Metropolitan Accessibility and Transportation Sustainability: 
Comparative Indicators for Policy Reform

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Summary:

Transportation planning and policy have frequently been assessed through measures of mobility. We argue that a shift from mobility to accessibility as transportation’s overarching goal is necessary for consistency with understandings of transportation demand, and is also an approach to increasing the sustainability of the transportation system, including its global warming impacts. To this end, this paper compares transportation accessibility outcomes for 24 of the largest metropolitan regions in the United States. Accessibility outcomes are related to urban form, with denser and more centralized regions showing greater accessibility than others.
Accessibility and Mobility in Transportation Policy

“An experienced Australian traveler once said that on business trips to Australian cities he could reckon to make four meetings in a day,” writes Thomson (1977:48). “In Europe he could manage five; in the United States he could manage only three.” The reason behind the variations in this traveler’s itineraries was not an American propensity for long meetings, or the speed of travel in American cities, which is in any case faster than in Western Europe or Australia (Kenworthy and Laube 2002). Instead, his schedules were determined by the great distances—and hence long travel times—separating his business contacts in metropolitan areas of the United States. What the traveler wanted was interaction in the form of personal contact with the people with whom he did business. The speed with which he was able to travel was relatively unimportant to him; much more central was the amount of interaction he could accomplish in a given time.

This traveler was unwittingly expressing a view of transportation policy based in accessibility, in contrast to the mobility-centered view so dominantly reflected in current policy and in the physical form of the built environment in metropolitan areas in the United States and many countries around the world. This mobility-oriented view extends to the metrics by which transportation systems are assessed. When evaluating the performance of a transportation system, the fundamental criterion for success has long been faster vehicle operating speed (Éwing 1995). Common indicators include delay per capita, dollars wasted while waiting in traffic (Schrank and Lomax 2007) and highway level-of-service (U.S. Department of Transportation 2002; Transportation Research Board 1994; Edwards 1992). This mobility-based perspective of transportation policy dominates the view of the general public as well. The widely publicized congestion measures that routinely appear in newspapers nationwide when the Texas Transportation Institute publishes its annual Urban Mobility Report (Schrank and Lomax 2007) have helped to elevate the alleviation of traffic congestion to a top public policy priority. Under all such mobility-based evaluation measures, planners, engineers, and the general public deem rapid movement as definitive success.

These mobility-based evaluations suffer from a distinct logical flaw. Pursuit of congestion relief through added transportation capacity can induce destinations to move farther and farther apart (Transportation Research Board, 1995). A paradox can thus arise: increased mobility can be associated, over the long run, with more time and money spent in travel, rather than less. Travel to more remote shopping or work locations might be accomplished at a high speed, but the spread of these destinations can demand more travel than in more compact and clustered urban arrangements in which travel is slower.

If travelers do not consume transportation for its own sake but in order to access destinations, then policies that lead to increased costs per destination would be counterproductive because they would leave the travelers with less time and fewer resources to spend at their destinations. This formulation implies a rejection of “mobility” or congestion relief per se as an independent goal for transportation policy. The goal is more properly specified as accessibility, which has been defined as the “potential of opportunities for interaction” (Hansen 1959, 79) or the “ease of reaching places” (Cervero 1996, 1). Mobility is properly seen as one means to
accessibility; other means would include remote connectivity (e.g., via Internet or other electronic means), and proximity (Figure 1).

But mobility and proximity exist in tension with each other: places with many origins and destinations near one other tend to be places where surface transportation is slow; conversely, areas of rapid surface travel tend to be areas where origins and destinations are more spread. It is thus not immediately apparent which urban forms offer higher accessibility: areas of rapid surface travel and low densities, or areas of high densities but slower travel. Accessibility impacts would be the result of the net effect of speed and distance change as one moves from one urban form to the other.

Nearly all empirical research on accessibility has been focused on case studies of single metropolitan regions. This paper seeks to support policy reform by developing and estimating measures of accessibility that enable a meaningful comparison between multiple metropolitan areas of the United States. The indicators, which can be analyzed both within and between regions can help gauge the progress of policy on infrastructure and the built environment toward environmental sustainability.

**Accessibility, Sustainability, and Climate-Change Policy: Reductions in Vehicle Kilometers Traveled is not Enough**

We contend that a shift from mobility to accessibility as the primary criterion by which transportation policy is evaluated is a necessary step towards sustainability in the transportation system, including transportation policy towards climate change. If “sustainable development” is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations World Commission on Environmental Development 1987), then operationalizing the concept involves one of three broad options. First,
policy could seek to reduce current needs, or limit their fulfillment. Second, the harms associated with need fulfillment could be reduced, either through mitigation or through innovation. But a third and perhaps even more promising means presents itself: the reconceptualization of needs themselves. When needs are both misconstrued and defined in ways that are environmentally consumptive, their redefinition offers an approach to moderating environmental impacts—including greenhouse gas emissions—even as the need remains filled.

The ostensible “need” for mobility is one of these definitions of needs that is both misdefined and environmentally consumptive. An axiom of modern transportation planning is the notion that transportation is a "derived demand” (Meyer and Miller 2001; Stopher and Meyburg 1975; Morlok 1978); that is, people rarely consume transportation for the pleasure of movement per se, but rather travel in order to reach opportunities available at destinations. Thus the direct demand for access drives the derived demand for mobility. Since proximity is an approach to filling the need for access that is frequently less environmentally degrading, it opens up the possibility of “doing good by doing well” – i.e., getting more of what we want while reducing environmental impacts.

Inspired by the potential to mitigate transportation’s environmental impacts, many current transportation planning studies seek to assess transportation policy reform through its capacity to reduce in automobile trips (Ewing and Cervero 2001). Reductions in auto trips surely mitigate the environmental impact of the automobile, and the current study is oriented towards policy to realize these gains. Yet auto-use reductions in isolation fail to serve the tripartite goals of sustainability: environment, equity, and economy. For example, auto-use reductions that degrade the accessibility of lower-income people, or those that are the product of a depressed regional economy, or even those that are associated with reduced interaction within cities and regions could be considered “successes” under a simple “reduction-of-VKT” (vehicle-kilometers traveled) criterion.

By contrast, accessibility evaluation focuses not on the austere value of travel reductions alone, but on the capacity of the built environment to offer a high quality of life while offering a range of options for travel—not just long distance auto trips. The evaluation of accessibility also inherently incorporates dimensions of the urban economy, which thrives on interaction among locations within a metropolitan region. The capacity of accessibility to capture dimensions of environment, economy, and equity simultaneously makes it the crucial link between transportation and the built environment on the one hand, and sustainability and climate-change policy on the other.

**Urban, Auto Use, and Accessibility**

U.S. Metropolitan Areas are notable both for their low average densities and for their high auto use. For example the, densest U.S. urbanized area, Los Angeles, ranks 125th in density in the list of the 150 largest metropolitan areas of the world, less than half the density of London (Demographia 2009). And U.S. metropolitan car use is approximately 2.5 times greater than that
of European cities on a per capita basis (Lyons et al 2003). Nevertheless, significant variation in both metropolitan densities and auto use per capita are observed in U.S. metropolitan areas. For example, daily VKT per capita ranges from a low of 26 in metropolitan New York to a high of 63 in the Houston region (Figure 2). To people familiar with U.S. cities, the forces behind the auto-use gap between these locations will seem clear: New York is an older, denser, transit-oriented metropolis, while Houston is an exemplar of low-density auto-oriented urban form.

Other comparisons are more surprising. For example, Phoenix and Las Vegas generally score highly on sprawl rankings, (Galster et al. 2001; Glaeser, Kahn, and Chu 2001) yet show relatively moderate VKT per capita. Figure 2 explains this in terms overall urban densities: notwithstanding Las Vegas’ sprawling urban form, it is in fact a higher-density urbanized area even than metropolitan New York, and shows a concomitantly low VKT. That Las Vegas and Los Angeles are among the highest-density urbanized areas in the United States will surprise many observers who might expect that the older cities of the Northeast to fit that description. The apparent paradox is resolved through the distinction between average and peak densities: at their centers, New York and Chicago are far denser than Las Vegas or Los Angeles. But a majority of metropolitan U.S. residents—and a large majority of U.S. metropolitan territory—are found in the suburbs. Hence suburban densities have greater weight in overall urbanized area statistics than those of downtowns. Physical constraints and water availability restrict the outward spread of a number of cities in the Southwest, leading to high overall suburban densities, and thus high metropolitan densities overall.

A negative relationship between metropolitan densities and VKT per capita has been demonstrated globally (Lyons et al 2003); Figure 2 suggests that a version of this relationship also holds internally to the U.S. context. Yet Figure 2 leaves unexplored the relationship of density to accessibility. With its low population density and high car use, does Atlanta offer its residents higher or lower accessibility than do New York, Los Angeles, or Las Vegas? It may be the case that Atlanta’s higher daily VKT per capita supports a high-accessibility lifestyle in which people are able to interact with a large number of destinations daily. Alternatively, high levels of auto use may simply be the product of people trying accomplish a set of daily activities comparable to that of other regions.
Centralization, Concentration, and Dispersion

In addition to the effect of overall urbanized area densities on accessibility, this paper explores the impact of the distribution of development within an urbanized area. Specifically, we define *centralization, concentration, and dispersion* in the following fashion:

**Centralization:** The proportion of the population living in areas of employment density of three standard deviations above the average or more. This corresponds generally with the downtown of the central city and a periphery around that area that varies in size with the metropolitan region.

**Concentration:** The proportion of the population living in areas of employment density of between 1 and 3 standard deviations above the mean.
Dispersion: The proportion of the population living in areas of employment density lower than 1 standard deviation above the mean.

Figure 3: Centralization, Concentration, and Dispersion in U.S. Metropolitan Regions

Results are presented in Figure 3. The most centralized of the study areas, Tucson, Arizona was an atypical region with nearly 50% centralization. More typical of the high centralization regions were older urban centers with 15 or 20% of the population living in areas of highest employment density. At the low end were urban centers that had suffered significant job loss—Baltimore and Detroit—with less than 5% percent of the population living in areas of significantly concentrated employment. These results will explored for their potential to explain, in conjunction with overall densities, intermetropolitan variations in accessibility.
The Gravity Approach to Accessibility Measurement

This study bases its accessibility metrics in the gravity model (Isard 1960; Wilson 1971), a powerful conceptual tool because it simultaneously accounts for both the transportation network and its surrounding land-use conditions (Handy and Niemeier 1997). Measures of accessibility derived from a gravity model are commonly used by urban planning scholars to evaluate the relative ease of reaching jobs in a metropolitan region (Cervero, Rood, and Appleyard 1999; Grengs 2009; Shen 2001). We use a common form of the gravity model proposed by Hansen (1959), as follows:

\[
(A_i) = \sum_j O_j F(c_{ij})
\]

where:

\( (A_i) \) is the accessibility index for people living in zone \( i \). Whereas our larger study examined both work purposes and both travel modes, this paper focuses exclusively on work travel via auto.

\( O_j \) is the number of opportunities in destination zone \( j \); for work travel the value is the sum of jobs in a zone.

\( F(c_{ij}) \) is a composite impedance function capturing travel conditions across multiple metropolitan areas, associated with the cost of travel \( c \) for travel between zones \( i \) and \( j \).

The \( F(c_{ij}) \) bears some explanation. The term is equal to \( \exp(-\beta T_{ij}) \), where \( \exp \) is the base of the natural logarithm, \( \beta \) is a parameter empirically derived to maximize the fit between predictions of the gravity model and observed distributions of travel times. The \( \beta \) term ordinarily varies between metropolitan regions and has an important interpretation. People’s willingness to travel a given time differs from region to region: in some, a 20 minute trip would be considered long and would be avoided if possible; in others, it would be considered to be a short trip. The value of \( \beta \) would be lower in the latter region than in the former, indicating a higher impedance of travel.

Variations in willingness to travel are a function both of opportunities nearby and those farther away. Regions in which many destinations were close by and few far away would presumably demonstrate greater reticence to travel (and thus a higher value for \( \beta \)) than those with few closeby destinations and many farther away. In order to compare accessibility between regions, we considered two possibilities: a \( \beta \) term that varies between regions, and a single \( \beta \) term across all comparison regions. The former would have accounted for interregional variations in propensity to travel; the latter would aid consistent comparison of accessibility between regions.

We chose the unitary \( \beta \) option. This research project primarily seeks to assess the effect of land use patterns on accessibility. Variations in \( \beta \) are largely endogenous to land use patterns, as described above. For this reason, using region-specific parameters would have the effect of giving accessibility “credit” to a region in which people readily take long trips. But if their propensity to take long trips is a function in part of lack of nearby destinations, then the region-specific parameter would tend to overestimate the accessibility of these places compared to others where long-distance trips were less necessary.
To develop a shared $\beta$ parameter we estimated individual $\beta$ values for 16 metropolitan regions for which we had complete data. Values of the parameter were negatively correlated with metropolitan population, and we estimated a regression with individual values $\beta$ dependent and metropolitan population independent. The best-fitting regression: estimated $\beta = 0.109*\exp(-3.52*10^{-8}\text{Population})$ was then used to predict the value of $\beta$ for the 20th largest metropolitan region, roughly the median in our sample in size terms. The search for a single aggregate $\beta$ was necessary in order to reach meaningful comparisons of accessibility between regions. We note that even a single regional $\beta$ term is in effect a composite of numerous and varying $\beta$ terms for individuals within the region. Thus the process of aggregation here is not new; where most travel modeling suffices with a $\beta$ aggregated to the regional level, this project required a higher level of aggregation.

**Metropolitan Cases and Data Sources**

Metropolitan areas included in the current study are those within the largest 50 regions throughout the United States for whom sufficient data on transportation conditions could be collected. Regions included are listed in Table 1. The region was defined by the boundaries of its relevant Metropolitan Planning Organization (MPO). The most important data item is travel demand modeling data, collected from the MPO. These data contain matrices of interactions between all zones in the region, including travel times and the number of trips between zones. The zonal interactions are provided in several levels of detail, by travel mode (auto and transit), by time period (during congested peak period conditions and less congested off-peak conditions), and by trip purpose (home-based work and home-based nonwork). Travel demand modeling data employed were the latest available. These varied by MPO, depending on when their regional travel models were last calibrated and ranged from 2000 to 2009.

We purchased data on business establishments from the private vendor Claritas, Inc. (Claritas 2002). These data are collected from a variety of sources, including the U.S. Department of Labor, telephone books, county agencies, the U.S. Postal Service, and private utility companies. Business establishments include the number of jobs at a location in 2007, and codes from the North American Industry Classification System (NAICS) allowing us to identify businesses by industry type. We geocoded establishments to the street-address level, then aggregated the number of jobs to the travel analysis zone (TAZ). The TAZ is the primary geographic unit of transportation modeling, and each of our metropolitan areas is divided up into these zones, with approximately one to five thousand zones per region.

Finally, we collected data on population at the block group level from the 2000 Census of Population and Housing, Summary Files 1 and 3 (U.S. Bureau of the Census 2002, 2002).
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<th>Metropolitan Region</th>
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<th>Size Rank</th>
<th>Population</th>
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Table 1: Metropolitan Areas Included in the Study

Metropolitan Size and Shape

In order to explore metropolitan accessibility and its determinants, we initially group metropolitan regions into matched clusters of two or three for comparative purposes. Matching of cases is performed on the basis of two variables that can influence accessibility but are largely unaffected by transportation and land use policy: metropolitan size, and metropolitan shape.

Size is was selected as a classifying variable because larger metropolitan regions offer their residents greater destinations than smaller areas, a factor that would tend to increase accessibility in these areas. On the other hand, larger areas tend to have more roadway traffic congestion, a factor that would tend to lower accessibility. Our clustered comparisons thus grouped metropolitan regions of similar size.
In addition to size, we grouped metropolitan regions by shape. Some metropolitan areas are roughly circular, while others are highly irregular, usually a product of physical barriers such as seacoasts, mountains, or bays. Shape would be relevant to accessibility calculations because for a given set or origins and destinations, a circular shape will minimize travel distance (and in all likelihood, time) from all origins to all destinations. Greater deviations from circularity are associated with increasing travel distances for a given set of origins and destinations. Consider, for example, a metropolitan region around a bay, such as San Francisco. Territory that would have been close to the region’s core without the physical barrier of the water is uninhabited, a fact that would tend to lower accessibility compared to a more regularly shaped region. For this reason we calculated a shape index as follows. We determined the area of average employment density or greater for the region. The circumference of that area \( C_a \) was measured and compared to the circumference of a circle enclosing the same area \( C_c \). The resulting shape index, \( C_a / C_c \), is a measure of the circularity of a region. The statistic ranges between 0 and 1, with higher numbers indicating a more circular region.

![Figure 4: Size and Shape Classification to Determine Comparison Clusters](image)

Figure 4: Size and Shape Classification to Determine Comparison Clusters
Metropolitan areas were then classified by size and shape to determine similar cities for comparison. Clusters are identified in Figure 4, and include: New York and Los Angeles; Washington, D.C. and San Francisco; Atlanta and Boston; Philadelphia, Houston, and Baltimore; Detroit and Dallas; Memphis and Portland; and Columbus and Las Vegas. The following section compares the population distribution of work-based automobile accessibility among these various clusters.

**Cluster Comparisons**

Clustered regions are compared on the basis their population distribution of accessibility. Initially, each TAZ within a metropolitan area was assigned an accessibility score. TAZs vary in population; by assigning the accessibility score to the population residing in the TAZ, we were able to analyze the distribution of work-based auto accessibility across the population as whole.

![Figure 5: New York-Los Angeles Accessibility Comparison](image)
This approach to comparison can be seen in Figure 5, which compares the population distribution of work-based auto accessibility between residents of metropolitan New York and metropolitan Los Angeles. The horizontal axis, titled “population percentile” refers to the percentile distribution of accessibility within the population. The 1st percentile individual would be the person who has lower accessibility than 99% of the population (and probably lives in a peripheral area of his or her respective region); the 99th percentile individual enjoys greater accessibility than 99% of the residents of the region, and probably lives at the center. The median (50th percentile) individual probably lives in a close-in suburb; the values for the median resident will be used below to compare accessibility between regions. The vertical axis, labeled “accessibility score” presents the score from equation 1 above. This accessibility score is a ratio variable (thus, for example 400,000 represents twice the accessibility of 200,000), but its units have no direct interpretation.

The clustered comparisons presented in this section exhibit consistency in the apparent determinants of metropolitan accessibility. These include overall urbanized-area densities as a primary factor, and metropolitan centralization, as described above. Metropolitan densities would have the effect shrinking average distances between residences and job. By locating high proportions of the population within job concentrations, centralization would be expected to have a similar effect. For example, for the highest 70% of the population, New York dominates Los Angeles in their paired accessibility comparison (Figure 5). This may be seen as a paradox, given that the Los Angeles urbanized area is considerably denser than that of New York (1970 vs. 1636 persons per square kilometer). But the 17% centralization of New York was considerably greater than Los Angeles’ 10%, apparently giving New York the accessibility advantage in this comparison; the median New Yorker enjoyed about 1.5 times the work-based auto accessibility of the Los Angeles resident. This gap grew as one moved the high end of the accessibility distribution—i.e., to the center of each region—with the New Yorkers enjoying nearly three times the accessibility of their Los Angeles counterparts.

The high accessibility offered by the New York metropolitan region offers a marked contrast with the assessment of the same region in mobility terms. In Mobility First: A New Vision for Transportation in a Globally Competitive Twenty-First Century, Staley and Moore (2009) write:

New York also faces severe transportation challenges. Commuters and other travelers in the New York City area—which includes northern New Jersey, lower New York State, Long Island, and southwestern Connecticut—spend more than 384 million hours stuck in traffic every year. This waste adds up to more than $7.4 billion each year according to the Texas Transportation Institute…New York City is the largest, densest, most transit oriented city in the U.S. It also faces some of the nation’s most severe mobility challenges and problems. (pp. 55, 58)

While the statement is accurate about the severity of New York congestion, it (like the book as a whole) errs by treating mobility as the proper goal of transportation policy. It neglects New
York’s significant accessibility advantage—and hence a better transportation outcome, if one gauges transportation by its fundamental purpose—than its competitor regions.

Other clustered comparisons revealed differences that were not as extreme, but showed similar consistency with regard to density and centralization. Metropolitan San Francisco is considerably denser than Metropolitan Washington D.C. At 11.2%, Washington is somewhat more centralized than San Francisco. In this case, the greater density of the San Francisco region seemed to dominate, and San Francisco’s accessibility over most of the population was greater than that of Washington (Figure 6).

Figure 6: Washington D.C.-San Francisco Accessibility Comparison
Metropolitan Boston is both considerably denser and considerably more centralized than Atlanta, a metropolitan region of similar size and shape. Predictably, it offers higher accessibility throughout its population distribution (Figure 7). The difference is marked; throughout most of the distribution, Boston offers at least twice the accessibility of Atlanta.
Results for the Baltimore-Houston-Philadelphia comparison are much closer. The three are quite closely matched in urbanized-area density, but Philadelphia (at 15.4%) is more centralized than either Houston (12.3%) or Baltimore (5.1%). Over nearly the entire population distribution, Philadelphia’s accessibility is greater than that of the other two regions. The curves
for Houston and Baltimore cross between the 75\textsuperscript{th} and 80\textsuperscript{th} percentile, indicating Houston’s greater accessibility at the high end of the population distribution—an apparent outcome of Houston’s greater centralization.

Figure 8: Baltimore-Houston-Philadelphia Accessibility Comparison
Figure 9: Dallas-Detroit Accessibility Comparison
Dallas and Detroit are closely matched in terms of urbanized-area densities. Yet at 14.1%, Dallas is a surprisingly centralized metropolitan area and edges out Detroit in the accessibility index for the entire population stretch (Figure 9).

Figure 10: Portland-Memphis Accessibility Comparison

Portland, Oregon is often held up as the U.S. example of a region that has strived to follow “smart growth” principles. Its centralization is not unusually high, but its overall urbanized-area density is considerably greater than that of Memphis, Tennessee, the region with
which is shares size and shape characteristics. The results are predictable, with Portland offering up to 2.5 times the accessibility of Memphis.

Figure 12: Columbus-Las Vegas Accessibility Comparison
The final comparison pits one of the densest, yet least-centralized regions (Las Vegas) against the medium-density, highly centralized area of Columbus, Ohio. In this case, the very high average density of Las Vegas seemed to dominate the centralization of Columbus, leading to higher accessibility in the newer, Western metropolis.

**Decomposition of Intermetropolitan Accessibility Differences**

Accessibility gaps between metropolitan areas can be decomposed into those differences attributable to roadway travel speeds and those due to differences in proximity between populations and their destinations (in this case, overall job locations). This is accomplished by transforming the speed distribution of metro “A” into that of metro “B.” The difference between the transformed and the original curves represented the speed-related advantage to metro “B.” The difference between the distribution for metro “B” and the transformed curve for “A” then represents the proximity-related advantage to metro “B.”

Figures 13 and 14 demonstrate this decomposition for the pairs San Francisco-Washington, D.C. and Boston-Atlanta. Washington holds a modest advantage over San Francisco in proximity terms, visible as the shaded area below the Washington, D.C. curve in Figure 13. This may be partly a function of the greater centralization of the Washington, D.C. metropolitan region. The proximity gap emerges at around the 50th percentile of population. Thus the outer suburbs of Washington enjoy no particular proximity advantage over their San Francisco counterparts, but closer-in D.C. locations have a greater range of job locations nearby. But the proximity advantage in Washington D.C. is overcome by a distinct disadvantage in roadway travel speeds; notwithstanding San Francisco Bay Area congestion, slow peak-hour highway speeds reported in the Washington, D.C. transportation model degraded work accessibility by car overall, usurping the proximity advantage that the D.C. urban form offered. Figure 13 amply illustrates the fact that accessibility and proximity are analytically distinct concepts; notwithstanding Washington’s proximity advantages, poor mobility led to lower accessibility than San Francisco.

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1 We observed that travel speeds between TAZs within a metro are approximately normally distributed. The transformation was accomplished by taking the z-score of each travel speed in the zone-to-zone trip table from metro A. This z-score was then applied to the mean and standard deviation of speeds from metro B in order to transform the speed distribution of metro A into that of metro B.
Figure 13: Decomposition of Accessibility Differences between San Francisco and Washington, DC
Figure 14: Decomposition of Accessibility Differences between Atlanta and Boston

The Atlanta-Boston decomposition (Figure 14) reveals a different kind of comparison in which the proximity advantage of Boston dominates the accessibility gap between the two metropolitan areas. Boston holds a slight peak-hour travel-speed advantage over Atlanta throughout most of the population distribution. But from the remote suburbs and increasing toward the central city, Boston offers a considerable proximity advantage, leading to higher work accessibility by car overall.

**Accessibility, Metropolitan Density, and Centralization**

This paper began by observing that even within the auto-oriented form of the U.S. metropolis, significant variations in both density and in car use exist, with metropolitan density being negatively correlated with daily VKT per capita. The clustered comparisons above suggest that in addition to being less auto-intensive, the denser metropolitan regions may also enjoy higher job accessibility by car. These findings receive additional support from Figure 15; within the U.S. context, metropolitan density is positively correlated with accessibility. It seems for this
group of cities, the proximity advantage of a denser land-use pattern tends to outweigh any travel-speed disadvantage.

Average urbanized-area densities do a better job of predicting accessibility than the finer-grained metrics of urban form that we explored. These included centralization, concentration, and dispersion of population, employment, and (as described above) population in employment. Job accessibility by car was also not especially predicted by the presence of walkable urban places in a metropolitan region. Leinberger (2008) surveys walkable urban places nationwide, finding Washington, Boston, San Francisco, Denver, and Portland to lead the United States in terms of walkable places per capita. All cities on this list with the exception of Boston fall below the regression line (Figure 15), which is their predicted median accessibility given their overall metropolitan density. It is notable that Boston is the only city on this list of top walkable places that also demonstrates a level of centralization significantly above the median for the cities studied here. While the sample size of study cities is too small for statistical inference, results from the largest cities in the table below suggest a possible influence of centralization on accessibility; of the four largest cities falling well above the regression line of Figure 15 (New York, Philadelphia, Baltimore, and Dallas) only Baltimore is less centralized than the median in the sample. Conversely, of the four largest cities falling well below the regression line (Washington, San Francisco, Atlanta, and Seattle), only Seattle is more centralized than the median in the sample. Thus while overall densities appear to be a primary variable explaining work accessibility by car, metropolitan centralization may exert a secondary effect.

Figure 15 suggests an answer to the question posed at the beginning of this paper: do the low-density metropolitan areas, with their high car-use per capita offer a high-accessibility lifestyle? Results presented here suggest that the opposite is the case: the high VKT per capita of the low-density metros are a product of people’s efforts at meeting the ordinary needs of an ordinary day. People in those regions seem to experience less accessibility overall than those in denser regions with less car travel.
Figure 15: Median Work Accessibility by Auto by Urbanized Area Population Density
(Circle sizes proportionate to metropolitan population; shading proportionate to centralization)

Conclusions and Interpretation

Much current transportation and land-use research seeks to identify urban forms that can curtail automobility by reducing (or reducing the growth in) VKT per capita. Research in this tradition tends to focus on the external costs of transportation, including carbon emissions, regional air pollution, and energy dependence. Underpinning this research is a view that reductions in automobility are likely more than counterbalanced by environmental gains.

While similarly inspired by the potential to reduce transportation’s environmental harms, this study takes a different approach. Rather than presuming that people must inherently accept some costs in constrained mobility as a tradeoff for environmental gains, this study asks whether accessibility—transportation’s ultimate purpose—and sustainability might go hand in hand.
Results presented here suggest that this approach has promise. In the U. S. context, metropolitan density is associated both with lowered VKT per capita and with higher work accessibility by car. Thus people living in higher density regions are not sacrificing transportation benefits for reductions in carbon emissions; they are simultaneously reaping the benefits of accessibility and driving less than their counterparts in lower-density regions.

That sheer urbanized-area density, rather than finer-grained metrics of urban form, seems to predict accessibility might seem surprising at first blush. Urban planners often like to focus on nodes of high-intensity activity, transit-oriented development, and other forms of walkable urbanism. Few are likely to get excited about high-density urban sprawl. Yet an auto-oriented region like Las Vegas or can in fact exhibit, higher accessibility, and lower VKT per capita than regions with dense cores and walkable subcenters (but lower densities overall) like Boston or Washington, D.C.

This is not to suggest that the auto-oriented, highly decentralized Las Vegas is in any sense a model for urban form. We do argue, however, that with the majority of Americans living in suburban zones, efforts to densify the broad suburban expanses are needed in order to increase accessibility overall. In the near term, concentrated nodes of walkability and transit orientation will suffer from the “drop-in-the-bucket” problem: while they provide excellent accessibility via multiple modes to their residents, they are too small to affect overall metropolitan averages appreciably. This should change over time as demographics and tastes shift towards urbanist lifestyles (Nelson 2006) and these urban forms begin to gain critical mass. In the meantime, suburban densification through redevelopment and development of passed-over sites at higher densities is an important element of accessibility-oriented planning. Where U.S. land use planning has begun to create special zones for mixed-use development, this development is unlikely to affect U.S. metropolitan accessibility in the near term because these areas remain tiny relative to the metropolitan region as a whole. This suggests a more broadly based approach to policy reform that can include the redefinition of the spatially dominant single family zone itself to allow for ancillary commercial uses, accessory apartments, and even some forms of attached dwelling (Hirt 2007).

In the more immediate term, this research is designed to demonstrate the feasibility of using accessibility metrics to evaluate transportation outcomes between multiple metropolitan regions. In contrast to traditional metrics of mobility, the measures demonstrated here are consistent with the basic understanding that the purpose of transportation is not movement, but access. Though transportation evaluation remains largely mobility-based, current transportation discourse has begun to shift, referring frequently to “mobility and accessibility” as the twin goals of transportation planning. While we applaud the spread of the accessibility concept, the pairing of these goals as if they were co-equal still fails to acknowledge the fundamental implications of the derived nature of transportation demand: mobility is a means and accessibility is an end. The accessibility concept simultaneously subsumes both mobility and proximity, rendering the “mobility and accessibility” formulation both redundant and incomplete for its neglect of the central role of proximity in shaping the accessibility of cities and metropolitan regions. Perhaps the frequent pairing of “mobility and accessibility” indicates that we are on an evolutionary path
towards a more fundamental transformation in our understanding of the purposes of transportation and transportation planning. The approach to intermetropolitan accessibility comparisons presented here is offered as a step in that direction.

References


