TRAVEL TIME BUDGETS: A REASSESSMENT OF THE CONCEPT AND ITS EMPIRICAL EVIDENCE

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ABSTRACT

In their desire to detect and establish stabilities or regularities in human behavior for planning purposes, transportation planners and economists have investigated the hypothesis that some form of constant expenditure on travel exists. The concept of travel time budgets has received substantial attention in the research literature.

This paper provides a critical view of both the concept and the empirical evidence provided to illustrate the concept. Three major issues are investigated in the research: (1) computing travel time for all persons leads to different conclusions than computations based on travelers only; (2) results differ depending on whether reported or "objective" travel times are considered; (3) the comparison of travel time budgets and trip rates shows that trip rates are at least as stable as travel time budgets.

This paper proposes the study of human activity patterns as an alternative concept in order to explore regularity and stability in human behavior. Groups of people with similar activity patterns are investigated under the hypothesis that they might spend similar amounts of time on travel. That would imply that different travel time budgets exist for different population groups.

Three sets of variables reflecting human activity patterns are investigated: the social and family role of an individual, the stage of his/her household in the life cycle, and life-style. The Baltimore Travel Demand Dataset was used to explore the influence of "role," "life cycle," and "life-style" on travel time budgets. A large amount of variation for travel time budgets across different groups was observed. In many cases, the systematic variation presented some definite patterns that could be explained by, or associated with, the variables considered in the analysis.

The variability of travel time budgets and trip rates within each group could also be associated with the considered variables. It was found that for persons with rigorously scheduled activities, these acted as a stabilizing factor which reduced the variability in comparison to less constrained persons who have more freedom to select their activities. Furthermore, the absence of a stabilizing factor seemed to affect travel time budgets and trip rates differently. For housewives and retirees the variability of trip rates tends to be smaller than the variability of travel time budgets, while for working people the variability of both variables is similar.

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1. INTRODUCTION

Efforts to better understand people's travel decisions have increased dramatically both in number and in sophistication over the last 10 to 15 years. The reasons lie in the intellectual challenge that is imbedded in the issue, and in the necessity to use any insights gained to advantage in improved transportation planning and modeling. Meaningful planning involving human activities is only possible under the assumption that a certain degree of stability and regularity exists in human behavior.

The need to identify such stabilities and regularities in human behavior for planning purposes has led researchers in the transportation field to investigate, among others, the hypothesis that some form of constant expenditure on travel time exists. Particular attention has been given to the study of travel time budgets, or the average amount of time spent daily on travel by the population as a whole or by subgroups of the population.

There exist good reasons for researchers to have concentrated on the analysis of travel time. First, total daily travel time expenditure shows more regularity than any other travel expenditure. Second, time is unique as a resource in that it cannot be earned and it is equitably distributed among all members of a population. Third, time is a continuous variable with the desirable associated analytical tractability. And, finally, the relatively tight budget of twenty-four hours might help reduce the variability of total travel times, especially in view of the subtraction of "committed" time allocated to obligatory activities (e.g. work, school).

The research that underlies this paper (Strambi, 1981) generated an extensive assessment of the concept and the empirical evidence of travel time budgets. It identified a number of instances of conflicting evidence, and it proposed a shift from the analysis of travel itself as the basis of observing regularities and stability to the more appropriate concept of activities that give rise to travel. This paper summarizes the major research results.

2. SUMMARY OF RESEARCH ON TRAVEL TIME BUDGETS

One of the most prolific researchers in the subject of travel time budgets is Zahavi. Analysis of Zahavi's work on the subject revealed the evolution of the concept, from an overall average daily travel time for vehicles (Zahavi, 1973), to average values per traveler systematically influenced by socioeconomic factors, to a final relationship with the average speed of the transportation system (Zahavi, 1979b). Through most of Zahavi's work, contradictory results arise when studying the systematic influence of different factors on travel time budgets for different cities. A summary of his results regarding average time budgets, as well as variability around these means (as expressed by the coefficient of variation) can be found in Tables 1 and 2, reproduced from Zahavi, et al. (1981).

Zahavi's claims of geographical and temporal transferability of travel time budgets seem to be weakened not only by some of his own contradictory

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Table 1. Average daily travel time per motorized traveler in selected cases (figures in hours).

1.	By Income		High	Low
	Bogota, Colombia		1.78	1.05
	Santiago, Chile		1.52	1.09
	Singapore		1.36	1.14
2.	By Mode		Car	Transit
	Washington, D.C.	1955	1.09	1.27
		1968	1.11	1.42
	Minneapolis-St. Paul, Minn.	1958	1.14	1.05
		1970	1.13	1.15
	All U.S. (1970)		1.06	0.99
3.	By Car Ownership			
	St. Louis (1976)	0 car	1.06	
		1 car	0.99	
		2 cars	1.05	
		3+ cars	1.06	
		Average	1.04	
4.	By Household Size and Car Ownership			
	The Nuremberg Region (1975)	Household Size	1 Car	0 Car
		1	1.22	1.41
		2	1.25	1.42
		3	1.28	1.36
		4+	1.27	1.35
5.	By Survey Days			
	Munich (1976)	1st day	1.15	
		2nd day	1.16	
6.	Total			
	Toronto (1964)		1.09	
	Calgary (1971)		1.11	
	Montreal (1971)		1.18	

[Source: Zahavi, et al., 1981, Table 3.1, p. 15]

results, but by the results of other researchers. Two major differences are noted between the work of Zahavi and that of other researchers. First, Zahavi only considers the number of persons who actually traveled, the travelers, when computing travel time budgets; the majority of other authors base their computations on all persons, including non-travelers. The consequences of considering all persons or only travelers for the computation of travel time budgets will be considered later. Second, Zahavi tends to include only trips by motorized modes in his computations, while other researchers generally include all modes, especially walking, when calculating travel time budgets. Gunn warns against the exclusion of walking trips and writes that "it seems dangerous to assume that trends and relationships based on travel by mechanised modes alone can be given any general 'behavioural' interpretation" (Gunn, 1981, p. 17). This point is also made by Kirby (1981).

Table 2. Coefficient of variation of the daily travel time per traveler in selected cases.

City			Coefficient of Variation[a]
Munich	1st day[b]		0.57
	2nd day		0.56
Bogota			0.57
Santiago	0 car[c]		0.55
	1 car		0.60
	2+ cars		0.62
Singapore	0 car[c]	Before[d]	0.70
		After	0.51
	1+ cars	Before	0.60
		After	0.56
Washington, D.C.[e]	North corridor		0.61
	South corridor		0.63

[Source: Zahavi, et al., 1981, Table 3.7, p. 23]

a The (estimate of the) coefficient of variation is obtained by dividing the (estimate of the) mean by the (estimate of the) standard deviation.
b Results of a three-day long survey.
c Refers to the number of cars in the traveler's household.
d Results of the surveys conducted with same households before and after the introduction of Singapore's Area License Scheme.
e Outliers were excluded from the data set.

In his initial analyses Zahavi considered network travel times as derived from trip assignment models; later, reported door-to-door travel times, as obtained from respondents in a survey, were used for computing travel time budgets. This is a common feature in most of the results presented by others. However, while many analyses are based on data obtained from conventional home-interview surveys, some of the results are derived from surveys of daily activities of individuals, in which not only travel, but all other activities are recorded. In this case, there is a strong logical check for a continuous accounting of time over the day. Consequently, the reported time may be less distorted by subjective perceptions than in conventional transportation surveys; also, the chance of underreporting of trips is significantly reduced. These issues will be discussed later in this paper.

The results obtained by other authors do not reinforce the notion of a stable travel time budget (e.g. Brög (1980), Herz (1981), Supernak (1982)). Although similarities can be found in some cases, the results vary considerably in terms of the effect of different variables on travel time budgets. Evidence exists to suggest the importance of variables other than those conventionally utilized in transportation studies, related to the social and family roles of individuals and to the structure of their households, such as employment status, marital status, presence of children, and others. As an example, Table 3 presents results obtained by several authors on average

daily travel time per person per day for three basic categories of individuals. Despite the differences in survey objectives, methods, definitions, location and timing, the results for these three categories present a consistent pattern, with employed men having the highest travel time budget of all, followed closely by employed women, and housewives having a significantly lower travel time budget.

Careful consideration of the evidence on travel time budgets requires attention to three major issues. First, the differences between persons and travelers have to be considered. Second, in much of the research, travel time budgets are computed from reported travel times as obtained from survey respondents. However, the physical possibilities of access open to an individual are limited by the real effective door-to-door speeds available, and not by the perceived speed or travel time. Finally, there is evidence that trip rates show less variability than travel time budgets. This is critical, for a whole organizational structure exists for the use of trip rates in transportation planning. These three issues are the focus of the next section.

Table 3. Average daily travel time per person for different categories of individuals (figures in hours).

Location (Year)	Discrimination	Travel Time Budget			Type of Survey
		Employed Men	Employed Women	Housewives	
U.S. (1975)[a]	National	1.6	1.4	0.9	Time-budget study
Bogota (1972)[b]	---	2.16	1.99	1.68	Travel survey
Reading (1971)[c]	---	1.99[g]	1.99[g]	0.66	Travel survey
Reading (1973)[d]	Car-owning households	1.59	1.47	0.81	Activities survey
	Non car-owning households	1.51	1.42	0.93	
Australia (1974)[e]	Melbourne	1.52	1.38	0.88	Time-budget study
	Albury-Wodonga	1.03	0.90	0.68	
Netherlands (1975)[f]	National	1.12	1.11	0.70	Activities survey

Sources: a Robinson, 1977, Table 3.10, p. 87
b Roth and Zahavi, 1981, Table 4, p. 91.
c Prendergast and Williams, 1981, Table 4, p. 43.
d Gunn, 1981, Table 1, p. 14.
e Wigan and Morris, 1981, Table 1, p. 69.
f van der Hoorn, 1979, Table X, p. 325.
Note: g Figure not provided by sex; refers to all employed persons.

3. CRITICAL ISSUES IN THE ANALYSIS OF TRAVEL TIME BUDGETS

Some of the issues treated in this section - travelers versus persons, objective versus reported travel times, and the stability of travel time budgets as compared to trip rates - have been studied jointly by some authors. Thus, although the issues will be examined individually, there are cross-references to findings relevant to the other issues.

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Travelers and Non-Travelers

When comparing the results obtained from the computation of travel time budgets for all persons and those computed after the exclusion of the non-travelers, there are two different aspects of the problem that should be recognized. One is the systematic variability of average travel times between different groups in the population; it can be seen that the exclusion of non-travelers leads to a reduction in this variability in some cases. However, this reduction is not a benefit in itself since systematic effects may exist that lead to very different travel behavior and allocation of time to travel for different person types.

It is the second aspect of variability though, that within each group, which is more problematic. If an average is to be used in an explanatory or predictive function, the smaller the variance around it, the more meaningful it will be. However, it is expected that values of travel time budget computed on the basis of travelers only as opposed to all persons will show less variability around the mean, since one "tail" of the frequency distribution of total travel time is cut off when non-travelers are excluded. The difference is reinforced by the fact that the exact point which is cut off is the one at which the probability density function reaches its maximum, for zero travel time is the most likely individual value when the whole population is considered (see Prendergast and Williams, 1981). The obvious consequence of excluding this point of the overall distribution is a reduction in variability which is reflected in the different coefficients of variation of travel time budget per person and per traveler.

Objective Versus Reported Travel Times

The expression "objective travel time," as it is used here, is taken to represent travel times derived from network models. These usually approximate actual travel times, although some evidence indicates that times measured along actual routes traveled are greater than the network travel times (Talvitie and Deghani, 1979).

The choice of whether to use objective or reported travel times can have a significant effect on the conclusions to be drawn from any given analysis. For example, Zahavi (1974) analyzed data collected in the Washington, D.C. area in 1968. Using network in-vehicle travel time (plus estimated access/egress times), the travel time budget of car travelers was found to be affected by residence distance from the city center. For the same data set, the use of reported door-to-door travel times revealed no effect of distance from the city center on the travel time budget of car travelers (Zahavi, 1979a).

However, the use of reported travel times brings with it another set of problems which may affect any potential conclusions on travel time budgets. According to Brög (1978), "each individual experiences [the] objective situations uniquely... [The] subjective situations are different from objective situations because of the incomplete or (consciously or unconsciously) distorted perceptions" (p. 135).

Nevertheless, if the deviations from reality caused by perception were not significantly large to interfere with the results of the analyses, this would be a minor problem. Unfortunately, empirical evidence does not

support this hypothesis. Meyburg and Brög (1981), using data from West Germany, found that transit riders and auto drivers considerably misestimate their travel times, based on comparisons with actually measured times.

Travel Time Budgets and Trip Rates

Most of the research in travel time budgets has been oriented towards the possible determination of a stable parameter of travel behavior, whose consequent utilization for modeling purposes would be immediate. However, in order to be adopted, it has to be proven that travel time budgets have advantages over their most direct "competitor," trip rates. Some comparative studies have shown that trip rates exhibit less variability than the corresponding travel time budgets, both between and within groups.

Landrock (1981) performed comparative analyses of trip rates and travel time budgets. Table 4 shows the values obtained by dividing the maximum by the minimum trip rate or travel time budget occurring for different categories of each of the classificatory variables, both for all persons and for travelers only.

According to Table 4, in all but one case, the systematic variation caused by the classificatory variables was smaller for trip rates than for travel time budgets. Landrock's results also show that the exclusion of non-travelers did not reduce the variation in travel time budgets between groups, but the effect was quite marked for trip rates which varied within a narrower range when the values were computed on the basis of travelers only.

Table 4. Ratio of maximum to minimum average trip rates and travel time budgets, per person and per traveler, obtained for individuals belonging to different categories of three classificatory variables.

Classificatory Variable	Population Size		Ward Density		Local Authority Density	
	Trip Rates	TT Budgets	Trip Rates	TT Budgets	Trip Rates	TT Budgets
Per Person	1.14	1.21	1.19	1.19	1.19	1.11
Per Traveler	1.06	1.23	1.08	1.18	1.11	1.11

[Source: Landrock, 1981, Tables 1, 2 and 3, pp. 56-58]

Another important study in this regard is that of Downes and Morrell (1981). They found no clear systematic effect of household location on either trip rates or travel time budgets. Travel time budgets tended to copy the trend of the trip rates with some enlargement of the fluctuation (since, in theory, one trip can take any amount of time). Accordingly, the coefficients of variation within each group were found to be higher for travel time budgets than for trip rates.

The study of intensity of car use made by Goodwin (1978) compared trip rates and total travel times of surveyed automobiles. The average time each

"used" car was driven on a given day was 55 minutes, with a coefficient of variation of 0.63. For trip rates, the average value was 4.03 and the coefficient of variation 0.59, indicating a marginally better stability for trip rates. Since these results apply to vehicles, care should be taken before generalizing them to travelers.

Studies by van der Hoorn (1979) and van Es (1978) support these findings. van der Hoorn, for example, divided individuals into five distinct groups, according to the person's occupation and sex (variables that strongly influence the set of roles fulfilled by one person). Using his results, it is possible to study the systematic effect of these variables on travel time budgets and trip rates, as well as the variability of both within each group. The trends observed are: different average values for different groups of persons, and consistently lower coefficients of variation for trip rates than for total travel times. It is interesting to note that the coefficients of variation are smaller when computed for a full week as compared with those for weekdays, although they are highest when only the weekend days are considered.

The coefficients of variation for travel time budgets for weekdays are comparable to those of other studies. These range from 0.39 to 0.66 which compare favorably with the average 0.5-0.6 identified by Zahavi for travelers only. However, it should be taken into consideration that van der Hoorn used data from an extended survey, which supposedly reduces the effects of day-to-day variability.

It should be evident from the discussion in this section that most of the results presented indicate that trip rates exhibit higher cross-sectional stability and less variability than corresponding travel time budgets.

4. A REASSESSMENT OF TRAVEL TIME BUDGETS

There is increasing evidence and conviction among researchers of travel behavior that the reasons for stabilities and variabilities in travel time budgets are related to overall activity patterns of individuals as opposed to travel in isolation. The activities that people have to perform, determined in part by their social and family roles, may specify the amount of travel required. This interpretation leads to the assertion that travel time, as well as travel, is considered to be "a by-product of the way in which each person schedules his/her other activities in space and time" (Kirby, 1981, p. 4). This assertion is in line with the human activity approach to the analysis of travel behavior.

This approach is characterized by the recognition that travel ought to be treated as a complex, choice-constrained behavior. In particular, three key features of travel are recognized: the known fact that travel is a derived demand; the existence of intertemporal linkages between the different trips of one individual; and the existence of interpersonal linkages, or the influence that households or other interpersonal relations have on travel behavior.

Constraints play a very important role in defining and determining activity patterns (Hägerstrand, 1975; Kutter, 1981). Similar groups of constraints may apply to similar groups of people. These people may be alike in their social or family roles (e.g. a full-time worker or housewife), or in their stage in life cycle; a composition of these factors may be fundamental for

defining groups of people who have similar needs and wants and who have to live under the same sort of constraints on their actions.

Constraints on behavior lead to a certain stability of the activity patterns performed by the individuals. This stability arises due to a reduction in the freedom of choice of the individual in establishing his/her own scheduling of activities. Therefore, it is possible to identify groups of people whose activity patterns are similar. Some of the predominant factors which lead to stability in behavior within a certain group were suggested by Kutter (1981).

This hypothesis has been confirmed by studies which considered temporal dimensions of activity patterns (Kutter, 1973 and 1981), and those which analyzed the whole spatio-temporal pattern of individuals and households (Jones, et al., 1980; Pas, 1980). Groups with significantly different patterns of behavior can be distinguished, but the variation within each group is small.

The factors which influence travel time budgets are similar to those which are important in the formation of activity patterns. Hence, the following hypothesis is formulated: similarity in travel time budgets arises from similar activity-travel patterns. In other words, the sequences of activities that similar people engage in may require similar amounts of travel. This similarity could be expressed in terms of the total amount of time traveled (or the total frequency of travel). Travel time budgets arise as a consequence of grouping people with similar general activity-travel patterns. Differences in detailed patterns are hypothesized to be responsible for most of the variability around the mean travel time budget for a similar group of people (see also, Kutter, 1973; Burnett and Hanson, 1979; Jones, et al., 198D; Pas, 1980).

The choice of proper variables that measure activity patterns was based on research by others (e.g. Charles River Associates, 1978; Bourgin, 1978; Reichman, 1978; Burnett, et al., 1978; Jones, 1980; Pas, 1980; Wigan and Morris, 1981; Allaman, et al., 1981; Havens, 1981) who have demonstrated that social and family roles as well as stage in family life cycle and life style constitute important influences on general activity-travel patterns.

5. EXPLORING THE INFLUENCE OF ROLES, LIFE CYCLE AND LIFE-STYLE ON TRAVEL TIME BUDGETS

The data base used to investigate the hypothesis stated in section 4 is the Baltimore Travel Demand Dataset (CDMSIS and CRA, 1978), a home-interview survey of 967 households performed during May and June of 1977. The detailed description of the quality and characteristics of the data set including the data preparation necessary for this research is provided in Strambi (1981). Only trips on weekdays were considered in the computation of average daily travel time budgets and trip rates.

The transformation of the concepts of roles, stage in life cycle and life-style into objective indicators which can be derived from the information obtained in the survey was a rather complicated matter. Since there are no standards for doing that, most of this work was based on the few examples provided in the literature, some common sense judgment, and the data limitations in terms of availability of information and sample size. Particularly

in the case of roles and life-style, there are no direct measurements or indicators for these variables; suitable approximations had to be selected with the hope that they represent the most important characteristics of what is actually being measured or categorized. Again, the detailed rationale for role classification, life cycle definition and life-style measures cannot be presented in the context of this paper. Some of the stratifications and definitions will become evident in the discussion of the analysis results presented below. The classification of stages in life cycle is presented Table 5. The matching of variables defining roles and stage in life cycle provided the framework for the empirical analysis of travel time budgets.

Table 5. Description of the adopted classification for stages in life cycle and number of families in the sample in each stage.

Stage in Life Cycle	Description (Based on years of age of household members)	Number of Families
1	Persons living alone. Age < 65.	85
2	Persons living alone. Age ≥ 65.	65
3	Young adults living together or married couples without children. 16 ≤ age of youngest member ≤ 35; age of oldest ≤ 40.	50
4	Household with pre-school children. Age of youngest member < 5; age of other members < 5 or ≥ 16.	81
5	Household with pre-school and school-aged children. Age of youngest member < 5; at least one other member 5 ≤ age < 16.	104
6	Household with school-aged children. 5 ≤ age of youngest member < 12.	160
7	Household with older school-aged children. 12 ≤ age of youngest member < 16.	92
8	Household of adults. 16 ≤ age of youngest member ≤ 35; age of oldest > 40.	128
9	Household with older adults. Age of youngest member > 35.	128
10	Adults beyond retirement age. All members age ≥ 65 or at least one aged ≥ 65 and none working (full or part time).	73

[Based on Jones, et al., 1980]

The research that constitutes the basis for this paper analyzed the influence of role, life cycle and life-style on travel time budgets and trip rates per person and per traveler in a highly stratified, disaggregate fashion. The presentation here is confined to the results of the combined influence of a limited number of stratifications for these three variables.

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The hypothesis that any of the variables considered - travel time budgets per person, travel time budgets per traveler, and trip rates per person - was normally distributed, could be rejected at the one percent level on the basis of a Kolmogorov-Smirnov test.

The non-normality of the variables created a problem because of the generally small number of observations in many of the subgroups to be analyzed; the relatively small number of observations also made non-parametric methods unattractive. A suitable alternative was to make a simple exploration of the influence that different categories of role indicators, different stages in life cycle and different life-styles had on travel time budgets and trip rates. This was accomplished through the computation of averages for each subgroup, complemented by visual inspection of plots based on these results.

Two groups of persons were selected for the analysis of the influence of different life-styles on activity and travel patterns - married males working full time and housewives (married female homemakers). Also, two variables were chosen as life-style indicators, namely level of education and race. Tables 6 and 7 show the computed travel time budget per person and per traveler, respectively, for each of the groups considered in this phase of the analysis.

The two groups considered for this part of the analysis presented a quite stable pattern of travel time budgets per person through different stages in life cycle. For married males working full time, most of the values fluctuated within a small range, while for housewives there was a slight decrease across life cycle stages (in the ordering utilized here). In addition to this, for the case of persons working full time, the variability around the mean is relatively small due to the stabilizing function of work (as will be discussed next). This fact makes the analysis less revealing than it might otherwise be since the patterns are not much varied.

The effect of race on travel time budget per person was noticeable. The results for the group of married males working full time show that whites generally have smaller travel time budgets per person than blacks. For housewives, the results were split: in two cases, blacks have larger travel time budgets (stages 4 and 7); in three other cases, they were reasonably similar (stages 5, 6 and 9), and in stage 8, white housewives had a higher travel time budget.

The results indicate that the more educated working husbands generally have higher travel time budgets, although the differences seem to be larger in those stages of life cycle in which there are no children in the household (stages 3, 8 and 9). This may indicate that in these stages the individual's interest in participating in additional activities matches his independence from children-related household duties.

The Variability of Travel Time Budgets and Trip Rates

In this section, a simple analysis of variability is made using the estimates of the coefficients of variation obtained for some of the groups analyzed in the previous section. The purpose of this analysis is twofold: first, to compare the coefficient of variation of travel time budgets, especially per traveler, with similar results existing in the literature, and summarized in Table 2; second, to compare the coefficients of variation of travel time budgets and trip rates, in light of the discussion in section 3.

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Table 6. Travel time budget per person (in minutes), according to role indicators, stage in life cycle and life-style indicators (number of observations in parentheses)

Role Indicator	Life-Style Indicators		Stage in Family Life Cycle						
			3	4	5	6	7	8	9
Married Males Working Full Time	Race	White	94.5 (19)	66.7 (28)	65.0 (28)	66.5 (44)	71.1 (27)	71.3 (35)	60.7 (25)
		Black and Others	81.7 (3)	99.5 (10)	82.6 (14)	97.9 (19)	64.1 (14)	99.6 (13)	85.0 (8)
	Level of Education	Some H. School or Less	85.0 (4)	88.0 (10)	60.8 (13)	72.4 (15)	70.7 (17)	75.0 (18)	60.0 (14)
		Completed High School	80.0 (7)	88.2 (13)	74.7 (12)	74.6 (15)	63.7 (14)	68.8 (20)	71.4 (13)
		Some College or More	103.6 (11)	59.6 (14)	75.9 (17)	78.2 (33)	72.2 (18)	106.3 (10)	86.0 (5)
Housewives (Married Female Homemakers)	Race	White		41.5 (30)	46.5 (19)	37.5 (34)	29.3 (18)	42.7 (24)	39.5 (20)
		Black and Others		96.7 (6)	50.6 (11)	44.6 (12)	85.4 (5)	16.0 (5)	32.5 (6)
	level of Education	Some H. School or Less		41.9 (7)	42.8 (11)	33.9 (14)	41.2 (12)	38.6 (12)	45.0 (11)
		Completed High School		62.1 (15)	46.7 (11)	43.6 (20)	35.0 (10)	32.5 (13)	36.2 (12)
		Some College or More		42.8 (14)	56.9 (8)	30.7 (12)	110.0 (1)	55.0 (4)	10.3 (3)

Note: Life cycle codes as defined in Table 5.

Table 7. Travel time budget per traveler (in minutes), according to role indicators, stage in life cycle and life-style indicators (number of observations in parentheses)

Role Indicator	Life-Style Indicators		Stage in Family Life Cycle						
			3	4	5	6	7	8	9
Married Males Working Full Time	Race	White	94.5 (19)	69.1 (27)	70.0 (26)	68.0 (43)	71.1 (27)	75.6 (33)	69.0 (22)
		Black and Others	81.7 (3)	99.5 (10)	89.0 (13)	97.9 (19)	69.0 (13)	99.6 (13)	85.0 (8)
	Level of Education	Some H. School or Less	85.0 (4)	88.0 (10)	65.8 (12)	72.4 (15)	70.7 (17)	75.0 (18)	60.0 (14)
		Completed High School	88.0 (7)	88.2 (13)	74.7 (12)	79.9 (14)	63.7 (14)	72.4 (19)	84.4 (11)
		Some College or More	103.6 (11)	59.6 (14)	86.1 (15)	78.2 (33)	80.2 (9)	118.1 (9)	86.0 (5)
Housewives (Married Female Homemakers)	Race	White		54.1 (23)	55.2 (16)	55.4 (23)	58.7 (9)	64.1 (16)	79.0 (10)
		Black and Others		116.0 (5)	111.4 (5)	89.2 (6)	106.8 (4)	26.7 (3)	48.8 (4)
	Level of Education	Some H. School or Less		73.2 (4)	78.5 (6)	79.0 (6)	70.7 (7)	57.9 (8)	70.7 (7)
		Completed High School		77.7 (12)	73.4 (7)	58.1 (15)	70.0 (5)	60.3 (7)	87.0 (5)
		Some College or More		49.9 (12)	56.9 (8)	58.0 (8)	110.0 (1)	55.0 (4)	27.5 (2)

Note: Life cycle codes as defined in Table 5.

Table 8 presents the coefficients of variation of travel time budget per traveler in different categories, as defined by role indicators and stage in life cycle. Two distinct groups can be identified easily: one including all working persons, and the other including homemakers and retired persons. The first group has values of the coefficient of variation considerably lower than those for the second group.

Table 8. Coefficient of variation of travel time budget per traveler (percent), according to role indicators and stage in life cycle (number of observations in parentheses).

Role Indicators			Stage in Family Life Cycle									
Occupational Status	Marital Status	Sex	1	2	3	4	5	6	7	8	9	10
Full Time Job	Married	Male			55 (22)	61 (37)	63 (39)	60 (62)	50 (40)	69 (46)	59 (30)	
		Female			68 (12)	76 (10)	54 (7)	60 (17)	63 (13)	59 (22)	45 (23)	
	Not Married	Male	57 (12)		60 (5)		54 (5)	61 (9)	85 (8)	61 (30)	59 (8)	
		Female	38 (15)		48 (6)		43 (11)	75 (19)	41 (15)	71 (30)	24 (7)	
Part Time Job	Married	Female				107 (3)	47 (10)	48 (10)	54 (7)	71 (7)	72 (6)	
Homemaker	Married	Female			31 (4)	79 (28)	112 (21)	66 (29)	74 (13)	100 (19)	67 (14)	57 (6)
	Not Married	Female		98 (5)			76 (9)	66 (2)	143 (3)			
Retired	Married	----								83 (6)	64 (11)	84 (24)
	Not Married	----		75 (16)						38 (3)	45 (5)	54 (8)
	----	Male								86 (7)	58 (11)	82 (16)
	----	Female								25 (2)	90 (6)	76 (16)

Note: Life cycle codes as defined in Table 5.

The values in Table 8 can be compared to those in Table 2, although the latter are based on a much higher level of aggregation. All but two of the values in Table 2 are between fifty-five and sixty-five percent; they are thus comparable to the coefficients of variation obtained for the working persons group. (It is important to keep in mind that the values of the coefficient of variation in Table 8 and in Table 2 are based on quite different numbers of observations.)

In section 3, a discussion of some research results on the variability of travel time budgets and trip rates indicated that trip rates seem to be at least as stable as travel time budgets. The results obtained here confirm that observation. The coefficients of variation of travel time budget per person and trip rates per person are presented in Tables 9 and 10, respectively. Again, it is possible to identify the same two groups with different patterns of variability. For both travel time budgets and trip rates, the coefficients of variation of working persons have most values in the range of fifty to eighty percent (higher than the corresponding values per

traveler). For the homemakers and retired, most of the values are above one hundred percent. The smaller variability encountered for working people is most likely due to the existence of an obligatory daily activity in their schedules, which exerts a stabilizing influence on the travel time budget of the members of this group. On the other hand, the absence of rigorously scheduled daily activities requiring travel may cause the variability of the second group to be larger.

Although the general patterns of variability of the coefficients of variation of travel time budgets and trip rates are similar, in general the values associated with trip rates are smaller than those associated with travel time budgets. A simple non-parametric test, the sign test, can be utilized to verify if this trend is statistically significant or not. This test is equivalent to the test of the null hypothesis that the means of the distributions of the coefficient of variation of travel time budgets and trip rates are the same.

A close look at the tables indicates that, when comparing the coefficients of variation of travel time budgets and trip rates, the same two groups identified above - working people and non-working people - present quite different patterns. From the thirty-four possible comparisons for the group of working people, the coefficient of variation of travel time budgets was larger in twenty-one cases. For this category of persons, the null hypothesis of equal means could not be rejected at the five percent level of significance. In contrast to that, for the group of non-working persons (housewives and retired), twenty out of twenty-five possible pairs had a larger coefficient of variation of travel time budget. In this case, the null hypothesis could be rejected at the one percent level of significance.

These results add an interesting dimension to the analysis. The stabilizing function of daily compulsory activities in people's patterns seems to act in the direction of lowering the variability of both travel time budgets and trip rates to approximately an equal level. For persons with fewer obligatory activities, there seems to be less variability in trip rates than in travel time budget, probably reflecting the additional variability in trip times, which may be subject to the influence of factors which have not been considered in this analysis.

6. CONCLUSIONS

An important implication of the findings of this work is that the development of planning models based on the hypothesis of stable travel time budgets is, to say the least, premature. The assumption of stability is dubious, and, furthermore, there is not a unique appropriate value or set of values of travel time budget to be used in such a model. One important conclusion is that travel time budgets should not be viewed as a characteristic of an aggregate group of people but rather as a composition of different travel time budgets specific to particular groups of persons having similar patterns of activity and travel. It is also important to note that the type of variables considered in this work, although unconventional, can be shown to influence activity-travel patterns and travel time budgets. One important advantage of these variables is that they can be put under one common explanatory framework, where the separate influence of each of them, as well as the relationships among them, can be understood.

Table 9. Coefficient of variation of travel time budget per person (percent) according to role indicators and stage in life cycle (number of observations in parentheses)

Role Indicators			Stage in Family Life Cycle									
Occupational Status	Marital Status	Sex	1	2	3	4	5	6	7	8	9	10
Full Time Job	Married	Male			55 (22)	64 (38)	71 (42)	62 (63)	61 (41)	73 (48)	69 (33)	
		Female			85 (14)	76 (10)	54 (7)	80 (19)	72 (14)	68 (24)	60 (26)	
	Not Married	Male	57 (12)		80 (6)		92 (7)	73 (10)	108 (10)	68 (32)	73 (9)	
		Female	48 (16)		48 (6)		43 (11)	80 (20)	57 (17)	84 (34)	24 (7)	
Part Time Job	Married	Female				175 (6)	59 (11)	70 (12)	70 (8)	71 (7)	89 (7)	
Homemaker	Married	Female			85 (6)	105 (36)	149 (30)	113 (46)	132 (23)	151 (29)	130 (26)	153 (15)
	Not Married	Female		198 (13)			134 (16)	210 (8)	212 (6)			
Retired	Married	----								144 (11)	90 (14)	138 (41)
	Not Married	----		96 (20)						140 (8)	99 (8)	120 (15)
	----	Male								157 (14)	92 (15)	152 (32)
	----	Female								140 (5)	124 (7)	117 (24)

Note: Life cycle codes as defined in Table 5.

Table 10. Coefficient of variation of trip rates per person (percent), according to role indicators and stage in life cycle (number of observations in parentheses)

Role Indicators			Stage in Family Life Cycle									
Occupational Status	Marital Status	Sex	1	2	3	4	5	6	7	8	9	10
Full Time Job	Married	Male			54 (22)	57 (38)	81 (42)	54 (63)	55 (41)	60 (48)	85 (33)	
		Female			117 (14)	58 (10)	54 (7)	74 (19)	100 (14)	57 (24)	71 (26)	
	Not Married	Male	47 (12)		73 (6)		87 (7)	70 (10)	66 (10)	98 (32)	43 (9)	
		Female	55 (16)		45 (6)		56 (11)	66 (20)	54 (17)	69 (34)	33 (7)	
Part Time Job	Married	Female				171 (6)	87 (11)	78 (12)	77 (8)	46 (7)	73 (7)	
Homemaker	Married	Female			82 (6)	75 (36)	110 (30)	105 (46)	124 (23)	125 (29)	124 (26)	152 (15)
	Not Married	Female		151 (13)			106 (16)	105 (8)	108 (6)			
Retired	Married	----								131 (11)	76 (14)	141 (41)
	Not Married	----		81 (20)						160 (8)	107 (8)	115 (15)
	----	Male								144 (14)	06 (15)	110 (32)
	----	Female								142 (5)	89 (7)	148 (24)

Finally, it must be remembered that if a stable value is being sought, it is fundamental that its random variation be studied in addition to its pattern of systematic variation. Curiously, in this respect, it seems that trip rates have an advantage over travel time budgets. Although the stability of trip rates has been studied for years, the analyses were not related to the individual's pattern of activities. Perhaps a closer investigation of trip rates within this new framework, considered as part of the individual activity-travel pattern, will reveal that they really are the most appropriate parameters to be used.

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