Property Value and Fiscal Benefits of BART

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Bay Area Rapid Transit (BART)

Report Authors

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EXECUTIVE SUMMARY

This report examines the value that BART confers to properties near its stations and the importance of BART for the tax base of local jurisdictions. Previous studies of BART's effect on property values found positive results. Now that BART has been operating for more than 40 years, this study revisits BART's influence on property values in light of recent research about the economic benefits of transit. It includes an analysis of the importance of BART for the local tax base, and an estimate of the property value generated by BART specifically for condominiums and single-family homes.

Property Value Benefits of Transit

Transit access is associated with a wide range of direct and indirect economic benefits, including reduced transportation costs, improved connections to jobs, and reduced costs for maintenance of road infrastructure. These benefits are reflected in higher property values near stations, and result in higher property tax receipts for local governments. Studies demonstrate that transit has the greatest positive impact on property values when the transit system significantly improves residents' access to employment centers and other regional destinations, and when service is fast, frequent, and reliable. Pedestrian-friendly, mixed-use neighborhoods with good connections to transit stations generally experience the most significant property value benefits from transit, particularly when local governments implement zoning and land use regulations to facilitate transit-oriented development (TOD).

The BART system has many of the characteristics that have been shown to support higher property values near transit, including:

- **Frequent, fast, regional service.** BART provides significant accessibility advantages for riders, and plays an increasingly critical role in connecting the Bay Area as both population and traffic congestion continue to grow.
- **Connections to the region's most important destinations.** BART serves some of the region's most important employment centers (including Downtown San Francisco, Downtown Oakland, Downtown Concord, and Walnut Creek) and has helped reinforce the regional competitiveness of those centers over time. In addition to providing access to jobs, BART also provides access to important education, health care, and entertainment destinations in the region.
- **Supportive local land use context and public policy.** The BART system serves many walkable, amenity-rich neighborhoods, and over the years BART and local governments have invested in improvements to reinforce the pedestrian, bicycle, transit, and auto connections to many stations. Moreover, many local governments now have station area plans and zoning in place to allow for higher densities around BART stations.
- **Significant new development.** In the four decades since BART began service, the system has helped shape local real estate markets by attracting significant new transit-oriented development to station areas such as Pleasant Hill, Richmond, Fruitvale, Hayward, Colma, East Dublin/Pleasanton, and Castro Valley. These projects have been designed to capitalize on the benefits associated with BART access.

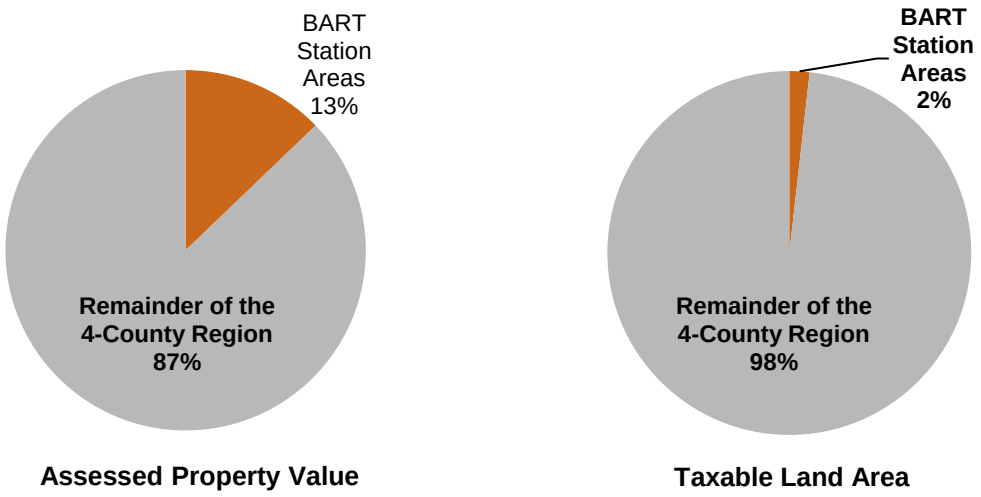
These characteristics of the BART system suggest that proximity to BART stations should confer a significant value premium to nearby properties.

BART and the Bay Area Property Tax Base

Strategic Economics evaluated assessed property values in the four BART-served counties (Alameda, Contra Costa, San Francisco, and San Mateo) in 2000 and 2010. Key results from the analysis are summarized below.

BART station areas account for 13 percent of the property tax base in the four counties served by BART, but only 2 percent of the land area. The 43 BART station areas (defined as the areas within a half-mile radius around the stations[1]) accounted for $75 billion of assessed property value in 2010, or 13 percent of the total $582 billion in assessed value in Alameda, Contra Costa, San Mateo, and San Francisco counties. In comparison, the station areas accounted for only 2 percent of the taxable land area in the four counties (Figure 1).

Figure 1. BART Station Areas as a Percent of Total Assessed Value and Taxable Land Area in Alameda, Contra Costa, San Francisco, and San Mateo Counties



Calculations exclude properties that are not taxable.
Sources: Alameda, Contra Costa, San Francisco, and San Mateo County Assessor's Offices, 2000 & 2010; Strategic Economics, 2012.

BART station areas generate over $750 million each year in general property tax revenues for local governments. The $75 billion of assessed property value in the BART station areas generates $750 million a year in property tax revenues for cities, counties, schools, community college districts, and other local government entities.[2] This estimate is property tax revenues is based on California's one percent general property tax levy, and does not include additional special taxes, assessments, and debt payment rates that voters in many jurisdictions have approved.

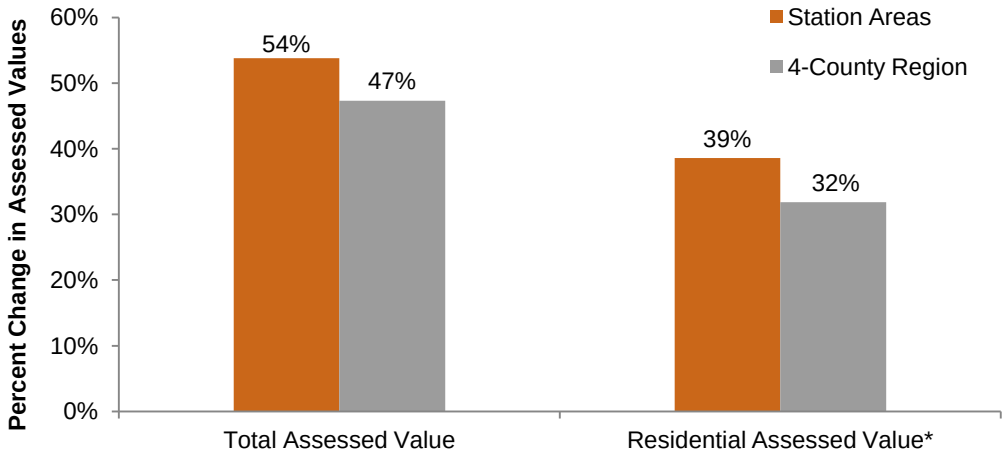
[1] The West Dublin/Pleasanton station was excluded from the analysis because it opened in 2011.

[2] Under Proposition 13, the general property tax rate in California is limited to one percent of assessed value. The revenues from the one percent rate are allocated to city and county General Funds, K-12 schools, community college districts, and special districts. The allocation of the one percent rate varies widely throughout the state, based on each local government's share of countywide taxes prior to the passage of Proposition 13, when each local government determined its own property tax rate. Additional special taxes, assessments, and debt payment rates over and above the one percent general tax levy may be approved by voters. Source: Alamo and Whitaker, *Understanding California's Property Taxes*.

Properties near the BART stations in San Francisco's Financial District and Civic Center account for half of the total assessed value of all BART-served properties, and nearly a third of the value of all properties in San Francisco. The total assessed property value in the Embarcadero, Montgomery, Powell, and Civic Center station areas was $38 billion in 2010 – accounting for half of the total assessed value in all BART station areas, and 27 percent of the total assessed value in the City of San Francisco. The concentration of value in the four Downtown/Financial District station areas reflects the value that businesses and residents place on being located at the center of the BART district, as well as other factors such as the density of development and Downtown San Francisco's position as the region's primary central business district. The assessed value in these station areas likely under-represents the total value of development in Downtown San Francisco, because Proposition 13 limits increases in assessed value to two percent a year unless the property changes ownership or undergoes significant new construction. There is some evidence to suggest that major commercial property owners in particular often avoid transfers of ownership that would result in reassessment.[3]

The assessed value of properties near BART is increasing faster than the region as a whole. Between 2000 and 2010, total assessed values in the BART station areas increased by 54 percent after adjusting for inflation, compared to a 47 percent increase in the four-county region overall. Over the same time period, the assessed value of existing residential properties in the BART station areas increased by 38 percent, compared to 32 percent in the four-county region (Figure 2).

Figure 2. Percent Change in Assessed Value: BART Station Areas Compared to 4-County Region, 2000-2010 (Inflation Adjusted)



Calculations exclude properties that are not taxable.
*Includes existing development only (i.e., properties that did not experience significant new development)
Sources: Alameda, Contra Costa, San Francisco, and San Mateo County Assessor's Offices, 2000 & 2010; Strategic Economics, 2012.

[3] Goldberg and Kersten, *System Failure: California's Loophole-Ridden Commercial Property Tax*.

BART's Impact on Single-Family and Condominium Values

Strategic Economics used a statistical model to isolate the benefit of proximity to BART for single-family and condominium property values as of 2012 in Alameda, Contra Costa, and San Mateo Counties.[4] This analysis is based on prices recorded in actual property transactions (as opposed to assessed property values), and controls for differences in home size, home quality, and neighborhood characteristics.

Key findings from the analysis are described below.

A condominium located within a half mile of BART is worth 15 percent more than one located more than five miles from BART, all else being equal. For the average condominium, this translates to a $69,000 price premium (in 2012 dollars) associated with proximity to BART (Figure 3).

A single-family home located within a half mile of BART is worth 11 percent more than a home located more than five miles from BART, all else being equal. For the average single-family home, this translates to a $72,200 price premium (in 2012 dollars) associated with proximity to BART (Figure 3).

Figure 3. BART Proximity Premium: Value of Locations within a Half Mile of a BART Station Compared to Locations 5 or More Miles from BART (2012 values)

	Predicted Price of an Average Unit		*BART Value Premium*	
Property Type	Within 1/2 Mile of BART	5+ Miles from BART	Average Dollar Value	Percentage Premium
Condominium	$528,173	$459,121	$69,052	15.00%
Single Family	$743,915	$671,716	$72,199	10.70%

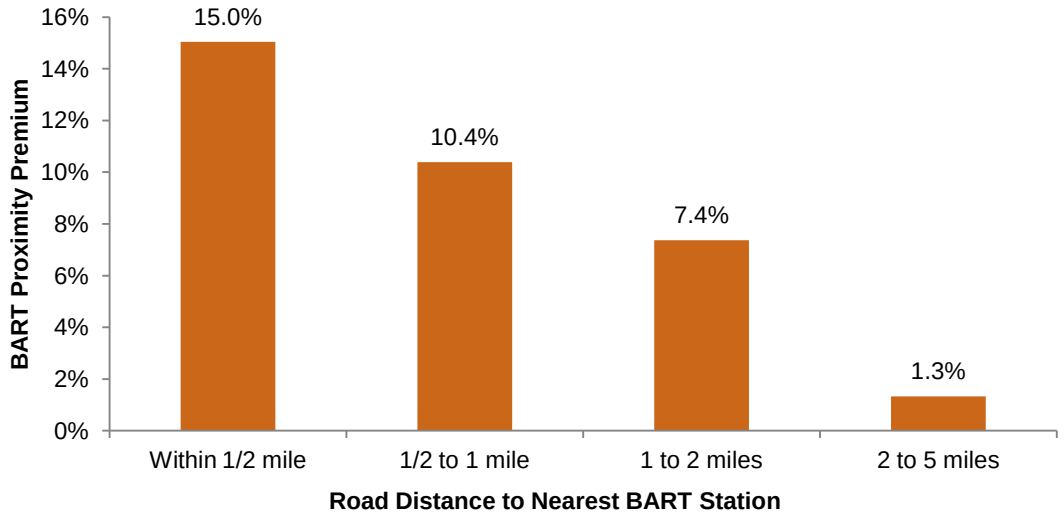
Source: Strategic Economics, 2014.

Properties as far as two to five miles away from the nearest BART station experience a benefit from proximity to BART. Figures 4 and 5 show the percentage price premiums that properties at different distance intervals (within a half mile, a half to one mile, one to two miles, and two to five miles from a BART station) command compared to properties located more than 5 miles away from a BART station Within shorter distances from BART, condominiums experience a significantly higher premium than single-family homes, indicating that condo buyers place greater value on being within a short distance of BART. However, for single-family homes, the premium declines less steeply with greater distance from BART. This indicates that single family home buyers value relative proximity to a BART station, even if the station must be accessed by car or another form of transportation.

[4] San Francisco was excluded because of the significant challenges involved in isolating BART's impact in a city where BART is only one of many rail transit options, as well as the dissimilarities between real estate market conditions in San Francisco and other parts of the Bay Area. While condominiums are more typical of the type of higher-intensity, transit-oriented development that BART and many cities encourage near transit stations, this study also included an analysis of single-family properties. In addition, the single-family home analysis allows for comparison with other studies on the property value impacts of transit; most previous studies have focused on single-family properties.

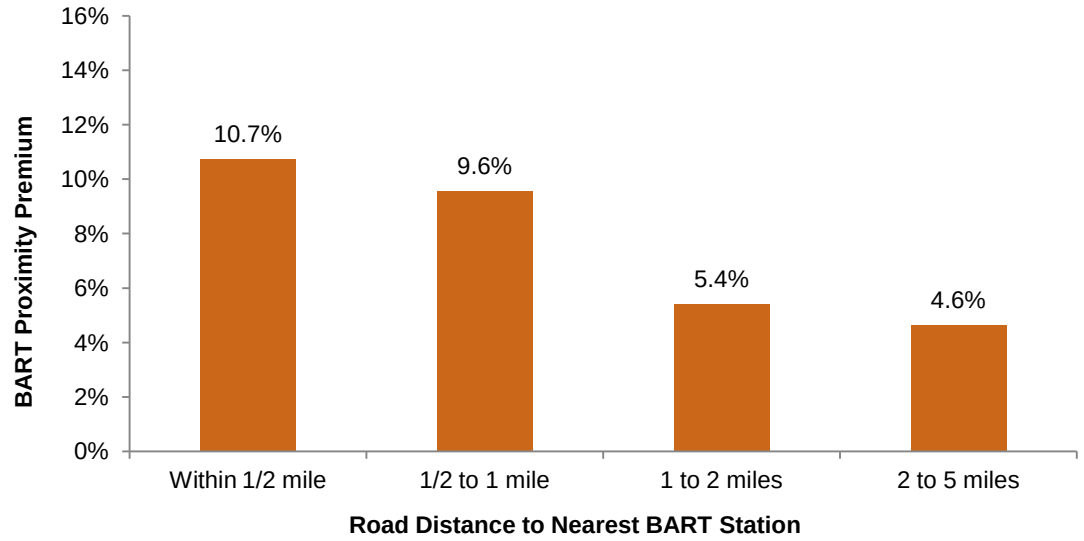
In aggregate, BART contributes an estimated $17.3 billion in added property value to single-family and condominium properties in Alameda, Contra Costa, and San Mateo Counties.[5] There were an estimated 435,570 single-family homes and 34,300 condominiums located within five miles of a BART station in Alameda, Contra Costa, and San Mateo Counties in 2012. Applying the average property value premiums predicted by the model to these homes results in an estimate of $17.3 billion in total property value impacts associated with proximity to BART stations.

*Figure 4. Percentage Price Premiums Associated with Different Distances to BART for Condominiums**



*Percentage difference in property value, compared to being located more than 5 road miles from a BART station.
Source: Strategic Economics, 2014.

*Figure 5. Percentage Price Premiums Associated with Different Distances to BART for Single-Family Homes**



*Percentage difference in property value, compared to being located more than 5 road miles from a BART station.
Source: Strategic Economics, 2014.

[5] Amount estimated as of 2012.

I. INTRODUCTION

Numerous studies of US transit systems demonstrate that proximity to rail transit can have a significant impact on property values, and consequently, the local tax base. However, few recent studies have focused on the BART system, despite its extensive geographic reach, high ridership, and location in one of the most populous regions in the US. In 1995, researchers at UC Berkeley evaluated property value and rent impacts of BART over the first 20 years of the system, and found significant effects for residential properties.[6] Given BART's expanding physical reach, rising gas prices, and shifting consumer preferences that favor walkable neighborhoods with good transit access, it is reasonable to expect that the value of locations near BART remains high, and is likely to be increasing over time. Now that BART has been operating for more than 40 years, this seems like an opportune time to revisit the relationship between BART and property values.

This report examines the value that BART confers to property values near stations, and in turn, the contribution of BART for the tax base of local communities. The report includes:

- A summary of findings from previous studies in the US that consider the property value and fiscal impact of public transit, and a discussion of the implications for BART (Chapter II);
- An evaluation of County assessor's data to understand the importance of BART for the local property tax base (Chapter III); and
- An estimate of the property value premiums associated with proximity to BART stations for single-family and condominium homes (Chapter IV).

Details regarding the statistical model used to estimate BART's contribution to residential property values are provided in Appendix A. Appendix B provides a bibliography of research cited in the report.

[6] John Landis and Robert Cervero, *BART at 20: Property Value and Rent Impacts*, Transportation Research Board, 1995.

II. LITERATURE REVIEW: PROPERTY VALUE AND FISCAL IMPACTS OF TRANSIT

Public transit provides many economic, environmental and social benefits. Some of these benefits result in higher property values and greater concentrations of development near transit, which in turn generates increased property tax revenues for local governments. This chapter reviews the literature on the property value and fiscal impacts of transit, with a focus on studies that are comparable to the statistical analysis conducted by Strategic Economics and presented in Chapter IV. Appendix B provides a complete bibliography of the studies reviewed in this chapter.

The Link between Transit, Property Values, and Local Government Finances

A large body of research has shown that transit access generates a wide range of benefits. Some of the benefits of transit service improvements accrue directly to households and businesses. For example, improved transit access directly benefits transit riders by providing increased convenience, speed, and savings from decreased auto use and ownership. Transit improvements can also benefit households and employers by allowing transit riders to access employment centers, schools and colleges, and other destinations more quickly and reliably, increasing workers' long-term productivity and reducing absenteeism. Other economic benefits, such as reduced traffic congestion and improved environmental quality, result from an overall shift from automobile to transit travel and benefit the larger economy and society as a whole.[7] Previous studies, summarized on the following page, have demonstrated that the BART system provides these and other benefits for Bay Area households, businesses, and the region as a whole.

The Transit Premium

The expectation that property values will be higher around transit stations rests on the assumption that property owners and renters who value the improved accessibility and other benefits provided by transit will be willing to pay a premium to locate in transit-served areas where they can take advantage of those benefits. This premium is transmitted (or "capitalized") into higher property values near transit stations, and is known as a "land value premium" because the benefit of transit is primarily a function of the location of the land (as opposed to the value of buildings or other structures).[8] These higher values can also result in higher density development near transit stations, as property owners use their land more intensively in order to compensate for higher land costs. Supportive public policy can help reinforce the value of transit-served locations for new, higher-intensity development by allowing higher densities (resulting in increased potential revenues) and reduced parking requirements (resulting in decreased construction costs).[9]

Figure II-1 categorizes the direct and indirect economic benefits of transit according to who benefits, whether the benefits are primarily local or regional in nature, and the extent to which the benefits are capitalized in land values. Those benefits of transit access that accrue directly to households and businesses are most likely to have a direct impact on property values.[10] On the other hand, property values in transit station areas are less likely to reflect external or "indirect" benefits that benefit the economy or society as a whole.[11] Note also that higher property values near transit do not necessarily

[7] Litman, *Evaluating Public Transit Benefits and Costs: Best Practices Guidebook*.
[8] Cervero and Landis, "BART at 20"; Landis, Guhathakurta, and Zhang, *Capitalization of Transit Investments into Single-Family Home Prices: A Comparative Analysis of Five California Rail Transit Systems*.
[9] Fogarty et al., *Capturing the Value of Transit*.
[10] Property values also reflect other neighborhood amenities which transit may in some cases help attract, such as retail, services, entertainment, and community activities. Bowes and Ihlanfeldt, "Identifying the Impacts of Rail Transit Stations on Residential Property Values."
[11] Litman, *Evaluating Public Transit Benefits and Costs: Best Practices Guidebook*.

indicate that transit has caused regional economic growth. In some cases, transit investments may redistribute economic activity that would have occurred even without the transit infrastructure.

Previous Research on the Economic and Property Value Benefits of BART

Since BART began service in the 1970s, many studies have examined BART's economic and property value benefits for the region. The most recent, comprehensive efforts include "BART at 20," a 1995 study led by Professors Robert Cervero and John Landis from U.C. Berkeley, and "BART's Contributions to the Bay Area," a 2004 report led by Amy Herman of the Sedway Group.

"BART at 20" examined the land use, development, and property value impacts of BART in its twentieth year of operation. Cervero and Landis found that single-family homes in Alameda and Contra Costa Counties increased in value by $2.00 for every meter closer a home was located to the nearest BART station. The study also found that the regional accessibility provided by BART had played an important role in enabling downtown San Francisco to grow and maintain its importance as the region's central business district, attracting new public and private investment to downtown Oakland, and supporting new office and multifamily housing development around several other BART stations such as Walnut Creek, Pleasant Hill, and Fremont.

The 2004 report by the Sedway Group identified a broader range of benefits from BART, including:

- Faster, easier commutes for BART riders.
- Reduced congestion on the Bay Area's major highways.
- Reduced commute costs. An average East Bay resident commuting to downtown San Francisco saved up to $5,500 per year in 2004 by choosing to take by BART rather than drive.
- Improved access to airports, shopping, entertainment, and cultural destinations for residents and tourists.
- Reduced vehicle miles traveled, reduced emissions, and improved air quality.
- Enhanced regional competitiveness. BART access reinforces the importance of Downtown San Francisco and Oakland as regional employment centers, provides businesses with access to an expanded labor pool, and helps attract and retain new businesses to the region.
- Significant new office and residential development near BART stations.

Sources: Cervero and Landis, "BART at 20"; Cervero, *BART @ 20: Land Use and Development Impacts*; Sedway Group, *BART's Contributions to the Bay Area: An Update*.

Figure II-1. Economic Benefits of Transit

Benefit	Description	Primary Beneficiaries	Geography of Primary Benefit*	Capitalized in Land Values?
Direct Benefits				
User benefits	Access, convenience, speed and comfort provided to users of transit service.	Transit Riders	Transit-served areas	Yes
Consumer savings	Reduced consumer transportation costs, including vehicle operation/ownership costs.	Transit Riders	Transit-served areas	Yes
Increased productivity	Improved access for employers to workforce and customers.	Businesses, Transit Riders	Transit-served areas	Yes
Indirect Benefits				
Facility cost savings	Reduced costs on other transportation facilities, such as roads and parking facilities.	Government/ Taxpayers, Developers	Transit-served areas & regions	Some
Reduced congestion	Reduced traffic congestion on roadways.	Drivers/Everyone	Transit-served areas & regions	Some
Efficient land use	More compact development, reduced sprawl; potential infrastructure and services savings.	Everyone	Transit-served areas & regions	Some
Agglomeration efficiencies	Productivity gains from more clustered land use patterns and economic activity.	Businesses/ Everyone	Transit-served areas & regions	Some
Road safety	Savings from reduced per capita traffic crash rates, reduced need for emergency services.	Everyone	Transit-served areas & regions	Mostly not
Environmental quality	Reduced pollution emissions and habitat degradation.	Everyone	Transit-served areas & regions	Mostly not

*Transit-served areas are defined as locations in close proximity to transit stations, where workers and households can take advantage of the improved accessibility and other benefits provided by transit service.
Based on Litman, *Evaluating Public Transit Benefits and Costs: Best Practices Guidebook*, p 67.

Fiscal Benefits

Many of the economic benefits of transit translate into fiscal benefits for local governments. Regional economic growth associated with transit improvements should lead to higher overall tax revenues, and some local governments and special districts may also benefit from higher property values and tax revenues in transit station areas. Transit agencies' spending on capital and operating expenses can also result in higher revenues for local governments by generating new income for workers and vendors (ranging from construction contractors to accounting services), which in turn results in increased local spending and sales tax revenues.[12] In addition, improved transit can result in reduced use of other facilities such as roads and parking lots, reduced traffic facilities and crash rates, and reduced pollution. These benefits can result in savings to local governments by reducing the need for road maintenance, police and emergency services, and environmental mitigation or clean up.[13] Moreover, high-quality transit service can assist in fostering more compact development and reduced suburban sprawl. Studies show that more efficient land use can result in savings on the cost of infrastructure and services.[14]

It is important to note that in California, increased land values do not lead directly to new property tax revenues. As discussed in greater detail in the following chapter, Proposition 13 limits annual increases in assessed value to two percent a year or the rate of inflation unless the property changes ownership or undergoes significant new construction. Therefore, appreciation of existing homes and commercial properties will affect the tax base at a relatively slow pace, as individual properties turn over or are redeveloped. Major new development near transit stations, however, will provide immediate fiscal benefits.

Empirical Evidence of Transit's Effect on Property Values

A large of body of literature documents that rail transit investments have a positive effect on property values and new development after controlling for other factors such as regional differences in property values, property attributes, and other neighborhood characteristics.[15] However, different studies have found highly variant property value premiums, ranging anywhere from a few percentage points to over 100 percent. A few studies have found negative property value impacts, suggesting that in some cases the negative externalities of transit – related to noise, crime, or other externalities – outweigh the accessibility benefits.[16] The impact of transit stations on property values generally appears to depend on several factors, including:

- **Accessibility benefits:** Because the fundamental value of transit is the accessibility it provides to other places, transit has the greatest impact on property values when it significantly improves residents' access to employment, education, entertainment, and other destinations.[17] Studies have also shown that transit systems that provide frequent, convenient access to multiple employment centers or other important destinations are likely to attract more new development.[18]

[12] Clower et al., *Through Recession and Recovery: Economic and Fiscal Impacts of Capital and Operating Spending by Dallas Area Rapid Transit*.
[13] Litman, *Evaluating Public Transit Benefits and Costs: Best Practices Guidebook*.
[14] Smart Growth America, *Building Better Budgets: A National Examination of the Fiscal Benefits of Smart Growth Development*.
[15] Most of the studies referenced below use hedonic regression analysis or other methods to control for these and other factors that may influence property values.
[16] Fogarty et al., *Capturing the Value of Transit*.
[17] Pindus, Wial, and Wolman, *Urban and Regional Policy and Its Effects*; Wardrip, *Public Transit's Impact on Housing Costs: A Review of the Literature*.
[18] Fogarty and Austin, *Rails to Real Estate: Development Patterns along Three New Transit Lines*; Fogarty et al., *Downtowns, Greenfields, and Places in Between: Promoting Development Near Transit*.

- **Type of transit and level of service:** The land value premium is also influenced by the frequency, quality, and extensiveness of the transit system. A few studies have compared the property value effects of heavy rail, commuter rail, and light rail and found that heavy rail and commuter rail have a greater impact on property values, likely due to the greater frequency, speed of service, and geographic coverage that the these systems provide.[19] Systems like BART, which provide frequent, reliable, fast, and regional service, have been shown to generate higher property value premiums than systems that provide more limited service and serve a smaller market area (such as CalTrain, and San Jose and Sacramento Light Rail).[20]

- **Property type:** Several studies have directly compared residential and commercial capitalization effects. In their 1995 report "BART at 20," Cervero and Landis found that single-family homes increased in value by $2.00 for every meter closer to BART in Alameda and Contra Costa Counties. There was no appreciable effect for commercial properties, and smaller but significant premiums for multifamily rental rates. Similarly, a study of land values in the Chicago region found that station proximity had a significant positive effect on single-family and multi-family residential properties, but not on commercial properties.[21] In a series of studies of the Santa Clara, Los Angeles, and San Diego rail systems in the early 2000s, Cervero and Duncan found wide variations in discount/premium effects, depending on the transit line as well as the use type.[22]

  However, other studies have indicated that multifamily residential and office property values benefit more from proximity to rail than single-family property values. A study of the Metro system in Washington D.C. found that proximity to Metro increased property values by 6.8 percent for single-family residential, 9.4 percent for multifamily apartment buildings, and 8.9 percent for office properties.[23] In one of a series of studies of property values and transit in San Diego, Duncan found that condominiums generally experience higher capitalization effects than single-family homes, perhaps because households in the market for condominiums place a greater value on proximity to transit.[24] Debrezion et al. conducted a meta-analysis of the empirical literature and concluded that while the premium effect on residential properties extended further out from station areas, the premium may be higher for commercial than for residential properties within short distances of the station areas.[25]

- **Local land use context and connectivity:** Neighborhood land use context and connectivity to transit stations also plays an important role in driving property value effects. For example, a study of the Hiawatha Line in Minneapolis[26] found that while properties on the west side of the alignment benefited from an accessibility premium, properties on the east side – which are separated from the line by a four-lane road and an industrial area – did not. In San Diego, Duncan has shown that condominiums located near light rail stations and in a pedestrian-oriented environment experience a price premium, while condominiums near less walkable, park-and-ride

[19] Debrezion, Pels, and Rietveld, "The Impact of Railway Stations on Residential and Commercial Property Value: A Meta-Analysis"; Wardrip, *Public Transit's Impact on Housing Costs: A Review of the Literature*.
[20] Landis et al., *Rail Transit Investments, Real Estate Values, and Land Use Change: A Comparative Analysis of Five California Rail Transit Systems*.
[21] Zegras, Jiang, and Grillo, *Sustaining Mass Transit through Land Value Taxation?*.
[22] Cervero and Duncan, "Land Value Impacts of Rail Transit Services in San Diego County"; Cervero and Duncan, "Land Value Impacts of Rail Transit Services in Los Angeles County"; Cervero and Duncan, "Rail Transit's Value-Added: Effects of Proximity to Light and Commuter Rail Transit on Commercial Land Values in Santa Clara County, California."
[23] Washington Metropolitan Area Transit Authority, *Making the Case for Transit: WMATA Regional Benefits of Transit*.
[24] Duncan, "Comparing Rail Transit Capitalization Benefits for Single-Family and Condominium Units in San Diego, California."
[25] Debrezion, Pels, and Rietveld, "The Impact of Railway Stations on Residential and Commercial Property Value: A Meta-Analysis."
[26] Goetz et al., *The Hiawatha Line: Impacts on Land Use and Residential Housing Value*.

stations actually sell at a discount.[27] Similarly, Kahn studied a sample of 14 cities that invested in major transit system expansions between 1970 and 2000 and found that home prices generally increased in neighborhoods where a new "walk and ride" station was constructed, and decreased in neighborhoods that received new "park and ride" stations.[28]

On the other hand, in a recent study of suburban single-family home transactions commissioned by the Southeastern Pennsylvania Transportation Authority, researchers found that the property value premiums generated by proximity to a regional rail were greatest near stations that provided significant levels of parking and a high level of service, and lower near stations with limited parking and low levels of service.[29] This result could reflect the importance of parking capacity for commuter rail stations in relatively low-density, suburban neighborhoods.

- **Supportive land use policy:** Local zoning and land use regulations that facilitate transit-oriented development (TOD) can help support property value premiums, especially in walkable, mixed-use neighborhoods. For example, Atkinson-Palombo compared property values in different neighborhoods during planning and construction of the Phoenix METRO Rail System, and found that condos and single-family homes located in amenity-rich, mixed-use neighborhoods experienced property value premiums, but homes located in primarily residential neighborhoods did not. Homes in mixed-use neighborhoods with TOD overlay zoning experienced the greatest premiums.[30] A study in San Diego showed that single-family homes in high-density zoning districts experienced a premium from proximity to a light rail station, while single-family homes in low-density zones experienced a neutral or slightly negative effect from proximity to rail.[31]

- **Neighborhood demographics:** Studies in Atlanta and southern New Jersey have found that proximity to transit had a positive impact on homes located in lower-income neighborhoods, and negative or neutral effect on property values in higher-income neighborhoods.[32] The authors hypothesize that low-income households place a greater value on living near transit stations because they are more transit-dependent. Other researchers, however, have found positive value effects in high-income neighborhoods and negative effects in low-income neighborhoods, suggesting that in some circumstances upper-income households may place a greater value on access to central business districts and other white-collar employment centers.[33]

- **Time period:** A few studies have examined how the real estate market adjusts to the announcement, construction, and completion of a transit line. In two studies of Chicago's Orange Line, McDonald and Osuji[34] and McMillen and McDonald[35] found that positive capitalization effects occurred as early as six years before the opening of the line in 1993, and that single-family residential properties located within a half-mile of the stations had experienced a 17 percent value premium three years before the line opened. On the other hand, Gatzlaff and Smith found that the announcement of the Miami Metrorail station locations in the early 1980s had at best a weak positive impact on housing prices in the station areas. Chatman et al. found that property values

[27] Duncan, "The Impact of Transit-Oriented Development on Housing Prices in San Diego, CA."
[28] Kahn, "Gentrification Trends in New Transit-Oriented Communities."
[29] Econsult Solutions, *The Impacts of SEPTA on Suburban House Prices*.
[30] Atkinson-Palombo, "Comparing the Capitalisation Benefits of Light-Rail Transit and Overlay Zoning for Single-family Houses and Condos by Neighbourhood Type in Metropolitan Phoenix, Arizona."
[31] Duncan, "The Synergistic Influence of Light Rail Stations and Zoning on Home Prices."
[32] Chatman, Tulach, and Kim, "Evaluating the Economic Impacts of Light Rail by Measuring Home Appreciation"; Nelson, "Effects of Elevated Heavy Rail Transit Stations on House Prices with Respect to Neighborhood Income."
[33] Bowes and Ihlanfeldt, "Identifying the Impacts of Rail Transit Stations on Residential Property Values"; Hess and Almeida, "Impact of Proximity to Light Rail Rapid Transit on Station-Area Property Values in Buffalo, New York."
[34] McDonald and Osuji, "The Effect of Anticipated Transportation Improvements on Residential Land Values."
[35] McMillen and McDonald, "Reaction of House Prices to a New Rapid Transit Line: Chicago's Midway Line, 1983–1999."

around New Jersey's River Line light rail system declined after groundbreaking in 2000. While property values increased again after the line opened in 2004, the net effect was neutral or slightly negative.[36]

Some researchers have suggested that real estate markets may take more than a few years after a transit line opens in order to adjust. Thus, early studies of the BART system observed reduced property values around some station areas, while *BART at 20* found that single-family home prices in 1990 increased by about $2.00 per meter of distance closer to the nearest BART station.[37]

Note that most of the studies described above are based on transactional data – i.e., property sales – usually of single-family homes, and controlled in various ways for neighborhood and home quality factors. Only a few studies have used assessed valuations data to compare property appreciation in station areas and control areas.[38] This study included analyses of both types of data. The analysis discussed in Chapter III used assessed valuation data to explore the fiscal effects of proximity to BART. The analysis described in Chapter IV relied on transactional data, and used statistical methods to isolate the influence on property values of proximity to BART.

Conclusion

Transit access is associated with a wide range of benefits, including increased property values, new development, and fiscal benefits for local governments. Studies have demonstrated that transit has the greatest positive impact on property values when the transit system significantly improves residents' access to employment centers and other regional destinations and service is fast, frequent, and reliable. Pedestrian-friendly, mixed-use neighborhoods with good connections to transit stations generally experience the most significant property value benefits from transit, particularly when local governments implement zoning and land use regulations to facilitate transit-oriented development (TOD).

The BART system has many of the characteristics that have been shown to support higher property values near transit, including:

- **Frequent, fast, regional service.** BART provides significant accessibility advantages for riders, and plays an increasingly critical role in connecting the Bay Area as both population and traffic congestion continue to grow.
- **Connections to the region's most important destinations.** BART serves some of the region's most important employment centers (including Downtown San Francisco, Downtown Oakland, Downtown Concord, and Walnut Creek) and has helped reinforce the regional competitiveness of those centers over time. In addition to providing access to jobs, BART also provides access to important education, health care, and entertainment destinations in the region.
- **Supportive local land use context and public policy.** The BART system serves many walkable, amenity-rich neighborhoods, and over the years BART and local governments have invested in improvements to reinforce the pedestrian, bicycle, transit, and auto connections to many stations. Moreover, many local governments now have station area plans and zoning in place to allow for higher densities around BART stations.

[36] Chatman, Tulach, and Kim, "Evaluating the Economic Impacts of Light Rail by Measuring Home Appreciation."
[37] Cervero and Landis, "BART at 20."
[38] Ko and Cao, *Impacts of the Hiawatha Light Rail Line on Commercial and Industrial Property Values in Minneapolis*; Hess and Almeida, "Impact of Proximity to Light Rail Rapid Transit on Station-Area Property Values in Buffalo, New York"; Weinstein and Clower, *DART Light Rail's Effect on Taxable Property Valuations and Transit-Oriented Development*; Weinstein and Clower, "The Initial Economic Impacts of the DART LRT System."

- **Significant new development.** In the four decades since BART began service, local real estate markets have had time to adjust to the system. BART station areas such as Pleasant Hill, Richmond, Fruitvale, Hayward, Colma, East Dublin/Pleasanton, and Castro Valley have attracted significant new transit-oriented development. Presumably, these projects have been built with land uses, design features and other characteristics intended to capitalize on the location near BART, and hence maximize the transit "premium".

In "BART at 20," Cervero and Landis demonstrated that households valued these benefits enough to pay a premium in order to live near BART.[39] In the two decades since the Cervero and Landis study, population and traffic congestion have increased, BART and local governments have continued to invest in station area planning and connectivity improvements, and the station areas have attracted significant new transit-oriented development. These changes support the idea that the premium associated with proximity to BART may have increased over time. The analysis presented below evaluates the role that BART plays in supporting property values and the local property tax base in the region as the system enters its fifth decade of service.

[39] The analysis discussed in Chapter IV is most comparable to methodology used in the "BART at 20" study; see Chapter IV for a discussion of the similarities and differences between this study and "BART at 20."

III. ASSESSED PROPERTY VALUES IN THE BART SYSTEM

Strategic Economics used data from county assessor's offices to evaluate property values in 43 BART station areas (defined as the area within a half mile radius of each station) in 2000 and 2010.[40] This analysis provides an estimate of the total magnitude of property values in the BART system, and illustrates how values changed in the station areas over time.

The results of this analysis must be interpreted in the context of Proposition 13, which generally works to keep the assessed value of properties below their market value (i.e., the value if sold on the open market). Passed by voters in 1978, Proposition 13 rolled property assessments back to their estimated value in 1975 and limited the reassessment of real property (i.e., land, buildings, and other property improvements). Prior to Proposition 13, county assessors reappraised real property at least once every five years; as a result, assessed values were kept relatively close to market values. Under Proposition 13, properties are reassessed to current market value only when the property changes ownership or undergoes new construction; otherwise, real property valuations may only increase at a factor tied to the rate of inflation, but by no more than 2 percent each year.[41] As a result, property assessments in California often reflect the length of time that an individual or entity has owned a property, rather than the current market value. Nevertheless, studying assessed values around transit stations is important from the perspective of understanding fiscal impacts, since local government revenues are tied to assessed values rather than market values.

Data and Methodology

The analysis is based on property assessment rolls from 2000 and 2010, purchased from Alameda, Contra Costa, San Francisco, and San Mateo County assessors' offices. Using ArcGIS, Strategic Economics determined the Euclidean (i.e., straight line or "crow flies") distance of each parcel from the nearest BART station.[42] The "BART station areas" were defined to include all of the parcels located within a half-mile radius of a BART station. A half mile is the farthest distance that most riders will walk to access a transit station, as is commonly used as the basis for station area planning and analysis.[43]

As in the rest of the state and nation, the 2000s in the Bay Area were characterized by two real estate booms at the beginning and middle of the decade, each followed by a steep decline in values. To account for these market cycles and other regional and sub-regional market trends, the analysis compared assessed valuations in the 43 half-mile BART station areas with total assessed values in the counties in which the station areas are located. (Alameda, Contra Costa, San Francisco, and San Mateo Counties are referred to below as the "BART-served counties" or the "four-county region.")

Key Findings

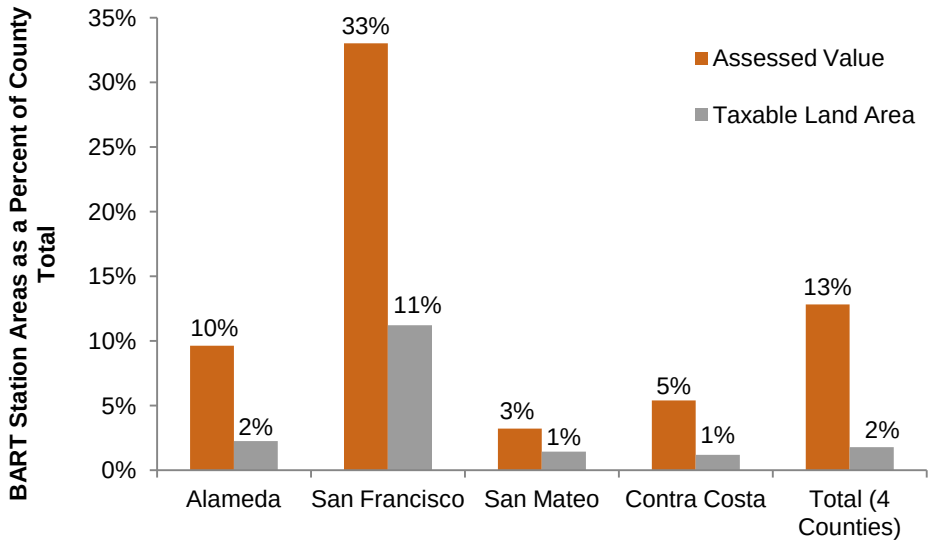
Scale of Assessed Property Values in BART Station Areas

In order to understand the relative importance of the BART station areas in contributing to the tax base of local governments, Strategic Economics evaluated the scale of the assessed property value located within

[40] The analysis included all BART stations except West Dublin/Pleasanton, which opened in 2011.
[41] California Board of Equalization, *California Property Tax: An Overview*.
[42] The four assessors' offices only keep current year (in this case, 2011) parcel shapefiles. Strategic Economics joined the 2000 and 2010 property assessment data to the 2011 parcel shapefiles based on the assessor's parcel numbers (APNs). For parcels where the assessment data did not join (in most cases, because the parcel APNs had changed), Strategic Economics geocoded the addresses associated with the parcels in order to determine their location. In each county in each year, approximately 0.5 to 3 percent of parcels could not be successfully matched to a location, and were excluded from the analysis. Assuming that this "match error" is distributed evenly throughout the counties, it should not affect the validity of the results comparing the station areas to the counties as a whole.
[43] Guerra, Cervero, and Tischler, "The Half-Mile Circle."

a half-mile of BART stations. For each county, Strategic Economics compared the share of assessed property value located in BART station areas to the share of total taxable land in the station areas.[44] This gives a sense of the relative "density" of value in BART station areas compared to other parts of the region. Figure III-1 shows the results by county.

Figure III-1. Proportion of Assessed Property Value in BART Station Areas vs. Taxable Land Area, by County



Calculations exclude properties that are not taxable.
Sources: Alameda, Contra Costa, San Francisco, and San Mateo County Assessor's Offices, 2000 & 2010; Strategic Economics, 2012.

Key findings from this analysis are discussed below.

- **In 2010, the BART station areas accounted for approximately 13 percent of total assessed value in the four-county region, on only 2 percent of the taxable land area.** In all four counties, the proportion of property value in BART station areas is significantly higher than what would be expected based solely on taxable land area (Figure III-1). This indicates that BART station areas are highly valuable places that generate a disproportionate share of property tax revenues compared to other places.
- **BART station areas generate over $750 million a year in general property tax revenues for local governments.** The total assessed value of property in the 43 BART station areas was $75 billion as of 2010. Under California's one percent general property tax levy, this amount of assessed value generates $750 million each year in general property tax revenues for cities, counties, schools, community college districts, and other local government entities.[45] Voters in

[44] Certain types of property are exempt from property taxation under California law, including most government-owned property and property owned, irrevocably dedicated to, and used for religious, hospital, scientific, and/or charitable purposes. All the results in this chapter exclude non-taxable property. Source: California Board of Equalization, *California Property Tax: An Overview*.

[45] Under Proposition 13, the general property tax rate in California is limited to one percent of assessed value. The revenues from the one percent rate are allocated to city and county General Funds, K-12 schools, community college districts, and special districts. The allocation of the one percent rate varies widely throughout the state, based on each local government's share of countywide taxes prior to the passage of Proposition 13, when each local government determined its own property tax rate. Additional special taxes, assessments, and debt payment rates

many jurisdictions have approved additional special taxes, assessments, and debt payment rates over and above the one percent general tax rate; this estimate of property tax revenues does not include revenues from those sources.

- **The total assessed property value in the Embarcadero, Montgomery, Powell, and Civic Center station areas was $38 billion in 2010 – accounting for over half (51 percent) of the total assessed value in all BART station areas, and 27 percent of the total assessed value in the City and County of San Francisco.** Excluding the Downtown/Financial District station areas, the remaining San Francisco BART stations (16th Street Mission, 24th Street Mission, Glen Park and Balboa Park) account for 8 percent of the county's total assessed value and 7 percent of the county's taxable land. The concentration of value in the four Downtown/Financial District station areas reflects the value that businesses and residents place on being located at the center of the BART service area, as well as other related factors such as the density of development and Downtown San Francisco's position as the region's primary central business district. Indeed, the assessed value in these station areas likely under-represents the total market value of development in Downtown San Francisco. Proposition 13 limits increases in assessed value to two percent a year unless the property changes ownership or undergoes significant new construction, and there is some evidence to suggest that major commercial property owners often avoid transfers of ownership that would result in reassessment.[46]

- **Almost all of the individual BART station areas are higher value places compared to the counties where they are located.** Except for the 16th/Mission Street, 24th/Mission Street, Glen Park, and Balboa Park station areas in San Francisco, all of the BART station areas have higher assessed values per square foot of taxable land compared to the average value-per-square-foot in the county where each station is located. The relatively lower values at the Mission Street, Glen Park, and Balboa Park station areas are a function of the very high average countywide average assessed value per square foot in San Francisco.[47]

Changes in Assessed Values Over Time

Strategic Economics also compared the rate at which assessed values increased in the station areas between 2000 and 2010 to the rate of growth on taxable land in the four BART-served counties overall. Figure III-2 shows change in total assessed value and change in the assessed value of residential development[48] for the station areas and the four-county region. Key findings include the following.

- **Between 2000 and 2010, total assessed value in the station areas increased by 54 percent, compared to a 47 percent increase in the four BART-served counties.** Over the course of the 2000s, assessed values in the BART station areas increased from $49 billion to $75 billion, or 54 percent (adjusted for inflation to 2010 dollars). Total assessed value in the four counties increased from $395 billion to $582 billion, or 47 percent.

- **Residential assessed values in BART station areas increased by 39 percent, compared to a 32 percent increase in the BART-served counties.** The assessed value of residential properties

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over and above the one percent general tax levy may be approved by voters. Source: Alamo and Whitaker, *Understanding California's Property Taxes*.

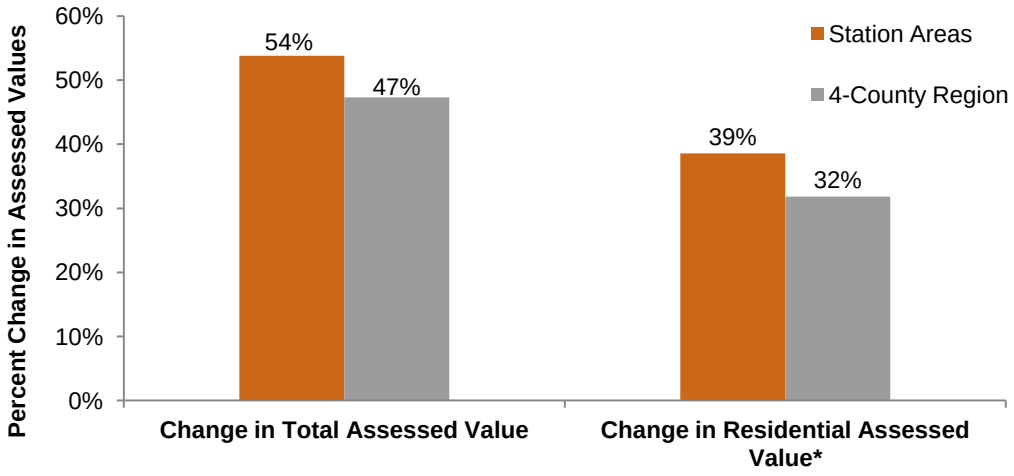
[46] Goldberg and Kersten, *System Failure: California's Loophole-Ridden Commercial Property Tax*.

[47] For example, the average assessed value per square foot in the four Downtown/Financial District stations is over $1,600 per square foot; in the rest of San Francisco, the average assessed value per square foot is $190 per square foot.

[48] Because parcel-level land use codes from 2000 were not available for Alameda and Contra Costa Counties, Strategic Economics could not calculate the total change in assessed value by land use type; the calculation for residential properties shown in Figure II-2 is based on existing development only (i.e., properties that did not experience significant new development between 2000 and 2010).

in the BART station areas grew from $14 million to $19 million between 2000 and 2010, or 39 percent (in 2010 dollars). Meanwhile, total residential assessed value increased by 32 percent in the four-county region.

Figure III-2. Percent Change in Assessed Value: BART Station Areas Compared to 4-County Region, 2000-2010 (Inflation Adjusted)



Calculations exclude properties that are not taxable.
*Includes existing development only (i.e., properties that did not experience significant new development)
Sources: Alameda, Contra Costa, San Francisco, and San Mateo County Assessor's Offices, 2000 & 2010; Strategic Economics, 2012.

Conclusion

The BART station areas account for an important share of the property tax base in Alameda, Contra Costa, San Mateo and San Francisco Counties. The station areas make up 13 percent of total assessed value in the four-country region, compared to just 2 percent of the taxable land area. Moreover, the BART station areas experienced faster growth in assessed values between 2000 and 2010 compared to the BART-served counties.

The relatively high assessed values in BART station areas likely reflect the value that households and businesses place on the accessibility advantages provided by BART. However, the high assessed values may also reflect other differences between BART station areas and other parts of the region. For example, BART station areas likely have relatively high building densities compared to other parts of the region, both because high-value, centrally located, transit-served locations tend to attract higher intensity development, and because many local governments allow developers to build at higher densities in transit-served areas. In order to quantify the property value premium associated with proximity to BART stations, the analysis would need to control for differences in local land use regulations, market conditions, property attributes, and neighborhood characteristics. Unfortunately, controlling for these factors with the assessed value data is not possible, both because of the influence of Proposition 13 (which limits the extent to which assessed values accurately reflect market conditions) and the quality of the data. The analysis presented in Chapter IV relies on data from actual property transactions in order to isolate the specific impacts of BART on property values.

IV. BART'S IMPACT ON SINGLE-FAMILY AND CONDOMINIUM VALUES

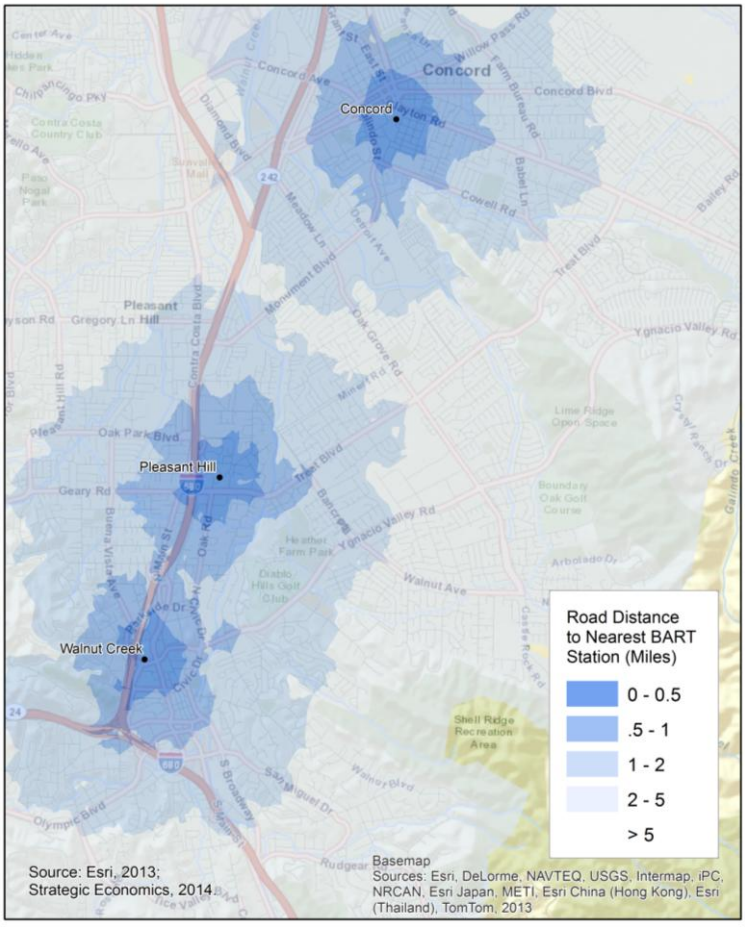
This chapter presents the results of a statistical analysis of BART's impact on single family and condominium prices. The chapter includes an overview of the data and methodology and a discussion of key findings. Appendix A provides more detail on data and methodology as well as the complete results.

Data and Methodology

This analysis used hedonic regression models – a statistical method – to estimate the property value premiums associated with proximity to BART for single-family homes and condominiums. By breaking the value of a property into its constituent parts, hedonic regression analysis allows the researcher to isolate the value associated with each specific attribute. Cervero and Landis used a similar methodology in "BART at 20" in 1995, and found that there was a positive impact for both single-family and multifamily properties in Alameda and Contra Costa Counties.[49] In conducting this study, Strategic Economics drew on the methodology used in "BART at 20" and other work by Cervero and Duncan,[50] as well as other literature reviewed in Chapter II.

The analysis is based on a database of all the single-family homes and condominium sales that occurred between 2005 and 2012 in Alameda, Contra Costa, and San Mateo Counties, purchased from DataQuick. San Francisco was excluded because of the significant challenges involved in isolating BART's impact in a city where BART is only one of many rail transit options. Using ArcGIS, Strategic Economics geocoded each property and calculated the road distance (i.e., the shortest route using the street network) from the property to the nearest BART station.

Figure IV-1. Example Road Distance Categories



The regression analysis modeled the transaction price of a single-family home or condominium as a function of four types of attributes:

1. **Transportation characteristics**, including the road distance from the property to the nearest BART station; the Euclidean (straight line) distance to the nearest above-

[49] Cervero and Landis, "BART at 20."
[50] Duncan, "Comparing Rail Transit Capitalization Benefits for Single-Family and Condominium Units in San Diego, California"; Cervero and Duncan, "Land Value Impacts of Rail Transit Services in San Diego County"; Cervero and Duncan, "Land Value Impacts of Rail Transit Services in Los Angeles County."

ground BART right-of-way; road distance to the nearest freeway on-ramp; and the Euclidean distance to the nearest freeway. The transactions were then aggregated into categories based on distance from the nearest BART station (within a half mile, a half to one mile, one to two miles, and two to five miles from a BART station), as shown in Figure IV-1. These distance categories were found to produce more robust results than using a single continuous variable for distance from BART.

2. **Property attributes**, including living area, lot size, number of bedrooms, number of bathrooms, and the year the property was built.
3. **Neighborhood socioeconomic and demographic characteristics**, including median household income, owner occupancy rate and race/ethnicity variables. Research has found that homes in neighborhoods with high incomes and high of owner occupancy tend to have higher values. Race and ethnicity variables serve as proxies for neighborhood characteristics that affect home prices, reflecting the legacy of housing discrimination.[51]
4. **Controls** for the year the property was sold and whether the property is located in one of the region's highest income cities. Location in a high-income city is used as a proxy for high-quality public services (e.g., school districts), which are capitalized into property values.

In order to create a statistical model that fit the data well and met the assumptions required for regression analysis to provide statistically valid results, this analysis used a different form of regression model than "BART at 20."[52] As a consequence, the results from this analysis are not directly comparable with the results from "BART at 20." Specifically, the results of this analysis are expressed as the percent change in sales price associated with locations at different distances from the nearest BART station (e.g., within a half-mile of BART, compared to more than five miles from BART) if all other factors are held constant. In contrast, the "BART at 20" study resulted in an estimate of the dollar value change in the sales price associated with each meter of increased proximity to BART (i.e., the study found that single-family homes in Alameda and Contra Costa Counties increased in value by $2.00 for every meter closer a home was located to the nearest BART station).

Key Findings

The analysis found that proximity to BART is associated with a significant property value premium for both single-family homes and condominiums. Major findings from the analysis are discussed below.

- **A condominium located within one-half mile of BART is worth 15.0 percent more than a home located more than five miles from BART, all else being equal.** Figure IV-2 shows the estimated average premium that properties within a half-mile of a BART station command, compared to properties located five or more miles from BART. All else being equal, condominiums located within a half-mile road distance of a BART station are worth 15 percent more than condominiums located more than five miles away from a BART station. For the

[51] Historically, people of color have often been excluded from neighborhoods with high-quality housing and services. Studies have shown that even today, minority homebuyers and renters often face more subtle forms of discrimination when they search for housing. As a result of housing discrimination and other factors (e.g., disparities in wealth and income), neighborhoods with high concentrations of minority households are likely to have higher crime rates, poorer quality schools, and fewer amenities and opportunities compared to predominantly white neighborhoods. Source: Turner et al., *Housing Discrimination Against Racial and Ethnic Minorities 2012*.

[52] "BART at 20" used a linear regression equation. However, preliminary models using a linear equation for this study indicated the presence of strong heteroscedasticity and non-normally distributed residuals, meaning that the models predicted some transactions better than others. In order to correct for these issues, the models were estimated using a log-log functional form (i.e., taking the base 10 logarithm of the sales price and all continuous independent variables). The log-log form is commonly used for housing price models, because it captures the nonlinear relationship between housing prices and housing attributes. For example, one might expect that the value of each additional square foot or bedroom might decline as more are added to a housing unit.

average condominium located within a half-mile of BART, this translates to a $69,000 price premium.

- **A single-family home located within one-half mile of BART is worth 10.7 percent more than a home located more than five miles from BART, all else being equal**. For the average single-family home within a half-mile of BART, this translates to a $72,200 price difference (Figure IV-2). These premiums are within the range found in the literature. Studies have generally found a transit premium of 10 percent or less for single-family homes, and more than 10 percent for condominiums.[53]

Figure IV-2. BART Proximity Premiums (2012 Values)

	Predicted Price of an Average Unit*		BART Proximity Premium	
Property Type	Within 1/2 Mile of BART	5+ Miles from BART	Average Dollar Value	Percentage Premium
Condominium	$528,173	$459,121	$69,052	15.0%
Single Family	$743,915	$671,716	$72,199	10.7%

*Calculated by assuming mean values for all variables; see Appendix A for additional discussion.
Source: Strategic Economics, 2014.

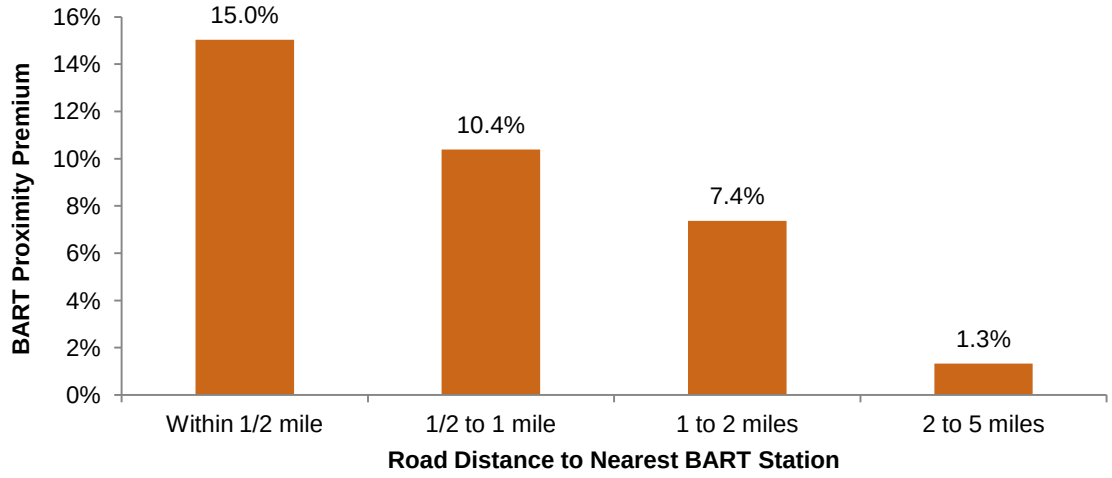
- **Properties as far as two to five miles away from the nearest BART station experience a benefit from proximity to BART.** Figures IV-3 and IV-4 show the percentage price premiums associated with different distance intervals (within a half mile, a half to one mile, one to two miles, and two to five miles from a BART station) experience, compared to properties located more than 5 miles away from a BART station. Within shorter distances from BART (within a half mile, and between a half and one mile), condominiums experience a significantly higher premium than single-family homes, indicating that condo buyers place greater value on being within a short distance of BART.

  However, the BART proximity premium declines fairly steeply for condominiums, from 15 percent within a half-mile to 1.3 percent at two to five miles from the nearest station (Figure IV-3). In comparison, the premium declines much more gradually for single-family homes (Figure IV-4). Indeed, the model implies that single-family homes within half to one mile of a BART station command nearly the same premium (9.6 percent) as single-family homes within a ½ mile (10.7 percent). These results suggest that condominium buyers may place a greater value on being located within walking distance (a half mile) of a BART station, while single-family home buyers may value locations within a short drive to BART nearly as much as locations within walking distance.

- **BART contributed approximately $17.3 billion in added property value for single-family and condominium properties in Alameda, Contra Costa, and San Mateo Counties in 2012.** There were an estimated 435,570 single-family homes and 34,300 condominiums located within five miles of a BART station in Alameda, Contra Costa, and San Mateo Counties in 2012. Applying the average property value premiums predicted by the model to these homes results in an estimate of $17.3 billion in total property value impacts associated with proximity to BART stations. Appendix A provides additional detail on the methodology used to arrive at this estimate.

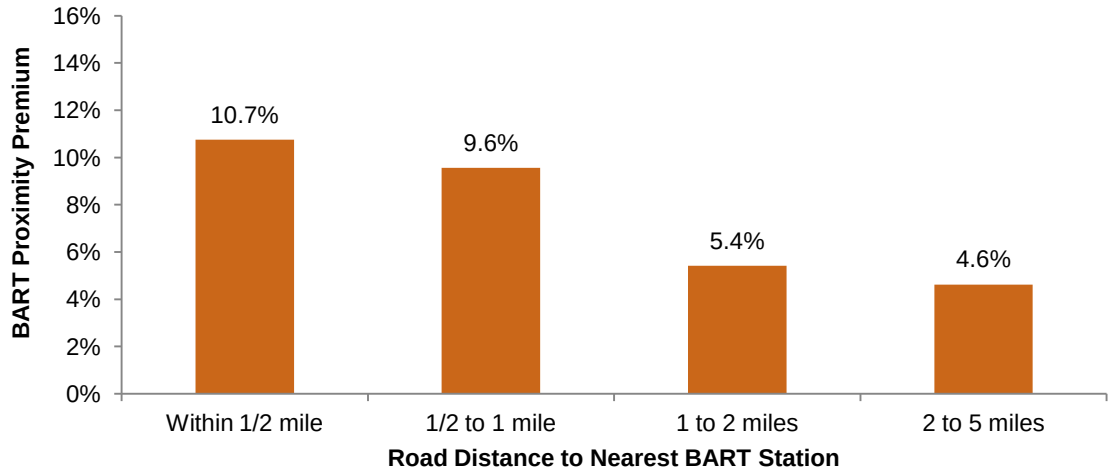
[53] Duncan, "Comparing Rail Transit Capitalization Benefits for Single-Family and Condominium Units in San Diego, California."

Figure IV-3. Price Premiums Associated with Proximity to BART: Condominiums*



*Percentage difference in property value, compared to being located more than 5 road miles from a BART station.
Source: Strategic Economics, 2014.

Figure IV-4. Price Premiums Associated with Proximity to BART: Single Family Homes*



*Percentage difference in property value, compared to being located more than 5 road miles from a BART station.
Source: Strategic Economics, 2014.

Conclusion

Proximity to a BART station is associated with significant property value premiums for condominiums and single-family properties in Alameda, Contra Costa, and San Mateo Counties. After controlling for the attributes of individual properties, neighborhood characteristics, and other transportation accessibility factors, condominiums within a half-mile of BART are, on average, worth 15 percent more than condominiums located five miles away from BART. Single-family homes located within a half-mile of BART experience a 10.7 percent premium. Although this analysis is not directly comparable to "BART at 20" due to the differences in methodology discussed above, these results confirm that BART continues to be associated with significant property value premiums for residential properties in the Bay Area. These premiums reflect the many benefits that residential property owners derive from proximity from BART,

including convenient access to jobs and other destinations throughout the region, reduced time spent waiting in traffic congestion, and savings from decreased auto use and ownership.

APPENDIX A. SINGLE-FAMILY AND CONDOMINIUM ANALYSIS: DATA AND METHODOLOGY

The following sections provide a detailed discussion of the data and methodology of the hedonic regression analysis presented in Chapter IV, as well as the complete set of results.

Home Sales Data

The analysis used a database of all the single-family homes and condominium sales in Alameda, Contra Costa, and San Mateo Counties, purchased from the commercial vendor DataQuick. The database includes information on each transaction (e.g., sales price, seller and buyer name, mortgage information) and the characteristics of each property (e.g., size of living area, size of lot, number of bedrooms) that commercial vendors assemble from county recorders' and assessors' offices. ArcGIS was used to geocode the transactions and calculate the neighborhood and transportation accessibility variables discussed below.

The home sales data were filtered using the following criteria, in order to eliminate missing and erroneous data and other outliers, and obtain a dataset that would be appropriate for analysis.

- Time period: Only transactions that occurred between 2005 and 2012 were included in the analysis, in order to ensure contemporaneity with the Census data discussed below. Sales prices were adjusted to 2012 dollars, using the Consumer Price Index for all Urban Consumers (CPI-U).
- Non-arms-length and distressed transactions: Non-arms-length transactions and distress sales (including foreclosure auctions, short sales, and REO liquidations) were identified using flags provided by DataQuick and removed from the analysis.
- Extreme values: Properties with extremely large or small living areas, number of bedrooms or baths, or lot sizes or floor area ratios (for single-family) were excluded from the analysis.[54] These filters were based on natural breakpoints in the distribution of the data, and applied in order to ensure that extremely large/luxury or small/low-quality properties would not unduly influence the model. In addition, transactions with extremely low or extremely high per-square foot prices were excluded;[55] the initial exploratory analysis indicated that extreme prices were often non-arms-length, the result of distress sales, or incorrect.
- Missing and incorrect data: Transactions with no listed sales price or other missing fields were excluded from analysis, as were addresses that did not successfully geocode[56] or had other errors (for example, several addresses had inconsistent city and county entries). In addition, properties listed as being built before 1900 were excluded, as the exploratory analysis indicated that such entries were often errors.

Prior to filtering, the initial dataset included approximately 367,000 single-family residential transactions and 100,000 condominium transactions between 2005 and 2012. After applying the filters described above, the final dataset included 146,419 single-family transactions and 43,704 condominium

[54] Single-family properties with the following characteristics were excluded from the analysis: living areas less than 700 square feet or more than 4,000 square feet; lot sizes less than 200 or more than 12,840 square feet; floor area ratios (FARs) less than 0.1 or more than 1.1 square feet; no bedrooms or more than 6 bedrooms; less than 1 full bath or more than 6 baths. For condominiums, properties with the following characteristics were excluded: living areas less than 600 square feet or more than 2,150 square feet; no bedrooms or more than 4 bedrooms; less than 1 full bath or more than 3.5 baths.

[55] Transactions with prices less than $100 per square foot or more than $800 per square foot were excluded.

[56] 1.3 percent of all single-family transactions and 4.7 percent of all condominium transactions did not successfully geocode.

transactions.[57] Figure A-1 shows the number of transactions included in the final dataset by road distance from the nearest BART station.

Figure A-1. Number of Transactions in the Final Dataset by Property Type and Road Distance from the Nearest BART Station

	Single-Family Homes		Condominiums	
Road Distance from Nearest BART Station	**Number of Transactions**	**Percent of Total**	**Number of Transactions**	**Percent of Total**
Within 1/2 mile	2,754	2%	2,200	5%
1/2 to 1 mile	11,215	8%	5,198	12%
1 to 2 miles	30,038	21%	9,488	22%
2 to 5 miles	46,068	31%	16,109	37%
5 or more miles	56,344	38%	10,709	25%
Total	146,419	100%	43,704	100%

Sources: DataQuick, 2013; Strategic Economics, 2014.

Form of the Statistical Models

Hedonic regression analysis uses a statistical model to decompose the value of a property into its constituent parts. The coefficient of each variable can then be interpreted as the value associated with each specific attribute. The regression analysis models the transaction price of a single-family home or condominium as a function of four types of attributes – transportation accessibility variables, property attributes, neighborhood socio-economic characteristics, and other control variables – using the general form:

$$P_i = f(\text{T, A, N, C})$$

Where

P_i = the sales price of a given property (property *i*).
T = transportation accessibility variables, including road distance from property *i* to the nearest BART station.
A = attributes of property *i*, such as living area, lot size, or number of bedrooms.
N = neighborhood socio-economic and demographic characteristics, based on the demographics in the Census Tract or Block in which property *i* is located.
C = controls for spatiotemporal effects, such as year when property *i* was sold and city where it is located.

The models were estimated using a log-log functional form (i.e., by taking the base 10 logarithm of the sales price and all continuous independent variables). The log-log form is commonly used for housing price models, because it captures the nonlinear relationship between housing prices and housing attributes. For example, one might expect that the value of each additional square foot or bedroom might decline as more are added to a housing unit.[58] The log-log form was found to fit the data well, creating a model that meets the assumptions required for regression analysis to provide a statistically valid result.[59]

[57] Includes repeat sales of properties that sold multiple times between 2005 and 2012. In the final dataset used to create the statistical models, 21 percent of the single-family residential transactions and 34 percent of the condominium transactions represent repeat sales (i.e., the second, third, or subsequent sale of the same property).
[58] DiPasquale and Wheaton, *Urban Economics and Real Estate Markets*; Coulson, *Hedonic Methods and Housing Markets*.
[59] In particular, preliminary models using a linear equation indicated the presence of strong heteroscedasticity and non-normally distributed residuals, meaning that the models predicted some transactions better than others. The log-log function corrected these problems.

Independent Variables

Many variables were tested for this analysis. This section describes the variables that were found to provide the model that best isolated the property value impact of proximity to BART. Figure A-2 summarizes the variables included in the models. Figure A-3 provides summary statistics for each variable, including either the mean value (for continuous variables) or the proportion of total transactions (for categorical variables).

- **Transportation accessibility variables:** ArcGIS was used to calculate the road distance (i.e., the shortest route using the street network) between each property and the nearest BART station. Based on price breaks observed in the exploratory data analysis, the transactions were then aggregated into categories (a half mile,[60] half to one mile, one to two miles, two to five miles, and five or more miles from the nearest BART station).[61] These distance categories were found to produce more robust results than using a single continuous variable for proximity to BART. ArcGIS was also used to calculate the road distance to the nearest freeway interchange, and the Euclidean (straight line distances) to the nearest above-ground BART and freeway right-of-ways.[62] All else being equal, one would expect homes with easy access to freeway interchanges to have higher prices, while proximity to the BART and freeway right-of-ways would have negative effects on home prices due to the noise, pollution, and other disamenties associated with being located adjacent to these facilities.[63]

- **Property attribute variables:** The DataQuick database provided information on the attributes to each property, including unit living area, lot size (for single-family only[64]), number of bedrooms, number of bathrooms, and the year the property was built. Properties were grouped into five year built categories based on year built (before 1940, 1940-1959, 1960-1979, 1980-1999, and 2000-2012) in order to capture the different architectural styles associated with different time periods. For example, pre-1940 housing in the Bay Area is often valued for its architectural features and high-quality building materials.[65]

- **Neighborhood socio-economic and demographic characteristics:** Using data from the 2007-2011 American Community Survey (ACS) and 2010 Decennial Census, Strategic Economics calculated the median household income, percent of housing units occupied by homeowners, and black and Hispanic residents as a percent of total population by Census Tract or Block (as available).[66]

- **Controls for spatiotemporal effects:** Dummy variables were included in the analysis to control for the year each transaction occurred (i.e., temporal fixed effects). Strategic Economics also explored including several different variables to control for the effects of jurisdictional variation in tax rates, school quality, and other services, and the effects of proximity to job centers and

[60] Research demonstrates that a half-mile (or 20 minute walk) is the farthest distance that most transit riders will walk to access a transit station. Guerra, Cervero, and Tischler, "The Half-Mile Circle."
[61] West Dublin/Pleasanton station was excluded from the analysis because the station opened in 2011.
[62] ArcGIS was also used to calculate the elevation difference between each property and the nearest BART station. However, this variable was not significant and was excluded from the model.
[63] Cervero and Landis, "BART at 20."
[64] Lot size for condominiums was not included in the model because the lot size variable was missing for 70 percent of condominium transactions.
[65] The DataQuick database includes other variables (e.g., codes indicating the presence of a garage or carport, or the condition of the property) that also likely affect home prices; unfortunately, these fields were missing data for large percentages of the properties.
[66] Initial versions of the analysis also included percent of white and Asian residents. However, these variables were found to be strongly correlated with median household income. Other variables that have proved significant in previous analyses were also calculated, including percent of households earning less than $25,000; percent of households earning more than $100,000; residents under age 18 as a percent of total population; and residents over age 65 as a percent of population. However, these proved insignificant and were removed.

other regional destinations (i.e., spatial fixed effects).[67] However, the neighborhood socio-economic variables captured many of these differences. A dummy variable controlling for high income cities (citywide median family incomes in the upper quintile of all cities in each model) was found to have a significant effect and was included in the models.

[67] These included dummy variables for municipalities, subareas within the three counties, number of jobs in the city where the property was located, and the citywide median family income.

Figure A-2. Variables Included in Hedonic Regression Models

Variable	Description	Data Source
Dependent Variable		
Transaction price	Sales price of a given property, adjusted to 2012 dollars.	DataQuick
Transportation Accessibility Variables		
Within 1/2 mile of BART	Property located within 1/2 road mile of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013.
1/2 to 1 mile from BART	Property located between 1/2 and 1 road mile of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013.
1 to 2 mi from BART	Property located between 1 and 2 road miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013.
2 to 5 mi from BART	Property located between 2 and 5 road miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013.
5+ mi from BART*	Property located more than 5 road miles from the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013.
Road distance to freeway on-ramp	Road distance to nearest freeway on-ramp (miles)	ESRI 2013.
Euclidean distance to BART ROW	Straight-line distance to nearest above-ground BART right-of-way (feet)	BART, 2014.
Euclidean distance to freeway	Straight-line distance to nearest freeway (feet)	ESRI 2013.
Property Attribute Variables		
Unit size	Unit living area (sq. ft.)	DataQuick
Lot size	Unit lot size (sq. ft.), for single-family properties only	DataQuick
Number of bedrooms	Number of bedrooms	DataQuick
Number of bathrooms	Number of bathrooms	DataQuick
Built before 1940	Property built before 1940 (0=no; 1=yes)	DataQuick
Built 1940-1959	Property built between 1940 and 1959 (0=no; 1=yes)	DataQuick
Built 1960-1979	Property built between 1960 and 1979 (0=no; 1=yes)	DataQuick
Built 1980-1999	Property built between 1980 and 1999 (0=no; 1=yes)	DataQuick
Built 2000-2012*	Property built between 2000 and 2012 (0=no; 1=yes)	DataQuick
Neighborhood Socio-economic Characteristics		
Median household income	Median household income in Census Tract in which property is located (2011 dollars)	2007-11 ACS
Percent owner occupied	Percent of housing units occupied by owner in Census Block in which property is located	2010 Decennial Census
Percent Black or African-American	Black or African-American population as percent of total population in Census Block in which property is located	2010 Decennial Census
Percent Hispanic or Latino	Hispanic or Latino population as percent of total population in Census Block in which property is located	2010 Decennial Census
Control Variables		
YearSold05*	Transaction occurred in 2005 (0=no; 1=yes)	DataQuick
YearSold06	Transaction occurred in 2006 (0=no; 1=yes)	DataQuick
YearSold07	Transaction occurred in 2007 (0=no; 1=yes)	DataQuick
YearSold08	Transaction occurred in 2008 (0=no; 1=yes)	DataQuick
YearSold09	Transaction occurred in 2009 (0=no; 1=yes)	DataQuick
YearSold10	Transaction occurred in 2010 (0=no; 1=yes)	DataQuick
YearSold11	Transaction occurred in 2011 (0=no; 1=yes)	DataQuick
YearSold12	Transaction occurred in 2012 (0=no; 1=yes)	DataQuick
High-income city	Citywide median family income is in upper quintile of all cities included in model (more than $141,500 for condominium and more than $151,500 for single-family residential; 0=no; 1=yes)	2007-11 ACS

*Omitted dummy variables. Coefficients for dummy variables the regression models should be interpreted in relation to these variables; for example, all "YearSold" coefficients are in relation to transactions that occurred in 2005.
ESRI 2013: ESRI North America Streets file, 2013.

Figure A-3. Variable Summary Statistics

	Mean or Percent of Total Transactions	
	Single-Family Homes	**Condominiums**
Dependent Variable		
Transaction price (mean; 2012 dollars)	$698,514	$489,141
Transportation Accessibility Variables		
Within 1/2 mile of BART (percent of total)	2%	5%
1/2 to 1 mile from BART (percent of total)	8%	12%
1 to 2 mi from BART (percent of total)	21%	22%
2 to 5 mi from BART (percent of total)	31%	37%
5+ mi from BART (percent of total)	38%	25%
Road distance to freeway on-ramp (mean; miles)	2.0	1.6
Euclidean distance to BART ROW (mean; feet)	21,378	14,061
Euclidean distance to freeway (mean; feet)	6,860	5,052
Property Attribute Variables		
Unit size (mean; square feet)	1,760	1,184
Lot size (mean; square feet)	6,139	
Number of bedrooms (mean)	3.3	2.1
Number of bathrooms (mean)	2.1	1.8
Built before 1940 (percent of total)	15%	2%
Built 1940-1959 (percent of total)	29%	1%
Built 1960-1979 (percent of total)	22%	35%
Built 1980-1999 (percent of total)	18%	43%
Built 2000-2012 (percent of total)	16%	19%
Neighborhood Socio-economic Characteristics		
Median household income (mean)	$91,611	$84,394
Percent owner occupied (mean)	77%	64%
Percent Black or African-American (mean)	8%	8%
Percent Hispanic or Latino (mean)	21%	14%
Control Variables		
YearSold05 (percent of total)	25%	27%
YearSold06 (percent of total)	19%	22%
YearSold07 (percent of total)	13%	15%
YearSold08 (percent of total)	8%	8%
YearSold09 (percent of total)	8%	7%
YearSold10 (percent of total)	9%	7%
YearSold11 (percent of total)	8%	6%
YearSold12 (percent of total)	10%	8%
High-income city (percent of total)	6%	6%

Sources: DataQuick, 2013; Strategic Economics, 2014.

Model Results

Figures A-4 provides the complete outputs from the single-family and condominium models. As discussed above, both the dependent variable (transaction price) and the continuous independent variables have been log transformed. The coefficients shown in Figure A-4 can be interpreted in the following manner:

- **Log-transformed variables:** The coefficients can be interpreted as partial elasticities, or the percent change in sales price that results from a one percent increase in a given independent variable if all other factors are held constant. For example, for single-family homes, a one percent increase in distance from a freeway on-ramp is associated with a 0.1 percent decrease in sales price, all else being equal.
- **Dummy variables:** The exponentiated coefficient can be interpreted as the percent difference in sales price associated with the given variable, compared to the relevant omitted variable. For example, single-family homes that are located within ½ mile of the nearest BART station are worth 10.7 percent more than properties located more than five miles away from a BART station (10^0.044 =1.107), all else being equal.

The R-squared for both models is about 0.68, meaning that the models explain about 68 percent of the variance in transaction price. This R-squared is in line with those achieved in other, comparable studies.[68] R-squared is only one measure of a model's explanatory power; the models were also tested for other measures of validity[69] in order to ensure that they were as robust as possible. Most coefficients are statistically significant (Figure A-4).

The results related to proximity to BART stations are discussed in detail in Chapter IV. Other coefficients are generally in the expected directions. For example, the negative coefficient of the distance to the nearest freeway on-ramp variable indicates that properties located at a greater distance from an on-ramp have a lower property value. Proximity to the BART and freeway right-of-ways has a small negative effect on home prices (i.e., homes located farther away are worth more), likely due to the noise, traffic, and other impacts of these transportation facilities.

A few coefficients require additional explanation. While larger unit sizes have a strong positive effect on home price, the coefficients for number of bedrooms is negative. This is consistent with findings from previous studies, and does not indicate that homes with more bedrooms are worth less. Instead, the negative coefficient suggests that buyers prefer larger homes where the additional square footage is not broken up into additional bedrooms.[70] The negative coefficient for lot size (for single-family homes) suggests that interior floor area, rather than lot size, is the primary feature valued by homebuyers. Similarly, the negative coefficient for owner-occupancy rates likely indicates that median household income is the more relevant measure of neighborhood quality – i.e., that homes sell for more because they are located in higher-income neighborhoods rather than in neighborhoods where more homes are occupied by homeowners.[71]

[68] For example, in studies of the land value impacts of rail transit in Los Angeles and San Diego, Cervero and Duncan achieve R-squared values of 0.605 to 0.735 for hedonic models of single-family and condominium properties In "BART at 20," Cervero and Landis achieved R-square values of 0.76 for Contra Costa County and 0.80 for Alameda County.
[69] Including normality and homoscedasticity.
[70] Cervero and Landis, "BART at 20."
[71] Ibid., 20.

Figure A-4. Single-Family and Condominium Model Outputs

	Single Family Model Coefficients	Condominium Model Coefficients
Transportation Accessibility Variables		
Within 1/2 mile of BART[(a)]	.044*	.061*
1/2 to 1 mile from BART[(a)]	.040*	.043*
1 to 2 mi from BART[(a)]	.023*	.031*
2 to 5 mi from BART[(a)]	.020*	.006*
Log of road distance to freeway on-ramp	-.104*	-.070*
Log of Euclidean distance to BART ROW	.008*	.036*
Log of Euclidean distance to freeway	.014*	.006*
Property Attribute Variables		
Log of unit size	.623*	.722*
Log of lot size	-.018*	N/A
Log of number of bedrooms	-.057*	-.068*
Log of number of bathrooms	.016*	.111*
Built before 1940[(b)]	.114*	.045*
Built 1940-1959[(b)]	.096*	.040*
Built 1960-1979[(b)]	.063*	-.050*
Built 1980-1999[(b)]	.024*	-.029*
Neighborhood Socio-economic Characteristics		
Log of median household income	.335*	.105*
Log of percent owner occupied	-.157*	-.169*
Log of percent Black or African-American	-.819*	-.820*
Log of percent Hispanic or Latino	-.725*	-.714*
Control Variables		
YearSold06[(c)]	.000	.002
YearSold07[(c)]	-.042*	-.029*
YearSold08[(c)]	-.144*	-.121*
YearSold09[(c)]	-.201*	-.192*
YearSold10[(c)]	-.210*	-.214*
YearSold11[(c)]	-.238*	-.268*
YearSold12[(c)]	-.225*	-.247*
High-income city	.085*	.050*
Constant	2.301*	2.964*
R-Squared	**0.683**	**0.681**

*Statistically significant at the 95% confidence level.
(a) Compared to properties located more than 5 miles away from the nearest BART station.
(b) Compared to properties built between 2000 and 2012.
(c) Compared to transactions that occurred in 2005.
Source: Strategic Economics, 2014.

The coefficients for the year built variables are also of note. All else being equal, the analysis shows that condominiums built before 1960 are worth more compared to new condominiums (built between 2000 and 2012), while condominiums built between 1960 and 1999 are worth less. This finding likely reflects the premium placed on historic structures, and the relatively lower quality of many buildings dating from the 1960s, 70s, and 80s. For single-family homes, however, the coefficients for all the "year built" variables are positive, indicating the all else being equal, older homes are worth more than homes built between 2000 and 2012. This may reflect the spatial pattern of recent development activity in the Bay Area; much of the recent single-family home construction has occurred at the outskirts of the region, in places that also suffered most from the foreclosure crisis and subsequent decline in home values.[72]

Calculating Property Value Premiums

Figure A-5 shows the premiums predicted for single-family homes and condominiums located at different distances from BART. As discussed above, the percentage premiums were calculated as the exponentiated coefficient of the distance variables. The predicted price of an average unit at different distances from BART was calculated by assuming the mean values for all other variables in the single-family and condominiums models, respectively (shown in Figure A-2, above).[73] The dollar value premiums were then calculated by taking the difference between the predicted price of an average unit in each distance category (within a half mile, a half to one mile, etc.) compared to the predicted price of an average unit located five or more miles away from BART.

For example, assuming the mean values for the variables in the single-family model, the predicted price of an average single-family home located within a half-mile of BART is $743,915, while the predicted price of an average single-family home located five or more miles from BART is $671,716. The difference ($72,199) is the average property value premium associated locations within a half-mile of a BART station.

Figure A-5. Predicted Prices of Average Units at Different Distances from BART and BART Proximity Premiums (2012 Values)

	Single-Family Homes			Condominiums		
Distance from Nearest BART Station	Predicted Price of an Average Unit*	BART Proximity Premium**		Predicted Price of an Average Unit*	BART Proximity Premium**	
		Average Dollar Value	Percentage Premium		Average Dollar Value	Percentage Premium
Within 1/2 mile	$743,915	$72,199	10.7%	$528,173	$69,052	15.0%
1/2 to 1 mile	$735,930	$64,214	9.6%	$506,794	$47,673	10.4%
1 to 2 miles	$708,117	$36,401	5.4%	$492,965	$33,843	7.4%
2 to 5 miles	$702,783	$31,067	4.6%	$465,229	$6,108	1.3%
5 or more miles	$671,716			$459,121		

*Calculated by assuming the mean values (shown in Figure A-2) for all variables except distance from BART.
**Compared to properties located 5 or more miles from BART.
Source: Strategic Economics, 2014.

In order to estimate the aggregate value of the BART proximity premium for all single-family and condominium properties in the three counties, Strategic Economics multiplied the dollar value premiums shown in Figure A-5 by the estimated number of single-family and condominium units in each distance

[72] Schafran and Wegmann, "Restructuring, Race, and Real Estate."
[73] As per the log-log form of the model, the mean values are log transformed before being multiplied by the coefficients shown in Figure A-4. For categorical variables (year built, year sold, and location in a high-income city), the value with the highest proportion of transactions is assumed.

category. Figure A-6 shows this calculation. The number of existing units in each distance category was estimated using Census Tract level data from the 2008-2012 American Community Survey.[74]

Figure A-6. Calculation of Total Estimated Value from BART Proximity Premium

Distance from Nearest BART Station	Estimated Number of Units in Alameda, Contra Costa, and San Mateo Counties		Average BART Proximity Premium (per Unit)		Total Estimated Value (Millions)	
	Single-Family Homes	Condos	Single-Family Homes	Condos	Single-Family Homes	Condos
Within 1/2 mile	15,554	2,947	$72,199	$69,052	$1,123	$203
1/2 to 1 mile	44,926	4,333	$64,214	$47,673	$2,885	$207
1 to 2 miles	148,843	10,546	$36,401	$33,843	$5,418	$357
2 to 5 miles	226,249	16,474	$31,067	$6,108	$7,029	$101
5 or more miles	257,238	9,663				
Total	692,810	43,963			$16,455	$868
Grand Total						**$17,322**

Sources: U.S. Census Bureau, 2008-2012 American Community Survey (prepared using Social Explorer); Strategic Economics, 2014.

[74] Census Tracts were assigned to distance categories based on the network distance between the centroid of each Tract and the nearest BART station (including West Dublin/Pleasanton). All owner-occupied units in structures with three or more units were assumed to be condominiums.

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