Capitalization of Transit Investments into Single-Family Home Prices: A Comparative Analysis of Five California Rail Transit Systems

John Landis
Subhrajit Guhathakurta
Ming Zhang

UCTC
No 246

The University of California Transportation Center

University of California
Berkeley, CA 94720

The University of California Transportation Center

The University of California Transportation Center (UCTC) is one of ten regional units mandated by Congress and established in Fall 1988 to support research, education, and training in surface transportation The UC Center serves federal Region IX and is supported by matching grants from the U S Department of Transportation, the California Department of Transportation (Caltrans), and the University

Based on the Berkeley Campus, UCTC draws upon existing capabilities and resources of the Institutes of Transportation Studies at Berkeley, Davis, Irvine, and Los Angeles, the Institute of Urban and Regional Development at Berkeley and several academic departments at the Berkeley, Davis, Irvine, and Los Angeles campuses Faculty and students on other University of California campuses may participate in Center activities Researchers at other universities within the region also have opportunities to collaborate with UC faculty on selected studies

UCTC's educational and research programs are focused on strategic planning for improving metropolitan accessibility, with emphasis on the special conditions in Region IX Particular attention is directed to strategies for using transportation as an instrument of economic development, while also accommodating to the region's persistent expansion and while maintaining and enhancing the quality of life there

The Center distributes reports on its research in working papers, monographs, and in reprints of published articles It also publishes *Access*, a magazine presenting summaries of selected studies For a list of publications in print, write to the address below

University of California Transportation Center

108 Naval Architecture Building
Berkeley, California 94720
Tel 510/643-7378
FAX 510/643-5456

Capitalization of Transit Investments into Single-Family Home Prices: A Comparative Analysis of Five California Rail Transit Systems

John Landis
Subhrajit Guhathakurta
Ming Zhang

I. INTRODUCTION

It has become popular in recent days to suggest that rail mass transit investment can be a useful implementation lever for guiding urban growth (Calthorpe, 1993; Katz, 1993) It is often argued that rail mass transit extensions, along with supportive land use policies, will encourage higher residential densities and the development of mixed-use, pedestrian-oriented urban "villages," particularly at transit stations By helping to cluster development at station nodes and along rail corridors, investments in rail mass transit will discourage low-density suburban sprawl, promote open-space preservation, reduce development pressures on the natural environment, and make better use of existing infrastructure— thereby lowering total public service costs Moreover, to the extent that residents of such station area villages substitute transit use for auto use, vehicle emissions and traffic congestion will also be reduced Because congestion and auto-based emissions reductions are key goals of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Clean Air Act Amendments of 1990, numerous agencies charged with implementing these two acts are seriously considering programs that emphasize rail mass transit construction and the coordinated development of urban or transit villages

As yet, two things are missing from this rosy view a consistent *theory* that explains how and under what circumstances transit investments will promote greater development densities and a different development mix: and an *empirical record* demonstrating that past transit investments have in fact generated more desirable land use forms

Economics provides a clear theoretical framework within which to test the proposition that transit investments will significantly affect land use patterns *capitalization theory.* Capitalization theory assumes that the market value of improved public services will be transmitted (or "capitalized") into the values of nearby or adjacent land parcels. To the extent that new or improved mass transit service provides a real economic benefit, the value of that benefit should be capitalized into nearby land parcels. Put another way, if consumers truly value transit service, then they should be willing to pay a premium for transit-accessible locations. Since the supply of transit-accessible locations is necessarily limited, the prices of such locations should rise Capitalization theory provides a framework for testing the market value of rail mass transit service· the site values of parcels or homes near a transit station should be significantly higher than the site values of otherwise comparable parcels not near a transit station.

This paper provides a comparative perspective on the relative economic benefits (as capitalized into nearby home values) of five California heavy and light-rail transit systems:[1]

* BART —the Bay Area Rapid Transit system
* CalTrain —a commuter railroad serving the San Mateo Peninsula and San Francisco
* San Jose's light-rail system
* Sacramento's light-rail system
* the San Diego Trolley

This paper breaks new ground in a number of areas. It is the first capitalization study of rail transit to compare so many systems and, in particular, to compare heavy and light-rail systems It is one of only a handful of capitalization studies to measure and compare accessibility to rail transit with accessibility to the primary competing mode: freeways Finally, it is the first transit capitalization study to distinguish between the benefits of living near a rail transit station — improved accessibility— with costs of living too near a transit route — noise and vibration.

This paper is organized into six parts. The next part, Part II, summarizes previous transit and highway capitalization studies Part III introduces the basic capitalization model to be tested, and explains how the data used in the model were assembled Part IV presents several summary comparisons of the five transit systems examined in this analysis Part V presents the various model results, and Part VI summarizes the study findings and examines their policy implications

II. TRANSPORTATION CAPITALIZATION MODELS: A REVIEW

The assumption that accessibility is capitalized into property values lies at the heart of contemporary urban economics Urban location and density models developed by Alonso (1964), Mills (1967, 1972), and Muth (1969) all describe how and why firms and households bid up the prices of accessible sites The result of the bidding process, at least in the case of the mono-centric city, is the classical, negative exponential density/land rent gradient

Capitalization theory is predictive as well as descriptive It predicts that outward transportation extensions should be followed by higher suburban land values as improvements in accessibility are quickly capitalized. A number of historical studies of urban structure and land prices have demonstrated exactly this dynamic (Hoyt, 1933, Adkins, 1958, Brigham, 1964).

Few transportation investments produce uniform improvements in accessibility. Most modern transportation systems are designed around nodal instead of uniform access. In the case of a freeway, users must access the system at an interchange, in the case of rail transit, patrons board at particular stations The nodal-access nature of modern transportation systems suggests that (within the general context of a declining metropolitan land rent gradient) property values should be higher near points of system access, be they transit stations or freeway interchanges.

Empirical Studies of Transport Capitalization

The literature on transport capitalization focuses on this question Are, in fact, property values higher near highway rights-of-way, adjacent to freeway interchanges, or near mass transit stations? Empirical studies of transport capitalization can be organized along a number of dimensions (Table 1)

1 *Type of facility:* Some studies consider highway or freeway capitalization, others focus on transit.

2 *Type of effect* Some studies consider only positive capitalization effects— that is, the benefits of improved accessibility. Other studies consider negative capitalization— the disamenity costs of noise or congestion

3 *Type of property and transaction:* Empirical studies of transport capitalization are nearly evenly split between analyses of undeveloped land values (usually based on appraised or assessed values), and analyses of housing prices (usually based on sale transactions, and limited to single-family homes). Owing to a lack of reliable data, studies of commercial rent or value differentials attributable to transportation accessibility are virtually non-existent [2]

4. *Method of comparison.* Most empirical studies of the capitalization of transport facility benefits take one of two approaches (1) longitudinal studies comparing land value or price changes for sites near or adjacent to a newly constructed facilities,[3] or (2) "Hedonic" studies comparing price variations across multiple properties as a function of distance or proximity to a particular transport facility, holding constant other property attributes [4] A few empirical studies have been based on case studies and/or survey data.

Highway Capitalization Studies

Economists have been conducting empirical studies of the property value effects of highways for nearly 40 years. Most measure capitalization in the same way in terms of increased property values over time as a function of distance to the highway right-of-way. Virtually all of the early highway studies found large and significant land value increases associated with highway construction. Buffington's and Meuth's 1964 report on Temple, Texas, for example, tracked 19 years of land value changes and concluded that: "the probable highway bypass influence in the Temple area was 2,562 percent, or $2,331. This represents a tremendous increase in land value in the study area as opposed to the control area" (p. 11).

More recent studies —especially those which focus on home prices instead of land— have been more ambivalent. Langley (1981), for example, used 17 years of home sales data from North Springfield, Virginia, to evaluate the impacts of the Washington Capital Beltway. He concluded that properties adjacent to the Beltway sold at a discount and appreciated at a reduced rate when compared with more distant properties. Palmquist (1982), in an analysis of single-family home prices in Washington state, and Tomasik (1987), in a study of home prices in Phoenix, both report net positive property value effects associated with highway construction, but also acknowledge that for the closest homes, accessibility premiums may be offset by noise-related price reductions

Table 1 Summary Comparisons of Selected Highway and Transit Capitalization Studies

Authors	Facility and Study Area	Property Type	Comparison Method	Effect Type (Accessibility or Disamenity)	Accessibility Measure	Result
Highway Studies						
Adkins (1957)	Dallas	Land	Sales prices and Assessed values	Both	Distance rings	Proximity to highway associated with higher property values
Cribbins (1962)	Cumberland, Guilford, and Rowan counties (North Carolina)	Land	Sales prices	Both	Airline distance	No highway effect observed
Buffington (1964)	1 Austin, TX 2 Temple, TX	Unimproved Land Subdivided Land	Sales prices Sales prices	Both Both	Distance rings Distance rings	163% premium associated with highway proximity 13% discount associated with highway proximity
Brown and Michael (1973)	Indianapolis	Land	Assessed land value	Both	Distance Rings	Positive accessibility/Negative disamentity values
Allen (1981)	1 Northern Virginia 2 Tidewater, VA	Single-family homes Single-family homes	Sales prices Sales prices	Disamenity Disamenity	Decibel level Decibel level	-$94 per decibel No effect
Langley (1981)	Washington, D C	Single-family homes	Sales prices	Both	Distance rings	$3,000 to $3,500 discount for homes within 1000 feet of highway
Palmquist (1982)	Washington (state)	Single-family homes	Sales prices	Both	Distance rings	Up to 15% appreciation premium from accessibility, up to 7 2% discount based on noise
Tomasik (1987)	Phoenix	Single family homes	Sales prices	Both, separately	Distance rings	Highway had positive effect, but no gradient observed
Transit Studies						
Davis (1970)	BART/San Francisco	Residential	Sales prices	Both	Airline distance	Concludes BART stations had a positive effect on home values
Lee (1973)	BART/San Francisco	Single-family homes	Sales prices	Both	Airline distance from BART station	Price premium observed in BART service corridor, but no station effect observed
Damm, et al (1980)	Metro/Washington, D C	Single and multi-family housing, retail	Sales prices	Both, separately	Airline distance from station	Found negative price elasticities with respect to distance from Metro stations
Boyce, et al (1972)	Lindenwold Line/Philadelphia	Single-family homes	Sales prices	Accessibility	Commute cost savings	Positive impact of line on property values
Dornbusch (1975)	BART/San Francisco				Airline distance from station	Reduced property values around some station areas
Dewees (1976)	Bloor St Subway/Toronto	Low-density housing	Sales prices	Accessibility	Weighted commute time	
Blayney Associates (1978)	BART/San Francisco Bay Area	Residential, commercial		Both	Airline distance from station	Increased property values for properties within 1000 feet of some stations
Baldassare, et al (1979)	BART/San Francisco Bay Area	Residential	Resident surveys	Disamenity	Distance rings	Reduced preference for homes near selected BART stations
Bajic (1983)	Spadina Line (Toronto)	Residential	Sales prices	Both	Weighted commute time	$2,237 premium for the average home, based on commute time savings
Picket & Perrett (1984)	Metro/Tyne and Wear Counties (UK)	Residential	District values	Accessibility	Distance rings	L360 appreciation premium for properties near Metro
Allen, et al (1986)	Lindenwold Line/Philadelphia	Single-family homes	Sales prices	Accessibility	Commute cost savings	$443 home value premium per dollar of commute cost savings, $4581 average home value premium
Ferguson (1988)	Light-Rail/Vancouver	Single-family homes	Sales prices	Both, separately	Airline distance from station	C$4 90 premium per foot associated with station proximity in 1983
Voith (1991)	PATCO Commuter Rail/Philadelphia SEPTA Commuter Rail/Philadelphia	Single family homes Single-family homes	Census tract median home values	Both	Tract adjacency to rail station	10% home price premium for median home in served tracts 3 8% home price premium for median home in served tracts
Alterkawi (1991)	1 Metro/Washington, D C, 2 MARTA/Atlanta	Land Land	Assessed values Assessed values	Both Both	Airline distance from transit stations	Higher assessed values (Range $- 01 tp $- 11 per square foot for sites near stations
Nelson (1992)	MARTA East Line/Atlanta	Single-family homes	Sales prices	Both, separately	Airline distance from station	Magnitude of premium or discount varies with neighborhood income level
Al-Mosaind, et al (1993)	Light Rail/Portland	Single-family homes	Sales prices	Both	Distance rings based on walking distance	$4,324 premium for homes within 500m walking distance of light rail station
Gatzlaff and Smith (1993)	Metrorail/Miami	Single-family homes	Sales prices	Both	One-mile section for repeat sales, airline distance for hedonic models	No effect

Transit Studies

Most contemporary studies of transit capitalization utilize hedonic models of residential sales prices (as opposed to assessor or appraiser estimates of value) No single functional form dominates the literature Many studies use simple linear forms; others model multiplicative or exponential relationships.

Most transit capitalization studies use distance from the nearest transit station (either as measured along streets, or as-the-crow-flies, or in terms of distance rings) as the critical independent variable for modelling the price effects of transit Studies of the Toronto Subway and Philadelphia-Lindenwold High Speed Line, however, obtained good results using alternative independent variables Dewees (1976) concluded that a weighted travel-time based measure was superior to distance-based measures for predicting the rent gradient around Toronto's Bloor Street Subway Bajic's 1983 study of the Toronto Subway's Spadina Line also relied on weighted travel time instead of distance Three Lindenwold studies published during the 1970s (Boyce et al , 1972; Allen et al , 1974; and Mudge et al , 1974) used relative travel cost savings to model the property values effects of the line More recently, Allen, Chang, Marchetti, and Pokalsky (1986) attempted to calculate the actual commute cost savings associated with the Lindenwold line

As shown in Table 1, transit capitalization studies have produced wildly different estimates of the value of station proximity Two studies published in 1993 provide a good illustration of this range At one extreme, Gatzlaff and Smith used both repeat sales indices and a hedonic price model to evaluate the change in home prices attributable to the Miami Metrorail system. They concluded that residential sales prices were, at most, only weakly affected by the announcement of the new rail system At the other extreme, Al-Mosaind, Dueker, and Strathman (1993) estimated that single-family homes located within a 500-meter walk of stations on Portland's light-rail system sold at a premium of $4,324 (or over 10 percent) when compared with otherwise similar homes beyond that distance.

Other transit capitalization studies have produced estimates somewhere between these two extremes In Vancouver, Ferguson (1988) estimated an accessibility price premium of $4.90 (Canadian) per foot of distance from the closest light-rail station, but only for those homes within one-half mile of the line. In Atlanta, Nelson (1992) found that transit accessibility increased home prices in lower-income census tracts, but decreased values in upper-income tracts In Philadelphia, Voith (1991) found that home prices in census tracts served by the PATCO commuter rail system were ten percent higher than home prices in unserved tracts

Perhaps the single most studied transit system in the country is BART BART began partial East Bay service in 1972, with full Transbay service following in 1975. Two preliminary studies by Dornbusch (1975) and Burkhardt (1976) noted reduced property values around some BART station areas— a finding they attributed to increased noise and auto congestion. In a survey of homeowners, Baldassare et al. (1979) found a reduced preference for homes near elevated BART station By contrast, Blayney Associates (1978) concluded that BART had a small but significant positive effect on prices of single-family homes within 1,000 feet of some (but by no means all) stations. Owing to the relative newness of the BART system at the time these four studies were conducted, their results should be regarded as preliminary.

Still Needed: Comparability

As Table 1 suggests, it is difficult to draw any generalizations from the transport capitalization literature regarding the magnitude, extent, or duration of the capitalization effect. None of the studies are comparative, each uses a different methodology to model a different property market and a different transportation facility during a different period. Only three studies (Allen et al, 1986; Bajic, 1983; and Voith, 1991) are explicitly multi-modal, typically, those studies that consider transit accessibility do not consider highway capitalization, and vice versa. The exclusion of competing modes may not be that significant in highway capitalization studies of small cities or rural property markets where transit service is lacking, but it is likely to be significant in transit capitalization studies of urban property markets

Finally, with the exception of the recent Toronto and Philadelphia Lindenwold studies, accessibility is defined very loosely — usually as a general function of airline (or as-the-crow-flies) distance to the transportation facility Depending on the area and the configuration of the transportation system, as-the-crow-flies distance may substantially underestimate actual travel distance A preferable measure of accessibility would be network-door-to-interchange/station distance, that is, travel distance along the street network from the front door of the subject property to the nearest freeway interchange or transit station The common mis-measurement of distance also makes it difficult to differentiate between the (presumed) positive capitalization effects associated with greater accessibility, and the (presumed) negative capitalization effects associated with direct proximity to a noisy or congested transportation facility

Timing, Congestion Effects, and Realized Accessibility

Capitalization, like much in life, is a matter of timing In the case of transport capitalization, property values may rise in advance of a new transit system or expanded freeway capacity as speculators bid up prices in anticipation of additional gains later on To the extent that the market responds quickly to transportation investments — that is, demand for nearby sites increases — such speculative behavior may well be rewarded. The opposite case — in which the market responds slowly to transportation investments — is much more typical. Speculators may well lose out in such cases, as prices readjust themselves downward — at least in the short run. Given such a dynamic, one frequently finds a higher level of capitalization immediately prior to the opening of a major transportation facility than afterwards. Studies that compare "right-before" and "right-after" prices without the benefit of longer-term price information will tend to mis-estimate capitalization's extent

Not waiting long enough to study the capitalization effect can be a problem But so too can waiting too long — particularly with respect to additional highway capacity. To the extent that traffic expands to fill available highway capacity, new highway facilities may quickly become congested. When that happens, the initial accessibility advantages (and higher property values) associated with that highway investment would begin to dissipate Moreover, to the extent that transportation investments relieve congestion on other facilities, such investments may actually contribute to higher property values elsewhere.

Finally, one must recognize that there is a difference between transportation capacity (or accessibility potential) and realized accessibility Accessibility potential is about the ease of travel (in terms of time, cost, or convenience) regardless of demand. Realized accessibility concerns the ease of travel between specific origins and destinations. To the extent that a specific transportation investment makes possible trips for which there is only minimal demand, its contribution to improving (realized) accessibility and thus to higher property values will also be minimal Similarly, in areas in which (realized) accessibility is already ubiquitous, the capitalization effects of incremental transportation investments will tend to be minimal.

III. MODEL SPECIFICATION AND DATA

This study develops a series of hedonic price models to determine the contribution of various structural, neighborhood quality, and, most importantly, *transportation access* variables to the price of single-family homes in six California counties Hedonic price theory assumes that many goods are actually a combination of different attributes, and that the overall transaction price can thus be decomposed into the component (or "hedonic") prices of each attribute (Rosen, 1974, Freeman, 1979, Bartik, 1987, 1988). As commonly applied to the study of housing markets, hedonic price theory suggests that a home is a combination of shelter, locational, and financial services Shelter services reflect the physical size, quality, and design of the unit Locational services include neighborhood quality as well as the combination of taxes and public goods associated with a particular parcel's location. Financial services include the tax shelter and appreciation benefits associated with homeownership, and vary with housing quality and location Accessibility is generally viewed as a locational service, and is commonly measured in terms of travel time or travel distance between the home and some combination of work or non-work opportunities

Statistical techniques —generally regression — are used to compare prices across a sample of different homes, and to control for their different attributes. The estimated regression coefficients can then be interpreted as the hedonic prices associated with each attribute Hedonic price models have been estimated to test for the existence of relationships between housing prices and a wide variety of neighborhood attributes, including environmental quality (Thayer, Albers, and Rahmatian, 1992), distance from landfills (Smolen, Moore, and Conway, 1992), tax incidence (Chadry and Shah, 1989), noise pollution (Allen, 1981), and proximity to non-residential land uses (Grether and Mieszkowski, 1980)

The hedonic price models estimated in this report all follow the same general form

1990 Single-Family Home Sales Price*(i)*
= [Home attributes *(i)*,
Neighborhood quality variables*(i)*,
Transportation accessibility variables *(i)*]
where *i* indicates a specific home sale.

Housing and Neighborhood Quality Attributes

Home sales prices and attributes were extracted from the TRW-REDI data service for six representative samples[5] of 4,180 single-family home transactions in Alameda, Contra Costa, Sacramento, San Diego, San Mateo, and Santa Clara counties for the second quarter of 1990 1990 was the last year of positive house price appreciation across California. Since that time, real housing prices have either been flat, or trending downward (1991-92), depending on the specific area In addition to the home sales prices (SALEPRICE), five measures of home quality were extracted·

1. *Square footage of living area (SQFT)* SQFT measures the living area size of each home, excluding garage, porch, and deck space. All else being equal, one would expect this variable to be positively correlated with home prices the larger the home, the more expensive it is likely to be. Previous hedonic price models have usually revealed this variable to be the single best predictor of home prices

2 *Lot area in square feet (LOTSIZE)* All else being equal, we would expect households to prefer larger lots.

3 *Home age (AGE)* Depending on the city, this variable may be positive or negative In neighborhoods where older homes are prized for their architectural or historical value, one would expect this variable to be positively correlated with price the older the home, the higher the price it is likely to bring. In more modern neighborhoods, where older homes are smaller or less functional (by modern standards), this variable may have a negative sign.

4 *Number of bedrooms in the home (BDRMS)* By itself, this variable should be positively correlated with home price all else being equal, the more bedrooms a home has, the larger and more expensive it is likely to be. Difficulties of interpretation arise, however, when BDRMS is included in hedonic price models together with SQFT. Since both variables measure home size, they are highly correlated In markets where homebuyers place a premium on having more and larger bedrooms, BDRMS should be positive when coupled with SQFT In markets where buyers prefer other types of space (e g , kitchens or bathrooms), this variable may have a negative sign.

5 *Number of bathrooms in the home (BATHS)*: Like bedrooms, this variable is positively correlated with price All else being equal, the more bathrooms a home has, the larger and more expensive it is likely to be. When BATHS is included together with SQFT, however, the results may be different In markets where homebuyers place a premium on having more and larger bathrooms, BATHS should be positive when coupled with SQFT In markets where buyers prefer other types of space (e.g , kitchens or bedrooms), or in which the typical home has a large number of bathrooms, this variable may have a negative sign

Previous hedonic price studies have demonstrated that home prices are sharply reflective of neighborhood quality The same house may sell at a tremendous premium if located in a high-income neighborhood with higher levels of public services, or at a tremendous discount if located in a blighted, deteriorating neighborhood. There are, of course, many ways to measure neighborhood quality Past studies have utilized measures of income levels, public service frequency and quality, school achievement scores, indices of deterioration, and racial mix. This study identifies neighborhoods as census tracts, and draws on six census tract-based measures of neighborhood quality from the 1990 Census[6].

6. *1990 census tract median household income (MEDINC90).* This variable measures the 1990 median household income of the census tract in which the home is located. All else being equal, one would expect this variable to be positively correlated with home prices: the higher the tract median income, the nicer the area, the more households should be willing to pay for housing. This is the demand side of the income variable. There is also, however, a "supply" side. Because most homes are financed, and because a household's income determines its ability to obtain financing, home prices are necessarily linked to household incomes. This is particularly true in census tracts or neighborhoods in which there is a large amount of housing turnover[7]. The fact that income enters hedonic price models on both the supply and demand sides means that it must be interpreted very carefully.

7. *Share of census tract households in 1990 that are homeowners (PctOWNER).* This variable, like income, above, can go both ways. On the demand side, one might expect that homebuying households might be willing to pay a premium to live in communities of people similar to themselves: homeowners. Thus, one might expect this variable to be positively correlated with home prices. An opposite effect would occur on the supply side: the lower the homeownership rate, the fewer the number of available homes for purchase, the more dear such homes are likely to be.

8-11 *Share of census tract population in 1990 that was African-American (PctBLACK), Asian (PctASIAN); Hispanic (PctHISP); and White (PctWHITE).* We begin with the assumption that most households have a preference to live in the midst of communities of similar color (holding socio-economic characteristics such as income and age constant). Black households would thus be expected to pay a premium to live in census tracts with a significant Black population; White households should be willing to pay a premium to live in White-majority tracts, and so on. The problem with testing this assumption is that we lack information on the race or ethnicity of the buyer.

A second-best hypothesis is that most households, regardless of their race, would prefer to live in a White-majority tract. This has less to do with social preferences, per se, than with the recognition that homes in White-majority tracts have tended to appreciate at a faster rate than homes in non-White-majority tracts. Applying this theory, we would expect to find a positive correlation between housing prices and PctWHITE, but a negative correlation between housing prices and PctBLACK, PctASIAN, and PctHISP. To the extent that we do not find such correlations, or find them to be statistically insignificant, one might conclude that housing prices and neighborhood racial make-up are unrelated.

Measuring Accessibility

Proximity to any sort of transportation facility is a two-edged sword. On one side, homes located adjacent to, or nearby, a highway or rapid transit line usually have excellent accessibility. On the other side, homes located right next to major transportation facilities must also suffer such disamenity effects as noise, vibration, and, in the case of highways, localized concentrations of pollution. Homes located far away from transportation facilities can avoid such disamenities, but must sacrifice accessibility.

All else being equal, one would expect accessibility to be positively capitalized into home values homes located near transit stations and highways interchanges should sell at a premium when compared with similar homes located farther away Similarly, one would expect the disamenity effects of being located too near a transit line or freeway to be negatively capitalized into property values: homes located adjacent to such facilities should sell at a discount when compared with comparable homes located at a distance The extent of capitalization will depend in part on the configuration and the design of the transportation facility Commuter rail lines, for example, may have fairly sizeable disamenity zones, as may some types of at-grade highways. By contrast, underground transit lines, or above-grade freeways, may minimally impact neighboring land uses.

Four measures of transportation accessibility and proximity were included in the various hedonic price models

12 *Roadway distance from each home to the nearest rapid transit station (TRANDIST)* TRANDIST measures the minimum distance along local roads from each home in the dataset to the nearest rapid transit station. A negative value for TRANDIST (the expected result) means that homes located near transit stations would sell at a premium compared with homes located farther away

13 *Roadway distance from each home to the nearest freeway interchange (HWYDIST)* HWYDIST measures the minimum distance along local roads from each home in the dataset to the nearest rapid transit station A negative value for HWYDIST (the expected result) means that homes located near transit stations would sell at a premium compared with homes located farther away.

14 *Adjacency to the nearest rapid transit line (TRANADJ)*: TRANADJ is a dummy variable coded to one if a house is within 300 meters of an above-ground transit line, and zero otherwise A negative value for TRANADJ (the expected result) means that homes located within 300 meters of surface transit lines would sell at a discount when compared with homes located farther away.

15. *Adjacency to the nearest freeway (HWYADJ)*: HWYADJ is a dummy variable coded to one if a house is within 300 meters of an above-ground freeway, and zero otherwise A negative value for HWYADJ (the expected result) means that homes located within 300 meters of surface transit lines would sell at a discount when compared with homes located farther away

Measuring each of these four variables by hand using paper maps for a sample of this size would be an impossibly arduous task. Instead, ARC/INFO, a geographic information system (GIS), was used to locate each home, transit line and station, and highway and interchange, and to measure the various distances The GIS procedures used for this task are summarized in Appendix I

Table 2 reviews the variable data sources and summarizes the mean values of the model variables for each county

Table 2

Mean Values of the Model Variables by County Sample

			County					
Variable	units	Data source	Alameda	Contra Costa	Sacramento	San Diego	San Mateo	Santa Clara
1990 Saleprice	1990$	TRW-Redi	$233,600	$238,902	$157,176	$207,297	$334,195	$289,828
Home Square Footage (SQFT)	sqft	TRW-Redi	1447	1706	1513	1635	1437	1591
Lotsize	sqft	TRW-Redi	6,545	9,756	29,726	15,242	6,383	7,991
Home Age (AGE)	years	TRW-Redi	44 6	25 5	23 1	24 7	38 5	30 3
# of Bedrooms (BEDRMS)	#	TRW-Redi	3 0	3 3	3 2	3 2	2 9	3 4
# of Bathrooms (BATHS)	#	TRW-Redi	1 6	1 9	1 9	1 9	1 6	1 9
Median Census Tract Household Income (MEDINCOM)	1989$	1990 Census	$45,041	$50,051	$36,687	$42,242	$49,270	$54,324
% of Population-White (PctWHITE)	%	1990 Census	66%	78%	76%	83%	72%	71%
% of Population-Asian (PctASIAN)	%	1990 Census	13%	10%	10%	6%	17%	17%
% of Population-Black (PctBLACK)	%	1990 Census	15%	8%	9%	3%	6%	3%
% of Population-White (PctHISPN)	%	1990 Census	14%	11%	10%	17%	16%	18%
% Homeowners (PctOWNER)	%	1990 Census	65%	73%	64%	67%	64%	69%
Home to Transit Station Network Distance(TRANDIST)	meters	Arc/INFO	6,392	11,682	6,844	28,927	5,290	8,508
Home to Frwy Interchange Network Distance(HWYDIST)	meters	Arc/INFO	1,993	3,320	3,475	3,817	2,514	2,657
Within 300m of Transit Line (Dummy variable TRANADJ)		Arc/INFO	0 05	0 03	0 05	0 01	0 11	0 01
Within 300m of Freeway (Dummy variable HWYADJ)		Arc/INFO	0 27	0 10	0 06	0 09	0 15	0 09
Number of Observations			1132	1229	942	1129	236	1367

IV. CALIFORNIA'S FIVE RAIL MASS TRANSIT SYSTEMS

The degree to which transport service is capitalized into home values is more than a matter of distance or proximity It also depends on the quality of that service All else being equal— including distance and proximity —transport service capitalization should be greater for homes that are accessible to higher-quality transit service than for homes accessible to lower-quality transit service A similar assumption should hold for highways· transport capitalization should be greater for homes accessible to higher-speed (or congestion-free) highways than for homes accessible to highways with a lower quality of service On the disamenity side, homes adjacent to noisy transit systems or freeway rights-of-way should be worth less than otherwise similar homes located adjacent to quieter facilities.

California's five transit systems —BART, CalTrain, the San Diego Trolley, and the Sacramento and San Jose light-rail systems —offer very different levels and qualities of service (Table 3). BART, the Bay Area Rapid Transit system, is a modern, grade-separated, heavy-rail regional rail transit system with frequent service CalTrain is a state-operated commuter railroad serving San Francisco workers who live on the San Mateo Peninsula Although not grade-separated, CalTrain does have its own right-of-way Opened in 1986, the San Diego Trolley serves downtown San Diego from the south and east Except in the downtown areas, the trolley operates in its own right-of-way Sacramento's light-rail system, also completed in 1986, is much like San Diego's in configuration. It links several residential areas of the city to downtown Sacramento on a combination of common and separated rights-of-way Opened in 1988, San Jose's light-rail system is concentrated in the city's downtown area, and does not yet extend to many residential areas. All three light-rail systems are of similar length.

Service Quality

How do the five transit services compare in terms of service quality? BART offers the fastest trains, the most frequent service, and is open from four a m. to midnight on weekdays (Table 4) CalTrain offers frequent, speedy service during commute hours, but not during off-peak periods Two of the three light-rail systems —Sacramento and San Diego —offer comparable levels of service: vehicles on both systems travel at an average speed of about 20 miles per hour at 15 minute headways during commute hours. Non-peak headways for both systems are roughly 30 minutes. San Jose's light-rail vehicles are slower than San Diego's or Sacramento's but service is more frequent, especially during commute hours. Because all three of the light-rail systems use downtown city streets, service quality and headways may vary according to auto congestion levels.

Three of the five systems —BART, CalTrain, and San Diego —use a distance-dependent fare structure Sacramento Light Rail and San Jose Light Rail have a flat-fare structure Average fares for BART and CalTrain were calculated by dividing total 1991 revenue from fares by total unlinked trips. Average fares for the three light-rail systems were calculated as the average of the minimum and maximum fares. At $1 66 per trip, the average CalTrain trip is considerably more expensive than the average BART, San

Table 8
Capitalization Effects of BART
on 1990 Contra Costa County Single-Family Home Prices

Dependent Variable SALEPRICE (1990)

	Contra Costa County	
	Coefficient	t - stat
Home Characteristics		
SQFT	93 22	25 16
LOTSIZE	2.33	13 50
BEDRMS	-8,218 73	-3 24
AGE	-932 34	-7 85
Neighborhood Characteristics:		
MEDINCOM	0 24	1 67
PctASIAN	-108,747 98	-2 40
PctBLACK	-55,319 85	-3 60
Locational Characteristics		
TRANDIST (BART)	-1 04	-3 44
HWYDIST	1 32	1 80
City Dummy Variables		
MORAGA	47,885	3 72
KENSINGTON	40,041	2 36
LAFAYETTE	28,241	2 62
ORINDA	26,745	1 98
DANVILLE	-23,102	-2.17
SAN RAMON	-34,307	-3 07
WALNUT CREEK	-38,739	-4 45
BETHEL	-63,186	-2 63
CLAYTON	-68,037	-3 79
PLEASANT HILL	-69,146	-6 83
BYRON	-70,973	-5 19
CROCKETT	-80,106	-3 93
RICHMOND	-80,439	-9 12
PINOLE	-82,726	-8 62
MARTINEZ	-91,522	-9 50
SAN PABLO	-92,544	-9 78
CONCORD	-98,229	-11 65
EL SOBRANTE	-100,593	-7 76
PACHECO	-104,628	-2 14
RODEO	-105,543	-4 58
OAKLEY	-124,073	-11 54
PITTSBURG	-127,176	-14 08
ANTIOCH	-132,185	-13 63
BRENTWOOD	-136,089	-11 18
CONSTANT	195,342 77	13 14
R -Squared	0 83	
Observations	1229	

Jose, Sacramento, or San Diego light-rail trip With an average fare of $1 00, San Jose Light Rail offers the least expensive service Average per trip fares on BART, the San Diego Trolley, and Sacramento Light Rail are comparable

Market Area Penetration and Ridership

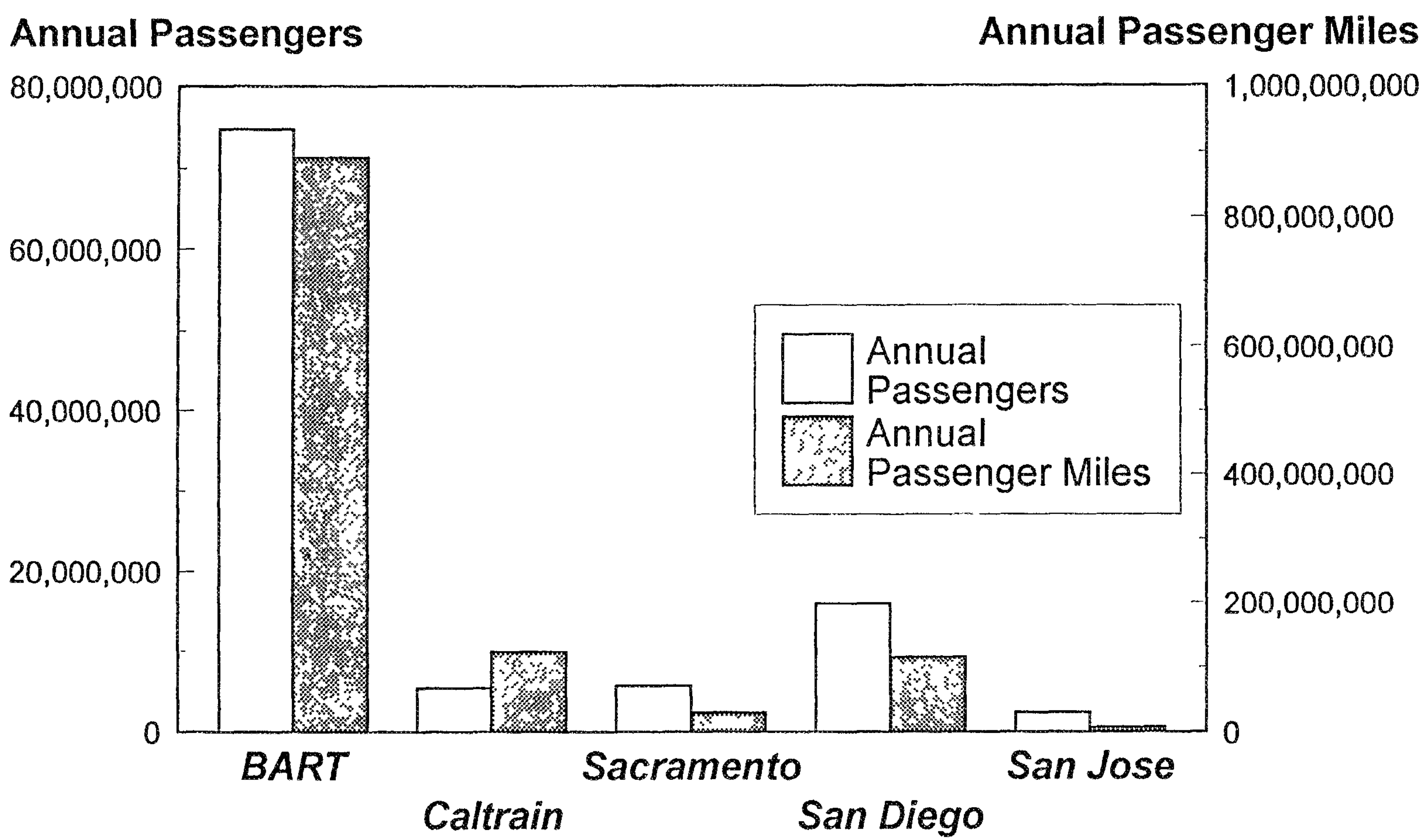
Patronage levels vary sharply across the five systems (Figure 1 and Table 5). BART, with 74.7 million riders and 892 million passengers miles in 1991, significantly outperformed CalTrain (5 4 million passengers and 123 million passenger miles) and the three light-rail systems. Among the light-rail systems, the San Diego Trolley carried significantly more passengers (for greater distances on average) than either the Sacramento or San Jose transit systems Of the five systems, the San Jose light-rail system attracted the fewest passengers in 1991 (2 4 million) and recorded the fewest passenger miles of travel (7 5 million)

Transit ridership depends on many things· service quality and cost, competition from other modes, and the size of the overall market area To determine the extent of each system's market area, we first assumed a maximum market radius of three miles for each transit station, and five miles for the end-of-the-line stations Next, we used a geographic information system (GIS) to superimpose the various market areas on census tracts to estimate the population within the market areas The results are shown in Table 5. Of the five systems, BART has the largest market area (2,102,767 persons as of 1990), followed by the San Diego Trolley (1,030,183 persons) CalTrain, Sacramento Light Rail, and San Jose Light Rail each serve a market area of about 3/4 million persons

Dividing passenger ridership by market size provides a useful index of market capture. For BART, the value of this index in 1991 was 35 6 This is analogous to saying that every person in BART's market area made 35 6 BART trips in 1991 The next highest market capture index was for the San Diego Trolley 15 5 passenger trips per market area resident For Sacramento Light Rail, the value of this index in 1991 was 7.7, for CalTrain, it was 7 2 This means that Sacramento Light Rail captured a greater share of its market area than did CalTrain. At 3.3 passenger trips per market area resident, San Jose had the lowest market capture index of the five systems.

The ability of a particular transit station to capture its market area depends in part on how easy it is for potential riders to get to that station. Market capture depends on the extent to which complementary bus service is available, on the convenience of kiss-and-ride facilities, and on parking availability It is in this last area —parking capacity —that there are significant differences between the five systems. Systemwide, BART can accomodate more than 31,000 daily parkers at 24 stations (seven stations do not have parking facilities). Nineteen of 26 CalTrain stations have some parking facilities; however, their collective capacity —at 3,438 spaces —is much lower than that of BART. The three light-rail systems offer parking at their outlying stations Systemwide, the San Diego Trolley can accomodate 4,533 daily parkers at 16 stations. Thirteen San Jose Light Rail stations offer a total of 6,298 parking spaces The Sacramento light-rail system is the most parking-constrained of the five systems: parking is available at

Figure 1:
Ridership Statistics for Five California Rail Transit Systems: 1991



Source: APTA Yearbook: 1992

only nine of the system's 28 stations. BART's ability to park so many more cars at more of its stations than the other four systems make it much more accessible to its service area

Operating Cost Efficiency

Operating cost efficiency affects market share only indirectly To the extent that a transit service is more expensive to operate (on a per-passenger or per-passenger-mile basis), or to the extent that sizeable operating deficits must be covered out of other local-source funds, it may be politically difficult to expand service to attract additional riders Operating costs (as of 1991) for the five systems ranged from a low of $ 12 per passenger mile for the San Diego Trolley to a high of $1 01 per passenger mile for the San Jose light-rail system (Figure 2) At $.17 per passenger mile and $ 21 per passenger mile, respectively, CalTrain and BART were closer to the bottom end of this range. Operating costs for Sacramento's light-rail system in 1991 were $ 37 per passenger mile Note that both the least and most expensive systems to operate (the San Diego Trolley and San Jose Light Rail) are both light-rail systems.

The San Diego Trolley also outperforms all other California systems in recovering its operating costs from the farebox (Figure 3). Over 85 percent of its expenses are collected through passenger fares Next best is BART, with a farebox recovery ratio of 44 percent. CalTrain's farebox recovery ratio is nearly 40 percent Sacramento Light Rail recovers less than a third of its operating expenses from the farebox, and San Jose's farebox recovery rate is a dismal 8 percent

Of the five systems, BART and the San Diego Trolley are the least dependent on federal operating subsidies. Each recieves less than 20 percent of annual operating costs from federal subsidies Sacramento Light Rail and CalTrain, conversely, depend on federal subsidies for 60 percent or more of their operating costs. BART and San Jose Light Rail fund a significant share of their operating costs out of local property and sales taxes — sources not used by the other three systems

V. THE CAPITALIZATION EFFECTS OF RAIL TRANSIT

We have divided our analysis of the housing price effects of transit accessibility/proximity into two sections The first section examines the housing price capitalization effects for the two heavy-rail systems, BART and CalTrain Both systems span multiple counties and political jurisdictions A second section examines the housing price capitalization effects of the three light-rail systems San Diego, Sacramento, and San Jose.

BART and CalTrain

Our analysis of the capitalization effects of BART and CalTrain is itself organized into two parts (1) a common model specification applied separately to home sales in Alameda, Contra Costa, and San Mateo Counties, and (2) unique, "best-fit" model specifications for each county.

Table 6.
Capitalization Effects of Heavy Rail Transit Investments on Single Family Home Prices
Common Specification for Alameda, Contra Costa, and San Mateo Counties

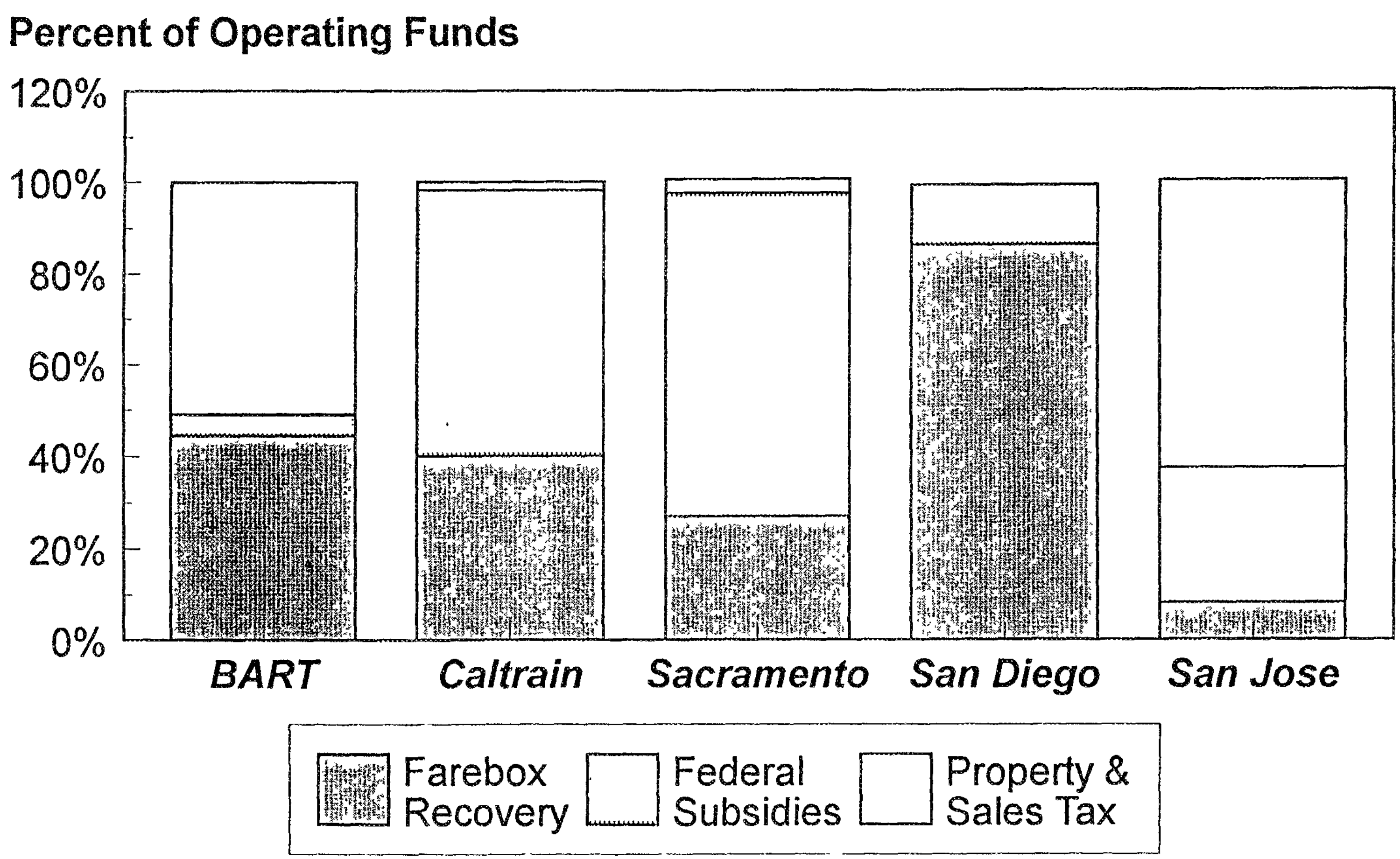
Dependent Variable. SALEPRICE (1990)

	Alameda County		Contra Costa County		San Mateo County	
	Coefficient	t - stat	Coefficient	t - stat	Coefficient	t - stat
Home Characteristics:						
SQFT	**110.62**	**27.48**	**107.37**	**22.91**	**145.71**	**8.92**
LOTSIZE	**1.81**	**5.79**	**2.51**	**12.71**	**4.17**	**3.26**
BATHS	3,768 88	1 23	297 03	0 07	**27,397.66**	**2.25**
AGE	91 63	1 00	2 08	0 02	-16 19	-0 04
BEDRMS	**-5,523.37**	**-2.20**	**-13,335.03**	**-4.60**	**-27,134.33**	**-2.84**
Neighborhood Characteristics:						
MEDINCOM	**2.10**	**12.02**	**2.21**	**10.81**	**1.57**	**3.87**
PctWHITE	-125,164.75	-1 62	-88,629 47	-1 02	808 02	0 23
PctASIAN	**-175,514.43**	**-2.21**	-61,199 46	-0 70	-256 26	-0 07
PctBLACK	**-214,791.49**	**-2.66**	-138,114 63	-1 55	-207 94	-0 06
PctHISPN	**-225,039.93**	**-4.14**	**-143,943.67**	**-2.78**	-147 49	-0 12
PctOWNER	**-57,769.56**	**-4.92**	**-85,097.96**	**-4.73**	**-65,855.08**	**-2.09**
Locational Characteristics.						
HWYDIST	**2.80**	**2.30**	**3.41**	**6.48**	4 41	1 15
TRANDIST	**-2.29**	**-10.50**	**-1.96**	**-8.78**	-2 61	-1 17
HWYADJ	-108 43	-0 03	631 86	0 11	-6,217 90	-0 04
TRANADJ	5,240 62	0 81	10,484 16	1.00	-31,424 99	-1 62
CONSTANT	**182,376.87**	**2.23**	138,127 16	1 58	55,308 08	0 16
R -squared	0 80		0 76		0 64	
Observations	1131		1228		232	

Note Coefficients in bold print are significant at the 95% confidence level

Figure 3:

Sources of Operating Funds for Five California Rail Transit Systems: 1991



Source: APTA Yearbook: 1992

Common Model Specification

We begin with the common specification (Table 6). The three regressions, one each for Alameda, Contra Costa, and San Mateo Counties, include exactly the same variables, regardless of their statistical significance This allows us to determine the explanatory power of a single specification in three somewhat different housing markets

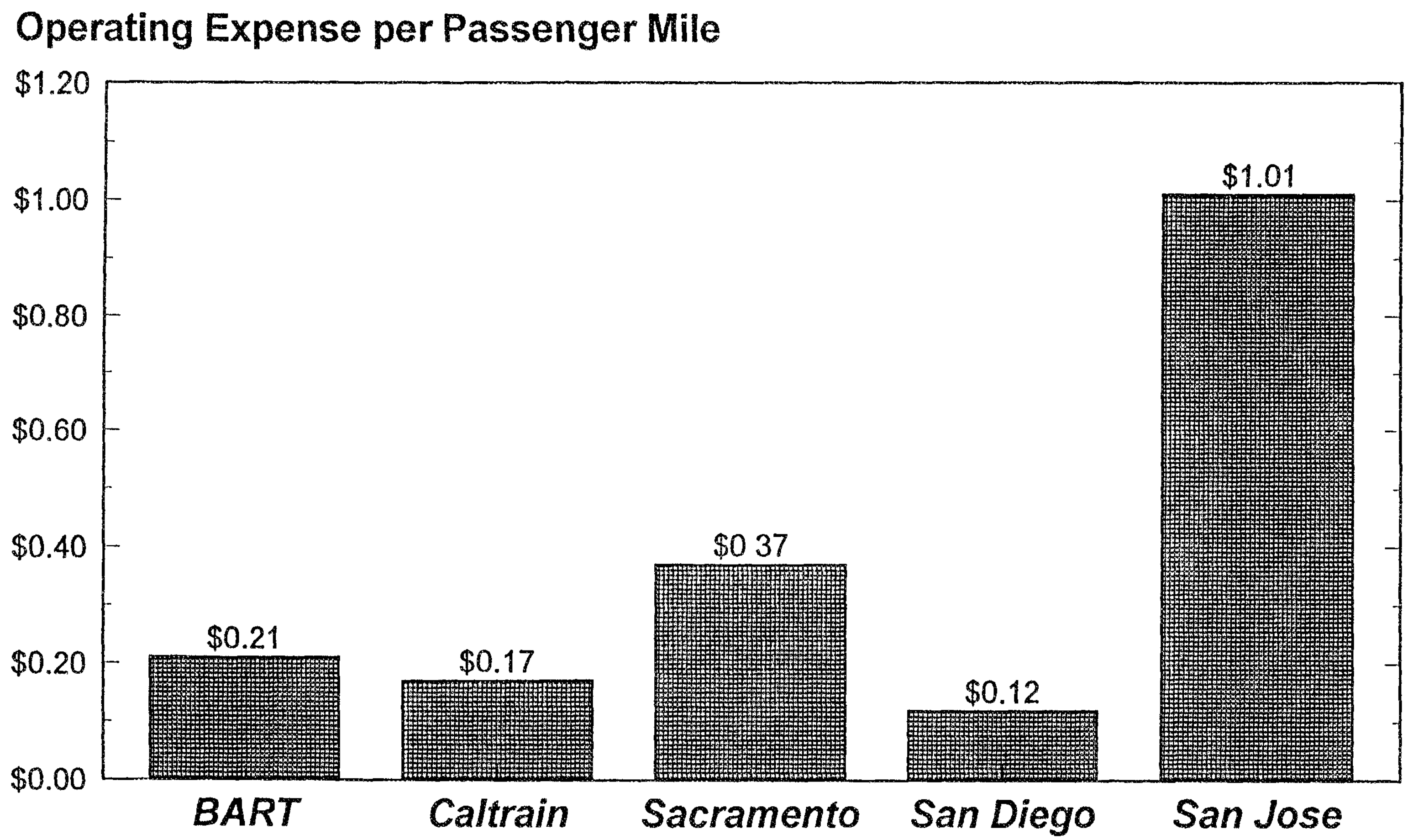
The common model fits the data fairly well, explaining 80 percent of the variation in the sample of Alameda home prices, 76 percent of the variation in the sample of Contra Costa home prices, and 64 percent of the variation in the sample of San Mateo home prices. Given the size and diversity of the samples, these are very good goodness-of-fit results.

The value and statistical significance of the coefficients of the home attributes varies by county Home square footage (SQFT) is the most significant variable in all three counties, followed by lot square footage (LOTSIZE) In Alameda County, every additional square foot of home size (above the mean) added $110 62 to the price of a home sold in 1990. In Contra Costa County, every additional square foot of living area added $107 37 And in San Mateo County, the estimated hedonic price of an additional square foot of living area was $145 71 The coefficient for the number of bedrooms (BDRMS) was statistically significant and consistently negative in all three counties. This result does not mean that homes with more bedrooms sell at a discount It does mean that buyers prefer their additional square footage in a form other than additional bedrooms Buyers of homes in Alameda and Contra Costa County were unwilling to pay a premium for additional bathrooms (above the average), in contrast to homebuyers in San Mateo County, who were willing to pay $27,398 additional dollars for an additional bathroom The coefficient for the variable measuring home age (AGE) was not statistically significant in any of the three counties.

The six variables describing neighborhood income and racial make-up also vary in importance and significance by county Of the six variables, only two are consistently significant 1990 median family income (MEDINC), and the owner-occupied share of the housing stock (PCTOWNOCC) As with the case of square footage and bedrooms above, this does not mean that houses in neighborhoods with a preponderance of owner-occupied homes sell at a discount. Rather, it is because income, not housing tenure, is regarded as the primary measure of neighborhood quality All else being equal, homes sell for more because they are in wealthy neighborhoods, not because they are in neighborhoods dominated by owner-occupied housing.

The coefficients of the various race variables also require some explanation: although they vary in significance by county, all are consistently negative, even for white-dominant census tracts As above, this is the result of multicollinearity — in this case between racial make-up and income In Alameda County, homes in Hispanic-dominant and African-American-dominant census tracts sell at a deep discount when compared with similar homes in White-dominant neighborhoods Homes in Asian-dominant census tracts also sell at a discount compared to White-dominant neighborhoods. Race is considerably less important in Contra Costa County, where the only homes that sell at a discount are those in Hispanic-dominant

Figure 2:
Comparative Operating Expenses for Five Rail Transit Systems: 1991



Source: APTA Yearbook: 1992

census tracts Finally, in San Mateo, neighborhood racial composition and home prices are statistically unrelated

We turn now to the four variables measuring transportation access and proximity The two proximity variables measuring the potential disamenity effects of transit and highways, TRANADJ and HWYADJ (measuring whether or not a particular home is within 300 meters of a transit line or freeway, respectively), are statistically insignificant for all three counties. This means that houses within 300 meters of a major transportation facility did not sell at a discount in 1990 when compared to comparable homes located elsewhere in other words, there is no systematic disamenity effect associated with living near either BART, CalTrain, or a major freeway

The two accessibility variables, TRANDIST and HWYDIST, by contrast, are statistically significant, at least for homes in Alameda and Contra Costa counties that sold in 1990 Homes near BART stations sold at a premium in 1990, while homes near freeway interchanges sold at a discount For every meter closer an Alameda county home was to the nearest BART station (measured along the street network), its 1990 sales price increased by $2 29, all else being equal For Contra Costa homes that sold in 1990, the sales price premium associated with the nearest BART station was $1 96 per meter The results for San Mateo County and CalTrain are different accessibility to a CalTrain station did not boost the prices of San Mateo County homes sold in 1990

The important contribution of BART accessibility to home prices in Alameda and Contra Costa counties is shown graphically in Figure 4 Holding all other home and neighborhood characteristics constant (and evaluated at their average values), home prices in Alameda County vary from $250,000 for homes immediately adjacent to a BART station, to $180,000 for home located 35 kilometers (or about 20 miles) from a BART station In Contra Costa County, homes directly adjacent to BART stations sell at a premium of $68,600 compared with otherwise similar homes located 35 kilometers distant.

In the case of freeway accessibility (i e., measured as street distance to the nearest interchange), the opposite effect was observed in Alameda and Contra Costa counties, homes near freeway interchanges sold for less than comparable homes elsewhere For every meter it was closer to a freeway interchange, the 1990 sales price of an Alameda county home declined $2.80 The per-meter discount associated with highway accessibility was even greater in Contra Costa County $3 41. Highway accessibility had no effect on the 1990 sales prices of San Mateo county homes.

Incorporating Inter-jurisdictional Differences

A second set of regression models includes a unique "best" model for each county (Tables 7, 8, and 9) Here, in addition to the home, neighborhood, and transportation variables included above, we also included dummy variables for each incorporated city If homes near BART are located in cities that provide a higher quality of public services at a lower tax cost than elsewhere, then the accessibility premiums estimated above might be significantly over-stated. The dummy variables allow us to test for this possibility

Figure 4:
Distance Decay Functions of Single Family Home Sale Prices: Alameda and Contra Costa Counties, 1990

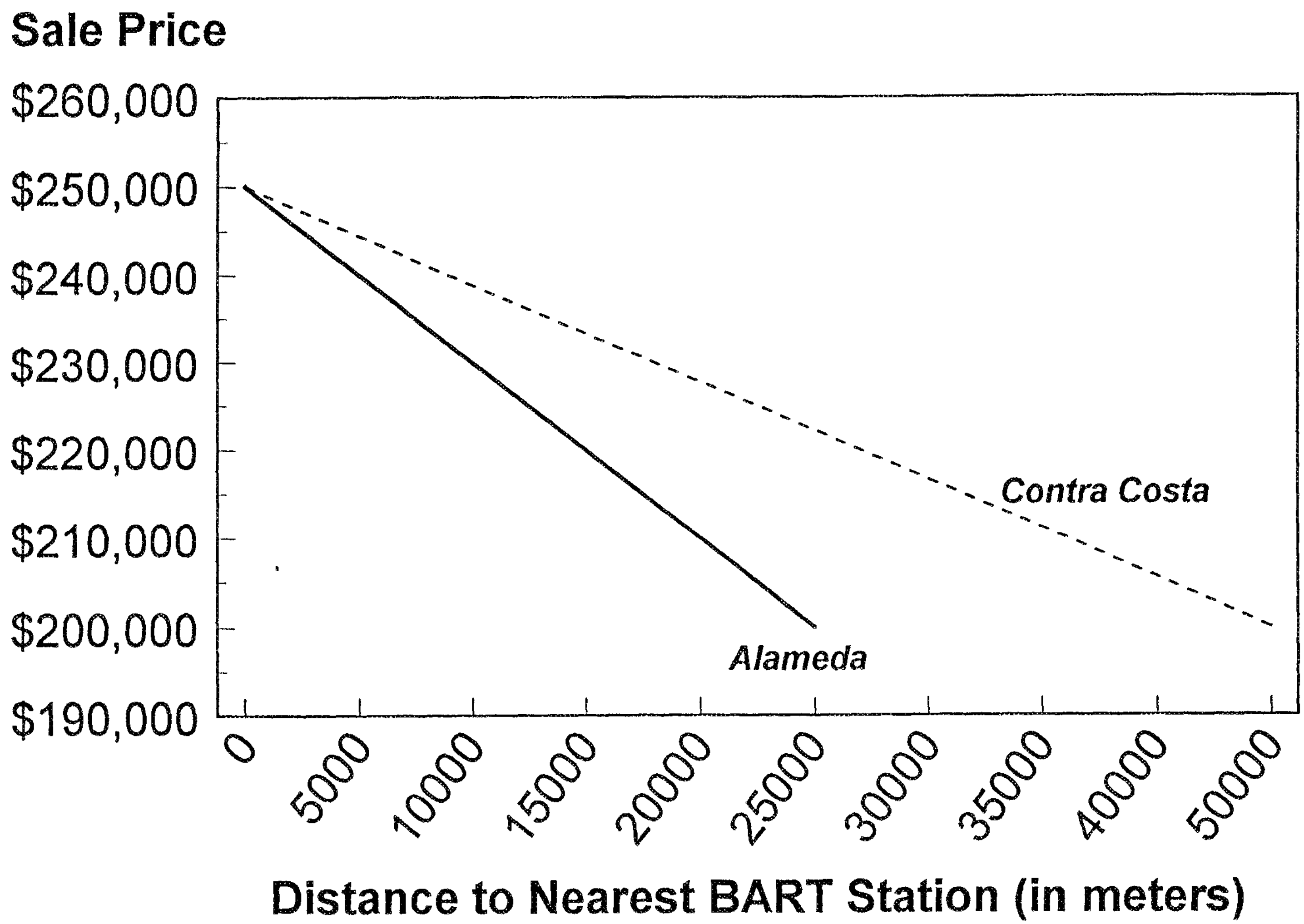


Table 7
Capitalization Effects of BART
on 1990 Alameda County Single-Family Home Prices

Dependent Variable SALEPRICE (1990)

	Alameda County	
	Coefficient	t - stat
Home Characteristics		
SQFT	100 73	34 28
LOTSIZE	2.41	8 33
AGE	-548 07	-5.72
Neighborhood Characteristics:		
MEDINCOM	1 64	9 57
PctWHITE	88,594 87	-1.62
PctHISPN	-48,852 69	-2 40
PctBLACK	-47,710 62	-2 66
PctOWNER	-53,241 79	-4 94
Locational Characteristics		
TRANDIST (BART)	-1 91	-9 61
City Dummy Variables		
BERKELEY	68,817	11 36
OAKLAND	50,379	9 71
ALAMEDA	102,201	7 13
PIEDMONT	100,502	6 48
ALBANY	53,697	4.95
UNION CITY	24,208	2 62
CONSTANT	-1,022 00	-0 06
R -squared	0 83	
Observations	1132	

Table 3
System Comparisons between BART, Caltrain, the San Diego Trolley, Sacramento Light Rail, and San Jose Light Rail

Transit System	Year Opened	System Length (in miles)	Number of Stations	Stations with Parking Facilities: # of Stations	Stations with Parking Facilities: Spaces
BART	1972/75	142 0	34	24	31,062
Caltrain	1980	93 8	26	19	3,438
San Diego Trolley	1986/ 1989	41 0	22	16	
Sacramento Light Rail	1986	36 1	28	9	3,387
San Jose Light Rail	1988	39 0	33	13	6,298

Source American Public Transit Association and individual operators

Table 4
Level-of-Service Comparisons between BART, Caltrain, the San Diego Trolley, Sacramento Light Rail, and San Jose Light Rail

Transit System	Hours of Service	Frequency of Service (min): Peak	Frequency of Service (min): off-peak	Avg Vehicle Speed (mph)	Avg Fare*
BART	4 am - 12 am	3	20	32 1	$1 27
Caltrain	4 50 am -10 pm	4-30	60-120	32 1	$1 66
San Diego Trolley	4 45 am - 1 15 am	7	15-30	19 3	$1 20
Sacramento Light Rail	4 30 am -12 30 am	15	30	19 9	$1 25
San Jose Light Rail	5 25 am - 2 30 am	10	30	12 8	$1 00

*Notes * For BART & Caltrain this was calculated as Annual Revenue from Fares/ Annual Unlinked Trips, for light rail systems, these were the actual fares or the average of the minimum and maximum fares*
Source American Public Transit Association and individual operators

Table 5
Ridership, Market Area, and Market Capture Comparisons between BART, Caltrain, the San Diego Trolley, Sacramento Light Rail, and San Jose Light Rail

Transit System	1991 Ridership: Passengers	1991 Ridership: Passenger-Miles	Avg Trip Length (miles)	Population of Market Area*	Market Capture Index**
BART	74,761,736	891,228,943	11 9	2,102,767	35 6
Caltrain	5,437,393	123,483,189	22 7	750,543	7 2
San Diego Trolley	15,933,546	115,518,215	7.3	1,030,183	15 5
Sacramento Light Rail	5,702,520	30,783,073	5 4	739,058	7 7
San Jose Light Rail	2,432,298	7,526,763	3 1	739,891	3 3

*Notes * Estimate of 1990 population within 5 miles of terminal stations and 3 miles of line stations*
*** Market capture index is calculated by dividing market area population into 1991 ridership*
Source American Public Transit Association and individual operators

Table 9
Capitalization Effects of Caltrain Service
on 1990 San Mateo County Single-Family Home Prices

Dependent Variable SALEPRICE (1990)

	San Mateo County	
	Coefficient	t - stat
Home Characteristics:		
SQFT	128 19	8 17
LOTSIZE	3 30	2 88
BEDRMS	-26,138 00	-2 96
BATHS	37,432 00	3 47
Neighborhood Characteristics:		
MEDINCOM	0 92	3 11
PctBLACK	-975 30	-2 24
Locational Characteristics		
TRANADJ (Caltrain)	-51,011 36	-2 71
HWYDIST	4 68	2 13
City Dummy Variables		
WOODSIDE	4,564,422	6 29
BURLINGAME	129,936	5 11
MILLBRAE	111,717	3 63
MENLO PARK	87,240	3 96
BELMONT	66,464	2 98
SAN CARLOS	66,163	2 63
REDWOOD CITY	53,594	3 64
SAN MATEO	51,732	3 44
CONSTANT	59,004 00	2 40
R -Squared	0 72	
Observations	233	

by capturing the price effects of municipal variations in tax rates and school and public facility quality, and by accounting for the possibility that at least some of the accessibility premiums associated with BART (reported in Table 6) might be the result of inter-municipal service quality differentials

After first estimating each model with a full set of city dummy variables, we then eliminated all variables found to be statistically insignificant The best model for each county selects only those explanatory variables that are significant at the 95 percent confidence level As a result, only the significant locational variables are reported

Six Alameda County municipal dummy variables were found to be statistically significant: ALAMEDA, ALBANY, BERKELEY, OAKLAND, PIEDMONT, and UNION CITY. The estimated coefficients are effectively the price premiums associated with a particular home being located in a specific city Homes located in Piedmont, for example, sold for $100,502 more in 1990 than comparable homes located elsewhere in Alameda County. Inserting the municipal dummy variables in the model reduces the statistical significance of the highway accessibility variable (HWYDIST), but it has a negligible effect on the transit station accessibility variable (TRANSDIST) All else being equal, homes in Alameda County sold at a $1 91 premium in 1990 for every meter they were located closer to a BART station Put another way, for every kilometer more distant a house was from a BART station in 1990, its price declined by about $2,000

The price effects of municipal service and tax differentials are more apparent in Contra Costa County, where just about all of the municipal dummy variables were found to be statistically significant (Table 8). Compared to comparable homes located in unincorporated Contra Costa County, homes located in Orinda, Kensington, Moraga, and Lafayette sold at premiums of $26,745, $40,041, $47,885, and $28,241 respectively Comparable homes in other municipalities sold at discounts, ranging from a minimum discount of $38,739 in Walnut Creek to a maximum discount of $136,089 in Brentwood Including the municipal dummy variables raises the overall goodness-of-fit of the model from 76 (for the common specification shown in Table 6) to .83.

Not surprisingly, the municipal dummy variables are correlated with the two transportation accessibility variables Compared with the common specification in Table 6, inserting the municipal dummy variables in the model renders the highway accessibility variable (HWYDIST) insignificant, while reducing the premium associated with being near BART — from $1 96 per meter to $1 04 per meter The two transportation adjacency variables, HWYADJ and TRANADJ, remain statistically insignificant.

Inserting the various municipal dummy variables also affects the values and significance levels of the home and neighborhood coefficients. Compared to the common specification shown in Table 6, the SQFT, LOTSIZE, and BEDROOMS coefficients are reduced in magnitude, while the AGE variable becomes statistically significant. Inserting the municipal dummy variables renders the MedINCOME, PctHISPANIC, and PctOWNER variables statistically insignificant at the same time that the PctBLACK and PctASIAN variables become statistically significant

In San Mateo County, including the various municipal dummy variables increases the overall goodness-of-fit from 64 to .72 (Table 9) Eight municipal dummy variables are statistically significant in San Mateo County Woodside, Millbrae, San Carlos, Burlingame, Menlo Park, Belmont, Redwood City, and San Mateo. Compared to San Mateo County as a whole, price premiums vary from a high of $4,564,422 for Woodside to a low of $51,732 in San Mateo.

Compared to the common specification shown in Table 6, including the municipal dummy variables has no effect on the transit accessibility (TRANDIST) or highway proximity variable (HWYADJ), but has a big effect on the highway accessibility (HWYDIST) and transit proximity (TRANADJ) variables both become statistically significant. According to the results shown in Table 9, for every meter a San Mateo County home was closer to a major freeway, its 1990 sales price declined by $4.68 Clearly, homebuyers in San Mateo County are willing to pay a premium *not* to be near a freeway. They are also willing to pay money not to be located within 300 meters of the CalTrain right-of-way. All else being equal —including neighborhood income, racial composition, and municipal service level— homes located within 300 meters of the CalTrain line sold at a discount in 1990 of $51,011 The disamenity value associated with living near the CalTrain line is probably a function of the noise levels generated by CalTrain service, noise levels that are much higher than BART's Note also that while BART is underground in some communities, and contained by a freeway in others, CalTrain runs at grade for its entire length

These results pose two basic questions The first is why should there be a price premium associated with accessibility to BART stations but not CalTrain stations? We believe that the answer lies with BART's superior level of transit service and greater parking capacity. Because of its greater speed, more frequent service, and ability to accommodate a wider commuter shed through large amounts of parking, BART generates true accessibility advantages for large areas of Alameda and Contra Costa counties CalTrain service, by contrast, is more limited and is targeted toward a relatively small number of commuters in San Mateo and Santa Clara counties.

A second question is why does accessibility to BART stations generates a housing price premium, while accessibility to freeway interchanges does not? We believe that the reason is that freeway access in the Bay Area is fairly ubiquitous regardless of where one lives or works, a freeway interchange is almost sure to be nearby. Compared to BART access, which is a relatively scarce commodity, freeway access is a relatively plentiful one. Thus, few households are willing to pay extra for it.

Light-Rail Systems

Table 10 presents the results of the common model specification presented in Table 6 as applied to home sales around California's three light-rail systems: Sacramento, San Diego, and San Jose In contrast to BART accessibility, accessibility to a light-rail station does not appear to increase home values signifi-

Table 10

Capitalization Effects of Light Rail Transit Investments on Single Family Home Prices

Common Specification for Sacramento, San Diego, and San Jose Cities

Dependent Variable SALEPRICE (1990)

	Sacramento City		San Diego City		San Jose	
	Coefficient	t - stat	Coefficient	t - stat	Coefficient	t - stat
Home Characteristics.						
SQFT	**96.07**	**17.86**	**58.15**	**6.33**	**109.42**	**24.83**
LOTSIZE	0 00	-0 56	-0 21	-1 02	**6.23**	**10.89**
BATHS	7,649 00	1 49	9,003 48	1 10	-2,608 57	-0 07
AGE	1,349 02	8 99	**-2,065.19**	**-4.41**	25.72	0 18
BEDRMS	**-12,872.00**	**-4.01**	5,378 64	1 00	1,589 39	1 38
Neighborhood Characteristics						
MEDINCOM	**2.59**	**6.12**	**2.52**	**5.61**	0 23	-0 74
PctWHITE	-58,204 00	-0 49	**-5,606.46**	**-2.50**	22,064 05	0 41
PctASIAN	-7,360 00	-0 06	**-8,035.42**	**3.57**	51,093 00	0 90
PctBLACK	-102,841 00	-0 85	**-10,942.52**	**-3.37**	**-672,046.28**	**-7.38**
PctHISPN	**-217,132.43**	**-2.52**	**-4,885.02**	**-3.05**	-44,194 17	-1 27
PctOWNER	**-105,175.00**	**-5.83**	**723.42**	**-2.53**	**-600.42**	**-3.75**
Locational Characteristics:						
HWYDIST	-1 66	-1 01	**-1.85**	**-0.44**	**4.41**	**1.15**
TRANDIST	-0 65	-0 73	**-2.72**	**-3.78**	**-2.61**	**-1.17**
HWYADJ	-10,537 82	-1 35	6,560 96	0 73	-6,217 90	-0 04
TRANADJ	9,668.75	1 23	-8,391 97	-0 42	-31,424 99	-1 62
CONSTANT	182,376 87	2 23	138,127 16	1 58	55,308 08	0 16
R -squared	0 80		0 76		0 64	
Observations	1131		1228		232	

Note Coefficients in bold print are significant at the 95% confidence level cantly Of the three light-rail systems, only the San Diego Trolley shifted home prices in its favor. San Jose's transit system had the opposite effect, with average home prices actually declining with increasing proximity to transit stations The third light-rail system in our analysis, Sacramento Transit, had no significant effect on home prices [8] These results are explored in greater detail below.

The San Diego Trolley: Of the light-rail transit systems examined in this study, the San Diego Trolley is the most successful It has the highest ridership, and as recently as 1993 recovered almost 90 percent of its operating cost from the farebox

Applied to a sample of 134 home sales in the City of San Diego in 1990, the common model specification explains 83 percent of the variation in home prices Of the five home characteristic variables included in the model, only two, SQFT and AGE, are statistically significant. By contrast, all six of the neighborhood characteristic variables are statistically significant

Of the four transportation accessibility and proximity variables included in the model, only one, TRANDIST, is statistically significant and of the expected sign. For the typical single-family home in the City of San Diego in 1990, for every meter it was closer to a Trolley station, its 1990 home price increased by $2 72 Note that this premium is actually higher than the accessibility premiums associated with BART stations

The premium associated with accessibility to a Trolley station applies only to homes in the City of San Diego If the home sales data set is expanded to include home sales outside the city, TRANDIST becomes statistically insignificant. This suggests that while the accessibility premium associated with the San Diego Trolley is quite high, it is limited in extent to homes in the City of San Diego This is quite different from the BART case above, where the extent of the accessibility premium is more far-reaching

San Jose Perhaps because of its newness, the San Jose light-rail system has not had much of an impact Ridership remains quite low, as do rates of farebox recovery

Nor, judging from the results of the common model, has the San Jose system had a positive impact on nearby home prices. Quite the contrary Transit in San Jose actually *takes away* value from homes that are located within easy reach of its stations. The decline in average home prices in San Jose is about $1.97 per meter of distance between a home and the nearest transit station. As large as this number is, it is considerably less than the discount associated with proximity to the nearest freeway interchange for every meter the typical home was closer to a freeway interchange, its 1990 sales price declined by $4 36 San Jose homes within 300 meters of a freeway sold at an additional discount of $11,486

What accounts for these results? Part of the reason why San Jose homebuyers prefer not to live near transportation facilities (whether transit or highways) is because those facilities tend to be located in neighborhoods dominated by commercial and industrial uses The housing stock located in such neighborhoods is simply less valuable Over time, transit service may add value to the older housing stock, but as yet, such an effect is not apparent Equally important— unlike BART, CalTrain, and to a lesser extent, the San Diego Trolley —San Jose's light-rail stations are designed for pedestrian and bus access, and include only minimal amounts of parking This significantly reduces the system's ability to attract riders from San Jose's more affluent and lower-density areas

Sacramento: Sacramento's light-rail system is similar in many respects to those in San Diego and San Jose. The system is of the same vintage, operates at roughly the same speeds, is not grade-separated, and extensively serves the downtown area. Unlike the San Jose system, Sacramento's light-rail system does pass through several established residential neighborhoods Moreover, several of the system's outer stations are located in freeway medians, and include large amounts of parking

Despite these advantages, Sacramento's light-rail system has had no discernable positive or negative effect on home prices within the city This is also true for freeways In fact, none of the four variables measuring transportation accessibility or proximity are even marginally significant. What drives housing prices in Sacramento is home size (larger homes sell at a significant premium), home age (older homes also sell at a premium), and neighborhood income levels.

This finding is not unexpected Although nearly as long as the San Diego Trolley, Sacramento's light-rail system served 60 percent fewer passengers in 1991 As discussed above, the Sacramento system is also considerably less efficient than the San Diego Trolley in terms of both total operating cost and operating cost per passenger mile Finally, Sacramento's freeways are far less congested than those in San Diego. Thus, the Sacramento light-rail system plays a far smaller role in providing congestion relief than does the San Diego Trolley.

A Note on Model Robustness

How temporally robust are these results? Is it possible that they reflect conditions in California housing markets during the sample period (the second quarter of 1990), and do not apply to other periods? To explore the stability of the models over time, we compared the results of the Alameda County and San Diego city models estimated using 1990 sales data with the results of a second set of model runs using 1987 sales data. The results of this latter set of runs is included as Appendix II

Although the coefficient estimates in the 1990 models were expectedly higher (since we had not adjusted for inflation), overall, there were no significant structural differences between the 1990 and 1987 estimates for either the Alameda County or San Diego city samples. This comparison leads us to believe that our samples of 1990 single family home sales are sufficiently representative of home sales in other periods as to warrant our generalizations regarding the values of transit and highway accessibility.

VI. CONCLUSIONS and POLICY IMPLICATIONS

Summary and Conclusions

This study compares the capitalization effects of transit and highway investments on single-family home prices across six California counties and five rail transit systems. It breaks new ground in a number of areas It is the first capitalization study of rail transit to compare so many systems, and in particular to compare heavy and light-rail systems. It is one of only a handful of capitalization studies to compare accessibility to rail transit with accessibility to the primary competing mode· freeways. It is the first transit capitalization study to distinguish between the benefits of living *near a rail transit station*—improved accessibility —with costs of *living too near a transit route*— noise and vibration Finally, it is the first capitalization study to exploit the analytic capabilities of geographic information systems to develop alternative measures of accessibility and proximity for use in hedonic modelling

Beyond issues of methodology and technique, this study presents four findings regarding the nature and extent of transport capitalization:

1 The capitalization effects of rail transit can be significant Among 1990 Alameda County home sales, the price premium associated with (street) distance to the nearest BART station was \$2.29 per meter For 1990 home sales in next-door Contra Costa County, the price premium associated with distance to the nearest BART station was \$1 96 per meter

2 Not all regional transportation facilities generate capitalization benefits. In none of the six counties studied did accessibility to a freeway interchange increase home prices Quite the contrary In Contra Costa and San Mateo counties, as well as in the City of San Jose, proximity to a freeway was associated with lower overall home prices

3 The extent to which transit service is capitalized into increases in home prices depends on many things. First and foremost, we believe, it depends on the quality of service Regional systems such as BART, which provide reliable, frequent, and speedy service, which serve a large market area, and which are able to capture that market by providing parking, are more likely to generate significant capitalization effects. The San Diego Trolley also falls within this category. By contrast, systems that provide limited service (such as CalTrain), serve a limited market (San Jose Light Rail), lack parking for suburban commuters (Sacramento Light Rail), operate at slower speeds, or do not help reduce freeway congestion (Sacramento and San Jose Light Rail), are unlikely to generate significant capitalization benefits The importance of service quality is corroborated by previous studies of the MARTA system in Atlanta (Nelson, 1992), and the Philadelphia Lindenwold line (Allen et al , 1986).

4 The negative externalities associated with being extremely close to an above-ground transit line (300 meters in this analysis) are not necessarily capitalized into home values In only one of the five systems studied in the analysis— CalTrain— was proximity to the right-of-way associated with reduced home sales prices Given that the CalTrain trackbed is minimally separated from adjacent uses, and that the CalTrain train cars are not specifically designed for quiet operation, this is not a surprising finding.

Policy Implications

These findings lead to two significant policy conclusions and two very large caveats The first policy conclusion is that the capitalized housing price premiums associated with BART access, as significant as they are, are not large enough to promote higher residential densities. Even in the best of cases, the market, left to its own devices, is unlikely to generate significantly higher residential densities near transit stations Supportive land use policies— and in many locations, development subsidies or incentives —are necessary to support the development of higher-density housing at or near transit stations

Second, this analysis suggests that it may be possible to widen transit's operating funding base. Transit system operating funds have historically been drawn from (1) fares; (2) federal assistance, and (3) sales tax revenues A few cities, notably Denver and Los Angeles, have experimented with commercial benefit assessment districts [9] The results of this analysis suggest that transit districts may want to consider establishing residential benefit assessment districts around stations as a means for recapturing some of the accessibility benefits that are capitalized into home values. We estimate, for example, that a yearly benefit-assessment fee of $50, applied to all single-family homes within a one-mile radius of a BART station, could raise as much as $4 million per year [10]

These policy conclusions are subject to two obvious caveats that bear mention. The first is that the existence and magnitude of the station access capitalization effect is by no means a sure thing Of the five rail transit systems analyzed in this paper, only BART and the San Diego Trolley generated station access premiums The existence and size of the premium are based on many factors, including system level-of-service, levels-of-service on competing modes (particularly freeways), parking availability, travel patterns, and local land use forms Although the existence of transit access price premiums may be evident in retrospect (as is the case here), they are certainly not guaranteed before the fact.

The magnitude of any transit access premiums will also vary by station. The fact that the average BART access premium associated with 1990 Alameda County homes sales varied between $1.91 and $2.29 per meter of distance from a BART station does not mean that home values were correspondingly higher in every home in every neighborhood near a BART station. In neighborhoods suffering from weak housing demand, or in neighborhoods in which the quality of the housing stock is poor, there may well be no additional value associated with transit access

Endnotes

[1]Because they are so new, the Red and Blue Metro lines in Los Angeles are not included in this analysis Nor is Metro-link service

[2]An exception is Cervero and Landis (1992), and Cervero (1993).

[3]Some longitudinal studies have also been quasi-experimental That is, they have involved comparisons of price changes between sites nearby transportation facilities (the "experimental group") and those more distant (the "control group")

[4]The choice of facility and approach is mostly a function of study age Older studies —those undertaken in the 1950s and 1960s —tend to focus on the impacts of highways, and generally take a longitudinal approach More recent studies focus on transit capitalization, and rely on hedonic models

[5]The selected samples included a complete set of recorded sales during the April-June 1990 period Excluded from the samples were homes that were excessively inexpensive (less than $50,000), excessively expensive (greater than $500,000), or excessively small (one bedroom or less)

[6]Home sales were assigned to census tracts as follows first, each home sale was "address-matched" to a street map using a geographic information system Next, a map of census tracts was overlaid on top of the street map to determine which homes where in which tracts This procedure was accomplished using ARC/Info

[7]In areas with minimal turnover, housing sales prices are determined at the margins according to transactions between a limited number of buyers and sellers In such cases, housing prices track with the incomes of buyers, and not necessarily with the incomes of existing residents

[8]In contrast to BART and CalTrain, the light-rail systems covered in this study were entirely within a single city's boundaries Hence, a second analysis controlling for inter-jurisdictional differences in service quality and taxes is not necessary

[9]Los Angeles's benefit assessment district, which was established to help finance subway construction, was overturned by the courts in 1991

[10]Capitalizing this fee at an interest rate of 5 percent yields a total value of $1,000 This is far less than the housing price premium associated with BART access

Appendix I

Procedures Use to Estimate the Transit and Highway Accessibility Variables and to Match Home Transactions with 1990 Census Tract Data

Steps

1 Housing transactions during the second quarter of 1990 were sampled (by county) from on-line transaction records provided by the TRW-Redi Company Included in the sampled data was the street address of each house

2 Each housing transaction was located in space according to its address. Specifically, each transaction was address-matched to a computerized street map using Arc/Info, a leading geographic information system (GIS).

3 Arc/Info was used to measure the street distance from each newly address-matched home to each transit stop and highway interchange in the county. The result of this operation was a matrix of street distances from each home (row) to every transit station or highway interchange (column) in each county

4 For each home, the nearest rapid transit station and highway interchange was identified The measured distance to the nearest transit station became the variable TRANDIST, the measured distance to the nearest highway interchange became the variable HWYDIST

5 Arc/Info was next used to construct a 300-meter "disamenity zone" or corridor around each transit line and highway A value of 1 was given to the variable TRANADJ for those homes that fell within a transit disamenity zone. Similarly, a value of 1 was given to the variable HWYADJ for those homes that fell within a highway disamenity zone. A value of zero was given to the variables TRANADJ and HWYADJ for those homes outside the transit and highway disamenity zones Disamenity values were not assigned to homes within 300 meters of underground transit lines or highways

6 Arc/Info was used to identify the census tract within which each home was located Census tract specific information on median household income, homeownership, and racial makeup was then matched to each observation.

Appendix II

Comparison of Capitalization Effects of Investments on Single Family Home Prices Between 1987 and 1990 for Alameda and San Diego Counties

Dependent Variable SALEPRICE (1990)

	Alameda County				San Diego County			
	1990 Sample		1987 Sample		1990 Sample		1987 Sample	
	Coefficient	t - stat	Coefficient	t - stat	Coefficient	t - stat	Coefficient	t - stat
Home Characteristics:								
SQFT	110 62	27 48	70 12	30 69	99 25	23 97	84 04	30 01
LOTSIZE	1 81	5 79	0 09	2 82	0 65	7.89	0 17	4.44
BATHS	3,768 88	1 23	6,430 22	3 14	5,099 49	1 31	8,136 43	3 06
AGE	91 63	1 00	417 28	7 04	271 00	1 93	379 08	3 98
BEDRMS	-5,523 37	-2 20	995 55	-0 68	-17,590 02	-6 86	-13,323 33	-7 24
Neighborhood Characteristics:								
MEDINCOM	2 10	12 02	2 18	18 64	4 53	21 36	1 98	13 90
PctWHITE	-125,164 75	-1 62	30,871 84	1 73	-1,111 08	-1 68	39,949.32	0 87
PctASIAN	-175,514 43	-2 21	-1,092 07	-0 06	-2,405 26	-3 07	-28,615 64	-0 60
PctBLACK	-214,791 49	-2 66	-14,393 70	-0 74	-1,419 27	-1 54	40,647.13	0 80
PctHISPN	-225,039 93	-4 14	-106,504 26	-6 47	-494 09	-1 25	-11,453 46	-0 39
PctOWNER	-57,769 56	-4 92	51,009 74	-6 33	-1,619 40	-11 97	-91,426 06	-10 25
Locational Characteristics:								
HWYDIST	2 80	2 30	3 90	5 22	-0 84	-2.46	-0 09	-0 24
TRANDIST	-2 29	-10 50	-1 32	-9 02	0 17	2 36	-0 08	1 28
HWYADJ	-108 43	-0 03	4,094 24	-2 03	-2,631 09	-0 47	-4,815 82	-1 16
TRANADJ	5,240 62	0 81	5,499 41	1 56	-5,265 95	-0 39	1,917 84	0 2
CONSTANT	182,376 87	2 23	-35,151 34	-1 71	109,724 56	1 61	-24,811 70	-0 53
R -squared	0 80		0 73		0 73		0 67	
Observations	1131		2242		1128		1501	

References

Adkins, W G. 1958 "Land Value Impacts of Expressways in Dallas, Houston, and San Antonio, Texas." *Highway Research Board Bulletin 227.* 50-65

Al-Mosaind, Musaad A., Kenneth J. Dueker, and James G Strathman 1993. *Light Rail Transit Stations and Property Values: A Hedonic Price Approach.* Portland, OR Center for Urban Studies.

Allen, Gary R 1981 "Highway Noise, Noise Mitigation, and Residential Property Values." *Transportation Research Record 21.*

Allen, W Bruce, and Richard R Mudge 1974 *The Impact of Rapid Transit on Urban Development. The Case of the Philadelphia-Lindenwold High-Speed Line* Santa Monica, CA. RAND Corporation Paper No P-5246

Allen, W Bruce, Kuo-Ping Chang, David Marchetti, and Joseph Pokalsky 1986. *Value Capture in Transit: The Case of the Lindenwold High-Speed Line* Washington, D C. Urban Mass Transportation Administration, University Research and Training Program.

Alonso, William 1964. *Location and Land Use* Cambridge, MA Harvard University Press

Alterkawi, Mezayad. 1991 *Land Economic Impact of Fixed Guideway Rapid Transit Systems on Urban Development in Selected Metropolitan Areas The Issue of the Price-Distance Gradients* Dissertation, Texas A & M University

Bajic, Vladimir 1983 "The Effects of a New Subway Line on Housing Prices in Metropolitan Toronto." *Urban Studies* 20

Baldassare, Mark, Robert Knight, and Sherrill Swan. 1979 "Urban Services and Environmental Stressor· The Impact of the Bay Area Rapid Transit System on Residential Mobility " *Environment and Behavior* 11. 4.

Bartik, T. J 1987 "The Estimation of Demand Parameters in Hedonic Models " *Journal of Political Economy* 95(1)· 81-88

____. 1988 "Measuring the Benefits of Amenity Improvements on Hedonic Models " *Land Economics* 64(2) 172-83

Blayney (John) Associates / David M. Dornbusch & Co., Inc. 1979 *Land Use and Urban Development Impacts of BART* San Francisco, CA: Metropolitan Transportation Commission.

Boyce, David E, Bruce Allen, Richard R. Mudge, Paul B. Slater, and Andrew M Isserman 1972. *Impact of Rapid Transit on Suburban Residential Property Values and Land Development; Analysis of the Philadelphia-Lindenwold High-Speed Line.* Philadelphia, PA: Wharton School Regional Science Department.

Brigham, E F. 1965. "The Determinants of Residential Land Values. *Land Economics* 41(4), November

Brown, Fred A , and Harold Mıchael. 1973 *The Impact of Land Value on a Major Hıghway Interchange Near a Metropolıtan Area An Interım Report* Joınt Hıghway Research Project Report No .34 West Lafayette, Indıana: Purdue Unıversıty

Buffington, Jesse L , and Hugo G Meuth 1964a. *Changes ın Land Value, Land Use, and Busıness Actıvıty Along a Sectıon of Interstate 35 ın Austın, Texas* Texas Transportatıon Instıtute Research Report No. 26. College Statıon, Texas Texas Transportation Instıtute

_____ 1964b *Changes ın Land Value, Land Use, and Busıness Actıvıty Along a Sectıon of Interstate 35 ın Temple, Texas* Texas Transportatıon Instıtute Research Report No 27 College Statıon, Texas Texas Transportatıon Instıtute

Burkhardt, R. 1976. *Summary of Research. Joınt Development Study* New York The Admınıstratıon and Managerial Research Assocıatıon of New York Cıty

Calthorpe, Peter 1993 *The Next Amerıcan Metropolıs. Ecology, Communıty, and the Amerıcan Dream* Prınceton, New Jersey Prınceton Architectural Press

Cervero, Robert. 1993. "Raıl Transıt and Joınt Development Land Market Impacts ın Washıngton, D C and Atlanta " *Journal of the Amerıcan Plannıng Assocıatıon* 60(1), Wınter. 83-90

Cervero, Robert, and John Landıs 1993 "Assessıng the Impacts of Urban Raıl Transıt on Local Real Estate Markets Usıng Quası-Experımental Comparısons." *Transportatıon Research A* 27(1) 13-22

Crıbbens, Paul D., Wıllıam T. Hıll, and Harold O Seagraves 1962. *The Economıc Impact of Selected Sectıons of Interstate Routes on Land Values and Land Use* Raleıgh, North Carolına. Engıneerıng Research Department, North Carolına State College.

Damm, Davıd, Steven R. Lerman, Eva Lerner-Lam, and Jeffrey Young 1980 "Response of Urban Real Estate Values in Antıcıpatıon of the Washıngton Metro " *Journal of Transport Economıcs and Polıcy* 14(3).

Davıs, Fredrıck W. 1970. "Proxımıty to a Rapıd Transıt Statıon As a Factor ın Resıdentıal Property Values " *The Appraısal Journal* 38 (October).

Dewees, Donald N. 1976 "The Effect of a Subway on Resıdentıal Property Values ın Toronto." *Journal of Urban Economıcs* 3

Dornbusch, D. M 1975. "BART-Induced Changes ın Property Values and Rents." *Land-Use and Urban Development Projects, Phase I, BART.* Workıng Papers WP 21-5-76. Washıngton, D C.· U. S. Department of Transportatıon and U S. Department of Housıng and Urban Development

Ferguson, Bruce G , Mıchael A Goldberg, and Jonathan Mark. 1988. "The Pre-Servıce Impacts of the Vancouver Advanced Lıght Raıl Transıt System on Sıngle-Famıly Property Values." In *Real Estate Market Analysıs· Methods and Applıcatıons*, John M. Clapp and Stephen D Messner, eds, New York Cıty Praeger

Freeman III, A M. 1979 *The Benefits of Envıronmental Improvement.* Baltımore. Resources for the Future Baltımore, MD Johns Hopkıns Press.

Gatzlaff, Dean H , and Marc T Smith 1993. "The Impact of the Miami Metrorail on the Value of Residences Near Station Locations" *Land Economics* 69(1)

Grether, D M., and P. Mieszkowski 1980 "The Effects of Non-Residential Land Uses on the Prices of Adjacent Housing: Some Estimates of Proximity Effects." *Journal of Urban Economics* 8 1-15

Hoyt, Homer 1933. *One Hundred Years of Land Values in Chicago* Chicago University of Chicago Press

Katz, Peter. 1993 *The New Urbanism* New York McGraw Hill.

Langley, C John, Jr 1981 "Highways and Property Values The Washington Beltway Revisited " *Transportation Research Record* 16

____ 1981 "Highways and Property Values The Washington Beltway Revisited." *Transportation Research Record* 16.

Mills, E. S. 1972 Studies in the Structure of the Urban Economy Baltimore: Johns Hopkins University Press

Mudge, Richard R. 1974 *The Impact of Transportation Savings on Suburban Residential Property Values.* Santa Monica, CA. RAND Corporation Report No P-5259.

Muth, R 1969. *Cities and Housing* Chicago, IL University of Chicago Press.

Nelson, Arthur C , and Susan J. McCleskey 1992. "Improving the Effects of Elevated Transit Stations on Neighborhoods." *Transportation Research Record* 1266

Palmquist, R. 1982 "Measuring Environmental Effects on Property Values without Hedonic Regressions " *Journal of Urban Economics* 11. 333-347.

Pickett, M W , and K. E Perrett 1984 *The Effect of the Tyne and Wear Metro on Residential Property Values* TRRL Supplementary Report No 825 Crowthorne. Berkshire Transport and Road Research Laboratory.

Rosen, Sherwin. 1974 "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition " *Journal of Political Economics* 82 34-55.

Tomasik, Jack. 1987. *Socioeconomic and Land Values of Urban Freeways in Arizona* Phoenix, Arizona: Arizona Department of Transportation

Voith, Richard. 1991 "Transportation, Sorting and House Values " *AREUEA Journal* 117(19) 2,