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Abstract

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When the public sector sponsors projects to promote general welfare, disproportionate benefits or disproportionate burdens often fall on individuals. In Santa Clara County, California, private property owners claimed a burden due to the existence of a light rail transit system (LRT). Looking at rental rates for commercial property this research tests several hedonic specifications to determine what effect, if any, the LRT has on proximate property values; it compares transit accessibility with highway accessibility as determinants of rent; and it uses a series of hedonic indices to analyze the effects over time. Traditionally, hedonic price models have relied on sale price as the variable of interest. Rental rates, which are both more abundant and more dynamic, thus more sensitive to changes in the market, are used in place of sale price. The substitution allows for more robust models.

Results indicate that controlling for other factors, properties that lie within ½ a mile of a light rail station command a higher lease rate than other properties in the County. When controlling for highway access, the rail proximity benefit was maintained and it was shown that highway coverage in the County is adequately dense that there are no

particular locational advantages associated with highway coverage. Furthermore, as the transit system matured a greater benefit accrued to the proximate properties but in times of more intense general market pressure, the rent premium was dampened.

This dissertation is dedicated to my grandmother Florence R. Lloyd.

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1 Introduction

1.1 Overview

The relationship of transportation to urban form has long been debated. This dissertation addresses one element of that debate: the question of how accessibility to transit stations is capitalized in rental rates. From rental rates inference is made to value. Finally, it is assumed that changes in the capitalization are a reflection of how markets value accessibility to transit stations. Using Santa Clara County, California as a case study, several hedonic models are developed to study the determinants of rental rates for commercial office space throughout the County. The research focuses special attention on the property's proximity to light rail transit (LRT) stations.

A valuable dataset was made available for this research because the County was confronted with litigation over the effects of light rail transit on adjacent commercial property values in the County. While there was no dispute regarding the value of property actually taken, the plaintiffs sued for damages to the remaining property; and while the system was built to add capacity to the existing transportation infrastructure, the effect of increased accessibility, tempered by potential nuisance effects, had the potential to increase or decrease the monetary value of property within some area of influence. To respond responsibly to the damage claim, the county sought to understand what, if any, was the effect of LRT on the plaintiffs' property. This research greatly benefited from, indeed, perhaps was made possible by the County's mobilization of resources to contest the litigation.

The research presented here examines relative property value as a function of access to light rail and other controlling factors. The methodology developed extends the established technique of hedonic price modeling. The extensions help to provide new insights to an important question, one that arises in many transportation projects, namely the impact of access on property values.

1.2 Extrapolating From the Present Case

Concomitant with the increasing interest in building light rail systems is the increasing need to understand LRT's impacts. In addition to the 'pure transportation' aspects, ancillary issues, such as the effect on adjacent property must be understood. The case was selected because the 'crisis' precipitated by this litigation provoked a response in which resources were marshaled and data made available that would likely have been otherwise inaccessible for academic and public policy research. While every jurisdiction has its unique features and those unique aspects of Santa Clara County are detailed in Chapter 4, the intent here is to take advantage of the opportunity that is provided by Santa Clara's case and the availability of data to study the broader question of increased accessibility and its effect on property value.

As in Santa Clara County, existing transportation infrastructure in many U.S. regions is operating near or beyond capacity. Many planning efforts to increase capacity include the consideration of fixed heavy and light rail alternatives. The features of Santa Clara County that can be identified and found elsewhere include a growing region surrounding a downtown central business district (CBD) that is no longer well served by an overburdened transportation system. This combination causes the CBD to compete, often unsuccessfully, with outlying areas for development. As development disperses, travelers may save time in the short run but vehicle miles traveled (VMT) increases and ultimately the negative externalities of automobile transportation are compounded.

Increased accessibility, achieved by the introduction of LRT systems, can help reestablish or preserve competitive advantage in locations that no longer dominate, or are in danger of losing their dominance. Cities such as Denver, Charlotte, Nashville, and Cleveland, where LRT construction is in the planning stage, as well as other cities where LRT may be considered, will be better informed as to LRT's viability and impact by reviewing Santa Clara County's experience.

1.3 Dissertation Plan

Following this introduction, the remainder of the dissertation follows this plan:

Chapter 2. Problem Statement and Research Question: Chapter 2 introduces the issues of transportation investment and urban form and transportation investment and property value. In it, I articulate issues that motivate this research. I outline the research question and how it should bear on public policy in this area.

Chapter 3. Previous Research: Chapter 3 presents a formal introduction to urban economic theory as it pertains to this question. It also contains a selected literature review of recent studies relevant to this research.

Chapter 4. Case Study: A description of the County's population, housing, economic growth, and transportation history is presented in Chapter 4. The chapter concludes with a discussion of a recent series of lawsuits that catalyzed this research by having brought this question to my attention.

Chapter 5. Data: Chapter 5 summarizes and describes the data.

Chapter 6. Methodology: The research design and value and shortcomings of the approach are described in Chapter 6.

Chapter 7. Model Results/Findings: This chapter contains a presentation and critique of several models and their results. The relationships of rail proximity, highway proximity, and passage of time on lease rates are discussed.

Chapter 8. **Conclusions: Finally, a summary of the research and its implications are presented.**

2 Problem Statement and Policy Context

One way in which government fulfills its responsibility to protect the public health, safety and welfare is by building appropriate and adequate infrastructure. However, the benefits and costs of infrastructure are rarely evenly distributed. Projects that promote general welfare or improve conditions for particular groups sometimes do so at the expense of other groups. Also, from time to time a public investment provides a general benefit and at the same time provides disproportionate benefit to particular groups or individuals.

Constitutional protections aim to prevent the government from overstepping and causing excessive harm or damages. The Fifth Amendment to the US Constitution, made applicable to the states by the Fourteenth Amendment, protects private property rights by requiring just compensation for property taken for public use. Both the question of what constitutes a public use and the question of what compensation is just have been subjects of legal inquiry, and case law has addressed issues ranging from partial takings to 'inverse condemnation', the indirect taking of part or all of a property's value. State constitutions, statutes, and case law comply with federal law and provide additional protections.

In the present case, private property owners claimed damages to their remaining holdings following partial takings for the construction of light rail transit (LRT). Because LRT service has the potential to confer benefits to property owners in the form of accessibility as well as costs, a key issue in the case was what the net benefits and costs might be. This in turn meant there was a need to establish a method for measuring possible benefits and costs, and to estimate the net impact. Ultimately, that is what this research aims to accomplish.

2.1 Transportation Investments and Property Value

Urban economists have developed both theory and a growing body of empirical evidence on the effects of transportation investments on property values. Economic theory asserts that if a particular property has the ability to yield greater profit than other properties (or if the profit potential increases), demand will be higher and competitors for the land will bid higher, driving the price up (Sullivan 1991). Public investment can change the value of real property if the investment produces benefits for, or imposes additional financial burdens on the property (Huang 1994).

A profit-maximizing enterprise will wish to keep its cost as small as possible while still operating its business; a utility maximizing household will make decisions in a similar way. Given that transportation is a necessary ingredient in their production cycle, one way that both households and businesses can decrease the cost of transport is to locate near well-connected transportation facilities. Origins farther away imply a more costly trip to access the central location. As transportation becomes cheaper (a smaller part of the production budget) the demand for that specific central location will decrease. Transportation improvements that reduce the cost of movements have the effect of making the parcels that are affected by the transportation 'closer' and thus those locations become more highly demanded. In this respect, transportation and location can be thought of as imperfect substitutes for each other. *Ceteris paribus*, the areas best connected to the transportation network will command a higher price (see Sullivan 1991, Mills and Hamilton 1989).

Transportation investments along corridors that serve desired locations will tend to have two effects. Locations along the corridor become more accessible and should, therefore, gain in value. Absent zoning restrictions, the land becomes more densely developed. This latter effect occurs because more people wish to capitalize on the transportation savings, and because denser development can generate more income, which is used to pay the higher land costs. The market value for the land will re-equilibrate at some point equal to the savings (to the consumer of the transportation service) from the transportation improvement and the additional capital that can be gained from the higher density development. As density increases around a transportation node, economies of agglomeration should begin to accrue at the node, thus resulting in multi-nucleated regions.

While transportation accessibility is an important component of land value, it clearly is not the only one and is not necessarily the most important. Economic cycles clearly push land values and rents up and down, for example. A long line of research has identified numerous factors that give land value; in addition to transportation, factors that come into play include (depending on the land use and location in question) topography and other land features, e.g., views, natural hazards; building type, quality and size;

infrastructure and service availability, quality, and cost; local tax rates; access to educational and cultural resources, parks and open space; environmental amenity; crime rates; neighborhood characteristics including the characteristics of the local populace, and so on (Garrison and Deakin, 1992.)

Compared to this multitude of other variables, proximity to a light rail station may have a small influence on the value of property. In part this is true because light rail is often incorporated as a marginal transportation improvement in an already mature transportation system. Transit's effects are likely to be more circumscribed than those of highways for two reasons. First, transit networks are not as comprehensive or well connected as highways; and they depend on inherently slower modes (bus access, walking, biking) for some of their connections. Second, while both passengers and freight move on highways, only passengers move on transit. The scope of potential benefits is smaller.

Nevertheless, improved transit access should be of value to commercial properties. Better transit access provides additional connections (options) for the workforce, which in turn should help to moderate wage demands. With added alternatives the time and money costs of getting to work should be lower than they otherwise would be. Indeed, Bollinger et al. (1998), in their study of Atlanta rents, found that wage rates in part determined rental rates. Transit access should also increase the size of the labor pool within a reasonably sized commute shed. To the extent that these effects occur and are valued, they will be reflected in higher demand for transit-served sites and therefore higher rents.

Transportation facilities also have negative effects on nearby properties resulting from noise, pollution, traffic and intrusion. Transit has the added disadvantage of its reputation for bringing an 'undesirable' population to an area (see Metropolitan Transportation Commission, 1979). These negative impacts may partially offset or even overwhelm the benefits derived.

Overall, then, urban economic theory says that the additional access provided by a new transportation facility should be reflected in higher land values and rents, that negative externalities should reduce these values, and that the size of the effects will reflect how much the resulting attributes are valued. Transportation is only one of a larger set of factors affecting land values, however, and the relationships are likely to be complex.

2.2 Research Question

The research seeks to shed light on the relationship between transit infrastructure, specifically light rail, and the value of commercial office property. This research seeks to understand whether investment in transportation infrastructure has an effect and if so whether it contributes to a decrease or increase in commercial property value in close proximity to the improvement. The research question is thus posed as "What is the effect of proximity to light rail on commercial property values?"

This research differs from other attempts to address the question of transportation investment and its effect on land value in two significant ways:

1. **The focus is on commercial property**. The impact of transit on commercial property values is an important, but under-studied, part of the broader question of transportation infrastructure investment and its effect on land value. As discussed in further detail in later chapters, the vast majority of transit-property values research has examined transit's impacts on residential property values only. In the few cases where researchers have looked at commercial property values around transit, their data has tended to be extremely limited – data sets are small, cover only a short time period, cover only a tiny geographic area, etc. Data limitations have also limited the utility of the results of these studies.

2. **The data to be used is an extensive multi-year collection of lease rates**. The data includes information on over 4,600 lease transactions that occurred between 1984 and 2000. Rental rates have two distinct advantages over sales prices. First, rental rates are far more elastic and responsive to changes in market conditions. Second, rental transactions are far more abundant than sales transactions, permitting the assembly of a much richer data set than would be otherwise possible. The first characteristic makes rental rates a better barometer of market response. The second characteristic permits more statistically robust models. A search of the literature has found no other hedonic price models used to estimate the effect of proximity to transportation on rental rates.

By addressing this question I hope to make a contribution in two areas:

1. To better understand if there is role for transportation infrastructure investment in economic development.

2. To estimate the extent and direction of one of the externalities associated with the development of major transportation infrastructure.

The value of the contribution is twofold. First, transportation funding is often justified on the basis of assumed contributions to the economic development of particular places and corridors. (Investments of the type and magnitude considered here probably affect development location within a region rather than the overall level of economic development; that, indeed, is often the intent of the investments' proponents.) It behooves us to learn whether the desired effects on property values, hence development potential, in fact occur. Information on transit's impact on land values is therefore important in evaluating transportation investment policies. Second, by examining the costs and benefits of rail projects, we can make better decisions regarding value capture and impact mitigation. By accounting for positive or negative value transfer to private commercial property owners, the cost-benefit picture is made more complete. By accounting for the externality, the net cost of the project changes.

The hypothesis to be tested is that there is no effect, i.e., there is no relationship between property value and the presence or absence of rail and there is no relationship between property value and distance to a rail station. Most of the theoretical arguments suggest that there would be some benefit to private property owners of increased transportation facilities. The argument is even more compelling in the case where existing transportation demand exceeds existing capacity. This work seeks to test this theory.

3 Previous Research

There is a growing body of literature that describes research on property values around transit. The vast majority of that work is focused on hedonic methods of valuation for residential property. A small number of studies have been completed that apply this method to commercial property. Although the current study is focused exclusively on commercial property, the theoretical and conceptual framework is generally informed by all research on property valuation and specifically by research using hedonic models.

The following review covers, briefly, the theory of urban economics as it pertains to this question and then in greater detail the history and application of hedonic models to residential and commercial property valuation.

3.1 Urban Economic Theory

Economic theory asserts that the value of an asset is equal to the net present value of the benefits and costs associated with owning it. To fit land value to this model, real property must be viewed as a bundle of services, obligations and rights. The value of land is a function of characteristics that include improvements on the land, potential improvements, location (which serves as a proxy for accessibility to the land and accessibility to other complementary land uses), and other endowments. In this section I discuss theories of location choice within this economic framework. Consumers trade off transportation costs for productivity and other endowments (Alonso 1964, Muth 1969).

Land prices follow from choice theory, as the price is an outcome of competition between, and among, households for residential locations, and businesses for commercial locations (see also Mills and Hamilton 1989, Sullivan 1990).

3.1.1 Residential Location

As with other consumer choices, residential location outcomes reflect the household or householder's preference for a bundle of characteristics that define housing. For housing these characteristics include differing levels of shelter, size of shelter, land, privacy, location (or proximity to work, schools, shopping, neighbors, other family, or other local destinations) and many other things. Households will bid for housing and housing locations that best satisfy their particular needs and desires. Subject to budget constraints, a householder will pay higher prices for housing that best embodies the characteristics that they desire.

The amount of their housing budget will depend on their income and other expenditures. An expenditure that is variable and concomitant with housing location choice is transportation. As the household spends more money on transportation there is less available for other purposes. To the extent that transportation expense becomes a binding constraint on the household's budget the household will pay more, up to the difference in the cost of transportation, to locate closer to their desired destinations. In this calculus transportation costs can be thought of both in terms of money and time cost.

3.1.2 Business Location

Theories of business location have identified transport costs for inputs (materials, labor) and outputs (products) as important determinants of location and land use. The relationships are complex; substitution of inputs and variation in input qualities, relative orientation to raw material or market, agglomeration benefits and economies of scale are just some of the considerations that affect location decisions (Hoover 1948; Isard 1956; Moses 1958, Alonso 1964). Many businesses can choose where to locate by weighing the relative costs and benefits of alternate sites, and decreases in transportation cost at particular locations will make those locations attractive to businesses. For example, good transportation can increase the effective size of labor pool for an area, allowing employers to hire at lower rates. Transportation improvements that make a parcel more accessible from more disparate locations have the effect of bringing the remote sites 'closer,' in a sense, putting them in a more competitive situation for development dollars. (For additional discussion on land capitalization of employees' commute time see Weisbrod 1988 and Zax 1991; for a discussion of the effects on development, see Cervero 1997).

Clearly many other factors are at work in business location choice, in addition to transportation. Businesses consider site costs and utility costs, the effects of government policies, the availability of business services, amenities and image.[1] While the considerations will vary for different businesses, locations that for one reason or another are endowed with greater profit potential, e.g., that have a transportation advantage, should command a higher price, all else being equal.

3.2 Empirical Evidence

A number of studies have attempted to identify the variables that affect land value, including characteristics of the land and any improvements on it, transportation access, available services, and so on. These studies are often done using so-called hedonic methods. Although generally attributed to the 1960s and 1970s work of Zvi Griliches (Williams 1991; Goodman 1998), the origin of hedonic price models and coinage of the term are traced further back. Andrew Court, an economist for the Automobile Manufacturer's Association, developed price indices that related the relative importance of different components or characteristics of an automobile to its price. As early as 1935 he developed a series of regression models that yielded price indices 'weighted' by the parameter estimates. He called it a hedonic model based on his understanding that "Utilitarianism, seeking the good in the greatest happiness of the community as a whole, is the chief hedonistic doctrine" (quoted in Goodman 1998, 292), thus he created an index of 'usefulness and desirability' in which the price index is a

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[1] There is evidence that the location of several major businesses was chosen to respond to the desires of chief executives for a convenient commute to and from their preferred residential locations. However, the locations selected were also well connected to transportation facilities, labor markets, etc.

weighted function of components that define the commodity. In general the parameter estimates are now referred to as implicit or shadow prices of the characteristics of the object under study.

Court cautioned regarding some possible shortcomings of his model. Those cautions remain valid today. For example, there can be problems with over specification or otherwise inappropriate specification of the model: have the right variables been included? There can be problems of multi-colinearity in the variables (Goodman 1998). This is a particularly persistent issue for models of residential property where price may be a function of both number of bedrooms and number of bathrooms but the number of bathrooms in a house may also be a function of the number of bedrooms.

Level of aggregation is another concern. Different researchers have studied the same system at different levels of geographic specificity and in different time frames, ultimately reporting inconsistent results (see, for example, Landis et al. 1994 contrasted with Lewis-Workman and Brod 1997). In the former study, region wide effects of BART were studied based on a single quarter's sales data, the authors found only a small, almost negligible, but positive effect of proximity to transit on home sale prices (Landis et al. 1994). In the latter study multi-year, inflation adjusted, data were used and the area studied was tightly circumscribed around a single BART station. These authors conclude that there was a relatively large and positive effect of proximity to transit on home sale prices (Lewis-Workman and Brod 1997). The differential was large enough, the authors claim, to reflect much more than the transportation savings, they suggest that the transit, as an anchor, attracts other land use features that add additional amenity value to the area.

The bulk of quantitative research on transit's effects on land value deals with residential properties. A plethora of studies of the impact of rail transit on residential property sales price have been published since 1970; see Huang 1994 and Vessali 1996 for two thorough reviews of the literature through the early 1990s. This review summarizes the work covered by Huang and Vessali and examines in greater detail new studies conducted more recently.

Most of the early studies are of commuter or heavy rail, and they analyze changes in home prices based upon either distance to the transit station or commute cost savings associated with the transit improvement, or both (see for example Davis 1970, and Nelson 1992 for studies measuring distance; Boyce et al. 1972, and Allen et al. 1986 for studies measuring commute cost savings; Mudge 1974 for a study examining both measures of accessibility).

For the most part, researchers attempted to control for characteristics of the unit; characteristics of the neighborhood; locational features such as distance to the central business district (CBD) or distance to rail and, for multi-year studies, for economic cycle variables. Though data quality and methodologies varied, almost all of these studies found some benefit capitalized into residential land value that could be associated with the presence of the rail system. Typically, functional form was expressed as linear or semi-log. For a discussion of functional form and an application to office buildings, but without reference to transportation or locational variables, see de Silva and Gruenstein (1988).

3.2.1 Transit's Effects on Residential Property Values

In their study of neighborhood effects Lewis-Workman and Brod (1997) looked at neighborhoods in three cities. They looked at station areas in Pleasant Hill, California which is served by Bay Area Rapid Transit (BART); Forest Hills and Rego Park, New York, both served by the New York City Transit Authority; and Portland, Oregon, served by the Portland MAX (Metropolitan Area Express). They specified separate models for each city, describing home value for properties within one mile of each station area. In general the models included variables accounting for home size and age, lot size, distance to the transit station and distance to the nearest highway. In two cases they concluded that transit provides "large and measurable benefits" from proximity to transit. Their BART and New York CTA results suggest that the benefit exceeds the value of transportation savings, thus implying an added neighborhood value, such as attraction of desirable retail stores et cetera.

Their Portland models were more equivocal. In contrast to other studies of Portland in which a clear benefit was shown (Al-Mosaind et al. 1994 and Chen et al. 1998), they showed a negative correlation between proximity to light rail and house values for Portland. Two explanations they provide for these anomalous results are that benefits of heavy rail are likely more pronounced than benefits of light rail, and that the effects may be somewhat confused as the Portland system is located in the right of way of a major arterial. Along with the benefit of proximity to rail, Lewis-Workman and Brod had shown a negative correlation between house value and proximity to highway. In a case like that of Portland, where rail proximity and highway proximity are concomitant, there will be a confused result.

Shortly after the Portland system opened, Al-Mosaind et al. developed two hedonic models to explain home prices in an area served by MAX light rail. In the first model a dummy variable was included for properties within ¼ of a mile of a rail station. The second model, limited to properties within the ¼ mile band but using a continuous distance measure, showed a negative correlation, implying increasing property value as the properties were closer to the stations. A later study of the Portland MAX attempts to separate the proximity effect from the nuisance effect (Chen et al. 1998). Following up on the work by Al-Mosaind et al., Chen et al. looked at LRT effects on property value for houses in Gresham and Portland, Oregon. Expecting to better capture the market reaction Chen et al. used data for house sales 6 to 8 years after the opening of the light rail, versus Al-Mosaind et al.'s two years. They included locational variables to represent distance to the nearest LRT station (proximity effect), shortest distance to the LRT line (nuisance effect), distance to the nearest park and distance to the CBD. They found housing price decreasing with distance from rail but decreasing at a declining rate. They also found support (though not statistically significant) for the nuisance effect and concluded that the combined effect yields house values described as a truncated and left skewed, negative parabola, reaching a maximum value at about 700 feet from the rail line.

An earlier study of BART had also attempted to separate the nuisance effect from the accessibility effect using a distance to highway and distance to rail variable along with a highway and rail adjacency variable (Landis et al. 1994). In the 1994 work Landis et al. found no statistically significant relationship between 'adjacency' (a dummy variable defined for properties within 300 meters of a transit line or highway) and home price. They did find a correlation between home sale price and the continuous network distance to transit or a highway access point.

A look at light rail as an extension to the existing heavy rail system in Manchester, England showed a drop in property value associated with proximity to the light rail (Forrest et al. 1996). The authors conceded difficulty in interpretation because the light rail extension serves the heart of Manchester where residential values are expected to be lower. There is a high probability that there is an omitted variable tying a particular type of construction, age of a neighborhood (age of structure is accounted for), or some other factor to the lower price.

3.2.2 Transit's Effects on Commercial Property

There is a relative dearth of land value models and research on commercial properties. A recent study, using quasi-experimental, or matched pair, comparisons, showed mixed results with respect to a rail proximity advantage (Cervero and Landis 1993). They showed that office projects near rail stations sometimes, but not always, experienced a competitive advantage in terms of rental rates, occupancy rates or other measures of market performance. Cervero, in another study of the same areas, found more conclusive evidence of a positive effect (Cervero 1995).

Landis et al. (1995) studied the relationship between transit (BART and San Diego Trolley) and the value of commercial properties, but they found it difficult to apportion price differentials into a "quality" component and a "transit accessibility" component (Landis et al. 1995, 51). The issue arose because commercial properties near BART and the San Diego Trolley were found to be bigger, newer, and better than more distant properties. Landis et al. noted that the number of sales observations that they collected was small, and suggested that given a richer dataset, results might be different.

Again examining BART impacts, Landis and Loutzenheiser (1995) estimated several models of rental asking price in the San Francisco Bay Area. Their models proved inconsistent and the authors offer the qualified conclusion that there is no measurable benefit of proximity to transit. The qualifications were, first, that the models are based on reports of asking rents, not actual lease rates; second that the analysis is limited to a single year; and third, that the results apply only to BART, and not to other transit systems. They refer to another study of their own: "A similar study did find a relationship, albeit a small one, between office market performance and transit accessibility." (Landis and Loutzenheiser 1995, 23). Furthermore, sample sizes for the various models were quite small; in fact, for one model (Fremont buildings), there were no observations in the zero to one-eighth mile distance band.

Work by Bollinger et al. (1998) examined the determinants of office rents in the Atlanta region. Their research sought to demonstrate how rents are affected by differing concentrations of employment types. They included accessibility variables that represent access to highways and access to transit. They showed a positive correlation between rent and proximity (within one mile) to a highway access point but they estimated a negative coefficient for proximity to transit. In this case the transit access is to Metropolitan Atlanta Rapid Transit Authority (MARTA). They concluded that the finding with respect to MARTA is consistent with other research that shows MARTA has thus far had a negligible impact on transit ridership. Their study is of ten counties only two of which are served by MARTA, and they postulate that the MARTA areas are perceived as high crime areas and are therefore dismissed as less desirable than some of the other areas.

3.2.3 Transit's Effects on the Value of Undeveloped Land

Another study of Portland's MAX showed that the announcement of plans to extend the system had a positive effect on the sales price of proximate vacant land (Knaap et al. 1999). Using hedonic models, they conclude that the sales price per acre of unimproved land increased once plans for the rail line were announced. They showed a large increase in sales the first year after the extension was announced. In the second year they showed that prices had decreased from the previous year but remained at price levels higher than those prior to the announcement. The authors suggested that the speculative increase is either a reflection of market sorting or developer interest.

Anecdotal evidence to support the latter interpretation was found in a separate study of land acquisition patterns and developer participation in response to light rail extensions in London (Schabas 1990).

3.3 Summary of Findings

Previous studies show that the value added to land by proximity to rail stations has three possible components: a transportation or 'accessibility' component, an 'urban environment' component, manifested as amenities are attracted to the station area, and a density bonus. Studies to date have produced mixed findings. Most studies have examined rail proximity effects on the price of housing, and the majority has found some land value increases. Relatively few studies have looked studied commercial property, and those few have been based on limited data, so are more suggestive than definitive.

4 Case Study: Santa Clara County

Santa Clara County is the southernmost county in the San Francisco Bay Area. Encompassing over 1,300 square miles, it includes the high tech area known as Silicon Valley, and by almost every measure it is one of the fastest growing counties in the country. Though the Bay Area is comprised of nine separate counties, Santa Clara houses about 25% of the area's population and is home to the same proportion of jobs[2]. Alameda County follows with about 20% of the region's jobs, while San Francisco and San Mateo Counties have about 12 and 11% respectively. In Santa Clara County, the North Valley is extensively urbanized, housing about 90% of the County's population. The South Valley remains largely rural, the home to only two of Santa Clara County's fifteen cities. The County has over 4,850 miles of publicly maintained roads, about 27% of all such roads in the Bay Area.

The following sections illustrate growth rates in population, housing, and employment. Most of the graphics display growth rates relative to the first year for which data is shown. For example, population is shown from 1930 forward, expressed as a percentage of the 1930 population. The final section describes the County's

[2] The Association of Bay Area Governments estimates about 25% of Bay Area jobs are in Santa Clara County. According to the U.S. Census Bureau County Business Patterns the number is closer to 29 or 30%.

transportation system and some of the events that led up to construction of the light rail system.

4.1 Population and Housing

Santa Clara County's population growth has been phenomenal, averaging about 5.2% per year since 1930. The County's population more than doubled between the 1950 and 1960 censuses. Growth is expected to continue, albeit at the slower rate of 1.1% per year, through 2020, at which time the County's population is projected to reach 2 million residents. In 1980, the County population reached 25% of the regional total where it has remained and is projected to remain. Figure 4.1 shows the County's population growth and projections compared with growth for the Bay Area and for the State of California. The growth trend covers the period 1930 to 2020, showing percentage growth relative to 1930.

Most of the population growth, 54%, is expected to occur in San Jose, the County's largest city. An additional 15% is projected in Sunnyvale and the City of Santa Clara. Limited growth, 9%, is expected in the South Valley cities of Gilroy and Morgan Hill, with very little growth, 2.2% each, distributed over the remaining ten cities in the North and West Valley. While population is expected to have increased 35% between 1990 and 2020, the number of households is expected to increase by only 28%. This disparity implies that household size will be increasing. Indeed, household size is projected to increase from 2.81 people per household in 1990 to a high of 3.05 in 2005 and then decline again to 2.97 by 2020.

In an attempt to house the population, the cities that form Silicon Valley[3] added almost 155,000 new homes to their housing roster between 1980 and 1998. The bulk of these units were built in the 1980s with about 51,600 built during the 1990s. According to the Silicon Valley Manufacturing Group and the Greenbelt Alliance (1999), of the units built in the '90s, about 14% of Silicon Valley houses constructed were built outside of Santa Clara County proper. Approximately 73% of the units constructed in the County were built in the five years from 1995 to 1999 and over half of those were built in 1997 and 1998.

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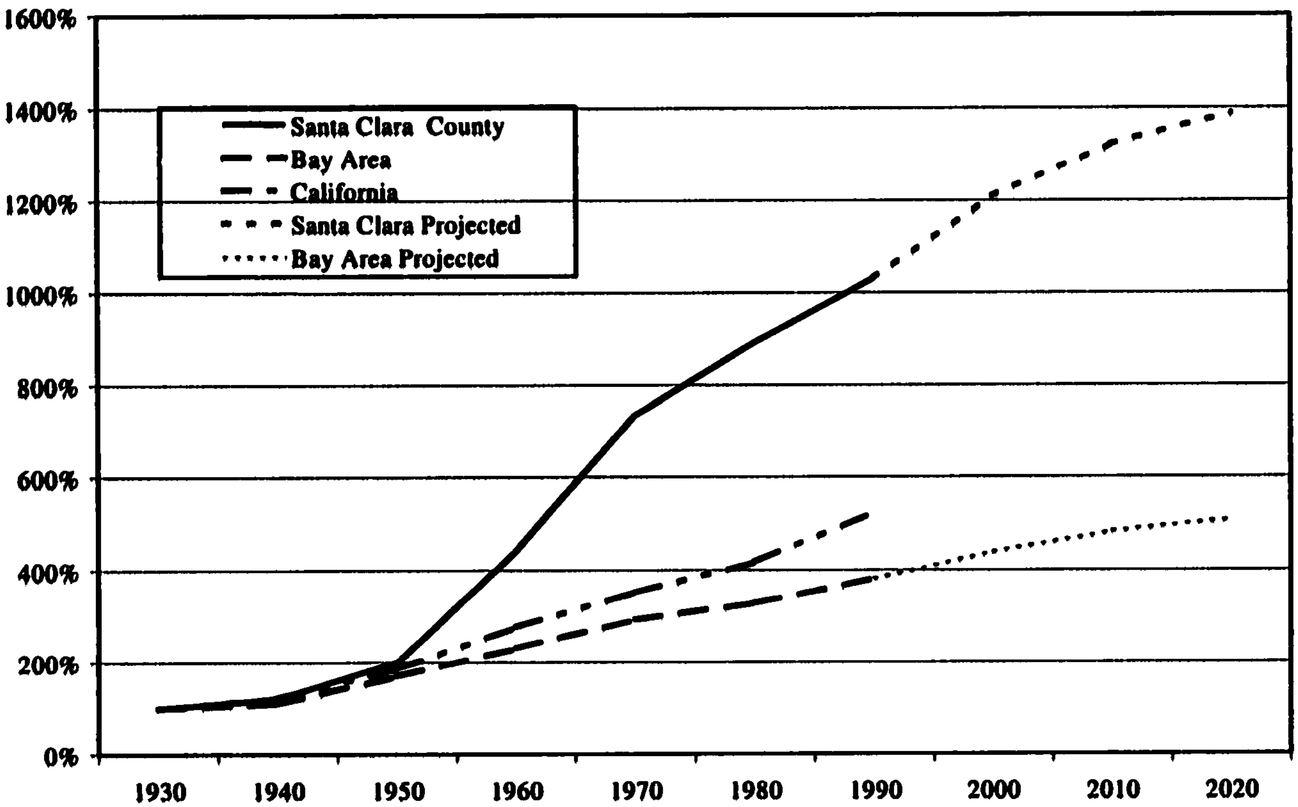
[3] Numbers reported by the Silicon Valley Manufacturer's group include an expanded definition of Silicon Valley. In addition to Santa Clara County their definition includes the cities of Fremont, Newark, and Union City in Alameda County, East Palo Alto, Menlo Park, and Redwood City in San Mateo County.

Figure 4.1. Historic and Projected Population Growth 1930 to 2020



Source: U.S. Department of Commerce Bureau of the Census; Association of Bay Area Governments *Projections 2000* series

4.2 Jobs and Employment

In the nine years from 1988 to 1996, overall job growth in Santa Clara County lagged slightly behind the Bay Area. Both the County and the Bay Area experienced some decline in jobs in the early 1990s but relative to 1988 the County's job growth overtook the Bay Area's job growth in 1997. County jobs are projected to continue outpacing the Bay Area only until 2000, at which time the County's growth will slow, evening out with the Bay Area around 2010. These trends in job growth and decline are shown in Figure 4.2.

The greatest share of projected new jobs, about 43%, will be located in San Jose. Another 13% will be added in the City of Santa Clara and 8% in each of the cities of Sunnyvale, Milpitas and Mountain View.

Santa Clara's largest industry is manufacturing, with wholesale trade a distant second. Though a declining share, Santa Clara is home to about 50% of the Bay Area's manufacturing jobs. Wholesale trade, on the other hand, is a growing industry. Currently 37% of the Bay Area's wholesale trade jobs are in Santa Clara County. The proportion of jobs by industry is illustrated in Figure 4.3.

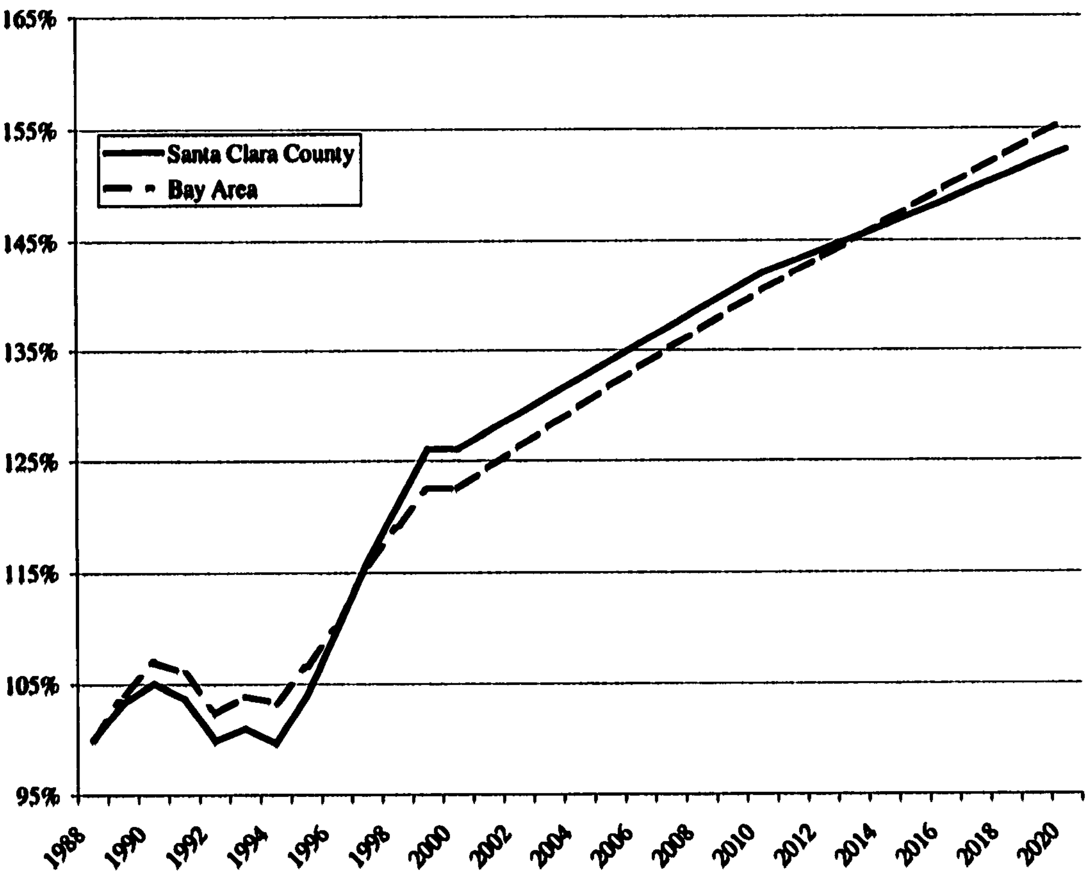
Although Figure 4.3 shows that the trend in manufacturing jobs is declining and in wholesale trade it is increasing, together these industries are projected to increase at a much slower rate in Santa Clara County than in the region as a whole. County growth in retail and service industry jobs is projected to exceed the Bay Area growth for these industries.

Growth in the number of businesses located in Santa Clara began to exceed growth in Bay Area businesses in 1992. This trend is illustrated in Figure 4.4

Throughout this period growth in employed residents was also inconsistent. Employment rates in both the County and the Bay Area were declining in the early part of the decade but Santa Clara began to outpace the region in labor force growth beginning in 1994. Figures 4.5 and 4.6 show rate of change for both employed residents and labor force. Growth and decline are both shown relative to 1990.

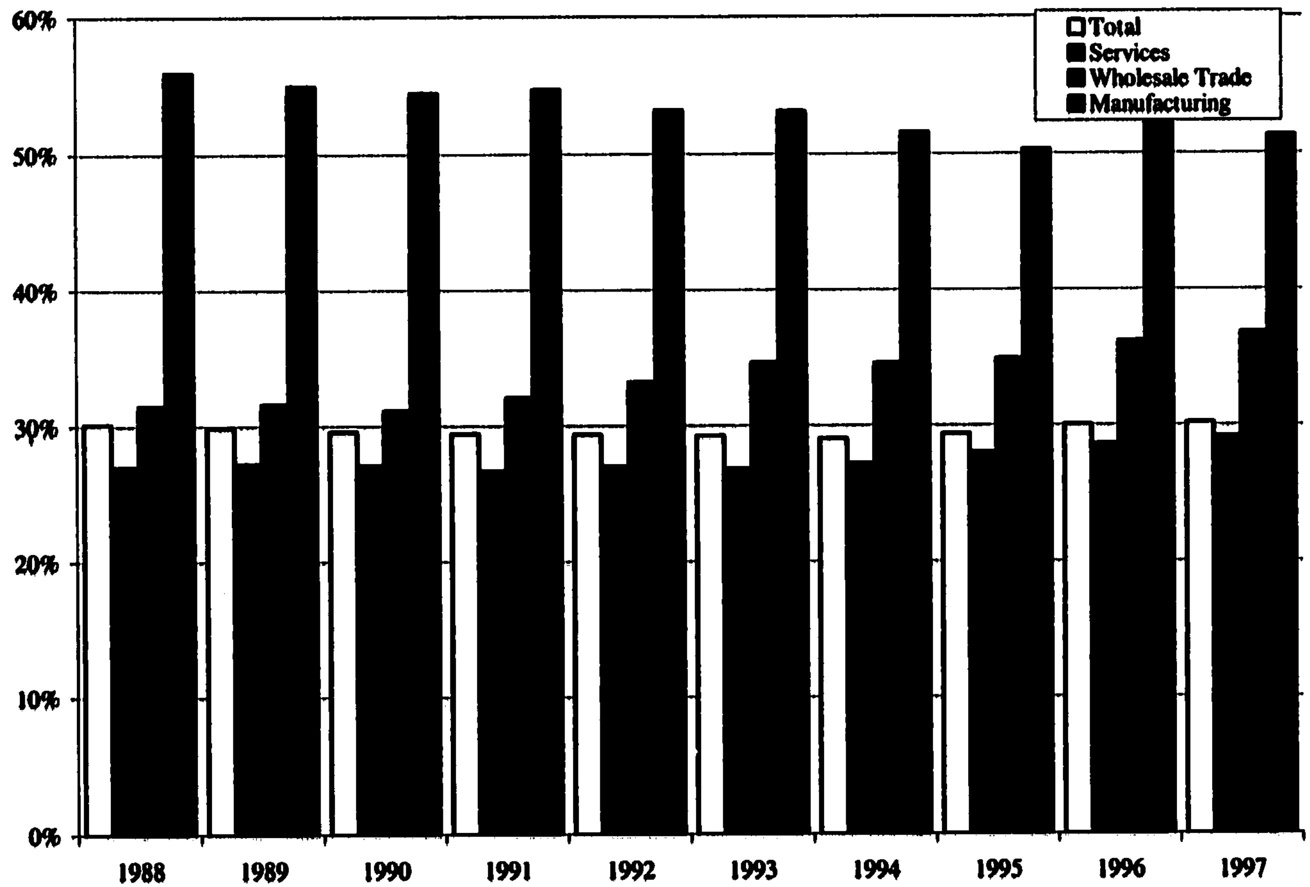
Finally, over the period 1990 to 1997, the County's labor force averaged about 5.5% greater than employed residents. Figure 4.6 below, shows the change in the County's labor force relative to 1990 and relative to the Bay Area. Unemployment peaked at 7.4% in 1992 and has declined steadily since then.

Figure 4.2. Historic and Projected Job Growth 1988 to 2000 Santa Clara County and the Bay Area



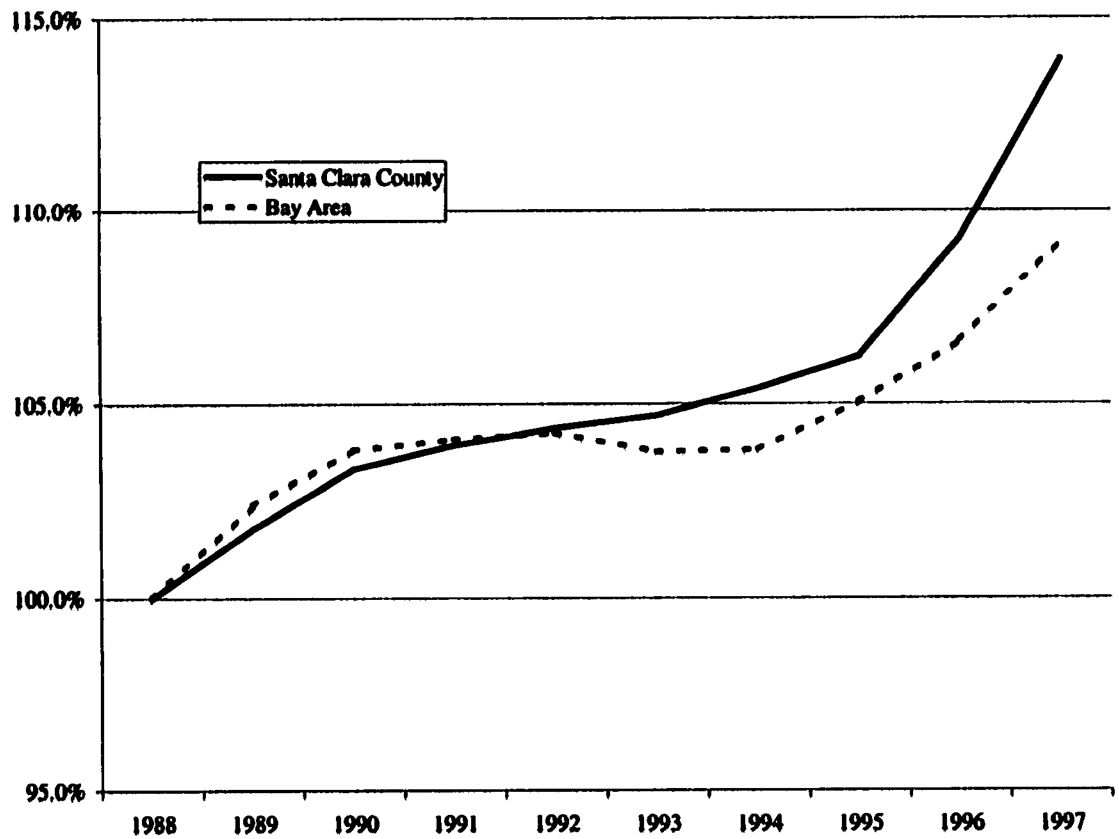
Source: US Bureau of the Census County Business Patterns; ABAG *Projections 2000* series.
ABAG projections are adjusted to match county business patterns.

Figure 4.3. Employees by Industry Santa Clara County as Percent of Bay Area 1988-1997



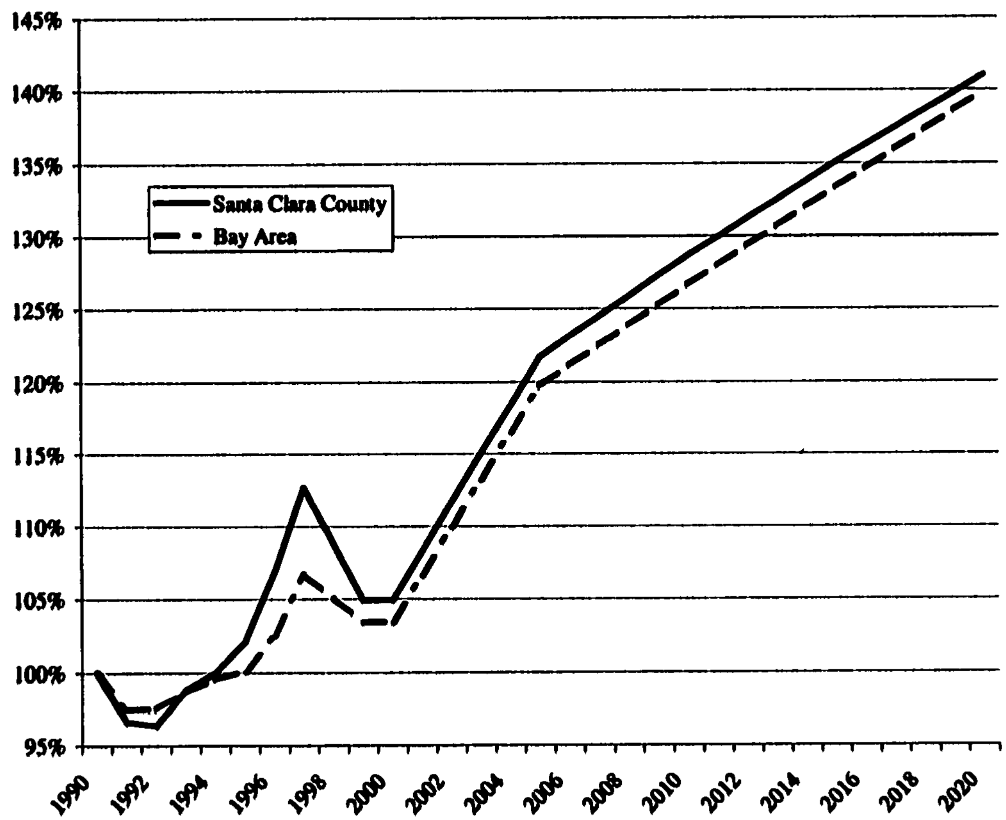
Source: US Bureau of the Census County Business Patterns

Figure 4.4. Growth in Number of Establishments 1988 to 1997: Santa Clara County and the Bay Area



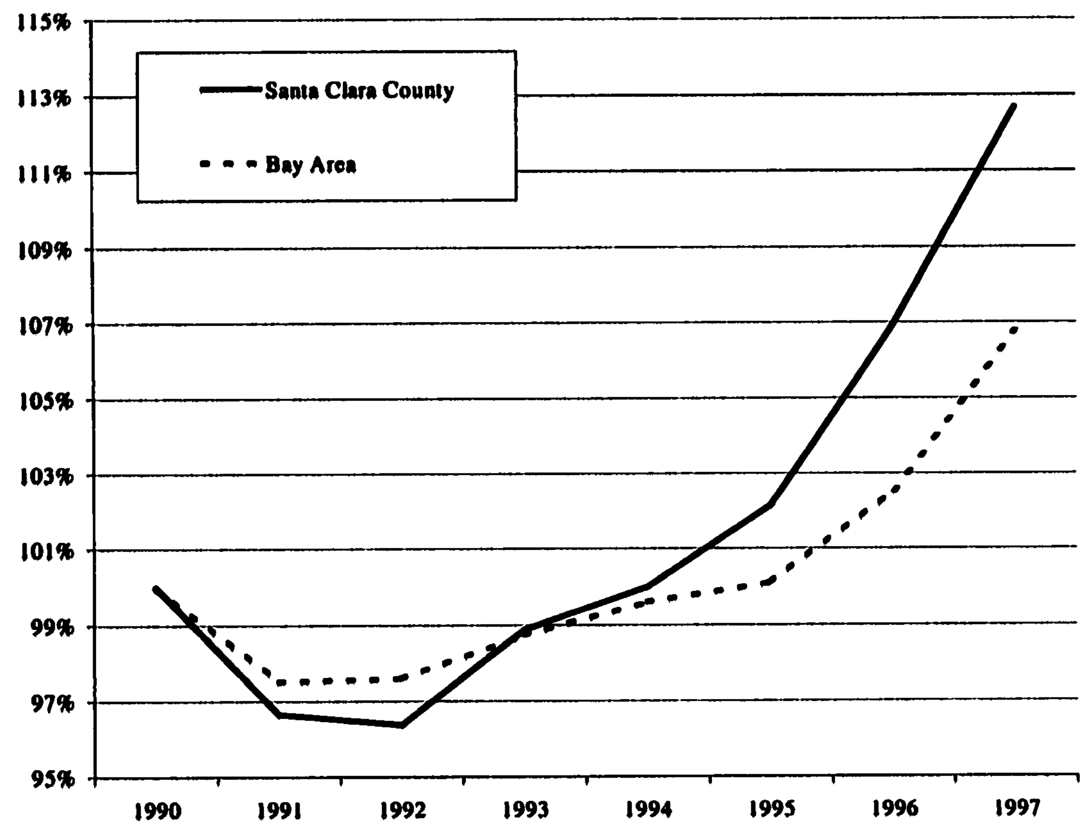
Source: US Bureau of the Census County Business Patterns

Figure 4.5. Historic and Projected Employed Residents: Santa Clara County and the Bay Area



Source: State of California, Employment Development Department;
ABAG *Projections 2000*

Figure 4.6. Labor Force Growth and Decline 1990 to 1997



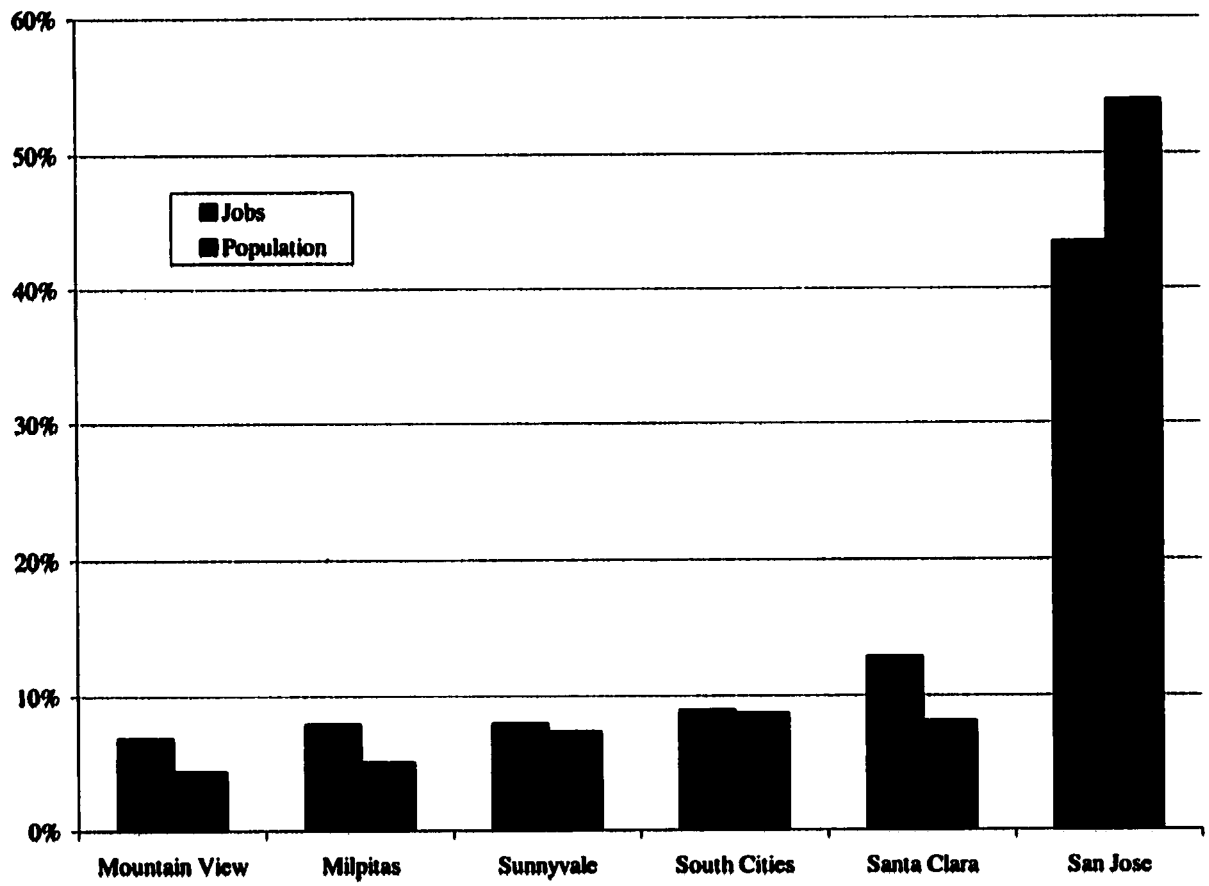
Source: State of California, Employment Development Department

4.3 Transportation

To accommodate this increase in population, housing, and employment, the County has had to squeeze as much use from its transportation system as possible. In addition to the sheer growth, the only partial coincidence of the jobs and housing growth, as shown in Figure 4.7, has helped to produce long commutes. The five North County cities and the two South County cities shown account for 87% of the population growth and 88% of the jobs growth.

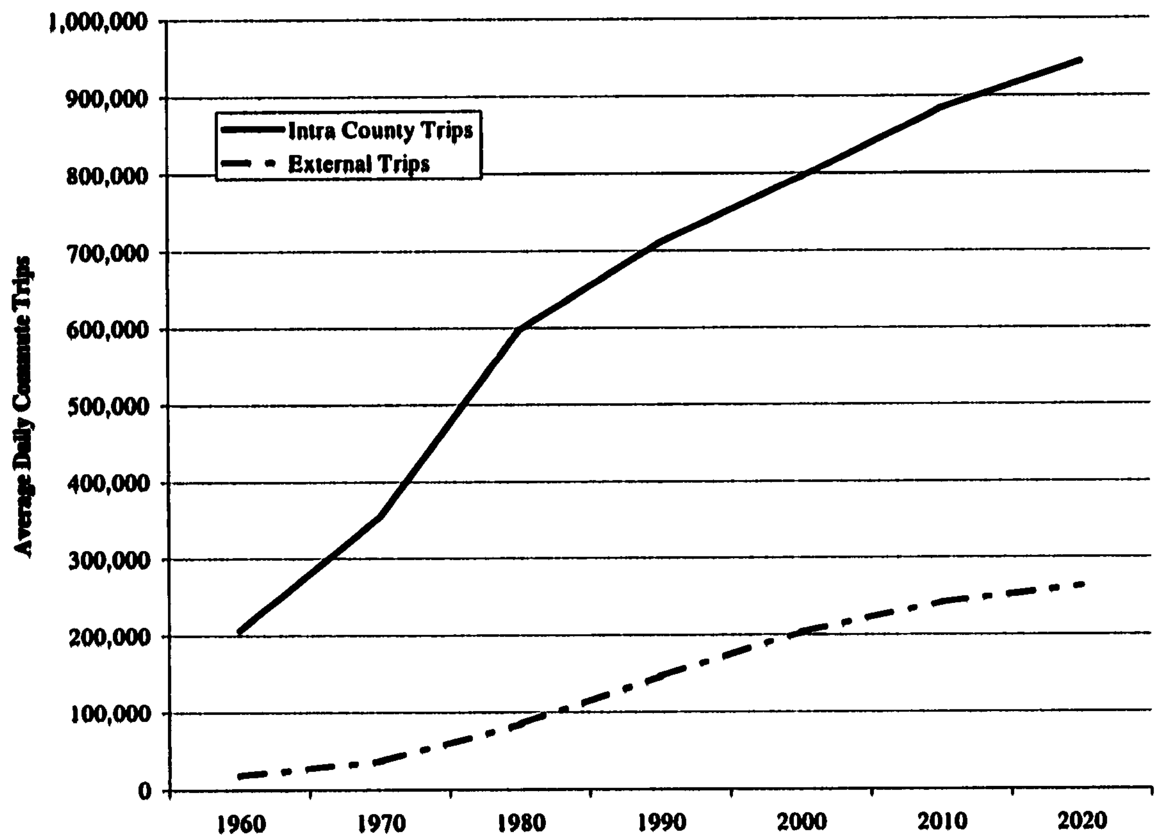
In recent years the County's system has been extremely overburdened. Intra-county commute trips doubled between 1960 and 1980. They have likely more than tripled today and are projected to more than quadruple by 2020. Trips bound for Santa Clara County destinations from outside of the County have increased more than ten-fold. Figure 4.8 shows the growth in average daily commute trips into and within the County as estimated and projected by the Metropolitan Transportation Commission (MTC). At the same time Santa Clara residents are commuting to destinations outside of the County at the rate of 73,400 per day, a 50,000 trip increase since 1960. Another 13,000 average daily commuters, bound for work sites outside of the County are projected to be on the road by 2020.

Figure 4.7. Distribution of Population and Job Growth within Santa Clara County



Source Association of Bay Area Governments: *Projections 2000* Series

Figure 4.8. Historic and Projected Average Daily Commute Trips Destinations in Santa Clara County

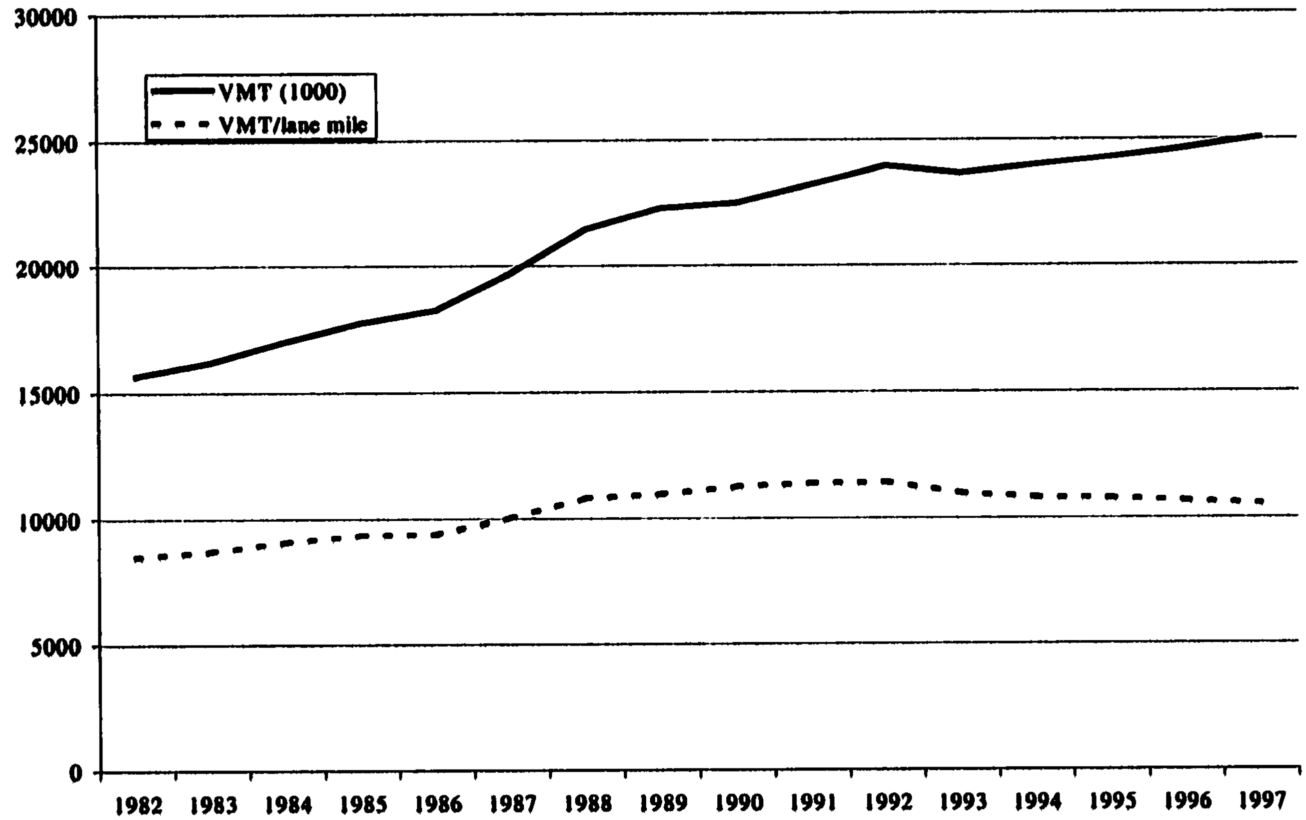


Source: Metropolitan Transportation Commission

The County's Congestion Management Agency, the Santa Clara Valley Transportation Authority (VTA), monitors approximately 287 directional miles of freeways. VTA has determined that over the last nine years, about 90 of those miles, about 30%, have deteriorated from traffic level of service (LOS) E or better to traffic level of service F. In addition, a number of freeway segments of freeway were already operating at LOS F in 1991. The current estimate is that of the 287 miles monitored, there are about 130 miles operating at LOS F in the A.M. or P.M. peak period.

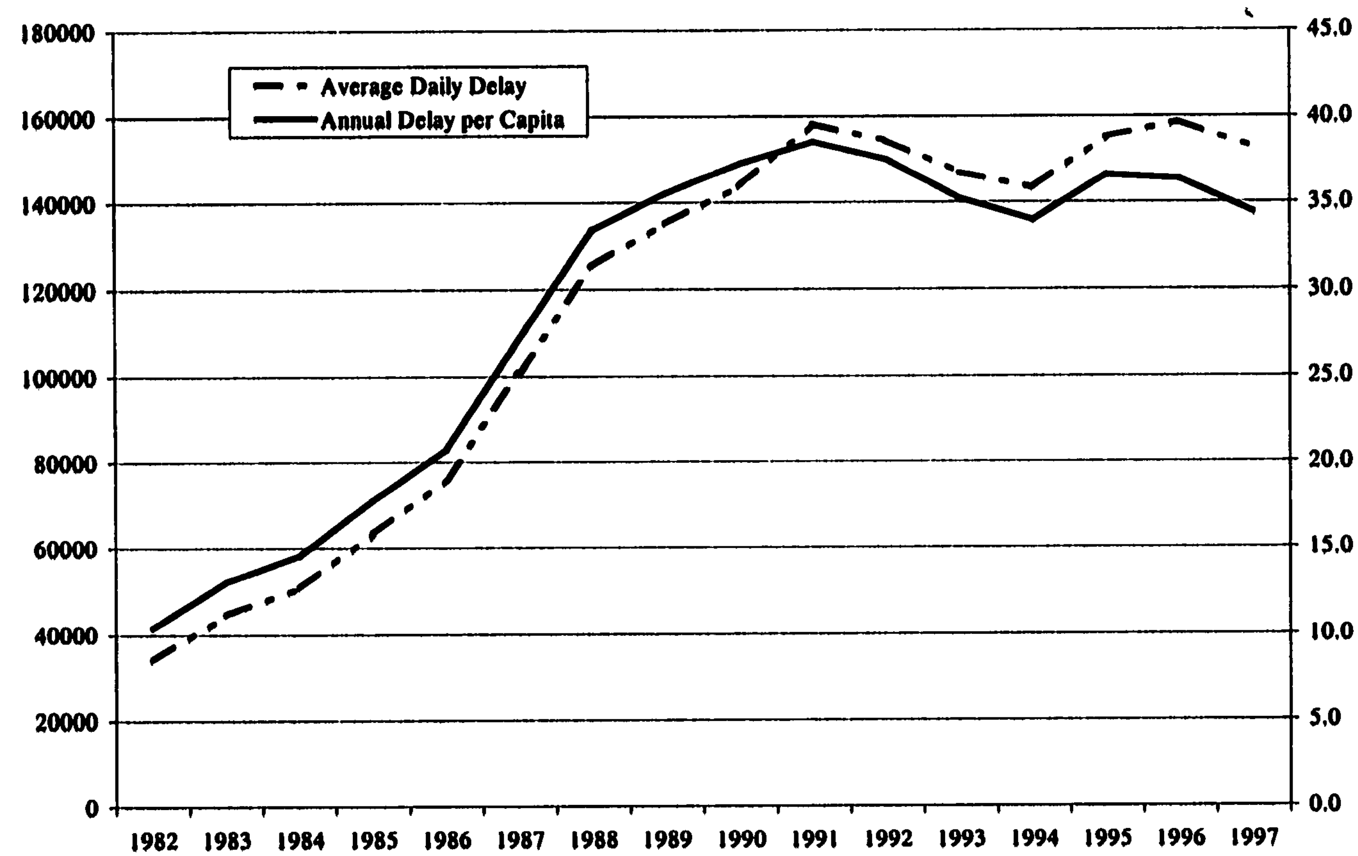
Between 1982 and 1998 vehicle miles traveled (VMT), and VMT per lane mile in the County had grown at the rates of 59.9% and 24.2% respectively. The accompanying person hours of delay increased 346% from 34,200 average daily hours. The delay translates to roughly ten minutes per commute trip in 1990. These trends are shown in Figures 4.9 and 4.10. VMT per capita for Santa Clara County and the Bay Area are shown in Figure 4.11. While the differences are actually quite small, 0.25 miles in 1990 and .5 miles in 2000, the differential in VMT per capita between the County and the Bay Area may be due to the more rapidly increasing development of the rural parts of the Bay Area relative to those areas, such as Santa Clara County, that are already developed.

Figure 4.9. Vehicle Miles Traveled and VMT per Lane Mile Santa Clara County



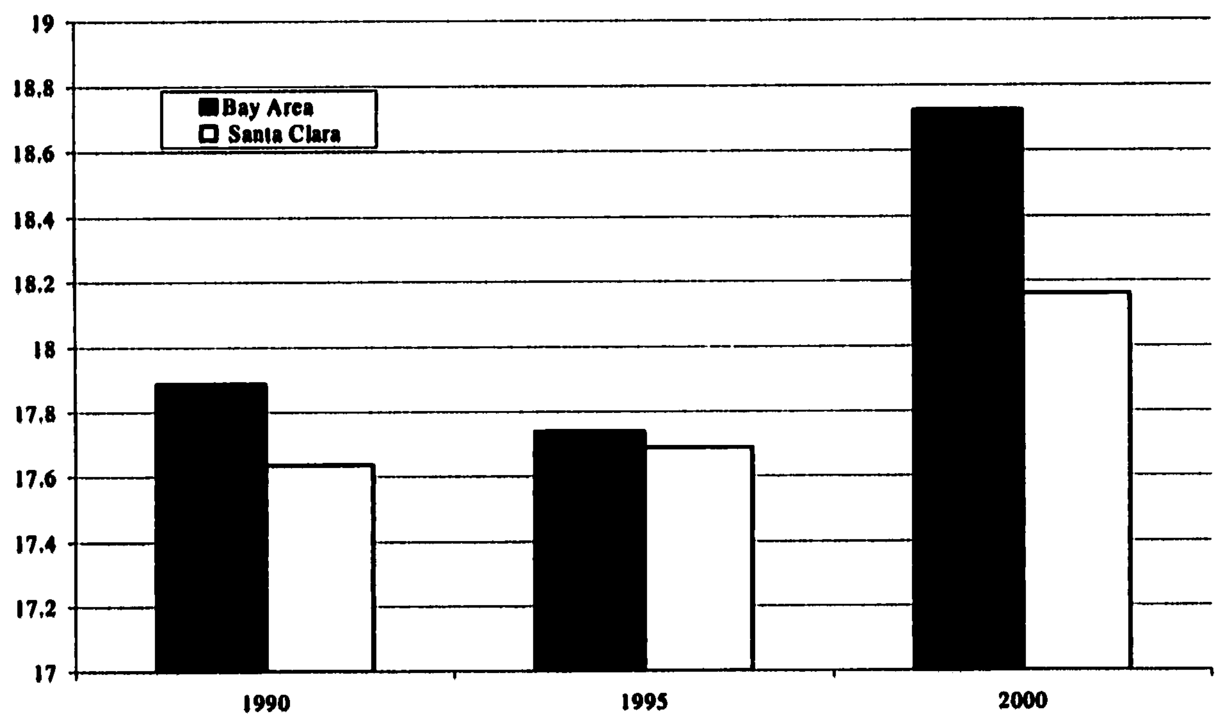
Source: Texas Transportation Institute *Urban Mobility Study*

Figure 4.10. Person Hours of Delay Santa Clara County



Source: Texas Transportation Institute *Urban Mobility Study*

Figure 4.11. VMT per Capita Santa Clara County and the Bay Area



Source: Metropolitan Transportation Commission

Traffic problems have long been considered severe, and several groups and task forces have been formed over the last several decades to address traffic issues. One such effort was a San Jose Mercury News Blue Ribbon Panel which was convened in the early 1970s to study and promote the light rail system. Another group that has played an active role in trying to affect the County's transportation picture, including supporting the light rail construction, is the Silicon Valley Manufacturers Group (SVMG). The group, founded in 1978, is comprised of 150 businesses who account for 25% of the County's jobs. The Manufacturers group identifies itself as the pre-eminent regional business group that identifies and addresses regional transportation, housing, environmental and land use issues. Some of the initiatives they have claim to have spearheaded include the State's transportation half-cent sales tax (Measure A) in 1984; renewal of the transportation sales tax (Measures A and B) in 1996; and the business effort to begin the Altamont Commuter Express (ACE) train service linking the Central Valley with Silicon Valley in October, 1998.

The Golden Triangle Task Force was formed in 1985 to address the perception that traffic congestion and housing costs were threatening the future economic growth of the 'golden triangle' –an area bounded by Highway 101 on the southwestern border, State Route 237 on the north and Interstate 880 on the east. The County's 1997 deficiency plan came to the conclusion that building its way out of congestion by increasing highway capacity is an infeasible solution for the County. Even with the $750 million then programmed to be spent on improving roadways the County would face a net increase of lane miles operating at unacceptable[4] levels of service.

Through a combination of strong popular and political support several general transportation and some specific transit initiatives were passed ultimately resulting in construction of the County's light rail system.

4.4 Santa Clara's Light Rail System

In the face of severe and increasing traffic congestion, Santa Clara County determined that a high capacity rail transportation system would be a sound complement to its existing transportation infrastructure. Planning was initiated in the mid 1970s, construction began in the early 1980s, and the first segment of the 20.8 mile system opened in 1987. Since then the County has built out several phases of the system most recently completing the Tasman West extension.

The light rail opened in several stages, beginning with the northernmost section in 1987. Several additional stations were opened in 1988 and the line was completed to its southwestern terminus in 1990. In 1991 the southeastern spur was added bringing the Guadalupe line to completion.

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[4] Unacceptable as defined by the California Legislature

The Guadalupe line has been fully operational between South San Jose and the Great America industrial area of Santa Clara since 1991. Including these end stations the line serves 30 stations spaced at approximately 0.7 mile intervals and serving the San Jose Civic Center, the North First Street industrial area, Downtown San Jose and the residential areas of South San Jose. A station map is included as Appendix A.

Consistent with the County's planning efforts and transportation goals for the Tasman Corridor, an Alternatives Analysis/Draft Environmental Impact Statement/ Draft Environmental Impact Report was circulated in 1991. In February of 2000 the Tasman West extension began revenue service. With this extension the system reaches downtown Mountain View. Eventually the line will be further extended east along the Tasman Corridor.

Service is provided 7 days a week, 24 hours a day. Light rail vehicles operate every 10 minutes weekdays and every 15 minutes Saturdays and Sundays and holidays. Service is provided every 30 minutes on all evenings. The light rail stations are served by dozens of SCVTA bus routes, and 6,700 free parking spaces are provided at the 10 light rail stations in south San Jose.

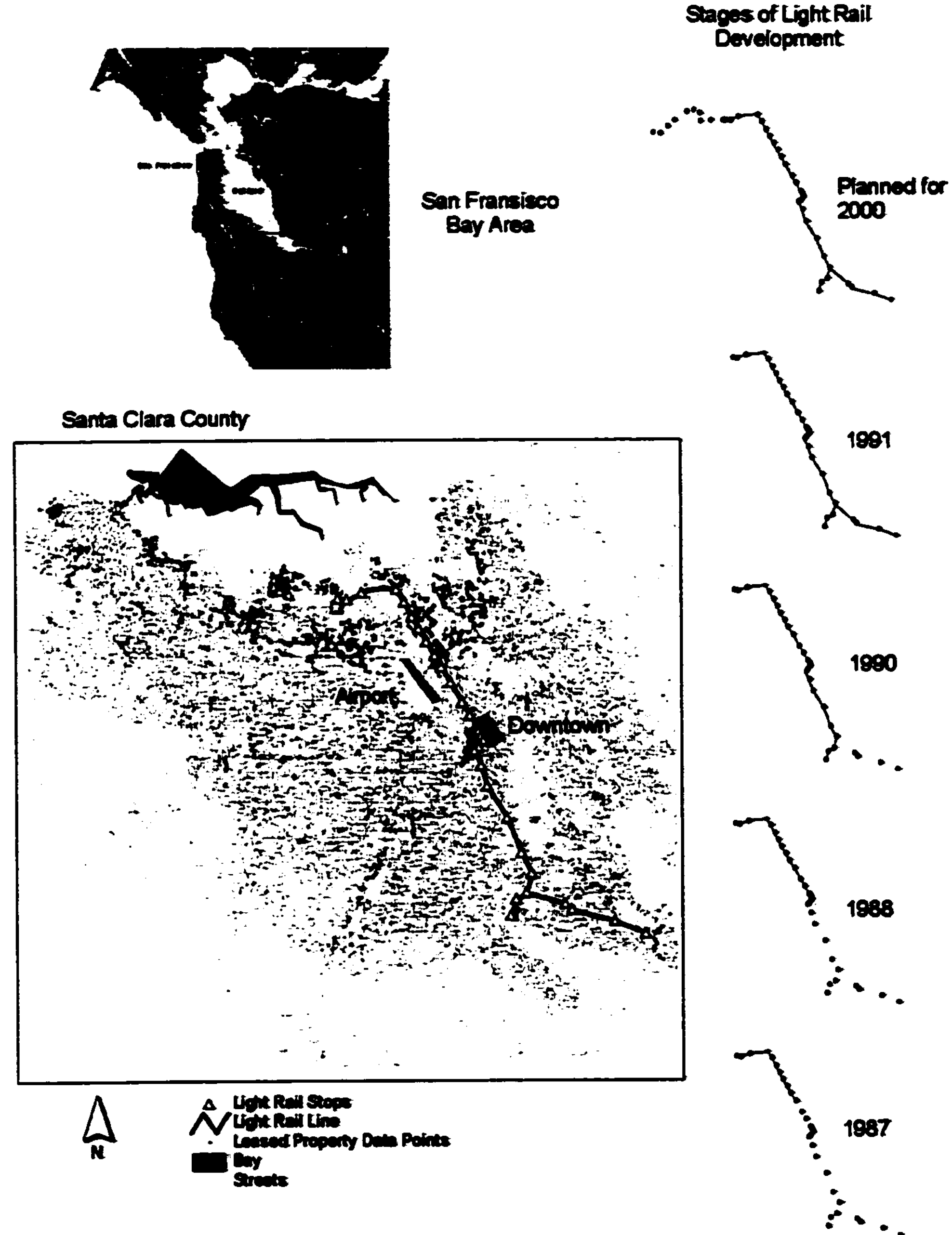
4.5 Conflict Over Light Rail Impacts

In 1996 the County faced several lawsuits alleging damages in connection with the construction of their light rail system. At that time, the light rail (LRT) extended 20 miles from south San Jose to the Great America industrial area (approaching Sunnyvale).

Figure 4.12 shows the existing system and the stages of development. The light rail is designed to run along the median of an existing roadway, but to build the system, the County had to widen the existing right-of-way. Most of the acquisitions were resolved in negotiations with the property owners. For those that were not negotiated, the County exercised their power of eminent domain, condemning a narrow strip from each of those properties.

While the value of the property taken typically was not disputed, several property owners alleged that the existence of the LRT degraded the remainder of their property. Using this argument they filed suit for severance damages, damages to the part not taken that occur due to the taking. California legal code provides for protection in this event under the code sections (Code Civ. Proc. §§ 1263.310, 1263.410). The decrease in the fair market value of the remainder property is the usual measure of severance damages. However, the code also allows that the calculation of damages in a case of severance can be offset by benefits accruing to the property. The code states that compensation for injury to the remainder can be reduced by the benefit to the remainder. In the event that benefits are greater than the damages no compensation is due; however, no amount of the excess can be applied to remunerate for the damages incurred in the part taken.

Figure 4.12. Santa Clara LRT: Stages of Development



Not to scale

Although the statute is written in terms of benefits, historically the California court has viewed benefits very narrowly as 'special benefits': an offsetting benefit is credited only if a special benefit accrued exclusively to the individual property. Benefits accruing to a neighborhood or group of properties had not been considered eligible as offsetting benefits in a taking. Recently the California Supreme Court ruled against this precedent, overturning almost 100 years of judicial history, and determined that benefits accruing to the specific property, regardless of whether or not the same benefit accrues to other properties, can be used to off-set damages (Los *Angeles County Metropolitan Transportation Authority v. Continental Development Corporation* (1997) 16 Cal.4th 694).

In light of the *Continental* decision, Santa Clara County was permitted to respond to the damage claim by showing that there were offsetting benefits. To prevail, however, the County had to demonstrate the value and extent of benefits conferred to affected properties. Whether rail transit conferred a benefit to commercial properties was not a settled question (as the literature review of Chapter 3 has shown.) Nor was there a standard methodology used in practice for estimating benefits to commercial property in the vicinity of light rail transit. Thus, new research was needed.

The research presented in this dissertation was initiated to identify and estimate the property value effects of light rail transit on nearby commercial properties. The dissertation also expands on the research by examining alternative model specifications and their performance.

5 Data

The data used for this study are lease transaction records maintained by one of the largest real estate brokerage firms in the County. The brokerage firm is an international commercial real estate broker with Santa Clara County offices in San Jose, Palo Alto and Gilroy. As a client of the brokerage firm, the VTA has some access to their database, and through the VTA the data was made available for this research. While access to the database was allowed for this study, it was permitted only on the condition of anonymity. The lease transactions included in the study represent over 107 million square feet of commercial space. For the years 1984 to 2000 the average annual rentals were in excess of 6.67 million square feet. To establish credibility for the dataset without violating the conditions for use, a partial list of the firm's clients is included in Appendix B.

The database contains information on over 5,000 lease contracts between 1984 and 2000. Although the sample is large and allows for extensive segmentation, I must reiterate that it is not a random sample. Rather, it is a census from one brokerage firm. The firm's share of the total lease market is unknown but, given the size and orientation of the firm it is assumed that the transactions are typical and representative of the Santa Clara County real estate market. A random sample could yield different results.

Records in the lease database have the following information:

- Address of the property;
- Lease date;
- Lease term (in months);
- Lease square footage;
- Total building square footage;
- Name of the tenant;
- Name of the owner;
- Building type (office or research and development);
- Lease type (full service or otherwise);
- Effective rent per square foot per month (total rent over lease term);
- Coupon rent per square foot per month (starting rent per square foot; often zero);
- Notes on terms and conditions of the rental agreement;
- Notes on tenant improvement allowances;
- Notes on existing tenant improvements/square foot – estimated by the broker; and
- Building interior designator (shell or improved).

As many of the lease negotiations include a certain number of months free or at a reduced rate while tenant improvements are made, the coupon rent was not considered a good estimator of market value. As an alternative, the monthly effective rent, calculated as the total rent collected over the lease term divided by the number of months in the lease, was used as the dependent variable. The models presented thus estimate effective rent. To the extent they are quantifiable, the remaining variables are used as explanatory variables in the model.

5.1 Data Cleaning, Geocoding, and Variable Transformations

Almost 5,400 database records were reviewed for accuracy and completeness. Because the research seeks to understand the effect of location on rent, two data items were of the utmost importance: The price data, represented as effective rent and complete address information, critical for measuring the distance to a transit station. Records with incomplete rental information and records with incomplete address information were corrected where possible; where the deficiencies were insurmountable, the records were deleted from the dataset.

Five hundred and forty-three records had no effective rent value. Effective rents were calculated for about 340 of these records based on the original, or coupon, rent and notes that the brokers had on rent increase schedules. In most cases it was a straightforward calculation, in some an assumption was made that the effective rent was equal to the coupon rent. Of the remaining records, several had no coupon rent listed and several others had notes that the lease terms would not be disclosed. These records were not usable and therefore deleted from the estimation set. Several properties had their rent increases keyed to future changes in the consumer price index (CPI) and effective rents could not be calculated. Others had rent increases specified in ranges, and no accurate estimates of effective rent could be made for those. A few other records were deleted due to miscellaneous contradictions such as one record in which a 36 month lease term was specified along with a schedule that included rent increases at the 50th month. Ultimately 229 records were removed because the rent data was not usable or correctable.

Transaction data for the rental transactions in two cities was extremely limited, with only 3 records for the City of Gilroy and 40 for the City of Morgan Hill. Considering the paucity of available data for these cities and their great distance from the LRT (any address in Morgan Hill is at least 20 miles from a station and any address in Gilroy would be at least 30 miles) these records were deleted from the estimation set.

The remaining records were given to the Santa Clara County Center for Urban Analysis (CUA) for geocoding. At the CUA, geographic information system (GIS) experts used an address-matching databank to identify an (x, y) coordinate pair so that each property could be properly located in space. The CUA was able to match 90% of the records to addresses in their databank. Of the records that could not be matched, 80% were in Cupertino or Palo Alto and the remainder distributed over 8 cities. These data were deleted from the analysis. Their loss was not considered critical to the analysis; they would have added information regarding property values in the County but both cities are at a considerable distance from the light rail catchment area. Ultimately, the CUA GIS analysts were able to successfully match over 4,600 records. These records represent the final dataset used in this research.

Once the records were properly geocoded an 'on street' or network, distance from the property to the nearest LRT station was measured. The distance variable represents distance to the nearest station in 1999. Although the lease data spans from 1984 to 1999, and the line was opened in stages beginning in 1987, the Guadalupe line, representing a partial system was only fully operational, with the residential areas being linked to the industrial areas, in 1991. The distance to a transit station is a meaningful measure only in the case where the transit station links to a transit system. To manage this issue, a further modification to the distance to transit variable was necessary. A binary (0,1) 'rail indicator' variable was created to specify pre- or post-1991 and interacted with the distance variable. In this way distance shows up in the model only if it is measuring a meaningful distance to a transit station that is part of a more comprehensive transit system and not a distance to an abstract longitude, latitude coordinate pair.

The following other variables were created:

1. The transaction dates were transformed to a series of year indicator variables. This was done to capture economic cycle effects and inflation;
2. An inflation adjusted effective rent was calculated using the Consumer Price Index (CPI), 1982-1984=100, for the San Francisco-Oakland region;
3. A series of indicators were included to identify analysis zones that are defined by the County in their regular modeling efforts. These zones are illustrated in Figure 5.1. Assuming some homogeneity of the pre-defined transportation analysis zones, these zonal variables were used as a way to control for location effects other than proximity to LRT; this should ensure that any observed effect

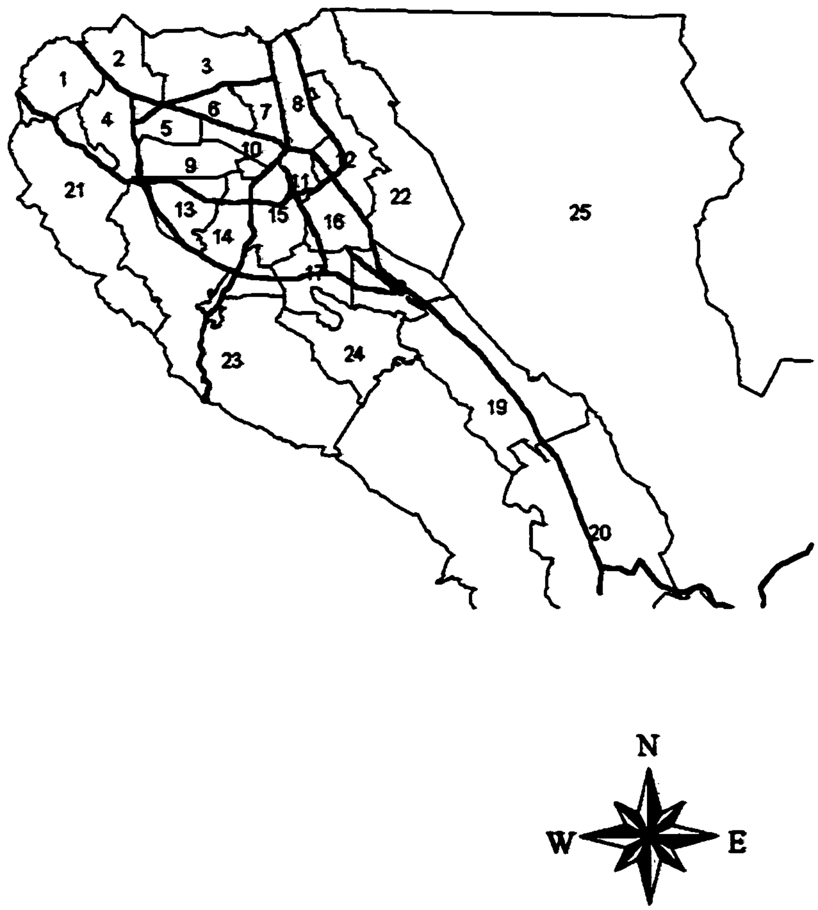
is not due simply to pre-existing higher, lower, or equal land values in the LRT corridor.

4. Indicator variables for ¼ mile distance bands from transit and highway access points; and

5. Piecewise distance variables from transit and highway access points.

All the indicators are binary 0,1 variables.

Figure 5.1 Santa Clara County Analysis Areas with Major Highways



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5.2 Descriptive Statistics

Ultimately, 4,632 records were determined usable for the analysis. These data represent ten of Santa Clara's fifteen cities. As Table 5.1 shows, the bulk of the records, almost 40%, are for transactions that occurred in the City of San Jose. Santa Clara and Sunnyvale follow with 18% and 17% respectively. The remaining 27% are split among the other seven cities represented.

Table 5.1. Distribution of Cities Represented

	Frequency	Percent
San Jose	**1775**	**38.3%**
Santa Clara	830	17.9%
Sunnyvale	797	17.2%
Mt. View	471	10.2%
Milpitas	414	8.9%
Campbell	168	3.6%
Los Gatos	87	1.9%
Palo Alto	40	0.9%
Los Altos	29	0.6%
Saratoga	21	0.5%
Total	4632	100%

The distribution of lease begin dates is shown in Table 5.2. For analysis purposes, the 6 records for leases that begin in 1984 were combined with the 1985 data. Four leases were scheduled to begin in the future, i.e., 2 leases begin in 2001 and one each in 2002 and 2003. As it is common practice to lease a commercial space for a future date these records seem reasonable to maintain; however, they are too few to retain for statistical analysis and so were omitted from the model estimation. The frequency of lease transactions was found to be increasing in time, with the most falling in 1999. This is consistent with other evidence of increases in market activity and pressure.

Table 5.2. Distribution of Lease 'Begin Dates'

	Frequency	Percent
1984*	6	0.1%
1985*	98	2.1%
1986	99	2.1%
1987	160	3.5%
1988	175	3.8%
1989	177	3.8%
1990	238	5.1%
1991	266	5.7%
1992	335	7.2%
1993	328	7.1%
1994	421	9.1%
1995	438	9.5%
1996	431	9.3%
1997	406	8.8%
1998	433	9.3%
1999	**501**	**10.8%**
2000	116	2.5%
2001**	2	0.0%
2002**	1	0.0%
2003**	1	0.0%
Total	4632	100.0%

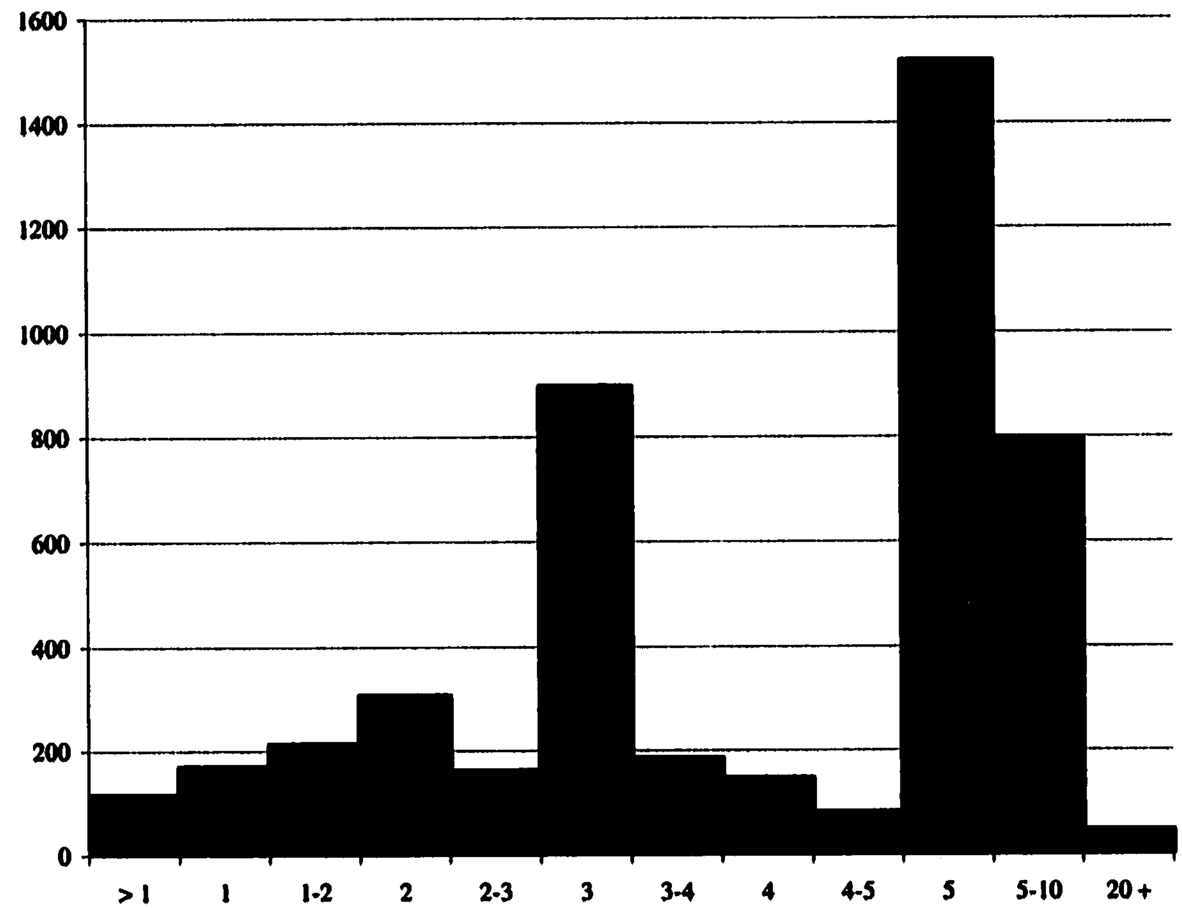
* 1984 and 1985 combined; **Omitted from model estimation

Table 5.3 and Figure 5.2 show the distribution of the lengths of the leases. Most leases are for five years. Three-year leases are the next most common. These two groups constitute over 52% of the records. A somewhat artificial peak in the graph is shown for leases between 5 and 10 years; these 796 records comprise 17.2% of the records.

Table 5.3. Distribution of Lease Length

	Frequency	Percent
Less than 1 year	115	2.5%
One year	169	3.6%
Between 1 and 2 years	212	4.6%
Two years	306	6.6%
Between 2 and 3 years	161	3.5%
Three years	895	19.3%
Between 3 and 4 years	185	4.0%
Four years	146	3.2%
Between 4 and 5 years	80	1.7%
Five Years	**1517**	**32.8%**
Between 5 and 10 years	796	17.2%
Ten or more	46	1.0%
Missing	4	0.1%
Total	4632	100.0%

Figure 5.2. Distribution of Lease Lengths



The three types of leases are 'triple net,' 'gross' and 'full service.' These range in services provided. Triple net provides the fewest services; in fact, the tenant is typically responsible for all maintenance to the grounds and physical plant. With full service, the lessor provides all services including waste disposal et cetera. Gross leases vary between these two extremes. The distribution of lease types is shown in Table 5.4. Most leases fall into the triple net category. A few were not specified.

Table 5.4. Distribution of Lease Types

	Frequency	Percent
Full Service	1519	32.8
Gross	400	8.6
Triple Net	**2698**	**58.2**
Unspecified	15	0.3
Total	4632	100

The average effective rent, total rental income for the lease term divided by the length of the lease, for the data set is $1.32 per square foot per month in current dollars and $0.87 in inflation adjusted dollars (1982-1984=100). Average rent, by year in which occupancy began, is shown in Table 5.5 and Figure 5.3. The data show some recession in the mid 1980s and, consistent with the 1992-1994 dip in jobs, rent rates were also lower in those years. It is clear from the data that the general trend in Santa Clara County commercial real estate is upward.

Figure 5.3. Effective Rent: Current and Inflation Adjusted (1982-1984=100) Dollars

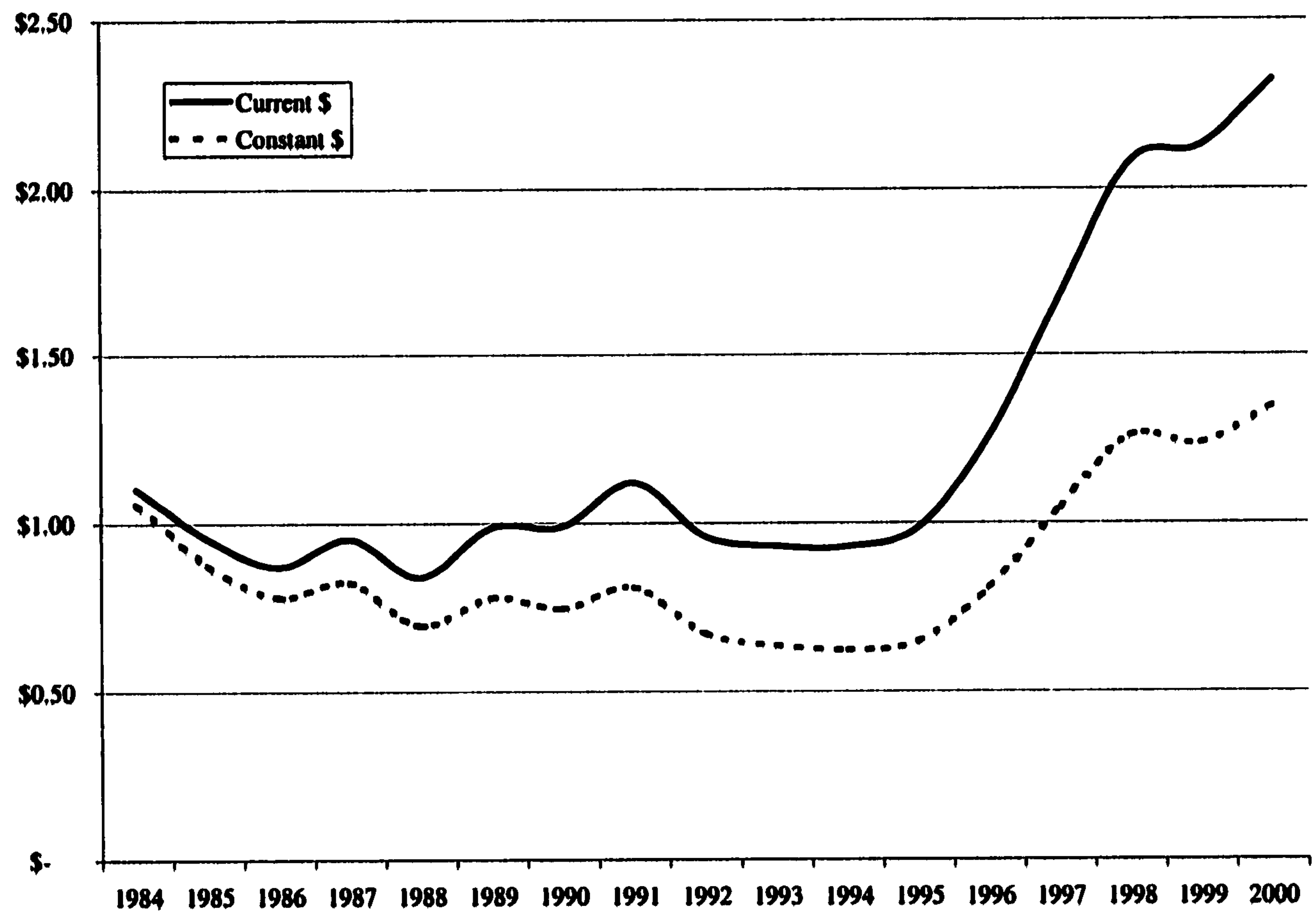


Table 5.5. Effective Rent: Current and Inflation Adjusted (1982-1984=100) Dollars

Lease Year	Current $	Standard Deviation	Constant $	Standard Deviation
1984	$ 1.10	0.43998	$ 1.06	0.42306
1985	$ 0.95	0.37990	$ 0.88	0.35047
1986	$ 0.87	0.39304	$ 0.78	0.35219
1987	$ 0.95	0.41659	$ 0.83	0.36100
1988	$ 0.84	0.37228	$ 0.70	0.30895
1989	$ 0.99	0.43052	$ 0.78	0.34060
1990	$ 0.99	0.38753	$ 0.75	0.29336
1991	$ 1.12	0.44953	$ 0.81	0.32598
1992	$ 0.96	0.45800	$ 0.67	0.32140
1993	$ 0.93	0.38426	$ 0.64	0.26265
1994	$ 0.93	0.40646	$ 0.62	0.27334
1995	$ 0.98	0.40350	$ 0.65	0.26616
1996	$ 1.25	0.46676	$ 0.81	0.30094
1997	$ 1.67	0.54706	$ 1.04	0.34106
1998	$ 2.08	0.66553	$ 1.26	0.40213
1999	$ 2.13	0.67991	$ 1.23	0.39415
2000	$ 2.32	0.78121	$ 1.35	0.45288
Average	$ 1.32	0.70165	$ 0.87	0.40778

Tables 5.6, 5.7, and 5.8 show the effective rent by city, lease length and lease type. As before, rent is shown in both current and constant dollars.

Table 5.6. Effective Rent by City

CITY	Current $	Standard Deviation	Constant $	Standard Deviation
Campbell	$ 1.63	0.72898	$ 1.08	0.40100
Los Altos	$ 1.88	0.51184	$ 1.24	0.30361
Los Gatos	$ 1.64	0.71520	$ 1.09	0.38687
Milpitas	$ 0.89	0.41557	$ 0.61	0.24275
Mt. View	$ 1.62	0.85835	$ 1.05	0.48010
Palo Alto	$ 1.54	0.82800	$ 1.01	0.46857
San Jose	$ 1.34	0.68544	$ 0.89	0.40441
Santa Clara	$ 1.41	0.71040	$ 0.92	0.40876
Saratoga	$ 1.87	0.56279	$ 1.26	0.27947
Sunnyvale	$ 1.07	0.52106	$ 0.71	0.29682
Average of Total	$ 1.32	0.70165	$ 0.87	0.40778

Table 5.7. Effective Rent by Lease Length

Lease Length	Current $	Standard Deviation	Constant $	Standard Deviation
Less than 1 year	$ 1.18	0.71722	$ 0.80	0.43300
One year	$ 1.33	0.70305	$ 0.87	0.40000
Between 1 and 2 years	$ 1.38	0.72756	$ 0.88	0.41338
Two years	$ 1.14	0.58162	$ 0.76	0.33461
Between 2 and 3 years	$ 1.31	0.67694	$ 0.85	0.38759
Three years	$ 1.27	0.67530	$ 0.85	0.39248
Between 3 and 4 years	$ 1.39	0.75998	$ 0.88	0.43099
Four years	$ 1.43	0.84842	$ 0.93	0.49453
Between 4 and 5 years	$ 1.41	0.67202	$ 0.92	0.39395
Five years	$ 1.32	0.69673	$ 0.88	0.40861
Between 5 and 10 years	$ 1.38	0.72451	$ 0.90	0.41978
Twenty years or more	$ 1.50	0.64173	$ 0.98	0.39677
Total	$ 1.32	0.70165	$ 0.87	0.40780

Table 5.8. Effective Rent by Lease Type

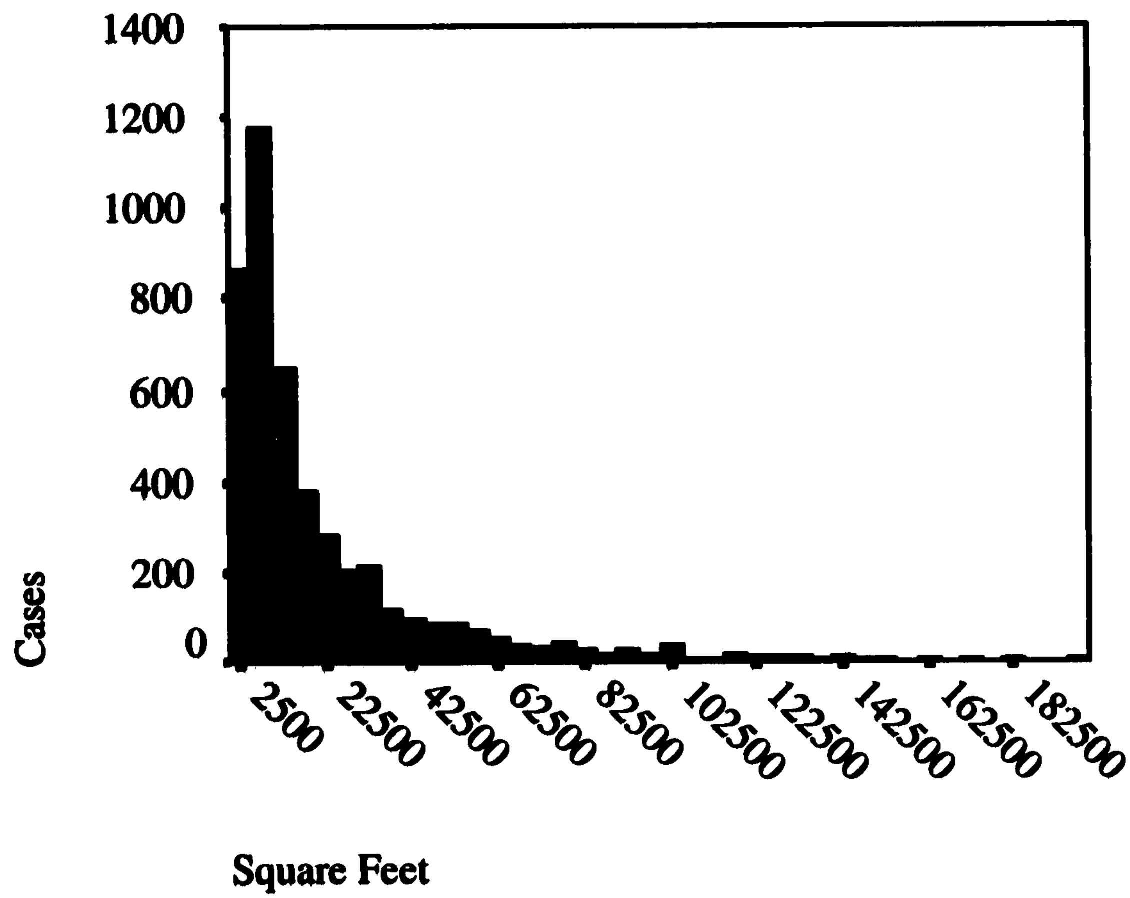
Lease type	Current $	Standard Deviation	Constant $	Standard Deviation
Full Service	$ 1.81	0.66761	$ 1.19	0.35846
Gross	$ 1.02	0.52413	$ 0.68	0.30316
Triple Net	$ 1.09	0.59018	$ 0.72	0.33341
Not Specified	$ 1.48	0.77107	$ 0.94	0.43642
Total	$ 1.32	0.70165	$ 0.87	0.40778

The average lease length is just over four years, with a standard deviation of over 2 years. The median and modal values for lease length are both 5 years. The average size of a leased space is 23,100 square feet (31,960 standard deviation). The median value is 11,560 square feet, about half the average. The minimum space was 3,000 square feet with a highly skewed distribution. This is illustrated in the histogram shown as Figure 5.4.

Building square footage was very poorly maintained data with over 1,000 records missing. For the reported data, the ratio of leased square footage to building square footage was about 0.49 or about half of the building space. In 30% of the reported cases, approximately 1,050 cases, the rental space encompassed the entire building. The mean size of buildings in the sample is 74,400 square feet, the median value is 49,000.

Although about half the stations on the Guadalupe line were opened prior to 1991, they were almost exclusively in industrial areas; the entire line, extending into residential areas, was opened in 1991. For the purposes of this research, the line is treated as having come into existence when these later stations opened in the spring of 1991. Since, it is only meaningful to speak of access to transit in the case where transit, in fact, exists. While the pre-1991 records were maintained for model estimation and analysis, the following description of properties and their distance to transit pertains only to the 80% of the sample where leases were entered into in 1991 or later.

Figure 5.4. Distribution of Leased Square Footage



The average distance to a transit station of all properties is 2.63 miles; the median value of 2.21 shows that the more distant properties are weighting the average to greater distance. As shown in Table 5.9, 30% of the properties are actually within 1 mile of a transit station.

Table 5.9. Distance Distribution of Properties

	Frequency	Percent	Cumulative Percent
Within ¼ mile	508	13.8	13.8
¼ to ½ mile	322	8.8	22.6
½ to ¾ mile	197	5.4	27.9
¾ to 1 mile	78	2.1	30.1
Beyond 1 mile	2570	69.9	100.0
Total	3675	100.0	

6 Methodology

To examine the effect of the proximity of a light rail transit system on commercial rents in office and research and development buildings, a series of explanatory hedonic models were developed. The hypothesis being tested was that proximity to a light rail station has no statistical effect on property values. The dataset used to estimate the models contains 3,701 records. Following Mark and Goldberg (1988), a randomly selected hold out sample of 20% of the original data was used to test the explanatory and predictive power of the models. In addition to the usual tests of parameter significance, explanatory power as shown by R^2, and goodness of fit as reflected by the F statistic, model strength was assessed by studying a series of bivariate correlations that show how well the predicted effective rent matches the actual effective rents of the holdout sample.

As discussed further in the paragraphs that follow, the hedonic model is a regression model that is used as a tool to explain how consumers value the different components or attributes that make up a real property. The dependent variable is a measure of price. The independent variables are divided into study variables, and control variables. An error term is added to explain variation not accounted for in the known variables. In this case the study variables are locational attributes that describe a parcel's distance to nearby transportation facilities with both distance to the LRT and distance to highway studied. The control variables include proxy variables to describe characteristics of the space and lease terms, location (as defined by the study areas described in Chapter 5, Figure 5.1), and the transaction year as a proxy for regional economic cycles. Parameter estimates of hedonic models are interpreted as shadow prices and provide information on how the market values a given attribute relative to the other attributes.

The study design used in this research attempts to reconcile both longitudinal and cross-sectional effects in a single model. Cross-sectional studies, some of which were noted in Chapter 3, use data for a single year thus rendering it impossible for the researcher to draw meaningful conclusions with respect to the transportation improvement's effect. All that can be shown in that type of approach is that the corridor in which the improvement is located has a greater, lesser, or equal value to other properties in the study area.

A longitudinal study that looks only at changes in property value for the affected area also has certain limitations. A matched pair analysis that looks at the same property at multiple points in time –or other study design that considers only longitudinal effects– could give a different picture of the effects over time but it would not indicate whether the changes in value were correlated with the transportation improvement. In fact, in this design the analyst would not be able to discern whether property values in the corridor were moving consistently with the region, contrary to the region or in some other relationship to the region.

By considering property over the two dimensions of primary interest, time and space, as well as by controlling for other variables a more comprehensive analysis is attempted. Another robust analysis, a stratified matched pair scheme could also incorporate the longitudinal and cross-sectional effects. This approach could be implemented in further research.

6.1 Assumptions of Hedonic Models and Violations of Those Assumptions

There are a few assumptions upon which the justification for hedonic modeling is based. First of all the approach assumes that the market is in equilibrium. Second, it is assumed that the study area represents a single market. Third, that the researcher knows what factors affect price and that the researcher is able to obtain data that represent those factors. Fourth, it is assumed that there is continuous product differentiation along the dimensions included as explanatory variables. Fifth, that consumers share common utility functions that they use to guide their decision process. Finally, that there is no friction in moving, i.e., there is no arbitrage nor transaction costs.

It is obvious that the area under study does not represent a market in equilibrium. Rather, it is a dynamic market with a public policy intervention having been intentionally introduced with the goal of effecting some aspect of the market. In fact the objective of the study is to gain insight into the effectiveness of that policy intervention. However, it is assumed that the market is constantly re-equilibrating and the use of longitudinal data attempts to address that issue. The 'requirement' also calls into question the meaning of the difference between a static equilibrium and an equilibrating process.

To satisfy the second assumption a segment of the real estate market is studied. All the properties studied are commercial office and research and development uses; dummy variables are introduced to control for other market segmentations. The data used in this study represents a mix of those variables that were available and others that were developed based on theoretical justifications as described earlier. The fourth and fifth assumptions are believed to be reasonably well satisfied by a large market size and by the relative simplicity of needs for office space, as compared with other land uses such as housing. Finally, while there is clearly arbitrage and some friction in moving, commercial leases are also characterized as highly negotiated. The advantage of rental rates over sales prices is that there are more opportunities to negotiate and renegotiate leases thus allowing a much quicker response to the re-equilibrating market.

In addition to this list, hedonic models are also subject to the usual assumptions regarding regression models, to wit: the data have been measured and recorded accurately; the relationship being modeled is linear or adequate variable transformations have been executed; the independent variables are uncorrelated; the errors are independent and normally distributed; the dependent variable is normally distributed with a constant variance σ^2.

Every effort has been made to comply with the basic assumptions or to understand how the violations will affect interpretation of the model results. Recognizing their pitfalls, hedonic models, nevertheless, are believed to be relatively robust and among the best tools available for this type of research.

6.2 Errors in Specification, Multicollinearity

It would be remiss to not spend some time discussing the possible pitfalls of model specification. In general there are three specification dangers, over specification, under-specification, and misspecification. The most severe problem would be a complete misspecification of the model. Hedonic models are employed to study empirical relationships between variables but they must be based on defensible *a priori* theoretical assumptions regarding those relationships. The analytic technique simply processes numbers; if there are correlations by coincidence then the results are not meaningful in application. A model is over-specified if more variables are included than those necessary to explain or predict the dependent variable. Mark and Goldberg (1988) argue that over-specification is a non-issue because the expected value of the estimated parameter is zero and inclusion of an irrelevant variable will not bias the other coefficients. However, there is clear danger that if a model is over-specified there is likely to be some spurious correlation and the inclusion of extraneous data will likely bias the true explanatory variable parameters. Even if the irrelevant variable is uncorrelated, its presence adds to the size of the estimation error. It behooves the researcher to be parsimonious, using variables sparingly, but not stingy, as under-specification also can be problematic. If a model is under-specified its explanatory power is weakened and the unexplained variation is inappropriately loaded onto the error term. In this case the assumption of normal, mean 0, variance σ^2 error terms is likely to be violated, resulting in heteroscedastic problems.

Multicollinearity exists when two or more of the independent variables are not in fact independent of each other. As a result, a specification with multicollinearity is often considered a misspecification. Collinearity can exist in the sample even though it may not necessarily exist in the population under study. Collinearity does not bias the parameter estimators but it increases their standard errors, thus casting doubt on the statistical significance. Note, however, that multicollinearity among the control variables does not affect the estimates or the errors of the study variables (Berry and Feldman 1985).

In the present case building size and size of leased space are highly correlated. In this particular study building size is not expected to add to the analysis while it may certainly detract from or undermine the statistical results. It is, therefore, omitted.

6.3 Possible Problems With Hedonic Price Estimation

There are two principal areas of potential trouble in estimating hedonic price models to assess implicit prices and to explain or predict property value. The first is model specification and the second is market stability. Both issues will be discussed here.

The problems of model specification tend to revolve around selection and availability of appropriate attributes, treatment of multicollinearity, separation of conflicting effects such as station proximity versus line proximity, heteroscedasticity, and choice of functional form. There is little or no consensus in the research with respect to explanatory variables or functional form. In general, models with the best fit (as defined by adjusted R^2 statistics) are defended with conclusions and caveats made on a specific case by case basis. Another problem in model specification bleeds into the question of market stability. For markets in disequilibrium, any prices estimated are, almost by definition, inaccurate.

Questions of market stability come into play in terms of when is the appropriate time to look at the real estate market; and what other local, regional, and global market forces are at work. Some studies have attempted to capture the speculation effects; others have looked to capture market responses immediately after the opening of a system; others have argued that the real estate market is slow to respond and a long interval after opening is required in order to understand market response to transportation infrastructure improvements (see Landis et al. 1994 and Chen 1998).

6.4 Models estimated

The general model estimates effective rent as a function of building characteristics, locational characteristics, and an economic control variable.

It is specified as:

$$ER/SQ=\alpha+\beta\bullet V+\varepsilon$$

Where ER/SQ is the effective rent per square foot, α is a constant and $\beta \bullet V$ is the dot product of a vector of estimated parameters and a vector of explanatory variables and ε is an error term.

The explanatory variables include the following building characteristics: size of the leased space, a dummy indicating whether the space is a shell or has improvements, and the type of lease; in addition it includes a series of dummy variables representing the transaction year for economic cycle controls, and two locational type variables, one measuring the distance to a light rail station and the other a series of dummy variables to represent planning districts. The remaining models are variations on the basic model:

$$ERC/SQ=\alpha+\beta \bullet V+ \varepsilon$$

$$Ln(ER/SQ)=\alpha+\beta \bullet V+ \varepsilon$$

$$Ln(ERC/SQ)=\alpha+\beta \bullet V+ \varepsilon$$

Where ERC/SQ is the effective rent per square foot in constant dollars, using the Consumer Price Index (1982-1984=100) for the San Francisco-Oakland region, and the right hand is as specified above, and Ln(ER/SQ) is the natural log of the dependent variable and Ln(ERC/SQ) is the natural log of effective rent converted to constant dollars.

7 Model Results and Interpretation

Much of the data is nominal or ordinal with only very few continuous interval variables. To accommodate ordinal and nominal data in the models, a series of indicator variables are developed to represent the district in which a property lies, the year in which it was leased, the type of lease, and the limited information that is available on the condition of the space.

The basic model includes indicator variables to represent all of these factors. It also includes the size of the space, the length of the lease, and of course the variables in which we are most interested: distance to the light rail station. The base model uses indicator variables to represent 3 concentric rings surrounding the light rail stations. The rings represent properties with ¼ mile, properties that are ¼ to ½ mile from the station and those that are ½ to ¾ mile away. Variations on the model also include a ring representing properties that are ¾ to 1 mile distant from the station.

The first two models were estimated with the full data set and then with the randomly selected 80% sample respectively. The first section covers how the parameter estimates vary with sample size. The remaining models are developed using only the 80% sample and the final section evaluates the predictive capability of the models by comparing the predicted with the actual rents for the holdout sample. Comparisons between the 100% and 80% sample are made in order to demonstrate that there is no need for concern regarding lack of precision by using the smaller sample. In fact, given the sample size, the advantage of being able to validate the models using the holdout sample is worth any loss that might otherwise be felt.

7.1 Basic model

Tables 7.1 and 7.2 present the model summary and the parameter estimates for model 1, estimate of effective rent, Figures 7.1 and 7.2 show the scatter plot of residuals plotted against the dependent variable for each version of this model. The residuals indicate some effects of non-linearity or heteroscedasticity which will be addressed later in this section.

Both models have relatively high R^2 statistics, implying that a fair amount of the variation in rents is explained by the variables and functional form proposed. The high values for F imply that the model fits the data reasonably well. Somewhat unexpectedly, it appears that the model estimated from the 80% sample has greater explanatory power than the full sample model. Because the holdout was randomly selected, it is only by chance that some of the more volatile records were included in the holdout sample thus leaving a more stable estimation set behind.

Table 7.1 Basic Model –Summary Statistics

	R	R Square	Adjusted R Square	Std. Error of the Estimate
(100%)	0.880	0.775	0.773	0.334585
(80%)	0.885	0.783	0.781	0.326449

ANOVA		Sum of Squares	Df	Mean Square	F	Sig.
100%	Regression	1764.7517	43	41.04074	366.60	0
	Residual	513.1663	4584	0.111947		
	Total	2277.918	4627			
80%	Regression	1407.3279	43	32.72856	307.11	0
	Residual	389.40222	3654	0.106569		
	Total	1796.7302	3697			

Table 7.2. Basic Model Parameter Estimates Comparison of 100% and 80% Samples

	Unstandardized Coefficients						Standardized Coefficients	
Variable	B (100%)	S.E	T-stat	B (80%)	S.E	T-stat	Beta (100%)	Beta (80%)
(Constant)	1.1988	0.0951	12.61**	1.1648	0.1105	10.54**		
AREA2	0.1647	0.0883	1.86*	0.2301	0.1032	2.23**	0.0414	0.0587
AREA3	-0.4848	0.0862	-5.62**	-0.4397	0.1011	-4.35**	-0.165	-0.1495
AREA4	-0.0556	0.087	-0.64	0.018	0.1020	0.18	-0.0165	0.0053
AREA5	-0.3534	0.0853	-4.15**	-0.3126	0.1001	-3.12**	-0.1562	-0.1362
AREA6	-0.3496	0.0857	-4.08**	-0.3069	0.1004	-3.06**	-0.149	-0.1329
AREA7	-0.4901	0.0854	-5.74**	-0.4471	0.1002	-4.46**	-0.2525	-0.2318
AREA8	-0.5783	0.085	-6.8**	-0.5427	0.0997	-5.44**	-0.2817	-0.2696
AREA9	-0.2898	0.1067	-2.71**	-0.2253	0.1210	-1.86*	-0.0309	-0.0249
AREA10	-0.3449	0.085	-4.06**	-0.3023	0.0998	-3.03**	-0.178	-0.1569
AREA11	-0.4833	0.0873	-5.54**	-0.4371	0.1022	-4.28**	-0.1704	-0.1536
AREA12	-0.3621	0.1318	-2.75**	-0.2156	0.1474	-1.46	-0.0251	-0.0152
AREA13	-0.0606	0.1062	-0.57	-0.0183	0.1188	-0.15	-0.0066	-0.0021
AREA14	-0.2211	0.0865	-2.56**	-0.1776	0.1012	-1.76*	-0.0734	-0.0599
AREA15	-0.2511	0.0876	-2.87**	-0.1908	0.1024	-1.86*	-0.0719	-0.055
AREA16	-0.7965	0.1352	-5.89**	-0.7074	0.1520	-4.65**	-0.0527	-0.0472
AREA17	-0.8491	0.2517	-3.37**	-0.8022	0.2518	-3.19**	-0.0252	-0.0268
AREA18	-0.7692	0.0909	-8.47**	-0.7141	0.1060	-6.74**	-0.1579	-0.1454
AREA22	-0.32	0.1879	-1.7*	-0.2802	0.1916	-1.46	-0.0134	-0.0132
AREA23	-0.0336	0.1315	-0.26	0.009	0.1472	0.06	-0.0023	0.0006
AREA24	-0.9777	0.2517	-3.88**	-0.9432	0.2518	-3.75**	-0.029	-0.0315
1986	-0.1533	0.0467	-3.28**	-0.1711	0.0512	-3.34**	-0.0316	-0.0357
1987	-0.2673	0.042	-6.37**	-0.2637	0.0461	-5.71**	-0.0696	-0.0694
1988	-0.2519	0.0412	-6.12**	-0.2274	0.0454	-5.01**	-0.0685	-0.0623
1989	-0.1882	0.0411	-4.58**	-0.1681	0.0456	-3.69**	-0.0514	-0.0456
1990	-0.1744	0.0392	-4.45**	-0.1725	0.0432	-3.99**	-0.0549	-0.0545
1991	-0.1442	0.0387	-3.73**	-0.138	0.0425	-3.25**	-0.0478	-0.0466
1992	-0.2282	0.0375	-6.08**	-0.2334	0.0413	-5.65**	-0.0843	-0.0874
1993	-0.2534	0.0375	-6.75**	-0.2542	0.0414	-6.13**	-0.0927	-0.0931
1994	-0.2266	0.0365	-6.2**	-0.2163	0.0404	-5.36**	-0.0929	-0.0882
1995	-0.1703	0.0364	-4.68**	-0.1733	0.0401	-4.32**	-0.0711	-0.073
1996	0.0411	0.0364	1.13	0.0412	0.0404	1.02	0.017	0.017
1997	0.4467	0.0367	12.17**	0.4474	0.0404	11.06**	0.1797	0.183
1998	0.8373	0.0365	22.92**	0.8287	0.0402	20.61**	0.3475	0.3502
1999	0.9076	0.036	25.23**	0.9048	0.0398	22.76**	0.4016	0.4009
2000	1.0551	0.0453	23.28**	1.0391	0.0499	20.82**	0.2351	0.2322

Table 7.2. Basic Model Parameter Estimates Comparison of 100% and 80% Samples (cont.)

Variable	Unstandardized Coefficients B (100%)	S.E	T-stat	B (80%)	S.E	T-stat	Standardized Coefficients Beta (100%)	Beta (80%)
Improved space	-0.0005	0.0311	-0.02	-0.0091	0.0337	-0.27	-0.0002	-0.0032
New shell	0.2228	0.0402	5.54**	0.247	0.0436	5.66**	0.0594	0.0667
Full service lease	0.6593	0.0131	50.46**	0.6527	0.0142	45.82**	0.4413	0.4385
Leased sq. footage	0	0	-1.17	0	0.0000	-1.52	-0.0094	-0.0136
Length of lease (months)	0.0026	0.0002	13.33**	0.0027	0.0002	12.41**	0.1053	0.1083
Within ¼ mile	0.1257	0.0195	6.43**	0.133	0.0217	6.13**	0.0569	0.0592
¼ to ½ mile	0.0735	0.0222	3.31**	0.0656	0.0240	2.73**	0.0266	0.0242
½ to ¾ mile	0.0012	0.0268	0.05	0.0104	0.0288	0.36	0.0004	0.0031

* significant at $\alpha = 0.1$ ** significant at $\alpha = 0.05$ or lower

All of the variables, save one, entered the model as expected. The model suggests, as discussed further below, that 'new shell' construction is valued more highly than is space with existing improvements. Otherwise it is worth noting from Table 7.2 that most of the parameters, from both versions of the model, are highly significant. The corresponding parameter estimates are relatively close. For variables that are statistically significant in one model or the other the average ratio of parameters is 0.95. On average, the parameters estimated on the smaller dataset are slightly lower than the parameters estimated on the full set.

Of the 20 area variables included, 17 have significant parameter estimates in the 100% sample and 15 do in the smaller sample. Twenty-one area variables are included in the dataset but Area 1 was excluded from the model in order that perfect colinearity is not introduced. Of the year variables, properties leased in 1984-1985 were not explicitly specified, again to avoid colinearity. All of the year variables except 1996 are highly significant in both versions of the model. The ordinal variable describing interior conditions takes three values: New shell, gutted shell, and improved. These are specified in two indicator variables. The indicator for improved space is small, negative, and not statistically significant in either model. The parameter implies that improvements are not highly valued in the market although the relationship between whether or not a space is improved and effective rent is weak and subject to large random fluctuations. A new shell on the other hand is clearly valued more highly than the other two interior conditions, other things being equal, a new shell commands an additional $0.22 per square foot per month. The type of lease is also significant in both models. The amount of space leased however has an almost negligible effect but there is weak evidence, based on the T statistic, of a discount per square foot for larger spaces. In any case the effect is so small that it is less than 1 ten thousandth of a cent per square foot per month. Consumers also pay higher rents for longer leases, a gamble against more precipitous rent increases in future years.

Finally, the distance variables behave according to expectation in that relative to other properties in the sample, the highest premium is found for properties that are within ¼ mile of the light rail stations; a slightly lower premium is paid for properties that are between ¼ and ½ mile of the station. Beyond the ½ mile boundary (which is roughly an upper limit on a comfortable walking distance) there is no statistical relationship between the distance from transit stations and the rents for those properties. This result holds for both model versions. The first two distance bands are both highly significant but it is notable that the t-statistics for the parameters estimated from the larger sample are slightly higher.

Adding an additional distance band, i.e. the ¾ to 1 mile band yields a model with the same explanatory power and very similar coefficients, (ratio .99) but shifts the parameters on the distance variables. The first band, within ¼ mile becomes significant at $\alpha = 0.01$; the second band, ¼ to ½ mile is still significant at $\alpha = 0.05$; the third band is still not significant but the sign changes and for properties that are ¾ mile to 1 mile away from the light rail station, well out of a reasonable sphere of influence, there is a penalty on rental rate that is statistically significant at $\alpha=0.01$.

There is some reason to believe that the LRT was strategically located to serve an area of relatively valuable land values. This is true because the system was designed to serve an area that was perceived as economically important to the county the continued growth and viability of which was considered to be hampered by overcrowded highways and streets. The existing levels of congestion can be interpreted, to some extent and by proxy, as an indication of high demand i.e., the high levels of traffic congestion indicate an intensity of land use, the more intensive land use implies a valued, or sought after, location, the more highly valued location will theoretically command a higher price.

As mentioned in section 5.1, additional location variables, 'districts', were included in the model in order to control for conditions such as a relatively lower or higher pre-existing market value. Over 94% of the properties that lie within half a mile of an LRT station also lie within the districts 6, 7, 10 and 11. Similarly, 93% of the properties that lie within three quarters of a mile of an LRT station lie within those same districts. A review of the estimated parameters on the district variables shows an average parameter estimate of –0.22 with a spread of approximately ±.36. The parameters on districts 6, 7, 10, and 11, those which are home to so many of the properties in the study that are defined as within ¾ mile of a rail station, are –0.2, -0.29, -0.19 and –0.28 respectively. The minus sign on these parameters means that relative to the omitted district, and controlling for other factors, properties in those districts are valued lower.

Furthermore, each is relatively close to the average parameter estimate (-0.22), two are below, (districts 7 and 11) one almost the same (district 6) and one slightly higher (district 10), suggesting that, controlling for other factors, properties in districts 6,7,and 11 are valued slightly lower or the same as all properties in the county. Properties in district 10, while still valued lower than the omitted district, thus the negative sign, are slightly better than the county average. This suggests that the model controls well enough for the cross-sectional effects, i.e. the question of whether the LRT station areas are simply higher rent districts relative to the county. Extrapolating further, this finding suggests that the observed premium, correlated with proximity to the station is in fact a function of the proximity to the transit system, not simply an artifact of the district value, therefore of the pre-existing, non LRT influenced value.

Figure 7.1 Residual Scatter Plot 100% Sample

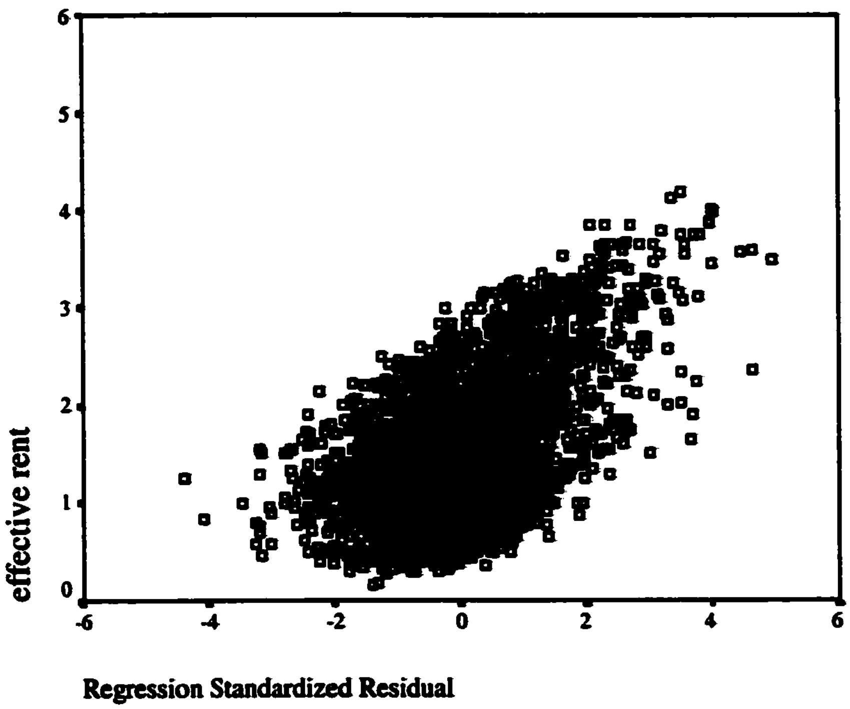
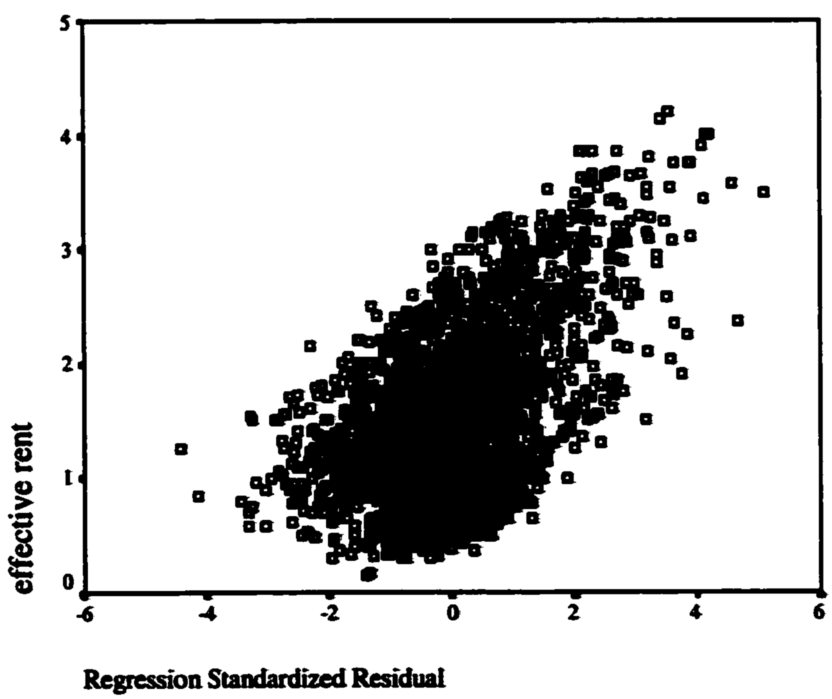


Figure 7.2 Residual Scatter Plot 80% Sample



The pattern of residuals is almost identical for the two versions of this model. But the scatter suggests increasing residuals with higher rents, therefore a potential problem with misspecification or heteroscedasticity. A review of the partial residuals sheds no apparent light on which of the variables may be causing the observed result. But there are some theoretical ideas to explore.

The year indicator variables were expected to capture three effects: inflation (national economic cycle) effects, market pressure (local economic cycle) effects, and the existence or non-existence of the light rail system. To partially unload the year indicators, effective rent is transformed into constant dollars. Also, a rail indicator variable was included, so the year variable has only to account for local market pressure. The pattern of residuals also suggests a non-linear relationship so a log transformation may provide a better fit. Based on these ideas a series of exploratory transformations was conducted to find a better model. The following models estimate effective rent in constant (1982-1984) dollars, the log of effective rent, and the log of effective rent in constant dollars. All of these models are estimated using the 80% sample. The effect of a rail indicator variable is discussed on page 95 and shown in Figure 7.3 which appears on page 96.

Table 7.3 shows the summary statistics for these models, Tables 7.4, 7.5, and 7.6 show the parameter estimates, standard errors, beta coefficients and t-statistics for each model in turn.

Table 7.3. Summary Statistics

Dependent variable:	R	Adjusted R Square	Std. Error of the Estimate	F
Effective rent	0.885	0.781	0.326	307
Effective rent (constant $)	0.857	0.732	0.210	235
Log of rent	0.889	0.788	0.239	321
Log of rent (constant $)	0.862	0.741	0.238	246

Table 7.4. Parameter Estimates: Effective Rent in Constant (1982-1984) Dollars

Variable	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T-Stat
(Constant)	1.0086	0.0711	0	14.2 **
AREA2	0.1407	0.0663	0.0618	2.12 **
AREA3	-0.2887	0.065	-0.1689	-4.44 **
AREA4	0.0078	0.0656	0.004	0.12
AREA5	-0.2102	0.0644	-0.1575	-3.27 **
AREA6	-0.2	0.0646	-0.1489	-3.1 **
AREA7	-0.2939	0.0644	-0.2621	-4.56 **
AREA8	-0.3598	0.0641	-0.3074	-5.61 **
AREA9	-0.1487	0.0778	-0.0282	-1.91 *
AREA10	-0.1922	0.0642	-0.1716	-2.99 **
AREA11	-0.277	0.0657	-0.1674	-4.22 **
AREA12	-0.1218	0.0948	-0.0148	-1.28
AREA13	-0.0045	0.0764	-0.0009	-0.06
AREA14	-0.1084	0.0651	-0.0628	-1.67 *
AREA15	-0.1091	0.0659	-0.0541	-1.66 *
AREA16	-0.4628	0.0977	-0.0531	-4.74 **
AREA17	-0.5875	0.1619	-0.0337	-3.63 **
AREA18	-0.4568	0.0681	-0.1599	-6.7 **
AREA22	-0.1701	0.1232	-0.0138	-1.38
AREA23	0.017	0.0946	0.0021	0.18
AREA24	-0.6005	0.1619	-0.0344	-3.71 **
1986	-0.1597	0.0329	-0.0573	-4.86 **
1987	-0.2213	0.0297	-0.1002	-7.46 **
1988	-0.2542	0.0292	-0.1197	-8.72 **
1989	-0.2298	0.0293	-0.1071	-7.84 **
1990	-0.2665	0.0278	-0.1448	-9.59 **
1991	-0.2658	0.0273	-0.1545	-9.73 **
1992	-0.3615	0.0266	-0.2328	-13.6 **
1993	-0.3928	0.0266	-0.2474	-14.74 **
1994	-0.3784	0.026	-0.2654	-14.57 **
1995	-0.3617	0.0258	-0.2619	-14.02 **
1996	-0.241	0.026	-0.1713	-9.28 **
1997	-0.0145	0.026	-0.0102	-0.56
1998	0.1839	0.0259	0.1337	7.11 **
1999	0.1791	0.0256	0.1365	7.01 **
2000	0.2521	0.0321	0.0969	7.86 **

Table 7.4. Parameter Estimates: Effective Rent in Constant (1982-1984) Dollars (cont.)

Improved space	-0.0073	0.0217	-0.0044	-0.34
New shell	0.1591	0.0281	0.0739	5.67 **
Full service lease	0.4365	0.0092	0.5044	47.66 **
Leased sq. footage	0	0	-0.0181	-1.83 *
Length of lease (months)	0.0019	0.0001	0.1319	13.67 **
Within 1/4 mile	0.0776	0.0139	0.0594	5.57 **
1/4 to 1/2 mile	0.0411	0.0154	0.0261	2.67 **
1/2 to 3/4 mile	0.0062	0.0185	0.0031	0.33

* significant at $\alpha = 0.1$ ** significant at $\alpha = 0.05$ or lower

Table 7.5. Parameter Estimates: Dependent Variable Natural log of Effective Rent

Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T-stat	
(Constant)	0.0711	0.0809	0	0.88	
AREA2	0.1223	0.0755	0.0419	1.62	
AREA3	-0.3389	0.074	-0.1547	-4.58	**
AREA4	-0.0193	0.0747	-0.0077	-0.26	
AREA5	-0.2398	0.0733	-0.1402	-3.27	**
AREA6	-0.257	0.0735	-0.1494	-3.49	**
AREA7	-0.3522	0.0734	-0.245	-4.8	**
AREA8	-0.4445	0.073	-0.2963	-6.09	**
AREA9	-0.1387	0.0886	-0.0205	-1.57	
AREA10	-0.2115	0.0731	-0.1474	-2.89	**
AREA11	-0.3104	0.0748	-0.1464	-4.15	**
AREA12	-0.1955	0.108	-0.0185	-1.81	*
AREA13	0.0035	0.087	0.0006	0.04	
AREA14	-0.1085	0.0741	-0.0491	-1.46	
AREA15	-0.1282	0.075	-0.0496	-1.71	*
AREA16	-0.573	0.1113	-0.0513	-5.15	**
AREA17	-0.8047	0.1844	-0.036	-4.36	**
AREA18	-0.5137	0.0776	-0.1403	-6.62	**
AREA22	-0.1357	0.1403	-0.0086	-0.97	
AREA23	0.083	0.1078	0.0079	0.77	
AREA24	-0.6592	0.1844	-0.0295	-3.57	**
1986	-0.1969	0.0375	-0.0551	-5.26	**
1987	-0.2369	0.0338	-0.0837	-7.01	**
1988	-0.2453	0.0332	-0.0901	-7.39	**
1989	-0.1558	0.0334	-0.0567	-4.67	**
1990	-0.1407	0.0317	-0.0596	-4.44	**
1991	-0.1062	0.0311	-0.0482	-3.41	**
1992	-0.2227	0.0303	-0.1119	-7.36	**
1993	-0.2307	0.0303	-0.1134	-7.6	**
1994	-0.2136	0.0296	-0.117	-7.22	**
1995	-0.1499	0.0294	-0.0847	-5.1	**
1996	0.0538	0.0296	0.0299	1.82	*
1997	0.3471	0.0296	0.1905	11.72	**
1998	0.5554	0.0294	0.315	18.86	**
1999	0.5934	0.0291	0.3529	20.38	**
2000	0.643	0.0365	0.1928	17.6	**

Table 7.5. Parameter Estimates: Dependent Variable Natural log of Effective Rent (cont.)

Variable	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T-stat	
Improved space	-0.0258	0.0247	-0.0122	-1.05	
New shell	0.1569	0.032	0.0569	4.91	**
Full service lease	0.5037	0.0104	0.4542	48.3	**
Leased sq. footage	0	0	-0.0162	-1.84	*
Length of lease (months)	0.0023	0.0002	0.1238	14.43	**
Within 1/4 mile	0.0951	0.0159	0.0568	5.99	**
1/4 to 1/2 mile	0.0748	0.0176	0.0371	4.26	**
1/2 to 3/4 mile	0.0249	0.0211	0.0098	1.18	

* significant at $\alpha = 0.1$ ** significant at $\alpha = 0.05$ or lower

Table 7.6. Parameter Estimates: Natural Log Effective Rent in Constant Dollars

Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T-stat	
(Constant)	-0.0181	0.0807	0.0000	-0.22	
AREA2	0.1223	0.0754	0.0465	1.62	
AREA3	-0.3386	0.0738	-0.1714	-4.59	**
AREA4	-0.0192	0.0745	-0.0084	-0.26	
AREA5	-0.2394	0.0731	-0.1552	-3.27	**
AREA6	-0.2565	0.0734	-0.1653	-3.5	**
AREA7	-0.3521	0.0732	-0.2716	-4.81	**
AREA8	-0.4453	0.0729	-0.3291	-6.11	**
AREA9	-0.1384	0.0884	-0.0227	-1.57	
AREA10	-0.2111	0.0729	-0.1631	-2.9	**
AREA11	-0.3095	0.0746	-0.1618	-4.15	**
AREA12	-0.1935	0.1077	-0.0204	-1.8	*
AREA13	0.0035	0.0868	0.0006	0.04	
AREA14	-0.1083	0.0739	-0.0543	-1.46	
AREA15	-0.1279	0.0748	-0.0549	-1.71	*
AREA16	-0.572	0.111	-0.0567	-5.15	**
AREA17	-0.8043	0.184	-0.0399	-4.37	**
AREA18	-0.5125	0.0774	-0.1553	-6.62	**
AREA22	-0.1356	0.14	-0.0095	-0.97	
AREA23	0.0829	0.1075	0.0087	0.77	
AREA24	-0.6593	0.184	-0.0327	-3.58	**
1986	-0.2177	0.0374	-0.0676	-5.82	**
1987	-0.2913	0.0337	-0.1141	-8.64	**
1988	-0.3428	0.0331	-0.1397	-10.35	**
1989	-0.3013	0.0333	-0.1215	-9.05	**
1990	-0.3302	0.0316	-0.1553	-10.45	**
1991	-0.3386	0.031	-0.1703	-10.91	**
1992	-0.4877	0.0302	-0.2718	-16.15	**
1993	-0.5222	0.0303	-0.2845	-17.25	**
1994	-0.5213	0.0295	-0.3164	-17.67	**
1995	-0.4769	0.0293	-0.2988	-16.27	**
1996	-0.296	0.0295	-0.1821	-10.04	**
1997	-0.0364	0.0295	-0.0221	-1.23	
1998	0.1407	0.0294	0.0885	4.79	**
1999	0.1372	0.029	0.0905	4.72	**
2000	0.1869	0.0365	0.0621	5.13	**

Table 7.6. Parameter Estimates: Natural Log Effective Rent in Constant Dollars (cont.)

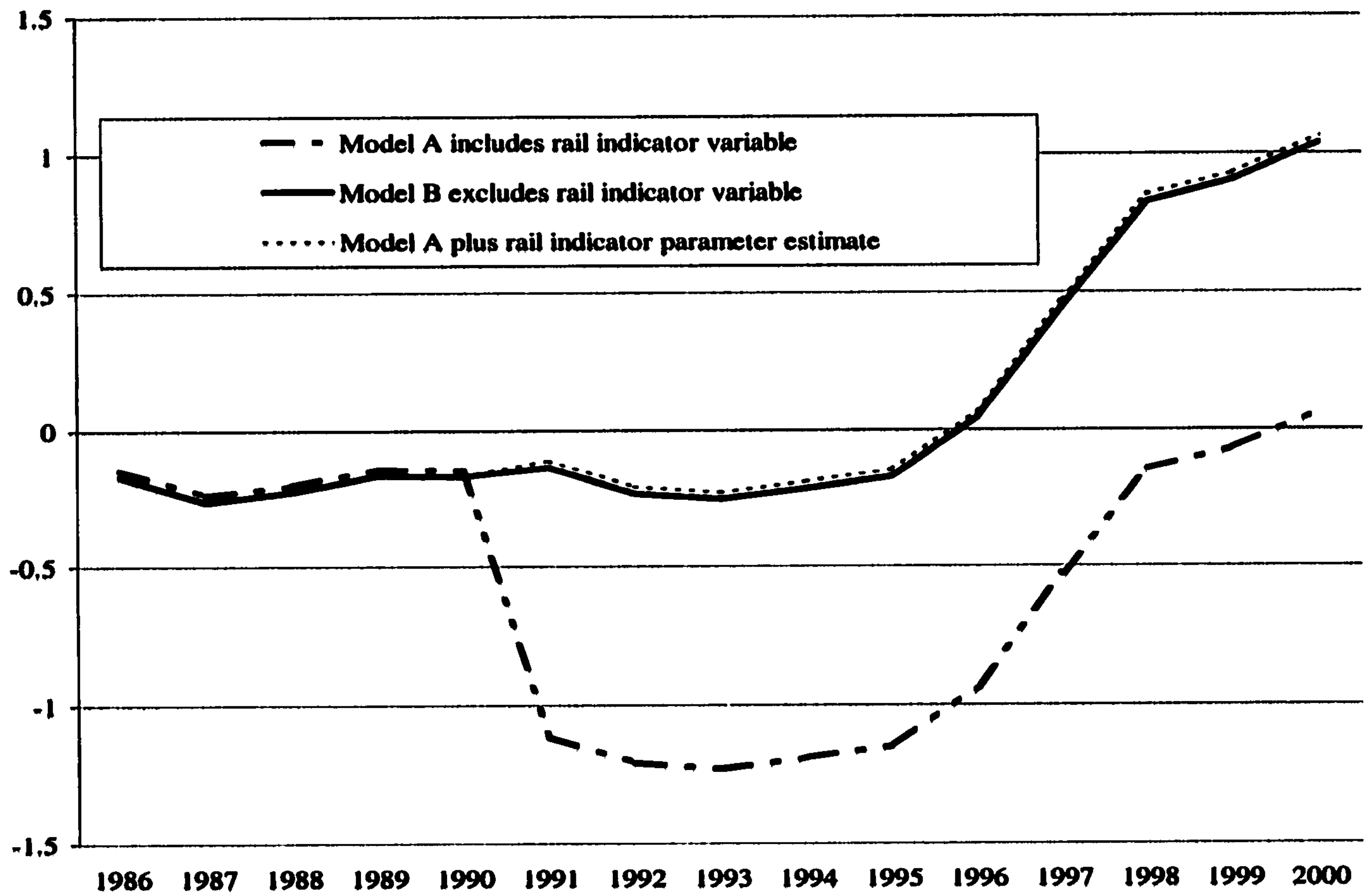
Variable	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T-stat	
Improved space	-0.0256	0.0246	-0.0134	-1.04	
New shell	0.1571	0.0319	0.0631	4.93	**
Full service lease	0.5036	0.0104	0.5035	48.4	**
Leased sq. footage	0	0	-0.0178	-1.84	*
Length of lease (months)	0.0023	0.0002	0.1372	14.46	**
Within 1/4 mile	0.0947	0.0158	0.0627	5.97	**
1/4 to 1/2 mile	0.0743	0.0175	0.0408	4.24	**
1/2 to 3/4 mile	0.0216	0.0211	0.0095	1.03	

* significant at $\alpha = 0.1$ ** significant at $\alpha = 0.05$ or lower

All of the models have explanatory power in a very close range varying from 0.732 to 0.788. The 'goodness of fit' is also highly significant for all models. The patterns of parameter estimates are very similar with the distance variables for 0 to ¼ mile and ¼ mile to ½ mile all showing up as significant at α=0.01. The residual scatter plots for the log models and the constant dollars model differed from the others but showed the same pattern in terms of the model over predicting for higher rents.

The model with the rail indicator variable showed a difference in the parameters on the years indicators and the parameter on the rail indicator was equal to the difference in the year parameters. Otherwise the model was identical to the others, depending on which dependent variable was estimated. This effect is illustrated in Figure 7.3. In addition to these models a model testing the reciprocal of rent was analyzed. This transformation was selected to dampen the effect of over-prediction at the higher rent range. However, the model was rejected because the explanatory power was considerably lower with R^2=0.66, and the pattern of residuals was far less random suggesting an inappropriate model.

Figure 7.3. Year Variable Parameter Estimates: With and Without Rail Indicator Variable



The model results for this group of models are all very similar and so the one that is most appealing *a priori* is selected for further analysis. The model that predicts the log of effective rent without the rail indicator variable is selected for two reasons: First, all the models are tending to over predict prices for higher rent properties, thus the log-linear model is appealing. Second, using a single variable as a proxy for three effects is likely to produce biased estimates. As previously noted using constant dollars removes the inflation effects; as adding the rail indicator does not affect the model it adds additional specification without gaining additional information.

While a weighted least squares model could be developed, ultimately problems of heteroscedasticity were dismissed. The pattern of residuals shows over prediction as the dependent variable increases but it does not suggest increasing variance. Finally, the model is run without including the non-significant variable indicating improved space. The other non-significant variables are retained as they are parts of series whose integrity should be maintained.

Table 7.7. Final Parameter Estimates: Natural Log Effective Rent in Constant Dollars

Variable	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T-stat	
(Constant)	-0.0467	0.0771	0	-0.61	
AREA2	0.1196	0.0752	0.0454	1.59	
AREA3	-0.3366	0.0737	-0.1704	-4.56	***
AREA4	-0.0213	0.0744	-0.0093	-0.29	
AREA5	-0.2413	0.073	-0.1564	-3.31	***
AREA6	-0.2517	0.0733	-0.1622	-3.44	***
AREA7	-0.3412	0.0732	-0.2632	-4.66	***
AREA8	-0.447	0.0727	-0.3304	-6.15	***
AREA9	-0.1407	0.0882	-0.0231	-1.59	
AREA10	-0.2105	0.0728	-0.1626	-2.89	***
AREA11	-0.3013	0.0746	-0.1575	-4.04	***
AREA12	-0.1926	0.1075	-0.0203	-1.79	*
AREA13	0.0015	0.0866	0.0003	0.02	
AREA14	-0.1098	0.0738	-0.0551	-1.49	
AREA15	-0.1288	0.0747	-0.0553	-1.72	*
AREA16	-0.5725	0.1109	-0.0568	-5.16	***
AREA17	-0.7997	0.1837	-0.0397	-4.35	***
AREA18	-0.5024	0.0774	-0.1522	-6.49	***
AREA22	-0.1367	0.1398	-0.0096	-0.98	
AREA23	0.0809	0.1073	0.0085	0.75	
AREA24	-0.6655	0.1837	-0.033	-3.62	***
1986	-0.2177	0.0373	-0.0676	-5.83	***
1987	-0.2911	0.0337	-0.114	-8.65	***
1988	-0.3422	0.0331	-0.1394	-10.34	***
1989	-0.3029	0.0333	-0.1221	-9.11	***
1990	-0.3296	0.0316	-0.155	-10.45	***
1991	-0.3338	0.031	-0.1678	-10.76	***
1992	-0.4835	0.0302	-0.2695	-16.03	***
1993	-0.5172	0.0302	-0.2818	-17.11	***
1994	-0.5138	0.0295	-0.3118	-17.41	***
1995	-0.4715	0.0293	-0.2954	-16.11	***
1996	-0.2908	0.0295	-0.1789	-9.87	***
1997	-0.0311	0.0295	-0.0189	-1.05	
1998	0.1444	0.0293	0.0908	4.92	***
1999	0.1435	0.029	0.0946	4.94	***
2000	0.1941	0.0365	0.0646	5.32	***

Table 7.7. Final Parameter Estimates: Natural Log Effective Rent in Constant Dollars (cont.)

Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T
New shell	0.1872	0.0219	0.0752	8.57 ***
Full service lease	0.5036	0.0104	0.5035	48.47 ***
Leased sq. footage	0	0	-0.0176	-1.81 *
Length of lease (months)	0.0023	0.0002	0.1382	14.66 ***
Within 1/4 mile	0.0849	0.0161	0.0563	5.28 ***
1/4 to 1/2 mile	0.0639	0.0178	0.0351	3.6 ***
1/2 to 3/4 mile	0.0104	0.0213	0.0046	0.49
3/4 to 1 mile	-0.1062	0.032	-0.0293	-3.32 ***

*** significant at $\alpha = 0.01$ ** significant at $\alpha = 0.05$ * significant at $\alpha = 0.1$

7.2 Distance Gradient

All of the models estimated indicate that there is a distinct rental premium associated with proximity to rail and that the premium is decreasing as distance increases. This section looks at an additional model that helps to elucidate the continuous relationship. The model is similar in functional form to the one specified in Table 7.7. The difference is that the distance band indicator variables are replaced with a series of stepped, or piecewise continuous distance variables.

The results from the piecewise model are similar to the base model. The explanatory power and the goodness of fit measures are almost the same. The parameter estimates, displayed in Table 7.8, are very similar to those of the base model but the piecewise variable suggests a very interesting result. At first blush and without the information provided by the other model, the fact that the parameter estimate for the first distance band is not statistically significant, might suggest that there is no measurable benefit of being close to rail. However, the correct interpretation of a variable's lack of statistical significance is that it is not statistically different from 0, thus corresponding to a 0 slope.

This model tells us that, holding the other factors constant, properties within ¼ mile of the LRT station are valued similarly. Between ¼ and ½ mile and between ½ and ¾ mile there are negatively sloped gradients which means that property values are decreasing, albeit at two different rates, after ¼ mile. Finally, after ¾ mile there is no longer any effect. This pattern is illustrated in Figure 7.4, which shows a flat line between 0 and ¼ mile a negative slope from ¼ to ¾ miles with a break at ½ mile and a flat line beyond ¾ mile.

Table 7.8. Natural Log Effective Rent in Constant Dollars: Piecewise Distance

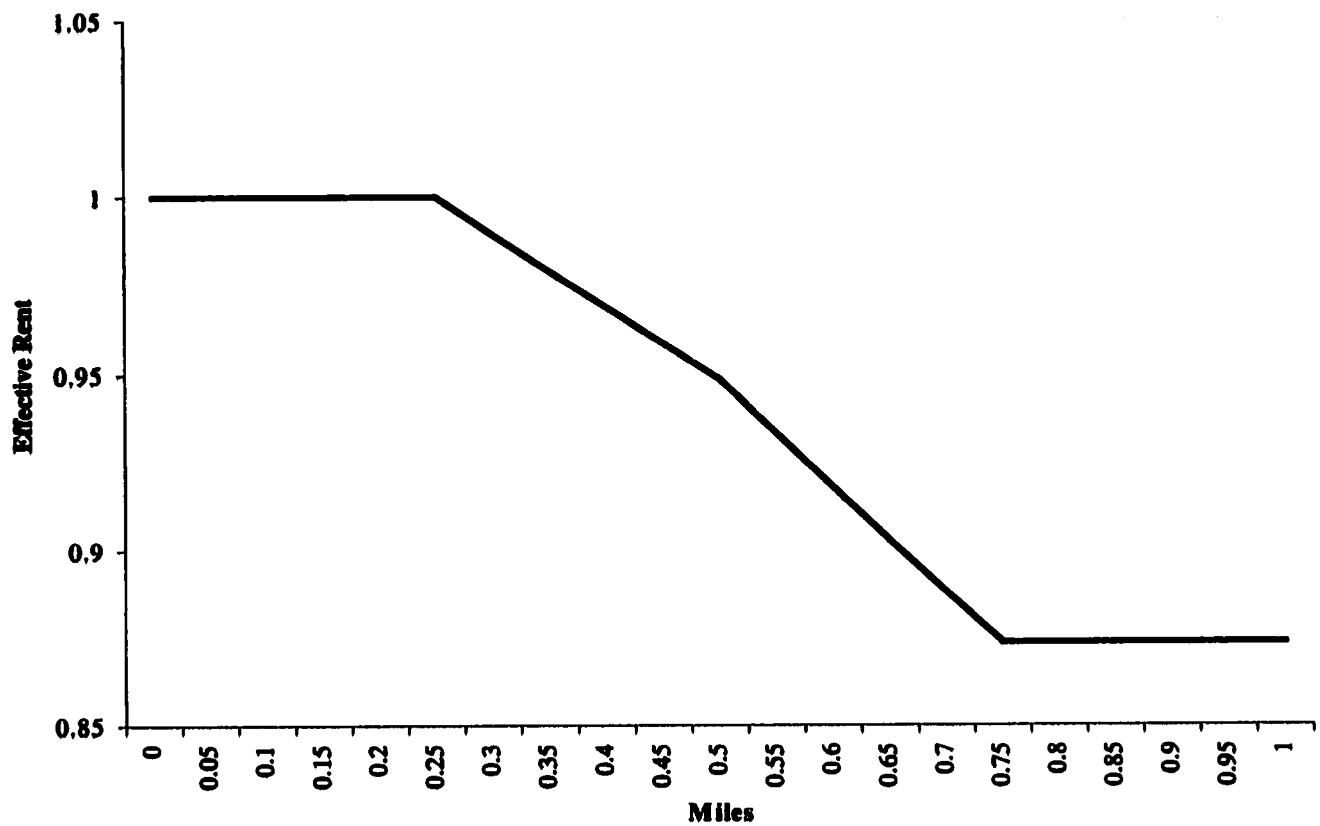
Variable	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	
(Constant)	-0.0443	0.0772	0	-0.57	
AREA2	0.1194	0.0754	0.0453	1.58	
AREA3	-0.339	0.0739	-0.1716	-4.59	***
AREA4	-0.0217	0.0745	-0.0095	-0.29	
AREA5	-0.2413	0.0731	-0.1564	-3.3	***
AREA6	-0.2525	0.0734	-0.1627	-3.44	***
AREA7	-0.3447	0.0733	-0.2659	-4.7	***
AREA8	-0.4468	0.0729	-0.3303	-6.13	***
AREA9	-0.1409	0.0884	-0.0231	-1.59	
AREA10	-0.2103	0.0729	-0.1625	-2.88	***
AREA11	-0.3064	0.0747	-0.1602	-4.1	***
AREA12	-0.1951	0.1077	-0.0205	-1.81	*
AREA13	0.0001	0.0868	0	0	
AREA14	-0.1103	0.0739	-0.0553	-1.49	
AREA15	-0.1298	0.0749	-0.0557	-1.73	*
AREA16	-0.5697	0.1111	-0.0565	-5.13	***
AREA17	-0.8062	0.184	-0.04	-4.38	***
AREA18	-0.5071	0.0775	-0.1536	-6.54	***
AREA22	-0.1377	0.14	-0.0097	-0.98	
AREA23	0.0801	0.1075	0.0084	0.74	
AREA24	-0.6654	0.184	-0.033	-3.62	***
1986	-0.2193	0.0374	-0.0681	-5.86	***
1987	-0.2913	0.0337	-0.1141	-8.64	***
1988	-0.3426	0.0332	-0.1396	-10.33	***
1989	-0.3052	0.0333	-0.1231	-9.17	***
1990	-0.3317	0.0316	-0.1559	-10.49	***
1991	-0.2771	0.0392	-0.1394	-7.07	***
1992	-0.4244	0.038	-0.2366	-11.18	***
1993	-0.4597	0.0382	-0.2505	-12.03	***
1994	-0.4594	0.038	-0.2789	-12.09	***
1995	-0.414	0.0376	-0.2594	-11	***
1996	-0.2327	0.0378	-0.1432	-6.16	***
1997	0.0266	0.0377	0.0162	0.71	
1998	0.2029	0.0375	0.1276	5.41	***
1999	0.2005	0.0372	0.1322	5.4	***
2000	0.2486	0.0437	0.0827	5.69	***

Table 7.8. Natural Log Effective Rent in Constant Dollars: Piecewise Distance (cont.)

Variable	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	
New shell	0.1826	0.0218	0.0734	8.36	***
Full service lease	0.5055	0.0104	0.5054	48.52	***
Leased sq. footage	0	0	-0.0167	-1.72	*
Length of lease (months)	0.0023	0.0002	0.139	14.73	***
Within 1/4 mile	0.1467	0.1301	0.0327	1.13	
1/4 to 1/2 mile	-0.2106	0.1204	-0.0522	-1.75	*
1/2 to 3/4 mile	-0.3303	0.1518	-0.0851	-2.18	**
3/4 to 1 mile	0.1498	0.116	0.0394	1.29	

*** significant at $\alpha = 0.01$ ** significant at $\alpha = 0.05$ * significant at $\alpha = 0.1$

Figure 7.4. Rent Gradient



7.3 Distance to Highways

The above models have not taken account of the accessibility benefit of highway access. In the following section the base model is modified by the addition of a highway access variable. The first variation attempted included a continuous distance variable for all properties in the sample. Inclusion of the continuous distance to a highway ramp does not increase the explanatory power of the model, the parameter estimate on this variable is not significant and the detailed results have therefore been omitted. The County is well served by freeway access points and no property in the sample is farther than 3.3 miles from a freeway or highway ramp.

Next, a series of highway access indicator variables was developed and then a piecewise distance variable for highway access. The break points for these variables are at 1 mile increments with the finally band representing the remaining 0.3 miles.

The parameter estimates from the model with the indicator variables are shown in Table 7.9. To best present the results some of the non-significant area variables have been deleted from the table. Addition of the highway access variable does not improve the model, nor does it affect the model in any substantial way. Only the most distant band is significantly different from zero, suggesting that there is a price penalty on property that is more than three miles from a highway access point. Likewise in the piecewise model the first three piecewise variables are not significant.

It seems likely that the ubiquitous nature of freeway access, seldom more than 8 minutes away at 25mph, makes it difficult to assign any particular advantage. Almost all properties in the County seem to benefit equally from the existing high level of highway accessibility.

Table 7.9. Parameter Estimates Effects of Highway Access

Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T-stat	
(Constant)	-0.0217	0.0787	0	-0.28	
AREA3	-0.3512	0.0739	-0.1777	-4.75	***
AREA5	-0.2528	0.0731	-0.1639	-3.46	***
AREA6	-0.2642	0.0734	-0.1702	-3.6	***
AREA7	-0.3529	0.0733	-0.2723	-4.81	***
AREA8	-0.4549	0.0727	-0.3362	-6.25	***
AREA10	-0.2281	0.073	-0.1762	-3.12	***
AREA11	-0.3212	0.0749	-0.168	-4.29	***
AREA12	-0.214	0.1077	-0.0225	-1.99	**
AREA14	-0.1238	0.0739	-0.0621	-1.68	*
AREA15	-0.1454	0.0749	-0.0624	-1.94	*
AREA16	-0.5869	0.1109	-0.0582	-5.29	***
AREA17	-0.8216	0.1838	-0.0408	-4.47	***
AREA18	-0.5187	0.0775	-0.1571	-6.69	***
AREA24	-0.689	0.1848	-0.0342	-3.73	***
1986	-0.2172	0.0374	-0.0675	-5.81	***
1987	-0.2913	0.0337	-0.1141	-8.66	***
1988	-0.3412	0.0331	-0.139	-10.32	***
1989	-0.3022	0.0333	-0.1219	-9.09	***
1990	-0.3287	0.0315	-0.1545	-10.42	***
1991	-0.3341	0.031	-0.168	-10.77	***
1992	-0.4828	0.0301	-0.2691	-16.02	***
1993	-0.5175	0.0302	-0.282	-17.12	***
1994	-0.5138	0.0295	-0.3119	-17.42	***
1995	-0.4714	0.0293	-0.2954	-16.11	***
1996	-0.2906	0.0294	-0.1788	-9.87	***
1997	-0.031	0.0295	-0.0189	-1.05	
1998	0.144	0.0293	0.0906	4.91	***
1999	0.1435	0.029	0.0946	4.94	***
2000	0.1934	0.0365	0.0643	5.3	***

Table 7.9. Parameter Estimates Effects of Highway Access (cont.)

Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T-stat	
New shell	0.1859	0.0219	0.0747	8.47	***
Full service lease	0.5026	0.0104	0.5025	48.1	***
Leased sq. footage	0	0	-0.0162	-1.67	*
Length of lease (months)	0.0023	0.0002	0.1378	14.61	***
LRT within 1/4 mile	0.0853	0.0163	0.0565	5.24	***
LRT 1/4 to 1/2 mile	0.0639	0.018	0.0352	3.55	***
LRT 1/2 to 3/4 mile	0.0104	0.0214	0.0046	0.49	
LRT 3/4 to 1 mile	-0.1044	0.0321	-0.0289	-3.25	***
Hwy 0 to 1 mile	-0.0056	0.0212	-0.0033	-0.26	
Hwy 1 to 2 mile	0.0384	0.029	0.0214	1.32	
Hwy 2 to 3 mile	-0.0121	0.0417	-0.0034	-0.29	
Hwy 3 to 3.3 mile	-0.034	0.0152	-0.0345	-2.24	**

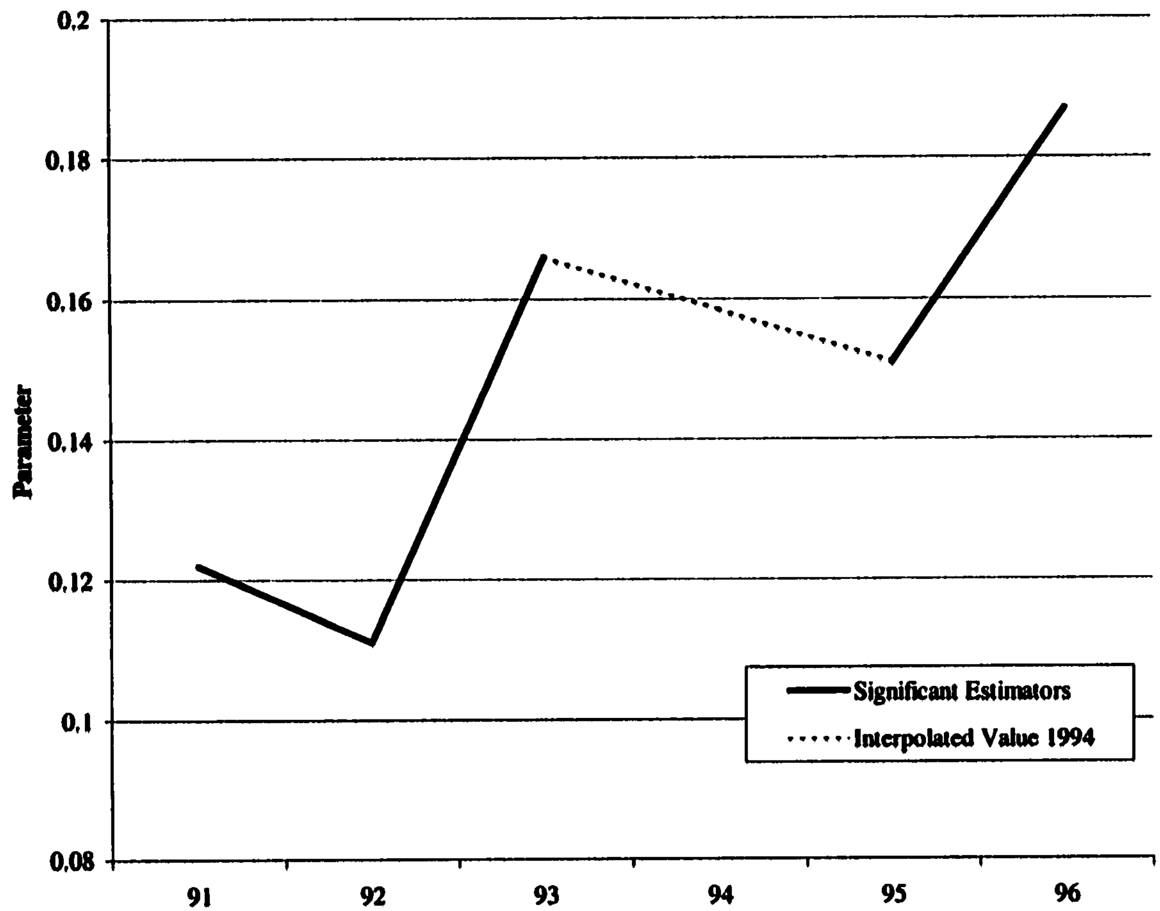
*** significant at $\alpha = 0.01$ ** significant at $\alpha = 0.05$ * significant at $\alpha = 0.1$

7.4 Effects of Time and Distance on Property Value

In the next group of models the log of rent in constant dollars is also used as the dependent variable but a different model is estimated for each year. This approach is expected to provide some insight regarding the change in value of the distance parameters. Initially, ten models were estimated, one for each year beginning with 1991 and ending with 2000.

The stratification left insufficient observations to provide meaningful results for all the parameters in all the years. However some interesting information did emerge. The focus of this section is limited to the parameter estimates on the first two distance band indicator variables. Neither independent variable, 0 to ¼ and ¼ to ½ mile distance indicators, was statistically significant for the 1997, 1998, 1999, or 2000 model. The parameter estimate on the first band was significant in all the earlier years except for 1994, this value was interpolated for the graph in Figure 7.5. The parameter estimate is clearly showing an increasing trend, suggesting that as the system matures it proves itself as an economic asset. However, the insignificance of parameter estimates beyond 1997 warrants additional investigation.

Figure 7.5. Parameter Estimate 0 to ¼ Mile Distance Band: 1991-1996



In another attempt to understand the effect of time the observations were aggregated and re-stratified to create three models covering three year periods: 1992-1994; 1995-1997; 1998-2000. The parameter estimates on the distance variables in the first two models, 1992-1994 and 1995-1997 were all significant ($\alpha = 0.01$) and increasing across the models. In the 1998-2000 model, the parameter on the first distance band was also significant ($\alpha = 0.1$), but at a lower level, and the rent premium was somewhat smaller than in the earlier years. Table 7.10 shows the parameter estimates from the models and their effects on effective rent. The premiums shown are relative to other properties in the same subset of years rather than relative to other years. A property within ¼ mile of a transit station would lease in 1993 for 13.8% more than other properties leased in the County in that year, if it were leased in 1997 it would command a 14.6% premium but only 5.2% in 1998.

Table 7.10. Time Series Parameter Estimates on Distance to Transit Variables

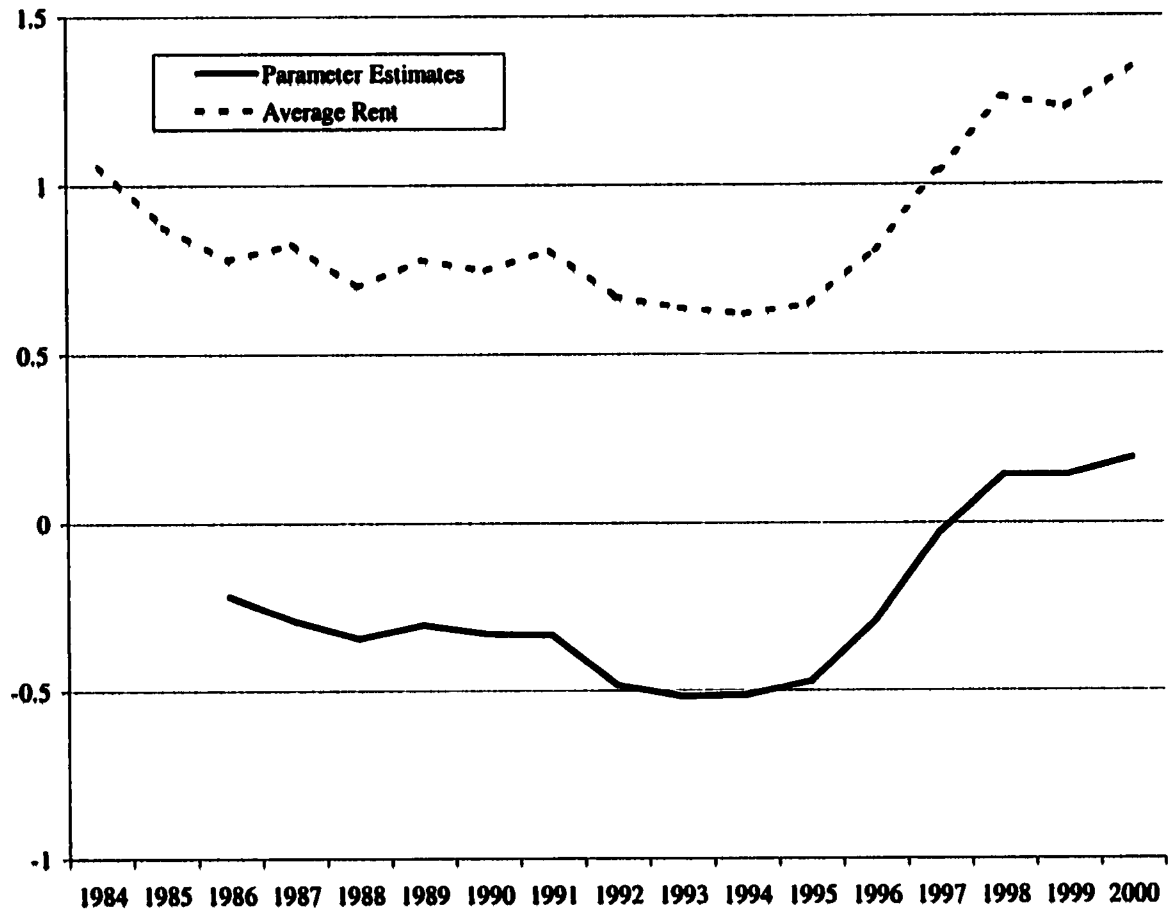
Model	Parameter on		Effect on rent (e^{β})	
	0 to ¼ mile	¼ to ½	0 to ¼ mile	¼ to ½
1992-1994	.13***	0.09***	13.8%	9.4%
1995-1997	.146***	0.11***	14.6%	11.6%
1998-2000	.051*	Not Significant	5.2%	none

*** significant at $\alpha = 0.01$
* significant at $\alpha = 0.1$

To examine this model result in context, we must recall the trend in average effective rents for the County. As was shown in Section 5, Figure 5.3, effective rents began to increase dramatically in 1997. For convenience, this trend is re-illustrated in

Figure 7.6 along with a line representing the 'year' parameter estimates from the base model. Given the apparent increase in market pressure measured by increased rents and increased number of transactions throughout the County, it seems plausible that property owners throughout the County were able to capitalize on the market pressure and all the rents were driven up. During the earlier period where rents were stable or declining, the properties with transit accessibility appear to have held additional value.

Figure 7.6. Average Annual Effective Rent & Model Parameter Estimates



7.5 Comparison Using Holdout Sample

Ultimately, while the different models provided different insight into the effects of transportation infrastructure on property values in the County, compared with the base model variants, none provided additional explanatory power. The final part of this analysis returns to the four models discussed in the first section of this chapter and tests how well each predicts the rental values of the holdout sample. To do this, 'predicted' rents are calculated based on the statistically significant parameter estimates for each model and then a bivariate regression is run on each to see how well the predicted rent compares to the actual rent. Table 7.11 shows these prediction results.

Table 7.11. Comparison of Base Models to Holdout Sample

Variable	Parameter	R^2	S.E.E
Effective Rent	1.000	.789	.3181
Effective Rent Constant $	0.992	.737	.2055
Log of Effective Rent	1.000	.780	.2456
Log of Effective Rent (constant $)	0.987	.730	.2437

All the models perform reasonably well. Ironically, the model with the most theoretical appeal proves to be the poorest performer. The estimator of log of effective rent in constant dollars has the lowest R^2 at 0.730 and a middle range standard error (s.e.e.). The model with the least theoretical appeal, that predicting effective rent, has the highest R^2 but also the highest standard error, therefore the widest variation of residuals. Based on these results it seems the best overall model predicts the natural log of effective rent in current dollars.

8 Summary and Conclusions

The research presented here represents an addition to the existing literature on transportation investment and property values. Using a dataset of negotiated lease transactions for commercial office space that spans 16 years, several models were developed and tested to better understand how the real estate market in Santa Clara County responded to public investment in a public transportation system. The longitudinal and cross-sectional nature of the data allowed for comparisons of property values over time and geography. The study uses data from five years prior to the system's opening and ten years after, allowing a measure of the 'before' conditions and adequate time for the market to restabilize after the disruption caused by the system's introduction. The cross-sectional data permits an analysis of comparable properties across space. The longitudinal analysis helps to demonstrate changes as the system matured and effects of differing market pressure. The development of several hedonic model specifications showed that the best theoretical model is not necessarily the one that best fits the empirical data.

The purpose of this research was to understand the relationship between proximity to light rail stations and commercial property value. The null hypothesis is that there is no market valuation of proximity to light rail. The research design allowed for a series of statistical models that examine the question from a variety of angles and the analysis demonstrates that this hypothesis should be rejected and that the presence of the light rail system in Santa Clara County is associated with a rental premium on office properties that lie within an important part of its catchment or service area. A property value premium is inferred from the rent premium based on the theory that an asset has increased value if it has increased potential for profit.

The basic results indicate that after controlling for factors such as length and type of lease, building improvements, regional and local economic cycles, and location, properties that lie within ½ a mile of a light rail station command a higher lease rate than other properties in the County. Variations on the model controlled for highway access and effects over time. In every model the transit proximity premium was shown to exist and decrease with distance. When controlling for highway access, the rail proximity benefit was maintained and it was shown that highway coverage in the County is adequately dense that there are no particular locational advantages associated with that coverage. Looking at the effect over time it appears that in a more stable market, as the light rail transit system matured, its value was more widely recognized. However, it also appears that during a time of more extreme market pressure and activity, rental rates for property beyond the light rail catchment area came closer to properties within.

These results pertain only to the case study of Santa Clara County. As such, it would be presumptuous to make broad policy decisions on their basis alone. The results indicate a property value / rent benefit associated with public transportation. Assuming that studies of other areas yield similar results we can move beyond the statistical results and examine the implications for the planning and policy making community.

First, while increased property value is not the only measure of a successful transportation project it is a strong indicator. If the additional accessibility does not afford a measurable advantage, we might infer that nothing is added and that the project is therefore of questionable merit. Second, if there is a profit advantage to owners of property within ¾ miles of a light rail station, consideration of additional (severance) damages is not indicated in the cost benefit calculus for such a project. In the Santa Clara County case, it seems apparent that the positive externality for commercial property outweighs any nuisance effect. This is borne out in the current study as well as in studies reviewed in Chapter 3.

Third, several studies of residential property have shown a complex relationship between value and distance from rail. The evidence suggests that properties that abut or are within a short distance (e.g. several 100 feet) of rail are likely to suffer a price penalty. For the commercial properties studied here, however, adjacency is as highly valued as proximity and in fact, there is little difference in value among the properties that lie within ¼ of a mile of a rail station.

Fourth, the results add some insight into the question of transportation investment as a tool for shaping the development landscape. While in this case the area around the light rail system was rezoned for higher density this research has not looked at that type of development effect. Nor has it attempted to see if development dollars were redirected to the LRT catchment area rather than being expended elsewhere in the County or region. The results do not directly reveal patterns of development but they demonstrate that there is a greater profit potential within ¾ miles of the LRT stations. The theoretical argument can be easily made though: if the market will bear higher prices in an area it is a declaration that consumers believe they are receiving higher value due to the transit accessibility. The greater profit potential in turn makes that area more desirable for development.

If it continues to be demonstrated that transportation infrastructure investment can help to attract development within its catchment area, that the positive externality is consistent and outweighs the nuisance effect and that there is a positive economic gain that accrues to private property owners, the final policy implication involves the consideration of value capture, particularly as a means to fund or finance the LRT construction or operation. One method is to create a direct value capture tax assessment within the LRT's expected catchment area. The downside of this approach is that the development community has not necessarily embraced the idea that there is an advantage, and business decisions are often made in relatively short time-frames; the additional assessment diminishes that advantage or distributes additional risk, thus discouraging or counteracting the desired development outcome. Alternatively, if transportation improvements are funded from general funds the increased property taxes on increased value may satisfy the value capture. This is a more difficult mechanism to implement, particularly in California where Proposition 13 effects are keenly felt and additional assessments are made only when property changes hands. Furthermore, the improvements are likely to be funded only in part by general funds and it would be difficult to direct the increased taxes toward promoting the transportation agenda.

The most promising direction would be to implement tax increment financing (TIF) to leverage the expected tax increase for bond sales thus facilitating the LRT construction. In this scenario the TIF uses the projected future growth in property tax revenues generated within a redevelopment area to finance the redevelopment project itself. The projected revenue stream from the increase in property tax assessments that results from project development serves as collateral for the issuance of tax-exempt bonds. The city can issue tax allocation bonds, in which the future tax increment is pledged as security against the public debt, with no obligation to repay if anticipated tax yields do not materialize; or cheaper lease revenue bonds, in which the city undertakes a direct obligation to make the payments.

Light rail transit can be a valuable complement to an existing transportation system. Studies to date of LRT effects on residential property values have relatively consistently demonstrated a positive value transfer. Studies of LRT effects on commercial property have been equivocal and have not offered a foundation of evidence that supports the value of this added transportation capacity. With the evidence presented here, as more systems are proposed and constructed throughout the country, planners can more comfortably attest to the potential benefits, more effectively respond to damage claims such as the ones brought in Santa Clara, and can seek new ways of leveraging the expected increases in property tax due to the increased accessibility provided by the additional transportation infrastructure.

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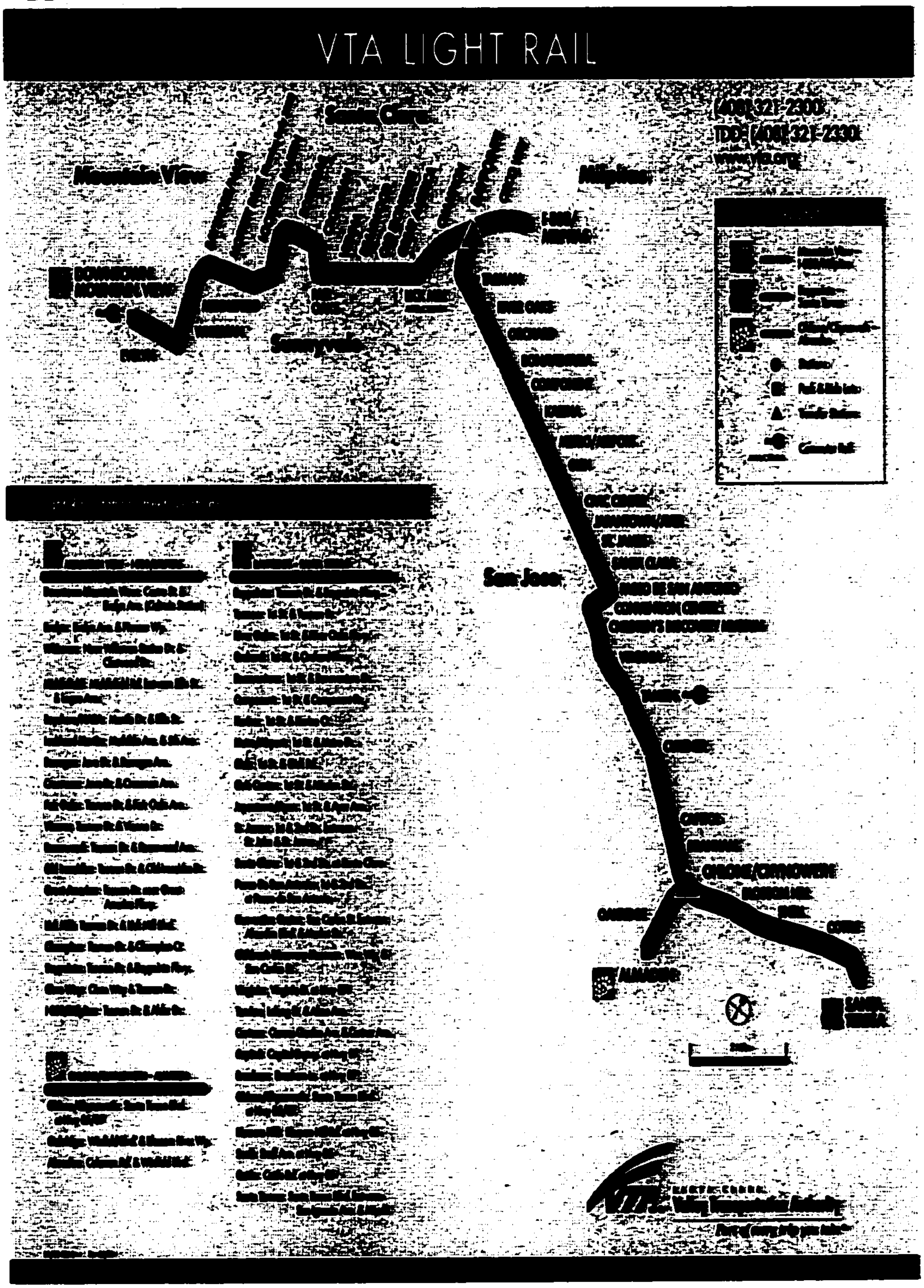
Appendix A


VTA LIGHT RAIL
(408) 321-2300
TDD: (408) 321-2330
Mountain View
San Jose

Appendix B

A&M Homes

A.D.N. Corporation

A.J. Callo

Aetna Property Services

Aldrich Eastman Waltch

AMB Properties

American Realty Advisors

Bailey Farms

Bank of America

Barry Swenson Builders

Bedford Property Investors

Berg & Berg

BRE Properties

Cabot Partners

California Federal S&L

California Property Services

Callahan Property Company

Catellus Development Corp.

CBBS Investments

Cigna Real Estate

Citation Homes

Citibank

Citicorp Investment

Geomax

Gibson Speno Developers

Glenborough Corporation

Greenbriar Development

GSIC Realty Corporation

Hagstrom Realty Company

Hillsdale Development Company

Home Federal Savings Bank

Hunter Properties

Imwalle & Stegner

Insignia O'Donnell Commercial Group

J.E. Robert Companies

Jackson-Shaw Company

JMA Properties

John Hancock Life Insurance

Jules Duc Construction

Karsten Realty Advisors

Kaufman & Broad

Keenan Land Company

Kimball Small Properties

Koll Company, The

Oakwood Financial Service

Opus Southwest, Inc.

Orchard Properties

Pacific Rim Financial

Pacific West Investment Group

Paulsen Properties

Pearlman Joint Ventures

Peery and Arrillaga

Pelio & Associates

Pell Development Company

Perini Investment Properties, Inc.

Principal Financial Group

Principal Mutual

Prometheus Development Co.

Providian Life Company

Prudential Development Group

Pruneyard Towers

Pulte Home Corporation

R&B Realty Group

Renco Properties, Inc.

Resolution Trust Corporation

Robert Wheatley Properties

Management
Cochrane Business Ranch
Compass Management &
Leasing
Cooperage Development Co.
CRI Properties
Crocker Properties
DDD W-S Partnership
Dell Investors
Denholm Harris & Co.
Devcon Construction, Inc.
Dewey Land Company
E.A. Hathaway & Company
Emerson Trust
Equitable Real Estate
Investment
Ferari Development Company
Firemans Fund
First City California
First Interstate Bank
Fortune Trade Associates
Freestone Properties
Garlock & Company
GE Capital Investment
Advisors, Inc.

Kontrabecki Group, Inc.
Lafayette Properties
Lewis Road Investors
Lincoln National Investment
Mgmt. Co.
Lincoln Property Company
Longmeadow Development Co.
Marchese Family Trust
Mars Equities, Inc.
Mattison and Shidler
Maxim Investments
McCandless Companies
McMorgan & Company
Metropolitan Life Insurance
Company
Mission Peak Company
Morgan Hill Industrial Partners
Mutual of New York (MONY)
Noble Properties
North American Building
Management
North Block Partnership
O'Donnell Group
Oakwood Cranbrook Joint
Venture

RREEF Funds, The
Sarofim Investors Realty Fund
Security Capital Industrial
Security Pacific
Silicon Valley Diversified
Sobrato Development
Companies
South Bay Construction & Dev.
Co.
Spieker Partners
Summerhill Development Corp.
Teachers Insurance
Terrence J. Rose, Inc.
Toeniskoetter & Breeding, Inc.
Trammel Crow Company
Trinity Investment Company
Union Pacific Realty
W. Leslie Pelio & Associates
WDT Development
Wells Fargo Asset Management
Co.
Western Federal Savings
William Wilson & Associates
Wolff Sesnon Buttery White

A.G. Edwards & Sons, Inc.
Accolade, Inc.
Adept Technology
ADEX Corporation
Adidas U.S.A.
Adobe Systems
Advanced Business Solutions
Advanced Vision Research
Advansoft Research
Corporation
AIO Microservice
Alantec Corporation
Alcatel, N.V.
All American Semiconductor,
Inc.
Alliance Semiconductor
Allied Container Corp.
Allstate Insurance
Alpha-Graphics
Alphatec Electronics
Alphatec Group
Amdahl Corporation
American Kotobuki Electric
Amfac Distribution Corp.
Analog Devices, Inc.

General Electric Company
General Electric Plastics
Division
General Motors
Gibraltar Moneycenter
Glico Harmony Foods
Corporation
Granny Goose Corporation
GTE Government Systems
Guardian Insurance
Guzik Technical Enterprises
Hal Computer
Hello Direct
Hewlett-Packard
Hitachi America, LTD.
Hitachi Kinzoku
Hitachi Metals
HMT Technology
Hyundai Electronics of
America
IBM
ICI Array Technology
IDEC Corporation
ILS Mortgage
Image Quest Technology

Power Up! Software Corp.
Powernet Systems, Inc.
Premier Industries, Inc.
Premisys Communications,
Inc.
Progressive Insurance
Public Defenders Office
Pulte Homes
Quadra Graphics
Quantum Corporation
Quintel Corporation
Ra-Tek Precision Sheetmetal
Radius, Inc.
Rand McNally
Raycon Industrial
Read-Rite Corporation
Recyclable Container Corp.
Reed, Elliott, Creech & Roth
Ricoh Corporation
Rohm Corporation
Rolm, Inc.
Rosendin Electric, Inc.
Ross Systems
Royal Crown/Canada Dry
Safeway Stores

Anchor Technology
Anderson Soft-Teach
Anthem Electronics
Apple Computer, Inc.
Applied Data
Communications
Applied Signal Technology
Arthur Andersen & Co.
AT&T Information Systems
Atari Games
Atmel Corporation
Austec International
Autodesk
Automation Technology
Axiom Technology
Corporation
Baker Hughes, Inc.
Ballard Medical Products
Bank of America
Becton Dickinson Company
Bekins Moving & Storage
Beneficial Mortgage
Bermo, Inc.
Borland International
Bromar
Brookland Financial Corp.

InfoCorp
Information Processing
Techniques
Ingram Micro
Intertech Communications
ITT
J & S Distribution
J.C. Paper Company
J.C. Penney`s
JD Distributors
JSR Microelectronics
JVD, Inc.
Kawasaki
Kidsoft
Kimtron
King Bearing, Inc.
KPMG Peat Marwick
Levy, Greenfield & Davidoff
Lifescan
Lightwave Electronics
LindsayÕs Contract Furniture
Lite-On
Litton Industries, Inc.
Lockheed Missiles & Space
Co.
Logical Design

Samsung Electronics
San Jose Cleveland Ballet
San Jose Mercury News
San Jose Police Officers
Assoc.
San Jose Symphony
Sanmina Corporation
Santa Clara Warehouses
Santa Cruz Operation
Sanyo Business Systems
Sausedo Metal Products
Schlage Electronics
Schlumberger Technologies
Science Application
Scotts Valley Group, Inc.
Seagate Magnetics
Seagate Technology
Semi Gas Systems
Sentinel Technologies
Siemens Rolm Corporation
SIIG, Inc.
Skyway Freight Systems, Inc.
Smart Modular Technology
Snelling & Snelling
SOCS Research, Inc.
Softcom, Inc.

Brooks Technical Group
BTI Computer Systems
BTU Engineering Corp.
Burke Industries
CADAM, Inc.
Cadence Design Systems
California Insurance Group
California Keyboard
Company
California Microwave, Inc.
Cardiometrics, Inc.
Centigram Communications
Century Data Systems
Chase Manhatten Bank
Chemical Waste Management
Circuit Works, Inc.
Cirpro Technology, Inc.
Cirrus Logic
Citation Homes
Citation Insurance
Clarify, Inc.
CM Lee & Company
Coast Commercial Bank
Coffee Service Co.
Collagen Corporation
Compro Insurance Services

Logitech, Inc.
Loral Aerospace
LSI Logic
M.E.Fox & Company
Macrovision
Martec International
Mathews & Clark
Maximum Strategy
Medasonics, Inc.
Mektec Corporation
Memorex Corporation
MenÕs Wearhouse
Menlo Industries, Inc.
Mentor Graphics Corp.
Metagraphics
Micro Chassis
Micro Linear Corporation
MicroClean
Microelectronics Technology
Microland Electronics Corp.
Micronics
MicroUnity Systems Eng,,
Inc.
MIPS Computers
Mission Communications
Systems

Software Resource Group,
Inc.
Solbourne Computer, Inc.
Solectron Corporation
Soletek Computer Supply,
Swan Instruments
Synatech Computer Power
Synergistic Detector Systems
Synnex Information Systems
Systel Computers, Inc.
T & R Communications, Inc.
Tandem Computers
Tandon Computer Corp.
Target Stores, Inc.
TCBY Yogurt
TCI Viacom
TDK Corporation
Technalloy, Inc.
Technic, Inc.
Technology Sales, Inc.
Tektronix, Inc.
Terra Research, Inc.
Texmac, Inc.
Thermal Mechanical, Inc.
Time Warner, Inc.
Timesavers, Inc.

CompuServe Incorporated
Consolidated Software
Contour Computers
Convergent Technologies, Inc.
Cooper Biomedical
Coopers & Lybrand
County of Santa Clara
Cray Research
Cypress Ritchey
Dai-Ichi Kangyo Bank
Datasonics
Del Monte Corp.
Deskin Research
Diamond Multimedia Systems
Diasonics
Digital Microwave
Digital Software
Documentum
Dolch American Instruments
Duquesne Systems
Dysan International
E.C.I. Semiconductor
Econo Line Express, Inc.
Economics Laboratory, Inc.
Mitsui Manufacturers Bank
Modulus Power Corporation
Mohler, Nixon & Williams
Money Store Investments
MOS Plastics
Moscom, Inc.
Motorola Computer Systems
Mountain Computer, Inc.
Mountain Network Solutions
MultiGen
Multitech Design & Test, Inc.
MQA
Mylex Corporation
Nabisco
National Advanced Systems
National Benefit
National Microcom Service
National Semiconductor Corp.
NEC Electronics, Inc.
NEC Technologies
NetFRAME Systems
Nexgen Microsystems
NEXT Computer, Inc.
North American Van Lines
Novell, Inc.
Tool Technology Corp.
TRACE/Mt. Products
Trend Plastics, Inc.
Trident Microsystems, Inc.
True Tech Corporation
Ultratest International, Inc.
Unigard Security Insurance Co.
United Consumer Marketing
United Technologies Chemical
US Web
USF&G
Valmark Industries
Varian Associates, Inc.
Velodyne Acoustics, Inc.
Verbatim Corporation
Versatec
Victron, Inc.
Viking Freight Systems, Inc.
Visioneer
Vitelic, Inc.
Vocomtec
Waddell & Reed
Waste Management
Watkins Johnson Company

Edge Information Systems
Elcon Products International
Electronic Supply, Inc.
Engineered Process Controls
Epson America, Inc.
Epson Technologies
ESD Corporation
ESL Corporation
Everex Systems
Exatron, Inc.
Excelsior Manufacturing
Federal Auto Parts
Fidelity Investments
Financial Savings & Loan
Fireside Thrift
First Corporate Mortgage
First Funding Corporation
First International Computer
First United Federal Credit
Union
FMC Corporation
Franklin-McKinley School
District
Fujitsu Business Systems Co.
G.S.A. Immigration
Gateway Design Automation

Ocean Genetics, Inc.
Octal Communications
Olsten Financial Services
Oracle
Orbit Semiconductors, Inc.
OSHA
Overland Parts Express
Owens Design, Inc.
Owens-Illinois, Inc.
Pac Tel InfoSystems
Pacific Bell
Pacific Coast Trane
Pacific Financial Services
Pacific Italia, Inc.
Pan International
Panasonic Semiconductor
Dev. Co.
Parnelli Jones
Paul Masson, Inc.
Peacock Insurance
Pettit & Martin
Pharos, USA
Philips Semiconductors, Inc.
Phoenix Technology, Inc.
Pioneer Electronics
Plaza Savings & Loan

Wells Fargo Bank
Wells Fargo Equity Fund
Wesco Management, Inc.
Westates Pacific Corporation
Western Way Landscapes
Westinghouse
Wheel Works West, Inc.
Wyse Technology
XA Systems
Xerox Corporation
Xtra Business Systems
Yes! Entertainment
Zack Electronics
Zenger Miller
Zuken America
ZVI Contracting
Zycad