Rail Transit's Value-Added:
Effects of Proximity to Light and Commuter Rail Transit on Commercial Land Values in Santa Clara County, California

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Abstract

Transit-oriented development has gained favor as a means of reducing traffic congestion, promoting affordable housing, and creating more efficient urban arrangements. Real estate markets reflect the degree to which concentrating development around transit facilities yields benefits. This study models the effects of proximity to light and commuter rail stations as well as freeway interchanges on commercial-retail and office properties in fast-growing Santa Clara County, California. Hedonic price models are used to control for other factors, such as regional accessibility and neighborhood quality, in isolating the effects of proximity to transit on land values. Substantial capitalization benefits were found, on the order of 23 percent for a typical commercial parcel near an LRT stop and more than 120 percent for commercial land in business district and within a quarter mile of a commuter rail station. Such evidence is of use not only to commercial developers and lenders but also to rail transit agencies embroiled in legal battles over purported negative externalities associated with being near rail. It can also help in designing creative financing, such as value capture programs. Understanding the market value of properties near rail transit stops can also inform and elevate the practice of joint public-private development.

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1. Rail Transit and Land Values

Across the United States, transit oriented development (TOD) has gained currency as a means of redressing a host of contemporary urban problems, including traffic congestion, affordable housing shortages, air pollution, sprawl, and urban blight (Bernick and Cervero, 1997; Duanes, *et al.*, 2001; Calthorpe and Fulton, 2001). Fueling the TOD movement have been several notable trends. One is today's receptive public-policy environment, reflected in livable communities grants, smart growth initiatives, and transit village acts.[1] Two, demographic shifts – childless couples, empty-nesters seeking to down-size, and influxes of foreign immigrants (many of whom come from countries with a heritage of transit-oriented living) -- are spawning a ready-made market for transit-based housing. Third, traffic congestion is prompting more and more Americans to seek out residences near transit in the quest for less stressful commutes. Companies are also gravitating to station areas (e.g., the Discovery Channel's new headquarters adjacent to the Silver Spring, Maryland Metrorail station; Bell South's new headquarters under construction above Atlanta's Lindberg Station), in part to open up more commuting and housing options for their work forces.

To the public sector, the chief benefit of TOD is getting people out of cars and into trains and buses. To private developers, being near transit holds promise of investment profits. This is because, theory holds, parcels near transit stops enjoy better connectivity, or access, to activities within a region – i.e., residents can more easily and conveniently reach jobs, shops, and other destinations; more potential shoppers pass by retail outlets; and for businesses, the laborshed of potential workers is enlarged. Since the numbers of benefiting parcels are finite, in a competitive marketplace, households and firms bid for these choice locations, driving up the price of sites. Accessibility benefits get absorbed, or "capitalized", into property values in reasonably competitive land markets (Alonso, 1964; Muth, 1969).

This paper presents research that explores the capitalization effects of proximity to rail transit – both light rail and commuter rail – in fast-growing Santa Clara County, California. It aims to augment the fairly limited empirical insights we have on the effects of rail-induced accessibility benefits on commercial land values. Besides gauging the degree to which proximity to different forms of rail transit confer benefits to commercial landholders, there are practical reasons for conducting such research.

- Many developers, and perhaps more importantly lenders, question whether being near transit yields net benefits. Yes, being near a regional rail system enhances accessibility, however in the minds of many, this is offset by the stigma of transit as an inferior form of mobility. TOD is not necessarily a money-making proposition in the minds of some commercial developers.

- Research on transit's capitalization benefits can also help assess the degree to which any negative consequences of transit investments are offset by accessibility benefits. Across the country, transit authorities are being sued for severance damages by land-owners who claim the incursion of noise, vibration, and increased traffic, as well as partial takings that reduce the usable size of their parcels, diminish property values. In the case of the BART heavy-rail extension to the San Francisco International Airport, commercial land-owners in the cities of San Bruno and Millbrae have charged that BART's presence will lower land values on these very grounds. Recently, the California Supreme Court overturned one hundred years of legal precedence in this area, allowing a broader interpretation of offsetting benefit in a condemnation case than it previous had.[2] This has placed the onus on transit agencies to produce expert testimony demonstrating that proximity to rail transit confers net benefits to commercial properties, expressed in terms of land-value premiums and overall real-estate market performance. Thus empirical evidence of capitalization benefits is needed to help mediate legal disputes.

- Evidence of transit's value-added opens up opportunities for joint development and new forms of creative financing (Landis, *et al*, 1991; Cervero, *et al.*, 1992). Transit boards are likely to become more entrepreneurial, acquiring vacant parcels near planned rail stations early in the development process, if they believe they can not only reap profits but also leverage transit-supportive projects. Washington's regional rail authority, WMATA, has aggressively acquired parcels around rail stations over the years, many times at bargain rates. The agency has in turn entered into long-term lease arrangements with commercial developers, recapturing costs not only through rent but also from higher farebox revenues generated by increased activities around stations. As of 1999, WMATA's 24 joint development projects were generating nearly $6 million in annual revenue (McNeal and Doggett, 1999). Municipalities are also in a position to capture some of the value-added in the form of increased property-tax proceeds and possibly through such revenue-generating mechanisms as forming benefit assessment districts. Value can also be recaptured through assembling and banking land on the open market, waiting until market conditions are ripe to reap a return on investment.

Besides these practical reasons, this study was carried out in hopes of filling research gaps and refining our understanding of the influences of contemporary rail investments on land values. Most past studies of capitalization benefits have focused on heavy rail systems; in truth, far more track mileage is being laid for light and commuter rail than for heavy-rail projects in the United States.[3] In addition, past research on rail's capitalization impacts has focused on residential properties, in part because data on housing sales transactions tend to be more plentiful and readily available. However, because commercial and office properties stand to benefit more, at least on a per square foot basis, from the accessibility benefits conferred by rail transit systems, one could postulate the existence of stronger capitalization benefits for such uses. Moreover, since most transit joint development projects involve commercial land uses, evidence on the accessibility benefits that accrue to non-residential properties can aid in introducing such joint-development initiatives as air-rights leases and station-connection fees.

This research also aims to augment and perhaps even challenge several studies released on the capitalization impacts of rail transit on commercial properties, specifically in the San Francisco Bay

Area. Several past studies (e.g., Falcke, 1978; Landis, *et al.*, 1994) concluded rail transit confers no measurable benefits to commercial properties in the Bay Area, however methodological concerns (discussed later in the paper) cast some doubt on these findings. Benefits associated with being near transit are thought to be the greatest in fast-growing, congested areas with buoyant and healthy economies, such as Santa Clara County, California. Because of a booming economy and the aggressive expansion of bus and rail transit services, Santa Clara Valley Transit Authority (SCVTA) experienced the second highest relative increase in ridership, 136 percent, between 1980 and 2000 (behind San Diego) among transit systems with light-rail services (Dunphy, 2001). Between 1999 and 2000 alone, ridership on commuter rail services to the county jumped 17 percent.[4] Traffic congestion – the worst in the Bay Area, which itself was recently ranked America's second most congested metropolis by the Texas Transportation Institute[5] -- is no doubt drawing more and more commuters to buses and trains. Extraordinary growth, an overheated housing market, and traffic tie-ups have spawned a culture change in how local residents and businesses think about transit. Residents are supporting transit at both the farebox and ballot box. In November, 2000, Santa Clara County voters cleared the two-thirds hurdle by overwhelmingly voting in favor of Measure A, an initiative that extends a half-cent sales tax dedicated to transit projects for an additional twenty years. Few areas around the country have mustered the votes to extend dedicated sales tax initiatives for transit programs in recent times.

2. Methodological Considerations

This section briefly reviews several methodological topics that are germane to this study: affects of transit technologies; value measurements; and matters of model specification.

Transit Technologies and Capitalization

Fixed-guideway transit systems – notably, heavy rail, commuter rail, and light rail networks -- can be expected to confer the greatest travel-time savings and thus the greatest accessibility benefits. Buses operating in stop-and-go conditions on regular surface streets generally produce inconsequential accessibility benefits, thus the effects of bus services on land values are not addressed in this study. And it is only around access points, or stations, that proximity benefits accrue; in general, there are disbenefits from being near a rail track but not near a station.

Among fixed-guideway systems, capitalization benefits are likely to be greater for heavy-rail transit than commuter rail or light rail because such services tend to operate more frequently, at faster speeds, and over a more geographically expansive territory. Light rail systems, as typified by Santa Clara County's service, tend to offer more modest mobility and accessibility advantages, and accordingly capitalization benefits can generally be expected to be more modest. Commuter rail services, like Santa Clara County's CalTrain, generally lie in between heavy and light rail systems in terms of service intensity, speed, and coverage, thus their capitalization effects should also fall somewhere in between.

Value Measurement

The few rail-transit capitalization studies that have been conducted to date on commercial properties have mostly gauged benefits in terms of rents as opposed to land values (as expressed by open, arms-length transactions). Rental data can be problematic, however, in that contract rents do not always capture the full array of concessions received by tenants. Even if contract rents are fairly accurate, they need to be adjusted for occupancy levels to reveal effective contract rates. Data limitations often preclude this, however. Focusing on sales transaction data avoids such problems.

In studying the sales value of commercial properties, one must also decide on whether to examine the price of land and improvements as a bundle or separately. In this study, we examine the effects of proximity to transit on the value of parcels only. This is partly because theory holds accessibility benefits get capitalized into land, not buildings and other on-site improvements. Statistically, focusing on land values also avoids the need to fully specify and measure factors, many of which are not readily available (such as attributes of on-site amenities like fiber-optic cabling or quality of building materials), that reflect the extent and quality of improvements to land.

Model Specification

It does not necessarily follow that if land prices jump once a rail service begins that transit *caused* this appreciation. Spikes in land values could be attributable to other factors, like an upswing in the regional economy, improved highway conditions, or better schools. The challenge, then, is to control for such potential confounding factors so that the unique effects of transit proximity on land values can be partialed out.

Three approaches have been used to date to separate out the effects on transit on land values: (1) matched pairs; (2) repeat sales ratios; and (3) hedonic price models. The first two approaches are the easiest but also the most problem-prone.[6] Hedonic models introduce more rigorous controls, and are thus widely considered to be the best method available for ascribing benefits associated with factors like proximity to transportation facilities (Cambridge Systematics, *et al.*, 1998). Hedonic price models apply the technique of multiple regression to apportion real estate values to various explanatory variables, shedding light into the marginal contribution of factors like accessibility, land-use type, and neighborhood quality to sales values.[7] For purposes of gauging land-value benefits, a normative hedonic model is generally of the form: $P_i = f(T, N, L\ C)$, where P_i equals the estimated price (per square foot) of parcel i; T is a vector that gauges proximity to transportation facilities; N is a vector of neighborhood characteristics (e.g., presence of mixed land uses; median housing income); L is a vector of location and regional accessibility attributes (e.g., accessibility to jobs); and C is a vector of controls (e.g., fixed-effect variables).

While most transit capitalization studies have turned to hedonic price modeling (versus matched-pair comparisons or repeat-sales ratios), no single functional form dominates the literature. Although most studies use simple linear forms, some model relationships in multiplicative or exponential terms. Few studies have sought to express accessibility in a multi-modal context (e.g., transit versus highways), and quite often accessibility is narrowly defined, usually simply as straightline ("as the crow flies") distance to the nearest station or interchange. Levels of regional accessibility are often ignored altogether. Different time lines for studying impacts (some prior to or right after the opening of a facility, others focused more on long-term effects) have also been adopted. It is partly because of differences in research design and model specification that empirical results of past research topics have varied widely, the topic we now turn to.

3. Previous Research on Transit and Property Values

As noted, most studies to date on the capitalization benefits of rail transit have focused on residential properties. Research on benefits to office and commercial-retail properties are few and far between. This is unfortunate since theory suggests that in rapidly growing and fairly congested settings like Santa Clara Valley, a high premium is placed on accessible locations, and that commercial properties generally outbid other uses for "choice" sites, thereby absorbing much of the value-added associated with being near transit.

Below, we briefly review evidence from studies on transit's impacts on residential property values. This is followed by summaries of what we know about the effects of proximity to transit on commercial and office values, distinguished in terms of heavy rail versus light rail systems.

Impacts on Residential Properties

Studies on the impacts of being near rail on residential property values in settings as diverse as Philadelphia, Washington, D.C., Miami, Portland, and the San Francisco Bay Area have produced mixed results. A study of residential properties near the 14.5-mile Lindenwold Line in Philadelphia concluded that access to rail created an average housing value premium of 6.4 percent (Voith, 1993). In a study of three light rail systems (Santa Clara County, San Diego, and Sacramento), a heavy rail system (BART), and a commuter-rail system (CalTrain) in California, Landis *et al.* (1994) found evidence of capitalization effects on single-family housing prices, with heavy rail systems conferring the biggest benefits. Negative externalities from being too near (within 300 meters) of transit were also evident, especially in the case of commuter rail.[8] Another California study, using matched-pair comparisons of apartment units, found monthly rent premiums on the order of 15 percent for otherwise comparable units within walking distance of a suburban BART station (Cervero, 1996). In contrast, a study of residential values near the Miami Metrorail system concluded that proximity to rail stations induced little or no relative increase in housing values (Gatzlaff and Smith, 1993). Nelson (1992) found that transit accessibility increased home prices in Atlanta's lower-income census tracts but decreased values in upper-income areas. While differences in findings are likely attributable, in part, to local contextual and real-estate market differences, they also likely reflect differences in methodology, measurements, and research design.

Impacts on Commercial-Retail and Office Properties: Heavy Rail Systems

What little research has been conducted to date on rail transit and capitalization benefits to commercial properties has produced inconsistent results. We believe this is partly because of problems related to both internal validity (i.e., poor model specification) and external validity (i.e., limited or unrepresentative experiences that are not easily generalizable).

Most evidence on commercial property impacts comes from heavy rail systems. One of the earliest studies was conducted on the San Francisco Bay Area Rapid Transit (BART) system. Using the technique of repeat-sales ratios, Falcke (1978) found no evidence that BART increased commercial properties around the suburban Walnut Creek station or in downtown Oakland and San Francisco's Mission District over the long term. In the case of the Mission District, commercial properties values near BART nearly tripled in anticipation of rail services, however this premium quickly disappeared. Such findings should be interpreted with caution not only because of the use of simple ratio comparisons but also because impacts were examined only within a few years of BART's opening. Studies of BART's longer term land-use impacts suggest greater benefits to office and commercial properties (Cervero and Landis, 1997).

A study in Washington, D.C. similarly found evidence of benefits to commercial properties in *anticipation* of heavy-rail services. Using hedonic price models, Damm *et al.* (1980) found a significant price elasticity of –0.69 for commercial-retail properties within 2,500 feet of a Washington Metrorail station – i.e., sales prices per square foot for retail parcels fell by about 7 percent for every 10 percent increase in the distance to a station portal. No follow-up work was conducted to see if value gains held in the wake of Metrorail services, though numerous subsequent case studies suggest that Metrorail has materially benefited nearby commercial properties (Dunphy, 1995; Bernick and Cervero, 1997; McNeal and Doggett, 1999).

Several studies on impacts of the Metropolitan Atlanta Rapid Transit Authority (MART) heavy rail services reached opposite conclusions on impacts to commercial properties. Bollinger *et al.* (1998) found offices within one mile of highway access points commanded office rent premiums, however those within a mile of MARTA stations typically leased for less than comparable space farther away. In contrast, Nelson (1999, p. 78) found commercial properties were "influenced positively by both access to rail stations and policies that encourage more intensive development around those stations". Nelson's findings suggest that the combination of targeting commercial development and forming special districts that relax parking and density requirements produce synergistic benefits.

In addition to studies on the benefits rail transit confers to commercial properties, research has also shown significant rent premiums associated with heavy-rail joint development projects (Cervero and Landis, 1993). A study of five rail stations in Washington, D.C. and Atlanta over the 1978-89 period found joint-development projects tended to be better performers: besides average office rent premiums in the 7 to 9 percent range, joint-development projects tended to enjoy lower vacancy rates and faster absorption of new, on-line space (Cervero, 1994). Joint-development projects, the study found, were also "better" projects – i.e., they were architecturally integrated, they enjoyed better on-site circulation (of both people and motor vehicles), and they made more efficient use of space through resource-sharing (thus creating more net leasable space).

<u>Impacts on Commercial-Retail and Office Properties: Light Rail Systems</u>

Studies on how light rail systems affect commercial property values are even scarcer, with empirical evidence only beginning to trickle in. A study of the Dallas Area Rapid Transit (DART) system compared differences in land values of fairly loosely matched pairs of "comparable" retail and office properties near and not LRT stations (Weinstein and Clower, 1999). The average percent change in land values from 1994 to 1998 for retail and office properties near DART stops was 36.8 percent and 13.9 percent, respectively; for "control" parcels, the average changes were 7.1 percent and 3.7 percent, respectively. For retail uses, this study suggested a value-added premium of 30 percent. Anecdotally, the authors noted that North Park, the only regional mall served by DART LRT, generally outperformed other malls in the Metroplex area, remaining 100 percent occupied during the 1994-1998 period while rents increased 20 percent.

Several studies of LRT impacts on commercial properties in California have been more rigorous in their research designs, but again findings were inconsistent. In one study, Landis *et al.* (1994) were unable to assign benefits of proximity to light stations in California because of confounding influences – commercial projects closer to rail stops tended to be better quality projects. A follow-up study by Landis and Loutzenheiser (1995), focused on the BART system and based on hedonic price models, found no evidence of commercial properties reaping benefits from being near transit. Among the limitations of this study was the use of asking rents (as opposed to effective contract rents) and the analysis of relationships for a single year that coincided with a downturn in the region's economy.

A more recent study of LRT impacts on commercial properties, and one most parallel to the work presented in this paper, was conducted by Weinberger (2000). This study examined impacts of proximity to Santa Clara County's LRT system on commercial rents and sales values. Using data on 3,400 lease transactions between 1984 and 1998 from a proprietary data set maintained by a real estate brokerage firm on retainer to the Santa Clara Valley Transportation Authority, a hedonic model of "effective rent per square foot"[9] was estimated as a function of straightline distance to station, transaction year, building type and size, and area location. Weinberger (2000) found that while properties within one-half mile of a station commanded a premium, surprisingly properties that were roughly one-quarter to one-half mile commanded an even higher premium. Compared to other properties in the county, Weinberger estimated a monthly lease premium within one-quarter mile of LRT of 3.3 cents per square foot and for properties between one-quarter and one-half mile away of 6.4 cents per square foot. Sales premiums of $8.73 and $4.87 per square foot, respectively, were found, though models of sales values had poorer statistical fits. A follow-up study (Weinburger, 2001) of commercial rents using what appears to be the same data base somewhat confusingly showed higher premiums for properties in the nearest distance band to LRT stations. This analysis suggested that commercial rent premiums extended to three-quarter miles from a station and then disappeared, leading Weinberger (2001, p. 16) to conclude "the presence of the light rail system has, in fact, conferred a rental premium on office properties that lie within its catchment or service area." Our work aims to build upon and refine Weinberger's work in several key ways: by adding richer metrics of accessibility, land-use composition, and neighborhood quality; by examining impacts on the land component of property sales values as opposed to rents; and by introducing measures of proximity to multiple forms of regional transportation facilities, including commuter rail and freeways.

4. Rail Transit and Development in Santa Clara County

Santa Clara County, the Bay Area's biggest in terms of both population and employment (1.68 million and 1.08 million, respectively, in 2000)[10], inaugurated light rail transit services in 1991. The initial Guadalupe corridor, 21 miles in length, connects the Silicon Valley to downtown San Jose and several residential communities to the south. In 2000, the 7.6-mile Tasman West extension was completed, linking employment centers and residential areas in four Silicon Valley cities – San Jose, Santa Clara, Sunnyvale, and Mountain View – and bringing the total number of LRT stops up to 43. This past year, the Tasman East line brought LRT services to the city of Milpitas, serving the Cisco company headquarters and several other large-scale high-technology campuses. Other extensions are currently in the pipeline. The County also boasts two commuter rail services – CalTrain, a diesel locomotive train service that connects downtown San Jose and downtown San Francisco via the San

Mateo County peninsula, and the recently opened Altamont Commuter Express (ACE) service that links the County to vast reservoirs of affordable housing in California's Central Valley.

Few areas of the United States can match the amount of development that has taken place near transit stops in Santa Clara County in the past few years. Between 1997 and 1999, an estimated 4,500 housing units and some 9 million square feet of commercial-office floorspace were added within walking distance of the Tasman West LRT corridor. A receptive public-policy environment has helped spawn TODs. Among the instruments introduced to date to leverage TOD have been tax-exempt financing, sliding-scale impact fees, public assistance with land assembly, and overlay zones that permit higher densities than the norm. Local planner hope that placing more residents and workers within convenient walking distance of LRT stations will relieve traffic congestion, promote affordable housing, and improve jobs-housing balance.

One of the County's first TODs was Almaden Lake Village, a 370-unit project of three-story townhouses built over a podium with sub-grade parking built on a former park-and-ride lot. Another early success story was the Ryland Mews housing project, an affordable "trandominium" project built adjacent to an LRT stop just north of downtown San Jose. Ryland Mews came about partly because the local redevelopment agency assembled multiple parcels into a site of sufficient size to support a large-scale project. With pressures for office space and affordable housing continuing to mount, zoning incentives and density bonuses are becoming the tools of choice to lure private capital to station areas. Over the past few years, Mountain View officials have rezoned 40 acres of industrial land to accommodate over 500 housing units adjacent to the Whisman LRT station. In Sunnyvale, density bonuses have spurred infill development in the Northside Industrial district near the Borregas and Fair Oaks LRT stations. Moffett Park in Sunnyvale was partly leveraged by the developer's ability to build a bigger complex of high-tech office buildings clustered around a new LRT stop. In return for a 60 percent increase in allowable floor area ratio (FAR), the developer, Jay Paul Company, agreed to foot the bill for a $2 million LRT station at Moffett Park. A 30-foot wide attractively landscaped walkway will connect the office campus to the station. Not all master-developers have needed carrots to attract them to LRT locales, however. The Irvine Company is currently constructing several thousand luxury apartments within walking distance of LRT stations in north San Jose absent any development incentives. The availability of large, undeveloped parcels that happened to be near LRT attracted the company's interest.

In Santa Clara County, TODs have even formed near CalTrain stations, most notably in Mountain View where an 18-acre, compact, mixed-use and walkable neighborhood, called The Crossings, replaced a once-dying shopping mall. To leverage this development, the city of Mountain View created a Transit Overlay Zone that allowed higher densities, up to a maximum of 50 percent, within 2,000 feet of the station. TODs are also slated for joint commuter-rail/light-rail stations, notably Tamien. In 1995, SCVTA sought to jump-start the Tamien TOD by building a day-care center that accommodates 140 children directly on the station site. Besides providing an important service to the nearby community, the on-site day-care center also seeks to promote rail-commuting by making it convenient for parents to drop off and pick up their kids each work day.

The latest and one of the most impressive examples anywhere of adaptively reusing and infilling a park-and-ride lot is San Jose's Ohloyne-Chenoweth project. The city, SCVTA, and a non-profit housing corporation recently joined forces in building a mid-rise, mixed-use project on the park-and-ride lot at the Ohlone-Chynoweth light rail station (Photo 1). As the demand for affordable housing with good access to the Silicon Valley has intensified, local policy-makers have come to the

Photo 1. Adaptive-Reuse of a Parking Lot. Three-story townhouses, built by Bridge Housing, occupy a former park-and-ride lot at San Jose's Ohlone-Chynoweth Station.

realization that parking-lot infilling was too good of an opportunity to pass up. At the time of project development, only 30 percent of the 1,140 original parking spaces at the Ohlone-Chynoweth station were used. In the past year, 500 parking spaces have been converted to 195 below-market-rate units of two and three story town homes, a retail plaza, a child-care facility, and a community recreation center. A combination of tax-exempt bonds, tax credit equity, loans from the city of San Jose, and various state and Federal grants were used to finance the $31.6 million project.

5. Methodology and Data

To gauge the value-added associated with being near light and commuter rail transit in Santa Clara County, a hedonic price model was estimated. The primary data source used to carry out this research was *Metroscan*, a proprietary data base that contains information on all real estate sales transactions that are recorded in county assessor offices.[11] *Metroscan* provides data on nearly a half million parcels in Santa Clara County, including: parcel address (which was in turn geo-coded into a GIS data base); a land-use code for the parcel; the square footage of the lot and the land value as assessed at the most recent time of sale; the square footage of all buildings on the parcel; and the assessed structure value at the most recent time of sale. The vast majority of *Metroscan* observations, however, predate the introduction of rail services in the County and were thus eliminated from the analysis.

For purposes of this study, we selected data observations for commercial, office, and light industrial properties for calendar years 1998 and 1999, a buoyant economic time marked by rapid growth and escalating land prices. These dates were also felt to provide a sufficient time lapse for the benefits of proximity to light and commuter rail services, which were introduced in the county in the early 1990s, to have taken form. Values of parcels in 1998 were adjusted upwards by 7 percent to express them in 1999 dollars, reflecting the County's cost-of-living adjustment for real estate over this one-year period.

The *Metroscan* data base presents the estimated value of land as well as buildings and improvements for each sales transaction, as apportioned by the county assessor office for property tax purposes. Since the benefit of being near transit presumably gets capitalized into the price of land, we opted to statistically examine impacts on parcel values only (exclusive of the dollar value of buildings and improvements). Of course, this assumes that assessor's offices accurately apportion sales transaction values into land and improvement components. While there are no doubt instances of mal-apportionments, on balance we believe that land-value estimates are fairly accurate and to the degree errors are introduced, they are unlikely systematically biased in one direction or the other.

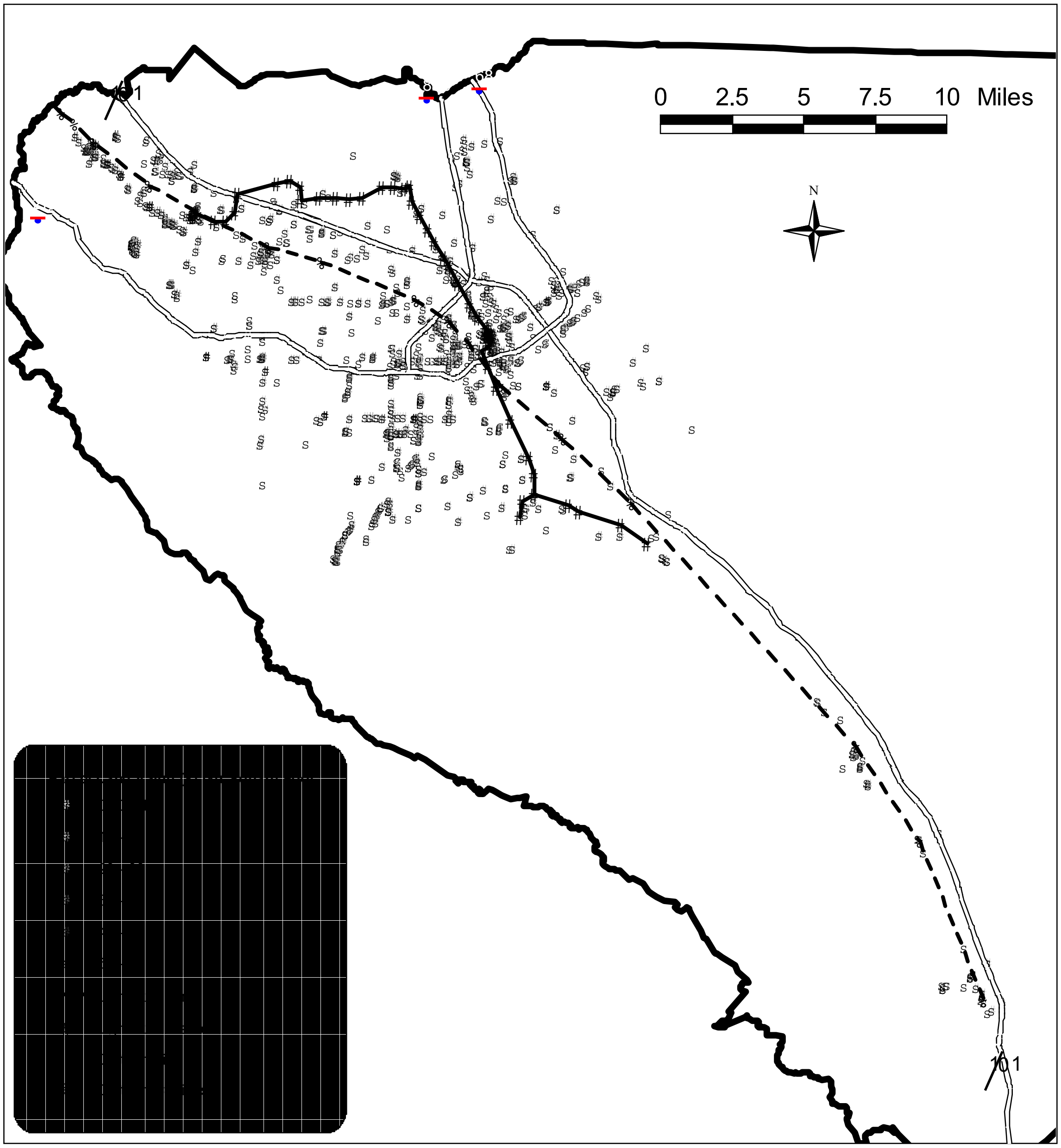
Broadly, the cases used in this analysis represented professional-office, commercial-retail, and light industrial/research and development (R&D) uses – activities that are thought to benefit from proximity to regional transportation facilities and services. The specific land-use categories, as defined in *Metroscan*, used in the analysis (along with the percentage of the 1,197 total observations) were:

- Commercial: Business District, San Jose Central (1.9%)
- Commercial: Business District, Local (6.1%)
- Commercial: Retail not in Shopping Center (40.1%)
- Commercial: Community Shopping Center (1.1%)
- Commercial: Neighborhood Shopping Center (5.6%)
- Commercial: Regional or Specialty Shopping Center (0.6%)
- Industrial or Manufacturing: Research and Development (2.8%)
- Professional: Offices, Banks, and Clinics (41.5%)

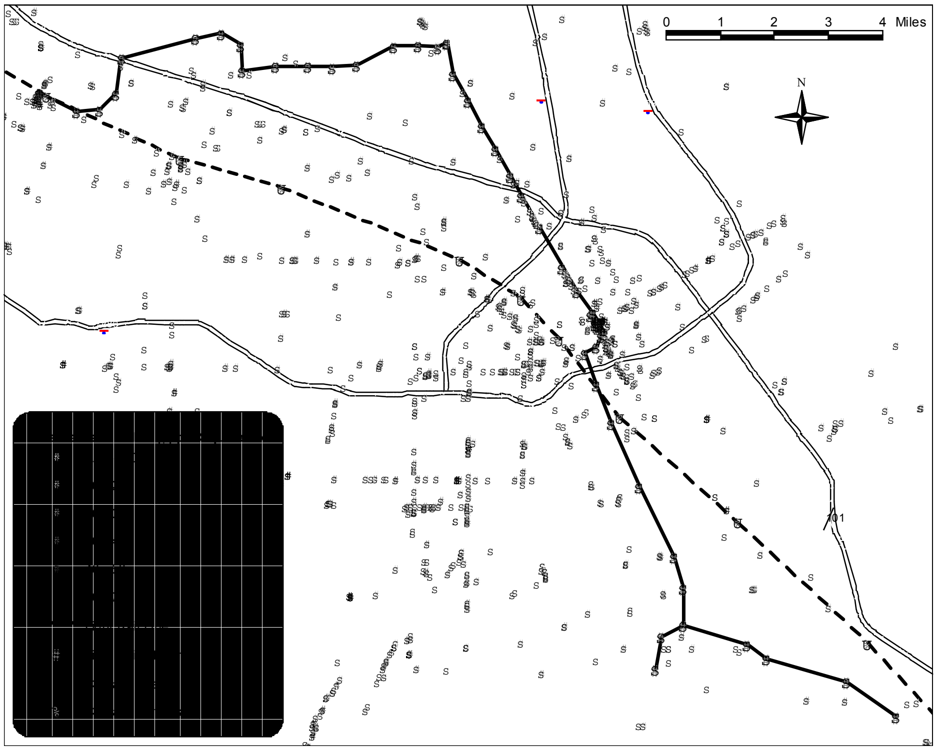
Professional activities (offices, banks, and clinics) and retail outside of shopping centers dominated the land-use categories, representing more than 80 percent of the data observations. The average parcel size was 38,350 square feet, with a fair amount of variation (standard deviation of 86,300 square feet), ranging from less than 500 square feet (for several professional-office sites) to as large as 1.28 million square feet (for a "research and development" campus site).

Throughout the remainder of this paper, the term "commercial" property is used as a catch-all to represent the eight specific land-use types listed above. After eliminating all parcels whose recorded sales predated 1998 and did not fall into any of the eight commercial land-use categories, we were left with 1,308 observations. After eliminating cases on the periphery of the county (lying one mile or less from the county boundary) and outliers with extremely high or low per square foot land values (including possibly those that did not involve arms-length transactions), 1,197 parcels remained for purposes of estimating a predictive model.[12]

Map 1 shows land values for the 1,197 sampled parcels in relation to Santa Clara County's light-rail and commuter rail systems as well as major freeways. While one can certainly identify commercial properties near rail stops that fetch high prices per square foot, the map's scale renders any spatial interpretation of relationships difficult. Map 2 "blows up" a portion of Map 1 to reveal land values of sampled parcels in relation to the County's LRT network. There are clearly instances of "darker



Map 1. Thematic Plot of Commercial Property Values in Relation to Major Rail and Freeway Transportation Facilities in Santa Clara County, 1998 and 1999



Map 2. Magnified Plot of Commercial Property Values in Relation to Santa Clara County's Light Rail Transit Network, 1998 and 1999

dots", or high per square-foot land prices, near LRT stations, although there are also a number of high-valued parcels that are some distance away from rail stops. The drawback of simple maps such as these is that they fail to convey the influences of other factors that might account for land-value premiums, like quality of neighborhood and spillover benefits from proximity to co-benefiting land uses. Only through statistical modeling can one reliably control for the influences of potentially spurious factors and isolate in on the marginal contributions of proximity to transit on land values. The analyses that follow seek to do this.

6. Descriptive Statistics

Basic statistics for the dependent variable, commercial per square-foot land value, as well as key predictive variables used in the hedonic price model are presented in Table 1. The table organizes and presents explanatory variables in four groups: proximity to rail and highways; accessibility and location; density and land uses; and neighborhood quality proxies. For ratio-scale variables, statistical means and standard deviations are presented. For nominal (categorical variables), proportions of total cases are shown. Also, more detailed descriptions of several variables that elaborate on Geographic Information Systems (GIS) techniques used to impute estimates for those variables are provided in the endnotes. GIS maps displaying values of some of the key explanatory variables used in this study can be found in the Appendix.

The average 1999 value of the 1,197 parcels used in the analysis was over $17 per square foot, with a fair degree of variation. More parcels were close to freeway or highway interchanges than to rail stations. Only around one in ten of the sampled parcels were situated within a quarter mile of a LRT or CalTrain station. (A much smaller share of parcels were within a quarter mile of an ACE station, however since being near an ACE station was found to have no appreciable effect on land values, statistics are not presented for this and other non-significant variables.)

Commercial properties had fairly good regional access to labor markets – on average, more than 1.3 million employed residents were within a 45 minute peak-period drive of a parcel via the region's highway network. Significant numbers of employed residents were also clustered around the commercial properties, with an average of nearly six employed-residents per gross acre within a one-mile radius of sampled parcels (or a total of 11,795 employed residents within a one-mile radius).[13] There were generally fewer numbers of non-employed residents nearby, and even sparser counts of service, retail, and manufacturing workers in the vicinity. Commercial parcels were generally in desirable neighborhoods, reflected by an average building value of more than $70 per square foot and mean household incomes of over $68,000.

7. Hedonic Price Model Results

The hedonic price model estimated for predicting office and commercial land values in Santa Clara County in 1998 and 1999 is presented in Table 2. As in Table 1, explanatory variables are organized into four categories. Because values of land were estimated, there was no need to include variables related to building size, quality, age, and other possible attributes of improvements to land. Weighted least squares (WLS) estimation was used to correct problems of heteroscedasticity that were encountered when attempting ordinary least squares (OLS) estimation. WLS estimation yielded a statistically significant model that explained over 30 percent of the total variation in land values across the nearly 1,200 parcels studied.[14] All of the variables in the model were significant at the 5 percent probability level, and most variables were significant at a 1 percent probability value. The influences of the explanatory variables are discussed below, organized in terms of the four sets of explanatory variables.

Rail and Highway Proximity

Do proximity benefits vary by type of transportation facility? To address this question, the effects of proximity to three types of regional and sub-regional transportation facilities were studied: light rail, commuter rail, and grade-separated freeways and expressways. Proximity was defined in terms of distance bands from access points (stations and interchanges) since this metric provided better statistical fits than did continuous-scale measures of distance.

Consistent with theory, being near rail transit was found to "matter" as expressed by commercial land-value premiums. However, the benefits only accrued to parcels that were located fairly close to

Table 1: Descriptive Statistics and Definitions of Variables Used in Hedonic Price Model

Variable	Mean or Proportion	Standard Deviation
Land Value: Commercial parcel land value per square foot ($, 1999)	17.51	16.32
Rail/Highway Proximity		
LRT: within ¼ mile of LRT station (1=yes; 0=no)	.089	--
Commuter Rail: within ¼ mile of CalTrain station for commercial uses in business districts (1=yes; 0=no)[15]	.017	--
Freeway: within ½ mile of grade-separated freeway or highway interchange (1=yes; 0=no)[16]	.313	--
Accessibility & Location		
Regional Labor Force Accessibility: No. employed residents (in 100,000s) within 45 min. peak-hour travel time on highway network[17]	1,325,272	158,802
Downtown San Jose: within ¼ mile of Santa Clara station LRT station in downtown San Jose (1=yes; 0=no)[18]	.018	--
Density & Land Uses		
Labor Force Density: No. employed residents per gross acre within one mile radius of parcel[19]	5.87	5.47
Non-Employed Resident Density: No. non-employed residents per gross acre within one mile radius of parcel	5.20	2.67
Single-Family Housing Density: No. single-family housing units per gross acre within one mile radius of parcel	2.06	0.77
Service Employment Density: No. service employees per gross acre within one mile radius of parcel[20]	3.23	2.29
Retail Employment Density: No. retail employees per gross acre within one mile radius of parcel	1.17	0.52
Manufacturing Employment Density: No. manufacturing employees per gross acre within one mile radius of parcel	1.52	.84
Other Employment Density: No. other (not professional, service, retail, manufacturing) employees per gross acre within one mile radius[21]	1.69	0.84
Professional-Office Land Use (1=yes; 0=no)[22]	.415	--
Institutional Uses: Square feet of public and institutional building area per gross acre within one mile radius of parcel[23]	33.56	39.53
Neighborhood Quality Proxies		
Building Values: Weighted average value of structures and improvements per square foot ($, 1999) for all properties within one mile radius of parcel[24]	72.24	13.81
Household Income: Mean household income (in $10,000, 1999) of households within one mile radius of parcel[25]	6.48	7.95

Table 2: Hedonic Price Model for Predicting Non-Residential Land Values per Square Foot ($, 1999) in Santa Clara County, California: Professional, Office, Commercial-Retail, and Commercial-Business Parcels, 1998 & 1999

Variable	Coeffi-cient	Standard Error	Prob. Value
Rail/Highway Proximity			
LRT: within ¼ mile of LRT station (1=yes; 0=no)	4.062	1.711	.018
Commuter Rail: within ¼ mile of CalTrain station for commercial uses in business districts (1=yes; 0=no)	25.430	3.289	.000
Freeway: within ½ mile of grade-separated freeway or highway interchange (1=yes; 0=no)	-1.881	.905	.038
Accessibility & Location			
Regional Labor Force Accessibility: No. employed residents (in 100,000s) within 45 min. peak-hour travel time on highway network	1.538	.000	.000
Downtown San Jose: within ¼ mile of Santa Clara station LRT station in downtown San Jose (1=yes; 0=no)	19.183	3.255	.000
Density & Land Uses			
Labor Force Density: No. employed residents per gross acre within one mile radius of parcel	3.328	.000	.000
Non-Employed Resident Density: No. non-employed residents per gross acre within one mile radius of parcel	-1.395	.000	.000
Single-Family Housing Density: No. single-family housing units per gross acre within one mile radius of parcel	-6.092	.000	.000
Service Employment Density: No. service employees per gross acre within one mile radius of parcel	1.696	.000	.000
Retail Employment Density: No. retail employees per gross acre within one mile radius of parcel	-2.558	.000	.050
Manufacturing Employment Density: No. manufacturing employees per gross acre within one mile radius of parcel	-0.940	.000	.001
Other Employment Density: No. other (not professional, service, retail, manufacturing) employees per gross acre within one mile radius	-2.147	.000	.002
Professional-Office Land Use (1=yes; 0=no)	7.417	.824	.000
Institutional Uses: Square feet of public and institutional building area per gross acre within one mile radius of parcel	0.032	.000	.013
Neighborhood Quality Proxies			
Building Values: Weighted average value of structures and improvements (in $, 1999) for all properties within one mile radius of parcel	0.086	.034	.011
Household Income: Mean household income (in $10,000, 1999) of households within one mile radius of parcel	1.410	.000	.000
Constant	-20.022	4.119	.000
Summary Statistics			
No. observations = 1,197			
F Statistic (prob.) = 32.798 (.000)			
R-Squared = .308			

light rail and commuter rail stations – specifically, within one-quarter of a mile (measured in straight-line distance) of a station, what is widely considered to be an acceptable walking distance to transit in fairly low density, suburban-like settings like Santa Clara County (Calthorpe, 1993; Bernick and Cervero, 1997).[26] Figure 1 depicts the relationship of land values and proximity to LRT based on a simple scatterplot: commercial land immediate to stations tended to be worth more per square foot, however beyond roughly a quarter mile distance there was no appreciable benefit from being closer to transit. That is, in a landscape of campus-style offices, auto-oriented retail strips, free and plentiful parking, and super-block development, only those commercial parcels that are within walking and often visual distance of stations are worth more per square foot; once one goes beyond an five or so minute walk, the value-added from transit largely vanishes. A policy implication of this finding is that the benefits of transit-oriented development in settings like Santa Clara County are likely to occur through densification, in-fill, and re-fill of sites fairly close to a rail stations. That is, placing significant shares of future commercial development within walking distances of stations can yield significant benefits, as revealed by land-value premiums.

Table 2 also sheds light on the relative benefits of proximity to light rail versus commuter rail. By far, the largest accessibility premium accrued to commercial properties near CalTrain stations, however this held only for commercial properties that were also in business districts -- i.e., fairly dense settings featuring mixes of retail, institutional, and office uses. Indeed, no appreciable benefits were associated with being near commuter rail stations that were not in business districts. The model reveals that parcels within a quarter mile of a CalTrain station and in a business district were worth more than $25 per square foot than otherwise comparable properties away from stations. This finding reflects, we believe, the affordable housing crisis that afflicts the Silicon Valley and its surroundings. To many employers, commuter rail lines function as conduits to affordable housing, helping not only to temper wages but also to recruit and retain workers. Being near a commuter rail stop opens up affordable housing opportunities for a company's workers while also allowing many to arrive to work everyday without having to fight traffic. In a competitive marketplace, land values tell us how much this benefit is worth.

In comparison, the capitalization benefits of being near LRT were smaller, around $4 per square foot, those associated with commuter rail in business districts. This benefit generally extended to parcels within a quarter-mile distance for all station settings, whether or not situated in business districts. Thus, a stand-alone office campus in a largely single-use environment accrued appreciable land-value benefits when within walking distance of an LRT station, even without commercial-retail and other uses nearby. The smaller premium reflects, we believe, the more modest regional accessibility benefits (particularly to reservoirs of affordable housing) of a slower speed light-rail system that stops more often and occasionally operates in mixed-traffic conditions.

While being near rail transit yielded measurable land-value benefits, somewhat surprisingly the opposite relationship held for major roadway facilities – being within a half-mile of a grade-separated freeway or expressway interchange was actually associated with lower land values. (Because people access thoroughfares via motor vehicles, a more generous half-mile, instead of quarter mile, was used to reflect immediate proximity to freeway or expressway interchanges.) We surmise that the abundance of freeways and super-highways that crisscross throughout Santa Clara County diminished the value of being right at a freeway or highway interchange. Indeed, the regression results likely reflect a dis-amenity effect associated with being too close to the noise, fumes, vibration, and headlight glare of a freeway. While small retailers (like gasoline stations and

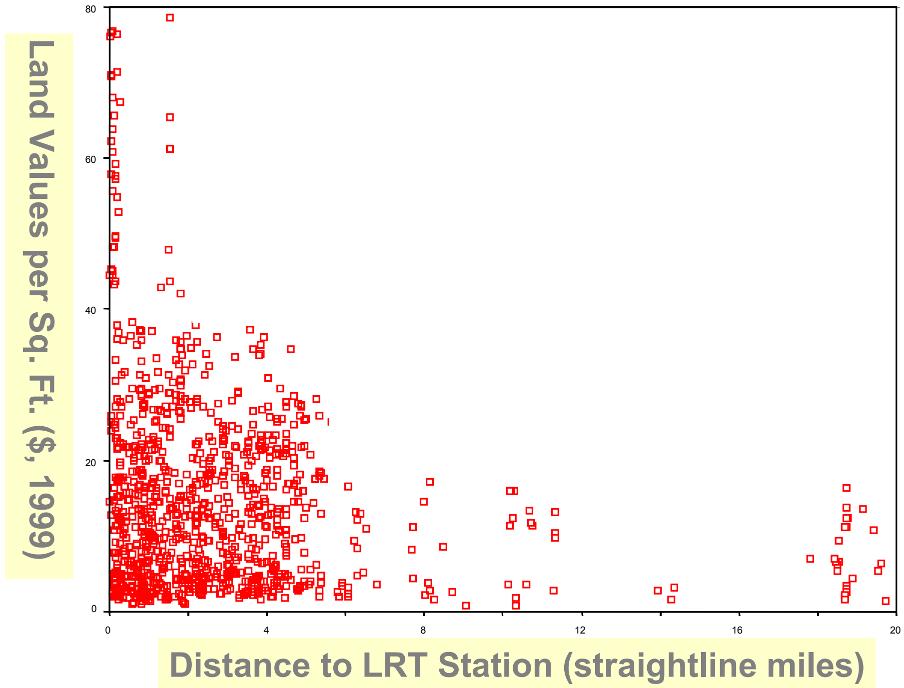


Figure 1. Scatterplot of Commercial Land Values per Square Foot in Relation to Distance from LRT Stations

fast-food chains) depend on exposure and visibility to snag pass-by traffic and impulse buyers, such commercial uses comprised a relatively small share of *Metroscan* observations. Most trips to professional offices, high-technology plants, and high-end retailers, uses that made up the bulk of data cases, are pre-planned, thus such activities need not be immediate or even very close to interchanges. The model results suggest the nuisance effects of being near a freeway was a lowering of land values by nearly $2 per square foot, all else being equal. As noted below, this finding should not be interpreted to mean that having good regional highway access does not matter; while being near a freeway interchange did not enhance commercial-office land values, this says nothing about the value of good connectivity to pools of labor via roadway networks.

Accessibility and Location

The regression results lend support to the real estate industry's "location, location, location" cliché. The larger number of employed residents that can reach a parcel within 45 minutes peak-period travel time over the region's highway network, the more a commercial property is worth. Positive results were also produced for labor-force commuter-sheds defined as 30 minutes and one hour, however the 45-minute travel-time threshold produced the most significant results. Also, non-residential parcels in and around downtown San Jose (defined as lying within one-quarter mile of the

Santa Clara LRT station in the heart of the CBD) were worth on average some $19 more per square foot, controlling for other factors, including proximity to rail transit.

Density and Land Uses

The intensities and types of land uses within one mile of commercial properties were found to influence land values, although in varying ways. Having significant numbers of employed-residents within a mile increased values while having non-employed residents nearby exerted the opposite effect. We interpret this finding to reflect, indirectly, socio-demographic influences. Office and commercial-retail uses benefit from having pools of employed-residents and labor within a mile, both in terms of forming potential customer bases (particularly in the case of retail) and employees (particularly in the case of offices). Every additional employed-resident per gross acre residing within a mile of a commercial parcel was associated with the parcel being worth $3.33 more per square foot, all else being equal. However, once labor-force density is controlled, the density of non-employed residents (presumably reflecting children, dependents, and retirees) within a mile is negatively associated with value. This possibly reflects the fact that being near non-employed individuals diminishes values to the degree these sub-populations living in predominantly single-family settings that conflict with and spawn not-in-by-backyard resistance to commercial and office uses. This is further supported by the negative sign on the "single-family housing density" variable. In sum, while having dual-earner childless couples and single-person households nearby appeared to increase commercial land values, having non-adults and retirees tended to depress them.

A number of variables in Table 2 also shed light on how the use characteristics of land within a one-mile radius of commercial properties affected values. Having clusters of service employees nearby was associated with higher parcel values whereas higher densities of retail, manufacturing, and other jobs within a mile radius tended to lower them. We believe the service employment density variable stands as a proxy for the kinds of mixed-use activities that commercial properties and professional offices benefit from having nearby. Notably, white-collar offices and tech centers benefit from being close to the kinds of businesses that hire those in the "service employment" category: consumer services, restaurants and eateries, repair shops, health clubs, lodging, and the like. Being close to public land uses like child care, universities, and government buildings, as reflected by the "institutional use" variable in Table 2, also added to commercial values. Having larger numbers of manufacturing and "other" jobs nearby, and perhaps more surprisingly, being close to retail shops, had the opposite effect. Overall, these results help to inform the kinds of activities that co-benefit from each other's presence, as expressed by real estate markets: namely, consumer services, restaurants, day care centers, and the like that are fairly close to offices and other (predominantly "white and pink collar") employment-oriented land uses.

Table 2 also reveals that, controlling for other factors, parcels used for professional-office activities (including banks and health clinics) commanded a $7.41 per square foot value premium over the other seven classes of commercial uses included in this study. That is, irrespective of proximity to rail transit, regional accessibility, or other factors, parcels zoned and used for professional and white-collar activities were worth around 42 percent more than the typical commercial parcel studied.[27]

Neighborhood Quality

As control variables, two proxies of neighborhood quality – average building value and household income, both expressed within a one-mile radius of parcels – proved to be significant predictors. For every dollar increase in the mean value of buildings within a mile of a commercial parcel, that parcel's per square foot value increased by around 8 cents, all else being equal. And every $10,000 increase in mean household income was associated with a $1.41 per square foot increase in sampled commercial parcels.

Excluded Variables

It is worth noting that a number of "dummy" variables that distinguished among land uses, city locations, and alternative commuter rail services failed to improve the model's predictive power and thus did not enter the hedonic price equation. One, while proximity to CalTrain commuter services yielded land-value premiums, nearness to the County's ACE commuter rail stations did not. The absence of benefits from being near ACE could reflect the limited number of ACE stations (just three compared to CalTrain's 16 stations) in the County, as well as the fact that ACE services are fairly new, only having started in late-1998, and accordingly have not had enough time for meaningful accessibility benefits to accrue. In addition, dummy variables that distinguished among the eight commercial land-use categories designated in the *Metroscan* data base were not significant, save for the "professional-office" dummy (that added $7.41 per square foot to land values) and the interactive dummy variable of commercial uses in business districts near commuter rail station (that bumped up values $25.43 per square foot). This suggests that the same market dynamics that impart value to land in relation to proximity to transit, regional accessibility, and neighborhood quality mostly hold across all land-use categories. Moreover, efforts to introduce fixed-effect variables that captured idiosyncratic influences of being in a particular city and that were not explicitly captured by included variables (e.g., degree of land-use regulation and "pro-business" attitude of government) failed to enhance the model's predictive power.

8. Policy Implications

In contrast to several previous studies on the value of proximity to rail transit on commercial properties, this research uncovered significant capitalization benefits. Being within walking distance of an LRT station in Santa Clara County increased land values on average by over $4, or by around 23 percent in relation to the mean per square-foot value of sampled commercial parcels of $17.51.[28] And for properties in commercial business districts and within a quarter mile of a CalTrain commuter rail stop, the capitalization premium was even larger – over $25 per square foot, or more than 120 percent above the mean property value.[29]

Besides the presence of real and demonstrative capitalization benefits, several other findings have relevance to the practice of land-use and TOD planning in fast growing settings like Santa Clara County. One, proximity to labor markets is important to employers, as reflected in sales prices of commercial and office parcels. Higher concentrations of employed-residents within one-mile distance of commercial properties – what is certainly an acceptable cycling distance and potentially an acceptable walking distance when matched by attractive landscaping and streetscape designs (see

Untermann, 1984) – were associated with higher land values. This could reflect the presence of a pent-up demand for niche-market housing in traffic-congested high-technology employment settings – notably, housing targeted at young, childless professionals who are willing to give up living space in return for a walkable commute. Having services and public uses nearby like restaurants, repair shops, pubs, and child-care centers also increased commercial land values in Santa Clara County, suggesting a market demand for particular combinations of commercial activities. From a transportation standpoint, having eateries and daycare centers near employment sites, especially those served by rail transit, can increase patronage since workers can more easily consolidate trip ends (e.g., drop the child off at day care and walk to a nearby job site) and take care of midday activities (like lunching at a restaurant) without needing a car.

From a public-policy perspective, these findings lend support to TOD initiatives, especially those that inter-mix co-benefiting commercial and office uses. Given a demonstrated market demand to be near rail transit and a finite supply of stations, concentrating larger shares of future commercial development around transit stops can yield net economic benefits, as reflected by real estate transactions. Whether this is best achieved by reducing barriers to TOD (e.g., restrictive zoning or not-in-my-back resistance) or introducing incentives (e.g., through tax breaks or streamlining the development review process) is likely best decided on a case-by-case basis. Overall, the research suggests commercial parcels flourish more in compatible mixed-use settings.

While these research findings should be good news to commercial property-owners with holdings near rail-transit stops and transit agencies trying to fend off legal suits by those who claim they are harmed by transit's presence, local governments also have something to gain from the findings of this and related research projects. Notably, under the right conditions, local governments stand to capture some of the value-added produced by public investment in rail transit, either indirectly through increased property tax proceeds or directly through programs like benefit assessment, betterment taxes, or negotiated joint development initiatives (such as equity partnerships between developers and local governments) (Callies, 1979; Harmon and Khasnabis, 1978; Bernick and Cervero, 1997). Of course, courts insist that there be a rational nexus between the benefits conferred and the dollar amounts that local governments exact, thus great care must be exercised in designing value re-capture programs. To the degree fair and equitable programs can be mounted, governments have a lot to gain in sharing in some of the profits introduced by new transit facilities. In particular, revenues gained through value capture can go toward leveraging TOD. Municipalities must often take the lead in attracting private capital to rail station areas by "sprucing up" the neighborhood through improved landscaping and urban design, by introducing complementary infrastructure improvements (like sidewalks and the under-grounding of utilities), and in the case of riskier settings, underwriting private-sector land acquisitions costs. All of this takes money, often lots of it. Thus, value capture stands as a potential source of revenue not only to help pay off the debt on transit investments but also to pay for upfront and ancillary neighborhood improvements that can help leverage TOD.

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NOTES

[1] Three recent and particularly noteworthy Federal initiatives that promote TOD are: new transit joint development policies, including a more permissive interpretation of the federal common-grant rules; FTA's revised "new starts" criteria that explicitly weigh attention given to coordinated transit and land use in

evaluating proposals; and the Location Efficient Mortgage (LEM) program, underwritten by Fannie Mae, that makes it easier to qualify for a loan to purchase a home situated near transit.

[2] *Los Angeles County Metropolitan Transportation Authority v. Continental Development Corporation.*

[3] The distinctions between these forms of rail transit are more or less as follows. Light rail systems typically operate as small 2-to-3 unit trains at grade (e.g., in the median of roads) in the suburbs and in mixed-traffic conditions downtown. Light rail trains normally operate along one or two main lines. They obtain their power from a pantograph that connects to overhead wires. In contrast, heavy rail systems are primarily grade separated (e.g., subway or elevated), cover large geographic territories, have central train control and built-in safety redundancies that permit higher operating speeds, and are propelled by a high-voltage middle rail. Commuter rail services often operate on former freight tracks, are propelled by diesel locomotives, feature long station spacing, operate principally during peak periods, and normally tie into stub-end stations on the periphery of large central business districts.

[4] Between 1999 and 2000, ridership on the Altamont Commuter Express (ACE) to San Jose increased 66.1 percent and ridership on CalTrain, a commuter rail service that connects downtown San Francisco and downtown San Jose and operated by the Peninsula Corridor Joint Powers Board, increased 14.2 percent. See: http://www.transact.org/ca/ridership_chart.htm.

[5] See: http://www.transact.org/Reports/tti2001/default.htm.

[6] Matched pairs rely on finding comparable properties that are in every way similar except one is close to rail transit and the other is not. Finding suitable matches can be difficult. Repeat sales ratios record changes in prices between two or more sales transactions for the same transit-served property. These are compared to price changes for repeat sales of properties un-served by transit to produce a ratio. The differential can be attributed to transit proximity, controlling for other factors (since features of buildings and neighborhoods will normally remain the same across time points).

[7] 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; Bartik, 1988).

[8] In the case of the Santa Clara LRT, the authors found single-family homes within 300 meters of a light-rail station with a parking lot were worth around $31,000 less than equivalent properties beyond the immediate impact zone of a station, controlling for other factors.

[9] Effective rents represented total rents over lease term divided by number of months, and as measured sought to capture all payments for commercial space including owner provided utilities and custodial services.

[10] Population figures are from the 2000 census tabulations. Employment estimates are from the Association of Bay Area Government's 2000 Projections: http://www.abag.ca.gov/abag/overview/pub/p2000.

[11] *Metroscan* is a product of First American Real Estate Solutions: http://www.metroscan.com.

[12] Estimated regression models employ explanatory variables that express land-use and demographic characteristics within a one-mile radius of a parcel. For parcels that lie less than one mile from the Santa Clara County boundary, the one-mile radius includes land outside of the county. Because we could only compile consistent data for Santa Clara County alone, all parcels that were within a mile of the county boundary were excluded, resulting in the elimination of 50 data observations. In order to flag and eliminate observations that were extreme outliers and potential contained transcription errors, we took the following steps. First, the ratio between the per square foot land value of a parcel and the average per square foot value of parcels within a one mile radius of the parcels were calculated. The average land value was calculated using parcels of all types whose latest date of sale was in 1998 or 1999 (with the 1998 parcel values also adjusted upward by seven percent). This average was also weighted by parcel size (i.e., a parcel that is 10,000 square feet receive ten times the weight in calculating the average relative to a 1,000 square foot parcel). After calculating the ratio of a parcel's land value to the average surrounding land value, 35 parcels that had land values that were either ten times greater or ten times less than the average value of surrounding land were eliminated. To further cull the data base of outliers, parcels with per square foot land values that were more than three standard deviation above the mean value of $19.19 per square foot were purged, leaving a total of 1,197 parcels for carrying out the analysis.

[13] (5.87 employed-residents per acre) x (3.142 square miles within a circle with a one-mile radius around a parcel) x (640 acres per square mile) = 11,795 employed residents within a one-mile radius.

[14] For what is largely cross-sectional data, this is considered to be a reasonably good statistical fit. While other studies, such as Weinberger (2001), produced r-squared statistics, this is substantially due to the use of longitudinal data (with 15 time points in the case of Weinberger's work) that tend to inflate goodness-of-fit statistics (see Pindyck and Rubinfeld, 1991).

[15] This interactive dummy variable identifies parcels that have a land use code of "commercial, business district" [(ncluding both San Jose central and local business districts) *and* lie within a quarter mile (as the crow flies) of a CalTrain station.

[16] A highway or freeway is defined as a "primary highway with limited access" in the Census Feature Class Codes, as defined by the U.S. Bureau of the Census.

[17] This variable was calculated using the following multi-step process. First, for each Traffic Analysis Zone (TAZ) in Santa Clara County, all of the TAZs in the San Francisco Bay Area within 45-minute travel time were determined. [Travel time data came from the Metropolitan Transportation Commission's (MTC's) year 2000 projected A.M. peak travel times for all TAZ to TAZ interchanges in the Bay Area.] The employed residents in all of the selected Bay Area TAZs within 45 minutes were then summed so that each TAZ in Santa Clara County was assigned the total number of employed residents within a 45-minute drive. Next, these data needed to be assigned from a TAZ to a parcel. This was done by determining all the TAZs that fell within a one-mile radius of each parcel and then calculating the average value among the TAZs (weighted by the amount of each TAZ's land area that fell within the one-mile radius). For example, two TAZs might fall within a parcel's one-mile radius, one with 1,000 employed residents within 45 minutes and the other with 3,000 employed residents within 45 minutes. If each of the TAZs made up half of the land area within the one-mile radius, the parcel would be assigned 2,000 as the imputed average of the two TAZs. However, if the TAZ with 3,000 employed resident within 45 minutes made up more than half of the land area within the one-mile radius it would be weighted more heavily and the parcel would be assigned a "regional labor force accessibility" value more than 2,000.

[18] The very heart of downtown San Jose was defined as the Santa Clara LRT station on Santa Clara Street. Because the northbound and southbound platforms of the Santa Clara station lie on separate streets, the center of downtown was treated as a point midway between 1st and 2nd Streets along Santa Clara Street.

[19] Estimates of employed residents came from year-2000 projections made by the Association of Bay Area Governments (ABAG), expressed at the TAZ level. Estimates were transferred from the TAZ to the parcel level by again determining all the TAZs within the one-mile radius and proportionally summing the employed residents of all of these TAZs. Proportionally summing means that the percentage of a TAZ that falls into the one-mile radius determines the percentage of the employed-residents of that TAZ included in the estimate. For example, if only 50 percent of a TAZ's land area coincides with the one-mile radius, then only 50 of the 100 employed residents within the TAZ go into the calculation of total employed residents within one mile of a parcel. To convert data to gross densities within a one-mile radius, the total estimates were divided by π (the area of a circle with a one-mile radius) times 640 (acres per square mile). Note that gross densities within a mile of a parcel for other activities listed in the table, including non-employed residents, single-family housing, service employment, retail employment, manufacturing employment, and other employment, were estimated in a similar manner.

[20] Service employment includes personal, business, repair, educational, health, lodging, and food services. Service employment density was calculated in exactly the same way as was labor-force density.

[21] "Other" employment includes construction, transportation, communications, utilities, fire, insurance, real estates, public administration, and government. Service employment density was calculated in exactly the same way as was labor-force density.

[22] This constitutes land classified by *Metroscan* as "Professional: Offices, Banks, and Clinics".

[23] This variable was calculated by finding all institutional parcels in the *Metroscan* database within a one-mile radius of each commercial parcel studied. The building square footage of identified institutional parcels was

then summed. Institutional buildings included childcare/preschool/adult/residential care facilities, universities, schools, public recreational structures, hospitals, churches, and public buildings.

[24] The average structure value was calculated using parcels of all types from the *Metroscan* data base whose latest date of sale was either 1998 or 1999 (with 1998 parcel values adjusted upward by seven percent to 1999 dollars). All parcels within a one-mile radius of each commercial parcel studied were identified and the average structure value was then calculated. This average was weighted by structure size (i.e., a building of 10,000 square feet had ten times greater influence on the average than a 1,000 square foot building).

[25] Household income estimates income came from ABAG's year-2000 projection, expressed at the TAZ level. TAZ income data were assigned to parcels in a way similar to what was done for "regional labor force accessibility" variable. TAZs falling within a one-mile radius of a commercial parcel were determine, and then an income was assigned to a parcel by taking a weighted average of the TAZ values. The average was weighted not only by geographic area but also the number of households per TAZ. For example, two TAZs might fall within a parcel's one-mile radius, one with a mean income of $30,000 and the other with a mean of $50,000. If each of the TAZs made up half of the land area within the one-mile radius and each TAZ had 100 households, the parcel would be assigned $40,000 as the imputed average of the two TAZs. However, if the TAZ with a mean income of $50,000 had more than 100 households while the other TAZ remained at 100 household, the parcel would be assigned a value higher than $40,000 because the average would be weighted towards the TAZ with more households.

[26] In estimating models, distance to the nearest transit station was measured in both straight-line and highway network terms. The results were very similar using either metric of distance, however since straight-line distances produced slightly better statistical fits, this measure was used in the model presented.

[27] This premium is based on the typical professional-office being worth $7.41 more than the typical parcel included in the data base, which was worth (based on the statistical mean) $17.51 [($17.51+$7.41)/$17.51) = 1.424].

[28] ($17.51+$4.06)/$17.51 = 1.23.

[29] ($17.51+$25.43)/$17.51 = 2.22.