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16. ABSTRACT
This project investigated how changes in rail transit service in California metropolitan areas (Los Angeles, the San Francisco Bay Area, and San Diego) are associated with the concentration of firms and commercial property values. A mixed-methods approach was used that combined quantitative and qualitative analysis. The quantitative method involved first, describing location patterns by industry according to transit access, and second, quantitatively modeling the relationship of transit access to (a) employment densification by industry and (b) commercial property values. The qualitative method involved in-depth interviews with real estate professionals that were aimed at finding different possible explanations for firm location, expansion, and productivity and the role, if any, of rail passenger transport in those decisions. The quantitative models suggest that rail development does promote employment densification and increased land value, but the magnitude of the effects differs across regions. San Francisco County had the highest employment densification and land value associated with rail proximity, while the Los Angeles region also had a relatively strong relationship between rail access and both employment density and property value. However, rail development in San Diego was somewhat positively associated with employment density and negatively associated with land value appreciation. The analysis of interviews was generally consistent with these findings, and also suggested that existing land use patterns and policies may play a greater role in the varying magnitude of rail influence on employment density and land value than the availability of rail access itself, and that downtown Los Angeles and San Francisco benefit more from rail than the outlying parts of the metropolitan areas.

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Introduction

The 2015-2016 California state budget proposal devotes approximately $601 million, or approximately 5 percent of the $11.35 billion total state transportation funds, to state transit assistance. Although metropolitan agencies can use the $601 million flexibly, its primary use has been for operating expenditures. There is an additional $265 million of state-proposed expenditure in the form of cap and trade revenues allocated to fund transit and intercity rail capital program. These projected expenses are smaller than federal and local expenditures on public transit, both in services and in capital expenditures. Of the $81 billion spent on transportation infrastructure between 2000 and 2010 in California from local, state and federal sources, between $5 and $6 billion was spent on public transportation infrastructure. These public transportation projects range from extensions to the Bay Area Rapid Transit system and the San Diego trolley, to new rail lines in the Los Angeles metropolitan area. But the next ten-year average will certainly be higher based on more recent spending trends.

Intra-city public transportation services are costly, and many new services such as new light rail lines are criticized for having low ridership and potentially small environmental benefits. Some have argued that in addition to ridership and environmental benefits (e.g., in the form of congestion reduction), transit investments should be understood as stimulants to the local economy, or as improvements to overall regional economic competitiveness. A body of research on transit has addressed the relevant questions in a general sense by investigating whether rail investments increase the value of land, primarily in the form of residential home sales (as summarized in Chatman, Tulach and Kim 2012).

Public transport infrastructure investments or service improvements could lead to higher-density employment clusters, and even to larger, denser, more diverse cities. These changes could, in turn, increase firm productivity and enhance consumer welfare, by enabling agglomeration economies: external economies of scale in regional and local density and diversity of firms, workers and residents. Generally speaking, agglomerations are clusters of firms, households, or both, as large as whole cities and as small as neighborhoods (DuRanton and Puga, 2004; Chatman and Noland, 2011). There is some evidence that large external benefits are possible. Application in the United Kingdom of guidance based on recent research resulted in an estimate of agglomeration benefits amounting to a 25 percent increase over the standard benefit estimate (Graham 2007a; Vickerman 2008). A recent American Public Transit Association (APTA) report has seized on this idea, arguing that high-value industries forming clusters may rely on public transit investments to reduce congestion enough to continue to grow and flourish. But the existence of such benefits is not well understood, in part because there has been very little research on the topic, and also because only recently have microdata on firms become available in order to more explicitly explore the connection between public transportation services and the clustering and location patterns of different firms.

Because agglomeration externalities are potentially significant, but could vary a great deal among proposed projects, there may be good reason to include estimates of their magnitude when deciding which public transit projects to fund and where services should be targeted.

Agglomeration externalities are *in addition* to the travel time savings that are sometimes already calculated when evaluating proposals. Transit may foster agglomeration and in turn increase productivity, but little is known about the spatial patterns that give rise to agglomeration economies, or how these might be related to the quality of public transit service specifically.

The research explores such claims more closely, with a focus on California metropolitan areas (including the San Francisco Bay Area, Los Angeles, and San Diego), and with the mixed method approach combining quantitative analysis of microdata on firms and property values and interviews of land developers. The quantitative analysis in the research is a time-series analysis of data with two main dependent variables, measured at the Census block level—change in firm clustering by industry and change in commercial property values—along with two main sets of independent variables: measures of transit accessibility and measures of local agglomeration. The data used in this analysis includes National Establishment Time Series (NETS) data from 1990 to 2011 for all firms in California as well as the Assessor's Property Value data. While these quantitative data do not allow a direct investigation of productivity, they do allow an understanding of its theoretical precursors. Also, the fact that a fairly long panel can be constructed means that statistical methods can be used to control for the endogeneity of service provision (that is, public transportation services may be provided in places that are economically highly performing, rather than causing that high performance). The types of rail in this analysis are not differentiated, since all rail services are considered "high-quality transit" in California (Pub. Resources Code § 21064.3). The qualitative part of this research utilizes qualitative methods in conducting the interviews—in particular, preparing and adhering to an open-ended topic guide that avoids leading questions and allows for any of a number of possible explanations for firm location, expansion, and contraction decisions to be offered by participants. The purpose of this component of the research is to illuminate which of the most important agglomeration mechanisms (such as information sharing, disaggregated production processes, or labor pool transport access) may be at play, if any, in decisions to locate near or far away from transit-served neighborhoods.

Appendices A through D provide an overview map of the three California regions analyzed, which are the San Francisco Bay Area (SF), Los Angeles Metropolitan Region (LA), and San Diego Region (SD) and maps of the respective rail systems analyzed.

Literature Review

Public transportation may influence firm productivity by encouraging firms to cluster and therefore be more innovative and efficient. In this literature review we describe scholarly studies that have investigated the links between transportation, agglomeration (e.g. clustering and firm densification), and economic productivity.

The mechanisms of agglomeration economies

Agglomerations are clusters of firms, households, or both, as large as whole cities and as small as neighborhoods. Agglomerations can increase productivity through three mechanisms: sharing, matching, and learning (DuRanton and Puga, 2004; Chatman and Noland, 2011).

Sharing mechanisms refer to the sharing of resources that may be indivisible and may have high fixed costs and large economies of scale, e.g. railways, airports, road networks, or even a large labor pool (Duranton and Puga, 2004). For example, in New England cities firms clustered near ports in order to access trade routes, and could share the costs of improving the ports as well. Though there is empirical evidence of sharing mechanisms in agglomeration economies, there are no studies that directly connect public transportation to sharing mechanisms. But public transport, by itself, is a shared asset with high fixed costs and economies of scale, particularly in cities with high road congestion where a significant fraction of the transit network is separated from roads. In theory, public transportation might also help facilitate sharing mechanisms by inducing city growth and labor market pooling (Chatman and Noland, 2011).

“Matching” mechanisms are a function of the size and density of an agglomeration. Bigger, denser cities allow workers to match with employers more quickly, consumers to match with sellers more quickly, firms to match with suppliers and services more quickly -- and vice versa. Not only the speed of matching, but also the closeness of matching, can be affected by the size and density of an agglomeration. A large market of consumers, sellers, and workers also allows consumers to find goods more tailored to their individual tastes, workers to find jobs more aligned with their preferences, and sellers to find suppliers with products that meet exact needs (Waldfogel 2003). For example, a sprawled area can make job-to-worker matches harder to make, simply because the farther jobs are from laborers, the more difficult it is for the firm to find out about the worker, and for the worker to find out about the job. A study of the relationship between transportation and employment search cost found that labor participation was negatively related to the average commute time, particularly for women (UK Department of Transport, 2010). We did not find any studies investigating how public transport affects matching mechanisms.

“Learning” mechanisms refer to the knowledge spillover effects of agglomerative economies, which is more difficult to capture in empirical work since learning is often informal. Empirical work on agglomeration and learning mechanisms has often focused on how city size or density relates to information exchange or idea generation (e.g. patents). While some scholars have suggested that transportation plays a role in learning mechanisms, for instance by making firm concentration possible, we have not found any studies explicitly connecting transportation generally, or public transport specifically, to learning mechanisms (Chatman and Noland, 2011).

The role of transportation improvement in facilitating agglomeration economies

What role, then, could transportation improvements play in influencing agglomeration economies? There are several possibilities (Chatman and Noland, 2011). First, public transportation improvements may induce the growth of a larger labor market. Firms may respond by clustering in order to share the labor market resource. In other words, public transportation could cause economies to grow and hence to become more productive on a per capita basis. The same growth and densification could also decrease employment search cost by increasing accessibility of firms to workers, facilitating labor-to-firm job matching. As for learning mechanisms, public transportation may encourage higher density development in local pedestrian-accessible clusters, which could lead to knowledge spillover effects by allowing more interactions between workers in different firms, through professional organizations and informal face-to-face interactions.

Most previous literature investigating agglomeration economies has measured agglomeration as employment density. Higher employment density is seen as a direct proxy for a larger labor pool and more knowledge spillovers. It is rare for empirical studies to investigate several different agglomeration measures simultaneously. In a study using a variety of different density measures, central city employment density, urbanized area employment density, and metropolitan area population, the first was found to be most highly correlated with both transit services and with wages (Chatman and Noland, 2013). Central cities are typically best served with transit, so this part of the finding is unsurprising. The study also found that agglomeration effects are larger in larger metropolitan areas (Chatman and Noland, 2013).

A unifying issue in studies that investigate the relationship between transit service and agglomeration is the uncertainty of whether the relationship between public transit and agglomeration is truly causal and in what direction the causality lies. This issue is often due to data limitations (usually cross-sectional data) and imperfect use of controls. In order to study the causal effect of transit service to agglomeration economies, panel data, or data over a period of time, is best suited. A panel study by Noland, Chatman and Klein (2014) traced the changes of firms from 1991 to 2008 to investigate the birth and death of firms in relation to the new light rail systems in the Portland and Dallas regions. The study found that the clustering effect for firms around light rail stations was much larger in Portland than Dallas. The substantial differences between the two regions suggest that rail access can have different effects on firm agglomeration depending on some other factors, such as parking regulation, planning policy, and existing transportation infrastructure.

The effect of transit on firm births and agglomeration in different industries also varied between the two cities. In Portland, financial industries showed the largest agglomeration effects around the light rail stations, followed by professional, scientific and technical services. Manufacturing appeared to have the smallest agglomeration effect. In Dallas, the entertainment and recreation industry has the largest agglomeration effect around rail station, followed by manufacturing. On the other hand, the professional, scientific and technical services industry in Dallas seems to have developed away from rail stations. Overall, agglomeration effects on each type of industry are generally smaller in Dallas. Additionally, the study found that agglomeration effects around transit are more significant for larger firms (with five or more employees), which the authors interpreted as suggesting that the nature of agglomeration benefits from transit may be primarily due to better labor market accessibility.

The quality of transportation infrastructure may also play an important role in firm productivity. For example, previous research has shown that the expansion of interstate highway has a large effect on economic development compared to lower tier road categories. Many studies have observed a non-linear relationship between the intensity of transportation infrastructure and economic growth, suggesting that there may be threshold effects from the accumulation of transportation investment (Deng 2013).

A recent report by the American Public Transportation Association (APTA, 2013) asserts the value of public transportation in an agglomerative economy. The report includes case studies of high-tech clusters, describing how private firms in some locations have provided shared transportation options (like shuttle buses) when public transportation services to the workplace are limited or not available. When confronted with the following choices: locating in clusters with an auto-dependent workforce and sustaining losses in workforce accessibility, or locating in clusters with limited public transit services that are privately subsidized by the firm, or locating away from clusters and forgoing the productivity and competitive advantages of clustering, many of the firms in their eight high-tech clusters chose to privately subsidize transit to augment the existing public transit system (e.g. corporate shuttles). However the data is descriptive and cross-sectional; again, causal relationships cannot be established from these case studies.

The impact of transportation improvements on land value

Adding economic value is often a justification for public transportation investments. Despite the high cost of infrastructure and maintenance, expectations for a high expected value from land appreciation will still favor the construction of a new system. However the anticipation of economic benefits from transit investment might not be realized. Such benefit depends highly on spatial and temporal factors, and the type of development. Researchers found that in San Diego, public transit service is positively correlated with commercial property value, especially if that property is in the downtown or other highly urban area (Cervero 2003). Research also found that multi-family housing located in a moderate-income class corridor gain positive benefit by the Trolley Line in San Diego, while in the case of single-family housing, the benefits are much less significant, even negative (Cervero 2003). A study of the River Line light rail service in New Jersey found that generally there was a negative or, at best, neutral effect on property value near the River Line after its groundbreaking and operation (Chatman, Tulach and Kim, 2012). Although property value started to increase after operation, the appreciation did not make up for the previous depreciation except for certain properties. This depreciation effect came from nuisances during construction, fear of crime, induced traffic, and negative media coverage. Property values in low income neighborhoods gained more than in high income neighborhoods near the River Line, suggesting that there was a shifting of land value from high-income neighborhood to low-income neighborhood (Chatman, Tulach and Kim, 2012).

Studies of how land value change over time in response to transit improvements might find increasingly positive effects if development patterns also changed. A longitudinal study looking at three decades of land value changes along MARTA (commuter rail systems in Atlanta, GA), found that MARTA had no impact on property values during the first two decades but then in the third decade, property values of single-family and multi-family units increased (Ward, 2015). Ward suggests that the value of transit is only realized when complemented with other infrastructure developments and change in land use (Ward, 2015). This argument, however, neglects the possibility that other infrastructure developments and relaxation of land use regulations might be the more proximate cause of land value increases than the transit service itself.

Perspectives of firm owners and developers on the value of public transit as location amenity

Very little research has been done on how firm owners and developers view the value of public transportation in terms of their development and location choices. The few reports on this have tended to find that firms perceive the benefit from public transit as marginal, and believe that access to transit alone is not valuable when not paired with other characteristics, like good pedestrian access. A survey targeting firms along the New Jersey River Line showed that proximity to the River Line was a relatively unimportant factor in location choice compared to highway access and proximity to markets (Chatman and DiPetrillo, 2010). Firms located within a half-mile from River Line rail stations were more than twice as likely to indicate that proximity to River Line is important compared to firms located farther away from the line, although it was still not as important as the aforementioned factors. These firms located within a half-mile from the River Line also reported that they have more employees and customers arriving by rail. However, business owners claimed that there was no significant improvement in their business after the River Line opened (Chatman and DiPetrillo, 2010).

In residential real estate, proximity to transit has not been a strongly attractive factor in some markets. For example, Los Angeles residential developers expressed general concerns about investing in residential TODs because these types of residences were perceived as attractive only to a narrow market of singles and "empty nesters" (Loukaitou-Sideris, 2010). But it has also been argued that residential and mixed-use TODs are becoming increasingly popular, due to continuing population growth, increasing housing prices, and road congestion (Loukaitou-Sideris, 2010). If public and private support of transit-oriented developments changes, developers will likely become more willing to invest. But transit access alone does not encourage development. Developers also value policies that are often adopted in TOD areas, such as increased floor-to-area ratios (FARs), reduced parking requirements, pedestrian amenities, and public sector subsidies (Loukaitou-Sideris, 2010; Mejias and Deakin, 2005, Cervero, 2004; Noland et al., 2013).

Descriptive Analysis

In this section, we summarized the descriptive data to show whether and how transit accessibility improvements are correlated with changes in employment by industry and land value, without attempting to account for whether the relationship is causal. The notion of agglomeration, though useful conceptually, is vague operationally. It is used to describe everything from the size of a city to the intensity of a single block's urban development; and since there are different kinds of agglomeration mechanisms, it can be understood as causing higher productivity in many different sorts of ways, and therefore can imply many different physical phenomena, ranging from a clustering of similar retail establishments in a neighborhood, to the accessibility of labor to access jobs throughout a metropolitan area. In this study we focus on two measurable physical phenomena: block level employment density by industry, and properties' annual appreciation rate.

Descriptive analysis of NETS data

Agglomerations are clusters of firms, households, or both, as large as whole cities and as small as neighborhoods. Firm agglomeration is measured in this study as employment density (number of employers in a certain industry per acre). First, the relationship between employment density (at block level) and proximity to rail stations were studied using the longitudinal National Establishment Time Series (NETS) data, which includes the size of employment of each firm from 1990 to 2011. The change of employment density for three metropolitan areas, which are the San Francisco Bay Area (SF Bay Area), Los Angeles Metropolitan Region (LA), and San Diego Region (SD), were investigated. According to the NETS data, a total number of 1,330,000 firms exist or have ever existed in the SF Bay Area during the period from 1990 to 2011. The data records 1,800,000 firms and 541,500 firms for the LA and SD region respectively. The types of rail were not distinguished for the purposes of this research. Data for the San Francisco Bay Area was collected from the Bay Area Rapid Transit (BART), Caltrain commuter rails and Municipal Railway (MUNI). The rails for the Los Angeles metro region consists of both light and heavy (subway) rail that serve regional commuters as well as shorter distance travelers. Rails in the San Diego region include the Metropolitan Transit System (MTS) Trolley.

Table 1 and Figure 1 below show the average employment density (number of employees per acre) in relation to rail proximity in the SF Bay Area. As indicated in the Table and Figure, the employment density is much higher in blocks that are located within 0.25 miles from rail. And with the increasing distance to rail, employment density tends to become lower.

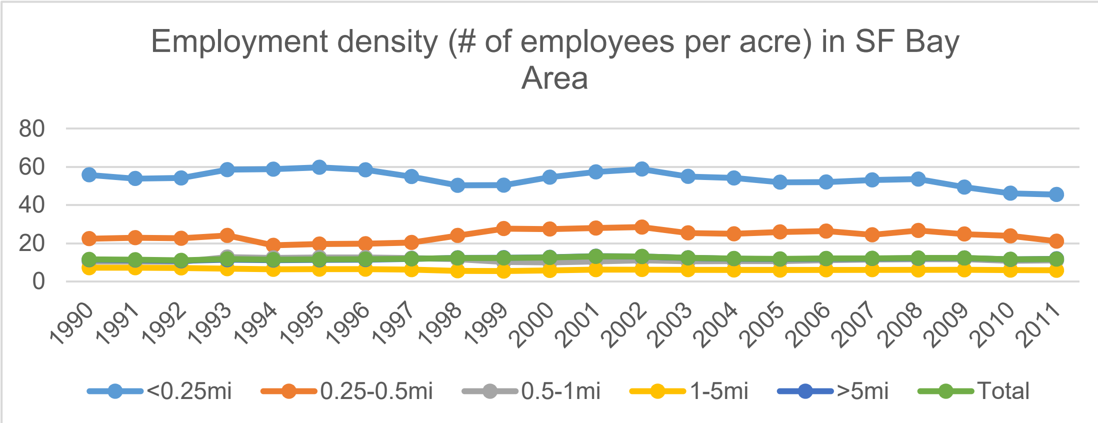

Figure 1. Average employment density at block level by distance to rail (SF Bay Area)

Table 1. Average employment density at block level by distance to rail (SF Bay Area)

employment density (# of employees per acre)	Distance to Rail					
	<0.25mi	0.25-0.5mi	0.5-1mi	1-5mi	>5mi	Total
1990	38.27	36.57	13.88	6.99	7.74	8.57
1991	38.02	36.78	13.24	6.89	7.67	8.47
1992	29.93	25.46	8.93	6.29	8.37	8.18
1993	41.27	17.29	7.78	6.52	8.66	8.33
1994	35.61	15.40	7.14	6.17	8.60	7.78
1995	31.55	13.01	6.23	5.94	8.60	7.36
1996	30.82	12.04	5.73	6.00	7.09	6.99
1997	28.63	10.94	5.74	5.58	6.82	6.58
1998	28.78	10.96	5.76	5.67	6.95	6.67
1999	27.77	10.71	6.11	5.94	6.98	6.90
2000	28.65	11.57	6.14	6.12	7.21	7.15
2001	29.45	12.70	6.20	6.45	7.53	7.50
2002	31.73	13.05	6.69	7.02	8.25	8.12
2003	30.36	12.85	6.36	6.97	8.26	8.12
2004	31.04	12.78	6.32	6.97	8.31	8.14
2005	31.28	13.20	6.43	7.03	8.35	8.23
2006	31.69	13.76	6.46	7.17	8.60	8.40
2007	32.78	14.02	6.71	7.30	8.84	8.60
2008	32.94	14.20	6.85	7.45	8.95	8.74
2009	30.83	13.71	6.87	7.58	9.21	8.85
2010	27.94	12.06	6.00	6.80	8.41	7.94
2011	28.07	12.89	6.09	6.85	8.79	8.09

Table 2 and Figure 2 show the average employment density (number of employees per acre) in relation to rail proximity in the LA region. The patterns are similar to those found in Table 1 and Figure 1, where the employment density is much higher in blocks that are located within 0.25 miles from rail. And with the increasing distance to rail, employment density tends to become lower. From 1990 to 1992, the average employment density is also high in blocks that are located between 0.25 to 0.5 miles from rail stations. But it declined dramatically after 1992. It is important to note that there was only one rail line in 1990 in the LA region, which is the Blue Line light rail connecting downtown Long Beach to downtown Los Angeles. Therefore the decline of employment density near rail may partly be due to the increasing construction of new rail systems.

Table 2. Average employment density at block level by distance to rail (LA region)

employment density (# of employees per acre)	Distance to Rail					
	<0.25mi	0.25-0.5mi	0.5-1mi	1-5mi	>5mi	Total
1990	38.27	36.57	13.88	6.99	7.74	8.57
1991	38.02	36.78	13.24	6.89	7.67	8.47
1992	29.93	25.46	8.93	6.29	8.37	8.18
1993	41.27	17.29	7.78	6.52	8.66	8.33
1994	35.61	15.40	7.14	6.17	8.60	7.78
1995	31.55	13.01	6.23	5.94	8.60	7.36
1996	30.82	12.04	5.73	6.00	7.09	6.99
1997	28.63	10.94	5.74	5.58	6.82	6.58
1998	28.78	10.96	5.76	5.67	6.95	6.67
1999	27.77	10.71	6.11	5.94	6.98	6.90
2000	28.65	11.57	6.14	6.12	7.21	7.15
2001	29.45	12.70	6.20	6.45	7.53	7.50
2002	31.73	13.05	6.69	7.02	8.25	8.12
2003	30.36	12.85	6.36	6.97	8.26	8.12
2004	31.04	12.78	6.32	6.97	8.31	8.14
2005	31.28	13.20	6.43	7.03	8.35	8.23
2006	31.69	13.76	6.46	7.17	8.60	8.40
2007	32.78	14.02	6.71	7.30	8.84	8.60
2008	32.94	14.20	6.85	7.45	8.95	8.74
2009	30.83	13.71	6.87	7.58	9.21	8.85
2010	27.94	12.06	6.00	6.80	8.41	7.94
2011	28.07	12.89	6.09	6.85	8.79	8.09

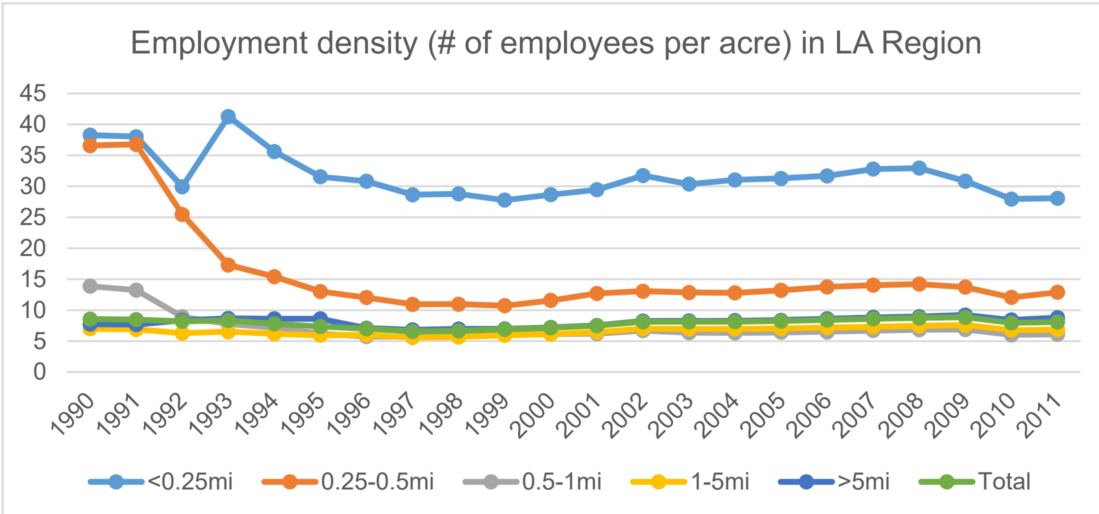

Figure 2. Average employment density at block level by distance to rail (LA region)

Table 3 and Figure 3 show the average employment density (number of employees per acre) in relation to rail proximity in the San Diego region. The patterns are similar to those found in SF Bay Area and LA, where the employment density is much higher in blocks that are located within 0.25 miles from rail. And with the increasing distance to rail, employment density tends to become lower.

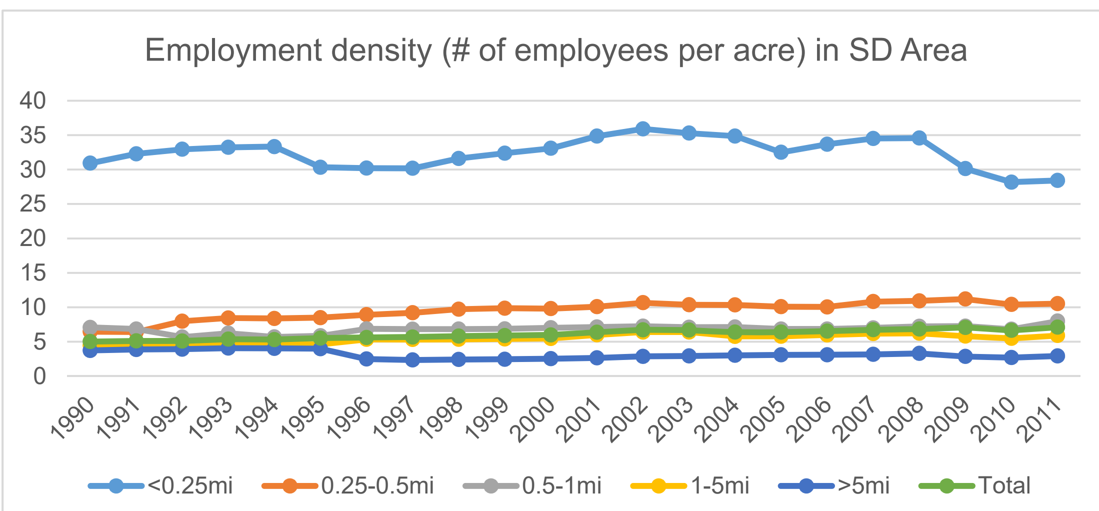

Figure 3. Average employment density at block level by distance to rail (SD region)

Table 3. Average employment density at block level by distance to rail (SD region)

employment density (# of employees per acre)	Distance to Rail					
	<0.25mi	0.25-0.5mi	0.5-1mi	1-5mi	>5mi	Total
1990	30.92	6.45	7.07	4.46	3.72	5.01
1991	32.28	6.40	6.83	4.42	3.86	5.09
1992	32.94	7.96	5.66	4.23	3.90	5.08
1993	33.22	8.44	6.22	4.60	4.05	5.35
1994	33.33	8.36	5.69	4.60	4.02	5.29
1995	30.33	8.48	5.84	4.61	3.97	5.50
1996	30.20	8.90	6.85	5.33	2.47	5.60
1997	30.18	9.19	6.80	5.30	2.33	5.67
1998	31.61	9.71	6.82	5.33	2.41	5.79
1999	32.37	9.84	6.86	5.39	2.44	5.87
2000	33.08	9.79	7.00	5.45	2.52	5.97
2001	34.85	10.08	7.12	5.98	2.63	6.36
2002	35.90	10.65	7.24	6.39	2.85	6.71
2003	35.29	10.35	7.09	6.39	2.91	6.68
2004	34.86	10.33	7.12	5.76	3.01	6.39
2005	32.50	10.07	6.83	5.77	3.07	6.37
2006	33.68	10.03	6.83	5.97	3.09	6.52
2007	34.51	10.82	6.99	6.17	3.14	6.72
2008	34.58	10.92	7.21	6.21	3.28	6.82
2009	30.13	11.18	7.25	5.80	2.84	7.06
2010	28.16	10.40	6.81	5.47	2.68	6.63
2011	28.41	10.51	7.98	5.89	2.92	7.09

Next, the pattern of employment density for different industries in relation to rail proximity were examined for all three metropolitan areas. The six industries examined were: Arts and Entertainment (NAICS: 71), Finance and Insurance (NAICS: 52), Information (NAICS: 51), Manufacture (NAICS: 31-33), Professional and Technical (NAICS: 54), and Retail (NAICS: 44-45).

Arts and Entertainment (NAICS 71)

Figures 4, 5, and 6 below show the employment density for Arts and Entertainment by rail proximity for SF, LA, and SD respectively. The patterns are generally similar to the overall density pattern by rail proximity as shown in the previous Figures, although there are some differences. In SF Bay Area, blocks that are located between 0.25 to 0.5 miles and less than 0.25

miles from rail stations yield the highest employment density for most of the years, and this is also true in LA from 1990-1991. But in LA, the differences in employment density became negligible after 1992 among all groups, except for blocks that are within 0.25 miles from rail stations. In SD, blocks within 0.25 miles from rail yields the highest density.

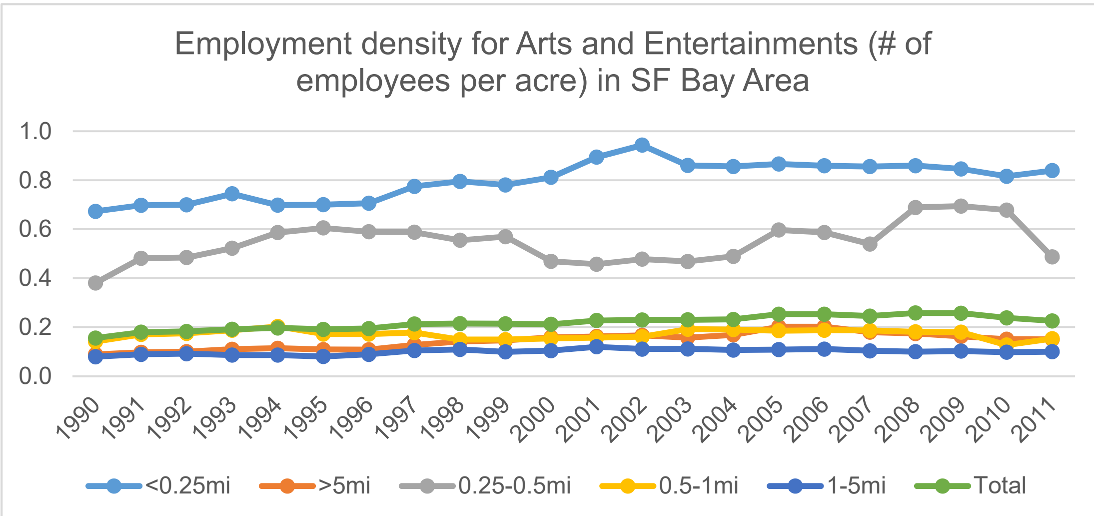

Figure 4. Average employment density for Arts and Entertainment at block level by distance to rail (SF Bay Area)

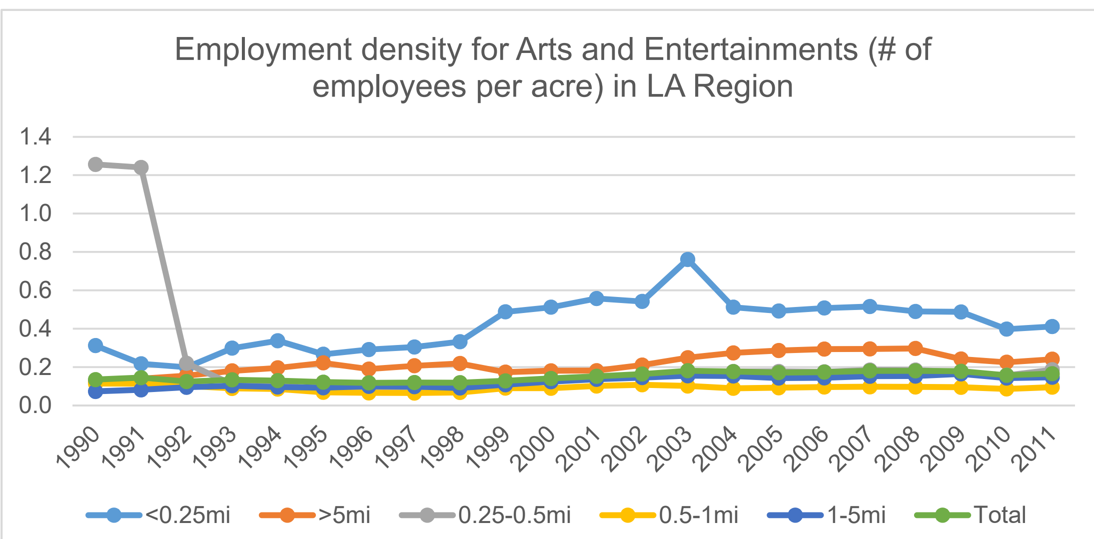

Figure 5. Average employment density for Arts and Entertainment at block level by distance to rail (LA region)

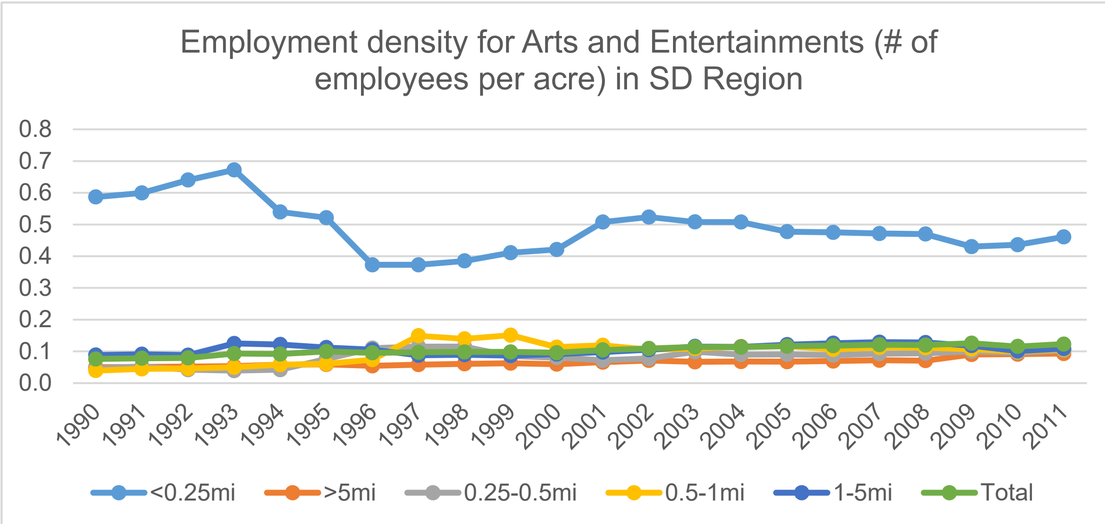

Figure 6. Average employment density for Arts and Entertainment at block level by distance to rail (SD region)

Finance and Insurance (NAICS 52)

Figures 7, 8, and 9 below show the employment density for Finance and Insurance by rail proximity for SF Bay Area, LA, and SD respectively. The patterns are generally similar to the overall density pattern by rail proximity as shown in Figures 1-3 where employment density for Finance is higher in blocks that are located closest to rail stations, except in SF where blocks that are furthest away from rail yields the second highest employment density.

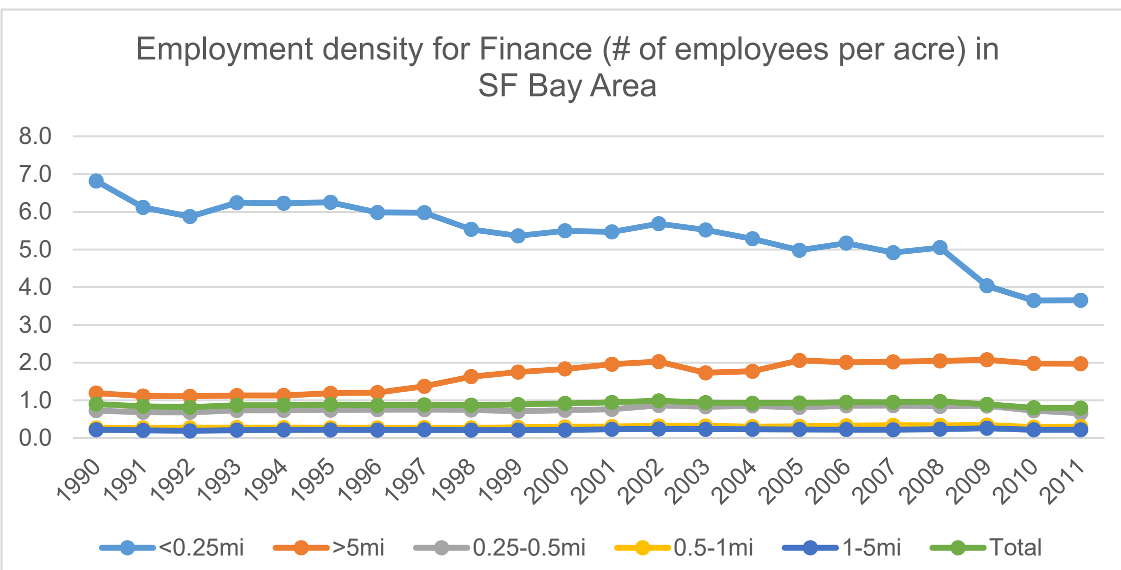

Figure 7. Average employment density for Finance and Insurance at block level by distance to rail (SF Bay Area)

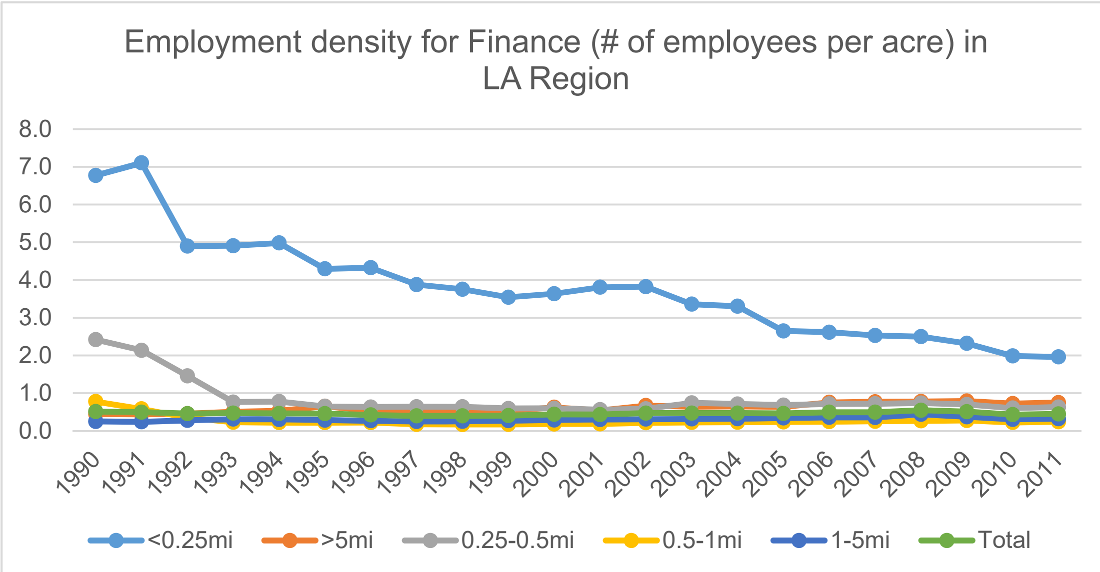

Figure 8. Average employment density for Finance and Insurance at block level by distance to rail (LA Region)

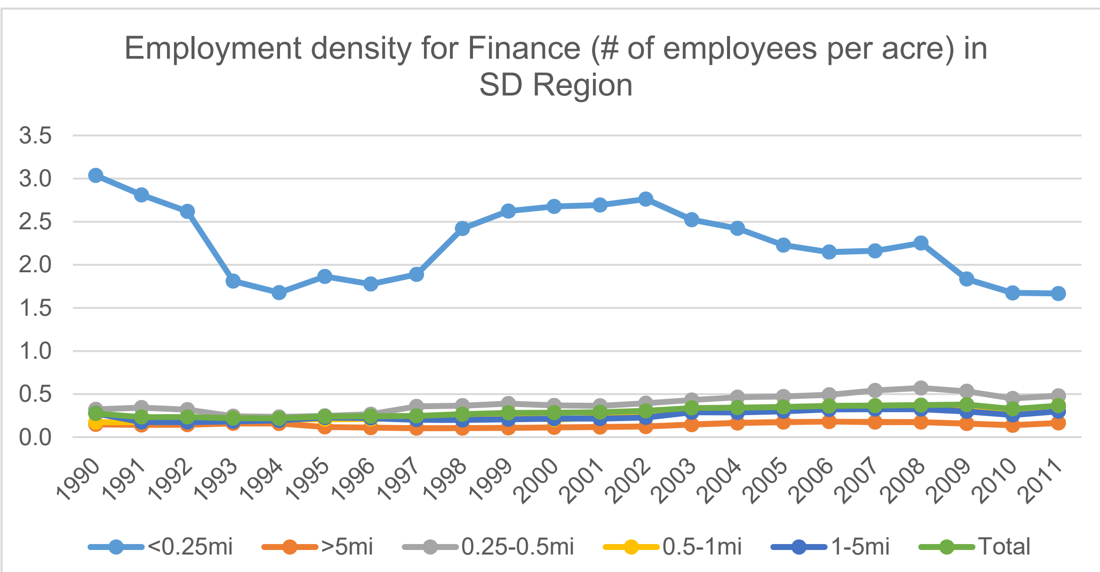

Figure 9. Average employment density for Finance and Insurance at block level by distance to rail (SD Region)

Information (NAICS 51)

Figures 10, 11, and 12 show the employment density for Information by rail proximity for SF Bay Area, LA, and SD respectively. The patterns are generally similar to the overall density pattern by rail proximity as shown in Figures 1-3. In LA, employment density for the information sector is higher in places that are 0.25 to 0.5 miles from rail stations from 1990 to 1992.

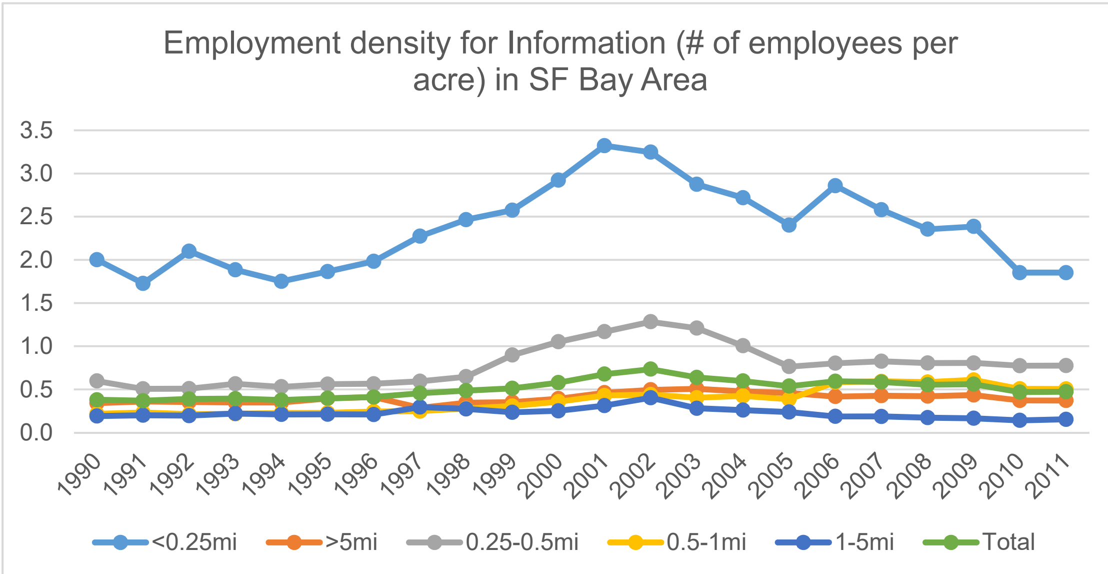

Figure 10. Average employment density for Information at block level by distance to rail (SF Bay Area)

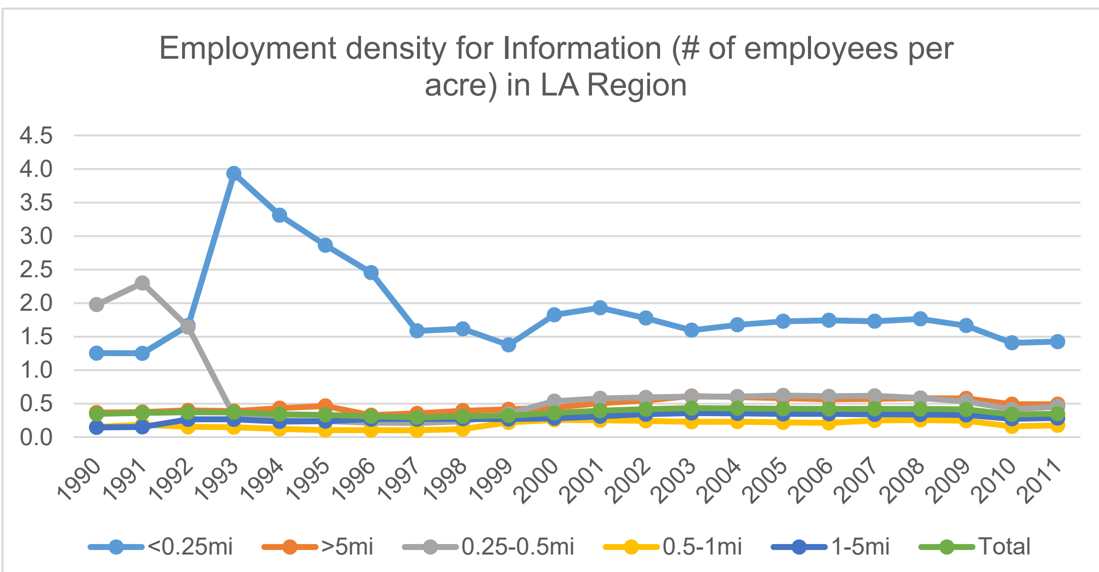

Figure 11. Average employment density for Information at block level by distance to rail (LA Region)

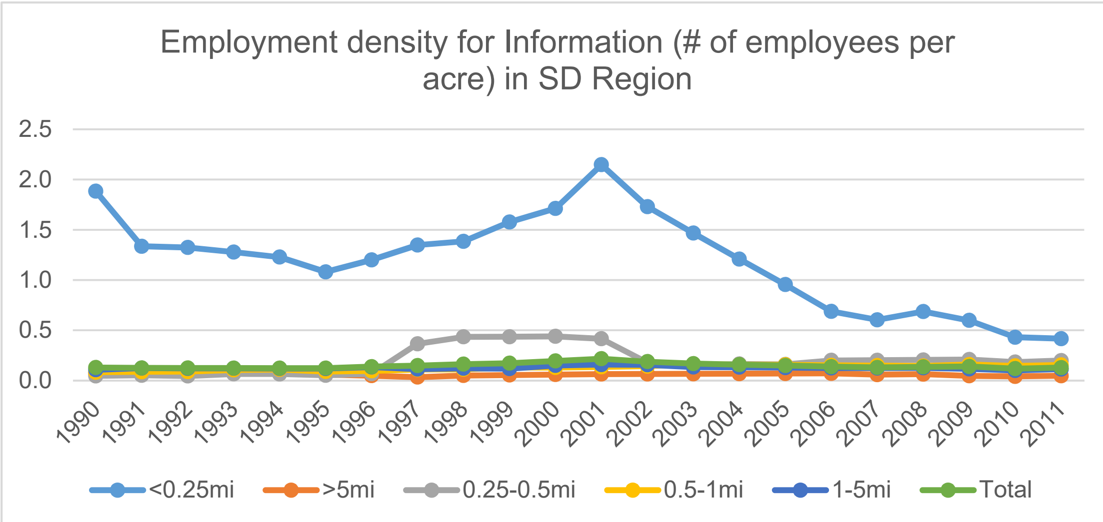

Figure 12. Average employment density for Information at block level by distance to rail (SD Region)

Manufacture (NAICS 31-33)

Figures 13, 14, and 15 show the employment density for Manufacture by rail proximity for SF Bay Area, LA, and SD respectively. In SF Bay Area, blocks that are located within 0.25 miles from rail stations yield the highest employment density for all years except during 1999 to 2002, when blocks that are located between 0.25 to 0.5 miles from rail yields the highest employment density. In LA, however, blocks that are located between 0.25 to 0.5 miles from rail stations have the highest employment density before 1995. In SD, the pattern is similar to those shown in Figures 1-3.

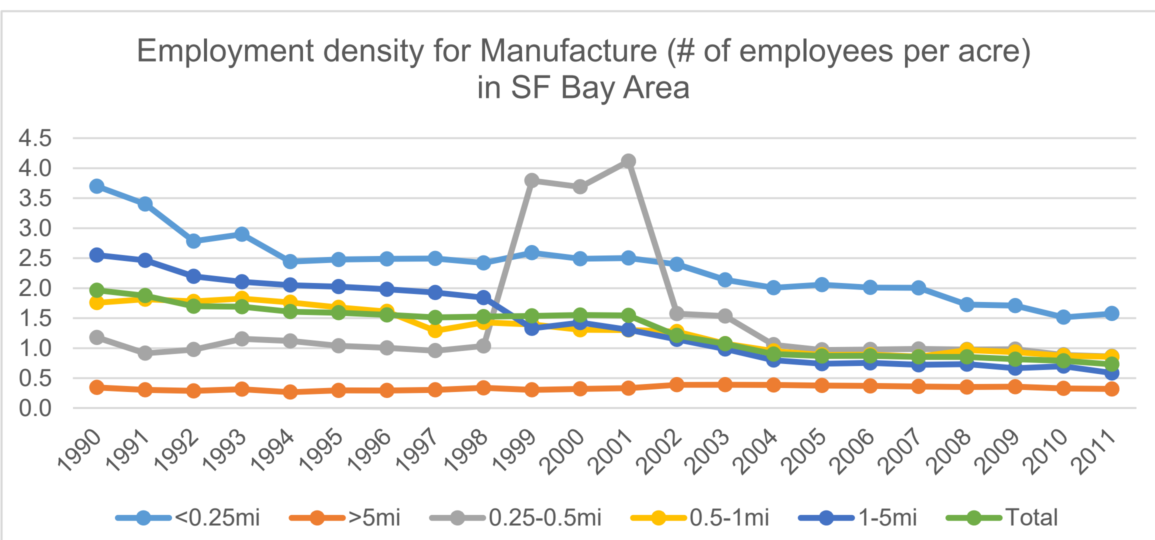

Figure 13. Average employment density for Manufacture at block level by distance to rail (SF Bay Area)

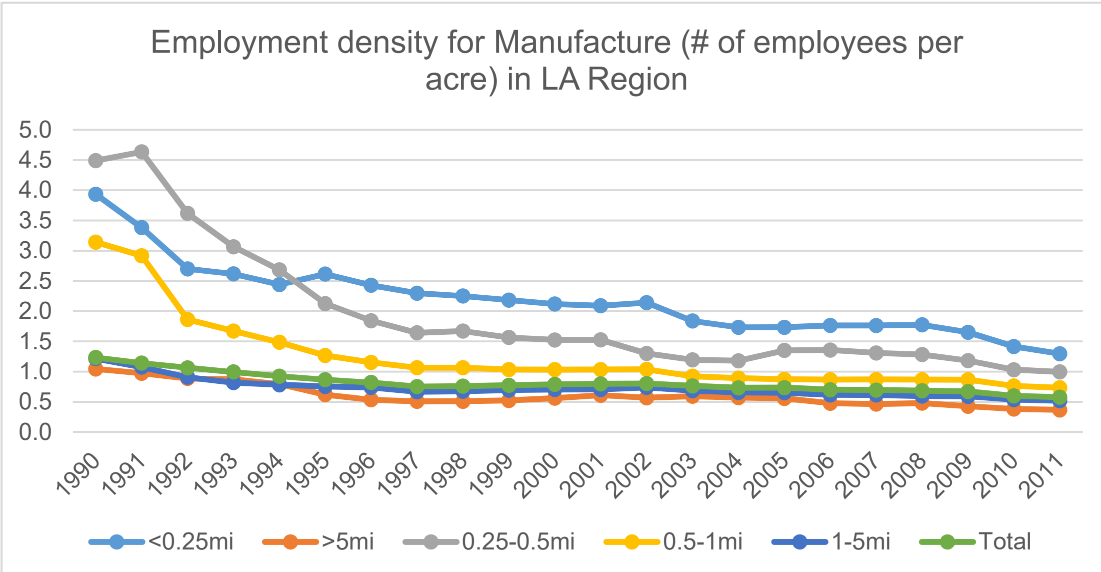

Figure 14. Average employment density for Manufacture at block level by distance to rail (LA Region)

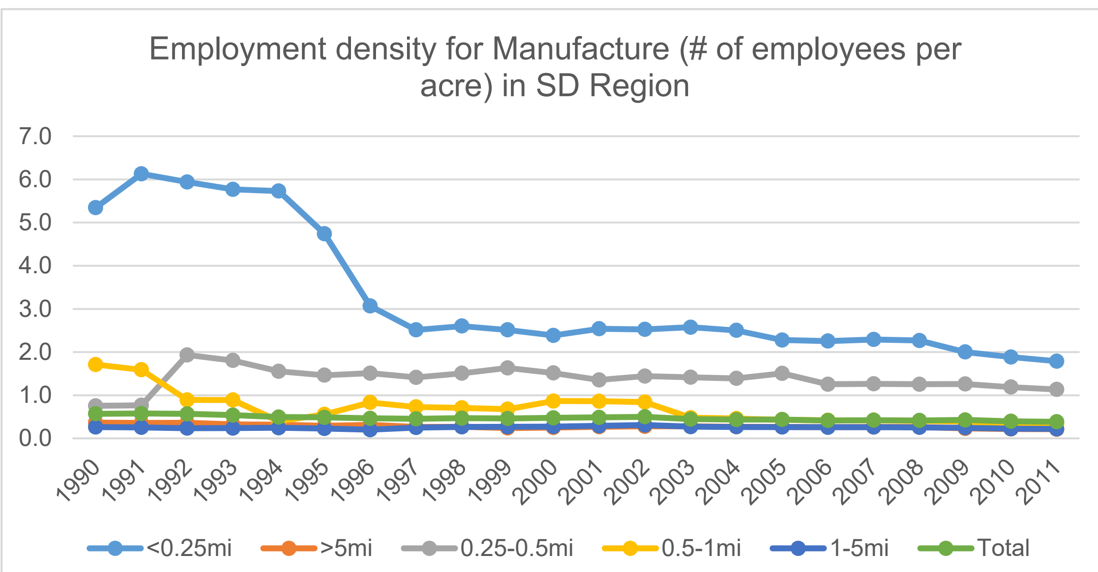

Figure 15. Average employment density for Manufacture at block level by distance to rail (SD Region)

Professional and Technical (NAICS 54)

Figures 16, 17, and 18 show the employment density for Professional and Technical by rail proximity for SF Bay Area, LA, and SD respectively. The patterns are generally similar to the overall density pattern by rail proximity as shown in Figures 1-3, where employment density for blocks that are located closest to rail stations are distinctively higher than blocks that are located further away from rail.

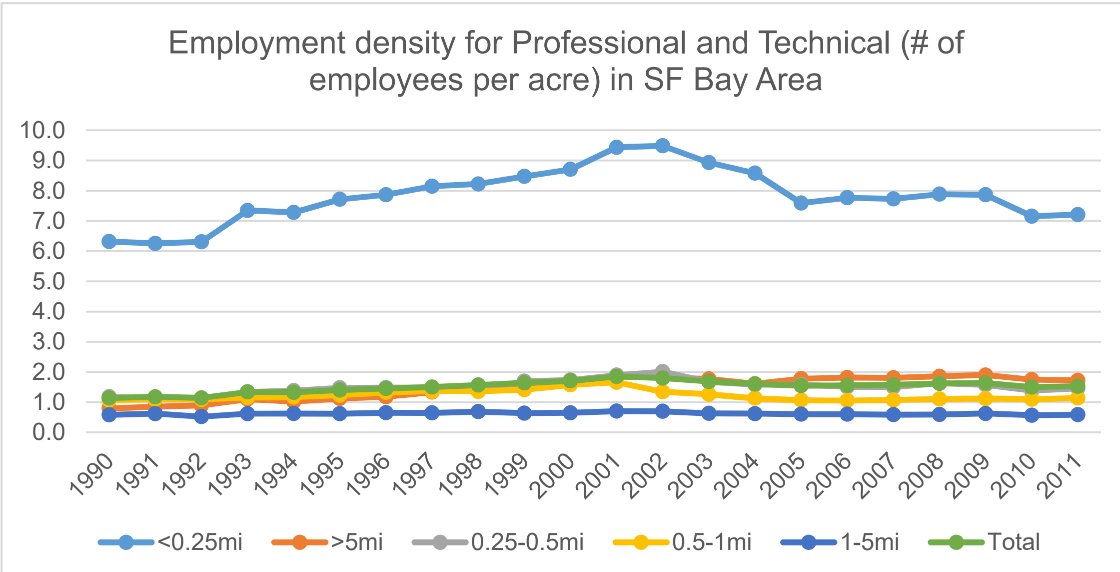

Figure 16. Average employment density for Professional and Technical at block level by distance to rail (SF Bay Area)

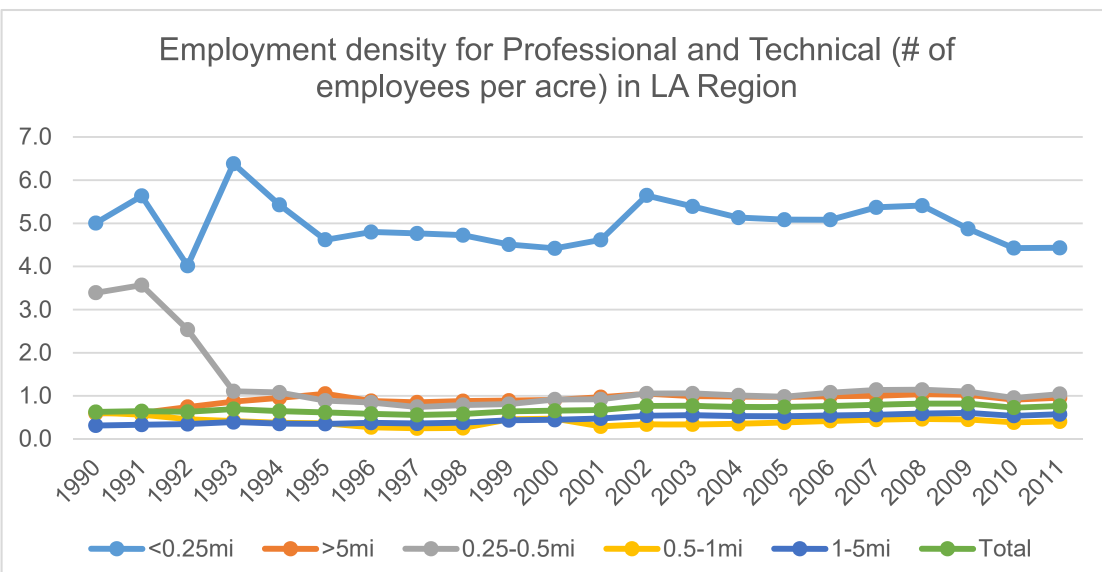

Figure 17. Average employment density for Professional and Technical at block level by distance to rail (LA Region)

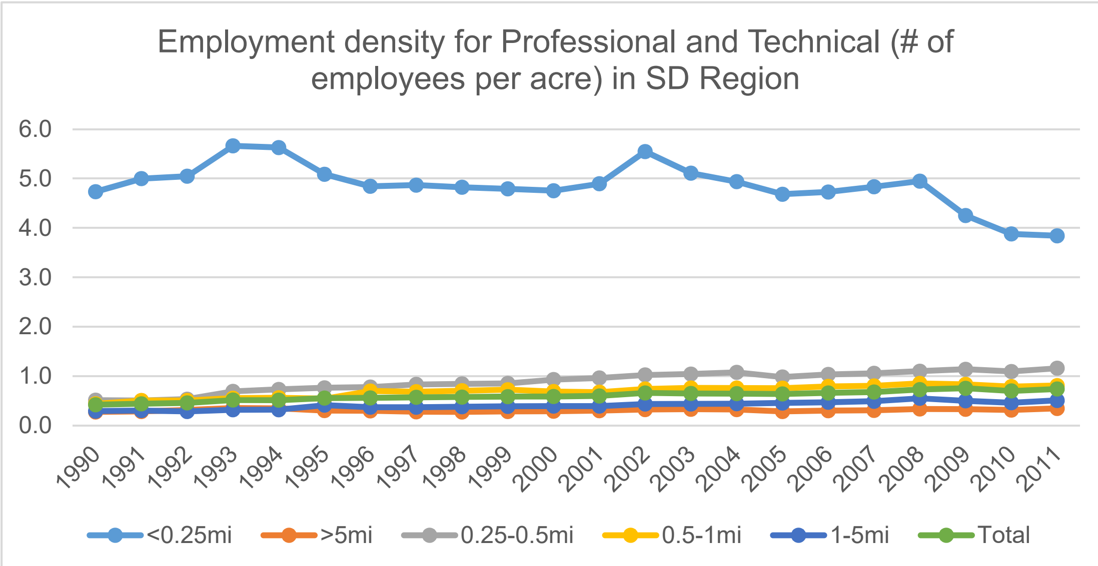

Figure 18. Average employment density for Professional and Technical at block level by distance to rail (SD Region)

Retail (NAICS 44-45)

Figures 19, 20, and 21 show the employment density for Retail by rail proximity for SF Bay Area, LA, and SD respectively. The patterns are generally similar to the overall density pattern by rail proximity as shown in Figures 1-3 with several notable differences. The Figures show a boom in employment density for blocks located between 0.25 to 0.5 miles from rail stations between 1999-2004 in SF Bay Area, during which period the density is higher for these blocks compared to all other blocks except those located closest to rail. But it quickly dropped below blocks that are located closest to rail after 2003. In LA, those two groups of blocks that are located within 0.5 miles from rail yield the highest employment density for retail. In SD, the density for retail is much higher when the blocks are located close to rail, but the level of densification shows a distinct pattern. Blocks that are less than 0.25 miles from rail have significantly higher density than others, followed by blocks that are located between 0.25 miles to 5 miles. When the distance is greater than 5 miles, the density for retail becomes significantly lower.

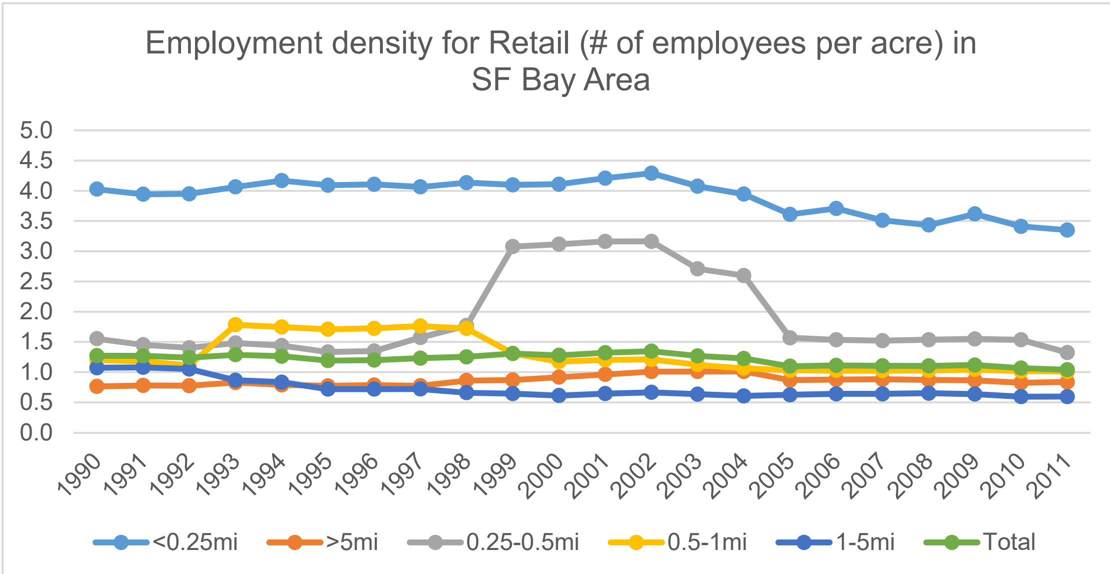

Figure 19. Average employment density for Retail at block level by distance to rail (SF Bay Area)

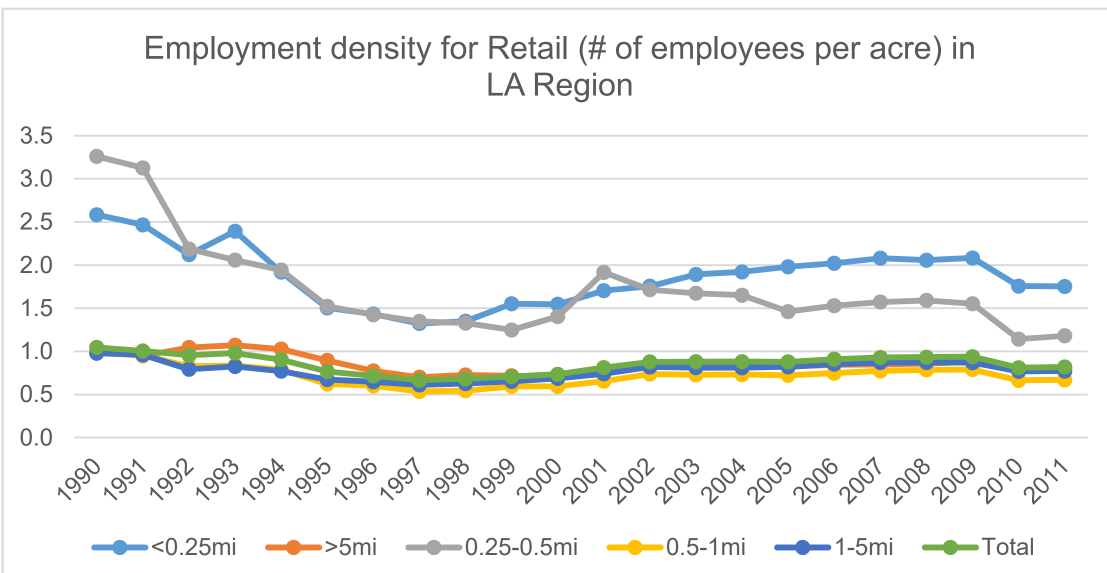

Figure 20. Average employment density for Retail at block level by distance to rail (LA Region)

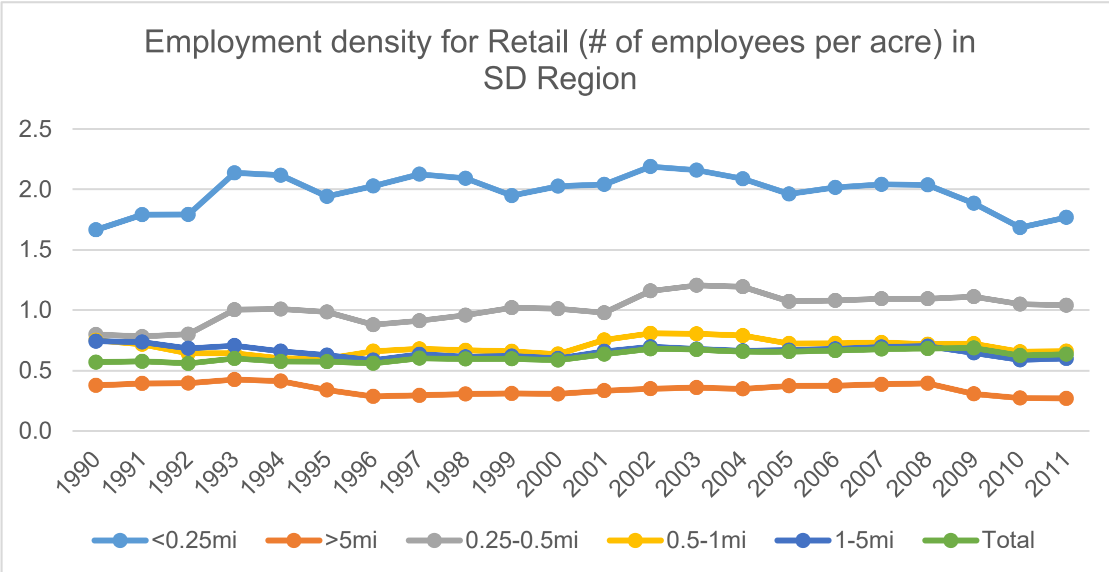

Figure 21. Average employment density for Retail at block level by distance to rail (SD Region)

Descriptive analysis with commercial property value

The second part of the analysis used commercial property data that includes sales transactions for properties in California metropolitan counties from 1960 to 2013. Only properties that experienced two or more transactions during the recorded period were included and their annual appreciation rate were compared by distance to rail and whether a rail station opened between sales (Tables 4-5 and Figures 22-23). In San Francisco Bay Area (which include six counties in this analysis: Alameda, Contra Costa, San Francisco, San Mateo, Santa Clara, and Solano), 360,000 out of 1.3 million recorded properties have repeat sales (two or more sales), while in Los Angeles County (LA), 540,000 out of 1.8 million have repeat sales.

Due to the inconsistency, incompleteness, and unreliability of some of the commercial data, a stringent truncating criteria were applied to the following analyses.

The following records are not included in the analysis:

1. Properties that appreciate greater than 100% annually;
2. Properties with sales price lower than $10,000; and
3. Properties with first sale year before 1980.

After truncating the dataset, the descriptive analysis was conducted.

Table 4. Annual Appreciation Rate for Repeated Sales Properties by Distance to Nearest Rail Station (SF Bay Area)

	No Rail Development between Sales		Rail Development between Sales	
Distance to Rail	Annual Appreciation	N	Annual Appreciation	N
<0.25mi	.262	24,374	.235	3,972
0.25-0.5mi	.263	30,159	.234	3,870
0.5-1mi	.262	60,999	.240	8,154
1-5mi	.254	162,459	.237	23,702
>5mi	.245	48,960		
Total	.255	326,951	.237	39,698

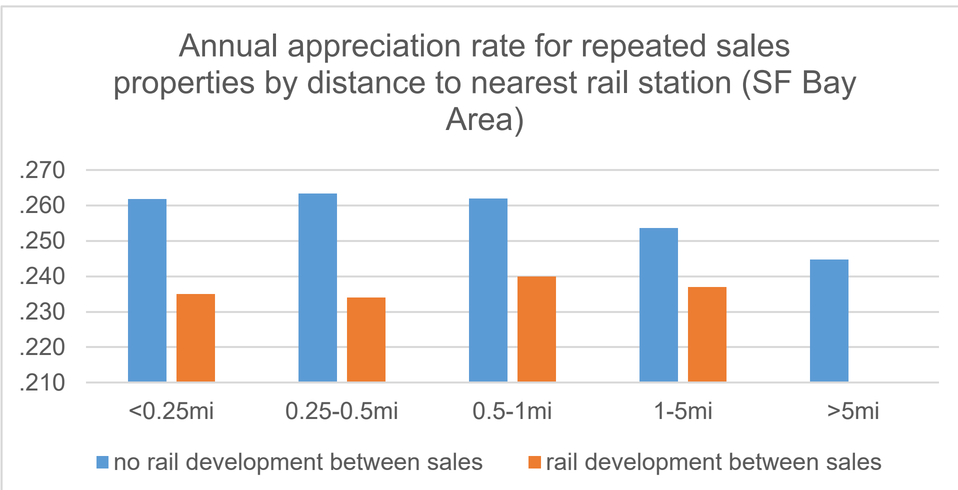

Figure 22. Annual Appreciation Rate for Repeated Sales Properties by Distance to Nearest Rail Station (SF Bay Area)

Table 4 and Figure 22 indicate that the SF Bay Area properties with rail development between sales yields a lower annual appreciation rate compared to properties that do not have rail development between sales. However, it appears that properties with rail development between sales have no discernible appreciation rate patterns with respect to rail distance; whereas properties that did not experience rail development between sales have higher appreciation rates for properties closer to rail.

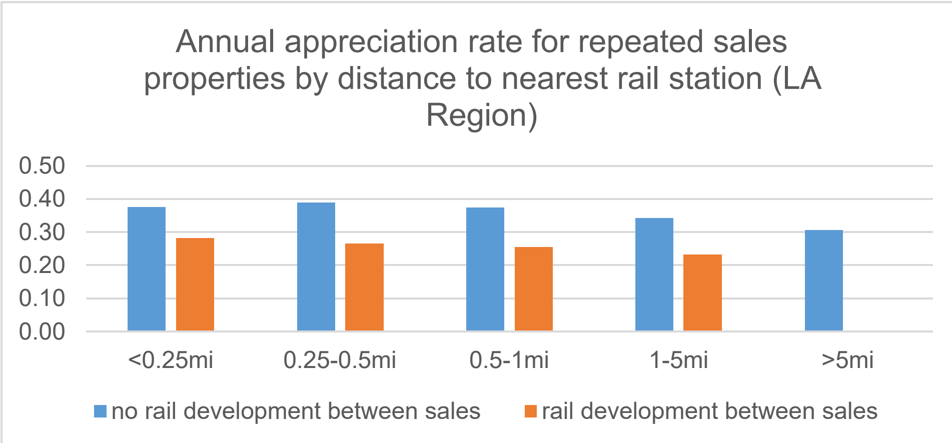

Figure 23. Annual Appreciation Rate for Repeated Sales Properties by Distance to Nearest Rail Station (LA)

Table 5. Annual Appreciation Rate for Repeated Sales Properties by Distance to Nearest Rail Station (LA)

	No Rail Development between Sales		Rail Development between Sales	
Distance to Rail	Annual Appreciation	N	Annual Appreciation	N
<0.25mi	0.376	11,446	0.282	1,284
0.25-0.5mi	0.390	20,435	0.265	2,256
0.5-1mi	0.374	51,055	0.254	6,278
1-5mi	0.342	291,007	0.232	24,909
>5mi	0.306	81,329	NA	
Total	0.342	455,272	0.240	34,727

Table 5 and Figure 23 show that properties in LA with rail development between sales are similar to those in SF Bay Area and yields a lower annual appreciation rate compared to properties that do not have rail development in between sales. Properties that are closer to rail stations have higher appreciation rate compared to properties that are further away from rail, regardless of whether there is rail development in between sales.

Table 6. Annual Appreciation Rate for Repeated Sales Properties by Distance to Nearest Rail Station (SD)

	No Rail Development between Sales		Rail Development between Sales	
Distance to Rail	Annual Appreciation	N	Annual Appreciation	N
<0.25mi	.240	10,549	.189	1,225
0.25-0.5mi	.249	11,471	.188	1,639
0.5-1mi	.247	23,357	.190	3,990
1-5mi	.238	108,792	.189	11,575
>5mi	.224	58,770	NA	
Total	.236	212,939	.189	18,429

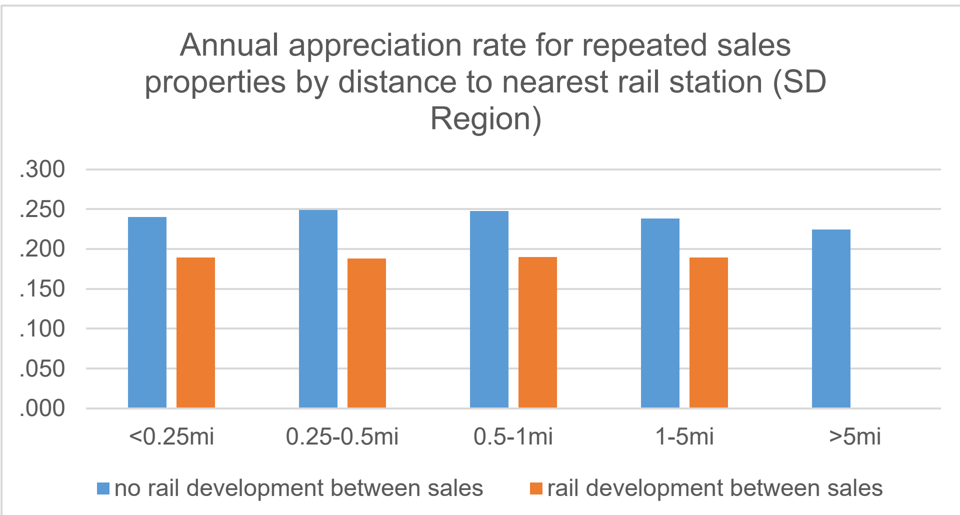

Figure 24. Annual Appreciation Rate for Repeated Sales Properties by Distance to Nearest Rail Station (SD)

Table 6 and Figure 24 show that the annual appreciation rate of properties in San Diego are pretty similar to those in SF Bay Area and LA. Properties with rail development between sales yields a lower annual appreciation rate compared to properties that do not have rail development in between sales. Properties that are closer to rail stations have higher appreciation rates compared to properties that are further away from rail, for those properties that did not have rail development in between sales. Distance to rail does not seem to have any effect on annual appreciation rate for properties that had rail development between sales.

Analysis of Quantitative Data

This section summarizes the time series analysis using National Establishment Time Series (NETS) data and Commercial Property Value data.

Regression analysis with NETS data

With a few exceptions, the descriptive analysis showed that census blocks that are closer to rail yield higher employment density. However such uncontrolled analysis is not capable of isolating the effect of rail development as an impetus to firm agglomeration. Higher employment density in rail accessible areas might not be the result of rail accessibility. On the contrary, rail development might take place in areas with already higher density in order to generate revenue and ridership. Therefore an approach that can capture the net effect of rail development to employment density was designed.

Since time series data was available, lagged variables were used to show rail accessibility in the past years as a predictor to the employment density of a census block in the current year. The lagged variables go up to two years prior to the year of the employment density that the dependent variable represents in order to allow for enough effect from rail development. The model specification is shown below. Note that all rail indicators in the model specification are categorized into 5 dummy variables by the distance to rail.

The $T_{(n\ year)}$s are a series of dummy variables indicating the year of the regressed dependent variable, since this is a pooled time series data. In this case since only data from 1990 to up to 2011 were available, only pooled dataset from 1993 to 2011 were able to be obtained since lagged variables would need to be included in the model.

Y (Employment density) = b_0+b_1*rail (current year) +b_2*rail (1 year) + b_3*rail (2 years) + B_1*$T_{(1\ year)}$ + B_2*$T_{(2\ years)}$+…+ B_k*$T_{(k\ years)}$ +*e*

b_0: constant
b_{1-3}: coefficients for rail proximity each year
B_{1-k}: coefficients for time variable each year
e: error term
Note: the meanings of each component in all equations in this report are the same as this notation

Pooled time series models for San Francisco Bay Area (SF Bay Area), Los Angeles metropolitan region (LA), and San Diego region (SD) were estimated. Table 7 shows the estimation results for

SF Bay Area. We estimated one model with the exact specification as above, and a second model without the time dummies. Comparing between the full model and reduced model using F-test suggests that excluding the time dummies would yield a better fix.

The model specification allows us to show the net effect of rail development to employment density. If rail development occurred two years ago, then the total effect of such development would be the sum of the coefficients of the specific distance to rail two years prior up to the current year. For example, if two years ago a census block was located 1-5 miles away from rail, but in that year a new rail development opened that made the census block only ¼ - ½ miles from the closest rail station, then the net effect of this rail development to employment density, according to the findings in Table 7, would be 2.42-3.32+11.55=10.65 (refer to highlighted rows in Table 7). Compared to another census block, which is located between 1 to 5 miles from rail station but with no rail development in the past two years, the net effect of rail accessibility to employment density would be 2.42+0.13-5.78=-3.23. The difference between the two hypothetical census blocks is approximately 14 workers per acre.

Here we clearly see the advantage of increasing rail accessibility in areas that are previously not accessible by rail: rail development brought a net increase of employment density to an area, while no rail development resulted in the decline of competitiveness of an area, therefore leading to the decrease in employment density. Note that some of the variables are statistically insignificant, but they are included in the model. This is because the expected explanatory power of the model will be diminished if a relevant but insignificant variable is taken out from the model, and statistics theory suggests that the inclusion of that specific variable will outperform the exclusion of that relevant variable.

A slightly modified model specification, shown as follows, would take the rail status in the current year out of the model. This is because rail development is likely to affect employment density later since land development decisions usually take time to come into effect. Again, all rail indicators in the model specification are categorized into five dummy variables by the distance to rail.

Y (Employment density) = b_0+b_2*rail(1 year) + b_3*rail (2 years)+*e*

Table 8 shows the estimation result for this model specification. Take the example mentioned above again, but with parameters from Table 7: if two years ago a census block was located 1 to 5 miles away from rail, but in that year a new rail development opened that made the census block only .25 to .5 miles from the closest rail station, then the net effect of such development to employment density, according to Table 8, would be 2.20+8.53=10.73. In comparison to another census block, also located between 1 to 5 miles from the closest rail station, but with no new rail development, the net effect of rail accessibility to employment density would be 2.20-5.378=-3.178. In this particular example, the effect from the two model specifications produce a similar outcome for the net effect of rail development (a difference of around 14 workers per acre: that is 10.73+3.178).

Table 7. Lagged Transit Accessibility Variables Estimation Result for SF Bay Area Model 1 (y: Employment density, # of workers per acre)

	Parameters	t
(Constant)	10.30**	31.12
<0.25 miles (current year)	5.37	1.27
0.25-0.5 miles (current year)	**11.55****	**3.12**
0.5-1 mile (current year)	-1.04	-.37
1-5 miles (current year)	-5.78**	-2.81
<0.25 miles (1 year)	-1.80	-.31
0.25-0.5 miles (1 year)	**-3.32**	**-.65**
0.5-1 miles (1 year)	-.99	-.25
1-5 miles (1 year)	.013	.01
<0.25 miles (2 year)	30.22**	7.42
0.25-0.5 miles (2 year)	-2.00	-.56
0.5-1 miles (2 year)	2.36	.86
1-5 miles (2 year)	**2.42**	**1.19**
N	56,416	
R^2	0.05	
Adjusted R^2	0.05	

**: 95% significant; *:90% significant

Since the San Francisco Bay area is a large and diverse region, we introduced regional dummies and their interaction with rail proximity in the model. There are three regional dummies in the model: San Francisco (SF County), East Bay (Alameda County and Contra Costa County), and South Bay (San Mateo County and Santa Clara County). Among which, the SF County dummy and the South Bay dummy were interacted with rail proximity indicator for the one-year lag. Table 9 shows the estimation result.

Table 8. Lagged Transit Accessibility Variables Estimation Result for SF Bay Area Model 2 (y: Employment density, # of workers per acre)

	Parameters	t
(Constant)	10.20**	31.22
<0.25 miles (1 year)	3.87	.95
0.25-0.5 miles (1 year)	8.53**	2.41
0.5-1 miles (1 year)	-1.66	-.60
1-5 miles (1 year)	-5.37**	-2.62
<0.25 miles (2 year)	30.03**	7.37
0.25-0.5 miles (2 year)	-2.20	-.62
0.5-1 miles (2 year)	2.16	.77
1-5 miles (2 year)	2.20	1.08
N	19*56,416	
R^2	0.05	
Adjusted R^2	0.05	

**: 95% significant; *:90% significant

Next a model for the LA metropolitan region were estimated. Table 10 shows the estimation result. The model specification is the same as Table 8. From Table 10 we know that in LA, blocks that are located within 0.25 miles from rail gain a much larger effect on its employment density from rail accessibility. Such effect is much larger than blocks that are located between 0.25 to 1 mile from rail stations with no rail development in the previous year. Therefore it can be concluded from the model that in LA, the majority of the employment density increase took place within 0.25 mile from rail. The incremental effect of rail proximity is particularly significant when the new rail development is within 0.25 mile of the census block.

Table 9. Lagged Transit Accessibility Variables Estimation Result for SF Bay Area Model 3 (y: Employment density, # of workers per acre)

	B	t
(Constant)	6.615	11.640
<0.25 miles (1 year)	20.842	4.874
0.25-0.5 miles (1 year)	24.478	6.596
0.5-1 miles (1 year)	4.926	1.736
1-5 miles (1 year)	-.559	-.270
<0.25 miles (2 year)	20.548	4.887
0.25-0.5 miles (2 year)	-8.603	-2.352
0.5-1 miles (2 year)	.660	.237
1-5 miles (2 year)	1.641	.815
South Bay		
South Bay dummy	-1.136	-1.224
<0.25 miles (1 year, South Bay)	-21.454	-14.288
0.25-0.5 miles (1 year, South Bay)	-10.283	-7.996
0.5-1 miles (1 year, South Bay)	.291	.268
1-5 miles (1 year, South Bay)	2.014	2.096
San Francisco		
San Francisco dummy	143.969	77.695
<0.25 miles (1 year, SF)	-135.884	-63.270
0.25-0.5 miles (1 year, SF)	-146.524	-69.101
0.5-1 miles (1 year, SF)	-142.948	-69.004
1-5 miles (1 year, SF)	-135.348	-62.856
East Bay dummy	-2.727	-3.645
N	19*56,416	
R^2	0.013	
Adjusted R^2	0.013	

**: 95% significant; *:90% significant

Table 10. Lagged Transit Accessibility Variables Estimation Result for LA Region Model (y: Employment density, # of workers per acre)

	Parameters	t
(Constant)	8.16**	82.66
<0.25 miles (1 year)	16.19**	12.56
0.25-0.5 miles (1 year)	-1.16	-1.20
0.5-1 miles (1 year)	-2.47**	-4.15
1-5 miles (1 year)	-1.40**	-4.94
<0.25 miles (2 year)	6.51**	4.95
0.25-0.5 miles (2 year)	6.51**	6.57
0.5-1 miles (2 year)	.77	1.27
1-5 miles (2 year)	-.20	-.76
N	19*75,455	
R^2	0.06	
Adjusted R^2	0.06	

**: 95% significant; *:90% significant

Next, a similar model for the San Diego region was estimated (Table 11). The model specification is the same as Table 8.

Table 11. Lagged Transit Accessibility Variables Estimation Result for SD Region Model (y: Employment density, # of workers per acre)

	Parameters	t
(Constant)	3.20**	18.82
<0.25 miles (1 year)	11.37**	4.01
0.25-0.5 miles (1 year)	7.68**	3.41
0.5-1 miles (1 year)	3.19**	2.09
1-5 miles (1 year)	2.29**	2.92
<0.25 miles (2 year)	18.98**	6.60
0.25-0.5 miles (2 year)	-.95	-.41
0.5-1 miles (2 year)	.57	.37
1-5 miles (2 year)	.15	.20
N	19*27,254	
R^2	0.06	
Adjusted R^2	0.06	

**: 95% significant; *:90% significant

From Table 11 we know that the block level employment density increases closer to rail stations. This pattern is much clearer in SD when compared to SF Bay Area and LA parameters. Furthermore, the incremental effect of rail proximity on employment density is more highly significant as rail development locates closer to a census block.

Table 12 below shows the incremental effects of rail development (2 years: nearest rail station between 1 and 5 miles, 1 year: nearest rail station within 0.25 miles) for the different study regions, controlling for all other factors. We can see from the Table that rail development appears to promote agglomeration for most regions except for the South San Francisco Bay area. And San Francisco County seems to yield the highest incremental effect from rail development, followed by the Bay Area as a whole, and then LA and San Diego.

Table 12. Incremental effects of rail development on employment density (distance to nearest rail stations changes from between 1-5 miles two years ago to within 0.25 miles one year ago)

Regions	incremental effect of rail development
SF Bay Area all	22.48
SF County	30.57
SF South Bay	-0.11
LA	15.99
SD	11.52

Regression analysis with commercial property value data

We estimated two regression models using property value data. The model specification is similar to the models that are estimated for employment density, but with annual appreciation rate as the dependent variable. Property size (sqft), number of years between sales, and number of total transfers for control variables were included.

Table 13 shows the estimation result for SF Bay Area (this includes six counties in this analysis: Alameda, Contra Costa, San Francisco, San Mateo, Santa Clara, and Solano). The effect of rail on appreciation is positive for the previous year, whereas slightly negative for two years prior. This suggests that rail proximity does have a positive effect on annual appreciation rate of properties. The values for different rail proximity dummy variables within the same year shows a decreasing pattern when the distance is larger, suggesting that rail proximity has positive effects on annual appreciation rate. This finding is more consistent with the descriptive analysis.

Table 13. Lagged Transit Accessibility Variables Estimation Result for SF Bay Area model (y: annual appreciation rate)

	Parameters	t
(Constant)	.147**	113.502
<0.25 miles (1 year)	.130**	13.673
0.25-0.5 miles (1 year)	.126**	12.570
0.5-1 miles (1 year)	.129**	15.911
1-5 miles (1 year)	.079**	12.231
<0.25 miles (2 year)	-.111**	-11.613
0.25-0.5 miles (2 year)	-.099**	-9.831
0.5-1 miles (2 year)	-.102**	-12.576
1-5 miles (2 year)	-.053**	-8.219
Years between sales	.058**	134.559
Number of transfer	-.006**	-134.796
N	366,649	
R^2	0.111	
Adjusted R^2	0.111	

**: 95% significant; *:90% significant

Similarly to Table 9, regional dummies and their interaction with rail proximity in the model were included. There are three regional dummies in the model: San Francisco (SF County), East Bay (Alameda County and Contra Costa County), and South Bay (San Mateo County and Santa Clara County). Among which, SF County dummy and South Bay dummy were interacted with rail proximity indicator for the one-year lag. Table 14 shows the estimation result.

Table 14. Lagged Transit Accessibility Variables Estimation Result for SF Bay Area model (y: annual appreciation rate)

	B	t-test
(Constant)	.123	81.608
all		
<0.25 miles (1 year)	.122	12.234
0.25-0.5 miles (1 year)	.117	11.410
0.5-1 miles (1 year)	.115	13.885
1-5 miles (1 year)	.061	9.437
<0.25 miles (2 year)	-.114	-11.867
0.25-0.5 miles (2 year)	-.100	-9.903
0.5-1 miles (2 year)	-.100	-12.298
1-5 miles (2 year)	-.049	-7.697
South Bay		
South Bay dummy	.026	15.618
<0.25 miles (1 year, South Bay)	-.002	-.652
0.25-0.5 miles (1 year, South Bay)	4.245E-05	.015
0.5-1 miles (1 year, South Bay)	.006	2.604
1-5 miles (1 year, South Bay)	.013	6.991
San Francisco		
San Francisco Dummy	.050	10.175
<0.25 miles (1 year, SF)	-.011	-1.995
0.25-0.5 miles (1 year, SF)	-.016	-2.923
0.5-1 miles (1 year, SF)	-.013	-2.332
1-5 miles (1 year, SF)	.003	.561
East Bay Dummy	.036	32.656
num_transf	.059	136.909
sale_year	-.006	-134.978
N	366,649	
R^2	0.114	
Adjusted R^2	0.114	

**: 95% significant; *:90% significant

Table 15 shows the estimation results for LA county. The parameters on rail proximity are similar to those in the SF Bay Area model. However, the pattern is much clearer here. Generally speaking, the effect of rail proximity on annual appreciation rate is gradually decreasing within the same year when distance is further away from rail; and it is increasing when we keep the distance to rail constant but with time approaching current year. Therefore, in this case, when rail development takes place in between years, the incremental effect of rail development is significant. This finding is also consistent with the descriptive analysis.

Table 15. Lagged Transit Accessibility Variables Estimation Result for LA County Model (y: annual appreciation rate)

	Parameters	t
(Constant)	.413**	226.713
<0.25 miles (current year)	.115**	15.375
0.25-0.5 miles (current year)	.082**	13.279
0.5-1 mile (current year)	.071**	17.775
1-5 miles (current year)	.074**	42.770
<0.25 miles (1 year)	-.073**	-10.415
0.25-0.5 miles (1 year)	-.032**	-5.326
0.5-1 miles (1 year)	-.031**	-8.008
1-5 miles (1 year)	-.055**	-28.652
Size (1,000 sqft)	.000**	3.807
Years between sales	-.021**	-318.211
Number of transfer	.043**	79.468
N	431,664	
R^2	0.232	
Adjusted R^2	0.232	

**: 95% significant; *:90% significant

Table 16 shows the model estimation result in SD county. The result is different for SD county compared to the previous two models, in that the estimation result indicates that properties that are located within 0.25 miles from rail with no rail development took place in between sales tend to have lower value. As for the incremental effect of rail development, the model provides similar output compared to the previous two models. There is incremental effect on appreciation rate when rail development took place prior to a second sale.

Table 16. Lagged Transit Accessibility Variables Estimation Result for SD County Model (y: annual appreciation rate)

	Parameters	t
(Constant)	.187	125.388
<0.25 miles (current year)	.057	13.764
0.25-0.5 miles (current year)	.049	12.607
0.5-1 mile (current year)	.034	13.028
1-5 miles (current year)	.046	33.918
<0.25 miles (1 year)	-.060	-15.205
0.25-0.5 miles (1 year)	-.049	-13.031
0.5-1 miles (1 year)	-.034	-13.526
1-5 miles (1 year)	-.038	-29.183
Size (1,000 sqft)	.001	13.715
Years between sales	.057	111.386
Number of transfer	-.010	-187.689
N	231,367	
R^2	0.213	
Adjusted R^2	0.213	

**: 95% significant; *:90% significant

Table 17 shows the incremental effects of rail development on annual appreciation rates (2 years: nearest rail station between 1 and 5 miles, 1 year: nearest rail station within 0.25 miles) for different study regions, controlling for all other factors. We can see from the Table that rail development is associated with the increase of appreciation rate for most regions except for San Diego. And San Francisco County seems to yield the highest incremental effect from rail development, followed by SF South Bay, SF Bay Area as a whole and then LA.

Table 17. Incremental effects of rail development on properties' annual appreciation rate (distance to nearest rail station changes from between 1-5 miles two years ago to within 0.25 miles one year ago)

Regions	incremental effect of rail development
SF Bay Area all	0.07
SF County	0.11
SF South Bay	0.10
LA	0.042
SD	-0.041

Summary of Quantitative Analysis

The analysis presented in this chapter showed that rail development generally promotes employment agglomeration and land value. However the magnitude of such effect differs across regions. The analysis finds that San Francisco County, and to a lesser extent the Bay Area as a whole, yields the largest benefit from rail development, measured by employment densification and land value. The LA region also benefits from rail development for both employment density and property value. Rail development in South San Francisco Bay Area, where Silicon Valley is situated, appear to have minimum effect on employment densification, but does have a positive effect on land value appreciation. On the contrary, rail development in the San Diego region is positively associated with employment density, while negatively associated with land value appreciation.

The models captured the different incremental effect from rail development to employment densification and land value appreciation. The factors for such differences possibly lies within the urban forms and policy landscape in the different regions. Factors such as urban density, current transit service, automobile ownership, major industries, and parking policy could affect developers' attitude toward rail proximity. The qualitative analysis would examine part of this question through interviews with real estate professionals.

Interview and Qualitative Analysis

This section summarizes the findings from interviews with real estate professionals in the San Francisco Bay Area (SF Bay Area) and Los Angeles (LA) metropolitan regions. The purpose of the interviews is to better understand the reasons why rail transit service has been coincident with, or unrelated to, changes in employment density, firm changes, location decisions, and higher property value.

Introduction

We conducted interviews with 23 real estate professionals, including developers, investors, tenant broker representatives, and in-house researchers of real estate professional services firms. In total, we were successful in scheduling interviews with seventeen experts in the Los Angeles metropolitan (LA) region and seven in the San Francisco Bay Area (SF Bay Area) region.

Table 18 below provides a summary of interviewee roles. Appendix E provides further characteristics of the individuals represented. Interviewees had varying degrees of real estate experience, ranging from newly hired to senior executives with three decades experience in the industry as well as company founders.

Table 18. Summary of interviewee roles

Role of Interviewee	No. of Interviewees Represented
Developer involved with projects of various complexities	4
Corporate researcher	7
Tenant/landlord broker representative	8
Real estate investment specialist	2
Other (involved broadly in real estate services)	2
TOTAL	23

The interviews were semi-structured and mainly open-ended to allow for in-depth discussions. Topic guides and questions included: the role of public rail transit in making investment and tenanting decisions; the reasons for why transit is valued; the types of industries/ tenants/owners that value transit; the transportation amenities that employers provide; and other factors that contribute to firm location. Appendix B provides a list of the guiding questions. The length of interviews ranged from approximately 30 minutes to two hours.

The purpose of the interviews with real estate professionals and land developers were to illuminate which of the most important agglomeration mechanisms may be at play, if any, in decisions to locate near or far away from transit-served areas. As presented in the the quantitative analysis section, rail development generally promotes employment agglomeration and land value, and as such we wanted to better understand qualitatively the reasons why rail transit service has been coincident with, or unrelated to, changes in employment density, firm changes, location decisions, and higher property value.

The findings from interviews vary distinctly between the LA and SF Bay Area regions. They are further distinguished within the regions. There was consensus among all interviewees that public rail transit is becoming increasingly more and more valued, particularly in less transit accessible areas of LA and the South Bay/Silicon Valley. Public transport infrastructure seems to play a role in facilitating agglomeration economies, that is, facilitation towards higher density employment clusters, although this is more pronounced in the SF Bay Area than in LA.

For the purposes of this research, the rail systems discussed are mainly commuter rail. In the Bay Area, the rail systems mainly involve the Bay Area Rapid Transit (BART) and Caltrain commuter rail. In LA, the rail systems are mainly light commuter trains that are utilized for cross county as well as local travel.

Insights from the Los Angeles Metropolitan Region

There is a general understanding in the Los Angeles metropolitan region that rail creates value. Transit-oriented development and transit-oriented community are the current buzz in the development industry in LA. The focus of commercial development is targeted at mixed-use, which usually means a retail component on the ground floor. There is a trend towards creating live-work-play communities that are amenity-rich and that are often located on or adjacent to rail stations.

According to developers and investment specialists, capital partners currently want to invest in places with transit. This is a notable shift for institutional capital that are now willing to invest in what was historically seen as potentially risky locales.

Transit in LA is largely driven by traffic congestion. According to interviewees, traffic is so bad that people no longer want to endure it. The shift to non-auto mobility may have less to do with rail investments and more to do with mitigation of traffic congestion on LA's freeways. As one interviewee suggests, LA is developing into "pocket cities" where people can live, work and play in the same urban location and in essence eliminating the need for cross-town driving on an everyday basis. Pocket cities cited were downtown Santa Monica, downtown Culver City, Brentwood, downtown LA and downtown Pasadena. These places are becoming more dense with housing, commercial and retail. Interviewees believe that these formations largely stemmed from the development of the Metro rail lines.

Rail does not seem to drive commercial office development so much as traffic congestion, demographics and the regulatory environment. The younger workforce wants to be near amenities and simultaneously the regulatory policies, such as allowing density bonuses, are enabling development to be located near rail.

Downtown Revitalization

Downtown Los Angeles comprises the rail transit hub of the LA region. Interviewees cited the adaptive reuse ordinance as the catalyst for the current downtown revitalization. The ordinance relaxed the zoning code in downtown and enabled historic buildings to be converted to live and work spaces. According to interviewees, downtown LA now carries a residential population of 50,000. Furthermore there are 60,000 housing units currently under construction or are about to be delivered in downtown. Interviewees are following this trend closely, because the office markets follow the housing and retail markets in tandem. This suggests that there is now a proximity to the workforce that did not exist before.

Downtown is fast becoming an appealing place to live and work. Downtown residents can more easily walk or take transit to jobs. The neighborhood can support amenities that make non-car living possible, such as being walking distance of restaurants, retail and entertainment. The Arts District, located directly northeast of downtown, was cited as the most exciting downtown neighborhood for real estate development. While it is still an active and productive industrial area, it is experiencing rapid conversion to creative offices and residential. As was suggested by one interviewee, downtown seems to characterize the "pocket cities" trend.

Another reason for the boom in downtown development is the push from historically more desirable areas on the west side of Los Angeles and Santa Monica. Commercial rents are currently lower in downtown. An interviewee also noted that there is very little room for development and it is more expensive to live on the west side.

Market Driven by Tech, Entertainment and Media

The real estate market and development is spurred by creative tenants in tech, entertainment, and media. Interviewees assert that these sectors make up nearly 50% of the current LA leasing market. Playa Vista, a neighborhood on the west side, has experienced a real estate boom in recent years driven almost entirely by the tech, entertainment and media sectors. Projects are in turn marketed at these firms.

The work and lifestyle preferences of the millennial cohort, who are predominant in the tech, entertainment, media sector, are also driving office products. Firms are reconfiguring their office space environment and providing bicycle amenities to attract and retain talent in this cohort.

Perception of Rail Transit

The perception of public rail transit in Los Angeles vary greatly amongst interviewees. While rail is generally perceived positively, interviewees stressed that the commute time has to be competitive to driving in order to attract riders to the system. Traffic congestion is the reason for rail becoming more and more important in the last few years therefore rail has to be faster than driving in order for people to transition.

Much of the LA metropolitan region is not currently being served by rail so the resistance to riding rail is because it is not convenient. The last mile issue is a major hurdle. Most people would still need to make a bus or other types of transfers. The most skeptical view came from a tenant representative who asserted that the car culture is still dominant in the region and he would rather that transportation investments be made to facilitate more efficient utilization of roadways.

On the other hand, researchers and developers interviewed see the larger value of transit to access the workforce. A theme echoed throughout all the interviews is that there is a shifting preference for transit amongst the millennial generation, which is the cohort that employers seek to recruit and retain.

While rail is currently not an important factor to firm location and expansion, interviewees all seem to support rail transit investments. This is due to the fact that mobility, or lack thereof, is becoming an increasingly costly condition that LA suffers through. One interviewee notes that the types of companies that value their employees are more inclined to locate in transit served areas.

Expansion of the Rail System

There is excitement on the part of land developers to tap into the development potential of the rail system expansions. The expansion of both the Expo and Purple rail lines to the west side of LA is seen as a valuable marketing tool for commercial real estate. Tenants are looking at proximity to the downtown rail stations and the connection to the Expo Line light rail as a criterion in site selection that ten years ago they did not. Interviewees believe that the expansion will benefit downtown more than it will benefit office buildings on the west side. The recent influx of creative tenants is coming from the west side, where rents are nearly double to downtown. However, while rail transit adds one more element to making downtown more marketable, the west side and Santa Monica are still more desirable places to locate.

There was consensus that the Expo light rail line is the most exciting rail expansion project for the commercial real estate industry. The line currently goes from downtown LA to Culver City, and its expansion to Santa Monica is slated to open in May 2016. Interviewees are closely monitoring this milestone as it will finally connect downtown to the ocean via rail. One interviewee optimistically asserts that for the first time, one could actually live in LA and not have to have a car.

Along the Expo Line, Culver City is perceived to have the greatest potential for commercial real estate development. The projects here are generally mixed-use redevelopments of formerly single-use or surface parking lots. Nearly all the interviewees' firms have various stakes in the area, whether through acquisition, development, investment or brokerage.

While rail is a positive marketing strategy in Culver City, an interviewee noted that they would nevertheless have gone through their recent acquisition of a notable building in the area even if the Expo Line was not there. In fact, a greater determinant was that the site has favorable parking and that Culver City is conveniently located at the midpoint between downtown LA and the west side. Furthermore, there are old warehouse buildings that are more amenable to conversion to the types of open floor office space that the current tenants like. In Culver City, forces have aligned to contribute to the city's current development renaissance and whereby properties have doubled or even tripled in value.

The eastward extension of the Gold Line commuter light rail from its current terminus at the Sierra Madre Villa station in the City of Pasadena to the City of Azusa is also anticipated to spur development activities. The extension opened in March 2016 and Pasadena recently updated its general plan to allow for increased housing development. An interviewee recently sold an office project that was adjacent to the Sierra Madre Villa station and whose surface parking lot will be developed into apartments. Numerous projects of similar scope and use are being developed within this area because developers are taking advantage of the increased floor area ratio (FAR) allowance. While developments in this part of the LA region are currently mainly focused on residential, it is because developers are catching up to demand for more affordable housing for white collar workers. These projects also provide dining and retail amenities, which in turn will drive the office market, as was noted by several interviewees. Clusters of industries already exist in Pasadena and developments here will further promote agglomeration economies.

Other rail lines on the Metro system are not perceived to be as valuable as the Expo or Gold lines. Rail is an added value to the extent that a firm happens to be in proximity to it, but office and industrial tenants and brokers do not consider it to be an important factor in site selection. One firm is utilizing sophisticated mapping software to track the millions of square feet of Class A office property along the Expo and Purple light rail lines, which will be important connectors between downtown and the west side. However, the Purple line is not expected to be completed until 2035, which may be too far in the future for current real estate development prospects and speculation.

In the meantime, the Regional Connector rail line that is currently under construction has already changed some development patterns in the Little Tokyo and Arts District. Interviewee cited a recent lucrative project that is located within a block of the future Regional Connector.

While in the South Bay, rail is not seen as a factor. While an interviewee noted that some of his company employees take the Green Line, the region is dominated by sprawling industrial pockets that are not conducive to transit. Lastly, the Blue Line, which is the first light rail line to be opened in the region, is completely discounted by interviewees for it has spurred very little development nor does it engender much development interest in the near future.

The Role of Parking

Parking plays a significant role all across LA. New parking structures are being built in the Arts District to accommodate the rapid conversion of industrial buildings in the area into more dense live and work spaces. Closer to the downtown core, parking is an issue that is yet to be fully figured out for the desirable historic buildings. These buildings often provide very low parking if at all, yet they are often occupied by the creative tenants that tend to provide higher density occupancy.

On the west side and Santa Monica, parking plays an outsized role in real estate development. Transit plays a minor role in site selection as indicated by the strong office growth and demand in non-rail locations such as Playa Vista and Santa Monica. While interviewees hope that people will utilize rail, they admit that any property would be struggling to lease if there is inadequate parking provisions. Interviewees believe that the parking ratio is not adequate to meet the demands of tenants on the west side. Projects have had to trench down as well as put in stacker parking to meet demands. It is a benefit to a development project if parking can be provided at 4 to 5 per thousand square foot. Tenants are willing to pay the high cost of parking and developers are able to over-sell parking by 15-25% to satisfy tenants' demands.

On the other hand, one interviewee believes that regulation that dictates high levels of parking construction is a major limiting factor to development in certain parts of LA. This interviewee's project was required to dedicate $30 million towards parking even though it is located a block and a half from the Union Station transportation hub. Interviewee believes that maximizing parking flexibility rather than requiring minimum parking will incentivize developments.

Parking demand do not seem to be relaxing thus far. In fact, one interviewee believes that the move towards rail will only create more demand for parking structures near rail stations. This interviewee is focused on acquiring properties for dedicated parking structures near rail stations.

Industrial Office

Rail does not play a role on the industrial office side. Industrial buildings are mainly located in the South Bay in close proximity to the ports and airports. Industrial buildings are also located on the outskirts of the LA metropolitan region where land is cheaper and are far away from commuter rail. One interviewee noted that the low-wage and blue collar employees working in these warehouse and distribution centers would benefit from commuter rail accessibility. While intermodal freight rail is a key component of the supply chain logistics and goods movement, there is virtually no interface between freight and passenger rail.

One interviewee is developing a 60-acre infill distribution center inside the LA urban core. It is located approximately 10 miles from the ports and airport. This is positioned to attract tenants that want to distribute goods quickly within the Southern California consumption zone. Employers will need to hire highly skilled workers to operate the more sophisticated and technical automated warehousing computers and equipment in these new generation distribution centers. In the current highly competitive environment for labor, it is important to attract and retain highly skilled workers. So while this project is not located within walking distance of rail, interviewee believes that its relative proximity to passenger rail could be a competitive advantage when it comes time to negotiate with possible tenants. It was noted that tenants might provide shuttles from the rail station as an incentive to access the labor pool.

Finally, clusters of agglomeration economies are dotted throughout the region. For instance, the San Fernando Valley has a lot of cosmetics, health and beauty. There is a clustering of third party logistics companies in the South Bay. Glendale and Burbank has strong clusters of the entertainment and media sector. The west side, Playa Vista, and increasingly El Segundo and Pasadena are establishing technology clusters. With the exception of Pasadena, rail does not seem to feature prominently in firm location patterns in these clusters. It seems to suggest that rail does not play a significant role in promoting agglomeration economies in the LA region.

Insights from the San Francisco Bay Area

Developers, researchers, investors, and tenant representatives all across the board agree that locating near rail transit is very important in the Bay Area, and especially so in San Francisco. The younger workforce in tech tend to be attracted to urban environments where active and public transportation are more accessible. Companies follow suit in order to attract and retain this workforce. Developments away from less transit accessible locations in the East Bay and Silicon Valley are paying a price in the form of reduced rent premium. Companies are having to provide transportation amenities such as shuttle buses and subsidies to connect workers to jobs.

The Changing Workplace

One interviewee notes that transit and office density are interrelated. As he has seen office get much denser in the past decade, transit accessibility is becoming more important. Tech and current users are putting 6-8 workers per thousand square feet in a building that traditional law and financial firms had in the past had 3-5 workers.

A case in point, this interviewee had moved a well-known client from a 295,000 square foot to a 195,000 square foot building without shrinking the workforce. Densification of the workforce could easily translate to an over-supply of office products, but the demand in San Francisco has been so strong that developers are scrambling to provide new office products. Densification of the workforce could also translate into demand for more parking, but there has been a steady decrease in driving in the city.

All interviewees echo the trend of young tech workers wanting to be in urban environments close to amenities and transit.

The Strong Tech-Driven Office Demand in San Francisco County

The dominant industry drivers in San Francisco City have changed from finance, insurance and real estate (FIRE)-focused to currently predominantly tech. One interviewee mentioned that tech tenants are taking up as much as 60% of the current office leasing.

According to interviewees, the entitlement process in San Francisco is significantly more complicated, bureaucratic and political than in most other major cities. In addition, Prop M has really constrained the amount of office supply that San Francisco can approve. The city also has a clear preference for development near transit. With the current economic boom in the city, there are 11 million square feet waiting to be approved, resulting in rent increases all across the city.

Neighborhoods with intense development, such as Mission Bay, would not exist or be as successful without the Third Street light rail. Additionally, the rail hubs along Market Street is vital to the urban experience. The Montgomery Station, with its vibrant retail component, makes it a part of the urban fabric as opposed to a bi-section of the city to get from place to place.

Tenant tours of properties used to be given to a company’s real estate person or a CFO-type, but now they give tours to the human resources personnel. The vast majority of tech companies are hiring, so in addition to taking care of their existing employee base, human resources are actively thinking about who they will be bringing in. They want to be located near public transportation and a nice location with good amenities. A recent client specifically only wanted to be within five minutes walking distance of BART. According to the interviewee, if potential hires have to walk 15 or 20 minutes from BART to get to the building, they are significantly less likely to want to work there, even if the pay is more or that it is a great space.

New office development within the last five years has been concentrated in and around the Transbay Center. Notably, this area is the halfway point between Caltrain and BART. This location is important to tech-driven companies. They need Caltrain for their workforce that live in San Francisco but need access to Silicon Valley. Silicon Valley is still considered the epicenter of tech. While BART enables access to the labor force living in the East Bay.

Caltrain, BART and the VTA

Sites that are within proximity of BART and Caltrain are highly valued. There is general agreement that an area is considered successful if there are diverse mixes of amenities that make it a destination. To these real estate professionals, rail can play a major role in facilitating these types of mixed use environments. One developer admits that one of his firm's current projects is not great in and of itself, but being on a Caltrain will make it more valuable. Others mention that specific places, such as Redwood City, would not be as popular without the Caltrain. In fact, a major in construction mixed-use project that includes housing, retail, office, and theatre is leveraging its proximity to the Redwood City Caltrain station.

On the East Bay, one developer cites Walnut Creek as the closest to being a destination shopping center rather than just a worker hub. Foster City suffers from a lack of rail whereby commuters only pass through via the freeways.

One interviewee believes that the pro-growth movement in North San Jose, while great for developers like him, is going to be a challenge 10 or 15 years from now. They are building commercial but virtually no residential, and the existing Santa Clara Valley Transportation Authority (VTA) light rail system does not have much accessibility value. With no housing, commuters from Union City, Fremont, Milpitas and Gilroy are driving in. Interviewee thinks the VTA is a positive attribute, but as he equates it to a LEED point, it does not meaningfully matter. He believes that a BART to San Jose will help.

On the other hand, while BART sites are valuable, it has been historically difficult to build at BART stations due to its requirements for subsidized and one-for-one parking replacement ratios.

The perceived value of rail transit varies among different industries. Clearly the tech industry sees value in transit, but that is not the case with the life sciences. Important life sciences hubs include South San Francisco and Emeryville, neither of which are convenient locations to Caltrain or BART. While interviewee notes that these clusters have been successful despite lack of transit, mass transit will become more and more important moving forward due to the changing demographics.

Rent Premiums

Over time, rent premiums for buildings near transit have increased, as was shown in the findings in the quantitative analysis section. While Silicon Valley is suburban and does not have great transit, the analysts interviewed have found that the sub-markets that have performed better in this market cycle are those that are walking distance to a Caltrain station.

The highest rents used to be on Sand Hill Road where there was a concentration of venture capital firms, but now the highest rents are near Caltrain stations such as downtown Palo Alto, downtown San Mateo, and downtown Redwood City. Rent premium in downtown Palo Alto is 179.7%; and the rent premiums at the California Avenue stop in Palo Alto and Mountain View Station command 126%.

A building located in downtown Mountain View and four blocks to the Caltrain station that one interviewee developed were comparatively priced to other less transit accessible buildings in North Bayshore in 2002, yet the Mountain View building can now command a 20 to 30% rent premium over North Bayshore. According to interviewees, more people want to live in Palo Alto than in the formerly posh areas of Woodside and Portola Valley.

Interviewees were mixed about the current value of transit in the East Bay. A tenant representative believes that it is increasingly more desirable to be closer to BART than to Caltrain stations. The types of midlevel tech workforce being hired – creatives, customer service, sales people, and some programmers – are coming from the East Bay. There has also been a slow trend of tech companies moving into San Francisco and stopping the busing of employees down to Silicon Valley. Some companies have dramatically increased their footprint in San Francisco while others choose to headquarter or locate entirely there.

However, other interviewees do not currently see the same kinds of pull in the East Bay as in Silicon Valley, where it is still considered the center of tech. All agreed that BART will be more important over time.

In the East Bay, downtown Walnut Creek outperformed the overall East Bay suburban markets because it has great access to the Walnut Creek BART and its walkable downtown. It commands a rent premium of 40.5%.

In order to compete in this environment, landlords must provide shuttles if they are not walking distance from Caltrain or BART. In the East Bay, the Bishop Ranch is a successful business park because there is a shuttle to connect to the Walnut Creek BART.

Yet while downtown San Jose has Caltrain as well as the VTA light rail access, its rent premium is at only 19.5%. The reasons for this low rent premium are unclear. On a case-by-case basis it may depend on the building and neighborhood itself. There are buildings that need to be infused with capital to make it work, whether because it has no amenity, outdated space or it is simply not functional. Others may be well-located but there is nothing to draw one to it. Oftentimes it just takes an anchor tenant, such as Twitter, to take the leap and get things going for an area. Uber going into uptown Oakland is going to be a catalyzing event for that market, according to interviewees. Moreover, a retrofit or conversion may not always fit the office market, and instead are converted into residential, retail and hotels.

The Role of Parking and Other Transportation Amenities

Parking provisions are vastly different in San Francisco than it is in the suburban areas of the South Bay or East Bay. This is due to regulations and tenant demands.

In San Francisco, there has been a steep decline in vehicle commuting and the topic of parking provision often does not even arise during negotiations. Over time driving to work has become very expensive. Most tenants do not get dedicated parking spaces because regulations dictate parking maximums at the rate of half a space per thousand square feet. It is now easily $400 a month to park in downtown San Francisco. This ratio is even less at the Transbay Center.

Companies are more likely to ask for bike facilities. It is now standard to build up bike lockers in the garages in San Francisco. There are clients who will only look at buildings that allow for bikes in the office space or that have bike showers. Companies will even design their office space to provide for wall-mounted bike racks. A prospective tenant for a 450,000 square foot building was looking at putting 8 workers per thousand square feet, yet only asked about bike parking.

Additionally, an interviewee commented that the new shared economy has allowed for more efficient non-auto mobility. Buildings also provide car share services while some companies provide rideshare compensation, especially if they are five or six blocks from BART.

Unlike San Francisco, parking is still a challenge in the South Bay. Tenants in places such as Sunnyvale are demanding 3 or 3.5 per thousand even if they are near Caltrain. An interviewee notes that major tech campuses usually have thousands of spaces for cars despite the fact that they also shuttle approximately 50% of their workers in.

An interviewee's buildings in Foster City that have high worker ratio is creating huge parking crunches because the buildings are not served by transit. On the other hand, another interviewee has noticed a trend of tenants not pushing for parking as they used to a decade ago. One suggestion may be that companies are shuttling employees in rather than build parking. He also admits though that these places typically do not charge for parking. The merchants on Castro Street in Mountain View in particular are adamant about free customer parking.

In the East Bay, Emeryville was brought up as a cautionary point. Development there in the early 1980s went without rail which has prompted the creation of the Emery Go Round to shuttle workers to and from BART. The same type of shuttle system has been instituted in Mountain View to link employees to the Caltrain.

Rail Transit Investment and Agglomeration Economies

Discussions with commercial developers and real estate professionals help illuminate the perceived value of public transportation in terms of firm development and location choices. This in turn provides answers to the question of what role could transportation improvements play in influencing agglomeration economies. Interviews clearly suggest that rail transit investment is valued in the San Francisco Bay Area as well as the Los Angeles region, but to varying degrees and for different reasons.

In the Los Angeles region, with the exception of downtown Los Angeles, the value of rail transit seems to be marginal. There is general agreement that rail is becoming increasingly more important as the region grapples with traffic congestion, but it has yet to play a major role in firm development and location choices. There is a perception that the current rail system does not serve the needs of firms, but land developers are also excited about the region's plans to expand the system. There is little evidence of rail playing a role in facilitating agglomeration economies. To the extent that it plays a role is because it is combined with land use regulations that incentivize development near rail and the shifting workforce demographics that value transit. The capital markets currently gravitate towards policies that encourage transit-oriented development, namely increased floor-to-area ratios (FARs) and adaptive reuse of historic buildings that are often located in transit-rich locations. The millennial workforce that firms try to attract also seem to desire these same types of places.

In San Francisco County, rail transit investment has shown to influence agglomeration economies greatly. Rail enables access to the labor force and access to other regions within the agglomeration economy. For instance, BART provides access to the labor force coming from the East Bay. The Caltrain provides the tech industry with access to the Silicon Valley. Rail transit helps induce firm growth by enabling increase workforce density within buildings. Higher density employment clusters may in turn facilitate learning mechanisms whereby increased spillover effects occur amongst workers and firms in close proximity to one another.

The South Bay and East Bay regions of the San Francisco Bay Area perceive the increasingly important value of rail. Proximity to Caltrain stations translates to higher rent premiums. In regards to access to labor, companies far from Caltrain must now provide private shuttles for their employees in order to maintain competitiveness. Parking is still an important factor in these more suburban locales.

In the East Bay, locations with rich amenities are more successful and can command higher rent premiums. With the current tech-driven economy, interviewees allude to the lack of an agglomeration economy in the tech industry in the East Bay. This can often be achieved with the arrival of an anchor tenant, as was the case with Twitter into the South of Market neighborhood of San Francisco. Developers are anticipating that Uber going into Oakland will catalyze that market.

Conclusion

Agglomerations are clusters of firms, households, or both, as large as whole cities and as small as neighborhoods. The quantitative analysis showed that rail development generally promotes employment agglomeration and land value. However the magnitude of such effect differs across regions.

San Francisco County yields the largest benefit from rail development, measured by employment density and land value. The LA region also benefits from rail development for both employment density and property value, but the magnitude of such benefit is smaller than that in SF Bay Area. Rail development in the South Bay part of the San Francisco Bay Area appear to have minimum effect on employment densification, but have positive effect on land value appreciation.

While the findings of this analysis indicate that there are higher employment densities near rail, the densities may not be the result of rail so much as rail developments might take place in areas with already higher density in order to generate revenue and ridership. This suggests that land use patterns and urban land policies may play a greater role in the varying levels of rail influence on agglomeration economies across regions. In particular, land use patterns in downtown LA and San Francisco County promote agglomeration economies more than the more car-dependent and sprawling parts of the LA metropolitan and San Francisco Bay Area regions.

The qualitative analysis confirmed that transit plays the greatest role in San Francisco County, and proximity to Caltrain stations in Silicon Valley provides greater rent premiums. However, because of the higher parking provisions and employer-provided shuttles, transit plays a lesser role in the Silicon Valley area. This is consistent with the quantitative analysis, and provides a valid explanation of the marginal impact of rail development on employment densification in the South Bay Area. The qualitative analysis also finds that in Los Angeles, rail is highly valued in the downtown area, and to a much lesser extent in the other regions such as the west side and South Bay. Developers in LA continue to believe that it is currently not feasible to shed auto-mobility due to the sprawling land use patterns and the perceived lack of transit accessibility, although they increasingly value transit accessibility.

Finally, the qualitative analysis may direct us to a future quantitative study. Further quantitative analysis can investigate the specific factors that would improve transit accessibility towards employment densification and increased land value.

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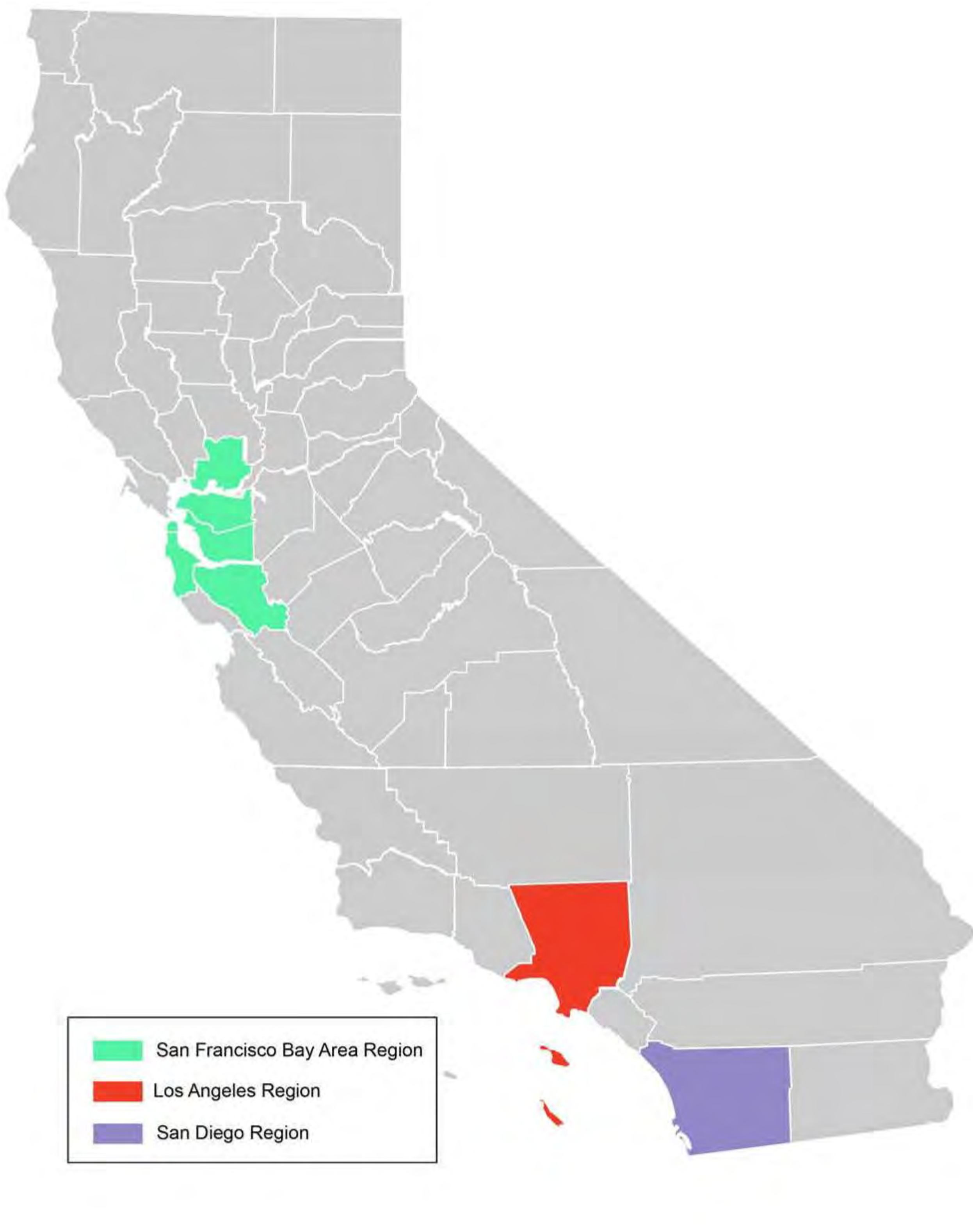
Appendix A. Map of California Regions Analyzed

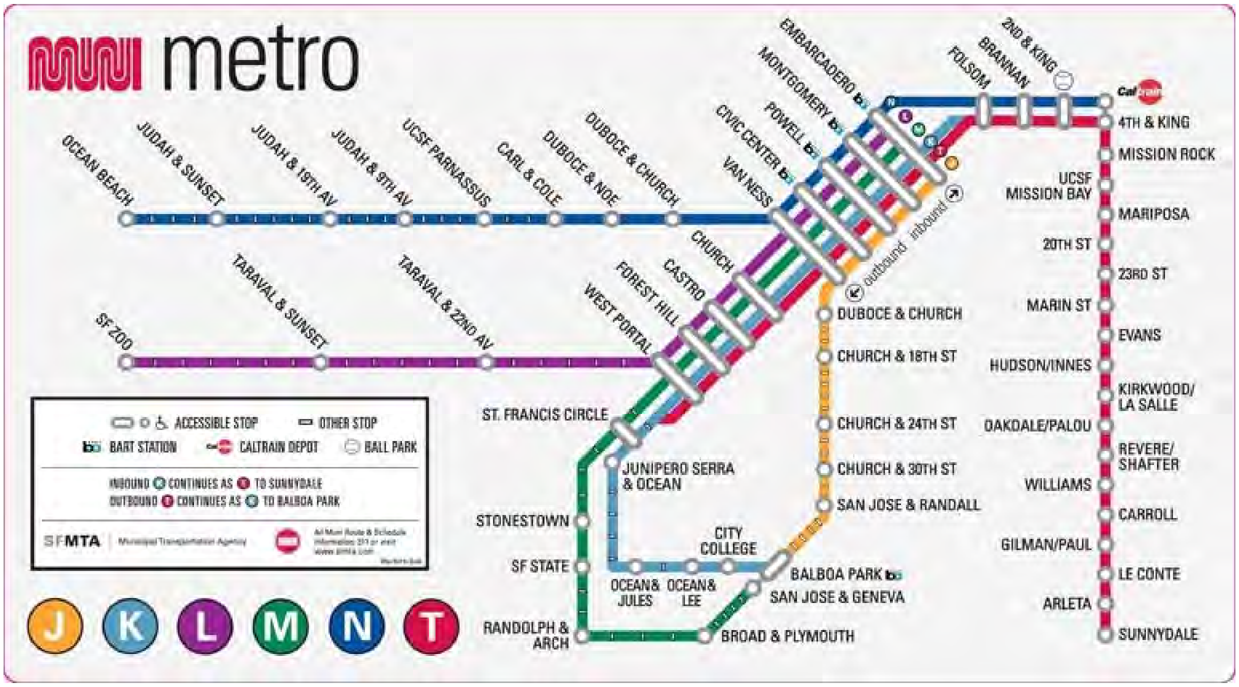


Appendix B. Maps of San Francisco Bay Area Rail Transit Systems Analyzed

BART Commuter Rail System Map

Source: Bay Area Rapid Transit

Muni Metro Light Rail System Map



Source: San Francisco Municipal Transportation Agency

Caltrain Commuter Rail System Map

Source: Caltrain

VTA Light Rail System Map

Source: Santa Clara Valley Transportation Authority

Appendix C. Map of Los Angeles Metropolitan Region Rail Transit Systems Analyzed

Metro Rail System

Source: Los Angeles County Metropolitan Transportation Authority

Appendix D. Map of San Diego Metropolitan Region Rail Transit Systems Analyzed

Trolley Light Rail System Map

Source: San Diego Metropolitan Transit System

Appendix E. Interviewee Overview

Firm Location (Metro Area)	Date of Interview	Type of firm	# of interviewees	Interview Name, Position Title, Name of Firm	Interview Format	Main Interviewer
Los Angeles	11/11/15	Development	1	Alex Valente, Senior Associate, Trammell Crow	Phone	Dan Chatman
Los Angeles	12/7/15	Multifaceted real estate services	6	Bryce Mordoff, Director of Research Tim Miller, Vice President of Leasing, Henry Gjestrum, Office Research Devon Parry, Office Research Taylor Coyne, Retail Research Shanie Adoptante, Industrial Research (all at JLL)	In-person	Dan Chatman
Los Angeles	12/8/15	Multifaceted real estate services; investment; development	3*	Michael Longo, Vice President, CBRE, Stephen Lindgren, Director, Lincoln Property Company, Alex Valente, Senior Associate, Trammell Crow	In-person	Dan Chatman
Los Angeles	12/8/15	Investment	1	John Norton, Director, LBA Realty	In-person	Dan Chatman
Los Angeles	12/8/15	Development	1	John Balestra, Senior Vice President, Trammell Crow	In-person	Dan Chatman
Los Angeles	12/8/15	Advisory services; investment	1	Jonathan Kaji, Founder, Kaji & Associates	In-person	Dan Chatman
San Francisco	2/3/16	Development	1	Michael Covarrubias, CEO, TMG Partners	Phone	Dan Chatman

San Francisco	2/5/16	Multifaceted real estate services	2	Amber Schiada, VP & Director of Research Julia Georgules, Director of Research	In-person	Dan Chatman
San Francisco	2/5/16	Development	1	Carl Shannon, Sr. Managing Director, Tishman Speyer	In-person	Dan Chatman
San Francisco	2/19/16	Multifaceted real estate services	1	Tom Poser, Senior VP of Tenant Representation, JLL	Phone	Dan Chatman & Kim Le
San Francisco	2/24/16	Development	1	Dan Kingsley, Managing Partner, SKS	Phone	Kim Le
Los Angeles	3/1/16	Tenant Representation	1	David Toomey, Principal, Cresa	Phone	Kim Le
San Francisco	3/17/16	Tenant Representation	1	Tim Mason, Executive Vice President, Kidder Mathews	Phone	Kim Le
Los Angeles	3/30/16	Tenant Representation	1	Michael Collins, Vice Chairman, DAUM Commercial	Phone	Kim Le
Los Angeles	3/31/16	Broker	1	John Lane, Associate, CBRE	Phone	Kim Le
Los Angeles	3/31/16	Broker	1	Kevin Duffy, Senior Vice President, CBRE	Phone	Kim Le

*Alex Valente was interviewed twice.

Appendix F. Interviewee Survey Questions

Opening Questions

- How did you start in this business?
- How long have you been with your firm?
- What is your role and focus within the firm?
- Describe some of your recent projects (and specific questions related to those projects).
- Describe the geography in which you work.
    - What are the geographic boundaries of this submarket?
    - What are the typical vacancy rates? How does this compare to other submarkets?
- Describe the types of tenants in these areas.

Research questions

- Do you believe that rail transit accessibility is important?
- What are the reasons for why transit is valued? (e.g. access to labor?)
- What are the industries that value transit and will this change over time?
- Does public transit facilitate clustering of firms?
- Describe the impact that the (Gold Line/Green Line/etc.) metro rail has on the particular commercial property market.
- Is proximity to transit featured in your marketing to prospective tenants?
- What are the other transportation amenities being provided (e.g. bike parking?) and are they effective in changing commuting behavior?
- What is the role of parking?
- What are other factors that contribute to firm location? (e.g. zoning changes? Office design and layout?)
- Describe the role of public transit in making investment decisions.
- Describe the decision-making processes of tenant/firm location or expansion.

Closing Questions

- Do you have recommendations for others we may be able to interview?
- May we follow-up if we have additional questions?