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Impact on Property Values: A Study of the Los Angeles Metro Rail

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ABSTRACT

Effects of transit investments on property values have been difficult to analyze due to the many factors that have influence on property values and the availability of information on such factors. In a city such as Los Angeles, impacts can be caused by regional behavior as well as local behavior. This study analyzes properties to determine if the *announcement* of rail transit in Los Angeles (Metro Rail) had any significant impact on property values. Announcement is denoted as a series of federal, state, and local funding propositions that began in 1983 and was legislated in July 1988 for the purpose of transit investments in Los Angeles. Determining and measuring the extent of impacts in relation to property values can be of use to decision-makers particularly for establishing land use/transportation policies around station areas.

The period under study extends over ten years from 1980 to 1990 during which the phenomenon of the announcement -- the duration and the scale of the investment -- became *realized.* Realization is used in the context of transportation investments that are secured and rail transit that is in the process of being designed and constructed but is not in operation for revenue services.

The key in determining any significant impact to property values is in isolating other factors that may cause increase in property values, both directly and indirectly. Isolating exogenous variables thus was accomplished at two levels: macro and micro. Using a pre-test/post-test control group, property values after the *period of realization* were found to be significantly different (in appreciation) from property values before the *period of realization.* Property values near the metro rail corridor were found to have an appreciated difference from property values located a distance from the metro rail corridor.

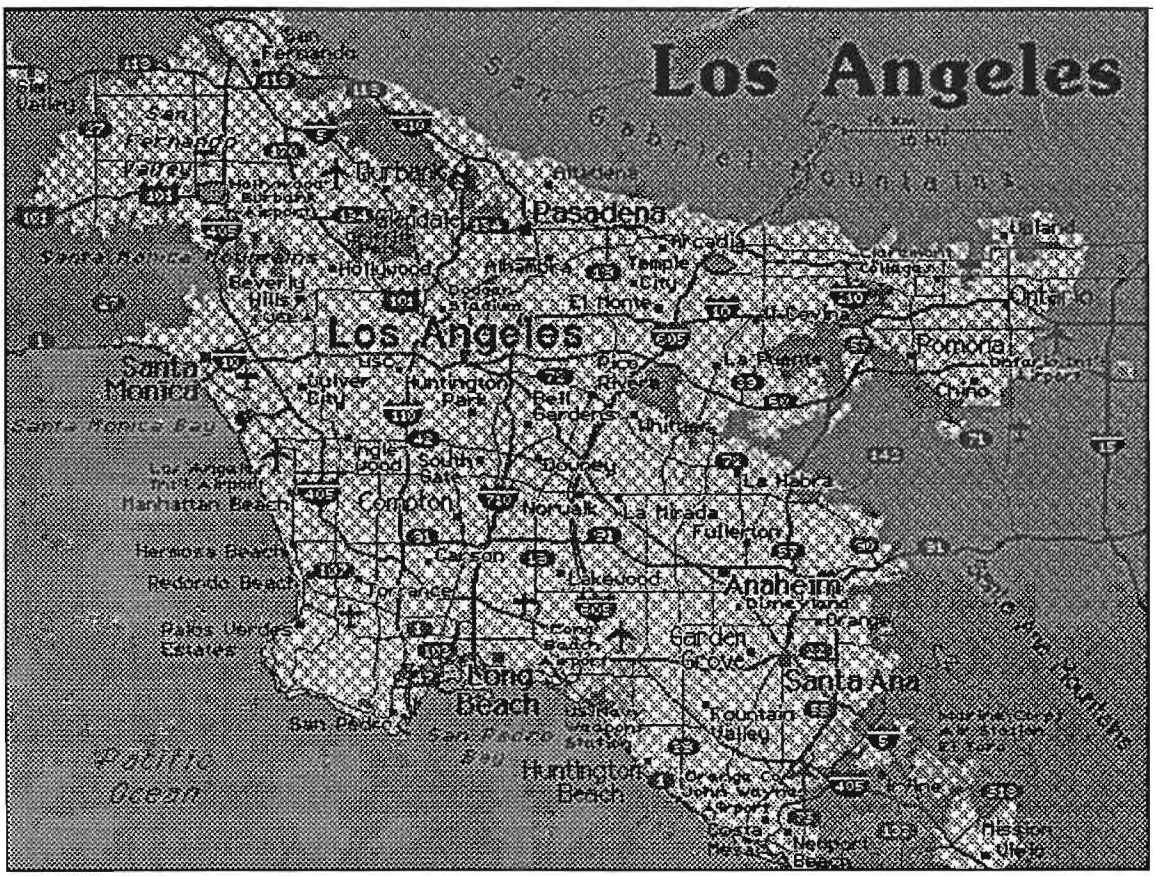
INTRODUCTION

Throughout the latter part of the twentieth century, Los Angeles had been designed around the automobile perhaps at greater lengths than any other large North American City. The present physical and cultural landscape reflects policies that have favored the automobile. To a visitor, the infrastructure would appear to be predominantly an extensive network of freeways. Residents of Los Angeles have accepted the automobile as their primary, perhaps only, mode of travel.

This manifestation is inherently supported by many who are directly responsible for the shape of the city - policy-makers, developers, financiers and business owners. In the 1960's, the same groups as well as environmentalists and economists began questioning the inefficiencies that have increased in the region. Concerned with the environment and shortage of energy (e.g., oil), rail was introduced to the region again. Major investments from federal, state and local funding sources were made to implement rail and other transit improvements.

The purpose of this study is to evaluate these investments as policy and determine their cause and effect at different periods beginning with the *announcement* of rail in Los Angeles. Announcement, a term typically used by economists, is characterized by a series of federal, state, and local funding propositions that began in 1983 and was legislated in July 1988 for the purpose of transit investments. The study period extends over ten years from 1980 to 1990. The events that have occurred are substantially measurable than the announcement of common stocks and various investment portfolios. Although the system was not in operation, the scale and duration of the investment produced a phenomenon that would be *realized* by investors, developers and speculators. Thus, realization is a more suitable term used in the context of transportation investments that are secured and rail transit that is in the process of being designed and constructed, yet the system is not in operation for revenue services. Unlike the riders of transportation system and consumer dependent establishments located near the system, property owners and developers are able to react to the investment knowing that there is government

commitment. That commitment makes it easier for developers and speculators to anticipate that transit investments will increase the value of adjacent properties.



Source: Software Toolworks, Inc.

Figure 1: Los Angeles County and Region

BACKGROUND

In November 1980, Proposition A was approved by the majority of the voters of Los Angeles County (see Figure 1). Proposition A authorized the collection of a one-half of one cent retail sales tax to fund the improvement of public transit in the County of Los Angeles. The Southern California Rapid Transit District (SCRTD) formulated plans and designs for a rail rapid transit system to foster the goal of improving mobility and achieving efficient land use and urban form in the regional core. The initial system will extend from the downtown Los Angeles Central Business District (CBD) west along the intensely developed Wilshire corridor, and through Hollywood and the Cahuanga Pass to the San Fernando Valley.

The project, which has been advocated since the 1970's, was initiated from a preliminary engineering phase of design by SCRTD in 1981. A description of the system and an assessment of its environmental impacts were presented in a draft EIS/EIR, released in June, 1983. Several alternatives were considered during the preliminary phase for improving travel conditions in the regional core. These alternatives included a Locally Preferred Alternative (LPA), a subway alternative with an aerial segment, and a Minimum Operable Segment (MOS-1) consisting of five stations in the CBD stretching from Union Station to Wilshire-Alvarado Station. The LPA was the first planned line that included 18 stations extending to North Hollywood.

In August, 1984, the Federal Transit Administration (FTA, formerly Urban Mass Transportation Administration) and SCRTD completed an environmental assessment for MOS-1 with a finding of no significant impact issued in November, 1984. The second phase of design experienced problems in December 1985 due to a natural gas explosion in the Fairfax area. The U.S. Congress attached to Public Law No. 99-1980 the stipulation that the SCRTD could not tunnel in any of the risk zones identified in the City Task Force report (1985). SCRTD then initiated a Congressionally Ordered Re-Engineering (CORE) study to identify and evaluate candidate alignments. In July, 1988, the New Locally Preferred Alternative (New LPA) was approved. The New LPA is a 22 mile, all subway alignment with sixteen stations, including the five-station 4.4 mile MOS-1 initial segment (see Figure 2).

The alignment (Phase II) continues from the MOS-1 Station at Wilshire and Alvarado along Wilshire Boulevard to Western Avenue, and north along Vermont Avenue from the Wilshire and Vermont Station to Hollywood Boulevard, west along Hollywood Boulevard and north through the Hollywood Hills to Universal City, before terminating at Lankershim and Chandler in North Hollywood.

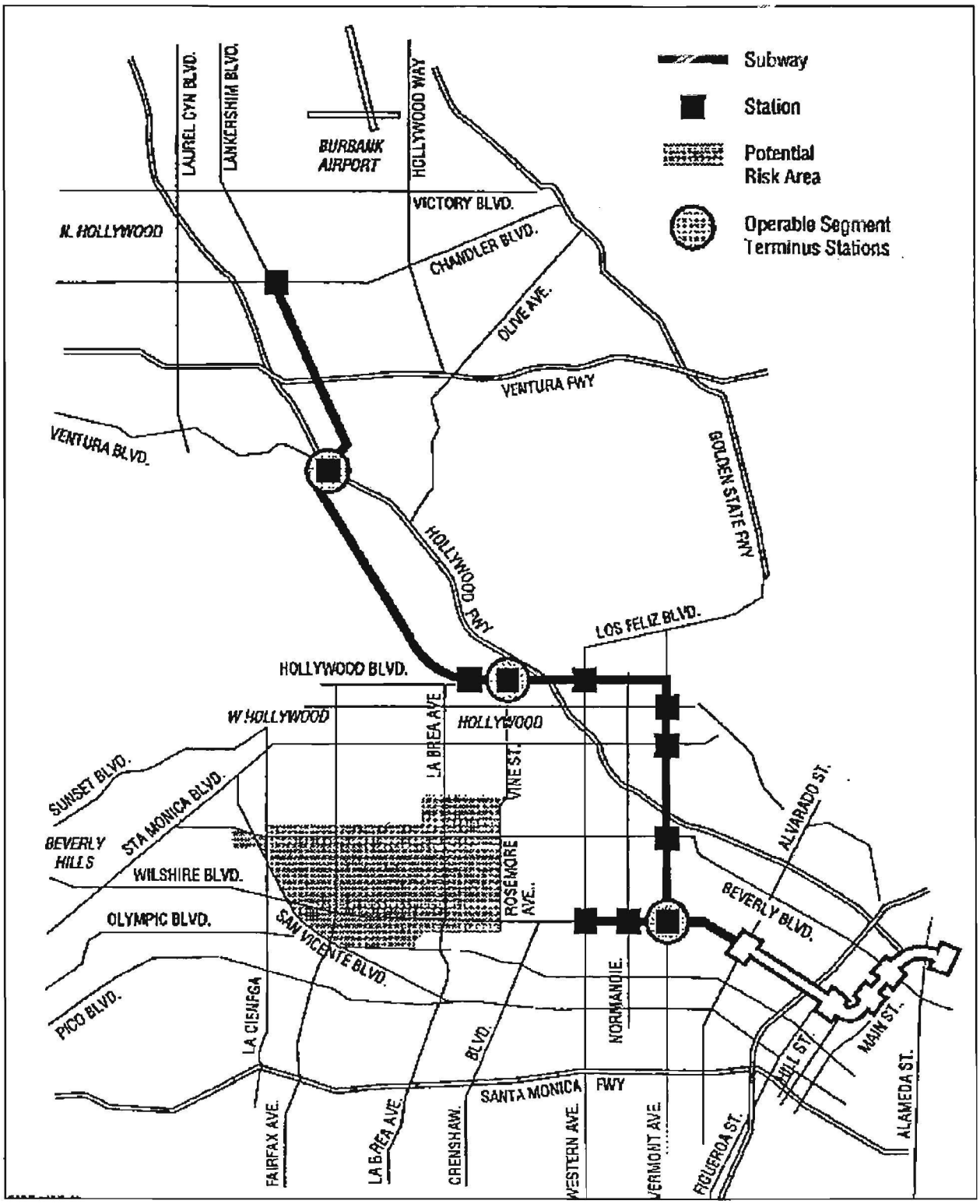


Figure 2: Locally Preferred Alternative

Benefit Assessment

A special benefit assessment program was established by a coalition of the SCRTD and Central City Association (representing businesses and property owners) as part of the need for new state and federal funding policies that encourage private sector participation. The Benefit Assessment program assumes that, for the most part, direct benefits accrue to private property because people walk some distance to and from stations, creating additional pedestrian activity and improved access for properties near the stations. This would result in increased levels of activity and enhanced opportunities for commercial growth and real estate development.

In October 1983, the State Legislature approved State Bill 1238 that allowed the SCRTD Board of Directors to levy an assessment on adjacent property owners deriving benefit from the Metro Rail. Under SB1238, SCRTD was permitted to issue bonds based on the anticipated revenue to pay for a portion of Metro Rail construction. Through establishment of benefit assessment districts, Los Angeles is expected to provide approximately $205 million in private funding ($130 million for MOS-1 and $75 million for Phase II). In 1985, the SCRTD adopted a resolution creating two special benefit assessment districts for the MOS-1 segment (see Figure 3). One district included the four stations in the CBD and includes all properties within a one-half mile walking distance from these stations. The second district covers the Wilshire/Alvarado Station and includes properties within a one-third mile walking distance.

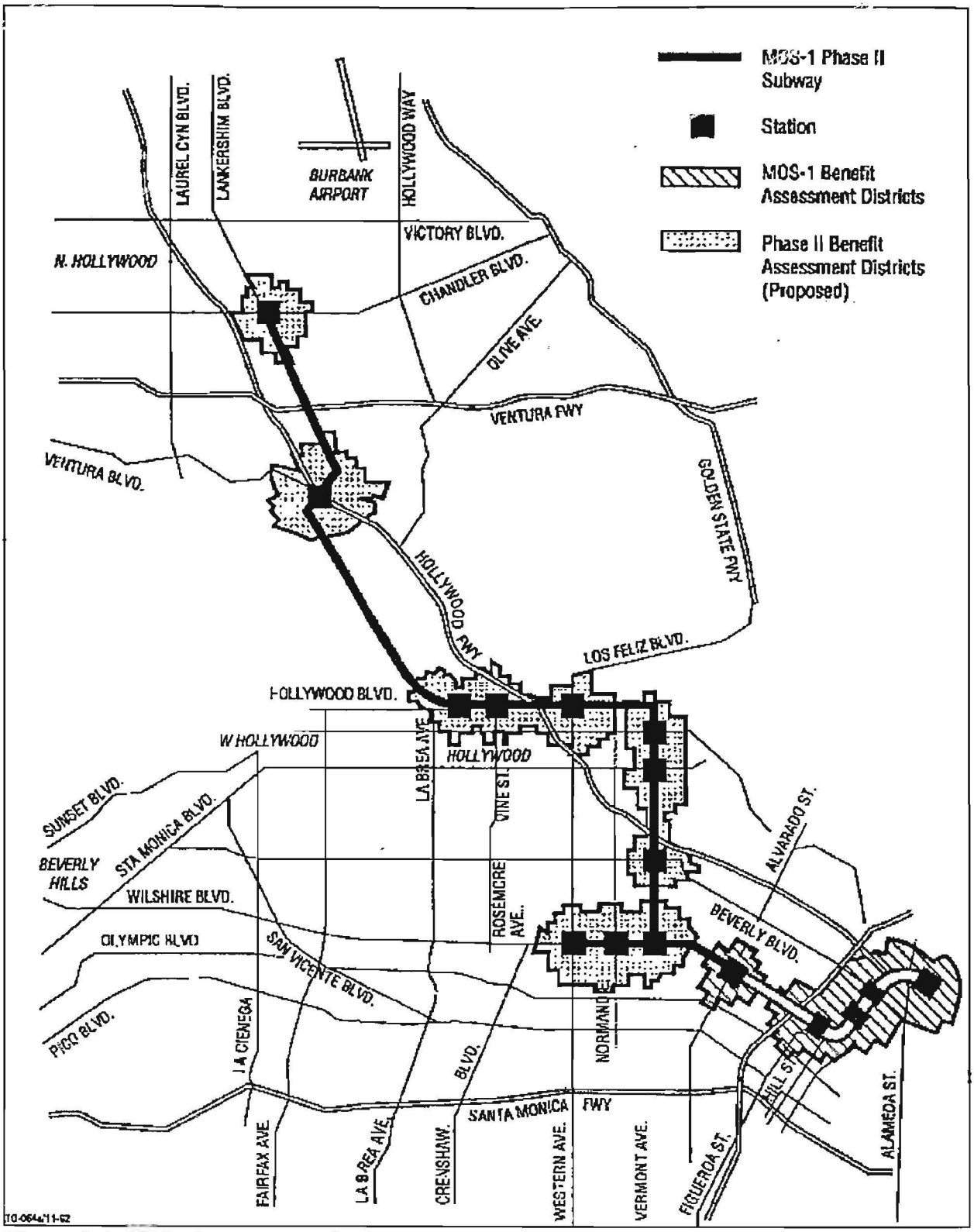


Figure 3: Benefit Assessment Districts

THEORIES

The investigation of land use and location theories have been scrutinized by related fields such as sociology -- studies of town-country relations, ecology, and economics (or land economics) dealing with urban land use. Relationships of location and land use theories have been addressed by theorists such as Ricardo (1), Thunen (2), Marshell(3), Weber(4) & Losch (5). The theories surveyed in this study deal mostly with land economics concerning issues on land rent and land values in relation to location.

Recent general theories of location seem to be in agreement that there is a *friction of space* (Alonso, 6). As a site becomes more attractive because of natural or other resources (such as water, soil, minerals, and labor), population would tend to increase. Production and distribution activities may begin with a goal to maximize profits taking advantage of the resources available. An agglomeration of economic activity then emerges at the location that is produced by the necessities of certain industries dependent upon one another (Weber, 4). Site rentals increase with attractiveness that causes the bid rent effect in which land owners tend to bid up prices of the most desirable locations. The closer the location is to the center of activities, the higher the price of rent, since the cost of distribution would be minimal. The investment of transportation is then used to help overcome this friction. Inevitably, there would exist a constant friction of space with site rentals and transportation costs as long as such a location maintains its attractiveness.

The underlying postulation that transportation investment has a significant effect on property values begins with a perception that land use changes and transportation are interrelated. Knight and Trigg (7) review evidence of land use impact through discussion of pre- and post- World War II experiences in the interaction between land use and transportation in America, Canada and Europe. Their study determined that transportation investments lead to favorable impacts on land use but indicate that such investments are not the only cause. They attribute land use changes

near transit stations to other factors such as regional growth trends, land use policies (e.g., redevelopment), physical characteristics of the area and the availability of land for development. The nature of their study was an approach not designed to isolate causes of the effects of transportation investments generally because each city contains a different set of economic and spatial characteristics. Instead, they provide a survey of transportation investments in order to compare the effects of transit investments throughout North America and Europe. Their survey concludes that other factors are similarly the cause of land use changes in which case the land use and transportation planning process requires more coordinated effort at an earlier stage.

Certain factors must be considered when determining the extent of land value impacts caused from transportation investments. Giuliano (8) identifies four of these factors:

- Land use changes- distinguished from economic growth
- Level of intensity -- technological improvements
- Level of analysis -- local, regional or both
- Longevity and durability of urban structure

Land use changes are differentiated from causes such as economic implications and focuses more on the spatial form. Level of intensity signifies the scale of the investment as well as technological aspects in relation to other systems. In relation to intensity, level of analysis is a consideration of the size of the area (e.g., micro and macro or local and regional). Longevity and durability concern the period and condition of the system or structure being studied.

Giuliano poses a model of the interdependencies of land use and transportation that is also illustrated by Stover (9). Their illustrations highlight the mutual dependencies being a continuous cycle between land use and transportation (see Figure 4).

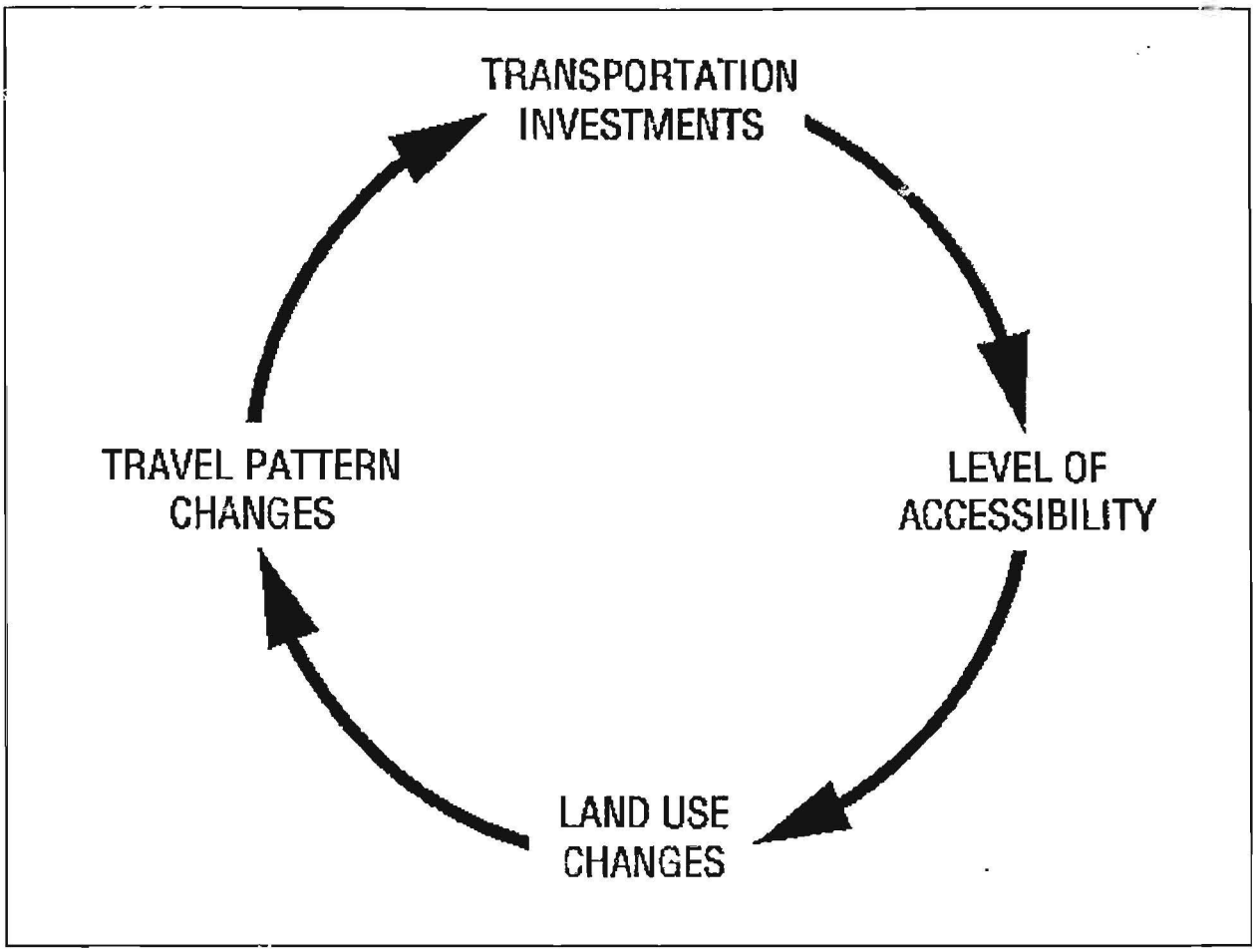
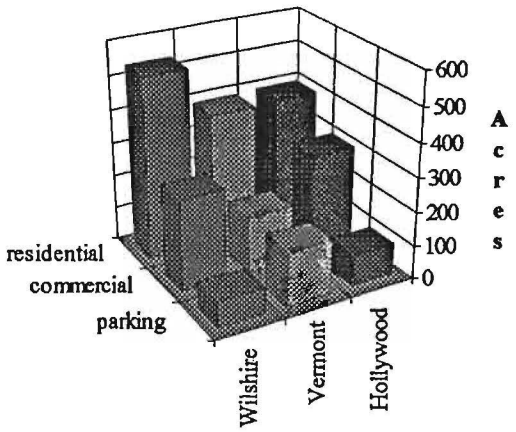


Figure 4: Land use - Transportation Cycle

The cycle begins with transportation investments determining the level of accessibility, which in turn determines land use changes -- the location of activities that promotes increased or decreased land values. The cycle then continues with land use changes which result in changes in travel patterns and ultimately determines the need for transportation investments. The illustration captures the essence of how one relationship is affected by another but was not meant to signify strength in any one of the relationships. It is simply an observation of the interdependencies between land use and transportation changes. The observations can be investigated via empirical research design to isolate land use (e.g., zoning and density) changes.

The most recent empirical analysis was a survey conducted by Taylor (10) that identifies existing land use patterns and development intensity (see Table 1) specifically within the Phase II Benefit Assessment districts. Taylor's objective was to identify and isolate joint development opportunities that could be related to the development of the station sites.

Table 1: Land use density



Source: Taylor (1992)

The three-dimensional table categorizes land use within the three corridors (Wilshire, Vermont, and Hollywood) by acres. The Wilshire corridor consists of 538 acres residential, 269 acres commercial and 76 acres parking. In the Vermont corridor there are 389 acres residential, 167 acres commercial and 161 acres parking. The Hollywood corridor consists of 395 acres residential, 300 acres commercial and 93 acres of parking. Taylor's analysis found that the current intensity of land use and the amount of surface parking available in each corridor provide an ideal situation for joint development opportunities. He notes that land use patterns would not essentially change unless land use policies reflect higher densities within each corridor.

Value Capture

If transportation investments lead to favorable impacts on land use, then economically the investment should provide an equally favorable return. The most likely source of capturing the return would be from the direct beneficiaries of the transportation system. Direct beneficiaries are the users of the system and non-users such as property owners who are located in proximity to gain benefit from the investment. Users of the system pay to use the system but non-users essentially receive a benefit at no cost. Such benefits are referred to as windfalls (Hagman, 11) -- profits unearned by property owners. The task of determining if there are any windfalls lies with the supplier of the system. The theories, situations, techniques and problems of capturing such windfalls become pertinent to the supplier.

Rajendra (12) uses classical economic theories of supply and demand and the cost of production where the cost of production equals value. Situations suitable for capturing windfalls begin with a perception or a need to capture windfalls. The need to capture windfall was prompted by the increase in cost of public transportation investments that have led to a growing interest in the concept of "taxing back" the publicly induced real estate value increases to help finance public investments. In the context of transportation investments, the concept has been generally labeled "value capture." An accepted definition of value capture is provided in a survey conducted by the Department of Transportation (DOT, Walther): "Value capture is the idea of a locality recovering some of the value added to, or accrued by, private parties from public sector improvements or investments (13)."

Several studies were conducted for validating value capture policies or assessing benefits accrued from public investments. Lind's (14) study is a model that was used in evaluating the benefits of large investments that affect specific parcels of land yet are not significant enough to affect the economic and spatial structure on the region. The model assigns a parcel of land to certain activities with a goal to maximize profits (for businesses, or rents if the occupant is a consumer).

Thus, if the value of a parcel of land is equal to the net productivity of the activity located on that parcel, then benefits are measured by the changes in these values. Benefits are measured by considering the total cost increase in profits of activities that locate on the land directly affected by the investment. Lind's results show that the relationship between the benefits of these public investments and the changes in land values is difficult to isolate and measure. He concludes that generally, changes in the value of land does not equal the benefits; except in the case where all profits are eliminated. In this case, the change in the value of land directly affected by the investment is taken into consideration.

Lerman's (15) study served to determine if impacts are large enough to be worth the effort of recapturing. He begins with the hypothesis that benefits can be capitalized into property values and that the distance of properties to a station significantly affects their values. His methodology consisted of a series of econometric models designed to estimate real estate values for parcels in Washington D.C. over the period of the system's development. The models were based on linear formulas as well as inverse specifications for the *distance to station* variable and found that applying logarithmic formulation produced the most reasonable results. The series of models included estimates for single-family dwellings, multi-family structures and retail establishments. The variables were divided into three categories: transit system-related, demographic, and parcel-specific, each covering the four factors defined by Giuliano. The results of the study found that distance from the station affected the value of a parcel.

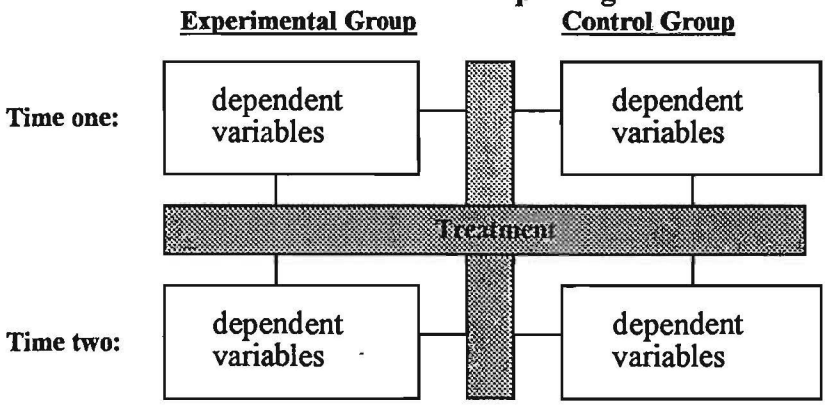
The variables selected for the empirical models tend to come in two forms: demographic and site-specific (e.g., lot area and building size). In appraisal models that apply statistical methods, the use of demographic variables are categorized into five areas: household information, household wealth indicators, population, other wealth indicators, and industry and occupation information (Rowan, 16). The most significant site-specific variables, building area and lot area, tend to be highly correlated with sale price (Adair, 17). The methodology of this study capitalizes on both

theories and proven empirical methods in building a strong foundation on critical analyses for measuring property values near transportation investments. It does so by incorporating such macro- and micro-analysis variables into a research study designed to control for many extraneous variables affecting property values.

METHODOLOGY

The methodology established is the pre-test/post-test control group that uses experiment and control groups in measuring the difference in property values due to transportation investments. Pre-test/post-test groups are used in measuring differences between time one and time two where treatment is signified as the realization period (see Table 2).

Table 2: Pretest - Posttest Control Group Design



Source: Adams (1985)

Unlike the traditional control method where both groups are random that ensures differences are eliminated, isolation is the key. The research design (see Figure 5) begins by isolating commercial properties from other land use types. In order to isolate rail from other factors that affect property values, the control area must be similar (as methodologically possible) in respect to the experimental area except for the presence of rail. Control is initiated at two levels. The first level of control is at the macro level that takes into account many of the broader economic impacts that might affect property values. The second level of control is at the micro level incorporating site-

specific characteristics affecting the parcel. Two sets of variables are used for each level of control. Demographic variables are used for the macro level of control and parcel-specific variables are used for the micro level of control.

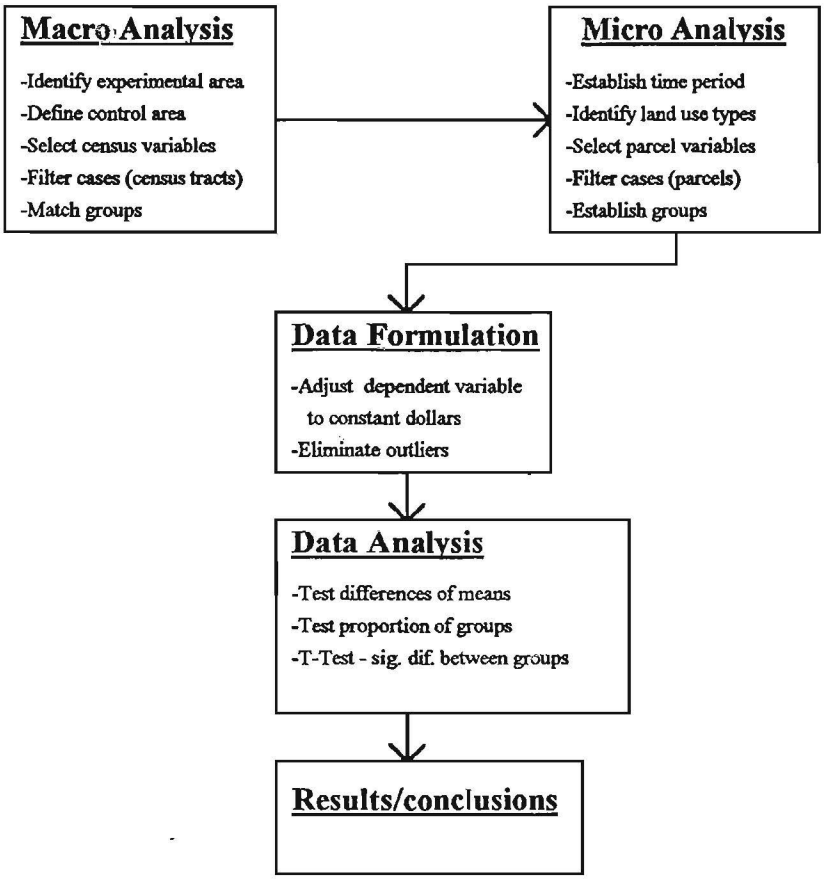


Figure 5: Flow of Research Design and Analysis

Study area

Prompted by the Trial Court ruling in June, 1987, the SCRTD formed five preliminary special benefit assessment districts (refer to Figure 3) for Metro Rail Phase II in October, 1988. The proposed boundaries are set at a one-half mile walking distance from the Phase II stations. The Phase II special assessment districts serve as the experimental group in this study with the exception of two districts. Universal City and North Hollywood districts were excluded due to the following reasons: first that the majority of properties in Universal City are owned by

Universal Studios; and second, a redevelopment district in the North Hollywood district was formed by the Community Redevelopment Agency of the City of Los Angeles (CRA) in which they will participate in joint development activities in these areas. The assessment districts in Hollywood were proposed for redevelopment but did not take effect during the 1980 to 1990 study period.

The areas selected for analysis are portions of the phase II alignment. The corridors consist of the following:

- Wilshire Boulevard (from Vermont Avenue west to Western Boulevard),
- Vermont Avenue (from Wilshire Boulevard north to Hollywood Boulevard), and
- Hollywood Boulevard (from Vermont west to the Hollywood Freeway).

Census tracts along the selected phase II corridors serve as the boundaries for the experimental cases to be selected. Census tract variables that are used for the analysis are an arrangement of 1990 census data and 1990 estimates based on 1980 census data. Household income and number of retail properties are 1990 estimates provided by the Southern California Association of Governments (SCAG). Population data are acquired from the 1990 Bureau of Census release. Several census tract boundaries were changed between 1980 and 1990. The experimental area consists of twenty-one census tracts based on 1980 census boundaries. The 1990 census boundaries contained two tracts within the Wilshire Boulevard corridor that were split. All census tracts that were merged or split were excluded from the experimental and candidate control groups. All parcels within Los Angeles City boundaries serve as the population for the selection of control group samples. Thus, all census tracts within Los Angeles city limits were subject to selection.

Location of the cases within Los Angeles City boundaries did not conflict with areas that may have influenced property values. In the case of zoning and other governmental impediments, census tracts selected were analyzed for their locational circumstances. If any of the tracts are unequally influenced by government policy affecting property values, such as redevelopment districts or other approved transit corridors, then census tract replacements would be selected by order of a standardized value list.

Macro Level Control

The demographic census variables are used to control for confounding factors (i.e., factors other than the treatment that may affect the dependent variable). Two *standard deviations* of the mean of each selected variable are used as the normal distribution criteria for *filtering* census tracts. In this case, two standard deviations represent the upper and lower limits of the normal distribution of characteristics within the experimental boundary. In essence, applying two standard deviations eliminates statistical outliers that do not fit within the characteristic distribution of the experimental group.

The process of filtering can be interpreted as a systematic and objective procedure for the selection or rejection of specific groups of cases based on certain criteria, in this case two standard deviations from each variable's mean. For example, given the criteria mean = x and standard deviation = o for each variable, a formula is established which assigns an upper limit (x + o) and a lower limit (x - o). Each variable, according to its *weighting*, would be filtered so that only those that meet the criteria (two standard deviations) to establish likeness are chosen. Thus, all census tracts that fall within the upper and lower limits are selected while the others are filtered.

The significance of the variables for filtering is determined using theory by Lösch (5) and empirical analyses Allen (19) and Hoag (20). The variables incorporated into this study are

weighted as follows: median household income, number of retail properties, square mile of tract area, population and number of households. Median household income represents the market expectations of the area. Number of retail properties represents the competitive commercial characteristics of the area. A combination of square mile per tract, number of households and population represents the density characteristics and potential consumers of the area under study.

Matching techniques are used since each experimental tract must have an identical control tract. To retain generalizability the number of matching criteria must be reduced or coarser groupings must be used. The data used at the macro level are census variables that represent a smaller number of matching criteria to include five variables. To eliminate any biases, the variables are transformed into one standardized value that is incorporated into the selection process. Each of the five variables is calculated to the logarithm base ten. The mean values of the five variables are then calculated in order to produce one standardized value called *meanlog*. Cases are then sorted on the meanlog value. The number closest to the accompanying experimental tract was selected as the matching control tract. For each of the experimental tracts, a control tract was selected through this matching process.

Micro Level Control

The process for controlling at the micro level is similar to the process used at the macro level. The objective is to control for site characteristics that have some effect on property values. Some of the variables used for commercial properties have a different effect on single- or multi- family residential properties. This was a reason for conducting separate studies for the different land use types. The variables selected consist of sale price, land use, lot area, building area and age of the structure. The search criteria for selecting properties are: census tract -- parcels within the boundaries of the experimental and control tracts; and year sold -- sold between the years of 1980 to 1981 and 1989 to 1990.

Parcels are divided into land use type using a code established by the Los Angeles County Assessor's Office. Shuler (23) identifies lot area and building area as site specific variables highly correlated with sales price. In this study, these two variables along with the age of the structure are analyzed for their correlations to sale price for both the experimental and control parcels. The results of the analysis found that building area was highly correlated with sale price $r = 0.87$ and lot area $r = 0.71$. The age variable produced a negative correlation with sale price $r = -0.12$.

The correlation analysis was used to determine the weight of each selected variable. When filtering properties by building area first and lot area second, the process is systematically controlling for these independent variables found to be highly correlated with sale price. All properties that were acquired, using the search criteria, are filtered by building area and lot area. The results would be a controlled set of parcels that fall within the normal distribution. This process ensures that the site specific characteristics highly correlated to sale price are not affecting any significance that rail may have on parcels in or out of the experimental area.

Sales price is adjusted to constant dollars to ensure that inflation rates do not have an effect on property values. A price index factor was created using properties that sold during the period of the study. The properties consist of the initial groups of parcels established using the search criteria. The factor was calculated using the mean value of the base year (properties that sold between 1980 to 1981) divided by the mean value of the year to be adjusted (properties that sold between 1989 to 1990). Constant dollars are established by multiplying current dollars by the factor or commercial real estate index for the appropriate year.

The adjusted sale price is standardized on building area (or lot area for vacant parcels) in order to measure sale price per square foot. The frequency distribution of sale price per square foot is analyzed to determine the typicality of certain measures of central tendency. Perfect symmetry is acquired when there are minimum statistical outliers. The importance of eliminating outliers at

this level serves to reduce observations that are abnormal relative to general parcel characteristics of the normally distributed observations.

Results

The total number of cases consists of 152 commercial parcels. Cases were categorized by groups -- pre-experimental, pre-control, post-experimental and post-control. The initial selection of cases began with a total of 15,150 cases (9,736 control parcels and 5,414 experimental parcels). Cases that did not contain sale price (8,101) were eliminated. Others were eliminated based on the filtering process using variables highly correlated with sale price that are two standard deviations from their mean. A total of 2,452 cases remain. All land use types were excluded except commercial as identified by the Los Angeles County Assessors code that resulted in 601 remaining cases. The commercial real estate price index was used to equalize fluctuations in market price and inflation. The factor, using the initial 15,150 cases is 0.8392 -- calculated by dividing the mean values for pretest cases with posttest cases. All posttest cases are adjusted using this factor. The adjusted sale price is then standardized using building area or lot area if the parcel was vacant. Filtering for normal distribution of the adjusted sale price per square foot produced a total number of experimental and control groups illustrated in Table 3:

Table 3 : Pretest - Posttest Control Groups (final cases)

	Experimental Group	Control Group
Time one:	pre-experimental 26 cases	pre-control 17 cases
	Realization period 1983 to 1988	
Time two:	post-experimental 51 cases	Post-control 58 cases

A cross-tabulation test was initiated to determine if the proportions of each group are insignificant to one another. In other words, the hypothesis that *the proportions of the groups are not equal* is tested. The *Observed significance level* of 0.05 is the criterion for determining the outcome of the hypothesis. Table 4 contains the observed frequencies, percentages and the significance level. The row totals indicate that a greater percentage of properties sold after the realization period. The level of significance is 0.12876 that indicate groups are equally proportioned.

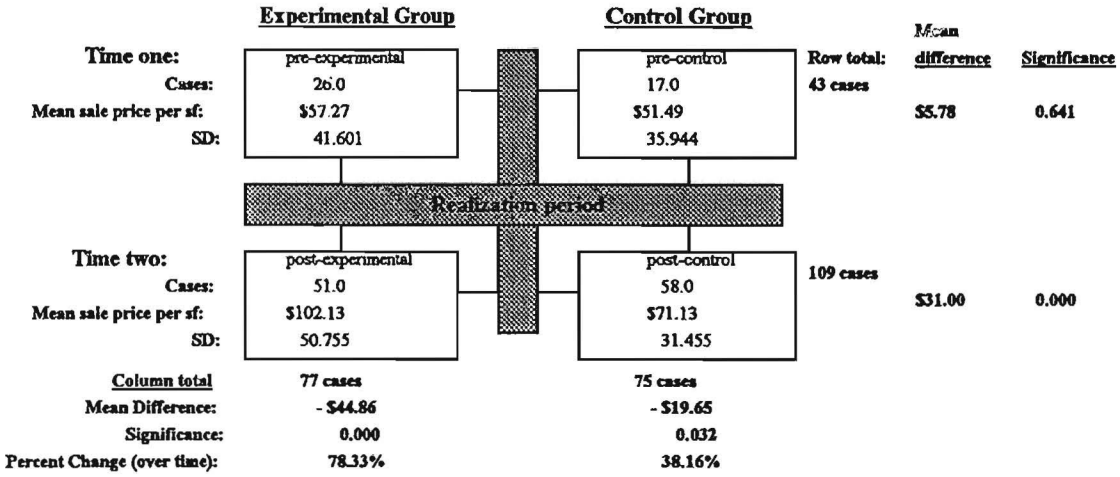
Table 4: Crosstabulation of Groups

	Experimental Group	Control Group	
Time one:	pre-experimental	pre-control	**Row total**
	26 cases	17 cases	**43 cases**
row %	60.5%	39.5%	**28.3%**
col %	33.8%	22.7%	
	Realization period 1983 to 1988		
Time two:	post-experimental	post-control	**109 cases**
	51 cases	58 cases	**71.7%**
row %	46.8%	53.2%	
col %	66.2%	77.3%	
Column total:	**77 cases**	**75 cases**	**152 cases**
	50.7%	**49.3%**	**100%**

Measure	Value	DF	Significance
Pearson	2.30735	1	.12876

A one-tailed t-test is used to assess significant differences between the treatment groups (see Table 5). The first groups to be tested are the pre-experimental with the post-experimental in order to determine if property values within the corridor are significantly different before and after treatment (the realization period). In the case of control groups, the significance level is 0.032 which can be interpreted as property values outside the corridor being significantly different before and after the realization period. The results of the pre-control and post-control indicate a close significance level before the realization period. The mean percent change for the experimental groups is 78 percent compared to 38 percent for the control groups. These percentages indicate more differences between the pre- and post-experimental groups.

Table 5: T-test results of pre-test/post-test control groups



The significance level for time one shows a value of 0.641. Thus, the experimental group in comparison to the control group before the realization period indicate that there is no significant difference in property values. Control properties matching the characteristics of the experimental properties before the realization period are generally the same. Time two identifies the results of the control group with the experimental group after the realization period. The mean difference of sale price per square foot between the post-experimental and the post-control group is $31. This indicates the largest difference between the other groups that were paired. The significance level verifies that the presence of rail in the experimental group produced a significant difference on property values compared to property values a distance from rail during the same period. Properties near rail have a mean sale price per square foot of $102.13 compared to properties away from rail with a mean sale price per square foot of $71.13.

The realization period of the Metro Rail in Los Angeles produced some property value differences that are easily seen in Figure 6. The pre-experimental group compared with the pre-control group show similar levels of increase from case to case. The mean difference between the two groups is 5.78. The post-experimental group compared with the post-control group show greater

differences of increasing levels from case to case. The post-experimental group consists of cases that increase more in price per square foot than the post-control group.

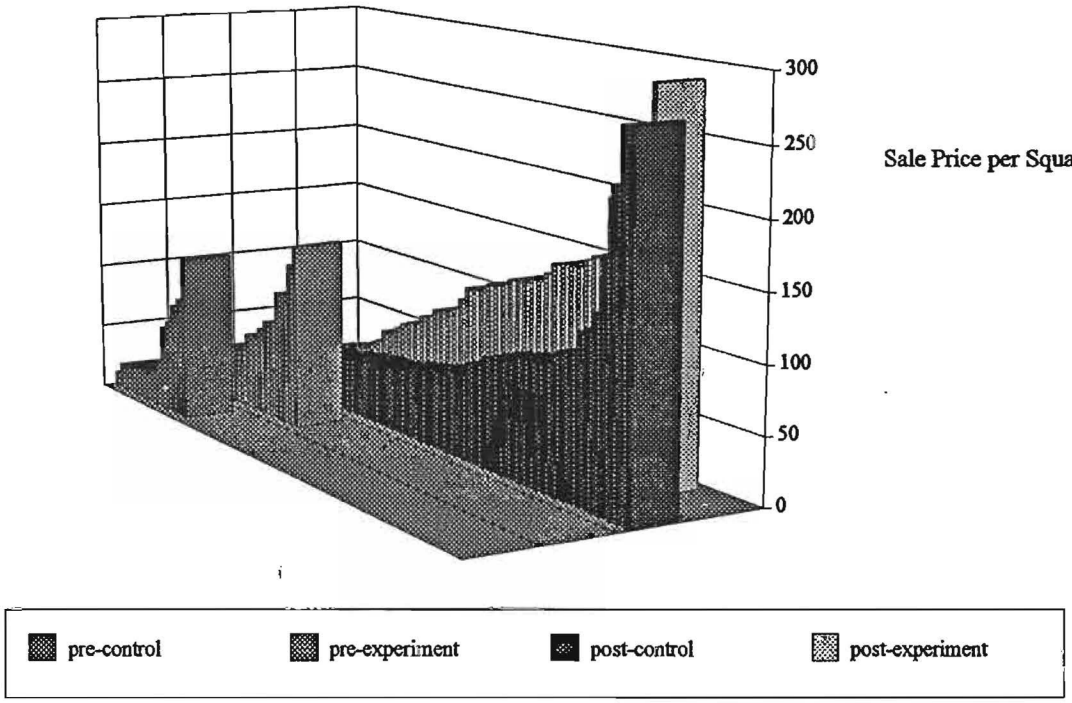


Figure 6: Levels of Difference for all groups

Comparing properties near the Los Angeles Metro Rail phase II corridor with similar properties located elsewhere within the city of Los Angeles indicates that transportation investments have locational impacts on land use, specifically, an increasing impact on property values near the Metro Rail stations. A comparison of the test before and after transportation investments were committed indicate that real estate activities have increased over the ten year period within the phase II corridor.

CONCLUSION

This study has shown that transportation investments produced property investment differences near rail where properties measured in the study have increased in value in proximity to rail compared to properties a distance from rail. Significant difference of property values over the

realization period has also been revealed. Such inferences of effects serve as a basis for future decisions by public decision-makers and private investors, particularly concerning the amount of government subsidy on rail, or infrastructure in general. As funding for infrastructure becomes more scarce, where and when to invest will become major issues to city and regional planners. Public policies have increasingly demanded the private sector to share in costs. Objectives for planners will apparently require the consideration of how much and where improvement is needed by monitoring development and growth patterns. Developers must also be aware of the land use-transportation cycle. By staying informed of local and regional patterns, both planners and developers are able to coordinate efforts that benefit their community.

In the case of the Los Angeles Metro Rail, a funding commitment for the implementation of rail from local sources was necessary to secure federal participation. Like many cities, it has typically been necessary to acquire federal funding for the implementation of a large magnitude of rail transit since most local revenue sources were not able to generate enough money. The consensus of public opinion has been to legislate public transportation programs that are paid for by general taxation. Those that will never benefit from the program must still pay. Exclusively, operating revenues tend to be insufficient to compensate the costs of design and construction. Private investment could generally be the obvious source of funding. In turn, private investors may question the benefits of public investments and demand assurance of the feasibility and completion of public projects.

In many instances, developers and speculators act upon government policies anticipating improved markets prior to operation of rail. They administer a variation of their own study to forecast market changes. If such forecasts are favorable, decision to invest is followed by government funding commitment and the realization period begins. It is important to note that the realization period may not have been significant enough to cause changes in property values. Knight and Trigg have cited that such benefits are not realized until some time after operation of a

rail transport system. Measuring the realization period in this case provides empirical evidence that real estate activity has occurred in anticipation to the outcome of the investment.

In addition to the realization phenomenon, other periods of the systems development consist of *operation* and *maturation*. Operation begins when construction is complete and users are able to benefit from the system. Maturation is a period after the system has been operational, usually signified by changes in density of the area or other land use changes. Measuring the effect of the operational period of rail requires data on ridership as well as sale revenues and lease rate changes.

As in all models there are strengths and weaknesses in terms of what the model explains and how much it explains. Although it can be inferred that differences in property values occurred over the realization period, the research design did not assess which parcels were different and by how much they differentiated. This process, referring to Hoag (20), requires a model that incorporates more site specific variables and a prospectus of each commercial property. Such a study would be initiated during the operation period to allow for data availability to be used on a case-by-case investigation of parcels. Another approach, as indicated by Rajendra (12), would be to determine the effect of permissible land use (i.e., lot size and distance of the parcel from the station) on the increase of property values, in other words, measuring property values affected by higher density near rail stations. This type of study would be measuring the maturation period of a transportation system. Given all analyses measuring the effect of realization, operation and maturation, a study could be initiated to investigate high density areas for possible rail alignment used to support land use-transportation related policies.

Bibliography

01. Ricardo, David. *Principles of Political Economy and Taxation.* (London: George Bell & Sons, 1903)

02. Thünen, Johann H. *Der Isoliete Staat in Beziehung auf Llandwirtschaft und Nationalekonomie.* (Hamburg: Wantig edition, 1921 [1st ed., 1826])

03. Marshell, Alfred. *Principles of Economics.* 9th ed.(London: Macmillan and Company , 1961 [1st ed., 1890]) bk. V, chi. XI, *Marginal Costs in Relation to Urban Values*

04. Weber, Alfred. *Theory of the Location of Industries.* translated by Carl J. Friedrich (Chicago, University of Chicago Press, 1929)

05. Lösch, August. *The Economics of Location.* translated from the second revised edition by William H. Woglom (New Haven: Yale University Press, 1954)

06. Alonso, William. *Location and Land Use: Toward a General Theory of Land Rent.* (Cambridge: Harvard University Press, 1964)

07. Knight, Robert L. and Lisa L. Trigg. *Land Use Impacts of Rapid Transit: Implications of Recent Experience.* (Washington D. C.: U.S. Department of Transportation, 1977)

08. Giuliano, Genevieve. *Land Use Impacts of Transportation Investments: Highways and Transit.* prepared for book entitled *The Geography of Urban Transportation* edited by Susan Hanson (New York: Guilford Press, 1986)

09. Stover, Vergil G. and Frank J. Koepke. *Transportation and Land Development.* (New Jersey: Prentice Hall, 1988)

10. Taylor, Irving N. *Metro Rail Red Line MOS-2 Corridor Land Use Analysis and Joint Development Potential.* Prepared for the Southern California Rapid Transit District (Los Angeles: National Technical Institute Services, 1992)

11. Hagman, Donald, G. *Windfalls for Wipeouts,* (Chicago: American Society of Planning Officials, 1978)

12. Rajendra, Kunwar. *Impact of Value Capture Policy on Selection of Transportation Facility Alignments.* (Michigan: Michigan State University, 1980)

13. Walther, Erskine and Lester A. Hokl and Louis J. Pignataro and Athanassios K. Bladikas. *Value Capture Techniques in Transportation.* (Washington D. C.: U.S. Department of Transportation, 1990)

14. Lind, R. C. *Spatial Equilibrium, the Theory of Rents, and the Measurement of Benefits from Public Programs,* Quarterly Journal of Economics, vol. 87, May, 1973 pp. 188-207

15. Lerman, Steven R., David Damm, Eva Lerner-Lamm & Jeffrey Young. *The Effect of the Washington Metro on Urban Property Values* (Cambridge: U.S. Department of Transportation, 1978)

16. Rowan, Timothy. *The Use of Computerized Demographic Database in Feasibility Studies.* The Real Estate Appraiser and Analyst, Winter, 1988, p.12

17. Adair, A.S. and W.S. McGreal. *Computer Assisted Valuation of Residential Property* The Real Estate Appraiser and Analyst, Winter, 1988 pp. 18-21

18. Adams, Gerald R. and Jay D. Schvaneveldt *Understanding Research Methods* (New York: Longman, Inc., 1985)

19. Allen, W. Bruce, Kuo-Ping Chang, David Marchetti & Joseph Pokalsky. *Value Capture in Transit: The Case of the Lindenwold High Speed Line* (Washington D. C.: U.S. Department of Transportation, 1986)

20. Hoag, James W. *Towards Indices of Real Estate Value and Return,* The Journal of Finance vol. 35. No. 2, May 1980 pp. 569-80

21. Shuler, F.G. *Econometric Analysis of House Prices* The Real Estate Appraiser and Analyst, Fall, 1990, p.20