Light Rail Transit Station Proximity, Urban Form and the Short Commute to Work

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Abstract

One theorized benefit of more compact and integrated urban forms—leading to such outcomes as improved job-worker balance—is that commute times will be reduced. Moreover, a theorized benefit of fixed guideway transit systems such as light rail transit (LRT) is that commute times should be shortened for people living near LRT stations. There is no apparent evidence supporting these propositions. In this article, we estimate the variation in the share of block group workers who commute less than 10 minutes one way from their home to the workplace—what literature calls a "short commute"—with respect to urban form and proximity to LRT stations. Using an objective measure of urban form (comprised of development density including job-worker balance, land use mix, centering, and street connectivity), we find that the higher the score the higher the share of workers engaging in a short commute. We also find that the share of workers engaged in a short commute falls with each 0.50-mile distance band from LRT stations to two miles. Implications for transit planning are offered.

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Introduction

The typical American worker spends about 25 minutes commuting one way to work (AASHTO 2013), or roughly one hour per day. Assuming 250 work days annually (excluding holidays and two weeks of vacation), this is equivalent to about 26 days per year—more days than one work month. Commuting time tends to be longer than times for non-commuting purposes and sensitive to travel schedule and travel delay because commuting to destination on time play a role in linking workers' economic activities at their workplace in time. At the household level, commuting consists of approximately one third of the total household vehicle travel (AASHTO 2013). The range is considerable, however, with 13 percent under 10 minutes each way, 43 percent between 10 and 24 minutes, 25 percent from 25 to 44 minutes, and 15 percent comprising the rest.[1] The distribution of commuting time is illustrated in Figure 1.

There is the concern in existing literature that long commuting times to work reduces the ability of lower income persons to secure and retain a job or be able to secure replacement jobs (Immergluck 1998; Allard and Danizger 2002). Low-income persons' instability of jobs is also associated with shorter commuting distance than other income groups because low income workers need to get to their workplace with fewer commuting trips and slower transportation modes such as standard bus service, walk, and bike even if the average commuting trip time is the same for all income groups (Giuliano 2005: 65). In short, proximity to job opportunities matters for lower-income, lower-skilled persons (Kneebone and Holmes 2015). Particularly, better mobility of low income persons to job by rapid transit systems like light rail transit can

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[1] The remaining are those who work at home.

increase their commuting distance while maintaining fewer affordable trips, provide them with more job opportunity, and improve degree of labor participation (Giuliano 2005; Sanchez 1999).

There is also a concern related to personal physical activities necessary for maintaining health and their survival. Christian (2009) reports that every ten minute devoted to commuting is associated with "a 0.257 minute (approximately 15 seconds) exercise time reduction, a 0.387 minute (approximately 23 seconds) food preparation time reduction, and a 2.205 minute sleep time reduction" (Christian 2009: 1). Christian defines a short commute as one which is 10 minutes or less, regardless of mode. Consider that the typical one-way commute in America is about 25 minutes or about 15 minutes longer than a short commute. This daily 30 minute increment above a short commute equals 125 hours per year, which are nearly the equivalent of four work weeks.

Over the past several decades, there is growing concern about increasing commuting trips and travel times with associated deterioration of individual quality of life. Weitz (2003) observes that the physical distance between where a worker lives and the location of jobs can be significant because often commuting by car is the only reasonable option for workers who cannot walk from home to their workplace. This echoes research by Lopez-Zetina, Lee and Friis (2006) who show that vehicle-miles traveled—a proxy for commuting time—is more strongly correlated with obesity than any other factor.

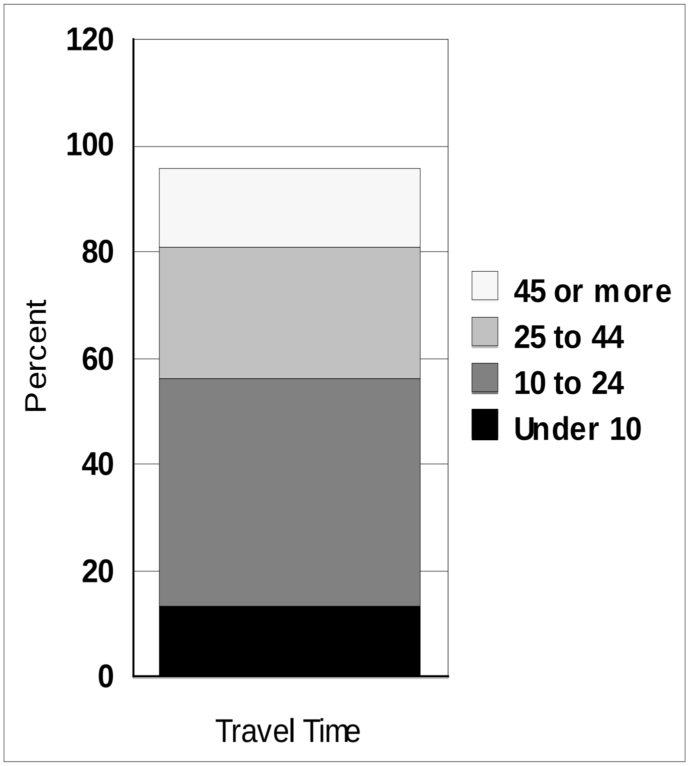

Figure 1 Distribution of commuting time in minutes

Improving accessibility to work not to mention achieving collateral benefits is complex. In this article, we will address these complexities in three ways. First, we will review the concept of jobs-worker balance. Conceptually, when jobs are located near where workers lives the need for long commutes—or any commute by motor vehicle—can be reduced. If jobs are close enough, workers can access them by walking, bicycling, public transit or short vehicle trips (Stoker and Ewing 2013). If all people who work also live in close proximity, this is called the “job-worker balance.” A more nuanced perspective related to creating an urban form in which jobs and housing can be supported; this will be our second discussion. Third, a key feature in making jobs more accessible is through a transportation system that connects people to employment nodes such as through light rail transit (LRT) systems. These concepts will be tested through a research design followed by discussions of results and implications especially for LRT systems, and by implication all fixed-guideway transit systems.

Job-Worker Balance

Stoker and Ewing (2013) [2] observe that for any given region or metropolitan area that is large enough, there will be a perfect balance between where workers live and their jobs. It is at the smaller, community scale however where there are often imbalances between where people live and where they work. In areas with an abundance of housing, residents who work may commute long distances to work outside the community. In areas with an abundance of jobs, workers will commute to fill them. However, even if a community has a mathematical balance between workers living there and available jobs, those jobs may require different skills than residents offer so resident workers would still commute out while others commute in.

This can lead to worsening congestion, increasing greenhouse gases, and lower quality of life. It can also lead to socioeconomic imbalances as lower-skilled workers incur high travels times and costs to access lower skilled jobs in high-value locations (Kain 1992). It is for this reason that the term "workforce housing balance" has gained popularity in recent years. It suggests the availability of housing affordable to households near where they work such as teachers and first-responders working in high-value communities.

The term "workforce housing" has its roots in "jobs-housing balance" literature. The term is often used in practice to mean a numerical balance between jobs and workers in a defined geographic area. For instance, if an area averages 1.5 workers per household, it should also have 1.5 jobs per households. As household sizes vary and thus the number of workers per household, the jobs-worker relationship is a more direct measure of balance.

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2 The author acknowledges Stoker and Ewing (2013) for their review of much of the literature that is summarized in this section.

Land-use planning, especially zoning, is seen as a key reason for reducing the job-worker housing balance (Weitz 2003). Exclusionary zoning—where lower income households are prevented from living in high-value areas—contribute especially to what Kain (1968, 1992) calls the "spatial mismatch" between lower-wage jobs in a community and the distance those workers travel to access them (Giuliano 2004, 2005; Giuliano and Small 1993; and Cervero 1989).

From a planning perspective, a key goal of achieving job-worker balance is to reduce the single-occupant vehicle (SOV) mode in the commute to work, decrease travel distances and times, and increase the use of transit, walking, biking as alternatives to the SOV option (see Frank and Pivo 1994; Guiliano & Small 1993; Ewing 1996; Ewing and Hamidi 2015; Sultana 2002; Rodriguez and Targa 2004). Arguably, commuting stress could be reduced and workplace productivity increased (Armstrong and Sears 2001). Reducing motorized travel can also reduce greenhouse gas emissions

Several social goals may also be achieved through job-worker balance. Cervero (1989) implores that the "provision of affordable housing closer to suburban job centers would vastly increase the residential opportunities of America's working class and would help reduce housing discrimination". Improving job-worker balance can reduce the spatial mismatch thereby reducing unemployment especially among lower-skill workers (Kain 1968, 1992).

In recent years, the concept of the spatial mismatch has been broadened to include a "modal mismatch" whereby jobs are inaccessible to residents without cars (Fan 2010, 2012; Fan and Huang 2011; Fan, Guthrie and Levinson 2011) and a "skill mismatch" whereby jobs are inaccessible to because nearby residents they do not have the necessary skills or education (Chapple 2001; Ong and Miller 2005; Grengs 2010; Fan 2012).

Cervero (1989) sums it best: “(M)any of the nation’s most pressing and persistent metropolitan concerns- congestion, energy depletion, air pollution, sprawl, and class segregation- would be relieved by balancing job and housing growth.”

There are many ways in which to measure job-worker balance. Stoker and Ewing (2013) note several conceptual issues as well as technical limitations in measuring distances and times between homes and jobs. Among researchers who have offered specific measures are from home to work are Levine (1998) at 6-8 miles, Deakin (1989) at 3-10 miles, Cervero (1989) at 3 miles, Pisarsky (1987) at 9 miles and Stoker and Ewing (2013) at 3 miles.

One view of measuring the appropriate job-worker balance area is not based on distance but rather travel time to work. Over the past several years, researchers have begun to correlate commuting time with quality of life. This literature indicates that people who incur long commuting times disproportionately suffer from stress and associated outcomes such as obesity and dissatisfaction with life (Lowrey 2011). It appears that the 10-minute commute, regardless of mode, could be considered ideal.

For instance, Robert Putnam in *Bowling Alone* (2001) notes that every 10 additional minutes engaged in commuting reduces "social connections"—which make people feel fulfilled and happy— by 10 percent. Lowrey also reports that the Gallop-Healthways Well-Being Index (Crabtree 2010) shows that a 90-minute commute stresses 40 percent of commuters but this falls to 28 percent—nearly a third— for those with "negligible" commutes of 10 minutes or less.

The 10-minute commute to work likely covers a small area. If it is to be used as a guide for achieving job-people balance, its spatial extent may range up to 3 miles when driving, less than that when using transit, and perhaps only a census tract when walking or biking to work. There is only one urban form metric designed at the census track that can be used to assess job-worker balance, which is discussed next.

Commuting Travel and the Built Environment: From Macro to Micro Level

The seemingly simple concept of job-people balance belies its complex dependency on urban form. Grengs, Levine and Shen (2014) put it well:

> … the very purpose of cities is the access they provide to help people gain economic prosperity by offering a wide range of jobs, a variety of goods for consumption, and an assortment of amenities and services to satisfy diverse desires. Where people live has a powerful effect on their capacity to achieve a high quality of life [reference omitted], in part through the accessibility that a place provides. Accessibility represents a measure of choice—as an indicator of a person's potential for seizing available opportunities. (Grengs, Levine and Shen 2014: 2).

Crafting an objective measure of urban form that captures relevant ingredients has proven elusive. Ewing and Hamidi (2014a, 2014b) have done so through an urban form metric that is comprised of these elements (adapted from Ewing and Hamidi 2014a: 2):

> **Development density** measured by combining six major factors: 1) total density of the urban and suburban census tracts; 2) percent of the population living in low-density suburban areas; 3) percent of the population living in medium- to high-density areas; 4) urban density within total built-upon land; 5) the relative concentration of density around the center of the MSA; and 6) employment density.
>
> **Land use mix** measured through a combination of factors relating to 1) the balance of jobs to total population and 2) the mix of job types within one mile of census block groups.

Urban centeredness measured as the proportion of people and businesses located near each other is also a key variable to define an area.

Street connectivity measured by combining a number of factors regarding the street network. The factors are average length of street block; average block size; percent of blocks that are urban in size; density of street intersections; and percent of four-way or more intersections, which serves as a measure of street connectivity. (Adapted from Ewing and Hamidi 2014a: 2; italicized emphasis added.)

These four factors are given equal weight, controlling for population, to generate an objective measure of urban form akin to an intelligence quotient (IQ) such that areas with scores over 100 have greater density, more integrated land uses, are more centered and have better street accessibility than areas with scores less than 100. Fortunately for our purposes, Ewing and Hamidi have generated urban form scores for metropolitan census tracts. Notably, this measure includes the principal elements of job-worker balance within a more robust urban form context.

At the micro level, effects of proximity to jobs and shorter commutes are analyzed as a function of distance between block group centroids and their nearest fixed guideway transit station because commuters who live close to the transit stations increase probability of using transit to get to their workplace. Ewing and Cervero (2010) confirm this by finding that a one percent decrease in a household's distance to transit increases ridership by 0.29 percent. Cervero (2007) also found that a person living within 0.5 mile of a transit station is four times more likely to use it than a person living between 0.5 and 3.0 miles. In their analysis of catchment areas, defined as the distance over which nearly all commuters walk to transit stops, Moreover, Guerra, Cervero and Tischler (2012) found that one-half mile distance was the best predictive distance; this is roughly comparable to a 10-minute walk. But neither these studies nor others apparently report the percent of commuters who incur a short commute time to work with respect to distance from downtowns or transit stations.

Recent research, however, shows that the real estate market responds to LRT station proximity up to two miles away (Petheram et al. 2014; Nelson et al. 2015). They surmise that transportation options along routes leading to transit stations—such as feeder buses, taxis, corporate vans and so forth—help explain the real estate premium. Thus, a person living two miles from a transit station could access it within 10 minutes. More to the point, we see from Figure 2 that LRT stations attract jobs increasingly from the most distant where associations are significant—1.75 miles—to the innermost distance band.

Though there are numerous ways in which to specific the variable representing distance from LRT stations, we choose 0.5-mile distance bands for the reasons that (1) there is a large literature addressing station area effects within one-half mile increments and (2) distance bands are more practical for planning purposes than continuous (especially continuously changing) distances. As the study area is five miles from LRT stations, our LRT station distance variable is comprised of four, 0.50-mile distance bands with the area between two 2.0 miles of the block group centroid to the LRT station and the five mile study area being the referent. We expect positive, declining associations with respect to block group short commute shares and distance band from LRT stations.

Transit Oriented Development as Job-Worker Centers

The third dimension we address is the extent to which distance to fixed-guideway transit stations contribute to short commutes. We note these observations from Owen and Levinson (2014):

> Land-use-based approaches to improving transit accessibility revolve around proximity and density for both origins and destinations. Proximity to transit service is critical in overcoming the low speed of pedestrian access to and from stops and stations. Density is the manifestation of the increasing value of more accessible locations. As residential areas become denser, more residents experience the local accessibility; as employment areas become denser, more jobs can be accessed through the same transit system.
>
> …. In general, areas with higher residential and employment density can achieve greater transit accessibility given the same level of transit service.
>
> At lower accessibility thresholds, and especially at the *10-minute threshold*, the job accessibility experienced by a typical worker is determined primarily by local employment density and only secondarily, if at all, by transit service. With a 10-minute travel time budget, reaching a stop, waiting for a vehicle, and walking to the destination after alighting leave little time available for actually traveling on a transit vehicle. It is likely that most jobs within this threshold are reached solely by walking and do not involve a transit vehicle at all….As the travel time threshold increases, so does the relative contribution of transit service and coverage …. (Adapted from Owen and Levinson 2014: 7; emphasis added.)

A key consideration is the extent to which transit oriented developments becomes job centers in their own right (Cervero et al. 2004) as well as attracts residential development.

Recent research by Nelson (2015a, 2015b) confirms this generally though with considerable variation among types of fixed-guideway transit systems and the metropolitan areas they serve.[3] For instance, in the context of light rail transit, figures 2 and 3 illustrate the shift in share of jobs and housing regionally to areas within one-half mile of LRT stations.

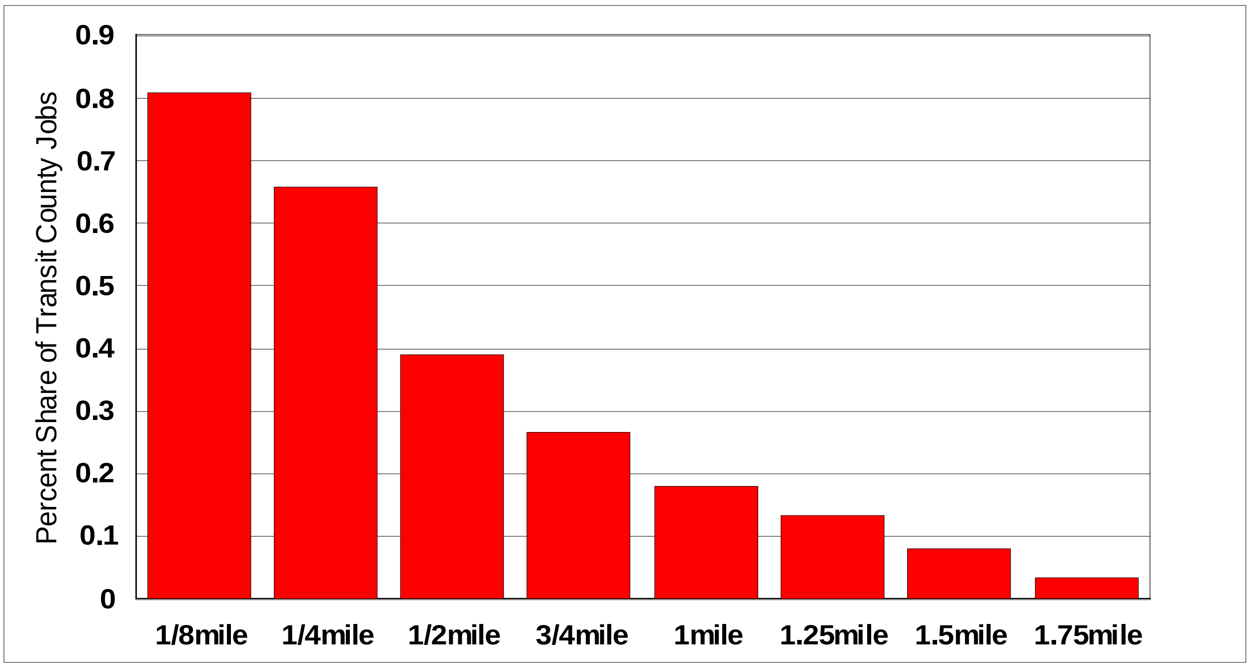

Figure 2 Share of change of regional jobs with respect to distance from light rail transit stations, 2008-2011. (Distance bands were selected because performance in each was statistically significant from 0, which was found for the 2.00 mile distance band and beyond.)

[3] Detailed results of Nelson's (2015a, 2015b) research are forthcoming.

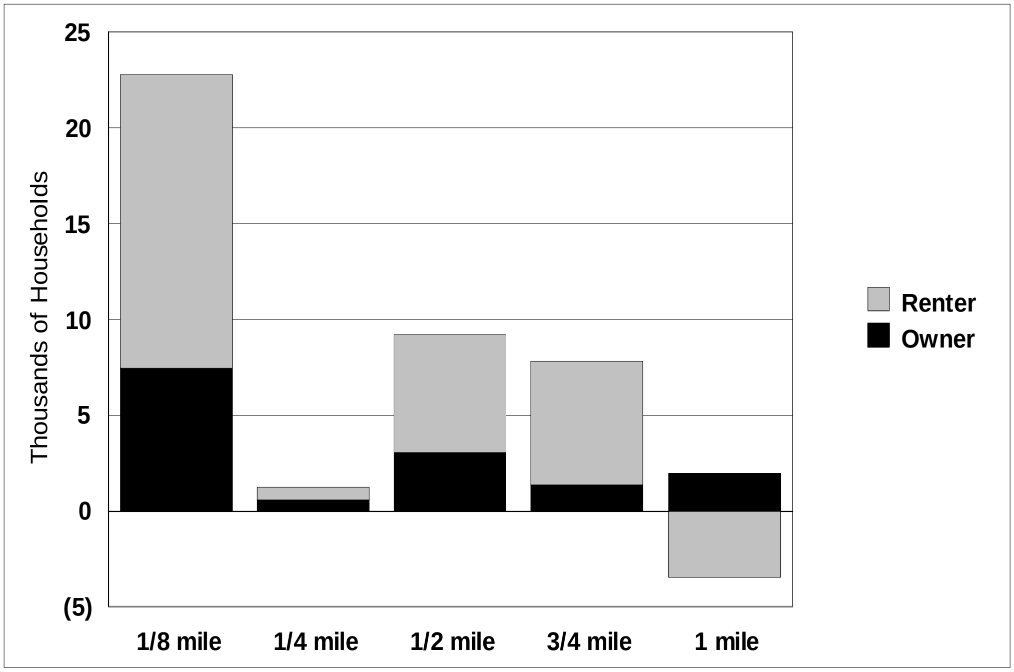

Figure 3 Share of change of occupied housing units by tenure with respect to distance from light rail transit stations, 2008-2011

Research Question, Model and Data

One may be struck by the parallels between the possibility that a 10-minute commute regardless of mode to work advances personal well-being and the conventional TOD 10-minute walk between the station and a destination. The 10-minute time frame can be characterized as a “short commute”. But what is the prevalence of a short commute with respect to residential location and proximity to fixed guideway transit stations—in our case light rail transit stations? Does this prevalence vary by socioeconomic factors, urban form, and the choice of mode to work?

To address these questions, this study uses quasi-experimental, cross-section regression analysis by applying census journey to work data to multiple fixed guideway transit systems – especially LRT systems. All eleven LRT systems that were operating in 2010 are used in our analysis including Charlotte, Dallas, Denver, Houston, Minneapolis, Phoenix, Portland, Sacramento, Salt Lake City, San Diego and Seattle.

The following linear regression equation is devised to test for the variation in short commutes with respect to residential location, urban form, and LRT station distance. The model is designed to use block group level data from the 2010 census.

Short Commute = *f*(Socioeconomic Status + Jobs by Wage + Centrality + Metropolitan Area + Commute Mode Choice + Urban Form + LRT Station Distance)

In the equation, *Short Commute* is the dependent variable. Short commute is defined as the percent of workers whose journey to work is 10 minutes or less. Data are from the 2010 Census at the block group level and measured within a five mile buffer of LRT stations. Because this variable is a percent, a one unit change in independent variables can be interpreted as a percentage point change in the dependent variable. In the right side of the linear regression equation, two experimental variables are considered in this study. *LRT Station Distance* is defined as the distance between block group centroids and their nearest LRT stations throughout 11 metropolitan statistical areas (MSAs). Considering the research questions, experimenting effects of proximity of block groups to their nearest LRT station explains how proximity to LRT stations can affect percent change in the number of workers whose journey-to-work time is less than 10 minutes. A measure of urban form is another experimental variable. In this study, *Urban Form* is the Ewing-Hamidi (2014) urban form score for the census tract within which a block group is nested. This index is calculated based on the four factor score – density, land use mix, connectivity, and centeredness factors. Each factor score is a proxy for job accessibility and job-worker balance. By experimenting variation in urban form index, this study expects a positive association between urban form and the percent of workers commuting 10 minutes or less to work.

To better explanation of variability and predictive power in our linear regression model, five control variables are used. *Socioeconomic Status* includes the percent of the population that is White non-Hispanic, median household income all at the block group level based on the 5-year sample of the American Community Survey for 2012, the home ownership rate of the block group. Based on Kain's body of work and those who followed, a positive association is expected between short commute and the share of a block group that is White non-Hispanic, and income. The reason is that minority households are segregated away from key destinations such as work based substantially on income (see also Galster and Cutsinger 2007, Emrath and Siniavskaia 2009). On the other hand, because land becomes more valuable the closer it is to transit stations

(Higgins and Kanaroglou 2015) we expect a negation association between home ownership and short commutes (see Figure 3).

Jobs by Wages is the share of upper and middle wage jobs in the block group with the expectation being that higher wage jobs are associated with shorter commutes because they offer incomes allowing workers to live near jobs. In contrast, low wage jobs do not allow workers to live near them (see Nelson 2015a). Using the County Business Patterns, Table 1 shows how we define high, moderate and low wage jobs. Longitudinal Employment-Household Dynamics (LEHD) jobs are assigned to wage groups accordingly. These are binary variables so that results for high and moderate wage jobs are with respect to low wage jobs.

Distance to CBD (centrality) is measured as the miles from the block group centroid to the center of the central business district. While there is no literature associating short commutes to distance from the CBD, we nonetheless expect a declining function outward. We use a quadratic transformation of this variable so we can estimate the inflection point where distance-decay is minimized.

Metropolitan Area is the metropolitan statistical area within which a block group is located. As metropolitan areas vary by growth rates, economic structure, landscape and climate, political orientations, and other differentiating features, the metropolitan area control helps account for these differences. Because they represent individual metropolitan areas, there are no *a priori* assumptions of associations between them and the percent of workers commuting 10 minutes or less to work. However, statistically significant coefficients for any or all metropolitan imply that the performance of each with respect to a referent (in this case Phoenix) warrants metropolitan area-specific analysis.

Table 1
Allocation of Jobs by Lower-, Middle- and Upper-Wage Category

NAICS	Description	Mean Annual Wages, 2013	Wage Category	Share of Jobs
44	Retail Trade	$25,779	Lower	
71	Arts, Entertainment and Recreation	$32,188	Lower	
72	Accommodation and Food Services	$17,453	Lower	
81	Other Services (except Public Administration)	$29,021	Lower	
	Weighted Mean Wages and National Share of Jobs		***$23,696***	***31%***
48	Transportation and Warehousing	$45,171	Middle	
53	Real Estate and Rental and Leasing	$46,813	Middle	
56	Administrative, Support, Waste Mgmt., Remediation	$35,931	Middle	
61	Educational Services	$35,427	Middle	
62	Health Care and Social Assistance	$44,751	Middle	
	Weighted Mean Wages and National Share of Jobs		***$41,723***	***35%***
22	Utilities	$94,239	Upper	
31	Manufacturing	$54,258	Upper	
42	Wholesale Trade	$65,385	Upper	
51	Information	$83,677	Upper	
52	Finance and Insurance	$88,677	Upper	
54	Professional, Scientific and Technical Services	$75,890	Upper	
55	Management of Companies and Enterprises	$105,138	Upper	
	Weighted Mean Wages and National Share of Jobs		***$70,490***	***34%***

Source: County Business Patterns, 2013.

Commute Mode Choice includes the percent of block group workers who commute via walking, biking or transit. Commuting via automobile, truck and other motor vehicle is the referent against which the binary variables are compared. Data are from the 5-year sample of the American Community Survey for 2012. Analysis by the Census Bureau of walking and biking to work indicate that whereas the mean travel time to work for walking is 11.5 minutes, for biking it is 19.3 minutes or nearly double (McKenzie 2014). For transit, it is nearly 50 minutes (McKenzie 2011). We expect a positive association between the share of block group workers commuting less than 10 minutes to work and the share who walk to work, but a negative one with respect to biking to work or talking transit. We also include the share of workers who work from home. There is no *a priori* expectation that the share of workers engaged in a short commute are associated with changes in the share of workers who work from home. We add this variable nonetheless because otherwise our model would not include all workers.

Results

Table 2 reports regression results. The overall coefficient of determination is modest (0.154) but all other performance indicators were reasonable. All variables are significant with the expected signs of association. Moreover, correlation coefficients did not reveal problematic multicollinearity. It is important to note that a key feature of hedonic regression analysis is that despite missing attributes that could help explain more of the variation in the dependent variable, the analysis otherwise performs as expected, as is now discussed.

Effects of LRT Distance and Urban Form

The key variable of interest to us is distance from the transit station in a TOD area. The regression equation shows positive, significant coefficients with declining magnitudes from the innermost band (less than or equal to 0.5 mile from the nearest LRT transit station) to the farthest band (greater than 1.5 miles to less than or equal to 2.0 miles). These coefficients are with respect to the referent being all block groups more than 2.0 miles from the nearest LRT station out five miles to the limit of our study area. The share of workers commuting to work in 10 minutes or less who live in the closest band increases by nearly 1.5 percentage points above the mean, falling to about 1.3, 1.1 and 0.7 percentage points respectively to the outermost distance band. These results are illustrated in Figure 4. To our knowledge, these are the first results to show a relationship between transit station distance and share of workers commuting 10 minutes or less.

The urban form variable in the regression model is also consistent with our expectations – the higher the Ewing-Hamidi urban form score, the larger the share of workers living in the block group who commuted to work in less than 10 minutes. This is an important finding by itself. Although Hamidi et al (2015) illustrate the utility of the Ewing-Hamidi urban form measure to explain variation in such things as traffic safety and public health outcomes, few if any studies have applied it to other questions. The regression model result shows that block groups located in the compact MSAs tend to have more workers with short commutes than block groups in sprawling MSAs. Particularly, the model tells us that 10 point increase in the urban form score can increase percent change in the number of workers with shorter commutes by 0.2 percent.

Table 2
Regression Results Estimating the Association between Percentage of Census Block Group Short Commutes (under 10 minutes) and Urban Form, and Distance Bands from Light Trail Transit Stations

Variable	**Beta**	**t score**	**Sig. (1-tailed)***
Constant	8.077	7.980	0.000
Socioeconomic Controls			
White non-Hispanic Percent	0.041	9.444	*0.000*
Median HH Income (000s)	0.016	4.529	*0.000*
Owner Percent	-0.029	-6.758	*0.000*
Jobs by Wages Control			
Upper Wage Jobs Percent	0.012	2.982	*0.002*
Middle Wage Jobs Percent	0.007	2.075	*0.019*
Centrality Control			
CBD distance (miles)	-0.071	-1.327	*0.093*
CBD distance (miles) squared	0.005	2.424	*0.008*
Metropolitan Area Controls[a]			
Charlotte	0.787	1.411	0.079
Dallas	-2.119	-5.585	0.000
Denver	-2.575	-6.902	0.000
Houston	-0.385	-0.829	0.204
Minneapolis	-1.996	-4.765	0.000
Portland	-1.777	-4.177	0.000
Sacramento	-1.539	-3.823	0.000
Salt Lake City	0.220	0.455	0.325
San Diego	-7.358	-7.600	0.000
Seattle	-2.303	-5.230	0.000
Commute Mode Controls[b]			
Walk Commute Percent	0.311	21.174	*0.000*
Bike Commute Percent	-0.062	-2.230	*0.013*
Transit Commute Percent	-0.153	-11.680	*0.000*
Work at Home Percent	-0.014	-0.796	0.213
Urban Form Experimental			
Urban Form Score	0.017	2.269	*0.012*

Table 2
Regression Results Estimating the Association between Percentage of Census Block Group Short Commutes (under 10 minutes) and Urban Form, and Distance Bands from Light Trail Transit Stations—continued

Variable	Beta	t score	Sig. (1-tailed)*
LRT Station Distance Experimental[c]			
LRT<=0.5 mile	1.453	3.597	*0.000*
LRT>0.5 mile to <=1.0 mile	1.258	4.145	*0.000*
LRT>1.0 mile to <=1.5 miles	1.091	3.681	*0.000*
LRT>1.5 miles to <=2.0 miles	0.695	2.317	*0.011*

**p < 0.10 in italics*

a. Phoenix is the referent.

b. All other commuting modes is the referent.

c. Distance beyond 2.0 miles is the referent.

Performance Metrics

n	6,921
Adjusted R-squared	0.154
F score	49.558
Significance F	0.000

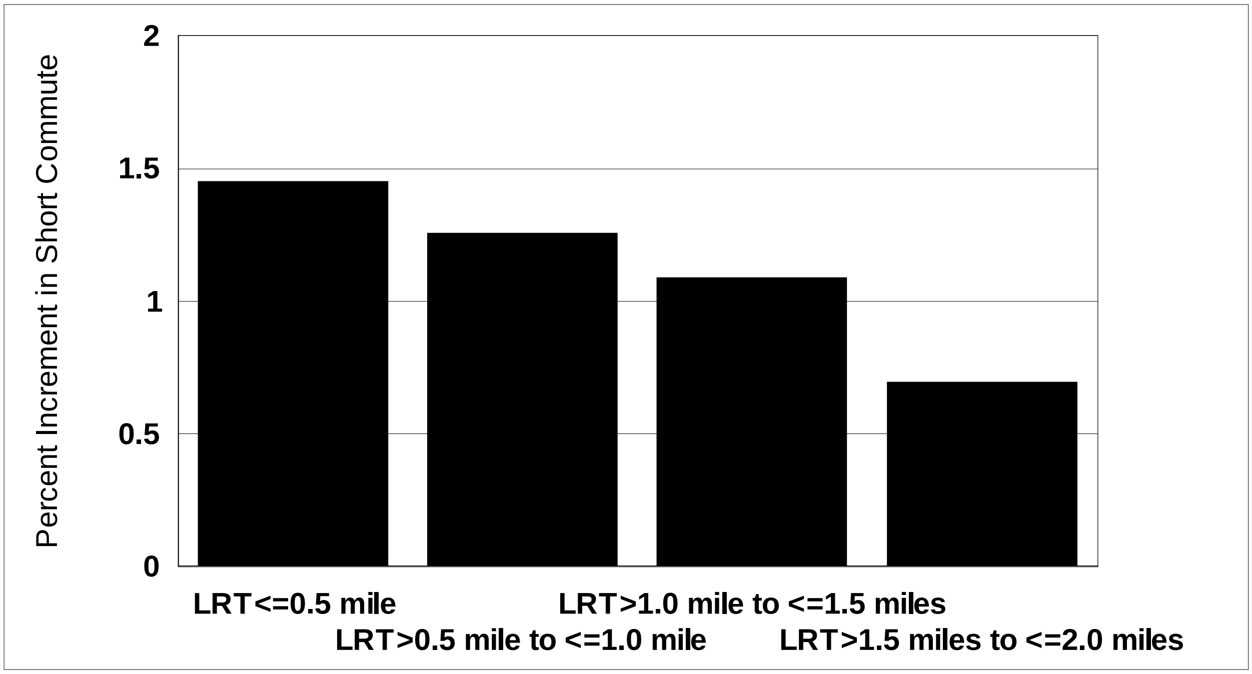

Figure 4
Change in percent of block group workers with a short commute (under 10 minutes) with respect to distance from LRT stations

Other Control Variables Affecting Short Commute

Socioeconomic Status—Using Kain (1968, 1992) and Kneebone and Holmes (2015) as a guide and as expected, the higher the percent of population that is White non-Hispanic and the higher the median household income, the larger the share of commuters with a short commute. Also as expected, the rate of home ownership is negatively associated short commutes. We suspect this is the case for two reasons. First, the more jobs and housing are mixed in compact settings the higher the property value and less affordable home ownership is even for households earning more than the regional median incomes. Second, even with demand for home ownership, financial institutions discriminate against condominium ownership options.[4]

Jobs by Wages—As expected, the higher the wage category for jobs in a block group the higher the rate of short commutes. The regression shows that relative to lower wage jobs, the share of higher wage jobs in a block group is associated with the highest share of short commutes followed by middle wage jobs. This is reasonable because when jobs and housing compete for the same space, prices for both. Higher wage firms displace lower wage ones while higher value housing replaces lower value housing, often leading to more rental housing albeit likely at higher rents.

Distance to CBD (centrality)—Also as expected, the farther from the center of the CBD a block group, the lower the share of workers with short commutes but at a declining rate. The quadratic equation shows the slope reaching minima at 7.1 miles.[5]

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4 For a discussion on historical practices which began to change in the late 2010s, see http://www.planetizen.com/node/89068/feds-propose-new-lending-standards-condo-developments.

5 Differentiating (-0.071X + 0.007X^2) gives -7.100 miles.

Metropolitan Area—Although there are no a priori expected directions of association between metropolitan area location and the share of block group workers engaged in a short commute, it is notable that nearly all metropolitan area variables were statistically significant with varying signs. The implication is that specialized analysis of at least the Charlotte, Dallas, Denver, Minneapolis, Portland, Sacramento, San Diego, and Seattle markets are warranted.

Commute Mode Choice—The variables for mode choice in the journey to work performed as expected. Relative to the vehicle option, the transit or biking modes to work are associated with lower shares of workers commuting to work in 10 minutes or less. But the reverse is found with respect to walking to work (see also Nelson et al. 2013). Given the variation in outcomes at the metropolitan scale, future research may apply the model or an expanded version to help understand determinants of short commutes in each of them. The coefficient for the variable representing those working at home is ambiguous; not only could we predict the direction of association between it and the share of workers engaged in a short commute based on literature or *a priori*, no statistically significant association was estimated in our model.

We offer some concluding observations and implications next.

Conclusions and Implications

Using a quasi-experimental, cross-section hedonic analysis, our study shows that while the coefficients for the urban form and LRT station distance band variables are small they are not trivial. Consider the urban form coefficient. For each one point increase in the urban form score, short commuting is increased by 0.017 points. An increase of 10 urban form score points over a 20-year period—which may occur anyway given changing development patterns favoring infill and redevelopment (see Nelson 2013), implies that short commutes will increase by 1.7 points to about 15 percent, an increase of nearly 13 percent from 2009. As the nation's workforce is projected to increase by about a quarter over that period (Woods & Poole Economics 2016), however, in 20 years the share of workers engaging in a short commute could increase by more than 20 percent.

A similar calculation with respect to LRT systems is more complicated because such would apply only to those metropolitan areas with LRT systems. Moreover, many current systems are likely to be expanded, and new ones added. Furthermore, while our analysis addresses only LRT systems, findings may be applicable to other forms of fixed-guideway transit systems such as bus rapid transit and streetcars—an area future research. We would hazard that over the next 20 years existing and expanded fixed guideway systems may add at least one percentage point to those workers who engage in a short commute, thereby increasing that number by nearly 20 percent.

Though the urban form and transit station increments may not be completely cumulative the very low correlation scores between them imply substantial cumulative effects.[6] Combined,

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[6] Correlations between the urban form score and LRT station distance band are 0.148, 0.117, 0.106 and 0.053 respectively from the closest to outermost bands.

these assumptions suggest that the share of American workers engaged in short commutes could increase from 13.4 percent to about 16 percent in 20 years, or 20 percent. The number of workers engaging in a short commute to work could increase by a third or more.

These are essentially status-quo estimates, assuming there are no proactive efforts to improve urban form, expand fixed guideway transit, and facilitate more integrated land uses through infill and redevelopment.

Despite findings, there is a caveat in this study. It uses cross-section data for 11 LRT systems that were operating in 2010. It does not consider other forms of fixed-guideway transit systems such as heavy (or third) rail), bus rapid transit, streetcar or other modes. Future research can consider these other modes. As noted earlier, analysis of individual metropolitan areas may also improve overall model performance. Furthermore, the model estimates associations but not causality. Using time-series data and longitudinal analysis may expect more causal relationship between percent change in the number of workers with shorter commutes and distance to the nearest transit station. However, such a model may be complicated because of the need to also control time for when each station was opened to trace a causal relationship. The model can become more complicated if it also considers the random group effects of percent change in the number of workers with short commute according to different MSAs. This can be the focus of future work.

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