Job growth, housing affordability, and commuting in the Bay Area

A report prepared for the
Bay Area Regional Prosperity Plan
Housing Working Group

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Executive summary

The post-recession growth in employment in the Bay Area has been welcome, but has also created concerns related to rapidly increasing housing prices. Addressing these concerns requires a regional perspective, since growth in high-wage jobs can drive up housing prices across the many jurisdictions where workers live. It also requires attention to equity issues, since high-wage job growth is associated with growth in low-wage service sector jobs. Housing these low-wage workers can be particularly challenging. Planning for an appropriate *fit* between the types of jobs that exist and the types of housing available is one important strategy for achieving an equitable region.

This study sought to help the Metropolitan Transportation Commission answer the question "How does growth in high-wage jobs in one jurisdiction affect low-wage job growth and affordable housing demand in multiple jurisdictions?" Using several publicly available datasets produced by the US Census Bureau, we constructed comparable and reproducible temporal and geographic datasets to quantify changes over time and examine potential relationships between changes in job numbers, housing affordability, and commuting behavior. The analysis of data available to date revealed a number of key findings:

- Low-wage job growth is heavily focused in the largest three cities of San Francisco, San Jose, and Oakland whereas high-wage job growth is more geographically dispersed, including parts of Silicon Valley and the East Bay.
- In general, growth in high-wage jobs is clearly associated with growth in low-wage jobs in the largest Bay Area jurisdictions. In smaller jurisdictions the relationship is weaker.
- Measures of total housing indicate that most jurisdictions added housing in proportion to total jobs in the time period under study. Yet disaggregating these values by wage level and housing affordability reveals key imbalances.
- In the time period under study, San Francisco was responsible for the largest growth in low-wage jobs but experienced no net increase in the number of affordable housing units available. In the same time period, Oakland added both low-wage jobs and had an increase in affordable housing while San Jose lost low-wage jobs but had an increase in affordable housing.
- Throughout the Bay Area, new low-wage workers are commuting further than new workers making higher wages. In San Francisco, new workers in the lowest wage category have to travel 4.4 times further than new workers in the highest wage category.
- There is some evidence that these commute patterns are driven by workers in some jurisdictions seeking housing in more affordable locales, but additional research is needed to quantify this effect.

Overall, these findings provide evidence of the links between job growth and housing affordability across wage levels and housing affordability thresholds. They also support the argument that regional planning and coordination of economic development and affordable housing initiatives is important for addressing the jobs/housing imbalance at different wage levels. These findings also suggest that improving jobs-housing fit can contribute to reduced commute travel, improving overall regional environmental performance. Key results for the Bay Area's three largest cities – San Francisco, San Jose, and Oakland – are summarized below.

Job growth and housing affordability in San Francisco, San Jose, and Oakland

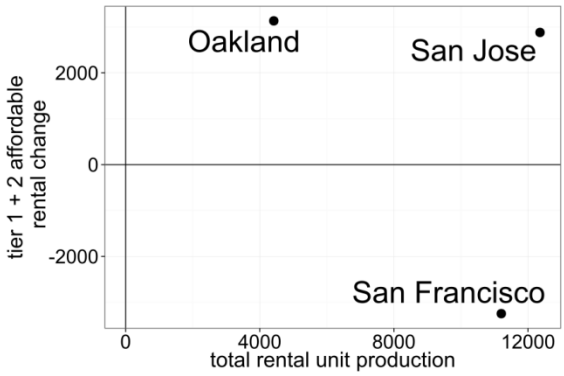
There were approximately 3.2 million jobs in the nine-county Bay Area in 2011. Three cities accounted for just over a third of the total: San Francisco (590,000), San Jose (365,000), and Oakland (198,000). In addition to total jobs, these three cities also employ substantial numbers of low-wage workers. About 1.5 million jobs in the Bay Area pay less than $40,000 per year and about 40% of those are located in these three largest cities.

In addition to being vibrant employment centers, San Francisco, San Jose and Oakland are also important housing centers, and a substantial portion of people who work in these cities also live there. The proportion of jobs in each of the cities held by local residents is shown in the table below for three different tiers of monthly wage levels. For example, 49.2 percent of people employed in tier 1 jobs (earning less than $1,250 per month) in San Francisco live in the city, while only 37.3% of people earning more than $3,333 a month live in the city. In general, higher proportions of workers earning in the lowest two tiers of wages are located in each city as compared to the highest tier. Other cities in the Bay Area generally have much lower rates of internal capture than these three, indicating that the relative match of jobs and housing units in San Francisco, San Jose, and Oakland, at least for existing workers, is high.

Proportion of total jobs held by residents of each city by monthly wage category, 2011

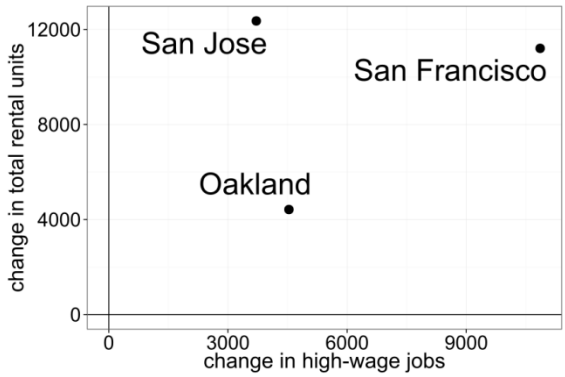
	Tier 1: < $1,250	Tier 2: $1,250 - $3,333	Tier 3: > $3,333/month
San Francisco	49.2	43.9	37.3
San Jose	50.8	47.6	39.8
Oakland	35.3	27.7	17.3

But the Bay Area is changing. To understand how growth in jobs and shifts in housing affordability across the Bay Area might be affecting the ability of those on the lower end of the income spectrum to afford local housing, we examined rental unit production and affordability shifts using the most recent data available. Rental units dominate total housing growth in the Bay Area and are particularly important for low-wage workers that are less likely to own their homes than higher earners.



Change in total and affordable rental units: 2013-2011 compared to 2010-2008 three-year

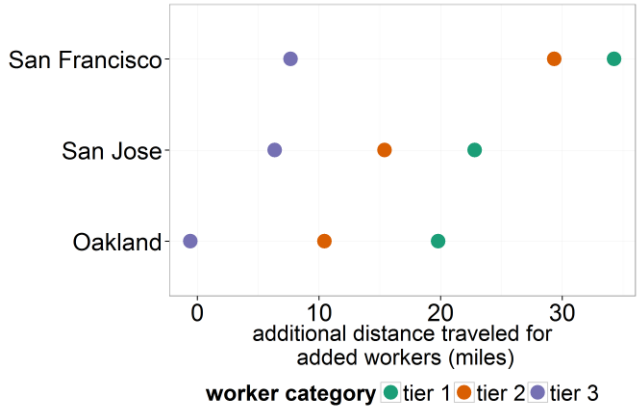
The figure at right compares total rental unit production to the change in rental units that are affordable for the lowest two income tiers. The figure clearly shows that total rental unit production is high in each of the three cities, but San Francisco lost affordable units and the increase in the number of affordable units in Oakland and especially San Jose are small compared to overall housing unit production. This is potentially a problem, especially in San Francisco, because it was the top city for growth in these low-wage jobs, adding 6,600 when comparing 2011 to the prior three-year period. Oakland saw affordable units grow roughly in proportion to the number of low-wage jobs added, while San Jose actually saw a decline in low-wage jobs over the time period.



Change in total rental units and high wage jobs

The situation on the other end of the income spectrum offers an important point of comparison. We grouped employment categories from sectors with relatively high wages, including information technology, finance, management, and professional services, to create a “high-wage” category. In general, total rental unit growth either exceeded or closely tracked growth in these high wage categories, as shown in the figure at left. The contrast between the change in total units as compared to affordable units provides some evidence that historical patterns of housing large numbers of low-wage workers in these three cities (as measured by internal capture) could be changing.

There is a strong equity argument to be made that cities experiencing growth in low-wage jobs should provide housing affordable to those workers. But there is also a very strong environmental argument to be made as well. To the extent that low-wage workers are unable to find housing in the cities where they are employed, they will have to look farther afield. We examined changes in the commute patterns of workers employed in the big three cities to determine both whether this shift was occurring and whether it differed for workers in each income tier. We looked at the commute patterns of new workers in 2011—that is the net increase in workers commuting to each of the three big cities from each residential jurisdiction—compared to existing workers (the average for the 2008-2010 period). The results are shown in the figure at right, which shows precisely how much further added workers are travelling to work in San Francisco, San Jose and Oakland than are existing workers.



Additional commute distance for added workers

The results demonstrate the very real challenges posed by ongoing shifts in housing affordability in the Bay Area. In general, added workers were commuting much further to work in the three major employment centers, but the burden of increasing commute distance was not equitably distributed. For each of the three big cities, tier 1 workers, those earning less than $15,000 per year, had to travel much further than workers employed in jobs earning more than $40,000 per year. This disparity was greatest in San Francisco and smallest in Oakland, but all three cities followed the same pattern.

As California continues to pursue its climate change goals through integrated transportation and land use policy and planning, these results demonstrate the vital importance of a regional equity lens. Low-wage workers are more likely to use public transit when available but are also more likely to drive older, more polluting automobiles when it is not. Ensuring that the housing stock exists in employment centers to house low-wage workers is not only social equitable but it may also provide important environmental (reduced emissions and congestion) benefits as well.

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1.0 Introduction

The post-recession growth in employment in the Bay Area has been welcome, but has also created concerns related to rapidly increasing housing prices. Indeed real estate markets in Silicon Valley, San Francisco, and elsewhere have become unaffordable for all but the area's wealthiest residents.[1] At the same time, growth in jobs – both high- and low-wage – in these locations creates increasing demand for housing, frequently resulting in low-wage workers being unable to locate close to where they work, and having to endure sometimes long and expensive commutes.

The authors of this study were retained by the Metropolitan Transportation Commission as part of the US Department of Housing and Urban Development-funded Regional Prosperity Plan to analyze patterns of jobs growth and decline and their relationship to housing affordability. The central research question was: how is the growth in high-wage jobs related to changes in low-wage jobs and housing affordability within and across jurisdictions in the Bay Area?

We have combined two publicly available data sources created and maintained by the US Census Bureau to provide insight into these housing and labor market changes. The two data sources are:

1) the Longitudinal Employer-Household Dynamics Origin-Destination Employment Survey (LODES) from which we extracted workplace area characteristics (jobs), residence area characteristics (resident workers), and commute flow data for 2008 - 2011 and
2) the three-year American Community Survey (ACS) estimates from which we extracted information on housing price and value for rental and owner-occupied units for 2008-2010 and 2011-2013.

These two sources have various limitations, but provide the best opportunity to shed light on the problem of growth and affordability using publicly available data. Additionally, the Census Bureau annually updates these data (though for various administrative reasons, post-2011 LODES data releases are behind schedule). In addition to these two main sources, we employed other publicly available data to derive estimates of commute distances. The methods developed here, along with the analysis and figures presented below, are all reproducible using the open source statistics and visualization software R.[2] All scripts needed to conduct the analysis and generate the included figures are located on the project's GitHub page. As new data are released, the analyses can be easily updated so that changes can be tracked over time.

A key finding of the work is that the Bay Area cities adding the greatest numbers of jobs in high wage categories are also the jurisdictions experiencing the greatest growth in lower wage

[1] Carlyle, Erin. "San Francisco Tops Forbes' 2015 List of Worst Cities for Renters." Forbes. April 16, 2015. http://www.forbes.com/sites/erincarlyle/2015/04/16/san-francisco-tops-forbes-2015-list-of-worst-cities-for-renters/; Carlton, Jim. "Bay Area Rally Sends Rents Soaring." The Wall Street Journal. July 16, 2013. http://www.wsj.com/articles/SB10001424127887324694904578602013087282582; Harrison, Laird. "Silicon Valley Has Nation's Highest Rents." KQED News. April 16, 2013. http://ww2.kqed.org/news/2013/04/16/silicon-valley-has-nations-highest-rents.

[2] Visualizations used the package ggplot2. Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. New York, Springer.

categories. At the same time, these jurisdictions are generally not experiencing increases in housing that is affordable to workers employed in low-wage jobs. Total housing numbers in these same cities has increased over the time period of the study, which means that the housing that is being added is appropriate only for those earning on the higher ends of the income distribution. In general, at the scale of individual jurisdictions, housing growth is more likely to track growth in high-wage jobs over the six year period under study. Low-wage workers employed in jobs created directly or indirectly as a result of this growth in high-wage jobs must seek housing in the Bay Area's more peripheral jurisdictions.

The analysis also underscores the challenges associated with using traditional, aggregate measures of jobs-housing balance to gauge the adequacy of the supply of housing in relation to jobs. In many cases, when the change in total housing units and total jobs is viewed at the jurisdiction level, growth in both categories appear to be moving in the same direction. When the total balance is disaggregated into measures of *jobs-housing fit,* however, discrepancies become apparent. These findings underscore the importance of matching the wage levels of locally-available jobs to the affordability of locally available housing to achieve equitable regions and also desirable environmental outcomes like reduced vehicle-miles traveled (VMT).

This report is structured as follows. We first provide a detailed overview of the data sources and methods employed in the analysis, followed by a geographic summary of changes in high/low wage jobs across the Bay Area. We determine where jobs at different wage levels have grown and how closely those changes are related. To examine patterns in housing affordability, the next section addresses how housing numbers in different affordability categories have changed when comparing 2008-2010 with 2011-2013 for the 19 jurisdictions with consistently available three-year ACS data. These are subsequently compared to job changes to identify whether housing and job growth and decline are related. The final section looks at the effect of the identified changes for places-of-work in the Bay Area to understand whether added workers have to travel further and seek out housing in more affordable locales. Some important implications for regionally equitable planning and environmental policy are also discussed in this section.

2.0 Data and methods

2.1 Jobs and housing

We employ a number of publicly available data sources to conduct the analysis of Bay Area job and housing changes. Two key sources embody important differences in methodology and coverage that partially constrain the analysis of the relationship between jobs and housing that can be conducted since we are limited by the variables included in each data source as well as the time periods for which data are collected. Importantly, LODES data are the best source of data on different types of jobs at a local level, with information available with complete geographic coverage annually because they are partly reported by employers and partly simulated by the census. This means that we have full information for all Bay Area jurisdictions for all LODES variables including workplace and residence location for job categories by wage level, industry classification, and age of worker. On the other hand, ACS data are the best data

source on housing, but it is based on a survey of people and housing units conducted by the Census Bureau each year. As such they do not offer complete coverage. This means that analyses that compare jobs and housing unit characteristics will be limited to those jurisdictions that have data available in the ACS.

Because the driving questions for our research involved assessing changes over time, we had to establish a basis for comparison that accounted for the limitations of both the LODES and the ACS datasets. The ACS data were the limiting factor, since they are available in one, three, and five year data-sets and do not offer complete geographic coverage. The correct interpretation of the ACS data that span multiple years is that they represent an average annual value over the time period. Ideally, we would match ACS one-year datasets with each year of LODES data, but the geographic coverage for the one year data are very poor; because the ACS survey is only conducted on a relatively low number of respondents each year, aggregating the data over multiple years is essential for increasing the coverage and reducing the margins of error (the confidence we have in each estimate). The five year data would offer the most extensive geographic coverage, but present additional challenges in terms of assessing changes over time. If partially overlapping five year periods are used, it becomes increasingly difficult to demonstrate that a difference is statistically different from zero. The most temporally distinct five year datasets available -- 2009-2013 and 2005-2009 -- overlap only one year, but the earlier data-set include much data from the depths of the recession. We elected to compare two three-year datasets that would allow us to attain acceptable geographic coverage including the Bay Area's largest employers and avoid including data from the recession. Specifically, we used the 2013 and 2010 ACS three year datasets. These datasets facilitate a comparison of average annual values from 2008-2010 with 2011-2013. To match the LODES data with the ACS, we constructed a three year average LODES dataset for 2008-2010. Because the most recent LODES year available as of this writing is 2011, we used 2011 as the basis of comparison with 2011-2013. When the next LODES release takes place, we can easily update the analysis to create completely consistent comparison groups.

The geographic scale of the analysis was another important analytical consideration. Under California law, the jurisdiction is a particularly important unit. It is cities and towns across the state that control land use and can provide incentives or disincentives for the construction of various types of housing. They can also pursue economic development policies to attract jobs or dissuade employers in order to maintain a residential character. Similarly, it is often at the local level that resistance to or support for particular housing projects, economic development efforts, or neighborhood changes are expressed. In our analysis, we focus on jurisdictions because of the inherent equitability and environmental benefits of living and working in the same city. Using jurisdictions also allows us to use ACS data that are more consistent and reliable. The 19 Bay Area jurisdictions for which there are data on housing unit costs across both three year periods are shown in Table 1. The 1.8 million jobs contained in these 19 jurisdictions accounted for 57% of the Bay Area's total 3.2 million jobs according to the LODES data in 2011. LODES data were aggregated to the jurisdiction level using appropriate geographic crosswalks.

Another important concern relates to the wage categories used within LODES. A goal of this analysis is to differentiate the effects of job growth in different income categories. LODES contains three income categories, but they are rather coarse, especially for the Bay Area. Here, we refer to these categories as “tiers” of wages. They are: tier 1 (< $1,251/month or ~$15,000/year), tier 2 ($1,251 - $3,333/month or ~$15,000 - ~$40,000/year), tier 3 (> $3,333/month or $40,000/year). LODES data also include two-digit North American Industry Classification (NAICS) categories, which allow for the analysis of a much wider range of income categories. These are summarized in Table 2 along with their average annual wages and we use these where possible. Also highlighted in Table 2 are two aggregated NAICS categories that we use to refer to low-wage and high-wage worker. The high-wage NAICS category is composed of information (NAICS 51), finance and Insurance (NAICS 52), professional and technical services (NAICS 54), and management of companies and enterprises (NAICS 55). The low-wage NAICS category is composed of retail trade (NAICS 44-45), administrative/support/waste remediation (NAICS 56), arts, entertainment, and recreation (NAICS 71), accommodation and food services (NAICS 72), and other services (NAICS 81).

Table 1: Bay Area jurisdictions with housing data consistently available in the 2013 and 2010 three-year datasets.

Jurisdiction	Total LODES jobs (2011)
San Francisco	589,717
San Jose	364,772
Oakland	197,708
Fremont	87,368
Sunnyvale	82,030
Santa Rosa	67,502
Hayward	64,865
Mountain View	53,707
Redwood City	49,845
Concord	48,539
San Leandro	38,742
Fairfield	37,047
Vallejo	30,096
Napa	28,488
Richmond	28,470
Vacaville	28,320
Union City	20,210
Antioch	18,923
Pittsburg	13,163
TOTAL	**1,849,512**

Table 2: Employment categories used in the analysis.

Employment category	LODES variable	Notes
Wage tier		
Wage level: Tier 1 (lowest), Tier 2 (middle), Tier 3 (highest)	CE01, CE02, CE03	Limited by coarse categories
Low-wage NAICS		
NAICS 44-45: Retail trade	CNS07	Average annual wage: $32,200[a]
NAICS 56: Administrative and support and waste management and remediation services	CNS14	Average annual wage: $39,800[a]
NAICS 71: Arts, entertainment, and recreation	CNS17	Average annual wage: $42,400[a]
NAICS 72: Accommodation and food services	CNS18	Average annual wage: $19,800[a]
NAICS 81: Other services (except public administration)	CNS19	Average annual wage: $34,200[a]
High-wage NAICS		
NAICS 51: Information	CNS09	Average annual wage: $147,000[a]
NAICS 52: Finance and insurance	CNS10	Average annual wage: $131,000[a]
NAICS 54: Professional and technical services	CNS12	Average annual wage: $104,000[a]
NAICS 55: Management of companies and enterprises	CNS13	Average annual wage: $141,000[a]
Other		
NAICS 11: Agriculture, forestry, fishing, and hunting	CNS01	Average annual wage: $25,740[a]
NAICS 21: Mining, quarrying, oil and gas extraction	CNS02	Average annual wage: $147,000[a]
NAICS 22: Utilities	CNS03	Average annual wage: $146,000[a]
NAICS 23: Construction	CNS04	Average annual wage: $56,600[a]
NAICS 31-33: Manufacturing	CNS05	Average annual wage: $84,300[a]
NAICS 42: Wholesale trade	CNS06	Average annual wage: $73,000[a]
NAICS 48-49: Transportation and warehousing	CNS08	Average annual wage: $50,000[a]
NAICS 53: Real estate and rental and leasing	CNS11	Average annual wage: $62,600[a]
NAICS 61: Educational services	CNS15	Average annual wage: $46,300[a]
NAICS 62: Health care and social assistance	CNS16	Average annual wage: $45,600[a]
NAICS 92: Public administration	CNS20	Average annual wage: Unknown

[a]Source: BLS Quarterly Census of Employment and Wages, First Quarter, 2014, California Average from: http://www.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables.

2.2 Commute distance

In order to determine the effect of shifts in job and housing markets on commute distances, we analyzed the LODES data on commute flows, combined with origin-destination distance-traveled data available from the Metropolitan Transportation Commission (MTC) and Google Maps. The aim of this analysis is to understand how far commuters are traveling to reach each Bay Area jurisdiction in locations where there are a greater number of commuters in the most recent year as compared to the prior three-year period. LODES data provide annual estimates of origin and destination flows for all employed residents to jobs at the census block level by income tier (tier 1, tier 2, tier 3), age (< 29, 30-54, >55), and broad industry category. The broad industry categories are summarized in Table 3 and are generally far too aggregate to draw meaningful conclusions. We therefore do not consider this category in the main analyses. We aggregated these data up to the jurisdiction for all work and residence locations in the Bay Area. Flows for workers employed in the Bay Area but living outside were summarized at the county level. All jurisdictions and counties were identified by their population-weighted centroid using census block populations nested within the larger geographies,[3] between which roadway distances were subsequently calculated. These distances assumed the actual roadway network, using calculated origin-destination values from travel model runs conducted for MTC's Plan Bay Area 2010 base year by associating particular transportation analysis zones (TAZs) with the population-weighted centroid for jurisdictions. For the county-based flows originating outside of the Bay Area, we used R combined with a Google Maps API query to generate roadway distances. Apparent net increases for origins located in Southern California counties (including San Luis Obispo, Kern, San Bernardino, Santa Barbara, Ventura, Los Angeles, Orange, Riverside, San Diego, and Imperial) were excluded from the analysis.

Table 3: Mapping of broad industry category in the LODES commute flow data to specific NAICS codes.

LODES group	NAICS codes
Goods producing	11 (Agriculture, forestry, etc.), 21 (Mining, quarrying, etc.), 23 (Construction), 31-33 (Manufacturing)
Trade, transportation, and utilities	22 (Utilities), 42 (Wholesale trade), 44-45 (Retail trade), 48-49 (Transportation and warehousing)
All other services	51 (Information), 52 (Finance and insurance), 53 (Real estate), 54 (Professional), 55 (Management), 56 (Administrative), 61 (Educational services), 62 (Health care), 71 (Arts, entertainment, recreation), 72 (Accommodation and food services), 81 (Other services [except public administration]), 92 (Public administration)

These calculated distances allowed us to estimate how far workers employed in each Bay Area jurisdiction travel to work and how that has changed over time. Specifically, we calculated a difference in the weighted average commute distance for each workplace jurisdiction, using the flows as weights as summarized in equation 1:

[3] The population-weighted centroid is a spatial average location within a jurisdiction or county representing our best estimate of a single point where the population is concentrated.

$$\frac{\sum_i (t_{ij}^b - t_{ij}^a) \times d_{ij}}{\sum_i (t_{ij}^b - t_{ij}^a)} - \frac{\sum_i t_{ij}^a \times d_{ij}}{\sum_i t_{ij}^a} \; \forall \; t_{ij}^b - t_{ij}^a > 0 \qquad (1)$$

where *i* indexes origin locations, *j* indexes workplace locations, *a* represents 2008-2010 values, *b* represents 2011, t_{ij} is the number of trips from *i* to *j*, and d_{ij} is the distance from origin location *i* to workplace destination *j*. The difference between 2011 and 2008-2010 flows can represent a number of situations, depending on whether the values are positive (i.e. greater in 2011) or negative (i.e. less in 2011). Specifically, increased flows may represent entirely new jobs created in the destination jurisdiction, the shift of a particular job to a different employee, or the move of an existing employee to a new location. Similarly, decreases may represent the elimination of particular jobs in the destination jurisdiction, the shift of a particular job to a different employee, or the move of an existing employee to a new location. Of course, the net result for a particular origin-destination pair can represent a combination of both positive and negative changes. Because we cannot differentiate between these different possibilities in the LODES data, we have chosen to focus only on the locations with net increases in jobs in 2011. This figure will capture shifts in commute patterns due to new employment and shifts in existing jobs, but in situations where jobs were actually lost in 2011 relative to the earlier period, the result might slightly overestimate or underestimate the commute distances of new workers because it will not adjust the 2008-2010 estimate to account for these changes. However, because most Bay Area jurisdictions generally saw growth or small (in percentage terms) declines in jobs by category (see discussion in section 3.1 below), the result of equation 1 is likely to accurately reflect the distance traveled by new or moved employees to each jurisdiction relative to the base year conditions.

2.3 Median rent and vacancy rates

Shifting jobs and housing affordability in the Bay Area might affect the residential preferences of workers. We examined this possibility by using median rental prices and rental vacancy rates as determined from the 2009-2013 five-year ACS estimates for each Bay Area jurisdiction. Similar to the commute distance analysis, here we calculated the difference between median contract rent, median asking rent, and vacancy rates in jurisdictions where there was a net increase of workers in 2011 relative to 2010. This calculation is summarized in equation 2:

$$\frac{\sum_i (t_{ij}^b - t_{ij}^a) \times h_i}{\sum_i (t_{ij}^b - t_{ij}^a)} - \frac{\sum_i t_{ij}^a \times h_i}{\sum_i t_{ij}^a} \; \forall \; t_{ij}^b - t_{ij}^a > 0 \qquad (2)$$

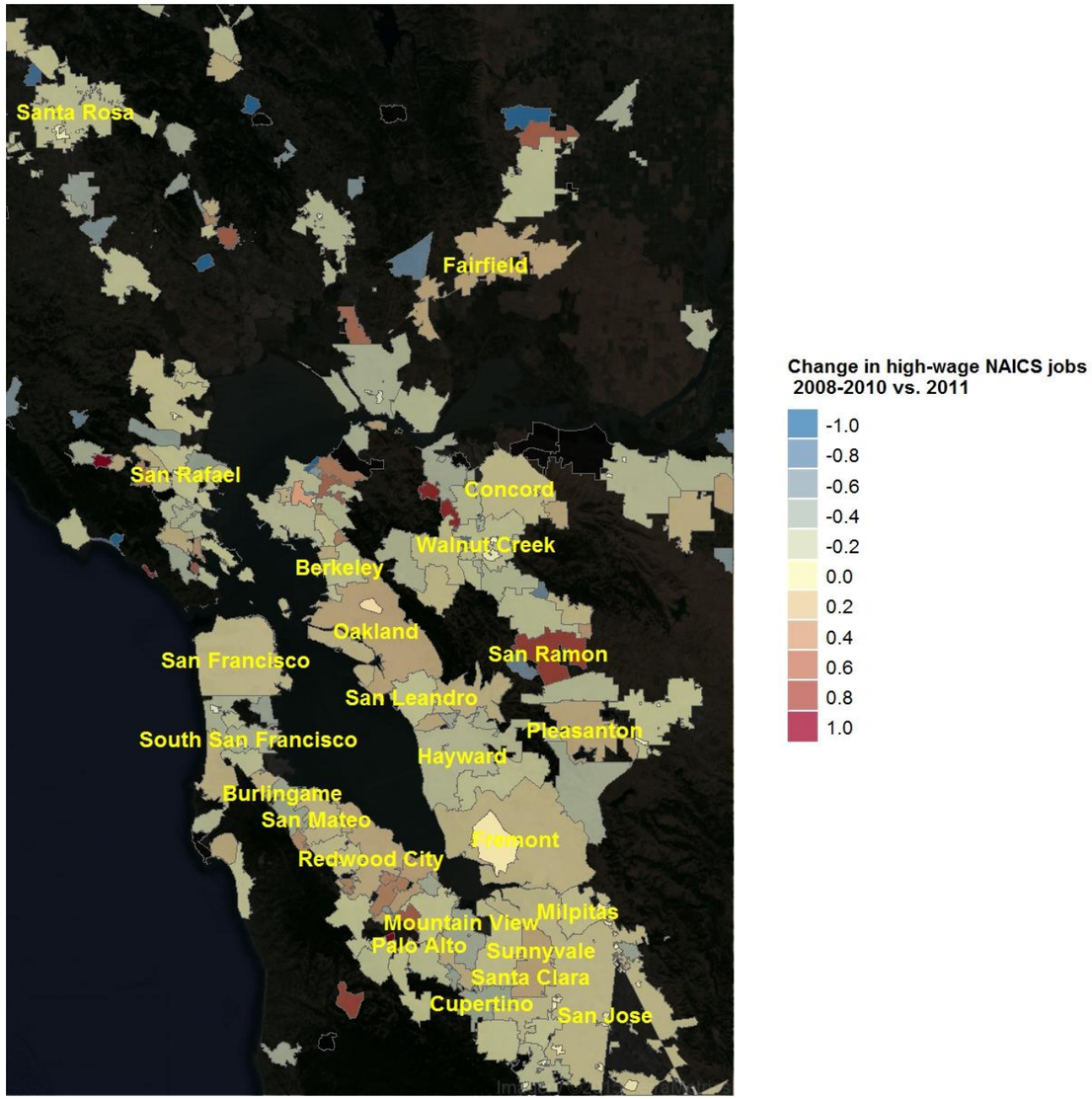
where *i* indexes origin locations, *j* indexes workplace locations, a represents 2008-2010 values, *b* represents 2011, t_{ij} is the number of trips from *i* to *j*, and h_i is the housing market characteristic of interest (one of median contract rent or vacancy rate). Median contract rent for occupied units was taken from table B25056 and vacancy rates from table B25004. The calculated vacancy rate used only for-rent vacant units as the numerator and the sum of renter-occupied housing units, vacant-for-rent and rented, not occupied housing units as the denominator.

3.0 Within-jurisdiction job growth and decline (2008-2010 vs. 2011)

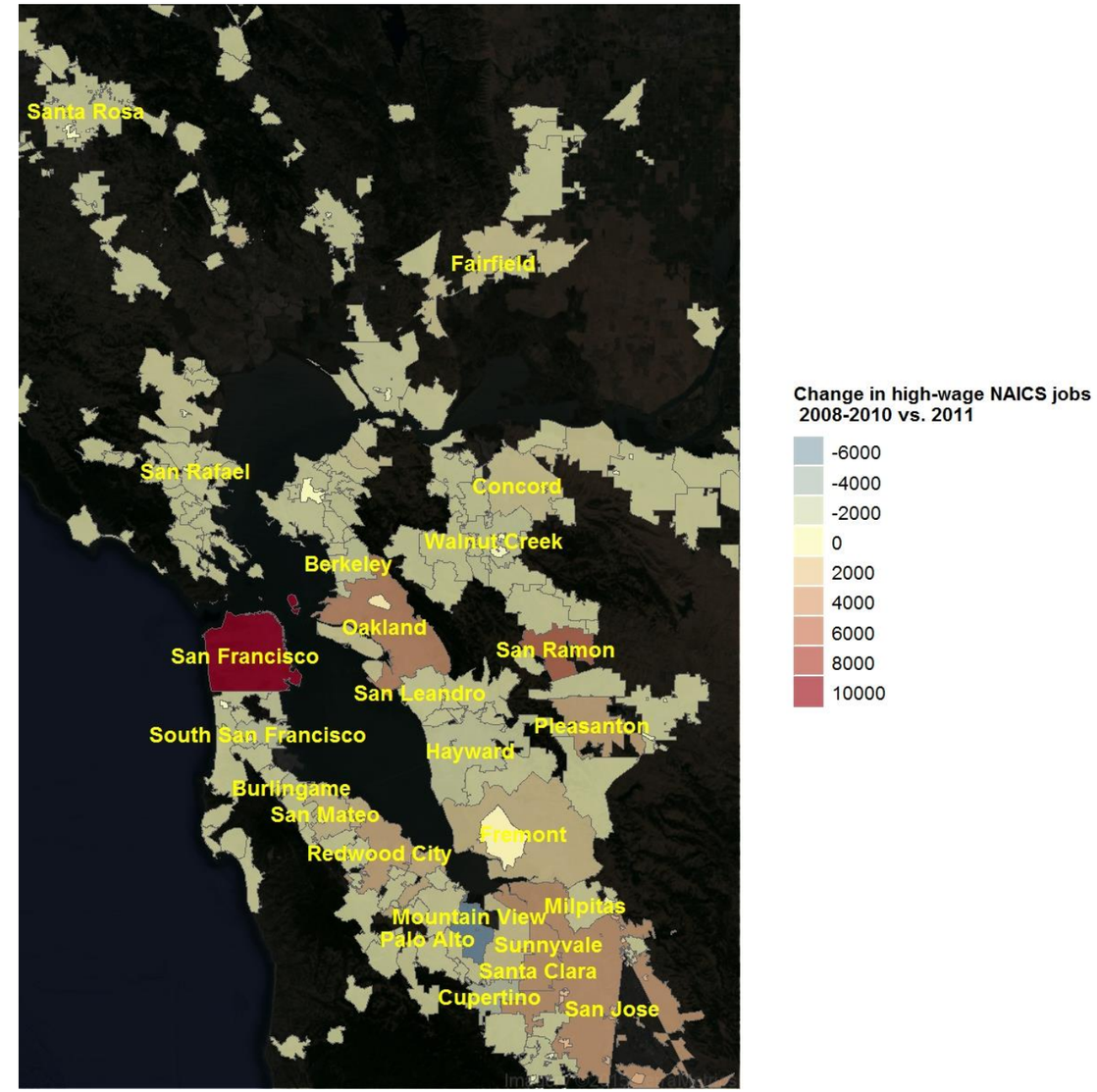
Below, we illustrate the rate of job growth and decline by wage level and NAICS category for all Bay Area jurisdictions using the LODES data to calculate a difference between 2011 compared to the three-year average period from 2008-2010. For each figure, percentage changes for jurisdictions are shown in the left pane and absolute changes are shown in the right pane. Positive values mean that total job numbers grew in 2011 relative to the prior three-year period and negative numbers mean that jobs declined over the same period. We summarize trends in high-wage jobs first followed by trends in low wage jobs, using aggregations of NAICS categories as one representation of each. We also examine wage levels, but for ongoing analysis these are less useful than the NAICS categories. Because the LODES data rely on static wage categories, the number of employees in each will change each year simply as a result of inflation. It is not possible to separate this inflation effect from actual changes in job numbers within a particular wage tier.

3.1 High-wage job growth and decline

Figure 1 shows the locations of those Bay Area jurisdictions that gained/lost high wage jobs in 2011 vs. the three year average period of 2008-2010. Although some smaller jurisdictions lost high wage jobs, proportionally, these were generally not in substantial absolute numbers. One exception is Mountain View, which lost about 7,000 high-wage NAICS jobs over the analysis period. In general, however, the largest numbers of high-wage jobs were created in the inner Bay Area - San Francisco, Silicon Valley, and parts of the East Bay including Oakland, San Ramon, and Pleasanton. Figure 2 shows the changes in jobs for the tier 3 wage category included in the LODES that counts all jobs earning greater than $3,333/month. Tier 3 job growth is concentrated in San Francisco, San Jose, and Oakland with some modest growth in nearby cities in Silicon Valley and the East Bay.

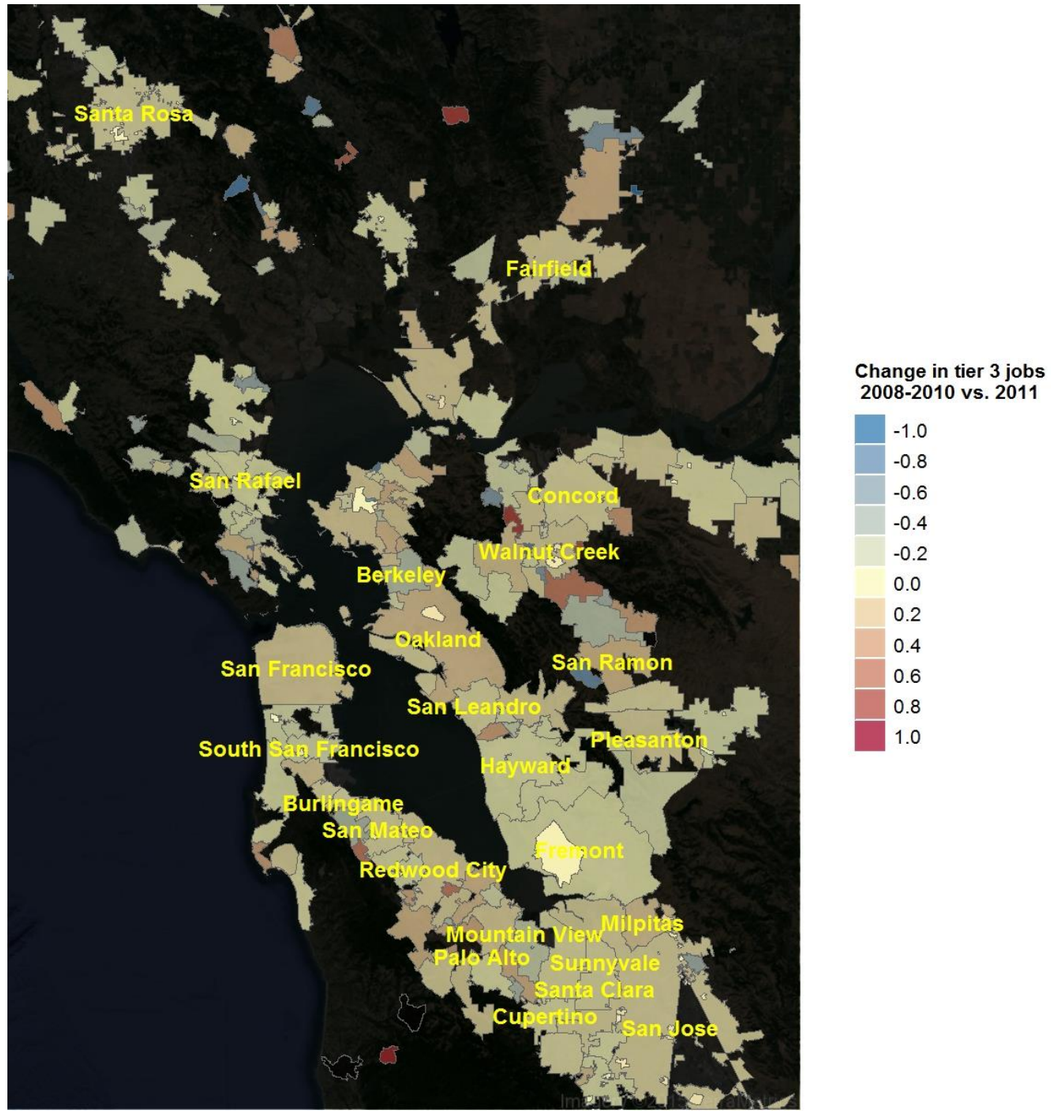


(a)

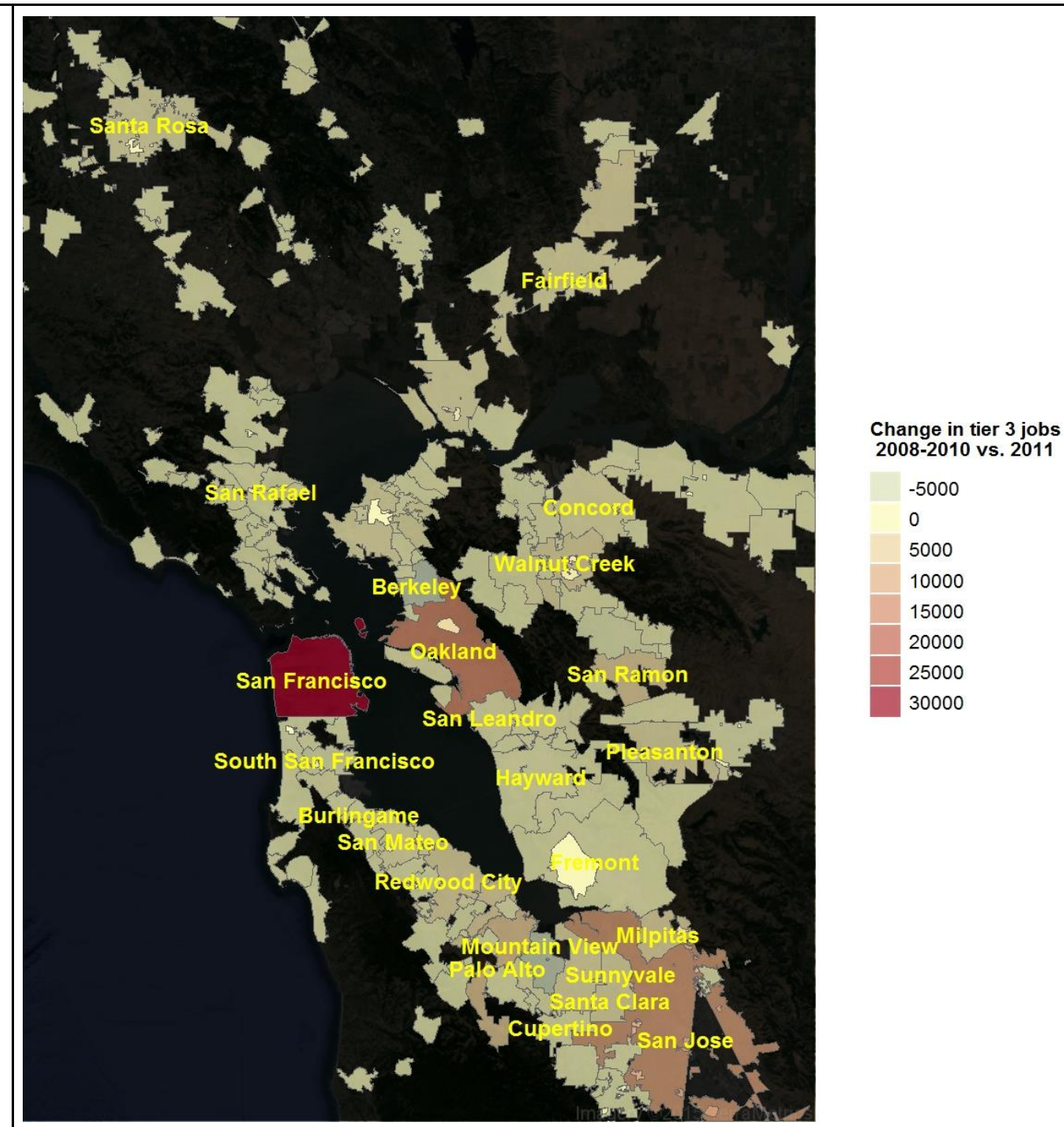


(b)

Figure 1: Percentage (a) and absolute (b) change in jobs for aggregate high-wage NAICS categories, 2008-2010 vs 2011. The high wage category includes information (NAICS 51), finance and Insurance (NAICS 52), professional and technical services (NAICS 54), and management of companies and enterprises (NAICS 55).



(a)



(b)

Figure 2: Percentage (a) and absolute (b) change in jobs for jobs in the Tier 3 (> $3,333/month) wage category.

3.2 Low-wage job growth and decline

Growth in low-wage jobs, according to aggregate NAICS codes, has been concentrated in San Francisco, San Jose, and Oakland (Figure 3). Most of the other jurisdictions show slight increases or decreases. Figures 4 and 5 illustrate the changes for tier 1 and tier 2 jobs, respectively. Figure 4 shows that, in general, the trend for the very low-wage tier 1 jobs has been to decrease in absolute terms across the Bay Area except in the three largest cities.

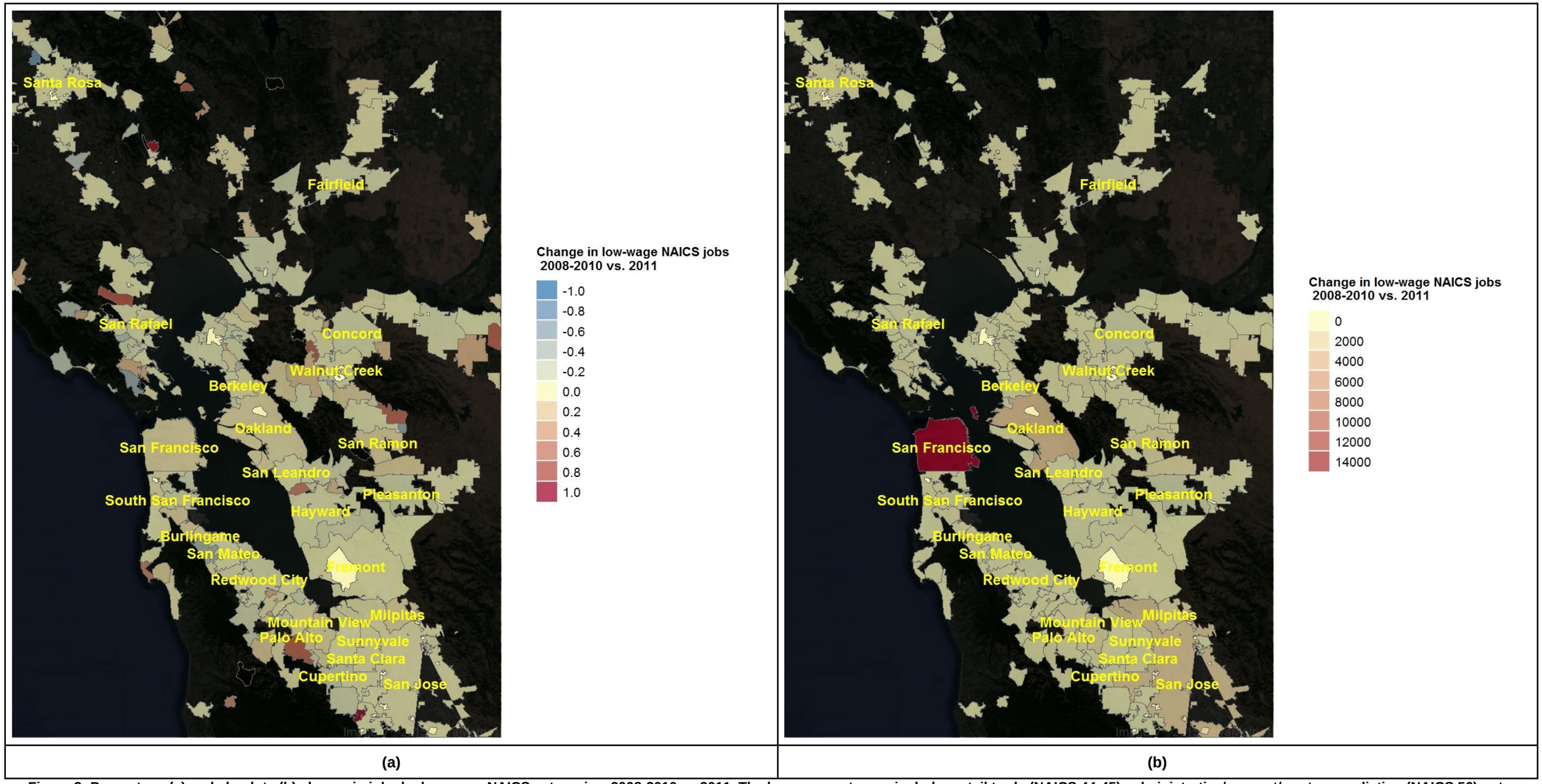
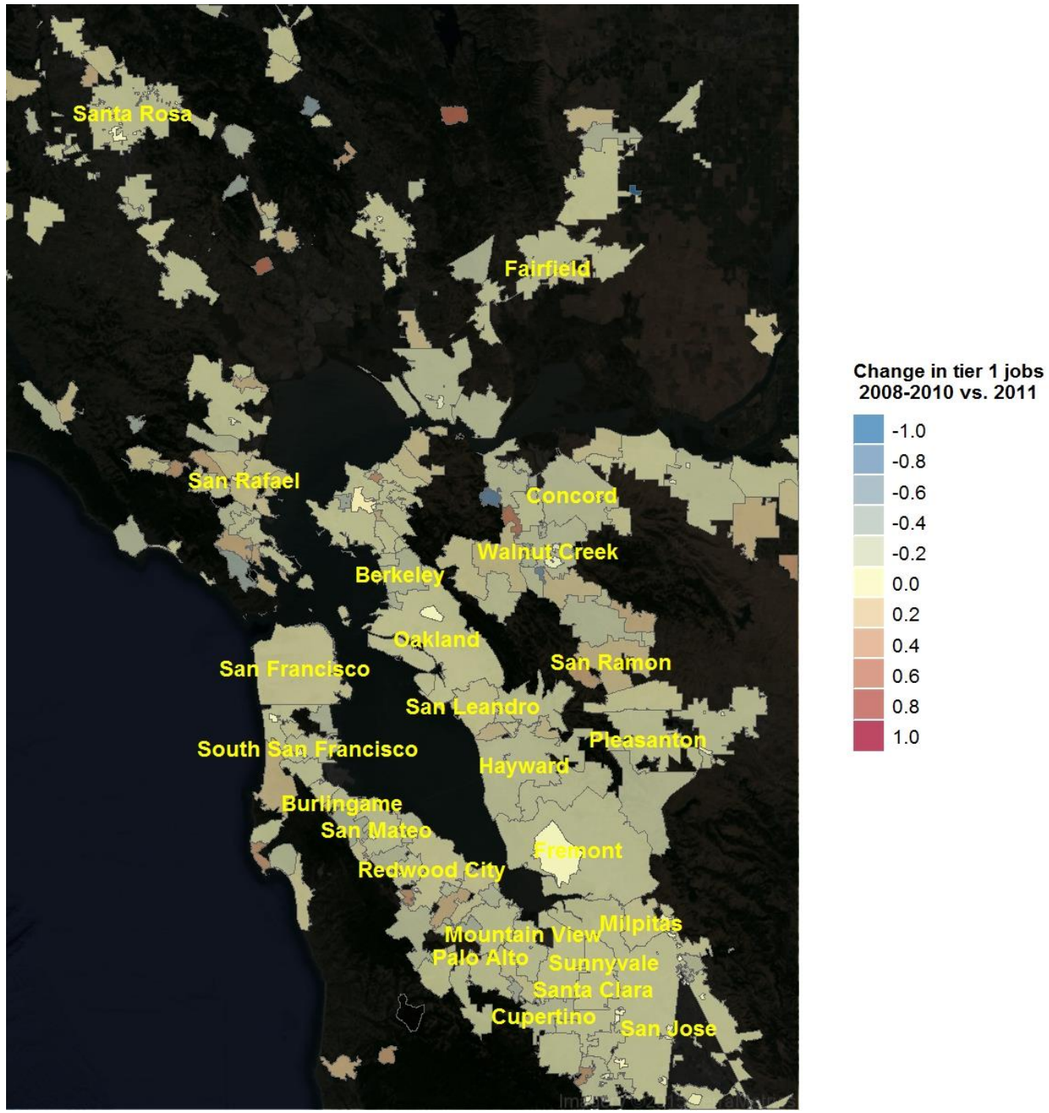
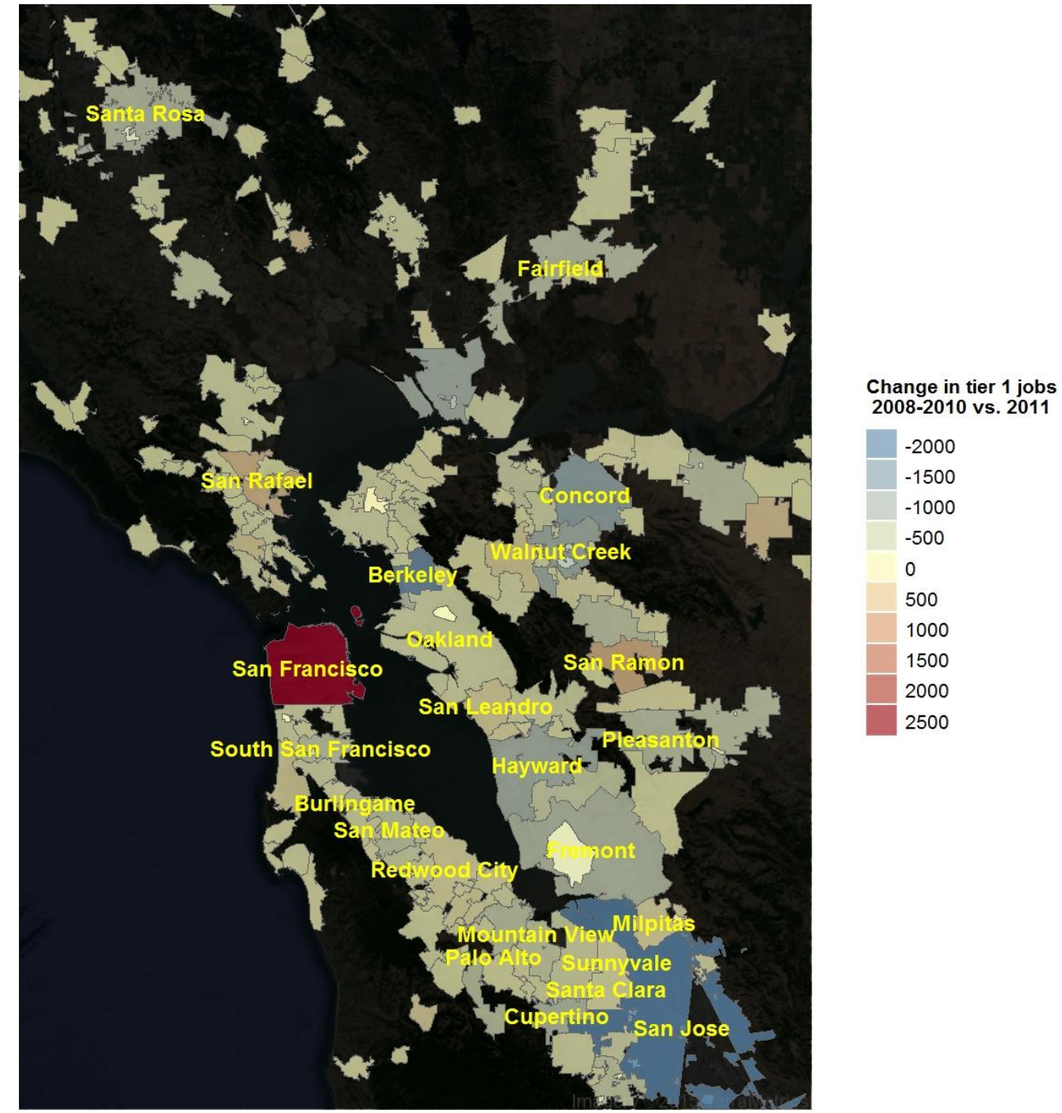


Figure 3: Percentage (a) and absolute (b) change in jobs by low-wage NAICS categories, 2008-2010 vs 2011. The low-wage category includes retail trade (NAICS 44-45), administrative/support/waste remediation (NAICS 56), arts, entertainment, and recreation (NAICS 71), accommodation and food services (NAICS 72), and other services (NAICS 81).

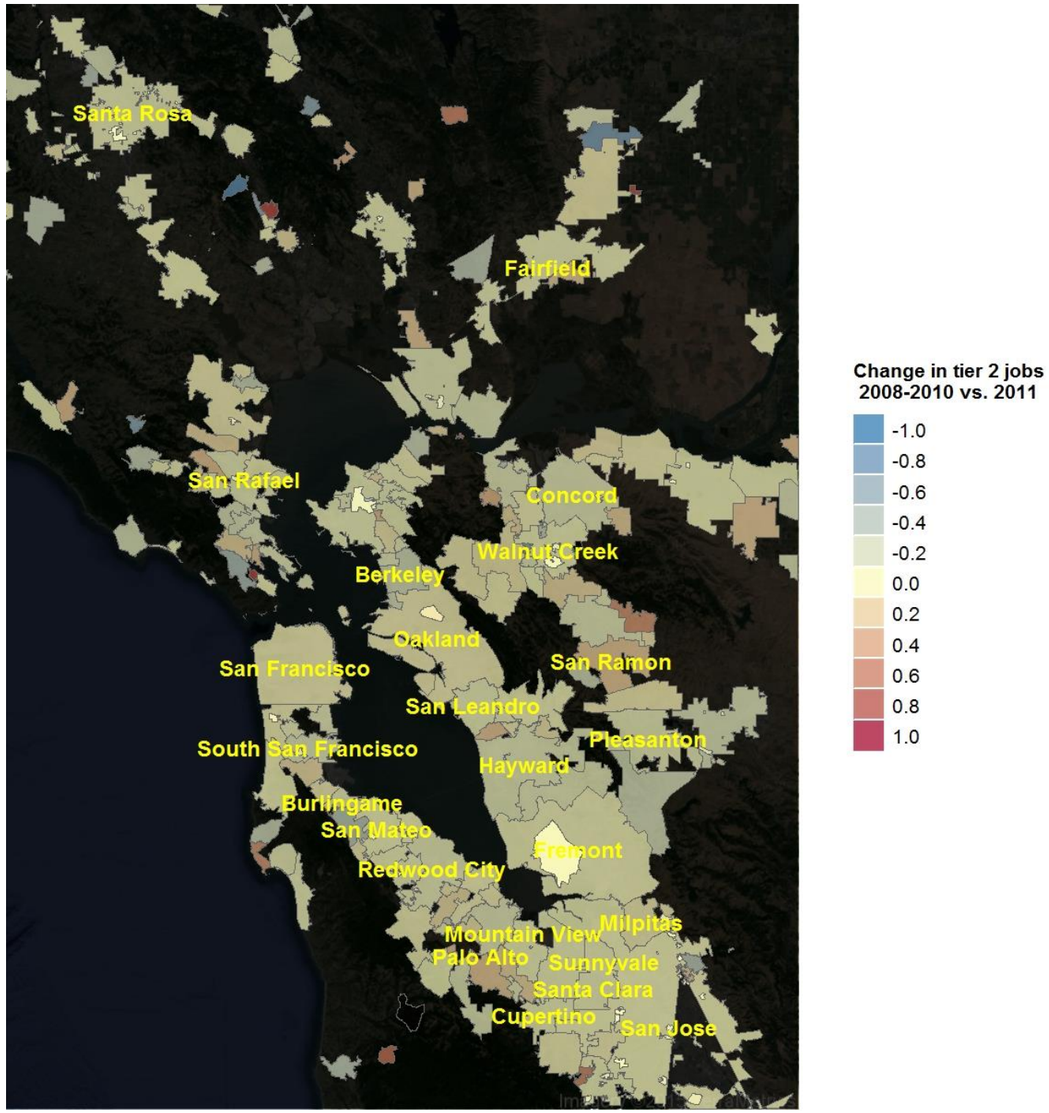


(a)

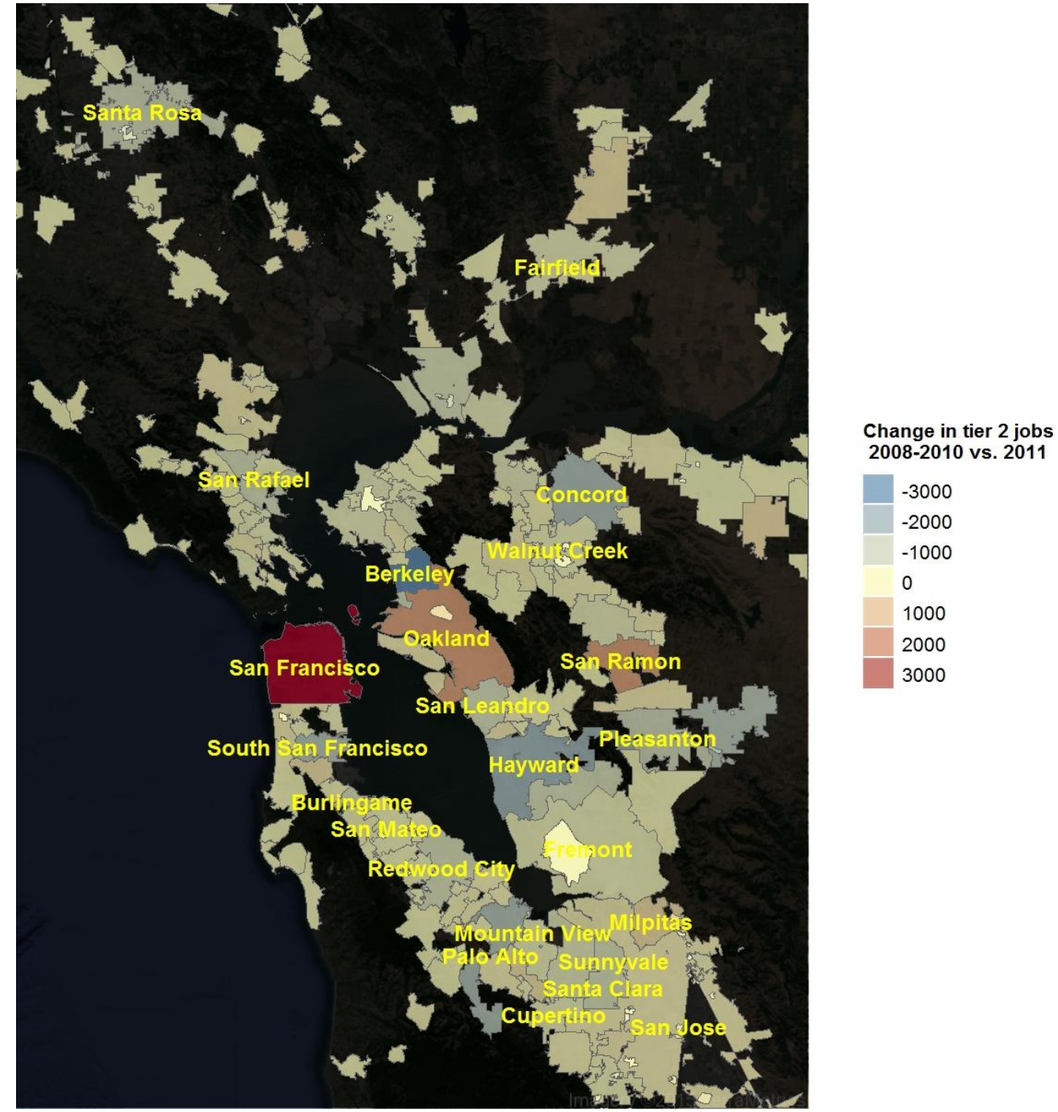


(b)

Figure 4: Percentage (a) and absolute (b) change in tier 1 (wage < $1,251/month) jobs, 2008-2010 vs 2011.



(a)



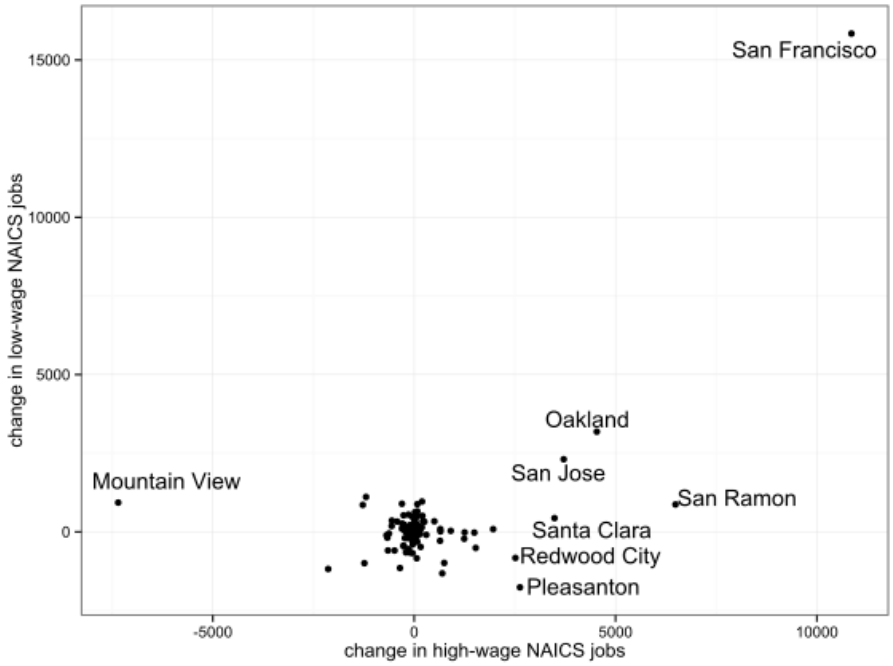
(b)

Figure 5: Percentage (a) and absolute (b) change in tier 2 (wage $1,251 - $3,333/month) jobs, 2008-2010 vs 2011.

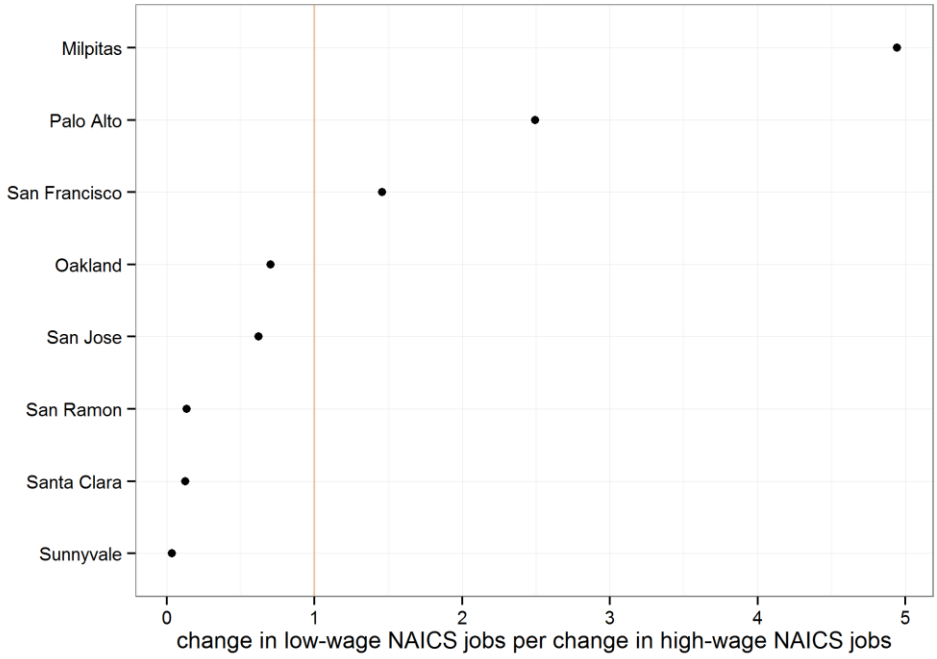
3.3 Relationship between low- and high-wage job growth and decline

To investigate the relationship between low- and high-wage job growth and decline, we produced pairwise scatterplots of each job category to identify outliers and subsequently calculated correlation coefficients. Correlation coefficients range between -1 and 1 and indicate the strength of the positive or negative correlation between two variables. They indicate precisely how strongly and in which direction one variable can be used to predict the other. Figure 6a shows the changes in job numbers for high- and low-wage NAICS categories for all 227 Bay Area jurisdictions and census designated places (CDPs). The vast majority of CDPs cluster close to zero, accounting for little of the overall change in jobs over this time period. Obvious outliers include San Francisco, which saw large gains in both types of jobs, and Mountain View, which saw a decline in high-wage jobs and very little change in low-wage jobs. With San Francisco and Mountain View removed from the data, the correlation between high-wage and low-wage job growth is still positive and statistically significant for the 23 jurisdictions accounting for the greatest numbers of total jobs ($r^2 = 0.46$, $p < 0.05$).

When all jurisdictions are considered, there is no statistically significant correlation. Figure 6b illustrates the ratio of low-wage to high-wage job change for jurisdictions that gained both low- and high-wage workers. For Milpitas, about five low-wage jobs accompanied each high-wage job gained over the time period under study. On the other hand, Sunnyvale and Santa Clara added low-wage jobs at a much lower rate than they did high-wage jobs. Clearly, the number of low-wage jobs gained or lost with each high-wage job can vary widely by jurisdiction.



(a)



(b)

Figure 6: Relationships between changes in high- and low-wage NAICS jobs in the Bay Area, 2008-2010 vs. 2011, by jurisdiction for (a) absolute changes for all jurisdictions and (b) the ratio of low-wage NAICS job change to high-wage NAICS job change in jurisdictions that gained both high- and low-wage jobs.

4.0 Within-jurisdiction housing affordability changes

A key question of interest is the relationship between observed changes in jobs in each category and housing affordability. Determining precisely which housing products are both affordable and desirable for particular workers is a challenging task. The study authors have previously defined such limits based on a review of the literature and keeping in mind the limitations of each data set.[4] Based on that work, we set empirical limits for housing affordability for both rental and owner-occupied units for workers employed in both tier 1 and tier 2 jobs. The limits were based on 30% of income devoted to housing, assuming two people earning the upper wage limit from the LODES data. It is convenient to use the precise wage categories from the LODES, rather than the NAICS aggregations, because these remain consistent over time and map directly to census rent and value categories. The calculation for rental affordability is simply based on this 30% of total income threshold. To calculate affordability of owner-occupied units, we assume a mortgage of 80% of the house's value, with a 30-year fixed rate mortgage at 3.5% interest. Table 4 summarizes the affordability assumptions used in this analysis. One analysis assumes that the tier 1 and tier 2 affordability categories are mutually exclusive. In other words, the tier 1 affordable units are not considered desirable for tier 2 workers. To consider a more complete picture of the low-wage housing market, we also analyze changes for a combined tier 1 and tier 2 category. For comparison purposes, we also look at changes in the total housing stock. The total stock includes all products, including those that are in the upper tiers of contract rent and value.

Table 4: Housing affordability assumptions.

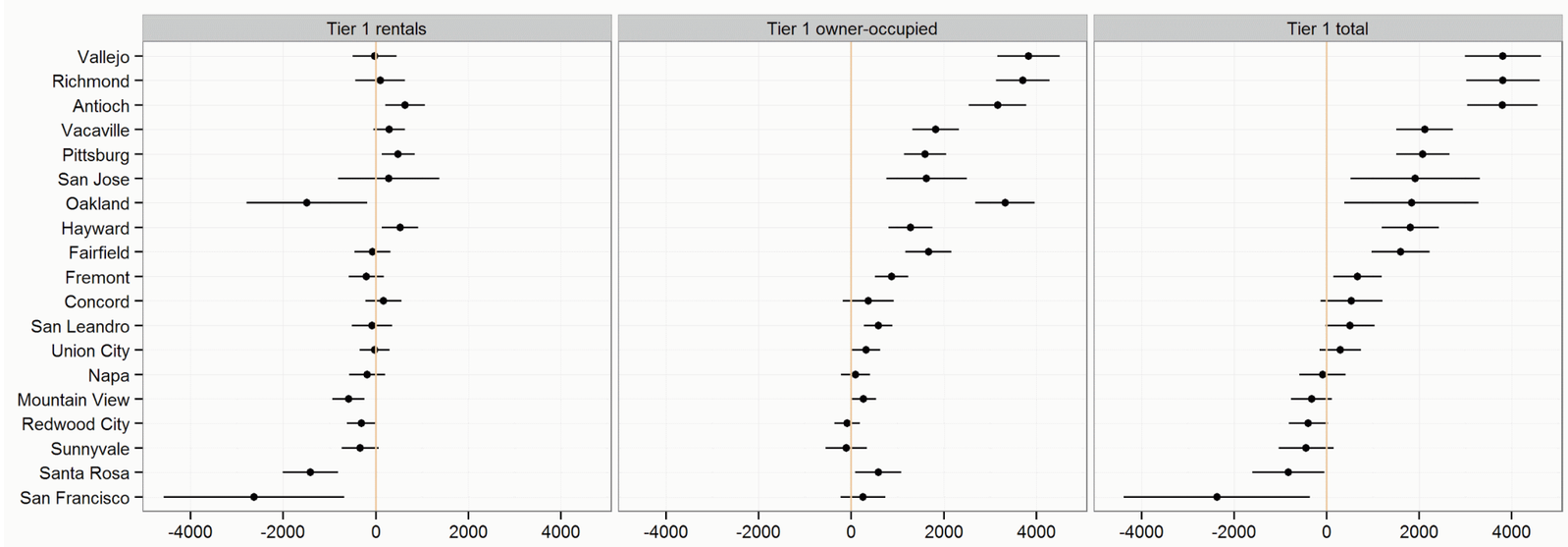
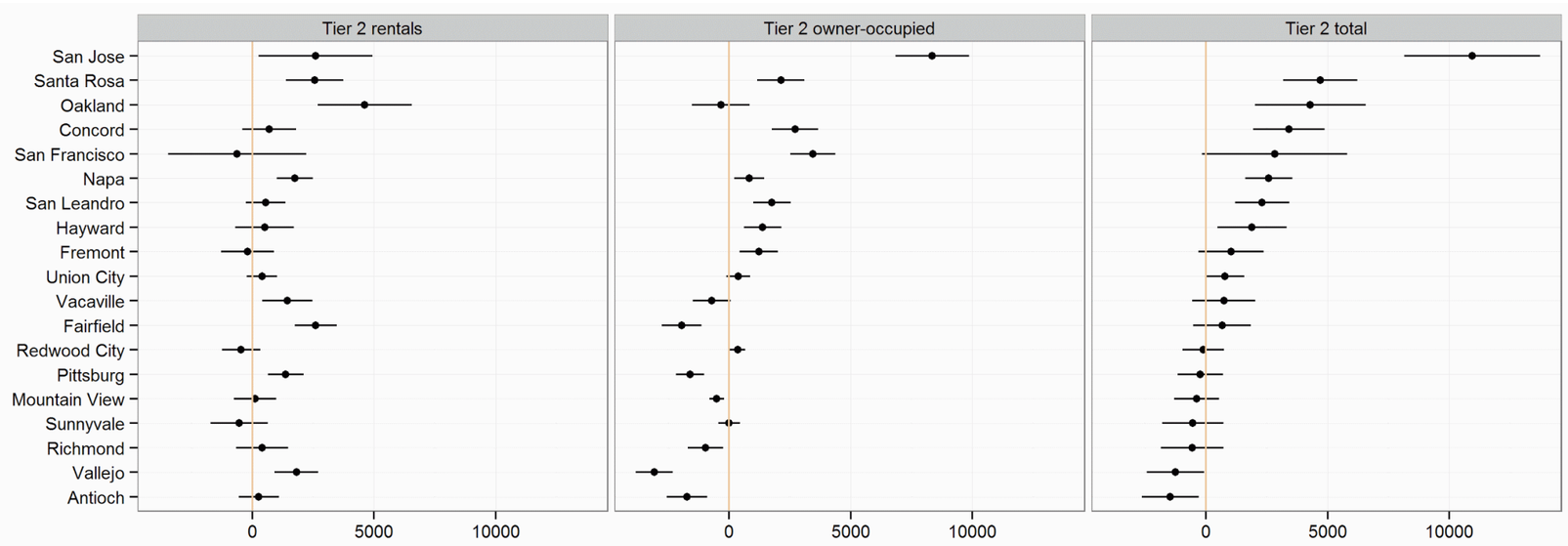
	Affordability limit	
Wage category	**Rental units**	**Owner-occupied units**
Tier 1	$1,250 * 2 * 0.3 = $750	(750 / (0.035/12 * (1 + 0.035/12)^360) * ((1 + 0.035/12)^360 - 1)) / 0.8 = $208,777
Tier 2	$3,333 * 2 * 0.3 = $2,000	(2000 / (0.035/12 * (1 + 0.035/12)^360) * ((1 + 0.035/12)^360 - 1)) / 0.8 = 556,738

Figure 7 compares values from the ACS three-year estimates for 2008-2010 to 2011-2013. The three-year estimates (compared to the ACS five-year estimates) trade off a focus on more recent data with reduced geographic coverage, meaning that not all places have data within these estimates. It contains change data for the 19 census places that have complete housing variables in both of the three year census products, providing the most complete data available to examine recent changes in housing conditions in the Bay Area. To develop these figures, we summed housing totals using the census categories of contract rent (for rental units) and value (for owner-occupied units). Two other categories would have ideally been included - asking price and rent asked - but these were not available in the three-year census products for these jurisdictions. These latter categories represent prices for housing units that are vacant and/or on the market, and represent a small share of total units.

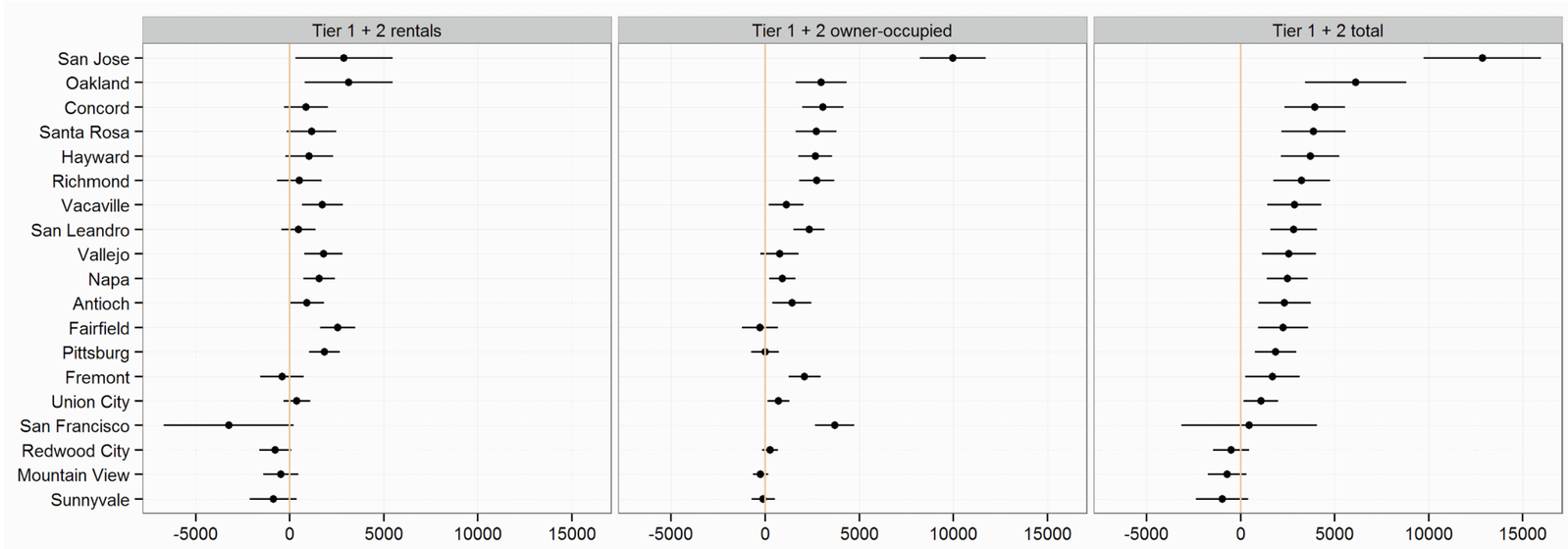
[4] Benner, C. and A. Karner (under review). "Measuring Jobs Housing Fit: Low-Wage Jobs and Proximity to Affordable Housing in the San Francisco Bay Area. Urban Geography.

The changes depicted in the housing unit figures below should be interpreted as the change in annual average housing numbers between two three-year periods: 2008-2010 and 2011-2013. Positive values indicate that more housing was available in the more recent estimates than in the earlier ones in each affordability category.

When assessing changes in the tier 1 and tier 2 affordability categories, note that changes must be interpreted as arising both from new construction/demolition as well as shifts in the value of the existing housing stock. Additionally, because the ACS data are estimates with associated errors, any calculated differences must be assessed with this in mind. In the figures, 90% margins of error are depicted for the differences using horizontal lines that extend symmetrically from the best estimate of housing unit change. If the margins of error overlap zero, this means that we cannot say with certainty whether an increase or a decrease occurred for that jurisdiction. Generally, as jurisdictions increase in size, margins of error increase, meaning that larger differences are needed to demonstrate difference from zero. Note also that the scale of the x-axis is different in each plot shown in Figure 7. The maximum change in tier 1 affordable units is 4,000 while the maximum change in total units is 30,000 - an order of magnitude difference. Finally, each plot separates rental, owner-occupied, and total units in each affordability category. The points are sorted by total housing units in each category so that the viewer can easily discern the locations of the greatest changes and compare across jurisdictions.

Tier 1 affordable units (for workers earning less than $1,250/month or $15,000/year)	
Tier 2 affordable units (for workers earning between $1,251 - $3,333/month or $15,001 - $40,000)	

Tier 1 and Tier 2 affordable units (for workers earning less than $3,333/month or $40,000/year)



Total housing units

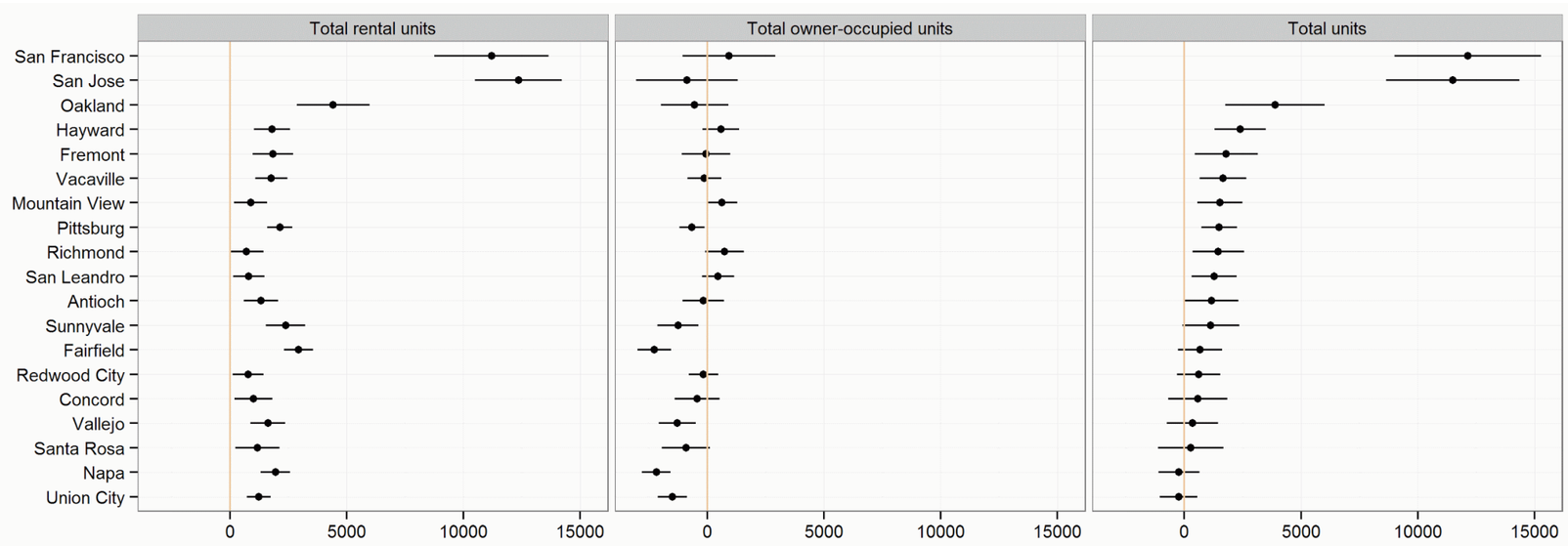


Figure 7: Change in housing units by affordability and rental/owner-occupied status for the 19 census places with complete data available in the ACS 2008-2010 and 2011-2013 three-year data products. Data from the ACS tables B25056 - Contract Rent and B25075 - Value. Data were generally not available for asking price and rent asked, but the number of units in these categories was relatively small. Error bars for each point indicate the 90% margins of error.

Figure 7 provides some evidence that the jurisdictions providing tier 1 and tier 2 affordable units are not the same as those providing total housing unit growth. Especially for tier 1 workers, jurisdictions with the greatest increases in affordable housing are Vallejo, Richmond, and Antioch. In terms of total housing unit production, these areas rank far behind many of their larger (in terms of population and housing) peers. To investigate this possibility further, we compared jurisdictions in terms of their total housing unit growth/decline and their growth/decline in tier 1 + 2 affordable units over the two three-year periods under study. Figure 8 compares the total housing production to changes in the total number of affordable units, by jurisdiction. There is clearly a cluster of places that are providing tier 1 + 2 affordable units in proportion to total housing production. On the other hand, San Francisco is a clear outlier. Its total housing production is the highest of all 19 jurisdictions, but it has had virtually no change in the number of affordable units. San Jose and Oakland are in almost the opposite situation. Both jurisdictions have added substantial total units, and have experienced a substantial increase in affordable units as well. Figure 9 shows the same two overall categories, but for rental units. From this figure, a different picture emerges. It is clear that there is a cluster of jurisdictions that grew affordable units in proportion to total rental unit production, but San Francisco, San Jose, Fremont, Sunnyvale, Mountain View, and Redwood City all added total housing capacity and either lost or did not add affordable rental capacity proportionately. Note that, because of the unavailability of LODES data beyond 2011, these figures will be subject to change once additional years of data are released.

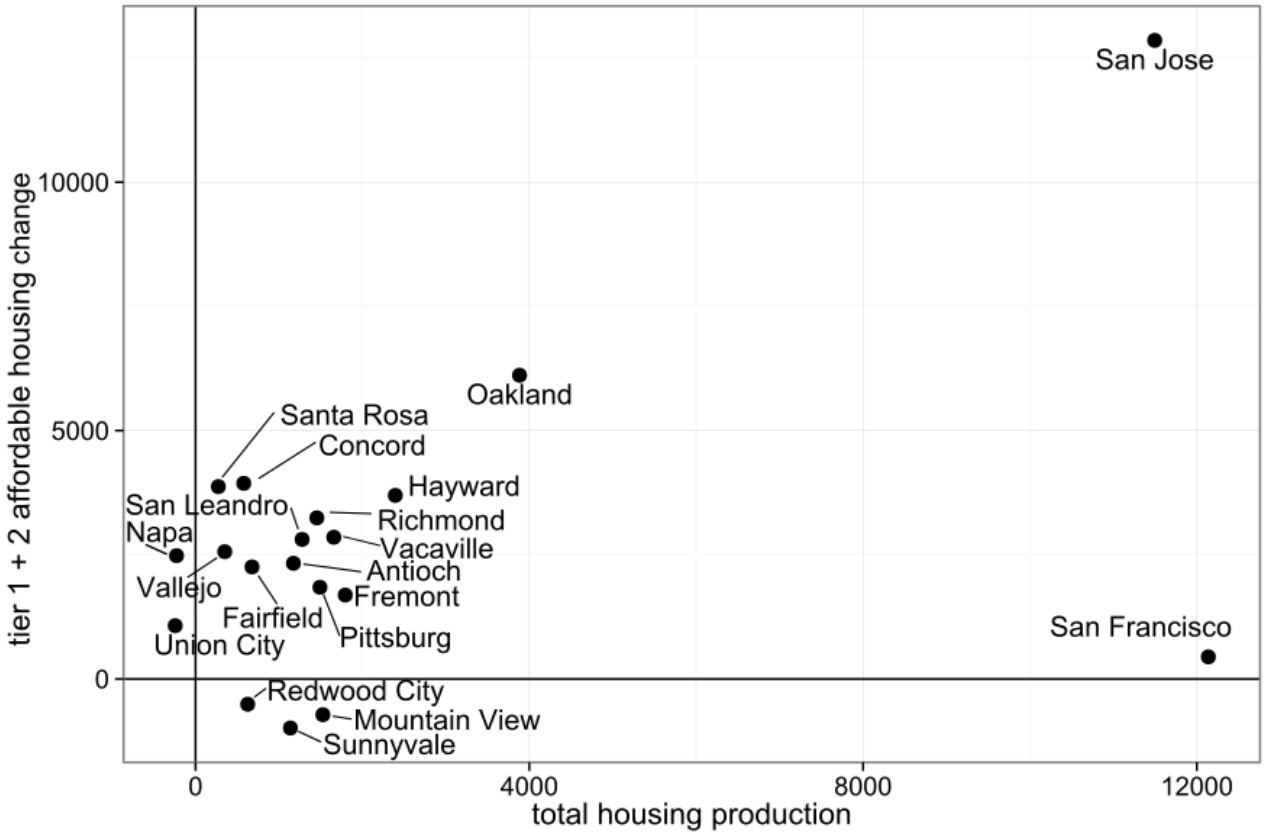


Figure 8: Comparison of total housing unit production to changes in tier 1 + 2 affordable units. The 19 jurisdictions shown have complete housing data available in the ACS three-year data products used for the comparison (2008-2010, 2011-2013).

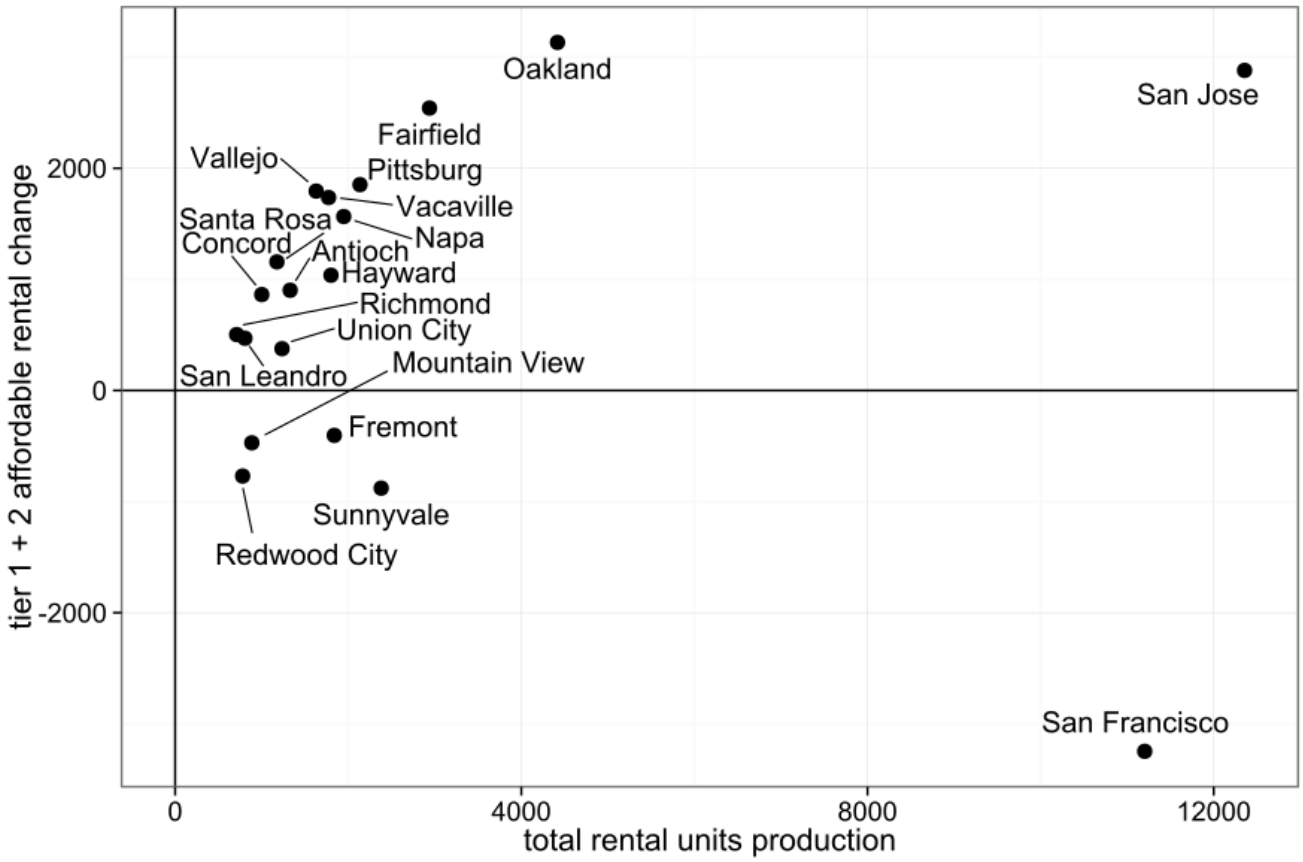


Figure 9: Comparison of total rental unit production to changes in tier 1 + 2 affordable rental units. The 19 jurisdictions shown have complete housing data available in the ACS three-year data products used for the comparison (2008-2010, 2011-2013).

5.0 Within-jurisdiction relationship between job growth/decline and housing affordability

The analysis has so far focused on changes in jobs and housing units in isolation from one another. But from a normative regional equity perspective, there would be a relationship between changes in job numbers at different wage levels and changes in available and affordable housing units. While it is often more desirable for jurisdictions to pursue economic development activities and eschew housing, under California Housing Element law, cities and counties must anticipate future housing needs for all income segments and plan accordingly. Although we would not expect housing supply to perfectly follow changes in locally employed workers, analyzing job and housing unit changes together can provide an important barometer of housing market health. Specifically, we can determine which jurisdictions are relatively “on course” and which are potentially off track.

The first set of figures below (Figures 10 - 13) charts the relationship between changes in jobs by wage tier and affordable units for tier 1, tier 2, and tier 1 + 2 combined. Jurisdictions were labeled in Figures 10 - 12 if they experienced a change greater than 500 for either jobs or housing units. For Figure 13 (total jobs), the threshold was increased to 2000. Because these figures combined LODES and ACS data, they again include 90% margins of error and show the confidence we have in the estimates of

changes in housing units. Jurisdictions whose error bars overlap with zero indicate that we have little certainty about whether the actual value of that change is positive or negative. The figures summarize results for rental units, owner-occupied units, and total units and also include a snapshot of the jobs-housing fit in each jurisdiction in 2010 and 2013. Jobs-housing fit captures that ratio of jobs in a certain wage category to the housing units that are affordable for that wage category and allows us to look at the starting and ending numbers for jobs and housing units in addition to the change over time. Additional metrics of jobs-housing balance and fit were calculated in the included Appendix A. Changes in affordable housing unit numbers should be interpreted carefully. Importantly, they do not necessarily indicate that new units in a particular affordability category were constructed, demolished, or taken off the market. They can simply reflect changes in the value of particular units. On the other hand, changes in the total number of units will reflect genuine growth or decline in housing unit numbers.

Figure 10 illustrates the particularly challenging situation for tier 1 employees who earn very low incomes. Very few affordable rental units were added in the Bay Area over our comparison time period and there is a statistically significant negative correlation between tier 1 jobs and affordable tier 1 rental units ($r^2 = -0.66$, $p < 0.01$). In San Francisco, where the strongest gains were made in tier 1 jobs, there was most likely a decline in housing units affordable to those tier 1 workers. Although Figure 10 shows some increases in affordable owner-occupied units in some jurisdictions, tier 1 workers are not likely to be in the market to purchase homes (this correlation was not significant). Total tier 1 affordable housing unit change was also negatively associated with tier 1 job growth ($r^2 = -0.49$, $p < 0.05$), indicating that the jurisdictions adding affordable capacity generally lost tier 1 jobs. The figure also illustrates one of the challenges associated with using the LODES wage data. Because the wage categories are static, the number of jobs in the tier 1 category (and in the combined tier 1 + tier 2 values) is reduced each year simply due to inflation. Any analysis of changes over time then will reflect both genuine changes in the number of jobs, but also differences based on wage changes within particular categories. The jobs-housing fit panel indicates that a number of jurisdictions had worse fit (i.e. a higher value) for tier 1 affordable rental units in 2013 as compared to 2010 - Redwood City, Fremont, Mountain View, Santa Rosa, and Sunnyvale - while others improved slightly including Concord, Hayward, Vacaville, and Antioch.

Tier 2 workers fared somewhat better than their tier 1 counterparts in terms of affordability changes in the rental market (Figure 11). For similar reasons to tier 1, the rental market is still likely to be quite important for tier 2 workers. San Jose and Oakland definitely saw tier 2 affordable rental units increase while San Francisco again saw no change, even though it is the jurisdiction in which tier 2 jobs grew the most. Changes in tier 2 fit for the rental market, as indicated by the jobs-housing fit panel, were modest for most jurisdictions. None of these correlations were statistically significant. Figure 12 shows the results for the combined tier 1 + 2 categories, to provide a picture of the most financially constrained workers on the housing market in the Bay Area. Those results show that San Jose and Oakland definitely saw an increase in housing units in this affordability category. Overall, San Francisco saw no change despite seeing the Bay Area's largest increase in jobs in this low-wage category. There was a negative correlation between change in tier 1 + 2 jobs and tier 1 + 2 affordable rental units ($r^2 = -0.51$, $p < 0.05$). The importance of considering change as well as the starting jobs-housing fit is evident from Figure 11 as well. Sunnyvale, Redwood City, and Mountain View cluster together, providing no increase in affordable units but also losing combined tier 1 + 2 jobs. Their starting indicators of fit,

however, indicate that they generally have higher numbers of jobs than affordable owner-occupied units meaning that adding affordable tier 1 + 2 units would mitigate existing disparities.

The figure for total jobs, total housing units, and overall jobs-housing balance (Figure 13) provides a useful comparison to the values disaggregated by wage levels. Numbers for total housing units include the highest categories of rent and value available in the ACS data, meaning that Figure 12 is capturing changes in very high value units. The figure indicates that major growth in the Bay Area housing market is driven by rentals, not owner-occupied units. The change in total owner-occupied units is far lower in magnitude than the change in any of the disaggregate changes in owner-occupied units by affordability tier. This means that a large portion of the increases in affordable owner-occupied units were due to shifts in value over the time period under study. Total rental units and total units overall definitely increased in San Francisco, San Jose, and Oakland, as well in some of the smaller jurisdictions. These changes tracked overall increases in total jobs to a much greater extent than was the case in the tier 1 and tier 2 affordability categories. Total job growth was positively correlated with both total rental unit change ($r^2 = 0.78$, $p < 0.001$) and with total housing unit change ($r^2 = 0.81$, $p < 0.001$). Despite this growth, overall jobs-housing balance indicators actually worsened (got slightly larger) in San Francisco and Oakland.

The extent to which the observed changes are associated with increases in high-wage jobs was a key question of interest to MTC and the research team. The scatterplots in Figure 14 address the relationship between changes in high-wage jobs (operationalized as jobs in the professional NAICS category) and housing affordability. Because of the apparent importance of the rental market in the Bay Area, the figures focus on changes in rental units by affordability category and in total. The results are illustrative. Jurisdictions that added jobs in the high-wage NAICS categories generally saw increases in total rental units ($r^2 = 0.72$, $p < 0.001$), decreases or no change in tier 1 affordable units ($r^2 = -0.55$, $p < 0.05$), and relatively modest growth in tier 2 affordable units ($r^2 = 0.05$, not significant). In sum, growth in high-wage NAICS jobs is associated most strongly with growth in total rental units (which includes those units in the highest rent categories). Mountain View was an outlier, as it saw decreases in high-wage jobs.

Overall, these results illustrate the importance of considering the fit between workers in particular wage categories and appropriate housing affordability categories. When viewed simply from the perspective of aggregate jobs-housing balance, the changes observed in the Bay Area appear to be quite favorable, with increases in housing generally following increases in jobs. But when fit is considered, and slices of job and disaggregate components of the housing and job markets are viewed together, it is clear that housing growth (operationalized as growth in rental units) is closely tracking growth in high-wage jobs while the opposite relationship is evident for low-wage jobs.

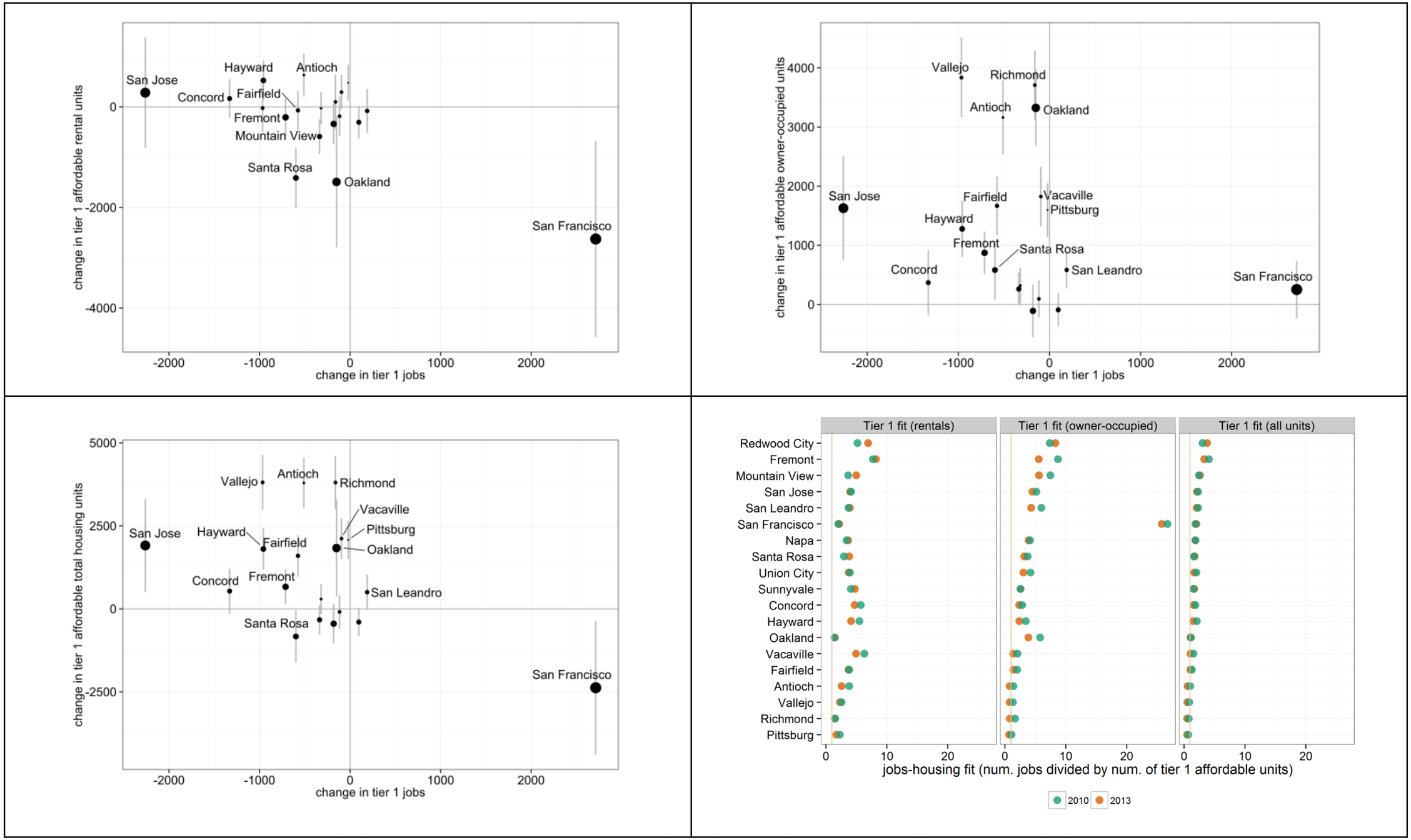


Figure 10: Relationships between changes in tier 1 jobs and tier 1 affordable units and jobs-housing fit by jurisdiction in the Bay Area.

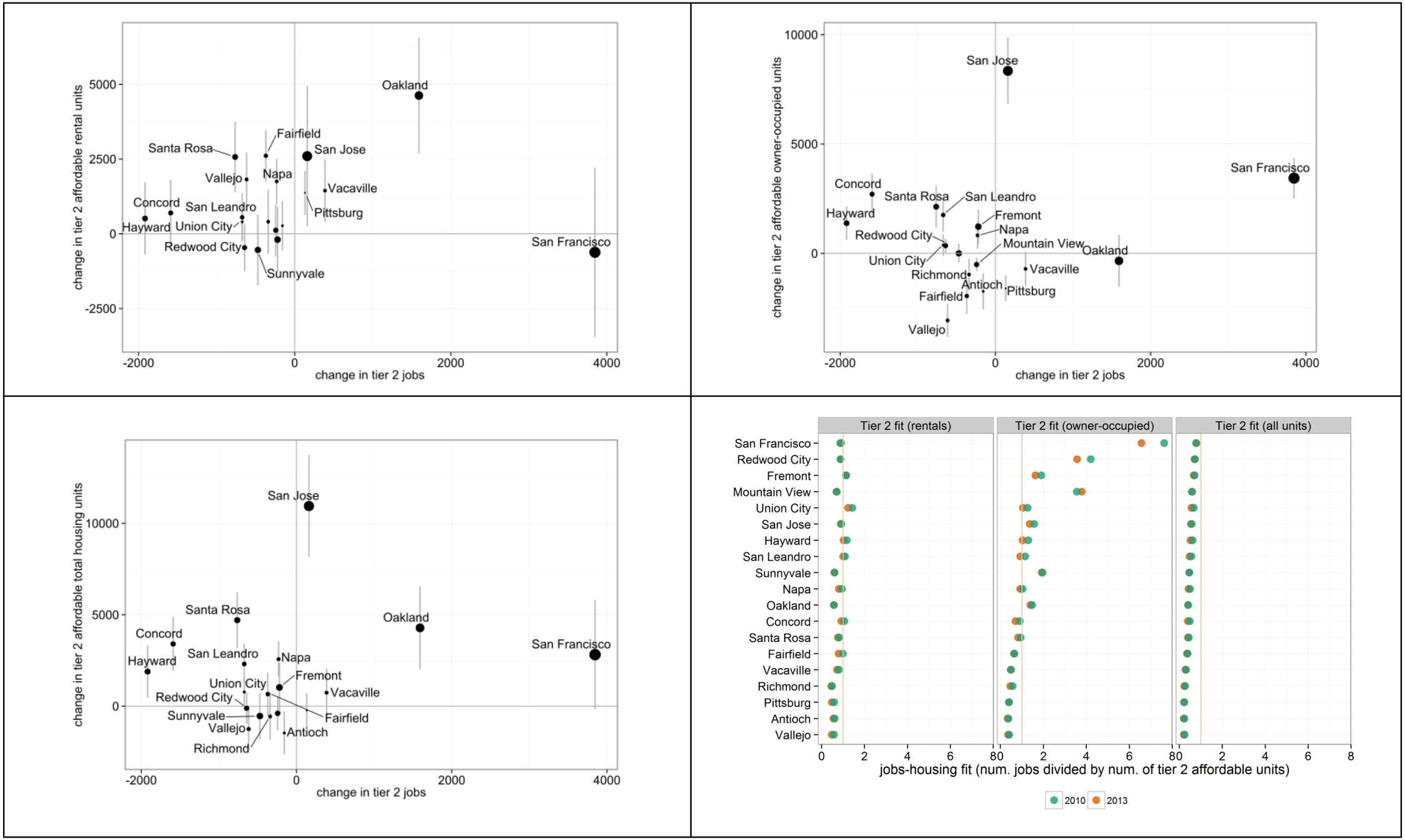


Figure 11: Relationships between changes in tier 2 jobs and tier 2 affordable units and jobs-housing fit by jurisdiction in the Bay Area.

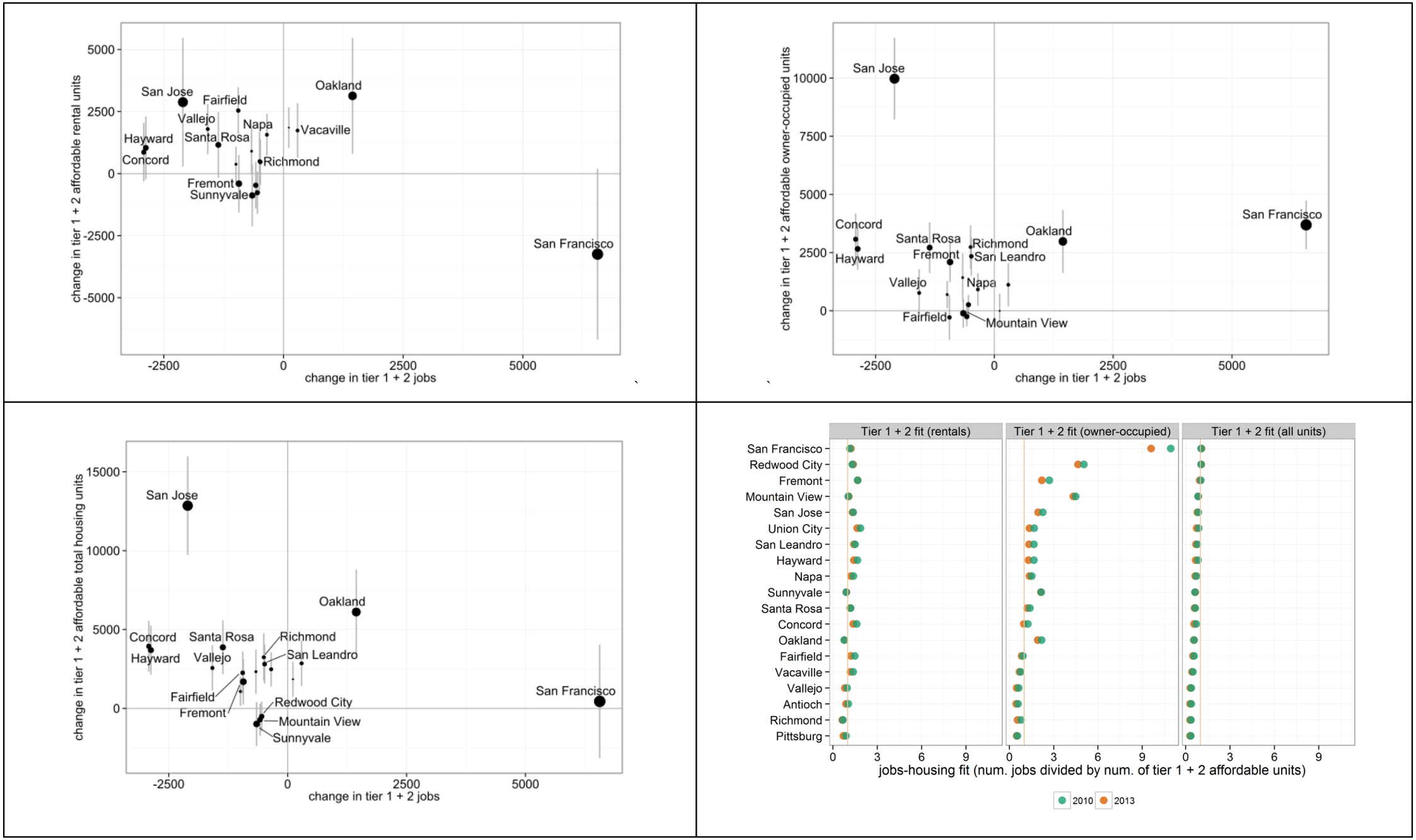


Figure 12: Relationships between changes in tier 1 + 2 jobs and tier 1 + 2 affordable units and jobs-housing fit by jurisdiction in the Bay Area.

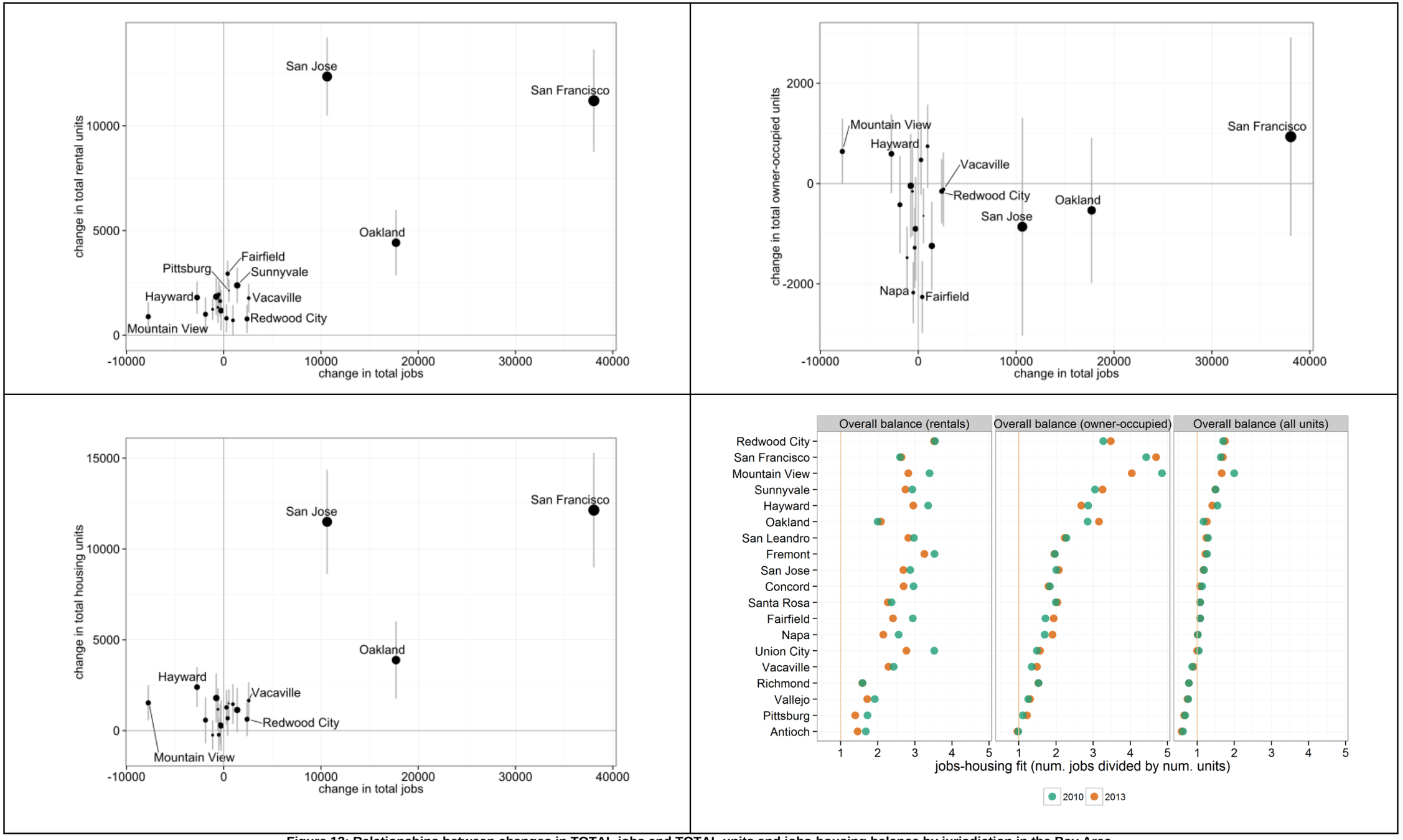


Figure 13: Relationships between changes in TOTAL jobs and TOTAL units and jobs-housing balance by jurisdiction in the Bay Area.

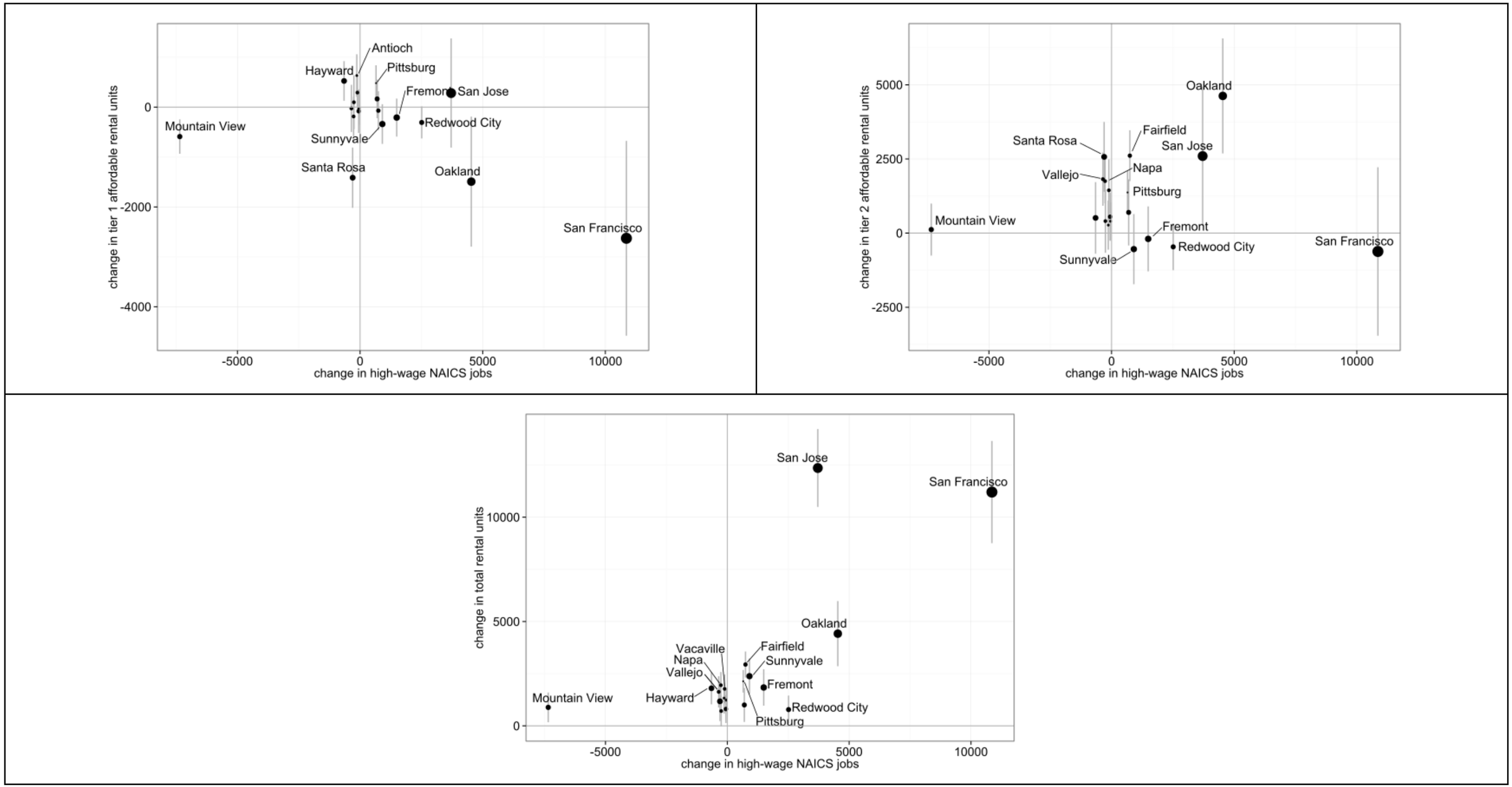


Figure 14: Relationships between changes in high-wage NAICS categories and rental units by affordability tier and total by jurisdiction in the Bay Area.

6.0 Between-jurisdiction job growth and housing demand

The within-jurisdiction analysis is helpful for highlighting those jurisdictions that are performing well or poorly in terms of providing housing supply well-matched to the wages of locally available jobs. However, when jurisdictions fail to provide adequate workforce housing, there may be material consequences that affect other locations. These consequences may be especially severe for low-wage workers who are likely to be more sensitive to housing price changes and to seek out opportunities to locate closer to where they work, when possible, to minimize combined housing and transportation costs.

The analyses presented below highlight how commute distances and housing affordability characteristics for workers located in jurisdictions that added jobs in 2011 differ from those that were employed in 2008-2010. We highlight the "commute penalty" that new workers face for certain place-of-work jurisdictions. We also show that these added workers are locating in jurisdictions with somewhat higher rental vacancy rates than the existing distribution of workers. These combined results build a strong case for the integration of affordable housing and environmental sustainability policies.

6.1 Added worker commute analysis

We developed several indicators of commute patterns for each jurisdiction including *internal capture* - the number of workers that live and work in the same census place as a proportion of total jobs - and *average commute distance* by age, income, and industry categories. Figures summarizing these two metrics are included in Appendix B. One issue with these measures is that they simply do not show much change over time; because so much residential and employment location choice is "locked in," the signal resulting from added employment or shifts in jobs and housing patterns for existing jobs and workers can get lost, meaning that it is difficult to track change over time when looking at aggregate totals. For this reason, we chose to focus on the net new work trips. To calculate this net increase, we looked at every unique place-of-work and place-of-residence pair, and summed together the incremental increase for all these job-home trips that saw an increase across our years of comparison. The figures below summarize the weighted average commute distance traveled for these new workers compared to all existing workers. The results indicate precisely how much further these net new workers were traveling to reach their jobs in 2011 as compared to the 2008-2010 average values.

Figure 15 shows the distance traveled per net added worker in 2011 for each of the 19 workplace destinations listed in Table 1 relative to the distance traveled per average worker in 2008-2010. For cities with positive values, the figure can be interpreted as the additional distance that a new worker has to travel, on average, relative to existing workers for that particular workplace jurisdiction. The results show that, for each city except Pittsburg, new workers are traveling substantially further than existing ones. This "gap" between new workers and existing workers ranges from about 3.1 miles in Oakland to about 56 miles in Santa Rosa. Closer investigation of the changes for Santa Rosa indicate relatively large numbers of workers added in neighboring Mendocino and Lake counties which entail substantial commutes. In general, the more centrally located cities have smaller average incremental distances likely because there are simply more opportunities to find housing in the inner Bay Area than at the periphery.

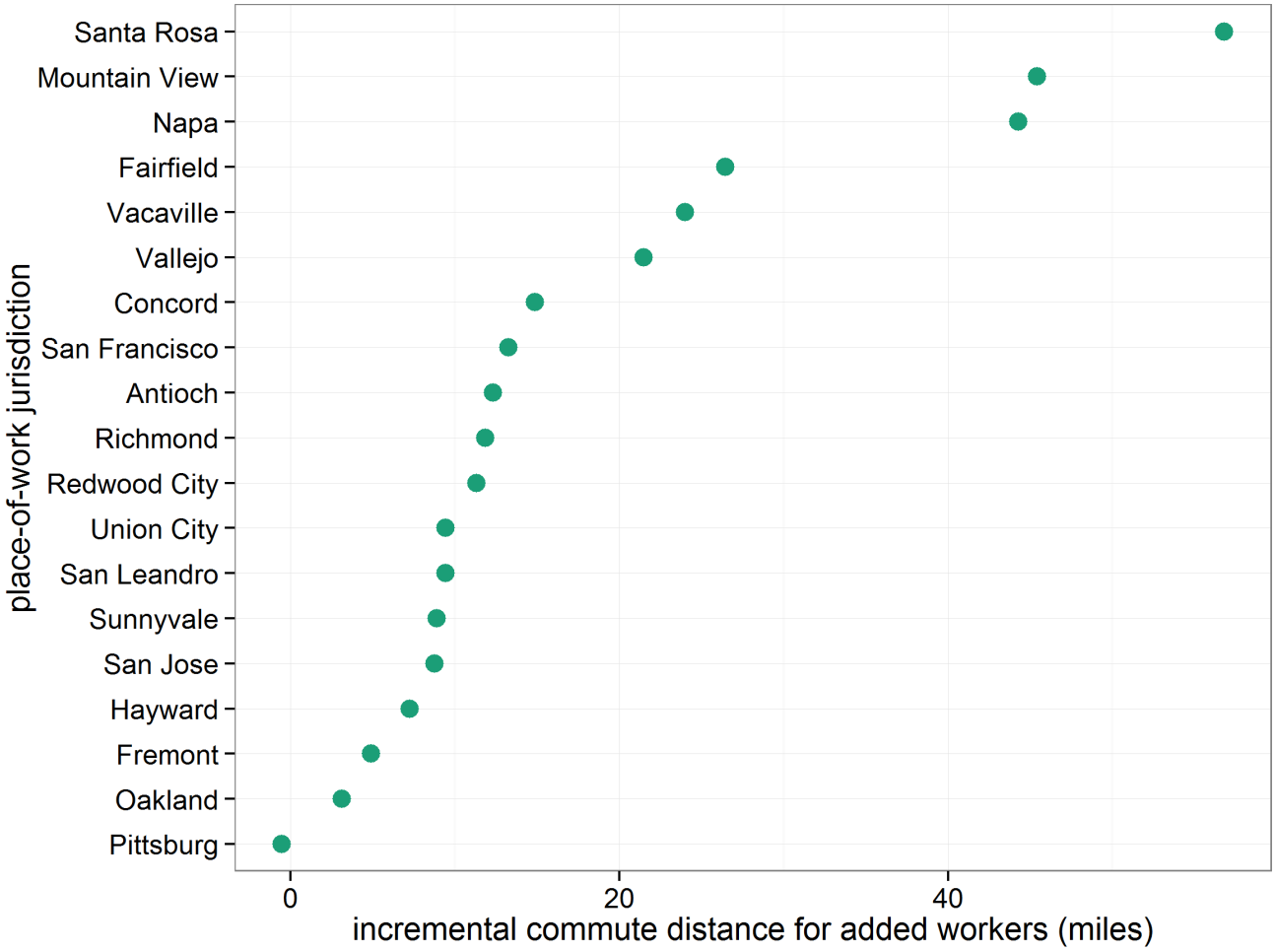


Figure 15: Incremental weighted commute distance impacts for added workers in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

Although the LODES commute flow data do not contain the disaggregate NAICS categories required to conduct an analysis of the high- and low-wage industry categories previously defined, they do include flow data for each of the three wage tiers which can facilitate an analysis of the incremental commute distance by wage. The results are shown in Figure 16 and indicate that the incremental distance varies widely by wage level, but is generally highest for tier 1 and tier 2 workers. In all cities except for Mountain View and Antioch, added tier 1 or tier 2 workers traveled further than added tier 3 workers to reach their jobs. In Oakland, new tier 3 workers can actually locate closer to their jobs than existing workers can. The pattern across the three largest Bay Area cities is the same, although there are differences in magnitude. Added tier 1 workers are commuting much further than added tier 3 workers - in San Francisco, added tier 1 workers travel 4.4 times further than a new tier 3 worker. In San Jose, the figure drops to 3.6. These strong differences are likely due at least in part to the general lack of growth in tier 1 affordable rental units over this time period (Figure 10). These results are worrying and provide initial evidence of a strong link between housing affordability and vehicle miles traveled.

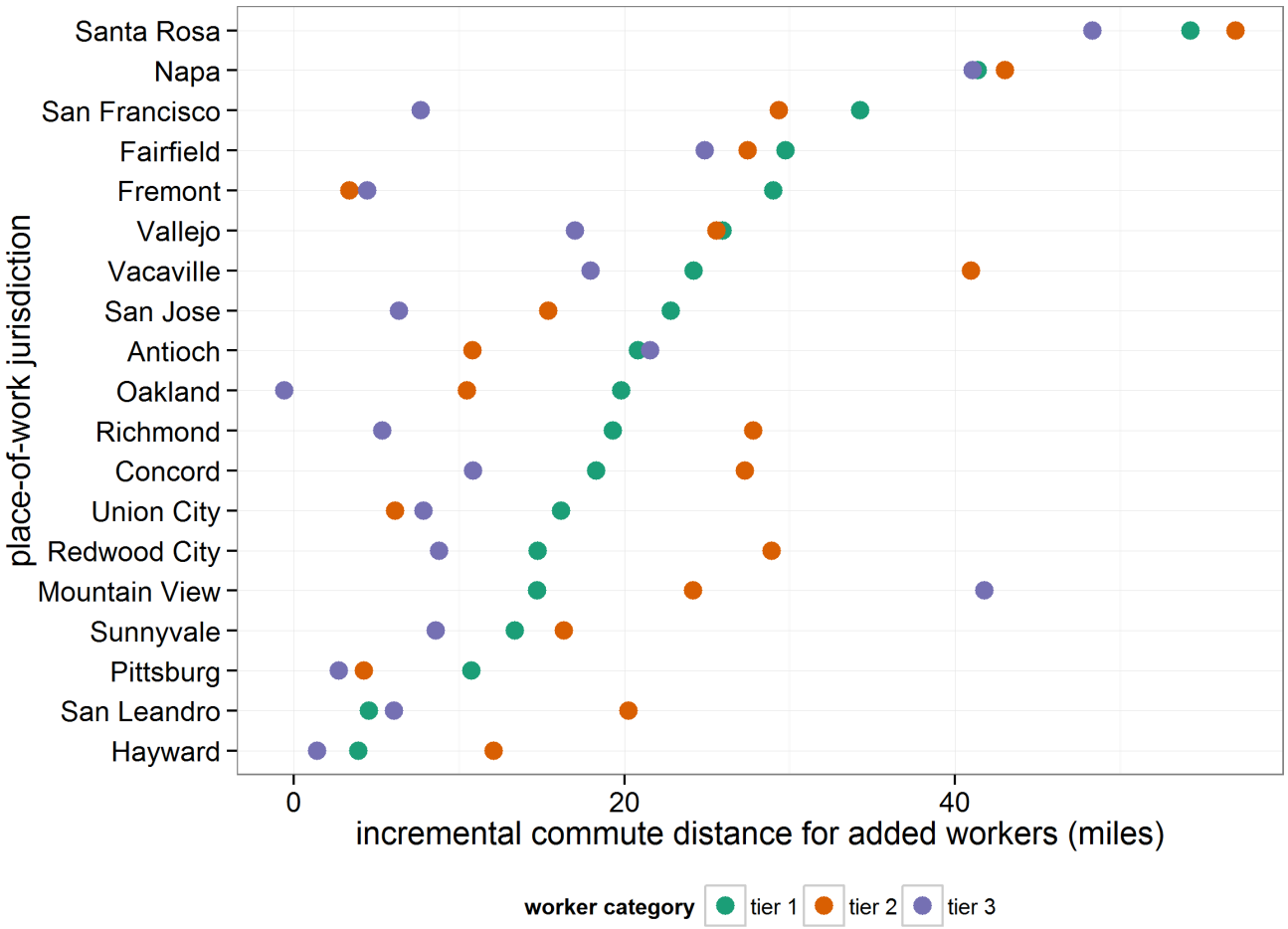


Figure 16: Incremental weighted commute distance impacts for added workers by wage tier in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

6.2 Net new worker housing market analysis

To understand how housing affordability might be related to the observed changes in commute distance, we conducted an analysis of housing markets in jurisdictions where net new workers are located. We were specifically interested in rent prices and vacancy rates, and sought to determine whether workers were locating in more affordable locales. Available census data are limited for this purpose in a number of respects. Typical indicators of housing affordability, including median contract rent are aggregate figures and may miss key dimensions of affordability if jurisdictions contain a mix of different housing types. Some of these issues are apparent in Figure 17, which shows the difference in median contract rent for net new workers compared to existing workers in the Bay Area. Aside from Mountain View and Sunnyvale, it shows that added workers are located in areas that have *higher* median rents than the existing distribution of workers. This result raises a number of possibilities. Either jurisdictions with lower-priced rental units do not have sufficient vacancy to house added workers, median contract rent is a poor indicator of affordability, the differences are not substantively large enough to be meaningful, or there are differences by income category that are masked when looking at aggregate values.

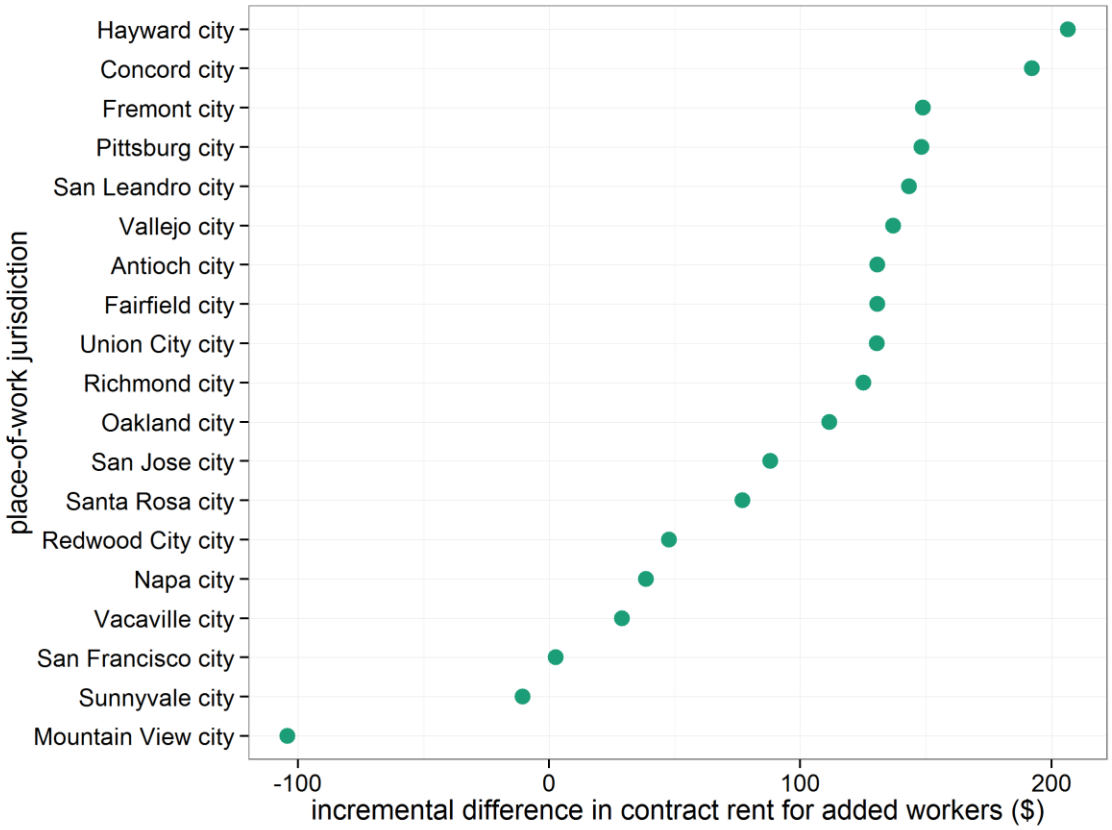


Figure 17: Incremental weighted contract rent impacts for added workers in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

To determine the extent to which aggregation is playing a role in these results, we produced Figure 18 which shows the results by wage tier. Broadly, the results are similar to those shown in Figure 17, with some important differences. Figure 18 also shows that added workers are residing in areas that have higher median contract rents than the existing distribution of workers. This is true for workers in each wage category in each of the jurisdictions shown except for Napa, Mountain View, Sunnyvale, Redwood City, and San Francisco. A clear result is that new tier 1 workers employed in San Francisco live in jurisdictions that have somewhat lower contract rents than the existing distribution of these workers employed in the city. Although San Francisco is the city responsible for the largest growth in tier 1 and tier 2 employment and is thus disproportionately important to low-wage workers, the patterns in the other cities do not follow expectations. We would expect that as commute distances increases, added workers locate more peripherally to take advantage of lower rents. Determining which of the explanations offered above for this pattern are true will require further work and follow up study.

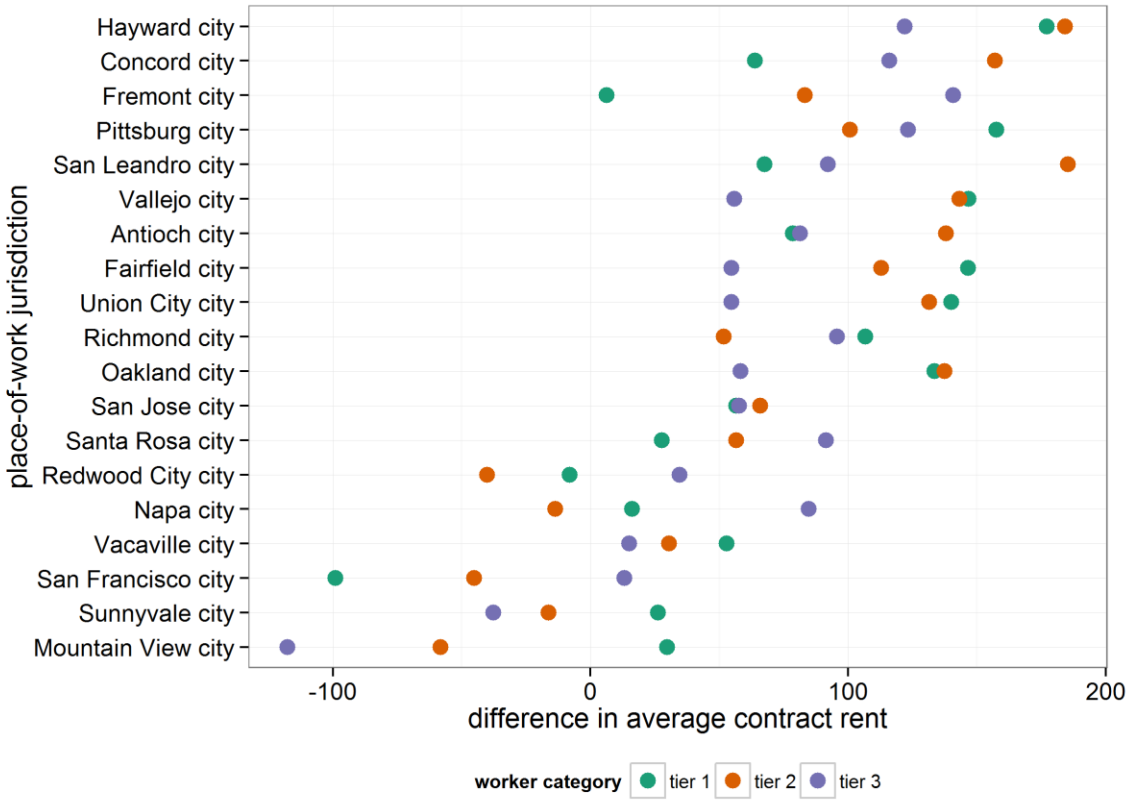


Figure 18: Incremental weighted contract rent impacts for added workers by wage tier in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

An alternative explanation is offered by an examination of vacancy rates for rental units. The Bay Area has quite low rental vacancy rates relative to the national average. Across the approximately 220 Bay Area jurisdictions, the median vacancy rate for rental units according to the 2013-2009 five-year ACS estimates is 2.7%. Figure 19 shows the incremental weighted difference between vacancy rates for added workers in each of the listed place-of-work jurisdictions. The figure again shows somewhat mixed results. While there are some place-of-work jurisdictions for which added workers locate in places that have generally higher vacancy rates, the opposite is also true. The vacancy rate results disaggregated by wage tier are shown in Figure 20 and show no clear patterns by wage category. These combined results on housing affordability and vacancy rates indicate that further study is needed to understand how housing markets in the locations where workers are being added in the Bay Area differ from those of existing workers. As a final note, the time period selected for study may also be affecting the results. When further iterations of the LODES data are released by the US Census Bureau, the analysis can be updated and further study undertaken.

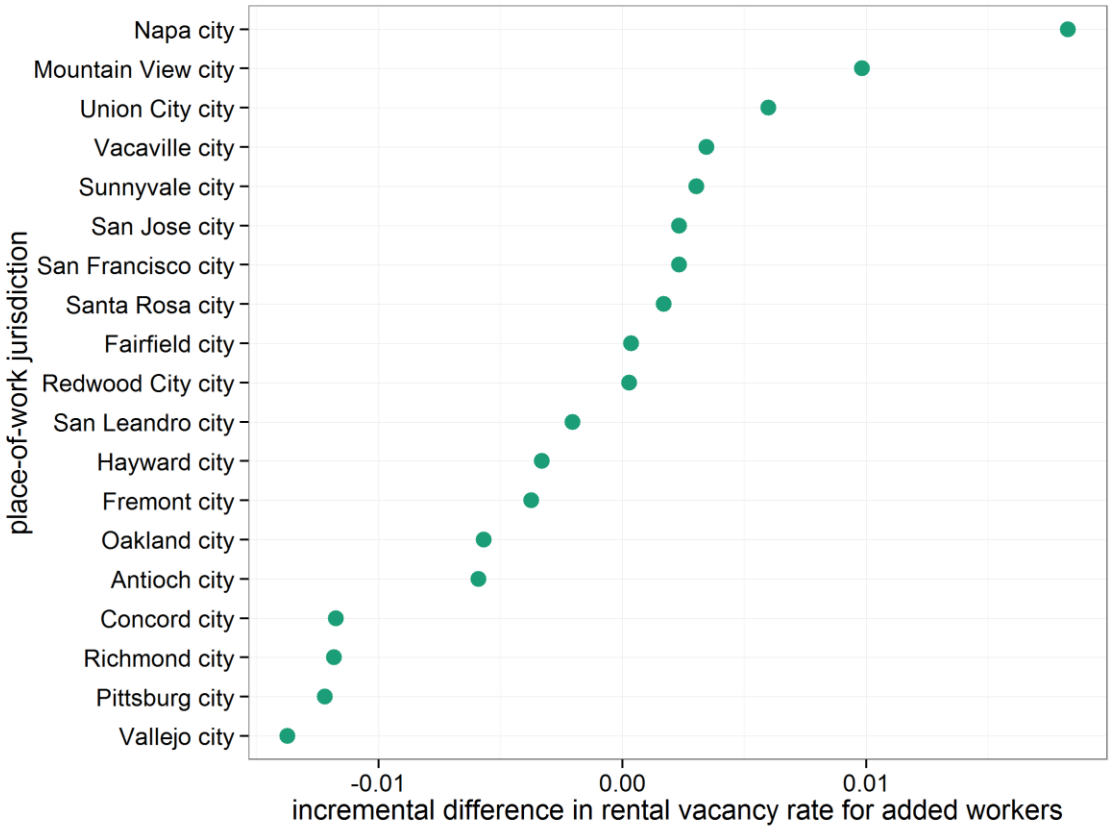


Figure 19: Incremental weighted vacancy rate impacts (percentage point difference) for added workers in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

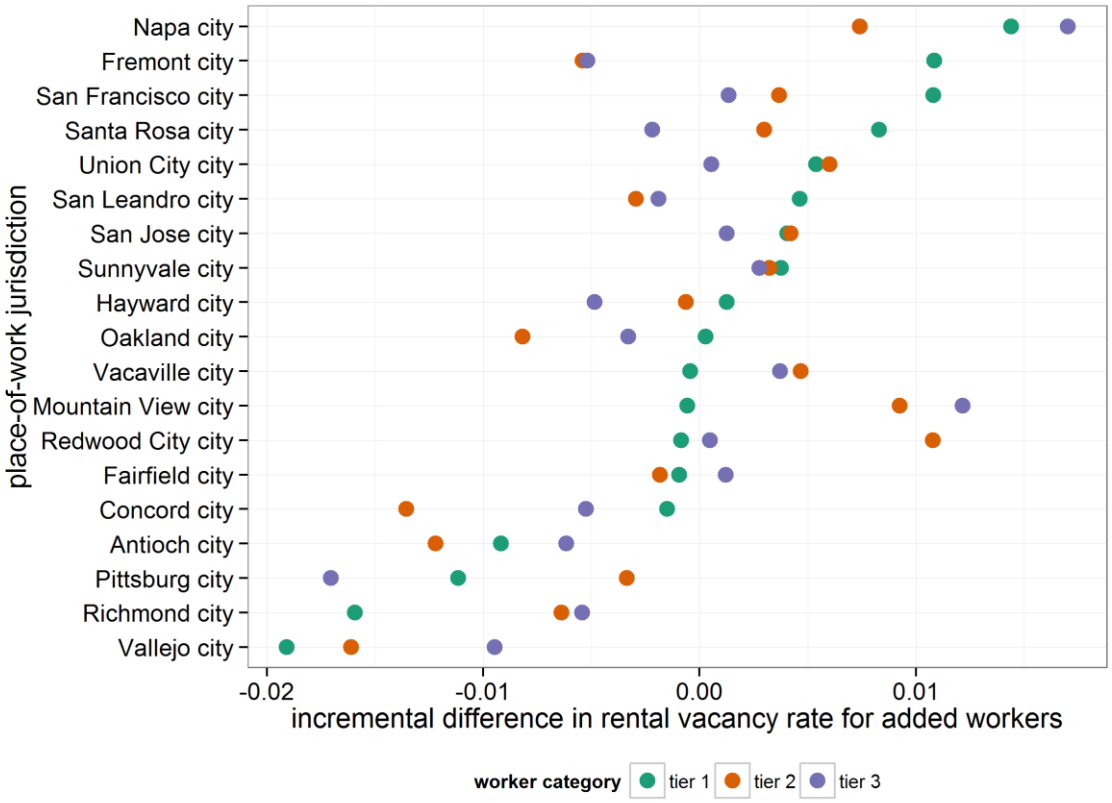


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Figure 20: Incremental weighted vacancy rate impacts (percentage point difference) for added workers by wage tier in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

7.0 Conclusion

This research effort was driven by a concern that current changes in job growth and housing affordability in the Bay Area are exacerbating the lack of affordable housing for low and middle-wage earners overall, and that the inter-jurisdictional connections in job and housing markets must be better understood in order to address those concerns. We set out to answer the question of how growth in high-wage jobs in one jurisdiction affects job growth and affordable housing in multiple jurisdictions. Overall, our analysis provides evidence that the concerns about changing patterns of affordability are well-founded, and provides some new analysis and methodologies for understanding these imbalances. Key patterns that emerged from our analysis include the following:

High-wage and low-wage jobs are not growing equally everywhere: High wage job growth in our time period of analysis has been geographically dispersed through substantial parts of Silicon Valley and the East Bay, along with the three major job centers of San Francisco, San Jose and Oakland. Low-wage job growth has been more heavily focused in these three core cities.

Relationship between high-wage and low-wage jobs varies substantially, though they are closely related in the largest job centers: Related to this difference in the geography of low-wage and high-wage job growth, there did not appear to be a consistent relationship between high-wage job growth and low-wage job growth across all jurisdictions. In the three major job centers of San Francisco, San

Jose, and Oakland, there was a close association between high-wage and low-wage job growth, but in smaller jurisdictions, this relationship is much weaker and when all jurisdictions are included, there is no statistically significant relationship between change in low and high wage jobs.

Overall jobs-housing balance has not changed dramatically, but disaggregating by affordability levels shows significant worsening of jobs-housing fit metrics: Measures of total housing indicates that most jurisdictions have added housing roughly in proportion to the increase in total jobs in the time period under study. However, disaggregating these values by wage levels and housing affordability reveals a significantly different picture with sometimes substantial imbalances and inequities. San Francisco was responsible for the largest growth in low-wage jobs, and added total numbers of housing units in rough proportion to the total number of new jobs, but saw no net increase in the number of affordable housing unit. Oakland added both low-wage jobs and had an increase in affordable housing while San Jose lost low-wage jobs but had an increase in affordable housing.

Commute patterns clearly show that new workers are travelling farther distances than existing workers. This is particularly true for low-wage workers: Throughout the Bay Area, in nearly every jurisdiction, new workers are travelling further distances than workers in existing jobs. The patterns are generally worse for low-wage workers, with people in low-wage jobs commuting further than new workers making higher wages. In San Francisco, for example, new workers in the lowest wage category have to travel 4.4 times further than new worker in the high wage category. In San Jose, the figure is 3.6. There is some evidence that these commute patterns are driven by workers in some jurisdictions seeking housing in more affordable locales, but additional research is needed to quantify this effect.

They also support the argument that regional planning and coordination of economic development and affordable housing initiatives is important for addressing the jobs/housing imbalance at different wage levels. These findings also suggest that improving jobs-housing fit can contribute to reduced commute travel, improving overall regional environmental performance.

Appendix A: Jobs-employed resident ratios

We calculated two measures of job-resident worker balance specific to individual categories of employment for the 25 jurisdictions with the greatest total job numbers according to the 2011 LODES data. These measures can be calculated directly from LODES and do not require assumptions about which types of housing are affordable to particular categories of workers. Specifically, we calculated one measure of balance that ranges between 0 and 1, where 1 is perfect balance between jobs and resident workers and zero is complete imbalance (i.e. all of one and none of the other). This measure was based on recent work by Stoker and Ewing.[5] It is calculated using the following equation:

$$1 - \frac{\text{abs(jobs - resident workers)}}{\text{jobs} + \text{resident workers}}$$

Because the measure ranges between 0 and 1, all jurisdictions can be compared on the same scale. A specific example is helpful for interpretation. Assume a particular jurisdiction has 100 jobs and 25 resident workers or 100 resident workers and 25 jobs. Its balance measure would be 1 - abs(100 - 25)/(100 + 25) = 0.40. We calculated this measure for each year of currently available data (2009 - 2011) for a number of different job-resident worker categories.

The second metric is the overall ratio of jobs to resident workers. The interpretation of this metric is straightforward, and can be helpful for thinking about the types of housing units that a jurisdiction needs to provide. Higher values of this metric indicate increasing imbalance.

The figures below show each measure (the balance measure is on the left and the ratio measure is on the right in each figure), for different job-resident workers categories: wage level (Figure A1), education level (Figure A2), two NAICS codes (professional and food service) (Figure A3), and two groups of NAICS codes meant to represent low- and high-wage employment (Figure A4).

[5] Stoker, P. and R. Ewing (2014). "Job–Worker Balance and Income Match in the United States." Housing Policy Debate 24(2): 485-497.

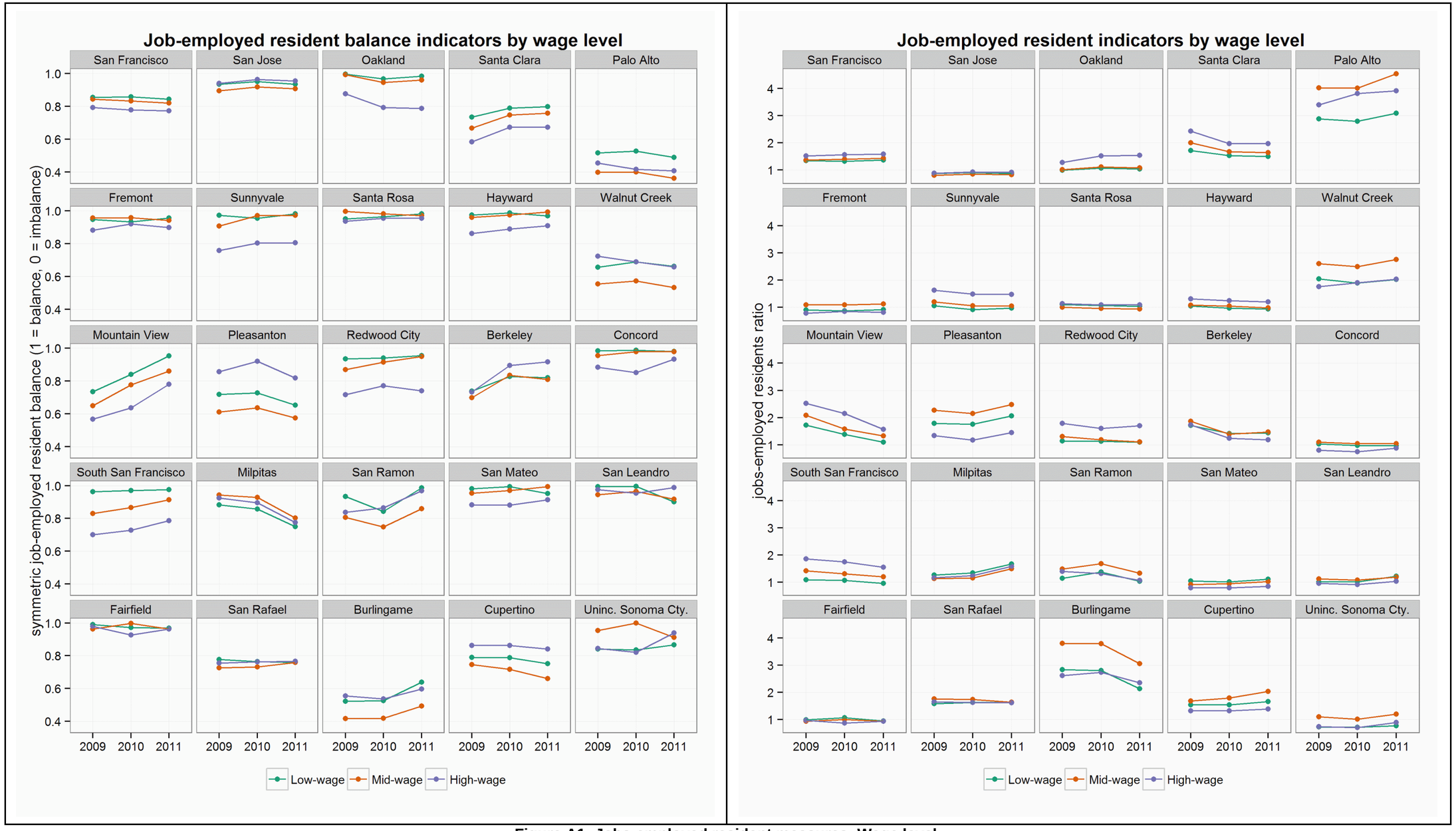


Figure A1: Jobs-employed resident measures: Wage level.

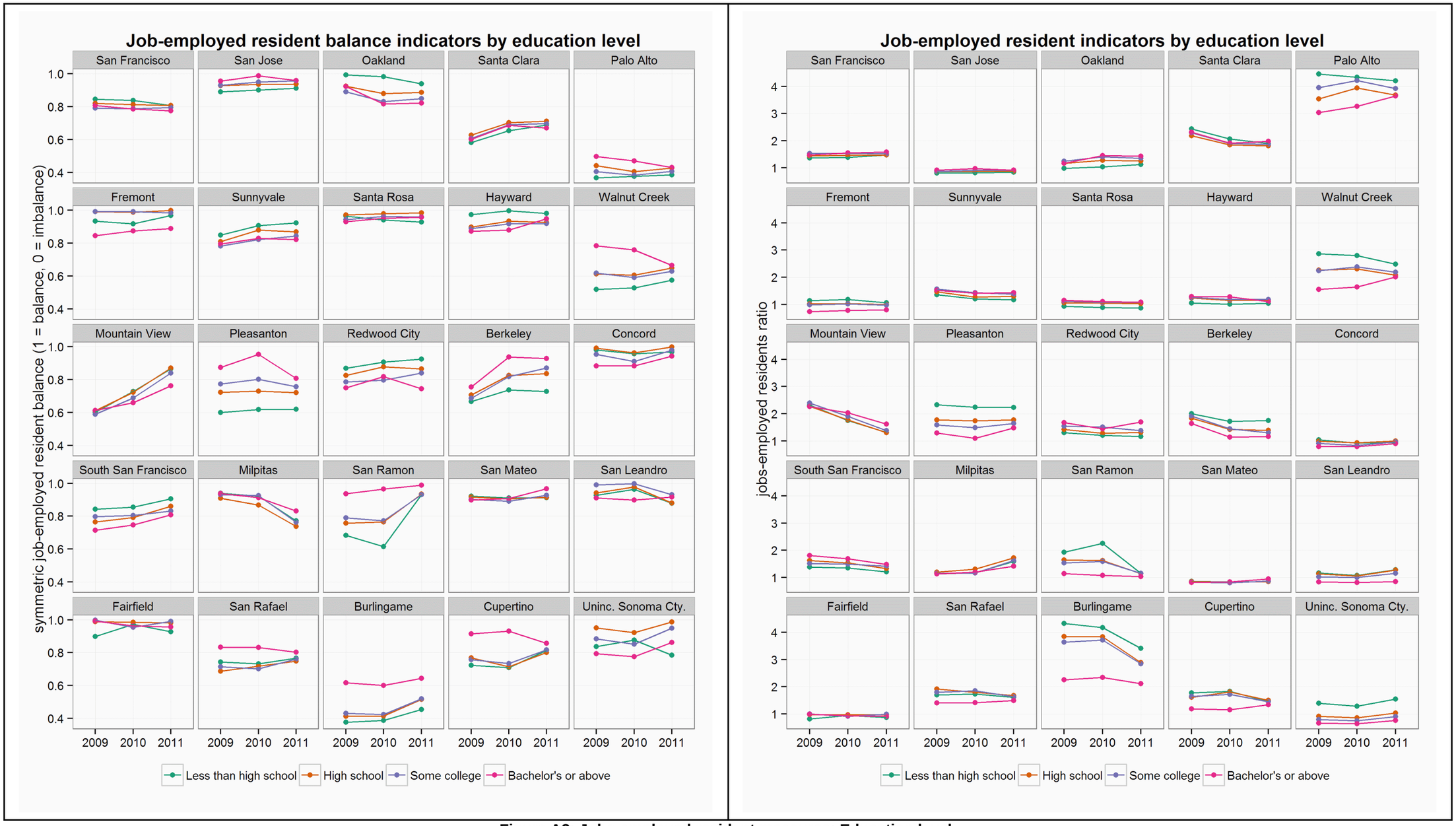


Figure A2: Jobs-employed resident measures: Education level.

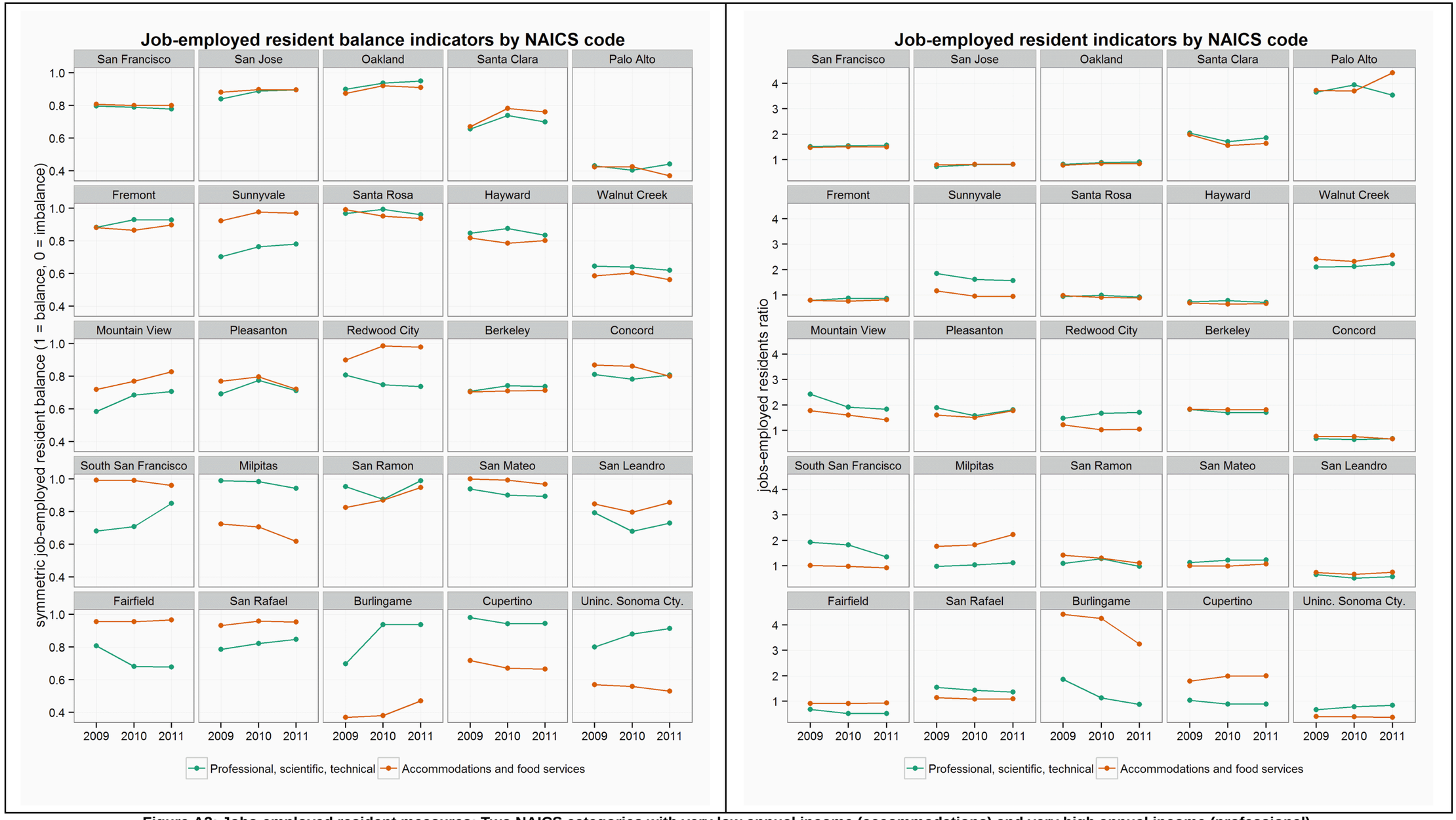


Figure A3: Jobs-employed resident measures: Two NAICS categories with very low annual income (accommodations) and very high annual income (professional).

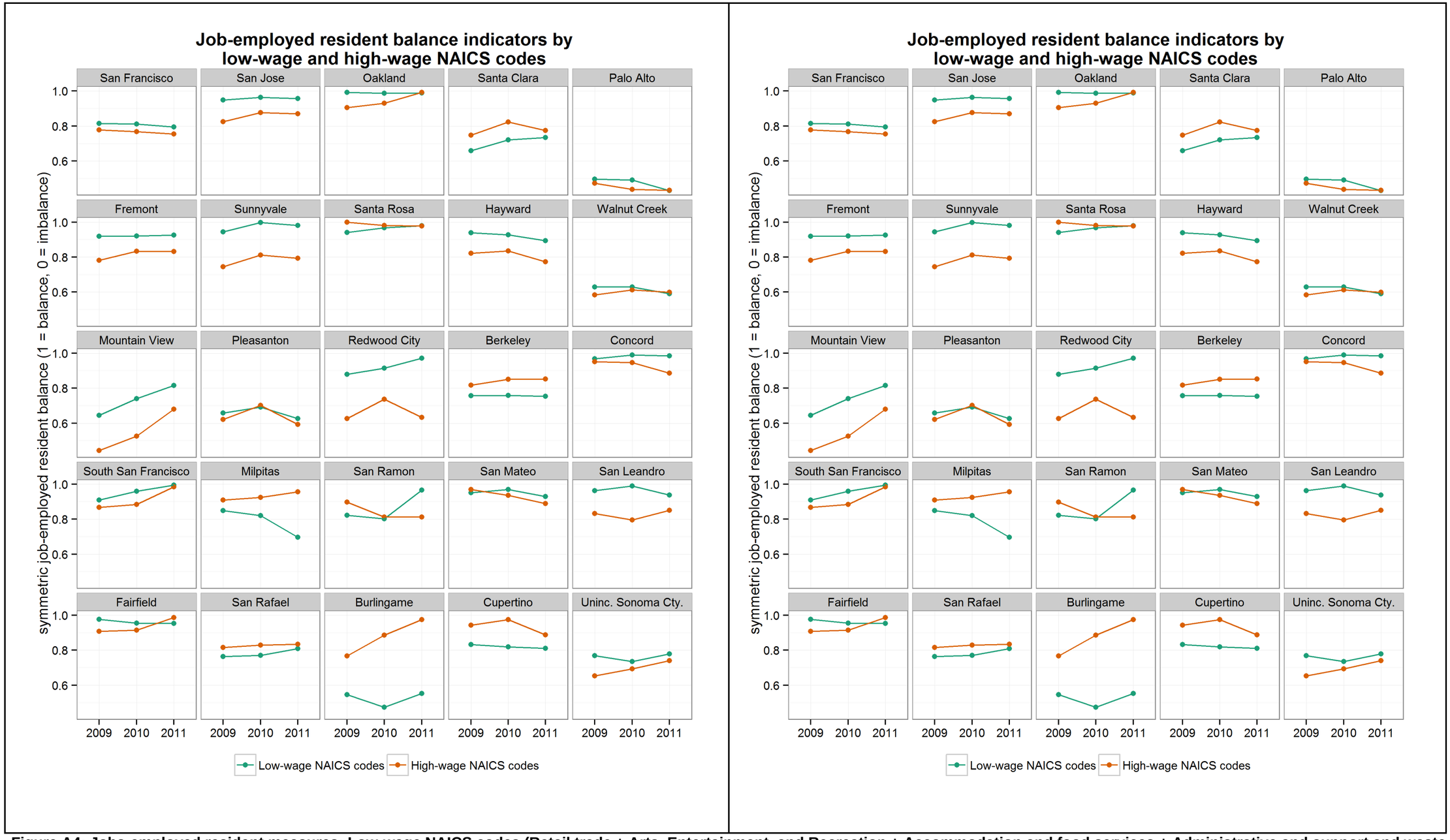
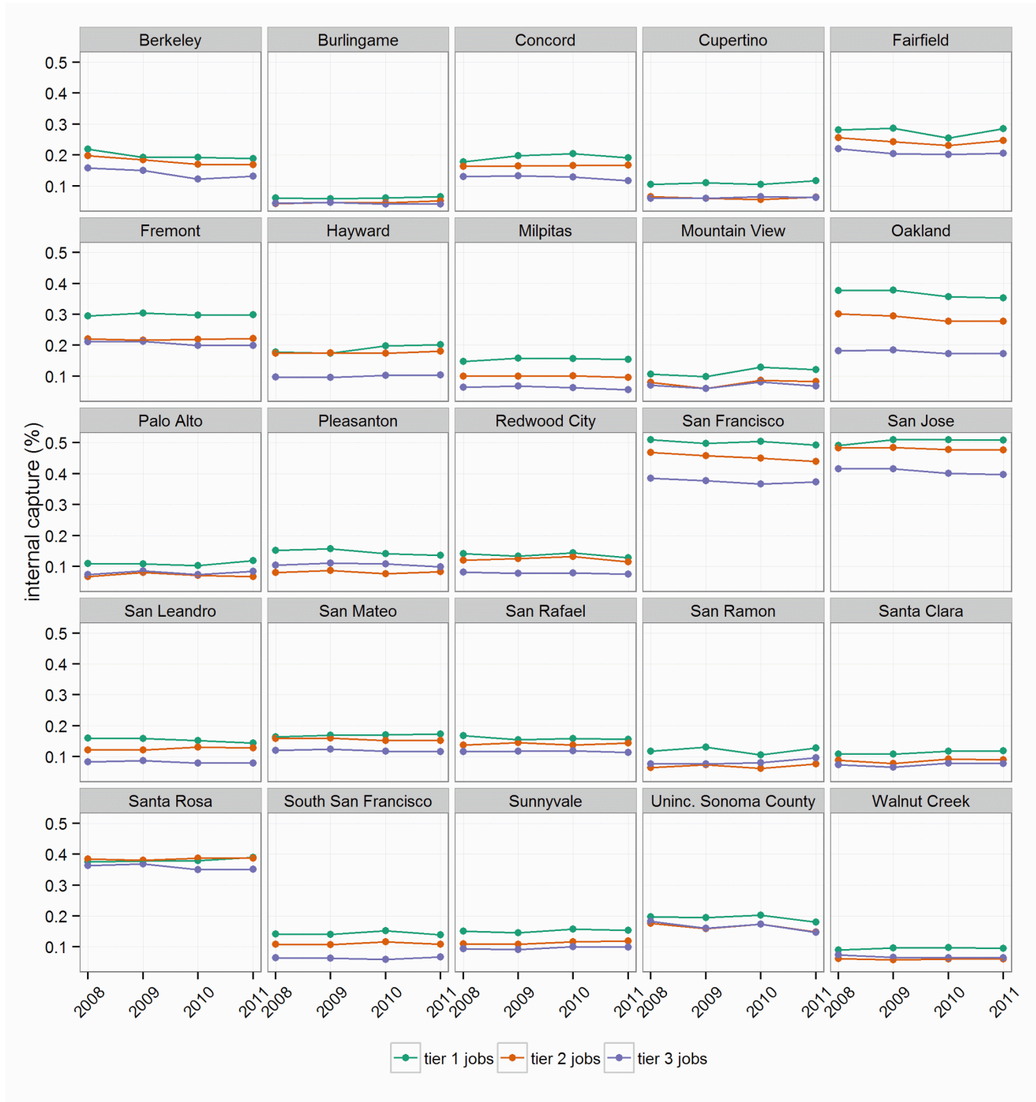


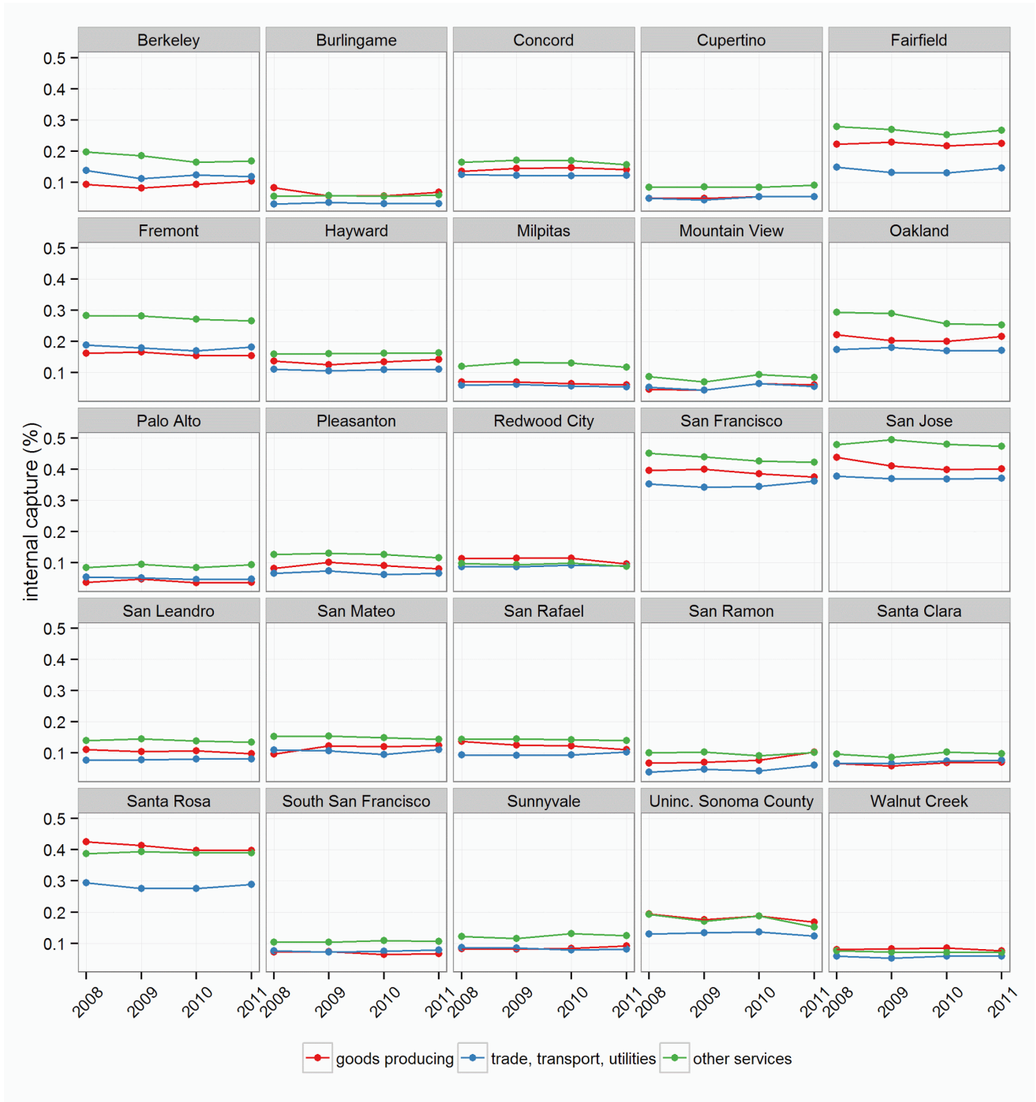
Figure A4: Jobs-employed resident measures: Low-wage NAICS codes (Retail trade + Arts, Entertainment, and Recreation + Accommodation and food services + Administrative and support and waste management and remediation + Other services [except public administration]) and High-wage NAICS codes (Information + Finance and Insurance + Professional + Management).

Appendix B: Internal capture and average commute distance

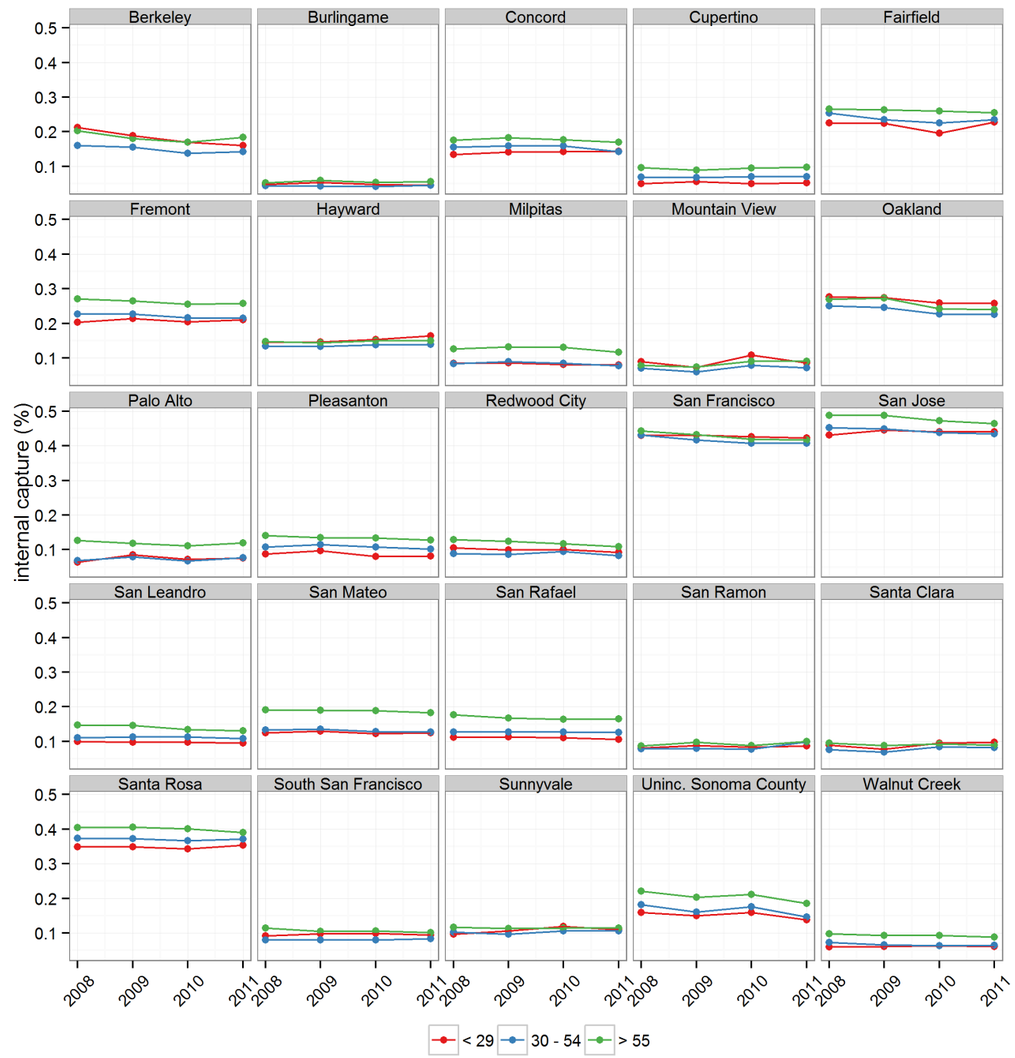
Figure B1 below illustrates the rates of “internal capture” - the proportion of total jobs held by people that live in the same jurisdiction - for the Bay Area’s 25 largest job centers from 2008 to 2011. Figure B2 summarizes the weighted average commute distance for each place-of-work jurisdiction for the same time period.



(a)

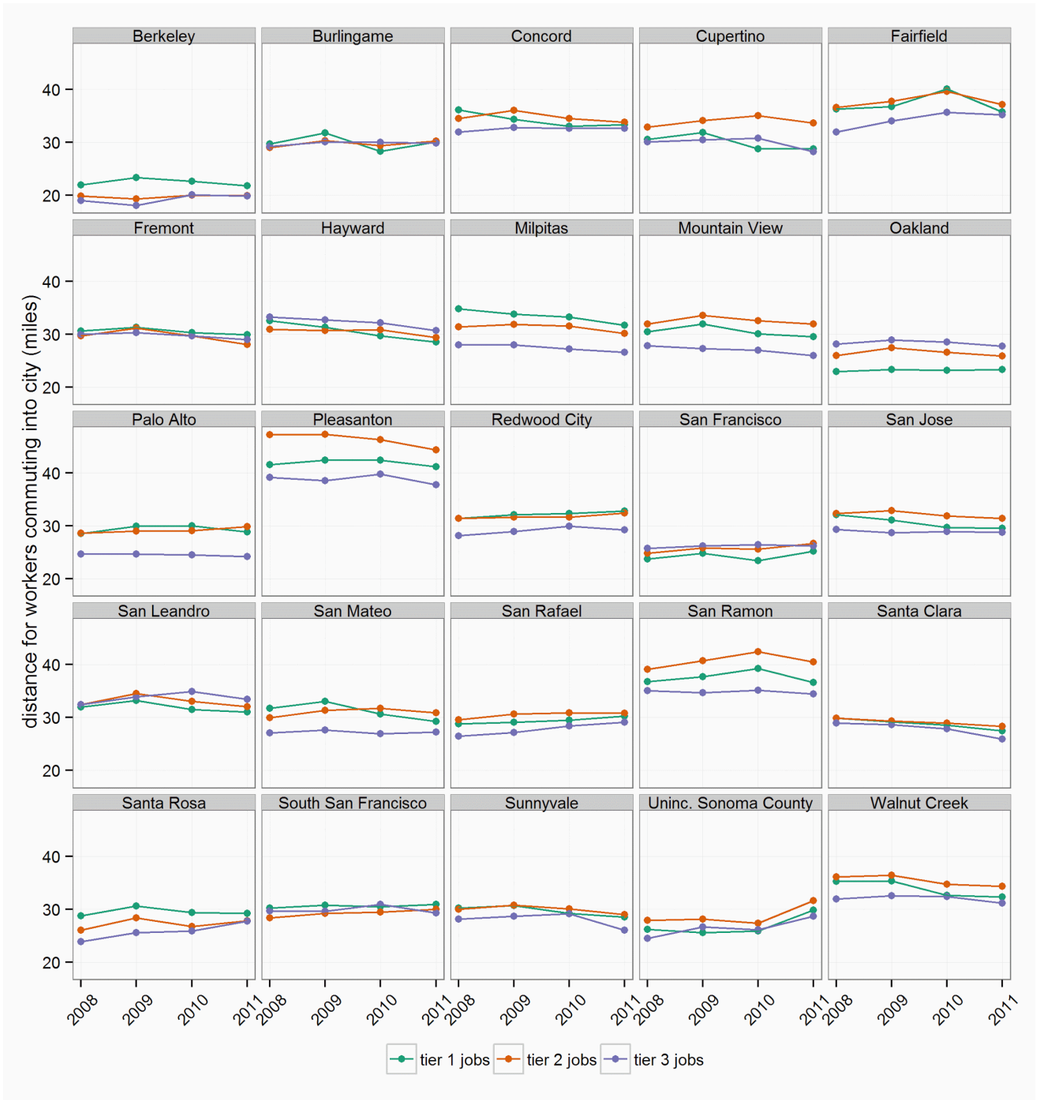


(b)

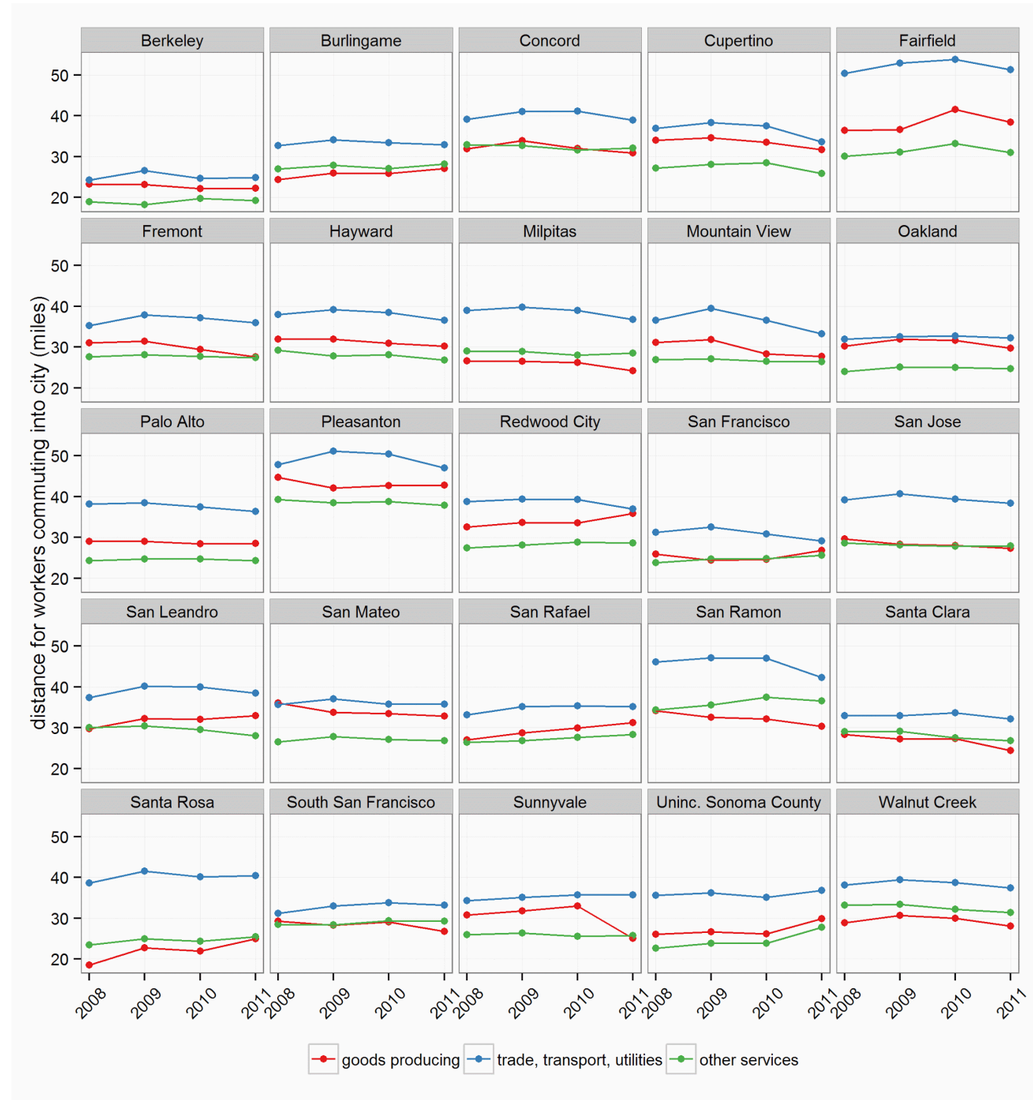


(c)

Figure B1: Internal capture for the 25 Bay Area places with the highest number of total jobs by (a) wage category, (b) industry category, and (c) age. Internal capture is calculated as the proportion of total jobs in a jurisdiction held by workers that live in that same jurisdiction.


Berkeley
Burlingame
Concord
Cupertino
Fairfield
Fremont
Hayward
Milpitas
Mountain View
Oakland
Palo Alto
Pleasanton
Redwood City
San Francisco
San Jose
San Leandro
San Mateo
San Rafael
San Ramon
Santa Clara
Santa Rosa
South San Francisco
Sunnyvale
Uninc. Sonoma County
Walnut Creek
distance for workers commuting into city (miles)
tier 1 jobs
tier 2 jobs
tier 3 jobs

(a)


Berkeley
Burlingame
Concord
Cupertino
Fairfield
Fremont
Hayward
Milpitas
Mountain View
Oakland
Palo Alto
Pleasanton
Redwood City
San Francisco
San Jose
San Leandro
San Mateo
San Rafael
San Ramon
Santa Clara
Santa Rosa
South San Francisco
Sunnyvale
Uninc. Sonoma County
Walnut Creek
distance for workers commuting into city (miles)
goods producing
trade, transport, utilities
other services

(b)

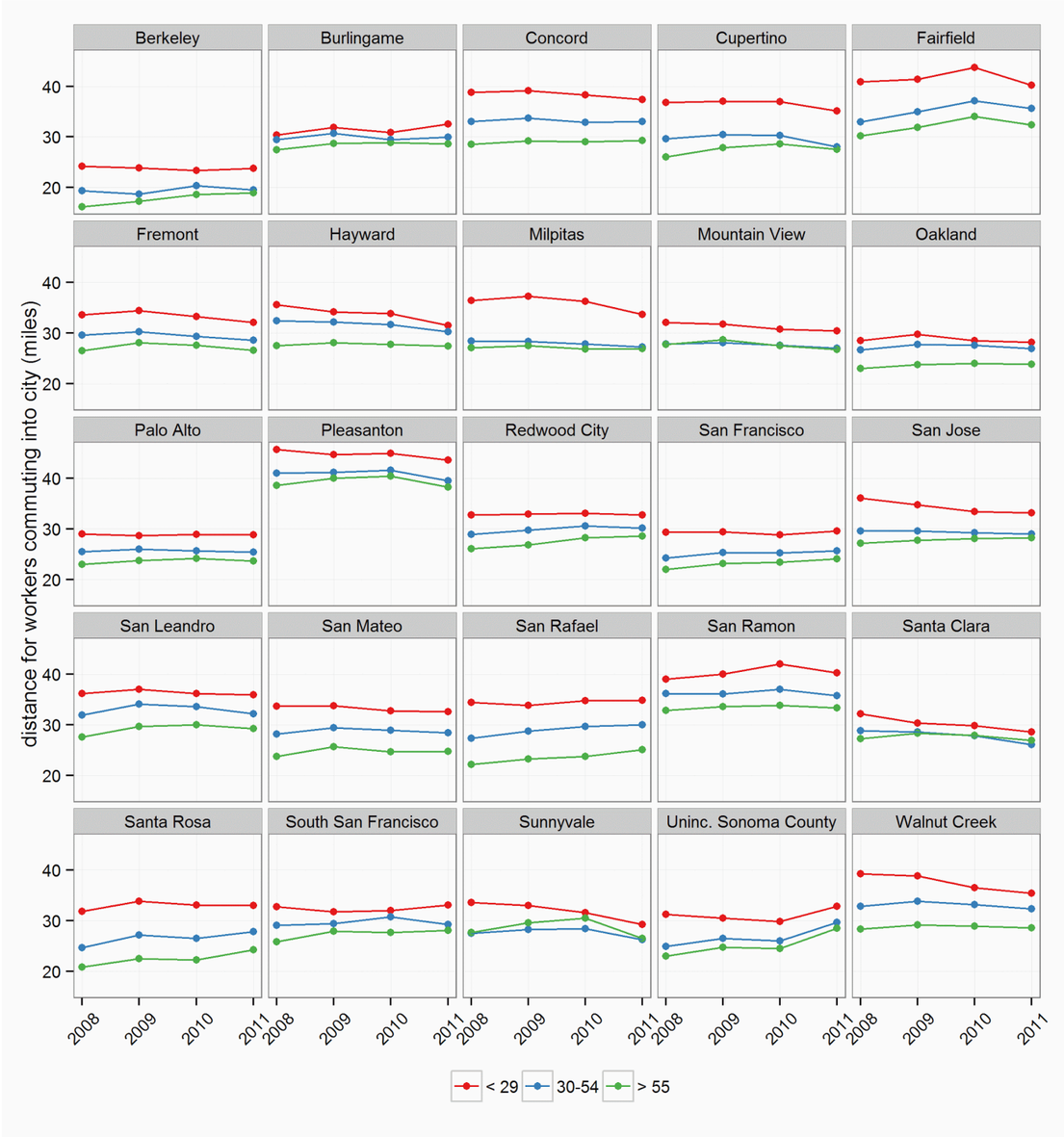


Figure B2: Average commute distance for the 25 Bay Area places with the highest number of total jobs by (a) wage category, (b) industry category, and (c) age.