Toward accessibility-based planning:

Addressing the myth of travel-cost savings

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Problem, research strategy, and findings: A growing consensus has formed among planners, especially planning scholars, that promoting accessibility is a major policy goal. However, efforts to promote accessibility-based planning face a conceptual impediment—a common assumption that equates the benefits of accessibility to travel-cost savings (TCS). Starting from this assumption, many researchers have interpreted the absence of TCS (e.g., savings in commuting cost and reductions in VMT) as evidence undermining the rationale for accessibility-promoting strategies such as job-housing balance and transit-oriented development (TOD). This study challenges these interpretations by suggesting that accessibility improvements can result in not only TCS but also destination-utility gains, which means the individual satisfaction from interacting with or choosing desirable destinations. The absence of TCS from accessibility-promoting policies can be explained by accessibility gains manifesting as destination-utility gains.

To analyze the importance of destination-utility gains, I engaged with literatures in economic geography and travel behavior and examined some recent urban trends (e.g., the rise of city-to-suburb commuting). I further estimated residential location choice models to test whether households value accessibility beyond the benefit of TCS. Results from the Puget Sound and Southeast Michigan regions supported the hypothesis, demonstrating that destination-utility gains shape residential location decisions.

Takeaway for practice: Planners should not automatically interpret the absence of TCS as evidence that accessibility-promoting strategies are not working. To advance accessibility-based planning, planners should start to explore and measure the various forms of destination-utility gains. The evaluation framework for land-use and transportation policies should shift from being centered on TCS alone to being accessibility-based.

Keywords*:* Residential location choice, accessibility, travel-cost savings, travel behavior, vehicle miles traveled

Spatial accessibility describes the potential from a location to interact with opportunities (e.g., jobs, amenities, and social services) distributed across space (Hansen, 1959). The concept of accessibility is illuminating to planning research and practice in many ways. Some consider accessibility as the unique good that cities offer to people and firms (Webber, 1964; Lynch, 1981), some view it as the most important indicator of metropolitan form and function (Wachs and Kumagai, 1973; Ewing, 1997), some use it as a way to characterize the choices provided to travelers by the built environment (Handy, 2020), and others apply it to conceptualize the issue of transport justice and to advocate for equity planning (Martens, 2016; Grengs, 2019). A growing crowd of scholars have suggested that transportation and land-use planning should focus on promoting accessibility instead of mobility by arguing that the primary role of transportation is to facilitate access to essential destinations rather than faster speeds (Handy, 2005; Duraton and Guerra, 2017; Levine, Grengs, and Merlin, 2019).

Despite the importance of the accessibility concept and its widespread support in academia, accessibility-based planning has made little inroads in practice. Recent studies have shown that few metropolitan planning organizations (MPOs) in North America have adopted an accessibility-oriented approach to guide their planning processes (Boisjoly and El-Geneidy, 2017; Proffitt, Bartholomew, Ewing, and Miller, 2019). Researchers have attributed this to a variety of factors, such as confusion about accessibility concepts, technical challenges associated with accessibility measurement, constraints due to governance structure, legacy institutional barriers, and professional norms (Geurs and Van Wee, 2004; Levine et al., 2019; Handy, 2020). This paper addresses an important but largely overlooked conceptual impediment to accessibility-based planning—the assumption that equates the benefits of accessibility to travel-cost savings (TCS). As I discuss below, this notion is present in a variety of policy contexts, where TCS-based measures such as savings in commuting costs, decreases in household transportation expenses, and reductions in vehicle miles traveled (VMT) are used as the main criteria to evaluate land-use and transportation strategies.

I begin by examining the controversies created by a TCS-based evaluation framework over accessibility-based planning. Notably, a mere focus on TCS has often led to study findings that undermine the rationale for accessibility-promoting policies. I argue that underlying this TCS-based evaluation framework often lies a TCS-based view of accessibility benefits, an assumption stemming from the classic urban economic theories. Building on previous work, I challenge this assumption by suggesting that accessibility improvements can also translate into destination-utility gains, which means the personal satisfaction from interacting with or choosing desirable destinations. In some cases, the absence of TCS from accessibility-promoting policies can be explained by accessibility gains manifesting as destination-utility gains. I further apply residential location choice modeling to empirically verify the importance of destination-utility gains. Results from the Puget Sound and Southeast Michigan regions support the hypothesis by showing that destination-utility gains shape residential location decisions. I conclude by suggesting that planners start to recognize destination-utility gains as an important land-use and transportation policy outcome. My main message here is not to suggest that planning efforts should center on destination-utility maximization but to urge planners to shift from a TCS-based evaluation framework to an accessibility-based one.

Travel-cost savings as a main policy criterion

In a variety of policy contexts, urban analysts have adopted TCS-based empirical measures to evaluate accessibility-promoting strategies. For example, in the residential location context, researchers have considered the value of improved job accessibility as primarily reducing commuting costs (Giuliano and Small, 1993). Similarly, the recent literature on location affordability has generally assumed that when households move to a more accessible place of residence, their travel expenditures would decrease (Haas, Newmark, and Morrison, 2016). In a standard cost-benefit analysis of transportation projects, analysts measure travel-time savings to represent the primary benefits associated with these projects (Berechman, 2009). Moreover, most built-environment and travel-behavior studies have focused on the amount of reduction in VMT to gauge the travel benefits of compact development (Ewing and Cervero, 2010; Stevens, 2017). Decreases in commuting cost or travel expenditure, travel-time savings, and reductions in VMT are all variants of TCS.

Controversies over accessibility-enhancing policies

Decades of accessibility research have accumulated a vast amount of evidence that establishes accessibility as a major planning goal. Accessibility has been regarded the central performance indicator of a land-use and transport system (Handy and Niemeier, 1997; Geurs and van Wee, 2004). By facilitating a greater potential for interaction, accessibility shapes land value (Hurd, 1903), fosters growth in the regional economy (Haig, 1926), and influences land-use patterns (Alonso, 1964). Furthermore, numerous empirical studies have shown that increased accessibility is associated with a variety of social and economic benefits such as higher property values (Debrezion, Pels, and Rietveld, 2007), lower car use (Ewing and Cervero, 2010), and enhanced economic growth and labor productivity (Chatman and Noland, 2014).

However, a TCS-based evaluation of land-use and transportation policies has created controversies over accessibility-based planning. For instance, planning scholars have engaged with a heated debate on whether accessibility-promoting strategies such as compact development can be justified based on their impacts on VMT reduction. Notably, contrary to what most planners have argued (Ewing and Cervero, 2010), several widely cited papers have suggested that compact-development strategies may not significantly reduce VMT. Salomon and Mokhtarian (1998) argued that a considerable segment of the population will not be inclined to reduce driving when faced with accessibility-enhancing strategies. They detailed a list of behavioral motivations to explain why people often engage in excess travel. Crane (1996a, 1996b) applied microeconomic theory to argue that accessibility increases can induce more trips by car and hence offset the potential VMT-reducing effects. He wrote: “Generally speaking, neotraditional designs both promote and discourage auto use, with the net effect being mixed. The analysis suggests that the generic transportation benefits of neotraditional and transit-oriented designs have been oversold” (Crane, 1996a, pp. 53). More recently, a meta-regression analysis done by Stevens (2017) found that the elasticity of VMT with respect to density was -0.22, based on which Stevens concluded that the impact of compact development on driving is small. Under a TCS-based—more specifically, VMT-based—evaluation framework, these studies undermine the policy rationale for compact development, and by extension, accessibility-based planning efforts.

A TCS-based evaluation framework has also raised doubt on policy efforts to promote location-efficient (i.e., compact, mixed-use, and accessible) neighborhoods. Some analysts have promoted these policies (e.g., location-efficient mortgages) because transportation costs can be lower in compact neighborhoods where residents can replace driving with the alternative travel modes such as public transit (Haas et al., 2016). And these policy efforts are consistent with the broader goals of planning for smart growth (Krizek, 2003). Nevertheless, in a rare longitudinal study, Smart and Klein (2018) found that households’ transportation expenditure did not decrease after moving into neighborhoods of higher transit accessibility. The Smart and Klein study challenged policies that promote residential development in location-efficient neighborhoods, at least from a transportation-cost savings perspective. In a related policy context, Giuliano and Small (1993) questioned the effectiveness of job-housing balance by arguing that such policies would have a minor effect on commuting.

Furthermore, applying TCS-based measures (e.g., VMT) to evaluate accessibility-enhancing policies can result in a conflict between equity and transportation goals. Consider the case of housing provision in transit-oriented development (TOD) areas. The displacement of low-income families from TODs in recent years raised equity concerns, creating a policy imperative for sitting affordable housing in TODs (Chapple and Loukaitou-Siseris, 2019). Nevertheless, several recent studies found that higher-income households reduce VMT more when moving to TODs than poorer households do (Chatman, Xu, Park, and Spevack, 2019; Boarnet et al., 2020). If the amount of VMT reduction alone is used to indicate transportation success, this finding would undermine the rationale for promoting affordable housing in TODs. As Boarnet et al. (2020) stated: “the higher absolute VMT reductions and relative TT [transit trips] increases of households with incomes above $50,000 call into question several rationales for siting affordable housing in TODs” (pp. 13).

In sum, while a growing number of planners have promoted accessibility as a major policy goal, a TCS-based evaluation of accessibility-enhancing strategies has often resulted in findings that undermine the rationales for these policies. When researchers examine if accessibility improvements lead to significant TCS, they can be motivated by two different policy questions. One asks whether promoting accessibility is an effective *means* to achieve TCS goals such as VMT reduction, where TCS is the policy focus; the other asks whether accessibility-promoting policies can be justified by their TCS benefits, where the focus is on promoting accessibility as an *end*. When the policy focus is the latter (which is the focus of this study), researcher's exclusive focus on TCS measures implies an assumption that accessibility's benefits are only realized through TCS.

A travel-cost-savings-based view of accessibility benefits

This TCS-based view of accessibility benefits originates from fundamental theories of urban and regional economics. Regional economists Robert Murray Haig (1926) first articulated a TCS-based view of accessibility benefits when describing the relationships between accessibility, transportation costs, and land rent: "Rent appears to be the charge which the owner of a relatively accessible site can impose because of the saving in transportation costs which the use of this site makes possible" (pp. 421). This idea was later adopted by Alonso (1964), Mills (1972), and Muth (1969), who jointly developed the classic urban economics and residential-location models. In these models, households are assumed to bid for locations by considering the trade-off between commute costs and housing costs, as more accessible sites allow households to reduce commute costs but command a higher land rent.

As building blocks of modern urban economics theory, the Alonso-Mills-Muth models have a significance influence on contemporary urban thinking. Despite numerous criticisms and extensions to these models—notably revisions to the assumption of a monocentric city (see, e.g., Brueckner et al., 1987), their core idea that household preferences for accessibility are driven by a desire to reduce transportation costs has remained unchallenged (Ahlfeldt, 2011). Some studies have explicitly adopted this idea and operationalized the concept of accessibility with TCS measures such as commute cost and distance to key points of interest (e.g., Kim, Pagliara, and

Preston, 2005; Debrezion, Pels, and Rietveld, 2007; de Palma, Picard, and Waddell, 2007; Chen, Chen, and Timmermans, 2008).

Since the late 1950s, many researchers have followed Walter Hansen to define accessibility as the potential for people to interact with spatially distributed opportunities (Hansen, 1959). This definition can be operationalized with cumulative-opportunity measures (e.g., number of jobs reachable within 30 minutes by transit), gravity-based measures, or utility-based measures (Handy and Niemeier, 1997; Geurs and van Wee, 2004). Hansen's definition of accessibility represents a conceptual shift from a TCS-based notion of accessibility to a potential-based one, which implies that the value of accessibility is not only in TCS but also in individual satisfaction from the capacity to reach a greater quantity and diversity of potential opportunities. Some writers recognized this theoretical implication and argued for the importance of accessibility as a measure of choice (e.g., Handy, 1992; Grengs, 2015; Martens, 2017). For instance, Handy (1992, pp. 267) wrote: "By increasing the range of options available to residents, a community with a high level of local accessibility thus enhances the quality of life for its residents." The value of accessibility in expanding choices justifies accessibility-promoting policies from a perspective that is independent of TCS. As Handy (1992, pp., 267) further noted: "Regardless of the impact [of higher accessibility] on total travel, this finding argues in favour of such communities, including neo-traditional developments."

Yet this choice-oriented view of accessibility is far from being universally accepted. So far, most researchers have not recognized the importance of non-TCS aspects of accessibility benefits, let alone measured these benefits to inform land-use and transportation policy and practice. As Levine (2020) argued, in the past several decades, researchers have primarily used the accessibility concept positively (for the purpose of describing, analyzing, and predicting certain outcomes) rather than normatively (in terms of defining the goals of land-use and transportation policies and transforming planning practices). Moreover, one can often infer an implicit TCS-based view of accessibility benefits from many studies that defined and measured accessibility beyond TCS terms. For instance, some authors viewed “accessibility” and “transportation costs” as interchangeable terms even though they operationalized accessibility with cumulative-opportunity (Fan, Khattak, and Rodriguez, 2011) or gravity-model measures (Ahlfeldt, 2011).

Therefore, despite the widespread recognition of Hansen’s accessibility definition and the associated empirical measures, these measures have made little inroads in the policy realm. While a growing number of MPOs in the U.S. have included potential-based accessibility measures as performance indicators in their regional plans (Handy, 2005; Boisjoly and El-Geneidy, 2017; Proffitt et al., 2019), planning decisions made by local governments are still guided by TCS-based evaluation procedures. For instance, development projects are usually assessed based on their impacts on local traffic conditions or, in the case of the State of California, VMT. Given that land-use planning decisions are usually made by local governments rather than MPOs, the progress toward accessibility-based planning is limited. In the following sections, I challenge the TCS-based view of accessibility benefits by elaborating on the non-TCS aspects of accessibility benefits.

The bifurcated nature of accessibility benefits

In economic terms, accessibility can be defined as the number (or more accurately, the value) of destinations reachable for a given investment of time and money on travel (Levine et al., 2019). Thus, accessibility improvements can come from either land-use policies that increase the quantity and diversity of destinations reachable within a travel-cost threshold or transportation policies that reduce the cost of travel on a per-mile basis. Similarly, when individuals experience accessibility gains, they can gain two distinctive types of benefits. First, they can save the time and money costs of travel by taking shorter trips and by switching travel modes. Second, they can gain greater personal satisfaction from interacting with or choosing from a greater quantity and diversity of destinations. In this study, I term the former travel-cost savings and the latter destination-utility gains.

Destination utility comes from two types of economic value—interaction value and choice value. The interaction value refers to personal utility gained from social and economic interactions. Normally, individuals can gain a higher level of utility from more interactions, which means that people are usually better off when they voluntarily choose to make more trips. Also, each destination conveys a distinctive degree of utility for each person; and if a person chooses a more remote destination rather than a closer alternative, it suggests that the former produces a higher level of utility for them. Therefore, the pursuit of higher interaction value can make someone spend more on travel, which can partially or even completely offset the TCS resulting from accessibility increases. And since interaction value can be the result of increased driving, it can result in environmental and social harms. In addition to interactions resulting from purposeful trips, individuals can gain utility from random interactions (i.e., spontaneous and unplanned "trips"), which are the main source of innovation happening in cities according to some theorists (Jacobs, 1970; Glaeser, Henderson, and Inman, 2000; Duranton and Puga, 2004).

The choice value is the welfare gains that individuals derive from the freedom of choice, that is, being able to choose among a range of potential destinations (Handy, 1992; Martens, 2017). Having a greater range of choices of destinations allows individuals to not only make more satisfying decisions but also to enjoy diversity and flexibility (Levine et al., 2019). While the value of choice is not directly observable, it can be estimated; and one approach to do so is the "logsum" method derived from the random-utility choice modeling framework. Several researchers have applied this method to estimate the choice value of accessibility, such as the option value of transit access (Laird, Geurs, and Nash, 2009) or the choice value of employment accessibility across a range of modes and destinations (Niemeier, 1997).

The importance of destination-utility gains

Some recent urban trends have verified the growing importance of destination-utility gains in shaping urban processes. For instance, recent decades have seen a rise of city-to-suburb commuting (Glaeser, Kolko, and Saiz, 2001; Aguilera, Wenglenski, and Proulhac, 2009). These people bear longer commutes to enjoy the enhanced social and economic interactions available in central cities (Jacobs, 1970). Moreover, home price (per square foot) in U.S. urban areas has increased much faster than those in suburban areas over the past two decades (Fuller, 2016). And property prices in TOD areas have increased significantly in many cities, as a growing number of higher-income households are moving into these areas (Dawkins and Moeckel, 2016; Chapple and Loukaitou-Sideris, 2019). In all of these cases, the economic actors involved pay a price premium to enjoy a higher level of accessibility, but they do not experience TCS at all or the associated TCS are hardly enough to offset this price premium.[1] This price premium must primarily derive from destination-utility gains.

The importance of destination-utility gains is further supported by a basic principle in transportation: the demand for travel is usually derived (Bonavia, 1936), that is, individuals usually travel to get to places rather than to enjoy movement itself. Under this notion, any economic value associated with accessibility stems from the need for interacting with destinations, and it is to fulfill the need for interaction that individuals are willing to pay a travel cost to overcome the spatial friction between places. It follows that TCS should be viewed as subsidiary to the destination-utility aspects of accessibility benefits, since no TCS would exist absent travel driven by the pursuit of destination value.

Furthermore, the short-run TCS benefits resulted from accessibility improvements are often converted into destination-utility gains in the long run. For example, while transportation projects such as the construction of a new highway allows people to travel faster and save time, these TCS often disappear over time as travelers either make more trips or engage in longer trips to visit more desirable destinations (Metz, 2008). van Wee (2011) described a similar process when considering the travel impacts of land-use policies. He imagined an “intervention” that shrunk a certain region to 25% of its original size. Assuming no changes to traffic conditions and if all travelers keep their original travel patterns, there would be a 50% reduction in travel costs. However, the actual savings will be smaller because of people’s behavioral changes: instead of keeping the potential TCS, many people would spend the “spared” travel budget on making more trips and on traveling to more remote but more desirable destinations. And the value of the resulting destination-utility gains, which motivated the behavioral changes, must be no less than the travel spending (i.e., the unrealized “savings”) involved. This thought experiment explains why accessibility-enhancing policies can often lead to lower-than-expected TCS.

A handful of studies have started to measure and evaluate destination-utility gains. For instance, Merlin (2015) argued that in addition to reducing VMT, a primary benefit of accessibility is to facilitate the opportunity to engage in activities. He empirically verified that greater accessibility promoted the participation of out-of-home nonwork activities. Similarly, Allen and Farber (2020) found that improvements in transit accessibility increased daily activity participation rates. Also, Couture (2015) showed that individual welfare gains from restaurant density (greater accessibility to restaurants) are mostly derived from variety as opposed to travel-time savings. More broadly, some theorists have suggested that the fundamental forces that drive city growth are urban variety and diversity and the random interactions that cities facilitate (Jacobs, 1969; Glaeser, et al., 2000). Accordingly, some researchers have argued that when conducting cost-benefit analysis of transportation projects, analysts need to account for not only TCS but also accessibility benefits beyond TCS (Geurs, Zondag, De Jong, and de Bok, 2010; Martens and Di Ciommo, 2017). Nevertheless, in most policy and research contexts, such as the ones discussed above, destination-utility gains remain largely unrecognized.

Testing how destination-utility gains influence residential location choice

To empirically verify the importance of destination-utility gains, I further apply discrete choice modeling to test if destination-utility gains have an independent and significant impact on household residential location choice. Since it is difficult to directly measure destination-utility gains, I employ the following empirical strategy. First, I fit a benchmark model that includes an accessibility variable. This accessibility variable captures both TCS and destination-utility gains, and its coefficient is expected to be positive and statistically significant. Then, I fit a comparison model (I implemented two models in practice) that additionally controls for all possible TCS associated with higher accessibility. In this comparison model, the accessibility variable only captures destination-utility gains since the TCS components are separately controlled for. If the coefficient of the accessibility variable remains positive and significant, we can conclude that destination-utility gains shape residential location choice; otherwise the results would lend support to a TCS-based view of accessibility benefits. A presumption for this empirical strategy is that accessibility has a positive and significant impact on residential location choice, which is supported by many previous studies (e.g., de Palma et al., 2007; Schirmer, van Eggermond, and Axhausen, 2014; Hu and Wang, 2019). Note that this impact does not need to be stronger than that of other factors such as affordability, school quality, and neighborhood safety.

Discrete choice modeling of residential locations

In a discrete choice model of residential locations, households are assumed to choose a residence by weighing the available alternatives based on a set of important attributes such housing cost, housing characteristics, and neighborhood characteristics, accessibility, and local services. Theoretically, households make the necessary trade-offs between costs and desirable attributes to decide on a residence that maximizes their utility (McFadden, 1978). Thus, the unit of analysis is the interaction of a household with an alternative (i.e., a residential location).

I built the model at the traffic analysis zone (TAZ) level. To build a residential location choice model, one must construct a choice set for each household that consists of their current residence and the non-chosen alternatives. Since the modeler does not usually know which neighborhoods (zones) that a household had considered, the common practice is to set up a choice-set identification procedure based on plausible affordability criteria and behavioral rules. I applied a set of decision rules to determine the possible TAZs in the region for each household to choose from and then randomly sampled 29 of these TAZs to form each household's choice set of nonchosen alternatives (see Technical Appendix for more details). Therefore, together with the chosen alternative (i.e., the current residence), each household was assumed to evaluate 30 residential alternatives. The list of independent variables considered is shown in Table 1. The main variables of interest are an accessibility variable and the TCS variables (i.e., commuting times and nonwork-trip VMT). Since households' travel behavior at the non-chosen TAZs is unobservable (i.e., we do not know how people would travel if they lived in a different TAZ), some assumptions were made to construct the TCS variables. I assumed that people's workplace would not change if they lived in a different TAZ and that their nonwork-trip destinations would change. I discuss the measurements of accessibility and TCS variables in detail below.

Table 1. Independent variables of the residential location choice model

Variable code	**Level of measurement**	**Variable description**
Accessibility-related variables		
Transit accessibility	Zonal	First principle component extracted from two variables: transit accessibility to jobs and transit accessibility to nonwork destinations
Commute time by auto	Household and zonal	Sum of commute time by auto from each household worker's workplace to a given TAZ.
Commute time by transit	Household and zonal	Sum of commute time by transit from each household worker's workplace to a TAZ.
Nonwork trip VMT	Household and zonal	Household VMT for nonwork trips at a given TAZ based on Tobit regression
Control variables		
Housing affordability	Household and zonal	Median value (for owners) or median rent (for renters) at a given TAZ divided by household income
School quality	Zonal	GreatSchools school rating score at a given TAZ
School quality (high-income with children)	Household and zonal	GreatSchools school rating score at a given TAZ interacted with high-income household with children
Crime rate	Zonal	Number of crimes per 10,000 people at a given TAZ
Population density	Zonal	Population density in a given TAZ
Population density (high-income)	Household and zonal	Population density in TAZ interacted with high-income household
Percentage of single-family property	Household and zonal	Percent of single-family property in a given TAZ interacted with household with children
Household size (difference)	Household and zonal	Absolute difference between median household size in a given TAZ and household size
Household income (difference)	Household and zonal	Absolute difference between median household income in a TAZ and household income
Size correction term		
Log of housing units	Zonal	Log of the number of housing units of the household's chosen tenure in a given TAZ

I built models for two US regions—Puget Sound and Southeast Michigan. Given the significant differences in metropolitan form and economic structure between the two regions, consistent model results can strengthen the generalizability of study findings. The main data sources used are the Puget Sound Regional Council (PSRC) 2014-2015 regional household travel survey and the Southeast Michigan Council of Government (SEMCOG) 2015 regional household travel survey. Neither of the two surveys sampled a statistically representative population. To address this sampling bias, I performed a geographically stratified sampling procedure, that is, I drew a total of 1,200 observations from the full sample by sampling in proportion to each Census County Subdivision's share of households in the region.

PSRC and SEMCOG also kindly provided the skim matrix which contains estimated morning-peak travel times for each origin-destination zone pair. The travel time data were used to calculate the accessibility and TCS variables. Other data used to construct the model database include Census Transportation Planning Products (CTPP), American Community Survey (ACS), and Longitudinal Employer-Household Dynamics (LEHD), school quality data extract from the Great Schools API, Walk Score data from the Walk Score API, and crime-rate data (for Southeast Michigan only). Table 2 presents the mean and standard deviation of the independent variables. Note that race/ethnicity was not controlled for here because neither of the surveys collected such information. Findings from the Atlanta region suggested that omitting race does not lead to much bias in the coefficient estimates of accessibility-related variables (Yan, 2020). Despite this preliminary finding, future research should address this limitation because numerous previous studies have shown the importance of race in determining residential patterns in the U.S. (e.g., Emerson, Chai, and Yancey, 2001).

Table 2. Mean and standard deviation of the independent variables

Variable code	Sample	Puget Sound		Southeast Michigan	
		Mean	Std.	Mean	Std.
Accessibility-related variables					
Transit accessibility	Chosen TAZs	0.42	1.21	-0.08	0.89
	Non-chosen TAZs	-0.06	0.83	-0.09	0.63
Commute time by auto	Chosen TAZs	27.24	26.94	20.47	26.96
	Non-chosen TAZs	67.07	58.65	36.7	45.07
Commute time by transit	Chosen TAZs	69.93	83.73	214.16	394.4
	Non-chosen TAZs	143.99	142.83	311	456.26
Nonwork trip VMT	Chosen TAZs	19.24	31.99	14.29	16.76
	Non-chosen TAZs	22.05	33.7	14.87	18.54
Control variables					
Housing affordability (owners)[1]	Chosen TAZs	8.55	15.2	5.65	6.98
	Non-chosen TAZs	7.19	14.27	5.32	8.6
Housing affordability (renters)[1]	Chosen TAZs	0.36	0.62	0.61	0.91
	Non-chosen TAZs	0.33	0.66	0.5	0.77
School quality	Chosen TAZs	5.86	2.12	5.64	2.11
	Non-chosen TAZs	5.68	2.02	5.39	2.19
School quality (high-income)	Chosen TAZs	0.45	1.73	0.73	2.16
	Non-chosen TAZs	0.38	1.52	0.58	1.83
Crime rate	Chosen TAZs			3.25	0.31
	Non-chosen TAZs			3.29	0.3
Population density	Chosen TAZs	5004.44	6785.83	3299.65	2834.62
	Non-chosen TAZs	2572.85	3799.75	3150.26	2767.97
Population density (high-income)	Chosen TAZs	1405.71	4470.99	590.4	1408.72
	Non-chosen TAZs	714.13	2281.8	807.42	1923.49
Percentage of single-family property	Chosen TAZs	0.11	0.25	0.21	0.37
	Non-chosen TAZs	0.12	0.27	0.2	0.35
Household size (difference)	Chosen TAZs	0.7	0.79	0.91	0.8
	Non-chosen TAZs	0.83	0.8	0.99	0.91
Household income (difference)	Chosen TAZs	4.23	4.37	3.23	2.9
	Non-chosen TAZs	4.81	4.46	4.67	3.81
Size correction term					
Log of housing units (owner-occupied)[1]	Chosen TAZs	276.98	269.89	721.55	460.47
	Non-chosen TAZs	274.35	235.84	553.13	387.59
Log of housing units (renter-occupied)[1]	Chosen TAZs	410.95	366.27	285.69	324.81
	Non-chosen TAZs	184.69	208.45	252.5	285.19

Data source: PSRC, SEMCOG, LEHD 2015 Origin-Destination Employment Statistics, American Community Survey 2012-2016 5-year estimates, Census Transportation Planning Products 2012-2016, and Walk Score.com.

Measuring accessibility and the associated travel-cost savings

I operationalized accessibility with a transit accessibility measure after experimenting with several alternative accessibility measures.[2] Conceptually, a transit accessibility measure is less ideal than an auto accessibility measure or a multi-modal accessibility measure because the mode share of public transit is low in the U.S.. In Puget Sound, survey respondents reported that about 10% personal trips were made by transit, whereas over 70% were made by driving. The corresponding percentages in Southeast Michigan were 4% transit and 85% auto. However, a focus on transit accessibility is reasonable here because people often consider transit access as an important factor in residential decisions (Urban Land Institute, 2015; Canadian Home Builders Association, 2015). For instance, the Puget Sound 2014-2015 regional household travel survey suggested that 45% of people considered being close to public transit as “very important” and 28% of them considered it as “somewhat important” when choosing their current home.

I used a common form of the gravity model to measure transit accessibility (see the Technical Appendix for further details). I considered transit accessibility to both employment opportunities and nonwork destinations, the former indicated by all jobs and the latter by retail and service jobs. Following Grengs (2015), I specified the value of the impedance factor β to be 0.1 for transit accessibility to job opportunities and 0.3 for transit accessibility to nonwork destinations. I further performed a principal component analysis to aggregate the two transit accessibility indicators into a composite transit accessibility index, extracting the first principal component.

Figure 1 shows the spatial distribution of transit accessibility in the two study regions, alongside which results for auto accessibility are presented as a comparison. As expected, locations of higher transit accessibility were largely concentrated at the centers of each region.

Auto accessibility was more evenly distributed, but places with the highest levels of auto accessibility also clustered around urban centers. The correlation coefficient between transit accessibility and auto accessibility at the TAZ level was 0.62 and 0.57 in Puget Sound and Southeast Michigan, respectively. The high correlation between the two suggests that the transit

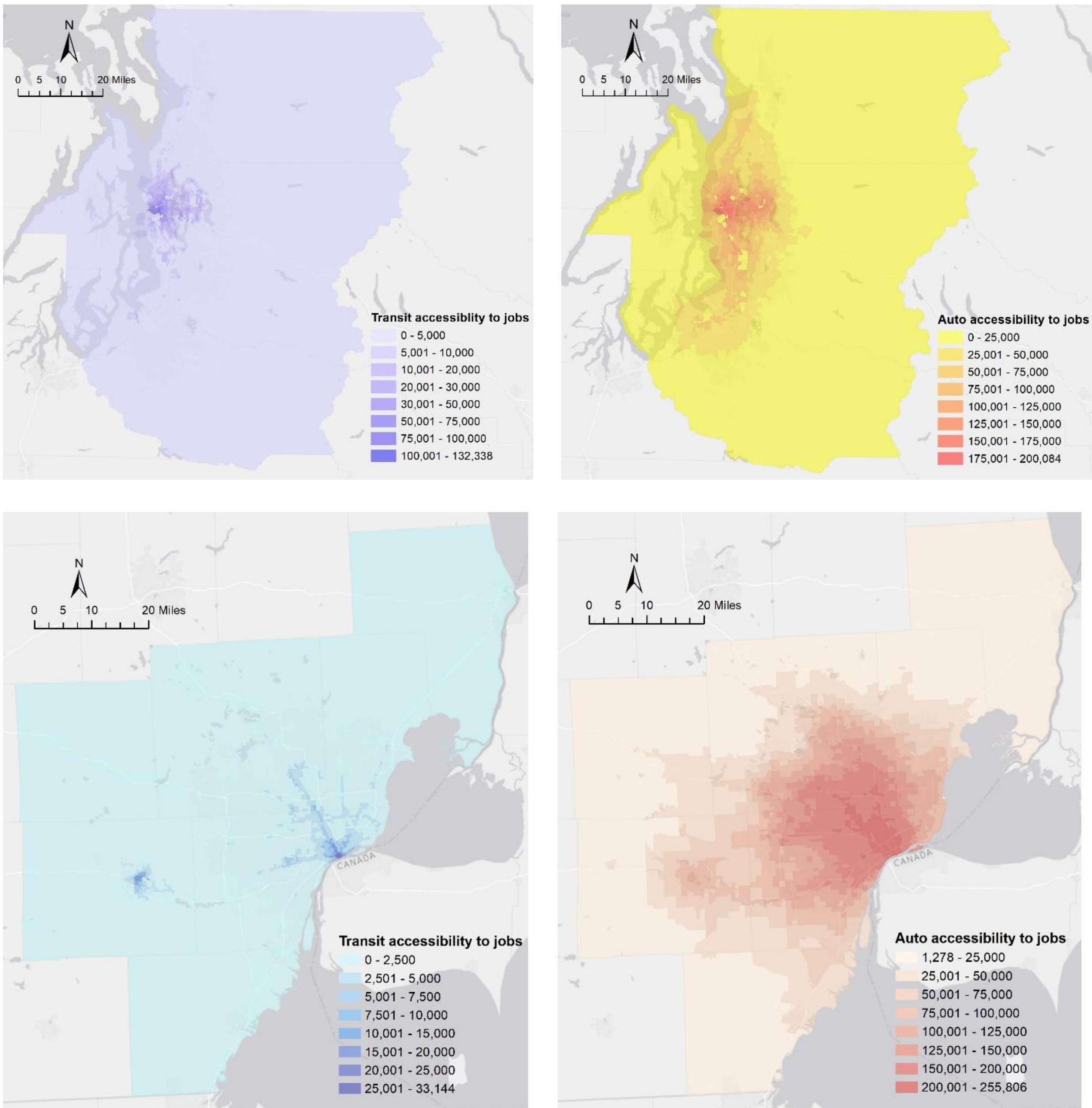

Figure 1. Transit and auto accessibility to jobs in Puget Sound and Southeast Michigan

accessibility measure is likely to pick up some effects of auto accessibility on residential location choice. It may also pick up the effects of some other neighborhood characteristics (e.g., walkability and neotraditional design) that correlate with transit accessibility. As I will discuss in the results section, this measurement issue complicates the interpretation of model outputs but does not change the main findings.

A household can gain two major types of TCS from improved accessibility—savings from commuting trips and savings from nonwork trips.[3] I measured the former with commuting time and the latter with home-based nonwork-trip VMT. As people's workplace was assumed to be fixed regardless where they live, the commuting times from each worker's workplace to their respective alternative home locations can be directly computed. If a household had more than one worker, their commuting times were summed up. I examined two travel modes—personal vehicle and public transit, which resulted in two commuting-cost variables.

The home-based nonwork-trip VMT at each household's home TAZ can be computed from the regional household travel survey data. I predicted each households' nonwork-trip VMT at their respective non-chosen TAZs with a Tobit regression model. Tobit regression rather than linear regression was used because a significant proportion (around 30%) of households had zero nonwork-trip VMT on the travel date recorded by the survey (i.e., the sample data were left-censored). I considered households with a nonwork VMT higher than 200 as outliers and excluded them from the final sample. Independent variables specified in the model include a vector of household characteristics such as household income, household size, and vehicle access and a vector of accessibility indicators such as auto accessibility to retail destinations. More details of this model are presented in the Technical Appendix.

Results

I estimated three models for each study region. The first model is a benchmark model with a transit accessibility variable but no TCS indicators. The second model adds two commuting-cost variables, and the third model further adds the nonwork-trip VMT variable. If households value accessibility beyond the value of TCS, the coefficient estimates of transit accessibility would be positive and significant in all three models.

Table 3. Residential location choice models in the Puget Sound region

Variable	**Model 1**		**Model 2**		**Model 3**	
	Coef.	z-value	Coef.	z-value	Coef.	z-value
Accessibility-related variables						
Transit accessibility	0.27	10.28***	0.09	2.90***	0.08	2.40***
Commute time by auto			-0.06	-18.15***	-0.62	-18.19***
Commute time by transit			0	-0.65	0	-0.59
Nonwork trip VMT					-0.02	-0.72
Control variables						
Housing affordability	-0.12	-2.32**	-0.29	-5.21***	-0.29	-5.19***
School quality	0.06	3.98***	0.04	2.24**	0.04	2.23**
School quality (high-income with children)	0.13	2.01**	0.12	1.65*	0.12	1.64
Population density	0.31	9.51***	0.12	3.45***	0.11	3.01***
Population density (high-income)	0.2	3.34***	0.05	0.78	0.05	0.74
Percentage of single-family property	0.01	0.04	0.55	1.76*	0.57	1.83*
Household size (difference)	-0.37	-5.67***	-0.4	-5.67***	-0.4	-5.67***
Household income (difference)	-0.12	-7.13***	-0.08	-4.98***	-0.08	-4.99***
Size correction term						
Log of housing units	0.97	21.11***	1.04	20.45***	1.03	20.35***
Observations (N)	1200		1200		1200	
Log-likelihood at convergence	-3399.48		-2676.39		-2676.13	
Log-likelihood (Null Model)	-4081.44		-4081.44		-4081.44	
Adjusted pseudo R-squared	0.17		0.34		0.34	

Note: *Significant at the 0.1 level, **Significant at the 0.05 level, ***Significant at the 0.01 level

The model outputs are presented in Table 3 and Table 4. The McFadden's adjusted pseudo-R-square, shown at the bottom of the tables, was in the range of 0.2 and 0.3 across all six models, which indicates satisfactory model fit. The size correction term was reasonably close to one in all models; this validates the assumption that a zonal-level residential location choice

Table 4. Residential location choice models in the Southeast Michigan region

Variable	**Model 1**		**Model 2**		**Model 3**	
	Coef.	z-value	Coef.	z-value	Coef.	z-value
Accessibility-related variables						
Transit accessibility	0.11	2.80***	0.09	1.96**	0.08	1.73*
Commute time by auto			-0.05	-18.74***	-0.05	-18.88***
Commute time by transit			-0.01	-4.70***	-0.02	-5.21***
Nonwork trip VMT					0.2	6.88***
Control variables						
Housing affordability	-0.12	-2.43***	-0.17	-3.10***	-0.15	-2.73***
School quality	0.01	0.66	0.01	0.54	0.01	0.34
School quality (high-income with children)	0.1	1.86	0.09	1.5	0.09	1.54
Crime rate	-0.02	-6.31***	-0.03	-9.25***	-0.02	-5.85***
Population density	0.01	0.42	-0.09	-2.47***	-0.01	-0.14
Population density (high-income)	-0.04	-0.83	-0.19	-3.10***	-0.19	-3.04***
Percentage of single-family property	0.38	1.46	0.47	1.69	0.42	1.5
Household size (difference)	-0.08	-1.28	-0.08	-1.33	-0.08	-1.26
Household income (difference)	-0.21	-14.50***	-0.22	-14.25***	-0.22	-13.95***
Size correction term						
Log of housing units	0.87	15.45***	0.97	16.27***	0.94	15.61***
Observations (N)	1200		1200		1200	
Log-likelihood at convergence	-3655.4		-3065.31		-3033.08	
Log-likelihood (Null Model)	-4081.44		-4081.44		-4081.44	
Adjusted pseudo R-squared	0.1		0.25		0.25	

Note: *Significant at the 0.1 level, **Significant at the 0.05 level, ***Significant at the 0.01 level model can result in parameter estimates consistent with a housing-unit level model (Lerman, 1975). As expected, the coefficient estimates on most variables—except transit accessibility—barely differed across the three models in each region.

The control variables generally had expected signs. In both regions, households were more likely to choose neighborhoods (i.e., TAZs) that are more affordable, have better schools, and safer. These findings are both intuitive and consistent with decades of residential location studies (Schirmer et al., 2014). Population density had a positive sign in Puget Sound but a negative sign in Southeast Michigan, which may be because denser neighborhoods are more attractive in Puget Sound or because Puget Sound residents have a greater preference for high-density living. Results also confirmed the conventional wisdom that households with children often prefer single-family homes. Moreover, I found strong neighborhood sorting by household size and household income, as households of similar sizes and of similar income levels tend to choose to live together.

Households value accessibility beyond travel-cost savings

The transit-accessibility variable was positive and significant at the 0.05 level in all models except the third model for Southeast Michigan (where it is statistically significant at the 0.1 level). Overall, these results suggest that households generally prefer to live in zones with higher transit accessibility, and this preference is not solely driven by their desire to reduce travel costs. In other words, the potential destination-utility gains available at locations of high transit accessibility are partially responsible for attracting households to those locations.

These destination-utility gains arise from accessibility facilitated not only by public transit but also by other travel modes. As discussed above, the transit accessibility measure is correlated with other types of accessibility such as auto accessibility and walkability. A large proportion of these destination-utility gains is likely the choice value of having access to a greater range of destinations via various modes (Levine et al., 2019). Also, living at accessible locations allows people to potentially derive more interaction value as they take more trips and travel to more remote but more desirable destinations. Considering that the mode share of public transit is small in both study regions, I expect that most of the interaction value results from increased driving and walking trips. However, some households may be attracted to locations of higher transit accessibility by the option value of transit access (Laird et al, 2009); that is, even if they do not use transit regularly, they prefer to have the transit alternative be available. Studies have shown that even though a small minority of Americans are frequent transit users, a much higher percentage (over half in certain metropolitan regions) of them take transit occasionally (Krizek and El-Geneidy, 2007; Hertz, 2015). For instance, the PSRC 2014-2015 regional household travel survey showed that while only 10% of all trips reported in the travel diary were transit trips, about 50% of the survey respondents stated that they ride public transit occasionally.

Two alternative interpretations of the results should be addressed. First, one may argue that the measured effect of transit accessibility on residential location choice is spurious. As transit accessibility is usually correlated with other neighborhood characteristics (e.g., centrality, housing mix, neotraditional design), the measured effect may not come from destination-utility gains. This concern is partially addressed by the fact that population density is a control variable in the models. As a major indicator of neighborhood type, population density is a reasonable proxy for the effects of various neighborhood factors (e.g., design, housing mix, and parking) on residential location choice. I fit additional models that replaced measures of population density with those of Walk Score,[4] another important indicator of the neighborhood environment. The sign and significance of the transit accessibility variable did not change. These results suggest that the association of transit accessibility with other neighborhood characteristics does not alter the study conclusion.

Moreover, one may argue that households prefer housing units with higher transit accessibility only because they see the investment value of these properties. For example, recent research has shown that transit access not only leads to a price premium but also makes housing value more resilient in economic downturns (Dong, 2015; Zhang, Wang, Barchers, and Lee, 2018). A consideration for property-value growth or resilience may indeed explain some households' preference for transit-accessible neighborhoods. The data available to me do not allow an exploration of the extent of this impact, and future studies may consider addressing this issue. Regardless, the investment potential of TOD properties should be considered as a subsidiary benefit of transit accessibility that are hardly TCS-based.

Finally, consistent with expectations, I found that commuting time by auto and commuting time by transit had negative impacts on residential location choice. However, nonwork-travel VMT was statistically insignificant in Model 3 of Puget Sound and had an unexpected positive sign in Model 3 of Southeast Michigan. I tested alternative specifications of the Tobit regression models used to predict the nonwork-travel VMT, but the results did not change. A plausible explanation is that households did not consider reducing nonwork travel as a major consideration when they decided where to live. Srour et al. (2002) and Chen et al. (2008) reported that accessibility to nonwork destinations only played a minor role in household residential location decisions. Omitted variable bias may also be a contributing factor; that is, some desirable features (e.g., open space) associated with car-dependent neighborhoods were not controlled for in my models, and so the coefficient estimates for nonwork-travel VMT may have an upward bias.

Toward accessibility-based planning

Academics and some leading planners have advocated for accessibility-based land-use and transportation planning for decades. Just like any major policy reform, however, change does not come overnight as many obstacles stand in the way. This paper identifies and addresses a major barrier to promoting accessibility-based planning: the use of travel-cost-savings-based measures as the main policy criteria for the evaluation of accessibility-promoting strategies. I argue that a TCS-based evaluation ignores destination-utility gains, i.e., the individual satisfaction derived from interacting with or choosing valuable destinations. Travel-cost-savings-based approaches understate the economic value of accessibility and consequently undermine the rationale for accessibility-enhancing policies. Empirical analysis supports this argument by demonstrating that transit accessibility remains a significant determinant of residential location choice after I control for all possible TCS associated with it.

A major limitation of the present analysis is that I did not control for the potential reduction in vehicle-ownership costs associated with transit accessibility in the residential location choice models. Future work may address this issue by fitting a joint choice model of residential location choice and vehicle ownership. Moreover, I have used cross-sectional data due to data availability issues. A longitudinal dataset which records individual travel behavior, preferences, and attitudes before and after experiencing significant accessibility gains could greatly enrich the research agenda. Finally, the empirical approach adopted here is only one of the possible approaches to demonstrate that accessibility benefits include TCS as well as destination-utility gains. Future research may fit hedonic price models to quantify how much the price premium commanded by accessibility results from TCS versus destination-utility benefits.

To promote an accessibility-approach in land-use and transportation planning, planners should pay attention to destination-utility gains. Accessibility-based planning efforts can garner wider support as planners bring into public discussions the various forms of destination-utility gains, such as activity participation (Allen and Farber, 2020), gains from destination diversity (Couture, 2015), and knowledge spillover from enhanced personal interactions (Jacobs, 1970). The notion of destination-utility gains is already implicit in Hansen's (1959) definition of accessibility, a widely cited definition. Destination-utility gains are also embedded in some commonly used accessibility measures such as the cumulative-opportunity measure. The analysis presented in this study suggests that planners should use these measures—as a replacement for TCS-based measures—to guide the evaluation of land-use and transportation strategies.

Note that the message here is not to discredit the importance of TCS, but to stress that accessibility-promoting land-use and transportation strategies can bring more travel benefits than what has been commonly measured. Substantial TCS (e.g., great VMT reductions) from accessibility-enhancing strategies provides a strong rationale for these policies. But when they result in little TCS, it does not necessarily suggest a lack of policy impact. It may well be that the accessibility gains from these policies have translated into destination-utility gains, which offsets the potential TCS. For instance, when the poor did not reduce driving as much as the rich after moving to TOD neighborhoods (Chatman et al., 2019; Boarnet et al., 2020), researchers should not assert that transit accessibility is less beneficial for the poor (Boarnet et al. acknowledged this). It is very likely that the poor has received greater destination-utility gains (e.g., greater activity participation and better job opportunities enabled by transit access) than the rich.

Moreover, although I have stressed here the importance of recognizing destination-utility gains, I am not suggesting that transportation and land-use planning should focus on maximizing destination utility. As discussed above, destination-utility gains can often result from increased driving, which carries environmental harms. This means that planners often need to confront and resolve the conflict between promoting individual welfare (destination utility) and protecting the environment (reducing VMT). To reconcile these competing aims in public policymaking is challenging. Planners face a similar dilemma concerning whether to support subsidizing car access for poor households (Blumenberg & Pierce, 2017; Grengs, 2010; Smart & Klein, 2018). This paper does not provide clear answers to these challenges. However, it highlights that land-use and transportation systems should not be evaluated by TCS-based criteria alone, as they also serve the society by providing destination-utility gains.

Endnotes

[1]For example, an analysis of the median sales prices for single-family homes in suburban areas along Metro-North Railroad's New Haven line suggests that homeowners pay tens of thousands dollars more for each minute less of rail travel time to Grand Central Station (Kolomatsky, 2016). It is hard to believe that this high price premium results solely from the potential time-plus-money savings associated with rail use.

[2]I have tested models that focus on auto accessibility rather than transit accessibility. To my surprise, the coefficient of auto accessibility either was insignificant (in the Puget Sound region) or even had a negative sign (in the Southeast Michigan region). This coefficient was positive and significant only if the commuting time by car variable was excluded from the model. A literature search suggests that these results were not uncommon, as several other authors reported similar findings (Guo and Bhat, 2007; Zolfaghari, Sivakumar, and Polak, 2012; Hu and Wang, 2017). These may simply be due to measurement errors. Another possible explanation is that U.S. households are indifferent to auto accessibility to nonwork destinations due to the ubiquity of public roads.

[3]In addition, a higher transit accessibility can help some households reduce car-ownership costs. I have attempted to control for these potential savings by adding a predicted car-ownership cost measure in the model. However, this measure had an unexpected positive sign, which means that most households ended up living in more car-dependent neighborhoods than less car-dependent ones. Given these results, I decided not to account for potential savings in car-ownership costs in this study.

[4]Though Walk Sore is often considered as an indicator of walkability, it measures many aspects of the neighborhood environment as it accounts for a host of nearby amenities.

References

Ahlfeldt, G. (2011). If Alonso was right: modeling accessibility and explaining the residential land gradient. *Journal of Regional Science 51* (2), 318–338.

Allen, J., & Farber, S. (2020). Planning transport for social inclusion: An accessibility-activity participation approach. *Transportation Research Part D: Transport and Environment*, 78, 102212.

Alonso, W. (1964). *Location and land use. Toward a general theory of land rent.* Harvard University Press, Cambridge, Massachusetts.

Berechman, J. (2009). *The evaluation of transportation investment projects*. New York: Routledge.

Blumenberg, E., & Pierce, G. (2017). Car access and long-term poverty exposure: Evidence from the moving to opportunity (mto) experiment. *Journal of transport geography*, 65, 92–100.

Boisjoly, G. and El-Geneidy, A. M. (2017). How to get there? a critical assessment of accessibility objectives and indicators in metropolitan transportation plans. *Transport Policy 55*, 38–50.

Boarnet, M. G., Bostic, R. W., Rodnyansky, S., Burinskiy, E., Eisenlohr, A., Jamme, H. T., & Santiago-Bartolomei, R. (2020). Do high income households reduce driving more when living near rail transit?. *Transportation research part D: transport and environment*, *80*, 102244.

Brueckner, J. K. (1987). The structure of urban equilibria: A unified treatment of the muth-mills model. *Handbook of regional and urban economics 2* (20), 821–845.

Canadian Home Builders Association. (2015). Home buyer preference survey. Technical report, Ottawa: Canadian Home Builders Association.

Chapple, K. and A. Loukaitou-Sideris (2019). *Transit-Oriented Displacement or Community Dividends?: Understanding the Effects of Smarter Growth on Communities*. MIT Press.

Chatman, D. G., Xu, R., Park, J., & Spevack, A. (2019). Does transit-oriented gentrification increase driving?. *Journal of Planning Education and Research*, *39*(4), 482-495.

Chen, J., C. Chen, and H. Timmermans (2008). Accessibility trade-offs in household residential location decisions. *Transportation Research Record: Journal of the Transportation Research Board* (2077), 71–79.

Couture, V. (2015). *Valuing the consumption benefits of urban density*. University of California, Berkeley.

Crane, R. (1996a). Cars and drivers in the new suburbs: linking access to travel in neotraditional planning. *Journal of the American Planning Association 62* (1), 51–65.

Crane, R. (1996b). On form versus function: Will the new urbanism reduce traffic, or increase it?. *Journal of Planning Education and Research*, *15*(2), 117-126.

Dawkins, C. and R. Moeckel (2016). Transit-induced gentrification: Who will stay, and who will go? *Housing Policy Debate 26* (4-5), 801–818.

de Palma, A., N. Picard, and P. Waddell (2007). Discrete choice models with capacity constraints: An empirical analysis of the housing market of the greater paris region. *Journal of Urban Economics 62* (2), 204–230.

Debrezion, G., E. Pels, and P. Rietveld (2007). The impact of railway stations on residential and commercial property value: a meta-analysis. *The Journal of Real Estate Finance and Economics 35* (2), 161–180.

Dong, H. (2015). Were home prices in new urbanist neighborhoods more resilient in the recent housing downturn? *Journal of Planning Education and Research 35* (1), 5–18.

Duranton, G. and D. Puga (2004). Micro-foundations of urban agglomeration economies. In *Handbook of regional and urban economics*, Volume 4, pp. 2063–2117. Elsevier.

Ewing, R. (1997). Is los angeles-style sprawl desirable? *Journal of the American planning association 63* (1), 107–126.

Ewing, R. and R. Cervero (2010). Travel and the built environment: a meta-analysis. *Journal of the American planning association 76* (3), 265–294.

Forsyth, A., Hearst, M., Oakes, J. M., & Schmitz, K. H. (2008). Design and destinations: Factors influencing walking and total physical activity. *Urban Studies*, 45 (9), 1973–1996.

Fuller, C. (2016). Rockin' the suburbs: Home values and rents in urban, suburban and rural areas. *Zil- low Retrieved August 21, 2019, from https://www.zillow.com/research/urban-suburban-rural-values-rents-11714/.*

Geurs, K., B. Zondag, G. De Jong, and M. de Bok (2010). Accessibility appraisal of land-use/transport policy strategies: More than just adding up travel-time savings. *Transportation Research Part D: Transport and Environment 15* (7), 382–393.

Geurs, K. T. and B. van Wee (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. *Journal of Transport geography 12* (2), 127–140.

Giuliano, G. (1995). The weakening transportation-land use connection. *ACCESS Magazine*, *1* (6), 3-11.

Giuliano, G. and K. A. Small (1993). Is the journey to work explained by urban structure? *Urban studies 30* (9), 1485–1500.

Glaeser, E. L., V. Henderson, and R. P. Inman (2000). The future of urban research: nonmarket interactions [with comments]. *Brookings-Wharton papers on urban affairs*, 101–149.

Glaeser, E. L., J. Kolko, and A. Saiz (2001). Consumer city. *Journal of economic geography*, *1* (1), 27–50.

Grengs, J. (2010). Job accessibility and the modal mismatch in Detroit. *Journal of Transport Geography*, 18, 42–54.

Grengs, J. (2015). Nonwork accessibility as a social equity indicator. *International Journal of Sustainable Transportation 9* (1), 1–14.

Grengs, J. (2019). On the way but not there yet: Making accessibility the core of equity planning in transportation. In N. Krumholz and K. W. Hexter (Eds.), *Advancing Equity Planning Now*, pp. 127–148. Cornell University Press.

Guo, J. Y. and C. R. Bhat (2007). Operationalizing the concept of neighborhood: Application to residential location choice analysis. *Journal of Transport Geography 15* (1), 31–45.

Haas, P., G. Newmark, and T. Morrison (2016). Untangling housing cost and transportation interactions: The location affordability index model—version 2 (laim2). *Housing Policy Debate 26* (4-5), 568–582.

Handy, S. L. (1992). Regional versus local accessibility: neo-traditional development and its implications for non-work travel. *Built Environment*, 253-267.

Handy, S. L., & Niemeier, D. A. (1997). Measuring accessibility: an exploration of issues and alternatives. *Environment and planning A*, *29*(7), 1175-1194.

Handy, S. (2005). Planning for accessibility: In theory and in practice. In D. M. Levinson and K. J. Krizek (Eds.), *Access to destinations*, pp. 131–147. Oxford: Elsevier.

Handy, S. (2020). Is accessibility an idea whose time has finally come? *Transportation Research Part D: Transport and Environment 83*, 102319.

Hansen, W. G. (1959). How accessibility shapes land use. *Journal of the American Institute of planners 25* (2), 73–76.

Hertz, D. (2015). Undercounting the transit constituency. *City Observatory*. Retrieved on May 4, 2020, from http://cityobservatory.org/undercounting-the-transit-constituency/.

Hu, L., & Wang, L. (2019). Housing location choices of the poor: does access to jobs matter?. *Housing Studies*, *34*(10), 1721-1745.

Jacobs, J. (1970). *The Economy of Cities*. New York: Vintage.

Kim, J. H., F. Pagliara, and J. Preston (2005). The intention to move and residential location choice behaviour. *Urban studies 42* (9), 1621–1636.

Kolomatsky, M. (2016). What's your commute time worth? *The New York Times. Retrieved on August 27, 2019, from https://www.nytimes.com/2016/10/30/realestate/whats-your-commute-time-worth.html?module=inline.*

Krizek, K. J. (2003). Transit supportive home loans: Theory, application, and prospects for smart growth. *Housing Policy Debate, 14*, 657–677.

Krizek, K. J. and A. El-Geneidy (2007). Segmenting preferences and habits of transit users and non-users. *Journal of public transportation 10* (3), 5.

Laird, J., K. Geurs, and C. Nash (2009). Option and non-use values and rail project appraisal. *Transport Policy 16* (4), 173–182.

Lee, B. H., Waddell, P., Wang, L., & Pendyala, R. M. (2010). Reexamining the influence of work and nonwork accessibility on residential location choices with a microanalytic framework. *Environment and Planning A*, 42(4), 913-930.

Lerman, S. R. (1975). *A disaggregate behavioral model of urban mobility decisions.* Ph. D. thesis, Massachusetts Institute of Technology.

Levine, J., J. Grengs, and L. Merlin (2019). *From Mobility to Accessibility: Transforming Urban Transportation and Land-Us Planning*. Cornell University Press.

Levine, J. (2020). A century of evolution of the accessibility concept. *Transportation Research Part D: Transport and Environment*, *83*, 102309.

Levinson, D. M. (1998). Accessibility and the journey to work. *Journal of transport geography, 6* (1), 11–21.

Lynch, K. (1981). *Good city form*. MIT Press: Cambridge, MA.

Martens, K. (2016). *Transport justice: Designing fair transportation systems*. Routledge.

Martens, K. and F. Di Ciommo (2017). Travel time savings, accessibility gains and equity effects in cost– benefit analysis. *Transport reviews 37* (2), 152–169.

McFadden, D. (1978). Modeling the choice of residential location. *Transportation Research Record* (673).

Merlin, L. A. (2015). Can the built environment influence nonwork activity participation? an analysis with national data. *Transportation 42* (2), 369–387.

Metz, D. (2008). The myth of travel time saving. *Transport reviews 28* (3), 321–336.

Mills, E. S. (1972). *Studies in the Structure of the Urban Economy.* The Johns Hopkins Press, Baltimore. Muth, R. F. (1969). *Cities and housing: The Spatial Pattern of Urban Residential Land Use.* University of Chicago Press, Chicago.

Niemeier, D. A. (1997). Accessibility: an evaluation using consumer welfare. *Transportation 24* (4), 377–396.

Proffitt, D. G., K. Bartholomew, R. Ewing, and H. J. Miller (2019). Accessibility planning in American metropolitan areas: Are we there yet? *Urban Studies 56* (1), 167–192.

Schirmer, P. M., van Eggermond, M. A., & Axhausen, K. W. (2014). The role of location in residential location choice models: a review of literature. *Journal of Transport and Land Use*, *7*(2), 3-21.

Smart, M. J. and N. J. Klein (2018). Complicating the story of location affordability. *Housing Policy Debate 28* (3), 393–410.

Smart, M. J., & Klein, N. J. (2020). Disentangling the role of cars and transit in employment and labor earnings. *Transportation*, 47(3), 1275-1309.

Srour, I. M., K. M. Kockelman, and T. P. Dunn (2002). Accessibility indices: Connection to residential land prices and location choices. *Transportation Research Record 1805* (1), 25–34.

Stevens, M. R. (2017). Does compact development make people drive less? *Journal of the American Planning Association 83* (1), 7–18.

Urban Land Institute. (2015). America in 2015: A uli survey of views on housing, transportation, and community. Technical report, Washington, D.C.: the Urban Land Institute.

van Wee, B. (2011). Evaluating the impact of land use on travel behaviour: the environment versus accessibility. *Journal of Transport Geography 19* (6), 1530–1533.

Wachs, M. and T. G. Kumagai (1973). Physical accessibility as a social indicator. *Socio-Economic Planning Sciences 7* (5), 437–456.

Webber, M. M. (1964). The urban place and the nonplace urban realm. In H. Priemus, K. Button, and P. Nijkamp (Eds.), *Land Use Planning*, pp. 163 – 196. Edward Elgar Publishing: CheltenHam, UK.

Yan, X. (2020). Evaluating household residential preferences for walkability and accessibility across three US regions. *Transportation Research Part D: Transport and Environment 80*, 102255.

Zhang, M. (2004). The role of land use in travel mode choice: Evidence from boston and hong kong. *Journal of the American planning association*, 70(3):344–360.

Zhang, W., Wang, F., Barchers, C., & Lee, Y. (2018). The impact of transit-oriented development on housing value resilience: Evidence from the city of atlanta. *Journal of Planning Education and Research*, 0739456X18787011.

Zolfaghari, A., Sivakumar, A., & Polak, J. W. (2012). Choice set pruning in residential location choice modelling: a comparison of sampling and choice set generation approaches in greater London. *Transportation Planning and Technology*, 35(1), 87-106.