Nowhere to Run

Speed, Proximity, and their Relative Contributions to Accessibility

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ABSTRACT

Access to destinations is widely held as the *raison d'être* of transportation systems. Given its importance, however, little attention has been paid to how the two primary determinants of accessibility – mobility and destination proximity – combine at the neighborhood level to determine levels of access. Accordingly, this study combines data on (1) employment locations, (2) neighborhood-to-neighborhood distances, and (3) peak-hour travel times to assess the relationships among speed, destination proximity, and destination accessibility for the greater Los Angeles region. Across all neighborhoods in the LA region, we observe that proximity is a substantially stronger predictor of accessibility than mobility. So in general, those living in centrally located, chronically congested areas have much higher levels of job access than those living in outlying, less congested areas. While this general observation holds at all geographic levels analyzed, with respect to mobility we find that *within* community differences in traffic speed/congestion levels are observed to affect accessibility more than *between* community differences in speed/congestion. These findings suggest a number of important implications for policy. Namely, if access to destinations is indeed a primary goal, policy makers and planners should question the logic of limiting new development in order to avoid increasing congestion delays: doing so may serve to reduce accessibility. This article shows that it is possible to meaningfully measure how proximity (density) and mobility (speed) trade off in explaining accessibility across neighborhoods in metropolitan areas; such information is central to informed decisions about how new developments and mobility changes combine to affect the accessibility of neighborhoods and regions.

INTRODUCTION

To many motorists and the officials whom they elect, traffic congestion is a bane of urban living. Long viewed as a sign of transportation system breakdown by engineers and planners, traffic delay and its mitigation represents an ongoing preoccupation of transportation professionals. In reasoning about congestion and ways of addressing it, transportation engineers and planners have frequently treated the speed of vehicular travel as an end in itself, rather than as a means to participate in the place-based interactions that people and firms value. Conventional wisdom, particularly among planners and planning scholars, is beginning to turn against this focus on speed, emphasizing instead the "access" to destinations, which frames transport as a means to social interactions and economic transactions, rather than an end in itself *(1)(2)(3)(4).* The utility of a grocery shopping trip, in other words, lies in the ability to purchase and transport home desired foodstuffs at reasonable time and monetary costs, and is only tangentially related to the speed of vehicular travel between home, the grocery store, and back.

This distinction between mobility and accessibility is important because travel speed is but one contributing component of the latter. The capacity to traverse space is a function of speed, but also of knowledge about destinations, modal options, possible routes, the monetary costs of travel, and risk and uncertainty *(5)(6)(7).* And the capacity to traverse space, in turn, is one dimension of access, the other being the array and proximity of destinations. Moreover, while higher travel speeds and a greater density of nearby destinations can both contribute to higher accessibility levels, the two factors oftentimes work at cross purposes. Areas that enjoy high travel speeds often exhibit low density and few nearby destinations, while dense hubs of activity often feature clogged roadways and slow travel.

The potentially complex interplay between density and speed means that gaining a functional understanding of accessibility is necessarily an empirical undertaking. It is simply not possible to say *a priori* how the relative levels of accessibility in, say, a neighborhood with easy highway access and smooth-flowing arterials will compare to those in a dense neighborhood with tightly gridded streets and heavy peak-hour congestion. Despite accessibility's status as an increasingly touted concept, however, its empirical investigation is only just catching up to its theoretical importance. Valuable empirical efforts have recently included comparisons of inter-regional accessibility, examining the interplay of region-level attributes of density, speed, and access *(1)(8),* as well as detailed assessments of vehicular, transit, and non-motorized accessibility at fine-grained neighborhood levels *(9)(10).* There has been little attention paid, however, to the potentially complex interplay of speed and density at the neighborhood level.

It is at this sub-regional level where an informed understanding of the relative influences of speed and density in helping people access destinations can have the greatest implications for policy and planning, particularly as such an understanding relates to our treatment of traffic congestion. Assuming accessibility to be largely a function of speed may lead us to inappropriately prioritize congestion reduction at the expense of land use considerations that may be more effective in improving accessibility in some places. Likewise, though likely a less common occurrence, prioritizing proximity in places where speed most importantly contributes to accessibility could prove problematic as well. Finally, we should expect that these relative contributions of speed and proximity vary not only among metropolitan areas, but within them as well.

To contribute to the still thin empirical literature on accessibility and congestion, we report in this article on a data-driven assessment of the relationships among speed, proximity, and accessibility in the greater Los Angeles region. Specifically, we analyze the three-way relationships among these variables for the region as a whole, as well as how these relationships vary by community within the region. Our goal with this analysis is to better inform how travel speeds are assessed, and how trade-offs between speed and development density are evaluated in different kinds of communities across a large region. Additionally, we carry out our research in a way that is broadly applicable to regions throughout the country.

BACKGROUND

Measuring roadway congestion has been an important part of transportation planning and engineering since the early years of professionalized practice, and as federal, state, and regional oversight of the transportation system has evolved, accurate measures of road performance have become a critical part of evaluation, planning, and finance *(11)(12).* Congestion measurement is a core part of practice but has tended to emphasize two distinct types of metrics: region-wide or highly localized. The widely-cited Travel Time Index developed by the Texas Transportation Institute is an example of the former, and delay and volume/capacity ratios for individual road segments or intersections are examples of the latter *(14)(15)*. While separated in scale, both types of measures have emphasized speed or reductions in speed on the network without taking travel alternatives or impacts on travelers' accessibility into account *(13)(15)*. Researchers have increasingly highlighted the importance of considering traffic congestion's effects not only on delay, but on interactions among delay and individual and firm choices, and economic and quality of life outcomes *(13)(16)(17)(18)*. Practitioners and policymakers as well have begun to shift from an emphasis on network-measured delay alone, especially if those measures are seen as detrimental to broad objectives such as sustainability and accessibility, with a notable example being the introduction of legislation in California to end consideration of roadway level of service impacts in state-mandated environmental impact analysis *(19).*

While Mondschein et al. *(13)* have proposed considering impacts on accessibility rather than mobility as an alternative approach to understanding traffic congestion, research on and methods for quantifying delay's effects on access remain limited *(13)(12)(20).* The appeal of an accessibility-oriented approach to evaluating traffic congestion is predicated on the idea that the transportation system should provide access *to places and opportunities*, and its smooth operation is not an end-in-itself *(4).* Accessibility can be measured in terms of places or individuals and households, whether considered in terms of cumulative opportunities from a place or the cost of a trip to the doctor *(21).* Traffic congestion will have a measurable impact on impedances such as time and pecuniary cost that shape access, but higher levels of access are also in part a product of concentrated opportunities. Metrics that account for both delay and proximity simultaneously remain largely undeveloped in the accessibility literature.

Sweet *(20)* provides one exception to the general absence of accessibility measures in accounting for the effects of congestion delay. As a predictor of firms' decisions to relocate, Sweet specifies a congestion penalty, defined as the accessibility measure for a location given hypothetical free-flow conditions minus the same accessibility measure under conditions of evening peak-hour congestion. While the results presented in this paper differ from Sweet's approach in terms of the specific operationalization of congestion, the general focus is the same: to frame differences in travel speed owing to congestion in terms of their relationship to accessibility. However, rather than emphasize hypothetical differences between free-flow and peak-hour congestion, we examine differences among locations within the region, operationalized at the level of traffic analysis zones (TAZs) under typical peak congestion levels. We expect that the tradeoffs between proximity and mobility vary widely between neighborhoods and cities within large regions such as Los Angeles, and the literature on congestion and accessibility has yet to demonstrate the scale of these tradeoffs, or how they are distributed. Our analysis addresses this omission.

DATA AND METHODS

Given our hypothesis that traffic congestion is best measured through its effects on access to destinations, we examine these effects in the greater Los Angeles region, using destination and mobility data for Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties. Our data come from two primary sources: traffic analysis zone-to-traffic analysis zone (TAZ) distance and travel time data from the Southern California Association of Governments (SCAG), and individual business attributes and precise locations derived from the National Establishment Time-Series (NETS) database.

For our focus year of 2008, we derived geographic coordinates for every establishment listed in the targeted Southern California counties. We obtained these geographic coordinates through the use of two different geocoding application programming interfaces (APIs), both accessed from within the R statistical programming language. We first used an API provided by the Data Science Toolkit website *(22)*, which makes use of Open Street Maps and Census data to translate street addresses into coordinates. For firms with complete address data that did not return valid coordinates through the Data Science Toolkit API, we attempted to re-code with Nokia's proprietary HERE geocoding API *(23)*. The final set of geocoded business records were then linked to the unique traffic analysis zones in which they fall. With each business associated with a traffic analysis zone, we then calculated the total employment within each zone.

Having a complete set of TAZs for our Southern California region of study, we calculated a number of mobility- and accessibility-related measures that figure centrally into the study of accessibility's determinants. First, using matrices of zone-to-zone road network distances and morning peak-hour automobile travel times, we calculated the average speeds of motorists over neighboring regions of specified size, giving us a basic set of speed measures for the entire region. Second, we calculated the total level of employment located within the same range of network distance threshold-based neighborhoods, giving us a basic measure of destination proximity. Finally, we combined speed and proximity into a single "gravity" weighted accessibility score for all traffic analysis zones. The accessibility models we used were all of the following form, as it appears frequently in the accessibility literature *(24)(25)(26):*

$$A_i = \sum_j E_j \; e^{-\beta T_{ij}}$$

In this equation, A_i represents the total accessibility for zone i, E_j represents the total amount of employment in each destination zone j, and T_{ij} represents the morning peak-hour travel time in minutes from zone i to zone j. Finally, the parameter β has the effect of determining how much travel impedance matters in weighting a zone's accessibility contribution; larger values of β mean that even relatively short travel times will greatly devalue the accessibility benefit of neighboring destinations, while smaller values of β mean that accessibility scores will give greater weight to a wider swath of destinations. In terms of labor markets, relatively lower skill, spatially dispersed jobs – like fast food worker – would tend to have higher β values (i.e. more friction of distance), while higher skill, scarcer jobs – like cardiologist – would tend to have lower β values (i.e. lower friction of distance); this is because workers are less likely to commute long distances to relatively low paying, spatially ubiquitous jobs, but more likely to be willing to endure long commutes to much rarer and higher paying work. For the purposes of our analysis, which emphasizes access across multiple industrial sectors, we apply a common β value to represent the friction of distance between residents and jobs across the entire labor market.

In assessing relationships among the speed, proximity, and accessibility variables just discussed, we are presented with a vast number of potential parameter combinations; we must choose a specific time impedance value for the gravity-based accessibility function, and we must choose network distance cutoff thresholds for both speed and proximity calculations. We address this problem of myriad modeling permutations in two primary ways. First, we selected our highlighted parameter values by drawing from the accessibility literature. We determined that representative gravity model parameter values typically range from approximately 0.05 to 0.5, with many values close to 0.2 *(20)(24)(25)*. Using this 0.2 value for β, we then identified the tightest empirical association (as determined by the goodness of fit of linear models) with speed and job proximity threshold values of 10km, motivating our choice for these threshold values for use in our analysis. Second, we tested the robustness of our findings by running descriptive models for a wide range of parameter combinations. While we focus our presentation on a single representative set of parameters, the same broad relationships reported here hold for a wide range of tested parameter value combinations. Table 1 provides a summary of the accessibility, proximity, and speed statistics associated with our selected model parameters.

TABLE 1 Summary Values for Accessibility, Proximity, and Speed Variables, Measured at the TAZ Level

Statistic	Mean	Standard Deviation	Minimum	Median	Maximum
Average Peak-Hour Speed (km/hr; distance threshold = 10 km)	47.5	6.1	20.7	47.1	80.0
Employment Proximity Count (distance threshold = 10 km)	265,640	226,803	0	230,612	1,002,659
Employment Accessibility Index (decay parameter = 0.2)	75,537	52,123	0	74,744	301,498

FINDINGS

The complex inter-relationships among speed, proximity, and accessibility are demonstrated in paired bivariate comparisons shown in Figure 1. These graphs present two clear and sharply contrasting pictures, with employment accessibility very closely linked to job proximity on the one hand, and with higher speeds actually inversely related to job accessibility on the other. How can this be? The answer is that these are actual data for Los Angeles and not hypothesized relationships. While all things equal, higher speeds will of course get one to more destinations in a given amount of time, all things are rarely equal. Higher peak hour speeds, at least in Los Angeles, tend to be in outlying areas where densities are low and jobs sparse. Conversely, jobs tend to be clustered in places where densities are high and traffic congestion chronic. In net, more jobs can be reached in a given amount of time via the crowded streets of Santa Monica, Westwood, Beverly Hills, Hollywood, Westlake, and Downtown, than on the fast moving freeways and boulevards on the fringes of the metropolitan area. Put in general terms: as speeds increase, the accessibility benefits of lower travel time impedances are more than canceled out by an associated lack of nearby destinations.

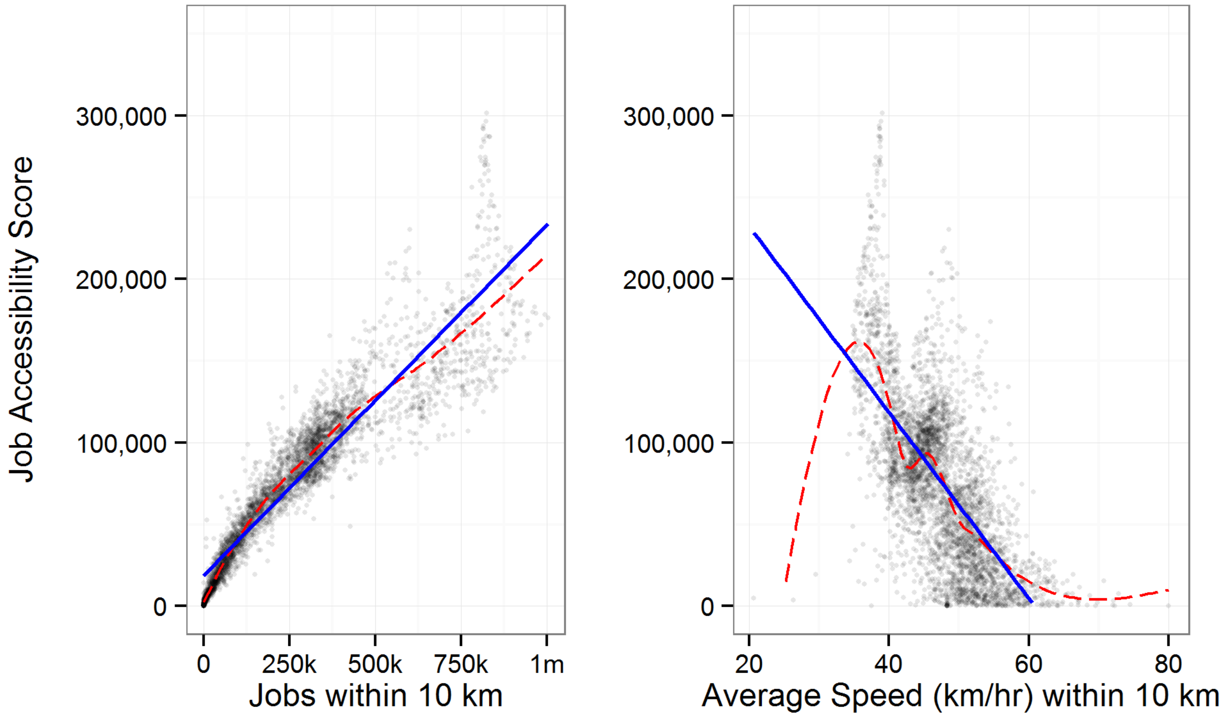
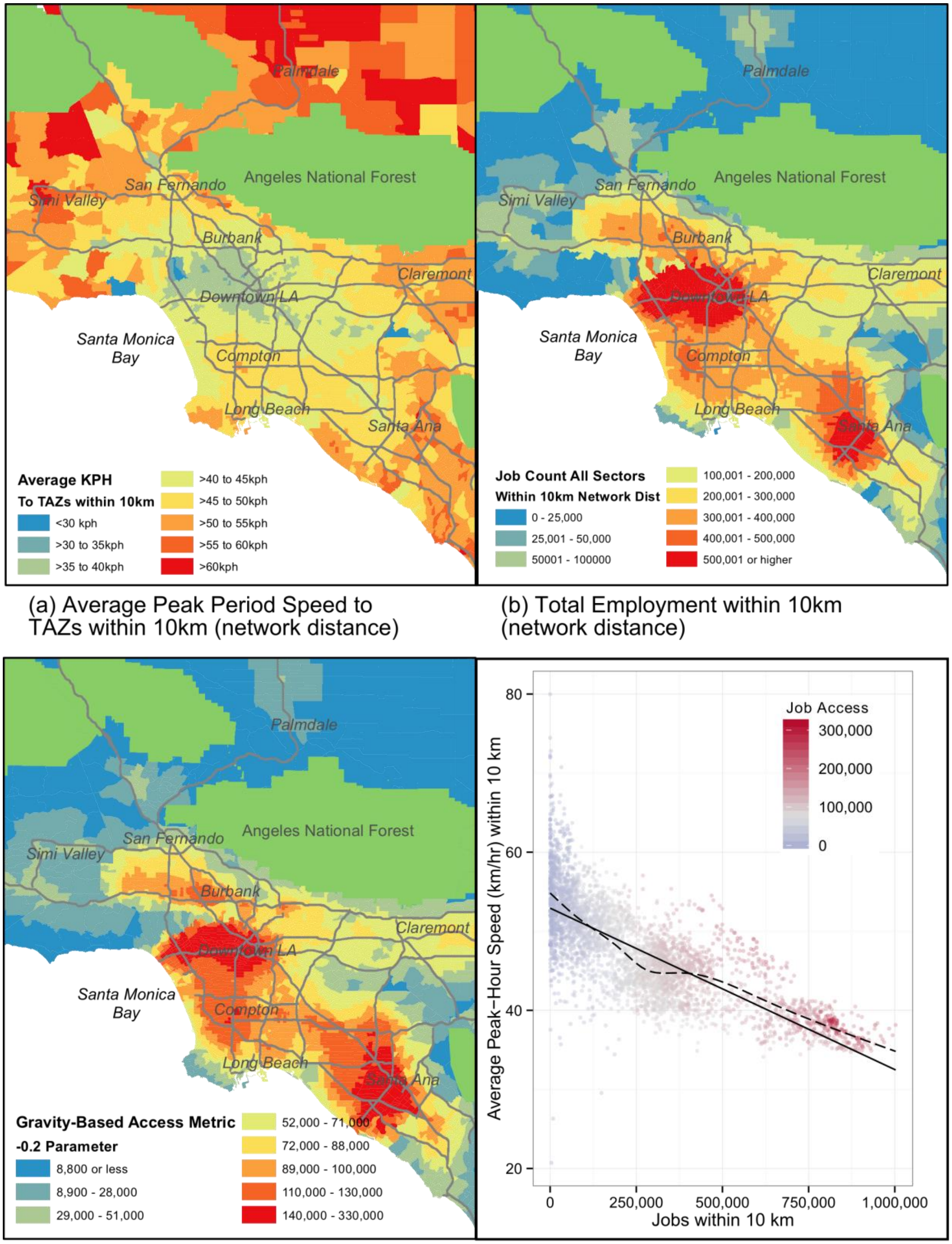


FIGURE 1 Bivariate Graphs Linking Accessibility to Proximity (left) and Speed (right)

This three-way link among accessibility and its two principal components is made clearer by examining all three variables mapped and plotted against each other in Los Angeles, as shown in Figure 2. Here, we see TAZ-level maps of speed (top left corner), proximity (top right corner), and accessibility (bottom left corner), all displayed such that higher values take warmer colors and lower values take cooler colors. Several observations jump out from these maps. As discussed above, speed and proximity do display a strong, negative relationship, with their respective coloration patterns displaying as rough inverses of one another. Also, corroborating the plots in Figure 1, the coloration of speed appears as an inverted version of the accessibility color pattern, while the coloration of proximity is very tightly aligned with that of accessibility. These qualitative visual observations are bolstered by the scatterplot in the lower right panel. Here, we again see a distinct and very nearly linear negative relationship between proximity (running horizontally) and speed (running vertically). This plot also displays the accessibility values of traffic analysis zones of different speeds and accessibilities. Again, we see a very clear trend of accessibility values increasing from left to right on the graph (indicating a strong proximity-accessibility relationship). The upper left corner of this scatterplot shows many low-accessibility TAZs, while the lower right corners has many high-accessibility TAZs. This pattern makes clear the overall negative relationship between speed and accessibility.

To more directly evaluate the patterns depicted in Figure 2, we specified a series of three ordinary least squares (OLS) regression models, accounting for accessibility in terms of speed, proximity, and a combination of the two. The results of these models are shown in Table 2. To better facilitate comparison among the models, each variable has been scaled, such that the standard deviation is one and the mean is zero. Model 1 shows that, in the absence of other predictors, a one standard deviation increase in speed corresponds to a 0.687 standard deviation *decrease* in employment accessibility, whereas Model 2 shows that by itself a one standard deviation increase in proximity to jobs corresponds to a 0.925 *increase* in accessibility. When both independent variables are included in the same model, proximity maintains its strength as a predictor of accessibility, while the sign for speed switches – speed now becomes a positive predictor of accessibility – but not a powerful predictor and does little in any case to increase the explanatory power of the model. As all variables here are scaled, they can be directly compared to one another, and in Model 3 we see that a one standard deviation change in proximity has ten times the effect on accessibility as does a similar change in speed. Likewise, looking at the different models' respective R^2 values, we see that adding proximity to the speed model results in a very large jump in predictive success, with the proportion of variance explained increasing from 0.451 to 0.874. In comparison, the proximity alone (Model 2) accounts for 87.2 percent of the variance in accessibility, nearly as much as the model that includes both speed and proximity as predictors. From these models, we see strong evidence that proximity to employment is what drives employment accessibility in the Los Angeles region.

To check the robustness of the findings shown in Table 2, we ran an additional set of models that account for both spatial autocorrelation in the dependent accessibility variable, as well as the heteroskedasticity that can be seen in the left panel of Figure 1. Running these additional models, specified using the "spdep" package in the R statistical programming language, we found very little change from the results in Table 2; both the speed and the employment predictors were highly significant, and the magnitude of their effects on accessibility were similar (and similarly lopsided), with standardized effects of 1.008 for proximity and 0.105 for speed.



(a) Average Peak Period Speed to TAZs within 10km (network distance)

(b) Total Employment within 10km (network distance)

(c) Gravity-Based Access to Jobs (0.2 decay parameter)

(d) Scatterplot of Speed vs. Job Proximity, Colored by Job Access

FIGURE 2 Speed, Proximity, and Accessibility Plotted Against Each Other, Cartographically and by Color-Coded Scatterplot

TABLE 2 Regression Model Output for Relationships among Scaled Speed, Proximity, and Accessibility Variables

	Dependent variable:		
	Employment Accessibility Score, Scaled		
	(1)	(2)	(3)
Peak-Hour Speed, Scaled	-0.687^{***}		0.078^{***}
	(0.012)		(0.009)
Employment Proximity, Scaled		0.925^{***}	0.980^{***}
		(0.006)	(0.008)
Constant	0.014	0.009^{*}	0.013^{**}
	(0.012)	(0.006)	(0.006)
Observations	3,977	3,999	3,977
R^2	0.451	0.872	0.874
(Standard errors in parentheses)	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$		

While the relative contributions of speed and proximity to regional employment accessibility in Los Angeles are clear, this does not mean that the predominant role of proximity holds in all parts of the region. Perhaps increasing job density is the primary predictor of increasing employment access in in some areas, while speed plays a greater role in access to jobs in other areas. Relatedly, perhaps *within* a given area (either high- or low-accessibility) where job proximity is roughly similar, the effect of speed on accessibility will be positive (and more in line with the average traveler's and elected official's intuition). To test these questions we partitioned the traffic analysis zones into different community groupings, using Los Angeles County community designations within LA County, and U.S. Census place designations outside of LA County, and county boundary files for non-LA unincorporated places *(26)(27)*. Doing so, we obtained 356 different community groupings with an average of approximately 11.5 traffic analysis zones per community.

Figure 3 shows how the relationships among our three variables of interest vary within given communities. We repeat the scatterplot shown in Figure 1, this time highlighting (by color coding) community-specific points. While the overall regional pairwise relationship between speed and accessibility is clearly negative, the relationship between speed and accessibility flips when just examined within these four example areas: Compton (a relatively low income inner-ring suburb), Downtown LA, Palmdale (a lower-middle income suburb on the fringe of the metropolitan area), and Santa Ana (a working class satellite central city in Orange County). The results can be split into two distinct patterns: communities with higher average speeds exhibit lower average levels of accessibility (which is consistent with the regional patterns reported above), however higher speed locations *within* the selected communities correspond to (at times much) higher levels of accessibility. So within a given community, the ability to move faster over the road network does indeed increase accessibility (as intuition, motorists, and elected officials would all suggest).

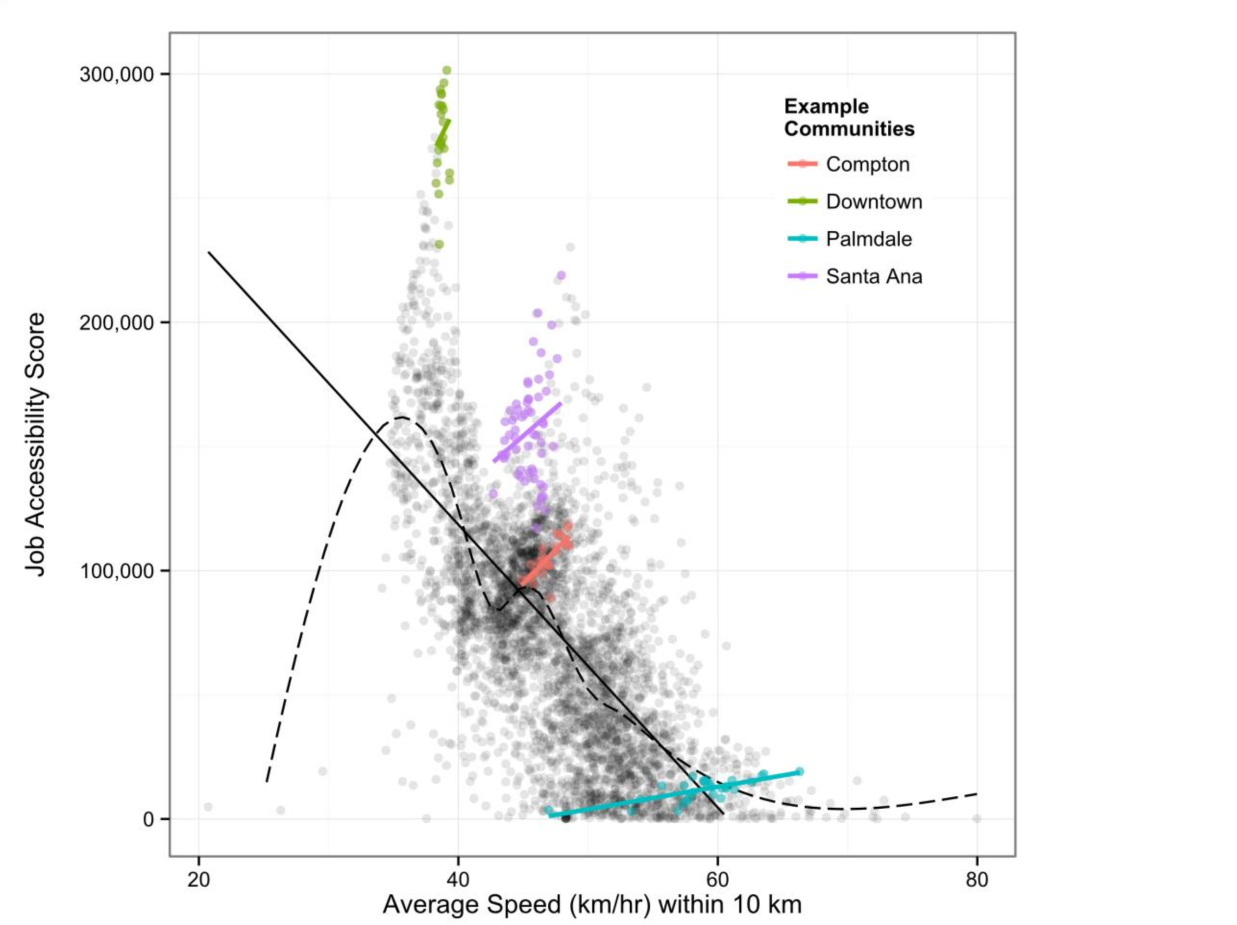


FIGURE 3 Region-Wide Relationship Between Speed and Accessibility, Overlaid with Selected Community-Level Relationships

While the patterns depicted in Figure 3 are interesting and suggestive, little can be reliably inferred from four communities selected arbitrarily from a set of 356. To establish a more rigorous understanding of these intra- and inter-community relationships, we specified a set of three hierarchical (or multi-level) linear models corresponding to those shown in Table 2, above. To directly model the difference between intra- and inter-community relationships, we follow Raudenbush and Bryk *(28)* by applying a technique of "group mean centering." Using this technique, we calculate the mean value of the (scaled) speed and proximity variables within each community designation. We then additionally specify a value corresponding to the difference in speed and proximity values observed in each local traffic analysis zone from their respective community means, thereby centering this new variable and allowing us to directly model intra-community effects. We carried out this hierarchical modeling using the "lme4" package within the R statistical programming language *(29).*

TABLE 3 Hierarchical Linear Model Output for Relationships among Speed, Proximity, and Accessibility Variables

	Dependent variable:		
	Employment Accessibility Score, Scaled		
	(1)	(2)	(3)
Scaled Peak-Hour Speed, Community-Level Mean	-0.618***		0.073***
	(0.037)		(0.023)
Scaled Peak-Hour Speed, Within-Community Difference from Mean	-0.012		0.172***
	(0.038)		(0.027)
Scaled Proximity to Employment, Community-Level Mean		0.977***	1.024***
		(0.017)	(0.025)
Scaled Proximity to Employment, Within-Community Difference from Mean		0.942***	0.966***
		(0.036)	(0.035)
Constant	-0.164***	-0.013	-0.008
	(0.035)	(0.015)	(0.015)
Observations	3,977	3,998	3,977
Log Likelihood	-1,085	1,084	1,304
Akaike Inf. Crit.	2,183	-2,155	-2,583
Bayesian Inf. Crit.	2,227	-2,111	-2,508
(Standard errors in parentheses)		*p<0.1; **p<0.05; ***p<0.01	

The results of this multilevel modeling, depicted in Table 3, are striking, and they corroborate the sample relationships shown in Figure 3. Looking first at the contextual effects of speed on accessibility (Model 1), we see that the accessibility score of a traffic analysis zone is strongly negatively predicted by that the average speed of that zone's parent community. Conversely, we see that within each community, increases in speed are actually (modestly) associated with increases in accessibility. This is exactly what one would predict by observing Figure 3.

Turning to Model 2 we see a parallel of the corresponding results in Table 2; increases in proximity are tightly linked to increases in accessibility. Interestingly, and in contrast to the relationship for speed, this effect of proximity on accessibility is very similar both among and within communities.

Finally, Model 3 (just as with the corresponding model shown in Table 2) shows an opposite effect for speed. When accounting for proximity, the increases in average speed of a zone's parent community correspond to slight increases in accessibility, and the effects of within-community increases in speed are greatly amplified. Still, as with the corresponding model in Table 2, proximity substantially outweighs speed in its effect on accessibility, both in terms of among and within community differences.

CONCLUSION

The findings presented here have important implications for transportation and land use decision makers, as well as for researchers. Most notably, the results confirm at the neighborhood and community levels what other researchers have found in comparing regions *(8)*: that there is a clear tradeoff between proximity to destinations and average vehicular travel speed, and that proximity does a great deal more work in determining neighborhood-level access to destinations than does speed. These relationships among speed, proximity, and accessibility are continuous and nearly linear across the region as a whole. While it is clear that proximity is by far the primary predictor of accessibility at the neighborhood level across the Los Angeles region, the results presented here show interesting and important complexities with respect to the community-level context of average speed. Namely, after accounting for the proximity of jobs, the average vehicular speeds estimated across a broader community make very little difference to a neighborhood's accessibility levels within that community. Speed variation *within* communities, however, can have substantially greater effects on accessibility (though these effects are still much weaker than those of between- and within-community differences in proximity).

These results imply a number of important lessons for city and regional planners and policymakers. First, as shown in Table 3, the strength of community-level proximity and the weakness of community-level speed in predicting accessibility make clear the potential harms of restricting development in order to avoid congestion. While the fear of clogged roadways is perhaps the most common reason for denying new development, this reaction is likely to have a negative effect on overall accessibility levels across a community's neighborhoods, even when we restrict our definition of accessibility to just that conferred by automobility. This finding, of course, runs smack against the intuition of any frustrated driver caught in traffic, or any public official presiding over a public meeting full of angry neighbors opposing a new development in an already congested neighborhood.

But those angry neighbors should be mollified a bit by our second finding, shown in Table 3, which may justify a careful targeting of infrastructure enhancements aimed at speeding up vehicular travel, particularly in built-up, congested areas. While positioning communities, whether on the periphery of the region or otherwise, as low-proximity and high-speed is likely to be ineffectual at best in improving accessibility outcomes, our results indicate that within-community improvements in travel speed can yield meaningful accessibility benefits. Provided that these increases in travel speed are achieved without artificially limiting the number of nearby destinations, they may indeed yield better overall travel outcomes for residents of affected neighborhoods. While we focus on vehicular speeds in this analysis, local enhancements in speed that do not inhibit destination density may involve other modes, whether walking, biking, or well-planned transit.

Beyond their direct implications for planners and policy makers, our findings offer additional insights for how transportation and land use decision makers evaluate potential projects. Namely, rather than focusing their attention on predicted link-level travel flows and congestion levels, or on vague notions of the value of broad-scale density, it is important for planners and public officials to consider explicitly how predicted changes in neighborhood-level speed and destination proximity will affect residents' access to destinations. It is this accessibility, after all, that is the true outcome of interest for transportation and land use systems. Still, we acknowledge that universal measures of accessibility such as those employed in this article may be insufficient for making this case. Because when that neighbor at the public hearing is expressing anger about a proposed new development, she is not worried about losing access to thousands of jobs, but instead her ability to reach nearby urban amenities such as grocery stores, health care, or any other of the destinations that may or may not be served by the density around them.

Further research on within-region trade-offs between proximity and speed can better aid the work of decision makers. While the analysis presented here provides a compelling picture of the overall shape of these trade-offs in the Los Angeles region, attributions of causal effect would be greatly aided by the use of time-series data. In order to make strong claims about the accessibility effects of *changes over time* to proximity and speed, it is important to directly assess such changes. Looking at variations in cross-section data can be highly suggestive, but it is limited in its ability to inform the sorts of predictions that are ultimately of interest to decision makers. Such time series analyses are not trivial to carry out; in addition to expanding the amount of data that need to be collected, they also require that estimations of zone-to-zone travel speeds be not just internally consistent within a given year, but consistent across years. Still, given the analytical benefits of consistent time series, the collection of such data should be a priority for regions. Additionally, beyond examining changes over time, analysts can better inform transportation and land use decisions by modeling more specific community-level factors that influence the contextual effects of speed and proximity differences. Such modeling can be done within a hierarchical framework similar to that employed in the models depicted in Table 3, above. In such a framework, various community-level attributes – such as job density in surrounding communities, the presence of highway infrastructure, etc. – can be used to predict where within-community differences in speed and proximity will be more influential with respect to accessibility levels. Along these lines, contextual influences on the speed-proximity-accessibility nexus can also be investigated through the use of structural equation models, similar to that reported by *(8)* in their assessment of between-region predictors of accessibility. Such equations allow for the explicit modeling of the interactions among a host of inter-related factors, and can provide a better feel for potentially complex causal pathways. Overall, we expect that continued investigation and an increased understanding of the complex relationships among speed, proximity, and accessibility will advance planners' ability to provide useful information to communities and officials as they evaluate opportunities for growth, infrastructure investment, and quality of life.

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