Mass Transportation, Apartment Rent and Property Values

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Abstract. **Rent plays a vital role in property valuation because any positive or negative influence on rent will in turn affect a property's value. This paper examines the effect of mass transportation on apartment rent. Specifically, this study investigates the impact on rent and value for residential income properties located in close proximity to Washington, D.C. Metrorail stations. After reviewing the empirical research which has focused on the effect of mass transportation availability on property values, this paper examines the benefits on apartment rent of Washington, D.C. apartment buildings from location near Metrorail stations. Our empirical results show that distance from a metro station has an adverse effect on apartment rent, i.e., each one-tenth mile increase in distance from the station results in a decrease in rent per apartment unit of about 2.50%. This analysis should be of interest to a host of domestic and international market participants including academics who study real estate markets, tax assessors who determine market value, appraisers who make market-derived rent adjustments, and property managers who set apartment rents.**

Introduction

Rent in the United States plays a vital role in property valuation and decisions about new construction. Identifying positive or negative influences on rent will provide decisionmakers with information to support decisions about whether or not to develop new or expand existing properties.[1] The paper provides information on mass transportation and apartment rents. This analysis should contribute knowledge about the transportation factors that are important in the determination of apartment rent in one of the world's most competitive real estate markets.

Using data for over 250 apartment observations from Washington, D.C., this paper develops a model to determine the effect on rent of mass transportation measured by the presence of a Metrorail station. Empirical results showing proximity to a Metrorail station as having a positive effect on rent would indicate enhanced demand and demonstrate that apartment owners would want to build multifamily properties near available mass transportation.[2] This finding is consistent with the notion that landlords would wish to maximize profit and, therefore, select apartment sites that increase rental demand for their properties.

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Background and Previous Literature

Mobility has always played a critical role in the evolution of urban development because proximity to work or other central points is an important determinant of rent and property value. In recent years, transportation has been a factor in the decentralization of cities, giving rise to various issues such as urban sprawl, traffic congestion and downtown revitalization as well as prompting policymakers and planners to seek more efficient land-use patterns. Fixed-rail transportation is considered one means to shape urban form, as evidenced by changes in property rental rates and values. Ferguson, Goldberg and Mark (1988) conclude that changes in access and transportation can have impacts on urban land and housing markets, including both price effects and land use effects.

Changes in property rents and values may arise with increased access, lower commuting costs, and/or potential changes in property utilization. Changes in value are important because they typically occur faster than changes in land use and may thus influence or change urban form. From this standpoint, our study of the D.C. Metrorail's effect on property rents and, therefore, on values is interesting. Because such a transportation system can influence development, policymakers and planners can employ it as a means to influence growth and revitalize certain areas rather than simply follow growth patterns. Such was the case with the Miami Metrorail system (see Gatzlaff and Smith, 1993).

Research confirms that metro systems have an impact on property values. One of the most significant impacts of a transit system has occurred in Toronto where transit corridors have experienced intense development. The first line was opened in 1954 and the last in 1977, resulting in a thirty-two-mile network. A study by Bajic (1983) shows that residential values were $2,237 higher near these rail lines than elsewhere. In Philadelphia, a study by the Joint Center for Urban Mobility Research (1987) on the effect of the Lindenwold line, which runs 14.5 miles from Philadelphia to the New Jersey suburbs, shows nearby housing values increased by 7%, or $4,500, on average. Voith (1991) finds that accessibility to train service resulted in an impact of a $5.714 average premium throughout Philadelphia. Gatzlaff and Smith (1993) find evidence, although weak, of increases in house values proximate to Miami Metrorail stations. Studies of the San Francisco Bay Area Rapid Transit (BART) show that the overall impact on land values has been modest but significant as property prices and rents have increased in certain station areas (Giuliano, 1986).

Although these studies confirm that the presence of a Metrorail system affects property values, research measuring the effect of a Metrorail system on income-producing properties is limited. For example, Ferguson et al. (1988), Gatzlaff and Smith (1993), Voith (1991), the Joint Center for Urban Mobility Research (1987), and others have measured primarily its effect on residential values. Studies of BART, however, have examined values and rents and show that both were raised in certain station areas (Giuliano, 1986). Since property value is a function of income, this study will fill an important gap in the literature by examining the effect of a mass transportation system on rents of residential income-producing properties.

Even in well-developed markets such as those in the United States and Great Britain, overbuilding and other economic influences have caused the real estate rental market to become fiercely competitive. Thus, it becomes important to recognize those mass transportation factors that impact on rent. Sherrod (1992), for example, indicates that rents in Chicago were expected to rise only marginally in 1992 and that transportation accessibility has been popular to maintain existing renters. Salter (1992) cites examples of use of an automobile as a concession to obtain renters in London.

Additional significance for examining the Washington, D.C. Metrorail system comes from the fact that it is a 101-mile network. In contrast, the Toronto system is thirty-two miles, the San Francisco Bay Area Rapid Transit is seventy-one miles, and the Miami Metrorail is twenty-one miles. Thus a study of the Washington, D.C. Metrorail allows not only a study of multifamily income properties but also analysis of a system with a much larger geographical base.

Model

To determine whether or not available transportation affects apartment rents and, therefore, value, we estimate hedonic models based on July 1992 apartment rents for over 250 rent observations from eighty-one apartment complexes in Washington, D.C.[3] The selection of Washington, D.C. as the sample source is deliberate. The Washington, D.C. housing market is typical of many large metropolitan housing markets; thus the competitive market practices that occur there should be representative of other cities. Summary statistics are given in Exhibit 1.

The following hedonic model (based on Guntermann and Norrbin, 1987) is employed to determine the extent to which the presence of a Metrorail station influences apartment rent:

$$Rent_i = f(P_{ij}, L_i, OCC_i, DEPOSIT_i, DISMETRO_i) \qquad i=1, \ldots, n \quad j=1, \ldots, n \tag{1}$$

where

$Rent_i$ = the observed monthly rent on the i^{th} apartment unit;

P_{ij} = a set of j physical characteristics for the i^{th} apartment including:

(a) the number of bedrooms (efficiency, one, two, three, or four bedrooms),
(b) the number of bathrooms,
(c) 0–1 dummy variable for all utilities paid,
(d) 0–1 dummy variable for parking available,
(e) 0–1 dummy variable if the apartment building is a high rise,
(f) 0–1 dummy variable if the apartment has a fireplace, and
(g) 0–1 dummy variable if the apartment has washer/dryer hookups;

L_i = a location variable identifying the i^{th} apartment by zip code;

OCC_i = the occupancy rate for each complex as a percentage of total apartment units in the complex;

$DEPOSIT_i$ = 0–1 dummy variable for the requirement of a security deposit for apartment i (one month's rent in all cases); and

$DISMETRO$ = distance to a Metrorail station in tenths of miles for the i^{th} apartment.

Because the square footage of each unit is not available, *number of bedrooms* stands as a proxy for apartment unit size. As rent should increase with size, its coefficient is

Exhibit 1
Summary Statistics for Variables in the Rent Model

Variable	Mean	Std Dev.	Minimum	Maximum
Rent	797.85	292.71	404	2375
Occupancy Rate	95.13	4.49	80	100
Distance to Metro	1.33	1.29	0	6
Deposit	.63	.34	.08	1
No. of Bedrooms	1.24	.69	.50	3
No. of Bathrooms	1.15	.36	1.00	2.5
All Utilities Paid	.67	.47	0	1
Parking Available	.90	.29	0	1
High Rise Building	.82	.38	0	1
Fireplace	.12	.32	0	1
Washer/Dryer in Unit	.09	.29	0	1
Z20001	.04	.20	0	1
Z20005	.06	.24	0	1
Z20007	.06	.24	0	1
Z20008	.19	.39	0	1
Z20009	.11	.32	0	1
Z20016	.10	.30	0	1
Z20036	.05	.22	0	1
Z22201	.04	.19	0	1
Other Zip Codes*	.35		0	1

n=251.
*Other Zip Codes includes a cumulation of zip codes where less than 3% of the observations in the sample came from each area.

expected to be positive. A positive relationship is also expected between rent and number of bathrooms.

The coefficients for *all utilities paid, parking available, fireplace,* and *washer/dryer hookups* are expected to be positive. The coefficient on *high rise* is also expected to be positive if tenants prefer high rise units to garden style apartments, a likely preference because most high rises have a secured entry. The *location zip code* variables are employed to hold constant location influences, and the coefficients for the *zip code* dummy variables will vary depending on the desirability of the area.

The relationship between *rent* and *occupancy* is less clear. In a market of high or excess demand (a surplus of renters), occupancy (demand) should drive rent and a positive relationship would result. However, if occupancy is a function of rent (as in a market with an excess supply of apartments), there would be an inverse relationship between rent and occupancy.

The availability or accessibility to public transportation such as a Metrorail system should increase the demand for apartment space. Consequently, apartment complexes located near Metrorail stations should command greater rent. These higher rents lead to greater property values and, in turn, should affect apartment construction and renovation decisions by investors and other suppliers of apartment space.

Model Estimation

Application of the data to equation (1) produces an estimate of the effects of the independent variables including location near a Metrorail station on apartment rents. Equation (1) is first estimated with rent in semilog form using OLS and the results are given in column two of Exhibit 2.[4] The variables behave as expected. All the physical characteristics are significant except *all utilities paid,* and all have positive signs. The

Exhibit 2
OLS and 3SLS Regression Results for the Rent Equation

Variable	OLS Results	3SLS Results
Intercept	5.47	1.265
	(19.71)*	(.67)
OCCRATE	.005	1.030
	(1.86)*	(2.51)*
DISMETRO	−.024	−.026
	(−2.44)*	(−2.55)*
DEPOSIT	−.138	−.127
	(−3.76)*	(−3.36)*
BDRMS	.243	.251
	(12.08)*	(12.12)*
BATHS	.107	.094
	(2.78)*	(2.37)*
ALLUTIL	.034	.011
	(1.21)	(.364)
PARKAVL	.163	.178
	(3.84)*	(4.10)*
HIGHRISE	.084	.100
	(2.64)*	(2.98)*
FIREPLACE	.058	.054
	(1.62)*	(1.51)
WD UNIT	.333	.327
	(7.20)*	(6.97)*
*Z*20001	−.218	−.212
	(−3.50)*	(−3.36)*
*Z*20007	.250	.290
	(4.84)*	(5.09)*
*Z*20008	.200	.189
	(6.11)*	(5.64)*
*Z*20016	.236	.224
	(5.66)*	(5.28)*
*Z*20036	.346	.353
	(6.61)*	(6.66)*
*Z*22201	−.145	−.167
	(−2.25)*	(−2.53)*
R^2	.744	
System Weighted R^2		.676

t-statistics in parentheses
*denotes significance at .10 level
Dependent variable: Ln*Rent*; occupancy is unlogged in OLS equation and logged in the 3SLS equation.

positive sign of *occupancy* indicates a market of strong demand. The variable of interest, *DISMETRO,* is significant with a negative sign indicating that rents decrease as distance from a metro station increases. The coefficient of −.0242 shows that with each one-tenth-mile increase in distance from a metro station, monthly rent decreases by 2.42%.[5] Thus, when distance has increased to one-half mile from the metro station, rent has declined by more than 10%.[6]

Because there is likely to be some simultaneity in the determination of *rent* and *occupancy,* equation (1) is also estimated in a three-stage least squares (3SLS) model with an occupancy equation.[7] The results from this estimation are given in column three of Exhibit 2.[8] Again, the results are as expected with all variables significant, except *all utilities paid* and *fireplace.* The *DISMETRO* variable has a negative coefficient of −.026 indicating that with each one-tenth-mile increase in distance from the metro station, rent decreases by 2.6%.

Summary and Conclusions

To determine the effect of public transportation accessibility on rent for multifamily residential properties, using apartment data for the Washington, D.C. area, we have estimated a model to measure the effect of proximity of the Metrorail stations on apartment rent. Our results show an inverse relationship between distance from a metro station and rent. We first estimate the model in OLS form and then in 3SLS (GLS) form to account for the simultaneity of rent and occupancy. In either form of estimation, while distance from a metro station does not have a significant effect on occupancy, distance from a metro station is seen to have a significant effect on rent.

It is possible to use our model to make estimates of apartment rent and apartment values in specific market areas. For example, applying the long-run solution to the estimated model with data from northwest Washington, D.C., the potential space development needs, based upon expected rents, in that local market can be estimated. In periods of excessive vacancies, application of the model may impose an additional requirement: the estimate of new potential space must be adjusted by some measure of the existing level of vacant space that remains to be absorbed. Such results would have implications for developers, lenders, appraisers, and others involved in the development, financing and valuation of apartment space.

Notes

[1]Other recent empirical work has produced substantial lists of factors, attributes, or characteristics to explain the determinants of apartment rents (see Sirmans and Benjamin, 1991; Benjamin and Sirmans, 1994).

[2]A location close to a Metrorail station would be desirable to renters because it reduces commute times, increases security from shorter walking distances, and provides greater availability of goods and services from merchants typically clustered near a Metrorail station.

[3]Apartment rent data was procured from various property management firms and apartment locator services. For each observation we obtained extensive physical, locational and quality-related information that includes the standard list of characteristics typically employed to explain variations in apartment rents (see Sirmans and Benjamin, 1991 and Benjamin and Sirmans, 1994 for good overviews). Developers, property managers, and appraisers use these lists of characteristics to predict market rents and property values for income-producing residential properties.

[4]A variety of transformations of the distance to Metrorail station variable, *DISMETRO,* are explored (including distance squared, quadratic transformations of distance, the inverse of the distance, and the inverse of the square root of the distance) with results being similar to those reported in Exhibit 2. We also estimate different functional forms of the model including logarithmic and linear, and find comparable results. Following Do, Wilbur and Short (1994), who note that any bias resulting from a misspecified functional model form is minimal, the coefficients reported in the paper include only those from the semi-logarithmic model using the non-transformed distance variable. Use of the non-transformed *DISMETRO* variable allows for easy estimation of the percentage change in rent for each unit change in the independent variable.

[5]We also employ distance dummy (0,1) variables in the OLS semilog model for each one-tenth-mile increase from the Metrorail station. The distance dummy variables indicate that rent decreases as the distance from the Metrorail station increases:

Distance Dummy (0,1)	Coefficient	*t*-value
0 (tenths)	.226	3.096
1 (tenth)	.199	2.730
2 (tenths)	.225	2.983
3 (tenths)	.178	2.216
4 (tenths)	.148	1.747

[6]Other location effects are captured in the coefficients for the zip code dummy variables (proxies for location and some demographic characteristics such as income). The 20001 zip code represents a lower income area of Washington, D.C. and has negative coefficients in both results. The 22201 zip code represents greater commuter distance to Washington, D.C. and also has negative coefficients. Segmentation of the data by zip code yields results comparable to those in Exhibit 2.

[7]In a three-stage least squares estimation, the equations are in "stacked" form where generalized least squares (GLS) is applied to the system as a whole so that the parameters of all equations are estimated simultaneously using all the information in the model. A three-stage system assumes non-zero correlations between the disturbance terms across the equations and, if this is the case, the 3SLS estimators will be more efficient than those obtained by OLS.

[8]Since the primary interest is the effect of the *DISMETRO* variable on rent and occupancy, the full results for the occupancy equations are not shown because this variable is not significant in either an OLS or 3SLS (GLS) estimation. In the OLS estimation using a semilog form for occupancy, the coefficient for *DISMETRO* is $-.003$ with a t statistic of -1.19. In the 3SLS estimation, the coefficient is $-.003$ with a t-statistic of -1.11. This is not a surprising result when one considers the occupancy level of the area. Table 1 shows that the average occupancy rate is over 95%. Demand for apartment units is strong throughout the area; thus the effect of proximity to a metro station results in differentiated rent rather than occupancy.

Also, to examine the rent-occupancy relationship, we observe the coefficient for occupancy in the rent equation. The coefficient for the log of occupancy in the 3SLS rent equation estimation is a positive 1.03 and is significant. This would seem to confirm that the Washington, D.C. market is of high or excess demand where occupancy should drive rent.

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