July 11, 2016

(via Email) Kyle Perata (ktperata@menlopark.org)
Planning Division
701 Laurel Street
Menlo Park CA 94025

RE: Comments on Facebook Campus Expansion Project Draft EIR

Dear Mr. Perata,

Thank you for the opportunity to comment on the Draft Environmental Impact Report for the proposed expansion of the Facebook campus in Menlo Park. We are commenting as two Professors who have conducted substantial research on the relationship between jobs, housing, and transportation patterns in California, particularly in the Bay Area and Sacramento regions (our CVs are attached). Given this research, it is very clear to us that the Draft EIR is substantially underestimating the housing demand and increased transportation needs associated with the proposed expansion. In what follows, we provide a more detailed description of the research and analysis that leads to this conclusion. We also are attaching a much longer and more detailed report on the impacts of high-wage job growth that we completed for the Bay Area Regional Prosperity Plan Housing Working Group, with funding from the U.S. Department of Housing and Urban Development. This report describes our methodology in more detail, and provides a more detailed analysis of regional impacts and trends.

I. High-Income Job Growth has substantial multiplier effects for population and housing estimates

Before commenting specifically on the estimates of jobs, population and housing associated with the proposed new development, it is important to acknowledge what the research demonstrates occurs when there is a substantial increase in high-wage jobs in a particular location like Menlo Park. Likely impacts include:

- In addition to the direct jobs associated with the project, there are always a substantial number of indirect jobs that are created as a result of both the supplier networks of the primary job location, and the increased consumer demand of people employed in the directly created jobs. These indirect jobs are likely to be spread throughout the region, not just located in Menlo Park and are likely to pay less than those located at the new Facebook campus.
- The housing demands for people employed in these direct and indirect jobs are also likely to be spread throughout the region, not just located in Menlo Park.
- Nearby low-income neighborhoods, like East Palo Also, are likely to face significant displacement pressures as a result of this increased housing demand across the income spectrum.
- Given existing housing levels and construction constraints limiting infill development across the Bay Area, this growth in housing demand is likely to result in construction of new housing in distant places.

It should be noted that Menlo Park already faces significant affordability challenges and an imbalance in the availability of housing associated with low-income jobs in the city. According to the most recent data, in 2014 there were 3,028 jobs in the city that paid less than $1,250 a month, and only 663 units that would be affordable to households with 2 workers earning that level. We have attached an article about a "Jobs-Housing Fit" indicator we've developed to analyze this relationship between low-wage jobs and affordable rental units, and the full data is available online here: http://interact.regionalchange.ucdavis.edu/roi/data.html

II. The DEIR underestimates jobs, associated housing demand, and transportation impacts

There are a number of assumptions in the Draft EIR that result in a significant underestimation of the jobs, housing and transportation impacts of this project.

Jobs: According to the Draft EIR, he proposed project is estimated to result in 6,550 new jobs at full buildout. Yet we know that all new jobs have substantial multiplier effects, and these multiplier effects are larger for the high-wage jobs that will result from this proposed project. The Bay Area Council, for example, estimates that for every job created in the high-tech sector in the region, approximately 4.3 jobs are created in other local goods and services sectors across all income groups.[1] This suggests that the 6,550 new project jobs could contribute more than 24,000 additional indirect jobs in the region. The majority of these jobs would be spread throughout the region, but some will be created in Menlo Park as well. The possible magnitude of this local impact can be estimated by looking at employment changes in Menlo Park between 2012 and 2014, after Facebook first moved their headquarters to the city. Overall, between 2012 and 2014, jobs in the Information and Professional, Scientific and Technical Services industries increased 2,731, from 10,378 to 13,109 (this represented an increase of over 5,000 in the Information sector, which represents Facebook's growth, but decline in other high-tech employment in the city). Meanwhile, employment in Retail Trade, Administration & Support, and Accommodation and Food Services industries grew over 1,000, from 3,941 to 5,082.[2] We can expect a similar increase associated with the proposed project, where the growth of 6,550 direct jobs is likely to be associated with another 2,000 indirect jobs in Menlo Park alone.

Housing: The Draft EIR uses a figure of 1.8 employees per worker household to estimate that the 6,550 additional direct jobs associated with the proposed project would result in an increased housing demand of 3,638 overall, and 175 in the City of Menlo Park (based on an estimate that 4.8% of existing Facebook employees live in Menlo Park). We believe it is clearly inappropriate to use this 1.8 employees per worker household statistic in this estimate. The 1.8 figure is for *all* households in San Mateo County. It is extremely rare, however, for two members of the same household to work for the same company. Thus, the additional 6,550 new direct jobs is more likely to result in an increased demand of close to 6,550 new housing units in the region, with the

[1] http://www.bayareacouncil.org/community_engagement/new-study-for-every-new-high-tech-job-four-more-created/

[2] All figures come from the U.S. Census Bureau Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics (LODES) database.

remaining 0.8 workers per household working in other jobs not directly linked with this project. This would mean *at least* an additional demand for 314 new housing units in Menlo Park just for *direct jobs* (4.8% of 6,550). If indirect jobs are taken into account, this number is likely to increase perhaps by another 100 units within Menlo Park, and well over 10,000 additional units throughout the region.

Transportation: Because the Draft EIR underestimates the number of jobs and associated housing demand in the region, it also substantially underestimates transportation impacts. These transportation impacts are particularly significant for people in low-wage jobs, who in the context of the significant regional lack of affordable housing, have to drive substantially longer distances to work than people in higher wage jobs. We compared the average commute distance for new workers employed in Menlo Park in the 2012-2014 period (compared to the 2008-2010 period). Commute distances for new workers earning less than $1,250 a month increased by about 25 miles, relative to existing workers earning that amount. Similarly, commute distances for workers earning between $1,250 and $3,333 a month increased by about 16 miles. These figures are similar for most cities on the Peninsula. With existing (auto-dependent) transportation systems, these increasing distances mean substantial greenhouse gas emission and congestion impacts.

The estimates above are based on a methodology we developed as part of a study on the relationship between high-wage jobs, low-wage jobs, housing demand and travel patterns in the entire Bay Area, which we have attached.

To summarize, our estimate is the following:

- The 6,550 direct jobs created on the new Facebook campus are likely to result in over 24,000 indirect jobs in the region, with at least 2,000 of those located in Menlo Park.
- In terms of additional demands for housing units, rather than the 3,638 additional units in the region and 314 in Menlo Park estimated in the Draft EIR, we calculate a more accurate figure, estimating that just the direct jobs would result in an increased demand for close to 6,500 additional units, including over 400 in Menlo Park, and just the indirect jobs would add demand for well over 10,000 additional units in the region, and another 100 within Menlo Park.
- Given the lack of affordable housing located in Menlo Park and many nearby communities, new workers, especially those in middle and low-wage jobs are travelling on average much longer distances than existing workers, and thus, in the absence of investments in substantial new transportation alternatives, this proposed project is likely to result in very substantial increase in greenhouse gas emissions and congestion.

III. Options for mitigation

There are a number of ways in which the City of Menlo Park and/or Facebook could help mitigate the environmental impacts of this proposed project. The City of Menlo Park, for example, could substantially increase the provision of affordable housing units in the city, thus reducing displacement and reducing transportation impacts. This could be accomplished through a variety of mechanisms, including: expanding the Below Market Rate housing program;

increasing commercial linkage fees; or even considering a surtax on payroll taxes to fund housing development, like the ""Fair Share – Homeless and Housing Impact Tech Tax" being considered by at least some members of the San Francisco Board of Supervisors.[3] Facebook could also make substantial investments in increased workforce and affordable housing production, through for example making major contributions to the Housing Trust of Silicon Valley and/or supporting expanded affordable housing programs and policies of the city. Facebook could also minimize displacement and long commutes, by helping ensure that indirect jobs produced by their expansion pay better wages. This could be done by adopting a responsible contractor policy with substantial wage provisions, or supporting union contracts for all their contracts like they did for their Loop Shuttle drivers.[4]

Our key point is that the estimated impacts of the proposed Facebook expansion—on job creation, housing demand and association transportation impacts—are substantially underestimated in the Draft EIR, and we encourage you to not approve the project without taking into account the actual, broader environmental impacts and adopting very substantial mitigation efforts. We would be happy to talk about these issues with you in more depth.

Sincerely,

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[3] http://www.sfexaminer.com/voters-may-asked-tax-sf-tech-companies/
[4] http://www.latimes.com/business/technology/la-fi-tn-facebook-teamster-union-20150312-story.html

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

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

By:
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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

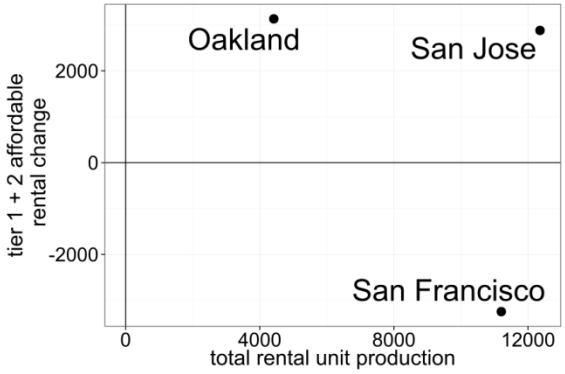
There were approximately 3.2 million jobs in the nine-county Bay Area in 2011. Three cities accounted for just over a third of the total: San Francisco (590,000), San Jose (365,000), and Oakland (198,000). In addition to total jobs, these three cities also employ substantial numbers of low-wage workers. 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

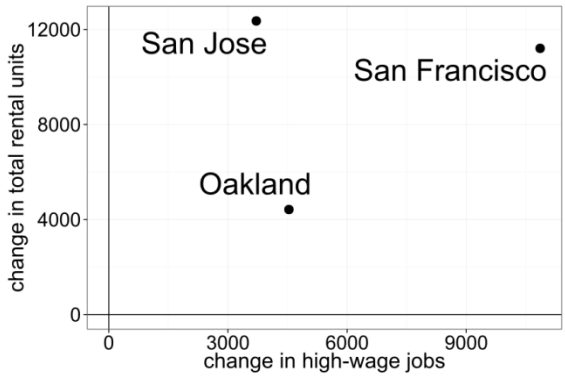
	Tier 1: < $1,250	Tier 2: $1,250 - $3,333	Tier 3: > $3,333/month
San Francisco	49.2	43.9	37.3
San Jose	50.8	47.6	39.8
Oakland	35.3	27.7	17.3

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

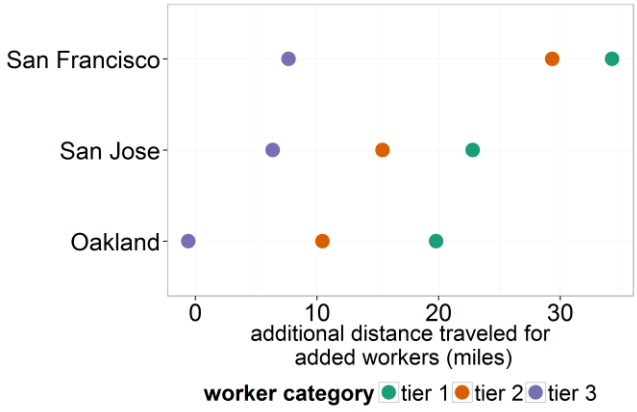
The figure at right compares total rental unit production to the change in rental units that are affordable for the lowest two income tiers. The figure clearly shows that total rental unit production is high in each of the three cities, but San Francisco lost affordable units and the increase in the 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:

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

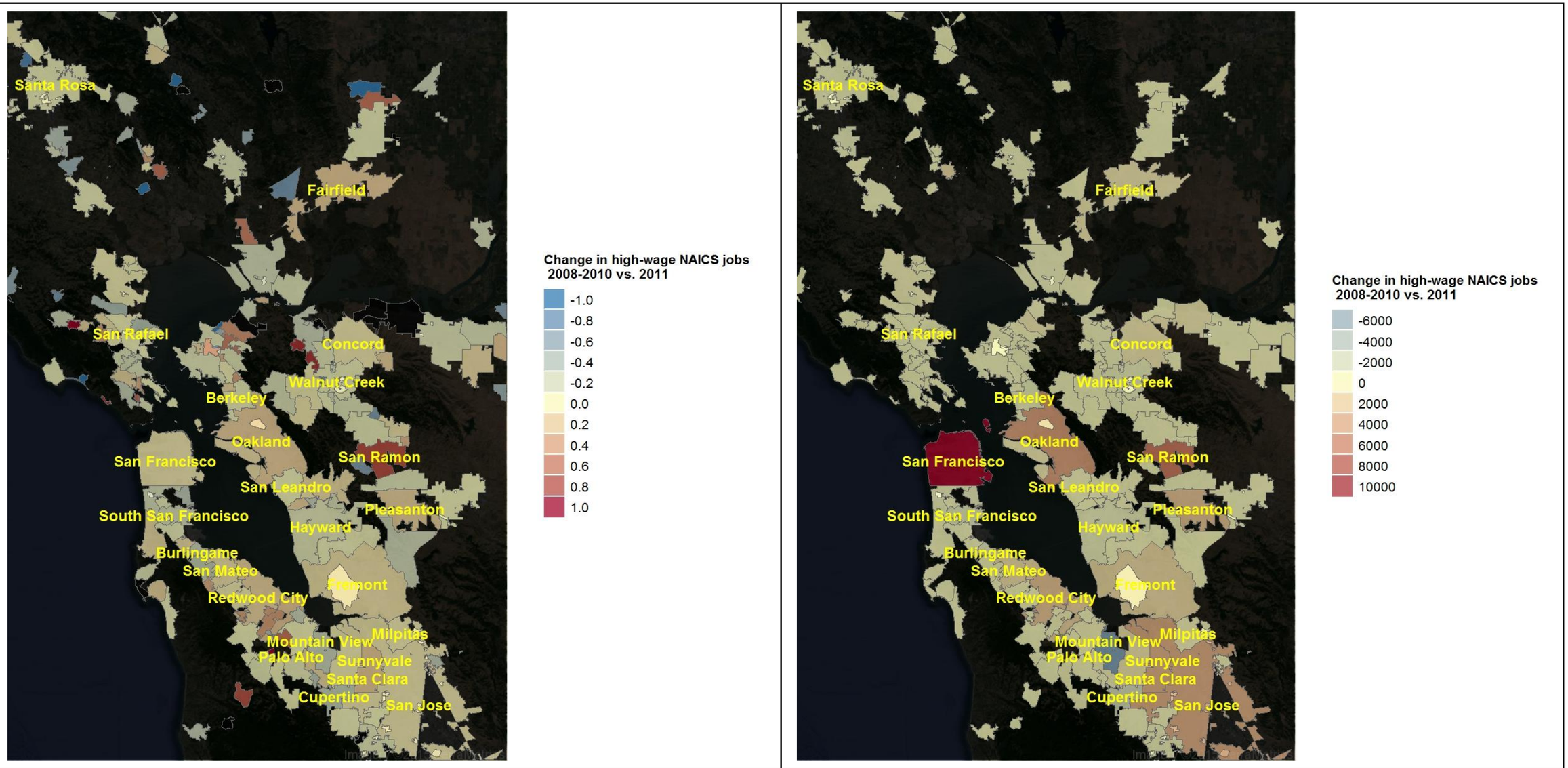
where *i* indexes origin locations, *j* indexes workplace locations, a represents 2008-2010 values, *b* represents 2011, t_{ij} is the number of trips from *i* to *j*, and h_i is the housing market characteristic of interest (one of median contract rent or vacancy rate). Median contract rent for occupied 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.

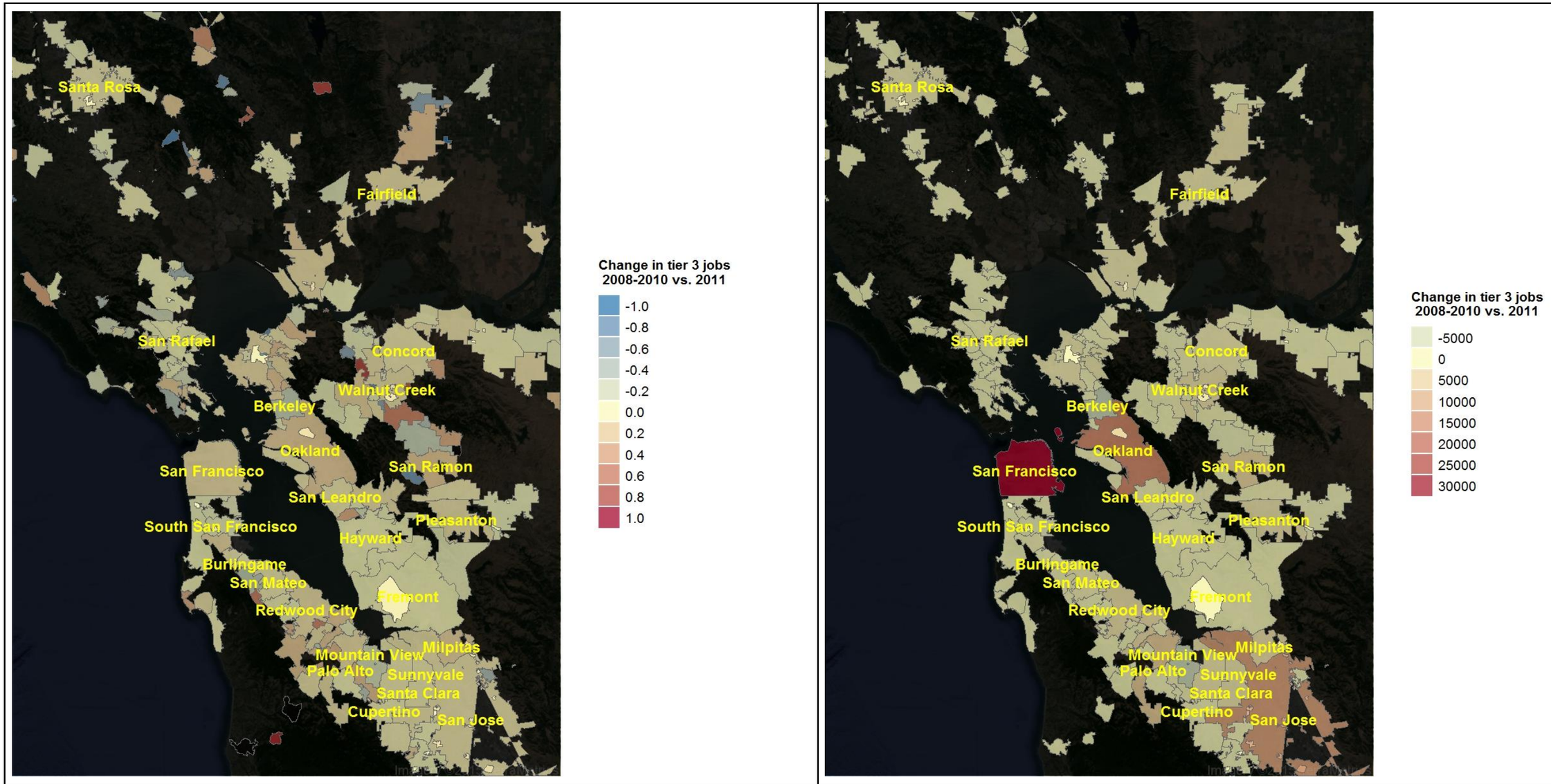
3.1 High-wage job growth and decline

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).

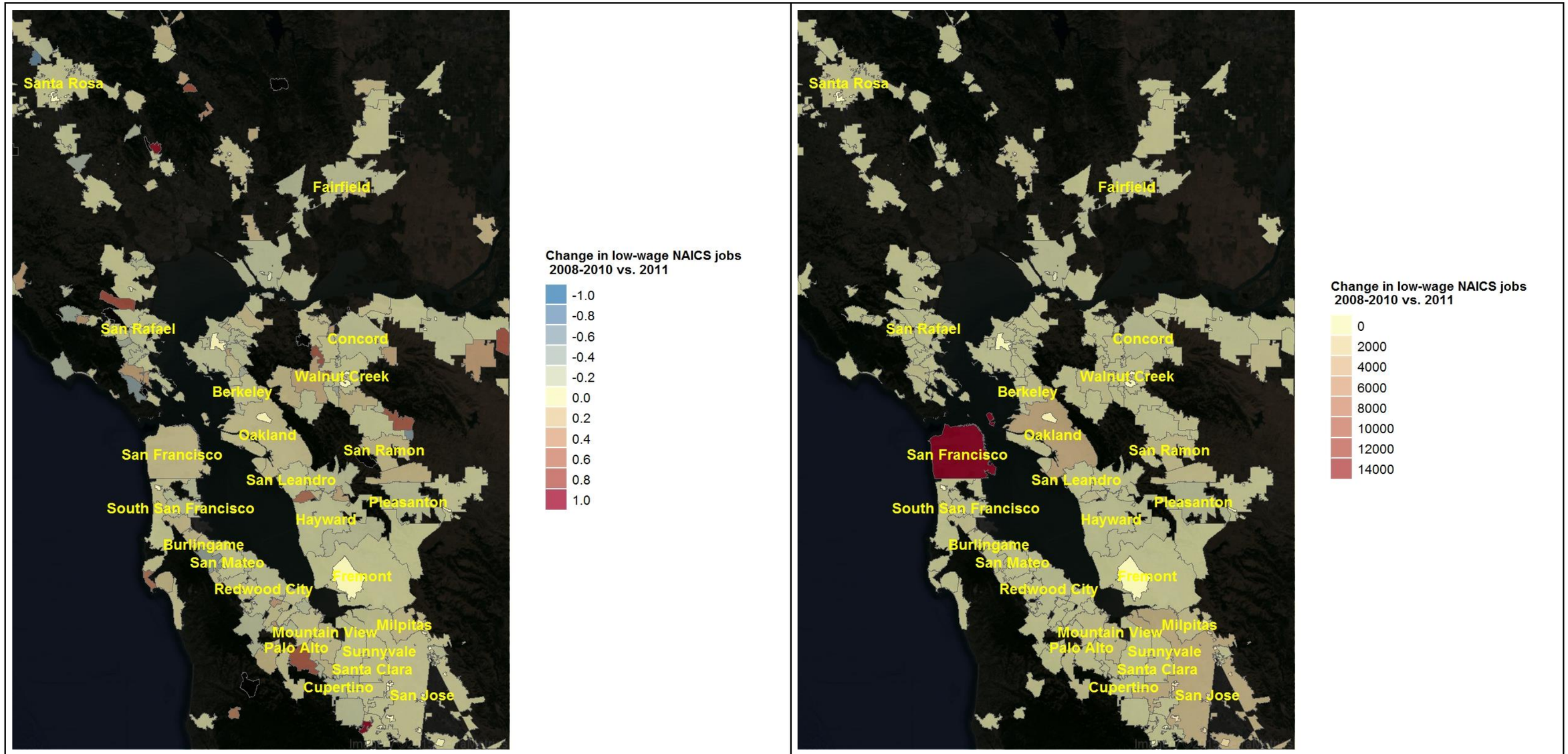


(a) (b)

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

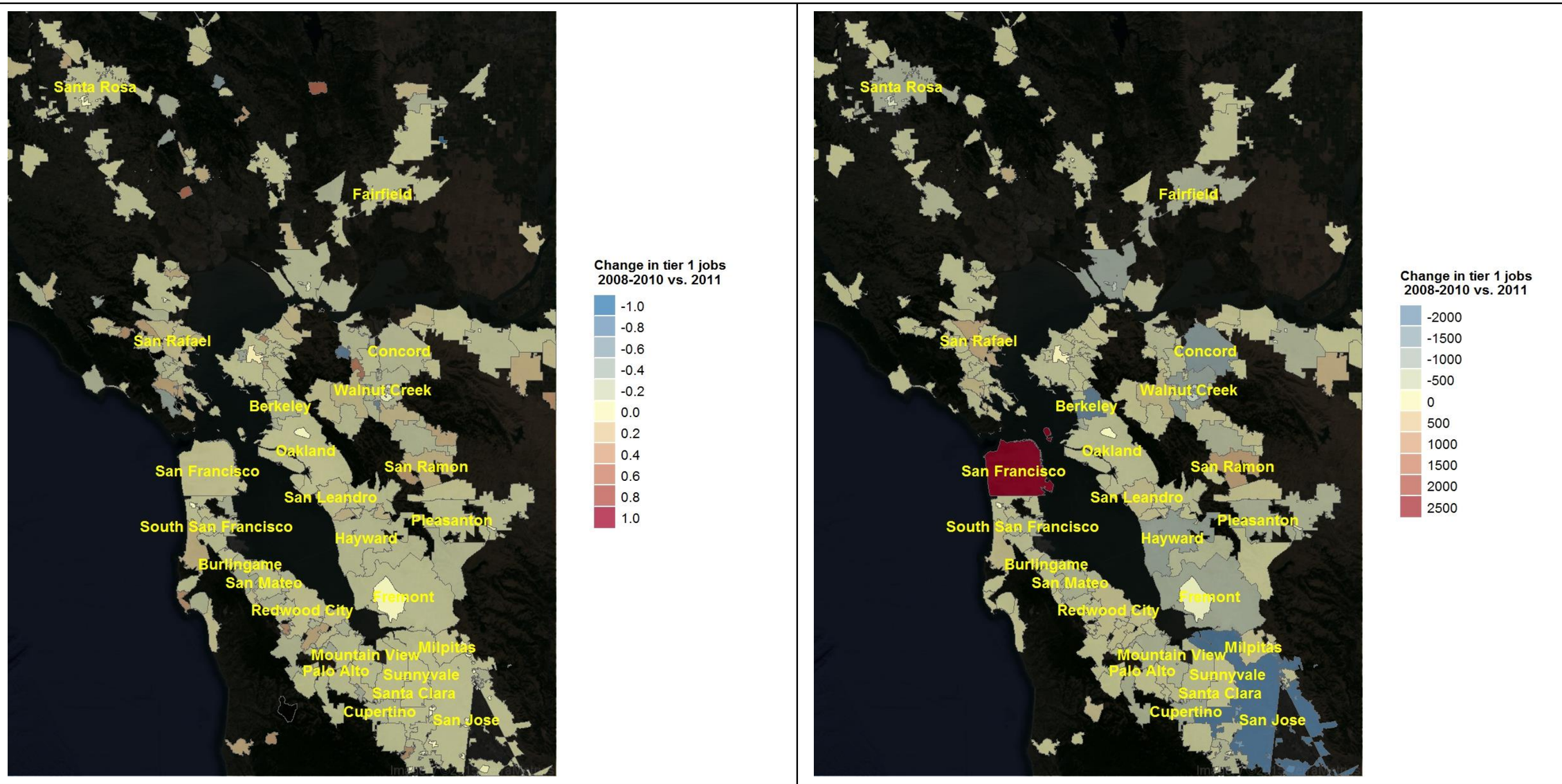
3.2 Low-wage job growth and decline

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.



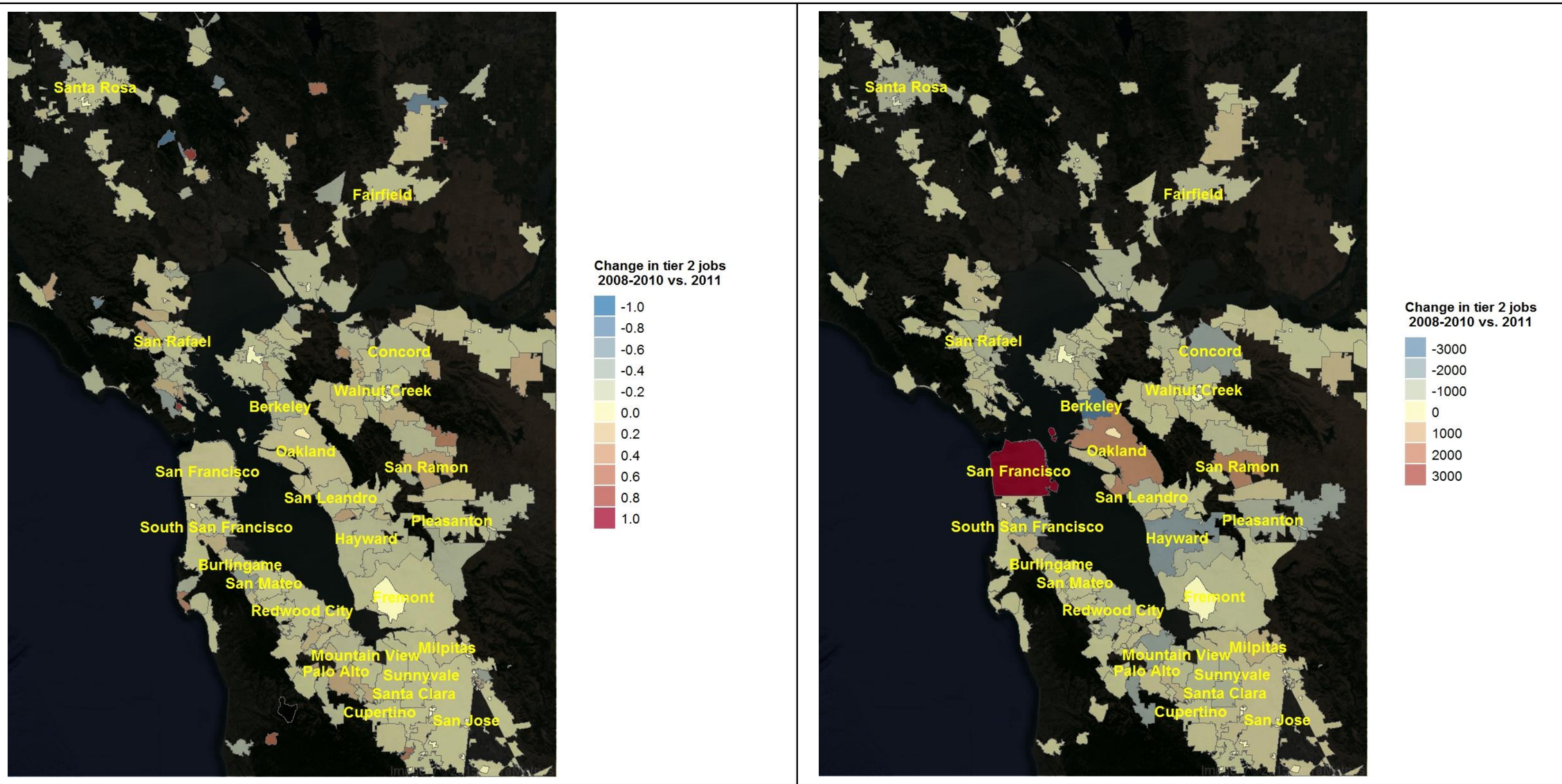
(a) (b)

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.



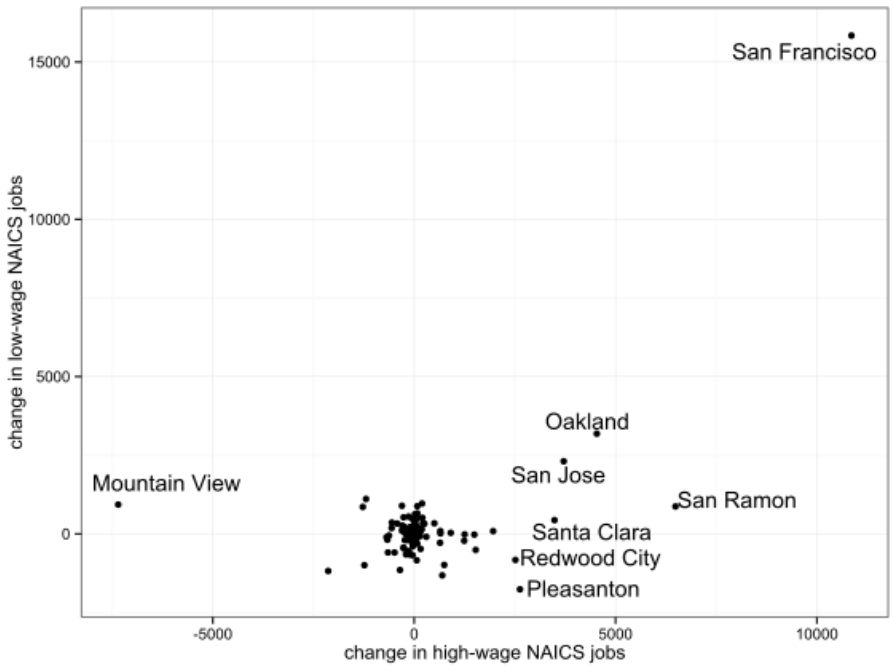
(a) (b)

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

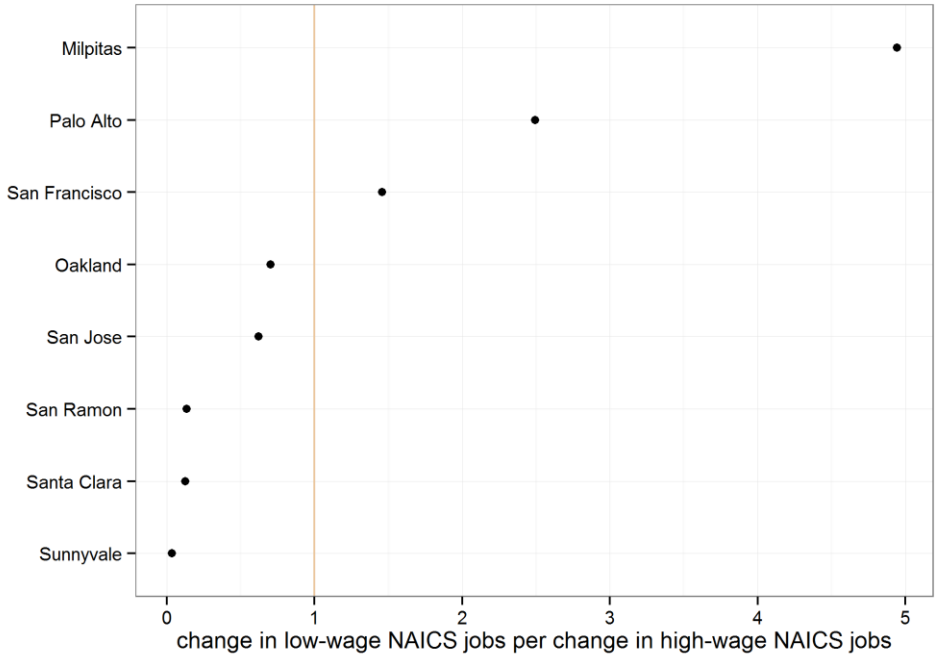
3.3 Relationship between low- and high-wage job growth and decline

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.

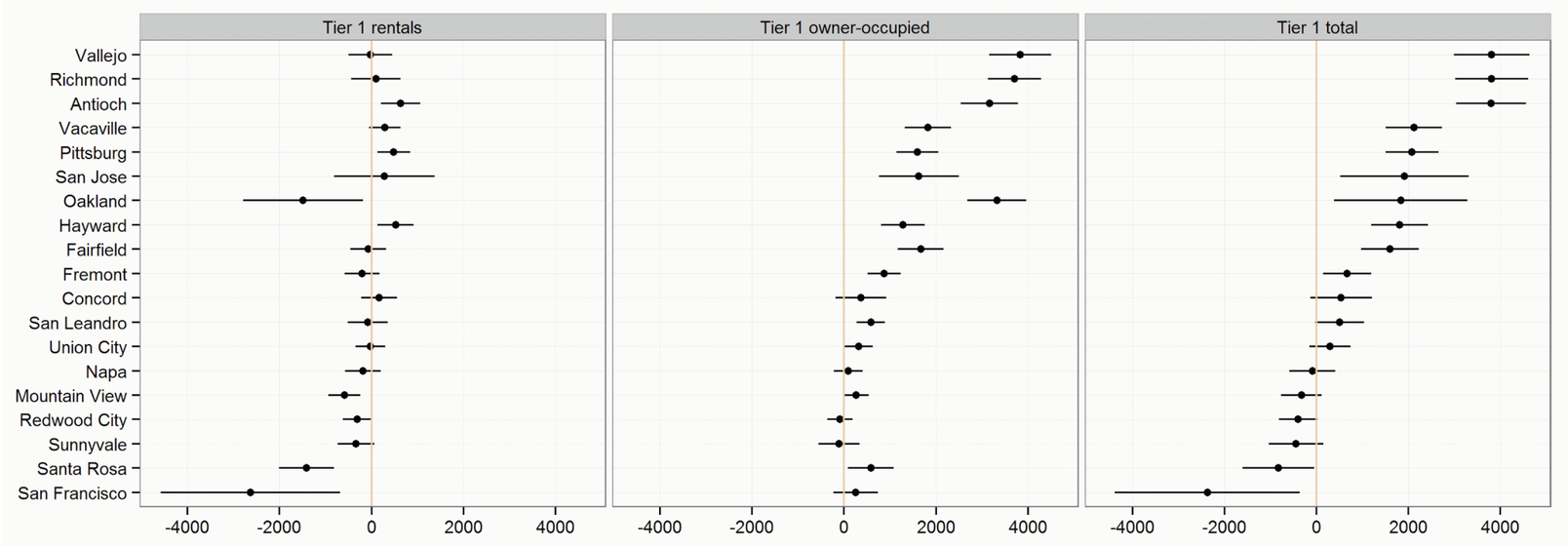
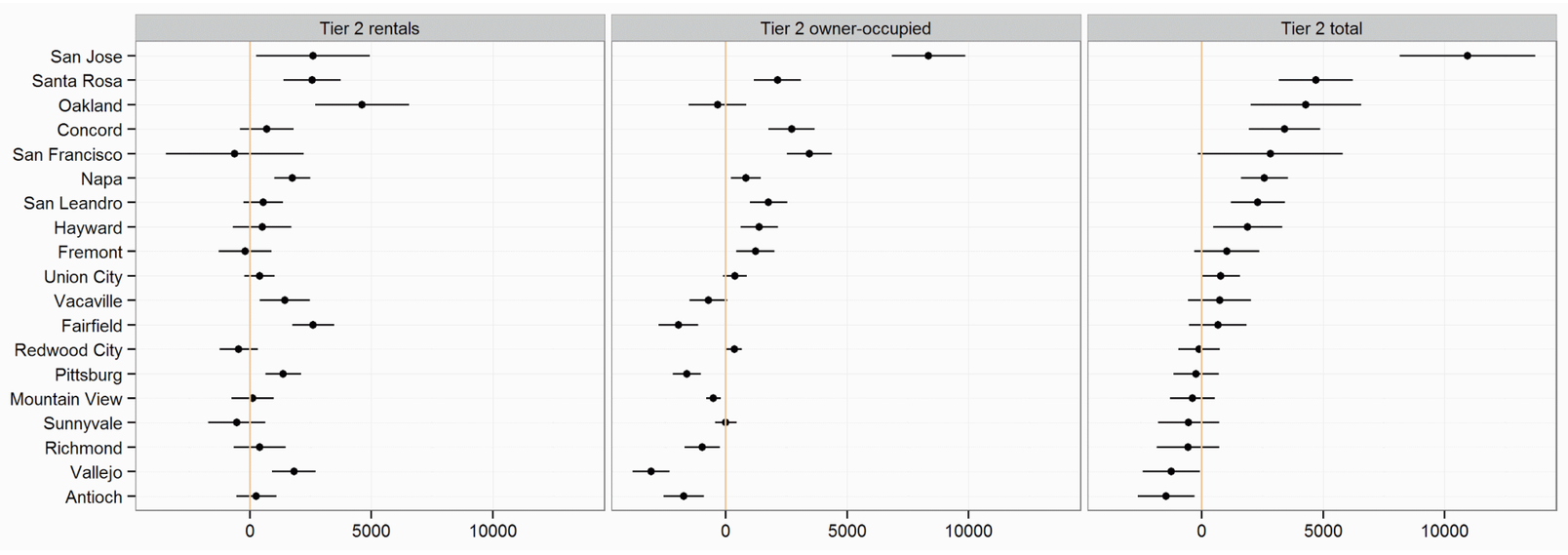
	Affordability limit	
Wage category	**Rental units**	**Owner-occupied units**
Tier 1	$1,250 * 2 * 0.3 = $750	(750 / (0.035/12 * (1 + 0.035/12)^360) * ((1 + 0.035/12)^360 - 1)) / 0.8 = $208,777
Tier 2	$3,333 * 2 * 0.3 = $2,000	(2000 / (0.035/12 * (1 + 0.035/12)^360) * ((1 + 0.035/12)^360 - 1)) / 0.8 =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

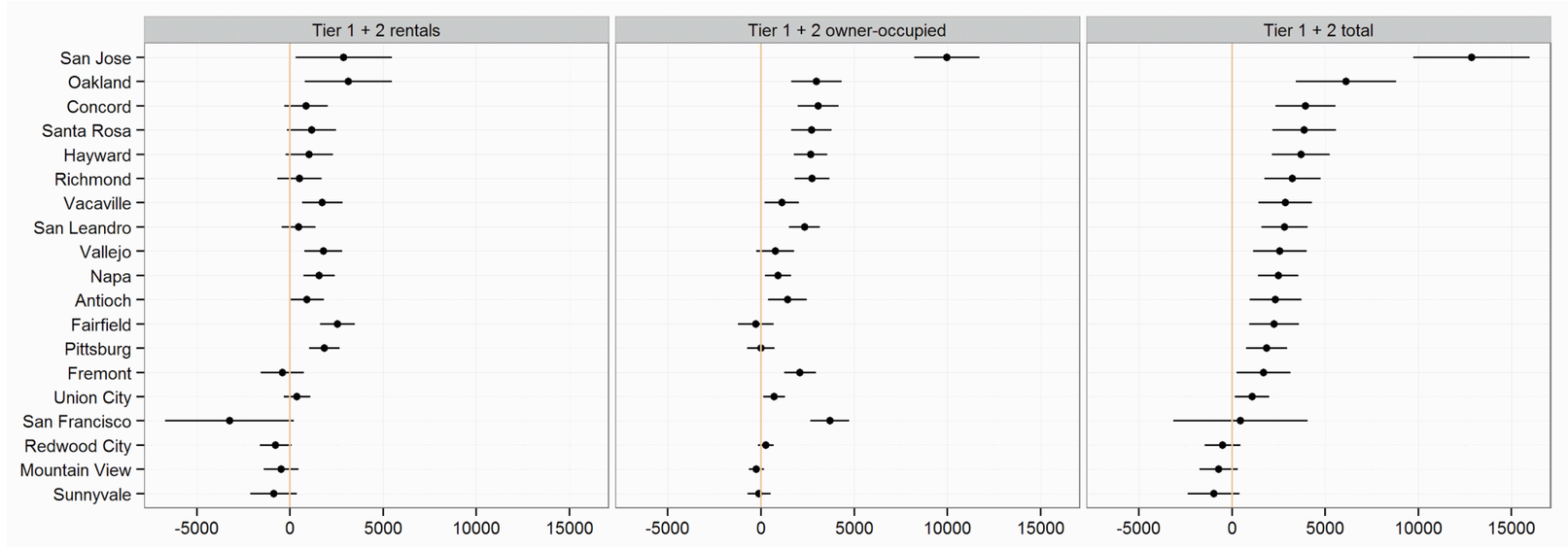
[4] Benner, C. and A. Karner (under review). "Measuring Jobs Housing Fit: Low-Wage Jobs and Proximity to Affordable Housing in the San Francisco Bay Area. Urban Geography.

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

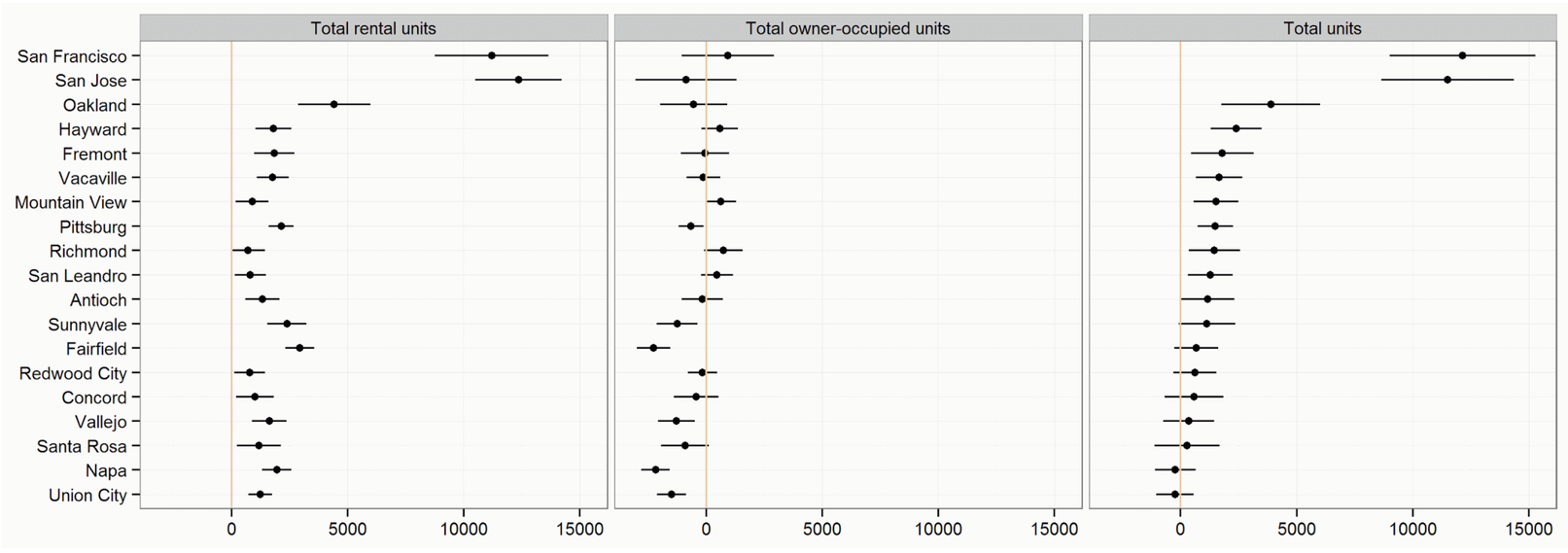


Figure 7: Change in housing units by affordability and rental/owner-occupied status for the 19 census places with complete data available in the ACS 2008-2010 and 2011-2013 three-year data products. Data from the ACS tables B25056 - Contract Rent and B25075 - Value. Data were generally not available 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.

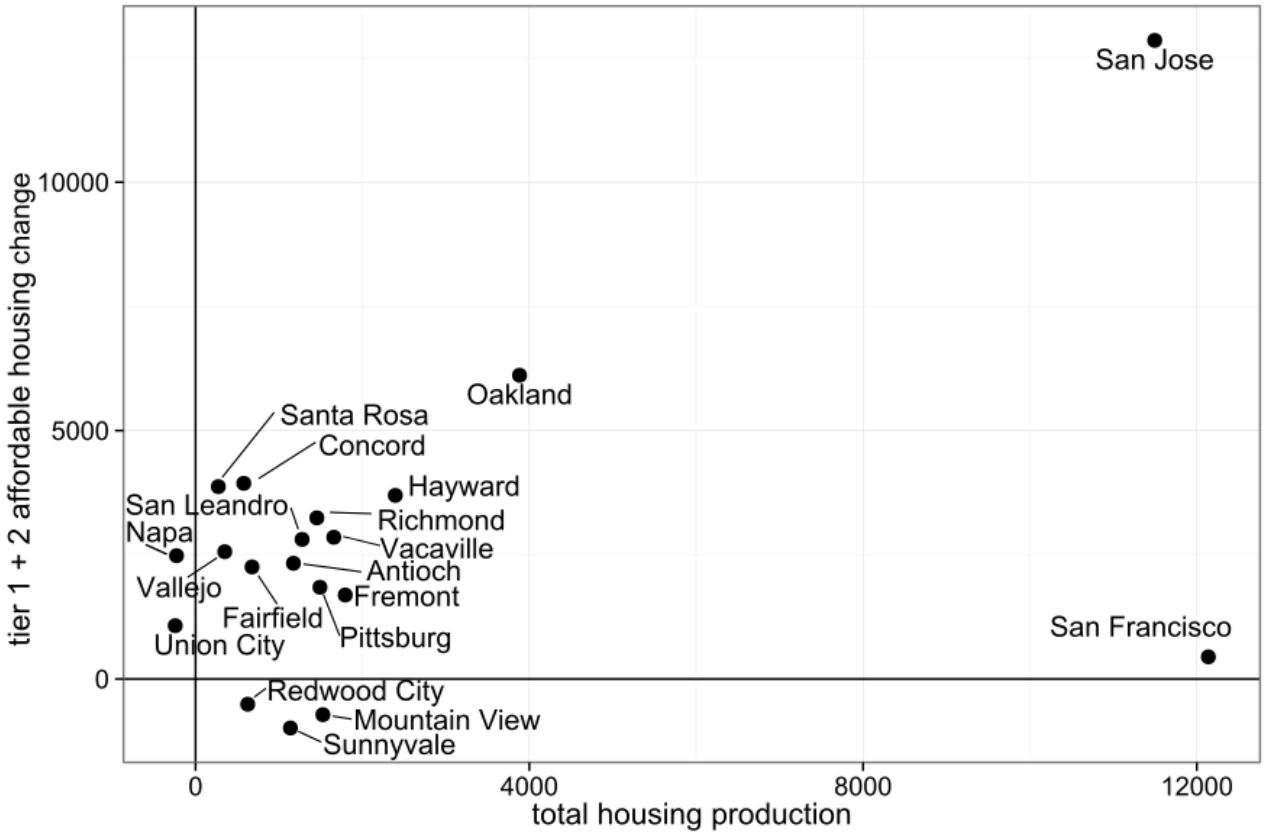


Figure 8: Comparison of total housing unit production to changes in tier 1 + 2 affordable units. The 19 jurisdictions shown have complete housing data available in the ACS three-year data products used for the comparison (2008-2010, 2011-2013).

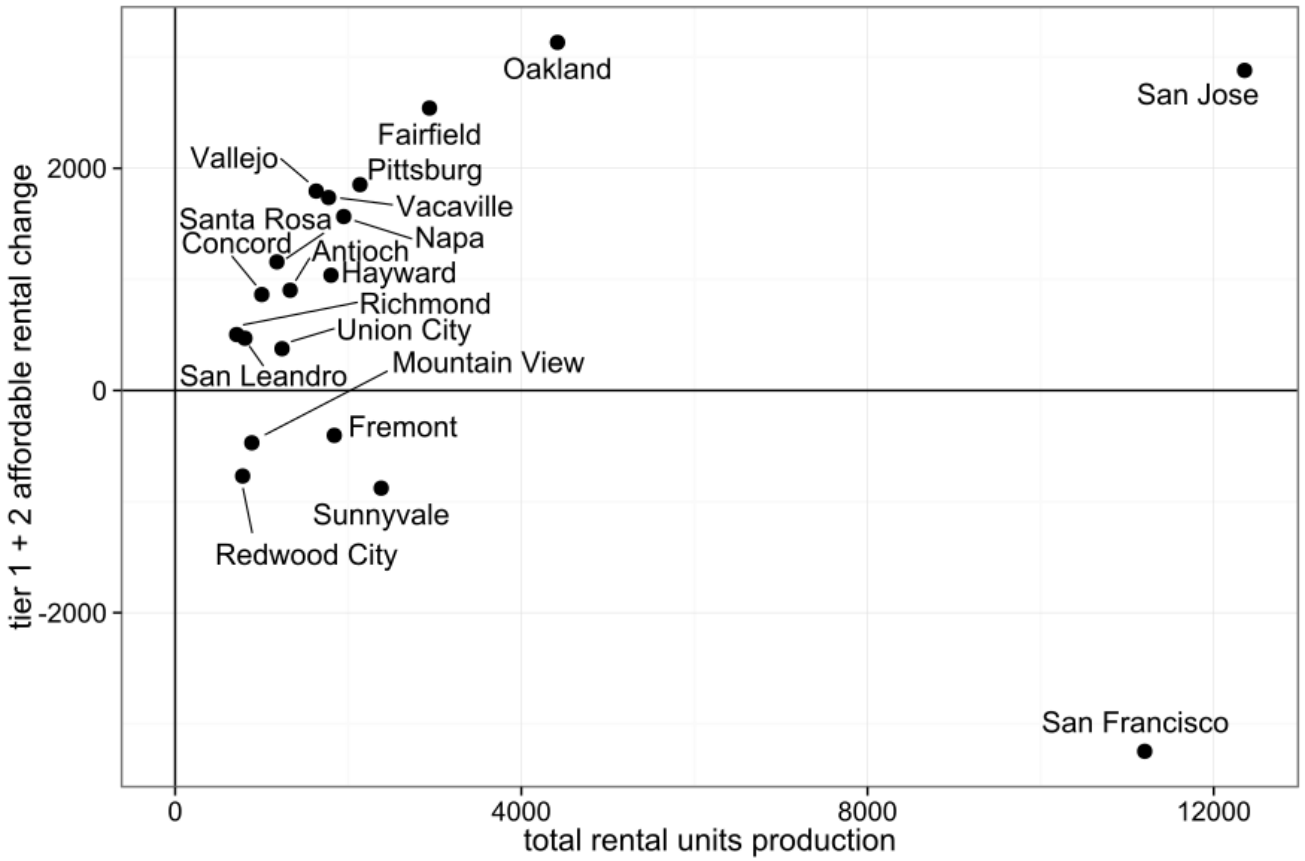


Figure 9: Comparison of total rental unit production to changes in tier 1 + 2 affordable rental units. The 19 jurisdictions shown have complete housing data available in the ACS three-year data products used for the comparison (2008-2010, 2011-2013).

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.

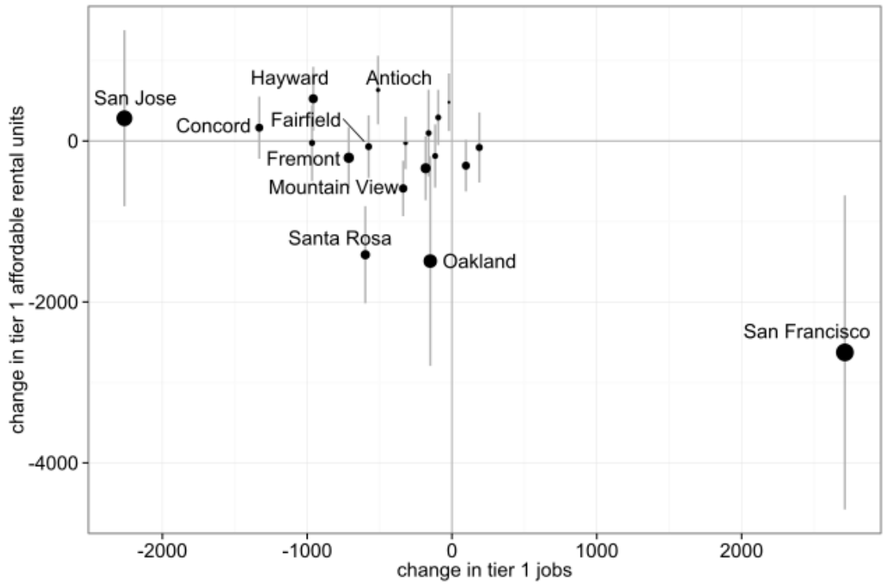
Tier 2 workers fared somewhat better than their tier 1 counterparts in terms of affordability changes in the rental market (Figure 11). For similar reasons to tier 1, the rental market is still likely to be quite important for tier 2 workers. San Jose and Oakland definitely saw tier 2 affordable rental 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,

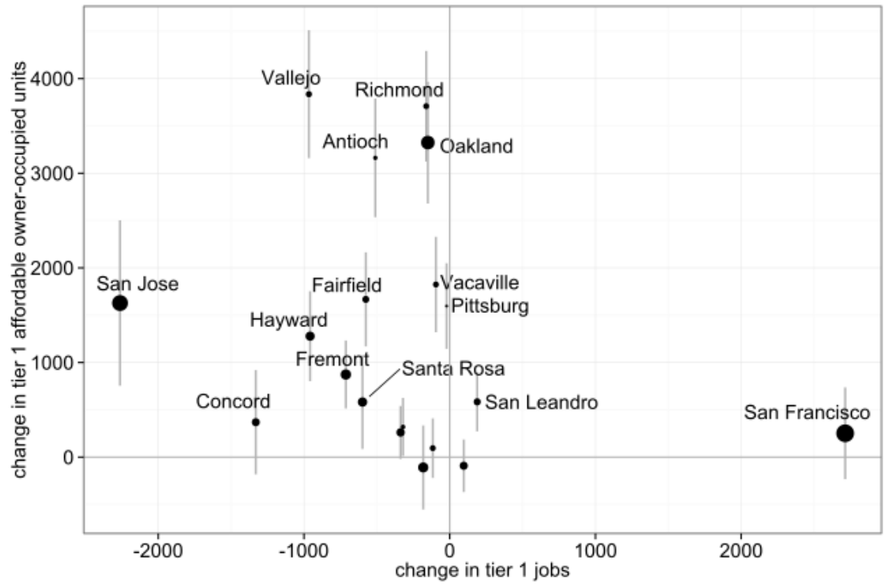
however, indicate that they generally have higher numbers of jobs than affordable owner-occupied units meaning that adding affordable tier 1 + 2 units would mitigate existing disparities.

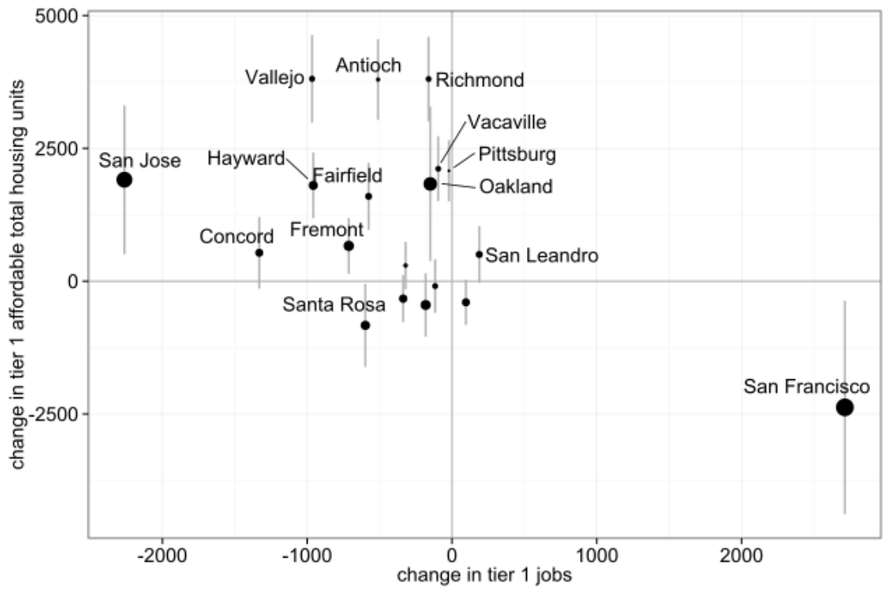
The figure for total jobs, total housing units, and overall jobs-housing balance (Figure 13) provides a useful comparison to the values disaggregated by wage levels. Numbers for total housing units include the highest categories of rent and value available in the ACS data, meaning that Figure 12 is capturing 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.







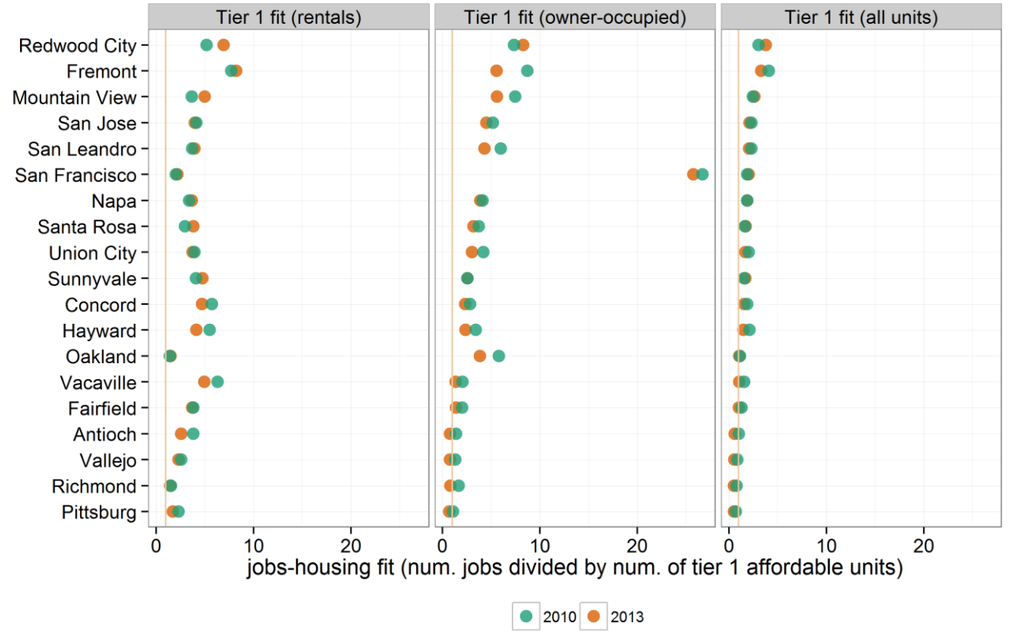
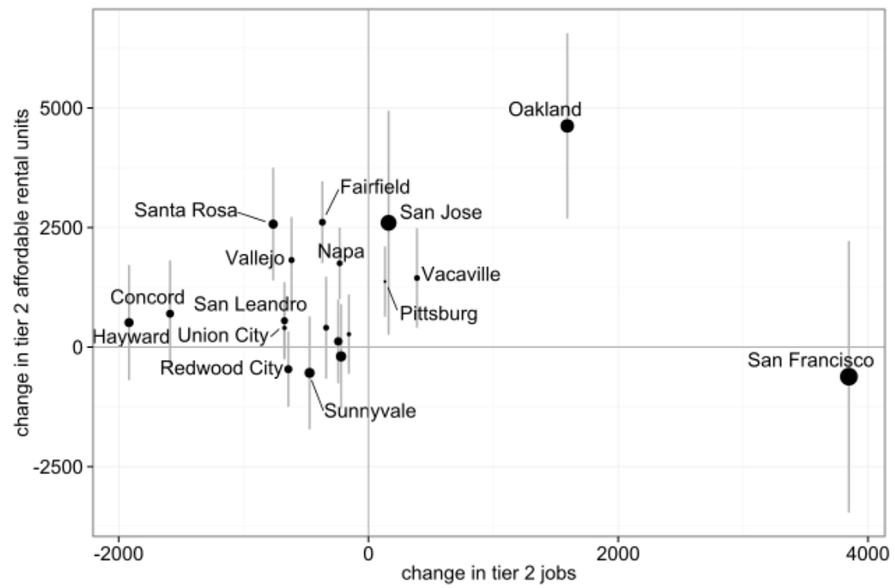
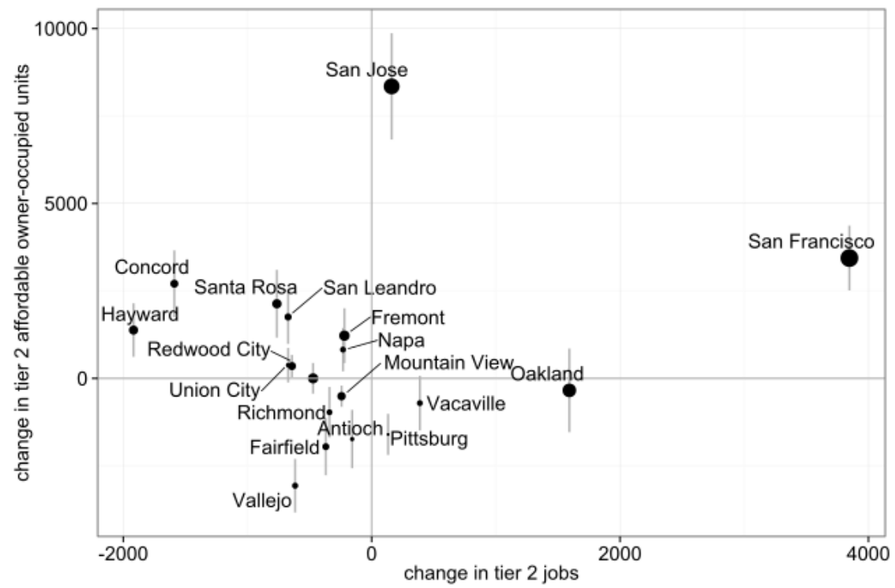
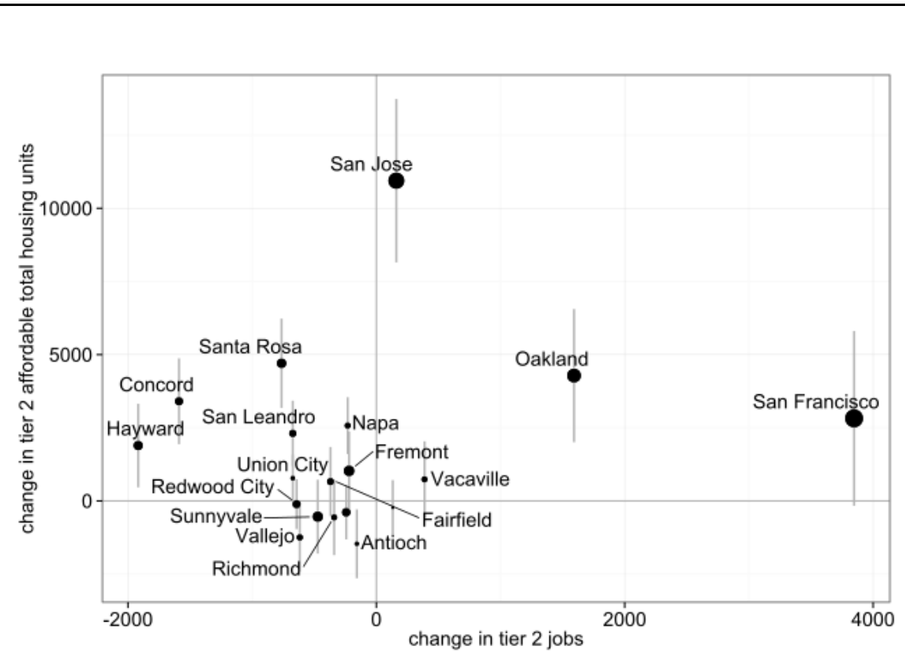


Figure 10: Relationships between changes in tier 1 jobs and tier 1 affordable units and jobs-housing fit by jurisdiction in the Bay Area.







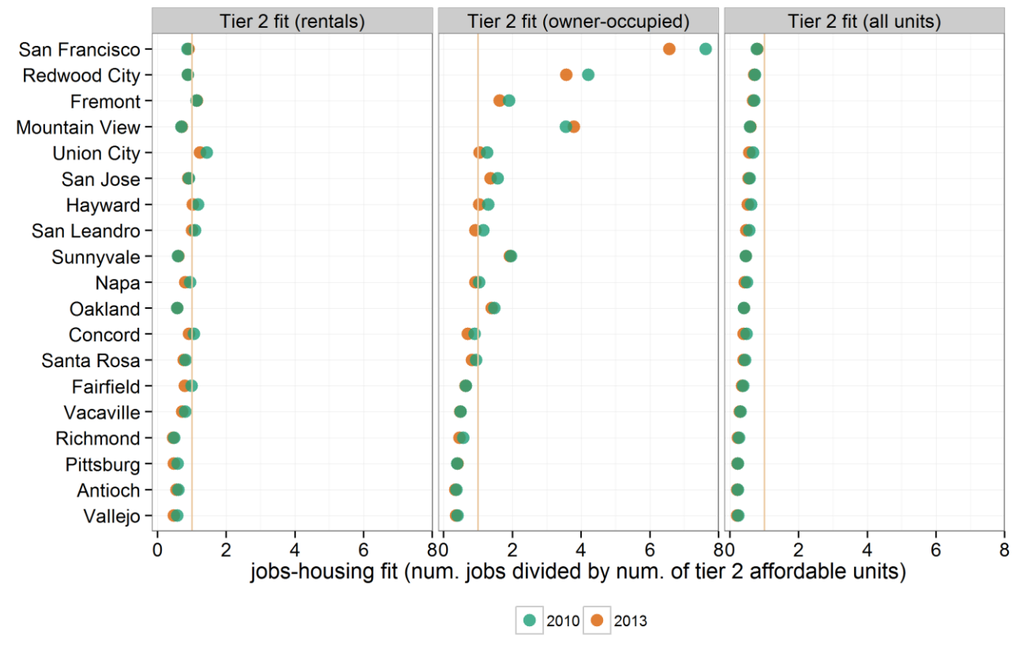
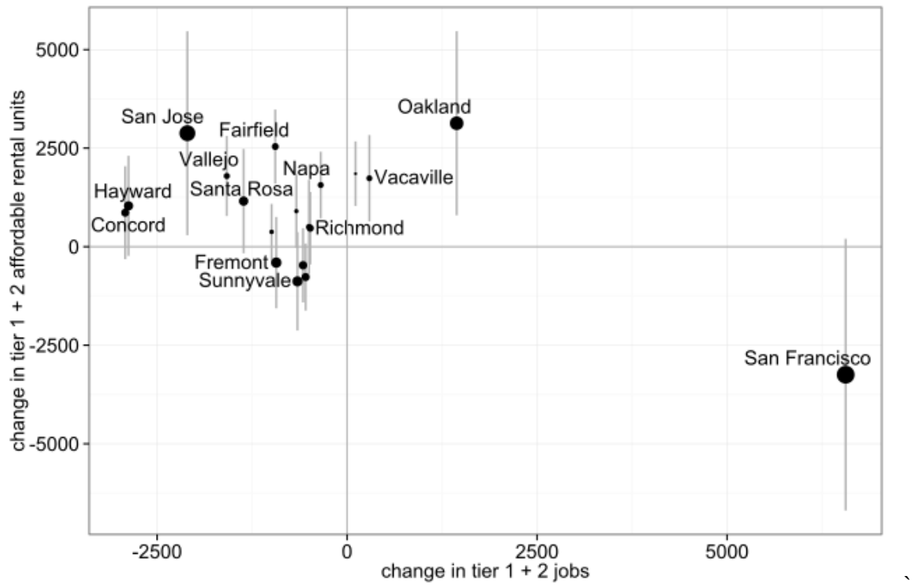
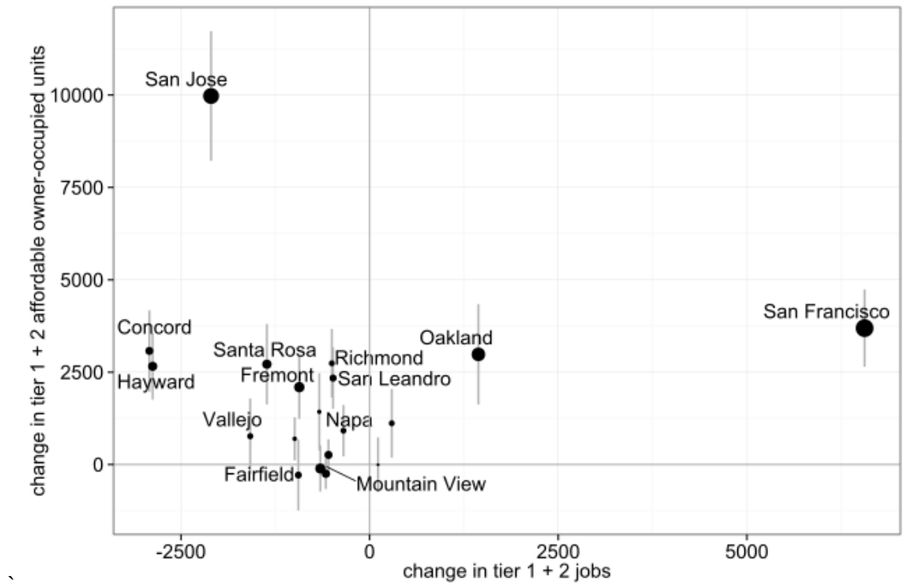
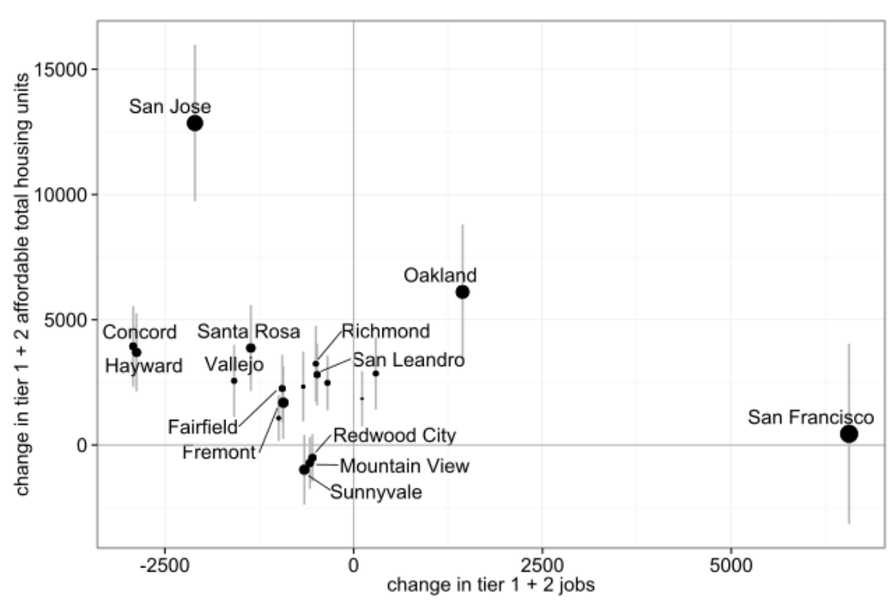


Figure 11: Relationships between changes in tier 2 jobs and tier 2 affordable units and jobs-housing fit by jurisdiction in the Bay Area.







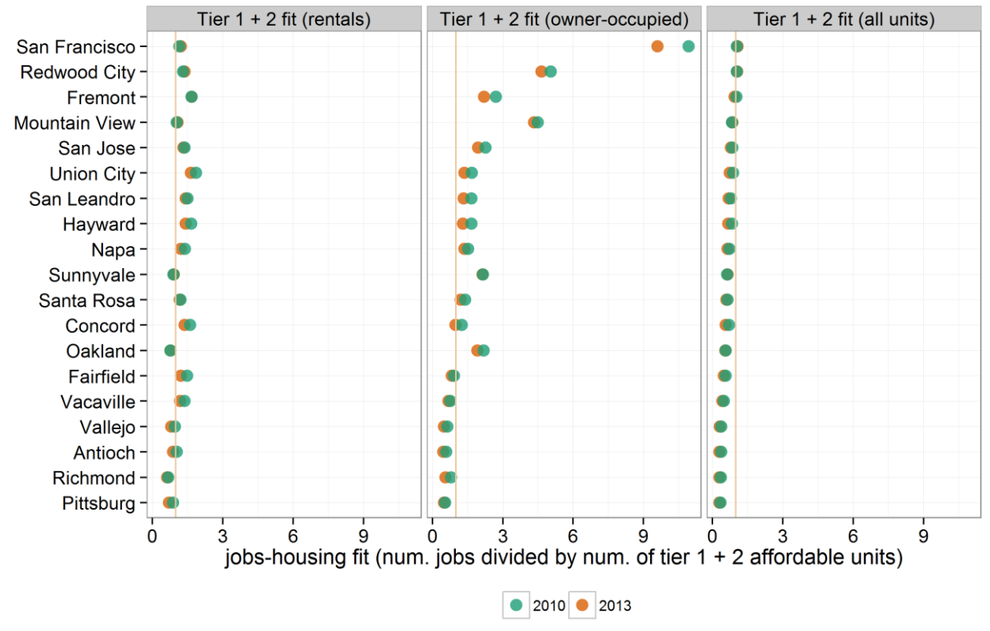
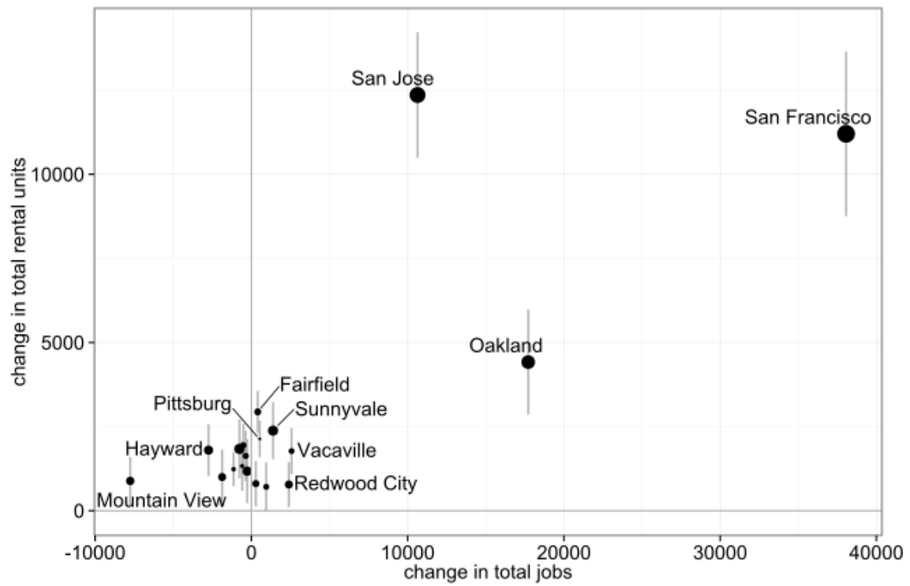
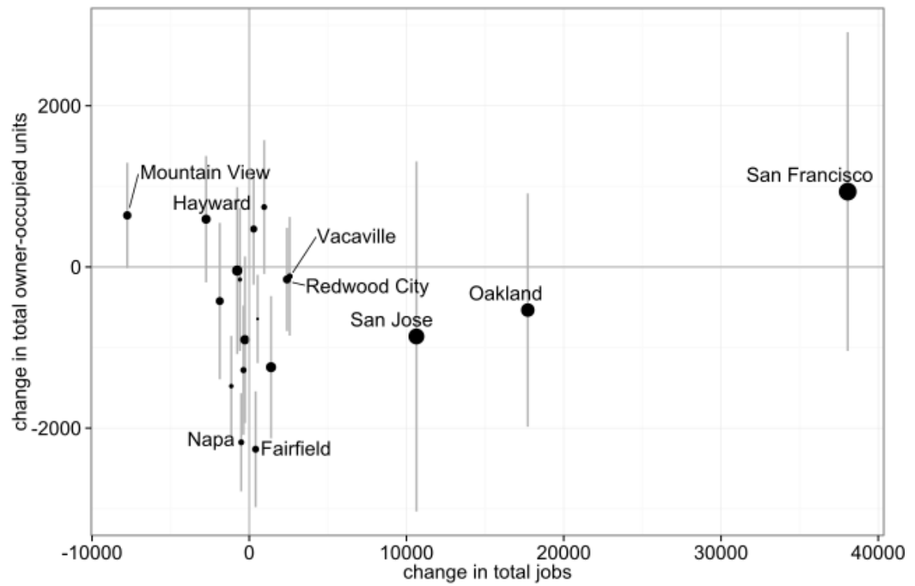
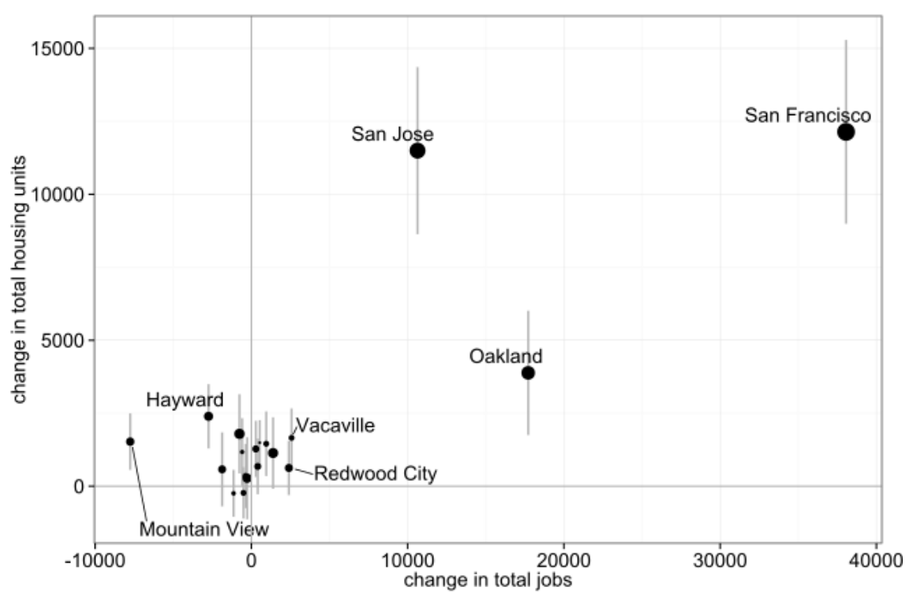


Figure 12: Relationships between changes in tier 1 + 2 jobs and tier 1 + 2 affordable units and jobs-housing fit by jurisdiction in the Bay Area.







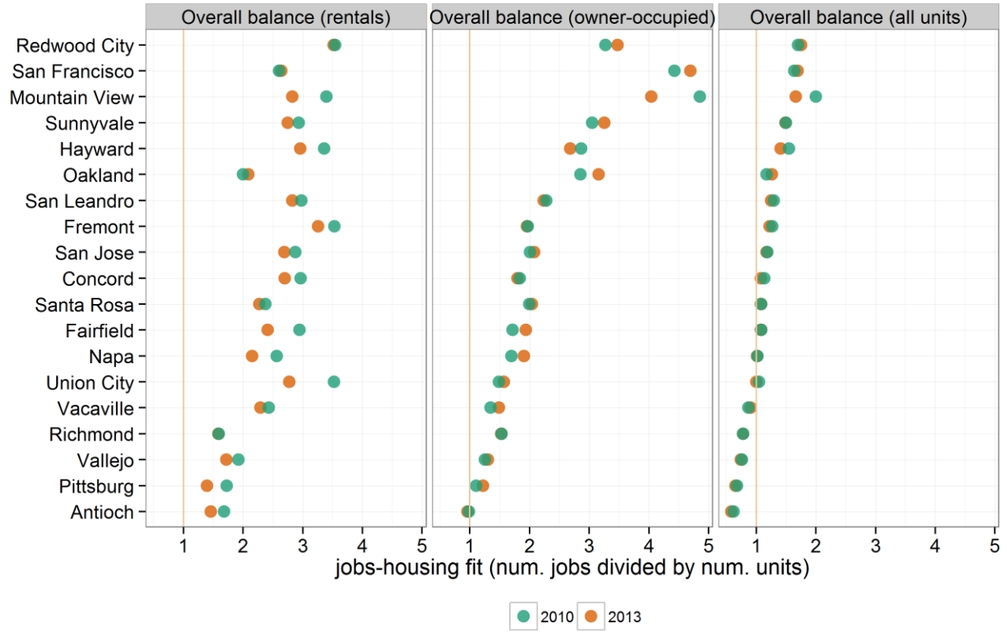
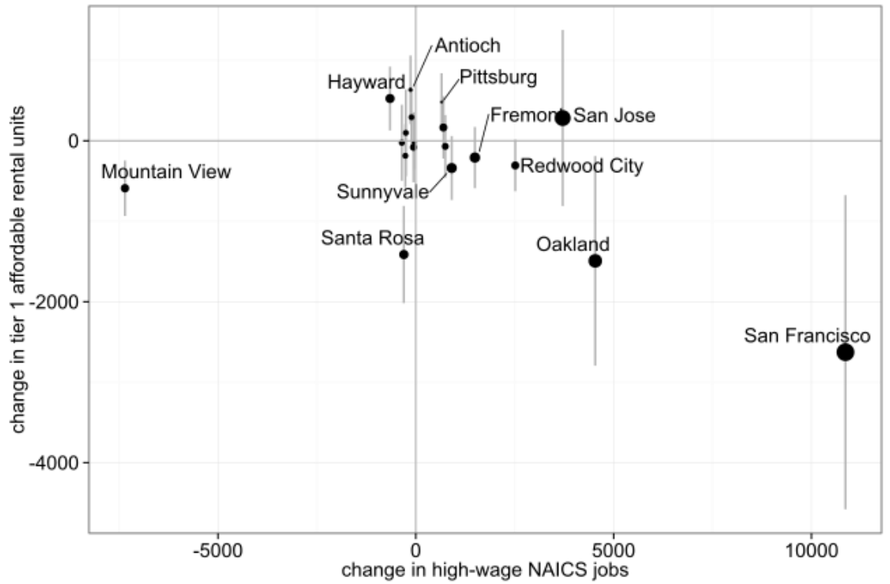
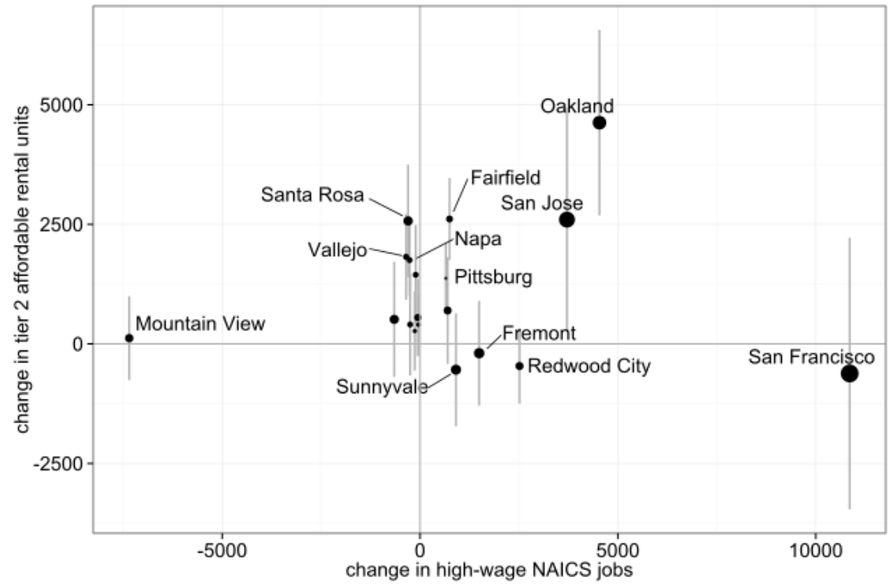


Figure 13: Relationships between changes in TOTAL jobs and TOTAL units and jobs-housing balance by jurisdiction in the Bay Area.





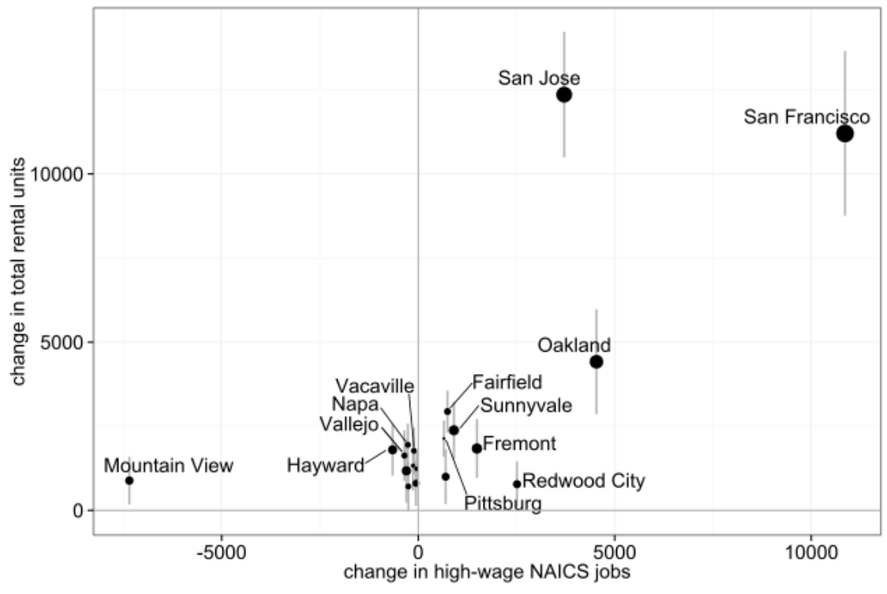


Figure 14: Relationships between changes in high-wage NAICS categories and rental units by affordability tier and total by jurisdiction in the Bay Area.

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.

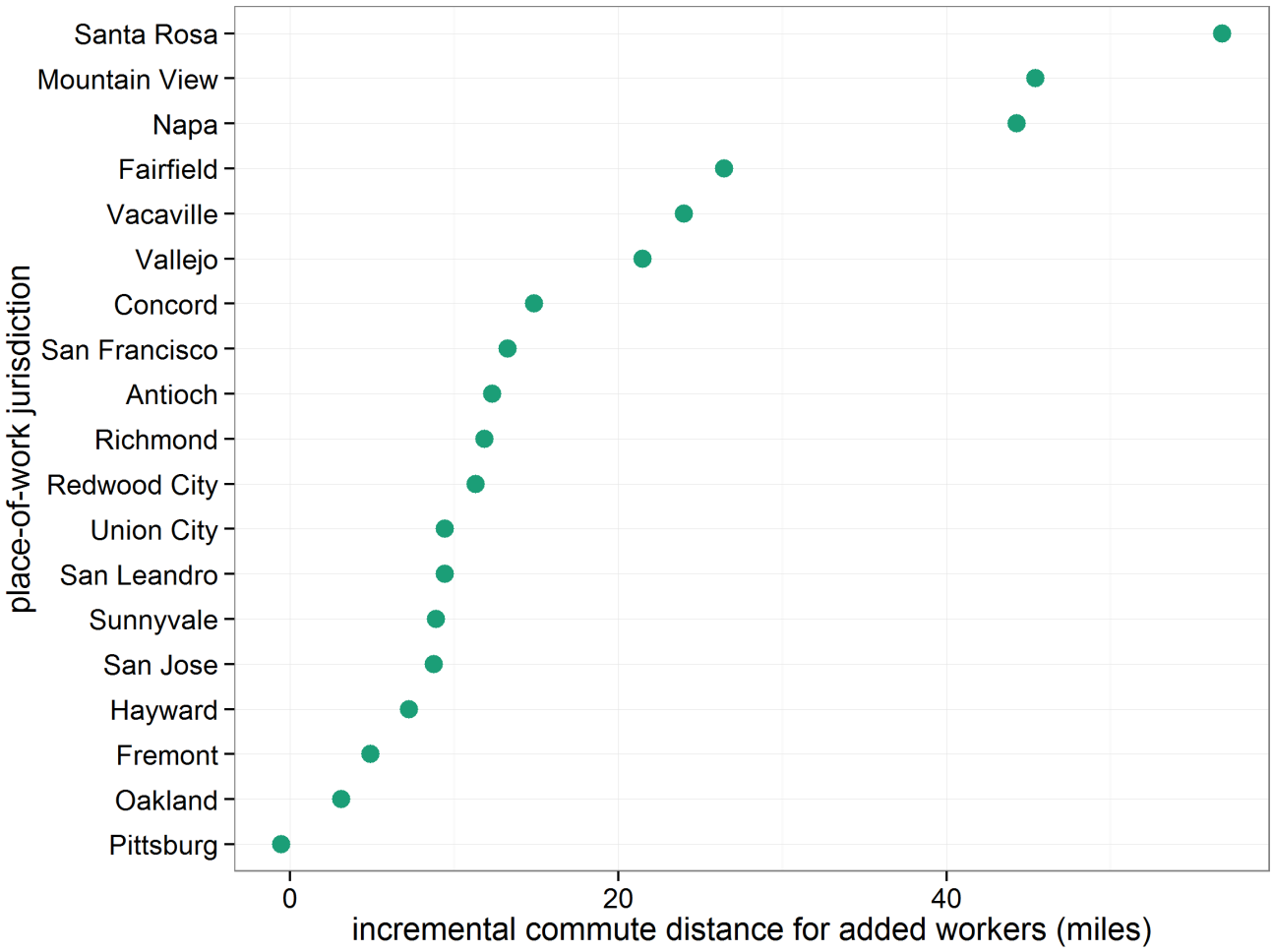


Figure 15: Incremental weighted commute distance impacts for added workers in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

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.

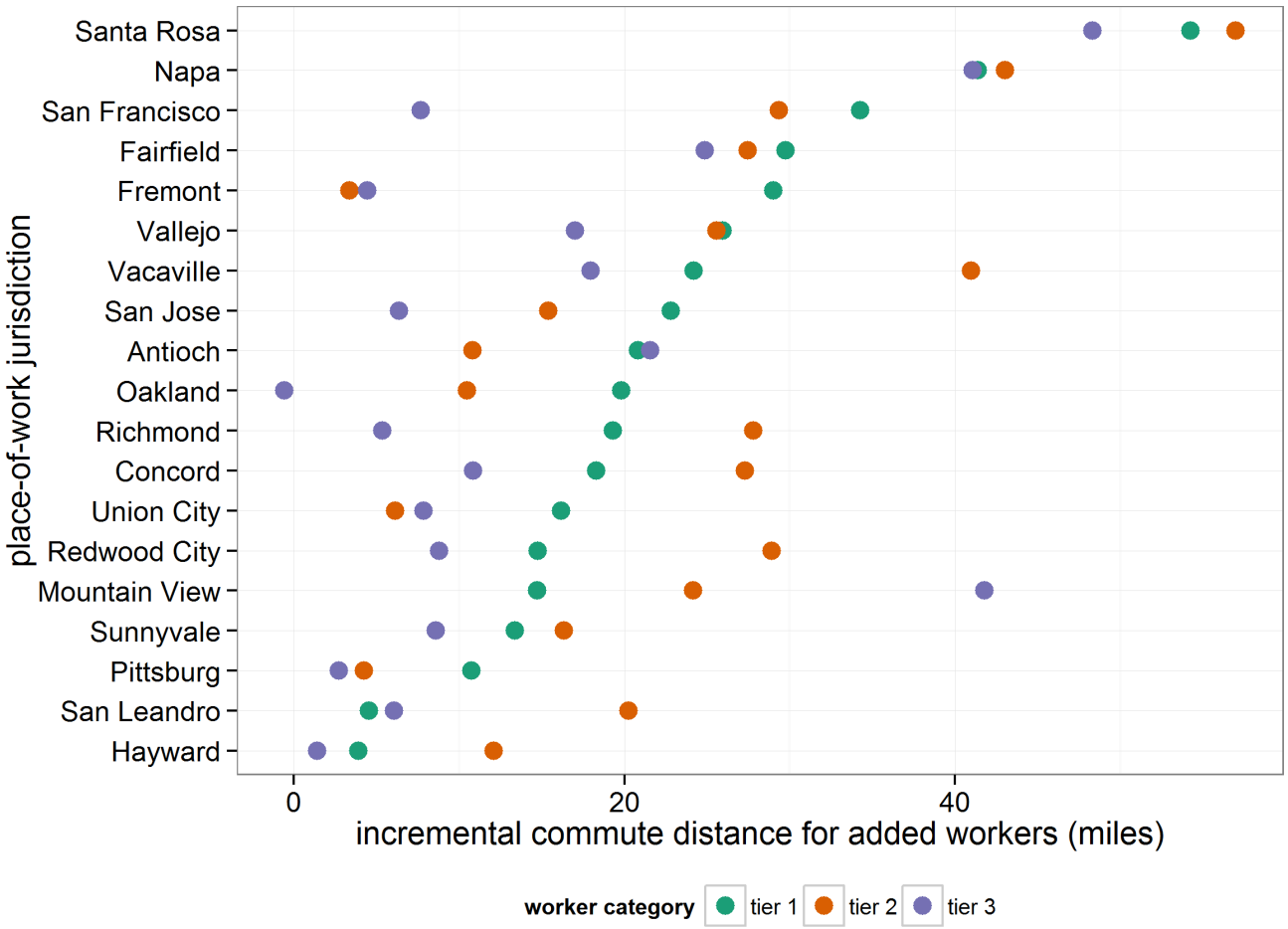


Figure 16: Incremental weighted commute distance impacts for added workers by wage tier in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

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.

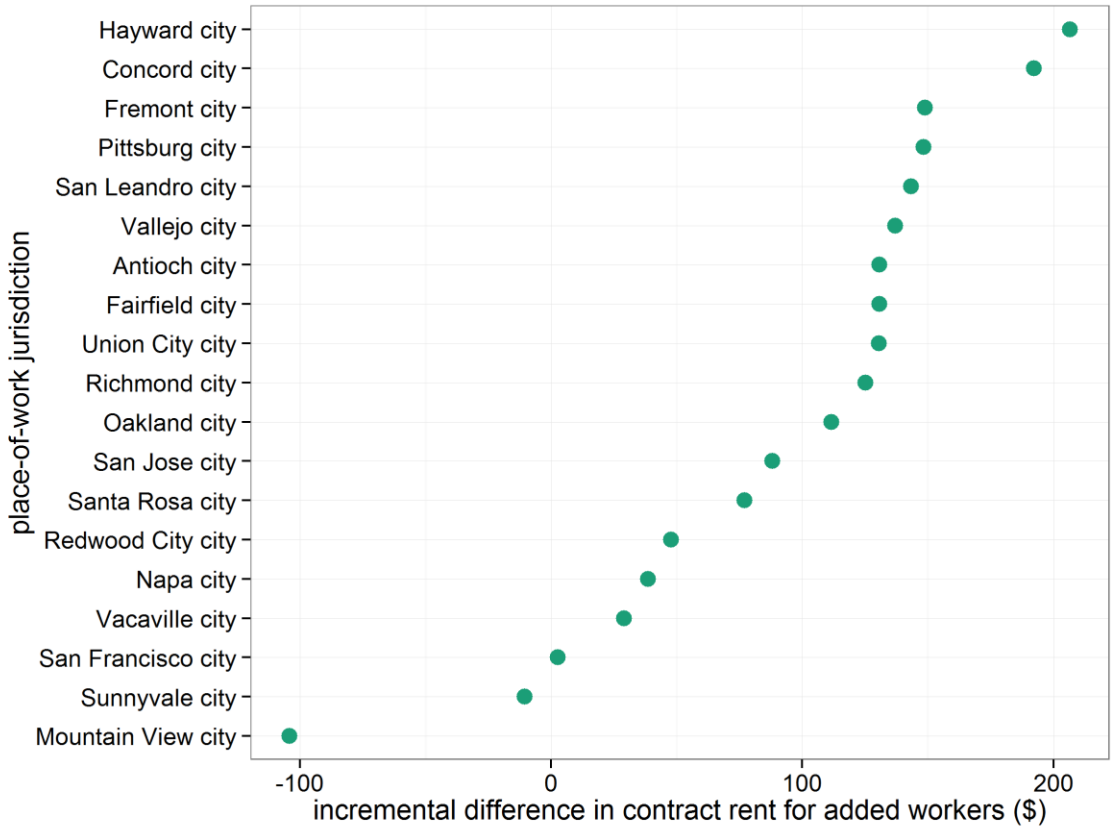


Figure 17: Incremental weighted contract rent impacts for added workers in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

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.

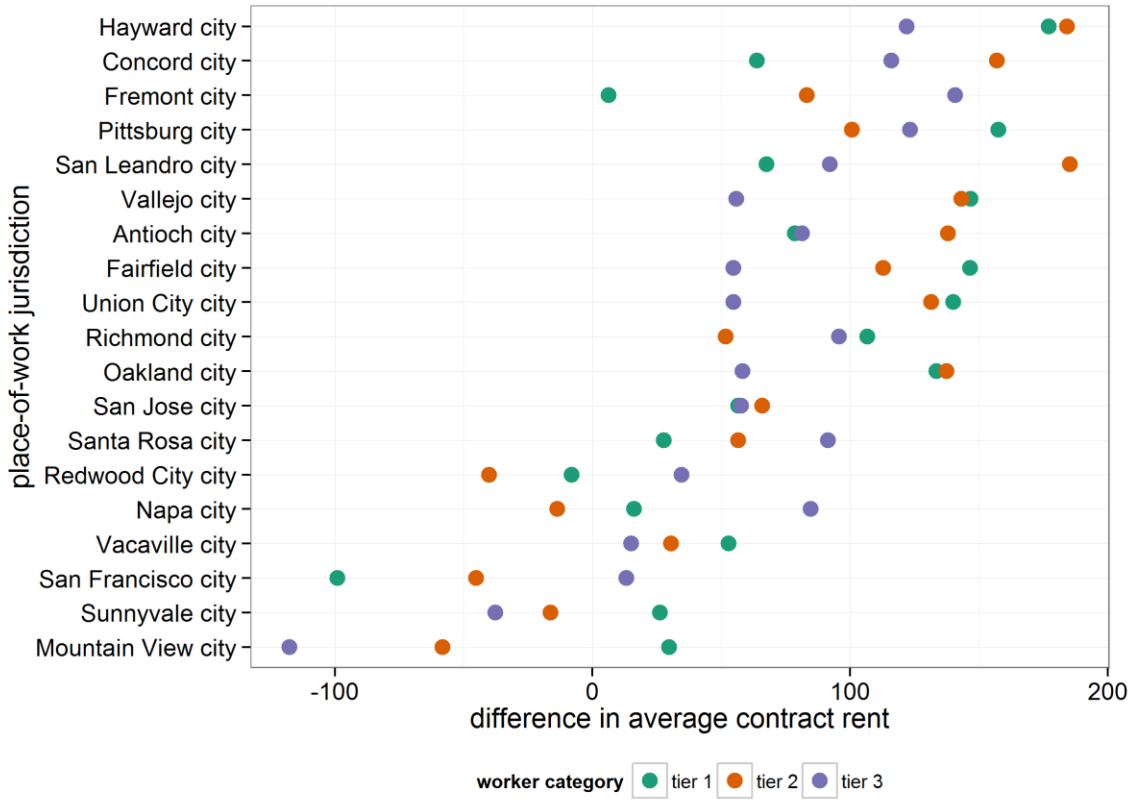


Figure 18: Incremental weighted contract rent impacts for added workers by wage tier in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

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.

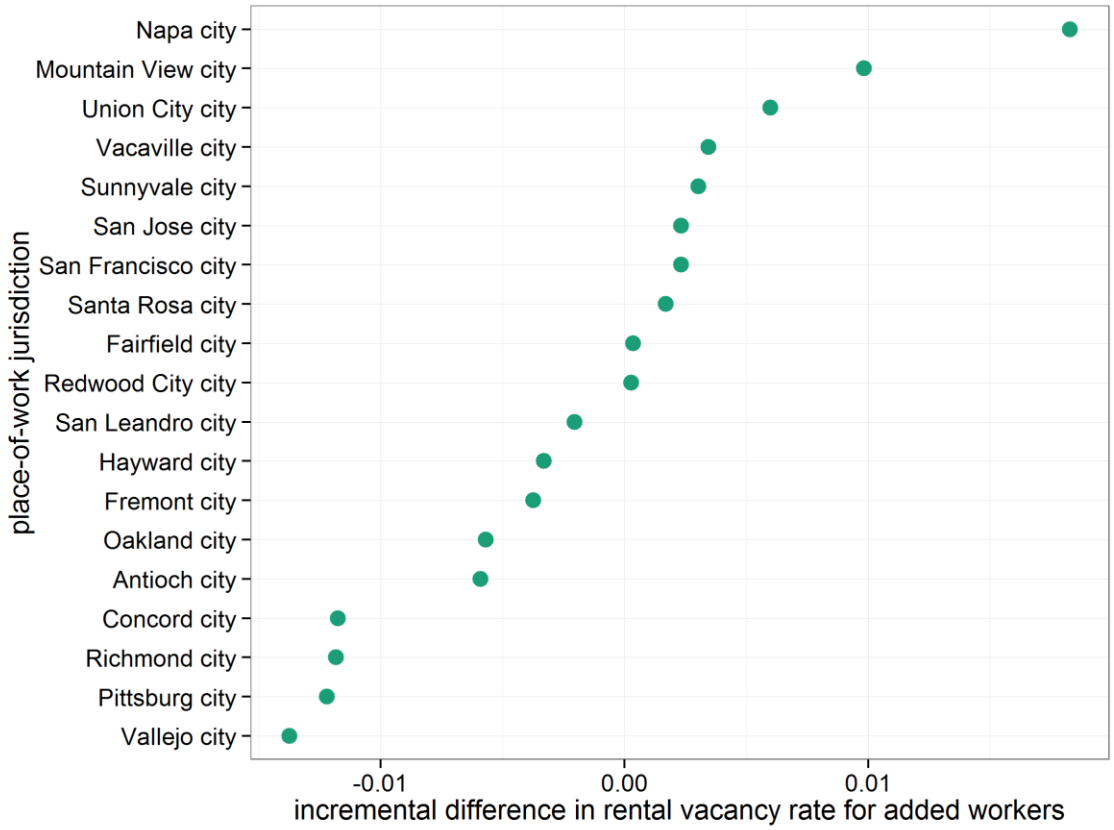


Figure 19: Incremental weighted vacancy rate impacts (percentage point difference) for added workers in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

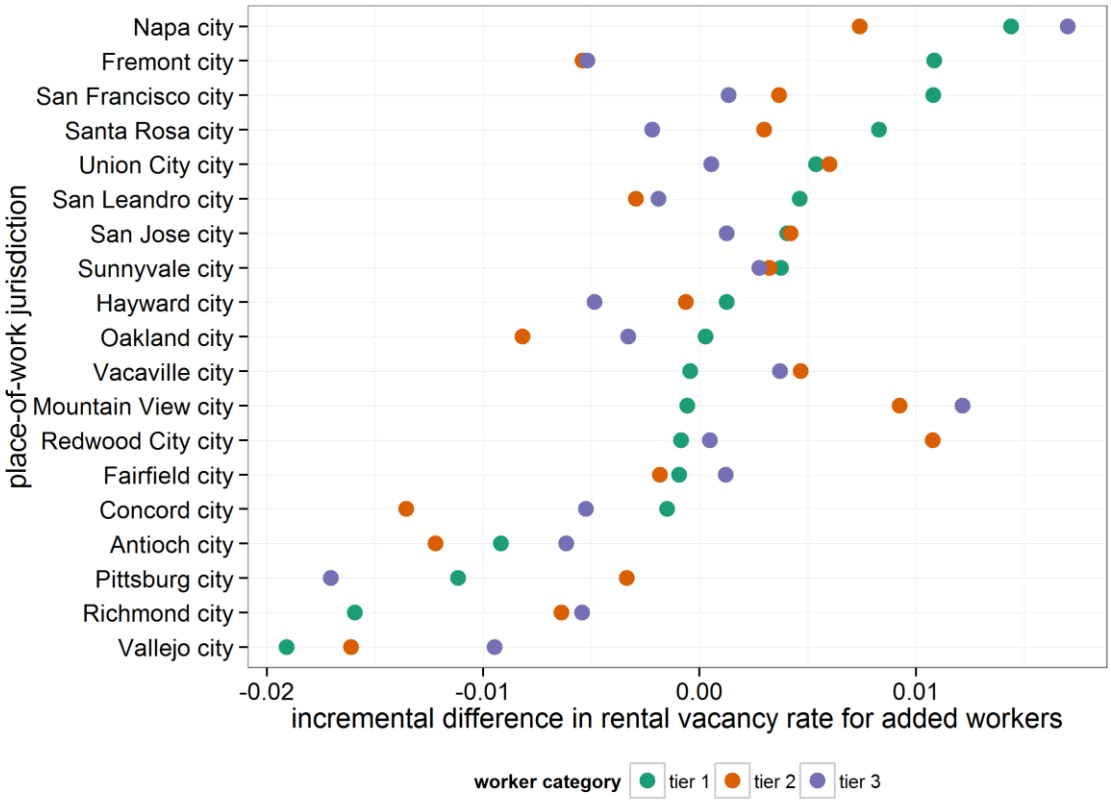


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Figure 20: Incremental weighted vacancy rate impacts (percentage point difference) for added workers by wage tier in 19 large Bay Area place-of-work jurisdictions, 2011 vs. 2008-2010 three-year average.

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:

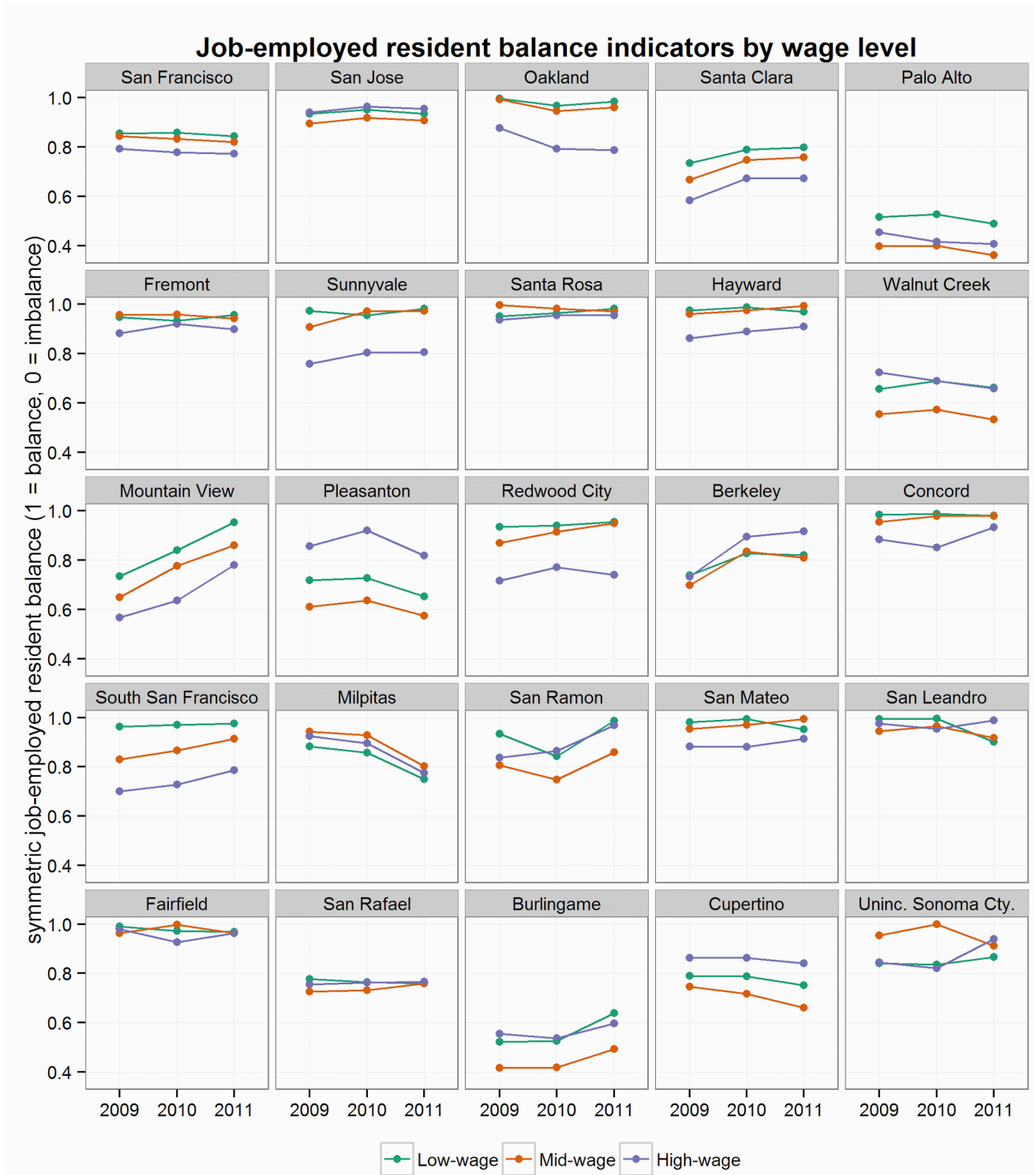
$$1 - \frac{\text{abs(jobs - resident workers)}}{\text{jobs + resident workers}}$$

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.



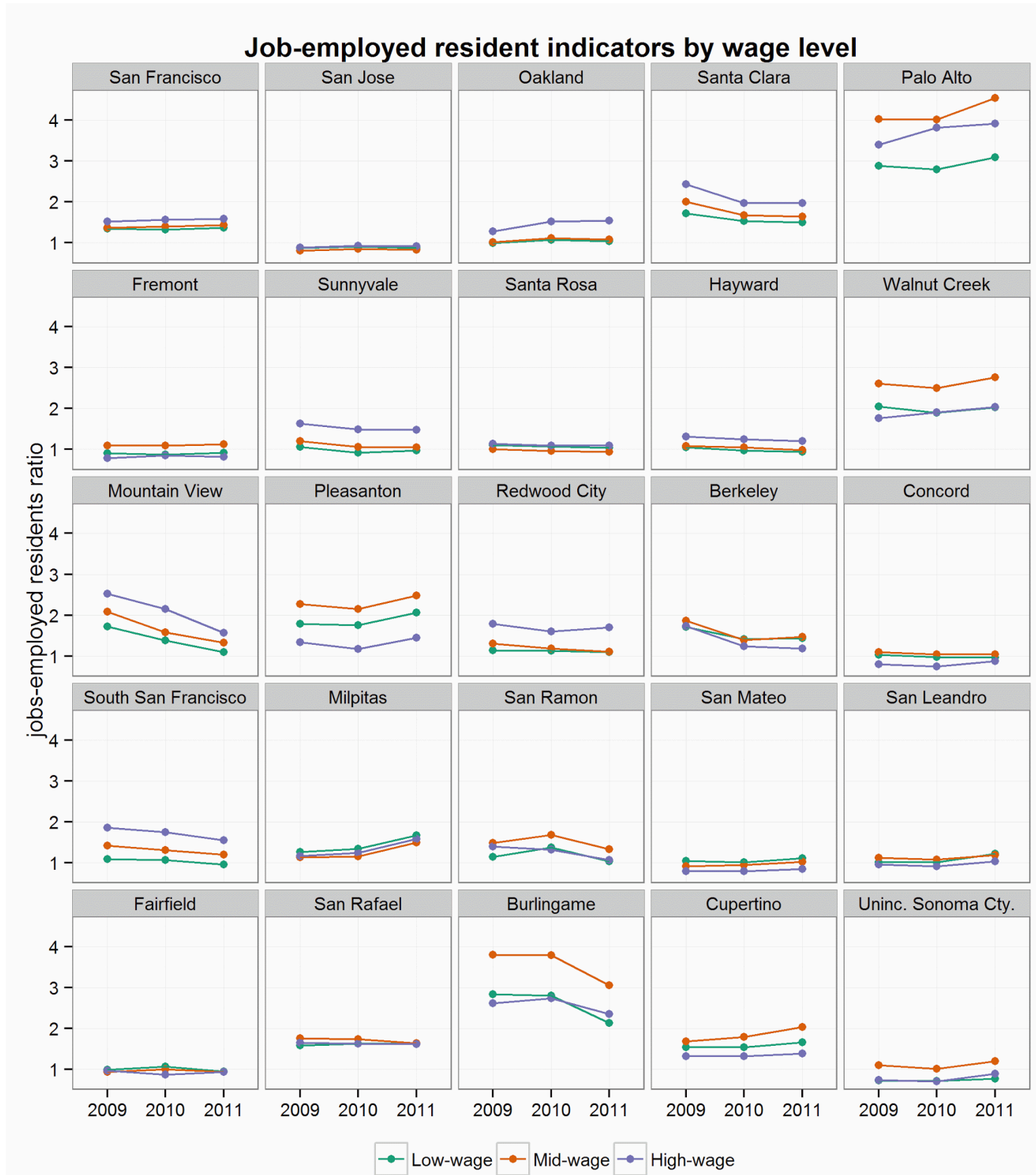
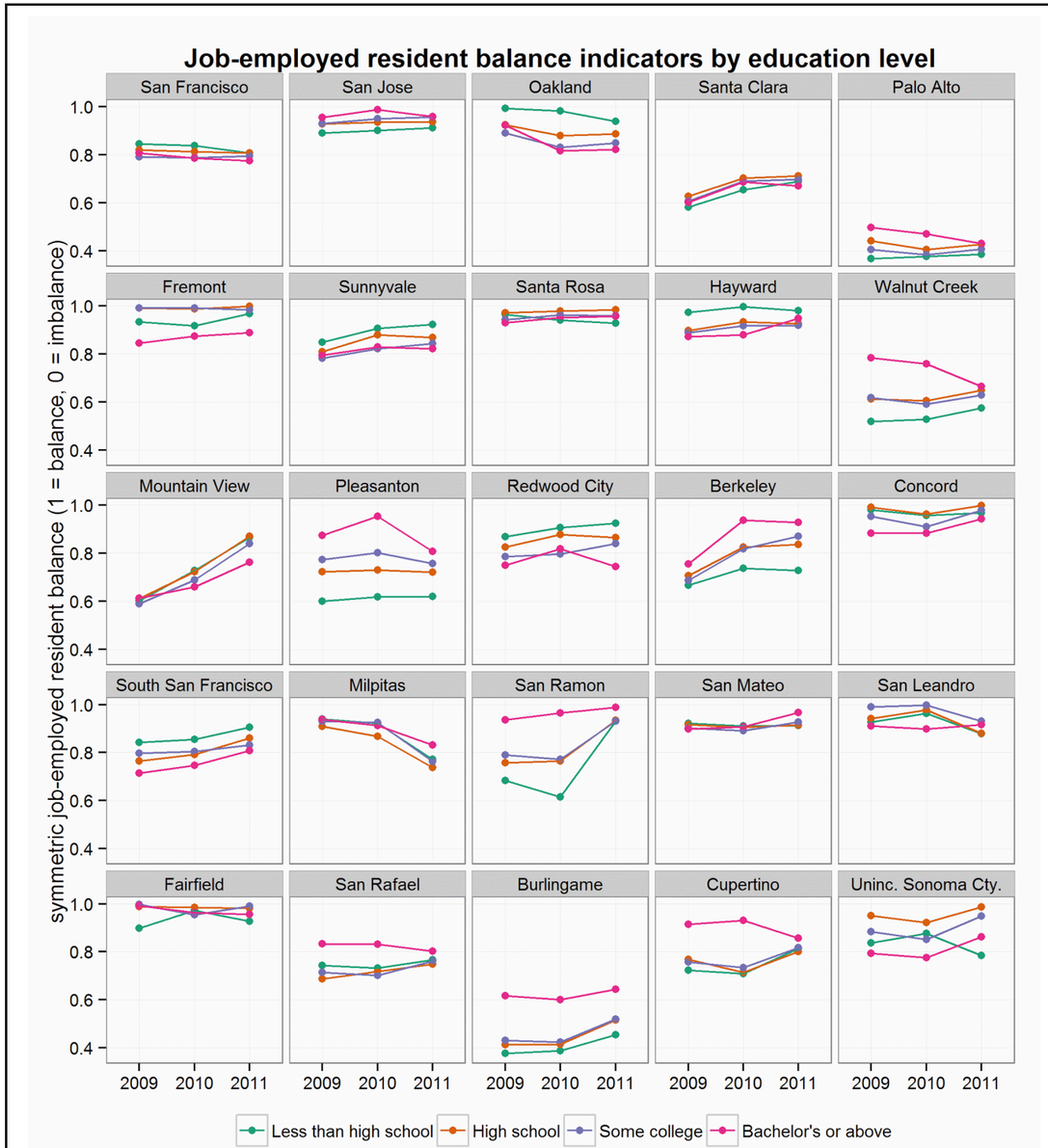


Figure A1: Jobs-employed resident measures: Wage level.



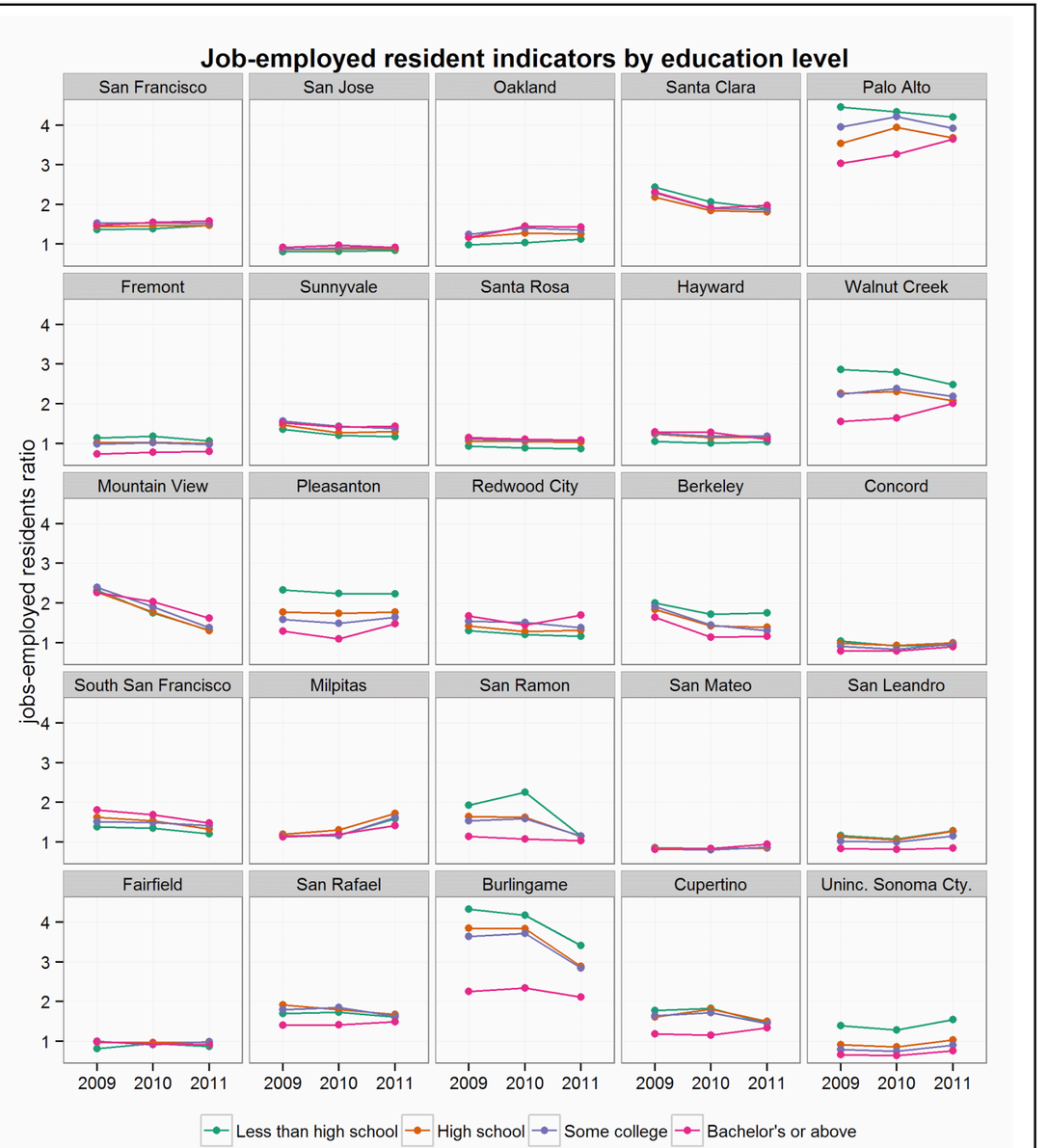
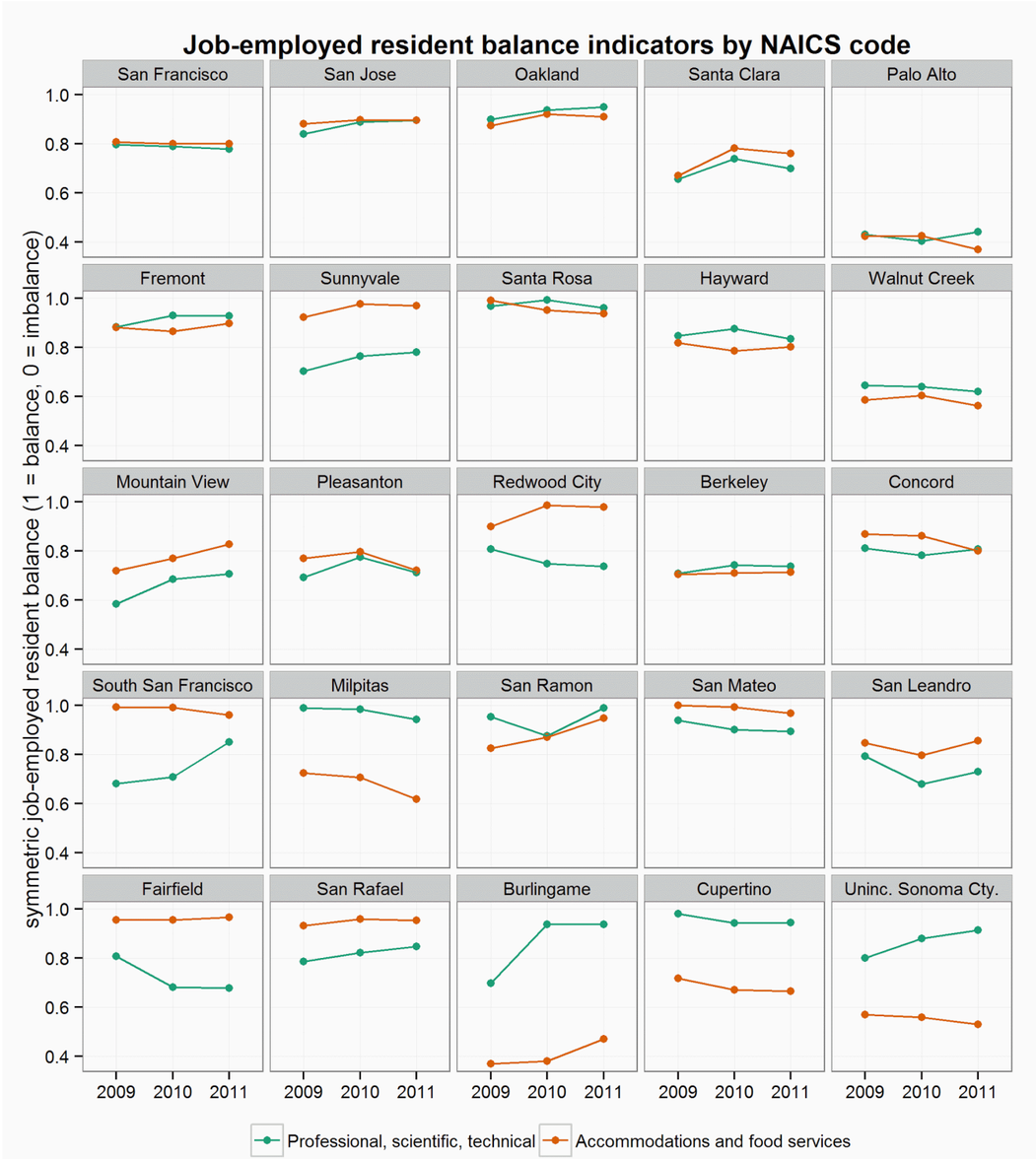


Figure A2: Jobs-employed resident measures: Education level.



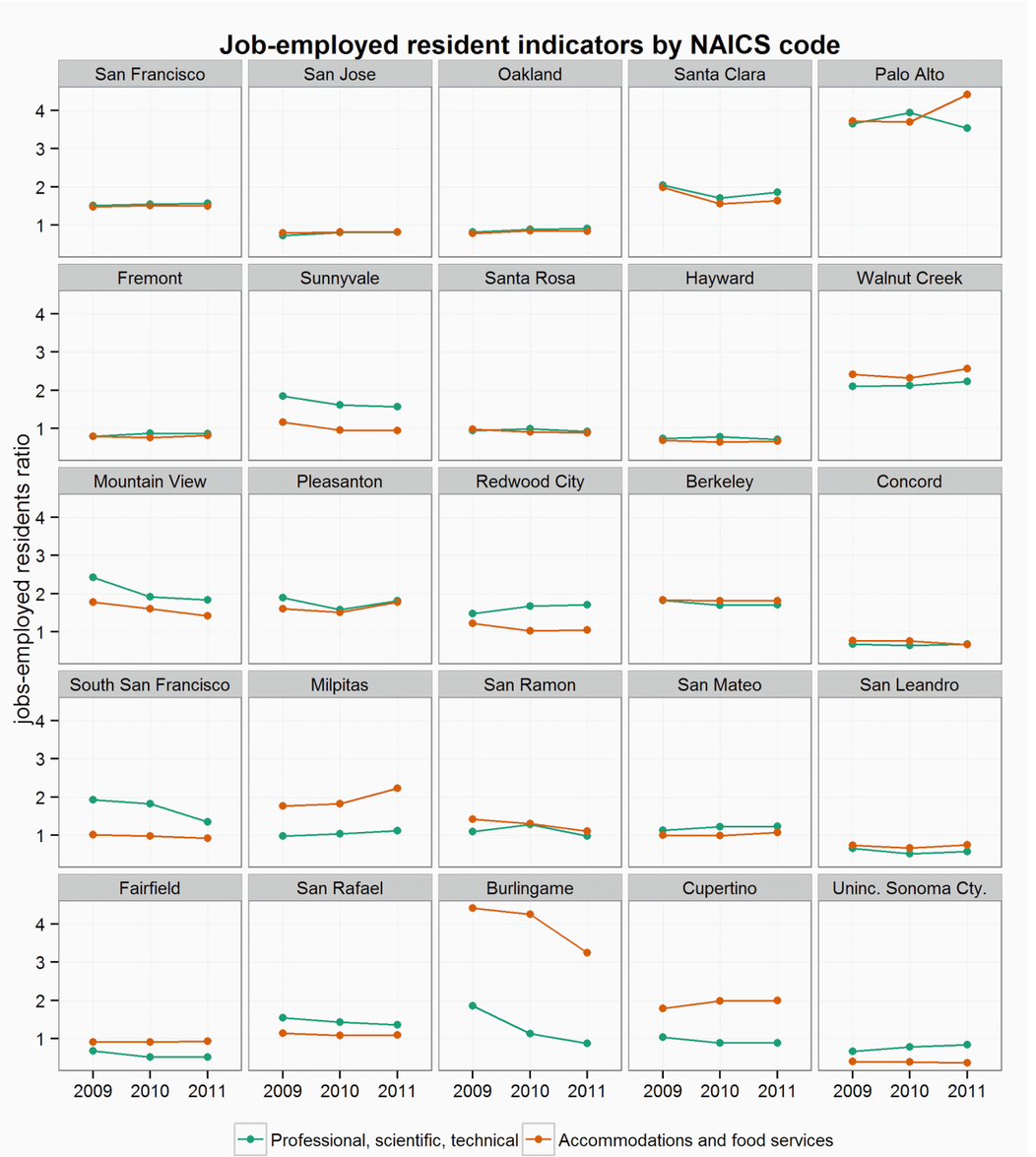


Figure A3: Jobs-employed resident measures: Two NAICS categories with very low annual income (accommodations) and very high annual income (professional).

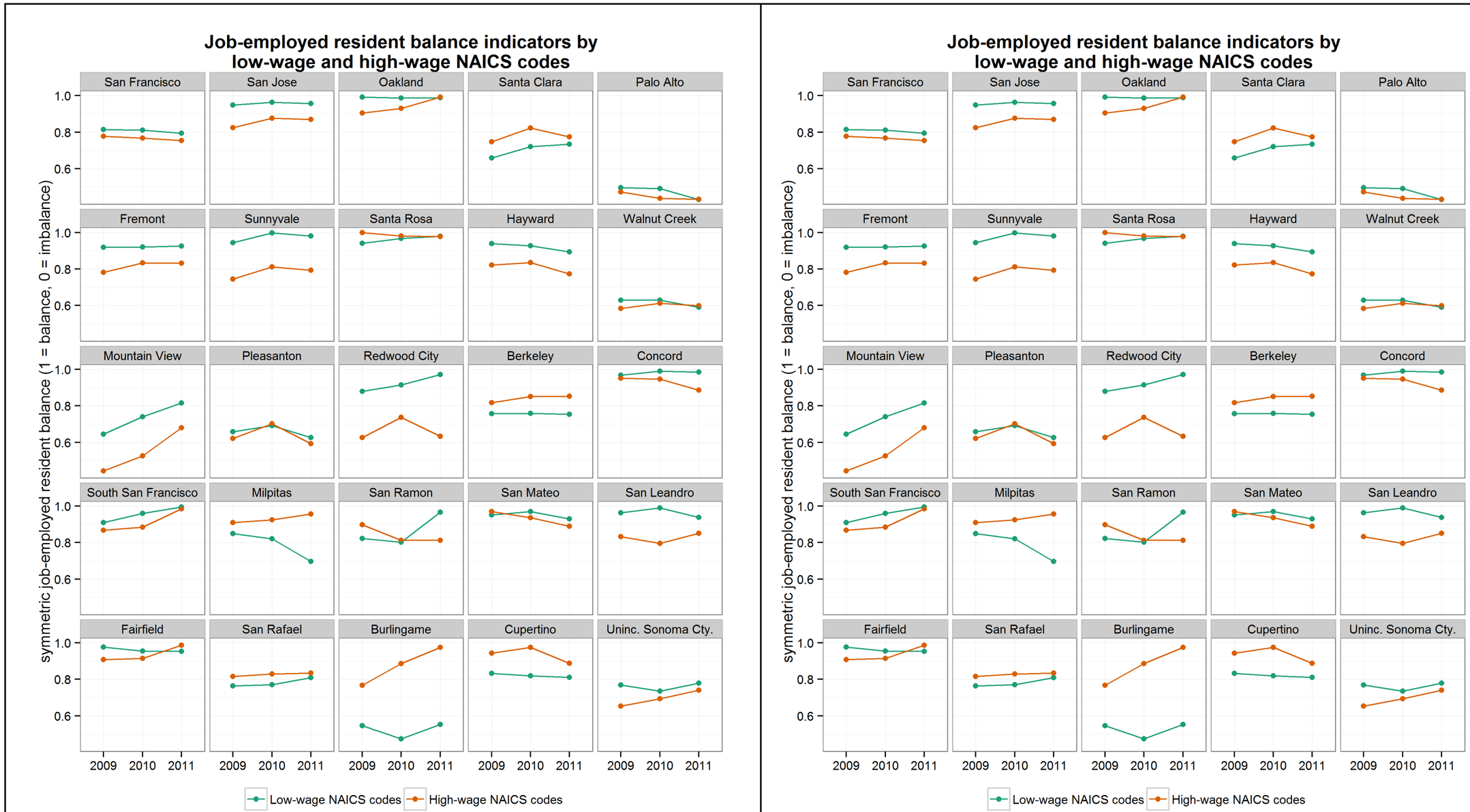
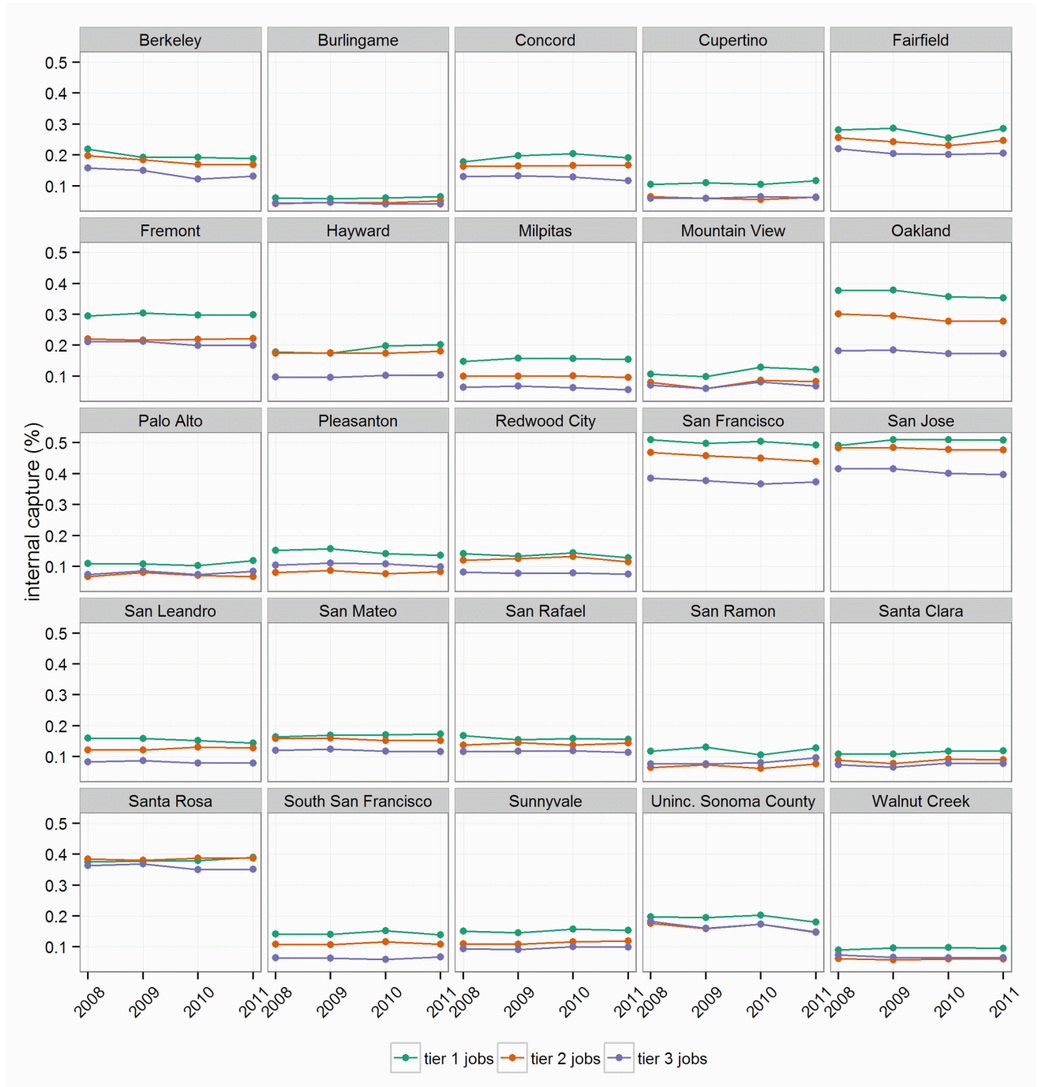


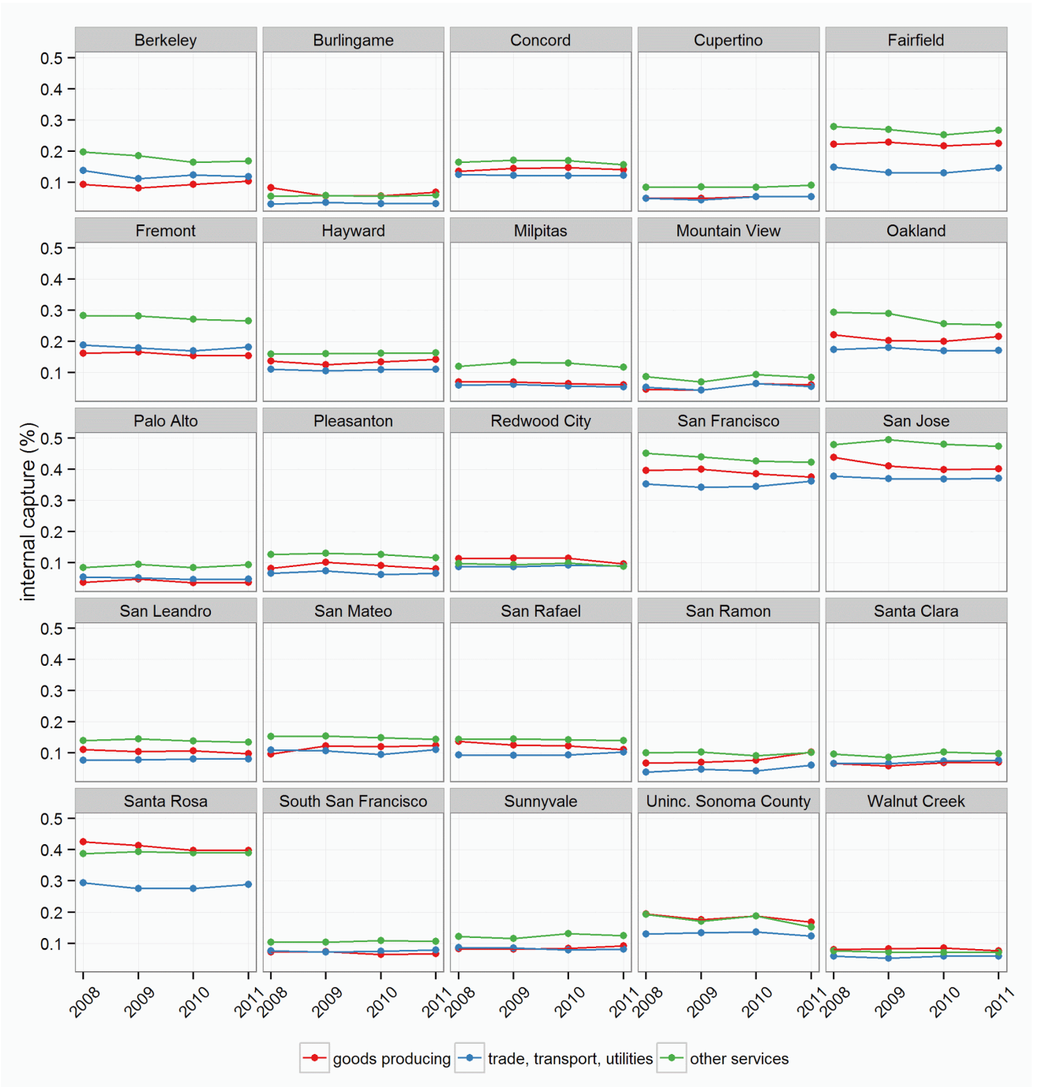
Figure A4: Jobs-employed resident measures: Low-wage NAICS codes (Retail trade + Arts, Entertainment, and Recreation + Accommodation and food services + Administrative and support and waste management and remediation + Other services [except public administration]) and High-wage NAICS codes (Information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

Appendix B: Internal capture and average commute distance

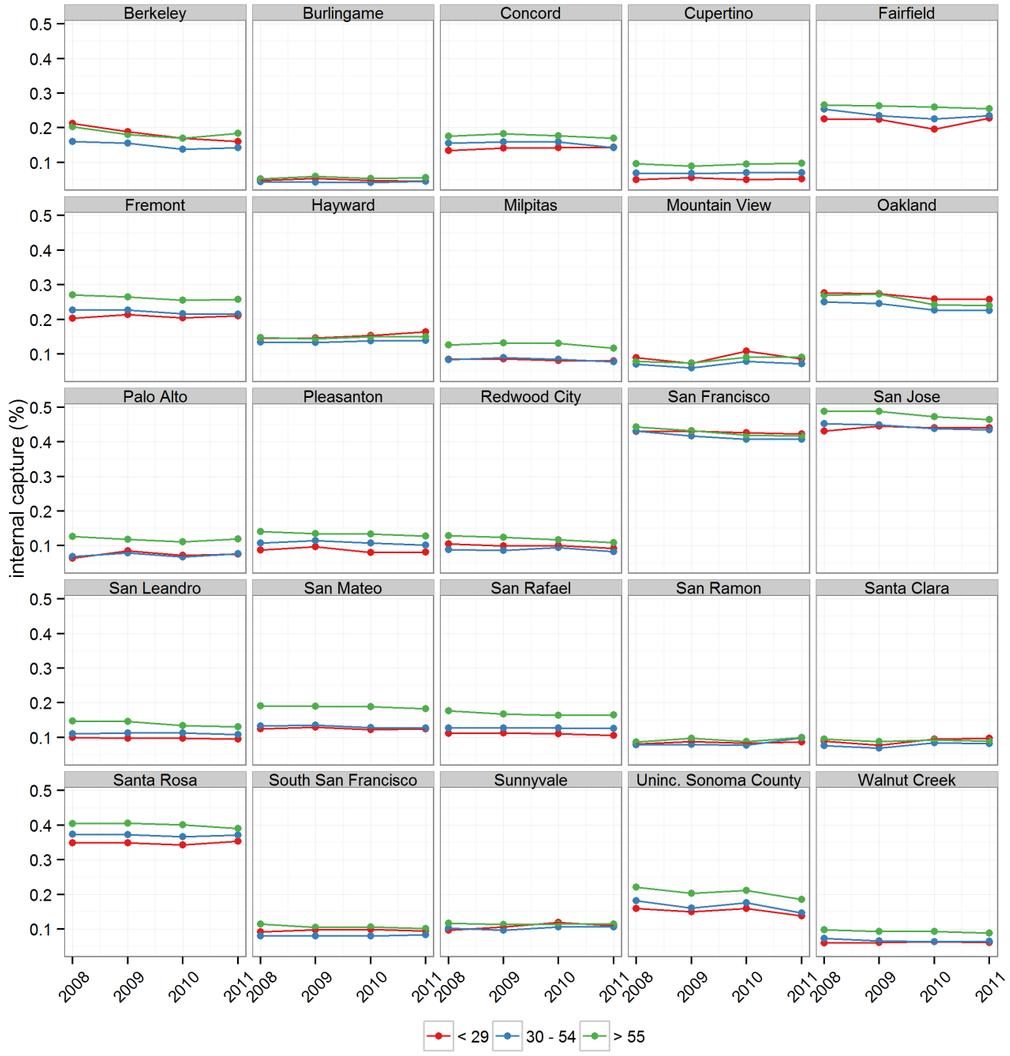
Figure B1 below illustrates the rates of “internal capture” - the proportion of total jobs held by people that live in the same jurisdiction - for the Bay Area’s 25 largest job centers from 2008 to 2011. Figure B2 summarizes the weighted average commute distance for each place-of-work jurisdiction for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



(a)

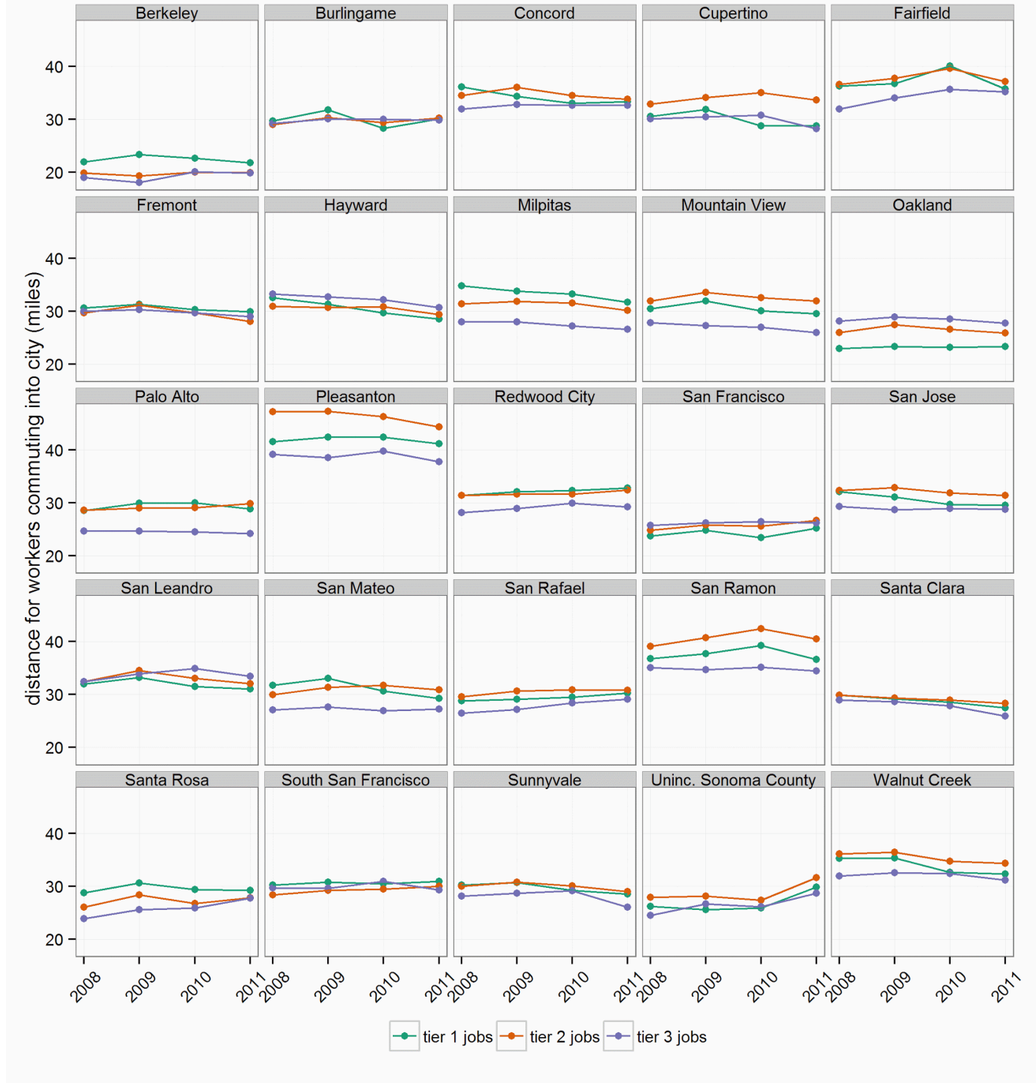


(b)

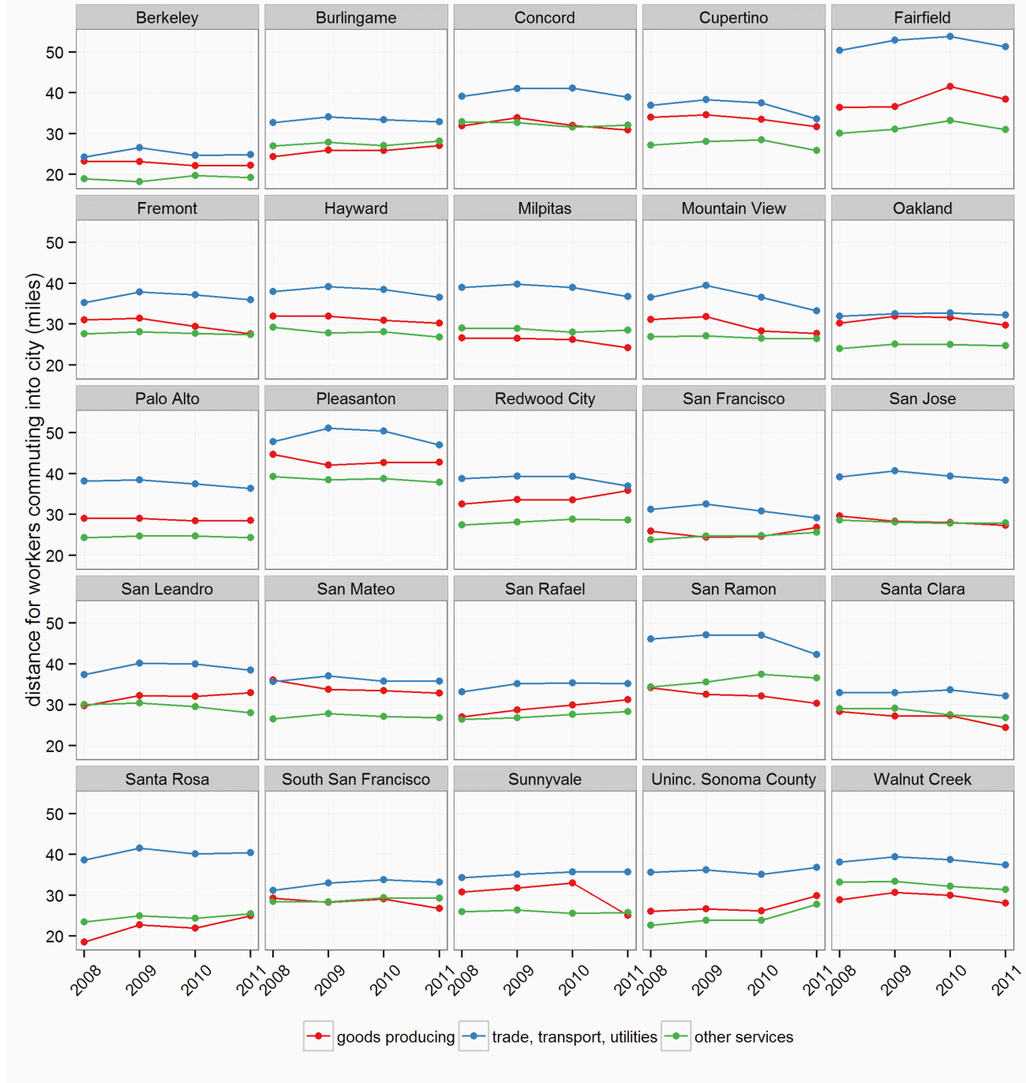


(c)

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)
20
30
40
2008
2009
2010
2011
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)
20
30
40
50
2008
2009
2010
2011
goods producing
trade, transport, utilities
other services

(b)

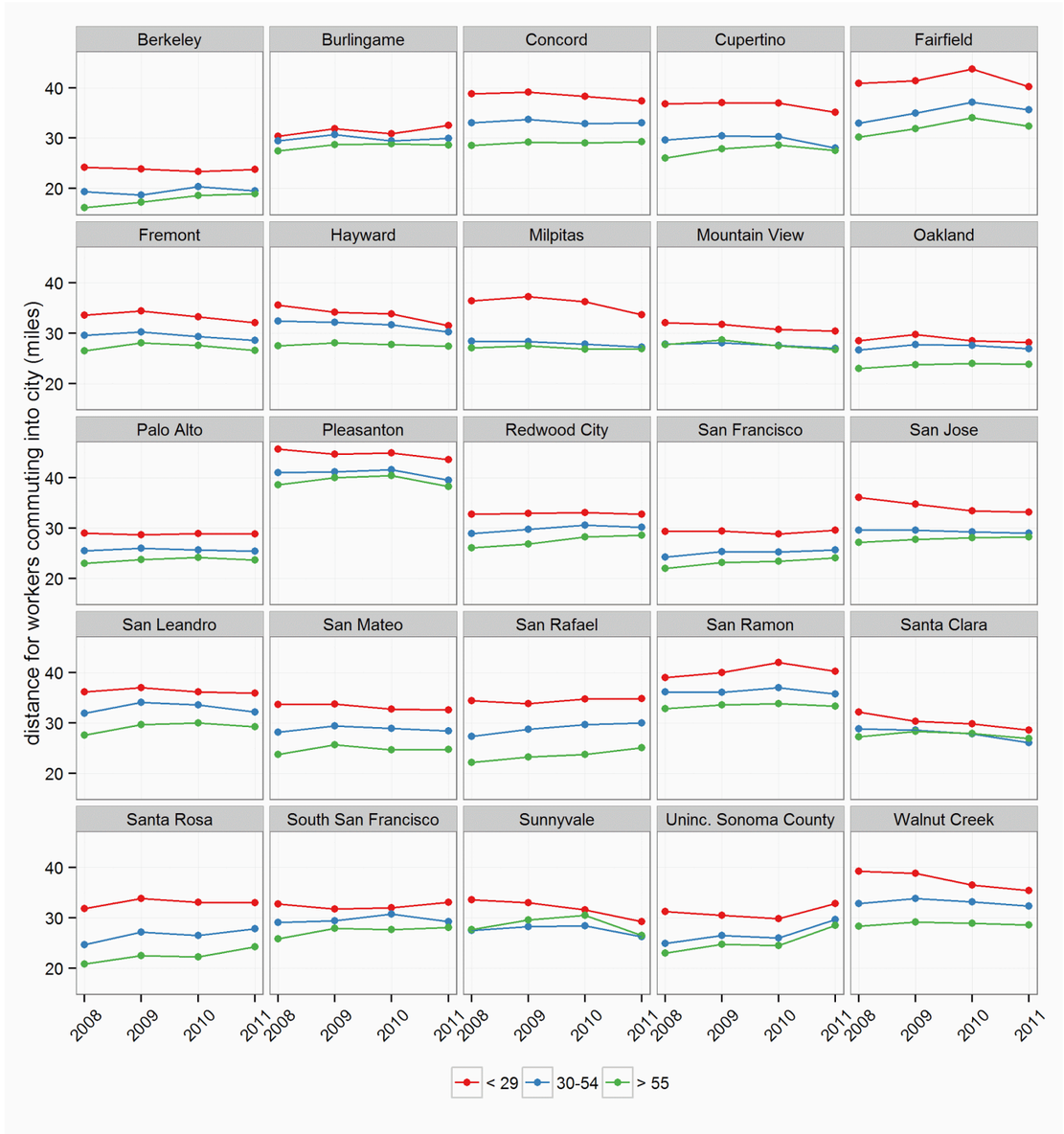
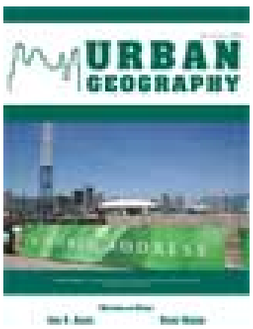


Figure B2: Average commute distance for the 25 Bay Area places with the highest number of total jobs by (a) wage category, (b) industry category, and (c) age.



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Low-wage jobs-housing fit: identifying locations of affordable housing shortages

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Low-wage jobs-housing fit: identifying locations of affordable housing shortages

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ABSTRACT

Finding the right jobs-housing *balance* has long been an important concern for urban planners. More recently, attention has turned to jobs-housing *fit* – the extent to which housing price is well matched to local job quality. Prior analyses have been constrained by a lack of local data on job quality, making it difficult to identify the geography and scale of the problem. We introduce a new methodology for calculating the low-wage jobs-housing fit at both a jurisdiction and neighborhood scale that was designed in collaboration with affordable housing advocates and has been directly applied in urban planning and affordable housing policy efforts. Low-wage fit is particularly important because of ongoing difficulties with affordable housing provision and the disproportionate benefits of reducing transportation costs for low-income earners. We use the calculated metric at both a city and neighborhood scale to identify what can be learned from a low-wage jobs-housing fit metric that is not evident in traditional measures of jobs-housing balance. In contrast to jobs-housing balance, the low-wage fit analysis clearly highlights those jurisdictions and neighborhoods where there is a substantial shortage of affordable housing in relation to the number of low-wage jobs. Because of the geographic coverage of the data sources used, the results can be widely applied across the United States by affordable housing advocates, land-use planners, and policy makers.

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Affordable housing; jobs-housing balance; jobs-housing fit; regional planning

Introduction

Planners have long promoted the benefits of jobs-housing balance within local areas (Cervero, 1989, 1991; Frank, 1994). Colocating housing and jobs can allow people to live close to their workplace, thus reducing overall congestion, vehicle miles traveled (VMT), and associated greenhouse gas (GHG) emissions (Cervero & Duncan, 2006; Ewing, Bartholomew, Winkelman, Walters, & Anderson, 2008). Ensuring an approximate balance of housing and jobs is also important for maintaining overall housing affordability, since an inadequate supply of housing in relation to jobs inevitably results in rising housing prices (Dowall, 1982; Gober, McHugh, & Leclerc, 1993).

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In addition to the overall *balance* between jobs and housing, planners and affordable housing advocates have also long recognized the importance of jobs-housing *fit*, though the concept has been much harder to operationalize and measure (Cervero, 1996; Smith, 2012). Jobs-housing fit refers to the extent to which the character and affordability of housing units in a particular area are well matched to the quality of locally available jobs. Although a poor fit at any income level could signal the potential for poor transportation performance, prior work has consistently demonstrated the unique barriers faced by low-income households, especially low-income households of color, as they engage in housing searches (Pendall, 2000b; Sharkey, 2012). In addition to outright discrimination in the housing market (Massey & Denton, 1993; Ross & Turner, 2005), land-use policies that restrict the supply of affordable housing, sometimes referred to as exclusionary zoning, are prevalent in suburban areas across the United States and have been shown to have measurable effects on neighborhood composition (Pendall, 2000a). Although some progress has been made in increasing affordable housing production in certain locations that have enacted inclusionary zoning policies, the pace of change has been slow (Bratt & Vladeck, 2014).

Because of this history and ongoing difficulties with affordable housing provision, ensuring *low-wage* jobs-housing fit is especially important from an equity perspective. Areas that perform well on this metric would generally evidence affordable housing provision adequate for the size of their low-wage workforce. Additionally, people employed in low-wage jobs spend a greater portion of their income on housing and transportation, are likely to value marginal monetary savings more than high-wage workers, and are more constrained in their ability to commute long distances (Haas, Makarewicz, Benedict, Sanchez, & Dawkins, 2006; Holzer, 1991; Murakami & Young, 1997). As a result, it is likely that low-wage workers in particular would be more likely to choose a residential location close to their workplace, if one is available.

Achieving low-wage jobs-housing fit could also yield environmental benefits, since low-income households on average drive older and less fuel-efficient cars (Binder, Macfarlane, Garrow, & Bierlaire, 2014; Kahn, 1998). Ensuring a low-wage jobs-housing fit might have a particularly substantial impact on GHG and air pollution emissions. Further, an imbalance in low-wage jobs and housing between particular jurisdictions can contribute to fiscal challenges and regional inequity (Miller, 2000; Orfield, 1997; Parlow, 2012; Rusk, 2003). This is because many low-wage jobs are in retail and restaurant industries that contribute substantial sales tax revenue to local jurisdictions, but affordable apartments and homes – which still create demand for local services but generate less tax revenue – can be a net fiscal drain on city coffers. Thus, jurisdictions with high numbers of low-wage jobs in relation to affordable apartments and homes realize a fiscal benefit, while simultaneously burdening those jurisdictions that possess the affordable housing needed to house those same low-wage workers. For these reasons, in this article, we design and apply a metric that characterizes low-wage jobs-housing fit at two geographic scales: the jurisdiction and the census tract. The metric is a ratio of the total number of low-wage jobs within a particular geography to the total number of affordable rental units; appropriately defining both the numerator and denominator requires a number of judgment calls. To the best of our knowledge, no such metric has previously been developed. The low-wage jobs-housing fit measure calculated here allows us to address a number of related research questions, specifically:

What value does a low-wage jobs-housing fit metric add above traditional measures of jobs-housing balance in terms of identifying locations with affordable housing shortages? What analytical choices need to be considered when constructing such a jobs-housing fit measure? How sensitive are the results to different calculation methods when looking at the census tract, or neighborhood, scale?

We subsequently employ the metric to analyze the geography of affordable housing in the San Francisco Bay Area in relationship to the geography of low-wage jobs. This mapping approach helps us identify key areas – primarily in the core of Silicon Valley and in the suburban East Bay – where the lack of affordable housing is particularly acute, given the concentration of low-wage jobs in those areas. For census tracts, we assess the implications of different units of analysis for our understanding of the adequacy of low-wage jobs-housing fit by comparing the use of a distance decay function and a hard distance threshold around census tract centroids for calculating the ratio. We argue that the hard distance threshold has significant advantages over the distance decay function. In our case study region, the statistical differences between these measures are minimal, and a particularly attractive property of a threshold-based metric is its interpretability and immediate identification of the affordable housing need in terms of number of units. In this way, it is intuitive for affordable housing advocates, planners, and elected officials, thus making it more amenable to incorporation into participatory planning and policy advocacy efforts. California is a particularly appropriate test location for this work because of the 2008 passage of Senate Bill (SB) 375, also known as the Sustainable Communities and Climate Protection Act (Barbour & Deakin, 2012). The law requires California's regions to reduce vehicle travel by pursuing integrated transportation, land use, and housing planning. Its implementation has sparked substantial interest regarding the implications of innovative planning measures on low-income and people of color populations and the integration of environmental and social equity goals (Marcantonio & Karner, 2014). The metrics developed in this paper are a first step toward quantifying the implications of related inequities in housing markets including exclusionary zoning and outright discrimination.

The remainder of this article is structured as follows. We first summarize previous literature on jobs-housing balance and the relatively new efforts to measure jobs-housing fit. We then describe our methodology for calculating the low-wage jobs-affordable housing fit ratio, including a discussion of the strengths and weaknesses of the datasets employed. We subsequently use the metric to visualize jobs-housing fit at a jurisdiction and census tract level in the San Francisco Bay Area while discussing the strengths and weaknesses of alternative operationalizations of the metric. We conclude with a discussion of future research opportunities to develop the relationship between the low-wage jobs-housing fit indicator and travel patterns.

Literature review

There is a substantial literature examining the issue of jobs-housing balance. In the late 1980s, policies to ensure that aggregate numbers of jobs and housing units were approximately balanced in an area were thought to be important for achieving regional congestion mitigation and air quality improvements. Academic studies soon followed,

with some authors arguing against the effectiveness of using jobs-housing balancing as transportation policy. In more recent years, the focus of jobs-housing research has expanded to include housing availability and affordability as well as the geographic influences of economic development strategies.

Early work by Cervero indicated that, in some cases, more closely balanced jobs and housing numbers tended to result in improved performance on congestion metrics (Cervero, 1989). That work showed that suburban job centers with balanced numbers of jobs and housing units tended to see increased rates of walking and bicycling and reduced congestion on nearby freeways. Other authors disputed whether specific policies should be pursued to achieve balance. Giuliano argued that areas naturally tended toward balance over time (Giuliano, 1991). For her and others (Downs, 2004; Gordon, Richardson, & Jun, 1991), attempting to achieve balance through policy was unnecessary. During typical urban development processes, these authors argued, jobs initially cluster in the city center to take advantage of proximity to other firms and workers (via transportation networks). Later, as congestion occurs, jobs migrate to suburban locations where workers soon follow. Market dynamics efficiently allocate land and commuters make rational choices – trading-off commuting distance with other quality-of-life factors including school quality, housing character, neighborhood amenities, and the needs of dual-earner households. For these authors, jobs-housing balance would explain only a small portion of location decisions and commuting behavior.

What these authors neglected, however, was the reality of actually functioning housing markets. Work in urban economics has documented the existence of exclusionary zoning practices and incentives that drive jobs-housing imbalances and create places where affordable housing is in extremely short supply and others where it is abundant (Hernandez, 2009; Quigley & Rosenthal, 2005). Cervero elaborated on some of these practices, noting that jurisdictions prefer to zone land for high revenue generation and low service demand (typically commercial properties) and that growth moratoria and restrictions limit the application of building permits and allowable densities, particularly in suburban locales (Cervero, 1989). He showed that the amount of residentially zoned land and housing prices affected the amount of in-commuting to employment sites in the San Francisco Bay Area. An analysis conducted by Levine corroborated these findings (Levine, 1998). That work showed that low- and middle-income workers had stronger preferences for affordability and density than did high-income workers. To the extent that suburban land use controls artificially restricted density and the total number of affordable housing units, then low- and middle-income workers would be disadvantaged by a "normally" functioning market.

Later work by Cervero complicated the debate while providing support for the focus on market failures in suburban job locations (Cervero, 1996). He found that, from 1980 to 1990, the Bay Area's largest cities tended toward increasing balance, but that this trend was uneven. Cities that were historically housing rich (early suburbs) saw increase in jobs over that period and tended to become more balanced. But, even in areas that had achieved balance, the proportion of local jobs that were filled by employed residents (referred to as "self-containment") was low. This led Cervero to conclude that there was a mismatch between the quality and character of available housing and the tastes, preferences, and resources of locally employed workers. Reframing the issue of jobs-housing balance, he stated that

> If reducing VMT and encouraging more walking, biking, and transit riding are explicit policy objectives, then building housing suited to the earnings and preferences of local workers and attracting industries suited to the skill levels of local residents could very well pay more dividends than ensuring parity in numbers of jobs and housing units would. (Cervero, 1996, p. 499)

In other words, it is not the *balance* between jobs and housing that matters for transportation outcomes, but rather the *fit* between locally available housing and the ability of locally employed workers to afford it. Because high-income workers inherently have more flexibility and choice in terms of their housing location decisions, and because of the dynamics of suburban housing markets, this is a problem that manifests primarily in suburban locations that tend to underprovide affordable housing options for low-wage workers. The marginal value of a dollar saved is also likely to be higher for a low-wage worker. When provided with an opportunity to live closer to where they work, the reduction in transportation costs would be comparably much more attractive for a low-wage worker than a high-wage worker, all else equal.

Although much of the prior work examined trends in jobs-housing balance indicators and location choices, explicit differences in observed commuting behavior and travel outcomes have also been observed in the literature, further underscoring the importance of looking at fit, not just balance. Using travel survey data for the Portland metropolitan region, Peng showed that areas with larger imbalances between jobs and housing attracted more in-commuting VMT while controlling for population density and number of high-income households (Peng, 1997). Similarly, Sultana examined mean commute travel times between zones in the Atlanta metropolitan region, showing that workers commuting to areas with balanced jobs and housing had shorter commute travel times than workers commuting to imbalanced areas (Sultana, 2002). These links to travel behavior appear to hold in the aggregate, for particular regions, but stronger predictions can be made when accounting for differences in subpopulations. For example, Cervero and Duncan calculated daily VMT for respondents to a Bay Area travel survey and included an indicator of the fit between jobs and housing (Cervero & Duncan, 2006). They demonstrated that a measure of "occupationally matched" jobs within 4 miles of a census tract was a better predictor of work tour VMT than total jobs.

The literature on "excess commuting" has also found fruitful points of contact with the jobs-housing balance literature and can provide results disaggregated by income group (Horner, 2002, 2007; White, 1988). Excess commuting is concerned with the optimal location of workers and households within a region, given existing spatial structure. In other words, given the extant transportation network and household locations, how short could the mean commute be if workers could be reassigned to new jobs closer to their residences? The result is referred to as the "theoretical minimum commute" and can be thought of as an indicator of aggregate jobs-housing balance, since it represents the locations of jobs and housing units independent of individual choices (Horner, 2002). Much of the excess commuting literature is based on aggregate indicators calculated for entire regions, with studies generally showing that the spatial arrangement of jobs and housing explains statistically significant but modest portions of commuting behavior (Giuliano & Small, 1993; Scott, Kanaroglou, & Anderson, 1997; Sultana, 2002). Few studies have looked in detail at whether the relationship might differ for low-income workers, but Giuliano and Small did present

results disaggregated by occupational category, noting that, "although the mismatch most commonly cited involves income level, it is very difficult to define accurately the relationship between observed incomes and feasible housing prices" (Giuliano & Small, 1993, p. 1496). In other words, determining which housing units would be affordable to which classes of workers would be quite a difficult exercise. Their results showed little difference between employment categories and the overall regional average minimum commute, but this result could have been due to the relatively wide variation in incomes possible within a single coarse job category. Larger differences in commuting behavior between occupational categories were described by O'Kelly and Lee using data for Boise, Idaho and Wichita, Kansas (O'Kelly & Lee, 2005).

Until recently, detailed data on job wage levels and commuting behavior simply were not available. Many of the prior studies on excess commuting relied on Census Transportation Planning Package (CTPP) data to examine the demographics of workers and employed residents. Horner and Mefford, for example, analyzed 1990 CTPP data disaggregated by race in Atlanta, showing that Black and Latino workers were relatively more constrained in their home and work location choices than were White workers (Horner & Mefford, 2007). Similarly, Stoker and Ewing used CTPP data to investigate the extent to which the proportion of people living and working in the same local area is related to both jobs – worker balance and income match (Stoker & Ewing, 2014). They found that both income match between residents and workers and overall jobs–worker balance influenced the internal capture of trips, but the effect size for balance was larger than that for income match. This analysis is constrained by limitations in the CTPP data for this purpose. The CTPP contains place-of-work data, but the income characteristics are based on individuals, not jobs, and are annual income, not wage levels. Given that more than 10% of US workers separate from their employers each quarter, and perhaps as much as 40% in a single year (Andersson, Holzer, & Lane, 2005; Burgess, Lane, & Stevens, 2000; Davis, Faberman, & Haltiwanger, 2006), it can be misleading to assign annual income figures to a single place of work.

The Longitudinal Employer-Household Dynamics (LEHD) dataset provides an opportunity for more detailed analysis of jobs-housing fit than was previously possible. The excess commuting literature is beginning to use these data and has compared results for workers in the three categories of wages available in the LEHD. For example, Horner and Schleith showed that low-wage workers in Leon County, Florida, had a shorter theoretical minimum commute than high-wage workers, indicating that the spatial arrangement of low-wage jobs and employed low-wage residents was relatively more balanced than other wage groups (Horner & Schleith, 2012). For the particular county examined in that study, high-wage workers tended to locate their residences at greater distances from available jobs than did low-wage workers. These theoretical minimum commute measures provide concise indicators of regional balance or fit, but provide little insight into subregional variation. Although the metric can be used to compare different groups (Horner & Mefford, 2007; Horner & Schleith, 2012), it has no ability to identify problematic areas in need of mitigation (i.e., the provision of affordable housing).

The conclusion that one can draw from this work is that jobs-housing fit appears to be more important than aggregate jobs-housing balance. In other words, aggregate numbers of jobs and housing can be approximately similar, but if the type of housing

available is not well matched in terms of quality and character to the wage and salary levels of jobs in the area, then there will still be an effective imbalance, resulting in the need for workers to commute long distances. While past work was limited in its ability to examine this issue due to data constraints, the emergence of new data sources allows researchers to take a new look at the issue of jobs-housing fit and apply some of the insights gleaned from the excess commuting literature regarding the travel behavior of different market segments. The remainder of this article describes the development and application of an explicit indicator of low-wage jobs-housing fit. We argue that the indicator can highlight problematic areas in a region that are in need of affordable housing development that are not evident from a traditional measure of jobs-housing balance, and illustrate the impact of using different distance thresholds for the neighborhood-level analysis.

Data and methods

In order to address some of the prior shortcomings identified in the broader jobs-housing balance literature, we develop an indicator of *low-wage jobs affordable housing fit*. An important consideration that guided the design process was the need to ensure both the metric's validity and its ease of use (Reed, Fraser, & Dougill, 2006). Specifically, we collaborated with affordable housing, civil rights, and climate change advocates throughout Northern California in a broadly collaborative process to determine the indicator's properties and data sources. Their fundamental concern involved identifying jurisdictions that were underperforming on their affordable housing production. They sought an indicator that was easy to use, could inform their advocacy, and could be updated over time as new data became available. We employed publicly available data on job numbers from the LEHD and housing numbers from the American Community Survey (ACS). Developing a metric from these two sources required a number of design decisions. These were made in collaboration with community partners and are discussed in detail below.

Jobs data

To avoid some of the limitations of CTPP data mentioned above, we extracted low-wage job numbers for census blocks from the 2011 LEHD Origin-Destination Employment Statistics (LODES) dataset. The dataset is developed by the US Census Bureau in collaboration with state partners and combines a variety of federal and state administrative data on employers and employees with core census products to provide employment characteristics based on place of residence and place of work, as well as commute flow data. The data are available at the census block level and can be aggregated to other geographies. We used the 2011 LEHD California Work Area Characteristics (i.e., job location) file. The low-wage job variable in the LEHD counts number of jobs with monthly earnings of $1250 or less. This is the equivalent of $15,000/year for someone working for 12 full months.[1]

Unlike the CTPP, the LEHD can contain multiple records per worker. Additionally, the LEHD does not indicate whether a job is full-time or part-time, short-term or long-term – it simply measures monthly earnings. There is a danger, then, that jobs

identified as low-wage in the LEHD could actually be held by individuals earning a higher annual income than the monthly earnings in that job would suggest. Individuals piecing together employment can afford more housing than they could if they were working a single job. However, our concern is not with the overall job searching behavior of a household, but whether a single job provides an income adequate to house a worker nearby. It is important to note that the jobs that are counted are those that are unemployment insurance-covered wage and salary jobs, as reported by state labor market information offices and by the Federal Office of Personnel Management. This covers most public- and private-sector employment, but excludes the self-employed, postal workers, the military and other security-related federal agencies, and some employees at nonprofit and religious institutions (Graham, Kutzbach, & McKenzie, 2014).

Housing data

Data on housing units were taken from the ACS 2007 – 2011 5-year estimates.[2] For this assessment of low-wage workers and low-wage jobs, we focused on rental units because low-income earners are far more likely than high-income earners to rent their homes (Schwartz, 2010). To calculate an affordable monthly rent for low-income households, we assumed that spending 30% of total household income on housing costs is reasonable. This figure is widely accepted among affordable housing developers and advocates, and is the threshold above which the US Department of Housing and Urban Development considers a household to be cost-burdened and may have difficulty in affording other necessities (Hulchanski 1995; Schwartz, 2010). But what is the appropriate total household income that would be appropriate for this low-income jobs/affordable housing ratio? Many affordable housing developers are accustomed to thinking about household income levels that are based on the area median income (AMI) and number of people per household, since these are used as criteria for various state and federal housing subsidy programs. For example, in 2011, 50% of AMI income limit (considered very low income) for a single person and four-person household in the City and County of San Francisco was $37,400 and $53,400, respectively.[3]

For the purposes of this analysis, however, it is essential to use some multiple of the $1250/month wage threshold, rather than AMI. This is because one of the primary strengths of the LEHD is that it is updated annually, making it possible to assess changes over time. But the $1250/month threshold used by the LEHD data has not been adjusted for inflation since the dataset was first developed. Thus, the percentage of jobs falling into that low-wage category shrinks year to year simply as a result of inflation. If some portion of the AMI was used as the housing affordability threshold, this figure would adjust year to year with inflation, thus artificially and inappropriately reducing the low-wage jobs to affordable housing ratio.

We thus considered several possible multiples of $1250/month for our low-income household income level. The overall jobs to housing ratio in all census places in the nine-county San Francisco Bay Area is 1.2,[4] suggesting that an annual income of $18,000 ($1250/month × 12 months × 1.2) might be reasonable. An alternative figure could be based on the average number of jobs per households headed by the *working age population*, since there are many households in the region headed by retirees, and

calculations of housing needs for this population are not directly related to jobs. This would suggest multiplying $1250 by 1.5 (the average number of jobs per household with the householder aged under 65 years in the region).[5] This calculation would result in an annual household income of $22,500 as the threshold. Since low-income households on average have fewer income earners than high-income households, this might provide a reasonably accurate picture of the challenges people employed in low-wage jobs actually face in trying to find affordable apartments and homes. On the other hand, some portion of people in these jobs are likely to be younger people still living with their parents, or students (and other young people) living in group houses or apartments. Furthermore, a threshold of $22,500 would be substantially below those used by affordable housing developers to define low-income status.[6]

Given these considerations, we decided to set the low-income threshold at $30,000 a year of household income, or two times the $1250/month threshold of the low-wage job category. It is important to stress that in selecting $30,000/year as our threshold, we are not assuming that there would necessarily be two low-income earners per household. We are simply selecting what we believe is a reasonable value to designate a low-income household that is a multiple of the low-wage job threshold, so that we can make consistent comparisons over time, including when the Census Bureau inevitably changes their low-wage definition in the LEHD data. Using this threshold, an affordable monthly rent for a low-income household with an annual income of $30,000 would be $750/month (30% × $30,000/12). We summed counts of rental units with both contract rent (renter-occupied units) and rent asked (vacant for-rent units) less than $750/month as well as the category "no cash rent" to count the number of affordable rentals. These variables measure the rent of housing units independent of the incomes of their current residents and are likely to understate the barriers to renting faced by newcomers to the market since they include rents for units that have been occupied for extended periods of time and rent-controlled units.

The smallest census geography for which there are ACS data available is the block group, but the associated margins of error (MOEs) are quite large and geographic coverage is not complete. We instead used affordable unit totals at both the census place and tract scale. From the tract, we created estimates of affordable rental units for census blocks assuming that affordable rentals were distributed throughout the blocks in the same proportions as total housing units according to the 2010 decennial census totals.

Geographic scale and metric calculation

With both housing units and jobs tabulated for census blocks, it is possible to calculate the low-wage jobs-housing fit metric for arbitrary geographies. Our primary interest here is at two scales: census places (including incorporated cities and towns as well as census-designated places) and a neighborhood (census tract) measure. Using places as the unit of analysis can highlight jurisdictions that are underproviding affordable housing relative to their demand for low-wage labor. The jurisdiction is important because it is ultimately jurisdictions that control land-use decisions. In California, jurisdictions are also responsible for meeting housing targets by affordability category under the state's Regional Housing Needs Allocation (RHNA) (Barbour & Deakin, 2012; Lewis, 2003). The metric for census places is calculated using Equation 1,

$$\text{Low-wage jobs-housing fit}_i^1 = \sum_j \frac{\text{Low-wage jobs}_j}{\text{Aff. Rentals}_j}, \quad (1)$$

where superscript 1 indicates that this is the place metric and j indexes all census blocks located within place i.

While important from the perspective of affordable housing provision, the jurisdiction level is quite coarse. Analyzing only jurisdictions can miss variations in jobs-housing fit that occur at a neighborhood scale within cities or locally, across jurisdictional boundaries. On the other hand, expecting individual census tracts to evidence perfect fit is not likely to be reasonable; these are often relatively small-area geographic units whose scale represents an unreasonably low commute distance. It is likely appropriate to develop a buffer distance based on a judgment regarding reasonable commute sheds or buffers around the tract (Cervero & Duncan, 2006; Peng, 1997; Stoker & Ewing, 2014).

We tested two different buffer definitions for the tract measure: one designed to be interpretable (an unweighted measure) and another designed to privilege the concentration of low-wage jobs and affordable housing near population centers by weighting using a distance-decay function. The first step for both measures was to calculate a population-weighted centroid for each tract based on the population within census blocks. Determining an appropriate method for calculating the number of low-wage jobs and affordable rental units within a reasonable or desirable commute distance of this population-weighted tract centroid is challenging. Depending on the decision, substantially different conclusions can be drawn. However, in an investigation of the scale dependence of three measures of commuting efficiency, Niedzielski, Horner, and Xiao (2013) found that measures of capacity used and commuting economy were relatively unaffected by the areal unit, though a measure of excess commuting was highly sensitive to modifiable areal unit problems, confirming earlier findings (Horner & Murray, 2002). The authors concluded, though, that "more aggregated data, such as LEHD data aggregated to census tracts for example, can be used safely in the knowledge that the metric results will hardly be different from those based on less aggregated data" (Niedzielski et al., 2013, p. 141).

Our interest here is primarily in determining whether affordable housing and low-wage jobs are relatively balanced, rather than on regional-scale commuting patterns, so we used a distance buffer that would be relevant for an analysis based on walking or biking as the primary means of travel to work. It is important to emphasize that focusing on a relatively short walk/bike-scale buffer can also provide insights into broader commute patterns, since home – workplace proximity continues to be a major factor in household location choice, and this is particularly important when people change their home or workplace. In the case of Paris, for example, commute length "exerts a much stronger influence [than economic, social, or demographic characteristics] on the likelihood that home or workplace changes will shorten trips to work" (Korsu, 2012, p. 1963).

A half-mile has become widely accepted as the appropriate distance for gauging people's willingness to walk to transit (Guerra, Cervero, & Tischler, 2012). The 2009 National Household Travel Survey (NHTS) found that the average commute trip length for those who walked on the day of the survey and reported a "usual commute" mode

of walking in the previous week was 0.98 miles (Santos, McGuckin, Nakamoto, Gray, & Liss, 2011, p. 48). According to the 2010–2012 California Household Travel Survey (CHTS), the equivalent figure for the state was close to 0.44 miles, and for the nine Bay Area counties, it was about 0.41 miles (California Department of Transportation, 2013).

For biking to work, the 2009 NHTS found that the average distance was 3.8 miles (Kuzmyak and Dill 2012; Stinson, Porter, Proussaloglou, Calix, & Chu, 2014). In the CHTS, the average bike commute statewide was 3 miles and in the nine Bay Area counties, it was about 2.8 miles. There are obviously a wide range of factors that shape the frequency and distribution of bike commutes, including topography, street connectivity, gender, and whether employers provide bike parking, lockers, and showers (Buehler, 2012; Iseki & Tingstrom, 2014; Winters, Brauer, Setton, & Teschke, 2013), but our analysis here only allows us to look at overall average patterns, not based on characteristics of individual workplaces.

Using these average walk- and bike-commute distances, we developed our two low-wage jobs-housing fit measures. For the intuitive metric, we followed the jurisdiction-based approach and calculated an unweighted ratio using a hard cutoff, counting all low-wage jobs and affordable rentals within a 2.5-mile buffer, as shown in Equation 2,

$$\text{Low-wage jobs-housing fit}_i^2 = \sum_j \frac{\text{Low-wage jobs}_j}{\text{Aff. Rentals}_j}, \tag{2}$$

where the superscript 2 indicates that this is the intuitive metric and j indexes census blocks within a 2.5-mile straight line distance of the population-weighted centroid of tract i.

For the weighted distance-decay metric, each low-wage job and affordable rental unit within 0.5 miles of the population-weighted tract centroid was weighted at 1.0. Jobs and housing units located between 0.5 and 3.0 miles were assigned a declining weight using a linear function, and those located further than 3.0 miles from the centroid were weighted at 0. This calculation is summarized in Equation 3,

$$\text{Low-wage jobs-housing fit}_i^3 = \frac{\sum_j \text{Low-wage jobs}_j + \sum_k \text{Low-wage jobs}_k \times (-0.4d + 1.2)}{\sum_j \text{Aff. Rentals}_j + \sum_k \text{Aff. Rentals}_k \times (-0.4d + 1.2)}, \tag{3}$$

where the superscript 3 indicates that this is the distance-weighted metric, i indexes census tracts, j indexes census blocks within 0.5 miles of tract i's population-weighted centroid, k indexes census blocks between 0.5 and 3.0 miles of tract i's population-weighted centroid, and d is the straight line distance between the population-weighted tract centroid of tract i and block k.

Results and discussion: Bay Area low-wage jobs-housing fit

Jurisdiction-level analysis

A key goal of this study was to compare traditional measures of jobs-housing balance with low-wage jobs-housing fit. Figure 1 shows a comparison of these metrics for census places in the San Francisco Bay Area by overlaying the kernel density plots

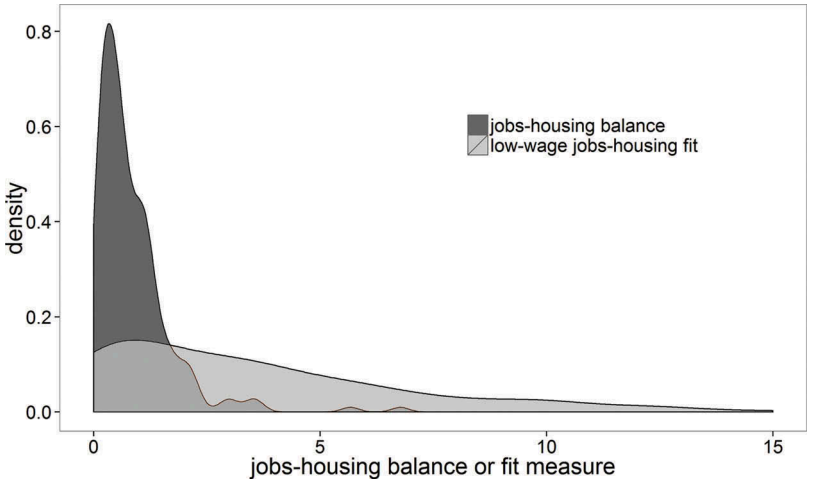

Figure 1. Kernel density plots for traditional jobs-housing balance and low-wage jobs-housing fit in census places in the Bay Area.

illustrating the distribution of each measure. The figure clearly shows that there is a dramatic difference between balance and fit. According to the traditional balance measure, most jurisdictions seem to have an adequate supply of housing units in comparison to the number of jobs available. The ratios cluster around 1. The low-wage jobs-affordable housing fit measure, however, shows that a substantially larger number of jurisdictions have a poor fit between the number of low-wage jobs and availability of affordable rental units, with much larger values of the ratio indicating that there are many more low-wage jobs than affordable rental units in many jurisdictions across the Bay Area. These results are obscured using traditional measures.

Figure 2 maps the actual low-wage jobs-affordable housing fit for census places in the Bay Area. Jobs-housing fit ratios are grouped into four categories, indicated by increasingly dark shades of grey: <1 (lightest grey), 1–2, 2–4, >4 (darkest grey). Hash-marks indicate places where the calculated MOEs cross these categorical boundaries, with the shading indicating whether the calculated MOEs include simply an adjacent category, or whether they are so large as to cross to multiple other categories.

This figure shows locations in the Bay Area facing substantial challenges with their low-wage jobs-affordable housing fit. For nearly all of the southern San Francisco Bay (the heart of Silicon Valley), the ratio of low-wage jobs to affordable rental units exceeds 4.0. One exception is the small city of East Palo Alto, a well-known pocket of poverty in the region. Similar ratios are evident in the East Bay suburbs of Concord, Walnut Creek, Livermore, Pleasanton, and surrounding areas. These are all residential suburbs that have significant concentrations of low-wage work in the retail, restaurant, and accommodation sectors, but provide relatively few affordable rental units. Jurisdictions with relatively good fit (ratio of 1–2.5) include the inner East Bay cities of San Pablo (1.3), Oakland (1.4), Richmond (1.4), and Berkeley (2.0), as well as older inner-ring suburbs such as Pittsburg (2.1) and Vallejo (2.2). San Francisco also has a relatively good fit (2.1), which is perhaps surprising given its reputation as a high-housing-cost city. This is likely due to complementary factors that reduce the numerator and increase

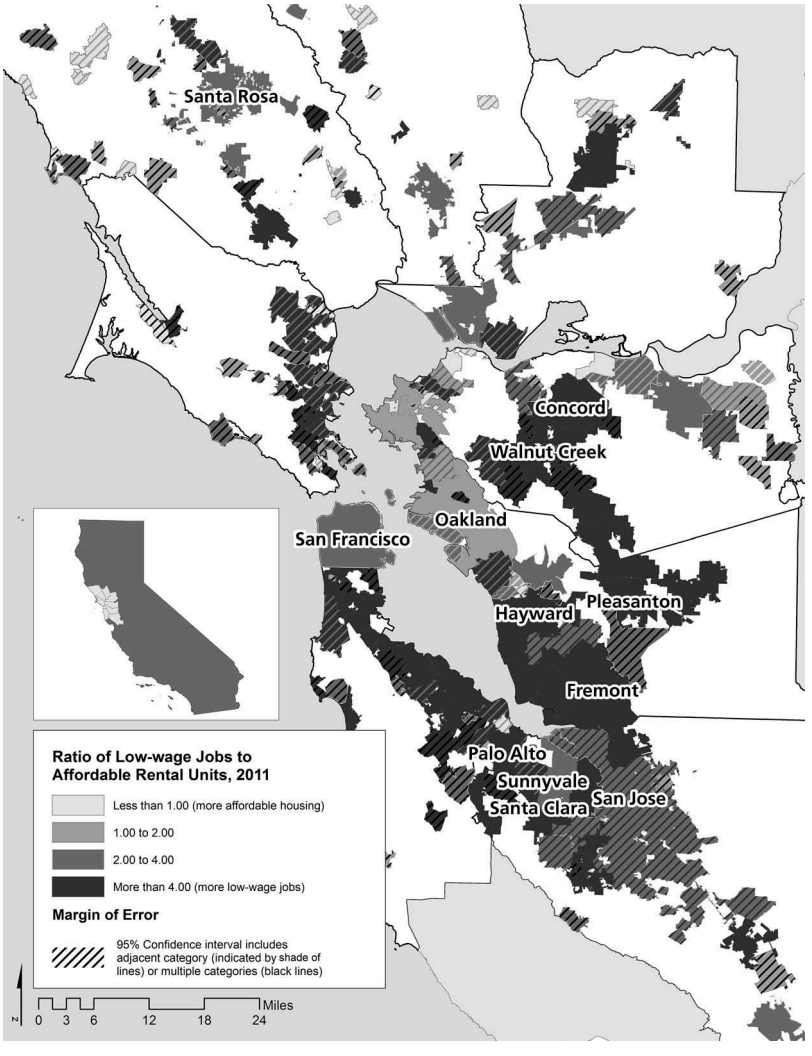

Figure 2. Low-wage jobs-housing fit for census places in the San Francisco Bay Area. Sources: 2011 LEHD Origin-Destination Employment Statistics dataset (job locations), 2007–2011 American Community Survey five-year estimates (rental unit locations and price).

the denominator of the jobs-housing fit ratio. The city's higher minimum wage (which was $9.92 in 2011) reduces the number of jobs paying less than $1250/month, and both rent control and an overall high proportion of rental units combine to increase the number of units below the $750/month affordable rental threshold.

Neighborhood-level analysis

For the neighborhood (census tract)-level analysis, Figure 3 compares the low-wage jobs-housing fit metric calculated using the unweighted 2.5-mile hard threshold to the 3.0-mile weighted distance decay metrics. The results are quite similar between both methods. A Kolmogorov–Smirnov test on the similarity of two variables fails to reject

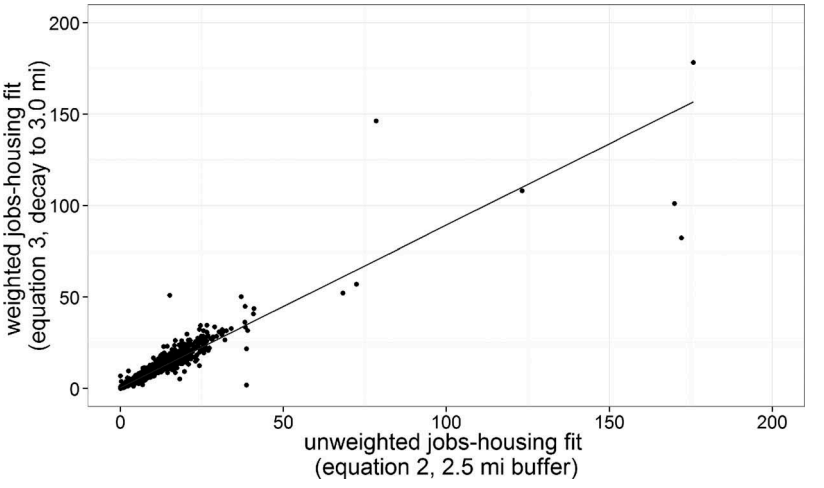

Figure 3. Comparison of low-wage job-housing fit metric calculated using unweighted 2.5-mile buffer (Equation 2) with weighted distance-decay metric to 3.0 miles (Equation 3).

the null hypothesis that the observations are drawn from the same distribution (D = 0.0127, p value = 0.5409). Accordingly, Figure 3 shows a nearly 1:1 relationship. Further, 90% of the tracts do not shift categories between the two methods. Thus, given the greater ease of interpretability of the simple ratio measure to a broader public, we focus the remaining discussion on the unweighted ratio measure calculated using a 2.5-mile buffer.

Figure 4 illustrates the result of calculating jobs-housing fit for 2.5-mile buffers around census tracts in the Bay Area. Two dimensions are plotted on the map: low-wage job density at the tract level and jobs-housing fit at the buffer level. Jobs-housing fit ratios are grouped into four categories: <1 (blue), 1–2 (green), 2–4 (yellow), and >4 (red). The three shades in each color indicate tertiles based on the number of low-wage jobs, with darker shades in each category indicating increasing numbers of low-wage jobs. Figure 4 also clearly shows areas with substantial issues with low-wage fit in the Bay Area. The only areas that appear to have relatively good fit are the urban core areas of Oakland and Richmond. These are also jurisdictions that experience high poverty and have high populations of people of color. The areas with the worst fit are located in the East Bay suburbs, the Peninsula (south of San Francisco), and Silicon Valley. Low-wage workers employed in these areas are unlikely to find affordable housing close to their jobs and may have to commute long distances.

These results are broadly consistent with opinions expressed by Bay Area housing and transportation advocates, particularly in the context of new regional planning initiatives. With California's passage of the Sustainable Communities and Climate Protection Act (SB 375) in 2008, the integrated issues of land use, transportation, and housing have been combined into a single regional planning process. The Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments (ABAG) completed their 2013 Regional Transportation Plan (RTP) and Sustainable Communities Strategy (SCS) entitled *Plan Bay Area*. The SCS is a new document

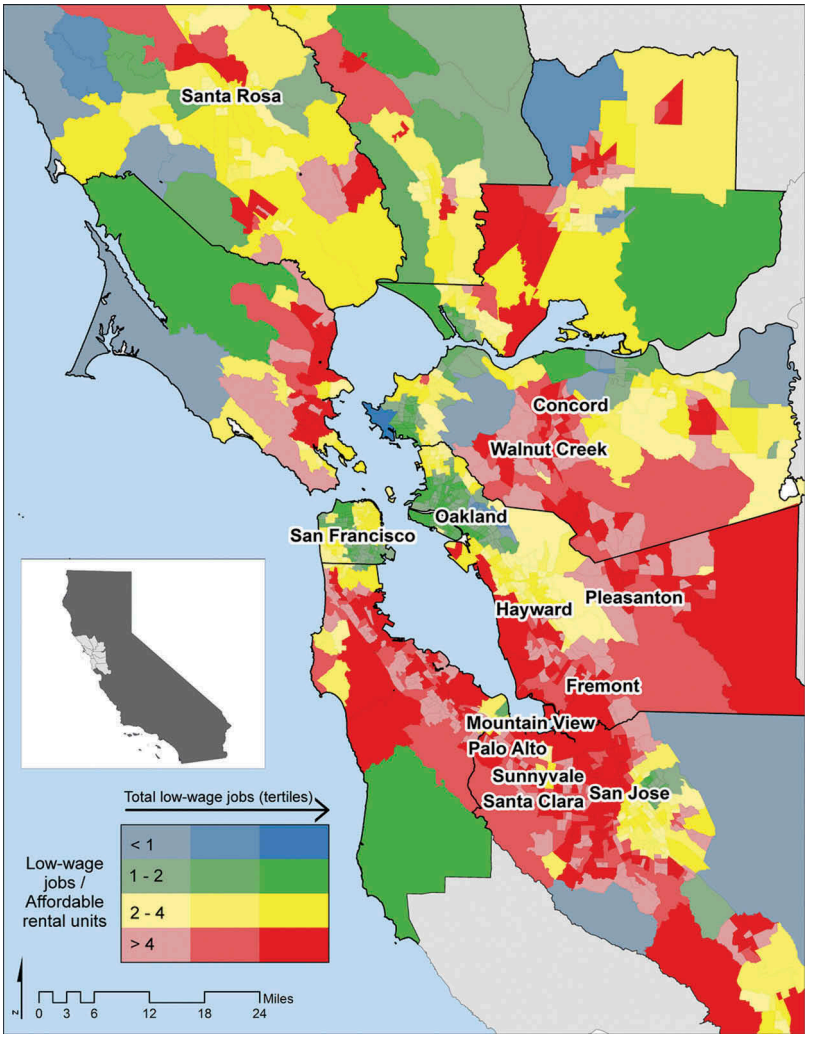

Figure 4. Jobs-housing fit for census tracts in the San Francisco Bay Area. Ratios calculated at 2.5-mile buffers around census tracts. Sources: 2011 LEHD Origin-Destination Employment Statistics dataset (job locations), 2007–2011 American Community Survey five-year estimates (rental unit locations and price).

required by SB 375 that illustrates how a region will meet a future GHG reduction target through coordinating transportation and land-use planning.

Advocates for affordable housing and transportation equity were deeply engaged in the *Plan Bay Area* public participation process and ultimately developed their own transportation–land-use scenario – entitled "Equity, Environment, and Jobs" (EEJ) – that was modeled by the regional agencies (Marcantonio & Karner, 2014). In contrast to the agencies' proposed plan, EEJ increased local transit operating funding, shifted overall capital expenditures from highways to transit, and located more low-income earners closer to low-wage jobs in many of the suburban areas identified in Figures 2 and 4. The EEJ scenario was designated the environmentally superior alternative under California's

environmental review laws. The agency plan placed most population growth adjacent to areas already well served by high-quality transit. While this strategy is important, it neglects areas with high numbers of low-wage jobs, poor transit service, and housing affordability issues. The EEJ scenario results show that strategies that simultaneously address housing affordability and transit-oriented development can perform better than those that focus only on the latter. The low-wage jobs-affordable housing fit metric developed here can identify areas in regions where such strategies could potentially result in overall environmental benefits, as there is some preliminary evidence that places in California with better low-wage jobs-affordable housing fit measures have lower VMT (Karner & Benner, 2016).

Limitations

There are a few important limitations to the use of this low-wage jobs-affordable housing fit metric that are rooted in the characteristics of the data sources and that are important to acknowledge. Probably the most important has to do with the earnings thresholds in the LEHD data. The LEHD only identifies jobs with monthly earnings of $1250 per month or less, from $1251 to $3333 per month, or more than $3333 per month. In the San Francisco Bay Area, the lowest wage category accounted for 19.7% of total jobs in 2011, and can be considered truly the lowest-wage jobs in the region. In other parts of the country, this threshold would include somewhat higher levels of the labor market. In the McAllen–Edinburg–Mission, TX MSA, for example, which is one of the lowest-earnings MSAs in the country, 36.1% of jobs in 2011 fell into the lowest wage category. Thus, in the San Francisco Bay Area, this metric does little to identify a lack-of-fit at higher earnings levels, and thus may understate housing affordability challenges for other low-wage workers who are not at the very bottom of the labor market.

Another limitation is that this analysis only looks at rental units. It is possible to develop a calculation of affordability based on the value of owner-occupied units, and we have done so in other venues (Benner & Tithi, 2012), but this approach requires various assumptions about mortgage interest rates, the value of mortgages in relation to home value, and other costs and benefits of ownership (e.g., property tax, insurance, mortgage interest, and property tax deductions) that make such analysis more speculative.

As discussed in our methods section above, there are also limitations related to the spatial scale of analysis. The ACS has quite high MOEs at small geographies, and the LEHD LODES dataset is a partially synthetic dataset, so the small-area geographies are also especially sensitive to modeling assumptions. This limits a reasonable analysis to the tract scale or larger (e.g., tract plus buffer, or census place), and even here the findings should be interpreted as estimates subject to measurement error.

Conclusion

The literature on jobs-housing balance has long posited that aggregate balance between jobs and housing units, while important, is not by itself a sufficient indicator of transportation performance or housing market health. That work has argued for a

qualitative match between the quality and character of local housing and the wages, tastes, and preferences of the locally employed workforce. Moreover, prior work has shown that parochial housing policy will likely be promulgated in areas that are jobs rich but housing poor. This ensures that truly affordable units will be undersupplied. Although individuals choose home and work locations for a number of different reasons – not just to minimize commute distance – we expect that low-wage workers would be particularly sensitive to the impacts of housing prices and commute distances. With less disposable income, the opportunity to save money on transportation costs by living close to one's workplace is relatively more attractive for a low-wage worker than a high-wage worker.

Prior to the widespread availability of the LEHD data, there was no way to adequately identify and quantify the location of low-wage jobs with a reasonably high degree of spatial resolution. The work presented above shows how these data can be used to develop a metric of low-wage jobs-housing *fit* that can be calculated at multiple geographies and used to target affordable housing investments. The collaborative nature of the metric's development ensured that it would be intuitive and useful to those affordable housing advocates that desired to use it. It has been actively applied to ongoing conversations regarding housing affordability and economic development in the Bay Area and elsewhere in Northern California. While we have used data specifically for the San Francisco Bay Area to illustrate the utility of the method, the data are available in the vast majority of states for any geography of interest.

One promising area of future work involves relating jobs-housing fit to travel behavior, total VMT, and location affordability.[7] After all, there are many factors that go into housing and workplace location decisions; a better jobs-housing fit on its own does not guarantee superior transportation and housing/labor market outcomes. Thankfully, the development of new data sources on job quality at a local level enables researchers and planners to more effectively investigate the impact of a better jobs-housing fit than was possible in the past. The development of the metric is timely, occurring in concert with the rise in concerns about housing affordability following the mortgage crisis and its aftermath. The development of improved measures of jobs-housing fit, like the one introduced here, will promote meaningful debates among a broad constituency about the relative importance and merits of promoting a jobs-housing fit in cities and neighborhoods throughout the country.

Notes

1. For comparison, the Federal poverty levels in 2011 for an individual, a family of two, and a family of four were $10,890, $14,710, and $22,350, respectively.
2. See Appendix 1 for a discussion of the associated margins of error (MOEs).
3. See: http://www.hcd.ca.gov/fa/home/homelimits.html.
4. Based on total number of jobs from the LEHD data, and total number of housing units from the ACS.
5. In the 9-County Area in 2011, the Employment Development Department estimates there were a total of 3,194,200 jobs, and the Decennial census identified 2,070,458 households with householders under the age of 65.
6. For San Francisco County in 2011, for example, the California Department of Housing and Community Development considered $48,100 to be low-income for the purposes of the

Community Development Block Grant (CDBG) programs, and $76,950 to be low-income for the purposes of the HOME Investment Partnerships Program. See http://www.hcd.ca.gov/fa/home/homelimits.html.

7. See http://locationaffordability.info/.
8. For details, see Appendix 3 of US Census Bureau (2008).
9. This value is calculated for each of the 50 states separately. Details of this methodology are described in chapter 12 of *American Community Survey Design and Methodology* (Washington, DC: UC Census) available here: http://www.census.gov/acs/www/methodology/methodology_main/.

Disclosure statement

No potential conflict of interest was reported by the author.

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Appendix 1. Margins of error in American Community Survey data

All of the data from the American Community Survey has a margin of error (MOE) associated with it, which represents the equivalent of a 90% confidence interval. In other words, we can be 90% confident that the actual value for any variable is the reported amount plus or minus the MOE. At the census place level, we calculated MOEs using the formula for calculating MOEs for derived ratios where the numerator is not a subset of the denominator.[8] The formula for this is:

$$\mathrm{MOE}_R = \frac{\sqrt{\mathrm{MOE}_{\mathrm{num}}^2 + \left(R^2 * \mathrm{MOE}_{\mathrm{den}}^2\right)}}{X_{\mathrm{den}}},$$

where $\mathrm{MOE}_{\mathrm{num}}$ is the MOE of the numerator, which in this case is 0 since the jobs numbers are reported without an MOE.

$R = \frac{X_{\mathrm{num}}}{X_{\mathrm{den}}}$ where the numerator is the job figure and the denominator is the housing figure.

$\mathrm{MOE}_{\mathrm{den}}$ is the MOE of the denominator, which in our case is the housing figure. In all cases, we are combining figures for multiple different categories, so this figure is calculated from the formula for calculating MOEs when aggregating count data, which is:

$$\mathrm{MOE}_{\mathrm{agg}} = \sqrt{\sum_c \mathrm{MOE}_c^2},$$

where MOE_c is the MOE of the cth component estimate.

We calculated this MOE_c by simply aggregating all the categories *below* our threshold (e.g., aggregating MOE values for contract rent that is less than $100; $100–$149; $150–$199; $200–$249; and so on up to $750/month), with some modifications as explained below.

In some of these narrow rent bands, the census has an estimate of zero. Since the normal way the census estimates MOEs is based in part on the survey weights assigned to the sample respondent, in these categories where there was no respondent selected, the formula used produces a zero standard error, which is clearly inaccurate since a different survey sample might have revealed some respondent in those categories. Thus, in those cases with a zero estimate, the census uses a method that is based on a comparison between the ACS and the decennial census that uses a calculation based in part on an *average* difference by state between the ACS estimate and the actual value from the census for variables in which this value is possible to compare. All geographies within a state are then assigned the same value as the state totals. In 2011, this resulted in a margin of error of ±95 for all categories with a zero estimate in California.[9] In most cases, therefore, the MOE for zero-estimate categories is actually higher than in cases where there is some estimate.

While this is reasonable for examining any single zero-estimate category, when aggregating across multiple zero-estimate categories in a single geography, we think this overstates the actual margin of error. To account for this, in calculating our combined MOE_{agg}, we combine all zero-estimate categories into a single category and use a single MOE_c of ±95. This was recommended to us by US Census Bureau technical data staff as an "unofficial" recommendation, and we believe it is a reasonable approach.

C U R R I C U L U M V I T A E

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EDUCATION:

2000	Ph.D., City and Regional Planning, University of California Berkeley. Advisor: Manuel Castells *Specialization in regional economic development, social organization of work, regional labor markets and economic geography*
1995	MCP, University of California Berkeley
1988	BA, *Summa cum Laude* with Honors, Dartmouth College, NH

ACADEMIC RESEARCH AND TEACHING APPOINTMENTS:

2015-	Dorothy E. Everett Chair in Global Information and Social Entrpreneurship, Director Everett Program in Digital Tools for Social Entrepreneurship, Professor of Environmental Studies & Sociology, University of California, Santa Cruz
2007-2015	Assoc. Professor to Full Professor (2013), Human Ecology Dept., University of California Davis 2008-11 Chair, Community Development Graduate Group 2010-15 Chair, Geography Graduate Group
2012-13	Visiting Scholar, Program on Environmental and Regional Equity, Univ. of Southern California
2000-07	Assistant Professor, Department of Geography, Pennsylvania State University
2001-08	Research Associate, Sociology of Work Program, University of Witwatersrand, South Africa
2001-08	Associate, Industrial, Organisation and Labour Studies Program, University of Kwa-Zulu Natal
2000-06	Associate Researcher, Center for Justice, Tolerance & Community, University of California, Santa Cruz
1996-99	Instructor, San Jose State University Extension

OTHER PROFESSIONAL EXPERIENCE (partial list):

2011-14	Research Consultant, CareerEdge, Manatee & Sarasota, FL.
2007-09	National Fund for Workforce Development, Evaluation Consultant
2001-07	Research Consultant, Keystone Research Center, Harrisburg, PA
2002-03	External Expert Consultant, OECD Territorial Review Unit
1996-99	Research Associate, Working Partnerships USA, San Jose, CA
1993-94	Consultant, PLANACT, Johannesburg, South Africa
1991-93	Field Representative, U.S.-South Africa Sister Community Project, Johannesburg, South Africa
1991-92	Field Representative and Technical Trainer, TecAfrica, Johannesburg, South Africa
1989-91	Program Associate, Institute for Technology and Development, Berkeley, CA

PUBLICATIONS:

I. *Books*

2015 *Equity, Growth and Community: What the Nation Can Learn From America's Metro Regions.* **Chris Benner** and Manuel Pastor. Berkeley: UC Press (In production)

2012 *Just Growth: Inclusion and Prosperity in America's Metropolitan Regions.* **Chris Benner** and Manuel Pastor. New York: Routledge.

2009 *This Could Be The Start of Something Big: Social Movements for Regional Equity and the Future of Metropolitan America.* Manuel Pastor, **Chris Benner,** and Martha Matsuoka. Ithaca: Cornell University Press

2007 *Staircases or Treadmills: Labor Market Intermediaries and Economic Opportunity in a Changing Economy* **Chris Benner,** Laura Leete and Manuel Pastor. New York: Russell Sage Foundation

2002 *Work in the New Economy: Flexible Labor Markets in Silicon Valley.* Oxford: Blackwell Press.

1997 *Local and Global: Management of Cities in the Information Age.* Jordi Borja and Manuel Castells, with Maria Behlil, and **Chris Benner**. London: Earthscan.

II. *Refereed Articles*

2016 "Low-Wage Jobs Housing Fit: Identifying Locations of Affordable Housing Shortages" **Chris Benner** and Alex Karner, *Urban Geography,* DOI:10.1080/02723638.2015.1112565

2016 "Whither Resilient Regions: Equity, Growth and Community" **Chris Benner** and Manuel Pastor, *Journal of Urban Affairs,* Vol. 38, No. 1, 5-24

2015 "Collaboration, Conflict and Community Building at the Regional Scale: Implications for Advocacy Planning" **Chris Benner** and Manuel Pastor, *Journal of Planning Education and Research.* Vol. 35, No. 3, 307-322

2015 "Brother, Can You Spare Some Time? Sustaining Prosperity and Social Inclusion in America's Metropolitan Regions" **Chris Benner** and Manuel Pastor, *Urban Studies,* Vol 52, No. 7, 1339-1356

2011 "Moving on Up? From Regions to Megaregions in Equity Strategies" **Chris Benner** and Manuel Pastor, *Urban Affairs Review,* Vol. 47, No. 3, 315-348

2011 "From internal to network labor markets? Insights on new promotion opportunities from the call center industry" **Chris Benner** and Ferran Mane, *Industrial Relations,* Vol. 50, No.2, 323-353.

2011 "For What It's Worth: Regional Equity, Community Organizing and Metropolitan America" Manuel Pastor, **Chris Benner,** and Martha Matsuoka, *Community Development,* Vol. 42, No. 4, 437-457

2007 "Regions and firms in eWork relocation dynamics: Pittsburgh's call center industry" *Work, Organisation, Labour and Globalisation* 1(2), 98-115

2006 "South Africa On-Call: Information Technology and Labour Restructuring in South African Call Centres" *Regional Studies,* 40:9, 1025-1040

2003 "'Computers in the Wild': Guilds and Next Generation Unionism in the Information Revolution." *International Review of Social History*, 48:S11

2003 "Learning Communities in a Learning Region: The Soft Infrastructure of Cross-Firm Learning Communities in Silicon Valley" *Environment and Planning A,* 35:10, 1809-1830

2003 "Digital Development and Disruption in South Africa: Balancing Growth and Equity in National ICT Policies", *Perspectives on Global Development and Technology,* 2:1

2003 "Labour Flexibility and Regional Development: The Role of Labour Market Intermediaries." *Regional Studies,* 37:6&7, 621-33

2003 "An Option for the Poor: A Research Audit for Community-Based Regionalism in California's Central Coast." Manuel Pastor, **Chris Benner**, and Rachel Rosner. *Economic Development Quarterly*. 17:3

1998 "Win the Lottery or Organize: Economic Restructuring and Union Organizing in Silicon Valley" *Berkeley Planning Journal,* 12, 50-71

1997 "Labor Markets and Employment Practices in the Age of Flexibility: A Case Study of Silicon Valley" Martin Carnoy, Manuel Castells and **Chris Benner**. *International Labour Review* 136:1

III. *Parts of Books*

Forth. "'An Island off the west coast of Australia': Multiple geography and the growth of transnational service work in Mauritius", with Jairus Rossi, in Mirchandani, Kiran and Poster, Winifred, eds. *Borders in Service: Enactments of Nationhood in Transnational Call Centers* (Palo Alto: Stanford University Press)

2015 "Fostering an Inclusive Metropolis: Equity, Growth and Community" with Manuel Pastor, in Wachter, Susan and Lei Ding, *Building Shared Prosperity in America's Communities* (Philadelphia: University of Pennsylvania Press)

2014 "Knowing Together, Growing Together: Epistemic Communities and Equitable Growth" with Manuel Pastor, in Conway, Maureen and Robert Giloth, eds, *Connecting People to Work: Workforce Intermediaries and Sector Strategies* (New York: American Assembly)

2014 "Digital Dynamics: New Technologies and Work Transformations in African Cities" in Parnell, Sue and Oldfield, Sophie, eds. *A Routledge Handbook on Cities of the Global South* (London: Routledge)

2011 "Planning for Equity, Fighting for Justice: Planners, Organizers and the Struggle for Metropolitan Inclusion" with Manuel Pastor, in Seltzer, Ethan and Carbonell, Armondo, eds., *Regional Planning for a Sustainable Century* (Cambridge, MA: Lincoln Institute for Land Policy)

2009 "Labor Flexibility" in Kitchin, Rob and Nigel Thrift, Eds. *International Encyclopedia of Human Geography, Vol. 1*, pp. 66-71. Oxford: Elsevier.

2009 "Regional Equity, Worker Voice and Growth in 21st Century Regional Economies" in Logan, John, ed. *Academics on Employee Free Choice: Multidisciplinary Approaches to Labor Law Reform*. Berkeley, CA: UC Berkeley Center for Labor Research and Education

2008 "Been Down So Long: Weak Market Cities and Regional Equity" Manuel Pastor and **Chris Benner** in Richard McGahey and Jennifer Vey, eds. *Retooling for Growth: Building a 21st Century Economy in America's Older Industrial Areas.* Washington DC: Brookings Institution Press

2007 "Economic Development and the Labor Movement in the New Economy: Lessons from Silicon Valley" in John Amman, Tris Carpenter and Gina Neff (eds), *Surviving the New Economy* Boulder, CO: Paradigm Publishers.

2006 "Improvisational Reform: Building Collective Voice and Security in the New Economy". Blind, peer reviewed chapter in: Lourdes Beneria, Neema Kudva eds. *Rethinking Informalization: Precarious Jobs, Poverty and Social Protection*. Ithaca, NY: Internet First University Press. Pp. 128-147. Available through the Cornell Open Access Repository http://dspace.library.cornell.edu/handle/1813/3716

2006 "The Regional Nexus: The Promise and Risk of Community-Based Approaches to Metropolitan Equity", Manuel Pastor, **Chris Benner** and Martha Matsuoka, in Paul Ong and Anastasia Loukaitou-Sideris, eds, *Community Economic Development in Minority Communities*. Philadelphia: Temple University Press

2004 "Labor in the Network Society: Lessons from Silicon Valley" in Castells, Manuel, ed. *The Network Society: A Global Perspective.* Cheltenham: Edward Elgar

2004 Encyclopedia entries for: "Career," "Contingent and Temporary Employment," "Life-long Learning," "New Economy," "Professionals," and "Silicon Valley." In Carl Van Horn and Herbert Schaffner (eds.) *Work in America: An Encyclopedia of History, Policy and Society.* Santa Barbara: ABC-CLIO.

2003 "Information Technology, Employment and Equity in South Africa: The Role of National ICT Policy." Chapter in I. Adesida, I. Kakoma, and P. Zeleza (eds.) *Technology and Development in Africa.* Lawrenceville, NJ: Africa World Press.

2003 "Labor Market Intermediaries in the Old and New Economies: A Survey of Worker Experiences in Milwaukee and Silicon Valley." Laura Leete, **Chris Benner**, Manuel Pastor, and Sarah Zimmerman. Chapter in R. Giloth (ed.) *Workforce Intermediaries*. New York: American Assembly.

2003 "Shock Absorbers in the Flexible Economy: The Rise of Contingent Employment in Silicon Valley." Chapter in Herb Shaffner, and Carl Van Horn (eds.) *A Nation at Work: The Heldrich Guide to the American Workforce*. New Brunswick, NJ: Rutgers University Press.

2001 "Staircases and Treadmills: The Role of Labor Market Intermediaries In Placing Workers and Fostering Upward Mobility." **Chris Benner**, Bob Brownstein, Laura Dresser, and Laura Leete.

Chapter in P. Voos (ed.) *Proceedings of the 53rd Annual Meeting of the Industrial Relations Research Association.* Champaign, IL: Industrial Relations Research Association, pp 34-47.

2000 "Labor in the New Economy: Lessons from Labor Organizing in Silicon Valley." **Chris Benner** and Amy Dean. Chapter in Francoise Carre, Marianne Ferber, Lonnie Golden and Stephen Herzenberg (eds.) *Nonstandard Work Arrangements and the Changing Labor Markets: Dimensions, Causes, and Institutional Responses.* Champaign, IL: Industrial Relations Research Association, pp 361-376.

IV. *Research Reports*

2016 *Silicon Valley Technology Industries Contract Workforce Assessment* Chris Benner and Kyle Neering. (UC Santa Cruz, Everett Program)

2015 *Delta: Regional Opportunity Analysis,* Chris Benner, with Cassie Hartzog and Sara Watterson. Report to Delta Protection Commission (Center for Regional Change, UC Davis)

2015 *Ending Jim Crow in America's Restaurants: Racial and Gender Occupational Segregation in the Restaurant Industry.* With Restaurant Opportunities Centers United (ROC United: New York)

2015 *Job growth, housing affordability, and commuting in the Bay Area: A report prepared for the Bay Area Regional Prosperity Plan.* By Alex Karner and Chris Benner (Metropolitan Transportation Commission, Oakland)

2014 *Shelved: How Wages and Working Conditions for California's Food Retail Workers Have Declined As the Industry Has Thrived.* Research Assistance to primary author Saru Jayaraman. Publishedy by Food Labor Research Center, UC Berkeley.

2012 *Jobs-Housing Fit in the Sacramento Region.* With Bidita Tithi. Report written for the Sacramento Area Council of Governments. UC Davis Center for Regional Change.

2012 *A Dime a Day: The Impact of the Miller/Harkin Minimum Wage Proposal on the Price of Food.* With Saru Jayaraman. Report released by the Food Labor Research Center, UC Berkeley, the Food Chain Workers Alliance, and the Restaurant Opportunities Centers (ROC-United)

2011 *Social Equity and Transit Oriented Development: Selecting Transit Priority Areas in the Sacramento Sustainable Communities Regional Planning Process.* With Bidita Tithi. Report written for the Sacramento Area Council of Governments. UC Davis Center for Regional Change.

2010 *Healthy Youth/Healthy Regions Research Reports:* "Race, Space, and Youth Labor Market Opportunities in the Sacramento Region" (with Gideon Mazinga and Ganlin Huang), "Costs of Drop-outs in the Sacramento/Capital region" (with Gloria Rodriquez, Bidita Tithi and Cassie Hertzog), and "Healthy Youth/Healthy Regions: Informing Action for the Nine-County Capital Region and its Youth" (Jonathan London and Nancy Erbstein lead authors).

2010 *The National Center for a Clean Economy Workforce: A Scoping Study* Produced for the California Energy Commission. By Carol Zabin, Chris Benner and Chris Tilly. UC Berkeley Institute for Research on Labor and Employment.

2009 *Next Generation Unionism and the Future of Journalism: Networking, Entrepreneurship and Hybrid Ownership.* With Samantha Sommer and Luther Jackson. Report published by Center for Regional Change, University of California, Davis.

2009 *Looking Forward: Lessons for Philanthropy from CWBH.* With Manuel Pastor, Rachel Rosner and Martha Matsuoka. Report to The California Endowment analyzing lessons for philanthropy and comprehensive community development initiatives from the California Works for Better Health Initiative

2009 *Scaling Up: Regions, Communities and CWBH* with Manuel Pastor, Rachel Rosner, and Martha Matsuoka. Report to the California Endowment evaluating the role of regionalism in shaping California Works for Better Health Initiative.

2009 *Inclusion in the Workforce: Positioning the Pittsburgh Region to Prosper and Compete* Written by Chris Benner and Radhika Fox, with Miriam Axel-Lute. Report published by Sustainable Pittsburgh and PolicyLink.

2009 *Planning for the Future of Sarasota and Manatee Counties: Highlights from a Labor Market Analysis,* with Barbara Baran, and data assistance from Justin Scoggins, Jennifer Tran and Manuel Pastor. Report to Sarasota/Manatee Counties Workforce Funders Collaborative

2008 *Economic and Workforce Development Opportunities in San Mateo County's Labor Market: A Snapshot and Preliminary Analysis* Report to San Mateo County Board to Supervisors, at request of San Mateo Council AFL-CIO Labor Council.

2008 *Fractures and Faultlines: Growth and Equity in California's Mega-regions* with Manuel Pastor. Published by America 2050 and the Regional Plan Association.

2008 *Coming Together: Lessons on Collaboration from California Works for Better Health* with Manuel Pastor, Rachel Rosner, Martha Matsuoka and Miranda Smith. Report to The California Endowment evaluating a multi-year, multi-million dollar, multi-stakeholder workforce and health funding initiative in California.

2007 *The South African Call Centre Industry: A Study of Strategy, Human Resource Practices and Performance.* Report published by LINK Centre, University of Witwatersrand, Johannesburg, South Africa

2006 *Pennsylvania Industry Partnerships: An Evaluation Methodology for Measuring and Promoting Effective Partnerships* with Steve Herzenberg. Report and recommendations submitted to the Department of Labor and Industry, Commonwealth of Pennsylvania.

2006 *Edging Towards Equity: Creating Shared Opportunity in America's Regions—Report from the Conversation on Regional Equity* Project Coordinators: Manuel Pastor, Chris Benner and Rachel Rosner. Report submitted to the Ford Foundation, and published by the Center for Justice, Tolerance and Community, University of California, Santa Cruz

2005 *Immigrant Workers Empowerment and Community Building: A Review of Issues and Strategies for Increasing Workforce and Economic Opportunity for Immigrant Workers.* Chris Benner, Tony LoPresti, Martha Matsuoka, Manuel Pastor and Rachel Rosner. Final research report submitted to Hewlett Foundation, Palo Alto, CA.

2005 *Workforce Choices: Business & Financial Services, Analysis of Occupational Structure, Employment Dynamics and Career Opportunities.* Research report prepared for Pennsylvania Department of Labor & Industry & Keystone Research Center to be published in 2005

2004 *Building An Effective Labor Market Infrastructure: The Role of Intermediaries and Industry Partnerships.* Report submitted to Keystone Research Center, to be published as chapter in report in 2005.

2004 *Community Building, Community Bridging: Linking Neighborhood Improvement Initiatives and the New Regionalism in the San Francisco Bay Area.* Manuel Pastor, **Chris Benner**, Rachel Rosner, Martha Matsuoka, Julie Jacobs. Santa Cruz: Center for Justice, Tolerance and Community. Published monograph.

2004 *Learning from the Regions: Community-Based Regionalism and Comprehensive Community Development in the San Francisco Bay Area*. Manuel Pastor, **Chris Benner,** Martha Matsuoka, Rachel Rosner, Julie Jacobs. Final research report prepared for the Hewlett Foundation. Palo Alto, CA.

2003 *Economic Opportunity in a Volatile Economy: Understanding the Role of Labor Market Intermediaries in Two Regions.* Manual Pastor, Laura Leete, Laura Dresser, **Chris Benner**, Annette Bernhardt, Bob Brownstein, Sarah Zimmerman. Final research report prepared for the Ford Foundation, McArthur Foundation and the Russell Sage Foundation. New York, NY.

2003 *Making the Whole Greater Than the Sum of the Parts: Developing a Collective Economic Vision for Greater Montreal.* Report prepared for the Organisation for Economic Cooperation and Development. Paris: OECD

2003 *A Workforce Development Agenda for the New Governor: Building The Infrastructure of a Learning Economy.* **Chris Benner**, Steve Herzenberg, and Kelly Prince. Report prepared for the Keystone Research Center, commissioned by Governor Mark Schweiker. Harrisburg, PA: Keystone Research Center.

2002 *Networking and Knowledge Development in the Øresund Region.* Report prepared for the Organisation for Economic Cooperation and Development. Paris: OECD.

2001 *Uncommon Alliances for the Common Good: A Regional Audit for Economic and Social Justice in the Monterey Bay Region*. **Chris Benner**, Manuel Pastor and Rachel Rosner. Report prepared for the Central Coast Interfaith Sponsors, Industrial Areas Foundation. Santa Cruz, CA: Center for Justice Tolerance and Community.

1999 *Betting on California's Regions: Understanding the Context for Labor Market Interventions by Community-Based Organizations*. Manuel Pastor, **Chris Benner,** Stephen Levy, Enrico Marcelli, Rachel Rosner, David Runsten and Ed Kissam. Report prepared for California Works For Better Health, A Strategic Alliance of the California Endowment and the Rockefeller Foundation. Santa Cruz, CA: Center for Justice Tolerance and Community.

1999 *Silicon Valley Labor Markets" Overview of Structure, Dynamics and Outcomes for Workers.* Report prepared for Task Force on Reconstructing America's Labor Market Institutions, MIT.

1999 *Walking the Lifelong Tightrope: Negotiating Work in The New Economy*. **Chris Benner**, Bob Brownstein and Amy Dean. Report prepared for Working Partnerships USA. San Jose, CA: Working Partnerships USA.

1999 *Silicon Valley Labor Markets: Overview of Structure, Dynamics and Outcomes for Workers.* Report prepared for Task Force on Reconstructing America's Labor Market Institutions, Working Paper #WP 07. Cambridge, MA: Sloan School of Management, MIT.

1998 *Living Wage, An Opportunity for San Jose: A Report on the Benefits and Impact of a Living Wage Ordinance on the City of San Jose*. **Chris Benner** and R. Rosner. San Jose, CA: Working Partnerships USA.

1998 *Growing Together or Drifting Apart? Working Families and Business in the New Economy.* Report prepared for Working Partnerships USA. San Jose, CA: Working Partnerships USA.

1997 *Bay Area Labor-Economic Digital Library: An Electronic Guide to the San Francisco Bay Area*. Report prepared for Institute of Industrial Relations. Berkeley, CA: Institute of Industrial Relations, University of California.

1996 *Shock Absorbers in the Flexible Economy: The Rise of Contingent Employment in Silicon Valley.* Report prepared for Working Partnerships USA. San Jose, CA: Working Partnerships USA.

V. <u>*Book Reviews*</u>

2009 *Workforce Development Networks in Rural Areas: Building the High Road* By Gary Paul Green." *Growth and Change* 40:193-196.

2003 *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition,* Stephen Graham and Simon Marvin. *Urban Geography*, 24:1. 90-92

2001 *Global Trends in Flexible Labour.* A. Felstead and N. Jewson (eds.) *Regional Studies,* 35:9, 881.

2001 *CyberUnion: Empowering Labor Through Computer Technology.* A. B. Shostak. *Contemporary Sociology,* 30:5, 480-482.

1999 *Worlds of Possibilities: Flexiblity and Mass Production in Western Industrialization*. Charles Sabel and Jonathan Zeitlin (eds.) *Economic Geography*, 75:3, 305-307.

VI. <u>*Non-refereed Articles*</u>

1998 "Growing Together or Drifting Apart?" *Perspectives on Work, 2:1.* Industrial Relations Research Association Magazine, 35-38.

1996 "Computer Workers Feel the Byte: Temp Workers in Silicon Valley." *Dollars and Sense, No. 207* Sept/Oct, 23-45.

1994 "Trade Unions and Labor Struggles in the 'New' South Africa" *Labor Center Reporter* Vol. 293

INVITED SPEAKER (partial list):

2015 "High-Tech Work and the New Economy: Inequality and Insecurity in Silicon Valley and the Bay Area", invited panel speaker, Tech Workers Coalition Community Meeting, San Francisco, CA. October 19.

2015 "Equity, Growth and Community: Jobs, Knowledge Communities and the Future of the California Workforce", Invited plenary speaker, AEGB Adult Education Regional Planning Summit, Sacramento, CA. September 25.

2015 "Jobs-Housing Fit in the Bay Area" Invited panel speaker, Regional Prosperity Plan Commission Meeting, June 12.

2015 "Regional Equity: Knowledge Networks and Data Tools", Invited presentation to San Francisco Foundation Koshland Program Retreat, Redwood City, CA. May 28.

2015 "Maintaining an Effective Regional Consortium", Invited panel speaker, California Career Pathways Trust, Grantee Network Institute, Berkeley, CA. May 7.

2015 "Jobs-Housing Fit in the Bay Area" Invited panel speaker, Housing California Annual Conference, Sacramento, CA. April 27.

2015 "Knowing Together, Growing Together: Equity, Growth and Community in America's Metropolitan Regions" Invited plenary speaker, Community College Association Spring Advocacy Conference, Costa Mesa, CA. April 25.

2015 "Jobs-Housing Fit in the Bay Area" Invited panel speaker, Bay Area Regional Prosperity Plan Consortium Capstone Conference, Oakland, CA. April 14.

2015 "Equity, Growth and Community: How inclusion and prosperity go together, and implications for the minimum wage". Invited panel speaker, Progressive Women's Minimum Wage Forum, Napa, CA. April 9.

2015 "Equity, Growth and Community: What the Nation Can Learn From America's Metro Regions". Invited panel speaker, 2015 Journalists Forum on Land and the Built Environment, Lincoln Institute for Land Policy, Cambridge, MA. March 27.

2015 "Knowing Together, Growing Together: Equity, Growth and Community in Metropolitan Regions", invited plenary speaker, Modesto Junionr College Civic Engagement Project Lecture Series, Modesto, CA. March 19.

2015 "Knowing Together, Growing Together: Equity, Growth and Community in Metropolitan Regions", invited seminar speaker, Simon Fraser University Urban Studies Graduate Program,

Vancouver, BC, February 2.

2014 "Jobs Housing Fit and Greenhouse Gas Emissions", invited panel speaker, 3rd Annual San Joaquin Valley Affordable Housing Summit, Stockton, CA. November 13.

2014 "Innovative New Tools for Identifying and Building Communities of Opportunity: Lessons for Public Policy", invited webinar speaker, U.S. Department of Housing and Urban Development (HUD), San Francisco, October 30.

2014 "Just Growth and the Minimum Wage: Inclusion, Prosperity, and Impacts of City Minimum Wage Laws", invited speaker, David Citizens for a Living Wage Forum, October 30.

2014 "Regional Opportunity Index and Rural Development", invited participant and speaker, California Coalition for Rural Housing annual conference, Asilomar, CA, October 24

2014 "Innovative New Tools for Identifying and Building Communities of Opportunity: Lessons for Public Policy", Invited speak, UC Sacramento Center and Center for Regional Change, October 23.

2014 "Knowing Together, Growing Together: Knowledge Communities and Equitable Growth in America's Metropolitan Regions", Invited plenary speaker, AB86 Adult Education Regional Planning Summit, Sacramento, CA, October 7.

2014 "Jobs Housing Fit in the Bay Area", invited panel speaker, Annual Conference, Non-Profit Housing Association of Northern California, San Francisco, CA, October 3.

2014 "Shelved: How Wages and Working Conditions for California's Food Retail Workers Have Declined as the Industry has Thrived", invited panel speaker, *Food & Labor: Forging a Truly Sustainable Food Policy Agenda for California in 2015,* panel discussion, Goldman School of Public Policy, University of California Berkeley, October 1

2014 "Knowing Together, Growting Together: Equity, Growth and Community in a Changing Economy", invited speaker, National Institute for Regional and Spatial Analysis, University of Maynooth, Ireland, September 15.

2014 "Epistemologies and Collaborative Methodologies" & "Engaged Careers and the Academy", invited workshop presenter and facilitator, Center for Collaborative Research for an Equitable California, UC Santa Cruz, August 21.

2014 "Organization of Economic Space and Social Justice", invited speaker, Rural Development Leadership Network, Davis, CA, June 4.

2014 "Regional Impacts of the Sacramento Region Sustainable Communities Regional Planning Grant: Regional Opportunity Index", invited speaker, Sacramento Area Council of Government, May 16.

2014 "University + Public + Labor", invited moderater and panel speaker, conference on *The Humanities and Changing Conceptions of Work,* University of California Berkeley, May 9.

2014 "Sarasota-Bradenton Regional Labor Market Updat and Context", invited plenary speaker, CareerEdge Funders Collaborative, *Jobs, Jobs, Jobs* event. April 10.

2014 "Labor and Health: Working Toward a Healthier Food Chain", invited panel speaker, Berkeley Food Institute Lecture Series, UC Berkeley, April 7.

2014 "Impacts of a Minimum Wage Increase on Prices and Employment", invited presentation to Davis Minimum Wage Coalition, March 15.

2013 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", invited plenary speaker, SEIU Local 1000, Real Time Strategic Change Meeting (400 person audience), San Diego, CA, December 13

2013 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", invited speaker, United Food and Connercial Workers Unions, Western States Council, Executive Board meeting, Phoenix, AZ, December 11

2013 "Just Growth or Just Growth?: Inclusion and Prosperity in America's Metropolitan Regions", invited plenary speaker, Fund For Our Economic Future, Northeast Ohio. Three plenary presentations in Cleveland and Akron, December 3.

2013 "Just Growth or Just Growth?: Inclusion and Prosperity in America's Metropolitan Regions", invited plenary speaker, Step Up Silicon Valley and Santa Clara University Economics Department, Santa Clara University, November 19.

2013 "Just Growth or Just Growth?: Inclusion and Prosperity in America's Metropolitan Regions", invited plenary speaker, Nashville Organized for Action and Hope (NOAH) Regional Summit, Nashville, September 28.

2013 "Sustainable Communities and Equity: Opportunities and Challenges in California's Climate Change Legislation", invited speaker, Energy Research Centre Seminar, University of Cape Town, September 9.

2013 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", invited speaker, *Faces of the City* Seminar Series, Centre for Urbanism and Built Environment Studies (CUBES), University of Witwatersrand, Johannesburg, South Africa, September 10.

2013 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", invited speaker, School of Build Environment and Development Studies Seminar, University of KwaZulu-Natal, Durban, South Africa, September 4.

2013 "Not Your Father's Jobs Market: Building Security in an 'iJob world'", invited plenary speaker, Town Hall Seattle on theme "Reclaiming Prosperity: Building Stability & Security for Part-time, Temporary and Contract Workers", Seattle, July 1.

2013 "Buddy Can You Spare Some Time? Social Inclusion and Sustained Prosperity in America's Metropolitan Regions", invited panel speaker, Building Resilient Regions Network Convening, Urban Institute, Washington DC, May 31

2013 "A Dime a Day: The Impact of the Miller-Harkin Minimum Wage Proposal on the Price of Food" Invited speaker, Webinar organized by Research Justice Collective of the Allied Media Conference, May 29.

2013 "Knowing Together, Growing Together: Inclusion, prosperity, and processes of regional governance", Invited speaker, Charting A New Path For US Transportation Policy, 3-Day Workshop Organized by Transportation for America, Bellagio, Italy.

2013 "Just Growth: Inclusion, prosperity, and lessons for the future of regional governance in California" Invited keynote speaker, People's Equity Summit For a Fair and Just Community, sponsored by North Bay Organizing Committee, Santa Rosa, CA, April 27.

2013 "Just Growth: Inclusion and Prosperity in the New Economy" Invited keynote speaker, "No Family Held Back" Silicon Valley Town Hall meeting sponsored by SEIU-USWW, San Jose, CA, April 17

2013 "Knowing Together, Growing Together: Our economic challenges and the power of just growth". Invited Keynote Speaker, Grand Rapids Chamber of Commerce 2013 Diversity Visionary Award Celebration. Grand Rapids, MI. March 20.

2013 "Knowing Together, Growing Together: Our Economic Challenge and the Future of the Regional Workplace". Invited speaker, Yolo County Workforce Investment Board. Woodland, CA. March 13.

2013 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions" Invited speaker together with Manuel Pastor. California State University at Long Beach. Long Beach, CA. February 27

2013 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions" Invited speaker, Silicon Valley Chapter of National Association of Business Economists. Menlo Park, CA. February 12.

2013 "Just Growth and Sacramento: Links between inclusion and prosperity". Invited lunch-time speaker. *Sacramento Urban Land Institute.* Sacramento, CA. January 17.

2012 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions". Invited lunch-time speaker, *Governor's Office of Planning and Research.* Sacramento, CA. December 4.

2012 "The Regional Workplace: California's Economic Challenges and The Future of Labor Market Institutions" Invited speaker. *Sacramento Central Labor Council Delegate's and WIB Representatives Meeting.* Sacramento, November 20.

2012 "The Regional Workplace: California's Economic Challenges and The Future of Labor Market Institutions" Invited keynote speaker. *California Workforce Investment Board.* October 30.

2012 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions". Invited keynote speaker. *Housing Leadership Council of San Mateo County, Annual Housing Leadership Day.* October 26.

2012 "Community Transformation—Gaining Ground, Dudley Street Neighborhood Initiative", Invited panel moderator. *Building Health Communities 3rd Annual Convening: Gaining Traction for Transformative Change.* The California Endowment, Los Angeles, CA. October 16.

2012 "The Power of Just Growth" Invited speaker. *TEDxSacramento, City 2.0 "the City: A Morning of Urban Inspiration" event.* Sacramento, CA. October 12.

2012 "Raising Davis: A Celebration of Cooperatives and Community" Invited panel moderator. Panel discussion sponsored by *Davis Food Coop, Davis Media Access,* and the *California Center for Cooperative Development,* Davis, CA. October 10.

2012 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", workshop presentation. *Service Employees International Union-United Service Workers West Industry and Economic Analysis Workshop*, Los Angeles, CA. September 20.

2012 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", Plenary presentation, *Housing Development Consortium Sustainable Communities Forum*, Seattle, WA. September 10

2012 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", Presentation, *Greater Seattle Chamber of Commerce*. Seattle, WA. September 9.

2012 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions", Panel presentation at *Association of Chamber of Commerce Executives Annual Convention,* Louisville, KY. August 3.

2012 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions" Plenary Presentation. *California's Tomorrow: Equity is the Superior Growth Model*. Housing CA, Coalition on Regional Equity, and PolicyLink sponsored Equity Summit. Sacramento, CA, April 10.

2012 "Equity and Affordability in Sacramento's Sustainable Communities Planning", *Ditching Dirty Diesel Transportation and Equity Planning Training Session, San Francisco Bay Area Sustainable Communities Strategies.* March 26, Oakland, CA

2012 "Equity and Affordability in Sacramento's Sustainable Communities Planning". Panel presentation at *Equitable Development Workshop: Advancing Equity Through Planning, Challenges and Opportunities.* New Partners for Smart Growth Annual Conference, February 1st, San Diego, CA.

2012 "Sustainable Communities Strategies in San Diego and Sacramento" Panel participant, Funders Network for Smart Growth and Livable Communities Funder Convening, January 31st, San Diego, CA

2011 "Just Growth: Inclusion and Prosperity in America's Metropolitan Regions". 2 talks: Korea Research Institute for Local Authorities, and Seoul Development Institute. Seoul, South Korea. June 28.

2011 "Regional Power Building for Inclusion and Prosperity" Plenary Panel Moderator. California Labor Federation, Workforce and Economic Development Program Annual Conference , San Jose, CA. May 25

2010 "Social Movements for Regional Equity: Implications for the Sacramento Region", Coalition for Regional Equity Annual Summit, Sacramento, November 5

2010 "City and Labor Planning? Regions, Communities and Next Generation Labor Organizations", Presentation to UC Berkeley Department of City and Regional Planning Colloquium, Berkeley, October 28.

2010 "Social Equity and the Economy: The Power of Just Growth", Presentation to the California State Legislature sponsored by the Greater Sacramento Urban League, August 11th

2010 "Planning for Equity, Fighting for Justice: Planners, Organizers, and the Struggle for Metropolitan Inclusion", Presentation of draft book chapter to workshop on Regional Planning for a Sustainable Century, Lincoln Institute for Land Policy, Cambridge, MA. June 17-18.

2010 "Regions, Competitiveness and Social Cohesion: The Power of Just Growth", Sacramento Asian Pacific Chamber of Commerce Board of Directors Meeting, Sacramento, January 22.

2009 "Regions, Competitiveness and Social Cohesion: The Power of Just Growth" American Leadership Forum-Mountain-Valley (Sacramento) Chapter Senior Fellows Retreat, St. Helena CA, November 15

2009 "Regional Competitiveness and Social Cohesion" Association of Chamber of Commerce Executives Fellowship for Regional Sustainable Development Program, Denver, CO, October 22

2009 "This Could Be the Start of Something Big: How Social Movements for Regional Equity are Reshaping Metropolitan America" Webinar Presentation, PolicyLink , August 28th

2009 "This Could Be the Start of Something Big: How Social Movements for Regional Equity are Reshaping Metropolitan America" Invited presentation, School of Social Work and Community Development, University of KwaZulu-Natal, Durban, July 6

2009 "Rising Out of the Ashes of the Newspaper Industry: Transforming Unionism in the Information Economy", Invited panel presentation to Building Workforce Partnerships conference, San Jose, May 28th

2009 "Next Generation Unionism and the Future of the Newspaper Industry". Invited keynote speaker, Future of the Media Industry Summit, Media & Communications Workers of America, January 10th.

2009 "This Could Be the Start of Something Big: How Social Movements for Regional Equity are Reshaping Metropolitan America" Presentation to Doing Debating Development speakers series, University of California, Davis, January 8th

2008 "Inclusion in the Workforce: Positioning the Pittsburgh Region to Compete and Prosper". Invited keynote speaker, 5th Annual Regional Equitable Development Summit, Sustainable Pittsburgh, December 11th.

2008 "Alternature Futures?: Perspectives from Across the Atlantic". Invited speaker, *"Fragmentation? The future of work in Europe in a global economy"* WORKS final international conference, Rome, Italy, 8-9 October

2008 "Next Generation Unionism: Politics, Powers and the Informational Labor Process." Invited speaker, Center for Labor Research and Education, University of California, Berkeley. April 21.

2008 "*Fractures and Faultlines: Growth and Equity in California's Mega-regions"* Invited speaker, America 2050 and the Regional Plan Association Research Seminar on Megaregions, Healdsburg, CA, March 19-21.

2007 "Next Generation Unionism: Politics, Powers and the Informational Labor Process." Invited speaker. Topologies of Technology Program, Technische Universitat Darmstadt, Germany. February 1.

2007 "eWork, International Outsourcing and Restructuring of the Labor Process: The Case of South African Call Centers" Invited speaker, Department of Economics, Universitat Rovira I Virgili, Reus, Spain. January 30.

2006 "Next Generation Unionism: Politics, Power and the Informational Labor Process". Invited luncheon speaker, *Organizing Our Futures: A Public Forum on Labor, Knowledge and the Economy,* Harry Bridges Center for Labor Studies, University of Washington, Seattle, October 14th.

2006 "Labor Market Intermediaries in the New Economy" Invited Presentation, Conference on *The Transformation of Work in a Global Knowledge Economy: Towards a Conceptual Framework,* Chania-Greece, September 21.

2006 "Reworking Silicon Valley: Politics, Power, and the Informational Labor Process in the U.S. and Ireland", Invited Presentation, National Institute for Regional and Spatial Analysis, National University of Ireland, Maynooth. May 11.

2006 "Regionalism and the New Economy: Understanding Dynamics, Documenting Trends, Identifying Opportunities", Invited Presentation, Workshop on *Building Regional Leadership Networks*, sponsored by Building Partnerships USA, Chicago, April 24-25.

2005 "Reworking Silicon Valley: Politics, Power, and the Informational Labor Process in the U.S. and Ireland", Invited Presentation, University of Massachusetts, Amhert, December 16.

2005 "U.S. Policy Responses to Offshoring", Invited Presentation, Workshop on *Canadian Responses to Global Sourcing,* sponsored by Canadian EMERGENCE Project, Ottawa, April 15.

2005 "American and Global Trends" Invited Panel Discussant, Conference on *Trends in Global Sourcing,* sponsored by Canadian Advanced Technology Alliance (CATA), Toronto, April 13.

2004 "Improving Intermediaries: Labor Market Infrstructures and Careers in the New Economy" Invited Presentation to *SENAI-Serviço Nacional de Aprendizagem Industrial*, São Paulo, Brazil, November 12.

2004 "Staircases or Treadmills: Organizing Work, Employment and Careers in the New Economy" Invited Plenary Presentation to *Seminário Internacional O Trabalho no Século XXI*, University of São Paulo, Brazil, November 10.

2004 "Staircases or Treadmills: Labor Market Infrastructure and Careers in the New Economy" Invited Presentation to the *National Center for Partnership and Performance*, Dublin, Ireland, September 6.

2003 "Computers in the Wild: The Future of Guilds in the Information Economy", Insited Presentation sponsored by the *Software Developmpent Forum and the Software Product Marketing Guild*, San Jose, CA, August 12.

2003 "Regions that Work: Community-Based Regionalism" Invited Plenary Speaker, *Seventh Annual Elected Officials Retreat*, University of Pittsburgh Office of the Chancellor and Institute of Politics, Hidden Valley, PA, July 17.

2003 "Labour Flexibility and Regional Development: The Role of Labour Market Intermediaries." Intied Panel Speaker, Conference on *Rethinking the Regions and Regional Competitiveness*, co-sponsored by the Cambridge-MIT Institute and Regional Studies, the journal of the Regional Studies Association, Cambridge, England, June 16-17.

2002 'Improvisational Reform':Building Collective Voice and Security in the New Economy", Invited Panel Speaker, Conference on *Rethinking Labor Market Informalization: Precarious Jobs, Poverty and Social Protection*. Gender and Global Change Program and Poverty, Inequality and Development Program, Cornell University, Ithaca, NY. October 18-19.

2002 "Work in the New Economy: Flexiblity and Labor Markets in Silicon Valley", Intied Series speaker, University Center for Social and Urban Research, University of Pittsburgh, Pittsburgh, PA, April 12

2002 "Transformation of Work & Employment in the New Economy", Invited Plenary Speaker, Center for Occupational and Environmental Health *Third Annual Spring Symposium*, University of California, Berkeley, CA, April 5

2002 "Labor and Local Economic Development: Lessons from Silicon Valley", Invited Seminar speaker, Labor Studies Program, University of Massachusetts, Amherst, MA, March 29

2002 "Work in the New Economy: Flexible Labor Markets in Silicon Valley", Center for Public Policy and Administration, *Public Policy and Inequality Speakers Series*, University of Massachusetts, Amherst, MA, March 28

2001 "Sustainability of Economic Clusters", Invited Panel speaker, conference on *Clusters and Opportunities for less Favoured Regions, Low/middle income Populations, and Small Enterprises*, Sponsored by the Ford Foundation and Regional Technology Strategies, Asheville, NC, December 2-4

2001 "California in the New Millennium: Changing Nature of Work and the Labor Force", Invited Plenary Speaker, *California Forum for Workplace Health and Safety*, Sponsored by the California Department of Industrial Relations Commission on Health and Safety and Workers' Compensation, San Francisco, CA, February 8

2000 "Transformation of Work and Employment in the Information Age", Invited Panel Speaker, *The Internet and Oregon's Future,* Public Forum Co-sponsored by Oregon Governor's Office and Willamette University's Public Policy Research Center, Salem, OR, October 18.

CONFERENCE PRESENTATIONS (partial list):

2015 "Three Models of Africa Study Abroad" Panel speaker, Association of American Geographers Annual Meeting, Chicago, IL. April 21

2015 "Securing Employment: The Informational Labor Process and the Regional Workplace" Panel speaker, Association of American Geographers Annual Meeting, Chicago, IL. April 21

2014 "Whither Resilient Regions: Equity, Growth and Community in a Changing Economy", Panel Speaker, Association of American Geographers Annual Meeting, Tampa, FL, April 9.

2014 "UC Davis Center for Regional Change/Rabobank Regional Opportunity Index", Panel Speaker, National Community Reinvestment Coalition Annual Meeting, Washington DC, March 14.

2013 "Jobs-Housing Fit: A Tool for Helping Identify Where Affordable Housing is Needed" Panel Speaker, San Joaquin Valley Housing Summit, September 25.

2013 "iJobs in the New Economy: Silicon Valley, Inequality, and the Future of 'Just Growth'", panel speaker, Netroots Nation Conference, San Jose, CA, June 21.

2013 "A Dime a Day: The Impact of the Miller-Harkin Minimum Wage Proposal on the Price of Food" Panel Chair and Panel Presentation, Labor and Employment Relations Association Annual Conference, June 8.

2013 "Sustainable Communities and Equity: Opportunities and Challenges in California's Climate Change Legislation". Panel Presentation, Association of American Geographers Annual Meeting, Los Angeles, CA. April 22

2012 "Beyond Jobs: Community-Based Careers and the Regional Workplace". Panel Presentation. Association of American Geographers Annual Meeting, New York, NY. February 25th.

2012 "Technologies of Solidarity: Collective Action, Web 2.0 and the Careers of Itinerant Professionals" Labor and Employment Relations Association Annual Conference, January 7.

2011 "Creating Just Growth: Regions, Epistemologies, and New Economic Paradigms". Panel Presentation. 3rd Global Conference on Econoimc Geography 2011. Seoul, South Korea, June 28-July 2.

2011 "Social Equity and SB 375 Implementation: Reflections on Sustainable Community Planning in Sacramento". Panel Presentation. California Geographical Society Annual Conference, Bishop, CA., April 29-May 1.

2011 "Sustainable Communities: Connecting Climate Change, Regional Planning and Jobs". Moderator and panel presentation, California Labor Federation, Workforce and Economic Development Program Annual Conference , San Jose, CA. May 25.

2011 "Just Growth: Inclusion and Prosperity for America's Metropolitan Regions". Conference panel presentation. Association of American Geographers Annual Meeting, Seattle, WA, April 12-16.

2010 "Union Sea Change: Navigating the New Economy", Presentaton and workshop, Building the Jobs Recovery Building Workforce Partnerships Conference, Workforce and Economic Development Program of the California Labor Federation, San Diego, June 2-3

2010 "Race, Space and Youth Employment: Explaining Youth Disparities in America's 'Most Integrated City'". Conference panel presentation, Association of American Geographers Annual meeting, Washington, DC., April 12-17th

2009 "This Could Be the Start of Something Big: How Social Movements for Regional Equity are Reshaping Metropolitan America". Roundtable presentation and discussion, Association of Collegiate Schools of Planning, Washington, DC, October 2.

2009 "Fractures and Faultlines: Growth and Equity in California's Mega-regions*"* Conference panel presentation, Association of American Geographers Annual Meeting, Las Vegas, NV, March 26

2008 "Off the west coast of Australia: Multiplex Geography and The Growth of Outsourcing in Mauritius" Panel presentation, American Association of Geographers, annual conference, April 15-19

2007 "International Outsourcing and New Forms of eWork: An Economic Boom for Africa?". Panel Presentation, Second International Conference on Economic Geography, Beijing, China, June 28

2007 "Dead End Jobs or Career Opportunities?: Factors Shaping Advancement Opportunities in Call Centers" panel presentation, American Association of Geographers annual conference, San Francisco, April 21.

2006 "What Matters in the Quality of Call Center Jobs? The Case of South Africa", panel presentation at American Association of Geographers annual conference, Chicago, March 8.

2006 "Regional Equity: Reflections on a Framework for Addressing Urban Poverty", panel presentation at American Association of Geographers annual conference, Chicago, March 11.

2004 "Outsourcing Trends and the Quality of eWork: The Case of Pittsburgh's Call Center Industry", panel presentation at Association of Collegiate Schools of Planning annual conference, Portland, Oregon, October 23.

2004 "Improving Intermediary Activity: Policy Recommendations from a Study of LMIs in Milwaukee and Silicon Valley", presentation at the Work, Employment & Society Conference, Manchester, England, September 1-3.

2004 "Improving Intermediary Activity: Policy Recommendations from a Study of LMIs in Milwaukee and Silicon Valley", presentation at the American Association of Geographers Annual Conference, Philadelphia, PA, March 15-19.

2004 "Public Scholarship/Service Learning in Geography: Project, Challenges and Rewards", panel presentation, American Association of Geographers Annual Conference, Philadelphia, PA, March 15-19

2003 "Calling the Cape: Information Technology, Restructuring of Work and the South African Call Center Industry", presentation at the American Association of Geographers Annual Conference, New Orleans, LA. March 4-8.

2002 "An Option for the Poor: A Research Audit for Community-Based Regionalism in California's Central Coast", presentation at the Association of Collegiate Schools of Planning Annual Conference, Baltimore, MD, November 21-24.

2002 "Labor Market Intermediaries in the Old and New Economies: A Survey of Workers Experiences in Milwaukee and Silicon Valley", presentation at the American Association of Geographers Annual Conference, Los Angeles, CA, March 19-23

2002 "Labor Market Intermediaries in the Old and New Economies: A Survey of Workers Experiences in Milwaukee and Silicon Valley", presentation at the Industrial Relations Research Association Annual Conference, Atlanta, GA, January 3-6.

2001 "Staircases and Treadmills: The Role of Labor Market Intermediaries in Placing Workers and Fostering Upward Mobility", presentation at the Association of Collegiate School of Planning annual conference, Cleveland, OH. Nov. 8-11.

2001 "Community-Based Regionalism: Linking Organizing and Research", colloquy presentation, Urban Affairs Association 31st Annual Meeting, Detroit, Michigan, April 25-28.

2001 "Information Technology, Employment, and Equity in South Africa: The Role of National ICT Policy", presentation at the 27th Annual Spring Symposium *Technology and Development in Africa, College of Engineering and the Center for African Studies, University of Illinois at Urbana-Champaign,* April 25-28.

2001 "Labor and Local Economic Development in the New Economy: Lessons from Silicon Valley", presentation at Association of American Goegraphers Annual Meeting, February.

2001 "Staircases and Treadmills: The Role of Labor Market Intermediaries In Placing Workers and Fostering Upward Mobility", presentation at the Industrial Relations Research Association Annual meeting, New Orleans, LA, January 4-8.

2000 "Learning Regions and Learning Communities: Building Cross-Firm Learning Networks in Silicon Valley", presentation at Association of Collegiate Schools of Planning Annual Conference, Atlanta, GA. November 2-5.

2000 "Building Community-Based Careers: Labor Market Intermediaries and Flexible Employment in Silicon Valley", presentation at three conferences: Urban Futures, Johannesburg, June 10-14; Association of American Geographers, Pittsburgh, April 4-8, and Association of Collegiate Schools of Planning, Chicago, October 21-24, 1999.

1999 "Intermediaries in Silicon Valley", presentation at conference on *Global Networks, Innovation and Regional Development,* University of California, Santa Cruz, November 12-13.

1999 "Labor and Regional Economic Development: Lessons From Silicon Valley", workshop presentation, Planners Network Conference, Lowell, MA, June.

1998 "Unions in the Information Economy: Lessons from Labor Organizing in Silicon Valley", paper presented at *Telecommunications and the City Conference*, University of Georgia, Athens, March 21-23.

1997 "Shock Absorbers in the Flexible Economy", paper presented at *Association of American Geographers* Conference, Ft.Worth, TX, April 2-5.

FUNDED RESEARCH AND EDUCATION PROJECTS:

2016-17 "Youth Empowerment Institute: Community-Driven Mobile Apps for Health" PI (Everett Program, UCSC). The California Wellness Foundation ($100,000)

2015-16 "Measuring Inclusive Economies: A State-of-the-Field Analysis of Product and Process" PI. The Rockefeller Foundation ($75,000)

2015-16 "Metropolitan Opportunity Index Northeast: Developing a Metropolitan Opportunity Index Mapping and Analysis Tool for the Northeastern States", Co-PI with Jonathan London. Santander Bank ($100,000).

2015-16 "Regional Opportunity Index 2.0: Expanding a powerful new tool to build healthy, prosperous, sustainable and equitablel communities". Co-PI with Jonathan London (Center for Regional Change). Wells Fargo Bank ($100,000)

2014-15 "Understanding and Addressing Racial Occupational Segregation in the Restaurant and Food Retail Industries" Co-PI with Saru Jayaraman (Restaurant Opportunities Center), Center for Collaborative Research for an Equitable California, CCREC ($20,000)

2013-14 "Building Capacity for Social Equity in Sustainable Communities Strategies in the San Joaquin Valley" Co-PI with Jonathan London, Resources Legacy Fund ($80,000)

2013-15 "UC Davis-Rabobank Rural Opportunity Index" Co-PI with Jonathan London. Rabobank. ($375,000 + $100,000 renewal)

2012-14 "From Development to Implementation of Social Equity Metrics and Scenarios for Sustainable Communities Strategies in the San Joaquin Valley". Co-PI with Jonathan London and Deb Niemeier. UC Transportation Center ($62,000)

2012-14 "Just Growth? Social Equity and Metropolitan Economic Performance" Co-PI with Manuel Pastor, Institute for New Economic Thinking ($100,000).

2011-12 "Sacramento Regional Consortium Sustainable Communities Planning Grant" Co-PI with Jonathan London for the Center for Regional Change, Consortium Partner with lead applicant Sacramento Area Council of Governments. U.S. Housing and Urban Development ($85,000 out of total grant of $1.5 million)

2010 "Develop a Model for a National Center for the Clean Economy Workforce" co-PI with Carol Zabin and Chris Tilly. California Energy Commission. ($170,000)

2009-11 "Sacramento Coalition on Regional Equity Collaborative Assessment of Regional Dynamics (SCORECARD)". Co-principal investigator with Jonathan London. The California Endowment. ($260,000)

2009-11 "Healthy Youth, Heathy Regions", co-principal investigator with Jonathan London, Michael Rios, Nancy Erbstein and Patsy Eubanks-Owens. Sierra Health Foundation and The California Endowment. ($700,000 SHF, $306,000 TCE))

2008-09 "Labor Outreach, Research and Education" co-principical investigator with Jonathan London and Natalia Deeb-Sossa. Institute for Labor and Employment Miguel Contreras Labor Studies Fund, University of California. ($110,000)

2007-09 "Just Growth: Linking Regional Equity and Regional Economic Development" co-Principal Investigator with Manuel Pastor. Ford Foundation ($340,000).

2006-07 "International Outsourcing and New Forms of eWork: An Economic Boom For Africa?" Principal Investigator. Africana Research Center, Pennsylvania State University. ($10,000)

2005-07 "A Center at the Center: New Partnerships for Metropolitan Equity and Social Change". Research, with co-PIs Manuel Pastor and Rachel Rosner (UC Santa Cruz) Ford Foundation ($220,000)

2005-07 "Regional Equity Theory, Regional Equity Practice: A Learning Program for Practitioners" Researcher with Manuel Pastor and Rachel Rosner (UC Santa Cruz). Ford Foundation ($400,000)

2005-07 "Conversations on Regional Equity" Researcher, along with Manuel Pastor and Rachel Rosner (UC Santa Cruz). Ford Foundation

2005-06 "Broadband and Rural Development in Pennsylvania: An Evaluation of Opportunity and Use" Co-PI with Amy Glasmeier. Grant from the Center for Rural Pennsylvania

2004-06 "Edging Towards Equity: Transforming the New Regionalism" Researcher, with Co-PIs Manuel Pastor and Rachel Rosner (UC Santa Cruz). Ford Foundation ($200,000)

2004-05 "Occupational Mapping in Pennsylvania's Business and Financial Services Industry". Principal Investigator. Grant to PSU Outreach, from Keystone Research Center. ($7,000).

2004-05 "Environmental Justice in South Africa—A Center for Advancement of Studies and Experience (CAUSE) Course Proposal". Principal Educator. Pennsylvania State University International Programs Office. ($3,000).

2003-04 "Workforce Choices: Occupational Dynamics and Employment Opportunities in Pennsylvania's Business & Financial Services Industry" Principal Investigator. Pennsylvania Department of Labor & Industry ($7,000)

2003-04 "Toward Next Generation Workforce Systems in Appalachia: An Assessment of Workforce Displacement and Adjustment Policies". Consultant researcher to the Keystone Research Center, Steve Herzenberg Principal Investigator. Appalachian Regional Commission ($200,000)

2003-04 "Public Scholarship on Urban Inequality in the New Economy". Principal Educator. Office of Undergraduate Education Public Scholarship Program, Pennsylvania State University ($1,500).

2002-03 "Applied Learning in International and Comparative Context: Building a U.S.-South Africa Collaboration in Urban Geography". Principal Educator. Wilson Education Grant, College of Earth and Mineral Sciences, Pennsylvania State University. ($3,700)

2002-03 "Connecting for the Common Good: A Research and Education Program Seeking to Build the Capacity of Comprehensive Community Initiatives to Understand and Make Effective Use of Regional Dynamics for Local Success." Co-Principal Investigator with Manuel Pastor. Hewlett Foundation. ($212,000)

2002-03 "Creating Good Jobs and Critically Needed Skills Through Innovative Training Consortia." Pennsylvania Governor's Office. Co-Principal Investigator with Stephen Herzenberg. ($60,000).

2002-03 "Competing in a Global Information Economy: The Call Center Industry in South Africa." College of Earth and Mineral Sciences, The Pennsylvania State University Wilson Research Initiation Grant. Principal Investigator. ($4,950)

2001-03 "Employment Volatility in California Labor Markets." Co-Principal Investigator with Manuel Pastor. Institute for Labor and Employment, University of California. ($35,000)

1999-2003 "Economic Opportunity in a Volatile Economy: Understanding the Role of Labor Market Intermediaries in Two Regions." Grant Writer and Researcher, along with PIs Manuel Pastor, Laura Leete, and Laura Dresser. Russell Sage and Rockefeller Foundation (Future of Work Program) ($300,000, with supplemental funding of $300,000 from the Ford Foundation.

1999-2000 "Working Families and Social Well-Being in the Heart of the New Economy: Getting a Grip on the Bay Area Labor Market." Institute for Labor and Employment, University of California. Co-PI with Richard Walker ($10,000)

COURSES TAUGHT:

Community Economic Development
Economic Geography: Organization of Economic Space
Community Development: Theory for Practice
Race, Class, and Community Development in the New South Africa
Socio-Spatial Analysis in Geography (Research Methodology and Qualitative Methods)
Advanced Research Design
Grant Writing & Field Methods for Social Entrepreneurs
Revitalizing Labor Organizing: Labor Segmentation, Immigration and the U.S. Labor Movement
Urban Geography: A Global Perspective
Digital Cities: Urban Processes and Urban Futures in the Digital Age
Race, Class and the Digital Economy: Inequality, Poverty and Urban Development
Labor in the Global Economy: U.S. and South African Perspectives
Information Technology and Work: Opportunity and Marginalization in the New Economy

PROFESSIONAL ASSOCIATIONS:

Member, *Association of American Geographers*
Member, *Labor and Employment Relations Association*
Member, *Planners' Network*

UNIVERSITY, PUBLIC AND COMMUNITY SERVICE:

Member, Advisory Board, *Center for Amazon Community Ecology* (2015-
Member, Steering Committee, *Coalition on Regional Equity* (2009-11)

Member, Editorial Board, *Perspectives on Global Development and Technology* (2001-)
Member, Steering Committee, Urban Habitat Program (San Francisco) (1999-2001)
Member, Advisory Board, Center on Policy Initiatives (San Diego) Report: *Prosperity and Poverty in the New Economy* (1998)
Member, Advisory Board, Joint Venture Silicon Valley Report: *1999 Index of Silicon Valley* (1998)
Member, Technical Advisory Team, California Economic Strategy Panel (1997-)
Participant, National Task Force on Rebuilding America's Labor Market Institutions (1997-1999)
Co-Editor, *Berkeley Planning Journal* (1997-98)
Member, Editorial Board, *Labor Center Reporter* (1994-95)

REFERENCES:

Available on request.

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ACADEMIC EMPLOYMENT

School of City and Regional Planning
Georgia Institute of Technology
Aug. 2015 – Present: Assistant professor

Center for Sustainable Urban Development
Department of Transportation Engineering and Logistics
Pontificia Universidad Católica de Chile
May 2015 – Aug. 2015: Postdoctoral researcher

Julie Ann Wrigley Global Institute of Sustainability
Walton Sustainability Solutions Initiatives
Arizona State University
Jan. 2014 – Aug. 2015: Postdoctoral research fellow

Department of Civil and Environmental Engineering and Center for Regional Change
University of California, Davis
Oct. 2012 – Jan. 2014: Postdoctoral researcher

EDUCATION

University of California, Davis
PhD, Civil and Environmental Engineering, 2012
Dissertation: Transportation Planning and Regional Equity: History, Policy, and Practice
Committee: Deb Niemeier, Patricia Mokhtarian, Jonathan London
MS, Civil and Environmental Engineering, 2008
Thesis: Near-Roadway Air Quality: Meta-Analysis and Mitigation

University of California, San Diego
Visiting graduate student, Department of History, Sep. 2009 – Mar. 2010

University of Toronto
BASc (Hons), Civil Engineering, 2006
Thesis: Evaluating the Life Cycle Energy and Emissions Implications of Transportation Fuels Derived from the Alberta Oil Sands

PUBLICATIONS

Peer-reviewed

Published or in-press

1. Benner, C. and **A. Karner**. "Low-Wage Jobs-Housing Fit: Identifying Locations of Affordable Housing Shortages." Urban Geography, In press.
2. Rowangould, D., **A. Karner**, and J. London. "Identifying Environmental Justice Communities for Transportation Analysis." Transportation Research Part A: Policy and Practice, 2016. 88: 151-162.
3. **Karner, A.** and A. Golub. "Comparison of Two Common Approaches to Public Transit Service Equity Evaluation." Transportation Research Record, 2015. 2531: 170-179.
4. **Karner, A.**, Hondula, D., and J. Vanos. "Heat Exposure and Vulnerability During Non-Motorized Travel: Implications for Transportation Policy Under Climate Change." Journal of Transport & Health, 2015. 2(4): 451-459.
5. **Karner, A.** and J. London. "Rural Communities and Transportation Equity in California's San Joaquin Valley." Transportation Research Record, 2014. 2452: 90-97.
6. **Karner, A**. and D. Niemeier. "Civil Rights Guidance and Equity Analysis Methods for Regional Transportation Plans: A Critical Review of Literature and Practice." Journal of Transport Geography, 2013. 33: 126-134.
7. London, J., **A. Karner**, J. Sze, D. Rowan, G. Gambirazzio and D. Niemeier. "Racing Climate Change: Collaboration and Conflict in California's Global Climate Change Policy Arena." Global Environmental Change, 2013. 23(4): 791-799.
8. **Karner, A.** "Multimodal Dreamin': California Transportation Planning, 1967-1977." Journal of Transport History, 2013. 34(1): 39-57.
9. **Karner, A.,** A. Urrutia, and D. Niemeier. "US Public Transit Fantasies: Performance and Economic Stimulus." International Journal of Transport Economics, 2012. 34(1): 39-55.
10. **Karner, A**., D. Eisinger, and D. Niemeier. "Near-Roadway Air Quality: Synthesizing the Findings from Real-World Data." Environmental Science & Technology, 2010. 44(14): 5334-5344.
11. Rowan, D., **A. Karner**, and D. Niemeier. "MPG Illusions and CAFE Distortions: When Even the Transport Experts Have Trouble." Transportation Research Record, 2010. 2191: 8-15.
12. Gould, G. and **A. Karner.** "Modeling Bicycle Facility Operation: A Cellular Automaton Approach." Transportation Research Record, 2009. 2140: 157-164.
13. **Karner, A.**, D. Eisinger, S. Bai, and D. Niemeier. "Mitigating Diesel Truck Impacts in Environmental Justice Communities: Transportation Planning and Air Quality in Barrio Logan, San Diego, California." Transportation Research Record, 2009. 2125: 1-8.
14. Sze, J., G. Gambirazzio, **A. Karner**, D. Rowan, J. London, and D. Niemeier. "Best in Show? Climate and Environmental Justice Policy in California." Environmental Justice, 2009. 2(4): 179-184.
15. Niemeier, D., G. Gould, **A. Karner**, M. Hixson, B. Bachmann, C. Okma, Z. Lang, and D. Heres Del Valle. "Rethinking Downstream Regulation: California's Opportunity to Engage Households in Reducing Greenhouse Gases." Energy Policy, 2008. 36(9): 3436-3447.

Under review or revisions requested

16. **Karner, A.** "Planning for Transportation Equity in Small Regions: Towards Meaningful Performance Assessment." Transport Policy, Revisions requested. (Initial submission 10/2015.)
17. **Karner, A.**, M. Kuby, and A. Golub. "Modeling Route-Level Transit Ridership Demographics for Use in Equity Analysis." Transportation, Under review. (Initial submission 10/2015.)
18. **Karner, A.** "Assessing Public Transit Service Equity using Route-Level Accessibility Measures and Public Data." Transportation Research Part A: Policy and Practice, Under review. (Initial submission 02/2015.)

In preparation

19. Cloutier, S., **Karner, A.**, Patel, S., Paralkar, S. Papenfuss, J. Briggs, A. and C. Carlson. "Measures of a Sustainable Commute as a Predictor of Happiness." Planned submission to Journal of Happiness Studies.
20. **Karner, A.** and Sagaris, L. "Towards an 'Ecology of Diverse Modes': Developing Mode Shift Targets for Sustainable Transportation Planning in Metropolitan Santiago de Chile and the San Francisco Bay Area." Planned submission to Transportation Research Part D: Transport and Environment.
21. Zhong, Q., **A. Karner**, A. Golub, and M. Kuby. "A Multiobjective Optimization Model for Dispersing Affordable Housing Location Considering Public Transit Accessibility." Planned submission to Environment and Planning-A special issue on resiliency.

Book reviews

22. **Karner, A.** "After the Car." Dennis, K. and J. Urry. Journal of the American Planning Association, 2010. 76(3):379-380.
23. **Karner, A.** "Socially Responsible Engineering: Justice in Risk Management." Vallero, D.A. and P.A. Vesilind. Science and Engineering Ethics, 2010. 16(2):415-417.
24. **Karner, A.** "Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change." Moser, S.C. and L. Dilling (eds.). Public Understanding of Science, 2008. 17(4): 503-505.

Book chapters

25. **Karner, A.**, A. Golub, K. Martens, and G. Robinson. "Transportation and Environmental Justice: History and Emerging Practice." In Handbook of Environmental Justice. Holifield, R., J. Chakraborty, and G. Walker (eds.), Routledge, Forthcoming in 2017.
26. **Karner, A.**, J. London, D. Rowangould, and C. Garoupa-White. "Putting Data into Action for Regional Equity in California's San Joaquin Valley." In What Counts: Harnessing Data for America's Communities. Federal Reserve Bank of San Francisco and the Urban Institute, (eds.), 2014. pp. 272-276.

Non-peer reviewed reports and articles

27. **Karner, A.**, A. Golub, and C. Chavis. "Understanding regional disparities in public transit performance using realtime transit data." National Transportation Center at Maryland, Research Report NTC2015-MU-R-1, 2016.
28. **Karner, A.** and C. Benner. "More market-rate units won't protect low-income renters." Invited contribution to Washington Post Wonkblog on the topic "How to make expensive cities affordable for everyone again." Short link: https://goo.gl/8sR1HZ.
29. Marcantonio, R. and **A. Karner.** "Social equity in transportation planning: A community-based framework." Progressive Planning, 2016. 206: 38-41.
30. **Karner, A.** and C. Benner. "Bay Area not meeting its affordable housing needs." Op-ed in Oakland Tribune, June 29, 2015.
31. **Karner, A.** and C. Benner. "Job growth, housing affordability, and commuting in the Bay Area." A report prepared for the Bay Area Regional Prosperity Plan Housing Working Group, 2015.
32. Chuang, W-C., **A. Karner**, N. Selover, D. Hondula, N.Chhetri, A. Middel, M. Roach, and B.Dufour. "Arizona Extreme Weather, Climate and Health Profile Report." A report prepared for Arizona Department of Health Services and the United States Centers for Disease Control and Prevention Climate-Ready States and Cities Initiative, 2015.
33. **Karner, A.** "Valley Needs Better Land, Transportation Planning." Op-ed in Zocalo Public Square, July 2, 2014. (Also ran in the Fresno Bee.)
34. Marcantonio, R. and **A. Karner.** "Disadvantaged Communities Teach Regional Planners a Lesson in Equitable and Sustainable Development." Poverty & Race, 2014. 23(1): 5-12.
35. Gould, G. and **A. Karner.** "Modeling Bicycle Facility Operation: a Cellular Automaton Approach." Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-09-10, 2009.
36. Silvis, J., W. Leighty, and **A. Karner**, "Folk Quantification of Transportation Energy: An Initial Investigation of Perceptions of Automobile Energy Use." Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-07-22, 2007.

MEDIA COVERAGE

- Georgia Public Broadcasting. "Is the Atlanta BeltLine in Danger of Being Too Popular?" June 30, 2016. http://gpbnews.org/post/atlanta-beltline-danger-being-too-popular.
- Yale Climate Connections. "Self-transportation in a Changing Climate." March 21, 2016. http://www.yaleclimateconnections.org/2016/03/self-transportation-in-a-changing-climate/.
- CityLab. "Why Boston's Late Night Service Cuts could be a Civil Rights Violation." March 18, 2016. http://www.citylab.com/cityfixer/2016/03/why-bostons-last-night-service-cuts-could-be-a-civil-rights-violation/474321/.
- NextCity. "Boston Bike Café Has Transportation Equity on the Menu." December 24, 2015. https://nextcity.org/daily/entry/boston-dorchester-bike-shop-cafe-sip-and-spoke-bike-kitchen.
- Streetsblog. "Study: Civil Rights Protections Lack Teeth When it comes to Transportation." February 14, 2014. http://usa.streetsblog.org/2014/02/14/study-civil-rights-protections-lack-teeth-when-it-comes-to-transportation/.

- Marin Independent Journal. "Report: Plan Bay Area would Reduce Bay Area's Greenhouse Gas Emissions, but Alternatives would Cut Even More." May 25, 2013. http://www.marinij.com/article/ZZ/20130525/NEWS/130529004.

SPONSORED RESEARCH

2016: Georgia Department of Transportation. Crowdsourced social media monitoring system development ($95,000, Co PI, with PI Amit Kumar and Co-PI Catherine Ross).
Georgia Tech, College of Design Faculty Development Grant. Affordable housing and sustainable commutes: Bay Area employee survey ($9,417, PI)
California Endowment. BEST: Building equitable student transit ($70,000, PI with Co-PI Nancy Erbstein).

2015: National Center for Sustainable Transportation (National University Transportation Center headed by University of California, Davis). Transportation equity whitepaper ($25,000, Co-PI, with PI Jonathan London and Co-PI Dana Rowangould).

2015: National Center for Strategic Transportation Policies, Investments, and Decisions (National University Transportation Center headed by University of Maryland). Understanding regional disparities in public transit performance using realtime transit data ($50,000, Co-PI with PI Aaron Golub and Co-PI Celeste Chavis).

2015: US Department of Housing and Urban Development and Metropolitan Transportation Commission. Investigating the impacts of high-wage job growth on housing demand and affordability ($40,000, Co-PI with PI Chris Benner).

GRANTS AND AWARDS

2012: University of California Center for Collaborative Research for an Equitable California Travel Award ($500)

2011-2012: University of California, Davis Sustainable Transportation Center Outstanding Student of the Year (awarded through the United States Department of Transportation's University Transportation Centers Program)

2011-2012: University of California, Davis, Sustainable Transportation Center Dissertation Fellowship ($21,500)

2010-2011: Social Sciences and Humanities Research Council of Canada (SSHRC) Doctoral Fellowship ($20,000)

2007-2008: Natural Sciences and Engineering Research Council of Canada (NSERC) Post Graduate Scholarship - Masters ($17,300)

2006: SSHRC Canada Graduate Scholarship - Masters ($17,500, awarded but declined)

2005: University of Toronto Department of Civil Engineering Faculty Undergraduate Summer Research Fellowship ($4,450)

INVITED PRESENTATIONS

Presentation at Kittelson & Associates, Inc. "Defining and measuring public transit service equity." Boston, MA. July 7, 2016.

Presentation at Workshop on Race & Transportation in Atlanta convened by Partnership for Southern Equity. "Opportunity Deferred: Race & Transportation in the Atlanta Region." June 23, 2016.

Presentation at the Atlanta Regional Commission. "Contemporary research on transportation equity." Workshop on Performance Measures and Equity. Atlanta, GA. January 27, 2016.

Presentation at the Atlanta Regional Commission. "Performance assessment and integrated planning." Community Planning Academy. Atlanta, GA. November 16, 2015.

CONFERENCE PRESENTATIONS

Ross, C., **A. Karner**, P. Hylton, E. Sperling, and S. Guhathakurta. "Quality of Life Benefits of Urban Trails: Analysis of the Atlanta BeltLine." Paper presentation at the 12th International Urban Planning and Environment Association Symposium. Lisbon, Portugal. May 31 – June 3, 2016.

Hylton, P., C. Ross, E. Sperling, and **A. Karner**. "Urban Revitalization: Changing Atlanta's Land Use Intensities." Paper presentation at the 12th International Urban Planning and Environment Association Symposium. Lisbon, Portugal. May 31 – June 3, 2016.

Karner, A., C. Ross, P. Hylton, R. Duckworth, and S. Guhathakurta. "Public Transit Equity and the Geography of Opportunity in Atlanta." Paper presentation at the 12th International Urban Planning and Environment Association Symposium. Lisbon, Portugal. May 31 – June 3, 2016.

Karner, A. and R. Duckworth. "Expanding transit, growing opportunity: Creating local transit service in Clayton County, Georgia." Paper presentation at the 2016 Savannah State University Urban Planning Conference. Savannah, GA. April 1-2, 2016.

Karner, A. "Assessing regional disparities in transit service using realtime data." Paper presentation at the 2016 Savannah State University Urban Planning Conference. Savannah, GA. April 1-2, 2016.

Karner, A., D. Hondula, and J. Vanos. "Heat exposure during non-motorized travel: Implications for transportation policy under climate change." Paper presentation at the Annual Meeting of the Association of American Geographers. San Francisco, CA. March 29-April 2, 2016.

Karner, A. and T. Welch. "Rethinking supply and demand in public transit accessibility studies." Paper presentation at the 46th Urban Affairs Association Conference. San Diego, CA. March 16-19, 2016.

Golub, A., **A. Karner**, and R. Marcantonio. "Observations from the rise of a regional transportation justice coalition in the San Francisco Bay Area." Paper presentation at the 46th Urban Affairs Association Conference. San Diego, CA. March 16-19, 2016.

Karner, A., M. Kuby, and A. Golub. "Modeling Transit Ridership Demographics for use in Equity Analysis." Paper presentation at the 95th Annual Meeting of the Transportation Research Board. Washington, DC. January 10-14, 2016.

Karner, A. and L. Sagaris, "Testing a new Approach to Planning Sustainable Transport using Data from Metropolitan Santiago de Chile and the San Francisco Bay Area." Paper presentation at the 95th Annual Meeting of the Transportation Research Board. Washington, DC. January 10-14, 2016.

Karner, A. and C. Benner, "The convergence of social equity and environmental sustainability: Jobs-housing fit and commute distance." Paper presentation at the 95th Annual Meeting of the Transportation Research Board. Washington, DC. January 10-14, 2016.

Karner, A. and A. Golub. "Bay Area transportation justice advocacy: Two decades of struggle and innovation." Paper presented at the Association of Collegiate Schools of Planning 55th Annual Conference. Houston, TX. October 22-25, 2015.

Karner, A. "Development of Highly Resolved Spatial and Temporal Metrics of Public Transit Accessibility and their Application to Service Equity Analysis." Paper presented at the 94th Annual Meeting of the Transportation Research Board. Washington, DC. January 11-15, 2015.

Karner, A. and A. Golub. "Comparing Two Common Approaches to Public Transit Service Equity Evaluation." Paper presented at the 94th Annual Meeting of the Transportation Research Board. Washington, DC. January 11-15, 2015.

Karner, A. and D. Niemeier. "Effects of Scale and Scope in Modeling and Decision Making." Presentation in Workshop on Integrated Land-Use, Travel Demand Air Quality, and Exposure Modeling: The Future of Regional Transportation Planning? At the 94th Annual Meeting of the Transportation Research Board. Washington, DC. January 11-15, 2015.

Rowangould, D., **A. Karner**, and J. London. "Identifying Environmental Justice Communities for Transportation Analysis." Paper presented at the 94th Annual Meeting of the Transportation Research Board. Washington, DC. January 11-15, 2015.

Karner, A. "Assessing Equity in Public Transportation Planning and Decision Making." Paper presented at the 52nd Paving and Transportation Conference. Albuquerque, NM. January 5-6, 2015.

Karner, A., D. Hondula, and J. Vanos. "Connecting transportation scenarios and extreme heat exposure in urban areas." Paper presented at the 95th American Meteorological Society Annual Meeting. Phoenix, AZ. January 4-8, 2015.

Karner, A. "Towards Equitable Public Transit Decision Making" Paper presented at the Association of Collegiate Schools of Planning 54th Annual Conference. Philadelphia, PA. October 30-November 2, 2014.

Karner, A. and C. Benner. "A Jobs-Housing Fit Metric and its Relationship to Vehicle-Miles Traveled." Paper presented at the New Partners for Smart Growth Conference. Denver, CO. February 13-15, 2014.

Niemeier, D., G. Rowangould, **A. Karner**, and D. Rowangould. "Limitations to Current Knowledge." Presentation in Workshop on The Next 50 Years in Travel Analysis: What We Don't Know but Need to Know at the 93rd Annual Meeting of the Transportation Research Board. Washington, DC. January 12-16, 2014.

Pasch, A., S. Bai, **A. Karner**, D. Eisinger, H. Hafner, L. Tidd, A. Polidori, and D. Niemeier. "Background and Ambient Near-Road PM Concentrations: Insights and Analysis Strategies." Presentation in Workshop on Particulate Matter Hot Spot Analyses: Research and Applications, Part 2 at the 93rd Annual Meeting of the Transportation Research Board. Washington, DC. January 12-16, 2014.

Karner, A. and J. London. "Rural Communities and Transportation Equity in California's San Joaquin Valley." Paper presented at the 93rd Annual Meeting of the Transportation Research Board. Washington, DC. January 12-16, 2014.

Karner, A., "Integrating Health into Regional Planning: Sketching a Path Forward." Paper presented at the 141st Annual Meeting of the American Public Health Association. Boston, MA. November 2-6, 2013.

Karner, A. and D. Niemeier, "A Review of Civil Rights Guidance and Equity Analysis Methods for Regional Transportation Plans." Paper presented at the 92nd Annual Meeting of the Transportation Research Board. Washington, DC. January 13-17, 2013.

Karner, A. and D. Niemeier. "Innovations in the Equity Analysis of Regional Transportation Plans." Paper presented at the 92nd Annual Meeting of the Transportation Research Board. Washington, DC. January 13-17, 2013.

Karner, A., "Innovations in Regional Transportation Equity Analysis." Presented at the International Conference on Inequality and Sustainability. Medford, MA, November 9-10, 2012.

Karner, A., "Transportation Equity Analysis for Activity-Based Travel Demand Models." Presented at the University of California Transportation Center Student Conference. Davis, CA. April 20, 2012.

Karner, A., "Evaluating Public Participation in California's Global Warming Solutions Act." Presented at the 2nd Annual Dimensions of Political Ecology Conference. Lexington, KY. April 13-15, 2012.

Karner, A. and D. Niemeier, "The Region or the State? California Transportation Planning, 1967-1977." Transportation History, Session 303. Paper presented at the 91st Annual Meeting of the Transportation Research Board. Washington, DC. January 22-26, 2012.

Karner, A., "Advanced Models, Advancing Equity: Harnessing Innovations in Forecasting Travel Demand." Presented during UC Davis College of Engineering visit by Dr. Chuck Vest, President of the National Academy of Engineering. Davis, CA. November 30, 2011.

Karner, A. and D. Niemeier, "Translating Policy to Practice: An Interdisciplinary Investigation of Transportation Planning." Presented at the 13th Transportation Research Board National Planning Applications Conference. Reno, NV. May 8-12, 2011.

Karner, A. and D. Rowan, "Moving Toward Equity: The Ongoing Struggle for Environmental Justice in California." Panel organizer and presenter. Interdisciplinary Graduate and Professional Symposium. Davis, CA. April 21-23, 2011.

Karner, A. and D. Niemeier, "Transportation Spending Under the American Recovery and Reinvestment Act in California." Taxation and Finance, Session 561. Paper presented at the 90th Annual Meeting of the Transportation Research Board. Washington, DC. January 23-27, 2011.

Karner, A., D. Eisinger, and D. Niemeier, "Near-Road Air Quality: Findings from Real World Data." Paper presented at the Coordinating Research Council Mobile Source Air Toxics Workshop. Sacramento, CA. November 30-December 2, 2010.

Karner, A., D. Eisinger, and D. Niemeier, "Near-Road Air Quality: Findings from Real World Data." Paper presented at the Air & Waste Management Association Symposium on Air Quality Measurement Methods and Technology. Los Angeles, CA. November 2-4, 2010.

Rowan, D., **A. Karner**, and D. Niemeier, "MPG Illusions and CAFE Distortions: When Even the Transport Experts Have Trouble." Energy and Greenhouse Gas Emissions from the Transportation Sector, Session 439. Paper presented at the 89th Annual Meeting of the Transportation Research Board. Washington, DC. January 10-14, 2010.

Karner, A., D. Rowan, J. London, J. Sze, and D. Niemeier, "Environmental Justice, Gender, and Conflict in California Climate Policy." Paper presented at the Fourth International Conference on Women's Issues in Transportation. Irvine, CA. October 27-30, 2009.

Karner, A., D. Eisinger, S. Bai, and D. Niemeier, "Mitigating Diesel Truck Impacts in Environmental Justice Communities: Transportation Planning and Air Quality in Barrio Logan, San Diego." Measuring Equity, Session 586. Paper presented at the 88th Annual Meeting of the Transportation Research Board. Washington, DC. January 11-15, 2009.

Gould, G. and **A. Karner,** "Modeling Bicycle Facility Operation: A Cellular Automaton Approach." Factors Affecting Bicycle Use and Mode Choice, Session 708. Paper presented at the

88th Annual Meeting of the Transportation Research Board. Washington, DC. January 11-15, 2009.

TEACHING EXPERIENCE

Assistant professor, School of City and Regional Planning, Georgia Institute of Technology

2016: Quantitative and Computer Methods (masters-level graduate, 54 students)
2015: Urban Transportation (upper division undergraduate, 40 students)

Instructor, School of Geographical Sciences and Urban Planning, Arizona State University

2014: Transportation Systems Professional Seminar (masters-level graduate, 30 students)

Instructor, UC Davis First Year Seminar Program

2013: Introduction to Environmental Justice Analysis for Engineers (freshman seminar, 12 students)

Teaching assistant, Department of Civil and Environmental Engineering, University of California, Davis

2011: Transportation and Land Use: Sustainable Design (upper division undergraduate, 50 students)

RESEARCH EXPERIENCE

Graduate student researcher, University of California, Davis

2011 – 2012: Center for Regional Change, PI: Jonathan London
2008 – 2010: John Muir Institute of the Environment, PI: Deb Niemeier
2009 – 2010: Department of Civil and Environmental Engineering, PI: Deb Niemeier
2006 – 2008: UC Davis-Caltrans Air Quality Project, PI: Deb Niemeier

PROFESSIONAL EXPERIENCE

Sustainable Systems Research, LLC, Davis, CA

2012 – Present: Principal

Sacramento Area Council of Governments, Sacramento, CA

2009: Transportation modeling intern

PROFESSIONAL SERVICE

School of City and Regional Planning, Georgia Institute of Technology

Member, PhD Committee

TRB Committee Member

Environmental Justice in Transportation Committee (ADD50), Transportation Research Board of the National Academies

Ad hoc reviewer

Atmospheric Environment
CLEAN – Soil, Air, Water
Environmental Science and Technology
International Development Planning Review
International Journal of Sustainable Transportation
Journal of Policy History
Journal of Planning Education and Research
Physics Letters A
Public Works Management & Policy
Sustainability
Transportation Research Part A: Policy and Practice
Transportation Research Part D: Transport and Environment
Transportation Research Record
Transport Policy