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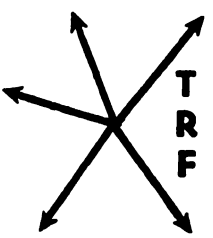

TRANSPORTATION RESEARCH FORUM

1. INTRODUCTION

NUMEROUS STUDIES of transport mode choice have indicated that the traveller's income is an important variable. Income may affect the importance the traveller places upon factors such as journey time, cost, and convenience, which influence his choice of mode. It may further affect his perceptions of the characteristics of alternative modes, and his attitude towards those modes Finally, income may determine the extent to which the traveller is willing to trade one characteristic, such as time, for another, such as cost. While the effect of income on the process by which mode choices are made is undoubtedly extremely complex, it is important that it should be understood, since decisions regarding the development, provision, and marketing of transport services depend upon information based on traveller likes and dislikes. Strategies for marketing management (i.e., development of services in response to traveller needs and attitudes can be successful only if they are based on sound data regarding the traveller's requirements. For example, if it is felt that people value convenience and are willing to pay for it, a good marketing strategy might indicate that a dial-a-bus system should be developed. However, it would be absurd to implement such a system in a neighborhood where budget constraints were sufficiently severe that travellers did not value convenience highly, in the sense that they were unable or unwilling to pay for it. Thus, the transport supplier must plan service levels against a background of what travellers of various income levels consider important, and of how much they are willing and able to pay for important service characteristics.

This paper reports on an investigation of the way in which the traveller's income affects transport mode choice and valuation of service characteristics. Section 2 describes various ways of treating income in an analysis of the mode choice decision, including a discussion of the value of time; Section 3 reports a series of empirical tests carried out using intercity data from the Edinburgh-Glasgow Area Modal Split Study; Section 4 reports supporting results from some intra-city studies; and Section 5 summarizes the conclusions and examines the implications of the findings for the development and marketing of transport services.

2. ALTERNATIVE APPROACHES TO ANALYZING THE EFFECT OF INCOME

The effect of income on travel choices may be investigated most readily by analyzing transport mode choice. The mode choice decision represents a choice between a relatively limited number of options; there is a fairly substantial body of literature on the attributes of importance in the decision process (e.g. Claffey, 1961; Warner, 1962; Hill and von Cube, 1963; Quarmby, 1967, etc.) Furthermore, these investigations may be made most effectively when considering the choice behavior of individual travellers (Reichman and Stopher, 1971). Hence, our analyses are based upon the use of disaggregate, behavioral, probabilistic models of transport mode choice, in which it is assumed that factors affecting the choice process comprise relative attributes of available travel modes and traveller income. Within this basic framework, the effect of income can be represented in three ways. The form, implications and assumptions of these three methods are described below.

2.1.: By Sub-stratification

Many analysts—e.g. Stopher (1969), Stopher and Meyburg (1974), Watson (1974)—believe that the effect of the income variable is essentially different from that of the trip characteristic variables in that, rather than influencing the choice made, it fundamentally affects the choice process. This viewpoint implies that each income group has a decision process which must be modelled separately. It is possible that the same variables with different coefficients will explain choices for all income groups; it is equally possible that the variables may be substantially different from group to group. The operational result of this viewpoint is to divide the sample into income groups which are analysed as distinct samples. An advantage of this method is that the relationship between the coefficients and income can be readily assessed. A strong disadvantage is that such stratifications require a large sample; this is a problem in a commuter study, but in a study concerned with a number of different journey purposes the problems are exacerbated, as it is necessary to carry out two stratifications, first by journey purpose and then by income.

Fortunately, the data sets used for the analyses reported in this paper were collected with the objective of sub-stratification in mind, and are therefore large enough for this to be achieved. However, it must also be pointed out that the sample sizes implied here are much smaller (c. 1000-5000 observations) than those traditionally associated with urban transportation studies.

2.2.: By Including Income as a Series of Dummy Variables

Although some studies, e.g. Lisco

The Effect of Income on the Usage and Valuation of Transport Modes

by Peter L. Watson and Peter R. Stopher***

(1967), Quarmby (1967), have included income as a variable, it is difficult to justify the inclusion of income as a direct variable, except on the grounds that it improves the fit of the model. The use of income directly or as dummy variables implies that the effect operates through a simple shift in the intercept (constant term), with the trip characteristic variables having the same effect in each income group. In other words, the effect of income is to add a constant bias towards the use of one mode and away from the other (in a binary choice situation). We feel that the use of such income variables does not reflect adequately the complex manner in which income affects mode choices.

2.3.: In Combination with Other Variables

Attempts to explain the complexities of the process by which income affects modal choices have led some analysts (e.g. Lave (1969), de Donnea (1971)) to the conclusion that income operates through or in conjunction with other variables—e.g., cost, time, comfort. In some cases it is argued that the cost difference is important only in relation to income, so that a given cost difference will produce different reactions in a higher-income-group traveller than in one from a lower income group; a suggested solution is to combine the income and cost variables to produce a new variable, e.g., the ratio of cost difference to income, or the product of the two variables. In other cases, it is argued that the time difference is perceived differently by different income groups, so that a given time difference will affect the higher-income-group traveller more. In yet others it is claimed that the higher-income-group traveller is more susceptible to differences in comfort, and so a new variable is derived, composed of the comfort variable multiplied by income.

2.4.: Summary

It would appear that two basic positions are tenable. One holds that the influence of income on the choice process is so fundamental that it is necessary to deal with each income group separately. The other position, enforced perhaps by the restriction of many samples, involves an attempt to develop a variable which accurately reflects the influence of income. It is contended that most attempts to do this are conceptually unsatisfactory because they consider the effect on individual variables, rather than on the choice process as a whole.

Nevertheless, an examination of the role of income should encompass all possibilities. The analysis reported below, therefore, will test each of the methods suggested above.

2.5.: The Value of Time

Given the interpretation of the choice process as a trade-off situation, it is necessary to consider the effect of income on the rate at which the traveller is willing to trade one service characteristic for another. The value of time, as commonly derived, is a measure of the rate at which travellers trade time for money. (Harrison and Quarmby (1969); Stopher (1974)) Thus, an examination of the values of time of various income groups may yield insights into the effect of income on this process.

3. EMPIRICAL RESULTS OF TESTS USING THE E.G.A.M.S.S. DATA

In this section, the three income inclusion methods discussed in the previous section are analyzed using the Edinburgh-Glasgow Area Modal Split Study data on inter-city trips (see Watson (1973)). Additionally, values of travel time are derived and analyzed in terms of the objectives of this paper. The data collected in this study which represent all journey purposes were originally used to build disaggregate models of mode choice for medium-range, intercity journeys in the Forth-Clyde corridor of the Central Lowlands of Scotland. The data were collected in order to yield sub-samples of adequate size after stratifications by journey purpose and income. The sample sizes are shown in Table 1.

All models are estimated by logit analysis and have the following form:

$$\text{Probability of Choosing the Train} = \frac{e^{(\alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \ldots \alpha_n X_n)}}{1 + e^{(\alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \ldots \alpha_n X_n)}}$$

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SAMPLE SIZES

	Income Group	To Work	Journey Purpose: Business	Social/Recreational	Total
(1-2)	less than £1250	88	143	495	726
(3-4)	£1251-£1750	81	192	259	532
(5-6)	£1751-£2250	82	173	162	417
(7-8)	greater than £2250	109	370	286	765
TOTAL		360	878	1202	2440

£ = sign for English Pound Sterling

TABLE 1

Where the X's are variables hypothesized to influence the choice between train and car, such as time by train, difference in time, cost, convenience. All variables are reported for the sake of convenience using their computer code-names; a glossary of these names is presented in Table 2.

3.1.: Stratification Tests

The stratification tests proceed by first estimating the best model for the income group in each journey purpose. Each income group is then analyzed separately to find the best model for that group. This process involves step-wise regression analysis, followed by the estimation of many models by logit analysis until the "best" model was found. Since the models may be judged on multiple criteria, the decision as to which model is best for any group is clearly a matter of judgment. Similarly, the interpretation of the results reflects the use of more art than science.

The results are presented in Table 3. They are shown separately for each income group and journey purpose so that interactions between these stratifications may be examined. In general, intuition would lead us to expect that costs would be more important to the lower income groups, while time and convenience (journey units and walk/wait time) would be more important to the higher income groups. These income effects may, however, be overridden or modified by the influence of the journey purpose.

Among the journey-to-work travellers, the effect of income appears to be limited to the time variable: while the journey time by car is marginally significant for the lowest income group, it does not enter again until the highest income group is analyzed. On the other hand, costs and time spent walking and waiting are important for all income groups. This would indicate that the stronger influence on the intercity commuter's choice process is the nature of the journey to work: costs are important as they must be met daily, and walks and waits should be eliminated, possibly because they are the most variable elements of travel time, which may lead to the commuter being late for work. Income effects for this group appear to be small.

Business travellers, on the other hand, are concerned at all income levels with cost. All income groups are also concerned with convenience, but only in the higher income groups do we find time to be important. This is a strong income effect which is consistent with our intuition. Although the walking-and-waiting-time variable does not appear for the two higher income groups, this may be a perverse confirmation of our intuition, in the sense that these groups have eliminated walks and waits, thus indicating that they are very important to them. This shows up as very low walking and waiting times, which then appear to be statistically insignificant.

This hypothesis may also be true for the social-recreational traveller, since the same phenomenon is observed. In

GLOSSARY OF VARIABLE CODE—NAMES

TIMDIF	= Difference in total journey time
COSDIF	= Difference in total journey cost
JU DIF	= Difference in journey units*
TJT TR	= Total journey time by train
TJC TR	= Total journey cost by train
TJT CA	= Total journey time in automobile
TJC CA	= Total journey cost in automobile
WW TIM	= Difference in walking/waiting time
SUBTIM	= Station access/egress time
SUBCOS	= Station access/egress cost
LHTIMD	= Difference in line-haul time
LTCOSD	= Difference in line-haul cost
TD REL	= Time difference relative to total journey time
CD REL	= Cost difference relative to total journey cost
WW REL	= WW TIM relative to total journey time
JU TRA	= Number of journey units by train

*A "journey unit" is defined as a single trip segment, i.e. walk to bus is one unit; bus ride, wait at station, train ride are each one additional journey unit. This variable is used as a partial proxy for convenience.

TABLE 2

"BEST" MODELS FOR EACH INCOME GROUP

Total	1-2	3-4	5-6	7-8
3.1: Journey to Work				
JU DIF**				
WW REL**	WW TIM**	WW REL**	WW REL**	WW REL**
TD REL**	TJT CA*			TD REL**
CD REL**	CD REL^{I}	CD REL**	TJC TR**	CD REL*
LR = 124.79	25.98	17.19	59.81	29.17
3.2: Business Travel				
JU TRA**	JU DIF*	JU TRA**		JU TRA**
TD REL**			TD REL**	TD REL**
CD REL**	CD REL*	CD REL**	CD REL**	CD REL**
WW REL**	WW TIM*	WW REL**		
LR = 221.48	23.99	68.74	51.07	71.58
3.3: Social/Recreational Travel				
JR TRA**	JU TRA**	JU TRA^{I}	JU TRA*	JU TRA**
SUB COS**	SUB COS**	SUB COS**	SUB COS^{I}	SUB COS*
WW REL**	WW REL**	WW REL**	WW REL*	
TD REL*				TD REL**
CD REL*				
LR = 189.04	76.33	40.82	25.91	73.8

KEY — * = significant at 0.05 level
** = significant at 0.01 level
I = insignificant
LR = likelihood ratio

TABLE 3

this group, the journey unit proxy variable for convenience is important to all income groups. The cost of access to the railway station falls in importance as the income group rises, and the time variable is only important for the highest income group. The cost variable is not important for any group; this leads us to suspect that the second-best model may be more appropriate. This mode substitutes TJT CA for TD REL and CD REL. Thus, our intuition regarding the role of income is confirmed by the social/recreational travellers.

While the conclusions that may be drawn from this analysis are not very strong, there is some indication of systematic income effects; however, the strength of these effects appears to be influenced by the purpose of the journey.

3.2.: Dummy Variables for Income

In order to test the appropriateness of using dummy variables to represent the effect of income in mode choice models, three dummy variables were created. Models were then estimated which contained the set of variables from the "best" model described above plus the three dummy variables. The coefficients on the dummy variables should be interpreted as an increase or decrease in the probability of choosing the train relative to the probability for the combined lowest (1-2) income group. Intuition would lead us to believe that the higher the income group, the less likely the traveller is to take public transport. Thus, we would expect the coefficients to have negative signs and to increase in size. The results of the estimations are presented in Table 4.

For the journey-to-work group and the business group, the coefficients on the dummy variables have unexpected signs and are statistically insignificant. For the social/recreational group, however, the coefficients are statistically significant, have the correct signs, and are close to the expected relative magnitudes. These results confirm the stratification results in indicating that income effects are manifested most strongly in the social/recreational group; in the other groups, the effects of journey purpose are strong enough to outweigh the income effects.

3.3. Income in Interaction with Service Variables

Variables composed of income and service characteristics are used to measure the effect of income on the decision process, when the data will not bear stratification. The measurement of these interactions constitutes a middle road between dummy variable formulations and stratification. The tests reported here use the "best" model for each journey purpose and, in turn multiply each variable by income.

For the journey-to-work and business groups, no improvement can be obtained from this procedure. For the journey to work, the best interaction model is shown in Table 5.

ESTIMATIONS INCLUDING DUMMY VARIABLES

	Variable Name	Coefficient	T-value	Significance
JTW	JU DIF	— .204	—3.469	.01
	TD REL	—1.402	—3.490	.01
	CD REL	— .725	—3.189	.01
	WW REL	—6.335	—5.486	.01
	Dummy 1	— .007	— .187	I
	Dummy 2	.008	.194	I
	Dummy 3	— .595	—1.506	I
	CONST.	3.731	7.263	.01
	Likelihood Ratio Test = 128.397			
BUS	JU TRA	— .264	—6.374	.01
	TD REL	—1.464	—4.988	.01
	CD REL	— .804	—6.507	.01
	WW REL	—1.688	—3.333	.01
	Dummy 1	— .289	—1.147	I
	Dummy 2	— .337	—1.299	I
	Dummy 3	.004	.203	I
	CONST.	2.801	7.016	.01
	Likelihood Ratio Test = 226.358			
SOCREC	JU TR	— .207	—5.875	.01
	SUB COS	— .832	—4.549	.01
	TD REL	— .477	—2.068	.05
	CD REL	— .357	—3.069	.01
	WW REL	—3.149	—6.537	.01
	Dummy 1	— .634	—3.663	.01
	Dummy 2	— .999	—4.514	.01
	Dummy 3	— .823	—4.719	.01
	CONST.	2.885	8.783	.01
	Likelihood Ratio Test = 234.931			

TABLE 4

For the business group, the best interaction model is shown in Table 6. The former is no better and the latter is worse than the best model from Table 3. For both groups, the interaction of income with the walk/wait and journey unit variables reduces the level of significance for those variables.

For the social/recreational group, the best interaction model is shown in Table 7. This indicates that level of income interacts strongly with the TD REL variable, more than doubling its t-value and increasing the Likelihood Ratio by 16%. This result confirms the finding that income effects are significant for the social/recreational group. In addition, it identifies the specific interaction which is important, notably that between income and the journey time variable.

3.4.: The Value of Time

The value of time indicates the rate at which travellers are willing to trade time for money. It is frequently argued that travellers from higher income groups will pay more to save time—i.e., they have a higher value of time. In this study, the derivation of values of time is difficult, as the "best" models do not always contain the necessary time and cost variables. Nevertheless, suitable models have been created by adding TD REL and/or CD REL to each model as necessary. The coefficients estimated for these augmented models were then used to derive values of time. These values, expressed as a percentage of the wage rate, are presented in Table 8.

Given the sub-optimal nature of the models used to derive these values of time, it is not surprising that no expected patterns emerge. The values for the journey-to-work group and the business group have no rational interpretation; the only consolation lies in the fact that, for the social/recreational

JOURNEY-TO-WORK MODEL WITH INTERACTIVE INCOME

Variable Name	Coefficient	T-value	Significance
JU DIF	— .204	—3.51	.01
CD REL	— .796	—3.62	.01
WW REL	—6.44	—5.60	.01
YTD REL[1]	— .611	—3.29	.01
CONST.	3.45	7.86	.01
Likelihood Ratio Test = 125.920			

TABLE 5

BUSINESS MODEL WITH INTERACTIVE INCOME

Variable Name	Coefficient	T-value	Significance
JU TR	— .275	—6.69	.01
TD REL	—1.50	—5.19	.01
YCD REL[1]	— .326	—6.25	.01
WW REL	—1.67	—3.36	.01
CONST.	2.81	8.20	.01
Likelihood Ratio Test = 217.679			

1 YTDREL and YCDREL indicate that the variable TDREL, or CDREL, respectively, is multiplied by average income.

TABLE 6

SOCIAL-RECREATIONAL MODEL WITH INTERACTIVE INCOME

Variable Name	Coefficient	T-value	Significance
JU TR	— .175	—5.10	.01
SUB COS	— .893	—4.65	.01
YTD REL	— .710	—5.68	.01
CD REL	— .326	—2.83	.01
WW REL	—2.73	—5.95	.01
CONST.	2.28	7.43	.01
Likelihood Ratio Test = 228.997			

TABLE 7

VALUES OF TIME

Income	Journey Purpose		
	Journey to Work	Business	Social/Recreational
1-2	115%	37%	38%
3-4	149%	93%	26%
5-6	105%	197%	116%
7-8	89%	118%	116%

TABLE 8

group the two higher income groups have a higher value of time than the two lower income groups. These results, especially the journey-to-work values, which are much higher than expected, tell us less about the effect of income on the value of time than they tell us about the problems of estimating values of time from mis-specified models.

3.5.: Summary

In general, the results derived in this section cannot be said to be very strong; nevertheless, some patterns have emerged. Notably, the effect of income on mode choice models for intercity travel choices appears consistently stronger for social/recreational travellers. For commuters and business travellers, other factors, such as the necessity to meet an arrival deadline, appear to outweigh the effects of income. For the social/recreational group, the time variable appears to be the factor which grows in importance as income grows.

4. COMPLEMENTARY RESULTS FROM OTHER STUDIES

In this section, supporting results from intraurban studies are reported and analyzed. While the previous section reported on new findings, this section is concerned with synthesizing results from other studies which further illustrate the role of income in travel choices. In both cases, income is assumed to change a traveler's evaluation of the transportation system characteristics, and is used in the models through substratification.

4.1.: London

The first study is based upon data for commuting trips to a single, centrally located office complex in London. The data collected in 1967, are described in more detail in Stopher (1969). Five income groups were used for substratification, with sample sizes and income group ranges shown in Table 9. An initial model was run, using regression analysis for the entire sample. From this, it was determined that cost differences and time differences were the most appropriate variables to use. Based on this finding, models were then built for each income stratum, using cost and time differences alone. The results are shown in Table 9. All coefficients have the correct

STRATIFICATION MODELS FOR THE LONDON DATA

Income Group	Coefficients: Cost Diff.	Time Diff.	Constant	R^2	Sample Size
(1) Less than £1,000	.00998	.00449	.357	.77	415
(2) £1,000-£1,499	.00801	.00521	.336	.80	514
(3) £1,500-£1,999	.00698	.00558	.308	.77	321
(4) £2,000-£2,999	.00550	.00605	.300	.66	214
(5) £3,000 and over	.00376	.00075	.218	.49	73

TABLE 9

sign and are significantly different from zero at 95%, (except for the time difference for income group 5), and F-statistics for the models are significant at better than 0.1%.

Examination of the results reveals that the cost coefficient declines in value as income increases. At the same time, the time difference coefficient increases for the first four income groups and then plummets in value for the highest income group, becoming statistically insignificant. Calculating the implied values of time also reveals an increasing absolute value of time for the first four income groups, but a major drop for the highest group. Thus, our intuition of the effect of income is borne out until the highest income group is reached, at which point travel time is no longer significant. The data do not contain measures relating to convenience and comfort, so that further investigation in this direction is precluded.

It is also of interest to note that the declining value of the constant indicates an increasing bias away from the use of the car. This may be explained in part by the extreme peak-hour road congestion in London, and in part by the fact that people in the higher income categories were observed to reside at greater distance from work and to use high-speed rail services to commute.

It is pertinent to note that all attempts to build a model with dummy variables for income failed. The dummy variables always lead to non-significant coefficients, frequently with wrong signs. Regardless of the ways in which income groups were combined, these results did not improve.

4.2.: Suburban Chicago

The data used for the second study of this section were collected in 1968 by the Chicago Area Transportation Study staff as part of the Northwest Chicago Modal Split Project. The data are described in Stopher and Lavender (1972). In this data set, four income groups were utilized, with sample sizes ranging from 96 to 264. Again, best-fit models were not sought in each income group; rather all models were built using cost and time differences only. The models were built using logit analysis (see Reichman and Stopher, 1971); results are shown in Table 10.

As for the London data, all models and all coefficeints are significant at the 95% confidence level, and the coefficient signs are correct. There is however, less appearance of a clear pattern in the values of the coefficients across the strata. It is notable that the time difference coefficient is again much less significant for the highest income group than for any other group. Computing the implied values of travel time is more revealing of patterns in the income effect, as shown in Table 11. In this case, the value of time is lowest for the lowest income group and appears to be stable at twice the value for the next two income groups. However, in the last income group, the value declines to a point close to the value for the lowest income group. (The decline of the value of time between income groups 2 and 3 is too small to be considered of any significance). Again, these values are in agreement with our intuition, except for the highest income group; and again, no data are available on other transportation services, such as convenience or comfort, which might throw light upon the results for the highest income group.

The Chicago data were also analyzed with dummy variables for income; the

STRATIFICATION MODELS FOR THE CHICAGO DATA

Income Group	Coefficients: Cost Diff.	Time Diff.	Constant	Sample Size	Likelihood Ratio
Less than $12,000	—.0381**	—.00093**	—2.152*	178	115.0
$12,000-$16,999	—.0179**	—.00087**	— .810	264	76.5
$17,000-$24,999	—.0271**	—.00130**	—1.702*	189	98.5
$25,000 and over	—.0338**	—.00089*	—2.969*	96	50.8

* = Significant at .05 level
** = Significant at .01 level

TABLE 10

VALUES OF TRAVEL TIME FROM THE CHICAGO MODELS

Income Group	Value of Time ($/Hour)
1	$0.88
2	$1.76
3	$1.73
4	$0.95

TABLE 11

results are shown in Table 12. The first dummy variable takes the value of unity for income group 2, the second for income group 3, and the third for income group 4. There is little indication of any trend in these values, although it is interesting to note that the significance of the coefficient for the highest income group dummy is greater than for the other two. The difference in value between the first and second dummy variable coefficients is not significant, suggesting that these two could be combined. Since the model is constructed as a probability of choosing commuter rail as a function of differences between rail and auto times and costs, the negative dummy coefficients and constant imply a bias against use of rail. The larger value and significance of the dummy coefficient for the highest income group implies a much greater weight of attributes other than times and costs in the decision of these commuters. This is consistent with the results of the stratification analysis.

4.3: Summary

In both cases of intraurban commuting trips, an identical pattern of income effects is seen—a significant decrease in importance of travel time and a concomitant decrease in implied value of travel time for the highest income group. This pattern is even more significant when it is noted that the two study locations are in different countries. In both cases, computing value of time as a proportion of the wage rate indicates a decreasing proportionate value of time with increasing income, as shown in Table 13. These results are also comparable to results obtained in Australia by Hensher (1971), who found that within sample size limitations, value of travel time decreased as a proportion of income. Hensher also found significant drop in the value of travel time for the highest income group for CBD-oriented commuter trips.

CHICAGO MODEL WITH INCOME DUMMY VARIABLES

Variables	Coefficient
Time diff.	—.000999**
Cost diff.	—.0249**
Dummy 1	—.696*
Dummy 2	—.668*
Dummy 3	—1.024**
Constant	—.884*
Likelihood Ratio	330.0

* = Significant at .05 level
** = Significant at .01 level

TABLE 12

VALUE OF TRAVEL TIME AS A PROPORTION OF WAGE RATE

Sample	Income Group	Value of Travel Time
London	1	0.32
	2	0.26
	3	0.23
	4	0.21
	5	0.03
Chicago	1	0.25
	2	0.24
	3	0.16
	4	0.05

TABLE 13

5. CONCLUSIONS AND IMPLICATIONS FOR TRANSPORT MARKETING

While the results of the tests reported above indicate that the effect of income on the mode choice process is extremely complex, certain relatively stable patterns emerge. In general, we conclude that the purpose and length of the journey and the transport system interact with the level of income. This is indicated by the bias against the automobile in the London study as compared with the opposite bias for the other data considered. Given this situation the conclusions are divided into two parts.

5.1.: Conclusion for Inter-City Trips

For inter-city trips, we conclude that the constraints involved in the work journey and in business travel outweigh the effects of income in the mode choice process: meeting a deadline has a stronger influence than income on the relative importance of variables. Only in the case of social/recreational travellers, for whom most constraints are relaxed, does income play an important role. For this category of travellers, the effect of income is consistent. The dummy variable tests indicate a propensity to use the automobile which grows with income. The other tests indicate that income influences most heavily the evaluation of the time variable.

The usefulness of the values of time is severely limited because the coefficients come from sub-optimal models. The model for the social/recreational group alone contains appropriate variables, and in this case we can conclude that the value of time for the two higher income groups is considerably higher

than that for the two lower income groups.

5.2.: Conclusions for Intra-urban Trips

The results for intra-urban trips are somewhat easier to interpret. In general, they indicate that importance of travel time increases with income, while importance of cost decreases. This conclusion is weakened by some disconcerting peculiarities in the behavior of the highest income group, wherein the importance of travel time decreases drastically. This may be explained by a concommitant increase in the importance of variables such as comfort and convenience; it may also be the result of successful attempts to minimize time. Further research is required before a satisfactory explanation may be advanced.

These conclusions are supported by the value of time results. Again, with the exception of the highest income group, these values increase as income increases, although at a less rapid rate yielding a decreasing proportionate value of time.

In general, these relationships are exhibited by all the data sets considered. Further research, is required, however, particularly to investigate the behaviour of the highest income group.

5.3.: Implications for Marketing

The major conclusion from the work reported above is that rules of thumb, such as "the value of time increases with income," should be regarded extremely cautiously. Such a rule may lead to reductions in travel time and increases in cost which might be quite unjustified. The purpose of the journey, its length, and the availability of transport services will all interact with income to modify the mode choice process. Thus, marketing strategies must be developed with these considerations in mind. For example, the above results would indicate that for intercity work trips the best marketing strategy might be to meet deadlines and increase reliability by reducing time variations; for social/recreational travellers, it would be more appropriate to reduce time for high income.

While these conclusions do not point to explicit marketing strategies, they confirm that such strategies must be developed in the context of specific trips and travellers. There are no universal prescriptions. The results further point out the need for additional research on the effect of income and its interactions both with journey and system characteristics and with the mode choice process. Only against a background of such research can meaningful research strategies be developed.

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