Enjoy your meal: Restaurants and house prices in Amsterdam

Authors: Jeroen van Haaren[1], Frank van Oort[2], Anna Wildeboer

Work in progress – Please do not cite this version. For questions, concerns or the most recent version of this paper contact the corresponding author: vanhaaren@ese.eur.nl

Abstract

This paper elaborates on the relationship between the presence and quality of local restaurants and house prices. Local house price premiums are derived for the availability, diversity and quality of restaurants in neighborhoods. This paper extends the consumer-city thesis to the micro-level of homes in Amsterdam, the Netherlands. We add to the traditional hedonic house prices models which so far are mostly based on structural housing attributes, physical and social neighborhood characteristics and public amenities. We add a consumption amenity and show that restaurant availability and diversity significantly affect house prices. Furthermore, we find indications that quality moderates the effect of availability, as middle tier quality restaurants drive the availability premium. We use historic instruments on permits and employment to make a case for causality of the effects.

Keywords: Hedonic House price models, consumer city, amenities, GIS

[1] Erasmus Centre for Urban Port and Transport Economics, Erasmus University Rotterdam, vanhaaren@ese.eur.nl
[2] Erasmus School of Economics, Erasmus University Rotterdam & Faculty of Geosciences, Utrecht University

Introduction

Each house is unique: houses are fully differentiated products. No two properties are the same, for the very reason that they are not in the same location (Evans, 2004). Each property offers access to a unique set of environmental characteristics. Given this set of characteristics, we may assume that home owners value these characteristics when buying or selling a property. Therefore, the value of these characteristics may be estimated by those interested in the components of house prices. There is a rich tradition of research on house prices with his objective. Early work includes Kain and Quigley (1970), Witte et al. (1979), Butler (1982), Palmquist (1984). At present the dominant approach uses hedonic price models to decompose the price of composite goods into their individual utility bearing attributes. This work builds on a theory set forth by Rosen (1974) which has been widely applied to the housing market. Each of these attributes is valued by the home owner for the utility that can be derived from consuming the benefits (or experiencing the drawbacks) of that attribute. As such, each of these attributes can be valued positively (or negatively) by the home owner. The attribute is not traded separately in a marketplace, but the valuation of the owner is capitalized into the price of the composite good (Sheppard, 1999). Hedonic models aim to decompose the attributes of the composite good, in this case a house, into implicit prices for each of the attributes. To provide an example, a hedonic model can provide an estimate of the implicit price of an extra square meter of living space, an additional bathroom or proximity to particular amenities. Hedonic models have been used to price a wide variety of attributes, either structural or location attributes (Luttik, 2000). Most recent work focuses on the implicit price of location attributes, such as green space. This follows a tradition of measuring externalities as initiated by Wilkinson (1973) and is linked to a recent debate on the resurgence of cities, as places for production and consumption. A city has production advantages, but increasingly it is recognized, also due to a shift in preferences following increased income levels, that cities offer consumption advantages as well. Cities are considered attractive places to live as they offer advantages in commuting time and offer many tangible and intangible amenities (Bakens, 2016). Glaeser et al.

(2001) identify four critical urban amenities. Three of these amenities have been extensively considered at neighborhood level: accessibility (among others Alonso, 1964; Muth, 1969, Li & Brown, 1980), public services (see for example Cheshire & Sheppard, 1995; Oates, 1969; Kain & Quigley, 1970; Haurin & Brasington, 1996; Gibbons & Machin, 2003 & 2008; Gibbons, 2004) and the physical environment (Luttik, 2000; Irwin, 2002; Geoghegan, 2002; Morancho, 2003; Baranzini & Schaerer, 2011). The fourth urban amenity, consumer amenities, has received considerably less attention at micro level, with some exceptions (see for instance Kuang, 2015 and Bakens, 2016). A city benefits from a rich variety of consumer amenities especially if they offer non-tradable goods and services. Cities benefit as these amenities may directly provide utility as they are considered esthetically pleasing, such as the value attributed to monuments (Lazrak et al, 2011) and old city centers (Storper & Manville, 2006), and also because they allow for face-to-face contact and personal encounters (Storper & Venables, 2004). Recent innovations in big-data availability allow for a much more detailed inclusion of services (Glaeser et al, 2016), allowing for a much more detailed analysis of the role of urban consumption amenities. Challenges remain however, as even very large datasets do fully account for potential omitted variable bias or allow identification of causality in the case of endogeneity.

Restaurants as local amenities

Restaurants are prime examples of highly localized urban amenities: they are eminently local, stimulate local ‘buzz’ and active street life and are hard to transport (Glaeser et al., 2001). Their presence redefines the local context and adds liveliness to the urban fabric which is experienced by residents, visitors and passersby (Clark, 2003). As Schiff (2014) shows, restaurant diversity is directly related to city size and density: larger cities have more to offer. In addition, restaurants are often part of a larger ecosystem of consumer amenities. They are complements to other urban amenities. A restaurant visit is often combined with visits to other urban amenities, for instance dinner after a day spend in the city, dinner before a theater visit, or dinner and drinks in a bar afterwards. As Vermeulen et al. (2011) argue, the viability for one amenity often also implies the viability for others, resulting in clusters of amenities.

Restaurants can be considered good candidates for evaluating the consumer-city hypothesis, because they yield utility directly as centers of consumption and indirectly as facilitators of knowledge exchange and because restaurants are indicators of local clusters of amenities. If we accept that restaurants yield utility, we may expect that this utility is capitalized into house prices. Therefore the local restaurant offer should, in theory, have an implicit price. Therefore, the central research topic of this paper is: *to what degree is the utility of the local restaurant offer capitalized into house prices*? By answering this question we add to the existing literature by further extending the producer-consumer city debate towards the field of housing economics and by attempting to measure the implicit price of one of the potential benefits of a consumer city. In addition, we add to the hedonic house price literature by including a type of amenity which has received relatively modest attention. Furthermore, we include a measure of the (perceived) quality and diversity of this amenity, making a modest contribution to the question how capitalization occurs, e.g. which mechanisms are responsible for the value derived from restaurants.

Assessing the role of restaurants in affecting house prices

We assess the impact of restaurants on house prices by focusing on three separate mechanisms: availability, quality and diversity. Firstly, in order for restaurants to positively affect house prices, the presence of local restaurants is by definition a requirement. Restaurants may offer value, either by facilitating consumption, by increasing liveliness or even through indirect pathways such as identity or image. Regardless, the restaurant should be available to the urban consumer in order for the consumer to derive utility from its presence. Following Tobler's first law, we argue that availability effects are stronger if restaurants are nearer (more proximate). Therefore, we hypothesize that *the availability of proximate restaurants positively affects house prices, c.p.* (hypothesis one).

Secondly, if we proceed in the same vein as earlier work on public amenities (such as work on schools and house prices - see for instance Gibbons & Machin, 2008), we can argue that quality of the amenity also affects home prices. The argument that could be put forth is that higher quality restaurants offer an experience which yields a higher utility from consumption. However, we argue this relationship is more complex. A quality-utility relationship does not mean that the highest quality restaurants necessarily have the strongest effect on house prices. For instance, high quality restaurants may be city-wide amenities for the consumption of which consumers may have a much higher transportation tolerance, thus at local level the capitalization of these amenities may differ very little[3]. Moreover, extending the quality-utility argument, we have to consider that the highest regarded or most expensive restaurants do not necessarily yield the largest total utility for a given budget constraint, as argued by Kuang (2015). Qualitatively lower valued restaurants may very well yield less utility per visit, but can be frequented more often given a particular budget constraint, resulting in a higher total utility if frequency is valued over quality. Therefore the relationship between quality and house price is not necessarily linear or continuous. Therefore we posit that *the quality of restaurants affects house prices, c.p.* (hypothesis two). Thirdly, we argue that choice yield utility, and restaurants offer a unique set of choice due to ethnic and cultural diversity. In the words of Ottaviano and Peri (2006): *"…Italian restaurants, French beauty shops, German breweries, Belgian chocolate stores, Russian ballets, Chinese markets, and Indian tea houses all constitute valuable consumption amenities…"* (p.10.). In our view this translates well to restaurants (see also Bakens, 2016). If we base our argument on the principle of 'love of variety' (and following Schiff, 2014), we argue that *the diversity of local restaurant cuisines positively affects house prices, c.p.* (hypothesis three).

Lastly, we argue that there may be interaction effects between availability, quality and diversity. In particular we highlight two cases: Firstly, an effect of availability may be moderated by quality, as for

[3] Such variation would be expected between cities, as transport tolerances are easily exceeded by inter-city distances.

instance very low quality restaurants may add little to the local environment, but also because the transport tolerance for high quality restaurants reduces capitalization in house prices at local level. Secondly, following our line of reasoning for hypothesis two: A higher frequency of restaurant visits may also result in more variety of consumption for a given budget, and this may be stronger if we consider the potential of consuming a wider selection of cuisines. Frequency may be valued differently at different levels of variety. We explore these potential interaction effects further in the results section.

Data description: Linking restaurants and house prices using geography

We explore the hypotheses above based on a rich dataset from Amsterdam. The data used in this paper is combined from various data sources, which are publicly available or have been made available for the purpose of this study. The starting point for data collection is a set of transaction data from the Netherlands' Cadastre, Land Registry and Mapping Agency for the period January 2013 till June 2016 (n=19.061) for the city of Amsterdam. This transaction data includes transaction price, transaction date and days to sale. In order to smooth outliers, transaction prices are winsorized at 99%. Subsequently, these transaction are matched to the sales advertisement as published on "Funda.nl", which provides details on among others important structural attributes such as property type, size, volume, year of construction, rooms, garage(s), storage, monument status, heating and exterior space[4]. Using geographic information system software, we combine the transaction data with restaurant data by matching transactions and restaurants spatially. The restaurant data is collected from the leading Dutch restaurant platform "Iens.nl". By recording the average review grade, number of reviews, location and cuisine, a rich dataset of 2725 restaurants is created, which covers the restaurant offer in the entire city of Amsterdam as of August 2016[5]. Using python scripting where we loop over all housing transactions and all restaurants, the restaurant data is matched to transactions using both administrative boundaries

[4] These advertisements may suffer from a bias, as dwellings are presented by real estate agents to attract potential buyers. The platform is however managed by the association of real estate brokers, which has a code of professional conduct which requires real estate agents to report accurately. We therefore argue that this potential bias is minimal.

[5] While registration is not mandatory, most restaurants are represented on this platform.

(hierarchical multilevel) and a distance based approach for which we vary the buffer radii. Neighborhood controls are included by matching both 6-digit zip codes (lowest spatial scale) and coordinates[6] of the transaction data to data of the Department for Research, Information and Statistics of the City of Amsterdam. Controls include socio-demographic characteristics, accessibility, schools and crime, land use, esthetic properties and other consumption amenities on 95 neighborhoods in Amsterdam. Lastly, Euclidian distances are calculated from each house to the city center, the nearest heavy rail station and the nearest highway ramp. After combining these data sources we retain 14,440 observations in our dataset.

Indicators: Developing restaurant indicators for different locations

The popular real estate agent mantra of 'location, location, location' may be seen as a universally applicable law in that particular profession, it is not readily modelled. Based on our three hypotheses we develop three restaurant indicators a quantity, quality and diversity measure. Each of these measures has been calculated for various definitions of 'location'. For each area *k* of these location definitions, restaurant measures are calculated. Firstly, we will discuss the restaurant measures, secondly we'll discuss how location has been operationalized.

Our first restaurant measure is the quantity measure, which is a simple count obtained by counting the number of restaurants within each area *k*:

$$(1)\quad R_k = \sum_{i=1}^{N} D_i$$

Our second restaurant measure is the quality measure, which is a simple average of all grades of graded[7] restaurants:

$$(2)\quad G_k = \frac{\sum_i^N D_i * g_i}{\sum_i^N D_i * D_g}$$

[6] ZIP-code matching and coordinate matching showed a 99,9% consistency, exceptions are due to the level of precision of administrative borders.

[7] Some restaurants are registered, but have insufficient reviews (<2) to receive a grade. These restaurants are included in the quantity and diversity measure, but not in the quality measure.

Our third restaurant measure is the diversity measure, which is Herfindahl-Hirschman Index obtained using:

$$(3)\quad HHI_k = \sum_{c=1}^{M} p_{ck}^2$$

where:

$$(4)\quad p_{ck} = \frac{\sum_{i-1}^{N} D_i * D_i^c}{R_k}$$

which is normalized as:

$$(5)\quad HHI_k^* = 1 - \frac{HHI_k - \frac{1}{M}}{1 - \frac{1}{M}}$$

Where:

R_k	=	Number of restaurants in area k		
G_k	=	Average grade of restaurant in area k		
i	=	Restaurant index, i = 1 … N		
D_i	=	Indicator for area match:	1	Restaurant i is located in area k
			0	Restaurant i is not located in area k
g_i	=	Grade of restaurant i (missing is zero)		
D^g_i	=	Indicator for graded restaurant:	1	Restaurant i has a non-missing grade
			0	Restaurant i has a missing grade
D^c_i	=	Indicator for a particular cuisine:	1	Restaurant i offers cuisine c
			0	Restaurant i does not offer cuisine c
C	=	Index of cuisine types, c = 1 … M, and M = 15 types		

We define our areas k in two conceptually distinct ways. Firstly, we model the direct environment of a house by considering a buffer around the house with a particular radius. Secondly, we use administrative borders to define each area. We use these two versions of locations to account for two separate mechanisms which may explain a potential impact of restaurant offer on house prices. The first mechanism is based a line of reasoning in which each house may provide access to a unique, though potentially overlapping, set of restaurants of particular quality and diversity, based for instance on an acceptable travel distance. We will designate this the 'structure' version of our conceptualization. In this 'structure' approach, the restaurant offer is an attribute of the house (hence structure), and the mechanism thus originates at micro-level. Each dwelling is valued for all of its attributes including some implicit price which represents the unique access provided to the local restaurant offer. Our methodology, although developed separately, resembles the approach taken by Sheppard and Udell (2016) who evaluate the effect of AirBnb on home prices.

Secondly, each house may be a member of a construct at a higher spatial scale which provides access to a shared set of restaurants of particular quality and diversity, based for example on administrative borders. In this neighborhood effects approach (see Can, 1990), the restaurant offer is an attribute of the neighborhood which is shared by any number of structures, this mechanism thus originates at an aggregate level. Each dwelling is in this case valued for all of its attributes including the implicit price of being part of a neighborhood with a particular restaurant offer. As the total set of amenities is captured in a named administrative unit, perception may interact with actual conditions. For the purposes of this paper neighborhood indicators are based on the administrative boundaries of 95 neighborhoods in Amsterdam. To account for variations in neighborhood size, neighborhood level data on restaurant accessibility is weighted per thousand inhabitants and per km2 in order to derive an accessibility and density measure.

Both approaches have benefits and drawbacks. The first approach, our structure approach, is highly localized and allows for more variation. Nevertheless, it can be argued that a degree of arbitrariness in setting the buffer radius is unavoidable. The second approach, our neighborhood approach, is much less localized but allows for price formation on various scale levels. It can, however, be argued that the administrative borders are arbitrary and do not represent the 'market' for restaurants. Both approaches suffer from a potential modifiable areal unit problem. That is, the empirical results are dependent upon the chosen, modifiable areal boundaries over which spatial data is collected or aggregated (Openshaw, 1983; Fotheringham & Wong, 1991). We account for this by using multiple radii have been used to define the set of restaurants per transaction. These radii are defined by considering neighborhood size, walking tolerance and pace and city morphology. Firstly, the area of an average neighborhood is 135 hectares, which corresponds to a buffer with a radius of 655 meters. Secondly, considering an average pace of 5 kilometers per hour and a walking tolerance of 10 minutes, the appropriate buffer would have a radius of 833 meters. Thirdly, if we consider the previous in de context of a city grid, and not Euclidian distance, we can follow Arnott and Rowse (2009) suggested correction of $\sqrt{2}$ times the radius, which reduces the radius to 589 meters. These three alternate approaches yield a bandwidth of approximately 500 meters to 800 meters for the buffer radii, with 650 meters as a central point used in the results. 500 and 800 meters are explored in the results section to evaluate whether effects are robust to changing buffer radii. These results are subsequently confronted with the neighborhood effects results, to evaluate whether effects are robust to changing the specification of location.

Identification and Causality

Cities may be our most complex invention yet. As with most complex entities a city is made up of may interacting parts. This make the estimation of causal effects not a trivial challenge. In our case how can we be sure that restaurants capitalize into house price and not the other way around: may restaurants capitalize on more expensive neighborhoods? In the context of a hedonic house price model the estimates of our implicit prices of restaurants will be biased if restaurants do not sort randomly into neighborhoods. For instance, more expensive (and presumably higher quality) restaurants may sort into expensive neighborhoods, while less-expensive restaurants sort into middle income neighborhoods, either through preference or business strategy, or simply through the coordinating role of rent. It is not unrealistic to expect amenities to sort themselves into neighborhoods based on a variety of neighborhood characteristics, such as density, income or lifestyle of local residents. It would be rational for a restaurant owner to locate near a substantial client based, which can be segmented along various dimensions. If such location behavior would be present among restaurant owners, this would bias estimates of the implicit price of restaurant availability due to endogeneity. Additional sorting may occur as specific segments of the population may have a higher preference for status related spending behavior, of which fine dining and expensive houses may be considered large components.

In order to evaluate the causal nature of our three hypotheses, we've developed an identification strategy based on instrumental variables. We base our argument on the availability of restaurants. In order for our restaurant data to have a causal effect on home prices, we need as a minimum to demonstrate a causal relationship between availability and house prices. The existence of such a causal relationship is a prerequisite in order for the quality and diversity indicators to also have causal effects on home prices.

We develop four instruments: Firstly, we use permit data on restaurants. These permits are provided and revoked by the government and can be considered exogenous and non-discriminatory spatially, this would yield a valid instrument as permits are required for restaurant activity, but are not necessarily correlated to home prices[8]. We use permit data for 2002 and 2017, resulting in two instruments. We use 1259 permits for restaurants in the year 2002 as made available by the city of Amsterdam. Of these we were able to geocode 1207. We've used the same strategy as in our 'structure' specification and set the buffer radius to 650 meters. We subsequently instrument restaurant availability by the number of permits provided within the radius in 2002. We subsequently repeat the process with the 2017 permits. These permits originate after the housing transactions, but quite close in time. We are able to geocode

[8] A comparison of the residuals of a benchmark OLS model and our instrument shows no correlation between the instrument (permits) and OLS residuals. In addition, the first stage shows that the instrument is a significant predictor of the instrumented variable. The instrument therefore satisfies the relevancy criterion.

2651 out of 2659 permits allocated for 2017. Employing the same strategy as before, we use the 2017 permits to instrument for restaurants. We argue that this instrument is complementary to the 2002 instrument as it is forward looking, more permits will be allocated in the future in those places where restaurants exist, however future permits should not drive home prices (unless these permits resemble expectations of home owners). Therefore it is reasonable to assume permits are exogenous to home prices under the condition that current prices reflect all available public information, but not expectations on new future amenities.

Secondly, we use data on all companies in Amsterdam from 1996 to extract companies active in the restaurant industry. We've extracted information on all firms and restaurants in particular from the 1996 LISA database, which provides registrations of all firms as well as employment. We use data on employment to instrument for restaurant availability. Employment in the industry is an indicator of the size of restaurant market, and serves as a basis for future restaurant development, which is our third instrument. Subsequently we calculate a location quotient to show specialization in the restaurant industry by 4-digit postal code. We employ this data since the 1996 restaurant specialization may be a valid predictor of future restaurant activity, but not of current home prices. We argue this is a valid instrument[9] as it may function as a foundation for later restaurant activity, but has no direct relationship with home prices[10]. We compare our IV estimates with a benchmark OLS model for ease of comparison. We believe that demonstrating causality using an OLS – IV comparison would support the argument for causal effects in our other specifications as well. We use a GMM IV estimator to obtain a causal estimates of our restaurant availability indicator.

[9] Both the level of spatial aggregation and the indirect link between restaurants and labor market specialization in the restaurant industry, may give rise to concerns on the strength of our instrument. An F-test of our instrument in the first stage shows an F-statistic of 38.64, which is well over the required value of 10.

[10] We've also explored 1996 restaurants and employment as instruments, again using the 650 meter radius. These instruments yield results that are highly similar to the results for permits. Therefore, we do not find these instrument of additional value. In our view the specialization index is a complement to the permit instruments, and is therefore reported.

Models

We estimate five models, which all include a wide set of control variables. These include common structure characteristics (type, construction year, outside space, rooms, height, storage, garage and monument status), quarter-year indicators and seasonality, accessibility controls (distance to the centre, rail and road infrastructure), environmental controls (on the quality of green space, public space and architecture) and neighborhood effects (f.i. income, density, ethnicity and amenities).

We start by estimating a benchmark ordinary least squares model (OLS). This model contains our three restaurant indicators at the structure level, as well as our controls. Subsequently, we estimate a second ordinary least squares model where we decompose our quality variable into counts per quality category (over six quality tiers), to look at the interaction between quality and availability (OLS2). As a next step, we estimate a hierarchical multilevel model with two levels: the structure level and the neighborhood level. We again include our controls, our 'structure' restaurant variables on level 1 and our neighborhood restaurant variables at level two (MLM). Next, we estimate another multilevel model using our decomposed quality categories (MLM2). Finally we estimate an instrumental variables model using GMM to instrument for restaurant availability using our four instruments (IV GMM). We present the results of our analysis in the next section.

Results and discussion

The results in table 1 indicates a consistent positive and significant effect of restaurant availability on house prices. This effect is robust over all specification, although the magnitude of the effect varies. Quality effects are however, heterogeneous between different specifications, potentially indicating a more complex relationship or moderation effect.

Table 1: Results

Model	OLS	OLS2	MLM1	MLM2	IV GMM
Dependent			Square meter price (winsorized)		
Structure level (continuous space / buffer 650m)					
Number of restaurants	**105.991***		**35.576***		**59.007****
(simple count)	(2.30)		(2.07)		(2.99) z
Average grade	-3.741		**-22.843****		-7.152
(simple average)	(-0.29)		(-3.04)		(-1.09) z
Quality counts					
Tier 1 (lowest)		-106.555 f		-20.314 c	
no grade		(-1,57)		(-0.63)	
Tier 2		52.814 f		32.911 c	
< 5.5		(1.16)		(1.13)	
Tier 3		-87.831 f		**-86.422***	
5.5 < 6.5		(-1,14)		(-2.28) c	
Tier 4		81.178 f		-12.885	
6.5 < 7.5		(1.42)		(-0.43) c	
Tier 5		**197.361**** f		**165.388****	
7.5 < 8.5		(3.68)		(5.47)	
Tier 6 (highest)		-41.874 f		**-46.961*** c	
>=8.5		(-1.00)		(-2.27)	
Diversity Index	**103.267****	**92.603****	**33.748***	**37.975****	**99.062****
	(3.98)	(4.50)	(2.57)	(3.50)	(8.78) z
Neighborhood level (administrative borders					
Number of restaurants			**86.935**** n		
(simple count)			(3.09)		
Average grade			**203.432***		
(simple average)			(2.18)		
Quality counts					
Tier 1 (lowest)				-95.358 c	
no grade				(-0.76)	
Tier 2				157.271 c	
< 5.5				(1.24)	
Tier 3				-44.617	
5.5 < 6.5				(-0.56) c	
Tier 4				**231.461****	
6.5 < 7.5				(2.56) c	
Tier 5				119.128	
7.5 < 8.5				(1.64)	
Tier 6 (highest)				.202 c	
>=8.5				(0.00)	
Diversity Index			-149.533	-5.226	
			(-0.99)	(-0.19)	
Controls					
Structure attributes	Yes	Yes	Yes	Yes	Yes
Quarter-Year Dummies	Yes	Yes	Yes	Yes	Yes
Accessibility controls	Yes	Yes	Yes	Yes	Yes
Environmental controls	Yes	Yes	Yes	Yes	Yes
Neighborhood effects	Yes	Yes	Yes	Yes	Yes
Observations (N)	14,440	14,440	13,473	14,440	12,822
Explanaroty power (R2)	0.7586	0.7636			0.7263

* p<0.05; ** p<0.01
f & c = jointly significant at 1%
n = normalized per 1000 inhabitants to account for neighborhood size

By decomposing availability and quality into counts of six specific quality categories, we find that the positive effect of restaurant counts is driven by the middle tier quality restaurants (with the most robust results for tier five at the structure level). Indicating that lower tier restaurants do not yield effects on house prices, while middle tier restaurants yield positive local effects, and top tier restaurants also do not yield effects. The top tier restaurants may serve as city wide or regional amenities, with little differentiation at local level. Based on these results we argue that the availability effect of restaurants is moderated by restaurant quality. Local availability of middle tier restaurants appears to be valued by home owners.

Diversity at the structure level yields a consistently positive, significant effect, while at the neighborhood level no significant effect is found. These effects were evaluated for robustness by applying different buffer radii (500 and 800 meters) and by evaluating two different subsamples (within the ring road and outside the ring road), see table 2. These specifications provide results consistent in sign and significance with our results in table 1. In addition, using a buffer radius of 500 meters increases the magnitude of the diversity effect. This would indicate that a potential positive impact of diversity is highly localized. To return to our hypotheses: Restaurant supply does affect house prices - we find strong evidence in support of our first hypothesis. We also find strong evidence of diversity effects in our ‘structure’ specification, but no evidence of such an effect in the neighborhood effects specification. Therefore, the third hypothesis is rejected in the case of neighborhoods, but may tentatively hold for localized effects. With respect to the quality of restaurants, we find that it is primarily the middle quality tier restaurants that drive the positive effect of restaurant availability on house prices. Therefore, we conclude that our second hypothesis requires modification into a proposition for future research: value for money restaurants increase home prices. This would imply measuring not quality per se, but developing a quality-for-budget measure.

Table 2: Robustness checks, varying buffer radii and relevant subsamples

Results robustness checks for varying buffer radii and subsamples					
Model	MLM1	MLM2	MLM3	MLM4 Subsample within ring-road	MLM5 Subsample outside city center
Dependent	Square meter price (winsorized)				
Structure level (radii)	500 m	650 m	800 m	650 m	650 m
Quality counts					
Tier 1 (lowest) no grade	-5.51	-20.31	6.67	-7.39	-75.01
Tier 2 < 5.5	**-48.13***	32.91	**149.70****	47.82	-15.83
Tier 3 5.5 < 6.5	-35.22	**-86.42***	**-210.75****	**-100.23***	**-104.78***
Tier 4 6.5 < 7.5	19.67	-12.88	-14.39	3.26	11.46
Tier 5 7.5 < 8.5	**76.76****	**165.39****	**148.69****	**131.94****	**210.97****
Tier 6 (highest) >=8.5	0.26	**-46.96***	-16.51	**-47.18***	**-105.95****
Diversity Index	**53.63****	**37.98****	23.90*	**98.73****	**34.05****
Neighborhood level (administrative borders)					
Quality counts					
Tier 1 (lowest) no grade	-86.20	-95.36	-116.80	165.94	-108.57
Tier 2 < 5.5	197.21	157.27	81.59	-116.56	201.47
Tier 3 5.5 < 6.5	-43.60	-44.62	-20.78	-154.49	-169.86
Tier 4 6.5 < 7.5	**210.93***	**231.46****	**240.08****	87.63	**417.63****
Tier 5 7.5 < 8.5	136.97	119.13	**145.72***	**202.09****	**445.01****
Tier 6 (highest) >=8.5	-17.56	0.20	-17.74	-42.97	-139.81
Diversity Index	-6.85	-5.23	-1.47	91.64	-11.53
Controls					
Structure attributes	Yes	Yes	Yes	Yes	Yes
Quarter-Year Dummies	Yes	Yes	Yes	Yes	Yes
Accessibility controls	Yes	Yes	Yes	Yes	Yes
Environmental controls	Yes	Yes	Yes	Yes	Yes
Neighborhood effects	Yes	Yes	Yes	Yes	Yes
Observations (N)	14,440	14,440	14,440	10,174	12,760

* p<0.05; ** p<0.01

The results of our instrumental variable model indicate that restaurant availability does affect house prices through a causal process. However, if we compare the results to those from a comparable ordinary least squares specification, the magnitude of the effect of restaurant availability is more modest (roughly half), suggesting a substantial degree of upward bias due to reverse causality. Nevertheless, the sign is similar and the magnitude is still significantly different from zero, supporting the argument of a (residual) causal effect of restaurants on house prices.

Conclusion

We find that restaurant availability has a causal effect on home prices, which is positive but modest. We use two conceptualizations of location to show this effect: neighborhood effects and a structure based measure. We find that quality effects are complex, but show that the price effects of restaurants on homes are mainly driven by 'middle tier' quality restaurant availability. Furthermore, we find that diversity matters for these price effects, but only on the local level.

Our analysis does however have its limitations. Firstly, we employ a cross-sectional analysis. We have not been able to extend our analysis towards a longitudinal model due to data discontinuity. We believe that restaurant location dynamics in a longitudinal model would allow for a much more detailed analysis of the causal effects of restaurants on home prices. Secondly, we've attempted to establish causality using the available instruments, although we believe these instruments to be valid and have argued accordingly, we also realize there is no empirical test to evaluate their validity. Thirdly, we've used an instrumental variables approach which we benchmarked using OLS. We believe our analysis would benefit from developing a multilevel-IV specification. Finally, we've evaluated the city of Amsterdam, arguably an interesting, although somewhat special case in the Dutch housing market. We view our paper as work in progress and represents some initial steps towards measuring the effect of localized amenities on home prices.

References

Alonso, W. (1964) *Location and land use: Toward a general theory of land rent,* Cambridge, MA: Harvard University Press.

Arnott, R., & Rowse, J. (2009) Downtown parking in auto city, *Regional Science and Urban Economics*, 39:1, pp. 1-14.

Bakens (2016) *Economic impacts of immigrants and ethnic diversity on cities*, Doctoral Thesis VU, available on http://hdl.handle.net/1871/54569.

Baranzini, A., & Schaerer, C. (2011) A sight for sore eyes: Assessing the value of view and land use in the housing market*, Journal of Housing Economics*, 20:3, pp. 191-199.

Butler, R.V. (1980) Cross-sectional variation in the hedonic relationship for urban housing markets, *Journal of Regional Science,* 20:4, pp. 439-453.

Can, A. (1990) The measurement of neighborhood dynamics in urban house prices, *Economic Geography*, 66:3, pp. 254-272.

Cheshire, P., & Sheppard, S. (1995) On the Price of Land and the Value of Amenities, *Economica,* 62:246, pp. 247-267.

Cheshire, P., & Sheppard, S. (2004) Capitalising the value of free schools: the impact of supply characteristics and uncertainty, *The Economic Journal*, 114:499, pp. 397-424.

Clark, T. N. (2003) Urban amenities: lakes, opera, and juice bars: do they drive development? In: Clark (ed.) *The city as an entertainment machine*, pp. 103-140, Bingley: Emerald.

Evans, A. (2004) *Economics, Real Estate & the Supply of Land*, Oxford: Blackwell Publishing.

Fotheringham, A.S. & Wong, D.W.S. (1991) The modifiable areal unit problem in multivariate statistical analysis, *Environment and planning A*, 23:7, pp. 1025-1044.

Geoghegan, J. (2002) The value of open spaces in residential land use, *Land use policy*, 19:1, pp. 91-98.

Gibbons, S. (2004) The costs of urban property crime, *The Economic Journal*, 114:499, pp. 441-463.

Gibbons, S., & Machin, S. (2003) Valuing English primary schools, *Journal of Urban Economics*, 53:2, pp. 197-219.

Gibbons, S., & Machin, S. (2008) Valuing school quality, better transport, and lower crime: evidence from house prices, *Oxford Review of Economic Policy*, 24:1, pp. 99-119.

Glaeser, E. L., Kolko, J., & Saiz, A. (2001) Consumer city, *Journal of Economic Geography*, 1:1, pp. 27-50.

Glaeser, E.L., Kominers, S.D., Luca, M. & Naik, N. (2016) Big data and big cities: The promises and limitations of improved measures of urban life, *Economic Inquiry*, July 2016, pp. 1-24.

Haurin, D. R., & Brasington, D. (1996) School quality and real house prices: Inter-and intrametropolitan effects, *Journal of Housing Economics*, 5:4, pp. 351-368.

Irwin, E.G. (2002) The effects of open space on residential property values, *Land Economics*, 78:4, pp. 465-480.

Kain, J. F., & Quigley, J. M. (1970) Measuring the value of housing quality, *Journal of the American statistical association*, 65:330, pp. 532-548.

Kuang, C. (2015) Does Quality Matter in Local Consumption Amenities? An Empirical Investigation with Yelp, Available at http://dx.doi.org/10.2139/ssrn.2606775.

Lazrak, F., Nijkamp, P., Rietveld, P., & Rouwendal, J. (2014) The market value of cultural heritage: An application of spatial hedonic pricing, *Journal of Geographic Systems*, 16:1, pp. 89-114.

Li, M. M., & Brown, H. J. (1980) Micro-neighborhood externalities and hedonic housing prices, *Land economics*, 56:2, pp. 125-141.

Luttik, J. (2000) The value of trees, water and open space as reflected by house prices in the Netherlands, *Landscape and urban planning*, 48:3, pp. 161-167.

Morancho, A. B. (2003) A hedonic valuation of urban green areas, *Landscape and urban planning*, 66:1, pp. 35-41.

Muth, R. F. (1969) *Cities and housing*. Chicago, IL: University of Chicago Press.

Oates, W. E. (1969) The effects of property taxes and local public spending on property values: An empirical study of tax capitalization and the Tiebout hypothesis, *Journal of political economy*, 77:6, pp. 957-971.

Openshaw, S. (1984) Ecological fallacies and the analysis of areal census data, *Environment and Planning A*, 16:1, pp. 17-31.

Ottaviano, G.I.P., & Peri, G. (2006) The economic value of cultural diversity: evidence from US cities, *Journal of Economic Geography*, 6:1, pp. 9-44.

Palmquist, R. (1984) Estimating the demand for the characteristics of housing, *The review of Economics and Statistics*, 66:3, pp. 394-404.

Rosen, S. (1974) Hedonic prices and Implicit Markets: Product Differentiation in Pure Competition, *Journal of Political Economy*, 82:1, 34-55.

Schiff, N. (2015) Cities and product variety: evidence from restaurants, *Journal of Economic Geography*, 15:6, pp. 1085-1123.

Sheppard, S. (1999) Hedonic Analysis of Housing Markets, In: Cheshire, P. & Mills, E.S. (eds.) *Handbook of Regional and Urban Economics*, volume 3, pp. 1595-1635.

Sheppard, S. and Udell, A. (2016) Do Airbnb properties affect house prices? Working Paper, available on http://web.williams.edu/Economics/wp/SheppardUdellAirbnbAffectHousePrices.pdf.

Storper, M., & Manville, M. (2006) Behavior, preferences and cities: Urban theory and urban resurgence, *Urban studies*, 43:8, pp. 1247-1274.

Storper, M., & Venables, A. J. (2004) Buzz: face-to-face contact and the urban economy, *Journal of economic geography*, 4:4, pp. 351-370.

Vermeulen, W., de Groot, H. L. F., Marlet, G. A., & Teulings, C. N. (2011) Steden, grondprijzen en de lokale overheid. In: J.H. Garretsen, R. Jong-a-Pin and E. Sterken (eds) *De economische toekomst van Nederland*, pp. 233-253, Den Haag: Sdu uitgevers.

Wilkinson, R.K. (1973) House prices and the measurement of externalities, *The Economic Journal*, 83:329, pp. 72-86.

Witte, A.D., Sumka, H.J. and Erekson, H. (1979) An Estimate of a Structural Hedonic Price Model of the Housing Market: An Application of Rosen's Theory of Implicit Markets, *Econometrica*, 47:5, pp. 1151-1173.