
Diemen		192874	226353	33478	39.9	40.2
Haarlemmerliede		195849	253658	57809	47.5	55.1
Haarlemmermeer		188879	262474	73595	46.6	60.1
Landsmeer		206782	310377	103594	52.1	75.2
Muiden		224802	267977	43175	50.1	58.3
Oostzaan		189357	269137	79781	48.6	66.1
Ouder-Amstel		222688	286674	63986	51.4	58.1
Waterland		194735	265102	70367	49.1	66.6
Weesp		204458	217276	12817	36.1	29.3
Zaanstad		156280	199865	43585	37.2	42.6

Note: The predicted house prices, taken into account the general equilibrium property of the sorting framework and the scaling, are reported as a counterfactual simulation that sets all urban heritage to zero.

Columns 4 and 5 of Table 5 report the actual percentage of high income households and the counterfactual percentage of high income households after we set the area of conservation areas at zero in all neighborhoods. For many districts and municipalities the changes in the shares of the high income households hardly changes. However, we find strong increases in the share of high income households in suburban municipalities where the initial share of high income households was already high, such as Abcoude and Landsmeer, and almost no changes in Diemen and Amstelveen, which are closer to the city of Amsterdam. This implies that when urban heritage in the city center disappears, high income households are likely to move to ‘posh’ suburban municipalities. Our simulations thus confirm the impression that urban heritage contributes significantly to keep the rich households – especially those rich workers who are single, older and without young children as can be concluded from the MWTP figures – in the center of the metropolitan area.

5.3 Welfare analysis

The MWTP measures that were reported above give the change in the house price that compensates for a small change in one of the neighborhood characteristics. Although the utility function is linear, these numbers can only be interpreted as an appropriate welfare measure for *small* changes because they do not take into account the possibility that households switch to another alternative. Since households will move if they can avoid part of the welfare loss that would otherwise occur, or increase the welfare gain, an analysis based on marginal willingness to pay conditional on keeping the location unchanged should be expected to give biased results.³³ An important advantage of the logsum welfare measure that we discussed earlier is that it incorporates the possibility of moving to another neighborhood.

Another useful property of the logsum welfare measure is that it also allows one to compare counterfactual situations which are not price equilibria. A main theme of this paper is that the impact of urban heritage interacts with that of preferences for demographic composition, but the comparison of house prices in the previous subsection does not allow us to unravel these two effects. The welfare measure enables us to do so by splitting up the total effect into (1) the effect of the disappearance of urban heritage while the demographic composition of all neighborhoods and house prices remain unchanged, (2) the effect of the change in demographic composition of the neighborhoods after the urban heritage disappears and (3) the effect of the price change that restores equilibrium on the housing market.

Table 6. Welfare analysis of changes in conservation areas

	Total welfare effect	Conservation areas only (1)	Demographic composition (2)	Price change (3)
High income households	0.934	0.924	1.117	0.905
Middle income households	0.913	0.917	1.060	0.939
Low income households	0.869	0.857	1.045	0.971

Note: The values reported are associated with welfare measure k discussed in Section 2.3.

Table 6 shows the total welfare effect of the disappearance of urban heritage in the Amsterdam metropolitan area and the return to a new price equilibrium and the decomposition of this total effect. The figures in the table are the k 's associated with each of the changes for the three income groups. Recall that a value of k lower than 1 implies that the impact of the change itself is negative as the households have to be compensated for it by lower house prices. Column (1) shows that the

³³ See, for instance, De Palma and Kilani (2003) for more discussion.

disappearance of heritage clearly has a negative effect on welfare. The loss in welfare requires a drop in house prices of 6.6% to compensate the high income households, 8.7% to compensate the medium income households and 13.1% to compensate the low income households.³⁴ The disappearance of urban heritage is followed by a change in the demographic composition of the neighborhoods and a change in house prices that cause additional welfare effects. These two changes occur simultaneously, but we can compute their welfare consequences separately. Column (2) shows that the change in demographic composition has a positive welfare impact on all three income groups, as the relevant k 's are larger than 1. The welfare impact of the changing shares of high income households is less easy to interpret. Table 5 shows that the share of high income households decreases modestly in most areas, but increases substantially in a few suburban areas. The sign of the welfare impact is therefore *a priori* ambiguous. It may be noted that the possibility of households to switch residence implies that they can avoid the negative consequence of a lower share of high income households by moving to another area, for instance to one in which the share of high income households has increased. Mobility helps to shift the balance upwards. Column (3) shows that the change in prices has a negative welfare impact on all three income groups. This is easy to understand as the loss of urban heritage implies that a neighborhood becomes less attractive. The reaction of the housing market is that house prices in that neighborhood decrease which counteracts the impact of the loss of urban heritage.³⁵

The total welfare effect of the disappearance of urban heritage that we find is still substantial, even though if we take into account changes in prices and the counteracting impact of the changing shares of high income households. Urban heritage – and its associate (endogenous) amenities – seems to have a large impact on the metropolitan's economic welfare. Note, however, that our computations regard the Amsterdam metropolitan area as a closed region and do not take into account that the disappearance of urban heritage will result in a relative loss of attractiveness of this region in comparison with other part of the Netherlands or other metropolitan regions in Western Europe.

6 Conclusion

In this empirical paper, we use a logit-based sorting model to investigate the impact of urban heritage on demographic composition and house prices in a metropolitan region. Our analysis uses the sorting framework developed by Bayer, McMillan & Rueben (2004) in which the price of a

³⁴ For these computations the average house prices has of course not been restricted to stay constant.

³⁵ Note that housing is only modelled here as a consumption good. Wealth effects of changing house prices are thus not taken into account.

standard house is explained by the housing supply and demand equilibrium. To mitigate the concerns about endogeneity, we extended the sorting model by splitting the population into three groups, based on income, and we estimated different logit models for each of these groups. Within each group we allow for heterogeneous preferences of different households. More important, we allow for differences in the sensitivity for the housing price and the share of high income households between these groups, but not within them.

We find that all households attach a large value to the proximity of urban heritage and that its impact differences in proximity to heritage within the municipality are important. We also find that households attach value to the share of high income households living in a neighborhood. All households prefer to live in neighborhoods with a higher share of rich households, which differs from the pattern found by Bayer et al. (2007). We find that all income groups attach roughly the same value to urban heritage. This does not confirm our a priori expectations, which are partly based on Brueckner et al. (1999), but it unravels new insights in the value of urban heritage.

We use the estimated model to calculate marginal willingness to pay for neighborhood amenities and to compute counterfactual equilibrium prices for the situation in which urban heritage would be absent. Moreover, we calculate a simple welfare measure that can be interpreted as the percentage change in house prices in all neighborhoods that compensates a consumer for a change in utility caused by, for instance, the implementation of a policy change. We find a large willingness to pay for urban heritage that contributes to substantial differences in attractiveness and, as a consequence, in house prices between areas in the Amsterdam metropolitan region. Although we do not confirm Brueckner et al.'s (1999) suggestion that especially high income households are attracted to the urban amenities, our simulations show that the disappearance of urban heritage would lead to a substantially more suburbanized location pattern of the high income households in our study region.

References

- Ahlfeldt, G.M., K. Möller, S. Waights, and N. Wendland (2015): "Game of zones: The political economy of conservation areas", *Working paper*.
- Anas, A., and I. Kim (1996): "General Equilibrium Models of Polycentric Urban Land Use with Endogenous Congestion and Job Agglomeration", *Journal of Urban Economics*, 40, 232-256.
- Bayer, P., F.V. Ferreira, and R. McMillan (2005): "Tiebout Sorting, Social Multipliers and the Demand for School Quality", *NBER Working Paper No. 10871*.
- Bayer, P., F.V. Ferreira, and R. McMillan (2007): "A Unified Framework for Measuring Preferences for Schools and Neighborhoods", *Journal of Political Economy*, 115, 588-638.
- Bayer, P., R. McMillan, and K. Rueben (2004): "An Equilibrium Sorting Model of Sorting in an Urban Housing Market", *NBER Working Paper No. 10865*.
- Bayer, P., and C. Timmins (2005): "On the Equilibrium Properties of Locational Sorting Models", *Journal of Urban Economics*, 57, 462-477.
- Bayer, P., and C. Timmins (2007): "Estimating Equilibrium Models of Sorting across Locations", *The Economic Journal*, 117, 353-374.
- Bayer, P. and R. McMillan (2012) Tiebout sorting and neighborhood stratification. *Journal of Public Economics*, 96, 1129-1143.
- Berry, S. (1994): "Estimating Discrete-Choice Models of Product Differentiation", *The RAND Journal of Economics*, 25, 242-262.
- Berry, S., J. Levinsohn, and A. Pakes (1995): "Automobile Prices in Market Equilibrium", *Econometrica*, 63, 841-890.
- Bond, E.W., and N.E. Coulson (1989): "Externalities, Filtering, and Neighborhood Change", *Journal of Urban Economics*, 26(2), 231-249.
- Brueckner, J.K., and S.S. Rosenthal (2009): "Gentrification and Neighborhood Housing Cycles: Will America's Future Downtowns Be Rich?", *The Review of Economics and Statistics*, 91(4), 725-743.
- Brueckner, J.K., J.F. Thisse, and Y. Zenou (1999): "Why is Central Paris Rich and Downtown Detroit Poor? An Amenity-based Theory", *European Economic Review*, 43, 91-107.
- Chen, Y., and S.S. Rosenthal (2008): "Local Amenities and Life-cycle Migration: Do People Move for Jobs or Fun?" *Journal of Urban Economics*, 64, 519-537.
- Dagsvik, J.K. and Karlström, A. (2005): "Compensating Variation and Hicksian Choice Probabilities in Random Utility Models that are Nonlinear in Income", *Review of Economic Studies*, 72, 57-76.
- De Palma, A. and Kilani, K., (2003): "(Un)conditional Distribution of Compensating Variation in Discrete Choice Models", *Working paper*.
- Epple, D., R. Filimon, and T. Romer (1984): "Equilibrium Among Local Jurisdictions: Towards an Integrated Approach of Voting and Residential Choice", *Journal of Public Economics*, 24, 281-304.
- Epple, D. and G. J. Platt (1998): "Equilibrium and Local Redistribution in an Urban Economy When Households Differ in Both Preferences and Income", *Journal of Urban Economics*, 43, 23-51.
- Epple, D., and H. Sieg (1999): "Estimating Equilibrium Models of Local Jurisdictions", *Journal of Political Economy*, 107, 645-681.

- Falck, O., M. Fritsch, S. Heblich, and A. Otto (2015): "Music in the Air: Estimating the Social Return to Cultural Amenities", *Working paper*.
- Fernandez, R., and R. Rogerson (1996): "Income Distribution, Communities, and the Quality of Public Education", *The Quarterly Journal of Economics*, 111, 135-164.
- Fernandez, R., and R. Rogerson (2003): "Equity and Resources: An Analysis of Education Finance Systems", *Journal of Political Economy*, 111, 858-897.
- Klaiber, H.A., and D.J. Phaneuf (2010): "Valuing Open Space in a Residential Sorting Model of the Twin Cities", *Journal of Environmental Economics and Management*, 60, 57-77.
- Kleibergen, F., and R. Paap (2006): "Generalized reduced rank tests using the singular-value decomposition", *Journal of Econometrics*, 127, 97-126.
- Koster, H.R.A, and J. Rouwendal (2015): "Historic Amenities and Housing Externalities: Evidence from the Netherlands", *Working paper*.
- Lazrak, F., P. Nijkamp, P. Rietveld, and J. Rouwendal (2014): "The Market Value of Cultural Heritage in Urban Areas: An Application of Spatial Hedonic Pricing", *Journal of Geographical Systems*, 16(1), 89-114.
- Manski, C.F. and S.R. Lerman (1977) "The estimation of choice probabilities from choice-based samples" *Econometrica*, 45, 1977-1988.
- McPherson, M., L. Smith-Lovin, and J.M. Cook (2001): "Birds of feather: Homophily in social networks", *Annual Review of Sociology*, 27, 415-444.
- McFadden, D. (1973): "Conditional Logit Analysis of Qualitative Choice Behaviour", in ed. P. Zarembka, *Frontiers of Econometrics*. Academic Press, New York.
- McFadden, D. (1981): "Econometric models of Probabilistic Choice", in eds. C.F.Manski and D. McFadden, *Structural Analysis of Discrete Data with Econometric Applications*. MIT, chapter 5, 198-271.
- McFadden, D. (1999): "Computing Willingness-to-Pay in Random Utility Models", in eds. J. Moore, R. Riezman and J. Melvin, *Trade, Theory and Econometrics: Essays in Honor of John Chipman*, Routledge, 253-274.
- Moretti, E., and D.J. Wilson (2014): "State incentives for innovation, star scientists and jobs: Evidence from biotech", *Journal of Urban Economics*, 79, 20=38.
- Murdock, J. (2006): "Handling Unobserved Site Characteristics in Random Utility Models of Recreation Demand", *Journal of Environmental Economics and Management*, 51, 1-25.
- Nechyba, T.J. (1999): "School Finance Induced Migration and Stratification Patterns: The Impact of Private School Vouchers", *Journal of Public Economic Theory*, 1, 5-50.
- Nechyba, T.J. (2000): "Mobility, Targeting, and Private-School Vouchers", *The American Economic Review*, 90, 130-146.
- Rosenthal, S.S. (2008): "Old homes, externalities, and poor neighborhoods. A model of urban decline and renewal", *Journal of Urban Economics*, 63(3), 816-840.
- Rouwendal, J., and W. Weijschede-van der Straaten (2008): "The Costs and Benefits of Providing Open Space in Cities", *CPB Discussion Paper 98*.
- Schelling, T.C. (1971): "Dynamic Models of Segregation", *Journal of Mathematical Sociology*, 1, 143-186.
- Schelling, T.C. (1978): *Micromotives and Macrobehavior*. New York: Norton.
- Sheppard, S. (2015): "Culture Concentrations", *Working paper*.

Tiebout, C.M. (1956): "A Pure Theory of Local Expenditures", *Journal of Political Economy*, 64, 416-424.

Timmens, C. (2005): "Estimable Equilibrium Models of Locational Sorting and Their Role in Development Economics", *Journal of Economic Geography*, 5, 83-100.

Van Duijn, M., and J. Rouwendal (2013): "Cultural Heritage and the Location Choice of Dutch Households in a Residential Sorting Model", *Journal of Economic Geography*, 13(3), 473-500.

Wheaton, W. (1977) Income and Urban Residence: An Analysis of Consumer Demand for Location. *American Economic Review*, 620-632.

APPENDIX A. OVERVIEW OF THE CHOICE ALTERNATIVES

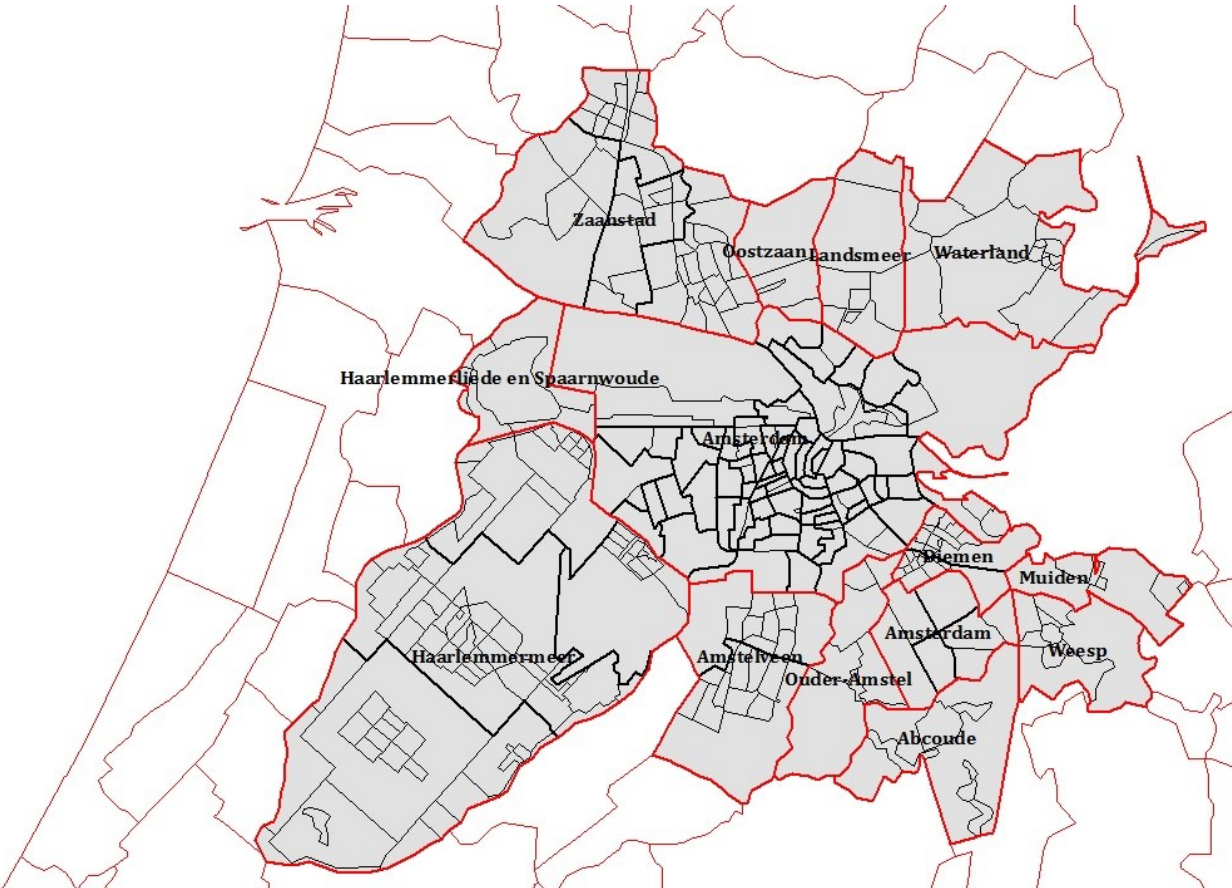


Figure A.1. Amsterdam and surrounding municipalities

Note: The thick red lines show the boundaries of the municipalities within our study area. The thin black lines show the boundaries of the administrative neighborhoods within each municipality. The thick black lines show the boundaries of the combinations of neighborhoods that have been used as choice alternatives within our modelling framework.

APPENDIX B. REGRESSION RESULTS CONTINUED

Table B.1. First step results for renters: Deviations from mean indirect utility

Neighborhood characteristics	Household characteristics					
	High income households					
	Couple		With children (-18)		Age	
Conservation areas (km2)	-0.230*	0.128	-0.141	0.143	0.022***	0.006
Conservation areas in surrounding neighborhoods	-0.168***	0.049	-0.199***	0.046	-0.009***	0.002
Distance to the nearest concentration of 100,000 jobs (km)	-0.019	0.019	0.052***	0.018	0.005***	0.001
Distance to the nearest intercity station (km)	0.008	0.027	-0.046*	0.025	0.000	0.001
Nature (km2)	-0.074**	0.037	-0.007	0.034	0.002	0.001
Nature in surrounding neighborhoods	-0.043*	0.024	-0.098***	0.024	-0.004***	0.001
Water (km2)	0.231***	0.051	-0.123***	0.044	-0.007***	0.002
Water in surrounding neighborhoods	0.044	0.030	0.109***	0.027	0.009***	0.001
Age of the neighborhood	0.003*	0.001	-0.004**	0.002	-8.81E-05	6.34E-05
Log-likelihood	-133928					
	Middle income households					
	Couple		With children (-18)		Age	
Conservation areas (km2)	-0.512***	0.097	-0.733***	0.124	0.012***	0.004
Conservation areas in surrounding neighborhoods	-0.267***	0.032	-0.125***	0.035	-0.001	0.001
Distance to the nearest concentration of 100,000 jobs (km)	-0.045***	0.013	0.020	0.014	0.003***	0.001
Distance to the nearest intercity station (km)	0.005	0.016	-0.055***	0.018	-0.001	0.001
Nature (km2)	-0.080***	0.024	-0.095***	0.027	0.002*	0.001
Nature in surrounding neighborhoods	-0.090***	0.016	-0.109***	0.019	-0.001*	0.001
Water (km2)	0.128***	0.030	0.025	0.033	-0.002*	0.001
Water in surrounding neighborhoods	0.071***	0.019	0.071***	0.020	0.004***	0.001
Age of the neighborhood	0.002*	0.001	-0.010***	0.001	-2.17E-04***	4.69E-05
Log-likelihood	-137213					
	Low income households					
	Couple		With children (-18)		Age	
Conservation areas (km2)	-0.426***	0.081	-0.963***	0.095	0.011***	0.003
Conservation areas in surrounding neighborhoods	-0.128***	0.028	-0.168***	0.029	0.002**	0.001
Distance to the nearest concentration of 100,000 jobs (km)	-0.031***	0.011	0.017	0.011	0.002***	0.000
Distance to the nearest intercity station (km)	0.003	0.014	-0.068***	0.015	0.000	0.001
Nature (km2)	-0.037*	0.020	-0.108***	0.021	-0.003***	0.001
Nature in surrounding neighborhoods	-0.041***	0.014	-0.094***	0.015	-0.001*	0.001
Water (km2)	0.050*	0.026	0.064**	0.027	0.001	0.001
Water in surrounding neighborhoods	0.036**	0.015	0.072***	0.016	0.001	0.001
Age of the neighborhood	0.000	0.001	-0.010***	0.001	-1.79E-04***	3.39E-05
Log-likelihood	-135997					

Note: Parameter estimates are used to calculate the deviations from the mean indirect utility with all variables normalized to have mean zero. Significance at 90%, 95% and 99% level are, respectively, indicated as *, **, and ***. The regression results based on other specifications can be obtained from the author.

APPENDIX C. DERIVATION OF THE MARGINAL WILLINGNESS-TO-PAY

Equation 1 can be rewritten almost as a hedonic price function allowing for heterogeneity in household preferences:

$$p_j^{g(i)} = \left(\frac{\beta^{g(i)}}{\alpha^{g(i)}} \right) \sigma_j + \left(\frac{\bar{\gamma}^{g(i)} + \gamma^i (z^i - \bar{z}^{g(i)})}{\alpha^{g(i)}} \right) x_j + \left(\frac{1}{\alpha^{g(i)}} \right) \xi_j^{g(i)} + \left(\frac{1}{\alpha^{g(i)}} \right) \epsilon_j^i - \left(\frac{1}{\alpha^{g(i)}} \right) u_j^i,$$

where $p_j^{g(i)} = \ln(P_j^{g(i)})$. Using this equation, it is simple to compute the MWTP of each income group g and each type of household i within each group g for each of the neighborhood characteristics x_j :

$$\frac{\delta P_j^{g(i)}}{\delta x_j} = \left(\frac{\bar{\gamma}^{g(i)} + \gamma^i (z^i - \bar{z}^{g(i)})}{\alpha^{g(i)}} \right) P_j^{g(i)}.$$

The household characteristics are constructed to have mean zero, $(z^i - \bar{z}^{g(i)})$. This simplifies the MWTP of the average household within each income group:

$$\frac{\delta P_j^{g(i)}}{\delta x_j} = \left(\frac{\bar{\gamma}^{g(i)}}{\alpha^{g(i)}} \right) P_j^{g(i)}.$$