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RESEARCH REPORT

Effects of Thoroughfares on Residential and Commercial Values in Two Cities

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16. Abstract

The objectives of this study are (1) to gauge benefits in the way property values relate to highways and radial thoroughfares in metropolitan Baltimore; (2) to compare these results specifically to studies done in Philadelphia, Portland, Oregon, and other locations as mentioned in the literature, and (3) to detect and describe property valuation patterns for main highways through Maryland's Lower Eastern Shore and Highways

The project involved multiple regression analysis (an hedonic model) to determine the presence and nature of apartment price gradients within the Baltimore Metropolitan area. Descriptive statistical analysis of recent sales of apartments and commercial properties on Maryland's Lower Eastern Shore was also conducted. Baltimore City and County apartment real estate prices decreased with distance from the city center. Baltimore County apartment real estate prices decreased with distance from 11 radial thoroughfares. No price gradient was found relating apartment prices with distance to the Baltimore Beltway. Impacts of recent road widening of the radial thoroughfares were not found. Otherwise, properties in the rural area of Maryland's Lower Eastern Shore were found to cluster near the three main highways and the towns consistent with general access to these features.

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Executive Summary

The objectives of this study are (1) to gauge benefits in the way property values relate to highways and radial thoroughfares in metropolitan Baltimore; (2) to compare these results specifically to studies done in Philadelphia, Portland, Oregon, and other locations as mentioned in the literature, and (3) to detect and describe property valuation patterns for main highways through Maryland's Lower Eastern Shore.

Standard urban economics theory is applied and a hedonic model based on the theory is tested for Baltimore City and County. This part of the study follows well-documented research on the nature and form of urban areas. Because of insufficient data, part of the research on the Lower Eastern Shore is merely descriptive and provides a contrasting view of the relationship between property values and transportation routes in non-urban Maryland.

The results of this study will further show how transportation routes affect property values and should assist the State Highway Administration in its relationships with property owners, and assist local governments in making planning and zoning decisions in the vicinity of highway corridors.

The key findings of this study are:

(1) Baltimore City and County apartment real estate prices decreased with distance from the city center in accordance with the basic monocentric model of urban economics.

(2) Baltimore County apartment real estate prices decreased with distance from the 11 main radial thoroughfares within the Baltimore Metropolitan area.

(3) No apartment price gradient was found relating apartment prices with distance to the Baltimore Beltway (I-695).

(4) Average apartment price declined three to five percent for each block distance from the city center and a radial thoroughfare.

(5) Impacts by way of differential apartment price gradients were not detected due to recent road widening of major radial thoroughfares.

(6) Recent sales properties in the rural area of Maryland's Lower Eastern Shore were found to cluster near the region's three main highways and the towns consistent with general access to these features.

INTRODUCTION

Cities and Land Use Location

Location has a universal role in determining property values in America's cities and towns. Literature on urban economics dating back to Ricardo (1818) and von Thunen (1826) is based on the fundamental idea that rents and property values of all property types have location components. The most basic and important aspect of location in a metropolitan area is distance from the central business district (CBD), as explained by Alonso (1964). Models of land and property gradients by Muth (1969) and Mills (1972) followed the basic notion of a monocentric city, and assumed the destination point for suburban residents was the CBD and that transportation costs were the same for suburban residents.

The crux of this model was that locations closer to the CBD had greater accessibility to locations within the metropolitan area. At some critical density for every metropolitan area in North America, accessibility to other points becomes critically important because of transportation costs and commuting times. Older, Eastern and Midwestern regions developed monocentric cities with only slight suburbanization in the decades of the 1890s and 1900s brought about by streetcars that radiated out from the city center. The economics of agglomeration or proximity were particularly important and encouraged centralized growth. Western American cities such as Phoenix and Las Vegas, developed after wide use of the automobile, had land rent and price gradients much less steep than those for Eastern and Midwestern cities.

The advent of the automobile in the 1920s, along with municipal zoning laws,[1] started suburbanization. Cities spread out and became more dynamic. No longer were cities structured in a strict monocentric mold. In the 1940s urban economists and geographers such as Harris and Ullman, formed a multiple nuclei theory where mini-CBDs developed in conjunction with the main, historical CBD. Homer Hoyt's (1933) urban sector pattern was another post-automobile-era explanation of how cities were structured along radial transportation routes.

Subcenters are now prominent in both new and old cities. Twenty or so subcenters can be identified for metropolitan Los Angeles. However, the presence of subcenters has by no means eliminated the importance of the main center. Though contemporary thought makes big-city downtowns passé, statisticians have continuously noted the predominant, overwhelming effects of the CBD. Whenever a downtown center and one or more subcenters is compared using the same criteria, downtown has more total employment, higher employment density, and a larger statistical effect on surrounding densities and land prices than does any subcenter.

[1] Zoning in the United States began in the 1920s, the first Supreme Court test coming in Ambler Realty (1926).

Housing Sector

Housing is primarily located in relation to employment and commuting distance. The standard explanation in urban economics is that intra-urban activities dominate the urban core because these land uses provide more in the way of rents than residences. Residential land use requires more space and people are willing to pay more in commuting costs for that space than for other uses.

In addition to the primary rent/price gradient from the CBD, housing values have shown to be affected by proximity to thoroughfares that provide direct access to the CBD. Main routes into the CBD provide accessibility-related increasing rent/price gradients. A third source of accessibility-related increasing rent/price gradients is the highway and beltways surrounding cities.

Commercial Sector

The aftermath of World War II and the decades of the 1950s and 1960s made the term "suburbanization" a household word. The 1950s also ushered in the era of shopping centers, pulling retail businesses out of the central shopping districts and replacing the downtown retail districts with urban and suburban shopping centers and strip malls. While in 1950 there were literally only a handful of shopping centers in the United States, by 1989 shopping centers captured 55.2 percent of all non-automotive retail sales.[2] The estimated retail sales in shopping centers for 1974 and 1982 were 25 percent and 42 percent, respectively.[3]

Highway spending accelerated during this time as population spread out and automobile transportation predominated (Figure 1). Property values for major cities increased along transportation routes, first along thoroughfares, like the spokes of a wheel, and then along the beltways, which were built after the 1950s. These patterns are not found in outlying areas where population growth has not reached the level of a Metropolitan Statistical Area (MSA), e.g., Salisbury, Maryland and Maryland's Lower Eastern Shore (Mills 1972).

[2] American Council of Life Insurance (ACLI), Survey of Mortgage Commitments on Commercial Properties, Quarterly, Washington, D.C. (1989)

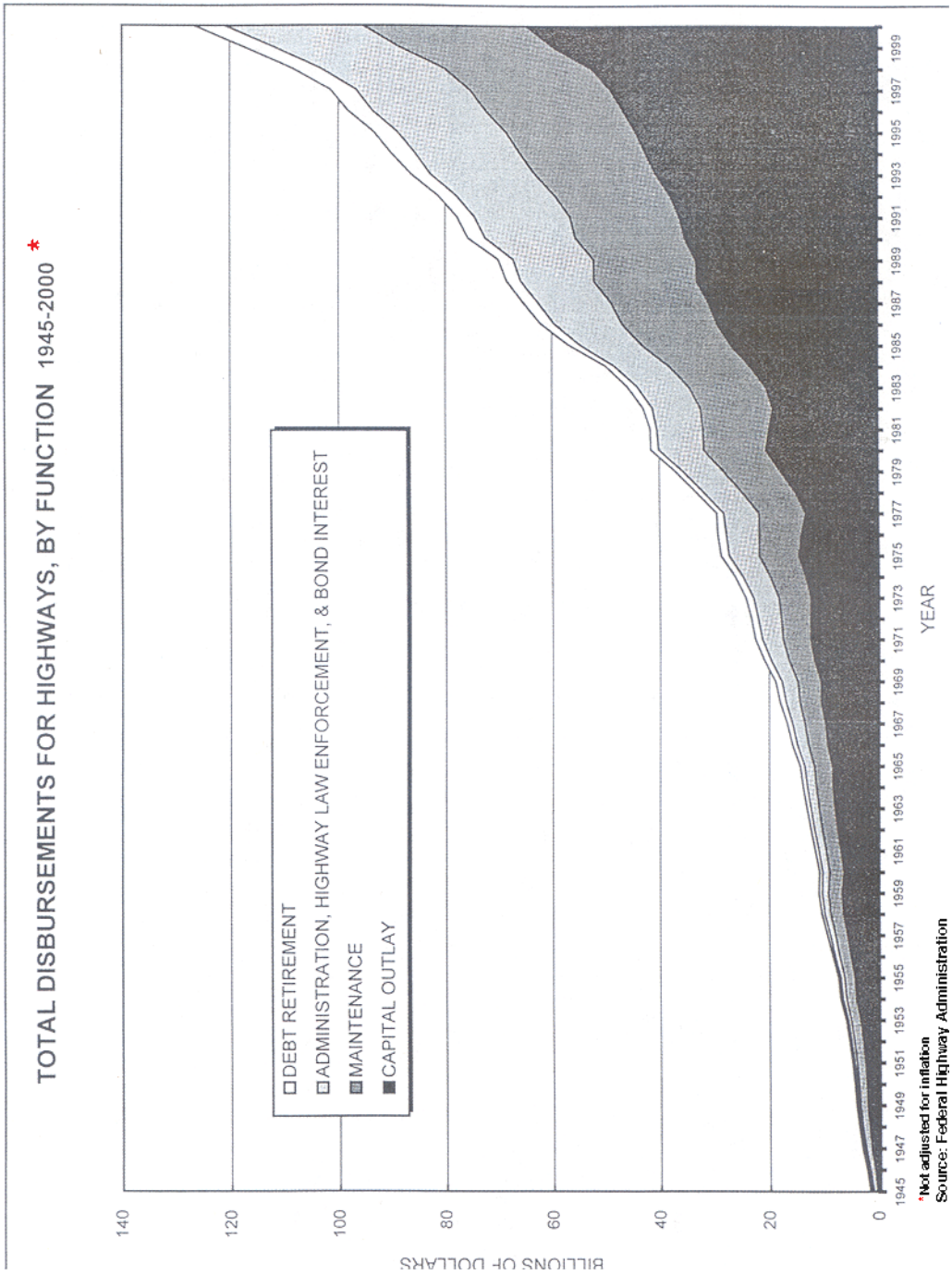
[3] Urban Land Institute (ULI), Shopping Center Development Handbook, 2nd ed., Washington, D.C.: ULI-Urban Land Institute (1985): 16

HYPOTHESES

The objectives of this study are (1) to gauge benefits in the way property values relate to highways and radial thoroughfares in metropolitan Baltimore; (2) to compare these results specifically to studies done in Philadelphia, Portland, Oregon, and other locations as mentioned in the literature, and (3) to detect and describe property valuation patterns for main highways through Maryland's Lower Eastern Shore.

Baltimore Metropolitan apartment real estate prices will decrease (1) with distance from the center of the City of Baltimore, (2) with distance from the radial thoroughfares within the Baltimore Metropolitan area and (3) with distance from Baltimore's Beltway (I-695). Otherwise, properties in the rural area of Maryland's Lower Eastern Shore will cluster near the main highways and towns consistent with general access to these features.

Figure 1 National Highway Spending



REVIEW OF THE LITERATURE: EMPIRICAL ANALYSES

Models

Hedonic pricing models that measure location factors affecting prices and values of single and multi-family housing have been widely used for years [Frew, Jud, and Winkler (1990); Sirmans, Sirmans, and Benjamin (1994); Asabere and Huffman (1996); Des Rosiers, Theriault, Kestens and Villeneuve (2001)]. Hedonic pricing models have also been used successfully to gauge factors effecting shopping malls [Guidry and Sirmans (1993); Gatzlaff, Sirmans, and Diskin (1994); Hardin and Wolverton (2000)]. These studies normally are meant to detect and quantify both positive and negative externalities for different types of properties, while accounting for more fundamental attributes of real property. For instance, apartment rents and prices are normally a function of common sense attributes such as square footage, age and lot size.

Highways and Property Values

The effects of highway improvements on property values have been studied extensively, especially the impacts on single family residential property. These effects are pretty well established. The amount of research on the effects on multifamily and commercial property pales by comparison. Siethoff and Kockelman (2002) conclude that most studies have shown that transportation facilities have a positive effect on property values. However, Ryan (1999) found that there is significant variation in effects, depending on how one measures "distance." A review of empirical studies showed that when access to highways is measured in terms of travel time, there is the expected inverse relationship between access and property values. When travel distance is used, effects on property values tend to be mixed.

Impacts also vary by time; there may be lead and lag effects. In the long run the effect may be positive, but for a particular time period the impact may not. Vadali and Sohn (2001) found that highway reconstruction has a short-term effect on residential properties in the immediate vicinity of a facility. The losses of values from sales during construction are usually overcome by increasing property values after construction is completed. Buffington and Wildenthal (1998), in a comprehensive study of upgrading and widening highways across the state of Texas, determined that the impacts on abutting or nearby businesses, residents and properties were temporarily negative with regard to sales, property values and tax revenues. They concluded that "...construction expenditures offset much of the negative effects."

Carey (2001) conducted one of the most recent comprehensive studies of improved highways' effects on property values of the Superstition Freeway (SF) in Phoenix. The SF (US 60) was completed in 1985, but has had widening and other improvements since then. In the mid-1990s, it was decided that because of rapid growth in the southeastern portion of the metropolitan area, additional general use and new HOV lanes should be built. Opposition among property owners to the improvements in the City of Tempe prompted this study.

Several categories of property types were studied, although the robustness of the analysis varied among those categories, because the numbers of sales by category varied. The study examined and attempted to identify the extent to which groups of property owners were impacted positively or negatively.

The methodology of this study consisted primarily of t-tests and zone-based and street-based regression analyses between location and property values, particularly for single family detached housing, and multifamily housing: condominiums and townhouses. The statistical analysis for multifamily housing, because of much fewer recorded sales, was deemed less reliable than for the single family detached housing analyses.

The SF was observed to have an adverse effect on the sales prices of proximate single family detached housing, but a positive effect on multifamily residential and commercial properties. However, the presence of the SF did not deter single-family homebuyers from purchasing properties adjacent to the facility. A similar relationship existed for major surface streets, that is, there were negative effects on sales prices of nearby detached housing. This result implies that thoroughfares with large traffic volumes in general, not only high volume expressways, cause these effects.

Carey also showed that sale prices of multifamily units are enhanced by immediate access to major thoroughfares. He pointed out that individual multifamily units are probably more sheltered from traffic than detached housing by landscaping, other building units, and walls. The analysis also did not distinguish distance from the thoroughfare by individual units in a multifamily structure, so actual distance may impact the sales price of individual units.

The sample of recorded sales for commercial and industrial properties was entirely too small for multivariate statistical analyses and thus the evaluation consisted of mapping, observation and judgment. Carey considered commercial property as consisting of office, restaurants, retail and apartment complexes. He acknowledged that because of the unavailability of sufficient numbers of sales data for commercial properties, the analyses were inconclusive. Even so, the analysis results for those properties were paid particular attention, because the research in Baltimore and Salisbury focuses on multifamily residential and retail property values. Carey's study, relying on just a few "data points," concluded that the distribution of commercial development is clearly associated with freeway locations, particularly for office and retail establishments, but the distance effects are unclear.

Apartment Rents and Values

Focusing on apartments, of particular interest are the studies by Asabere and Huffman (1996) and Frew and Wilson (2000), which looked at rent or value gradients for apartments in Philadelphia and Portland, Oregon, respectively. The authors use hedonic pricing models, not unlike the one used here, to measure rent gradients both from the city center and from major urban thoroughfares on apartment values.

The two main thoroughfares in Philadelphia, Broad and Market Streets, intersect at City Hall within the CBD. Broad St. is the major north/south artery with the Broad Street subway beneath it. Market St. serves as the major east-west artery with the Frankfort-Market Elevated Rail line under it for its length. No other street in the City approaches the importance of these two main arteries. Using data from only the city, Asabere and Huffman (1996) find a steep value (price) gradient from the city center but also clear evidence of the importance of Broad and Market Streets to property values. Value gradients showed apartment values declined away from Broad Street by 3.8 percent per block and away from Market Street by 2.2 percent per block. These location characteristics were capitalized into the land values.

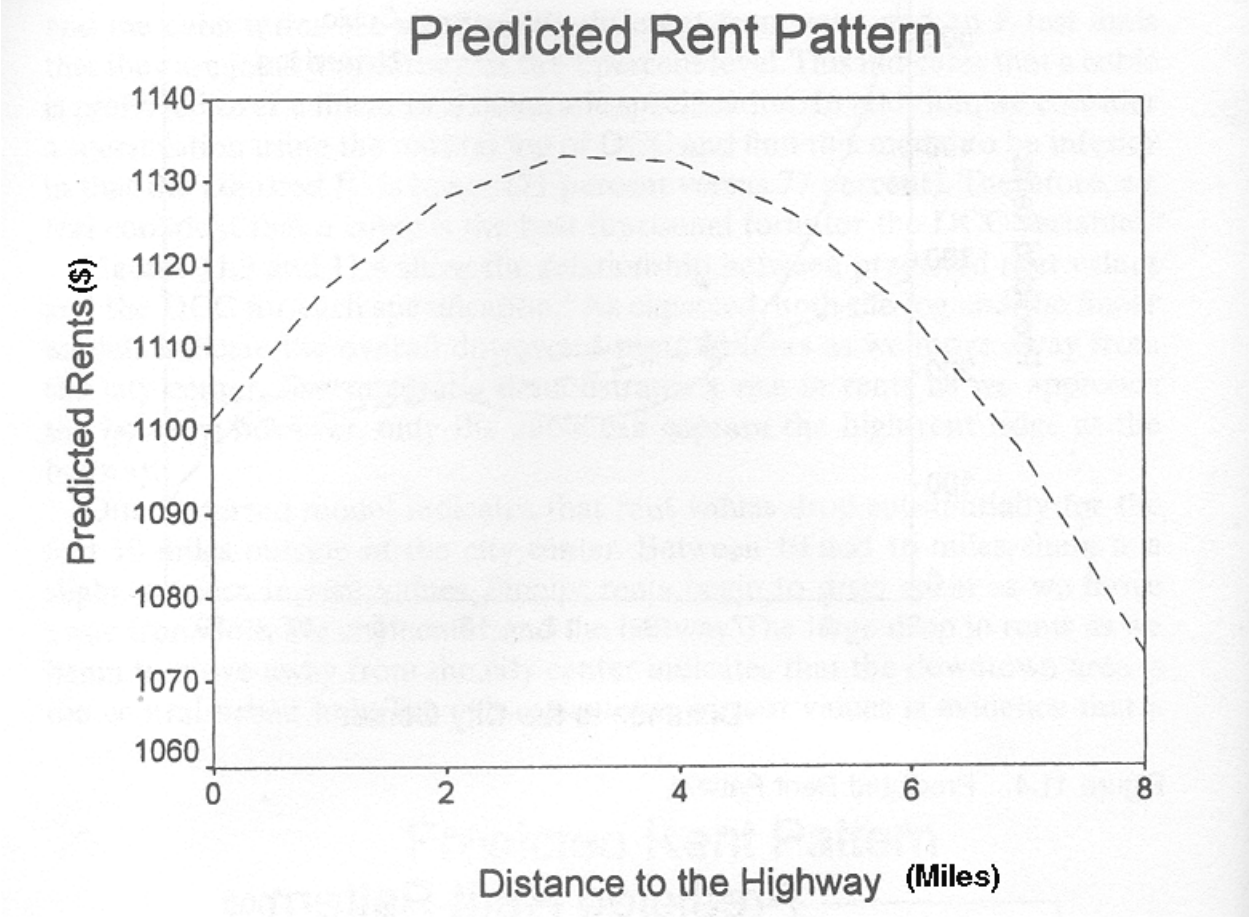
Using data from the entire Portland metropolitan area, Frew and Wilson (2000) identified an apartment rent gradient from the city center. Rents also decrease generally with distance to a highway. The combination of location rent gradients produces decrease in rents from zero to 10 miles from the city center and a slight increase in rents between 10 and 16 miles, associated with Portland's Beltway and then decrease with further distance.

There is a concave, parabolic relationship between distance to highway or intersection of highways and rents. The highest rents are approximately 3.3 miles from a highway (Figure 2) and 4.2 miles from an intersection.

Commercial/Retail Values

Hedonic studies of the determination of value variation across retail properties have also been done. The Sirmans and Guidry (1993) study found a significant increase in property value with increased traffic count along streets, other independent variables held constant. Other studies show retail property value increases with increased effective purchasing power in the area, defined by the product of the number of households and the average household income in the market area (Gatzlaff, Sirmans, and Diskin (1994); Carter and Haloupek (2000)). Rent or commercial price is affected primarily by customer buying power in the market area. Such other determinants like age of construction, size of a retail center, amount of vacant space and traffic count are also important, everything else held constant.

Figure 2 Rent Ridge from Frew and Wilson (2000)



DESCRIPTIVE OVERVIEW: BALTIMORE & EASTERN SHORE COUNTIES

Baltimore City and County

The City of Baltimore is roughly rectangular with an area of 81 square miles and a population of 651,154, according to the 2000 Census. Baltimore County is 599 square miles with a population of 754,291 (2000 Census), and extends north, east and west of the city. City and county jurisdictions do not overlap. Nearby suburban counties to the south, east and west, Anne Arundel, Carroll, Harford, Howard, and Queen Anne's, are much less dense than the urban core area.

The Baltimore Primary Metropolitan Statistical Area (PMSA)[4] is made up of Baltimore City and the Maryland counties of Anne Arundel, Baltimore, Carroll, Harford, Howard, and Queen Anne's. The Baltimore PMSA is itself one of three Metropolitan Statistical Areas (MSAs) making up the Washington-Baltimore Consolidated Metropolitan Statistical Area (CMSA) (Baltimore, Hagerstown, and Washington MSAs).

Metropolitan Growth

The Baltimore Metropolitan Area (BMA) experienced increases in population and employment during the period 1990-2000. Population increased in the BMA by 7 percent, compared to the national average of 13.2 percent, over the last decade. Baltimore City declined in population by 11.5 percent, but the outlying counties grew at more than twice the national rate. Howard and Carroll County populations increased 32.3 and 22.3 percent, respectively.

Employment increased by 7 percent in the BMA, at about the national average, while the rate of unemployment stayed slightly below the national average over the decade 1990-2000, according to the 2000 Census. Per capita personal income (PCPI) in the BMA, $32,265, was 109 percent of the national average, $29,469. The 2000 PCPI reflected an increase of 5.6 percent from 1999. The 1999-2000 national change was 5.8 percent.

[4] The general concept of a metropolitan area is that of a large nucleus, together with adjacent communities having a large degree of social and economic integration with that core. Metropolitan areas comprise one or more entire counties. A metropolitan area identified as a consolidated metropolitan statistical area (CMSA) has a population of one million or more and also has separate component areas (PMSAs – primary metropolitan statistical areas) meeting statistical criteria and supported by local opinion.

Lower Eastern Shore

The population of the four counties making up Maryland's Lower Eastern Shore—Wicomico, Dorchester, Worcester, and Somerset, is 186,608 (Figure 3). They occupy 1735 square miles (2000 Census). There are no metropolitan areas or MSAs. Population for the Lower Eastern Shore increased by 14.5 percent over the last 10 years, while employment increased by 15 percent over that period. For the purposes of this study, the two most populous counties were considered—Wicomico (86,644 population, 377 square miles, 2000 Census) and Worcester (46,543 population, 473 square miles, 2000 Census) counties, adjacent counties accounting for 71 percent of the population.

As a whole, population in Maryland increased by 10.8 percent over the last decade and employment increased by 13.7 percent. Overall, Maryland's demographics tilt in favor of the eastern part of the state. Hagerstown, the sole MSA west of the Baltimore-Hagerstown-Washington CMSA, ranks last in recent real rate of employment growth for 318 metropolitan areas.[5] Housing prices in areas of Maryland reflect much the same pattern. For the core areas of the BMA, Baltimore City and Baltimore County, average increases in prices were 8.0 percent and 10.5 percent for the year 2001, respectively.[6] The counties of Wicomico, Dorchester, Somerset and Worcester experienced average housing price increases of 29.8 percent, 12.6 percent, 86.9 percent and 47.5 percent for the year 2001, respectively.[6]

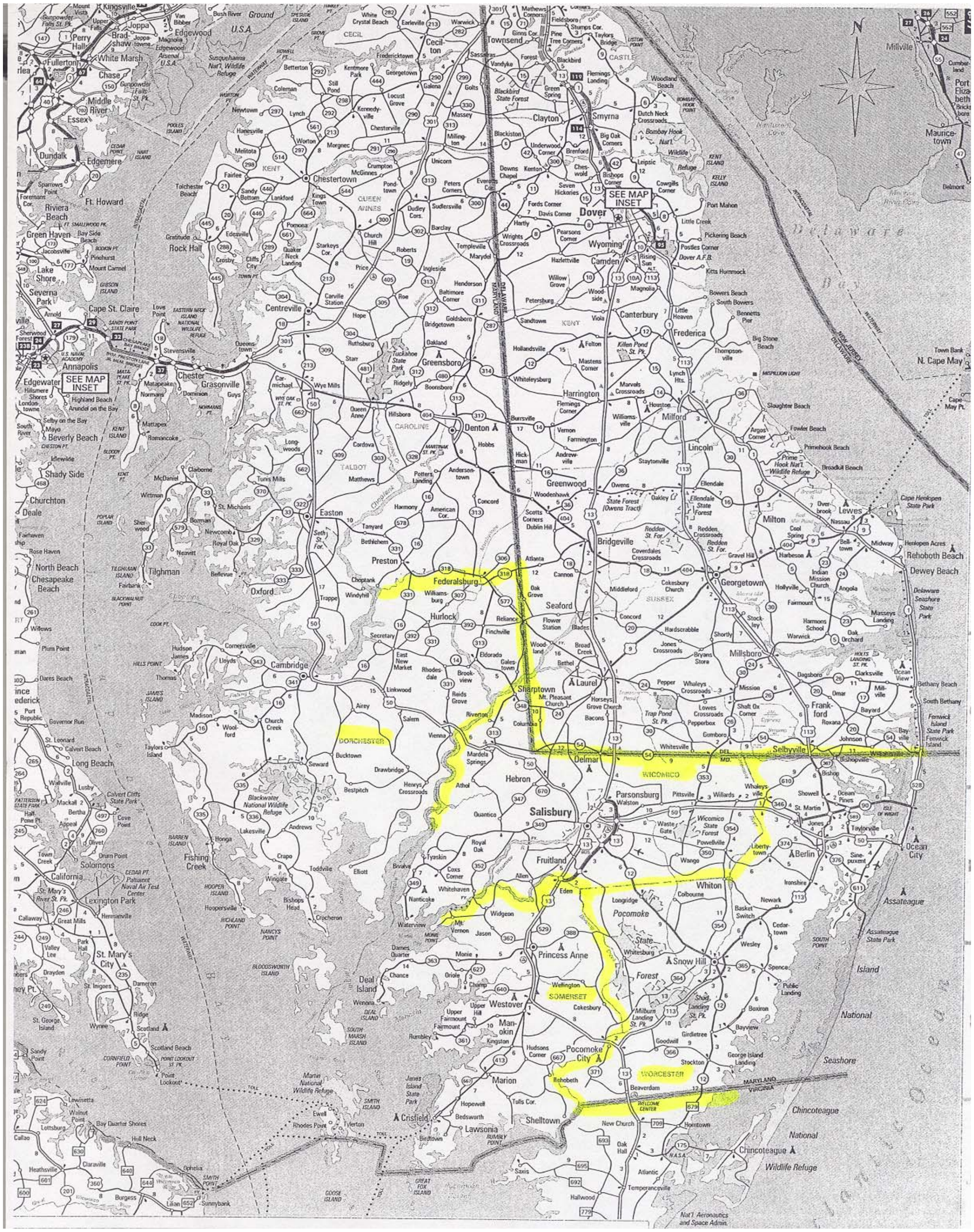
DESCRIPTION OF THOROUGHFARES/BELTWAY

Baltimore City streets are laid out in the usual checkerboard fashion, straight streets at right angles. Radiating from Baltimore's CBD are several "thoroughfares" laid out like the spokes of a wheel, extending through Baltimore City and into Baltimore County. The American Association of State Highway and Transportation Officials classify roadways as follows: interstate highways and freeways/expressways, arterials (principal and minor), collectors, and local roads. Classification factors include 1) length of road, 2) existing and projected traffic volume, 3) character of adjacent properties (including density and character of adjoining land uses), 4) possibility of expansion (including manmade and natural barriers), and 5) need to preserve accessibility and connections to activity nodes.

[5] Malpezzi, S., K. Seah, and J. Shilling(2002), "Is It What We Do or How We Do It? New Evidence on Agglomeration Economies and Metropolitan Growth," paper given at the ARES/AREUEA conference (July 2002). Statistics are for the 318 largest metropolitan areas in the United States over the past three decades.

[6] Maryland Realtor®, February/March 2002: 24-26

Figure 3   Maryland's Lower Eastern Shore



Interstate highways and freeway/expressways are multiple lane highways that carry high traffic volume and provide inter-county interaction. The remaining types of roadways are classified as follows:

> *Principal arterial*: more than 5 miles long; connects freeways and other principal thoroughfares; more than 30,000 vehicles per day; usually spaced three to five miles apart.
>
> *Minor arterial*: more than three miles long; connects freeways and principal arterials; more than 20,000 vehicles per day, usually spaced one-half to one mile apart.
>
> *Collector*: one to two miles long; connects minor arterials and local roads; more than 5,000 vehicles per day; less than one mile spacing.
>
> *Local Road*: less than one mile long; carries little traffic; provides access to homes and local businesses; accommodates on-street parking and pedestrians.

Major roadways making up the Baltimore metropolitan area are listed in Figure 4. Traffic frequency in the Baltimore area is shown in Figure 5 (average daily traffic during 2001). Figure 6 shows thoroughfares in Baltimore City and Baltimore County, from where the apartment data was collected. The city border is yellow and the county border is outlined in green. The 11 main radial thoroughfares (blue) and the beltway (I-695) (red) are indicated on the map. The 11 major radial thoroughfares extend from the central city; their state highway designations, are (1) Charles Street (MD 139), (2) Harford Road (MD 147), (3) York Road (MD 45), (4) Liberty Road (MD 26), (5) Edmondson Avenue (US 40), (6) Reisterstown Road (MD 140), (7) Frederick Avenue (MD 144), (8) Eastern Avenue (MD 150), (9) Pulaski Avenue (US 40), (10) Belair Road (US 1), and (11) Washington Blvd. (US 1).[7] Of these, US 1 and US 40 have been the subject of substantial widening and resurfacing within the past few years at several points, according to the Maryland State Highway Administration.

Both Baltimore and Washington, D.C. have distinctive beltways surrounding their city centers that were constructed during the 1970s. Thoroughfares radiating from the urban hub preceded them, as did trolley and railroad lines that ran roughly parallel. Generally, radial thoroughfares have accessed city centers for a much longer period of time than the beltways that bypassed them.

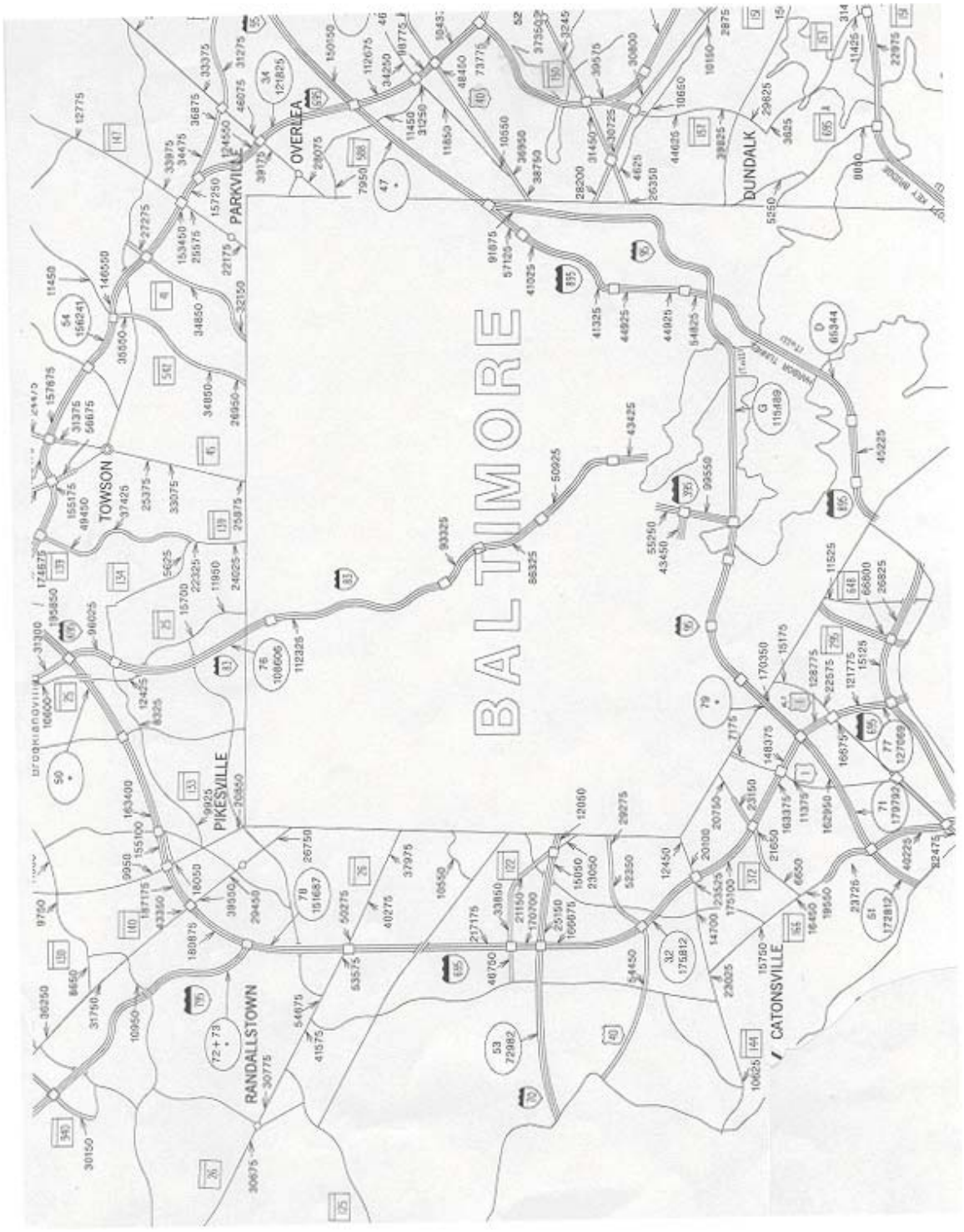
[7] Perring Parkway (US 41) was not considered since it does not extend beyond the beltway.

Figure 4 Major Thoroughfares in the Baltimore Metropolitan Area

Interstate Highways	Principal Arterials	Minor Arterials	Freeways/Expressways
I-70	Belair Rd./North Ave./Washington Blvd. (US 1)	Falls Rd. (MD 25)	Baltimore Washington Pkwy. (MD 295)
I-83	Calvert St./Hanover St./ Ritchie Hwy. (MD 2)	York Rd. (MD 45)	Hillen Rd./Perring Pkwy. (MD 41)
I-95	Liberty Heights Ave./ Liberty Rd. (MD 26)	Park Heights Ave. (MD 129)	
I-97	Baltimore National Pike/Edmondson Ave./Pulaski Hwy. (US 40)	Harford Rd. (MD 147)	
I-395	Greenmount Ave./ York Rd. (MD 45)	Eastern Ave. (MD 150)	
I-695	Charles St. (MD 139)	The Alameda/Loch Raven Blvd. (MD 542)	
I-795	Reisterstown Rd. (MD 140)		
I-895	Frederick Ave. /Frederick Rd. (MD 144)		
	Harford Rd. (MD 147)		
	Eastern Ave. (MD 150)		
	Erdman Ave./Northpoint Blvd. (MD 151)		
	Patapsco Ave./Caton Ave. (MD 173)		
	Loch Raven Blvd. (MD 542)		

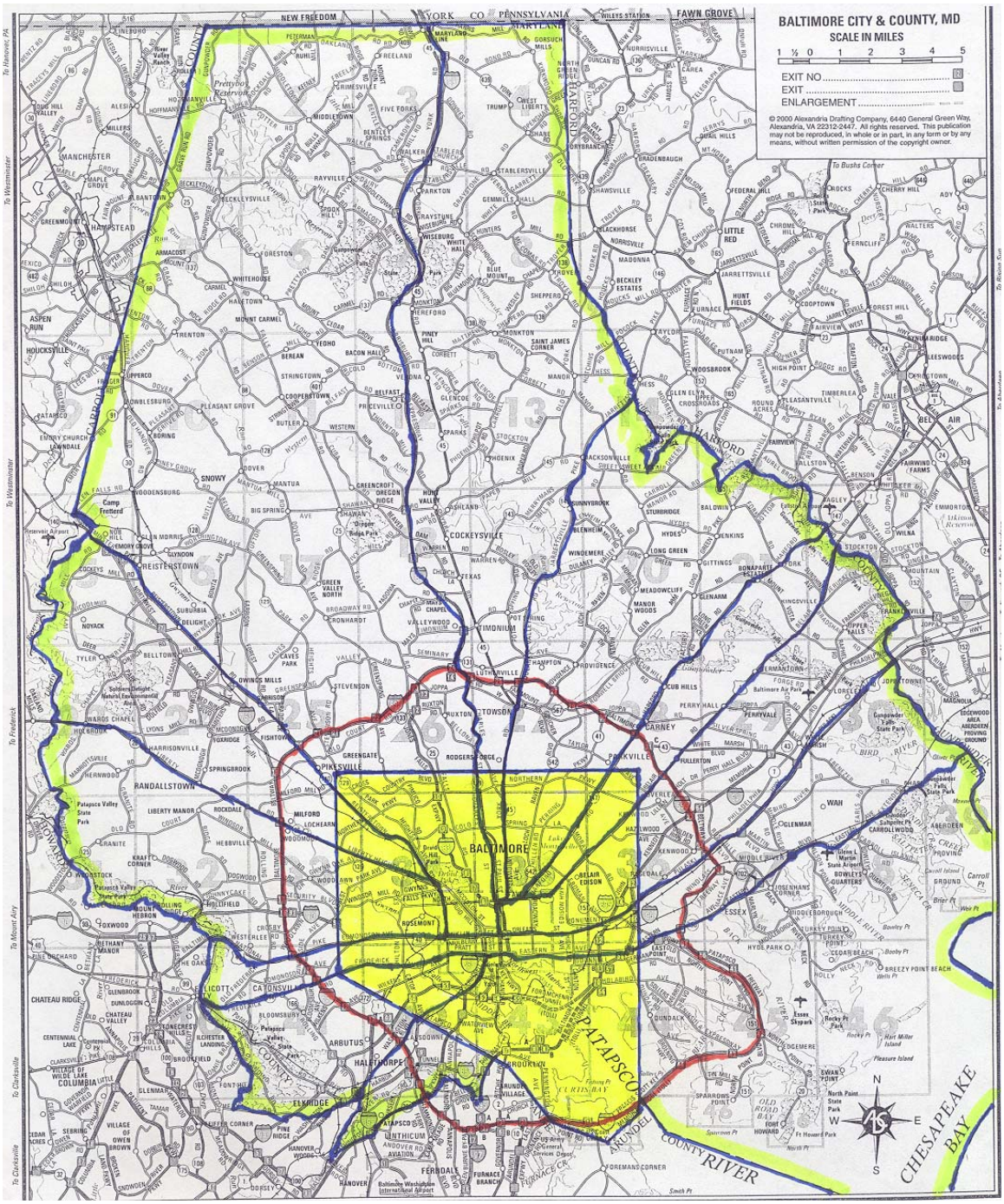
Source: Maryland State Highway Administration District 4, Highway Location Reference, 2001.

Figure 5 Traffic Counts Baltimore Metropolitan Area (Average Daily Traffic 2001)



Source: Maryland State Highway Administration.

Figure 6 Baltimore: Radial Thoroughfares and the Beltway



A widespread assumption during the 1970s was that beltway construction undermined central city development. Impacts of beltways included some shift to the suburbs of high-rise office development and a change in the location and timing of regional shopping malls during the 1980s (Schwager 1997).

THE EMPIRICAL FRAMEWORK: Baltimore Metropolitan Area

The objective of this study for the Baltimore metropolitan area is to detect and measure the impacts of major thoroughfares on apartment and commercial prices or values, other influential variables held constant. To measure the impacts of the area's major thoroughfares on apartment prices, the following empirical model was estimated:

$$SP_i = \alpha_0 + \beta_1 \text{BLDG SF}_i + \beta_2 \text{SITE SF}_i + \beta_3 \text{UNITS}_i + \beta_4 \text{SALE}_i + \beta_5 \text{THORO}_i + \beta_6 \text{CBD}_i + \beta_7 \text{BELT}_i + \beta_8 \text{RENT}_i + \beta_9 \text{HHINC}_i + e_i$$

where:

SP_i = the sales price of the *i* th apartment;
BLDG SF = size in square feet of the apartment;
SITE SF = size of the lot in square feet;
UNITS = number of units making up the bldg. (studio = 1, single bedroom = 2, double bedroom = 3, etc.);[8]
SALE = months since sale;
THORO = distance in feet from the nearest thoroughfare;
CBD = distance in feet from the center of the CBD;
BELT = distance in feet from beltway;
RENT = median rent in the census tract (2000);
HHINC = household income in the census tract (2000);
e = an error term.

Selling price and other data of single and multi-family housing was obtained through the Metropolitan Regional Information Systems, Inc. (MRIS). Supplemental data was obtained from the Maryland Department of Assessment and Taxation (MDAT).

Little commercial data for the Baltimore area was available from MRIS, mostly small shops and bars. A significant number of commercial properties were necessary for multiple regression analysis, so the analysis focused on apartments. There is little empirical research of this sort on commercial properties, probably due to the difficulty in obtaining data.

Distances, latitude and longitude were obtained using TransCAD® software, accurate to within 25 feet. One hundred eighty-eight MLS sales observations were crossed checked

[8] The variable UNITS reflects relative size of apartment buildings as follows:

with data from the MDAT, which is publicly available online. Square footage for all apartments were obtained. Census tract data was available online from the 2000 Census.

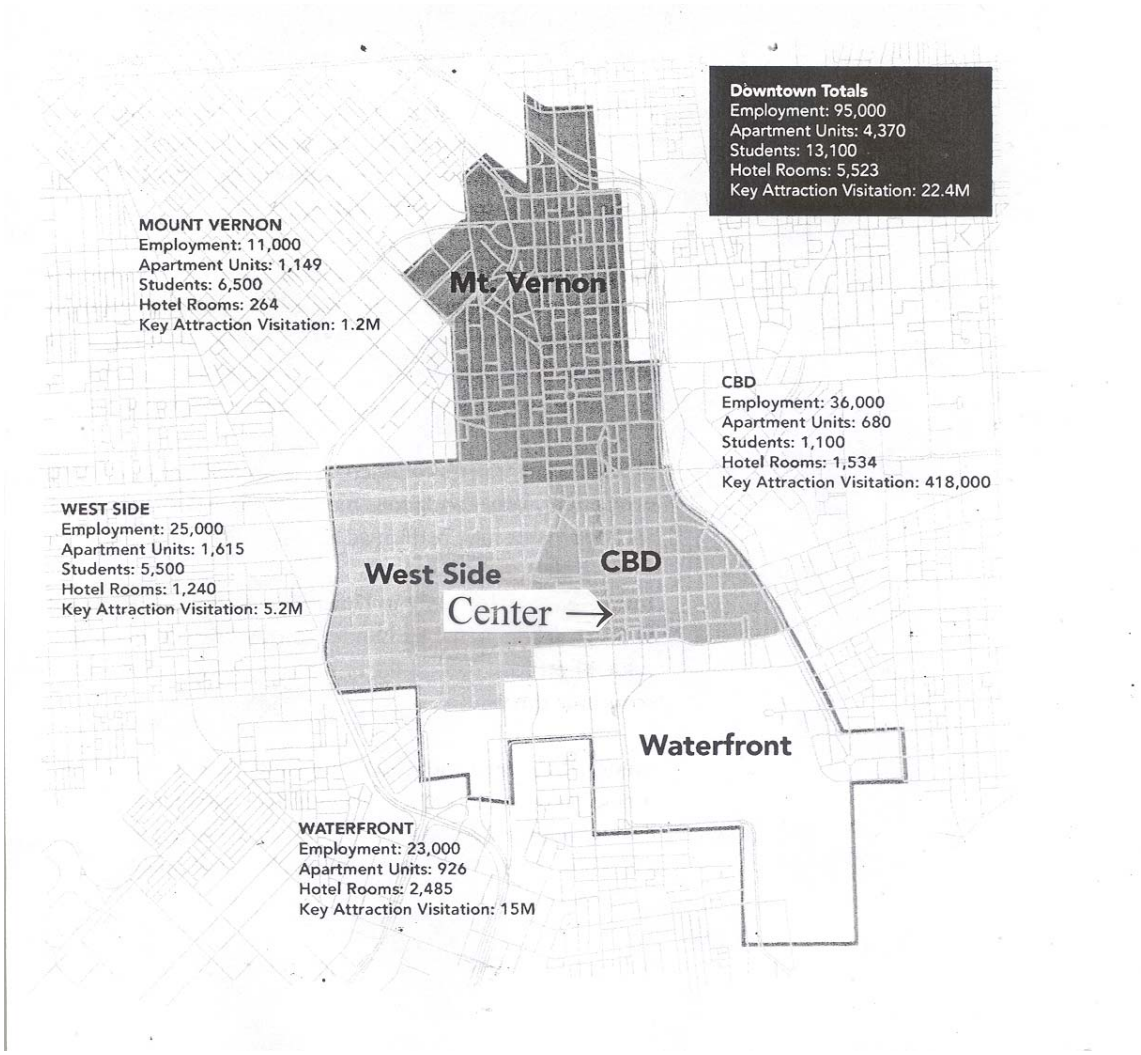
The center of Baltimore (Figure 7) is the center of the tract of land containing the downtown courthouse. This point is about a block from the intersection where all city streets separate into north, south, east and west demarcations. It is also centrally located within the downtown sub-district designated the "Central Business District" by the Downtown Partnership of Baltimore.[9]

The same hedonic model was used for two sets of data: 1) apartment data within Baltimore County (outside the city), and 2) apartment data for both Baltimore City and Baltimore County. Table 1 gives descriptive statistics for relevant variables for the 188 city and county observations. Average price for apartments outside the county was slightly higher (11 percent higher) than for apartments in the city. Average rent and income were higher for the census tracts outside the city than for the census tracts inside the city, by 22 percent and 21percent respectively. Apartments outside the city on average were farther from the closest radial thoroughfare (44 percent farther) and farther from the city center (42 percent further), but closer to the beltway (72 percent closer), than were apartments inside the city on average.[10]

[9] Downtown Partnership of Baltimore, Inc., 217 N. Charles Street, Suite 100, Baltimore, MD 21201, 410-224-1030.

[10] The radial thoroughfares are on average much closer together at the city-county border, and separate significantly as they extend into the county (see Figure 6).

Figure 7 Center Point for Baltimore Metropolitan Area



Source: Downtown Partnership of Baltimore

Table 1 Summary Statistics for Relevant Apartment Data for Baltimore (All Data)

Variable	Mean	Standard Deviation	Minimum	Maximum
Apartment				
SP	$135,926	$80,685	$50,000	$532,000
BLDG SF	2,631 SF	1,530 SF	936 SF	13,482 SF
SITE SF	8,709 SF	17,077 SF	840 SF	158,558 SF
UNITS	7.81	4.44	2	32
SALE	26 months	35 months	2 months	64 months
Distance				
THORO	0.51 miles (6.74 blocks)	0.66 miles (8.61 blocks)	0.00 miles (0.00 blocks)	3.84 miles (49.92 blocks)
CBD	4.05 miles (52.70 blocks)	2.52 miles (31.20 blocks)	0.70 miles (0.91 blocks)	12.5 miles (162.5 blocks)
BELT	2.03 miles (26.39 blocks)	1.86 miles (24.18 blocks)	0.05 miles (0.65 blocks)	6.40 miles (83.20 blocks)
Neighborhood				
RENT	$577	$141	$182.00	$1,408
HHINC	$36,575	$13,236	$9,010	$77,340

Regression Analysis: Results

The results for the two estimations are reproduced in Tables 2 and 3. R-Square and Adj. R-Square demonstrate that about 60 percent of the variation in apartment price is explained by the independent variables that characterize the apartments. The variance inflation factors (VIFs) on the right-hand side are checks for multicollinearity. All the VIFs are less than 10, which indicates the absence of serious multicollinearity among variables and assures us that the R-square and Adj. R-Square and other multiple regression measures will be reasonably accurate.

Individual impacts of apartment, neighborhood and distance variables can be discerned for T-ratios. A T-ratio of around 2.00 or a little lower (e.g. 1.66) shows the characteristic impacts apartment values.[11] Impacts of apartment, neighborhood and time-of-sale variables are generally as expected. Here square footage and number of units positively impact apartment price, while time since sale (inflation) and distance from the CBD negatively impact apartment price. So size of apartments generally adds to prices, as expected, and we can expect prices to rise slightly with time on the market. Average household income within the census tract also has a positive impact on apartment prices.

The interesting point to note is that neither distance to a radial thoroughfare nor distance from the Baltimore Beltway impact property prices**,** though according to the theory increased accessibility due to these thoroughfares should positively impact price. However, separating the apartment data into county data versus combined city and county data shows slightly different results. Analysis of apartment data for just Baltimore County (in Table 3) shows that prices tend to decline with distance from the nearest radial thoroughfare, with positive impact of accessibility to the CBD also clearly present. This result is not surprising, since the radial thoroughfares spread out past the city limits. These transportation routes in outlying areas still impact apartment values, whereas in the city their importance has declined.

[11] Significant at the 90 percent level or higher.

Table 2 Price per Square Foot Regressed on Distance, Apartment and Neighborhood Characteristics (Baltimore City & County)

Variable	Coefficient	T-ratio	Prob.	Variance Inflation
Apt. Square Feet (BLDG SF)	32.6272	9.29	<.0001	1.8473
Lot Square Feet (SITE SF)	0.4201	1.59	0.1135	1.3013
Weighted Units in Bldg. (UNITS)	2232.72	1.96	0.0515	1.7275
Months Since Sale (SALE)	- 83.4743	- 1.91	0.0618	1.0103
Distance from Thorofare (THORO)	- 11490	- 0.51	0.6113	1.1664
Distance from CBD (CBD)	- 58631	- 2.11	0.0364	1.7441
Distance from Beltway (BELT)	- 1174.60	- 0.50	0.6182	1.2204
Census Tract Median Rent (RENT)	36.1774	0.80	0.4255	2.5987
Census Tract Median HH Inc. (HHINC)	1.4305	2.78	0.0061	2.9736

N = 188

R-Square = 0.5725

Adj. R-Square = 0.5509

F Value = 26.48

Table 3 Price per Square Foot Regressed on Distance, Apartment and Neighborhood Characteristics (Baltimore County Data Only)

Variable	Coefficient	T-ratio	Prob.	Variance Inflation
Apt. Square Feet (BLDG SF)	29.047	6.68	<.0001	1.7949
Lot Square Feet (SITE SF)	3.313	2.74	0.0072	1.9802
Weighted Units in Bldg. (UNITS)	2793.21	2.24	0.0272	1.4686
Months Since Sale (SALE)	- 64.73	- 1.80	0.0741	1.0434
Distance from Thorofare (THORO)	- 42840	- 1.99	0.0514	1.5851
Distance from CBD (CBD)	- 59634	- 4.23	0.0001	2.1565
Distance from Beltway (BELT)	2110.84	0.63	0.5304	1.5746
Census Tract Median Rent (RENT)	24.06	0.41	0.6807	2.7478
Census Tract Median HH Inc. (HHINC)	1.1362	1.66	0.0988	2.7951

N = 122

R-Square = 0.5874

Adj. R-Square = 0.5542

F Value = 21.38

Price Gradients

The analysis also has something to say about the rates at which apartment prices decrease 1) with distance from the CBD (for both the county data and for the city and the county data combined) and 2) with distance from the nearest radial thoroughfare (for the county data). The coefficients (or parameter estimates) for the apartment characteristics are listed in the second columns of Tables 2 and 3 and reflect change in apartment prices, on average, with distance from the CBD or radial thoroughfare, in miles. Coefficients for distance from the CBD in Tables 2 and 3, and distance from the nearest thoroughfare (THORO) in Table 3, reflect decline in average apartment price of around three to five percent for each block distance from the city center and from a radial thoroughfare, commensurate with past findings.

Frew and Wilson (2000) detected a "rent gradient ridge" outside the city center where rents dropped near major highways, rose to about four miles from the highway, and then dropped pursuant to the general rent gradient extending from the CBD (see Figure 2). This study, as have others, did not detect a "rent ridge" from radial thoroughfares. Apartments in general appear to be less sensitive to the deleterious effects of immediate proximity to highways.

Road Widening

A dummy variable was added to the model (using both databases) in an attempt to discern if recent road widening on US 1 and US 40 impacted apartment prices. US 1 is commonly called Belair Road at the Northeast corner of the BMA and Washington Boulevard at the Southwest corner of the BMA. US 40 is commonly called Pulaski Highway on the eastern side of the BMA and Edmondson Avenue on the western side of the BMA. Substantial road widening occurred on US 40 northeast of Baltimore and just east of the beltway, and southeast of Baltimore, east of the beltway. Regression analysis did not show the dummy variable to be significant; thus, recent road widening did not appear to have significant (or lasting) impact on apartment prices.

THE EMPIRICAL FRAMEWORK: Lower Eastern Shore

The objective of the Lower Eastern Shore analysis was to detect and describe location patterns of sizeable apartments and commercial properties. Primarily, the study focused on measuring how these property types follow the three primary highways in Wicomico and Worcester counties, US 50, US 13 and US 113. Though this phenomenon can easily be represented visually, and is intuitively easy to understand, the object was to describe it in statistical terms. The R statistic from Nearest Neighbor Analysis was used as a measure of clustering (Lee and Wong 2001). This analysis was used because of insufficient data for a regression model.

The MDAT provided 65 recent sales of apartment and commercial buildings located in Wicomico and Worcester counties whose prices exceeded $100,000.[12] These properties ranged from older, two-story apartment buildings in Ocean City to a new Wal-Mart in Salisbury. A map of approximate locations is shown in Figure 8. Descriptive statistics of prices and distances from US 50, US 13 or US 113 are shown in Table 4.

No price gradient was detected from a city center (e.g., Salisbury or Ocean City), which was to be expected in this rural area. Property locations are very clustered in the area, near the towns and along the highways, when measured by the R statistic (randomness) of Nearest Neighbor Analysis (Lee and Wong 2001). On a scale of R = 0 (most clustered) to R = 1 (most dispersed) the locations rate an R of 0.003.

Average distance to the highway (both apartment and commercial properties) was 0.3476 miles (4.4 blocks) and median distance to the highway was 0.2950 miles (3.8 blocks), which compares to mean distance to the radial thoroughfares in Baltimore of 0.51 miles (6.74 blocks)(apartment properties only). This broad overview shows the Lower Eastern Shore properties cling relatively tightly to main highways, especially within the cities, consistent with the assumption that location value is not being internalized. This result is also consistent with the notions that walking distance from the highways is important and that plenty of space exists for further expansion.

[12] This was an insufficient number of observations for regression modeling.

Figure 8 Properties in Wicomico and Worcester Counties

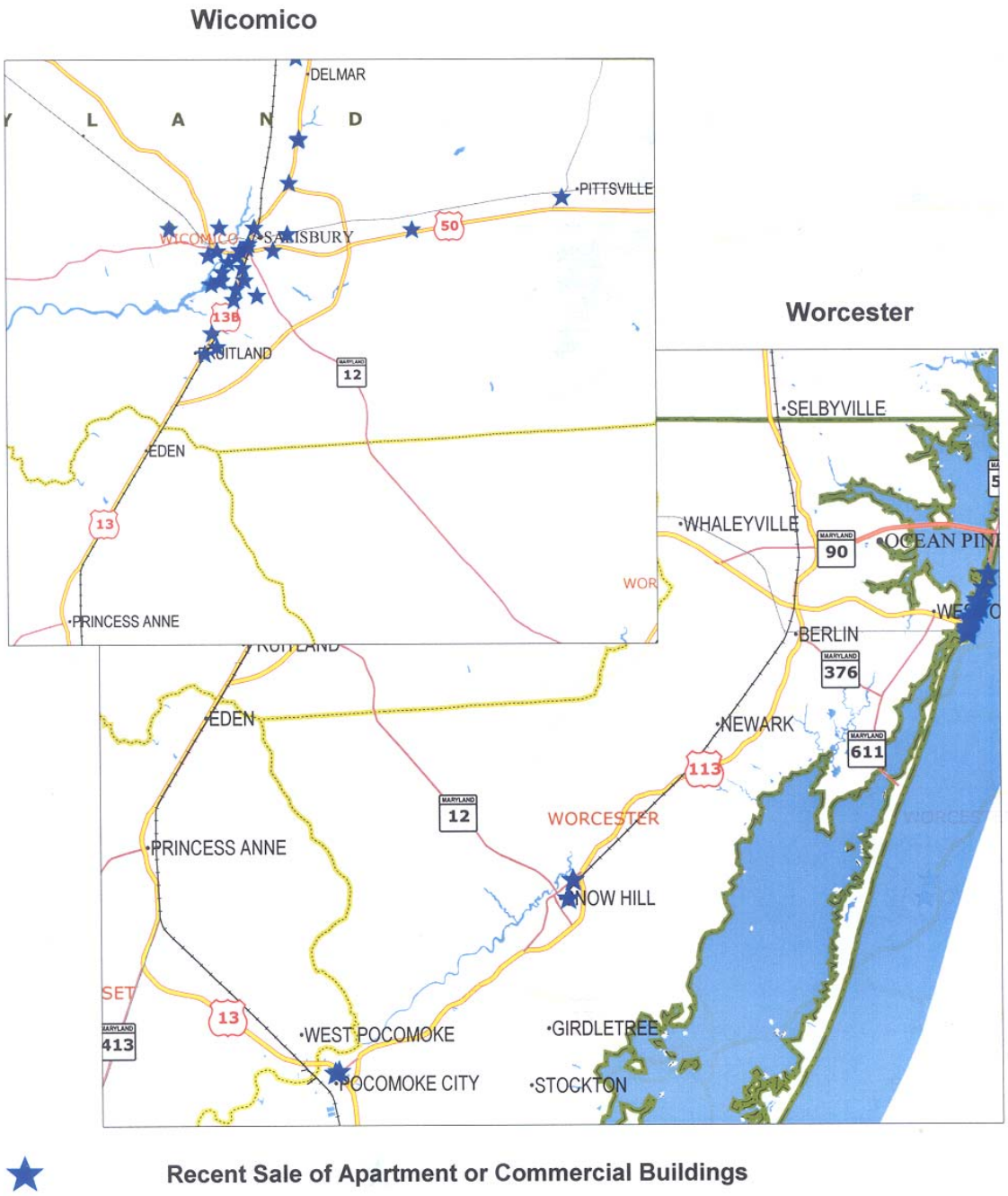


Table 4 Summary Statistics for Wicomico and Worcester Counties

Variable	Mean	Standard Deviation	Minimum	Maximum
Assessed Value	$1,735,768	2,663,702	$100,000	$10,528,000
Distance to Highway (miles)	0.3476	0.73820	0	1.6900

SUMMARY AND CONCLUSIONS:

Most studies have shown that roads or thoroughfares have a positive effect on property values or sales prices. In the long run the effect is usually positive, but for a particular time period the impact may not be positive. The losses of values from sales during construction are usually overcome by increasing property values after construction is completed. The study of the Superstition Freeway in Arizona observed that there is a positive effect on multifamily residential and commercial properties from proximity to the thoroughfare. Sale prices of multifamily units are enhanced by immediate access to major thoroughfares. Relying on just a few data points, the study also concluded that the distribution of commercial development is clearly associated with freeway locations, particularly for office and retail establishments, but the distance effects are unclear.

Past urban research on the impact of thoroughfares on apartment prices is confirmed by analysis of data in the Baltimore Metropolitan Area with respect to two of the three hypotheses tested. Azabere and Huffman's Philadelphia study looked at just the two main thoroughfares that crisscrossed the city, while the authors of this Baltimore study attempted to discern the impact of 11 main radial thoroughfares radiating from Baltimore CBD into the suburban area and the beltway surrounding the city.

No impacts on apartment prices were found for the radial thoroughfares within the city limits, but county data did reflect that radial transportation routes positively impact the pricing of apartments. Simply, the impact of these radial thoroughfares was evident at the point where they were separated by some distance, beyond the city limits. At the city limits these thoroughfares average 2.9 miles apart, while at 3 miles distance from the city limits the average is 4.3 miles. Half way between the city center and the city limits, roughly 3 miles distance from the city center, average distance between the radial thoroughfares is 1.2 miles. At six miles distance from the city limits the thoroughfares average 6.0 miles apart.[13] Thus most county observations are about five times the distance from a radial thoroughfare than city observations.

Advanced statistical analyses of spatial data, assuming abundant available date, could hold promise for further study of the interaction of transportation routes and apartment values (see, e.g., Des Rosiers, et al., (2001)). How exactly the Beltway figures in on accessibility and on the pricing impact may become determinable after further detailed research. However, nothing in this study showed there was a price gradient extending from the Baltimore beltway.

Descriptions of properties on Maryland's Eastern Shore show an obvious dependency on highways, but according to urban economic theory, the reasons are very different from those of urban Baltimore. Though the distribution is intuitively obvious, and the area's highways are obvious important, the authors know of no way to price distance from transportation routes in the area as was the case for Baltimore.

[13] Three of the 11 thoroughfares, at the southeast corner of the Baltimore metropolitan area, do not extend this far into Baltimore County.

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References

Al-Mosaind, M., K. Dueker, and J. Strathman (1993) "Light Rail Systems & Property Value," Transportation Research Record 1400: 90-94.

Alonso, W.(1964) Location and Land Use, Cambridge, Mass.: Harvard University Press

Anas, A., R. Arnott and K. Small (1998) "Urban Spatial Structure," Journal of Economic Literature, 36: 1426-1464.

Asabere, P.K., and F. E. Huffman (1996) "Thoroughfares and Apartment Values," Journal of Real Estate Research 12(1): 9-16.

Buffington, J. and M. Waldenthal (1998) Estimated Economic Impact of Selected Highway Widening Projects in Texas, Final Report FHWA-TX-01-260, available to public through National Technical Information Service, Springfield, VA 21261.

Cary, J. (2001) Impact of Highway on Property Values: Case Study of the Superstition Freeway Corridor, Final Report FHWA-AZ-01-516, available to public through National Technical Information Service, Springfield, VA 21261.

Carter, C. and W. Haloupek (2000) "Spatial Autocorrelation in a Retail Context," International Real Estate Review 3: 1.

Des Rosiers, F., M. Theriaut, Y. Kestens, and P. Villeneuve (2001) "Neighborhood Profiles and House Values: Dealing with Spatial Autocorrelation Using Kriging Techniques," presented at the AREUEA Meetings.

Frew, J., D. Jud and D. Winkler (1990), "Atypicalities and Apartment Rent Concessions," Journal of Real Estate Research 5(2): 195-202.

Frew, J. and B. Wilson (2000) "Transportation Routes, Apartment Rents, and the Assessment of Value," in J. R. DeLisle and E. M. Worzala, eds., Essays in Honor of James A. Grasskamp: Ten Years After, Boston: Kluwer Academic Press.

Gatzlaff, D., G. Sirmans and B. Diskin (1994) "The Effect of Anchor Tenant Loss on Shopping Center Rents," Journal of Real Estate Research 9(1) : 99-110.

Guidry, K A. and C. F. Sirmans (1993) "The Determinants of Shopping Center Rents," Journal of Real Estate Research, 8(1) : 107-116.

Hardin, W. and M. Wolverton (2000) "Micro-Market Determinants of Neighborhood Center Rental Rates," Journal of Real Estate Research 20(3): 299-322.

Hoyt, H. (1933) One Hundred Years of Land Values in Chicago, Chicago: University of Chicago Press.

Lee, J. and D. Wong (2001) Statistical Analysis with GIS, New York: John Wiley & Sons.

Malpezzi, S., K. Seah, and J. Shilling, "Is It What We Do or How We Do It? New Evidence on Agglomeration Economies and Metropolitan Growth," paper given at the ARES/AREUEA conference (July 2002).

Mills, E. (1972) Studies in the Structure of the Urban Economy, Baltimore: The Johns Hopkins Press.

Muth, R. (1969) Cities and Housing, Chicago: University of Chicago Press.

Nelson, A. (1999) "Transit Stations and Commercial Property Values: a Case Study with Policy & Land-Use Implications," Journal of Public Transportation 2: 3 77-95.

Pace, R.K. and O.W. Giley (1997) "Using the Spatial Configuration of the Data to Improve Estimation," Journal of Real Estate Finance and Economics, 14(3) : 333-340.

Pieser, R. (1987) "The Determinants of Nonresidential Urban Land Values," Journal of Urban Economics 22 (1987): 340-360.

Hurd, R.M. (1924) Principles of City Land Values, New York: Record and the Guide.

Ricardo, D. (1818) Principles of Political Economy and Taxation, London: John Murray.

Ryan, S. (1999) " Property Values and Transportation Facilities: Finding the Transportation – Land Use Connection," Journal of Planning Literature 13. pp. 412-427.

Schwager, D. S.(1997) "Consequences of the Development of the Interstate System for Transit," Research Results Digest, 21, Transportation Research Board, National Research Council, Washington, DC: 1-22.

Siethoff, B. and K. Kockelman (2002) "Property Values & Highway Expansions: An Investigation of Timing, Size, Location, & Use Effects," presented at the TRB annual meeting.

Sirmans, C.F., G. Sirmans and J. Benjamin (1994) "Apartment Rent Concessions and Occupancy Rates," Journal of Real Estate Research 9(3): 299-312.

Sirmans, C.F., and C. Guidry (1993) "The Determinants of Shopping Center Rents," Journal of Real Estate Research 8(1): 107-115.

Srour, I., K. Kockelman, & T. Dunn (2002) "Accessibility Indices: A Connection to Residential Land Prices & Location Choices," presented at the TRB annual meeting.

Vadali, S. and C. Sohn (2001) “Using a Geographic Information system to Track Changes in Spatially Segregated Location Premiums: Alternative Methods for Assessing Residential Location Use Impact of Transportation Projects,” Transportation Research Record, Transportation Research Board, Washington, DC: 180-192.

Von Thunen, J. (1920) The Isolated State, Jena: G. Fischer.