Analysis of the Variation in Apartment and Office Market Rents with Respect to Commuter Rail Transit Station Distance in Metropolitan San Diego and Salt Lake City

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The forgotten mode in research on how the real estate market responds to fixed guideway transit seems to be commuter rail. We help address this shortcoming. In theory, like all fixed guideway transit systems, proximity to commuter rail transit (CRT) stations should confer positive benefits capitalized by the market; the closer real estate is to those stations, the more valuable it should be. On the other hand, unlike other transit modes that are set amidst urban development, commuter rail stations are often located in industrial areas. As such, proximity to CRT stations may confer negative benefits capitalized by the market; the closer real estate is to those stations, the less valuable it would be. Using a quadratic distance function, we assess how rental real estate markets in two metropolitan areas—San Diego and Salt Lake City—respond to CRT station proximity. We find positive proximity benefits, albeit small for office land uses though much larger for multifamily rental land uses. We reason that the positive effects of CRT station proximity outweigh negative ones. We offer CRT system planning implications.

Overview

This article does three things. First, it reviews how rail transit stations may generate both positive and negative amenity effects on urban real estate markets based on conventional urban location theory. This leads to a theory that can detect both positive and negative amenities in the urban real estate market and suggests how it can be applied. Second, we apply our theory to the rental real estate market affected by two commuter rail transit (CRT) systems in the West: metropolitan San Diego—the one of the West's oldest CRT systems, and Salt Lake City—one of the West's newest. We find that the rental real estate market reveals both positive and negative effects of CRT station proximity. And third, it draws planning implications for the future of CRT system planning and perhaps all rail transit planning.

Theory and General Model

Conventional urban location theory articulated by Alonso (1964), Muth (1969) and Mills (1972) shows that in a monocentric city where all jobs are in the central business district (CBD), the cost of transportation increases as distance increases from the CBD at a declining rate, as a function of increasing land area of the commuting shed. Transportation costs thus affect land value so that the "bid rent" curve for land also declines as distance increases. Where transportation costs are lowest, in the CBD, land prices are highest. To afford higher land prices ("rent") in the CBD, more economic exchange is needed, resulting in higher development intensities among office, retail, and high-value multifamily housing land uses among others. Economic activities that cannot compete for CBD locations are pushed outward to locations where they can outbid other land uses, a process called urban land use invasion and succession (Park and Burgess 1925).

In relaxing the strict monocentric city model, one can imagine the same principles at work only at smaller scales that are distributed across a metropolitan area (see Hajrasouliha and Hamidi 2017). For instance, in focusing transportation activity at nodes, rail transit stations can become small version of CBDs. Economic activities will bid up land prices close to rail transit stations; lower value activity moves away from transitions to location there they can outbid competing land uses. Numerous studies show negative bid rent gradients with respect to distance from rail transit stations (Higgins and Kanaroglou 2016).

But rail stations themselves can be nuisances such that land value may be dampened very near them. The market capitalizes both positive amenity effects of rail station proximity as well as negative amenity effects such as those associated with noise and congestion (Nelson and McCleksy 1990; Nelson 1992). So long as positive amenity effects outweigh negative ones, the bid rent gradient will be sloping downward and away from rail transit stations. In theory, however, it is possible for negative amenity effects to outweigh positive ones. These interactions are shown in Figure 1, described as follows:

> The line R^a shows the land rent (R) curve with full amenity ("a" for positive amenity) value from a rail transit station, u_0, outward to a point, u_1, where the amenity effects of rail transit proximity disappear, beyond which the overall market rent, R^m is revealed.
>
> Negative effects of rail transit stations are shown in line R^n ("n" for negative amenity). As distance from the rail station increases, the negative amenity effects are reduced until they become zero at u^1.

Positive and negative amenity effects interact in the market leading to overall positive or negative bid rent curves with respect to distance from rail transit stations to u_1. Line $R^a + R^n{}_1$ is revealed where overall positive amenity effects outweigh negative ones. Line $R^a + R^n{}_2$ is revealed where overall negative amenity effects outweigh positive ones. Overall effects disappear at u_1 beyond which market rent, R^m, in the absence of positive and negative amenity is revealed.

Unless analysts use the proper distance measure variable, estimates of the revealed bid rent gradients with respect to distance from rail transit stations will not detect the interaction between positive and negative amenity effects. In our view, this requires a model wherein the distance effects of rail transit stations are specified using the quadratic functional form. The first term, linear, reveals the strongest of the two influences, positive or negative. In cases where value is affected negatively by such sites as landfills, the linear term would be expected to have a negative association with respect to landfill distance while the second term would be positive so that after some distance, u_1, the negative effect is offset (Nelson et al. 1992). In the case of rail transit stations, theory suggests there would be an overall positive amenity effect with respect to station distance—the first term—but it can be dampened by underlying negative amenities—the second term. A general model including a quadratic transformation of distance from a rail transit station to reveal both positive and negative amenity effects of rail transit stations on real estate values is:

$$\mathbf{R}_i = f(\mathbf{B}_i, \mathbf{S}_i, \mathbf{L}_i)$$

where:

R is the price of rent per square foot for property *i*;

B is the set of building attributes of property *i*;

S is the set of socioeconomic characteristics of the vicinity of property *i*; and

L is a set of location attributes of property *i* wherein the case of distance to transit stations (DTS) the functional form is:

$$L_i = DTS_i + DTS^2_i$$

In the next section, we review briefly the literature that assesses the influence of rail transit stations on rental real estate value with special reference to CRT stations.

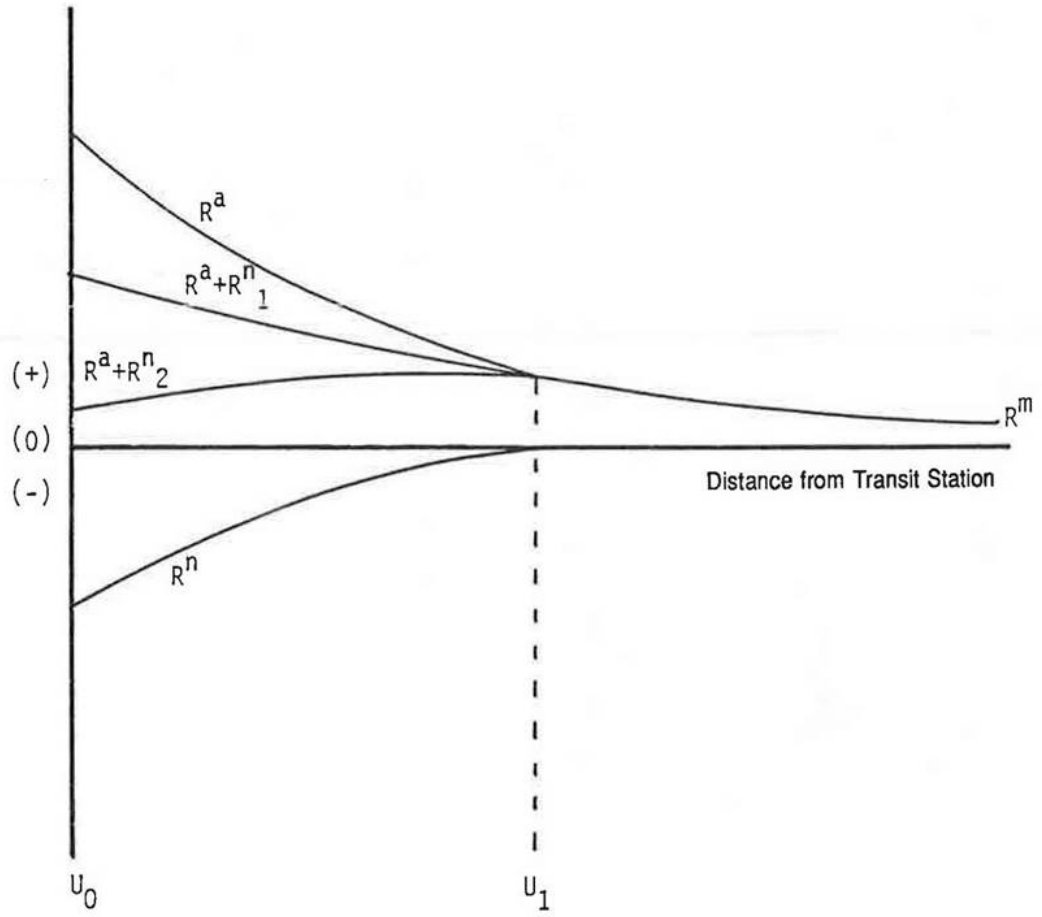

Figure 1

Positive Amenity (R^a) and Negative Amenity (R^n) influences of transition stations on proximate property values

Prior Research

Surprisingly few studies of transit station effects on real estate values use the quadratic functional form. Of the more than 60 studies reviewed by Higgins and Kanaroglou (2016), nearly none used a quadratic transit station distance variable. The common reason is that theorists seem shackled by the Alonso-Muth-Mills model of urban form wherein negative amenity effects with respect to distance from nodes such as a downtown or a transit station are simply not recognized—the functional form is thus ipso facto negative (linear) or declining at a declining rate (log, semi-log, or inverse). A minima or maxima is impossible to estimate, however, meaning that researchers cannot tell planners the distance over which the negative and positive influences occur.

What are commonly used (including us) are distance-band variables, as in the case of Cervero's (2004) study of the association between CRT station distance and real estate values in San Diego. As it seems to be among the leading CRT-based studies, it is worth reviewing in detail.

The San Diego study was based on the sale of numerous types of parcels during the period 1999-2000, including 1,495 multifamily housing parcels and 372 commercial parcels. Ordinary least squares (OLS) regression analysis was used to estimate the variation in sales price per parcel with respect to properties sold within one-half mile of a CRT station. Positive associations were predicted; that is, the sales prices of multifamily residential and commercial parcels were expected to be higher within one-half mile distance band around CRT stations compared to those outside that band. Instead, mean multifamily residential parcels were -$43,379 ($p = 0.148$) within the one-half mile band while mean commercial parcels were -$111,917 ($p = 0.004$). In other words, multifamily and commercial real estate values were *less* per parcel within one-half mile of a CRT station than beyond. Cervero's results are similar to most other studies of CRT effects on nearby multifamily and commercial property values reported by Higgins and Kanaroglou: only seven of 20 showed positive associations while 13 did not, with 11 of those having no significant association. Again, nearly all those studies used distance-band methods.

There are certainly exceptions as residential properties in and near downtowns especially value CRT rail station proximity as an overall amenity (see Cervero and Duncan 2002), but those outcomes seem limited to just downtowns and not CRT systems as a whole. In contrast, nearly all heavy- and light-rail transit systems have positive or insignificant effects on all land uses. Where standard theory posits positive effects of rail transit stations on nearby property values, research seems to show otherwise with respect to CRT stations, at least outcome downtowns. Could it be that CRT stations *per se* impose negative amenity effects near them? We address this next.

Research Design

Our research design is quasi-experimental in which variation in real estate market prices is estimated with respect to distance from commuter rail transit stations. The experiment considers building structure, local socioeconomic, and centrality controls.

We apply our analytic approach to two case study metropolitan areas: San Diego and Salt Lake City. San Diego is selected because it has already been studied and seems reasonably representative of Western—most Californian—CRT systems, and one of its oldest. Salt Lake

City is the second case study metropolitan area. It was selected because it is one of the newest non-California CRT systems in the West, and serves as area roughly comparable in population to the San Diego metropolitan area. (We include the Ogden and Provo metropolitan areas with Salt Lake City; they are often considered part of the Salt Lake City combined statistical area.)

The "Coaster" (see Figure 1) is a commuter rail transit service launched in 1995 that serves central and northern San Diego Country along the coast. It is operated by the North County Transit District (NCTD). The system is comprised of 62 miles of track with eight CRT stops. It operates mostly during weekday peak periods with occasional weekend and holiday service. The entire route can be covered in about an hour.

The FrontRunner (see Figure 2) commuter rail system started in 2008 and is operated by the Utah Transit Authority (UTA). It provides service along the Wasatch Front from Pleasant View in northern Weber County south to Salt Lake City, then to Provo. Its 88 miles of track that serve 17 stations, and takes about two hours to travel from end to end. Like the Coaster, it operates mostly during weekday peak periods with occasional weekend and holiday service.

Table 1 summarizes the office data collected for this study, variable specifications, and predicted signs of association. Notably, by permission, we are able to use CoStar's asking rent database for rental multifamily and office properties for the first two quarters of 2017. Our model is based on that noted earlier. Our dependent variable, asking rent per square foot, is logged so that the unlogged coefficients of the independent variables can be interpreted as percentage change in rental price associated with a unit change in the independent variable. Among the building attributes, we expect rents for Class A (the highest office market quality rating) to be higher than Class B and both to be higher than the referent, Class C; larger buildings will command higher rents than smaller ones because scale economies allow for more on-site amenities; and newer buildings will command higher rents than older ones. Among socioeconomic attributes, we expect higher rents associated with higher percentages of White non-Hispanic persons in census block groups, and higher median household income. Because the FrontRunner passes through four counties, our location variables include Davis, Salt Lake, and Utah counties with the referent being Weber County but no associations with respect to rent are predicted as these are merely geographic controls. Distance from the central business district (CBD) is expected to have a negative sign. Our experimental variable, distance from the nearest CRT station, includes the linear term and its quadratic transformation; based on conventional urban local theory, we expect negative and positive associations respectively. But the signs could just as easily be reversed if negative amenities outweigh positive ones near CRT stations. Table 2 presents the mean statistics for each metropolitan area.

Table 3 summarizes rental multifamily apartment rents much in the same way that Table 1 does for offices. For the most part, expected directions of association are the same as for offices with these exceptions: compared to properties that have overall rental restrictions (such as low and moderate income tax credit projects, certain Section 8 properties, and other publicly-assisted properties), rental properties without restrictions will command higher rent. Table 4 reports the mean statistics for each metropolitan area.

Results are reported next.

Figure 1

Coaster commuter rail transit route map

Source: North County Transit District

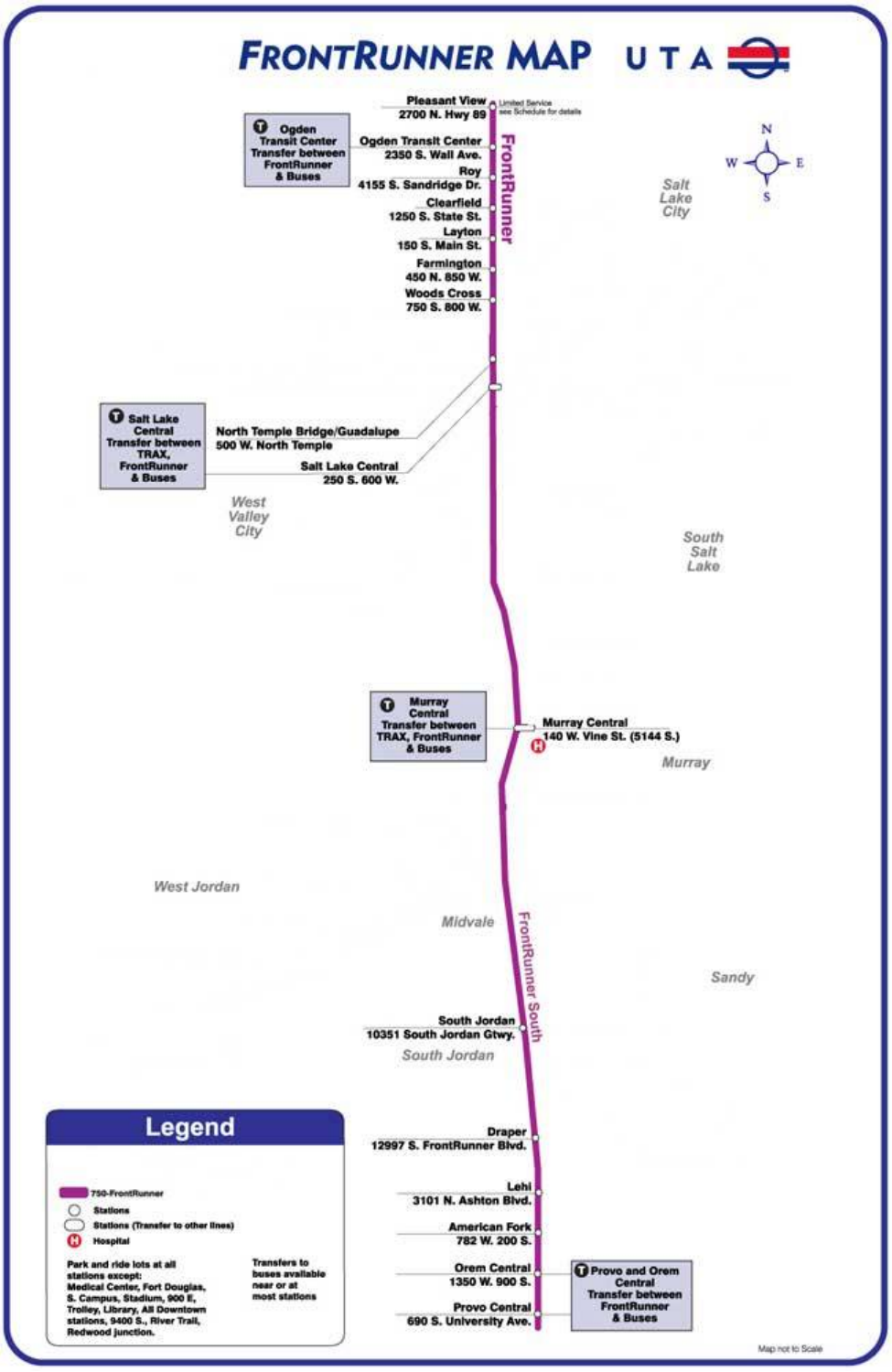

Figure 2

FrontRunner commuter rail transit route map

Source: Utah Transit Authority

Table 1
Office Property Variables, Specifications, Predicted Signs, and Data Sources

Variable	Specification, Predicted Sign	Data Source
Dependent Variable		
Asking rent per square foot	Continuous, logged	CoStar
Building Attributes		
Gross Leasable Square Feet	Continuous -	CoStar
Class A	Binary (Class C is the referent) +	CoStar
Class B	Binary (Class C is the referent) +	CoStar
Effective Year Built	Continuous +	CoStar
Socioeconomic Characteristics		
Percent Not White Non-Hispanic	Percent x 100 +	American Community Survey 2015
Median Household Tract Income	Continuous x 1,000 +	American Community Survey 2015
Location		
County location, Salt Lake City metro only	Binary for Davis, Salt Lake, Utah counties (referent is Weber County) ***np***	GIS
Distance to CBD, miles	Continuous -	GIS measure from parcel centroid to CBD centroid
Experimental		
Distance to Nearest CRT Station	Continuous -	GIS measure from parcel centroid to station centroid
Distance to Nearest CRT Station Squared	Continuous +	Square of Distance from station

Table 2
Mean Office Property Variable Statistics

Variable	Metro Salt Lake	Metro San Diego
Asking rent per square foot	$17.61	$27.43
Gross Leasable Square Feet	46,870	44,476
Class A	14%	16%
Class B	69%	53%
Effective Year Built	2000	1990
Percent Not White Non-Hispanic	86%	71%
Median Household Tract Income	$59,038	$75,261
Davis Co	9%	na
Salt Lake Co	57%	na
Utah Co	24%	na
Distance CBD, miles	16.27	15.65
Distance CRT station, miles	2.49	5.22

Table 3
Rental Multifamily Variables, Specifications, Predicted Signs, and Data Sources

Variable	Specification, Predicted Sign	Data Source
Dependent Variable		
Asking rent per square foot	Continuous, logged	CoStar
Building Attributes		
Gross Leasable Square Feet	Continuous -	CoStar
Effective Year Built	Continuous +	CoStar
Market Rent	Binary (rent restriction is the referent) +	CoStar
Socioeconomic Characteristics		
Percent Not White Non-Hispanic	Percent x 100 +	American Community Survey 2015
Median Household Tract Income	Continuous x 1,000 +	American Community Survey 2015
Location		
County location, Salt Lake City metro only	Binary for Davis, Salt Lake, Utah counties (referent is Weber County) ***np***	GIS
Distance to CBD, miles	Continuous -	GIS measure from parcel centroid to CBD centroid
Experimental		
Distance to Nearest CRT Station	Continuous -	GIS measure from parcel centroid to station centroid
Distance to Nearest CRT Station Squared	Continuous +	Square of Distance from station

Table 4
Mean Rental Multifamily Property Variable Statistics

Variable	Metro Salt Lake	Metro San Diego
Asking rent per square foot	$1.07	$1.78
Gross Leasable Area	53,209	52,455
Effective Year Built	1974	1975
Percent Not White Non-Hispanic	90%	73%
Median Household Tract Income	$45,604	$50,839
Market Rent	86%	86%
Davis County	6%	na
Salt Lake County	72%	na
Utah County	15%	na
Distance CBD, miles	11.73	12.16
Distance CRT station, miles	2.31	6.59

Results

Results first for office rents are reported in Table 5 and multifamily rents in Table 6. We review office results first, then multifamily results. We discuss implications in the next section.

Office

In the office regression equations, the building structure variables performed as expected. The difference in rents per square foot between Class A and Class B buildings (with Class C buildings as the referent) is substantial and expected. The incremental size of a building in the metropolitan Salt Lake market though not in the San Diego market showed small increases in rent suggesting bigger buildings confer slightly more value in the market's willingness to pay, we surmise because they offer additional amenities that smaller building cannot. Newer structures also conferred higher rents in the Salt Lake market than older ones, though only slightly and not in the San Diego market.

The socioeconomic variables in the San Diego regression had expected signs and were both significant, but only the coefficient for median household income was significant in the Salt Lake market, though the coefficient itself is quite small. We do not discuss the county-based controls for the Salt Lake market because of their role as merely geographic controls.

The CBD distance variable has the correct sign and was significant in both equations. We note that this variable was not included in most of the prior CRT studies. It is possible that re-analysis of those studies could reveal different outcomes with respect to CRT distance.

Of interest to us is the extent to which office rents are affected by proximity to CRT stations and if so how far away. Both coefficients for CRT distance are significant and have the anticipated signs; that is, as distance from a CRT station increases office rent falls at the margin (the negative coefficient on the distance variable) but at a declining rate (the positive sign on the quadratic transformation). Differentiating the coefficients and then setting for zero, the distance threshold is 30 miles in the Salt Lake market and 32 miles in the San Diego market. These are essentially slightly downward sloping gradients from CRT stations implying that negative amenities do not have a strong influence, though the influence is significant nonetheless.

Multifamily

In the multifamily regression equations, the building structure variable did not perform as expected as the rent per square foot falls when the overall size of the multifamily structure increases. It may be that larger structures gain managerial economies of scale that result in lower rents, making larger structures more competitive than smaller ones even if they may also have more amenities. Consistent with expectations, newer structures conferred higher rents in both markets than older ones. Also as expected, rental properties that are not restricted have higher rents per square foot than restricted ones.

Only the socioeconomic variables in the San Diego regression had expected signs and were significant, though the coefficient for median household income was negative, contrary to expectations. On the other hand, the coefficient itself is quite small suggesting that block group income levels have little meaningful influence on rents. As for the office market analysis, we do not discuss the county-based controls for the Salt Lake market because of their role as merely

geographic controls.

The CBD distance variable has the correct sign and was significant in both equations. Again, as noted for the office analysis above, we observe that this variable was not included in most of the prior CRT studies. It is possible that re-analysis of those studies could reveal different outcomes with respect to CRT distance.

Of interest to us is the extent to which multifamily rents are affected by proximity to CRT stations and if so how far away. Like the office rent analysis, both multifamily regressions have coefficients for CRT distance that are significant and have the anticipated signs; that is, as distance from a CRT station increases multifamily rent falls at the margin (the negative coefficient on the distance variable) but at a declining rate (the positive sign on the quadratic transformation). Differentiating the coefficients and then setting for zero, the distance threshold is 2 miles for both metropolitan areas. These are much steeper gradients than seen for office rents, suggesting the rental residential market is more sensitive to CRT station proximity than office markets.

Implications of both analyses are discussed next.

Table 5

Regression results for Office Rent with Respect to Commuter Rail Station Distance

Variable	Metro Salt Lake Coefficient	*p*	Metro San Diego Coefficient	*p*
Constant	6.290E-001		0.330	
Gross Leasable Area	6.664E-007	*	-0.000	
Class A	0.151	*	0.216	*
Class B	0.07	*	0.105	*
Effective Year Built	0.000E+000	*	0.000	
White Percent	0.000E+000		0.098	*
Median Household Income	9.918E-004	*	0.001	*
Davis Co	0.01		na	
Salt Lake Co	2.800E-002		na	
Utah Co	7.000E-002		na	
Distance CBD, miles	-4.000E-003	*	-1.000E-003	*
Distance CRT, miles	-0.015	*	-1.600E-002	*
Distance CRT Squared	0.001		1.000E-003	*
Cases	618		811	
Adjusted R-Square	0.306		0.311	
F-Ratio	23.643		41.533	

*$p < 0.05$, one-tailed test

Table 6
Regression results for Multifamily Rent with Respect to Commuter Rail Station Distance

Variable	Metro Salt Lake Coefficient	*p*	Metro San Diego Coefficient	*p*
Constant	-4.484		-0.349	
Gross Leasable Area	3.657E-007	*	2.155E-007	*
Effective Year Built	0.002	*	0.000	*
Market Rent	0.132	*	0.082	*
White Percent	-0.001		0.137	*
Median Household Income	-2.606E-005		8.186E-004	*
Davis County	-0.084		na	
Salt Lake County	-0.038		na	
Utah County	0.157		na	
Distance CBD, miles	-2.017E-006	*	-1.000E-003	*
Distance CRT, miles	-7.215E-006	*	-1.400E-002	*
Distance CRT Squared	1.171E-010	*	0.000E+000	*
Cases	618		3608	
Adjusted R-Square	0.306		0.205	
F-Ratio	23.643		94.047	

*$p < 0.05$, one-tailed test

Implications

Though we are not the first, we are among the few researchers who have devised a method to detect positive and negative amenity effects of rail transit stations on real estate properties. Our method is applied to office and multifamily rental properties in metropolitan San Diego and Salt Lake City with respect to distance from commuter rail transit stations. Our model further includes such controls as key structure features, socioeconomic factors, and CBD distance, the latter of which has not been used in many prior studies of the effect of CRT stations on the real estate market.

Our analysis indicates that both the rental office and multifamily markets respond favorably to CRT station proximity; but the real surprise to us is how sensitive the rental multifamily real estate market is. At first blush, we anticipated that negative amenity effects of CRT station proximity would outweigh the positive ones: who would want to live near very noisy diesel-powered train engines in areas where CRT stations are often in industrial locations? Yet, we notice that land use and facility planning around CRT stations in both metropolitan areas create attractive mixes of land uses and often have residential development located several hundred feet away from CRT stations, thus moderating potentially negative amenity effects. Indeed, the closest rental multifamily project to CRT stations was 380 feet in Salt Lake and 190 feet in San Diego. In contrast, the closest rental offices were 690 feet and 230 feet, respectively. The first few hundred feet from CRT stations are often occupied by park and ride lots, government facilities, and train-related facilities.

Though there may be some negative amenities associated with living near—though not too near—CRT stations, there are important benefits. For the San Diego market, Cervero et al (2004) observe that CRT access allows workers to live far away from their workplaces and still get to and from work much faster than any other mode, including other transit modes. We could imagine two-way benefits: one could live in a suburban area near a CRT station, either walk, bike or take a short bus trip to the station, and be at their downtown workplaces sooner than driving or using other forms of transit; or, one could live downtown and enjoy downtown amenities but work in a suburban location near CRT stations. Indeed, we observe that most if not all suburban CRT stations in both markets enjoy direct light rail or bus access to nearby employment centers.

Our analysis may embolden transportation planners to consider new or expanded commuter rail systems. For one thing, many potential commuter rail transit stations exist in underdeveloped industrial areas that are ripe for redevelopment to the next highest and best use. For another, as the demand for transit expands (see Nelson 2013), more modes will need to be explored, including commuter rail transit and associated commuter rail based transit oriented developments.

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[NOTE: The TRR reference protocol will be used for publication.]

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