Correlation Between Land Use and Metro Rail Ridership in Los Angeles

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by

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Abstract:

As oil price continues to grow and traffic jams making daily travel harder than never, public transportation is widely considered a preferred option for major metropolitans worldwide. Los Angeles County, facing the worst congestion in the nation, has several Metro rail extensions on the way. As rail stations are expected to grow, there are a great number of Transit Oriented Development (TOD) projects around the existing and new stations, aiming to increase the transit ridership. There have been various studies on factors that affect ridership. This paper studies the correlation between rail station ridership and land uses around the station in Los Angeles County. We found that different land use around different stations have different results. According to the findings, some suggestions are provided for future research.

Introduction

Los Angeles (L.A.) County voters approved the Measure R in 2008, committing a projected $40 billion from sales tax to traffic relief and transportation upgrades throughout the county over the next 30 years. There will be 11 new rail lines and extensions, including light rail, bus rapid transit, and the subway to the sea. The Los Angeles County Metropolitan Transportation Authority (L.A. Metro) is in the process of undertaking the 30/10 Initiative, which "accelerate construction of 12 key Metro expansion projects originally scheduled to be built over three decades – and complete them by 2019" (Metro, 2010). The transit system expansion will add 102 miles of rail transit and almost 100 new stations, while creating 400,000 new jobs.

However, infrastructure alone is not enough to promote public transit, nor to support residents in their ability to find affordable, healthy, and prosperous places to live. Transit Oriented Development (TOD) is the concept to based on to comply with transit infrastructure building. (CTOD, 2010) TOD is defined generally as "a mixed-use community that encourages people to live near transit services and to decrease their dependence on driving." (Carlton, 2007) There have been TOD projects implemented around existing stations in Los Angeles, such as the Wilshire and Vermont station, and the stations in Hollywood. TOD is on the rise in California, with new projects being pushed in conjunction with new rail lines in Southern California and the Bay area. The growth in transit is bringing a long list of TOD projects catering to a combination of mass transit, denser neighborhoods, and mixed-use and pedestrian scale development.

According to statistics gathered by the U.S. Department of Transportation (DOT) and the American Public Transportation Association (APTA), the number of trips taken on public transportation increased by 4.0% in the United States in 2008, while the number of miles traveled by vehicles fell by 3.6%. U.S. Congress approved legislation to reauthorize federal programs for public transit through September 2014. This represents a high-water mark in federal funding for public transportation (APTA, 2013).

To justify such large investments in public transportation and TOD, it is important to be able to understand the interaction between the station environment and the potential future transit usage. For this purpose, the identification of factors that affect

transit ridership is essential. In addition, these factors also provide insight on strategies to increase transit demand.

The growing trend of public transit lays the soil for studies on how to increase public transit ridership. Factors that affect transit ridership can be classified as internal or external variables. (Gregory L. Thompson, 2008) The internal factors include: fare policy, service frequency, service coverage, service orientation, and targeted marketing efforts. The external factors include: urban structure, local land use patterns, automobile ownership levels and costs, and regional economic conditions. Studies have shown that external factors have a greater impact on ridership than internal factors (Taylor, 2009). Among external factors, land use and density have been shown to have the biggest impact on transit use (Johnson, 2003).

There are plenty of literatures that study the relationship between land use and transit ridership. However, there is only one paper analyze such topic in Los Angeles and it is about ridership of Bus Rapid Transit (BRT) (Banerjee, Myers, & Irazabal, 2005). Therefore, the objectives of this paper are: (1) to develop a ridership model based on the L.A. Metro, (2) to better understand Los Angeles comparing to other cities, (3) to test the generally accepted theory of land use/ridership relationship.

This paper will begin with the state of the literature on TOD and ridership models, followed by data description and methodology sections. Various land use of will be run with L.A. Metro Rail station ridership using linear regression. The last two sections describe and discuss the results and provide suggestions for future studies.

Literature Review

Merit and Sin of Automobiles

The development and mass-produced of automobile represent a revolution in mobility and convenience. However, modern consequences of heavy automobile usage contribute to the use of non-renewable resources, global warming, urban sprawl and urban decay.

More than that, oil prices had folded more than twice for the start of this century, from about $20 per barrel to about $90 per barrel. Driving is getting less and less affordable. The motor vehicle ownership per 1,000 people of United State reached its top, 820, in 2007 and dropped to 797 in 2010 (The World Bank). On the other hand, congestion has never been more severe throughout the country. Collectively, Americans spent nearly 500,000 years stuck in traffic in 2007 – nearly 4.2 billion hours. The cost of traffic congestion hit $87.2 billion in wasted fuel and lost productivity, or $750 per traveler. (Tom Knopf, 2008) All these form a push against the automobile-dependent travelling pattern.

Factors that Affect Ridership

Over the past two decades, there has been a great deal of interest in the relationship between local land use patterns near public transit stations. Often labeled as Transit Oriented Development (TOD), these literatures hypothesize that density, land use mix, and urban design of a neighborhood can influence individual mode choice decisions.

The term TOD was introduced by Peter Calthorpe, a California planner and architect, in the late 1980s. Calthorpe defined it as a method to create dense, mixed-use, pedestrian-friendly, socio-economically diverse neighborhoods centered on transit stations. He believed that combining a rich local pedestrian environment with access to regional centers by transit would reduce dependence on the automobile and promote more environmentally friendly and sociable lifestyles (Paul, 2010).

More studies focused on the link between density, especially residential density, and transit ridership than any other factors.

So this paper studies the relationship between ridership and land uses. The research question is whether land uses, besides residential and commercial mix, such as open space and parking, correlate with ridership. If correlation does exist, what proportion

of each land uses, or what combination of land uses could best increase transit ridership. These answers can add up to the density-ridership discoveries and further guide TODs to fully utilized the public transit stations.

Distances Matters

Parker and others (McKeever, Arrington, & Smith-Heimer, 2002) did case study of TODs in California and found linkage between TODs and transit mode share, supporting the idea that if metropolitan areas promote developments characterized by higher density, more mixed uses, and more pedestrian-friendly designs, there will be auto use decline, while transit use, walking, cycling increase.

Cervero (1993) cited a study in Washington, DC in 1987 that transit mode share declines by 0.65% when distance of a residential site from a rail transit station increase by 100 feet. The same study also found that ridership declined gradually as distance to the station increased. So the TOD projects focus on the quarter mile radius around the transit station, which is normal people's 5 minutes' walk.

Density and Mix-Use Matters

In Kuzmyak's study (Kuzmyak, Pratt, & Douglas, 2003), places with mixed land uses tend to have higher transit use. However, they noted that many of these environments tend to also be characterized by higher densities, so separating the mixed use effect from the density effect is hard. Messenger and Ewing (1996) suggested that more balanced areas with jobs and homes tend to have higher transit mode share.

Tridib Banerjee and his colleagues used Simpson's diversity index in calculating land use diversity that captured both richness and evenness of species diversity. They conduct the study in Vermont and Ventura Corridor in 2000 and found that transit ridership increases as land use diversity or land use mix increases.

Employment Matters

Jed Kolko (Kolko, 2011) pointed in his study in California in 2011 that employment density is more strongly associated with transit ridership than residential density is. In California, residential density is higher than the national average and rising, but employment density is lower than the national average and falling.

In Tridib Banerjee's study, employment in retail and other commercial services contributes to an increase in ridership levels. In combination with high population and housing density, mixed use developments that support business with large service employees will ensure high transit ridership.

Measuring Ridership

Generally, there are two ways in literatures to measures ridership. The first method measures ridership as transit journey-to-work (commute) mode share, the percent of work trips made by public transit (Brown, 2012) (Kolko, 2011). The second method is to measure average weekday, monthly, or annual boarding (Banerjee, Myers, & Irazabal, 2005) (Maley & Weinberger, 2009).

Measuring Land Uses

Literatures measures land uses by the share of each uses' area in a certain place (Banerjee, Myers, & Irazabal, 2005) (Hess, Moudon, & Logsdon, 2001).

Data and Methodology

Data

Here is a table listing all the data.

Table 1. Data and details

Data	Format	Time	Source
Los Angeles County Land Use Map	Shapefile	2008	Southern California Association Governments (SCAG)
Metro Rail Stations	Shapefile	2012/12	Los Angeles Metro
Metro Rail Line	Shapefile	2012/12	Los Angeles Metro
Metro Rail Ridership	Numbers	2008	Los Angeles Metro
Median Household Income	shapefile	2007-2011	American Community Survey 5-Year Estimates Block Group Data

We used SCAG's 2008 land use data to perform land use analysis. In determining total ridership of each Metro rail line, we used 2008 Metro Average Estimated Weekday Ridership.

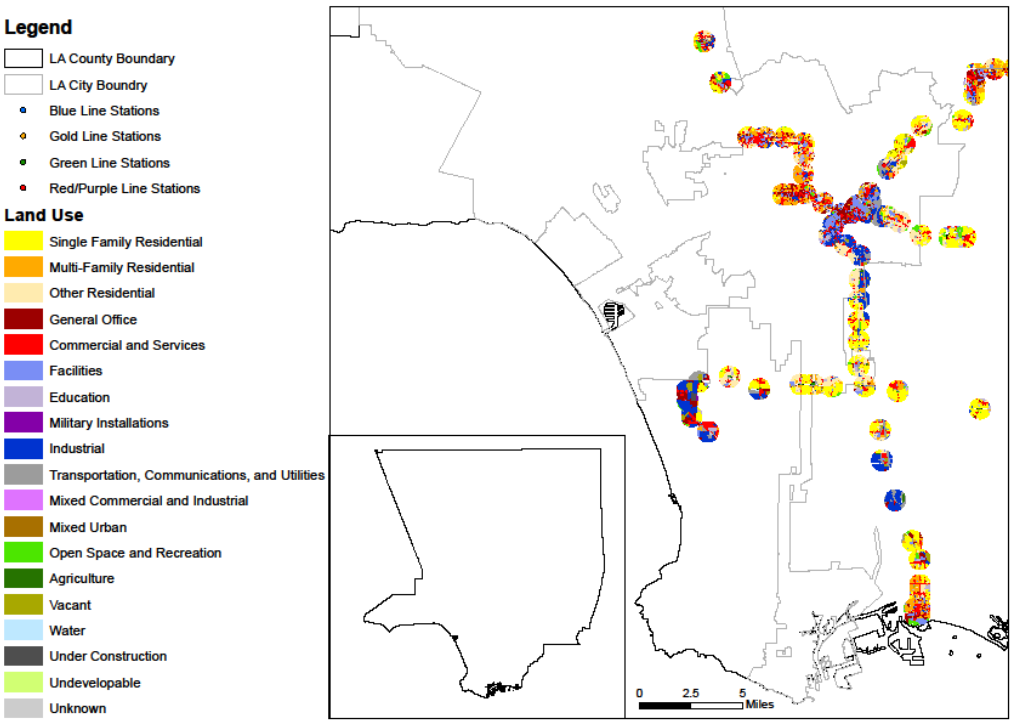

Figure 1. Land Use of All the Metro Rail Stations

Table 2. Ridership of Each Station

blue line station	ridership	gold line station	ridership
103rd_Street_Watts_Towers	2860	Allen	774
Anaheim	2272	Chinatown	811
Artesia	3112	Del_Mar	1054
Compton	4136	Fillmore	980
Del_Amo	3133	Heritage_Square_Arroyo	533
Firestone	2703	Highland_Park	1646
Florence	4450	Lake	1104
Grand	4538	Lincoln_Heights_Cypress_Park	758
Long_Beach_Transit_Mall	3015	Memorial_Park	1550
PCH	2051	Sierra_Madre_Villa	2260
Pico	2360	South_Pasadena	1257
San_Pedro	2023	Southwest_Museum	492
Slauson	2253		
Vernon	2708		
Wardlow	1668		
Washington	1609		

Willow	4017		
green line station	**ridership**	**red line station**	**ridership**
Avalon	2508	Civic_Center	5389
Aviation_LAX	3477	Hollywood_Highland	7341
Crenshaw	2405	Hollywood_Vine	4548
Douglas	582	Hollywood_Western	4594
El_Segundo	922	Pershing_Square	10581
Harbor_Freeway	2553	Universal_City	7525
Hawthorne_Lennox	2708	Vermont_Beverly	4258
Lakewood	2328	Vermont_Santa_Monica	5103
Long_Beach	2612	Vermont_Sunset	4018
Mariposa	1171	Westlake_McArthur_Park	8478
Norwalk	4345	Wilshire_Normandie	3290
Redondo_Beach	988	Wilshire_Vermont	10140
Vermont_Athens	3160	Wilshire_Western	4768

Table 3. Median Household Income Around Each Station

blue line station	**income**	**gold line station**	**income**
103rd_Street_Watts_Towers	16655	Avalon	24732
Anaheim	32292	Aviation_LAX	null
Artesia	59375	Crenshaw	41486
Compton	42578	Douglas	null
Del_Amo	44928	El_Segundo	null
Firestone	39344	Harbor_Freeway	15238
Florence	54205	Hawthorne_Lennox	30446
Grand	24183	Lakewood	51898
Long_Beach_Transit_Mall	72279	Long_Beach	38864
PCH	34302	Mariposa	null
Pico	60865	Norwalk	57083
San_Pedro	27132	Redondo_Beach	146875
Slauson	32279	Vermont_Athens	38110
Vernon	32212		
Wardlow	53333		

Washington	27708		
Willow	44250		
Willowbrook_Rosa_Parks	33971		
green line station	**income**	**red line station**	**income**
7th_Street_Metro_Center	31632	Allen	67027
Civic_Center	null	Chinatown	22344
Hollywood_Highland	25592	Del_Mar	44255
Hollywood_Vine	18984	Fillmore	82232
Hollywood_Western	19770	Heritage_Square_Arroyo	24352
North_Hollywood	30000	Highland_Park	38500
Pershing_Square	20389	Lake	63777
Union_Station	103289	Lincoln_Heights_Cypress_Park	30820
Universal_City	71875	Memorial_Park	44891
Vermont_Beverly	42654	Sierra_Madre_Villa	67692
Vermont_Santa_Monica	31159	South_Pasadena	73125
Vermont_Sunset	37422	Southwest_Museum	48701
Westlake_McArthur_Park	34350		
Wilshire_Normandie	35200		
Wilshire_Vermont	61488		
Wilshire_Western	26220		

Methodology

There is limited literature analyzing the relationship between rail ridership and land use. The most similar study was conducted by Banerjee in 2005. Banerjee studied the average weekday boarding of Bus Rapid Transit (BRT) along the Vermont and Ventura Corridor in Los Angeles and land use around the BRT stations. This paper is implementing its methodology.

Maps of bus lines and bus stops were created using Metro shapefiles with Geographic Information System (GIS). GIS was also used in defining the boundaries and mapping of the study area. Block groups were used as units of analysis.

Here are the detailed steps of this study:

1. In GIS, make 800 meters (0.5 mile) radius buffers around the Metro rail stations

as our study areas. Calculate the percentage of each land use of the total buffer area. The SCAG land use shapefile has more than a hundred land use categories. They are combined as the following types of land use: residential, commercial/office, industrial, transportation, open space, and others.

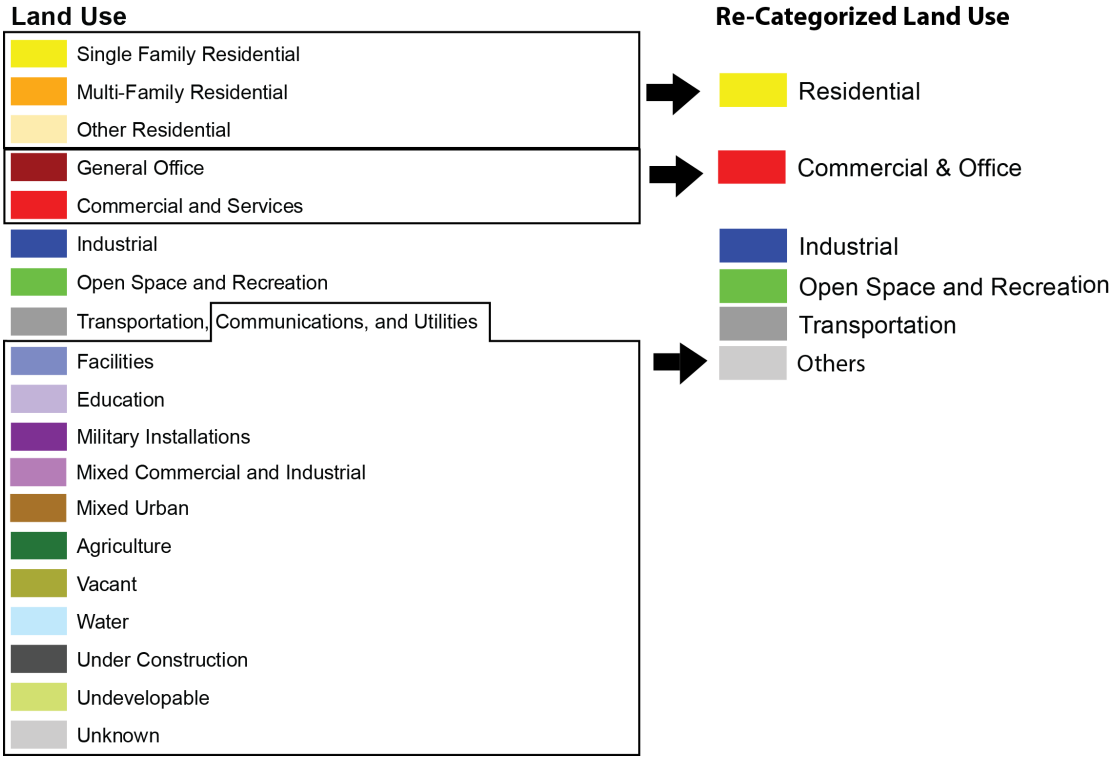

Figure 2. Re-categorizing Land Use

2. We regressed the dependent variable Metro Rail Ridership on each of the independent land use variables. The regression model is ordinary least squares regression model.

Table 4 Dependent and Independent Variables

Dependent Variable	Ridership of each metro rail line
Independent Variables	Residential
	Commercial/office
	Industrial
	Transportation
	Open space
	Others

According to the median household income data, stations are divided into two groups

by the median income of these stations. Regression is run on these two groups of stations, beside on each of the lines.

Analysis

Los Angeles County

Los Angeles County is located in the state of California. As of 2010 U.S. Census, it has a population of 9,818,605, the most populous county in the country. City of Los Angeles, the largest city in California and the second-largest city in the United States is seated in the county.

As where the sun-belt cities seat and experienced dramatic urban sprawl in the era of automobile and suburban development, Los Angeles County has a capita per square mile of 2,405, while Manhattan has 68,951 and New York City has 17,435. This is shown in Figure 3, comparing the population density between New York City and Los Angeles. The two maps have the same scale and same gradient. New York City has much darker and thus denser population. The sprawl and suburban character also bring the area plenty of highways, wide roads, and auto-dependent travel behaviors. According to the 2008-2012 ACS data, 72% of people in Los Angeles County drive alone to work and only 7% take the public transportation. It ranks the 65th among all the counties in U.S. The top 14 counties have more than 20% commuters taking public transit (Table 5 & 6). To make it worse, Los Angeles has the worst congestion in the nation, according to several studies. People increasingly suffer from congestion, losing an estimated $900 million annually from time spent driving.

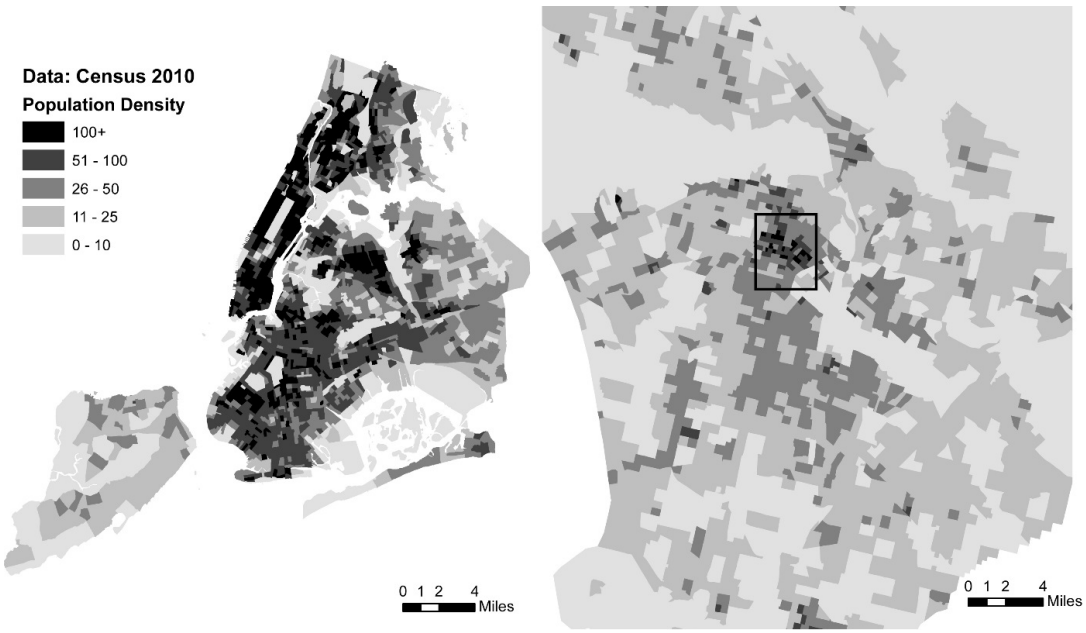

Figure 3. Comparing the Population Density between New York City and

Downtown Los Angeles

Table 5. The Make-up of Commuting Pattern in L.A., Compared with the Average Level in C.A. and U.S.

	Los Angeles County	%	California	U.S.
Workers 16 Years and Over	4384405	100.00%	16282943	139893639
Car, Truck, or Van—Drove Alone	3166094	72.21%	73.05%	76.14%
Car, Truck, or Van—Carpooled	477708	10.90%	11.53%	10.03%
Public Transportation	311615	7.11%	5.15%	4.98%
Walked	126810	2.89%	2.76%	2.82%
Other Means	90413	2.06%	2.36%	1.76%
Worked at Home	211765	4.83%	5.15%	4.27%

Source: 2008-2012 ACS

Table 6. Ranking Public Transportation Mode Share by County in U.S.

Rank	Take Public Transportation to Work Population Percentage	County / Population / Notes
1	60.80%	Kings, NY / 2,512,740 / Brooklyn
2	58.40%	New York, NY / 1,596,735 / Manhattan
3	58.30%	Bronx, NY / 1,386,364
4	51.70%	Queens, NY / 2,235,008
5	39.20%	Hudson, NJ / 636,194
6	37.80%	District Of Columbia, DC / 605,759
7	32.40%	San Francisco, CA / 807,755
8	31.80%	Suffolk, MA / 724,502
9	29.70%	Richmond, NY / 468,374 / Staten Island
10	27.50%	Arlington, VA / 209,077
11	26.30%	Philadelphia, PA / 1,525,811
…	…	…
16	17.70%	Cook, IL / 5,197,677 / Chicago
…	…	…
65	7.10%	Los Angeles, CA / 9,840,024

Source: 2008-2012 ACS

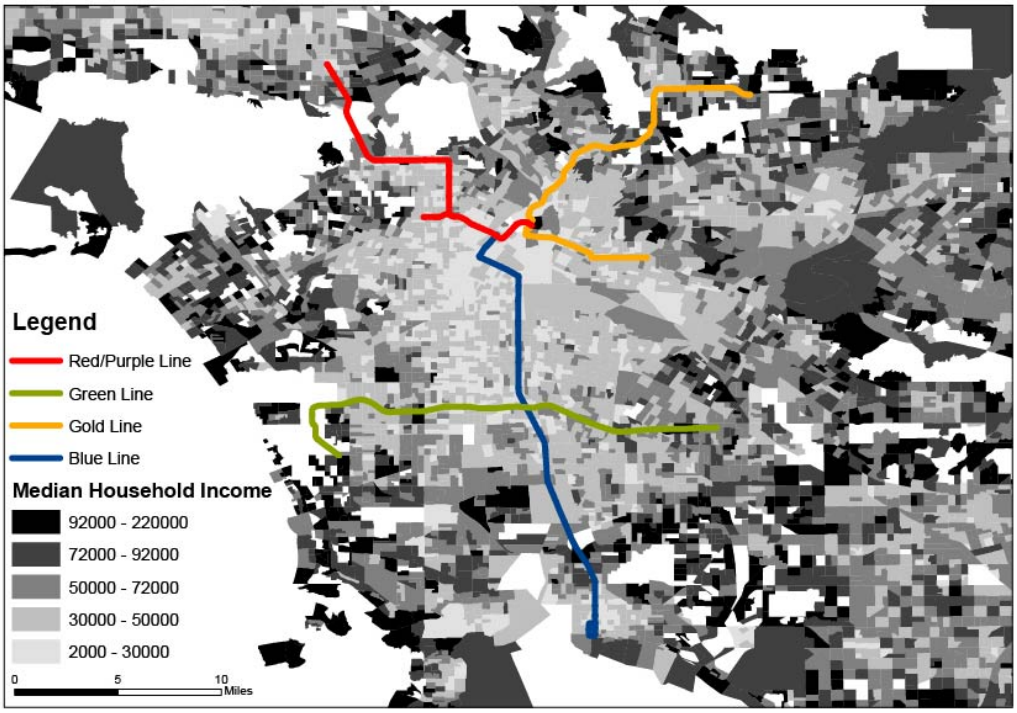

Figure 4. Median Household Income of Los Angeles County by Block Group

The median household income of the whole county is 56,241 USD, while the number for California is 61,400 USD, and the U.S. is 53,046. Most the block groups that the Metro lines go through are at the similar income level, except some part of Green Line, Red Line and Gold Line.

Los Angeles County Metropolitan Transportation Authority, branded as L.A. Metro, is the California state-chartered regional transportation planning agency. By 2008, it has five rail lines. Blue line is a light rail running between Downtown Los Angeles and Downtown Long Beach. Red line is a subway line running between Downtown Los Angeles and North Hollywood. Purple line is also a subway line running between Downtown Los Angeles and the Mid-Wilshire of Los Angeles. It shares lots of stations and thus combined in most circumstances and also in this study as Red/Purple Line. The Green line is a light rail line running between Redondo Beach and Norwalk, linking Los Angeles International Airport through a shuttle bus. The Gold line is a light rail line running between Downtown Los Angeles and Culver City.

Ridership data

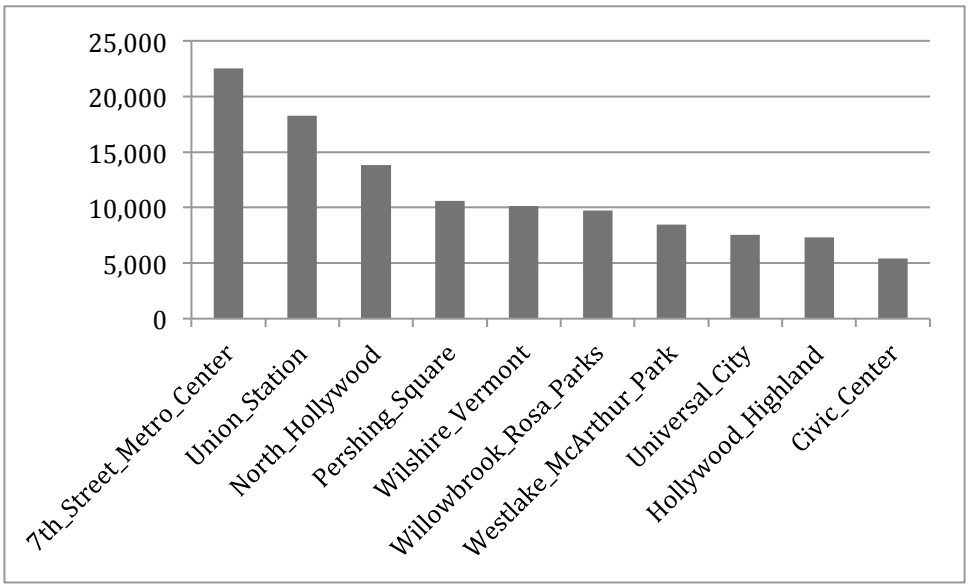

Figure 5. Top 10 Stations with the Greatest Ridership

Figure 2 only show the top 10 stations with the greatest ridership. The top three are all transfer stations. Actually, all the transfer stations of the five existing Metro Rail (in 2008) have the most weekday boarding, such as 7th/Metro Center of Blue Line, Red Line and Purple Line; North Hollywood of Red Line and Orange Line (bus rapid transit line); and Union Station of Red/Purple Line and Silver Line. Their ridership can be greater than 10,000 people/day, more than twice of the other station's. Therefore, these transfer stations are leaved out when running regression model.

The rest of the top 10 stations are all from Red/Purple Line. Indeed, Red/Purple Line has generally more ridership than the other lines. The average of each Red/Purple Line stations' ridership is 6156 people/day. But the average of the other lines are less than half of this number (2877 people/day for Blue Line, 1102 people/day for Gold Line, and 2289 people/day for Green Line).

Regression Model

We regressed the dependent, variable Metro Rail Ridership, on various independent land use variables separately. Each regression is a simple linear regression, since there is only one variable.

Blue Line

Table 7. Regression Result for Blue Line

	Beta	p-value	
Residential	-299.6	0.738	
Commercial	620.8	0.754	
Industrial	-497.4	0.752	
Transportation	-399.0	0.934	
Open Space	5289.0	0.855	
Signif. codes: 0 *** 0.001 ** 0.01 * 0.05			

There is no significant association between ridership and land use around Blue line stations.

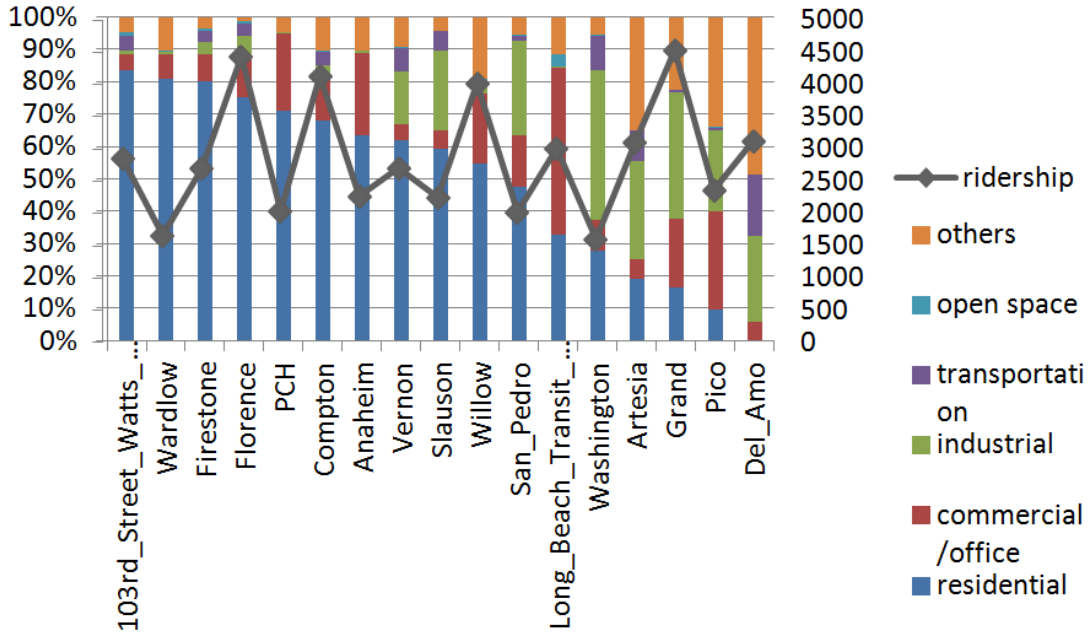

Figure 6. Land Use and Ridership of Blue Line

Shown in Figure 6, ridership only fluctuates when land use share changes. The closer to downtown, the fewer residential land use there are.

Gold Line

Table 8. Regression Result for Gold Line

	Beta	p-value	
Residential	-25.95	0.97447	
Commercial	769.5	0.4570	
Industrial	-3067.7	0.507633	
Transportation	-3746.0	0.341	
Open Space	-453.7	0.76	
Signif. codes: 0 *** 0.001 ** 0.01 * 0.05			

There is no significant association between ridership and land use around Gold line stations.

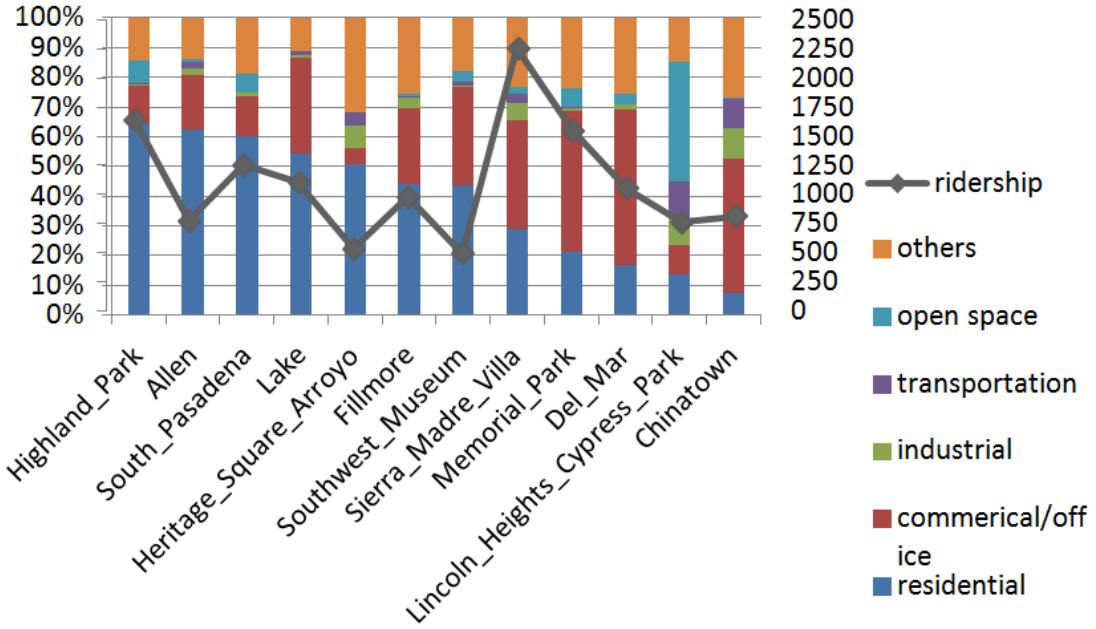

Figure 7. Land Use and Ridership of Gold Line

Similar to Blue Line, the further away from downtown, the more residential land use around Gold Line stations.

Green Line

Table 9. Regression Result for Green Line

	Beta	p-value	
Residential	2299.0	0.00453	**
Commercial	-6993.5	0.000737	***
Industrial	-4878.9	0.00586	**
Transportation	5993.4	0.442757	
Open Space	-29312.3	0.0554	
Signif. codes: 0 *** 0.001 ** 0.01 * 0.05			

There is significant positive association between Green Line ridership and residential land use. This complies with some literatures (Johnson, 2003) (Weizhou, Shusheng, & and Fumin, 2009) (Michael Kuby, 2004) (Hyungun Sung, 2010) that residential land use associated with higher demand of transit, since it contributes to the trip production.

Surprisingly, both commercial/office and industrial land use are significantly negatively associated with ridership.

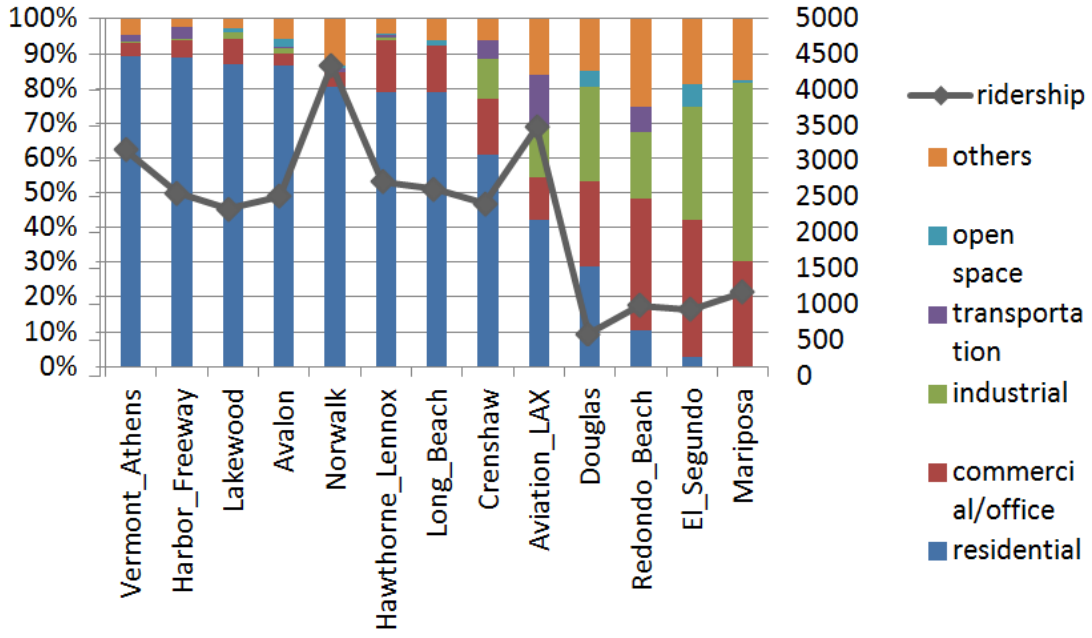

Figure 8. Land Use and Ridership of Green Line

According to Figure 8, ridership is much higher in the stations where great amount of residential land use is around. When surrounding land use are commercial/office and industrial, ridership goes down sharply. Thus Green Line ridership is generated by the

"home areas" – stations on the south part of the line. It is very likely that people from these neighborhood get on Green Line and transfer to downtown for work through Willowbrook Station and Blue Line.

Red/Purple Line

Table 10. Regression Result for Red/Purple Line

	Beta	p-value	
Residential	-7708	0.0306	*
Commercial	12848	0.0262	*
Industrial	18619	0.36000	
Transportation	3740.1	0.964	
Open Space	14286.1	0.407	
Signif. codes: 0 *** 0.001 ** 0.01 * 0.05			

There is significant negative association between Red Line ridership and residential land use. However, commercial/office land use is positively associated with ridership.

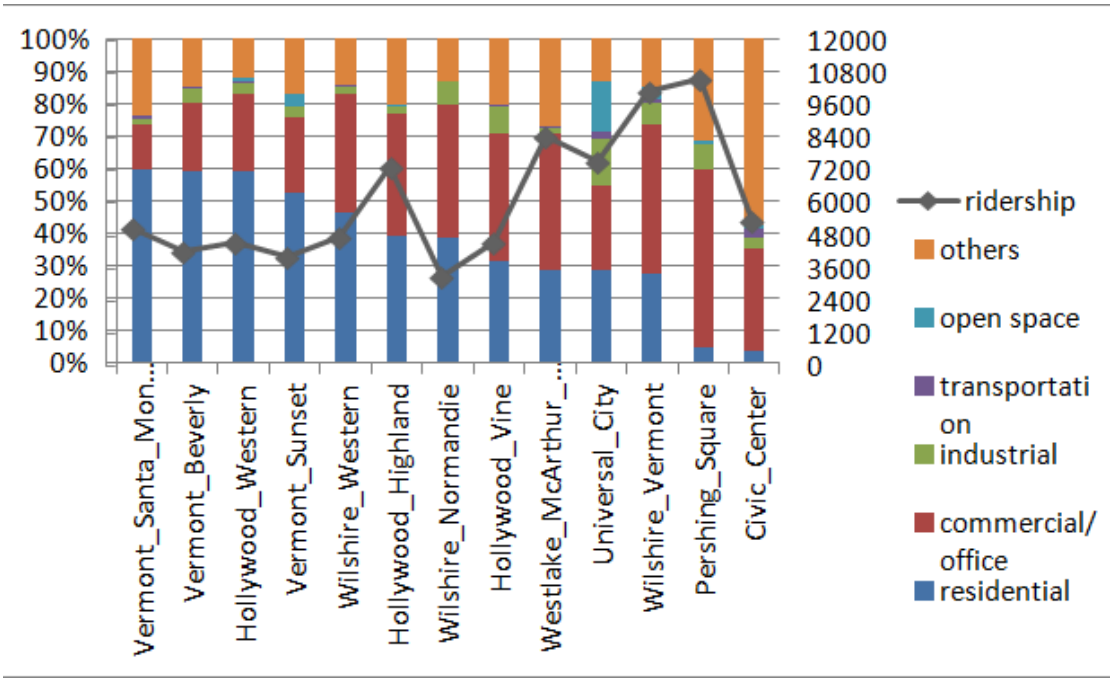

Figure 9. Land Use and Ridership of Red/Purple Line

According to Figure 9, stations with higher share of residential use (on the left) have fewer ridership, while stations with more commercial/office use (on the right) have higher ridership. The stations on the right are all around Downtown Los Angeles. Therefore, home and job are very imbalanced along the Red Line and most of its ridership is generated by the commercial/office use in downtown.

Comparing the above five lines, though the residential dominated stations along Red Line have fewer weekday boarding, they are already as much as the highest ridership of the other lines. That is to say, the land use and ridership patterns of these five lines show the commuting behavior of Los Angeles people.

Income Groups

Table 11. Regression Result for High Income Station Group

	Beta	**p-value**	
Residential	-241.0	0.90253	
Commercial	45.23	0.98902	
Industrial	3413.2	0.530997	
Transportation	1157	0.922	
Open Space	23196.4	0.100140	
Signif. codes: 0 *** 0.001 ** 0.01 * 0.05			

Table 12. Regression Result for Low Income Station Group

	Beta	**p-value**	
Residential	-3002	0.0932	
Commercial	9732.9	0.00039	***
Industrial	-2823.5	0.457	
Transportation	-32179.3	0.0074	**
Open Space	-7519.5	0.207	
Signif. codes: 0 *** 0.001 ** 0.01 * 0.05			

Comparing Table 11 and Table 12, low income stations show significant relationship between land use and ridership, while high income stations do not. It can be explained that low income people are less likely to own automobiles. So people do walk some distance to take the rail to their destination which is neat to another station. More destinations within the walking distance, more ridership will be. Thus, land uses within walking distance would affect the ridership. In contrast, high income neighborhoods are more likely to own automobile. Those stations' ridership is generated by transfers from and to other mode of transportation, other than the surrounding land use.

The significant association between commercial land use and ridership coincides with

most of the other studies. (Weizhou, Shusheng, & and Fumin, 2009) (Tridib Banerjee, 2005) (Michael Kuby, 2004) (Johnson, 2003) (Hyungun Sung, 2010) Commercial land use can both contribute to trip production and attraction. These areas provide employment in corporations, hospitals, schools, and other public works. The positive association of commercial use suggests that people use transit for both non-work and work-related travel or that employees of commercial activities are more likely to use transit. Studies in Washington D.C. and California show that a large portion of people working in offices around transit stations commute by rail. (Cervero R. , 2006)

As for the transportation land use, it is negatively associated with ridership. Transportation land use includes airports, freeways, parking lots, bus and truck terminals, which are automobile-dependent destinations. Therefore, when there are more such kind of land use around the station, less people would go there by the Metro Rail.

Discussion

A huge amount of studies on transit ridership and land use are based on traditional mono-centered cities, such as Chicago, Boston, New York, and San Francisco (Michael Kuby, 2004). The original Transit Oriented Development is also developed from these kinds of cities that commercial and residential land uses offer synergies of high number of ridership (Carlton, 2007). However, our study found that Los Angeles may not follow the same pattern.

From the comparison of the five lines, it is obvious that in downtown and around downtown, there are more commercial/office land uses around the Metro Rail stations. At the outer part of the rail lines, there are more residential land uses around the stations. The rail lines serve very well to connect these two. It tells us that if there is public transit available connecting the origins and destinations, people would be willing to take the transit, even in a place with the heavy atmosphere of driving.

But this indicates an obvious spatial segregation of home and job in the whole county. As a result, rail can only serve a single purpose – commute. Furthermore, the rails would be very busy during peak hours and very empty during off-peak, making the transit service of low efficiency and further hindering the growth of ridership in the future.

Among the residential land use around all the stations, only an average of 33% of them are multi-family housing. There is a great potential of capacity around the stations to hold more housing and jobs.

Plus, different rail lines show different correlation between land use and ridership. Some results seem to contradict with each other. For example, commercial land use can be positively and negatively associated with ridership in Green and Red Line. But the cause is the same – imbalance between home and job. Therefore, land use is not the deciding factor of ridership.

Future Studies

Significant advances have been achieved in transit/transportation-land use research in recent years, but much is left to be desired. Understanding the variation of land use pattern would greatly enhance the ability to provide efficient and effective transit service. Research on travel behavior, density, and demographic has created a strong foundation for understanding people's travel mode choice. Yet these studies in

western cities like Los Angeles, Phoenix, Salt Lake City and Dallas whose urban forms crystalized in the auto era are limited.

Another major drawback to transit-land use analyses is the difficulty in measuring land use design and diversity measure. To indicate land use design, it is usually the quantity of land use. However, there is lack of research on quality of land use. Diversity measures have employed entropy measure and a dissimilarity index and estimated the distances between several different retail commercial uses and residential unite. (Cervero R. K., 1997) (Frank & Pivo, 1995) (Handy, 1996) While these measures are innovative uses of existing data, they leave much to be desired. To truly illuminate the complex causes of transit demand, a much more robust statistical foundry is needed.

Conclusion

The recent resurgence of rail after its demise in the first half of the 20th century is one of the most remarkable turnarounds in transportation history. It is an idea that appears to have come, gone and come again. Although there is much doubt around the second coming of light rail, proponents hope it will gain moderate ridership, marginally reduce congestion and air pollution, promote higher efficiency of land use, and provide an alternative mode to automobile with higher capacity than buses along busy corridors.

In the midst of the current transit oriented development and light rail/subway explosion, it is important to deeper understand their dynamics. This paper analyze the correlation between transit ridership and land use around transit stations in Los Angeles County to understand the role of metro rail in this certain area. The findings are residential and commercial/office land use could be negatively correlated with ridership; Los Angeles has a severe home/job imbalance around the rail stations; and surrounding land use may not necessarily affect the stations' ridership. Based on these findings, future research can focus on measuring land use design and land use mix, especially in those suburban and automobile-dependent cities.

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