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## MEMORANDUM

Date: July 2015

To: Abby Thorne-Lyman, BART

From: Nadine Fogarty and Alison Nemirow, Strategic Economics

Project: BART Benefit Assessment District Feasibility Study – Phase 2

Subject: Benefits of BART to Single-Family and Condominium Property Values by County (Revised)

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In an August 2014 report, Strategic Economics described the results of a statistical analysis of the overall benefit of proximity to BART for single family and condominium property values in Alameda, Contra Costa, and San Mateo Counties.<sup>1</sup> As a follow-up to this regional analysis, BART requested that Strategic Economics adapt the existing statistical model to provide separate results for properties in each respective county. This memorandum summarizes the approach and key findings from the county-level analysis of BART's impact on for-sale home prices. The technical appendix describes the data and methodology and provides complete results from the statistical analysis.

### Summary of Approach

The original statistical analysis, as presented in the August 2014 report, estimated the average value of proximity to BART stations for single-family homes and condominiums in the region. This analysis provided an overall sense of the value that BART contributes to for-sale residential properties. However, it is reasonable to expect that the value associated with proximity to BART may vary across the Bay Area, given the wide range of transportation options, land use contexts, and housing market conditions in different parts of the region. In general, studies have shown that proximity to transit has the greatest impact on property values in places where transit service provides a significant improvement in households' access to important destinations – such as employment, education, or entertainment centers – compared to driving or other modes of transportation.<sup>2</sup> Within the Bay Area, transit is more competitive compared to driving for some trips than for others. For example, transit accounted for over 50 percent of trips from the East Bay counties (Alameda and Contra Costa) into San Francisco in 2012, compared to just 14 percent of trips from San Mateo

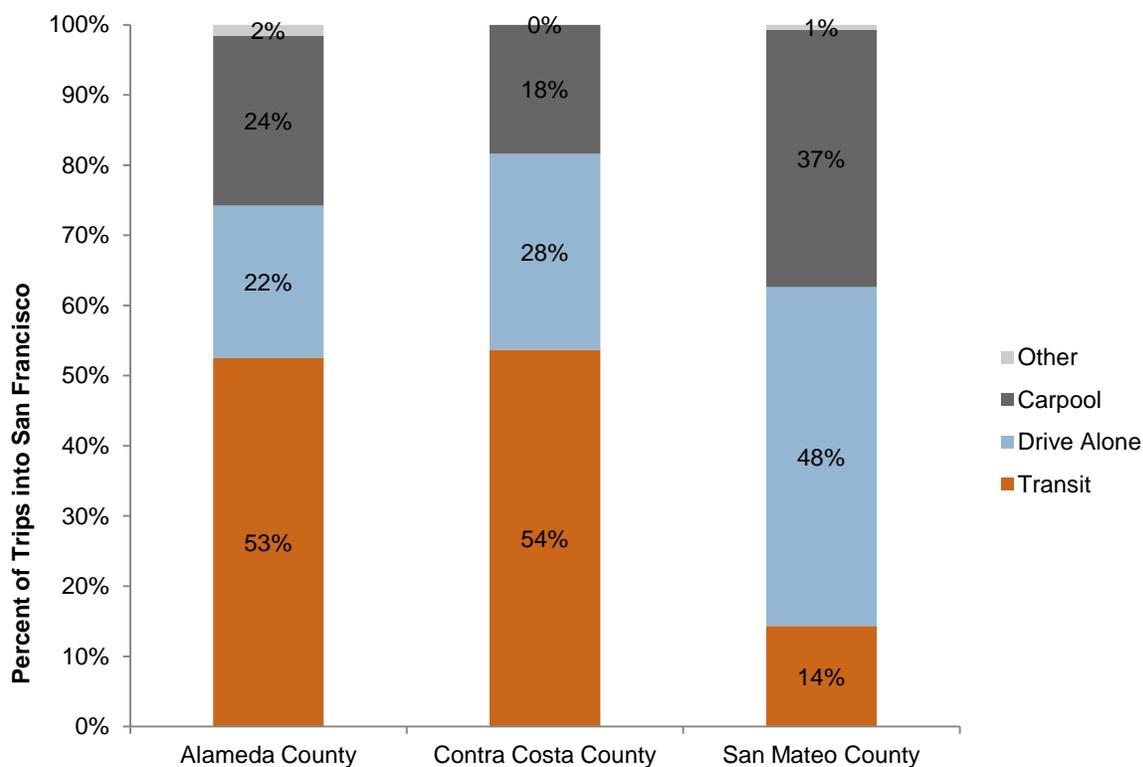
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<sup>1</sup> San Francisco was excluded because of the significant challenges involved in isolating BART's impact in a city where BART is only one of many rail transit options, as well as the dissimilarities between real estate market conditions in San Francisco and other parts of the Bay Area.

<sup>2</sup> Nancy Pindus, Howard Wial, and Harold Wolman, eds., *Urban and Regional Policy and Its Effects*, vol. 3 (Washington D.C.: Brookings Institution Press, 2010), <http://www.brookings.edu/research/books/2010/urbanandregionalpolicyanditseffectsvolume3>; Keith Wardrip, *Public Transit's Impact on Housing Costs: A Review of the Literature*, Insights from Housing Policy Research (Center for Housing Policy, August 2011), [http://www.nhc.org/media/documents/TransitImpactonHsgCostsfinal\\_-\\_Aug\\_10\\_20111.pdf](http://www.nhc.org/media/documents/TransitImpactonHsgCostsfinal_-_Aug_10_20111.pdf).

County to San Francisco (Figure 1). The extent to which BART competes not only with driving, but also with other transit systems, also varies by county. While East Bay residents benefit from a number of local and regional bus options, BART provides the primary option for rail travel both within the East Bay and between the East Bay and San Francisco.<sup>3</sup> In contrast, BART service in San Mateo County is limited to the northern part of the county, where Caltrain provides an alternative option for commuters traveling north to San Francisco as well as south to jobs in the Peninsula or Silicon Valley. Furthermore, within all three counties, there are some station areas where BART is competitive for all types of trips, and other station areas where BART primarily serves as an alternative for commuters taking peak period trips to congested job centers.<sup>4</sup> Local housing markets have also had more time to respond to the presence of BART service in some places than others; most East Bay stations opened in the 1970s as part of the original system, while the San Mateo County stations (with the exception of Daly City) opened in the late 1990s or early 2000s.

Figure 1. Trips into San Francisco by Mode of Transportation and County, 2012



Source: California Household Travel Survey, 2012; SFCTA, 2014.

In order to evaluate how BART’s influence on residential property values varies by county, Strategic Economics used a series of statistical models to isolate the benefit of proximity to BART for single-family and condominium property values as of 2012. The analysis is based on prices recorded in actual property transactions, and controls for differences in home size, home quality, and

<sup>3</sup> The East Bay is also served by Amtrak; however, Amtrak service is used primarily for commuting or taking other trips with destinations outside of the Bay Area (e.g., the Sacramento region).

<sup>4</sup> In recent planning documents, BART refers to these types of places respectively as Metro Core (which includes the BART service area between Daly City and Richmond, MacArthur and Bay Fair stations) and Metro Commute areas.

neighborhood characteristics. Strategic Economics created separate housing price models for the East Bay and San Mateo County. The East Bay housing models were used to test whether and how the relationship between proximity to BART varies between the two East Bay counties.<sup>5</sup> San Mateo County home prices were modeled separately in order to include variables to account for proximity to Caltrain stations. The San Mateo County model was also limited to transactions in the northern part of the county that is best served by BART.<sup>6</sup> Results for the East Bay and north San Mateo County are discussed separately below.

## Summary of Findings

### Alameda and Contra Costa Counties

**In the East Bay overall, a condominium located within a half mile of a BART station is worth 15 percent more than a home located more than five miles from BART, all else being equal.** For the average condominium in Alameda or Contra Costa County, this translates to a \$61,000 price premium (in 2012 dollars) associated with proximity to BART (Figure 2). This finding is consistent with the results from the original regional analysis (which included San Mateo as well as Alameda and Contra Costa Counties), which also found a 15 percent property value premium for condominiums located within a half mile of BART, compared to units located more than five miles away. No statistically significant difference was found between the BART proximity premiums in Alameda and Contra Costa Counties; therefore, condominium results are reported for the East Bay as a whole.

**In Alameda County, a single-family home located within a half mile of a BART station is worth 18 percent more than a home located more than five miles from BART, all else being equal.** For the average home in Alameda County, this translates to a \$93,800 price premium (in 2012 dollars) associated with proximity to BART (Figure 2). In comparison, the original statistical analysis found that on average in all three counties, single-family homes located within a half mile of a station were worth 11 percent more than homes located more than five miles away. Alameda County single-family homebuyers appear to place a greater value on close proximity to BART stations than buyers in the other counties.

**In Contra Costa County, a single-family home located within a half mile of a BART station 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 in Contra Costa County, this translates to a \$51,400 price premium (in 2012 dollars) associated with proximity to a BART station (Figure 2).

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<sup>5</sup> The analysis also tested how the value associated with proximity to BART might differ by submarket within the counties (e.g., West, Central, and East Contra Costa County) as well as by city; however, these variables were not found to have a consistent, significant effect and were ultimately omitted from the model in favor of the county variables.

<sup>6</sup> Including transactions in the cities of Daly City, Colma, San Bruno, Millbrae, South San Francisco, Brisbane, and Burlingame. In addition to their relative proximity to BART (all properties in these cities are located within five miles of a station), these northern San Mateo County cities also have relatively similar housing markets that are less strongly influenced than other parts of the county by factors such as proximity to the Pacific Coast or Silicon Valley.

Figure 2. East Bay 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)

Property Type/Region	Predicted Price of an Average Unit		BART Value Premium	
	Within 1/2 Mile of BART	5+ Miles from BART	Average Dollar Value	Percentage Premium
Condominium East Bay*	\$459,198	\$398,107	\$61,091	15%
Single-Family Residential Alameda	\$613,762	\$519,996	\$93,766	18%
Contra Costa	\$511,682	\$460,257	\$51,425	11%

\*No statistically significant difference was found between the BART proximity premiums in Alameda and Contra Costa Counties.

Predicted prices were calculated by assuming the mean value for all variables in the model except distance from BART.

Source: Strategic Economics, 2014.

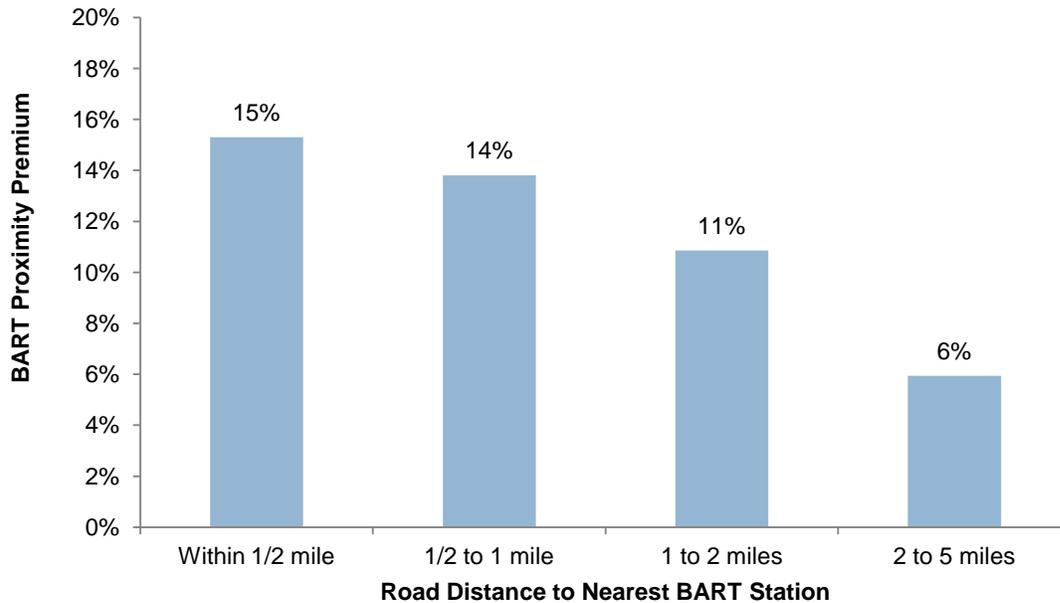
**Condominiums and single-family homes located as far as two to five miles away from a station experience a benefit from proximity to BART.** Figures 3 and 4 shows the percentage price premiums that properties at different distance intervals (within a half mile, a half to one mile, one to two miles, and two to five miles from a BART station) command compared to properties located more than 5 miles away from a BART station.

**The relationship between single-family property values and distance from BART differs by county.** Alameda County single-family homebuyers appear to place a greater value on living within walking distance of a BART station. Within one mile from BART, the value associated with proximity to BART is greater in Alameda County than in Contra Costa County (Figure 3). This suggests that Alameda County buyers place a greater value on living within a short distance (one mile) from BART. Close proximity to Alameda County BART stations may be particularly valuable for homeowners because parking at many stations in the county is limited or non-existent and fills up early on weekday mornings. At the same time, the pedestrian-friendly street grid in many Alameda County station areas makes walking or bicycling to the stations an attractive, convenient option.<sup>7</sup> Compared to Alameda County, the BART property value premium in Contra Costa County is lower at short distances from BART, but declines less steeply with greater distance from a station. This suggests that Contra Costa single-family homebuyers may value locations within a short drive to BART nearly as much as locations within walking distance.

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<sup>7</sup> Many Alameda County stations are also located in high-intensity, amenity-rich neighborhoods in close proximity to major job centers. While efforts were made to control for these factors (see discussion of independent variables in the technical appendix), the property value premium associated with proximity to BART may also partly reflect aspects of the urban environment that the analysis was not able to completely control for.

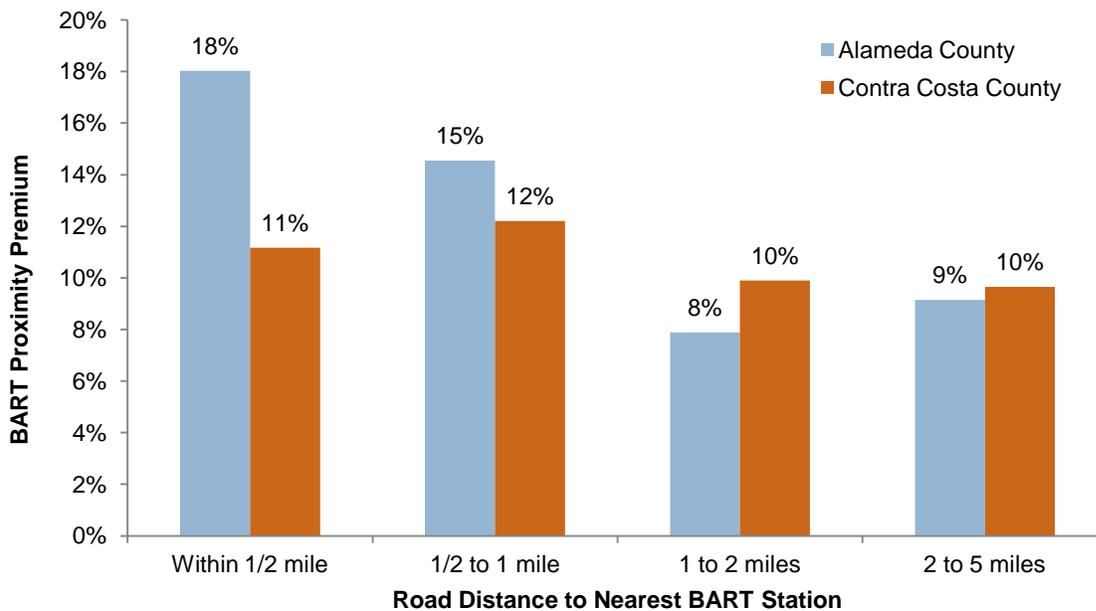
Figure 3. Percentage Price Premiums Associated with Different Distances to BART for Condominiums in the East Bay (Compared to 5 or More Miles from a Station)\*



\*Percentage difference in property value, compared to locations more than 5 road miles from a BART station in the respective county. No statistically significant difference was found between the BART proximity premiums in Alameda and Contra Costa counties.

Source: Strategic Economics, 2014.

Figure 4. Percentage Price Premiums Associated with Different Distances to BART for Single-Family Homes in Alameda and Contra Costa Counties (Compared to 5 or More Miles from a Station)\*



\*Percentage difference in property value, compared to locations more than 5 road miles from a BART station in the respective county.

Source: Strategic Economics, 2014.

### North San Mateo County

As discussed above, the San Mateo County analysis was limited to transactions that occurred in the northern part of the county, including the cities of Daly City, Colma, San Bruno, Millbrae, South San Francisco, Brisbane, and Burlingame. All properties in these seven cities are located within five miles of BART. Therefore, the BART proximity values for San Mateo County are discussed in relationship to values of properties located two to five miles from the nearest BART station, rather than five or more miles from BART.

**The north San Mateo County statistical models produced inconclusive results.** The statistical models of condominium and single-family home prices in north San Mateo County did not meet the assumptions of regression analysis as well as the East Bay model,<sup>8</sup> suggesting that there may be aspects of the north San Mateo County housing market that are not adequately captured. For example, there may be differences in neighborhood character and quality (e.g., related to proximity to amenities, school quality, crime, and/or weather), housing quality, proximity to major employment centers, or other factors that could not be sufficiently accounted for within the scope of this analysis.

**Although the analysis is inconclusive, the results suggest that proximity to BART is associated with increased property values for condominiums.** The analysis indicated that, all else equal, a condominium located within a half mile of BART in San Mateo County is worth 10 percent more than a condominium located two to five miles from a station. For the average condominium, this translates to a \$46,000 premium (Figure 5). The analysis also suggested that properties located up to two miles away from BART continue to command a premium compared to properties located two to five miles from a station (Figure 6).

On the other hand, the analysis of single-family home prices in north San Mateo County found that properties located within a half-mile of BART were, all else equal, worth slightly less than properties located within two to five miles of a BART station (Figure 5). For properties located within a half to one mile of BART, no statistically significant association with property values was found. Homes located within one to two miles of BART commanded a slight (two percent) but statistically significant premium compared to homes located two to five miles away (Figure 7).

**The limited evidence for a premium associated with proximity to BART in north San Mateo County may reflect the relatively recent introduction of BART service in the area, as well as the auto-oriented character of many San Mateo County station areas.** Some research has suggested that real estate markets can take more than a few years after a transit line opens in order to adjust. For example, early studies of the BART system from the 1970s observed reduced property values around some station areas in the East Bay, while more recent analyses have found significant premiums.<sup>9</sup> Previous research in other regions has also found that properties located near transit stations with good pedestrian connections tend to experience greater benefits from proximity to transit, compared

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<sup>8</sup> As discussed in the appendix, the R-square values for the San Mateo County models are high (0.86 for condominiums and 0.824 for single-family residential); however, the residuals are non-normally distributed (negatively skewed and peaked). Normal distribution of residuals is one of the underlying assumptions of linear regression analysis; in the absence of normally distributed residuals, the t-tests (tests of significance) for the coefficients may not be valid. A wide range of different variables were tested to try to correct this problem, including various measures of neighborhood character, land use context, and centrality. Variables for property elevation, dummy variables for the city where the property is located, and variables for distance to Caltrain stations and track were added to the original regional model to help improve the model validity; the other variables tested (concentration of low- and high-income households, household density, and average commute time for the Census Tract; BART station ridership and mode share) appeared to be irrelevant and were omitted.

<sup>9</sup> R. Cervero and J. Landis, "BART at 20: Property Value and Rent Impacts," in *74th Annual Meeting of the Transportation Research Board* (Washington D.C., 1995).

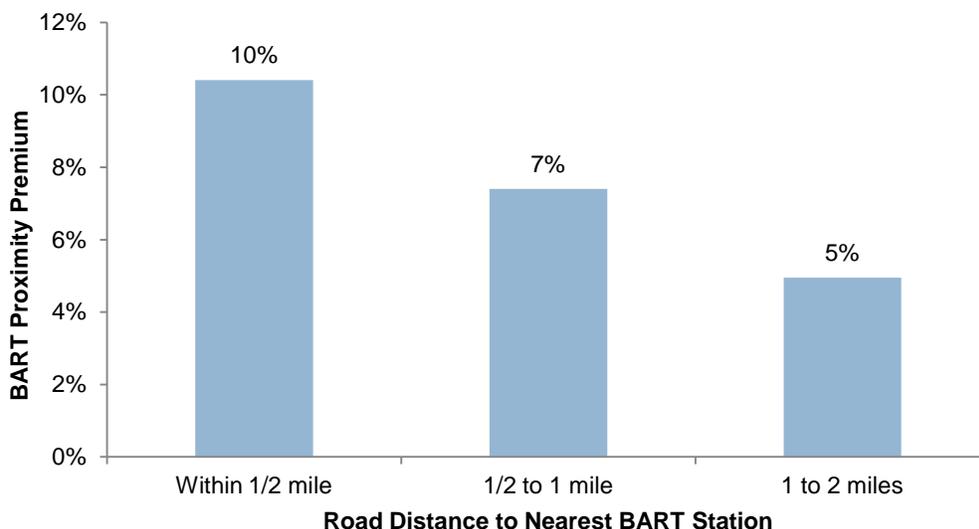
to properties located near “park-and-ride” transit stations or in less walkable neighborhoods.<sup>10</sup> Over time, supportive local land use policy, station connectivity improvements, and new transit-oriented development may make proximity to BART more valuable to San Mateo County homebuyers.

Figure 5. North San Mateo County: Value of Locations within a Half Mile of a BART Station Compared to Locations 2-5 Miles from BART (2012 Values)

Property Type	Predicted Price of an Average Unit		BART Value Premium	
	Within 1/2 Mile of BART	2-5 Miles from BART	Average Dollar Value	Percentage Premium
Condominium	\$488,652	\$442,588	\$46,064	10%
Single-Family Residential	\$763,836	\$783,430	-\$19,594	-3%

Predicted prices were calculated by assuming the mean value for all variables in the model except distance from BART. Source: Strategic Economics, 2014.

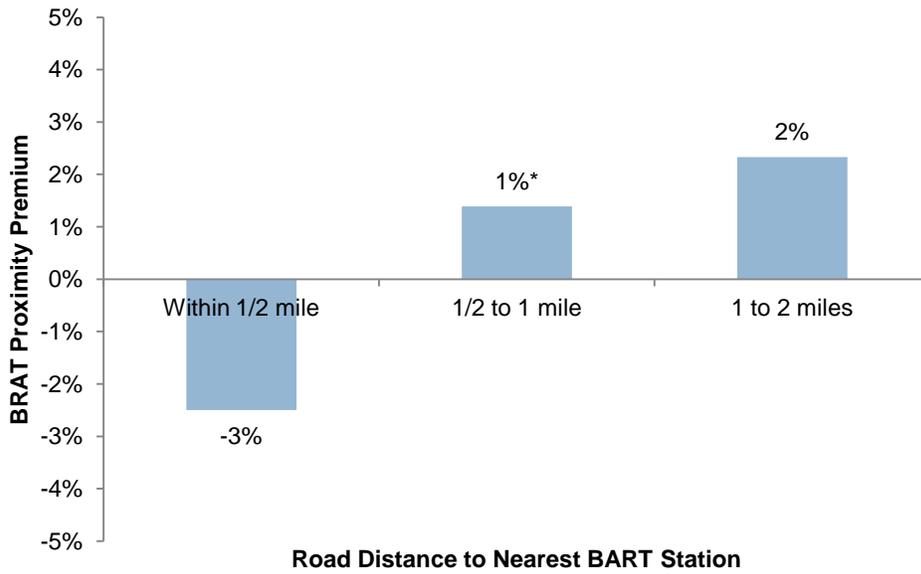
Figure 6. Percentage Price Premiums Associated with Different Distances to BART for Condominiums in North San Mateo County (Compared to 2 to 5 Miles from a Station)\*



\*Percentage difference in property value, compared to locations 2 to 5 road miles from a BART station in the respective county. Source: Strategic Economics, 2014.

<sup>10</sup> Edward G. Goetz et al., *The Hiawatha Line: Impacts on Land Use and Residential Housing Value* (Center for Transportation Studies, University of Minnesota, February 2010), <http://www.cts.umn.edu/Publications/ResearchReports/>; Michael Duncan, “The Impact of Transit-Oriented Development on Housing Prices in San Diego, CA,” *Urban Studies* 48, no. 1 (January 1, 2011): 101–27; Matthew E Kahn, “Gentrification Trends in New Transit-Oriented Communities: Evidence from 14 Cities That Expanded and Built Rail Transit Systems,” *Real Estate Economics* 35, no. 2 (June 1, 2007): 155–82.

Figure 7. Percentage Price Premiums Associated with Different Distances to BART for Single-Family Homes in North San Mateo County (Compared to 2 to 5 Miles from a Station)\*\*



\*Effect is not statistically significant.

\*\*Percentage difference in property value, compared to locations 2 to 5 road miles from a BART station in the respective county.

Source: Strategic Economics, 2014.

## TECHNICAL APPENDIX

This analysis used a series of 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. This analysis modeled the value of a single-family home or condominium as a function of four types of attributes: transportation characteristics (including proximity to a BART station), property attributes, neighborhood characteristics, and control variables (for example, for the year the property was sold and which county it is located in). For more information on the general approach of the analysis, including how the methodology compares to previous analyses such as Cervero and Landis’ “BART at 20” study, see Strategic Economics’ August 2014 report, “Property Value and Fiscal Benefits of BART.”

This appendix provides a brief description of the methodology used to adapt the model described in the August 2014 report in order to analyze property values at the county level. The description is technical and intended to provide guidance for future researchers. Full results from the regression analysis are also shown.

### Home Sales Data

The analysis used a database of all the single-family homes and condominium sales between 2005 and 2012 in Alameda, Contra Costa, and San Mateo Counties, purchased from the commercial vendor DataQuick. Transactions were adjusted to 2012 dollars, using the Consumer Price Index for all Urban Consumers (CPI-U). As described in the August 2014 report, the data were filtered to exclude non-arms-length and distressed transactions, extreme values, and other missing and obviously incorrect data in order to obtain a dataset that would be appropriate for analysis.

In addition to the filters described in the previous report, the data used for this analysis were further filtered to exclude transactions with per-square-foot prices greater than two standard deviations from the mean price for each product type (single-family homes and condominiums) in each respective county. For San Mateo County, the data were restricted to include only transactions in the cities of Daly City, Colma, San Bruno, Millbrae, South San Francisco, Brisbane, and Burlingame (northern San Mateo County). In addition, the small handful of condominiums built before 1960 in San Mateo County were excluded from the model. Figure A-1 shows the number of records in the dataset by county and distance from BART, after filtering the records as described above.

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

Road Distance from Nearest BART Station	Single-Family Homes			Condominiums		
	Alameda County	Contra Costa County	North San Mateo County	Alameda County	Contra Costa County	North San Mateo County
Within 1/2 mile	1,343	867	323	1,275	458	318
1/2 to 1 mile	5,678	3,448	1,517	3,363	1,340	117
1 to 2 miles	17,415	7,414	4,119	5,108	2,233	1,680
2 to 5 miles	27,709	13,080	2,756	7,722	5,790	726
5 or more miles	6,836	33,001	N/A	1,330	5,146	N/A
Total	58,981	57,810	8,715	18,798	14,967	2,841

Source: Strategic Economics, 2014.

## Form of the Statistical Models

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:

$$P_i = f(T, A, N, C)$$

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, freeway interchange, and (for San Mateo County) Caltrain 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.<sup>11</sup>

## Independent Variables

Many variables were tested for this analysis. Figures A-2 through A-4 summarize the variables that were included in the final statistical models, because they were found to contribute to a model that best isolated the property value impact of proximity to BART and met the assumptions needed to justify the use of the regression methodology. The variables are the same as those included in the original, regional model, with a few exceptions. A variable for property elevation was added to all of the models; while elevation was somewhat correlated with median household income, it does not cause overall multicollinearity problems in the model and was found to be an important predictor that helped isolate the value of proximity to BART (particularly in San Mateo and Contra Costa Counties, and for properties located within half to one mile of a station). For the San Mateo County model, fixed-effect (dummy) variables for the city where the property is located and continuous variables for distance to Caltrain stations and track were also added to the original regional model to help account for local conditions and improve the validity of the model. For the East Bay models, interaction variables were used to test how the value associated with proximity to BART differs by county. For condominiums in the East Bay, the interaction was not statistically significant and was omitted.

In addition to the variables shown in Figures A-2 through A-4, a number of other variables were also tested. In the East Bay, interaction variables were used to test how the value associated with proximity to BART might differ by submarket within the counties (e.g., West, Central, and East Contra Costa County) as well as by city; however, these variables were not found to have as significant or consistent effect as the county interaction variables and were ultimately omitted from the model in favor of the county variables. A number of other variables were tested – including concentration of low- and high-income households, household density, and average commute time for the Census Tract, as well as BART station ridership and mode share – in all the models but were not significant and were ultimately omitted.

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<sup>11</sup> Denise DiPasquale and William C. Wheaton, *Urban Economics and Real Estate Markets* (Englewood Cliffs, NJ: Prentice Hall, 1996); N. Edward Coulson, *Hedonic Methods and Housing Markets*, 2008, <http://www.econ.psu.edu/~ecoulson/hedonicmonograph/monog.htm>.

Figure A-2. Variables Included in the Hedonic Regression Model: East Bay Condominiums

Variable	Description	Data Source
<b>Dependent Variable</b>		
Transaction price	Sales price of a given property , adjusted to 2012 dollars.	DataQuick
<b>Transportation Accessibility Variables</b>		
Within 1/2 mile of BART	Property located within 1/2 network 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 network 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 network 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 network miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
5+ mi from BART*	Property located more than 5 network miles from the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
Network distance to nearest freeway on-ramp	Network 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 nearest freeway	Straight-line distance to nearest freeway (feet)	ESRI 2013
<b>Property Attribute Variables</b>		
Unit size	Unit living area (sq. ft.)	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
Elevation	Property elevation (meters)	ESRI 2013
<b>Neighborhood Socio-economic Characteristics</b>		
Median household income	Median household income in Census Tract in which property is located	2007-11 ACS
Percent owner occupied	Percent of housing units occupied by owner in Census Block in which property is located	2010 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 Census
Percent Hispanic or Latino	Hispanic or Latino population as percent of total population in Census Block in which property is located	2010 Census
<b>Control Variables</b>		
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; 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.

Figure A-3. Variables Included in the Hedonic Regression Model: East Bay Single-Family

Variable	Description	Data Source
<b>Dependent Variable</b>		
Transaction price	Sales price of a given property , adjusted to 2012 dollars.	DataQuick
<b>Transportation Accessibility Variables</b>		
[BARTDistance=1.00] x [County=1.00]	Property located in Alameda County and within 1/2 network mile of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=1.00] x [County=2.00]	Property located in Contra Costa County and within 1/2 network mile of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=2.00] x [County=1.00]	Property located in Alameda County and between 1/2 and 1 network mile of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=2.00] x [County=2.00]	Property located in Contra Costa County and between 1/2 and 1 network mile of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=3.00] x [County=1.00]	Property located in Alameda County and between 1 and 2 network miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=3.00] x [County=2.00]	Property located in Contra Costa County and between 1 and 2 network miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=4.00] x [County=1.00]	Property located in Alameda County and between 2 and 5 network miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=4.00] x [County=2.00]	Property located in Contra Costa County and between 2 and 5 network miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=5.00] x [County=1.00]	Property located in Alameda County and more than 5 network miles from the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
[BARTDistance=5.00] x [County=2.00]*	Property located in Contra Costa County and more than 5 network miles from the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
Network distance to freeway on-ramp	Network 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
<b>Property Attribute Variables</b>		
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
Elevation	Property elevation (meters)	ESRI 2013
<b>Neighborhood Socio-economic Characteristics</b>		
Median household income	Median household income in Census Tract in which property is located	2007-11 ACS
Percent owner occupied	Percent of housing units occupied by owner in Census Block in which property is located	2010 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 Census
Percent Hispanic or Latino	Hispanic or Latino population as percent of total population in Census Block in which property is located	2010 Census
<b>Control Variables</b>		
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

Figure A-3, cont'd.

Variable	Description	Data Source
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

\*Omitted dummy variables. Coefficients for dummy variables the regression models should be interpreted in relation to these variables.

Figure A-4. Variables Included in the Hedonic Regression Model: North San Mateo County Condominium and Single-Family Models

Variable	Description	Data Source
<b>Dependent Variable</b>		
Transaction price	Sales price of a given property , adjusted to 2012 dollars.	DataQuick
<b>Transportation Accessibility Variables</b>		
Within 1/2 mile of BART	Property located within 1/2 network 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 network 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 network 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 network miles of the nearest BART station (0=no; 1=yes)	BART 2011; ESRI 2013
Network distance to freeway on-ramp	Network 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
Network distance to Caltrain station	Network distance to nearest Caltrain station (miles)	MTC 2008; ESRI 2013
Euclidean distance to Caltrain ROW	Straight-line distance to nearest Caltrain right-of-way (feet)	MTC 2008; ESRI 2013
<b>Property Attribute Variables</b>		
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); single-family only	
Built 1940-1959	Property built between 1940 and 1959 (0=no; 1=yes); single-family only	
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
Elevation	Property elevation (meters)	ESRI 2013
<b>Neighborhood Socio-economic Characteristics</b>		
Median household income	Median household income in Census Tract in which property is located	2007-11 ACS
Percent owner occupied	Percent of housing units occupied by owner in Census Block in which property is located	2010 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 Census
Percent Hispanic or Latino	Hispanic or Latino population as percent of total population in Census Block in which property is located	2010 Census

Figure A-4, cont'd.

Variable	Description	Data Source
<b>Control Variables</b>		
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
City_Daly	Property located in Daly City (0=no; 1=yes)	DataQuick
City_Colma	Property located in Colma (0=no; 1=yes)	DataQuick
City_Brisbane	Property located in Brisbane (0=no; 1=yes)	DataQuick
City_Burlingame	Property located in Burlingame (0=no; 1=yes)	DataQuick
City_Millbrae	Property located in Millbrae (0=no; 1=yes)	DataQuick
City_SanBruno	Property located in San Bruno (0=no; 1=yes)	DataQuick
City_SSF*	Property located in South San Francisco (0=no; 1=yes)	DataQuick

\*Omitted dummy variables. Coefficients for dummy variables the regression models should be interpreted in relation to these variables.

## Model Results

Figures A-5 through A-7 provide the complete outputs from the models. As discussed above, both the dependent variable (transaction price) and the continuous independent variables have been log transformed. The coefficients shown below can therefore 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.
- **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.

The R-squared for all models is above 0.74. The models were also tested for other measures of validity (including for normality, homoscedasticity, and multicollinearity), in order to ensure that they were robust as possible. The East Bay models generally meet the assumptions for linear regression. However, for the San Mateo County models, the residuals are somewhat non-normally distributed (negatively skewed and peaked) and heteroskedastic. Normal distribution of residuals is one of the underlying assumptions of linear regression analysis; in the absence of normally distributed residuals, the t-tests (tests of significance) for the coefficients may not be valid. A wide range of different variables were tested to try to correct this problem (see description of the independent variables that were tested, above), with limited success. Additional research may be required in order to more fully understand the relationship between home prices and proximity to BART in San Mateo County.

Figure A-5. Model Outputs: East Bay Condominiums

Variable	Coefficients
<b>Transportation Accessibility Variables</b>	
Within 1/2 mile of BART <sup>(a)</sup>	.062*
1/2 to 1 mile from BART <sup>(a)</sup>	.056*
1 to 2 mi from BART <sup>(a)</sup>	.045*
2 to 5 mi from BART <sup>(a)</sup>	.025*
Log of network distance to freeway on-ramp	-.025*
Log of Euclidean distance to BART ROW	.011*
Log of Euclidean distance to freeway	.002
<b>Property Attribute Variables</b>	
Log of unit size	.691*
Log of number of bedrooms	-.006
Log of number of bathrooms	.068*
Built before 1940 <sup>(b)</sup>	.040*
Built 1940-1959 <sup>(b)</sup>	.039*
Built 1960-1979 <sup>(b)</sup>	-.050*
Built 1980-1999 <sup>(b)</sup>	-.021*
Elevation	.006*
<b>Neighborhood Socio-economic Characteristics</b>	
Log of median household income	.101*
Log of percent owner occupied	-.116*
Log of percent Black or African-American	-.417*
Log of percent Hispanic or Latino	-.651*
<b>Control Variables</b>	
YearSold06 <sup>(c)</sup>	.002
YearSold07 <sup>(c)</sup>	-.033*
YearSold08 <sup>(c)</sup>	-.126*
YearSold09 <sup>(c)</sup>	-.189*
YearSold10 <sup>(c)</sup>	-.204*
YearSold11 <sup>(c)</sup>	-.250*
YearSold12 <sup>(c)</sup>	-.235*
High-income city	.039*
Constant	3.107*
R-Squared	.742

\*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.

Figure A-6. Model Outputs: East Bay Single-Family Residential

Variable	Coefficients
<b>Transportation Accessibility Variables</b>	
[BARTDistance=1.00] * [County=1.00] <sup>(a)</sup>	.126*
[BARTDistance=1.00] * [County=2.00] <sup>(a)</sup>	.046*
[BARTDistance=2.00] * [County=1.00] <sup>(a)</sup>	.112*
[BARTDistance=2.00] * [County=2.00] <sup>(a)</sup>	.050*
[BARTDistance=3.00] * [County=1.00] <sup>(a)</sup>	.086*
[BARTDistance=3.00] * [County=2.00] <sup>(a)</sup>	.042*
[BARTDistance=4.00] * [County=1.00] <sup>(a)</sup>	.092*
[BARTDistance=4.00] * [County=2.00] <sup>(a)</sup>	.040*
[BARTDistance=5.00] * [County=1.00] <sup>(a)</sup>	.054*
Log of network distance to freeway on-ramp	-.022*
Log of Euclidean distance to BART ROW	-.021*
Log of Euclidean distance to freeway	.006*
<b>Property Attribute Variables</b>	
Log of unit size	.546*
Log of lot size	.049*
Log of number of bedrooms	-.014*
Log of number of bathrooms	.019*
Built before 1940 <sup>(b)</sup>	.059*
Built 1940-1959 <sup>(b)</sup>	.034*
Built 1960-1979 <sup>(b)</sup>	.026*
Built 1980-1999 <sup>(b)</sup>	.015*
Elevation	.017*
<b>Neighborhood Socio-economic Characteristics</b>	
Log of median household income	.297*
Log of percent owner occupied	-.076*
Log of percent Black or African-American	-.569*
Log of percent Hispanic or Latino	-.699*
<b>Control Variables</b>	
YearSold06 <sup>(c)</sup>	.260*
YearSold07 <sup>(c)</sup>	.258*
YearSold08 <sup>(c)</sup>	.209*
YearSold09 <sup>(c)</sup>	.093*
YearSold10 <sup>(c)</sup>	.028*
YearSold11 <sup>(c)</sup>	.020*
YearSold12 <sup>(c)</sup>	-.012*
Constant	2.261*
R-Squared	.753

\*Statistically significant at the 95% confidence level.

(a) Compared to properties in Contra Costa County 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.

Figure A-7. Model Outputs: North San Mateo County

Variable	Single-Family Model Coefficients	Condominium Model Coefficients
<b>Transportation Accessibility Variables</b>		
Within 1/2 mile of BART <sup>(a)</sup>	-.012*	.043*
1/2 to 1 mile from BART <sup>(a)</sup>	.005	.030*
1 to 2 mi from BART <sup>(a)</sup>	.010*	.020*
Log of network distance to freeway on-ramp	-.036*	.023*
Log of Euclidean distance to BART ROW	-.007	-.014
Log of Euclidean distance to freeway	.022*	.007
Log of network distance to Caltrain station	-.068*	-.018
Log of Euclidean distance to Caltrain ROW	.055*	-.046*
<b>Property Attribute Variables</b>		
Log of unit size	.394*	.543*
Log of lot size	.078*	N/A
Log of number of bedrooms	.042*	.106*
Log of number of bathrooms	.052*	.034
Built before 1940 <sup>(b)</sup>	-.031*	N/A
Built 1940-1959 <sup>(b)</sup>	-.031*	N/A
Built 1960-1979 <sup>(b)</sup>	-.033*	-.069*
Built 1980-1999 <sup>(b)</sup>	-.015*	-.064*
Elevation	.003	.069*
<b>Neighborhood Socio-economic Characteristics</b>		
Log of median household income	.050*	-.086*
Log of percent owner occupied	.068*	-.052*
Log of percent Black or African-American	-.191*	.251*
Log of percent Hispanic or Latino	-.186*	-.152*
<b>Control Variables</b>		
YearSold05 <sup>(c)</sup>	.157*	.238*
YearSold06 <sup>(c)</sup>	.158*	.235*
YearSold07 <sup>(c)</sup>	.140*	.200*
YearSold08 <sup>(c)</sup>	.060*	.117*
YearSold09 <sup>(c)</sup>	.028*	.059*
YearSold10 <sup>(c)</sup>	.016*	.024*
YearSold11 <sup>(c)</sup>	-.015*	-.024*
City_Daly <sup>(d)</sup>	.003	-.021*
City_Colma <sup>(d)</sup>	.003	-.042
City_Brisbane <sup>(d)</sup>	.056*	.017
City_Burlingame <sup>(d)</sup>	.197*	.101*
City_Millbrae <sup>(d)</sup>	.108*	.061*
City_SanBruno <sup>(d)</sup>	.010*	-.023*
Constant	3.774*	4.407*
R-Squared	.824	.863

\*Statistically significant at the 95% confidence level.

(a) Compared to properties located 2 to 5 miles away from the nearest BART station.

(b) Compared to properties built between 2000 and 2012.

(c) Compared to transactions that occurred in 2012.

(d) Compared to properties located in South San Francisco.

Source: Strategic Economics, 2014.