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User's Guide to RMTCM: Software for Travel Cost Analysis

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and
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Abstract

RMTCM is an interactive menu-driven program for performing travel cost analysis. The program consists of four main modules: (1) data input; (2) data modification; (3) regression analysis; and (4) report writing. The report graphs the "second-stage" demand curve and estimates consumer surplus. The program is written in FORTRAN-V and a version is available for use on an IBM personal computer or compatible machine.

NOTE

The computer program described in this publication is available on request with the understanding that the U.S. Department of Agriculture cannot assure its accuracy, completeness, reliability, or suitability for any purpose other than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone other than a Government-produced computer program.

In general, there is no cost for this computer program. However, the requestor must provide a formatted standard double-sided, double-density "floppy" diskette, suitable for use in IBM personal computers (PC's) or compatibles; in addition, the requestor must arrange for shipping both ways, for example, enclosing with the request, a self-addressed, postage-paid mailer with suitable protection for the diskette. For further information write Valuation of Wildland Resource Benefits Research Work Unit, Rocky Mountain Forest and Range Experiment Station, USDA Forest Service, 240 West Prospect Street, Fort Collins, CO 80526.

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User's Guide to RMTCM: Software for Travel Cost Analysis

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INTRODUCTION

RMTCM (Rocky Mountain Station Travel Cost Model) is an interactive computer program to help build travel cost models. Travel cost models are used to estimate the dollar value of recreation sites. Building travel cost models involves several steps that are usually performed independently. The RMTCM program allows the user to perform the various steps in one integrated computer program.

This user's manual is designed to provide suggestions related to building a travel cost model (TCM). It does not give a conceptual overview of what the travel cost model is or when and what situations it should be applied to. Readers interested in a conceptual overview are referred to Dwyer et al. (1977), Rosenthal et al. (1984), or the U.S. Water Resources Council (1979).

RMTCM is designed for estimating single-site zonal travel cost models. However, it can also be used for individual observation based travel cost models. The way to do this is explained at the end of this publication. RMTCM cannot be used to estimate multiple-site or regional travel cost models. The body of this publication assumes the program is being used to estimate a single-site zonal TCM.

Efficient use of RMTCM requires a background in multiple regression analysis, an understanding of basic concepts in microeconomic theory, and some familiarity with travel cost analysis. Without this knowledge, parts of this publication may be difficult to understand, and the possibility of misapplication of the program increases markedly. Errors in one part of the program are likely to invalidate all of the results.

Although the TCM is an extremely useful tool for estimating the net economic benefit of a recreation site, as with any model, when the assumptions of the model are violated, the estimates of economic benefits can be wrong. The key assumptions are discussed in Dwyer et al. (1977) and Rosenthal et al. (1984). Users of the program are urged to make sure their models meet these assumptions.

The RMTCM program is currently resident on a Univac 1100/84 Computer at the U.S. Department of Agriculture Computer Center in Fort Collins, Colo., (FCCC). There is also a personal computer version of RMTCM that runs on an IBM[3] personal computer or compatible machine. The FCCC version and the personal computer versions of RMTCM are identical, except for the operating systems of the host computers.

[3] *The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U. S. Department of Agriculture to the exclusion of others that may be suitable.*

Persons desiring a copy of the personal computer version of RMTCM may write to the authors requesting a copy and enclosing a blank formatted floppy diskette. The RMTCM program is written and compiled in ANSI standard FORTRAN-V. The personal computer version diskette contains three files: (1) a "READ.ME" file containing general information; (2) a "RMTCM.EXE" file containing the executable RMTCM file; and (3) a "TABLE1" file containing a test data set.

Before using the program, the reader is advised to review the entire user's manual. In particular, the sections on data collection and preparation should be thoroughly understood before using RMTCM.

ACCESSING RMTCM

USING RMTCM AT THE FORT COLLINS COMPUTER CENTER (FCCC)

The first step in using RMTCM is to log on to the FCCC computer. If the reader does not know how to log onto the FCCC computer, then speak to a computer specialist or call the FCCC (303–224–1510). It is recommended that <CTRL>H (i.e., depress and hold the control key and then press H) be designated as a destructive backspace during the log-on procedure. Also recommended is that the user specify a project identification abbreviation (proj. id.) other than "RM" on the @RUN statement to avoid possible file conflicts among multiple users. An example is @RUN RUNID, ACCT.NO., MY-PROJ-ID

Once the user is logged onto FCCC one of two states will exist. Either the RMTCM program is on disk file and ready for use, or it must "rolled in" from tape before it can be used. To see if it is on disk, enter the command: @ADD RM*TCM.RUN <CR> from your terminal. If the terminal responds

ENTER OPTION (0 FOR HELP) then the RMTCM program has been loaded and is ready for use. If the terminal responds that it is unable to find the file, then it must be mounted from tape before it can be used. To mount the tape enter the following commands:

```
@ASG,T RM*TCM-TAPE.,U9S,F32498       <CR>
@ASG,UP RM*TCM.                      <CR>
@COPY,G RM*TCM-TAPE.,RM*TCM.         <CR>
@FREE RM*TCM-TAPE.                   <CR>
@FREE RM*TCM.                        <CR>
@SAVE RM*TCM.,yymmdd                 <CR>
TRAVEL COST MODEL                    <CR>
@ADD RM*TCM.RUN                      <CR>
```

The "yymmdd" command on the sixth line refers to the year, month, and day when the RMTCM file will be purged from an account. For example, typing 860331 will result in the file being saved on an account number until March 31, 1986. After entering this sequence of commands, the terminal should respond with:

ENTER OPTION (0 FOR HELP)?

As the RMTCM program is executing, output will be generated at the terminal. Simultaneously, all the output appearing on the terminal will be echoed to a disk file. When the user exits RMTCM, a permanent file will be saved automatically at the FCCC on the account that accessed RMTCM. The contents of that permanent file are exactly what appeared at the terminal during the RMTCM session. Users working with a CRT screen can get a printed copy of the RMTCM session by routing the permanent file to the printer.

The name of the file that is automatically created when running RMTCM is "MY-PROJ-ID*TCM-LOG.". Unless specified otherwise, that file will be saved for 6 days. If during that six-day period RMTCM is run again, the old copy of the "MY-PROJ-ID*TCM-LOG." file will be replaced by an updated version. That updated version will be saved only until the 6-day period for the original "MY-PROJ-ID*TCM-LOG." file expires. To change the expiration date, enter:

@SAVE MY-PROJ-ID*TCM-LOG.,yymmdd

from the terminal after exiting RMTCM but before logging off the Univac.

Ordinarily, it will not be necessary to save "MY-PROJ-ID*TCM-LOG." for very long. If the terminal was printing while RMTCM was running the file is already printed. To print the file, enter one of the following two sets of commands after exiting RMTCM.

1) To send to a batch site:
   @FREE TCM-LOG
   @SYM,U MY-PROJ-ID*TCM-LOG.,,xxxxxx <CR>
   (where xxxxxx = batch site id).
2) To send to a demand terminal for printing after the @FIN statement:
   @SYM,U MY-PROJ-ID*TCM-LOG.,, yyyyy/U <CR>
   (where yyyyy = user id)
   @FIN <CR>
   @@SEND,U <CR>.

USING RMTCM ON A PERSONAL COMPUTER

The best way to use RMTCM depends on whether the personal computer has a hard disk or floppy disk(s). With a hard disk system, copy the "RMTCM.EXE" file from the floppy to the hard disk. Then make the hard drive and the directory where the "RMTCM.EXE" file is located the default drive and directory. At this point start the program by typing "RMTCM" followed by a carriage return.

With a two-floppy disk system, make drive B the default drive and place the diskette containing "RMTCM.EXE" in drive A. Place a formatted diskette in drive B and then start the program by typing "A:RMTCM" followed by a carriage return. On a one-floppy system, insert the diskette and start the program by typing "RMTCM." To run RMTCM with the test data set, copy the file "TABLE1" to the default drive.

When RMTCM is running, it will read files from and write files to the default drive and default directory. With a one-floppy system the data and program must be on the same diskette. If the user wants to read a data file from other than the default drive and directory, then a valid drive and path specification must be given. The same follows for writing files. For example, to read a data file named "RMTCM.DAT" from the "INPUT" directory of the A drive the user should type "A:\INPUT\RMTCM.DAT" when asked for the name of the input data file.

As RMTCM is executing the regression portion of the program, it temporarily writes the user's data file to a disk drive and then re-reads it once the regression is complete. This is done to conserve memory. The temporary file is written to the default drive and default directory. There is no way to alter this. User's should make sure there is enough storage space on the default drive and directory to accommodate this temporary file.

RMTCM can read only ASCII files with numeric data. If such a file is printed it will look "normal" and contain only numbers, decimal points, negative signs, positive signs, and blanks (or commas). RMTCM will not read .DIF files or .WKS files.

The simplest way to create an ASCII file is to use a wordprocessing program in non-document (ASCII) mode or a full-screen editor. Alternatively, ASCII files can be formed using the EDLIN feature of PC-DOS or MS-DOS. Some spreadsheet programs, such as Lotus 1–2–3[3], will write ASCII files if the user routes a print file to an output file. On Lotus 1–2–3 , be sure to specify "unformatted" output to avoid page breaks in the data set. An advantage of using a spreadsheet program is that the user can do all the data transformations inside the spreadsheet. Very complex data transformations can be done with a spreadsheet program. The transformed data then can be written as an ASCII file and subsequently used as input for RMTCM.

USING THE RMTCM PROGRAM

DATA COLLECTION

It is useful to distinguish between the different types of data that are needed for travel cost analysis. For RMTCM, data can be classified as either primary or secondary, and also as essential or nonessential. The four types of data that are used in RMTCM and the specific variables associated with each type are as follows.

Data Usable by RMTCM

Type 1: Primary, Essential
- where visitors to the site came from

Type 2: Secondary, Essential
- price of a trip
  - distance
  - cost per mile
  - persons per vehicle
  - average travel speed
  - per-capita income to figure opportunity cost of time
  - entry fee

. trips per-capita
.. trips from each origin
.. sampling rate[4]
.. population of origin

Type 3: Primary, Non-essential
. length of stay
. single versus multiple destination trips

Type 4: Secondary, Non-essential
. substitute recreation areas
.. imperfect substitutes
.. perfect substitutes
. demographic characteristics of origins.

Type 1 Data: Primary, Essential

Primary data refers to data that must be collected about persons using the recreation site being modeled. Essential data refers to data needed to make estimating a travel cost model mathematically possible. In the RMTCM program, there is only one primary and essential piece of data: the city and/or county where the recreationists who visited the site began their trip. One of the main reasons for the widespread use of the TCM is that it can be run with a minimal amount of information.

A good way to estimate where a group began its trip is to determine the zip code of its home. A better way is to directly ask for the city and county of residence. The latter method is preferable, because zip codes must be converted to cities and counties during the data preparation steps. Also, zip code boundaries do not always correspond with city and county boundaries. Information on home zip codes often is contained in visitor registration forms.

Type 2 Data: Secondary, Essential

In the zonal TCM the per-capita visitation rate of zones of origins is regressed on, as a minimum, the price of a trip to the recreation site. To use RMTCM, type 1 data must be combined with secondary information in order to calculate the value of the independent (price) and dependent (visits per-capita) variables for each zone of origin.

To calculate trips per-capita, it is necessary to form a number of zones of origin around the recreation site. Zones of origin can be defined as concentric rings around the recreation site (Clawson and Knetsch 1966, Sutherland 1982) or individual units of population located around the site. The least amount of aggregation is desirable. In practice, zones of origin are most easily defined as counties or aggregations of counties. Using individual counties is preferable to concentric rings because two counties located the same distance from the study site, for a variety of reasons, might have different visitation rates. If concentric rings were used, the two counties would be averaged into one large origin, and information would be lost. Forming origins is discussed in more detail later.

[4] *Essential to estimate total consumer surplus, but not essential to estimate consumer surplus per trip.*

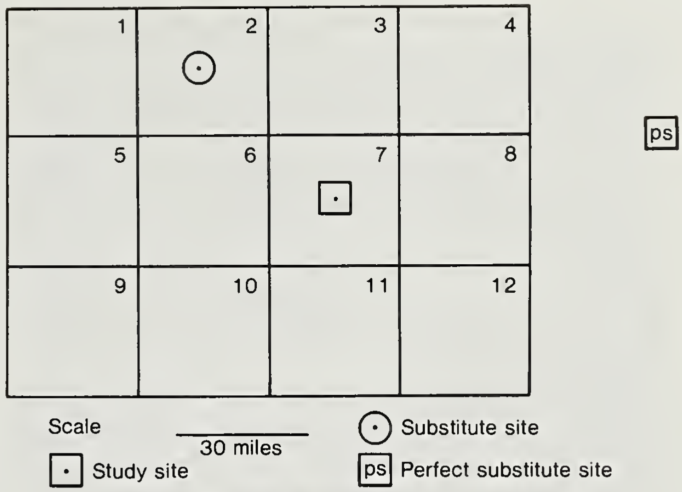

Figure 1.—Location of origins and study sites.

Figure 1 shows a hypothetical study site and 12 zones of origin around the site. Once the origins are defined, the type 1 information about where visitors came from can be used to determine the number of trips originating in each zone. The number of trips from each zone divided by the population of each zone (available from census data) is trips per capita.

Usually only a fraction of the trips to a recreation site are sampled. Therefore, the number of trips sampled from each zone must be multiplied by the inverse of the sampling rate to estimate the total number of trips from a zone of origin. If the sampling rate is not known, RMTCM can still be run using only the sampled trips. In this case, the consumer surplus per trip figure for the site will be valid, but the total consumer surplus for the site will be unknown. Consumer surplus is defined as the amount recreationists are willing to pay, in excess of existing costs, for the right to visit the study recreation site.

The per-person price of a round-trip from an origin i(i = 1,n) to the recreation site is defined as

$$P_i = \frac{(d_i)(a)(b)}{e} + \frac{(d_i)(a)(t)}{c} + \frac{f}{e} \qquad [1]$$

where: P_i = per-person dollar cost of a round-trip from the origin to the recreation site;
d_i = distance from the ith origin to the recreation site;
a = 1 if d is the round-trip distance, or 2 if d is the one-way distance;
b = variable operating cost, in dollars per mile, for a vehicle (usually in the range of $0.1 to $0.25);
e = average number of persons per vehicle;
t = hourly opportunity cost of travel time (recommend using 25–50% of the average hourly wage rate);
c = average travel speed in miles per hour; and
f = per vehicle entry fee at the site.

The first term on the right side of eq. [1] represents the out-of-pocket costs of driving a car from an origin to the recreation site and returning. This out-of-pocket cost is the number of miles traveled multiplied by the variable cost per mile of operating a vehicle. Fixed costs, such as insurance payments or interest charges, are not considered. Information on the cost of operating an automobile can be obtained from the U.S. Department of Transportation (1984). The total vehicle operating dollar cost is then divided by the average number of persons per vehicle. The cost should be expressed on a per person basis in order to be consistent with the trips per capita measure used for the dependent variable. In 1984, the average variable cost of operating a vehicle was about 12 cents per mile (i.e., b = $0.12) (U.S. Department of Transportation 1984).

Do not use the average traveling costs reported by persons contacted at the recreation site. With the zonal TCM, the traveling cost used must be the average of all persons living in an origin, not just those who visited the site. Visitors may have a different perception of cost than non-visitors.

The second term on the right side of eq. [1] represents the time cost of a trip. The reasoning behind this term is that time spent traveling also is a cost. Empirical studies of commuters indicate that people value their travel time at between 25% and 50% of their hourly wage rate (Cesario 1976). However, other research has shown that recreationists may value their travel time at the full wage rate (Smith et al. 1983). The correct figure to use for the opportunity cost of time is the subject of continuing research.

For RMTCM, the recommended opportunity cost of time is 50% of the hourly wage rate. The average hourly wage rate of a person living in an origin can be estimated by dividing average per-capita income by 2,080, the typical number of hours in a work year. Because per-capita income includes earned and unearned income, this estimate will somewhat overstate the hourly wage rate. Dividing the reciprocal of 2,080 by 2 equals 0.00024038. Therefore, multiplying the average per-capita income by 0.00024038 is equal to using 50% of the hourly wage rate (as estimated by per-capita income) as the opportunity cost of travel time. The second term on the right side of eq. [1] multiplies this hourly opportunity cost of travel time by the number of hours spent in travel.

The third term on the right side of eq. [1] represents the per-person entry fee to the site. The sum of the time cost, the out-of-pocket vehicle operating cost, and entry cost equals the per-person cost of a trip to the recreation site. To calculate price, information on d_i, a, b, t, f, c, and e is needed.

Type 3 Data: Primary, Non-essential

Two pieces of information that fall into this category: (1) the length of time on site for each trip to the recreation site; and (2) whether or not the recreation site was the only destination on the trip or one of several destinations. Time-on-site information is useful for two reasons. First, knowing this allows the analyst to express economic value on a per unit time basis (e.g., dollars per recreation visitor day). Second, the TCM assumes that the average time-on-site is the same for all origins. With time-on-site information, this assumption can be tested. If the assumption is severely violated, the data set can be segmented into separate data sets having homogeneous lengths of stay (e.g., split the data by day users versus overnight users).

In the TCM, only recreationists on single destination trips should be included in the analysis. For example, if a person left home and visited three recreation sites, one of which is the site being analyzed via travel cost analysis, then that person's trip should not be included as part of the data set. Only persons who left their residences, went to the study site and went directly back home should be included as data in the TCM.

Multiple destination recreationists are excluded from the analysis, because allocating a portion of their total trip costs to a specific recreation site is difficult. This is a shortcoming of the TCM. Excluding multiple destination recreationists from the data set is not the ideal solution, but it is the most reasonable one available at this time.

When there is no information on whether or not trips are multiple destination, then reasoned judgement must be used. Usually, most trips coming from within a certain distance radius will be single destination trips. A unique and scenic natural area might draw single destination visitors from as far away as 2,000 miles. In contrast, a local recreation area might only draw visitors from an area of 50 miles.

Type 4 Data: Secondary, Non-essential

In its most general form, the TCM models the number of trips per-capita from an origin as

$$VC_i = f(P_i, S_i, D_i) \qquad [2]$$

where: VC_i = trips per-capita from origin i;
P_i = price per-person per-trip to the recreation site from origin i;
S_i = a measure(s) of substitute recreation areas available to origin i; and
D_i = demographic characteristics of origin i.

Although the type 4 information is not required by RMTCM, gathering such information will greatly enhance the validity of the estimated model.

The number of trips per capita from an origin to a recreation site will be influenced by the number of alternative recreation sites offering similar recreation opportunities. When discussing substitute recreation sites, a distinction must be drawn between a perfect substitute recreation site and an imperfect substitute site. In RMTCM, for an alternative destination to be considered as a perfect substitute site, two conditions must be met: (1) the quality of the alternative site must equal or exceed the study site in all respects; and (2) there must be enough excess capacity at the alternative site so that the increased use that would occur at that site in the event of the closure of the study site would not deteriorate the quality enough to violate the first condition. Alternative sites that do not meet these two conditions are imperfect substitute sites. Perfect and imperfect substitute sites are handled differently by RMTCM.

It is not always clear what recreation sites to consider as substitutes. The simplicity of the hypothetical data shown in figure 1 is unlikely when using actual data. A few guidelines might be helpful. First, a substitute recreation site is an area where users of the study recreation site might go if the study site was no longer available for recreation. Second, there may be many substitutes to the study site. The effect of all of these substitute areas needs to be considered. Of primary importance are those offering similar recreation opportunities. One good way to reflect the influence of substitutes is to record the distance from each origin to each substitute recreation site (Burt and Brewer 1971, Cicchetti et al. 1975). Then, all the imperfect substitute distances should be entered as predictor variables in the estimated demand curve. Another way to handle multiple imperfect substitutes is to construct one or more indexes that reflect(s) the degree of substitution possibilities available to each origin (Knetsch et al. 1976).

In figure 1, the market area is the solid rectangle enclosing the 12 origins. Most trips to the study site are drawn from within the market area. Substitute recreation sites outside of the market area are as important to the TCM as substitute sites inside the market area. A natural question is just how far outside the market area should be considered. For example, when building a travel cost model in Colorado, do substitute recreation sites in California need to be considered? There is no clear answer to this question. As a guide, find the origin within the market area that is the greatest distance from the study site. In figure 1 this distance is 67 miles. Any substitute recreation sites that are within 67 miles of the market area boundary should be considered for inclusion in the TCM. Taking the network of substitute recreation sites into account is a very important part of building a TCM.

If one or more perfect substitute sites are identified, then the price (distance) of a trip from each origin to the closest perfect substitute site should be recorded. However, this price should not be entered into the demand equation in the same manner as imperfect substitute prices. Instead, the price of the perfect substitute site should be used to truncate the demand curve (Knetsch 1977). Quite simply, the price of a perfect substitute site places an upper bound on the willingness of a person to pay for the right to enter the study site. RMTCM has an option for truncating the demand curve. If the user is not sure if a site is a perfect substitute or imperfect substitute, the analysis can be easily run both ways in RMTCM.

The characteristics of an origin also may influence its per-capita visitation rate. Variables to consider including in the the demand curve are per-capita income, average age, average education, and anything else that might be related to visitation rates. Per-capita income is particularly important to consider, because economic theory indicates income is an argument in a demand function.

DATA PREPARATION

The data preparation step is most easily explained with an example. Consider the layout of origin and recreation sites shown in figure 1. The recreation site for which a TCM will be developed here, is in origin number 7. An imperfect substitute recreation site is shown in origin number 2. A perfect substitute site is shown on the far right side of figure 1. For the moment, the perfect substitute site will be ignored.

The main function of the data preparation step is to organize the information so that it can be used by RMTCM. Table 1 shows a simple way to organize the data needed by RMTCM. For each origin, the analyst will have gathered information on the population, per-capita income, the distance from each origin center to the study site, distance to the substitute site(s), and the number of trips from each origin to the study site. Table 1 shows it is 67 miles from origin 1 to the study site, 30 miles to the substitute site, and 136 miles to the perfect substitute site. Figure 1 distances were measured using a ruler. Actual distances should represent the driving distance between the origin center and the destinations. The origin center can be defined as either the point of a large centrally located city in the origin, or by using published information concerning the latitude and longitude of the population weighted center of each county in the United States (U.S. Bureau of Census 1974).

Table 1 lists the number of trips coming from each origin to the study site. Origin 1 delivered 224 trips to the study site in origin 7. A car with two persons visiting the site represents two trips. Customarily it is assumed that the number of persons per vehicle is constant across origins. The trips shown in table 1 have been expanded by a sampling fraction. If 10% of the trips to the study site were sampled, then only 22.4 trips from origin 1 to the study site would actually have been recorded.

DATA INPUT

When the data are entered into RMTCM, the program will prompt the user with a series of questions (fig. 2). The data collection and data preparation steps are the hardest part of building a travel cost model. The data input process consists of entering the information from table 1 into the RMTCM program. This is the time to begin the RMTCM program. The Appendix displays an RMTCM run in which an external ASCII file is used for data input.

The first prompt from the RMTCM program will be a short introductory statement succeeded by this message:

```
ENTER OPTION (0 FOR HELP)
?
```

If a "0" is entered (do not type the quotation marks), the following will be listed.

```
1) INPUT DATA
2) DISTANCE TO COST CONVERSION
3) MODIFY DATA
```

4) RUN REGRESSIONS AND REPORTS
5) EXIT RMTCM PROGRAM
ENTER OPTION (0 FOR HELP)
?

RMTCM is a menu-driven program. At each step, it prompts the user for the appropriate response. The five options above are the main menu. Throughout the RMTCM program, the main menu will be relisted. Users are free to jump between steps 2, 3 and 4 in any order. The normal progression through RMTCM is 1, 2, 3, 4, and 5, in order.

When entering data, enter a 1 in response to the main menu. The following prompt

1) INPUT DATA INTERACTIVELY FROM KEYBOARD
2) READ AN EXTERNAL ASCII DATA FILE
3) READ A PREVIOUSLY CREATED RMTCM SYSTEM FILE
4) RETURN TO MAIN MENU
CHOOSE FORM OF DATA ENTRY (1, 2, 3, or 4)
?

will be displayed. There are three options for loading data into RMTCM. Do not read data into the program twice during one RMTCM session. If the user is familiar with how to set up ASCII data files on the computer, that is the easiest option. If the data are input interactively

Table 1.—Data ready for input into RMTCM.

				Distance To			
Origin Number	Population[1]	Visits[1,2]	PCI[3]	Study[1] Site	Substitute Site	Perfect Substitute	Other Variables
1	30000	224	8000	67	30	136	-
2	9000	69	7000	42	1	106	-
3	6000	77	8100	30	30	76	-
4	9000	110	7900	42	60	47	-
5	30000	282	8800	60	42	136	-
6	12000	141	7300	30	30	106	-
7	4000	87	9100	1	42	76	-
8	12000	202	8150	30	67	47	-
9	40000	356	7700	67	67	142	-
10	3000	35	7000	42	60	114	-
11	6000	93	8100	30	67	87	-
12	14000	195	7375	42	85	64	-

[1]*Variable is required in order for RMTCM to execute.*
[2]*Visits have been expanded by the inverse of the sampling fraction.*
[3]*Per-capita income.*

Method of Data Input: Select one
1) Input data interactively from keyboard
2) Read an external ASCII data file
3) Read a previously created RMTCM system file

Name of Data File (not applicable for keyboard input): ______________________
Number of Variables per Case ____________
Variable Names (0–8 characters)

Program Generated Name	User Name	Description
C1	POP	origin population
C2	VISIT	number trips
C3	PCI	per-capita income
C4	DIS	distance to study site
C5	DSUB	distance to substitute
C6	DPER	distance to perfect substitute
C7	_____	______________
C8	_____	______________

Input format for external file (default is free field, each case starts on new line)
(______________________)

Missing Value Indicator (use negative integer, such as -999): ______________________

Figure 2.—Data input information.

at the terminal, it must be done without mistakes. There is no facility for correcting typos in RMTCM apart from a destructive backspace or entering a new column of data in the modify data option (see "Modify Data"). Interactive data entry only should be used on small data sets. The third option is used to reanalyze a previously created RMTCM system file.

Options 1 and 2

If option 2 was selected, the prompt

```
ENTER ASCII DATA FILE NAME
?
```

will ask for the location of the user's data file. Enter the name of the data file. The data file must be ASCII; RMTCM cannot read binary or EBCDIC files.

If option 1 was selected or the option 2 ASCII data file was successfully read, the program will display

```
ENTER NUMBER OF VARIABLES
?
```

The number of variables is equal to the number of data points being entered for each origin. In table 1 there are six variables. In that case, enter a 6 followed by a carriage return. The terminal will respond with:

```
MAXIMUM NUMBER OF CASES IS nnnn
NAME VARIABLES (0–8 CHARACTERS)
C1
ENTER NAME
?
```

This message gives three pieces of information. First, the program displays the maximum size of the data set that it can accommodate with the number of variables the user has indicated in the preceding step. The program is dimensioned to handle data sets of only a certain size. The size of the data set is determined by multiplying the number of variables times the number of cases. On the personal computer and FCCC versions, the maximum of this product is approximately 4,000. Additionally, RMTCM can handle a maximum of 20 variables. After displaying the data set size limitations, the program automatically feeds into the next step, naming the variables.

Each variable is automatically assigned the name Cnn, where nn is the column number. In the example data set shown in table 1, C1 refers to the population column, and C6 refers to the distance to perfect substitute column (see the sample output in the Appendix). The label can be from 0 to 8 characters. Each variable will have the name assigned to it and the default name associated with it. It is not necessary to name a variable; but it does help interpret the output. Both the default name (i.e., Cnn) and the assigned name can be used interchangeably in subsequent stages of RMTCM. The terminal will prompt for a variable name for each variable in the data set.

The next prompt depends on whether option 1 or 2 was selected. If 1 was selected,

```
TERMINAL INPUT IS FREE FORMAT. USES AS
MANY LINES AS REQUIRED FOR EACH CASE,
BUT EACH CASE M U S T BEGIN ON A NEW LINE.
ENTER "END" TO STOP DATA INPUT.
ENTER DATA NOW.
```

will be displayed. Enter data across each row with a space between each variable. At the end of each row's worth of data, enter a carriage return. The data for each origin must begin on a new line. If the data for an origin take up more than one line, enter a carriage return and continue that origin's data on the next line. Be sure to begin the data for a new origin on a new line. If there is missing information for a variable (e.g., per capita income for an origin is unknown) enter an integer that can be declared later as a missing value code. Negative integers work well, because they will not be confused with nonmissing data.

To terminate data input push carriage return to get on a new line, then enter an "E" (do not type quotations) followed by another carriage return.

If option 2 was selected, the prompt

```
SPECIFY INPUT FORMAT (Y OR N)
?
```

will ask if an format statement is going to be provided by the user. An "N" followed by a carriage return (alternatively omit the "N" and simply hit carriage return; for all yes-no questions "N" is assumed unless "Y" is entered) invokes the default format. The default format is free-field. Each data point must be separated by a blank and each origin must begin on a new record. If "Y" is entered, the prompt

```
ENTER FORMAT
?
```

will ask for the input format. The user should enter a valid F-type FORTRAN-V format statement including left and right parentheses (but not the word "format"). For example, the following is a valid response to the format query (do not type the quotations), "(4F2.0,3F6.2)". No syntax checking is performed on the format statement, and an execution error will result if it is not correct.

With either option 1 or 2, after all the data has been read, the message

```
NUMBER OF CASES READ = x
FIRST FOUR LINES OF DATA ARE AS FOLLOWS...
  [data for first four origins listed]
LAST LINE OF DATA IS AS FOLLOWS...
  [data for last origin listed]
LIST ALL THE DATA     (Y OR N)
?
```

verifies the number of cases read, lists the first four cases and the last, and asks if all the data are to be listed. Listing all the data helps verify that everything was read properly. Large or small data points will be listed using exponential notation. The sign and size of the exponent are displayed to the right of the letter E. For example, 0.13829E06 is equal to 138,290 and –0.13829E–02 is –0.0013829.

After the data listing prompt, the following prompt:

SUBSTITUTE MEANS FOR MISSING VALUES? (Y OR N)
?

will appear. Missing data can be replaced by the mean of that variable for cases on which the data is not missing. Users are urged to avoid having any missing data. It is especially important not to have any of the trip information missing. Nevertheless, many times missing data are unavoidable. If "N" is given, the main menu will be relisted. A "Y" response to this query results in

ENTER MISSING DATA VALUE (NUMERIC)
?

being displayed. The numeric value must be an integer. Every occurrence of this integer will be replaced by the mean of the corresponding nonmissing data. A number such as –999 is good, because it will not be mistaken for valid data. The mean then will be used in all subsequent statistical analyses.

Option 3

Option 3 is used to read a previously created RMTCM system file. When the user exits RMTCM, an option of saving the data file and associated variable names is given. If that option is selected, an RMTCM system file will exist with the name assigned by the user.

To use this file, select option 3 from input menu and answer this prompt.

ENTER NAME OF RMTCM SYSTEM FILE
?

Enter the name of the data file followed by a carriage return. After the file is read, summary information about the file will be printed and an option to list all the data will be given.

DISTANCE TO COST CONVERSION

After the missing values questions have been answered, the program will redisplay the main menu. Entering a 2 causes a series of self explanatory questions to appear. The questions give RMTCM the information it needs to calculate eq. [1]. Figure 3 is a worksheet summarizing the information needed at this stage of the analysis.

Two points should be made about converting distances to cost. First, any opportunity cost of time can be used, including zero. Second, if the user wants to use another formula to convert distances to cost, this can be done before entering the program or by using the modify data option.

After the user has answered the six questions related to the distance to cost conversion calculations (see the Appendix for listing of questions), the following prompt

ENTER NAME OF VARIABLE TO CONVERT
?

A. Average travel speed 50 MPH
B. Vehicle cost per mile 0.12 $/mile
C. Persons per vehicle 2.5
D. Are distances one-way (0) or round trip (R) 0
E. Cost of time 1.89 $/hour
F. Per vehicle entry fee 0 $/vehicle
G.

Variables to Convert	New Name
DIS (C4)	COST
DSUB (C5)	SUBCOST
DPER (C6)	PERCOST

Figure 3.—Worksheet for distance to cost conversion.

is displayed. This prompt asks for the name of the distance variable being converted to cost. For the example data in table 1, C4, or whatever name it was given in the name variable process, would be typed in. The distance to cost formula is then applied to each case for C4. The value of C4 represents d_i in the distance-to-cost formula.

The resulting cost data does not replace the distance data but is added as a new column of data. The prompt

ENTER NAME FOR NEW VARIABLE (Cnn)
?

asks for the name of the new variable. After naming the cost variable, the first four cases will be listed. Then the prompt

LIST ALL THE COST VALUES (Y OR N)
?

asks if all the cases are to be listed. The data will be listed in three columns with the case number, the distance data, and the cost data on each line.

If another distance variable is to be converted with the same parameter values (i.e., a, b, e, t, c, and f), enter "Y" when:

ANOTHER, WITH THE SAME VALUES (Y OR N)
?

appears at the terminal. If none of the parameters need to be changed or there are no other variables to convert, simply enter a carriage return (for all yes/no prompts, a carriage return defaults to no), and the program will return to the main menu.

MODIFY DATA

The modify option allows data transformations, thereby enabling the use of five different functional forms in RMTCM. The user must perform the transformations required to fit the different functional forms; it is not done automatically. These different functional forms are discussed in the next section. It is necessary to divide visits by population in order to calculate visits per capita. The modify data option also can be used to enter a new column of data as a replacement for a column that has an error in it.

Modify data is one of the options on the main RMTCM menu. After entering a 3 while in the main menu, the following prompt

```
 0) RELIST MENU
 1) ADD TWO COLUMNS (SEE ALSO OPTION 9)
 2) SUBTRACT (FIRST - SECOND)
 3) MULTIPLY (FIRST * SECOND)
 4) DIVIDE (FIRST/SECOND)
 5) MULTIPLY (COLUMN*CONSTANT)
 6) POWER (COLUMN**CONSTANT)
 7) NATURAL LOGARITHM
 8) ENTER NEW COLUMN OF DATA
 9) ADD A CONSTANT TO A COLUMN
10) EXIT TO MAIN MENU
 ENTER MODIFY CHOICE
 ?
```

will appear. The modify menu has 11 options. To relist the menu when you are in the middle of the modify process, simply enter 0 followed by a carriage return.

All of the operations in the modify menu, except 0, 8 and 10, act on the entire column(s) of data. Choices 1, 2, 3, and 4 require two columns of input data. Choices 5, 6, 7, and 9 require only one input column name. Choice 8, entering a new column of data, requires no input column. In all cases an output column must be specified. The output column can be an existing column or it can be a new column. If the output column is an existing column, the data in that column will be overwritten by the modified data. If the modified data are written on a new column (much better) the new variable will be added to the RMTCM data set. Sometimes it could be useful to overwrite an existing column to avoid exceeding the 20 variable maximum.

After selecting the modify choice and answering the appropriate questions, the following prompt will appear:

```
PUT RESULT IN EXISTING COLUMN (Y OR N)
?
```

If "N" is given, RMTCM will ask for the name of the new output column. After naming the new output column, the first four and last cases in the data set are listed. Then a prompt asks if all the data are to be listed. When the data modifications are complete, press 10 to return to the main RMTCM menu.

The Appendix gives an example of using the modify data option to compute visits per-capita.

FITTING A MODEL

Building a travel cost model has been divided into seven separate steps in this publication. The last two steps, fitting a model and report writing, are both combined in the run regression and reports option in the main RMTCM menu. Before entering this option, all the data needed for the travel cost model should be available. If all the data and the necessary transformations are not available, return to the modify data option. Before describing how the program actually works, an overview may be helpful.

Functional Forms

The RMTCM program uses multiple regression to analyze TCMs with five different functional forms. These functional forms are: (1) linear, (2) quadratic, (3) semi-log (independent), (4) semi-log (dependent), and (5) double-log. The best functional form to use in a TCM depends on the particular data set.

Past experience with the TCM suggests that either the semi-log (log-dependent) or double-log functional forms are the best suited in most cases. To fit these functional forms, the data must be transformed in the appropriate manner (much like any regression program) before fitting the regression. Good texts on multiple regression and data transformations in multiple regression include Draper and Smith (1966) and Kmenta (1971). To run RMTCM, regardless of which functional form is used, one column of data must represent the cost of the trip from the origin to the study site (the logarithm of cost is not good enough), and another column must show the population of each origin. The information on cost and population is needed to generate the RMTCM reports. The cost and population variable must be present in the data set, but need not be included in the regression itself.

The five functional forms are as follows;

Linear
$$VC_i = B_0 + B_1C_i + B_2Z_{i1} + B_3Z_{i2} + \dots + B_mZ_{iz} + \epsilon_i$$

Quadratic
$$VC_i = B_0 + B_1C_i + B_2C_i^2 + B_3Z_{i1} + \dots + B_mZ_{iz} + \epsilon_i$$

Semi-Log Independent
$$VC_i = B_0 + B_1Ln(C_i) + B_2Z_{i1} + \dots + B_mZ_{iz} + \epsilon_i$$

Semi-Log Dependent
$$Ln(VC_i) = B_0 + B_1C_i + B_2Z_{i1} + \dots + B_mZ_{iz} + \epsilon_i$$

Double-Log
$$Ln(VC_i) = B_0 + B_1Ln(C_i) + B_2Z_{i1} + \dots + B_mZ_{iz} + \epsilon_i$$

where VC_i = trips per-capita, i.e., visits/population from origin i(i = 1,n)

B_j = regression coefficients (j = 0...m) to be estimated by RMTCM

C_i = per-person cost of a round-trip from origin i to the site

Z_{ik} = other predictor variables used in the models (k = 1,z), usually per-capita income and the cost of substitute sites

ϵ_i = an error term, and

Ln( ) = natural logarithm of variable in parentheses.

Each of these functional forms is a different way of representing the relationship between trips per-capita from an origin to the study site.

The Z_{ik} terms are perfectly flexible. For example, in the linear functional form it is possible for one of the Z_{ik}'s to be the logarithm of per-capita income and another to be the squared average age of an origin. The one limitation is that Z_{ik} cannot be a function of C_i. In other words, changing C_i should not change the value of any Z_{ik} terms. The Z_{ik} terms customarily include the price(s) of substitute sites, per-capita income, and other measures about the characteristics of the origins such as average age, education level, etc. Despite the flexibility of RMTCM, these five functional forms are customarily used in a relatively standard way. Graphs of the five functional forms are shown in figures 4 and 5.

Linear

This functional form was popular in earlier TCMs mainly because of its simplicity. With a linear functional form the per-capita visitation rate is regressed on the cost of traveling from an origin to the site and other characteristics of the origin. The Z_{ik} terms usually are not transformed. For example, per-capita income usually is used instead of the log of per-capita income. However, RMTCM will work either way. Most empirical work shows that the linear function form does not fit travel cost data very well.

Quadratic

The quadratic functional form is identical to the linear functional form with the exception that a squared term of the cost of traveling from an origin to the site has been added. The quadratic form is much superior to the linear functional form for most applied travel cost models. The squared term on cost allows the estimated demand curve to bend. When using the quadratic functional form some cautions should be noted. The program assumes the B_1 coefficient is negative and the B_2 coefficient is positive. If the coefficients estimated do not have these signs, then get expert help or use a different functional form.

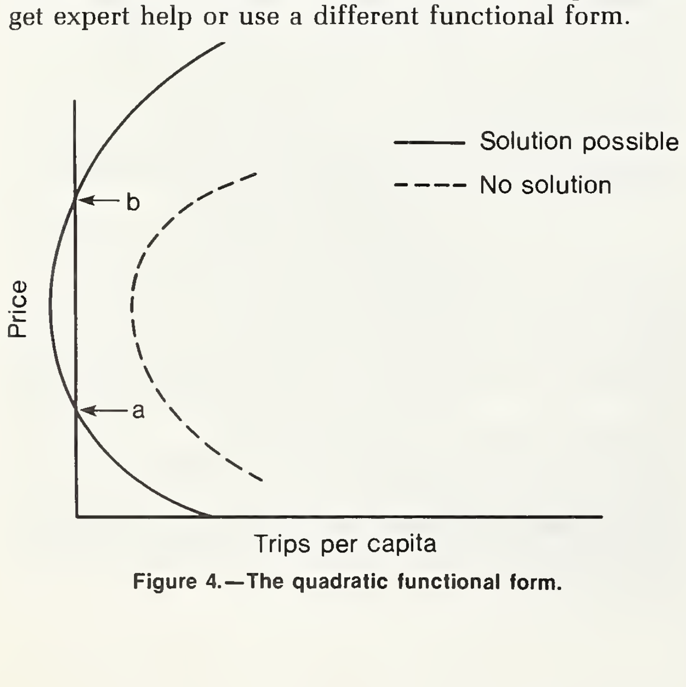

Figure 4.—The quadratic functional form.

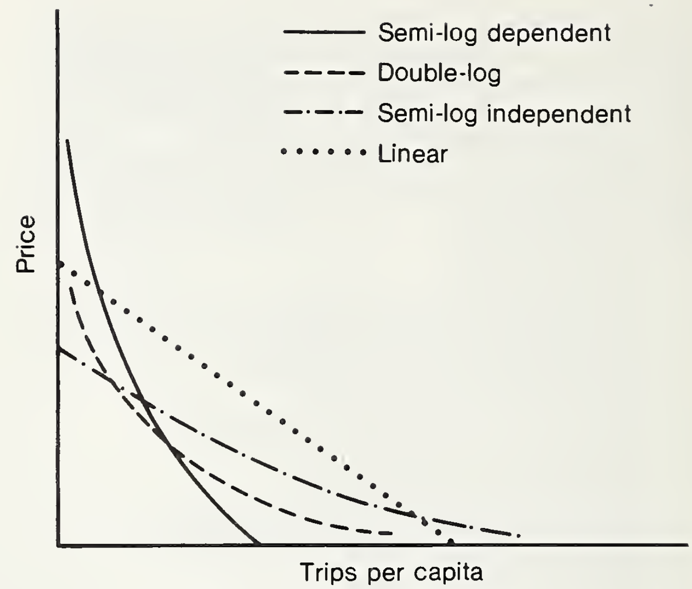

Figure 5.—Four functional forms.

A further problem with the quadratic functional form is that it may never predict zero visitation regardless of the fee imposed at the recreation site. Figure 4 graphs a quadratic functional form. To generate reports, the RMTCM program solves for the point labeled "a" on figure 4. That is, the cost at which zero trips from an origin will be predicted. In most cases there will be two solutions, point "a" and point "b." The RMTCM program uses only point "a". However, from some data the multiple regression program in RMTCM might fit a curve that looks like the dashed line in figure 4. In such a case, the curve bends backwards and upwards before trips per-capita is driven to zero. In other words, there is no finite fee increase that will result in zero predicted visitation. This is an unreasonable model, and RMTCM will inform the user of such a problem. Despite the cautions noted for the quadratic functional form, it can be quite useful in a number of applied studies.

Semi-log (Independent)

Like the quadratic form, the semi-log independent form also has been found to be useful in travel cost analysis. The semi-log independent form is shown in figure 5. It is asymptotic to the trips per-capita axis and crosses the cost axis. Depending on the coefficients for B_0 and B_1, the curve can have different shapes and positions. Because it crosses the cost axis, there is a finite price associated with zero trips per-capita. This is a nice property of the semi-log independent curve which is not shared by the two other log transform functional forms. The Z_{ik} terms are customarily not transformed, the same as in the linear or quadratic model.

Semi-log (Dependent)

This functional form and the double-log form are usually the ones most suited for travel cost analysis. The advantage of these functional forms is that they involve a logarithmic transformation of trips per-capita variable. Research has shown that the trips per-capita variable, in its untransformed state, is heteroskedastic (Strong 1983). Heteroskedasticity refers to the fact that the variance of the residuals varies across the range of the data. The nature of the heteroskedasticity is such that the larger the value of trip per-capita, the more error variance there is. Transforming the trips per-capita variable appears to often alleviate this problem. Users interested in technical treatment heteroskedasticity are referred to any econometrics text (e.g., Kmenta 1971, Maddala 1977). Furthermore, when formal tests for functional form have been performed, the semi-log (dependent) or double-log functional form appears to be superior to either linear, quadratic, or semi-log (independent). The choice of the proper functional form is a subject of some discussion. Users are urged to try different forms and see what happens to the results.

The semi-log dependent functional form is asymptotic to the price axis (fig. 5). Because of this, there is no finite price that predicts zero visitation from an origin to the study site. If B_1 is less than zero, the area under the semi-log dependent curve is finite. To graph the second stage demand curve and calculate consumer surplus in RMTCM, a finite upper bound on cost needs to be selected. For each origin, demand is assumed to fall to zero when the model predicts less than one trip will go from an origin to the site. In this functional form, the Z_{ik} terms are customarily not transformed. That is, simply entering the price of imperfect substitute sites, per-capita income, and other measures of the characteristics of the origin should perform reasonably well.

Double-Log

The double-log functional form is doubly asymptotic (fig. 5). It does not intersect either the price axis or the trips per-capita axis. For consumer surplus calculations, the demand curve is cutoff at the point it predicts one trip will go from the origin to the study site (same as the semi-log dependent). If B_1 is less than −1, the area under the double-log demand curve is finite. In the double-log demand curve, it is customary for the Z_{ik} terms also to be expressed using a logarithmic transformation. In other words, the logarithm of the price of the imperfect substitute site(s), the logarithm of per-capita income, etc., normally are entered as predictors into this demand equation.

Regression Analysis in RMTCM

The five functional forms are meant to give the user flexibility when using RMTCM. The five functional forms allow fitting of quite general models. The B_jZ_{ik} terms let the program account for many substitute sites and other demographic factors. The choice of the proper functional form is complicated. A few suggestions will be given in the section on advanced issues.

When the user first enters the "RUN REGRESSIONS" portion of RMTCM, the prompt

```
DISPLAY LIST OF VARIABLE NAMES   (Y OR N)
?
```

is displayed. Listing the variable names is useful, because it shows the variable names that can be used in the regression. The next prompt to appear is

```
USE ALL VARIABLES IN THE REGRESSION?
(Y OR N)
?
```

A "Y" response results in all variables being used in the regression. The usual response is "N", because population must be in the data set; but it is not normally used in the regression. After a "N" response the prompt

```
USE "VARIABLE NAME"? (Y OR N)
?
```

is displayed. This prompt will be repeated for all of the variables in a data set. If a variable is going to be used in the regression, answer "Y"; otherwise simply press carriage return. Figure 6 gives a worksheet that might help to organize the regressions. After the end of the prompts, RMTCM will ask for the name of the dependent variable by displaying

```
ENTER NAME OF DEPENDENT VARIABLE
?
```

at the terminal. Enter the name of the dependent variable. Do not worry if you indicated the dependent variable will be used in the regression on the previous step; the program works either way.

At this point, the RMTCM program produces a brief regression statistics output. The brief output consists of regression coefficients, t-statistics, probabilities, and R^2. A satisfactory TCM should have negative regression coefficients on the variable representing the cost of visiting a recreation site (note that in the quadratic model one would expect the mixed signs previously described). The R^2s in TCMs are usually not very high, and often range from between 0.1 and 0.5. The R^2 from the semi-log (log-dependent) and double-log function form is not comparable to the R^2 from the other three functional forms (see Comparing R^2 Across Functional Forms). Much literature has been written on how to select the best regression model (Draper and Smith 1966, Kmenta 1971). The R^2, t-statistics, and theoretical reasonableness are all factors that go into selecting the final model. After the brief output the prompt

```
PRODUCE EXPANDED OUTPUT? (Y OR N)
?
```

asks if there should be a diagnostic output of the regression. If "Y" is entered, an analysis of variance summary table will be printed and the residuals will be plotted. Specifically, the residuals are plotted versus the predicted value of the dependent variable. Readers not familiar with how to interpret residual plots are referred to any statistics text which discusses their interpretation (Draper and Smith 1966).

Independent Variable	REGRESSION 1 (Linear) VCAP	REGRESSION 2 (Semi-log(dependent)) LN(VCAP)	REGRESSION 3 (Double-log) LN(VCAP)
IV1	COST	COST	LNCOST
IV2	SUBCOST	SUBCOST	LNSUBCOST
IV3	PCI	PCI	LNPCI
IV4	________	________	________
IV5	________	________	________
IV6	________	________	________
IV7	________	________	________
Dependent Variable	vcap	ln(vcap)	ln(vcap)

Figure 6.—Worksheet for regression portion of RMTCM.

REPORT WRITING

The next prompt

PRODUCE SUMMARY REPORT? (Y OR N)
?

asks if a summary report should be generated. The summary report is based on the most recent regression estimated. If the most recent regression is not satisfactory, answer "N" to this prompt and re-estimate a different regression. Integrating the summary report with the regressions is the strength of RMTCM. It frees the user from the unique computations associated with the TCM.

If a "Y" response is given to the report prompt, the message

1) LINEAR
2) QUADRATIC
3) SEMI-LOG INDEPENDENT
4) SEMI-LOG DEPENDENT
5) DOUBLE LOG
ENTER FUNCTIONAL FORM USED
?

will appear at the terminal. To generate the report, RMTCM must know which functional form was used in the most recent regression. At this point, enter the appropriate number. Then the prompt

ENTER VARIABLE NAME FOR ROUND-TRIP COST
?

asks for the name of the variable representing the cost of a trip to the study site. In response to this question, enter the variable name, or column number, associated with the cost of traveling from an origin to the recreation site. If a quadratic form was used, there will be a second prompt asking for the name of the cost squared variable. If a double-log functional form was used, the user will first be asked for the names of the variables representing the logarithm of cost and cost itself. Next the prompt

ENTER VARIABLE NAME FOR POPULATION
?

appears. In response to this question, indicate the name of the variable containing the population of each origin.

After answering the population question, RMTCM responds with the following message.

A FEE INCREASE OF (XXXX.XXX) RESULTS IN ZERO VISITS FROM ALL ORIGINS
THE LAST ORIGIN TO PRODUCE VISITS IS X
ENTER NEW DEMAND CUTOFF POINTS ? (Y OR N)

The first line shows how much of an increase in per-person per-trip cost is needed to drive visitation from all the origins to the study site to zero. For example, let

$$VC_i = f(C_i, S_i, Z_i) \quad [3]$$

represent the functional form the user has fit with multiple regression. Then, the predicted visitation at a given fee increase, ΔC_i, is

$$VC_i(\Delta C_i) = f(C_i + \Delta C_i, S_i, Z_i). \quad [4]$$

The fee increase needed to drive trips to zero for a given origin i is

$$0 = f(C_i + \Delta C_i^*, S_i, Z_i) \quad [5]$$

The maximum ΔC_i^* is reported as the largest fee increase required to drive trips to zero from all origins. The case number associated with the maximum is also reported.

No Perfect Substitutes

The prompt asks whether or not new demand cutoff points should be entered. New demand cutoff points should be entered only if a perfect substitute site to the study site has been identified. Recall, a perfect substitute site is one which offers the same recreation opportunities at an equal or higher quality, and has sufficient capacity to handle the increased use that would result if the study site were closed. The price of a perfect substitute should not be used in the demand equation itself. For now, assume there is no perfect substitute site.

After answering "N" to the cutoff prompt, RMTCM will generate a summary report. The first part of the summary report is a table showing various simulated fee increases at the site and how many trips would occur at the site if that fee were charged. A fee increase of zero reflects the existing condition. The predicted number of trips at the zero fee increase should be reasonably close to the actual number of trips now occurring at the site. As a rough guide, plus or minus 25% is reasonably close. If the predicted number of visits is way off, consider trying a different functional form and/or different independent variables. The subsequent fee increases show how simulated visitation falls as fees are increased. The RMTCM program automatically calculates the upper bound of the fee increase and scales the increases between zero and the upper bound. At the upper bound of the predicted fee increases, the table should show zero, or very close to zero, trips.

Continuing under the assumption of no perfect substitute site(s), the next part of the report is a graph of the fee increase/visits table. In the travel cost literature, this is known as a "second stage" demand curve. Underneath the graph is an estimate of the total consumer surplus at the recreation site and the consumer surplus per trip. The total consumer surplus is the area under the second stage demand curve, and represents the net economic benefit to the consumer of the recreation site. This is an estimate of the willingness of recreationists to pay for access to that recreation site over and above their existing expenses. The consumer surplus per trip is the total consumer surplus value divided by the predicted number of trips at a zero fee increase. It can be interpreted as the average willingness-to-pay for a trip.

The total consumer surplus measure given by RMTCM does not reflect the costs of supplying the recreation facility to the public. The net benefits of the recreation site to society is consumer surplus minus the costs of providing the site. Any fees collected by the provider should be calculated as a benefit when calculating net benefit to society.

Following the output of the consumer surplus estimates, a table of revenue and revenue changes is printed. This table indicates how much revenue would be collected by the managing agency if various fees were charged at the recreation site.

The predictions of visitation at various fee increases are generated under the assumption that fees would be increased at the study site and held constant everywhere else. For example, if the study site has four substitute sites, RMTCM assumes that the prices of trips to the substitute sites would remain constant when fees are raised at the study site. This is unlikely if there is an agency-wide or region-wide decision to raise entrance fees. The TCM model cannot predict what would happen to visitation in the face of a system-wide increase in fees.

With Perfect Substitutes

A perfect substitute site sets an upper bound on the willingness of recreationists to pay for entry to the study site. The price of a trip from an origin to the closest perfect substitute site is termed the "demand cutoff" point for that origin. If fees at the study site are raised to a level that the travel cost plus fees exceed the demand cutoff point for an origin, then trips from the origin to the study site are assumed to be zero. This is the logic that is implemented when the demand cutoff option of RMTCM is invoked.

From eq. [5] let

$$C_i^* = C_i + \Delta C_i^*. \qquad [6]$$

C_i^* is the cost at which the demand equation predicts zero trips from origin i. Let the cost of a trip from origin i to the nearest perfect substitute site be represented as C_i'. The C_i' values must be entered by the user, as discussed later in this guide.

When demand cutoff points are used for report writing trips from origin i are modeled as falling to zero whenever

$$\Delta C_i + C_i > \tilde{C}_i \qquad [7]$$

where: $\tilde{C}_i$ = minimum of C_i^* and C_i'.

Regardless of what the demand equation predicts, trips will be assumed to fall to zero if $\Delta C_i + C_i$ is greater than C_i'. Because of this logic, if C_i' is always greater than C_i^*, the cutoff points will have no effect on the report. The logic behind these cutoff points is discussed by Knetsch (1977).

If there is a perfect substitute site, a "Y" response should be given to this

ENTER NEW DEMAND CUTOFF POINTS? (Y OR N)
?

prompt. Then the prompt

1) ENTER NEW DEMAND CUTOFF POINTS ONE BY ONE
2) SPECIFY COLUMN OF CUTOFF POINTS
MAKE SELECTION?

will ask how those demand cutoff points should be read.

The simplest way to enter demand cutoff points is to specify a column of these values. After indicating a "2" to the demand cutoff menu, RMTCM will prompt the user with

ENTER VARIABLE NAME FOR DEMAND CUTOFF
?

to determine the name of the variable to use as demand cutoff points. The demand cutoff point for an origin is the cost of a round-trip from that origin to the nearest identified perfect substitute site. If there is more than one perfect substitute, use the one with minimum cost for each origin. After the variable is named, a report will be generated. The demand curve is likely to have the truncated shape shown in figure 7 because of the cutoff points.

If option 1 is selected, RMTCM will display, origin by origin, the price that drives trips to zero, i.e., C_i^*. Following each display, RMTCM will ask for a demand cutoff point. The user should then enter the value of C_i' for each origin. After entering the cutoff points, RMTCM will display

ENTER NEW DEMAND CUTOFF POINTS? (Y OR N)

again. Answer "N", unless an input error was made, and then RMTCM will produce a summary report taking into account the demand cutoff points.

The perfect substitution assumption is a strong one. If an analyst is not certain about whether a site is a perfect substitute, RMTCM can be run both ways. To run RMTCM with a site as an imperfect substitute, the imperfect substitute price term should be included in the regression equation. With the questionable site entered as an imperfect substitute, the second stage demand curve can be generated without demand cutoff points. The second analysis then would run RMTCM under the assumption that the site was a perfect substitute. In this case, the price of the perfect substitute site would not be entered in the regression equation. Instead, the perfect substitute price would be reflected as column of demand cutoff points. The reason the perfect substitute price cannot be entered into the regression equation is that if a site is a perfect substitute, it is assumed to be the same commodity as the study site. Economic theory does not allow the price of the single commodity to be entered into a demand curve twice.

EXITING RMTCM

To exit the program, select option #5 when the main menu is displayed, and the prompt

WANT TO SAVE DATA AS RMTCM SYSTEM FILE (Y OR N)
?

will be displayed. To save the data and associated variable names answer "Y", and the prompt

ENTER NAME OF RMTCM SYSTEM FILE
?

asks for a valid file name. Enter the name of the file and a carriage return, then the file will be saved and the program will be finished. If means were substituted for missing data on the initial data input step, the substituted mean values will be saved on the RMTCM system file.

Regardless of whether a RMTCM system file was saved a file containing an exact duplicate of what occurred during the RMTCM session will have been automatically saved. On the FCCC Univac version, this file is named "RM*TCM-LOG.". (see section "Accessing RMTCM on the USDA Computer"); on the personal computer version, the file is named "RMTCM.LOG". This file can be printed for a permanent copy of the RMTCM run.

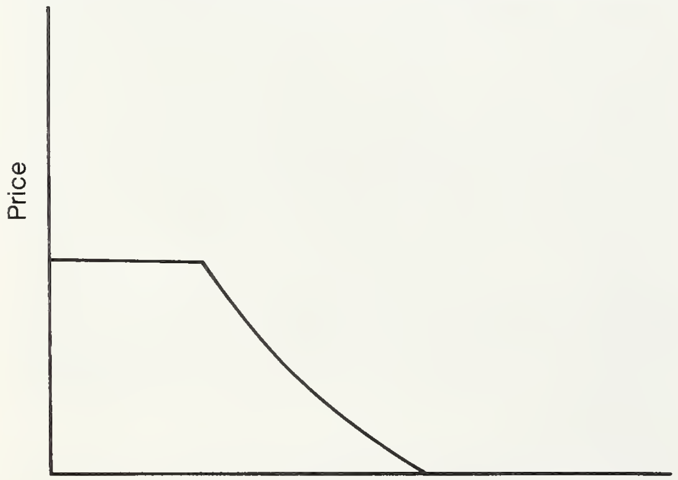

Figure 7.—Truncated second stage demand curve.

ADVANCED ISSUES

Users of RMTCM might want to use the program to do things it was not originally intended for. Also, technical issues will arise. What follows is an attempt to address some of these issues. Readers of this section are assumed to be fairly familiar with the TCM and statistical data analysis.

FINER FEE INCREMENTS

The RMTCM summary report usually generates tables of trips associated with rather large fee increases. For the purpose of formulating policies related to pricing a recreation area, it might be useful to have more resolution at the lower end of the fee/visits schedule. This resolution can be obtained by imposing a set of artificial demand cutoff points. Generate a new column of data in the modify data option of RMTCM. The new column of data will be the existing cost of travel from an origin to the study site plus a constant. The amount of the constant will set the upper bound of the fee increase table. Fit the model and then answer yes to the demand cutoff question. Specify this new column of data as a column of cutoff points, and the desired results will be obtained. If the constant added was 10, the fee/visits schedule will reflect 20 even increments between $0 and $10. Keep in mind that the consumer surplus calculations will be meaningless. However, the fee/visit schedule will be accurate between $0 and $10.

CALCULATING DISTANCES

In a travel cost model with many origins and many recreation sites calculating the distances from each origin to each site can be quite tedious. The usual means to calculating distances is a road map. An alternative technique in the case of many origins and many sites is to use geometry to estimate calculate distances. For any two points A and B, the airline distances between them is (U.S. Department of Commerce 1978):

$$A = [\cos^{-1}((\sin a \sin b) + (\cos a \cos b \cos P))]k_1 \quad [8]$$

where A = airline distance between A and B
a = latitude of point A
b = latitude of point B
P = degrees of longitude between A and B, and
k_1 = distance, in miles, of one degree at a given latitude (69.055 is a general case).

It is assumed that latitude and longitude are measured in degrees and tenths of degrees, not in degrees followed by hours, minutes, and seconds. Another way to measure distance with geometry is to determine the checkerboard, or right angle, distance between any two points. The checkerboard distance between any two points A and B is defined as

$$CB = k_1L + k_2P \quad [9]$$

where CB = checkerboard distance between two points A and B
L = degrees of latitude between points A and B, and
k_2 = miles in one degree of longitude (54 is a general case).

By recording the latitude and longitude of the recreation sites and origins, the checkerboard and airline distances between any two points can be calculated easily. Once the airline and/or checkerboard distances are calculated, the problem is to convert them into driving distances. To do this take a random sample of the distances that need to be calculated from a road map. A correction factor can than be found and used to predict driving distances. The predicted driving distance between two points A and B then would be

$$D\hat{D} = k_4G \quad [10]$$

where $D\hat{D}$ = predicted driving distance between A and B

$k_4 = \frac{k_5}{k_6}$

k_5 = average driving distance for sample of points
k_6 = average distance for sample of points based on geometry, and
G = distance between a and b based on geometry.

Whether or not to use the airline distance or checkerboard distance or geometrically based distances is a matter of choice. The best predictor of driving distances is the one to select.

A more formal way of relating driving distances to geometrically based distances is to use regression analysis. Rosenthal (1985) used regression analysis to estimate the following equation relating driving distances to geometrically based distances.

$$D\hat{D} = 6.86 + 1.075A + 0.4789(CB - A) \quad [11]$$
$$R^2 = 0.98.$$

The U.S. Department of Commerce discusses this problem in more detail and has a published set of road circuity factors (U.S. Department of Commerce 1978).

ORIGINS WITH NO VISITS

Frequently, no trips to the recreation sites will have been sampled from some origins in the market area. For example, if origins are defined as counties within a 100-mile radius of the recreation site, trips from some counties might not have been sampled. The analyst is faced with the question of what to do with counties from which no visitation was observed. The solution depends on the functional form being used.

If the linear, quadratic, or semi-log independent functional forms are used, then these zeros should be retained in the travel cost model. Zero trips from an origin to the site is a valid observation, which should be entered as a case, just like any other origin. In the example data set shown in table 1 if no trips had been observed from origin 10, then a zero would be entered in the trips column for that origin. The regression analysis, distance to cost conversions, and any other modifications would proceed as normal.

If the semi-log dependent or double-log functional forms are used, retaining zeros is not feasible. Taking the logarithm of zero is an undefined mathematical operation. A simple way to eliminate the zeros is to redefine the origins so that there are no origins with zero visitation. If origin 10 in figure 1 had a zero, the logical alternative would be to combine it with origin 9, 6, or 11. If origin 10 is combined with origin 9, then an aggregate origin representing the 9,10 combination would result. This would reduce the number of cases in the data set from 12 to 11. The visitation from this new origin would be the trips from 9 plus the trips from 10. In the example data set, there would be 356 trips from the new aggregate origin (assume there are 356 trips from origin 9 and zero trips from origin 10). The population of the new origin would be the sum of the two populations, or 43,000. To calculate distances, per-capita income, and other demographic statistics population weighted averages must be used. The population weighted per-capita income and distance to the study site for the new aggregate origin would be $7651 and 65 miles, respectively. The travel cost model then can be run using 11 cases with positive visitation recorded from all origins.

MULTICOLLINEARITY

Multicollinearity refers to the condition of two or more predictor variables in the demand equation being highly correlated.

Consider the layout of origins and recreation sites shown in figure 8. To run the TCM, four distances for each origin must be calculated — the distance from the origin to the study site and to each of the three substitute sites. When these data are subsequently used in the regression portion of RMTCM, multicollinearity between the sites can cause a problem. The two substitute sites located in origin 5 are almost right next to each other. Therefore, the distances to each of them from each origin are almost identical. In such a case, it is not necessary to calculate the distance to both sites. One of the sites, or a location between the sites, can be chosen to represent the combination of those two sites. Combining substitute sites in this manner only should be done when they are very close to each other. Otherwise, it is best to enter the separate sites in the RMTCM model.

A much more severe problem occurs if the substitute site is very close to the study site. For example, assume a substitute site is located at point "A" in origin 7. To run the TCM, the distance from each origin to each site in the market area is needed. Because the study site and point A are so close together, the distance measured to these sites from each origin will be almost identical. When the regression is run, little confidence can be placed on the own-price regression coefficient for the study site.

There are three ways to deal with this problem. First, the study site can be redefined to represent the combination of the original study site plus A. In this case, the TCM will value the two sites as a single site. Total trips would be defined as trips to either the study site or site A. Some central point between the study site and site A would be used for calculating distances. When the site is redefined in this manner, it is not possible to use the TCM to make statements about the value of either the original study site or site A in isolation.

The second way to deal with the problem shown in figure 8 is to assume that the site represented by A is a perfect substitute to the study site. Recall that a perfect substitute must provide recreation opportunities of equal or higher opportunities and have enough excess capacity to maintain this quality in the face of the increased use that would occur if the study site were closed. Then, the price of site A would not be used in the regression equation. Instead, the prices of trips to site A would be used for demand cutoff points. If site A is assumed to be a perfect substitute to the study site, the demand curve will be truncated at a very low level. The economic benefit of the study site under such an assumption would be very low. This makes sense, because if there is a perfect substitute site located right next to the study site, the loss in recreational opportunities by removing the study site is not very great.

The final way to deal with the multicollinearity problem is simply not to use the TCM. The TCM is not well suited to estimating the value of the study site alone in the face of such high multicollinearity. A study using the contingent valuation method may be better suited to determining the value of the study site.

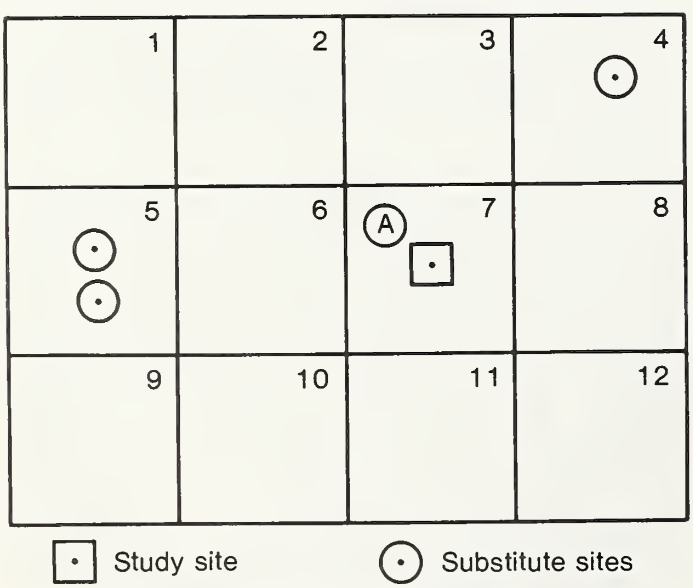

Figure 8.—Multicollinearity.

COMPARING R^2 ACROSS FUNCTIONAL FORMS

Many statistical texts discuss the issue of how to select the "best" regression. Important factors to consider are theoretical reasonableness of the model, how well the model fits the data, residual plots, and the statistical significance of individual regression coefficients. The reader is referred to any good statistics text for a discussion of these issues.

With RMTCM, the user has the option of fitting functional forms where the logarithm of trips per-capita is used as the dependent variable. The R^2 from these regressions cannot be meaningfully compared to the R^2 of regressions using trips per-capita as the dependent variable. This occurs because the dependent variables are measured in different units.

To compare a log dependent variable regression with a regular regression, the dependent variables must be transformed into equivalent units. Following Rao and Miller (1965) redefine the dependent variable as

$$VC_i^* = VC_i/g \qquad [12]$$

where $g = \exp[(1/n) \sum_{i=1}^{n} (\ln VC_i)]$

is the geometric mean of trips per capita. After this standardization fit, fc~ example,

$$VC_i^* = B_0 + B_1C_1 + \epsilon_i \qquad [13]$$

and

$$LN(VC_i^*) = \alpha_0 + \alpha_1 Ln(C_i) + \epsilon_i'. \qquad [14]$$

The equation with the lower residual sum of squares is the better fit. Standardizing by dividing by the geometric mean of the dependent variable allows direct comparison of residual sums of squares.

INDIVIDUAL OBSERVATION TRAVEL COST MODELS

The RMTCM program can be tricked into running individual observation based TCMs (Brown and Nawas 1973). In the zonal TCM, visits per-capita from each origin is regressed on price, income, and other predictors. In the individual TCM, the number of times each person visits the site is regressed on price, income, and other variables. The difference between the two approaches results from aggregation.

The individual observation based TCM can be run on RMTCM by treating each individual as a zone with a population of one. An individual observation based TCM run on RMTCM will have as many origins as there are individual observations. A column of 1s should be used to represent the population of these pseudo-origins. Once this is done, the analysis proceeds in exactly the same manner as the zonal TCM.

Brown et al. (1983) pointed out a serious shortcoming in the individual observation based TCM. Because only participants are included in the data set, the individual based model does not reflect the fact that a person might stop visiting the site altogether when faced with a price increase. To correct this deficiency they suggest using a new dependent variable termed "individual observed visits per-capita."

The details of their approach cannot be described here except to say that such a model can be run easily on RMTCM. This model is clearly superior to the simple individual observation based TCM. To use this approach, first calculate individual observed visits per-capita as

$$vcap^{*}_{ir} = t_{ir}\,(R_i/P_i)S \qquad [15]$$

where $vcap^{*}_{ir}$ = individual observed visits per-capita for the rth sampled recreationist ($r=1, R_i$) from the ith ($i=1,n$) origin

t_{ir} = number of trips to the study site made by the rth person from the ith zone

R_i = number of recreationists sampled from the ith zone

P_i = population of the ith zone, and

S = expansion factor to correct for the sampling rate, i.e., 1/(proportion of visitors sampled).

Then use $vcap^{*}_{ir}$ as the dependent variable in RMTCM; $\ln(vcap^{*}_{ir})$ also can be used as a dependent variable when fitting logarithmic functional forms.

Every value of $vcap^{*}_{ir}$ will be treated as a zone in RMTCM. Because of the way RMTCM calculates benefits, a population is needed for each one of these zones. When using RMTCM to run the Brown et al. (1983) model, the population associated with a given value of $vcap^{*}_{ir}$ is (P_i/R_i). Every observation from the ith origin has the same population, (P_i/R_i).

Do not get confused between the zones formed by the user and the number of zones RMTCM thinks there are. In the user's mind there are n zones ($i=1,n$). When fooling RMTCM into emulating the Brown et al. (1983) model, the program thinks there are $(R_1 + R_2 + \ldots R_n)$ zones. There are as many zones as there are people. Each of these people-zones has an associated population, (P_i/R_i).

Once the value of $vcap^{*}_{ir}$ and the associated population has been entered the analysis proceeds as normal. Users can try the sample data given in table 1 of Brown et al. (1983) as a check to see if they have set up the problem correctly.

The Brown et al. model assumes that the data on individual visit rates to a specific site were collected by either a household survey or by a survey of license holders for a particular activity (e.g., fishing). Persons with zero values for t_{ir} are not included in the analysis. With such a sampling scheme, all persons visiting the site one or more times have an equal probability of being sampled. In contrast, if persons are interviewed as they enter or exit the site, this equal probability property does not hold. Persons who visit the site often are more likely to be sampled than are infrequent visitors. The reasonableness of using the Brown et al. (1983) approach with data collected at the recreation site is an open question. Estimating regression models when there is sample stratification on the dependent variable is discussed by Hausman and Wise (1981).

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APPENDIX

Example of RMTCM Output

The data shown in table 1 were used to generate this example of RMTCM output. Comments shown were included by the authors to help readers understand the example. RMTCM does not generate these comments. This example was run on a personal computer (PC). Output from the RMTCM UNIVAC version at FCCC is the same except for possible differences in computational accuracy between the two computers. Also, differences in system-oriented file names are noted in the comments at the end of the example run.

```
WELCOME TO RMTCM.
RMTCM WAS DEVELOPED BY D. ROSENTHAL, D. DONNELLY, M. SCHIFFHAUER , AND G. BRINK AT
THE ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION, FORT COLLINS, COLORADO. THIS
PROGRAM IS IN THE PUBLIC DOMAIN AND, THEREFORE, MAY NOT BE COPYRIGHTED. IT MAY BE
DUPLICATED AND/OR DISTRIBUTED PROVIDED THAT NO FEE IS CHARGED AND THIS MESSAGE IS
NOT REMOVED. A USER'S GUIDE IS AVAILABLE FROM RMS PUBLICATIONS, 240 W. PROSPECT ROAD,
FORT COLLINS, CO 80526.

                                                        (BRACKETED COMMENTS ADDED
                                                        TO HELP INTERPRET OUTPUT)
  ENTER OPTION (0 FOR MENU)
?
          0                                             (OPENING MESSAGE)
1) INPUT DATA
2) DISTANCE TO COST CONVERSION
3) MODIFY DATA
4) RUN REGRESSIONS AND REPORTS                          (MAIN MENU)
5) EXIT RMTCM PROGRAM
  ENTER OPTION (0 FOR MENU)
?
          1
1) INPUT DATA INTERACTIVELY FROM KEYBOARD
2) READ AN EXTERNAL ASCII DATA FILE
3) READ A PREVIOUSLY CREATED RMTCM SYSTEM FILE
4) RETURN TO MAIN MENU
CHOOSE FORM OF DATA ENTRY (1,2,3, OR 4)
?
      2
  ENTER ASCII DATA FILE NAME
?                                                       (INPUT DATA: FILE NAME IS
                                                        TABLE1)
   table1
   OPENING table1
  ENTER NUMBER OF VARIABLES
?
          6
MAXIMUM NNUMBER OF CASES IS 666
NAME VARIABLES (0-8 CHARACTERS)
C1
  ENTER NAME
?
   POP                                                  (NAMING VARIABLES)
C2
  ENTER NAME
?
   VISITS
C3
  ENTER NAME
?
   PCI
C4
```

```
  ENTER NAME
?
   DIS
C5
  ENTER NAME
?
   SUBDIS
C6
  ENTER NAME
?
   PERDIS
  SPECIFY INPUT FORMAT
                                                  ?  (Y OR N)
?
   N                                                              (FREEFIELD FORMAT)

  NUMBER OF CASES READ  =  12

FIRST FOUR LINES OF DATA ARE AS FOLLOWS. . .

     .3000E+05          224.0          8000.          67.00          30.00          136.0
     9000.              69.00          7000.          42.00          1.000          106.0
     6000.              77.00          8100.          30.00          30.00          76.00
     9000.              110.0          7900.          42.00          60.00          47.00

LAST LINE OF DATA IS AS FOLLOWS. . .

     .1400E+05          195.0          7375.          42.00          85.00          64.00

  LIST ALL THE DATA
                                                  ?  (Y OR N)
?
   Y
     .3000E+05          224.0          8000.          67.00          30.00          136.0
     9000.              69.00          7000.          42.00          1.000          106.0
     6000.              77.00          8100.          30.00          30.00          76.00
     9000.              110.0          7900.          42.00          60.00          47.00
     .3000E+05          282.0          8800.          60.00          42.00          136.0
     .1200E+05          141.0          7300.          30.00          30.00          106.0
     4000.              87.00          9100.          1.000          42.00          76.00
     .1200E+05          202.0          8150.          30.00          67.00          47.00
     .4000E+05          356.0          7700.          67.00          67.00          142.0
     3000.              35.00          7000.          42.00          60.00          114.0
     6000.              93.00          8100.          30.00          67.00          87.00
     .1400E+05          195.0          7375.          42.00          85.00          64.00

  SUBSTITUTE MEANS FOR MISSING VALUES      ?  (Y OR N)
?
   N

  ENTER OPTION (0 FOR MENU)                                       (DISTANCE TO COST)
?
           2
  ENTER AVERAGE TRAVEL SPEED (MPH)
?
       50.00000
  ENTER COST/MILE FOR VEHICLE ($)
?
       .12000
  ENTER PERSONS/VEHICLE
?
```

```
        2.50000
   ENTER ONE-WAY (O) OR ROUND-TRIP (R)
?
    O
   ENTER COST OF TIME ($ PER HOUR)
?
        1.89000
   ENTER PER VEHICLE ENTRY FEE AT THE SITE ($)
?
        .00000
   ENTER NAME OF VARIABLE TO CONVERT
?
    DIS
   ENTER NAME OF NEW VARIABLE (C7)
?
    COST
FIRST 4 CASES ARE AS FOLLOWS. . .                          (LIST CONVERTED VALUES)

                 C4          C7
    CASE         DIS            COST
        1        67.000      11.497
        2        42.000       7.207
        3        30.000       5.148
        4        42.000       7.207

   LIST ALL THE COST VALUES                  ?  (Y OR N)
?
    Y

                 C4          C7
    CASE         DIS            COST
        1        67.000      11.497
        2        42.000       7.207
        3        30.000       5.148
        4        42.000       7.207
        5        60.000      10.296
        6        30.000       5.148
        7         1.000        .172
        8        30.000       5.148
        9        67.000      11.497
       10        42.000       7.207
       11        30.000       5.148
       12        42.000       7.207
   ANOTHER, WITH SAME VALUES                 ?  (Y OR N)
?
    Y                                                      (CONVERT NEW VARIABLES
   ENTER NAME OF VARIABLE TO CONVERT                       WITH SAME INPUT PARAMETERS)
    C5
   ENTER NAME OF NEW VARIABLE (C8)
?
    SUBCOST

FIRST 4 CASES ARE AS FOLLOWS. . .

                 C5            C8
    CASE        SUBDIS        SUBCOST

        1        30.000       5.148
        2         1.000        .172
        3        30.000       5.148
        4        60.000      10.296
```

```
  LIST ALL THE COST VALUES                  ?  (Y OR N)
                                                         (CARRIAGE RETURN DEFAULTS
                                                         TO N FOR ALL "Y OR N"
                                                         PROMPTS)
  ANOTHER, WITH SAME VALUES                 ?  (Y OR N)
?
   Y
  ENTER NAME OF VARIABLE TO CONVERT
?
   PERDIS
  ENTER NAME OF NEW VARIABLE (C9)
?
   PERCOST

FIRST 4 CASES ARE AS FOLLOWS. . .

                 C6            C9
   CASE        PERDIS        PERCOST

     1        136.000        23.338
     2        106.000        18.190
     3         76.000        13.042
     4         47.000         8.065

  LIST ALL THE COST VALUES                  ?  (Y OR N)
?
   N

  ANOTHER, WITH SAME VALUES                 ?  (Y OR N)
?
   N
  ENTER OPTION (0 FOR MENU)
?
             0

1)  INPUT DATA
2)  DISTANCE TO COST CONVERSION
3)  MODIFY DATA
4)  RUN REGRESSIONS AND REPORTS
5)  EXIT RMTCM PROGRAM
  ENTER OPTION (0 FOR MENU)
?
             3                                           (MODIFY DATA)

0)  RELIST MENU
1)  ADD 2 COLUMNS (SEE ALSO OPTION 9)
2)  SUBTRACT (FIRST-SECOND)
3)  MULTIPLY (FIRST*SECOND)
4)  DIVIDE (FIRST/SECOND)
5)  MULTIPLY (COLUMN*CONSTANT)
6)  POWER (COLUMN**CONSTANT)
7)  NATURAL LOGARITHM
8)  ENTER NEW COLUMN OF DATA
9)  ADD A CONSTANT TO A COLUMN
10) EXIT TO MAIN MENU

  ENTER MODIFY CHOICE (0 FOR MODIFY MENU)
?
             4                                           (DIVIDE FIRST COLUMN
  ENTER NAME OF FIRST INPUT COLUMN                       BY SECOND)
?
```

```
    VISITS
  ENTER NAME OF SECOND INPUT COLUMN
?
    C1

  PUT RESULT IN EXISTING COLUMN          ?  (Y OR N)
?
    N
  ENTER NAME FOR NEW VARIABLE (C10)
?
    VCAP

FIRST 4 CASES ARE AS FOLLOWS...

                  C2            C1           C10
   CASE         VISITS          POP          VCAP

      1         224.00        30000.      .74667E-02
      2         69.000        9000.0      .76667E-02
      3         77.000        6000.0      .12833E-01
      4         110.00        9000.0      .12222E-01
  LIST ALL NEW VALUES                    ?  (Y OR N)
?
    N
  ENTER MODIFY CHOICE (0 FOR MODIFY MENU)
?
              0

 0)  RELIST MENU
 1)  ADD 2 COLUMNS (SEE ALSO OPTION 9)
 2)  SUBTRACT (FIRST-SECOND)
 3)  MULTIPLY (FIRST*SECOND)
 4)  DIVIDE (FIRST/SECOND)
 5)  MULTIPLY (COLUMN*CONSTANT)
 6)  POWER (COLUMN**CONSTANT)
 7)  NATURAL LOGARITHM
 8)  ENTER NEW COLUMN OF DATA
 9)  ADD A CONSTANT TO A COLUMN
10)  EXIT TO MAIN MENU

  ENTER MODIFY CHOICE (0 FOR MODIFY MENU)
?
              7
  ENTER NAME OF INPUT COLUMN
?
    VCAP

  PUT RESULT IN EXISTING COLUMN          ?  (Y OR N)
?
    N
  ENTER NAME FOR NEW VARIABLE (C11)
?
    LVCAP

FIRST 4 CASES ARE AS FOLLOWS...

                    C10           C11
   CASE             VCAP          LVCAP

     1           .74667E-02      -4.8973
     2           .76667E-02      -4.8709
     3           .12833E-01      -4.3557
     4           .12222E-01      -4.4045
```

(COLUMN NUMBER CAN BE USED IN PLACE OF VARIABLE NAME)

(COMPUTE NATURAL LOG OF VISITS PER CAPITA)

```
  LIST ALL NEW VALUES                       ?  (Y OR N)
?
    N
  ENTER MODIFY CHOICE (0 FOR MODIFY MENU)
?
             10                                               (EXIT MODIFY)
  ENTER OPTION (0 FOR MENU)
?
             4                                                (START REGRESSION)

  DISPLAY LIST OF VARIABLE NAMES            ?  (Y OR N)
?
    Y
CURRENT VARIABLES ARE AS FOLLOWS:
    C1              POP
    C2              VISITS
    C3              PCI
    C4              DIS
    C5              SUBDIS                                    (LISTING VARIABLES)
    C6              PERDIS
    C7              COST
    C8              SUBCOST
    C9              PERCOST
    C10             VCAP
    C11             LVCAP

  USE ALL VARIABLES IN THE REGRESSION       ?  (Y OR N)
?                                                             (SELECT VARIABLES FOR
    N                                                         REGRESSION)

    USE POP                                 ?  (Y OR N)
?
                                                              (CARRIAGE RETURN
                                                              DEFAULTS TO N)
    USE VISITS                              ?  (Y OR N)
?


    USE PCI                                 ?  (Y OR N)
?
    Y

    USE DIS                                 ?  (Y OR N)
?


    USE SUBDIS                              ?  (Y OR N)
?


    USE PERDIS                              Y  (Y OR N)
?


    USE COST                                ?  (Y OR N)
?
    Y

    USE SUBCOST                             ?  (Y OR N)
?
    Y
```

```
    USE PERCOST                              ?  (Y OR N)
?

    USE VCAP                                 ?  (Y OR N)
?

    USE LVCAP                                ?  (Y OR N)
?
  ENTER NAME OF DEPENDENT VARIABLE                              (NAME DEPENDENT VARIABLE:
                                                                FUNCTIONAL FORM IS
?                                                               LINEAR)
    VCAP
DEPENDENT VARIABLE IS VCAP

         BRIEF REGRESSION STATISTICS

                                                                (BRIEF OUTPUT)

R SQUARED = .981
COLUMN NAME           COEFFICIENT          T STATS         PROB
   CONSTANT              .329790E-02          1.223         .2561
   C3  PCI               .166746E-05          5.198         .0008
   C7  COST             -.104919E-02         15.981         .0000
   C8  SUBCOST           .398056E-03          7.909         .0000

  PRODUCE EXPANDED OUTPUT                    ?  (Y OR N)
?                                                               (LENGTHY OUTPUT)
   N

  PRODUCE SUMMARY REPORT                     ?  (Y OR N)
?
   N                                                            (NO REPORT, TRY NEW
                                                                FUNCTIONAL FORM)

  ENTER OPTION (0 FOR MENU)
?
           4

  DISPLAY LIST OF VARIABLE NAMES             ?  (Y OR N)
?
   N

  USE ALL VARIABLES IN THE REGRESSION        ?  (Y OR N)
?                                                               (SELECT NEW VARIABLES
   N                                                            FOR REGRESSION)

   USE POP                                   ?  (Y OR N)
?
   USE VISITS                                ?  (Y OR N)
?

   USE PCI                                   ?  (Y OR N)
?
   Y

   USE DIS                                   ?  (Y OR N)
?
```

```
   USE SUBDIS                                  ?  (Y OR N)
?


   USE PERDIS                                  ?  (Y OR N)
?


   USE COST                                    ?  (Y OR N)
?
   Y

   USE SUBCOST                                 ?  (Y OR N)
?
   Y

   USE PERCOST                                 ?  (Y OR N)
?


   USE VCAP                                    ?  (Y OR N)
?


   USE LVCAP                                   ?  (Y OR N)
?

 ENTER NAME OF DEPENDENT VARIABLE
?
   LVCAP
DEPENDENT VARIABLE IS LVCAP                                        (FUNCTIONAL FORM IS
                                                                   SEMI-LOG DEPENDENT)
      BRIEF REGRESSION STATISTICS

                                                                   (BRIEF OUTPUT)

R SQUARED = .993
COLUMN                  COEFFICIENT          T STATS       PROB

   CONSTANT             -.491111E+01          39.603       .0000
   C3  PCI               .931798E-04           6.316       .0002
   C7  COST             -.821803E-01          27.217       .0000
   C8  SUBCOST           .378289E-01          16.342       .0000

 PRODUCE EXPANDED OUTPUT                     ?  (Y OR N)
?
   N

 PRODUCE SUMMARY REPORT                      ?  (Y OR N)
?
   Y

1) LINEAR
2) QUADRATIC
3) SEMI-LOG INDEPENDENT
4) SEMI-LOG DEPENDENT
5) DOUBLE LOG
 ENTER FUNCTIONAL FORM USED
?                                                                  (SELECT FUNCTIONAL FORM)
             4
 ENTER VARIABLE NAME FOR ROUND-TRIP COST
?
```

COST
ENTER VARIABLE NAME FOR POPULATION
?
POP
A FEE INCREASE OF 71.709 RESULTS IN ZERO VISITS FROM ALL ORIGINS
– THE LAST ORIGIN TO PRODUCE VISITS IS 9

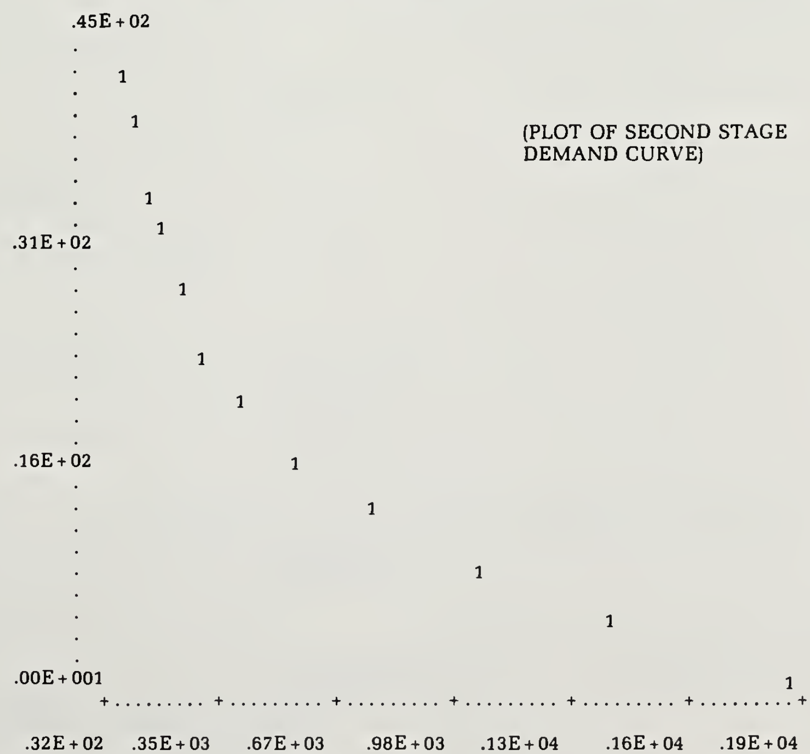
ENTER NEW DEMAND CUTOFF POINTS ? (Y OR N)
?
N

(NO CUTOFF POINTS USED)

FEE INCREASE	TOTAL VISITS
.000	1869.33
3.774	1370.83
7.548	1005.27
11.323	737.19
15.097	540.60
18.871	396.44
22.645	290.72
26.419	213.19
30.193	156.34
33.968	114.65
37.742	84.08
41.516	61.65
45.290	44.38
49.064	32.54
52.838	21.97
56.613	14.35
60.387	8.76
64.161	5.45
67.935	2.43
71.709	1.00

(SUMMARY REPORT)

SECOND STAGE DEMAND CURVE
COST INCREASE (DOWN) BY TOTAL VISITS (ACROSS)



(PLOT OF SECOND STAGE DEMAND CURVE)

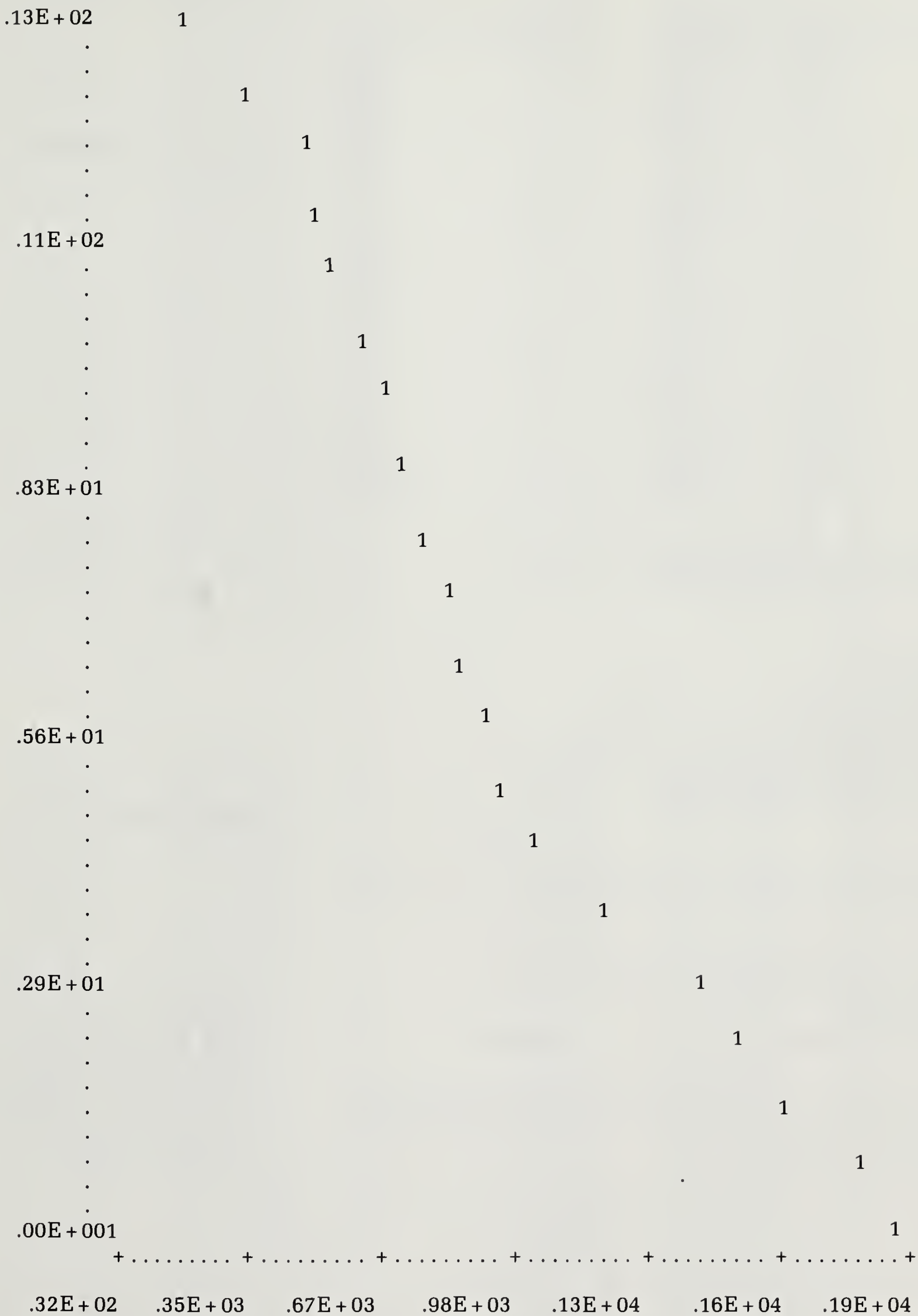
```
CONSUMER SURPLUS = 22780.97                          (CONSUMER SURPLUS)
C.S./TRIP =            12.19

 ADDITIONAL FEE    REVENUE    CHANGE IN REVENUE
           3.77    5173.76              5173.76
           7.55    7588.13              2414.36    (FEE REVENUE TABLE)
          11.32    8346.87               758.75
          15.10    8161.32              -185.55
          18.87    7481.16              -680.17
          22.65    6583.37              -897.79
          26.42    5632.39              -950.98
          30.19    4720.44              -911.95
          33.97    3894.34              -826.11
          37.74    3173.14              -721.20
          41.52    2559.65              -613.49
          45.29    2009.77              -549.88
          49.06    1596.63              -413.13
          52.84    1160.83              -435.80
          56.61     812.62              -348.21
          60.39     529.27              -283.35
          64.16     349.50              -179.78
          67.94     164.88              -184.62
          71.71      71.71               -93.17

                                                   (RE-ESTIMATE SAME MODEL:
 ENTER OPTION (0 FOR MENU)                          SUMMARY REPORT WILL USE
?                                                   DEMAND CUTOFF POINTS)
          4

 DISPLAY LIST OF VARIABLE NAMES        ?  (Y OR N)
?
  N

 USE ALL VARIABLES IN THE REGRESSION   ?  (Y OR N)
?
  N

  USE POP                              ?  (Y OR N)
?

  USE VISITS                           ?  (Y OR N)
?

  USE PCI                              ?  (Y OR N)
?
  Y

  USE DIS                              ?  (Y OR N)
?
  USE SUBDIS                           ?  (Y OR N)
?

  USE PERDIS                           ?  (Y OR N)
?

  USE COST                             ?  (Y OR N)
?
  Y
```

```
    USE SUBCOST                              ?  (Y OR N)
?
    Y

    USE PERCOST                              ?  (Y OR N)
?


    USE VCAP                                 ?  (Y OR N)
?


    USE LVCAP                                ?  (Y OR N)
?

  ENTER NAME OF DEPENDENT VARIABLE
?
    LVCAP
DEPENDENT VARIABLE IS LVCAP

              BRIEF REGRESSION STATISTICS

                                                              (SAME MODEL AS BEFORE)

R SQUARED = .993
COLUMN NAME          COEFFICIENT      T STATS      PROB

    CONSTANT          -.491111E+01     39.603      .0000
    C3  PCI            .931798E-04      6.316      .0002
    C7  COST          -.821803E-01     27.217      .0000
    C8  SUBCOST        .378289E-01     16.342      .0000

  PRODUCE EXPANDED OUTPUT                  ?  (Y OR N)
?
    N

  PRODUCE SUMMARY REPORT                   ?  (Y OR N)
?   Y

1) LINEAR
2) QUADRATIC
3) SEMI-LOG INDEPENDENT
4) SEMI-LOG DEPENDENT
5) DOUBLE LOG
  ENTER FUNCTIONAL FORM USED
?
              4
  ENTER VARIABLE NAME FOR ROUND-TRIP COST
?
    COST
  ENTER VARIABLE NAME FOR POPULATION
?
    POP
A FEE INCREASE OF     71.709 RESULTS IN ZERO VISITS FROM ALL ORIGINS
    - THE LAST ORIGIN TO PRODUCE VISITS IS     9

  ENTER NEW DEMAND CUTOFF POINTS       ?  (Y OR N)
?
    Y                                                          (ENTER CUTOFF POINTS)
1) ENTER NEW DEMAND CUTOFF POINTS ONE BY ONE
2) SPECIFY COLUMN OF CUTOFF POINTS
```

```
MAKE SELECTION (1 OR 2)
?
       2
  ENTER VARIABLE NAME FOR DEMAND CUTOFF
?
    PERCOST

  LIST NEW CUTOFF POINTS                    ?  (Y OR N)
?
    Y
LISTED BELOW ARE THE PRICES THAT DRIVE TRIPS TO ZERO WITH CUTOFF POINTS
IN EFFECT. SEE USER'S GUIDE.
ORIGIN      1     23.338
ORIGIN      2     18.190
ORIGIN      3     13.042                         (LISTING CUTOFF POINTS)
ORIGIN      4      8.065
ORIGIN      5     23.338
ORIGIN      6     18.190
ORIGIN      7     13.042
ORIGIN      8      8.065
ORIGIN      9     24.367
ORIGIN     10     19.562
ORIGIN     11     14.929
ORIGIN     12     10.982
A FEE INCREASE OF    13.042 RESULTS IN ZERO VISITS FROM ALL ORIGINS
   - THE LAST ORIGIN TO PRODUCE VISITS IS    9

  ENTER NEW DEMAND CUTOFF POINTS      ?  (Y OR N)
?
    N

FEE INCREASE   TOTAL VISITS
                                                 (SUMMARY REPORT WITH NEW
         .000            1869.33                 CUTOFF POINTS)
         .686            1766.80
        1.373            1568.98
        2.059            1482.92
        2.746            1401.59
        3.432            1180.58
        4.118             975.50
        4.805             922.00
        5.491             871.43
        6.178             823.64
        6.864             778.46
        7.550             735.77
        8.237             657.40
        8.923             621.34
        9.610             587.26
       10.296             514.24
       10.982             482.04
       11.669             432.23
       12.355             328.86
       13.042             144.34
```

SECOND STAGE DEMAND CURVE

COST INCREASE (DOWN) BY TOTAL VISITS (ACROSS)



CONSUMER SURPLUS = 11766.19
C.S./TRIP = 6.29

(CONSUMER SURPLUS ESTIMATES WITH CUTOFF POINTS IN EFFECT)

ADDITIONAL FEE	REVENUE	CHANGE IN REVENUE
.69	1212.73	1212.73
1.37	2153.89	941.16
2.06	3053.64	899.74
2.75	3848.20	794.57
3.43	4051.74	203.53
4.12	4017.51	−34.22
4.80	4430.03	412.51
5.49	4785.20	355.18
6.18	5088.09	302.89
6.86	5343.36	255.27
7.55	5555.32	211.96
8.24	5414.85	−140.47
8.92	5544.35	129.50
9.61	5643.35	99.01
10.30	5294.66	−348.70
10.98	5337.88	43.22
11.67	5043.62	−294.26
12.36	4063.13	−980.49
13.04	1882.40	−2180.73

(NEW FEE REVENUE TABLE)

ENTER OPTION (0 FOR MENU)
?
0

1) INPUT DATA
2) DISTANCE TO COST CONVERSION
3) MODIFY DATA
4) RUN REGRESSIONS AND REPORTS
5) EXIT RMTCM PROGRAM

ENTER OPTION (0 FOR MENU)
?
5

(EXIT RMTCM)

SAVE DATA AS RMTCM SYSTEM FILE ? (Y OR N)
?
Y
ENTER NAME OF RMTCM SYSTEM FILE
?
TABLE1.SYS
12 CASES WERE SAVED ON FILE TABLE1.SYS

(SAVE DATA AS RMTCM SYSTEM FILE)
(THE FILE NAMES IN THE "$AVE DIALOG USE PERIODS (".") ON THE PC AND DASHES ("-") ON THE UNIVAC: "TABLE1.SYS" ON THE PC IS "TABLE1-SYS" ON THE UNIVAC)

LOG OF SESSION HAS BEEN SAVED ON FILE 'TCM.LOG'

END OF TCM PROGRAM

Rosenthal, Donald H., Dennis M. Donnelly, Marie B. Schiffhauer, and Glen E. Brink. 1986. User's Guide to RMTCM: Software for Travel Cost Analysis. USDA Forest Service General Technical Report RM–132, 32 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

RMTCM is an interactive menu-driven program for performing travel cost analysis. The program consists of four main modules: (1) data input; (2) data modification; (3) regression analysis; and (4) report writing. The report graphs the "second-stage" demand curve and estimates consumer surplus. The program is written in FORTRAN-V and a version is available for use on an IBM personal computer or compatible machine.

Keywords: travel cost model, computer program, consumer surplus

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U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

Rocky Mountains

Southwest

Great Plains

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526