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Influence of Job Accessibility on Housing Market Processes: Study of Spatial Stationarity in the Buffalo and Seattle Metropolitan Areas

Sungsoon Hwang, *DePaul University*
Jean-Claude Thill, *University of North Carolina at Charlotte*

Chapter 19
Influence of Job Accessibility on Housing Market Processes: Study of Spatial Stationarity in the Buffalo and Seattle Metropolitan Areas

Sungsoon Hwang and Jean-Claude Thill

Abstract The impact of job accessibility on housing prices is examined in the Buffalo and Seattle metropolitan areas using a hedonic regression modeling framework. Global hedonic regression results show that job accessibility is positively associated with housing prices in the two study areas. Local hedonic regression modeling is also conducted to test whether the response of the housing market to job accessibility is spatially stationary. The statistical analysis reveals that the role of job accessibility in the house price-setting process varies locally in each metropolitan area. Empirical challenges with unraveling relationship between transportation and land use, and the policy implications of our findings, are discussed.

Keywords Job accessibility · Housing market · Geographically weighted regression · Land use/transportation interaction

19.1 Introduction

It is widely held that land use (activities) and transportation (linkage and movement) are intimately related (Pickrell 1999; Giuliano 1989; Cervero and Landis 1995; Newman and Kenworthy 1996). Many urban and regional policy measures are grounded in the land use/transportation linkage. For example, large-scale transportation investments such as interstate highways in United States (Rephann and Isserman 1994; Chandra and Thompson 2000) and high-speed rail in Japan (Nakamura and Ueda 1989) usually generate multiplier effects in economic activities through space-time convergence brought about by enhanced accessibility (Rietveld and Bruinsma 1998). Similarly, real estate development such as business parks, retail and recreational complexes generates new focal points for enhanced traffic flows and contributes to changes

S. Hwang (✉)
Department of Geography, DePaul University, Chicago, IL 60614, USA
e-mail: hwang.sungsoon@gmail.com

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in regional characteristics in the long term (Forkenbrock and Foster 1996; Banister and Berechman 2001).

Not all of these policy measures achieve their intended outcomes. The manner in which land use interacts with transportation is indeed heavily context-dependent. Multiple-path-dependent factors such as economic conditions and local land use/transportation policy influence the complex inner-workings of the land use/transportation relationship. Therefore, it is necessary to further examine how the land use/transportation relationship is uniquely manifested within the confines of local geographic contexts to ensure that pertinent policy measures are effective.

Gradual shifts in public opinion in developed countries support the need for research on the land use/transportation interaction and for integrating land use policy with transportation policy. In recent decades, the legislative landscape (e.g., Clean Air Act, ISTEA, TEA-21) and public sentiment have coalesced in support of an agenda centered on environmental concerns and inequity issues. Open space and agricultural land has been developed to the point that the future water consumption is at risk, while increasing automobile dependence is seen as steering society away from more environmentally sound and equitable practices (Ewing 1997; Kenworthy et al. 1999).

Land use and transportation policies evidently have a role to play in changing the course toward sustainability. Within this vein, policy measures such as transit oriented development (TOD) and smart growth have been implemented as a means to reduce automobile dependence and prevent further environmental degradation (Pickrell 1998; Porter 1998). It is important to note that these policy measures are based on the premise that urban form (e.g., density, land use mix, design) influences travel behavior. Not surprisingly, there was a surge of interest in the effects of urban form on travel behavior as documented in Boarnet and Crane (2001). Despite abundance of research, a conundrum surrounding the validity of this kind of research persists; measuring urban form pertinent to problems at hand admittedly remains a challenging task due to its complex dimension and scale factor (Krizek 2003).

In contrast to abundant research on the impact of land use on transportation, there is a relative lack of research on the effects of transportation on land use. Transportation improvement increases mobility (i.e., overall travel time is reduced), and as a result affected sites become more accessible. Accessibility influences location decision by firm and household in the long term (i.e., firms want to reduce transportation cost, households want to save on commuting, firms want to be located near a qualified labor pool). That is, a change in accessibility leads to land use change, and land use change reshapes accessibility reversely (Giuliano 2004). The concept of accessibility provides the key to understanding the link between transportation and land use.

This study examines how job accessibility influences residential land use at the neighborhood scale in the two metropolitan areas of Buffalo and Seattle. That is, in what manner and to what extent do job accessibility considerations matter in residential location choice? The hypothesis is that the demand for job accessibility in a metropolitan housing market is not spatially invariant within and across the metropolitan area. Geographically weighted regression (Fotheringham et al. 2002) is of a practical value in exploring how demand for job accessibility varies within and across a metropolitan area. This statistical modeling approach differs from global ordinary least squares (OLS) regression where coefficients are not allowed to vary spatially.

The rest of this chapter will be organized as follows. Section 19.2 discusses the literature on the effect of job accessibility on housing prices in terms of research strategy, and reviews empirical challenges with a particular emphasis on geographic aspects. Section 19.3 describes the methodology, including the formulation of job accessibility measures, the hedonic model, and the geographically weighted regression of housing prices. Section 19.4 reports on the results of the statistical analysis. Section 19.5 discusses the implications and limitations of the study.

19.2 Literature Review

19.2.1 Research Strategies

Studies that have examined the role of job accessibility in shaping urban housing markets have followed one of three research strategies. One strand of research looks at how increase in accessibility arising from new transportation investment is capitalized into housing price over time. It is usually conducted by regressing the change in housing prices on the change in accessibility resulting from transportation improvements, while controlling for other factors. It allows the analyst to examine how housing market adjusts to change in accessibility. Empirical findings are mixed (Huang 1996; Ryan 1999; Gibbons and Machin 2008). Scale and timing of transportation investment, local economic conditions, and land use policy are found to influence how land and housing markets respond to increase in accessibility.

In a second group of studies, the relationship between housing prices and components of housing services (including job accessibility) is examined using so-called hedonic price models. The theoretical underpinnings of hedonic modeling are that the value of consumer goods (housing service in this case) is composed of a bundle of composite attributes (Lancaster 1971). Hedonic modeling attempts to estimate how the bundling of housing-related attributes is reflected in housing prices. Structural characteristics of housing units and locational characteristics of the neighborhood of each housing unit usually constitute the dimensionality of the housing service. The modeling is operationalized by a multiple regression model where housing price is the dependent variable and multiple housing-related attributes constitute independent variables. The regression coefficients of job accessibility measures serve to estimate the implicit price of job accessibility or housing price (dis)premium attached to job accessibility. Hedonic modeling establishes how demand for job accessibility comes into play in housing market processes. The present study contributes to this line of research.

A third body of research has looked at the relative importance of accessibility in residential location decisions. Decision makers choose alternatives (residential locations in this case) by maximizing utilities derived from multiple attributes that characterize the alternative in their choice set; varying influence of these attributes (including job accessibility) on housing choice is estimated by multinomial logit models and other discrete choice models (McFadden 1978). A number of empirical studies have found that accessibility is of less significance to residential location decision than other factors such as housing and neighborhood characteristics (Molin and Timmermans 2003), but many others rank job accessibility among the most significant residential choice factors (Quigley 1985; Thill and Van de Vyvere 1989). In addition, household structure is an important determinant of the magnitude of job accessibility considerations in residential location decisions (Waddell 1996).

19.2.2 Empirical Challenges

This section reviews empirical challenges and evidences provided by studies that employ cross-sectional hedonic modeling (the second research strategy mentioned above). We focus on challenges of dealing with locational variables, and make recommendations for handling them.

First, it is notable that statistical results are often inconsistent depending on the specification of the job accessibility measure. The formulation of aggregate job accessibility measures ranges from a simple count of job opportunities within a certain distance of a reference location, to gravity-based forms. Gravity-based measures of accessibility are considered more accurate due to the continuous distance decay function, which is consistent with principles of spatial interaction (Roy and Thill 2004). Yet, gravity-based measures of accessibility can be specified in a number of ways, which may exhibit close collinearity (Kwan 1998; Thill and Kim 2005). Gravity-based cumulative opportunities access measures were found to be most helpful in predicting residential location according to Issam et al. (2002). Results are also inconsistent depending on whether measures are based on travel time or travel distance to job locations. In her survey paper, Ryan (1999) indicates that house price in US metropolitan areas is negatively associated with accessibility when measured on travel time, but is found to be otherwise when measured on travel distance. It is, however, unclear whether multicollinearity problems (i.e., accessibility is highly correlated with other explanatory variables) are explicitly treated in the studies reviewed. Also, the relationship may not be generalizable given the limited number of study areas. In principle, travel time-based accessibility should more accurately reflect what accessibility implies than travel distance-based measures given that commuters and other travelers are first and foremost responsive to travel time rather than to travel distance as travel time is tallied up against their time budget (Golledge and Stimson 1997). Accessibility to different types of activities (e.g., shopping, educational, recreational, and employment) is shown to have different impacts on property values, and employment accessibility positively contributes to property values in Seattle according to Franklin and Waddell (2003).

Second, research shows that including precisely measured locational variables in the hedonic model of house prices improves the performance of the model. The measurement of locational variables has become easier as geographic information systems (GIS) are increasingly used in real estate analysis (Anselin 1998). To some extent, this can mitigate biases related to omitted variables, a common occurrence in hedonic modeling. It is, however, not devoid of problems either; spatial autocorrelation can bias the model estimates as the assumption of independence among observations is violated. Moreover, more often than not, locational variables are highly correlated with other variables. Diagnostics for spatial autocorrelation (Anselin et al. 2006) and factor analysis may be useful in this regard, respectively. Once multicollinearity and spatial autocorrelation are treated statistically, it is found that house price premiums are attached to highly accessible sites in the Quebec urban community, Canada (des Rosiers et al. 2000). In Charlotte, NC, Munroe (2007) found housing value to decrease significantly with distance to the central business district (CBD) and to major employers, and to decrease in proximity of brownfield sites, whereas parks and greenways had no conclusive effect on real estate prices. Both travel time to the CBD (as a proxy of urban attraction or centrality) and gravity-based job accessibility contribute significantly to explaining spatial variation of housing prices in the southern Norwegian region (Osland and Thorsen 2008).

Third, more and more studies find that the impact of job accessibility on housing prices is not constant over the study area. Adair et al. (2000) show that job accessibility has a minimal impact on housing prices in the whole study area, but it exerts varying influence across sub-regions in the Belfast urban area (UK). It is likely that preference for employment accessibility is outweighed by the preference for large space (Alonso 1964), public service (Tiebout 1956), or amenities (Rosen 1974) in areas where job accessibility is negatively associated with housing prices. This suggests that the demand function of different attributes that compose housing quality is spatially disaggregated and non-stationary within a metropolitan area (Straszheim 1975; Maclennan et al. 1987).

In summary, the literature review suggests that research findings may be sensitive to the formulation of job accessibility measures, to the treatment of spatial autocorrelation and multicollinearity, and to the geographic scale of analysis (the so-called modifiable areal unit problem). In this study, factor analysis is employed to correct for multicollinearity among housing price factors, and a geographically weighted regression is used to deal with spatial autocorrelation and spatial non-stationarity of the relationship between job accessibility and housing prices. We now describe the methodology designed to address the empirical challenges identified here.

19.3 Methodology

The research methodology consists of three steps. First, we compute travel time-based job accessibility measures at the level of census tracts in two U.S. metropolitan areas of Buffalo and Seattle. Second, explanatory variables expected to influence housing value are transformed to underlying dimensions that are independent of each other by factor analysis. Third, factor scores including the job accessibility dimension are entered into the multiple regression model of hedonic house prices. This allows us to determine the magnitude of the effect of job accessibility on housing prices, which is assumed to be constant over the study area. Most importantly, we estimate local coefficients of job accessibility fitted to a geographically weighted regression model. The mapping of local coefficients permits us to examine the spatial variation of the demand for job accessibility at the neighborhood scale in the Buffalo and Seattle metropolitan areas.

19.3.1 Job Accessibility Measures

The job accessibility measure is calculated according to Hansen (1959)'s formulation as follows:

$$A_i = \sum_j O_j \exp(-\beta C_{ij}) \tag{19.1}$$

where A_i is job accessibility of residential origin i, O_j is an attractiveness measure of potential commute destination j, C_{ij} is a measure of spatial separation, and $f(C_{ij})$ is the function of spatial friction. In this study, the total number of workers employed in destination j is used as a proxy for O_j. Mean travel time in minutes between i and j is used as a measure of spatial separation between tracts. Data source of O_j and C_{ij} is the 2000 Census Transportation Planning Package (CTPP) Part 3 data at the level of the census tract. The transformation exp(- βC_{ij}) is chosen as a functional form of spatial friction. Spatial deterrence parameter β is calibrated by maximum likelihood estimation for each metropolitan area using a version of SIMODEL (Fotheringham and O'Kelly 1989) modified for processing CTPP Part 3 data.

19.3.2 Factor Analysis

Table 19.1 shows the list of explanatory variables compiled for hedonic regression modeling. Variables are chosen in accordance with the relevant literature (Follain and Jimenez 1985). The dependent variable is the neighborhood's median owner-occupied home value. Explanatory variables are related to neighborhood characteristics (school quality, crime, and job accessibility), resident attributes (income, educational attainment, occupation, life cycle, ethnicity, length of residence), and structural characteristics of the properties (house size, house type, house age). The unit of analysis is the census tract. Most variables are directly available from the 2000 U.S. Population and Housing Census, except for school quality and crime. Data are disaggregated to the census tract level through spatial overlay in GIS when data are available at a coarser geographic resolution.

As many explanatory variables are correlated with each other, factor analysis is used to extract underlying dimensions that are independent of each other from the variables listed in Table 19.1. The method of factor analysis is based on the extraction of principle components with a varimax rotation. The number of factors is determined so that the job accessibility measure indexes one of the

Table 19.1 Candidate explanatory variables for hedonic price model estimation

Name	Description	Data	Year	Geographic unit
Residents-related attributes				
pcincome	Per capita income	Census	2000	Census tract
College	% College degree holders	Census	2000	Census tract
Managep	% Management workers	Census	2000	Census tract
Prodp	% Production workers	Census	2000	Census tract
Famcpchl	% Family with children	Census	2000	Census tract
Nfmalone	% Nonfamily living alone	Census	2000	Census tract
black_p	% Black	Census	2000	Census tract
nhwht_p	% Non-hispanic white	Census	2000	Census tract
Nativebr	% Native born	Census	2000	Census tract
Housing-specific attributes				
Medroom	Median number of rooms	Census	2000	Census tract
Hudetp	% Detached housing units	Census	2000	Census tract
Yrhublt	Median year structure built	Census	2000	Census tract
Locational attributes				
Ptratio	Pupil to teacher ratio	NCES[a]	2002	School district
Schexp	School expenditure per student	NCES	2002	School district
Vrlcrime	Violent crime rate	FBI[b]	2003	Designated place
Prpcrime	Property crime rate	FBI	2003	Designated place
Jobacm	Job accessibility	CTPP[c]	2000	Census tract

components and that all components explain the variation in the original data adequately.

19.3.3 Hedonic Modeling

The relationship between housing prices and job accessibility is examined using two regression models: the first is a global regression and the other is a local regression. A global regression model can be written as:

$$y_i = \beta_0 + \Sigma_k \beta_k x_{ik} + \varepsilon_i \tag{19.2}$$

where y_i is the median owner-occupied home value in tract i , x_{ik} is a vector of predictors, and β_k and ε_i are vectors of parameters and errors, respectively. In a global model, it is assumed that the values of parameters are constant across the study area. In this model, geographic variation in the relationship is confined to the error term. Spatial variation can be accommodated such that the relationship is not treated in the error term, by taking account of the location of the study area. As a form of local regression, Geographically Weighted Regression can be rewritten as follows:

$$y_i = \beta_0(u_i, v_i) + \Sigma_k \beta_k(u_i, v_i) x_{ik} + \varepsilon_i \tag{19.3}$$

where (u_i,v_i) denotes the coordinates of the i th point in space and $\beta_k(u_i,v_i)$ is a realization of the continuous parametric function $\beta_k(u,v)$ at location i . In essence, Equation (19.3) measures the relationship inherent in the model around each location i. The estimation of β_k (u_i,v_i) is a function of the geographic weighting of each of the n observed data for regression point i . The spatial weighting function chosen for this analysis is a bi-square function where the size of the spatial kernel (i.e., the bandwidth) is allowed to vary spatially through minimization of the Akaike Information Criterion to best fit the spatially-varying distribution of observations (Fotheringham et al. 2002, pp. 57–62). It can be noted that Equation (19.2) is a special case of Equation (19.3) in which the parameters are spatially invariant.

Factor scores are entered into both global and local multiple regression models as independent variables. Residuals derived from global hedonic prediction are mapped to determine whether spatial autocorrelation is present. Testing for spatial autocorrelation such as Moran's I will indicate whether geographically weighted regression should be considered. The software GWR 3.0 (Fotheringham et al. 2002) attaches spatially varying coefficients to each observation (census tract in this case). We determine whether the GWR coefficient of job accessibility is consistent throughout the study area using a Monte Carlo test of spatial stationarity.

19.4 Results

19.4.1 Study Area

The Buffalo-Niagara Falls MSA (Metropolitan Statistical Area) is located in the western part of New York State, and is the second largest in the state after New York City. Like much of the Rust Belt, this region is faced with deep structural economic problems and a declining and aging population. The metropolitan area had a population of 1,161,832 according to 2000 Census. Seattle-Tacoma-Bremerton CMSA (Consolidated Metropolitan Statistical Area) is the largest metropolitan area in the Pacific Northwest. The metropolitan area had a population of 3,553,244 according to the 2000 Census of Population. In contrast to Buffalo, Seattle has enjoyed fast economic and population growth over the past three decades. Hence, the selected metropolitan areas represent highly contrasted regional economies and metropolitan housing markets. For simplicity, we will refer to the metropolitan areas as the Buffalo metropolitan area and Seattle metropolitan area, respectively, from this point forward.

Different economic conditions are well reflected in the range of housing prices as shown in Fig. 19.1. The map shows the spatial distribution of

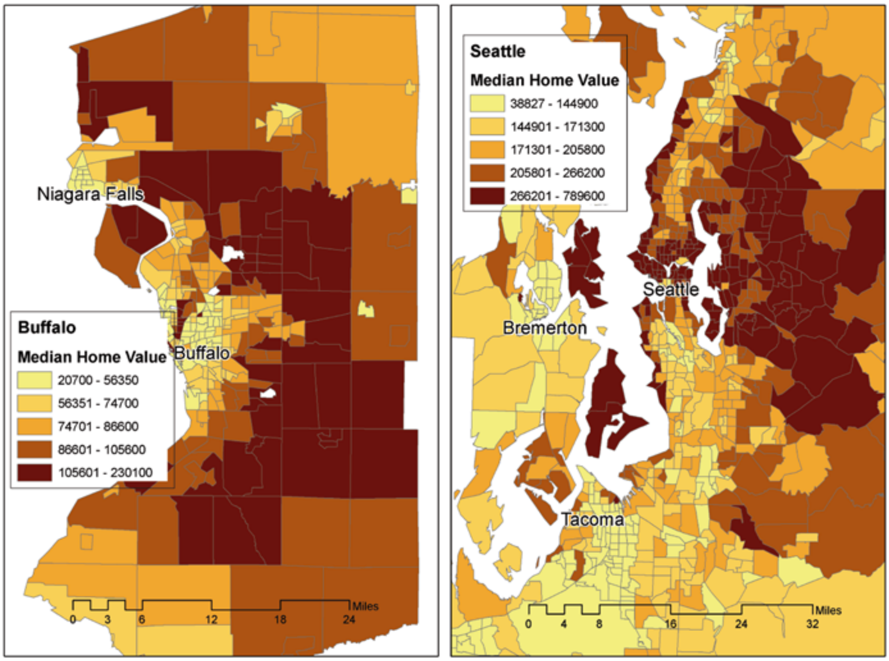

Fig. 19.1 Housing prices in the Buffalo and Seattle metropolitan areas

median price of owner-occupied housing units by census tract. Data is classified by a quantile method for comparison purposes. Each of the five classes represents 20% of data range in order. In general, areas of high housing prices in the Buffalo metropolitan area are concentrated in the outer suburbs (e.g., Amherst, Clarence, Orchard Park, Grand Island) and Elmwood Village (the swath extending northward from the downtown Buffalo). Areas of high housing prices in the Seattle metropolitan area are concentrated in the suburbs (Bellevue, Mercer Island, Bainbridge Island) and the shore sides of Seattle.

Similarly, the spatial distribution of jobs is depicted in Fig. 19.2 using a quantile method. Figure 19.2 maps the total number of workers per acre by census tract in the Buffalo and Seattle metropolitan areas. Worker-to-population ratio of the Buffalo metropolitan area as a whole is 0.44, and that of the Seattle metropolitan area is 0.5. Thus it can be said that there are more job opportunities in the Seattle metropolitan area than the Buffalo metropolitan area. Figure 19.2 shows that in general jobs are more decentralized in the Buffalo metropolitan area compared to the Seattle metropolitan area, after absolute job density is considered. It can be seen that high employment density is associated with the proximity to major highways.

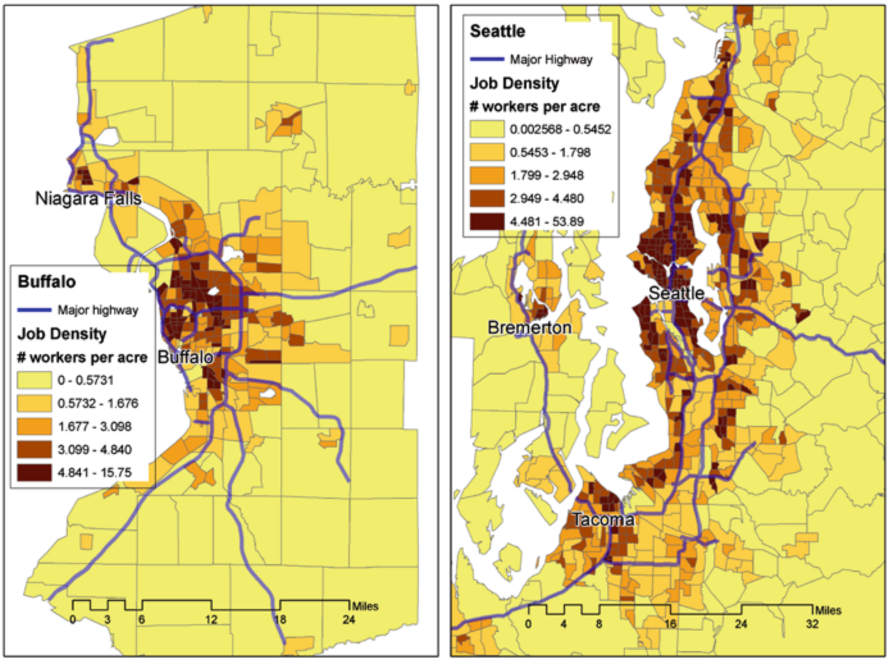

Fig. 19.2 Employment density in the Buffalo and Seattle metropolitan areas

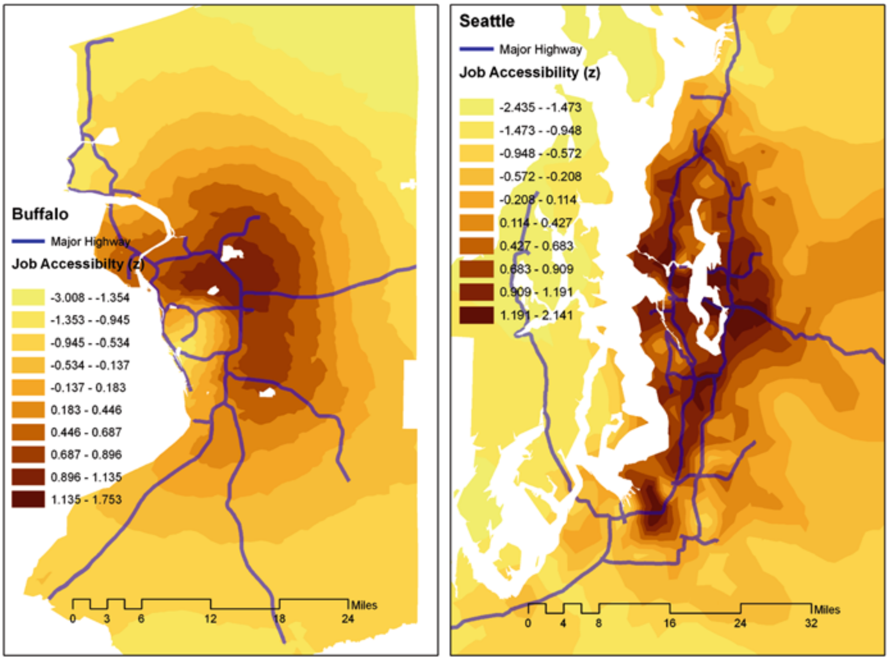

Fig. 19.3 Kriging maps of job accessibility measures in the Buffalo and Seattle metropolitan areas

19.4.2 Job Accessibility

Job accessibility measures are depicted in Fig. 19.3 as a contour map. Areas in darker shades are more accessible to job opportunities than others. Job accessibility measures are standardized (i.e., converted to *z*-scores) because job accessibility measures increase with the size of the study area (more specifically, the number of workers in this study). Job accessibility is computed on the basis of travel time, thus the proximity to major highways positively influences job accessibility measures. The spatial deterrence parameter β calibrated for the Buffalo metropolitan area is 0.03158, and the Seattle counterpart is 0.02443.

The combination of the long-term trend toward decentralization of employment from the city center and the building of limited-access highways in the inner suburbs of the Buffalo metropolitan area have led to high job accessibility in those areas (Amherst in particular). Downtown Buffalo and Niagara Falls no longer enjoy good accessibility to jobs. It can be seen from Fig. 19.3 that job accessibility is ubiquitously high in the City of Seattle, Bellevue, and Tacoma in the Seattle metropolitan area. It should be noted, however, that the Seattle metropolitan area is unique in many ways; for example, land is confined by the ocean and other bodies of water; thus highways (esp. I-5) cannot induce employment decentralization. Seattle provides an interesting case from which we can examine how nature-induced land use control plays a role in shaping job accessibility while economic conditions need to be controlled for.

19.4.3 Dimensions of Housing Markets

Factor analysis extracts principal components of the housing markets in the Buffalo and Seattle metropolitan areas. Six components constitute the Buffalo housing market, accounting for 86.15% of the total variation of all 17 variables listed in Table 19.1. They are interpreted as crime, human capital, life cycle, ethnicity, job accessibility, and length of residence. The human capital factor can be seen as an aggregate of income, educational attainment, and occupation. The variables of housing type and size are highly correlated with life cycle, while housing age is correlated with crime in the Buffalo metropolitan area.

The Seattle housing market is best represented by eight components. They are human capital, life cycle, crime, length of residence, school quality, ethnicity, housing age, and job accessibility. Collectively, those components explain 92.47% of the total variance. The percentage of non-Hispanic whites is correlated with the length of residence, and the ethnicity factor is negatively associated with the percentage of Blacks. There is more correlation between income and education/occupation in the Seattle metropolitan area than in the Buffalo metropolitan area.

19.4.4 Global Regression

Table 19.2 shows OLS regression results. In the case of the Buffalo metropolitan area, all of six components are found to be statistically significant in

Table 19.2 Global regression results

(a) Buffalo-Niagara Falls MSA			(b) Seattle-Tacoma-Bremerton CMSA		
Global hedonic model	B	t	Global hedonic model	B	t
(Constant)	82572.66	84.56	(Constant)	211754.7	107.946
Crime[a]	–8867.63	–9.066	Human capital[a]	73266.47	37.325
Human capital[a]	23418.08	23.941	Life cycle[a]	8510.768	4.336
Life cycle[a]	8583.926	8.776	Crime[b]	–3973.47	−2.024
Ethnicity[a]	6403.728	6.547	Length of residence	1116.597	0.569
Job accessibility[a]	5883.911	6.015	School quality	−1080.38	−0.55
Length of residence[b]	−2114.44	−2.162	Ethnicity[a]	9792.13	4.989
			Housing age	318.506	0.162
			Job accessibility[a]	26195.68	13.345
Adjusted R-square = 0.734			Adjusted R-square = 0.677		
Standard error = 16,743			Standard error = 54,398		

[a] Significant at the 0.01.level
[b] Significant at the 0.05 level.

explaining the variation of median housing value. Five components (human capital, life cycle, crime, ethnicity, and job accessibility) out of eight components turn out to be significant dimensions of the housing market in the Seattle metropolitan area. Higher standard error and relatively lower adjusted R-square in the Seattle metropolitan area compared to the Buffalo metropolitan area indicates that the hedonic model does not perform quite well compared to the former. It may arise from omitted variables (e.g., site characteristics such as ocean view) and the quality of school data.

Most importantly, job accessibility turns out to be a significant determinant of housing price in both metropolitan areas. This component is statistically significant at the 0.01 level. The positive sign of the coefficient of job accessibility component implies that sites accessible to job opportunities are considered more desirable, and good access to job offers house price premium in both Buffalo and Seattle metropolitan area. Interestingly, the elasticity of housing price to job accessibility is over four times larger in Seattle than in Buffalo. This could be the result of Buffalo's greater overall job accessibility (partly due to its smaller size), which provides little incentive for local residents to pay a real estate premium for housing that is more accessible to job opportunities.

We calculate Moran's I statistic to determine whether residuals from the global regression exhibits spatial autocorrelation. Buffalo's Moran's I index is 0.05 (z-score is 10.14), and that of the Seattle metropolitan area is 0.04 (z-score is 15.04). This indicates that regression residuals are positively spatially autocorrelated in both metropolitan areas. Hence we turn our attention to the estimation of geographically weighted regression models.

19.4.5 Local Regression

A summary of GWR estimation results is provided in Table 19.3. The rightmost column shows the statistical significance of the Monte Carlo test of spatial variability of local regression coefficients. It tests whether the null hypothesis that local coefficients of the respective component are constant over the study area (i.e., spatial stationarity of coefficients) can be rejected. It is notable that all components except for ethnicity and length of residence reject the null hypothesis at the 0.05 level in the Buffalo metropolitan area. That is, the impact of those components on housing prices varies spatially. Job accessibility is not an exception. While the median of the job accessibility coefficients is positive (which is consistent with the global regression results), their values range from positive to negative. In some cases, job accessibility depresses housing value as indicated by the negative coefficients estimated in the Buffalo metropolitan area.

Overall results in the Seattle metropolitan area are rather similar to those of Buffalo with regard to the spatial variability of the relationship between factors and housing price; all factors except for life cycle, crime, and housing age exhibit statistically significant variability at the 0.05 level. Combined with global regression

Table 19.3 Local regression results

(a) Buffalo-Niagara Falls MSA

Label	Minimum	Lwr quartile	Median	Upr quartile	Maximum	Sig.
Intercept	70618.20	75859.86	78340.75	82873.55	92678.50	0.00
Crime	−24158.39	−12158.78	−8722.78	−7116.00	−1070.97	0.00
Human capital	13400.33	17533.58	20502.66	25632.61	29127.53	0.04
Life cycle	−809.24	3237.95	7803.32	12602.80	19399.02	0.00
Ethnicity	−2393.25	5269.02	6493.57	7658.22	18719.68	0.29
Job accessibility	−5852.97	−559.46	5200.96	7752.86	12191.91	0.00
Length of residence	−9558.35	−5352.72	−3572.81	−1937.71	1385.32	0.07
Adjusted R-square = 0.861						
Standard Error = 13110						

(b) Seattle-Tacoma-Bremerton CMSA

Label	Minimum	Lwr Quartile	Median	Upr Quartile	Maximum	Sig.
Intercept	125495.11	177423.88	191496.49	206157.82	224078.04	0.00
Human capital	30531.06	44466.25	71933.14	97384.99	122000.87	0.00
Life cycle	−6447.06	129.18	4346.28	8624.06	17008.99	0.81
Crime	−18481.04	−6580.01	−3622.20	328.81	27509.61	0.08
Length of residence	−32583.44	−12513.29	−948.12	5804.33	18776.00	0.00
School quality	−21208.30	−6388.85	−1256.65	11191.19	47893.10	0.00
Ethnicity	−22438.75	6765.75	12552.73	14965.08	32997.48	0.00
Housing age	−17552.95	−5642.52	1776.13	4084.50	10070.33	0.17
Job accessibility	2782.17	13093.78	18189.55	43108.87	75501.66	0.00
Adjusted R-square = 0.79						
Standard Error = 44695						

results, it can be inferred that school quality and length of residence play important roles in some neighborhoods although they do not significantly contribute to explaining the variation of housing prices at a metropolitan scale, given high variability of corresponding local coefficients. In comparison to Buffalo, it is notable that job accessibility offers house price premium all across the Seattle metropolitan area. This premium is highest in the CBD and in Bellevue.

Geographically weighted regression improves the performance of hedonic modeling significantly as indicated by the higher share of variation explained and the lower prediction errors. More pertinent to real estate analysis, local regression results suggest that using a global regression model for housing valuation or estimating implicit price of attributes comprising housing quality is not quite valid due to the spatial non-stationarity of the relationship between predictors and housing prices. This study signifies that the manner in which some attributes exert influence on housing value is contingent upon local contexts. Consequently, spatial processes are more at play in the operation of housing markets than it has been recognized thus far. It warrants further study to better understand the spatial nature of housing market processes.

To examine how the implicit price of job accessibility varies at a fine geographic granularity, we map t-values of local job accessibility coefficients. Figure 19.4 shows how the relationship between job accessibility and housing

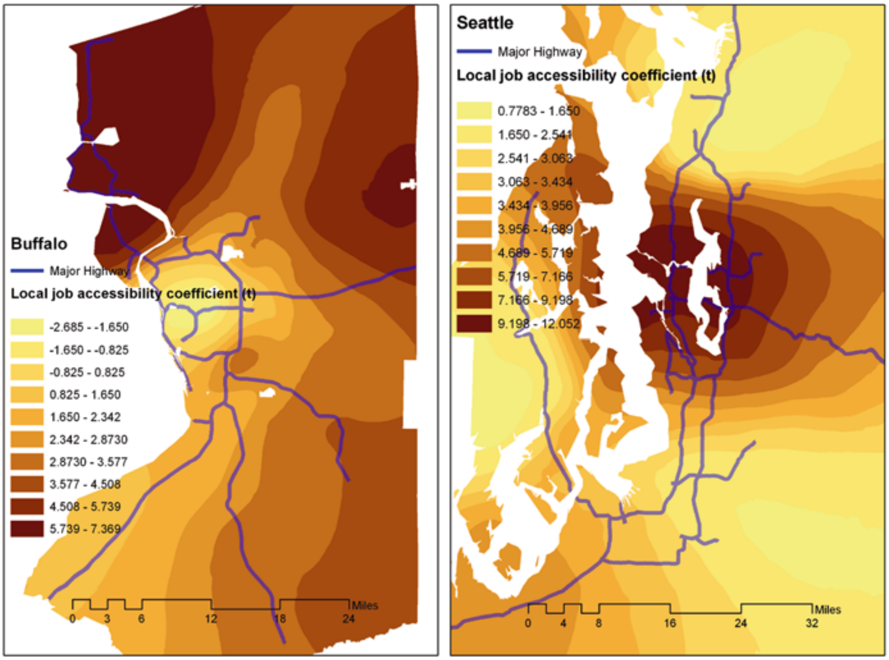

Fig. 19.4 The impact of job accessibility on median housing value as given by estimated t values in the Buffalo and Seattle metropolitan areas

prices varies spatially. Job accessibility positively influences home value in areas with t-values greater than 1.65 (significant at the 0.05 level). Job accessibility is negatively associated with housing prices in areas with t-values less than -1.65. Areas with t-values between -1.65 and 1.65 can be interpreted as areas where job accessibility does not influence the local housing market.

Striking difference between the Buffalo and Seattle metropolitan area can be observed with regard to the effect of job accessibility on housing prices. Areas with high demand for job accessibility are concentrated in the outer suburbs of the Buffalo metropolitan area. Strong positive demand for job accessibility is present throughout Seattle and Bellevue. Negative implicit price of job accessibility in the City of Buffalo is quite noteworthy. Although the hedonic model using aggregate data does not directly capture behavioral aspects, results indirectly suggest that nearly all city (Buffalo) residents and inner suburbia in the Buffalo metropolitan area are either indifferent to increases in job accessibility or do not consider job accessibility to be important in housing choice. The same interpretation can be made about the outer suburbs of the Seattle metropolitan area. Further research on this issue using disaggregate analysis is needed to validate this point.

19.5 Conclusions

Despite the importance of and the need for better understanding the land use/transportation relationship, the task of unraveling their intimate relationship remains challenging. This study attempted to overcome some of these empirical challenges. More specifically, we employed factor analysis to resolve multicollinearity of locational variables in hedonic modeling, and geographically weighted regression to examine the spatially variant role of job accessibility in articulating metropolitan housing markets.

A local hedonic model based on geographically weighted regression in the metropolitan areas of Buffalo and Seattle allows us to infer the implicit price of job accessibility with regard to housing choice. Compelling empirical evidence from two very dissimilar metropolitan areas indicates that the market response to job accessibility is not spatially stationary. Instead, a clear geographic pattern exists with regard to how job accessibility may influence housing value. Our analysis suggests that suburbanites are more willing to pay for additional increases in job accessibility in housing consumption than urban residents in the Buffalo-Niagara Falls MSA. In contrast, residents living near the urban core of Seattle are more likely to accept to pay a real estate premium for high job accessibility than those who live further away.

It is necessary to look at neighborhood-scale operations to fully grasp the role of job accessibility in housing markets. Inconsistent findings in this body of literature (Priemus et al. 2001) are not free from the scale of analysis. This study demonstrates the utility of geographically weighted regression in examining how the relationship between job accessibility and land use plays out locally. Results shed light on the localized nature of housing market processes.

Mapping local impacts of job accessibility on housing prices can inform policy analysts on how residents may respond to gains in job accessibility stemming from potential transportation investments in the short term. Marginal transportation improvement project in areas of low demand or negative demand for job accessibility (e.g., city of Buffalo, and outer suburbs of the Seattle metropolitan area) is not likely to harvest anticipated policy outcomes such as urban revitalization or economic development. Transportation policy alone would not be sufficient in reaping potential benefits in areas characterized as such, and should be supplemented with other land and human capital development policies. Conversely, sections of metropolitan areas with high demand will quickly respond to even marginal increases in job accessibility, and thus fully benefit from the regional multiplier effects.

Despite the rather complex nature of the concept of accessibility, we have shown that it deserves greater attention in studies of land use/transportation interaction because it provides a crucial medium to understanding this complex linkage. As demonstrated above, accessibility is in touch with equity and efficiency arguments (e.g., urban revitalization) of land use/transportation policies (Cervero et al. 1999).

A limitation of this study can be traced to quality of the data. Using more disaggregate data such as actual real estate transactions in addition to census data would improve the performance of hedonic models to understand housing market processes. In addition, neighborhood characteristics of crime, school quality, and accessibility to a range of urban amenities are best measured at a fine spatial resolution. Our analysis has demonstrated that housing markets have a strong local component and that market processes are fundamentally non-stationary over space. Spatial processes are known to often operate at multiple scales. Likewise, rejoining Pace and Gilley (1997), it can be conjectured that different factors shape metropolitan housing markets at different spatial scales. Therefore, an integrated multi-scale analysis may provide a well-suited research framework for the study of housing markets.

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