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MODAL CHOICE AND THE VALUE OF PASSENGER TRAVEL TIME LITERATURE: A SELECTIVE BIBLIOGRAPHY

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MARK I. ALPERT

RESEARCH REPORT 22

MARCH 1975

COUNCIL FOR ADVANCED TRANSPORTATION STUDIES

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AUSTIN, TEXAS 78712

In cooperation with

DEPARTMENT OF TRANSPORTATION
OFFICE OF UNIVERSITY RESEARCH
WASHINGTON, D.C. 20590

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle MODAL CHOICE AND THE VALUE OF PASSENGER TRAVEL TIME LITERATURE: A SELECTIVE BIBLIOGRAPHY		5. Report Date MARCH 1975
		6. Performing Organization Code
7. Author(s) Shane Davies and Mark I. Alpert		8. Performing Organization Report No. RR 22
9. Performing Organization Name and Address Council for Advanced Transportation Studies The University of Texas at Austin Austin, Texas 78712		10. Work Unit No. (TRAIS) 00 3655 8
		11. Contract or Grant No. DOT OS 30093
12. Sponsoring Agency Name and Address Department of Transportation Office of University Research 400 7th Street, S.W. Washington, D. C. 20590		13. Type of Report and Period Covered RESEARCH REPORT
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract Why people choose a particular mode and how this decision is affected by quality and cost variations are of interest to transportation planners. Each mode competes for its share of the passenger transportation market, which is the summation of all origin-destination flows within a city.

Most of the literature on modal split models has addressed the question of preferences indirectly, by focusing on the decision to use one mode of transportation rather than another.

Most of this work concerns the journey to work and it falls into three general research areas. First is the type of study which relates mass transportation usage to physical and social characteristics of the city, such as size, density and age, population, income, race, and automobile ownership. Second are models of modal choice developed to explain and predict public transport and private car usage for the work trip between specified geographic zones in urban areas. Third are models developed to explain and predict individual travel and household characteristics. The remaining work is primarily concerned with the value of travel time. This bibliography lists books and articles related to predicting passenger allocation among competing modes and to the estimates of the value of travel time savings.

17. Key Words Bibliography Modal Choice Value of Passenger Travel Time	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Virginia

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 73	22. Price

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ABSTRACT

Why people choose a particular mode and how this decision is affected by quality and cost variations are of interest to transportation planners. Each mode competes for its share of the passenger transportation market, which is the summation of all origin-destination flows within a city. Models are used to estimate the size of the travel market and to predict the passenger allocation among competing modes.

Most of the literature on modal split models has addressed the question of preferences indirectly, by focusing on the decision to use one mode of transportation rather than another. These models are generally presented either in regression format, that is, predicting transit usage from characteristics of the transit system and the city's urban structure, or in graphic or tabular form, which shows usage divergences between modes caused by changes in the quality or quantity of various mode characteristics, or as mathematical models.

Most of this work concerns the journey to work and it falls into three general research areas. First is the type of study which relates mass transportation usage to physical and social characteristics of the city, such as size, density and age, population, income, race, and automobile ownership. Second are models of modal choice developed to explain and predict public transport and private car usage for the work trip between specified geographic zones in urban areas. Third are models developed to explain and predict individual modal choice behavior, taking account of individual travel and household characteristics. The remaining work is primarily concerned with the value of travel time. This bibliography lists books and articles related to predicting passenger allocation among competing modes and to the estimates of the value of travel time savings.

THE VALUE OF PASSENGER TRAVEL TIME LITERATURE

The remaining work is primarily concerned with the value of travel time. This bibliography lists books and articles related to predicting passenger allocation among competing modes and to the estimates of the value of travel time savings. Travel time savings is an important determinant in the selection of which transport mode to use for the work trip. All other variables held constant, an individual will select that mode which provides him with the shortest commuter time constrained by his income, the money costs of available transportation, comfort, convenience, and so forth.

EXECUCTIVE SUMMARY

INTRODUCTION

The research articles listed in this bibliography are related to how people choose their mode of transportation in cities. Why people choose a particular mode and how this decision is affected by quality, cost, and time variations are of interest to transportation planners. This bibliography is designed to give the student interested in these topics a general introduction to the literature. The bibliography contains a selected listing of useful sources and is subdivided into modal choice and value of travel time literature.

With respect to modal split models, most of the literature has addressed the question of preferences indirectly, by focusing on the decision to use one mode of transportation. These models are generally presented either in regression format, that is predicting transit usage from characteristics of the transit system and the city's urban structure; or in graphic or tabular form, which shows divergent usage between modes caused by changes in the quality or quantity of various mode characteristics; or as complex mathematical models.

MODAL CHOICE LITERATURE

Most of the work on modal split models concerns the journey to work and it falls into three general research areas. First is the type of study which relates mass transportation usage to physical and social characteristics of the city, such as size, density and age, population, income, race and automobile ownership. Second are models of modal choice developed to explain and predict public transport and private car usage for the work trip between specified geographic zones in urban areas. Third are models developed to explain and predict individual travel and household characteristics.

MODAL CHOICE LITERATURE

The research articles listed in this bibliography are related to how people choose their mode of transportation in cities. Why people choose a particular mode and how this decision is affected by quality and cost variations is of interest to transportation planners since this knowledge allows them to estimate the number of people prepared to change modes if a competing mode becomes more attractive to them. Each mode competes for its share of the passenger transportation market. This market is the summation of all origin-destination flows within a city. The models estimate the size of the travel market and attempt to predict the passenger allocation or split among the various competing modes. This is based on such characteristics as the trip (cost), the trip maker (auto or non-auto ownership), and the transportation system (mode choice available). The data base for predicting modal split allocation is obtained from origin-destination surveys, the U.S. census, and attitudinal and behavioral data.

With respect to modal split models, most of the literature has addressed the question of preferences indirectly, by focusing on the decision to use one mode of transportation. These models are generally presented either in regression format, that is, predicting transit usage from characteristics of the transit system and the city's urban structure; or in graphic or tabular form, which shows divergent usage between modes caused by changes in the quality or quantity of various mode characteristics; or as complex mathematical models. Most of this work concerns the journey to work and it falls into three general research areas.

One type of study relates mass transportation usage to such physical and social characteristics of the city as size, density and age, population, income, race, and automobile ownership. Adams, in a study of this

sort, utilized regression analysis to explain city-wide transit usage in terms of population, level of transit service, income, and land use factors. Schnore related mass transportation usage in different cities to the size, density, and age of the cities. Kain and Beesley expressed transit usage as a function of density and income concluding that transit use was more responsive to differences in residential density and urban form than to differences in levels of automobile ownership. Kasoff, using a regression technique on data for 13 cities, related transit usage to level of service. He found that transit usage is positively related to the number of route miles per capita served. The above models are only partially satisfactory for predictive purposes since they generally assume prevailing transit conditions will endure. Unfortunately, the empirical relationships obtained from studies that link usage of public transportation to physical characteristics of the urban area embody no convincing causal hypotheses explaining people's actual travel behavior, and without this the relationships are of limited use in policy formation.

In the second general research area, models of modal choice have been developed to explain and predict public transport and private car usage for the work trip between specified geographic zones in urban areas. Several major studies including the Chicago Area Transportation Study and the Indianapolis Regional Transportation Study are of this type. They utilize modified "gravity model" formulations and "opportunity models" for replicating and predicting urban travel behavior (Voorhees, Bevis). They consider trip characteristics--purpose and length; characteristics of the trip user--age, sex, and race; and characteristics of the transportation system--travel time, convenience, and cost. These models are the best presently available for predicting aggregate travel in urban areas, but this type of zonal analysis suffers from loss of detail

precisely due to data aggregation. Estimates of future passenger changes on the available modes are predicted on the projected changes in trip, trip user, and transportation characteristics, which control total passenger transportation demand. By extrapolating future increases in household car ownership, mass transit ridership is estimated. However, automobile ownership or availability biases predictions since although family car ownership influences public transit ridership, future improvements in the competitive features of mass transit are discounted. Further, this type of analysis fails to take into account such factors as the fuel crisis, which diminishes the value of projections. The inclusion of captive riders of mass transit in a modal choice model is a further bias since theirs is a no-choice situation; this also applies for people who require their cars during work hours. Reducing total person trips by the number of captive riders would improve the predictive power of the model, as would the model's stability and predictive power over time if time series data were used (Fertal).

Attempting to incorporate all the relevant transport related variables in reliable modal split forecasting increases the model's complexity, further augmented by the increasing size and complexity of urbanized areas. Predicting future changes in family size, per capita income, and per capita auto ownership is difficult enough, but is made harder by the fact that many of these variables are subject to policy changes of a political nature. For example, parking fee charges play a role in determining which mode a person selects. The impact of these charges can be assessed from a person's income. However, the political attitudes of the city fathers towards future parking cannot be determined. To alleviate this problem, alternative contingency constraints can be built into the model in an attempt to handle diverse political views.

Why attitudes vary and how they can be satisfied are important inputs to any transportation planning process. Attitude surveys appraise people of their preferences for present and future transportation systems and provide planners with a base of community approval so that implementation of change is considerably eased. Naturally, there is a need to correlate the results of attitude surveys with actual travel behavior since people differ markedly in what they say they will do and what they actually end up doing. People have stronger negative than positive attitudes and more often reveal their dislikes (Ferrea). Freedom of choice for groups harboring common attitudes may not necessarily be compatible with efficient land use or other urban policies. Individual urban travel behavior is not fully treated in these studies since they are concerned with the choice of mode based upon the assumption that the purpose and destination of the trip have already been decided. Several authors have pointed out the complexities of individual travel behavior and suggested the need for a more developed theory in this area.

In the third general research area, individual modal choice behavior concerns individual travel and household characteristics. Warner, Beesley, Lave, Sharp, and Quarmby's works are interesting and probably the most comprehensive. Warner used multiple regression and discriminate analysis to arrive at probability functions which predict that a traveller with given travel time, cost and other characteristics will choose a particular mode for both wo rk and non-work trips. This method avoids the problems associated with zonal aggregation of data. Warner's method is also appealing because it relates travel behavior to explanatory variables, such as parking availability and transit speeds, which are appropriate for testing different policy alternatives for public transport. Using a conceptual framework similar to Warner's, Beesley

predicted modal choice by assessing the trade-off between time and cost. Lave used probit analysis to handle the yes-no decisions of modal selection and incorporated travel cost as a ratio and as a difference between modes. Quarmby, by combining the work of Warner and Beesley, used a multivariate approach to attack the modal choice problem. He developed a model from representing how people make their decisions about using private or public transport to travel to work and found relative door-to-door traveling times, time spent walking and waiting, and costs to be important in affecting the choice of mode. The model was used to predict the probability that a car owner given information about conditions of travel by available alternatives will choose to use his car to travel to work. Perhaps the most important aspect of his work is that the method of predicting individual choice now enables us to forecast, given the assumptions of the model, how many car commuters would be diverted onto proposed public transport, and this permits a more rigorous evaluation of projected public transport improvements than has previously been possible.

The remaining works are less sophisticated statistically and concern primarily the problem of valuation of time spent in travelling. This problem is related to modal choice research since it frequently involves a trade-off of time against money--i.e. one mode is cheaper but takes longer than the other. The following section of the bibliography addresses this issue more thoroughly.

In the literature cited we have learned something about why people choose one mode over another. The simple answer is that they prefer one mode to another , of course, but this begs the question why, and again the answer from the literature is "because of things like cost, time used, comfort and convenience." Some of these variables are fairly easily handled, e.g., time and cost, and Quarmby's work in particular does a

good job of relating them to the choice of mode. But how do we qualify "comfort and convenience," and how do we know how much weight they have in a final decisions? For that matter, we do not know as much as we would like about the trade-off between time and money costs. Although Moses and Williamson provide us with an excellent theoretical framework, they had to assume that time was worth the prevailing marginal wage rate in order to get empirical estimates.

The foregoing work provides us with an idea of the variables which we are likely to find associated with transportation, and with some idea of their relative importance. But they will not take us much beyond that point, primarily because the methodology of most of the empirical work has been elementary. However much random sampling and survey techniques may have appeared to be an advanced methodology only a few years ago, they cannot provide us with much data other than the percentages of people who answered thus-and-so to a series of questions. We need to measure preferences more accurately and to combine preferences related to different transportation modes, so as to assess the trade-offs that can be made between one good and another (Shinn). This is important since measures of transportation satisfaction must be aggregative in nature if they are to be of much use either as social indicators or for policy planning purposes.

THE VALUE OF PASSENGER TRAVEL TIME LITERATURE

Travel time savings is an important determinant in the selection of which transport mode - car, bus, rail, rapid transit, bike, etc. - to use for the work trip. Travel time includes the walking, waiting, and en-route time encumbered by going from one point to another. All other variables held constant, an individual will select that mode which provides him with the shortest commute time constrained by his income, the money costs of available transportation, comfort, convenience, and so forth.

Travel time has been separated into productive (production of goods and services) and unproductive (leisure) time. There are those who argue that travel time savings has no economic value, whereas others uphold its worth. The latter suggest that since the satisfaction of any desire has economic value, it must therefore follow that the desire to minimize travel time must also have such value. The opponents of this view advocate that since time inexplicably advances, value should only be assigned to the productive travel time saved. It is also argued that people would trade reduced income for additional leisure time or the reverse, depending on their personal values. A somewhat extreme view is that leisure time is a burden to people and to add to it through travel time savings benefits neither the individual nor society. People are not cognizant of the alternative uses to which they can put their leisure time. Others justify a value for leisure time by viewing it as an element of production; the time spent in purchasing tickets is part of the total cost involved in seeing the show. Others have suggested that the small amounts of travel time savings accruing to an individual may not produce the same benefits as one large amount which could be more productively used. Further, the value of the travel time saved varies so much among individuals that only aggregate travel time reductions have value.

Several attempts through an income or cost approach have been made to assess how an individual values his travel time savings. Early attempts to measure the value of travel time savings through the income or wage rate approach assumed that an individual valued his travel time the same way he valued his time at work, that is, at his average hourly wage rate. This was rejected on the grounds that there was no suggestion that time spent at work and traveling to work could be considered equivalent. The more popular cost or choice approach employs user charges (toll bridge situations) to estimate travel time savings. A motorist probably selects

a toll road as opposed to a free road if there is a travel time savings benefit. This savings is then equated to the toll charge to obtain the monetary value placed on commute time. The assumption of "rational man" and the failure to take into account the variable nature of travel time between individual situations detracts from these studies.

Travel time savings is recognized as a scarce resource which is purchased and utilized to satisfy human needs. It is an important input to decisions concerning highway improvements since it is used to evaluate the user benefits which accrue from highway improvements. Small changes in travel time estimates produce considerable change in the estimated rate of return from highway investment expenditures. Mohring, in attempting to estimate the value of travel time savings, suggested that highway authorities should maximize benefits by setting the price of a trip on each link of the network equal to its short run marginal costs and expanding or contracting each link so that the quasi-rents earned by the link were equated with its capital costs.

The choice between two modes of travel frequently involves a trade-off of time against money, i.e., one mode is cheaper but takes longer than the other mode. In this area, Moses and Williamson, using indifference curves, developed a model to predict peoples' choice of mode. Rates of substitution between working time, traveling time, and leisure time were calculated. Using the marginal wage rate to represent the value of time spent in traveling to work, they demonstrated that a fare reduction and service improvement in public transportation would not increase patronage. Their income-cost approach involved the wage rate, travel time, and the money cost of the mode available to the commuter. The time difference between the two modes was multiplied by the worker's marginal wage rate and from this was subtracted the additional cost of the faster mode. The diversion price revealed the price changes required to induce shifts

from auto commuting to public transport. The study showed that negative prices would be necessary on all modes of public transport to divert at least 50% of those making the work trip by car, i.e., a person would have to be given 50 cents to ride the bus. They concluded that the feasibility of significantly reducing auto congestion through reasonable price reductions in the cost of a public transit ride was slight. Naturally, travel time savings is but one of the many variables that influence mode selection. Other factors such as comfort, privacy, ride quality and social image also enter into a commuter's utility function and influences his patronage of the various transport modes available to him.

The bibilography is designed to give the student interested in these topics a general introduction to the literature. The bibliography contains a selected listing of useful sources and is subdivided into modal choice and value of travel time literature.

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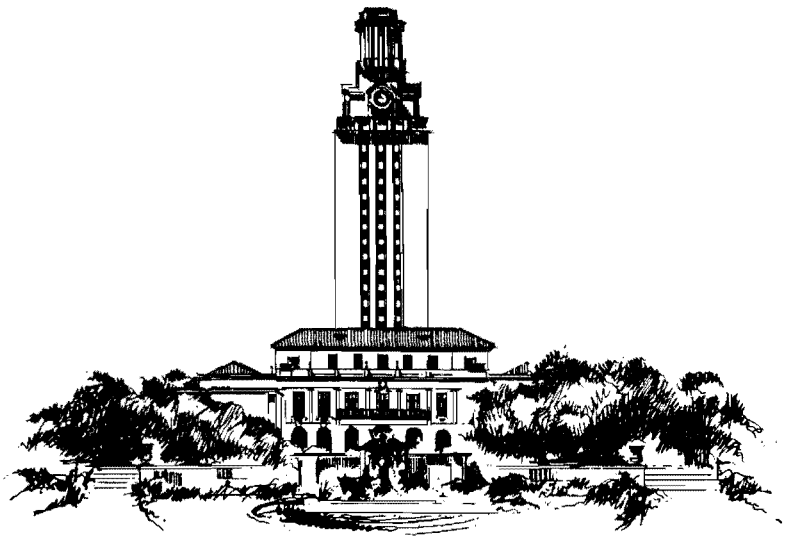

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