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# A FORTRAN 77 Program and User's Guide for the Calculation of Partial Correlation and Standardized Regression Coefficients

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# A FORTRAN 77 PROGRAM AND USER'S GUIDE FOR THE CALCULATION OF PARTIAL CORRELATION AND STANDARDIZED REGRESSION COEFFICIENTS

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## ABSTRACT

This document is for users of a computer program developed by the authors at Sandia National Laboratories. The computer program is designed to be used in conjunction with sensitivity analyses of complex computer models. In particular, this program is most useful in analyzing input-output relationships when the input has been selected using the Latin hypercube sampling program developed at Sandia (Iman and Shortencarier, 1984). The present computer program calculates the partial correlation coefficients and/or the standardized regression coefficients from the multivariate input to, and output from, a computer model. These coefficients can be calculated on either the original observations or on the ranks of the original observations. The coefficients provide alternative measures of the relative contribution (importance) of each of the various inputs to the observed output variations. Relationships between the coefficients and differences in their interpretations are identified. If the computer model output has an associated time or spatial history then the computer program will generate a graph of the coefficients over time or space for each input-variable, output-variable combination of interest, thus indicating the importance of each input over time or space. The computer program is user-friendly and written in FORTRAN 77 to facilitate portability.

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# 1. PARTIAL CORRELATION AND STANDARDIZED REGRESSION COEFFICIENTS

## Introduction

Sensitivity studies associated with computer models are frequently accomplished by making computer runs with the model on the basis of input selected in one of several different ways. One of these ways is a simple parametric approach that proceeds by varying only one input at a time while holding all other inputs fixed at some nominal value. Such an approach frequently is not cost effective and the results are conditional on the choice of the nominal values.

Another approach is to select the input on the basis of an experimental design. A design frequently selected for use with computer models is a fractional factorial where each input is represented by fixed levels such as "high" or "low" and the inputs are paired orthogonal to one another, i.e. all pairwise correlations among the inputs are zero. Such designs produce reliable sensitivity results if the output behaves in a linear fashion with respect to the input. If the behavior is nonlinear then it is necessary to use more levels with each input such as "high", "medium" and "low" or to alter the design in some manner that includes a denser selection of each of the inputs. As the number of levels increases it becomes necessary to make more computer runs. If runs are costly this can inhibit the use of such an approach to selecting the values of the inputs. Other questions that may contribute to the analyst's decision as to whether or not to use an experimental design include: (1) Are the inputs known to be correlated with one another? (2) Are estimates of means, variances, quantiles and cumulative distribution functions of the output desired as part of the analysis? (3) Are scatterplots of each input versus each output desired to aid in discovering relationships such as discontinuities between input and output that might not otherwise be easily detected?

An alternative approach to selecting input is simple Monte Carlo or restricted Monte Carlo. Such an approach has the advantage that it can easily be structured to address the three previous questions. A detailed comparison of the advantages and disadvantages of various methods of selecting input can be found in Iman and Helton (1985).

When using a Monte Carlo type approach, the analyst must be willing to give up the orthogonality of fractional factorial designs. However, if the input has been selected in an orthogonal manner then there is little need for the use of the program described in this report. That is, the program described in this report is most useful in conjunction with a Monte Carlo study. Such would be the case with input generated by the Latin hypercube sampling program at Sandia (Iman and Shortencarier, 1984).

Once the input has been selected and computer runs completed in a Monte Carlo study, it is necessary to quantify the sensitivity of the output to each of the inputs. This report describes how to use a computer program (PCC/SRC) developed at Sandia National Laboratories for measuring these sensitivities. Two closely related, but different, measures are presented. These are partial correlation coefficients (PCC) and standardized regression coefficients (SRC) computed on either the original observations or on the ranks of the original observations. This program is particularly useful when there are a large number of inputs and several outputs having an associated time history. Both coefficients are succinctly summarized for each output with respect to each input measured over time.

Standardized Regression Coefficients

Sensitivity analysis in conjunction with Monte Carlo sampling is closely related to the construction of regression models which approximate the behavior calculated by the computer model. Suppose a computer model has inputs $X_1, \ldots X_k$ and output Y. After making n runs of the computer model, the multivariate observations $(X_{1i}, \ldots X_{ki}, Y_i)$; $i=1, \ldots, n$ can be used to construct an approximate regression model of the form

$$\hat{Y} = b_o + \sum_{j=1}^{k} b_j X_j .$$

The constant $b_o$ and the ordinary regression coefficients $b_j$ are obtained by the usual methods of least squares. The ordinary regression coefficients are the partial derivatives of the regression model with respect to the input variables. However, these ordinary regression coefficients are easily influenced by the units in which the variables are measured, i.e., inches, feet, yards, miles, etc. Therefore, they do not provide a very reliable measure of the relative importance of the input variables.

The problem arising with different variables being measured in different units can be eliminated by standardizing all variables used in the regression model as $X^* = (X - \bar{X})/s_x$ where $\bar{X}$ and $s_x$ are the usual sample mean and standard deviation, respectively. The previous regression model can be rewritten in the following standardized form,

$$Y^* = \sum_{j=1}^{k} b_j^* X_j^* .$$

The coefficients in this standardized model are called <u>standardized</u> regression coefficients. Such coefficients are useful since they can be used to provide a direct measure of the relative importance of the input variables. Of course, the reliability of these results is conditional on the degree to which the relationship between Y and $X_1, \ldots, X_k$ is adequately described by the regression model.

## Adequacy of the Regression Model

An important property of least-squares regression is that

$$\sum_i (Y_i - \bar{Y})^2 = \sum_i (\hat{Y}_i - \bar{Y})^2 + \sum_i (Y_i - \hat{Y}_i)^2 .$$

Simply put, this means that the total variation in Y can be represented as the sum of the variation due to regression on the X's and the variation due to lack of fit by the regression model. This expression provides for a convenient way to measure the adequacy of the regression model as

$$R_Y^2 = \sum_i (\hat{Y}_1 - \bar{Y})^2 / \sum_i (Y_1 - \bar{Y})^2 .$$

$R_Y^2$ varies between 0 and 1 and is called the coefficient of determination. Thus, $R_Y^2$ provides a measure of the percent of the variation in Y explained by regression on the X's. Regression analysis is often performed in a stepwise fashion in which a sequence of regression models is constructed by adding one input variable at each step until all significant input variables have been included in the model. The order in which the input variables are added to the regression model is determined by the magnitude of the partial correlation coefficients. More details on stepwise regression can be found in the user's guide for the stepwise regression program in use at Sandia (Iman, Davenport, Frost and Shortencarier, 1980).

## Partial Correlation Coefficients

The <u>sample</u> correlation coefficient provides a measure of the linear relationship between Y and $X_j$. If this correlation coefficient is denoted by $r_{yj}$, then $\max_j |r_{yj}|$ can be used to identify the input variable having the strongest linear relationship with Y. This variable would be used as a starting point to build a linear model which expresses Y as a function of the input variables. However, the identification of additional input variables to add to the linear model is not as easy since such additions are dependent on the variables already in the model.

The <u>partial</u> correlation coefficient is a measure that explains the unique relation between two variables that cannot be explained in terms of the relations of these two variables with any other variables. Thus, it provides a means of identifying which additional variables could be added to the existing model.

As an example, consider a linear model having only one input variable,

$$\hat{Y} = b_0 + b_1 X_j$$

The residuals from this model are denoted by $Y_i - \hat{Y}_i$. The partial correlation for any remaining variable not in the model is found by computing the sample correlation coefficient between the residuals and that variable. Thus, a measure of linearity between any remaining variable and Y is obtained, given that an adjustment has been made for the variable(s) already in the model. Later in this section, a mathematical relationship is established between the partial correlation coefficient and the standardized regression coefficient.

## Rank Transformation

When nonlinear relationships are involved, it is often more revealing to calculate standardized regression coefficients and partial correlation coefficients on variable ranks than on the actual values for the variables: such coefficients are known as <u>standardized rank regression coefficients</u> (SRRC) and <u>partial rank correlation coefficients</u> (PRCC). Specifically, the smallest value of each variable is assigned the rank 1, the next smallest value is assigned rank 2, and so on up to the largest value which is assigned the rank n, where n denotes the number of observations. The standardized regression coefficients and/or partial correlation coefficients are then calculated on these ranks.

## Matrix Formulation

Suppose a computer model has inputs $X_1, \ldots, X_k$ and output Y. After making n runs of the model with varying input, a correlation matrix between the input and output is computed for a given point in the output time history (assuming that the output produces a time history). Let the correlation matrix be represented as follows,

$$
C = \left[\begin{array}{cccc|c}
1 & r_{12} & \cdots & r_{1k} & r_{1y} \\
r_{21} & 1 & \cdots & r_{2k} & r_{2y} \\
\cdots & \cdots & & \cdots & \cdots \\
r_{k1} & r_{k2} & \cdots & 1 & r_{ky} \\
\hline
r_{y1} & r_{y2} & \cdots & r_{yk} & 1
\end{array}\right]
$$

where $r_{ij}$, $1 \le i, j \le k$ is the sample correlation coefficient between inputs $X_i$ and $X_j$ while $r_{yj}$ is the sample correlation coefficient between Y and $X_j$. The value of $r_{yj}$ is computed by the following equation,

$$
r_{yj} = \frac{\sum_{i=1}^{n} X_{ij}Y_i - \sum_{i=1}^{n} X_{ij} \sum_{i=1}^{n} Y_i/n}{\left\{\left[\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n\right]\left[\sum_{i=1}^{n} Y_i^2 - (\sum_{i=1}^{n} Y_i)^2/n\right]\right\}^{1/2}}
$$

Further, let the symmetric matrix C be partitioned into submatrices as indicated by the dashed lines within the C matrix. That is,

$$
C = \begin{bmatrix} C_{11} & C_{12} \\ C_{21} & 1 \end{bmatrix}
$$

where $C_{11}$ is k x k, $C_{12}$ is k x 1 and $C_{21} = C'_{12}$ since C is symmetric. From Theorem 8.2.1 in Graybill (1969), the inverse of the symmetric matrix C can be written as

$$
C^{-1} = \begin{bmatrix} [C_{11} - C_{12}C_{21}]^{-1} & -C_{11}^{-1}C_{12}[1 - C_{21}C_{11}^{-1}C_{12}]^{-1} \\ -[C_{11}^{-1}C_{12}[1 - C_{21}C_{11}^{-1}C_{12}]^{-1}]' & [1 - C_{21}C_{11}^{-1}C_{12}]^{-1} \end{bmatrix}
$$

Both the SRCs and the PCCs can be derived directly from $C^{-1}$. The The k x 1 vector of SRCs is found as $B = C_{11}^{-1}C_{12}$. Furthermore, if

Y is regressed on $X_1,\ldots,X_k$, the model coefficient of determination, $R_y^2$ is found as $C_{21}C_{11}^{-1}C_{12}$. This information allows $C^{-1}$ to be written as follows.

$$C^{-1} = \begin{bmatrix} [C_{11} - C_{12}C_{21}]^{-1} & -B/(1 - R_y^2) \\ -B'/(1 - R_y^2) & 1/(1 - R_y^2) \end{bmatrix}$$

The diagonal elements of $[C_{11} - C_{12}C_{21}]^{-1}$contain the coefficients of determination, $R^2_{x_j}$, corresponding to regressing $X_j$ on Y and the remaining X's. Specifically, the diagonal elements are $1/(1-R^2_{x_j})$. Therefore, C can be written in expanded form as follows.

$$C^{-1} = \left[\begin{array}{cccc|c} 1/(1-R^2_{x_1}) & c_{12} & \cdots & c_{1k} & -B_1/(1-R_y^2) \\ c_{21} & 1/(1-R^2_{x_2}) & \cdots & c_{2k} & -B_2/(1-R_y^2) \\ \cdots & \cdots & & \cdots & \cdots \\ c_{k1} & c_{k2} & \cdots & 1/(1-R^2_{x_k}) & -B_k/(1-R_y^2) \\ \hline -B_1/(1-R_y^2) & -B_2/(1-R_y^2) & \cdots & -B_k/(1-R_y^2) & 1/(1-R_y^2) \end{array}\right]$$

where $B_j$ is the SRC for $X_j$.

The PCC for $X_j$ and Y is obtained directly from $C^{-1}$ as

$$P_{x_jy} = -c_{jy}/(c_{jj}c_{yy})^{1/2} .$$

Therefore, the PCC can be written as

$$p_{x_j y} = \frac{B_j/(1-R_y^2)}{\sqrt{[1/(1-R_{x_j}^2)]\ [1/(1-R_y^2)]}} = B_j \sqrt{\frac{1-R_{x_j}^2}{1-R_y^2}} \qquad (1)$$

Equation (1) shows the close relationship between $p_{x_j y}$ and $B_j$. This formula holds as long as $R_y^2 < 1$. If the X's and Y's have been standardized, then equation (1) can be written in another form by noting that $1 - R_{x_j}^2$ is the variance of $X_j$ conditional on Y and the remaining X's. Also, $1 - R_y^2$ is the variance of Y conditional on the X's. This allows (1) to be rewritten in the alternate form

$$\frac{p_{x_j y}}{B_j} = \frac{\sigma_{x_j|y,\ x_1,\ldots,\ x_{j-1},\ x_{j+1},\ldots,x_k}}{\sigma_{y|x_1,\ldots,x_k}} . \qquad (2)$$

<u>Example</u>

As an example to illustrate the preceding discussion, consider a model with four inputs $X_1, \ldots, X_4$ and output Y which produces the following correlation matrix C.

C =

| | | | | |
|---|---|---|---|---|
| 1.0000 | .2286 | -.8241 | -.2454 | .7307 |
| .2286 | 1.0000 | -.1392 | -.9730 | .8163 |
| -.8241 | -.1392 | 1.0000 | .0295 | -.5347 |
| -.2454 | -.9730 | .0295 | 1.0000 | -.8213 |
| .7307 | .8163 | -.5347 | .8213 | 1.0000 |

The corresponding inverse is

$C^{-1}$ =

| | | | | |
|---|---|---|---|---|
| 59.5004 | 112.8185 | 43.5726 | 94.8764 | -34.3504 |
| 112.8185 | 272.0920 | 107.1087 | 264.8053 | -29.7896 |
| 43.5726 | 107.1087 | 47.2565 | 111.5646 | -2.3752 |
| 94.8764 | 264.8053 | 111.5646 | 286.2671 | 9.2780 |
| -34.3504 | -29.7896 | -2.3752 | 9.2780 | 56.7671 |

The value $1 - R_y^2$ is found as the reciprocal of $C^{-1}$ (5,5) or 1/56.7671 = .0176. The SRCs are found by multiplying the first four elements in the last column of $C^{-1}$ by $-(1 - R_y^2)$ to get

$$B' = [.6051 \quad .5248 \quad .0418 \quad -.1634]$$

The values $1 - R_{x_j}^2$ are obtained from the reciprocals of the first diagonal elements of $C^{-1}$. Thus, from equation (1) the partial correlations are found as .5910, .2397, .0459 and -.0728.

Note that the output Y is most sensitive to $X_1$ and the least sensitive to $X_3$ as determined from both the SRCs and the PCCs. Although the rankings of the inputs by their sensitivity on the output are the same in this case and in most cases, it is important to recognize that they yield different types of information. SRCs are derived from a conditional univariate distribution, while PCCs come from a conditional bivariate distribution. PCCs allow one to judge the unique contribution that an explanatory variable can make. SRCs are equivalent to the partial derivatives of the standardized regression model. In order to illustrate the difference, consider two cases for a linear model with three inputs.

CASE I.

| | Correlation Matrix | | | i | PCC Y and $X_i$ | SRC Y and $X_i$ |
|---|---|---|---|---|---|---|
| $X_2$ | .8 | | | 1 | .320256 | .333 |
| $X_3$ | 0 | 0 | | 2 | .320256 | .333 |
| Y | .6 | .6 | .5 | 3 | .645497 | .500 |
| | $X_1$ | $X_2$ | $X_3$ | | | |

CASE II.

| | Correlation Matrix | | | i | PCC Y and $X_i$ | SRC Y and $X_i$ |
|---|---|---|---|---|---|---|
| $X_2$ | .8 | | | 1 | .585038 | .665556 |
| $X_3$ | 0 | 0 | | 2 | .000602 | .000556 |
| Y | .666 | .533 | .5 | 3 | .670285 | .500 |
| | $X_1$ | $X_2$ | $X_3$ | | | |

The difference between Cases I and II is small shifts in the correlation between Y and $X_1$ and between Y and $X_2$. While the ordering of the X's based on the size of the absolute values of the PCCs and SRCs are the same in Case I, they differ in Case II. The difference is that the PCCs are measuring the unique or unshared contribution of each variable. The SRCs, on the other hand, parcel out the non-unique or shared contribution in a manner that is consistent with maximizing the explanatory ability of the chosen model. This allocation of shared explanatory power is model dependent. In Case II, the SRCs correctly indicate that, in the fitted model, the partial derivative with respect to $X_1$ is larger than that of either $X_2$ or $X_3$. The PCCs correctly indicate that the removal of $X_3$ from the model would cause the greatest decrease in the explanatory power of the model. This is seen by noting that the coefficient of determination, $R^2$, falls from .693 to .443 when $X_3$ is removed from the model, while it falls to .534 when $X_1$ is deleted. Thus, both measures are useful in diagnosing the importance of the variables.

## 2. INPUT PARAMETERS

The PCC/SRC program recognizes 20 keywords (no abbreviations allowed) which dictate the characteristics of the problem. These keywords are used to describe the type of analysis desired, to describe the structure of the input file and to control the output. If the keyword requires accompanying numerical values or alphanumeric values, these values are input using list-directed read statements.

The only restrictions on the keywords are that there can be no leading blanks and at least one blank must follow each keyword. Information required with any keyword may be continued from one record to the next as long as the continuation record begins with a blank.

There are a number of internal checks built into the program to ensure that the input parameters have been correctly specified. In the event an improper specification is detected, an appropriate message is printed and the execution of the program is terminated.

The role of each keyword will now be explained. For purposes of illustration, Table 1 gives an example setup that uses 17 of the 20 keywords.

Table 1. Sample Setup Using 17 Keywords

```
 1.  TITLE  SAMPLE SETUP FOR USING THE PCC/SRC PROGRAM
 2.  NIV   6
 3.  NDV   5
 4.  NOBS   50
 5.  STEPS  1 5 1  5 15 2  15 30 5  30 50 10  50 100 50
 6.  PRCC
 7.  SRCC
 8   FILE TYPE   2
 9.  IND VARS   1   4   5   6
10   DEP VARS   4   5
11.  XLABEL   HEAT  DELAY  DECON  LD50  PROPERTY  MAGNITUD
12.  YLABEL   EFAT  EINJ  DCST  WBSOM  CANCE
13.  TABLE CUTOFF   .7
14.  PLOT CUTOFF   .8
15.  PLOT TITLE   PRCC AND SRRC FOR CRAC2
16.  PLOT XLABEL   TIME(MINUTES)
17.  XLOG
```

TITLE

This keyword can be followed with alphanumeric data to help describe the application (see line 1 of Table 1). This information will be printed as a one-line header on each page of the output. This keyword is optional. If it is omitted, a blank header is generated at the top of each page of output.

NIV ***<u>This keyword is required</u>.***

This keyword must be followed by a positive integer that specifies the number of independent variables (model inputs) on the input file. Line 2 of Table 1 indicates six independent variables. The maximum number of independent variables, currently 50, is easily changed (see Section 3).

NDV ***<u>This keyword is required</u>***

This keyword must be followed by a positive integer that specifies the number of dependent variables (model outputs) on the input file. Line 3 of Table 1 indicates five dependent variables. The maximum number of dependent variables, currently 20, is easily changed (see Section 3).

NOBS ***<u>This keyword is required</u>***

This keyword must be followed by a positive integer that specifies the number of observations on the input file. Line 4 of Table 1 indicates 50 observations. The maximum number of observations, currently 100, is easily changed (see Section 3).

STEPS

This keyword must be followed by k ordered triples that specify the interval (usually time steps) between successive readings of a particular dependent variable. Line 5 in Table 1 indicates 5 ordered triples. The first ordered triple means that readings were made on each dependent variable from step 1 to step 5 in increments of size 1. The remaining ordered triples indicate the next set of readings go from 5 to 15 in increments of size 2; from 15 to 30 in increments of size 5; from 30 to 50 in increments of size 10; and finally, from 50 to 100 in an increment of size 50. This information serves two purposes within the program. First, it identifies the number of steps (usually time steps) associated with each dependent variable which in turn is used in reading the data. The second use is to determine the proper spacing on the horizontal axis of the plot of the PCC or SRC. If this keyword is omitted, it is assumed that there is only one step in which case no plots would be generated. The maximum number of ordered triples, currently 10, and the maximum number of steps, currently 100, are easily changed (see Section 3).

***<u>At least one of the next four keywords is required</u>***

PCC

The partial correlation coefficients are computed on the original observations when this keyword is used. This keyword can be used in conjunction with the keyword SRC in which case both the PCC's and SRC's are computed and appear jointly in the plots generated by the program. <u>This keyword cannot be used in conjunction with the keywords PRCC and SRRC</u>.

SRC

The standardized regression coefficients are computed on the original observations when this keyword is used. This keyword can be used in conjunction with the keyword PCC in which case both the PCC's and SRC's are computed and appear jointly in the plots generated by the program. <u>This keyword cannot be used in conjunction with the keywords PRCC and SRRC</u>.

PRCC

The partial correlation coefficients are computed on the ranks of the original observations when this keyword is used. This keyword can be used in conjunction with the keyword SRRC in which case both the PRCC's and SRRC's are computed and appear jointly in the plots generated by the program. <u>This keyword cannot be used in conjunction with the keywords PCC and SRC</u>. This keyword is shown on line 6 of Table 1.

SRRC

The standardized regression coefficients are computed on the ranks of the original observations when this keyword is used. This keyword can be used in conjunction with the keyword PRCC in which case both the PRCC's and SRRC's are computed and appear jointly in the plots generated by the program. <u>This keyword cannot be used in conjunction with the keywords PCC and SRC</u>. This keyword is shown on line 7 of Table 1.

FILE TYPE ***<u>This Keyword is required</u>***

This keyword must be followed by a positive integer that specifies one of the filetypes listed below for the input of the independent and dependent variables. All files are assumed to reside on disk and be written using list-directed write statements. If both independent and dependent variables reside on a single file, that file must be assigned to <u>logical unit 1</u>. If the independent and dependent variables are on separate files, then the independent variable file should be assigned to <u>logical unit 1</u> and the dependent to <u>logical unit 2</u>.

1 - The input file contains both the independent (X) and dependent (Y) variables. The file has NOBS records and each record has NIV + NDV variables written on it with all NIV variables occurring first, followed by all NDV dependent variables. Each dependent variable may have more than value (step) associated with it. Thus, the Y portion under this option would contain all Y values for step 1, all Y values at step 2 are concatenated after step 1, and so on until all steps are included. The file can be represented as follows:

| | 1 ··· NIV | 1 ···NDV | ··· | 1 ··· NDV |
|---|---|---|---|---|
| 1<br>·<br>·<br>·<br>NOBS | All Independent Variables | First Step For All Dependent Variables | | Last Step For All Dependent Variables |

2 - The input structure differs from option 1 in that all steps for the first dependent variable ($Y_1$) are followed by all steps for $Y_2$ and so on for all steps for $Y_{NDV}$. The file can be represented as follows:

| | 1 ··· NIV | 1 ...NSTEPS | ··· | 1 ··· NSTEPS |
|---|---|---|---|---|
| 1<br>·<br>·<br>·<br>NOBS | All Independent Variables | All Steps For $Y_1$ | | All Steps For $Y_{NDV}$ |

3 - Same as option 1 except that X and Y are assumed to reside on two separate files with X assigned to logical input unit 1 and Y to logical input unit 2.

4 - Same as option 2 with X and Y on two separate files (see option 3).

5 - User must supply coding to read input into arrays X and Y that are dimensioned as follows: X(NOBS,NIV) and Y(NOBS,NDV, NSTEPS) where NOBS, NIV and NDV have been defined previously and NSTEPS is the number of steps as ascertained from the keyword STEPS. See Section 3 of this report for current dimensions on these arrays and instructions on how to modify these dimensions. Section 3 also contains an example of a user-supplied subroutine to read in a file under this option.

* - An asterisk attached to any of the options 1 to 4 as 1* to 4* is used to designate two leading integers on each record associated with the independent variables. Such would be the case if the independent variables were generated from the Latin hypercube sampling program (Iman and Shortencarier, 1984).

IND VARS

This keyword must be followed by a subset of the positive integers 1, 2,..., NIV that serves to identify which of the independent variables are to be included in the analysis. Line 9 of Table 1 shows that independent variables 1, 4, 5, and 6 are included in the analysis and hence, variables 2 and 3 are excluded from the analysis. If this keyword is omitted, all NIV independent variables are included in the analysis.

DEP VARS

This keyword must be followed by a subset of the positive integers 1, 2,..., NDV that serves to identify which of the dependent variables are to be included in the analysis. Line 10 of Table 1 shows that dependent variables 4 and 5 are included in the analysis and hence, variables 1, 2 and 3 are excluded from the analysis. If this keyword is omitted all NDV dependent variables are included in the analysis.

XLABEL

This keyword must be followed by identification labels for the NIV independent variables included in the analysis. The labels can each contain up to eight alphanumeric characters and are assumed to be in the order 1, 2,..., NIV. If this keyword is omitted, the generic labels X1, X2,..., XNIV are used. Line 11 of Table 1 shows the use of this keyboard.

YLABEL

This keyword must be followed by identification labels for the NDV independent variables included in the analysis. The labels can each contain up to eight alphanumeric characters and are assumed to be in the order 1, 2,..., NDV. If this keyword is omitted, the generic labels Y1, Y2,..., YNDV are used. Line 12 of Table 1 shows the use of this keyboard.

TABLE CUTOFF

This keyword must be followed by a real number p, $0 \leq p \leq 1$, which is activated when the keyword STEPS indicates more than one step. When more than one step is indicated under the PCC or PRCC options, a summary table is automatically generated that shows the largest partial correlation for each independent variable-dependent variable combination over all steps, provided that the absolute value of the partial correlation is $\geq$ p. Otherwise, a blank entry appears for the combination. Similar statements hold for the options SRC and SRRC. In the case of the pair PCC and SRC (or PRCC and SRRC) the table cutoff applies to the PCC (or the PRCC). Line 13 of Table 1 shows that the partial rank correlation (since both PRCC and SRCC are requested) must be greater than or equal to .7 in absolute value to appear in the table. If the value of p is set to 1, no table will be generated. If this keyword does not appear, the default value is set equal to .6.

PLOT CUTOFF

This keyword must be followed by a real number p, $0 \leq p \leq 1$, which is activated when the keyword STEPS indicates more than one step. In such cases a plot of either the partial correlation coefficient or the standardized regression coefficient (or both jointly) versus step number (usually time step) can be generated for each independent-dependent variable combination. Since it is unlikely that all NIV x NDV plots would be desired, this keyword allows for some control over the number of plots created by generating plots only for those combinations for which the absolute value of the partial correlation coefficient or standardized regression coefficient is $\geq$ p for at least one step. In case of the joint selection of PCC and SRC (or PRCC and SRCC), the cutoff applies to the PCC (or the PRCC) as with the keyword TABLE CUTOFF. Line 14 of Table 1 shows the value of p to be .8. If the value of p is set to 1, no plots will be generated. If this keyword is omitted, the default value is .6.

PLOT TITLE

This keyword must be followed by an alphanumeric string of up to 24 alphanumeric characters that serve as a title on each plot of the PCC or SRC. If this keyword is omitted, no title will appear. Use of this keyword is illustrated on line 15 of Table 1.

PLOT XLABEL

This keyword must be followed by an alphanumeric string of up to 24 alphanumeric characters that serve as a label for the x-axis on each plot of the PCC or SRC. If this keyword is omitted, no label will appear. Use of this keyword is illustrated on line 16 of Table 1.

XLOG

When this keyword is present the x-axis will appear with a log 10 scaling. If this keyword is missing, the scale on the x-axis will be linear with respect to the information supplied with the keyword STEPS.

YLIMITS

The default limits for the vertical axis of the graphs generated by this program are -1 and 1. This keyword allows the user to change the default limits by following the keyword with two values that the program will use respectively as a new lower limit and a new upper limit.

Table 2 provides a summary of the required keywords and default values for the optional keywords.

TABLE 2. Keyword Summary

Required Keywords:

- NIV
- NDV
- NOBS
- FILETYPE
- At least one of the pair PCC and SRC, or one of the pair PRCC and SRCC.

Defaults for Optional Keywords:

| Keyword | Default |
|---|---|
| TITLE | Blank |
| STEPS | 1 |
| IND VARS | All NIV independent variables are used in the analysis. |
| DEP VARS | All NDV dependent variables are used in the analysis. |
| XLABEL | Generic labels used: X1, X2,...,XNIV |
| YLABEL | Generic labels used: Y1, Y2,...,YNDV |
| TABLE CUTOFF | .6 |
| PLOT CUTOFF | .6 |
| PLOT TITLE | Blank |
| PLOT XLABEL | Blank |
| XLOG | Linear scale used on x-axis. |
| YLIMITS | Vertical axis in graphs goes from -1 to 1 |

## 3. MODIFYING THE COMPUTER PROGRAM

### Use of Subroutine USRINP for Nonstandard Input Files

Occasionally, the user may want to analyze data files that do not match any of the formats specified in Section 2 under the keyword FILE TYPE. In this case, the user must provide a subroutine, called USRINP, which will read the data files into the X and Y arrays. The data files must be read so that the data are stored into the appropriate locations in the X and Y arrays which are dimensioned as X(NOBS, NIV) and Y(NOBS, NDV, NSTEPS) where NOBS is the number of observations, NIV is the number of independent variables, NDV is the number of dependent variables and NSTEPS is the number of steps. In the example below, the independent and dependent variable data are on separate files and are stored one observation per record for each independent variable. The dependent variables are stored one observation per record and in addition are sorted by step.

```
      SUBROUTINE USRINP(X, Y)
C*****SUBROUTINE USRINP IS PROVIDED BY THE USER TO INPUT DATA FILES
C*****OF INDEPENDENT AND DEPENDENT VARIABLES THAT ARE OF DIFFERENT
C*****FORMS THAN THOSE DESCRIBED IN THE USER MANUAL
C*****THE COMMON AND DIMENSION STATEMENTS ARE REQUIRED
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      COMMON/PARAM/LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1                NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2                PC, TC, YMIN, YMAX
      DIMENSION X(MXNOBS,MXNIV), Y(MXNOBS,MXNDV,MXNSTP)


C*****READ IN THE INDEPENDENT VARIABLES
      DO 100 J=1,NIV
      DO 100 I=1, NOBS
100   READ(1,*) X(I,J)
C*****READ IN THE DEPENDENT VARIABLES
      DO 200 K=1,NSTEPS
      DO 200 J=1,NDV
      DO 300 I=1,NOBS
200   READ(2,*) Y(I,J,K)
      RETURN
      END
```

## Redimensioning

Section 2 indicated upper limits on the values of certain parameters. These were:

1. the maximum number of observations, MXNOBS=100
2. the maximum number of independent variables, MXNIV=50
3. the maximum number of dependent variables, MXNDV=20
4. the maximum number of ordered triples on the STEPS parameter card, MXNINT=10
5. the maximum number of steps, MXNSTP=100

These upper limits should be satisfactory for most situations. However, if any or all of these upper limits need to be adjusted, the new value(s) may be replaced in the PARAMETER statement found at the beginning of the main program.

## Graphics Output

The plots generated by the program are produced using the DISSPLA graphics package (version 9.0, proprietary software package of ISSCO, San Diego, California). This package should be available on most machines. If DISSPLA is not available on the user's choice of machine or if, for for any reason, the user decides not to use DISSPLA, it will be the user's responsibility to change the graphics subroutine calls to reflect their choice of graphics package. The majority of these calls may be found in SUBROUTINE PLOT.

# 4. REFERENCES


Graybill, F. A. (1969). Introduction to Matrices with Applications in Statistics, Wadsworth Publishing Co., Inc., Belmont, California.

Iman, R. L., Davenport, J. M., Frost, E. L., and Shortencarier, M. J. (1980). "Stepwise Regression with PRESS and Rank Regression (Program User's Guide)," Technical Report SAND79-1472, Sandia National Laboratories, Albuquerque, NM 87185.

Iman, R. L. and Helton, J. C. (1985). "A Comparison of Uncertainty and Sensitivity Analysis Techniques for Computer Models," Sandia National Laboratories, Albuquerque, NM 87185. NUREG/CR-3904, SAND84-1461.

Iman, R. L. and Shortencarier, M. J., (1984). "A FORTRAN 77 Program and User's Guide for the Generation of Latin Hypercube and Random Samples for Use with Computer Models," Sandia National Laboratories, Albuquerque, NM 87185. NUREG/CR-3624, SAND83-2365.

# APPENDIX

## Example of Program Output

This appendix presents output from the computer program. The parameter selection for this example is given in Table A1. The first line in Table A1 gives the title that will appear at the top of each page of output. Lines 2 through 4 indicate that the data set contains 20 independent variables, four dependent variables, and a total of 60 observations on these variables. Lines 5 and 6 indicate that both the PCCs and the SRCs will be computed on the ranks of the original observations. Lines 7 and 8 show that only dependent variables 1 and 3 along with independent variables 1, 2, 3, 13 and 20 will be used in this analysis. Line 9 shows a time history with these observations, scaled from 5 to 50 in steps of 5, from 50 to 200 in steps of 10, and from 200 to 400 in steps of 20. The input file is identified as type 2 on line 10. Joint plots of the partial rank correlation coefficients and the standardized rank regression coefficients versus time step will be generated for each combination of independent variable and dependent variable whose PRCC over all time steps is at least .85 in absolute value as indicated on line 11. Likewise, a table will be generated whose entries are the maximum value over time (positive or nega- tive) of the PRCC for each combination of independent and depen- dent variable, provided that such value is at least .60 in absolute value as shown on line 12. A similar table will be constructed for the SRRCs. Note that .60 is also the default value for the TABLE CUTOFF parameter as summarized in Table 2 of this report. Thus, the output in this example would be the same, with or without line 12. Lines 13 and 14 give labels for the plots while lines 15, 16 and 17 contain the labels for all variables.

Table A1. Parameter Selections for Example Problem

```
 1.  TITLE TURC1SS SENSITIVITY ANALYSIS
 2.  NIV 20
 3.  NDV 4
 4.  NOBS 60
 5.  PRCC
 6.  SRCC
 7.  DEP VARS 1 3
 8.  IND VARS 1 2 3 13 20
 9.  STEPS   5 50 5   50 200 10   200 400 20
10.  FILE TYPE 2
11.  PLOT CUTOFF  .85
12.  TABLE CUTOFF .60
13.  PLOT TITLE  TURC1SS SA
14.  PLOT XLABEL TIME (SECS)
15.  YLABEL POOLTEMP LOCATION HXFER DELTAX
16.  XLABEL TMALL TMFE GAMMAO HFAL HFFE CKA CKB CKC PCCA BWATER
17.    EWATER SPONC MTCONC HFCONC MGOA MGOB MGOC DMGO GRIDL VBUB
```

PAGE 1 OF THE COMPUTER OUTPUT

This page echoes the values of the parameters associated with the keywords in Table A1.

---

```
TURC1SS SENSITIVITY ANALYSIS

NUMBER OF    NUMBER OF IND       NUMBER OF      NUMBER OF DEP
IND VARS     VARS SELECTED       DEP VARS       VARS SELECTED
    20              5                4                2

 NUMBER OF      NUMBER OF     CUTOFF FOR     CUTOFF FOR     DATA FILE
OBSERVATIONS      STEPS          TABLE          PLOTS          TYPE
     60            35            0.600          0.850            2

PARTIAL CORRELATION AND STANDARDIZED REGRESSION COEFFICIENTS WILL
BE CALCULATED USING THE RANKS OF THE OBSERVATIONS

INDEPENDENT VARIABLES         DEPENDENT VARIABLES
SELECTED FOR ANALYSIS        SELECTED FOR ANALYSIS

      1  TMALL                      1  POOLTEMP
      2  TMFE                       3  HXFER
      3  GAMMA0
     13  MTCONC
     20  VBUB
```

PAGE 2 OF THE COMPUTER OUTPUT

This page lists the actual values of the partial rank correlation coefficient. Table entries are listed by time step for each of the five independent variables selected for this analysis for the dependent variable POOLTEMP. Thus, this page contains the coordinates used in making a plot of PRCC versus time for each independent and dependent variable combination. The last column contains the value of the model R-square for Y as discussed in Section 1.

---

TURC1SS SENSITIVITY ANALYSIS
PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -POOLTEMP-
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | 0.29 | -0.01 | -0.63 | 0.34 | -0.49 | 0.54 |
| 2 | 10.0 | 0.19 | -0.07 | -0.74 | 0.45 | -0.68 | 0.70 |
| 3 | 15.0 | 0.12 | -0.05 | -0.78 | 0.48 | -0.78 | 0.77 |
| 4 | 20.0 | 0.07 | -0.06 | -0.79 | 0.50 | -0.82 | 0.80 |
| 5 | 25.0 | 0.11 | -0.03 | -0.78 | 0.51 | -0.84 | 0.81 |
| 6 | 30.0 | 0.11 | -0.03 | -0.78 | 0.51 | -0.84 | 0.81 |
| 7 | 35.0 | 0.10 | -0.04 | -0.78 | 0.53 | -0.85 | 0.82 |
| 8 | 40.0 | 0.11 | -0.05 | -0.78 | 0.55 | -0.86 | 0.82 |
| 9 | 45.0 | 0.10 | -0.04 | -0.77 | 0.56 | -0.86 | 0.82 |
| 10 | 50.0 | 0.07 | -0.02 | -0.77 | 0.59 | -0.86 | 0.83 |
| 11 | 60.0 | 0.06 | 0.00 | -0.78 | 0.59 | -0.86 | 0.83 |
| 12 | 70.0 | 0.05 | -0.01 | -0.78 | 0.59 | -0.86 | 0.83 |
| 13 | 80.0 | 0.05 | 0.02 | -0.78 | 0.59 | -0.86 | 0.83 |
| 14 | 90.0 | 0.04 | 0.12 | -0.77 | 0.58 | -0.86 | 0.82 |
| 15 | 100. | 0.02 | 0.24 | -0.76 | 0.55 | -0.84 | 0.81 |
| 16 | 110. | 0.04 | 0.36 | -0.74 | 0.52 | -0.83 | 0.79 |
| 17 | 120. | 0.01 | 0.53 | -0.70 | 0.48 | -0.81 | 0.77 |
| 18 | 130. | 0.00 | 0.60 | -0.66 | 0.38 | -0.76 | 0.73 |
| 19 | 140. | -0.01 | 0.66 | -0.61 | 0.34 | -0.70 | 0.70 |
| 20 | 150. | -0.03 | 0.70 | -0.58 | 0.31 | -0.66 | 0.69 |
| 21 | 160. | -0.05 | 0.70 | -0.54 | 0.23 | -0.61 | 0.67 |
| 22 | 170. | -0.08 | 0.71 | -0.49 | 0.19 | -0.55 | 0.64 |
| 23 | 180. | -0.12 | 0.74 | -0.47 | 0.14 | -0.54 | 0.65 |
| 24 | 190. | -0.12 | 0.78 | -0.45 | 0.12 | -0.53 | 0.69 |
| 25 | 200. | -0.13 | 0.82 | -0.44 | 0.09 | -0.51 | 0.72 |
| 26 | 220. | -0.11 | 0.84 | -0.44 | 0.05 | -0.48 | 0.75 |
| 27 | 240. | -0.08 | 0.86 | -0.44 | 0.03 | -0.42 | 0.77 |
| 28 | 260. | -0.06 | 0.89 | -0.44 | 0.01 | -0.38 | 0.81 |
| 29 | 280. | -0.07 | 0.91 | -0.42 | 0.02 | -0.35 | 0.84 |
| 30 | 300. | -0.08 | 0.93 | -0.38 | -0.01 | -0.32 | 0.86 |
| 31 | 320. | -0.12 | 0.93 | -0.31 | -0.04 | -0.28 | 0.88 |
| 32 | 340. | -0.12 | 0.94 | -0.29 | -0.06 | -0.28 | 0.89 |
| 33 | 360. | -0.12 | 0.95 | -0.25 | -0.09 | -0.26 | 0.91 |
| 34 | 380. | -0.12 | 0.96 | -0.22 | -0.10 | -0.27 | 0.93 |
| 35 | 400. | -0.12 | 0.97 | -0.21 | -0.09 | -0.25 | 0.94 |

PAGE 3 OF THE COMPUTER OUTPUT

This page ranks from 1 to 5 the absolute values of the PRCC at each time step listed on page 2 of the computer output. This table allows one to quickly compare the relative importance of the five independent variables over time steps. Thus, it can be seen that independent variable TMFE is least important (rank 5) at early time steps but is most important (rank 1) at later time steps.

---

TURC1SS SENSITIVITY ANALYSIS
RANKS OF PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -POOLTEMP-
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 1 | 3 | 2 |
| 2 | 10.0 | 4 | 5 | 1 | 3 | 2 |
| 3 | 15.0 | 4 | 5 | 1 | 3 | 2 |
| 4 | 20.0 | 4 | 5 | 2 | 3 | 1 |
| 5 | 25.0 | 4 | 5 | 2 | 3 | 1 |
| 6 | 30.0 | 4 | 5 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 4 | 5 | 2 | 3 | 1 |
| 9 | 45.0 | 4 | 5 | 2 | 3 | 1 |
| 10 | 50.0 | 4 | 5 | 2 | 3 | 1 |
| 11 | 60.0 | 4 | 5 | 2 | 3 | 1 |
| 12 | 70.0 | 4 | 5 | 2 | 3 | 1 |
| 13 | 80.0 | 4 | 5 | 2 | 3 | 1 |
| 14 | 90.0 | 5 | 4 | 2 | 3 | 1 |
| 15 | 100. | 5 | 4 | 2 | 3 | 1 |
| 16 | 110. | 5 | 4 | 2 | 3 | 1 |
| 17 | 120. | 5 | 3 | 2 | 4 | 1 |
| 18 | 130. | 5 | 3 | 2 | 4 | 1 |
| 19 | 140. | 5 | 2 | 3 | 4 | 1 |
| 20 | 150. | 5 | 1 | 3 | 4 | 2 |
| 21 | 160. | 5 | 1 | 3 | 4 | 2 |
| 22 | 170. | 5 | 1 | 3 | 4 | 2 |
| 23 | 180. | 5 | 1 | 3 | 4 | 2 |
| 24 | 190. | 5 | 1 | 3 | 4 | 2 |
| 25 | 200. | 4 | 1 | 3 | 5 | 2 |
| 26 | 220. | 4 | 1 | 3 | 5 | 2 |
| 27 | 240. | 4 | 1 | 2 | 5 | 3 |
| 28 | 260. | 4 | 1 | 2 | 5 | 3 |
| 29 | 280. | 4 | 1 | 2 | 5 | 3 |
| 30 | 300. | 4 | 1 | 2 | 5 | 3 |
| 31 | 320. | 4 | 1 | 2 | 5 | 3 |
| 32 | 340. | 4 | 1 | 2 | 5 | 3 |
| 33 | 360. | 4 | 1 | 3 | 5 | 2 |
| 34 | 380. | 4 | 1 | 3 | 5 | 2 |
| 35 | 400. | 4 | 1 | 3 | 5 | 2 |

PAGE 4 OF THE COMPUTER OUTPUT

This page lists the actual values of the standardized rank regression coefficient. Table entries are listed by time step for each of the five independent variables selected for this analysis for the dependent variable POOLTEMP. Thus, this page contains the coordinates used in making a plot of SRRC versus time for each independent and dependent variable combination. The last column contains the value of the model R-square for Y as discussed in Section 1.

---

TURC1SS SENSITIVITY ANALYSIS
STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -POOLTEMP-
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | 0.20 | -0.01 | -0.55 | 0.25 | -0.38 | 0.54 |
| 2 | 10.0 | 0.10 | -0.04 | -0.61 | 0.28 | -0.50 | 0.70 |
| 3 | 15.0 | 0.06 | -0.03 | -0.60 | 0.26 | -0.59 | 0.77 |
| 4 | 20.0 | 0.03 | -0.03 | -0.58 | 0.26 | -0.64 | 0.80 |
| 5 | 25.0 | 0.05 | -0.01 | -0.55 | 0.26 | -0.67 | 0.81 |
| 6 | 30.0 | 0.05 | -0.01 | -0.53 | 0.26 | -0.69 | 0.81 |
| 7 | 35.0 | 0.04 | -0.02 | -0.53 | 0.27 | -0.69 | 0.82 |
| 8 | 40.0 | 0.04 | -0.02 | -0.52 | 0.28 | -0.70 | 0.82 |
| 9 | 45.0 | 0.04 | -0.02 | -0.51 | 0.28 | -0.70 | 0.82 |
| 10 | 50.0 | 0.03 | -0.01 | -0.50 | 0.30 | -0.71 | 0.83 |
| 11 | 60.0 | 0.02 | 0.00 | -0.51 | 0.30 | -0.70 | 0.83 |
| 12 | 70.0 | 0.02 | 0.00 | -0.51 | 0.30 | -0.70 | 0.83 |
| 13 | 80.0 | 0.02 | 0.01 | -0.51 | 0.31 | -0.69 | 0.83 |
| 14 | 90.0 | 0.02 | 0.05 | -0.51 | 0.30 | -0.70 | 0.82 |
| 15 | 100. | 0.01 | 0.11 | -0.51 | 0.29 | -0.68 | 0.81 |
| 16 | 110. | 0.02 | 0.17 | -0.50 | 0.28 | -0.68 | 0.79 |
| 17 | 120. | 0.00 | 0.30 | -0.46 | 0.26 | -0.65 | 0.77 |
| 18 | 130. | 0.00 | 0.38 | -0.45 | 0.21 | -0.60 | 0.73 |
| 19 | 140. | -0.01 | 0.48 | -0.42 | 0.20 | -0.53 | 0.70 |
| 20 | 150. | -0.02 | 0.54 | -0.40 | 0.18 | -0.48 | 0.69 |
| 21 | 160. | -0.03 | 0.57 | -0.37 | 0.14 | -0.44 | 0.67 |
| 22 | 170. | -0.05 | 0.60 | -0.34 | 0.12 | -0.40 | 0.64 |
| 23 | 180. | -0.07 | 0.64 | -0.31 | 0.08 | -0.38 | 0.65 |
| 24 | 190. | -0.07 | 0.70 | -0.29 | 0.07 | -0.35 | 0.69 |
| 25 | 200. | -0.07 | 0.75 | -0.26 | 0.05 | -0.31 | 0.72 |
| 26 | 220. | -0.06 | 0.79 | -0.25 | 0.03 | -0.27 | 0.75 |
| 27 | 240. | -0.04 | 0.82 | -0.23 | 0.01 | -0.22 | 0.77 |
| 28 | 260. | -0.02 | 0.86 | -0.22 | 0.00 | -0.18 | 0.81 |
| 29 | 280. | -0.03 | 0.89 | -0.18 | 0.01 | -0.15 | 0.84 |
| 30 | 300. | -0.03 | 0.91 | -0.15 | 0.00 | -0.12 | 0.86 |
| 31 | 320. | -0.04 | 0.92 | -0.12 | -0.01 | -0.10 | 0.88 |
| 32 | 340. | -0.04 | 0.93 | -0.10 | -0.02 | -0.10 | 0.89 |
| 33 | 360. | -0.04 | 0.95 | -0.08 | -0.03 | -0.08 | 0.91 |
| 34 | 380. | -0.03 | 0.96 | -0.06 | -0.03 | -0.08 | 0.93 |
| 35 | 400. | -0.03 | 0.97 | -0.05 | -0.02 | -0.06 | 0.94 |

PAGE 5 OF THE COMPUTER OUTPUT

This page ranks from 1 to 5 the absolute values of the SRRC at each time step listed on page 4 of the computer output. This table allows one to quickly compare the relative importance of the five independent variables over time steps. Thus, it can be seen that independent variable TMFE is least important (rank 5) at early time steps but is most important (rank 1) at later time steps.

---

TURC1SS SENSITIVITY ANALYSIS

RANKS OF STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS

DEPENDENT VARIABLE -POOLTEMP-

UNITS = TIME (SEC)

| | | | | INDEPENDENT VARIABLES | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 1 | 3 | 2 |
| 2 | 10.0 | 4 | 5 | 1 | 3 | 2 |
| 3 | 15.0 | 4 | 5 | 1 | 3 | 2 |
| 4 | 20.0 | 4 | 5 | 2 | 3 | 1 |
| 5 | 25.0 | 4 | 5 | 2 | 3 | 1 |
| 6 | 30.0 | 4 | 5 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 4 | 5 | 2 | 3 | 1 |
| 9 | 45.0 | 4 | 5 | 2 | 3 | 1 |
| 10 | 50.0 | 4 | 5 | 2 | 3 | 1 |
| 11 | 60.0 | 4 | 5 | 2 | 3 | 1 |
| 12 | 70.0 | 4 | 5 | 2 | 3 | 1 |
| 13 | 80.0 | 4 | 5 | 2 | 3 | 1 |
| 14 | 90.0 | 5 | 4 | 2 | 3 | 1 |
| 15 | 100. | 5 | 4 | 2 | 3 | 1 |
| 16 | 110. | 5 | 4 | 2 | 3 | 1 |
| 17 | 120. | 5 | 3 | 2 | 4 | 1 |
| 18 | 130. | 5 | 3 | 2 | 4 | 1 |
| 19 | 140. | 5 | 2 | 3 | 4 | 1 |
| 20 | 150. | 5 | 1 | 3 | 4 | 2 |
| 21 | 160. | 5 | 1 | 3 | 4 | 2 |
| 22 | 170. | 5 | 1 | 3 | 4 | 2 |
| 23 | 180. | 5 | 1 | 3 | 4 | 2 |
| 24 | 190. | 5 | 1 | 3 | 4 | 2 |
| 25 | 200. | 4 | 1 | 3 | 5 | 2 |
| 26 | 220. | 4 | 1 | 3 | 5 | 2 |
| 27 | 240. | 4 | 1 | 2 | 5 | 3 |
| 28 | 260. | 4 | 1 | 2 | 5 | 3 |
| 29 | 280. | 4 | 1 | 2 | 5 | 3 |
| 30 | 300. | 4 | 1 | 2 | 5 | 3 |
| 31 | 320. | 4 | 1 | 2 | 5 | 3 |
| 32 | 340. | 4 | 1 | 2 | 5 | 3 |
| 33 | 360. | 4 | 1 | 3 | 5 | 2 |
| 34 | 380. | 4 | 1 | 3 | 5 | 2 |
| 35 | 400. | 4 | 1 | 3 | 5 | 2 |

PAGE 6 OF THE COMPUTER OUTPUT

This page supplies the same information as page 2 of the computer output, except that this time the dependent variable is HXFER.

---

TURC1SS SENSITIVITY ANALYSIS
PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | -0.14 | 0.01 | 0.33 | 0.23 | 0.84 | 0.73 |
| 2 | 10.0 | 0.08 | -0.07 | 0.70 | 0.48 | 0.90 | 0.84 |
| 3 | 15.0 | -0.05 | -0.01 | 0.79 | 0.39 | 0.90 | 0.86 |
| 4 | 20.0 | -0.01 | -0.05 | 0.81 | 0.39 | 0.91 | 0.87 |
| 5 | 25.0 | -0.01 | -0.08 | 0.80 | 0.41 | 0.91 | 0.88 |
| 6 | 30.0 | 0.00 | -0.03 | 0.80 | 0.38 | 0.89 | 0.86 |
| 7 | 35.0 | -0.06 | 0.03 | 0.79 | 0.35 | 0.90 | 0.86 |
| 8 | 40.0 | 0.00 | 0.08 | 0.69 | 0.40 | 0.85 | 0.79 |
| 9 | 45.0 | -0.01 | 0.06 | 0.77 | 0.41 | 0.87 | 0.83 |
| 10 | 50.0 | -0.03 | -0.10 | 0.79 | 0.40 | 0.89 | 0.85 |
| 11 | 60.0 | 0.00 | -0.11 | 0.60 | 0.43 | 0.75 | 0.68 |
| 12 | 70.0 | -0.01 | -0.16 | 0.51 | 0.48 | 0.56 | 0.54 |
| 13 | 80.0 | -0.08 | -0.13 | 0.46 | 0.53 | 0.50 | 0.50 |
| 14 | 90.0 | -0.10 | -0.12 | 0.37 | 0.60 | 0.38 | 0.48 |
| 15 | 100. | 0.01 | -0.20 | 0.31 | 0.70 | 0.23 | 0.54 |
| 16 | 110. | 0.08 | -0.34 | 0.22 | 0.73 | 0.02 | 0.57 |
| 17 | 120. | 0.05 | -0.45 | 0.03 | 0.71 | -0.18 | 0.57 |
| 18 | 130. | 0.08 | -0.53 | -0.15 | 0.71 | -0.34 | 0.61 |
| 19 | 140. | 0.03 | -0.58 | -0.23 | 0.75 | -0.48 | 0.68 |
| 20 | 150. | 0.02 | -0.58 | -0.27 | 0.76 | -0.51 | 0.70 |
| 21 | 160. | 0.07 | -0.60 | -0.29 | 0.73 | -0.56 | 0.70 |
| 22 | 170. | 0.05 | -0.64 | -0.33 | 0.72 | -0.60 | 0.71 |
| 23 | 180. | 0.02 | -0.64 | -0.33 | 0.71 | -0.61 | 0.71 |
| 24 | 190. | -0.01 | -0.62 | -0.35 | 0.71 | -0.63 | 0.71 |
| 25 | 200. | 0.00 | -0.60 | -0.35 | 0.71 | -0.65 | 0.71 |
| 26 | 220. | -0.03 | -0.61 | -0.34 | 0.70 | -0.67 | 0.71 |
| 27 | 240. | -0.01 | -0.58 | -0.40 | 0.65 | -0.66 | 0.69 |
| 28 | 260. | -0.01 | -0.59 | -0.43 | 0.63 | -0.66 | 0.69 |
| 29 | 280. | -0.06 | -0.61 | -0.40 | 0.54 | -0.64 | 0.66 |
| 30 | 300. | -0.08 | -0.58 | -0.41 | 0.46 | -0.63 | 0.62 |
| 31 | 320. | -0.07 | -0.49 | -0.40 | 0.33 | -0.56 | 0.53 |
| 32 | 340. | 0.01 | -0.42 | -0.40 | 0.16 | -0.53 | 0.45 |
| 33 | 360. | 0.08 | -0.31 | -0.40 | 0.06 | -0.45 | 0.36 |
| 34 | 380. | 0.03 | -0.14 | -0.37 | 0.04 | -0.41 | 0.28 |
| 35 | 400. | 0.04 | -0.11 | -0.34 | 0.05 | -0.36 | 0.23 |

PAGE 7 OF THE COMPUTER OUTPUT

This page supplies the same information for dependent variable HXFER as page 3 of the computer output did for POOLTEMP.

---

TURC1SS SENSITIVITY ANALYSIS
RANKS OF PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 2 | 3 | 1 |
| 2 | 10.0 | 4 | 5 | 2 | 3 | 1 |
| 3 | 15.0 | 4 | 5 | 2 | 3 | 1 |
| 4 | 20.0 | 5 | 4 | 2 | 3 | 1 |
| 5 | 25.0 | 5 | 4 | 2 | 3 | 1 |
| 6 | 30.0 | 5 | 4 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 5 | 4 | 2 | 3 | 1 |
| 9 | 45.0 | 5 | 4 | 2 | 3 | 1 |
| 10 | 50.0 | 5 | 4 | 2 | 3 | 1 |
| 11 | 60.0 | 5 | 4 | 2 | 3 | 1 |
| 12 | 70.0 | 5 | 4 | 2 | 3 | 1 |
| 13 | 80.0 | 5 | 4 | 3 | 1 | 2 |
| 14 | 90.0 | 5 | 4 | 3 | 1 | 2 |
| 15 | 100. | 5 | 4 | 2 | 1 | 3 |
| 16 | 110. | 4 | 2 | 3 | 1 | 5 |
| 17 | 120. | 4 | 2 | 5 | 1 | 3 |
| 18 | 130. | 5 | 2 | 4 | 1 | 3 |
| 19 | 140. | 5 | 2 | 4 | 1 | 3 |
| 20 | 150. | 5 | 2 | 4 | 1 | 3 |
| 21 | 160. | 5 | 2 | 4 | 1 | 3 |
| 22 | 170. | 5 | 2 | 4 | 1 | 3 |
| 23 | 180. | 5 | 2 | 4 | 1 | 3 |
| 24 | 190. | 5 | 3 | 4 | 1 | 2 |
| 25 | 200. | 5 | 3 | 4 | 1 | 2 |
| 26 | 220. | 5 | 3 | 4 | 1 | 2 |
| 27 | 240. | 5 | 3 | 4 | 2 | 1 |
| 28 | 260. | 5 | 3 | 4 | 2 | 1 |
| 29 | 280. | 5 | 2 | 4 | 3 | 1 |
| 30 | 300. | 5 | 2 | 4 | 3 | 1 |
| 31 | 320. | 5 | 2 | 3 | 4 | 1 |
| 32 | 340. | 5 | 2 | 3 | 4 | 1 |
| 33 | 360. | 4 | 3 | 2 | 5 | 1 |
| 34 | 380. | 5 | 3 | 2 | 4 | 1 |
| 35 | 400. | 5 | 3 | 2 | 4 | 1 |

PAGE 8 OF THE COMPUTER OUTPUT

This page supplies the same information as page 4 of the computer output, except that this time the dependent variable is HXFER.

---

TURC1SS SENSITIVITY ANALYSIS
STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | -0.07 | 0.01 | 0.19 | 0.13 | 0.82 | 0.73 |
| 2 | 10.0 | 0.03 | -0.03 | 0.39 | 0.22 | 0.80 | 0.84 |
| 3 | 15.0 | -0.02 | 0.00 | 0.48 | 0.16 | 0.77 | 0.86 |
| 4 | 20.0 | 0.00 | -0.02 | 0.49 | 0.15 | 0.78 | 0.87 |
| 5 | 25.0 | 0.00 | -0.03 | 0.47 | 0.16 | 0.79 | 0.88 |
| 6 | 30.0 | 0.00 | -0.01 | 0.51 | 0.16 | 0.76 | 0.86 |
| 7 | 35.0 | -0.02 | 0.01 | 0.48 | 0.14 | 0.78 | 0.86 |
| 8 | 40.0 | 0.00 | 0.04 | 0.44 | 0.20 | 0.74 | 0.79 |
| 9 | 45.0 | 0.00 | 0.02 | 0.50 | 0.18 | 0.74 | 0.83 |
| 10 | 50.0 | -0.01 | -0.04 | 0.49 | 0.17 | 0.76 | 0.85 |
| 11 | 60.0 | 0.00 | -0.06 | 0.43 | 0.27 | 0.65 | 0.68 |
| 12 | 70.0 | 0.00 | -0.11 | 0.41 | 0.38 | 0.46 | 0.54 |
| 13 | 80.0 | -0.06 | -0.09 | 0.36 | 0.44 | 0.40 | 0.50 |
| 14 | 90.0 | -0.07 | -0.08 | 0.29 | 0.54 | 0.30 | 0.48 |
| 15 | 100. | 0.01 | -0.14 | 0.22 | 0.66 | 0.16 | 0.54 |
| 16 | 110. | 0.05 | -0.23 | 0.15 | 0.69 | 0.01 | 0.57 |
| 17 | 120. | 0.03 | -0.33 | 0.02 | 0.66 | -0.12 | 0.57 |
| 18 | 130. | 0.05 | -0.39 | -0.10 | 0.63 | -0.23 | 0.61 |
| 19 | 140. | 0.02 | -0.40 | -0.14 | 0.64 | -0.31 | 0.68 |
| 20 | 150. | 0.01 | -0.39 | -0.15 | 0.65 | -0.32 | 0.70 |
| 21 | 160. | 0.04 | -0.42 | -0.17 | 0.59 | -0.38 | 0.70 |
| 22 | 170. | 0.03 | -0.45 | -0.19 | 0.55 | -0.41 | 0.71 |
| 23 | 180. | 0.01 | -0.45 | -0.19 | 0.54 | -0.42 | 0.71 |
| 24 | 190. | 0.00 | -0.43 | -0.20 | 0.54 | -0.44 | 0.71 |
| 25 | 200. | 0.00 | -0.41 | -0.20 | 0.54 | -0.45 | 0.71 |
| 26 | 220. | -0.01 | -0.42 | -0.20 | 0.52 | -0.48 | 0.71 |
| 27 | 240. | -0.01 | -0.40 | -0.24 | 0.48 | -0.49 | 0.69 |
| 28 | 260. | -0.01 | -0.41 | -0.27 | 0.45 | -0.49 | 0.69 |
| 29 | 280. | -0.03 | -0.45 | -0.26 | 0.37 | -0.49 | 0.66 |
| 30 | 300. | -0.05 | -0.43 | -0.28 | 0.32 | -0.49 | 0.62 |
| 31 | 320. | -0.05 | -0.39 | -0.30 | 0.24 | -0.47 | 0.53 |
| 32 | 340. | 0.00 | -0.34 | -0.32 | 0.12 | -0.47 | 0.45 |
| 33 | 360. | 0.06 | -0.26 | -0.35 | 0.05 | -0.41 | 0.36 |
| 34 | 380. | 0.02 | -0.12 | -0.34 | 0.03 | -0.38 | 0.28 |
| 35 | 400. | 0.03 | -0.10 | -0.32 | 0.05 | -0.34 | 0.23 |

PAGE 9 OF THE COMPUTER OUTPUT

This page supplies the same information for dependent variable HXFER as page 5 of the computer output did for POOLTEMP.

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TURC1SS SENSITIVITY ANALYSIS
RANKS OF STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 2 | 3 | 1 |
| 2 | 10.0 | 4 | 5 | 2 | 3 | 1 |
| 3 | 15.0 | 4 | 5 | 2 | 3 | 1 |
| 4 | 20.0 | 5 | 4 | 2 | 3 | 1 |
| 5 | 25.0 | 5 | 4 | 2 | 3 | 1 |
| 6 | 30.0 | 5 | 4 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 5 | 4 | 2 | 3 | 1 |
| 9 | 45.0 | 5 | 4 | 2 | 3 | 1 |
| 10 | 50.0 | 5 | 4 | 2 | 3 | 1 |
| 11 | 60.0 | 5 | 4 | 2 | 3 | 1 |
| 12 | 70.0 | 5 | 4 | 2 | 3 | 1 |
| 13 | 80.0 | 5 | 4 | 3 | 1 | 2 |
| 14 | 90.0 | 5 | 4 | 3 | 1 | 2 |
| 15 | 100. | 5 | 4 | 2 | 1 | 3 |
| 16 | 110. | 4 | 2 | 3 | 1 | 5 |
| 17 | 120. | 4 | 2 | 5 | 1 | 3 |
| 18 | 130. | 5 | 2 | 4 | 1 | 3 |
| 19 | 140. | 5 | 2 | 4 | 1 | 3 |
| 20 | 150. | 5 | 2 | 4 | 1 | 3 |
| 21 | 160. | 5 | 2 | 4 | 1 | 3 |
| 22 | 170. | 5 | 2 | 4 | 1 | 3 |
| 23 | 180. | 5 | 2 | 4 | 1 | 3 |
| 24 | 190. | 5 | 3 | 4 | 1 | 2 |
| 25 | 200. | 5 | 3 | 4 | 1 | 2 |
| 26 | 220. | 5 | 3 | 4 | 1 | 2 |
| 27 | 240. | 5 | 3 | 4 | 2 | 1 |
| 28 | 260. | 5 | 3 | 4 | 2 | 1 |
| 29 | 280. | 5 | 2 | 4 | 3 | 1 |
| 30 | 300. | 5 | 2 | 4 | 3 | 1 |
| 31 | 320. | 5 | 2 | 3 | 4 | 1 |
| 32 | 340. | 5 | 2 | 3 | 4 | 1 |
| 33 | 360. | 4 | 3 | 2 | 5 | 1 |
| 34 | 380. | 5 | 3 | 2 | 4 | 1 |
| 35 | 400. | 5 | 3 | 2 | 4 | 1 |

PAGE 10 OF THE COMPUTER OUTPUT

This page presents a table of the maximum value (positive or negative) of the PRCC for each combination of independent and dependent variable provided that the absolute value of the maximum PRCC exceeds .60 as specified on line 12 of Table A1.

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TURC1SS SENSITIVITY ANALYSIS

TABLE ENTRIES REPRESENT THE MAXIMUM VALUE OF THE PARTIAL RANK CORRELATION COEFFICIENT OVER ALL STEPS FOR EACH COMBINATION OF SELECTED INDEPENDENT VARIABLE AND SELECTED DEPENDENT VARIABLE, PROVIDED THAT THE ABSOLUTE VALUE OF THIS COEFFICIENT IS GREATER THAN 0.600

| | POOLTEMP | HXFER |
|---|---|---|
| TMALL | | |
| TMFE | .97 | -.64 |
| GAMMA0 | -.79 | .81 |
| MTCONC | | .76 |
| VBUB | -.86 | .91 |

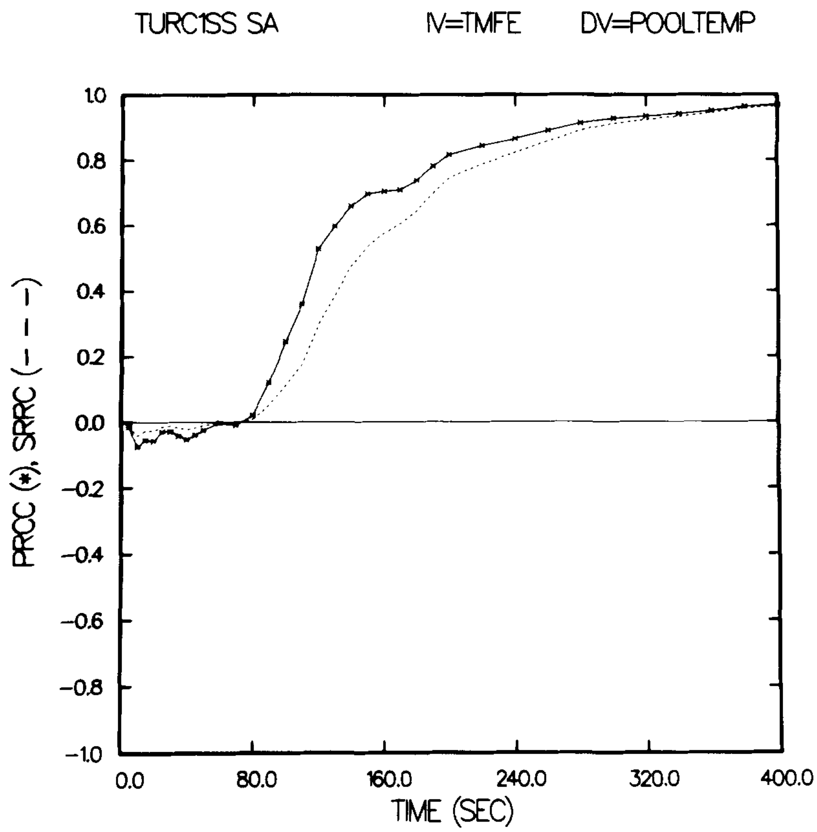
PAGE 11 OF THE COMPUTER OUTPUT

This page presents a table of the maximum value (positive or negative) of the SRRC for each combination of independent and dependent variable given in the previous table.

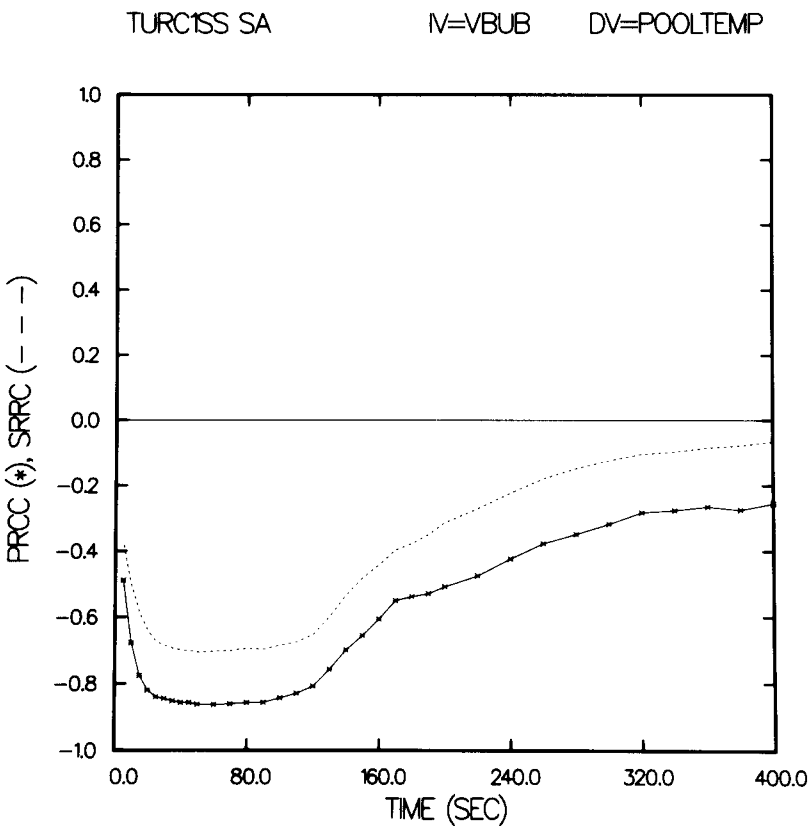
TURC1SS SENSITIVITY ANALYSIS

TABLE ENTRIES REPRESENT THE MAXIMUM VALUE OF THE STANDARDIZED RANK REGRESSION COEFFICIENT OVER ALL STEPS FOR EACH COMBINATION OF SELECTED INDEPENDENT VARIABLE AND SELECTED DEPENDENT VARIABLE, GIVEN IN THE PREVIOUS TABLE

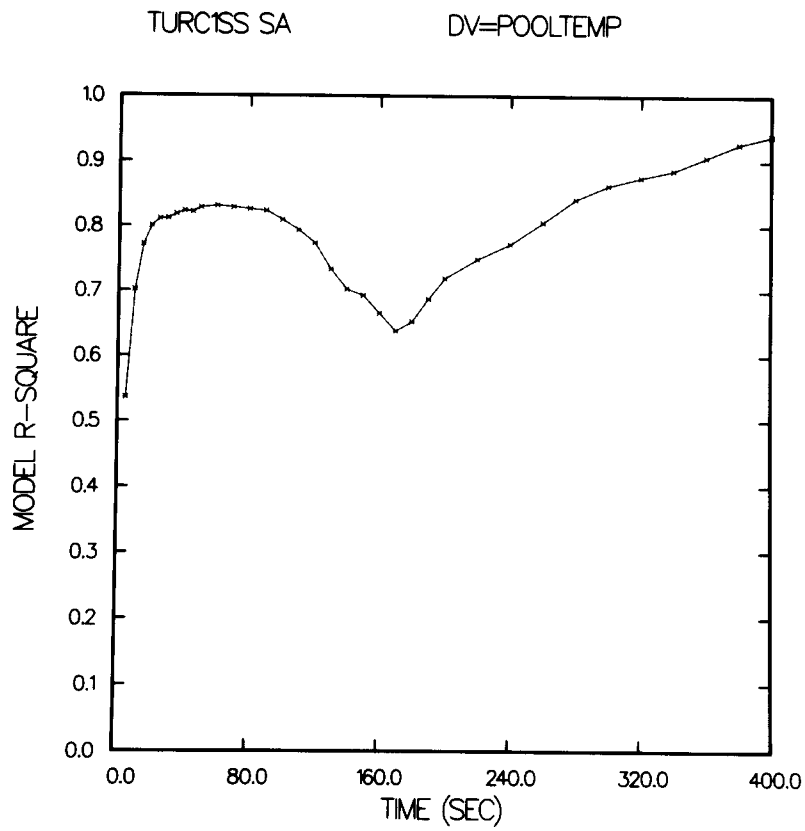
| | POOLTEMP | HXFER |
|---|---|---|
| TMALL | | |
| TMFE | .97 | -.45 |
| GAMMA0 | -.61 | .51 |
| MTCONC | | .69 |
| VBUB | -.71 | .82 |



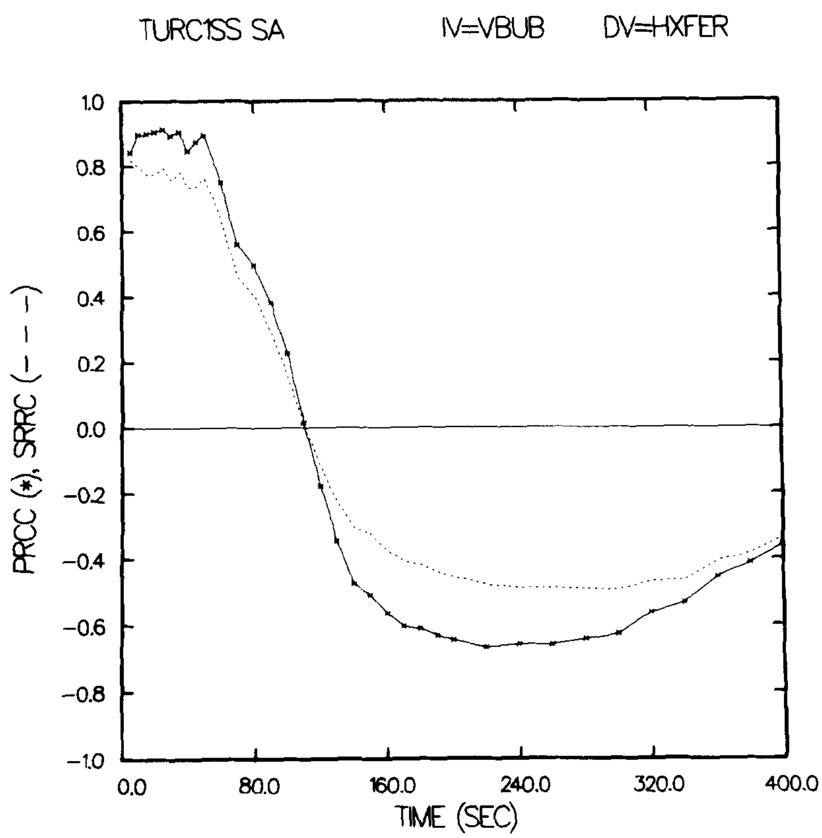

OUTPUT PLOT 1. This plot shows the values of the partial rank correlation coefficient and standardized rank regression coefficient versus time step (as identified by line 9 of Table A1) for the combination of independent variable TMFE and dependent variable POOLTEMP. This plot shows TMFE to have no effect (PRCC and SRRC near zero) through the first 80 seconds and then to rapidly increase in importance. The positive values of PRCC and SRRC means that TMFE and POOLTEMP increase together.



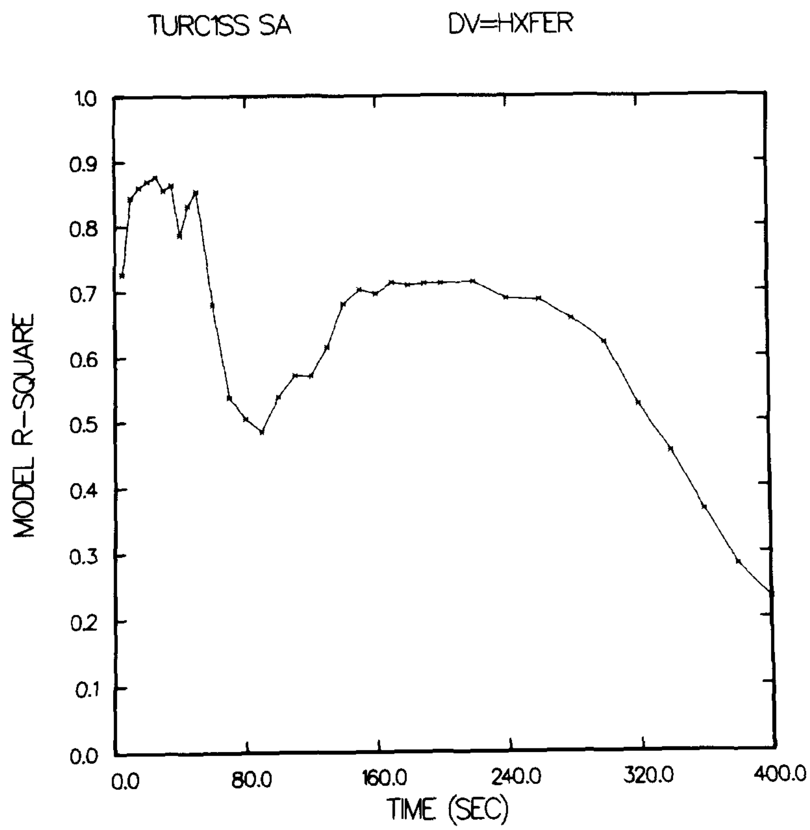

OUTPUT PLOT 2. This plot shows the sensitivity of the dependent variable POOLTEMP to the independent variable VBUB. The variable POOLTEMP is most sensitive to the value of VBUB at early time steps when the variable TMFE from Plot 1 played an insignificant role. However, the magnitudes of the PRCC and SRCC are not as large in absolute value as they were for the variable TMFE.




OUTPUT PLOT 3. This plot shows the value of the model R-square versus time step when the dependent variable POOLTEMP is fit as a function of the independent variables TMALL, TMFE, GAMMAO MTCONC and VBUB as identified in line 8 of Table A1.




OUTPUT PLOT 4. This plot shows the values of the partial rank correlation coefficient and standardized rank regression coefficient versus time step (as identified by line 9 of Table A1) for the combination of independent variable VBUB and dependent variable HXFER. This plot shows the independent variable VBUB having a moderately strong positive relationship with the dependent variable HXFER at early time steps and then changing to a weaker negative relationship at later time steps.




OUTPUT PLOT 5. This plot shows the value of the model R-square versus time step when the dependent variable HXFER is fit as a function of the independent variables TMALL, TMFE, GAMMA0 MTCONC and VBUB as identified in line 8 of Table A1.

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13 ABSTRACT (200 words or less)

This document is for users of a computer program developed by the authors at Sandia National Laboratories. The computer program is designed to be used in conjunction with sensitivity analyses of complex computer models. In particular, this program is most useful in analyzing input-output relationships when the input has been selected using the Latin hypercube sampling program developed at Sandia (Iman and Shortencarier, 1984). The present computer program calculates the partial correlation coefficients and/or the standardized regression coefficients from the multivariate input to, and output from, a computer model. These coefficients can be calculated on either the original observations or on the ranks of the original observations. The coefficients provide alternative measures of the relative contribution (importance) of each of the various inputs to the observed output variations. Relationships between the coefficients and differences in their interpretations are identified. If the computer-model output has an associated time or spatial history then the computer program will generate a graph of the coefficients over time or space for each input-variable, output-variable combination of interest, thus indicating the importance of each input over time or space. The computer program is user-friendly and written in FORTRAN 77 to facilitate portability.

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C     PARTIAL CORRELATION COEFFICIENT AND STANDARDIZED REGRESSION
C                        COEFFICIENT PROGRAM
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
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C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
      PROGRAM PCCSRC
      PARAMETER (LENC=80, LENTC=10, LLAB=8, MXNDV=20, MXNINT=10,
     1           MXNIV=50, MXNOBS=100, MXNSTP=100)
      DIMENSION CORINV((MXNIV+1)*(MXNIV+2)/2), DX(MXNINT),
     1          IRNK(MXNSTP,MXNIV), ITMP(MXNIV), IWK(MXNOBS),
     2          IWKDV(MXNDV), IWKIV(MXNIV+1), LSDV(MXNDV),
     3          LSIV(MXNIV+1), RK(MXNOBS), RS(MXNSTP,MXNIV+1),
     4          RSPLT(MXNSTP), RSRC(MXNSTP,MXNIV+1),
     5          RXCORR(MXNIV*(MXNIV+1)/2), STEPS(MXNSTP),
     6          X(MXNOBS,MXNIV), XB(MXNINT), XE(MXNINT),
     7          TMP1(MXNIV), TMP2(MXNIV), Y(MXNOBS,MXNDV,MXNSTP)
      CHARACTER CARD*(LENC), CX(MXNIV)*(LLAB), CY(MXNDV)*(LLAB),
     1          LABDV(MXNDV)*(LLAB), LABIV(MXNIV)*(LLAB),
     2          PTITLE*(LENC-11), PXLAB*(LENC-12), PYLAB*(LENC-12),
     3          TABLE(MXNIV+1,MXNDV)*(LLAB),
     4          TABLE1(MXNIV+1,MXNDV)*(LLAB), TITLE*(LENC-6),
     5          TMPCRD*(MAX(3*MXNINT*LENTC,MXNDV*LENTC,MXNIV*LENTC))
      COMMON /MAXDIM/ ITEMP(8)
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      COMMON /SPRC/ SPRC1, SPRC2, SPRC3
      CHARACTER PCLAB*20, PRCLAB*25, SRLAB*24, SRRLAB*29
      DATA PCLAB, PRCLAB, SRLAB, SRRLAB /
     1     'PARTIAL CORRELATION ',     'PARTIAL RANK CORRELATION ',
```

```
      READ(CARD(13:LENC),9001) PXLAB
      GO TO 8
C*****LOG X-AXIS
   ELSE IF(CRDTYP(1:5) .EQ. PXLOG) THEN
      LLN=1
      GO TO 10
C*****YLIMITS RECORD
   ELSE IF(CRDTYP(1:8) .EQ. PYLIM) THEN
      READ(TMPCRD,FRMTR,ERR=7000) YMIN, YMAX
      GO TO 10
C*****UNDEFINED KEYWORD RECORD
   ELSE
      WRITE(6,9007) CRDTYP
      INPERR=INPERR + 1
   ENDIF
   GO TO 10
 7000 CONTINUE
   WRITE(6,9027) CRDTYP
   INPERR=INPERR + 1
C*****CHECK FOR INPUT ERRORS
 8000 CONTINUE
   ISTP=0
   IF(NOBS .EQ. -9999) THEN
      WRITE(6,9008) PNOBS
      INPERR=INPERR + 1
   ENDIF
   IF(NIV .EQ. -9999) THEN
      WRITE(6,9008) PNIV
      INPERR=INPERR + 1
   ENDIF
   IF(NDV .EQ. -9999) THEN
      WRITE(6,9008) PNDV
      INPERR=INPERR + 1
   ENDIF
   IF(IFT .EQ. -9999) THEN
      WRITE(6,9008) PFT
      INPERR=INPERR + 1
   ENDIF
   IF(NSIV .EQ. 0) NSIV=NIV
   IF(NSIV .GT. NIV) THEN
       WRITE(6,9051) NSIV, NIV
       INPERR=INPERR + 1
   ENDIF
   IF(NSDV .EQ. 0) NSDV=NDV
   IF(NSDV .GT. NDV) THEN
       WRITE(6,9053) NSDV, NDV
       INPERR=INPERR + 1
   ENDIF
   IF(INPERR .NE. 0) STOP 'INPUT'
   LABIV(NIV+1)=RSQUAR
C*****PROCESS SELECTED INDEPENDENT VARIABLE PARAMETERS
   CALL SELVAR(MXNIV, NIV, NSIV, IWKIV, LSIV, INPERR)
C*****PROCESS SELECTED DEPENDENT VARIABLE PARAMETERS
   CALL SELVAR(MXNDV, NDV, NSDV, IWKDV, LSDV, INPERR)
C*****VERIFY NON-DUPLICATE SELECTED VARIABLES
   DO 8100 ISIV=1,NSIV-1
      IF(IWKIV(ISIV) .EQ. IWKIV(ISIV+1))THEN
           WRITE(6,9052) IWKIV(ISIV)
           INPERR=INPERR + 1
      ENDIF
 8100 CONTINUE
C*****VERIFY FULL RANK CASE
   NSIVP1=NSIV + 1
   IWKIV(NSIVP1)=NIV + 1
```



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```
               CORINV(LOC(I,J))=RXCORR(LOC(I,J))
 7000       CONTINUE
 7500     CONTINUE
          DO 8000 I=1,NSIV
              CORINV(LOC(NSIVP1,I))=RS(ISTEPS,I)
 8000     CONTINUE
          CORINV(LOC(NSIVP1,NSIVP1))=1.0
C*********INVERT CORRELATION MATRIX, CALCULATE PARTIAL CORRELATION
          IP=0
          CALL DSINV(CORINV, NSIVP1, IP)
          DO 8500 I=1,NSIV
C***************CALCULATE AND STORE PARTIAL CORRELATION COEFFICIENTS
              RS(ISTEPS,I)=-CORINV(LOC(NSIVP1,I)) /
     1            SQRT(CORINV(LOC(I,I)) * CORINV(LOC(NSIVP1,NSIVP1)))
C***************CALCULATE AND STORE STANDARDIZED REGRESSION COEFFICIENTS
              RSRC(ISTEPS,I)=-CORINV(LOC(NSIVP1,I)) /
     1                          CORINV(LOC(NSIVP1,NSIVP1))
 8500     CONTINUE
C*********STORE COEFFICIENT OF DETERMINATION (R-SQUARE)
          RSQUAR=-(1.0/CORINV(LOC(NSIVP1,NSIVP1)) - 1.0)
          RS(ISTEPS,NSIVP1)=RSQUAR
          RSRC(ISTEPS,NSIVP1)=RSQUAR
 9000 CONTINUE
      RETURN
      END
```

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```
      SUBROUTINE DSINV(A, N, IPARM)
C*****INVERT A SYMMETRICALLY STORED MATRIX IN PLACE
      DIMENSION A(1)
C
C
      IPARM=0
C*****CALL DMFSD TO PERFORM ERROR CHECKING ON MATRIX TO BE INVERTED
      CALL DMFSD(A, N, IPARM)
      IF (IPARM .LT. 0) RETURN
      IPIV=N * (N+1) / 2
      IND=IPIV
      DO 4000 I=1,N
           DIN=1.0 / A(IPIV)
           A(IPIV)=DIN
           MIN=N
           KEND=I - 1
           LANF=N - KEND
           IF (KEND .LE. 0) GO TO 3000
           J=IND
           DO 2000 K=1,KEND
                WORK=0.0
                MIN=MIN - 1
                LHOR=IPIV
                LVER=J
                DO 1000 L=LANF,MIN
                     LVER=LVER + 1
                     LHOR=LHOR + L
                     WORK=WORK + A(LVER)*A(LHOR)
 1000           CONTINUE
                A(J)=-WORK * DIN
                J=J - MIN
 2000      CONTINUE
 3000      CONTINUE
           IPIV=IPIV - MIN
           IND=IND - 1
 4000 CONTINUE
      DO 7000 I=1,N
           IPIV=IPIV + I
           J=IPIV
           DO 6000 K=I,N
                WORK=0.0
                LHOR=J
                DO 5000 L=K,N
                     LVER=LHOR + K - I
                     WORK=WORK + A(LHOR)*A(LVER)
                     LHOR=LHOR + L
 5000           CONTINUE
                A(J)=WORK
                J=J + K
 6000      CONTINUE
 7000 CONTINUE
      RETURN
      END
```

```
5       /6X,'THE PREVIOUS TABLE ',/)
  END
```



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```
TITLE  TURC1SS SENSITIVITY ANALYSIS
NIV 20
NDV 4
NOBS 60
PRCC
SRRC
DEP VARS 1 3
IND VARS 1 2 3 13 20
STEPS   5 50 5   50 200 10   200 400 20
FILE TYPE 2
PLOT CUTOFF  .85
TABLE CUTOFF .60
PLOT TITLE  TURC1SS SA
PLOT XLABEL TIME (SECS)
YLABEL POOLTEMP LOCATION HXFER DELTAX
XLABEL TMALL TMFE GAMMAO HFAL HFFE CKA CKB CKC PCCA BWATER
  EWATER SPONC MTCONC HFCONC MGOA MGOB MGOC DMGO GRIDL VBUB
```

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TURC1SS SENSITIVITY ANALYSIS
RANKS OF PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 2 | 3 | 1 |
| 2 | 10.0 | 4 | 5 | 2 | 3 | 1 |
| 3 | 15.0 | 4 | 5 | 2 | 3 | 1 |
| 4 | 20.0 | 5 | 4 | 2 | 3 | 1 |
| 5 | 25.0 | 5 | 4 | 2 | 3 | 1 |
| 6 | 30.0 | 5 | 4 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 5 | 4 | 2 | 3 | 1 |
| 9 | 45.0 | 5 | 4 | 2 | 3 | 1 |
| 10 | 50.0 | 5 | 4 | 2 | 3 | 1 |
| 11 | 60.0 | 5 | 4 | 2 | 3 | 1 |
| 12 | 70.0 | 5 | 4 | 2 | 3 | 1 |
| 13 | 80.0 | 5 | 4 | 3 | 1 | 2 |
| 14 | 90.0 | 5 | 4 | 3 | 1 | 2 |
| 15 | 100. | 5 | 4 | 2 | 1 | 3 |
| 16 | 110. | 4 | 2 | 3 | 1 | 5 |
| 17 | 120. | 4 | 2 | 5 | 1 | 3 |
| 18 | 130. | 5 | 2 | 4 | 1 | 3 |
| 19 | 140. | 5 | 2 | 4 | 1 | 3 |
| 20 | 150. | 5 | 2 | 4 | 1 | 3 |
| 21 | 160. | 5 | 2 | 4 | 1 | 3 |
| 22 | 170. | 5 | 2 | 4 | 1 | 3 |
| 23 | 180. | 5 | 2 | 4 | 1 | 3 |
| 24 | 190. | 5 | 3 | 4 | 1 | 2 |
| 25 | 200. | 5 | 3 | 4 | 1 | 2 |
| 26 | 220. | 5 | 3 | 4 | 1 | 2 |
| 27 | 240. | 5 | 3 | 4 | 2 | 1 |
| 28 | 260. | 5 | 3 | 4 | 2 | 1 |
| 29 | 280. | 5 | 2 | 4 | 3 | 1 |
| 30 | 300. | 5 | 2 | 4 | 3 | 1 |
| 31 | 320. | 5 | 2 | 3 | 4 | 1 |
| 32 | 340. | 5 | 2 | 3 | 4 | 1 |
| 33 | 360. | 4 | 3 | 2 | 5 | 1 |
| 34 | 380. | 5 | 3 | 2 | 4 | 1 |
| 35 | 400. | 5 | 3 | 2 | 4 | 1 |

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```
     2     'STANDARDIZED REGRESSION ', 'STANDARDIZED RANK REGRESSION ' /
      DATA NPLOTS / 0 /
C
C
C*****LOAD VARIABLE PARAMETER DIMENSIONS INTO COMMON BLOCK
      ITEMP(1)=LENC
      ITEMP(2)=LENTC
      ITEMP(3)=LLAB
      ITEMP(4)=MXNDV
      ITEMP(5)=MXNINT
      ITEMP(6)=MXNIV
      ITEMP(7)=MXNOBS
      ITEMP(8)=MXNSTP
C*****SET DEFAULT LABELS FOR DEPENDENT AND INDEPENDENT VARIABLES
      DO 100 I=1,MXNDV
           WRITE(CY(I),101) I
  100 CONTINUE
      DO 200 I=1,MXNIV
           WRITE(CX(I),102) I
  200 CONTINUE
C*****MAIN LOOP OVER INPUT DATA SETS STARTS HERE
 1000 CONTINUE
C*****CALL INPUT TO READ INPUT DATA SET
      CALL INPUT(CARD, CX, CY, DX, IWKDV, IWKIV, LABDV, LABIV,
     1           LSDV, LSIV, PTITLE, PXLAB, STEPS, TITLE, TMPCRD,
     2           X, XB, XE, Y)
C*****ENCODE Y PLOT LABEL
      IF(LRAW .EQ. 0) THEN
           IF((LPRCC .EQ. 1) .AND. (LSRRC .EQ. 1)) THEN
                WRITE(PYLAB,1001)
           ELSE IF(LPRCC .EQ. 1) THEN
                WRITE(PYLAB,1002)
           ELSE
                WRITE(PYLAB,1003)
           ENDIF
      ELSE
           IF((LPCC .EQ. 1) .AND. (LSRC .EQ. 1)) THEN
                WRITE(PYLAB,1004)
           ELSE IF(LPCC .EQ. 1) THEN
                WRITE(PYLAB,1005)
           ELSE
                WRITE(PYLAB,1006)
           ENDIF
      ENDIF
C*****CALL MATRIX TO BUILD CORRELATION MATRIX FOR SELECTED
C*****INDEPENDENT VARIABLES
      CALL MATRIX(IWK, IWKIV, RK, RXCORR, X)
C*****CALL CORREL TO CALCULATE CORRELATIONS BETWEEN SELECTED
C*****INDEPENDENT AND DEPENDENT VARIABLES
      CALL CORREL(CORINV, IRNK, ITMP, IWK, IWKDV, IWKIV, LABDV, LABIV,
     1            LSDV, LSIV, PTITLE, PXLAB, PYLAB, RK, RS, RSPLT,
     2            RSRC, RXCORR, STEPS, TABLE, TABLE1, TITLE,
     3            TMP1, TMP2, X, Y)
C*****CALL PRINT TO PRINT TABLE OF MAXIMUM PARTIAL
C*****CORRELATION COEFFICIENTS
      IPS=0
      IF((NSTEPS .GT. 1) .AND. (TC .LT. 1.0)) THEN
           IF(LPCC .EQ. 1) CALL PRINT(IPS, IWKDV, IWKIV, PCLAB,
     1                               LABDV, LABIV, TABLE, TITLE)
           IF(LPRCC .EQ. 1) CALL PRINT(IPS, IWKDV, IWKIV, PRCLAB,
     1                                 LABDV, LABIV, TABLE, TITLE)
           IF((LPCC .EQ. 1) .OR. (LPRCC .EQ. 1)) IPS=1
           IF(LSRC .EQ. 1) CALL PRINT(IPS, IWKDV, IWKIV, SRLAB,
     1                               LABDV, LABIV, TABLE1, TITLE)
```

```
      IF(NOBS .LE. NSIVP1) THEN
           WRITE(6,9009) NOBS, NSIVP1
           INPERR=INPERR + 1
      ENDIF
C*****VERIFY NON-DUPLICATE SELECTED VARIABLES
      DO 8300 ISDV=1,NSDV-1
           IF(INKDV(ISDV) .EQ. INKDV(ISDV+1)) THEN
                WRITE(6,9054) INKDV(ISDV)
                INPERR=INPERR + 1
           ENDIF
 8300 CONTINUE
      IF((LPCC .EQ. 0) .AND. (LPRCC .EQ. 0) .AND.
     1   (LSRC .EQ. 0) .AND. (LSRRC .EQ. 0)) THEN
           WRITE(6,9011) PPCC, PPRCC, PSRC, PSRRC
           INPERR=INPERR + 1
      ENDIF
      IF(((LPCC .NE. 0) .OR. (LSRC .NE. 0)) .AND.
     1   ((LPRCC .NE. 0) .OR. (LSRRC .NE. 0))) THEN
           WRITE(6,9012)
           INPERR=INPERR + 1
      ENDIF
      IF((LPCC .EQ. 1) .OR. (LSRC .EQ. 1)) LRAW=1
      IF(YMIN .GE. YMAX) THEN
           YMIN=-1.0
           YMAX=1.0
      ENDIF
C*****PROCESS STEPS PARAMETER
      IF(NINT .GT. 0) THEN
           IPRV=0
           DO 100 INT=1,NINT
                XBEG=XB(INT)
                XEND=XE(INT)
                IF(XBEG .GE. XEND) THEN
                     WRITE(6,9017) DELX, XBEG, XEND
                     INPERR=INPERR + 1
                     GO TO 110
                ENDIF
                DELX=DX(INT)
                IF(INT .GT. 1) THEN
                     IF(XB(INT) .NE. XE(INT-1)) THEN
                          WRITE(6,9029) XB(INT), XE(INT-1)
                          INPERR=INPERR + 1
                          GO TO 110
                     ENDIF
                     NSTEPS=NSTEPS + 1
                     STEPS(NSTEPS)=XBEG + DELX
                ELSE
                     STEPS(NSTEPS)=XBEG
                ENDIF
                GO TO 90
   80           CONTINUE
                NSTEPS=NSTEPS + 1
                STEPS(NSTEPS)=STEPS(NSTEPS-1) + DELX
   90           CONTINUE
                IF(STEPS(NSTEPS) .LT. XEND) GO TO 80
                IF(STEPS(NSTEPS) .NE. XEND) STEPS(NSTEPS)=XEND
                IPRV=NSTEPS
  100      CONTINUE
  110      CONTINUE
           IF(NSTEPS .GT. MXNSTP) THEN
                WRITE(6,9004) PSTEPS, MXNSTP
                INPERR=INPERR + 1
           ENDIF
      ENDIF
```

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```
      SUBROUTINE CORMAX(IY, IYC, IRNK, ITMP, IWKDV, IWKIV,
     1                  LABDV, LABIV, PTITLE, PXLAB, PYLAB,
     2                  RS, RSPLT, RSRC, STEPS, TABLE, TABLE1,
     3                  TITLE, TMP1, TMP2)
C*****BUILD TABLES OF MAXIMUM PARTIAL CORRELATION COEFFICIENTS AND
C*****MAXIMUM STANDARDIZED REGRESSION COEFFICIENTS AND PLOT
C*****COEFFICIENTS VS STEPS
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      DIMENSION IRNK(MXNSTP,MXNIV), ITMP(MXNIV),
     1          IWKIV(MXNIV), IWKDV(MXNDV), RS(MXNSTP,MXNIV),
     2          RSPLT(MXNSTP), RSRC(MXNSTP,MXNIV), STEPS(MXNSTP),
     3          TMP1(MXNIV), TMP2(MXNIV)
      CHARACTER*(*) LABDV(MXNDV), LABIV(MXNIV), PTITLE, PXLAB, PYLAB,
     1             TABLE(MXNIV,MXNDV), TABLE1(MXNIV,MXNDV), TITLE
      CHARACTER*1 BLANK
      CHARACTER*80 PXLABT, PYLABT
      DIMENSION D1(2), D2(2)
      DATA D2 / 2*0.0 /
      DATA I0, I1, I2 / 0, 1, 2 /
      DATA BLANK / ' ' /
      DATA IFIRST / 0 /
C
C
      IF(IFIRST .EQ. 0) THEN
         IF(NSTEPS .GT. 1) THEN
C***************SET X-AXIS LIMITS
            D1(1)=STEPS(1)
            D1(2)=STEPS(NSTEPS)
            IF(LLN .EQ. 1) THEN
               D1(1)=10.0 ** INT(ALOG10(D1(1)))
               D1(2)=10.0 ** INT(ALOG10(D1(2)) + 0.999)
            ELSE
               DIF=2*D1(1) - D1(2)
               DIV=D1(2) / D1(1)
               IF((ALOG10(DIV) .GT. 0.5) .AND. (DIF .LE. 0.0))
     1            D1(1)=0.0
               ALNMX=ALOG10(D1(2))
               IF(DIV .GT. 0.5) D1(2)=
     1           AINT(10.0**(ALNMX-AINT(ALNMX))+0.999) *
     2           10.0** INT(ALNMX)
            ENDIF
         ENDIF
         NPRNT=(NSIVP1-1)/10 + 1
         PXLABT=PXLAB
         IFIRST=1
         IF(NSTEPS .LE. 1) WRITE(6,2001)
      ENDIF
C*****LOOP TO BUILD TABLE OF MAXIMUM PARTIAL CORRELATION COEFFICIENTS
C*****IF PLOTS ARE REQUESTED THEY WILL BE GENERATED WITHIN THIS LOOP
      DO 3000 J=1,NSIVP1
C**********FIND MAXIMUM ABSOLUTE VALUE OF PARTIAL CORRELATION
C**********COEFFICIENTS
         RMAX=0.0
         RMAXS=0.0
         RMAX1=0.0
         RMAXS1=0.0
         DO 1000 ISTEPS=1,NSTEPS
            IF(ABS(RS(ISTEPS,J)) .GT. RMAX) THEN
               RMAX=ABS(RS(ISTEPS,J))
               RMAXS=RS(ISTEPS,J)
```

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```
      SUBROUTINE HEEPA(X, Y, N)
C*****PERFORM ASCENDING SORT ON ARRAY X CARRYING CORRESPONDING VALUES
C*****FROM ARRAY Y
      DIMENSION X(N), Y(N)
C
C
      L=N/2 + 1
      IR=N
 1000 CONTINUE
      IF (L .LE. 1) GO TO 7000
      L=L - 1
      XHOLD=X(L)
      YHOLD=Y(L)
 2000 CONTINUE
      J=L
 3000 CONTINUE
      I=J
      J=2 * J
      IF (J - IR) 4000, 5000, 6000
 4000 CONTINUE
      IF (X(J) .LT. X(J+1)) J=J + 1
 5000 CONTINUE
      IF (XHOLD .GE. X(J)) GO TO 6000
      X(I)=X(J)
      Y(I)=Y(J)
      GO TO 3000
 6000 CONTINUE
      X(I)=XHOLD
      Y(I)=YHOLD
      GO TO 1000
 7000 CONTINUE
      XHOLD=X(IR)
      YHOLD=Y(IR)
      X(IR)=X(1)
      Y(IR)=Y(1)
      IR=IR - 1
      IF (IR .GT. 1) GO TO 2000
      X(1)=XHOLD
      Y(1)=YHOLD
      RETURN
      END
```

```
      SUBROUTINE PRINT1(IPS, IYC, IRNK, ITMP, LABDV, LABIV, IWKDV,
     1                  IWKIV, NPRNT, PXLABT, RS, STEPS, TITLE,
     2                  TMP1, TMP2)
C*****PRINT INTERMEDIATE TABLE OF COEFFICIENTS AND RANKS VS STEPS
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      DIMENSION IRNK(MXNSTP,MXNIV), ITMP(MXNIV),
     1          IWKIV(MXNIV), IWKDV(MXNDV), RS(MXNSTP,MXNIV),
     2          STEPS(MXNSTP), TMP1(MXNIV), TMP2(MXNIV)
      CHARACTER*(*) LABDV(MXNDV), LABIV(MXNIV), PXLABT, TITLE
      CHARACTER PCLAB*20, PRCLAB*25, SRLAB*24, SRRLAB*29
      DATA PCLAB, PRCLAB, SRLAB, SRRLAB /
     1     'PARTIAL CORRELATION ',      'PARTIAL RANK CORRELATION ',
     2     'STANDARDIZED REGRESSION ', 'STANDARDIZED RANK REGRESSION ' /
C
C
      IF(NSTEPS .GT. 1) THEN
          WRITE(6,1001)
      ELSE
          WRITE(6,1002)
      ENDIF
C*****PRINT COEFFICIENTS VS STEPS
      DO 2000 IPRNT=1,NPRNT
          ISTRT=(IPRNT-1)*10 + 1
          IEND=MIN(ISTRT+9,NSIVP1)
          IF(LRAW .EQ. 0) THEN
              IF(IPS .EQ. 0) THEN
                  WRITE(6,2001) TITLE, PRCLAB,
     1                          LABDV(IWKDV(IYC)), PXLABT
              ELSE
                  WRITE(6,2001) TITLE, SRRLAB,
     1                          LABDV(IWKDV(IYC)), PXLABT
              ENDIF
          ELSE
              IF(IPS .EQ. 0) THEN
                  WRITE(6,2001) TITLE, PCLAB,
     1                          LABDV(IWKDV(IYC)), PXLABT
              ELSE
                  WRITE(6,2001) TITLE, SRLAB,
     1                          LABDV(IWKDV(IYC)), PXLABT
              ENDIF
          ENDIF
          WRITE(6,2002) (LABIV(IWKIV(J)),J=ISTRT,IEND)
          DO 1000 ISTEPS=1,NSTEPS
              WRITE(6,2003) ISTEPS, STEPS(ISTEPS),
     1                      (RS(ISTEPS,J),J=ISTRT,IEND)
 1000     CONTINUE
 2000 CONTINUE
C*****DETERMINE RANKINGS OF CORRELATION COEFFICIENTS AT EACH TIME STEP
      DO 5000 ISTEPS=1,NSTEPS
          DO 3000 J=1,NSIV
              TMP1(J)=ABS(RS(ISTEPS,J))
 3000     CONTINUE
C**********RANK INDEPENDENT VARIABLES FOR CURRENT TIMESTEP
          CALL RANKER(TMP1, TMP2, ITMP, NSIV)
          DO 4000 J=1,NSIV
C***************REVERSE RANKING ORDER
              IRNK(ISTEPS,J)=NSIV - IFIX(TMP2(J)+0.0001) + 1
 4000     CONTINUE
 5000 CONTINUE
      IF(NSTEPS .GT. 1) THEN
```

TURC1SS SENSITIVITY ANALYSIS

| NUMBER OF IND VARS | NUMBER OF IND VARS SELECTED | NUMBER OF DEP VARS | NUMBER OF DEP VARS SELECTED | NUMBER OF OBSERVATIONS | NUMBER OF STEPS | CUTOFF FOR TABLE | CUTOFF FOR PLOTS | DATA FILE TYPE |
|---|---|---|---|---|---|---|---|---|
| 20 | 5 | 4 | 2 | 60 | 35 | 0.600 | 0.850 | 2 |

PARTIAL CORRELATION AND STANDARDIZED REGRESSION COEFFICIENTS WILL BE CALCULATED USING THE RANKS OF THE OBSERVATIONS

| INDEPENDENT VARIABLES SELECTED FOR ANALYSIS | | DEPENDENT VARIABLES SELECTED FOR ANALYSIS | |
|---|---|---|---|
| 1 | TMALL | 1 | POOLTEMP |
| 2 | TMFE | 3 | HXFER |
| 3 | GAMMAO | | |
| 13 | MTCONC | | |
| 20 | VBUB | | |

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TURC1SS SENSITIVITY ANALYSIS
STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMAO | HTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | -0.07 | 0.01 | 0.19 | 0.13 | 0.82 | 0.73 |
| 2 | 10.0 | 0.03 | -0.03 | 0.39 | 0.22 | 0.80 | 0.84 |
| 3 | 15.0 | -0.02 | 0.00 | 0.48 | 0.16 | 0.77 | 0.86 |
| 4 | 20.0 | 0.00 | -0.02 | 0.49 | 0.15 | 0.78 | 0.87 |
| 5 | 25.0 | 0.00 | -0.03 | 0.47 | 0.16 | 0.79 | 0.88 |
| 6 | 30.0 | 0.00 | -0.01 | 0.51 | 0.16 | 0.76 | 0.86 |
| 7 | 35.0 | -0.02 | 0.01 | 0.48 | 0.14 | 0.78 | 0.86 |
| 8 | 40.0 | 0.00 | 0.04 | 0.44 | 0.20 | 0.74 | 0.79 |
| 9 | 45.0 | 0.00 | 0.02 | 0.50 | 0.18 | 0.74 | 0.83 |
| 10 | 50.0 | -0.01 | -0.04 | 0.49 | 0.17 | 0.76 | 0.85 |
| 11 | 60.0 | 0.00 | -0.06 | 0.43 | 0.27 | 0.65 | 0.68 |
| 12 | 70.0 | 0.00 | -0.11 | 0.41 | 0.38 | 0.46 | 0.54 |
| 13 | 80.0 | -0.06 | -0.09 | 0.36 | 0.44 | 0.40 | 0.50 |
| 14 | 90.0 | -0.07 | -0.08 | 0.29 | 0.54 | 0.30 | 0.48 |
| 15 | 100. | 0.01 | -0.14 | 0.22 | 0.66 | 0.16 | 0.54 |
| 16 | 110. | 0.05 | -0.23 | 0.15 | 0.69 | 0.01 | 0.57 |
| 17 | 120. | 0.03 | -0.33 | 0.02 | 0.66 | -0.12 | 0.57 |
| 18 | 130. | 0.05 | -0.39 | -0.10 | 0.63 | -0.23 | 0.61 |
| 19 | 140. | 0.02 | -0.40 | -0.14 | 0.64 | -0.31 | 0.68 |
| 20 | 150. | 0.01 | -0.39 | -0.15 | 0.65 | -0.32 | 0.70 |
| 21 | 160. | 0.04 | -0.42 | -0.17 | 0.59 | -0.38 | 0.70 |
| 22 | 170. | 0.03 | -0.45 | -0.19 | 0.55 | -0.41 | 0.71 |
| 23 | 180. | 0.01 | -0.45 | -0.19 | 0.54 | -0.42 | 0.71 |
| 24 | 190. | 0.00 | -0.43 | -0.20 | 0.54 | -0.44 | 0.71 |
| 25 | 200. | 0.00 | -0.41 | -0.20 | 0.54 | -0.45 | 0.71 |
| 26 | 220. | -0.01 | -0.42 | -0.20 | 0.52 | -0.48 | 0.71 |
| 27 | 240. | -0.01 | -0.40 | -0.24 | 0.48 | -0.49 | 0.69 |
| 28 | 260. | -0.01 | -0.41 | -0.27 | 0.45 | -0.49 | 0.69 |
| 29 | 280. | -0.03 | -0.45 | -0.26 | 0.37 | -0.49 | 0.66 |
| 30 | 300. | -0.05 | -0.43 | -0.28 | 0.32 | -0.49 | 0.62 |
| 31 | 320. | -0.05 | -0.39 | -0.30 | 0.24 | -0.47 | 0.53 |
| 32 | 340. | 0.00 | -0.34 | -0.32 | 0.12 | -0.47 | 0.45 |
| 33 | 360. | 0.06 | -0.26 | -0.35 | 0.05 | -0.41 | 0.36 |
| 34 | 380. | 0.02 | -0.12 | -0.34 | 0.03 | -0.38 | 0.28 |
| 35 | 400. | 0.03 | -0.10 | -0.32 | 0.05 | -0.34 | 0.23 |

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```
          IF(LSRRC .EQ. 1) CALL PRINT(IPS, IWKDV, IWKIV, SRRLAB,
     1                              LABDV, LABIV, TABLE1, TITLE)
      ENDIF
      WRITE(6,122)
      IF(NPLOTS .GT. 0) THEN
          CALL ENDPL(0)
          CALL DONEPL
      ENDIF
 9999 CONTINUE
      STOP
C*****FORMAT STATEMENTS
  101 FORMAT('Y',I2)
  102 FORMAT('X',I2)
  122 FORMAT('1')
 1001 FORMAT('PRCC (*), SRRC (- - -)')
 1002 FORMAT('PARTIAL RANK CORRELATION COEFFICIENT')
 1003 FORMAT('STANDARDIZED RANK REGRESSION COEFFICIENT')
 1004 FORMAT('PCC (*), SRC (- - -)')
 1005 FORMAT('PARTIAL CORRELATION COEFFICIENT')
 1006 FORMAT('STANDARDIZED REGRESSION COEFFICIENT')
      END
```

```
C*****READ DATA FROM FILE(S)
      IFTT=IFT + 5*LSTR
      DO 120 I=1,NOBS
           GO TO(101,102,103,104,105,106,107,108,109) IFTT
  101      CONTINUE
           READ(1,*,ERR=130) (X(I,J),J=1,NIV),
     1                    ((Y(I,J,K),J=1,NDV),K=1,NSTEPS)
           GO TO 120
  102      CONTINUE
           READ(1,*,ERR=130) (X(I,J),J=1,NIV),
     1                    ((Y(I,J,K),K=1,NSTEPS),J=1,NDV)
           GO TO 120
  103      CONTINUE
           READ(1,*,ERR=130) (X(I,J),J=1,NIV)
           READ(2,*,ERR=130) ((Y(I,J,K),J=1,NDV),K=1,NSTEPS)
           GO TO 120
  104      CONTINUE
           READ(1,*,ERR=130) (X(I,J),J=1,NIV)
           READ(2,*,ERR=130) ((Y(I,J,K),K=1,NSTEPS),J=1,NDV)
           GO TO 120
  105      CONTINUE
           CALL USRINP(MXNDV, MXNIV, MXNOBS, MXNSTP)
           RETURN
  106      CONTINUE
           READ(1,*,ERR=130) II, JJ, (X(I,J),J=1,NIV),
     1                    ((Y(I,J,K),J=1,NDV),K=1,NSTEPS)
           GO TO 120
  107      CONTINUE
           READ(1,*,ERR=130) II, JJ, (X(I,J),J=1,NIV),
     1                    ((Y(I,J,K),K=1,NSTEPS),J=1,NDV)
           GO TO 120
  108      CONTINUE
           READ(1,*,ERR=130) II, JJ, (X(I,J),J=1,NIV)
           READ(2,*,ERR=130) ((Y(I,J,K),J=1,NDV),K=1,NSTEPS)
           GO TO 120
  109      CONTINUE
           READ(1,*,ERR=130) II, JJ, (X(I,J),J=1,NIV)
           READ(2,*,ERR=130) ((Y(I,J,K),K=1,NSTEPS),J=1,NDV)
  120 CONTINUE
      GO TO 140
  130 CONTINUE
C*****ERROR ENCOUNTERED IN READING DATA FILE(S)
      WRITE(6,9028)
      INPERR=INPERR + 1
  140 CONTINUE
      IF(INPERR .EQ. 0) THEN
           WRITE(6,9010) TITLE, NIV, NSIV, NDV, NSDV, NOBS, NSTEPS,
     1                  TC, PC, IFT, STAR(LSTR+1)
C**********ECHO RAW OR RANK CORRELATION PARAMETER
           IF(((LPCC .EQ. 1) .OR. (LPRCC .EQ. 1)) .AND.
     1        ((LSRC .EQ. 1) .OR. (LSRRC .EQ. 1))) THEN
                WRITE(6,9013)
           ELSE IF((LPCC .EQ. 1) .OR. (LPRCC .EQ. 1)) THEN
                WRITE(6,9014)
           ELSE
                WRITE(6,9015)
           ENDIF
           IF(LRAW .EQ. 0) THEN
                WRITE(6,9018)
           ELSE
                WRITE(6,9019)
           ENDIF
C**********ECHO SELECTED VARIABLE DATA
           WRITE(6,9031)
```

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```
          ENDIF
          IF(ABS(RSRC(ISTEPS,J)) .GT. RMAX1) THEN
               RMAX1=ABS(RSRC(ISTEPS,J))
               RMAXS1=RSRC(ISTEPS,J)
          ENDIF
 1000     CONTINUE
     IF(TC .LT. 1.0) THEN
          IF((LPCC .EQ. 1) .OR. (LPRCC .EQ. 1)) THEN
               IF(RMAX .GE. TC) THEN
C**************************GENERATE TABLE ENTRY FOR MAXIMUM
C**************************PARTIAL CORRELATION COEFFICIENT
                    IF(RMAX .GE. 0.995) THEN
                         WRITE(TABLE(J,IYC),1001) RMAXS
                    ELSE IF(RMAXS .GE. 0.0) THEN
                         WRITE(TABLE(J,IYC),1002) RMAXS
                    ELSE
                         WRITE(TABLE(J,IYC),1003) RMAXS
                    ENDIF
C**************************GENERATE TABLE ENTRY FOR STANDARDIZED
C**************************REGRESSION COEFFICIENT
                    IF(RMAX1 .GE. 0.995) THEN
                         WRITE(TABLE1(J,IYC),1001) RMAXS1
                    ELSE IF(RMAXS1 .GE. 0.0) THEN
                         WRITE(TABLE1(J,IYC),1002) RMAXS1
                    ELSE
                         WRITE(TABLE1(J,IYC),1003) RMAXS1
                    ENDIF
               ELSE
C**************************ENCODE BLANK INTO TABLE ENTRY
                    WRITE(TABLE(J,IYC),1004)
                    WRITE(TABLE1(J,IYC),1004)
               ENDIF
          ELSE
C*********************GENERATE TABLE ENTRY FOR STANDARDIZED
C*********************REGRESSION COEFFICIENT
               IF(RMAX1 .GE. TC) THEN
                    IF(RMAX1 .GE. 0.995) THEN
                         WRITE(TABLE1(J,IYC),1001) RMAXS1
                    ELSE IF(RMAXS1 .GE. 0.0) THEN
                         WRITE(TABLE1(J,IYC),1002) RMAXS1
                    ELSE
                         WRITE(TABLE1(J,IYC),1003) RMAXS1
                    ENDIF
               ELSE
C**************************ENCODE BLANK INTO TABLE ENTRY
                    WRITE(TABLE1(J,IYC),1004)
               ENDIF
          ENDIF
     ENDIF
C**********IF REQUESTED, PLOT PARTIAL CORRELATION COEFFICIENTS
     IF((NSTEPS .GT. 1) .AND. (PC .LT. 1.0) .AND.
    1    ((J .EQ. NSIVP1) .OR. ((RMAX .GE. PC) .AND.
    2    ((LPCC .EQ. 1) .OR. (LPRCC .EQ. 1))) .OR.
    3    ((RMAX1 .GE. PC) .AND. ((LPCC .NE. 1) .AND.
    4    (LPRCC .NE. 1))))) THEN
          WRITE(PTITLE(25:50),1005) LABIV(IWKIV(J)),
    1                               LABDV(IWKDV(IYC))
          IF(J .EQ. NSIVP1) THEN
C*********************TEMPORARILY STORE PLOT PARAMETERS
               PYLABT=PYLAB
               WRITE(PYLAB,1007) LABIV(IWKIV(J))
C*********************CALL CENTER TO CENTER Y-LABEL
               CALL CENTER(PYLAB, 26)
               YMINT=YMIN
```

```
      SUBROUTINE MATRIX(IWK, IWKIV, RK, RXCORR, X)
C*****BUILD CORRELATION MATRIX
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXKNT, MXNIV,
     1                MXNOBS, MXNSTP
      DIMENSION IWK(MXNOBS), IWKIV(MXNIV), RK(MXNOBS),
     1          RXCORR(MXNIV*(MXNIV+1)/2), X(MXNOBS,MXNIV)
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      COMMON /SPRC/ SPRC1, SPRC2, SPRC3
C*****STATEMENT FUNCTION
      LOC(I,J)=J+(I*I-I)/2
C
C
C*****IF REQUESTED, RANK INDEPENDENT VARIABLE VALUES AND CALCULATE
C*****CORRELATION CONSTANTS
      ROBS=FLOAT(NOBS)
      IF (LRAW .EQ. 0) THEN
         SPRC1=-(ROBS * (((ROBS + 1.0) / 2.0)**2))
         SPRC2=SPRC1
         SPRC3=SPRC1
         DO 2000 J=1,NIV
            CALL RANKER(X(1,J), RK, IWK, NOBS)
            DO 1000 I=1,NOBS
               X(I,J)=RK(I)
 1000       CONTINUE
 2000    CONTINUE
      ENDIF
C*****LOOP TO BUILD CORRELATION MATRIX FOR SELECTED INDEPENDENT
C*****VARIABLES
      DO 6000 IX=2,NSIV
         I1=IX - 1
         I=IWKIV(IX)
         DO 5000 JX=1,I1
            J=IWKIV(JX)
C****************IF RAW VALUES ARE USED, FIND MEANS OF SELECTED
C****************INDEPENDENT VARIABLES AND CALCULATE CORRELATION
C****************CONSTANTS
            IF(LRAW .NE. 0) THEN
               SX=0.0
               SY=0.0
               DO 3000 IOBS=1,NOBS
                  SX=SX + X(IOBS,I)
                  SY=SY + X(IOBS,J)
 3000          CONTINUE
               SPRC1=-SX * SX / ROBS
               SPRC2=-SY * SY / ROBS
               SPRC3=-SX * SY / ROBS
            ENDIF
C****************CALCULATE SUMS OF SQUARES AND CROSS PRODUCTS
            SXY=0.0
            SX2=0.0
            SY2=0.0
            DO 4000 IOBS=1,NOBS
               SXY=SXY + X(IOBS,I) * X(IOBS,J)
               SX2=SX2 + X(IOBS,I) ** 2
               SY2=SY2 + X(IOBS,J) ** 2
 4000       CONTINUE
C****************CHECK FOR CONSTANT INDEPENDENT VARIABLE IN INPUT VALUES
            V=SXY + SPRC3
            V1=SX2 + SPRC1
            V2=SY2 + SPRC2
            IF((V1 .NE. 0.0) .AND. (V2 .NE. 0.0)) THEN
C*********************CALCULATE SPEARMANS RHO AND STORE IT IN
```



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```
            WRITE(6,1001)
      ELSE
            WRITE(6,1002)
      ENDIF
C*****LOOP OVER PRINT SECTIONS
      NPRNTR=(NSIV-1)/10 + 1
      DO 7000 IPRNT=1,NPRNTR
            ISTRT=(IPRNT-1)*10 + 1
            IEND=MIN(ISTRT+9, NSIV)
            IF(LRAW .EQ. 0) THEN
                  IF(IPS .EQ. 0) THEN
                        WRITE(6,5001) TITLE, PRCLAB,
     1                                  LABDV(IWKDV(IYC)), PXLABT
                  ELSE
                        WRITE(6,5001) TITLE, SRRLAB,
     1                                  LABDV(IWKDV(IYC)), PXLABT
                  ENDIF
            ELSE
                  IF(IPS .EQ. 0) THEN
                        WRITE(6,5001) TITLE, PCLAB,
     1                                  LABDV(IWKDV(IYC)), PXLABT
                  ELSE
                        WRITE(6,5001) TITLE, SRLA9,
     1                                  LABDV(IWKDV(IYC)), PXLABT
                  ENDIF
            ENDIF
            WRITE(6,2002) (LABIV(IWKIV(J)),J=ISTRT,IEND)
            DO 6000 ISTEPS=1,NSTEPS
                  WRITE(6,5002) ISTEPS, STEPS(ISTEPS),
     1                            (IRNK(ISTEPS,J),J=ISTRT,IEND)
 6000       CONTINUE
 7000 CONTINUE
      RETURN
C*****FORMAT STATEMENTS
 1001 FORMAT('1')
 1002 FORMAT('0')
 2001 FORMAT(/1X,A,
     1       /6X,A,'COEFFICIENTS  VS  STEPS',
     2       /11X,'DEPENDENT VARIABLE -',A,'-',
     3       /16X,'UNITS = ',A)
 2002 FORMAT(/1X,T60,'INDEPENDENT VARIABLES',
     1        /1X,'STEPS',2X,'UNITS',4X,10(2X,A))
 2003 FORMAT(1X,I3,1X,1PG10.3,0P10F10.2)
 5001 FORMAT(/1X,A,
     1       /6X,'RANKS OF ',A,'COEFFICIENTS  VS  STEPS',
     2       /11X,'DEPENDENT VARIABLE -',A,'-',
     3       /16X,'UNITS = ',A)
 5002 FORMAT(1X,I3,1X,1PG10.3,10(6X,I3,1X))
      END
```

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TURC1SS SENSITIVITY ANALYSIS
PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -POOLTEMP-
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | 0.29 | -0.01 | -0.63 | 0.34 | -0.49 | 0.54 |
| 2 | 10.0 | 0.19 | -0.07 | -0.74 | 0.45 | -0.68 | 0.70 |
| 3 | 15.0 | 0.12 | -0.05 | -0.78 | 0.48 | -0.78 | 0.77 |
| 4 | 20.0 | 0.07 | -0.06 | -0.79 | 0.50 | -0.82 | 0.80 |
| 5 | 25.0 | 0.11 | -0.03 | -0.78 | 0.51 | -0.84 | 0.81 |
| 6 | 30.0 | 0.11 | -0.03 | -0.78 | 0.51 | -0.84 | 0.81 |
| 7 | 35.0 | 0.10 | -0.04 | -0.78 | 0.53 | -0.85 | 0.82 |
| 8 | 40.0 | 0.11 | -0.05 | -0.78 | 0.55 | -0.86 | 0.82 |
| 9 | 45.0 | 0.10 | -0.04 | -0.77 | 0.56 | -0.86 | 0.82 |
| 10 | 50.0 | 0.07 | -0.02 | -0.77 | 0.59 | -0.86 | 0.83 |
| 11 | 60.0 | 0.06 | 0.00 | -0.78 | 0.59 | -0.86 | 0.83 |
| 12 | 70.0 | 0.05 | -0.01 | -0.78 | 0.59 | -0.86 | 0.83 |
| 13 | 80.0 | 0.05 | 0.02 | -0.78 | 0.59 | -0.86 | 0.83 |
| 14 | 90.0 | 0.04 | 0.12 | -0.77 | 0.58 | -0.86 | 0.82 |
| 15 | 100. | 0.02 | 0.24 | -0.76 | 0.55 | -0.84 | 0.81 |
| 16 | 110. | 0.04 | 0.36 | -0.74 | 0.52 | -0.83 | 0.79 |
| 17 | 120. | 0.01 | 0.53 | -0.70 | 0.48 | -0.81 | 0.77 |
| 18 | 130. | 0.00 | 0.60 | -0.66 | 0.38 | -0.76 | 0.73 |
| 19 | 140. | -0.01 | 0.66 | -0.61 | 0.34 | -0.70 | 0.70 |
| 20 | 150. | -0.03 | 0.70 | -0.58 | 0.31 | -0.66 | 0.69 |
| 21 | 160. | -0.05 | 0.70 | -0.54 | 0.23 | -0.61 | 0.67 |
| 22 | 170. | -0.08 | 0.71 | -0.49 | 0.19 | -0.55 | 0.64 |
| 23 | 180. | -0.12 | 0.74 | -0.47 | 0.14 | -0.54 | 0.65 |
| 24 | 190. | -0.12 | 0.78 | -0.45 | 0.12 | -0.53 | 0.69 |
| 25 | 200. | -0.13 | 0.82 | -0.44 | 0.09 | -0.51 | 0.72 |
| 26 | 220. | -0.11 | 0.84 | -0.44 | 0.05 | -0.48 | 0.75 |
| 27 | 240. | -0.08 | 0.86 | -0.44 | 0.03 | -0.42 | 0.77 |
| 28 | 260. | -0.06 | 0.89 | -0.44 | 0.01 | -0.38 | 0.81 |
| 29 | 280. | -0.07 | 0.91 | -0.42 | 0.02 | -0.35 | 0.84 |
| 30 | 300. | -0.08 | 0.93 | -0.38 | -0.01 | -0.32 | 0.86 |
| 31 | 320. | -0.12 | 0.93 | -0.31 | -0.04 | -0.28 | 0.88 |
| 32 | 340. | -0.12 | 0.94 | -0.29 | -0.06 | -0.28 | 0.89 |
| 33 | 360. | -0.12 | 0.95 | -0.25 | -0.09 | -0.26 | 0.91 |
| 34 | 380. | -0.12 | 0.96 | -0.22 | -0.10 | -0.27 | 0.93 |
| 35 | 400. | -0.12 | 0.97 | -0.21 | -0.09 | -0.25 | 0.94 |

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TURC1SS SENSITIVITY ANALYSIS
RANKS OF STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 2 | 3 | 1 |
| 2 | 10.0 | 4 | 5 | 2 | 3 | 1 |
| 3 | 15.0 | 4 | 5 | 2 | 3 | 1 |
| 4 | 20.0 | 5 | 4 | 2 | 3 | 1 |
| 5 | 25.0 | 5 | 4 | 2 | 3 | 1 |
| 6 | 30.0 | 5 | 4 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 5 | 4 | 2 | 3 | 1 |
| 9 | 45.0 | 5 | 4 | 2 | 3 | 1 |
| 10 | 50.0 | 5 | 4 | 2 | 3 | 1 |
| 11 | 60.0 | 5 | 4 | 2 | 3 | 1 |
| 12 | 70.0 | 5 | 4 | 2 | 3 | 1 |
| 13 | 80.0 | 5 | 4 | 3 | 1 | 2 |
| 14 | 90.0 | 5 | 4 | 3 | 1 | 2 |
| 15 | 100. | 5 | 4 | 2 | 1 | 3 |
| 16 | 110. | 4 | 2 | 3 | 1 | 5 |
| 17 | 120. | 4 | 2 | 5 | 1 | 3 |
| 18 | 130. | 5 | 2 | 4 | 1 | 3 |
| 19 | 140. | 5 | 2 | 4 | 1 | 3 |
| 20 | 150. | 5 | 2 | 4 | 1 | 3 |
| 21 | 160. | 5 | 2 | 4 | 1 | 3 |
| 22 | 170. | 5 | 2 | 4 | 1 | 3 |
| 23 | 180. | 5 | 2 | 4 | 1 | 3 |
| 24 | 190. | 5 | 3 | 4 | 1 | 2 |
| 25 | 200. | 5 | 3 | 4 | 1 | 2 |
| 26 | 220. | 5 | 3 | 4 | 1 | 2 |
| 27 | 240. | 5 | 3 | 4 | 2 | 1 |
| 28 | 260. | 5 | 3 | 4 | 2 | 1 |
| 29 | 280. | 5 | 2 | 4 | 3 | 1 |
| 30 | 300. | 5 | 2 | 4 | 3 | 1 |
| 31 | 320. | 5 | 2 | 3 | 4 | 1 |
| 32 | 340. | 5 | 2 | 3 | 4 | 1 |
| 33 | 360. | 4 | 3 | 2 | 5 | 1 |
| 34 | 380. | 5 | 3 | 2 | 4 | 1 |
| 35 | 400. | 5 | 3 | 2 | 4 | 1 |

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```
      SUBROUTINE INPUT(CARD, CX, CY, DX, IWKDV, IWKIV, LABDV, LABIV,
     1                 LSDV, LSIV, PTITLE, PXLAB, STEPS, TITLE, TMPCRD,
     2                 X, XB, XE, Y)
C*****PROCESS THE INPUT KEYWORD RECORDS
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      DIMENSION DX(MXNINT), IWKDV(MXNDV), IWKIV(MXNIV),
     1          LSDV(MXNDV), LSIV(MXNIV), STEPS(MXNSTP),
     2          X(MXNOBS,MXNIV), XB(MXNINT), XE(MXNINT),
     3          Y(MXNOBS,MXNDV,MXNSTP)
      CHARACTER*(*) CARD, CX(MXNIV), CY(MXNDV), LABDV(MXNDV),
     1              LABIV(MXNIV), PTITLE, PXLAB, TITLE, TMPCRD
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      CHARACTER*1 BLANK, DUM, STAR(2)
      CHARACTER*20 CRDTYP, FRMTA, FRMTAR, FRMTI, FRMTAI, FRMTR, RSQUAR
      CHARACTER     PT*6,    PNIV*4,    PNDV*4,    PNOBS*5, PSTEPS*6,
     1            PFT*10,    PIV*9,     PXL*7,     PDV*9,     PYL*7,
     2            PPCC*4,   PPRCC*5,   PSRC*4,    PSRRC*5,   PTC*13,
     3            PPC*12,   PPT*11,   PPXL*12,   PXLOG*5,   PYLIM*8
      PARAMETER (PT='TITLE ',           PNIV='NIV ',
     1           PNDV='NDV ',           PNOBS='NOBS ',
     2           PSTEPS='STEPS ',       PFT='FILE TYPE ',
     3           PIV='IND VARS ',       PXL='XLABEL ',
     4           PDV='DEP VARS ',       PYL='YLABEL ',
     5           PPCC='PCC ',           PPRCC='PRCC ',
     6           PSRC='SRC ',           PSRRC='SRRC ',
     7           PTC='TABLE CUTOFF ', PPC='PLOT CUTOFF ',
     8           PPT='PLOT TITLE ',     PPXL='PLOT XLABEL ',
     9           PXLOG='XLOG ',         PYLIM='YLIMITS ',
     A           BLANK=' ')
      DATA RSQUAR / 'R-SQUARE' /
      DATA STAR / ' ', '*' /
C
C
      REWIND 1
      REWIND 2
      DO 1000 I=1,MXNDV
           LSDV(I)=0
           LABDV(I)=CY(I)
 1000 CONTINUE
      DO 2000 I=1,MXNIV
           LSIV(I)=0
           LABIV(I)=CX(I)
 2000 CONTINUE
C*****INITIALLIZE PARAMETERS
      TITLE=BLANK
      INPERR=0
      IEND=0
      NIV=-9999
      NSIVP1=0
      NSIV=0
      NDV=-9999
      NSDV=0
      NOBS=-9999
      NINT=0
      NSTEPS=1
      LPCC=0
      LPRCC=0
      LSRC=0
      LSRRC=0
      IFT=-9999
      LLN=0
```

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```
         MXNV=MAX(NSDV, NSIV)
         DO 9000 IV=1,MXNV
              IF((IV .LE. NSDV) .AND. (IV .LE. NSIV)) THEN
                   WRITE(6,9032) IWKIV(IV), LABIV(IWKIV(IV)),
     1                          IWKDV(IV), LABDV(IWKDV(IV))
              ELSE IF(IV .GT. NSDV) THEN
                   WRITE(6,9032) IWKIV(IV), LABIV(IWKIV(IV))
              ELSE
                   WRITE(6,9033) IWKDV(IV), LABDV(IWKDV(IV))
              ENDIF
 9000    CONTINUE
      ELSE
         WRITE(6,9030) INPERR
         STOP 'INPUT'
      ENDIF
      RETURN
C*****FORMAT STATEMENTS
 9001 FORMAT(A)
 9003 FORMAT('0',5('>'),'THE PARAMETER ',A,' IS LESS THAN OR EQUAL TO ',
     1       'ZERO ')
 9004 FORMAT('0',5('>'),'THE VALUE OF THE PARAMETER ',A,' IS GREATER ',
     1       'THAN THE MAXIMUM ALLOWED ',I10,
     2      /1X,5('>'),'PLEASE CONSULT THE USER MANUAL FOR ',
     3       'INSTRUCTIONS ON HOW TO ADJUST THIS LIMIT')
 9005 FORMAT('0',5('>'),'AN INVALID FILE TYPE HAS BEEN REQUESTED',I10)
 9006 FORMAT('0',5('>'),'THE PARAMETER ',A,' IS NOT BETWEEN ZERO AND ',
     1       'ONE ',F10.3)
 9007 FORMAT('0',5('>'),'THE FOLLOWING RECORD IS NOT A VALID ',
     1       'KEYWORD RECORD',
     2      /1X,'>>>>>PLEASE CONSULT THE USER MANUAL FOR THE ',
     3       'CORRECT KEYWORD RECORD SYNTAX',
     4      /'0','>>>>>',A)
 9008 FORMAT('0>>>>>THE ',A,'KEYWORD RECORD IS REQUIRED BUT ',
     1       'MISSING')
 9009 FORMAT('0>>>>>THE NUMBER OF OBSERVATIONS ',I10,' IS LESS ',
     1       'THAN OR EQUAL TO THE NUMBER OF SELECTED INDEPENDENT',
     2      /1X,'>>>>>VARIABLES PLUS ONE ',I10,' THIS IS NOT A FULL ',
     3       'RANK CASE',
     4       /1X,'>>>>>SO NO PARTIAL CORRELATIONS CAN BE CALCULATED')
 9010 FORMAT('1',
     1      /1X,A,
     2      /'0','NUMBER OF',T14,'NUMBER OF IND',T33,'NUMBER OF',
     3       T47,'NUMBER OF DEP',T66,'NUMBER OF',T80,'NUMBER OF',
     4       T94,'CUTOFF FOR',T108,'CUTOFF FOR',T122,'DATA FILE',
     5      /1X,'IND VARS',T14,'VARS SELECTED',T33,'DEP VARS',
     6       T47,'VARS SELECTED',T65,'OBSERVATIONS',T82,'STEPS',
     7       T96,'TABLE',T110,'PLOTS',T124,'TYPE',
     8      /1X,I6,T16,I6,T33,I6,T49,I6,T66,I6,T80,I6,T94,F7.3,
     9       T108,F7.3,T122,I4,A)
 9011 FORMAT('0>>>>>AT LEAST ONE OF THE FOLLOWING KEYWORD ',
     1       'RECORDS IS REQUIRED BUT MISSING --',
     2      /1X,'>>>>>',4A)
 9012 FORMAT('0>>>>>WHEN MORE THAN ONE OF THE FOLLOWING ',
     1       'KEYWORD RECORDS IS SPECIFIED, ',
     2      /1X,'>>>>>THEY MUST BE PAIRED AS EITHER PCC AND SRC  ',
     3       'OR  PRCC AND SRRC')
 9013 FORMAT(/'0','PARTIAL CORRELATION AND STANDARDIZED REGRESSION ',
     1         'COEFFICIENTS WILL BE CALCULATED USING')
 9014 FORMAT(/'0','PARTIAL CORRELATION COEFFICIENTS WILL BE ',
     1         'CALCULATED USING')
 9015 FORMAT(/'0','STANDARDIZED REGRESSION COEFFICIENTS WILL BE ',
     1         'CALCULATED USING')
 9017 FORMAT('0>>>>>FOR X-AXIS STEP SIZE ',1PE10.3,' THE LOWER ',
     1       'LIMIT ',1PE10.3,
```

```
                    YMAXT=YMAX
                    YMIN=0.0
                    YMAX=1.0
                    WRITE(PTITLE(25:50),1006) LABDV(IWKDV(IYC))
               ENDIF
               CALL PLOT(LLN, I0, D1, D2, I2, I0, I1, PTITLE,
     1                   PXLAB, PYLAB, D1(1), D1(2))
               IF((LPCC .EQ. 1) .OR. (LPRCC .EQ. 1)) THEN
                    DO 2000 ISTEPS=1,NSTEPS
                         RSPLT(ISTEPS)=RS(ISTEPS,J)
 2000               CONTINUE
C********************PLOT PARTIAL CORRELATION COEFFICIENTS
                    CALL PLOT(LLN, I0, STEPS, RSPLT, NSTEPS,
     1                        I1, I0, PTITLE, PXLAB, PYLAB,
     2                        D1(1), D1(2))
               ENDIF
               IF((LSRC .EQ. 1) .OR. (LSRRC .EQ. 1)) THEN
                    DO 2500 ISTEPS=1,NSTEPS
                         RSPLT(ISTEPS)=RSRC(ISTEPS,J)
 2500               CONTINUE
C********************PLOT STANDARD REGRESSION COEFFICIENTS
                    CALL PLOT(LLN, I0, STEPS, RSPLT, NSTEPS,
     1                        I2, I0, PTITLE, PXLAB, PYLAB,
     2                        D1(1), D1(2))
               ENDIF
               IF(J .EQ. NSIVP1) THEN
C********************RESET PLOT PARAMETERS
                    PYLAB=PYLABT
                    YMIN=YMINT
                    YMAX=YMAXT
               ENDIF
          ENDIF
 3000 CONTINUE
      IF((LPCC .EQ. 1) .OR. (LPRCC .EQ. 1)) THEN
          IPS=0
C**********CALL PRINT1 TO PRINT INTERMEDIATE TABLE OF
C**********PARTIAL CORRELATION COEFFICIENTS AND RANKS VS STEPS
          CALL PRINT1(IPS, IYC, IRNK, ITMP, LABDV, LABIV, IWKDV,
     1                IWKIV, NPRNT, PXLABT, RS, STEPS, TITLE,
     2                TMP1, TMP2)
      ENDIF
      IF((LSRC .EQ. 1) .OR. (LSRRC .EQ. 1)) THEN
          IPS=1
C**********CALL PRINT1 TO PRINT INTERMEDIATE TABLE OF
C**********STANDARDIZED REGRESSION COEFFICIENTS AND RANKS VS STEPS
          CALL PRINT1(IPS, IYC, IRNK, ITMP, LABDV, LABIV, IWKDV,
     1                IWKIV, NPRNT, PXLABT, RSRC, STEPS, TITLE,
     2                TMP1, TMP2)
      ENDIF
      RETURN
C*****FORMAT STATEMENTS
 1001 FORMAT(F5.2,3X)
 1002 FORMAT(2X,F3.2)
 1003 FORMAT(1X,F4.2)
 1004 FORMAT(8X)
 1005 FORMAT('  IV=',A8,'  DV=',A8)
 1006 FORMAT('  DV=',A8)
 1007 FORMAT('MODEL ',A8)
 2001 FORMAT('1')
        END
```

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```
C********************CORRELATION MATRIX
                    RXCORR(LOC(IX,JX))=V / SQRT(V1 * V2)
               ELSE
                    RXCORR(LOC(IX,JX))=0.0
               ENDIF
 5000     CONTINUE
 6000 CONTINUE
C*****FILL MAIN DIAGONAL OF CORRELATION MATRIX WITH ONES
      DO 7000 I=1,NSIV
          RXCORR(LOC(I,I))=1.0
 7000 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE RANKER(X, RANK, IWORK, N)
C*****ASSIGN RANKS TO ARRAY X
      DIMENSION IWORK(N), RANK(N), X(N)
C
C
      DO 1000 I=1,N
           RANK(I)=FLOAT(I)
 1000 CONTINUE
C*****CALL SORT ROUTINE HEEPA
      CALL HEEPA(X, RANK, N)
      DO 2000 I=1,N
           IWORK(I)=IFIX(RANK(I))
           RANK(I)=FLOAT(I)
 2000 CONTINUE
C*****FIND TIES
      I=0
 3000 CONTINUE
      I=I + 1
      IF (I .GE. N) GO TO 8000
      IF (X(I) .NE. X(I+1)) GO TO 3000
C*****COUNT TIES
      NTIES=2
 4000 CONTINUE
      II=I + NTIES
      IF (II .GT. N) GO TO 5000
      IF (X(I) .NE. X(II)) GO TO 5000
      NTIES=NTIES + 1
      GO TO 4000
C*****AVERAGE TIED RANKS
 5000 CONTINUE
      AVG=0.0
      DO 6000 J=1,NTIES
           AVG=AVG + RANK(I+J-1)
 6000 CONTINUE
      AVG=AVG / FLOAT(NTIES)
      I=I - 1
      DO 7000 J=1,NTIES
           I=I + 1
           RANK(I)=AVG
 7000 CONTINUE
      GO TO 3000
 8000 CONTINUE
C*****REORDER
      I=1
 9000 CONTINUE
      K=IWORK(I)
      IF (K .NE. I) GO TO 1100
      I=I + 1
      IF (I .LT. N) GO TO 9000
      GO TO 9999
 1100 CONTINUE
      XHOLD=X(I)
      RHOLD=RANK(I)
      X(I)=X(K)
      RANK(I)=RANK(K)
      X(K)=XHOLD
      RANK(K)=RHOLD
      IWORK(I)=IWORK(K)
      IWORK(K)=K
      GO TO 9000
 9999 CONTINUE
      RETURN
      END
```

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TURC1SS SENSITIVITY ANALYSIS

RANKS OF PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS

DEPENDENT VARIABLE -POOLTEMP-

UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMAO | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 1 | 3 | 2 |
| 2 | 10.0 | 4 | 5 | 1 | 3 | 2 |
| 3 | 15.0 | 4 | 5 | 1 | 3 | 2 |
| 4 | 20.0 | 4 | 5 | 2 | 3 | 1 |
| 5 | 25.0 | 4 | 5 | 2 | 3 | 1 |
| 6 | 30.0 | 4 | 5 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 4 | 5 | 2 | 3 | 1 |
| 9 | 45.0 | 4 | 5 | 2 | 3 | 1 |
| 10 | 50.0 | 4 | 5 | 2 | 3 | 1 |
| 11 | 60.0 | 4 | 5 | 2 | 3 | 1 |
| 12 | 70.0 | 4 | 5 | 2 | 3 | 1 |
| 13 | 80.0 | 4 | 5 | 2 | 3 | 1 |
| 14 | 90.0 | 5 | 4 | 2 | 3 | 1 |
| 15 | 100. | 5 | 4 | 2 | 3 | 1 |
| 16 | 110. | 5 | 4 | 2 | 3 | 1 |
| 17 | 120. | 5 | 3 | 2 | 4 | 1 |
| 18 | 130. | 5 | 3 | 2 | 4 | 1 |
| 19 | 140. | 5 | 2 | 3 | 4 | 1 |
| 20 | 150. | 5 | 1 | 3 | 4 | 2 |
| 21 | 160. | 5 | 1 | 3 | 4 | 2 |
| 22 | 170. | 5 | 1 | 3 | 4 | 2 |
| 23 | 180. | 5 | 1 | 3 | 4 | 2 |
| 24 | 190. | 5 | 1 | 3 | 4 | 2 |
| 25 | 200. | 4 | 1 | 3 | 5 | 2 |
| 26 | 220. | 4 | 1 | 3 | 5 | 2 |
| 27 | 240. | 4 | 1 | 2 | 5 | 3 |
| 28 | 260. | 4 | 1 | 2 | 5 | 3 |
| 29 | 280. | 4 | 1 | 2 | 5 | 3 |
| 30 | 300. | 4 | 1 | 2 | 5 | 3 |
| 31 | 320. | 4 | 1 | 2 | 5 | 3 |
| 32 | 340. | 4 | 1 | 2 | 5 | 3 |
| 33 | 360. | 4 | 1 | 3 | 5 | 2 |
| 34 | 380. | 4 | 1 | 3 | 5 | 2 |
| 35 | 400. | 4 | 1 | 3 | 5 | 2 |

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TABLE ENTRIES REPRESENT THE MAXIMUM VALUE OF THE PARTIAL RANK CORRELATION COEFFICIENT OVER ALL STEPS FOR EACH COMBINATION OF SELECTED INDEPENDENT VARIABLE AND SELECTED DEPENDENT VARIABLE, PROVIDED THAT THE ABSOLUTE VALUE OF THIS COEFFICIENT IS GREATER THAN 0.600

| | POOLTEMP | HXFER |
|---|---|---|
| TMALL | | |
| TMFE | .97 | -.64 |
| GAMMA0 | -.79 | .81 |
| MTCONC | | .76 |
| VBUB | -.86 | .91 |

```
      LRAW=0
      TC=0.60
      PC=0.60
      PTITLE=BLANK
      PXLAB=BLANK
      YMIN=0.0
      YMAX=0.0
      NWRDS=MAX(3*MXNINT, MXNDV, MXNIV)
C*****ENCODE REAL FORMAT
      WRITE(FRMTR,9041) NWRDS, LENTC
      WRITE(FRMTAR,9042) LENTC, NWRDS, LENTC
C*****ENCODE INTEGER FORMAT
      WRITE(FRMTI,9043) NWRDS, LENTC
      WRITE(FRMTAI,9044) LENTC, NWRDS, LENTC
C*****ENCODE CHARACTER FORMAT
      WRITE(FRMTA,9045) NWRDS, LENTC
    8 CONTINUE
      IF(IEND .EQ. 1) GO TO 8000
C*****READ KEYWORD RECORD
      READ(5,9001,END=14) CARD
   10 CONTINUE
      IF(IEND .EQ. 1) GO TO 8000
      IF((CARD(1:6) .EQ. PT) .OR. (CARD(1:10) .EQ. PFT) .OR.
     1   (CARD(1:11) .EQ. PPT) .OR. (CARD(1:12) .EQ. PPXL)) THEN
           CRDTYP=CARD
           GO TO 30
      ENDIF
      CALL DATSQZ(CARD, CRDTYP, TMPCRD, IT, 0)
   12 CONTINUE
C*****READ KEYWORD RECORD
      READ(5,9001,END=14) CARD
      IF(CARD(1:1) .EQ. BLANK) THEN
           CALL DATSQZ(CARD, CRDTYP, TMPCRD, IT, 1)
           GO TO 12
      ENDIF
      GO TO 30
   14 CONTINUE
C*****SET END-OF-FILE FLAG
      IEND=1
   30 CONTINUE
C*****TITLE RECORD
      IF(CRDTYP(1:6) .EQ. PT) THEN
           I=6
   17      CONTINUE
           I=I + 1
           IF(CARD(I:I) .EQ. BLANK) GO TO 17
           READ(CARD(I:LENC),9001) TITLE
           GO TO 8
C*****NIV RECORD
      ELSE IF(CRDTYP(1:4) .EQ. PNIV) THEN
           READ(TMPCRD,FRMTI,ERR=7000) NIV
           IF(NIV .LE. 0) THEN
                WRITE(6,9003) PNIV
                INPERR=INPERR + 1
           ELSE IF(NIV .GT. MXNIV) THEN
                WRITE(6,9004) PNIV, MXNIV
                INPERR=INPERR + 1
           ENDIF
           GO TO 10
C*****NDV RECORD
      ELSE IF(CRDTYP(1:4) .EQ. PNDV) THEN
           READ(TMPCRD,FRMTI,ERR=7000) NDV
           IF(NDV .LE. 0) THEN
                WRITE(6,9003) PNDV
```

```
    2      /1X,'>>>>>IS GREATER THAN OR EQUAL TO THE UPPER LIMIT ',
    3       1PE10.3)
9018 FORMAT(1X,'THE RANKS OF THE OBSERVATIONS')
9019 FORMAT(1X,'THE ORIGINAL OBSERVATIONS')
9027 FORMAT('0>>>>>EITHER THE FOLLOWING KEYWORD RECORD OR THE ONE ',
    1       'IMMEDIATELY FOLLOWING IT ',
    2      /1X,'>>>>>DOES NOT CONFORM TO THE FORMAT SPECIFIED IN ',
    3       'THE USER MANUAL',
    4      /1X,'>>>>>',A)
9028 FORMAT('0>>>>>THE DATA FILE(S) HAVE NOT BEEN DESCRIBED ',
    1       'CORRECTLY',
    2      /1X,'>>>>>PLEASE CHECK THE NOBS, NIV, NDV, STEPS, AND ',
    3       'FILE TYPE PARAMETERS',
    4      /1X,'>>>>>CONSULT THE USER MANUAL FOR DETAILS')
9029 FORMAT('0>>>>>THE BEGINNING POINT FOR THE CURRENT STEP ',
    1       'SIZE ',1PE10.3,
    2      /1X,'>>>>>AND THE ENDING POINT FOR THE PREVIOUS STEP ',
    3       'SIZE ',1PE10.3,
    4      /1X,'>>>>>ARE NOT EQUAL BUT SHOULD BE')
9030 FORMAT(//'0>>>>>A TOTAL OF ',I2,' ERRORS FOUND IN INPUT ',
    1       'DATA FILE')
9031 FORMAT(/'0','INDEPENDENT VARIABLES',T30,'DEPENDENT VARIABLES',
    1      /1X,'SELECTED FOR ANALYSIS',T29,'SELECTED FOR ANALYSIS',/)
9032 FORMAT(1X,I6,2X,A,T30,I6,2X,A)
9033 FORMAT(1X,T30,I6,2X,A)
9041 FORMAT('(',I3,'F',I2,'.0)')
9042 FORMAT('(A',I2,',',I3,'F',I2,'.0)')
9043 FORMAT('(',I3,'I',I2,')')
9044 FORMAT('(A',I2,',',I3,'I',I2,')')
9045 FORMAT('(',I3,'A',I2,')')
9051 FORMAT('0>>>>>THE NUMBER OF SELECTED INDEPENDENT VARIABLES (',
    1       I3,') IS GREATER THAN ',
    2       /1X,'>>>>>THE TOTAL NUMBER OF INDEPENDENT ',
    3       'VARIABLES (',I3,')')
9052 FORMAT('0>>>>>DUPLICATE SELECTED INDEPENDENT VARIABLE --',I5)
9053 FORMAT('0>>>>>THE NUMBER OF SELECTED DEPENDENT VARIABLES (',
    1       I3,') IS GREATER THAN ',
    2       /1X,'>>>>>THE TOTAL NUMBER OF DEPENDENT ',
    3       'VARIABLES (',I3,')')
9054 FORMAT('0>>>>>DUPLICATE SELECTED DEPENDENT VARIABLES --',I5)
     END
```

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```
      SUBROUTINE CORREL(CORINV, IRNK, ITMP, IWK, IWKDV,
     1                  IWKIV, LABDV, LABIV, LSDV, LSIV,
     2                  PTITLE, PXLAB, PYLAB, RK, RS, RSPLT, RSRC,
     3                  RXCORR, STEPS, TABLE, TABLE1, TITLE,
     4                  TMP1, TMP2, X, Y)
C*****CALCULATE CORRELATIONS BETWEEN SELECTED INDEPENDENT AND DEPENDENT
C*****VARIABLES
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      DIMENSION CORINV((MXNIV+1)*(MXNIV+2)/2), IRNK(MXNSTP,MXNIV),
     1          ITMP(MXNIV), IWK(MXNOBS), IWKDV(MXNDV), IWKIV(MXNIV),
     2          LSDV(MXNDV), LSIV(MXNIV), RK(MXNOBS), RS(MXNSTP,MXNIV),
     3          RSPLT(MXNSTP), RSRC(MXNSTP,MXNIV),
     4          RXCORR(MXNIV*(MXNIV+1)/2), STEPS(MXNSTP), TMP1(MXNIV),
     5          TMP2(MXNIV), X(MXNOBS,MXNIV), Y(MXNOBS,MXNDV,MXNSTP)
      CHARACTER*(*) LABDV(MXNDV), LABIV(MXNIV), PTITLE, PXLAB, PYLAB,
     1              TABLE(MXNIV,MXNDV), TABLE1(MXNIV,MXNDV), TITLE
C
C
C*****LOOP OVER DEPENDENT VARIABLES
      IYC=0
      DO 4000 IY=1,NDV
C**********CHECK FOR SELECTED DEPENDENT VARIABLE
           IF (LSDV(IY) .EQ. 0) GO TO 4000
           IYC=IYC + 1
C**********IF REQUESTED, RANK DEPENDENT VARIABLE VALUES
           IF (LRAW .EQ. 0) THEN
                DO 3000 ISTEPS=1,NSTEPS
                     CALL RANKER(Y(1,IY,ISTEPS), RK, IWK, NOBS)
                     DO 2000 I=1,NOBS
                          Y(I,IY,ISTEPS)=RK(I)
 2000                CONTINUE
 3000           CONTINUE
           ENDIF
C**********CALL CORCAL TO CALCULATE CORRELATIONS BETWEEN SELECTED
C**********INDEPENDENT VARIABLES AND CURRENT DEPENDENT VARIABLE
           CALL CORCAL(IY, CORINV, IWKIV, RS, RSRC, RXCORR, X, Y)
C**********CALL CORMAX TO BUILD TABLE OF MAXIMUM PARTIAL CORRELATION
C**********COEFFICIENTS AND PLOT PARTIAL CORRELATION COEFFICIENTS VS
C**********STEPS
           CALL CORMAX(IY, IYC, IRNK, ITMP, IWKDV, IWKIV,
     1                 LABDV, LABIV, PTITLE, PXLAB, PYLAB,
     2                 RS, RSPLT, RSRC, STEPS, TABLE, TABLE1,
     3                 TITLE, TMP1, TMP2)
 4000 CONTINUE
      RETURN
      END
```

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```
      SUBROUTINE PLOT(LLX, LLY, X, Y, NPTS, IMARK, IADVNC,
     1                LABELT, LABELX, LABELY, XMIN, XMAX)
C*****PLOT X VS Y ARRAYS USING DISSPLA PLOT ROUTINES
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      CHARACTER*(*) LABELT, LABELX, LABELY
      CHARACTER*30 FMT
      DIMENSION LABT(15), LABX(15), LABY(15)
      DIMENSION X(NPTS), Y(NPTS)
      DATA BLANK / ' ' /
      DATA PAGEX, PAGEY / 14.0, 14.0 /
      DATA XAX, YAX / 10.0, 10.0 /
C
C
      IF(NPLOTS .EQ. 0) THEN
C*****INITIALLIZE PLOT DEVICE (SYSTEM DEPENDENT)
          CALL VSTART(0.0, 0)
C*****SET NO BLANK PAGES BETWEEN PLOTS (SYSTEM DEPENDENT)
          CALL VDESCP(900, 0, 0.0)
C**********CENTER PLOT LABELS
          CALL CENTER(LABELT, 25)
          CALL CENTER(LABELX, 26)
          CALL CENTER(LABELY, 26)
      ENDIF
C*****TERMINATE PREVIOUS PLOT (DISSPLA)
      IF((IADVNC .EQ. 1) .AND. (NPLOTS .GT. 0)) CALL ENDPL(0)
C*****INCREMENT NUMBER OF PLOTS
      NPLOTS=NPLOTS + 1
C*****INITIALLIZE PLOT FRAME (DISSPLA)
      CALL BGNPL(-1)
C*****SET PAGE LIMITS (DISSPLA)
      CALL PAGE(PAGEX, PAGEY)
C*****SUPPRESS PAGE BORDER (DISSPLA)
      CALL NOBRDR
C*****SUPPRESS PRINTING OF OUT-OF-RANGE POINTS (DISSPLA)
      CALL NOCHEK
C*****SET FONT FOR LABELS (DISSPLA)
      CALL SIMPLX
C*****DEFINE SUBPLOT AREA (DISSPLA)
      CALL AREA2D(XAX, YAX)
C*****ENCLOSE PLOT AREA (DISSPLA)
      CALL FRAME
C*****SET CHARACTER HEIGHT IN INCHES (DISSPLA)
      HITE=0.30
      CALL HEIGHT(HITE)
C*****CONVERT CHARACTER LABELS TO INTEGER HOLLERITH LABELS FOR DISSPLA
      NCHAR=50
      READ(LABELT,1001) LABT
      READ(LABELX,1001) LABX
      READ(LABELY,1001) LABY
C*****WRITE TITLE ON PLOT FRAME (DISSPLA)
      HTMULT=1.0
      NLINES=1
      CALL HEADIN(LABT, NCHAR, HTMULT, NLINES)
C*****REVERSE TICK MARKS ON X AND Y AXES (DISSPLA)
      CALL XREVTK
      CALL YREVTK
C*****WRITE X-AXIS LABEL (DISSPLA)
      CALL XNAME(LABX, NCHAR)
C*****ROTATE Y-AXIS NUMBERING TO HORIZONTAL (DISSPLA)
      CALL YAXANG(0.0)
```

```
      SUBROUTINE SELVAR(MXNV, NV, NSV, IWKV, LSV, INPERR)
C*****PROCESS SELECTED INDEPENDENT AND DEPENDENT VARIABLE PARAMETERS
      DIMENSION IWKV(NV), LSV(NV)
C
C
      IF(NSV .LT. NV) THEN
C**********PROCESS SELECTED VARIABLE NUMBERS AND FLAG VARIABLE NUMBERS
C**********THAT ARE GREATER THAN THE NUMBER OF VARIABLES REQUESTED
          DO 1000 I=1,NSV
              IF(IWKV(I) .LE. NV) THEN
                  LSV(IWKV(I))=1
              ELSE
                  INPERR=INPERR + 1
                  WRITE(6,9001) IWKV(I), NV
              ENDIF
 1000     CONTINUE
          CALL SIFT(NSV, IWKV)
      ELSE
C**********ALL VARIABLES ARE SELECTED (DEFAULT)
          DO 2000 I=1,NV
              IWKV(I)=I
              LSV(I)=1
 2000     CONTINUE
      ENDIF
      RETURN
C*****FORMAT STATEMENTS
 9001 FORMAT('0',5X,'VARIABLE NUMBER ',I5,' HAS BEEN SELECTED',
     1      /6X,'HOWEVER ONLY ',I5,' VARIABLES WERE REQUESTED')
      END
```

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TURC1SS SENSITIVITY ANALYSIS
STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -POOLTEMP-
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMAO | MTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | 0.20 | -0.01 | -0.55 | 0.25 | -0.38 | 0.54 |
| 2 | 10.0 | 0.10 | -0.04 | -0.61 | 0.28 | -0.50 | 0.70 |
| 3 | 15.0 | 0.06 | -0.03 | -0.60 | 0.26 | -0.59 | 0.77 |
| 4 | 20.0 | 0.03 | -0.03 | -0.58 | 0.26 | -0.64 | 0.80 |
| 5 | 25.0 | 0.05 | -0.01 | -0.55 | 0.26 | -0.67 | 0.81 |
| 6 | 30.0 | 0.05 | -0.01 | -0.53 | 0.26 | -0.69 | 0.81 |
| 7 | 35.0 | 0.04 | -0.02 | -0.53 | 0.27 | -0.69 | 0.82 |
| 8 | 40.0 | 0.04 | -0.02 | -0.52 | 0.28 | -0.70 | 0.82 |
| 9 | 45.0 | 0.04 | -0.02 | -0.51 | 0.28 | -0.70 | 0.82 |
| 10 | 50.0 | 0.03 | -0.01 | -0.50 | 0.30 | -0.71 | 0.83 |
| 11 | 60.0 | 0.02 | 0.00 | -0.51 | 0.30 | -0.70 | 0.83 |
| 12 | 70.0 | 0.02 | 0.00 | -0.51 | 0.30 | -0.70 | 0.83 |
| 13 | 80.0 | 0.02 | 0.01 | -0.51 | 0.31 | -0.69 | 0.83 |
| 14 | 90.0 | 0.02 | 0.05 | -0.51 | 0.30 | -0.70 | 0.82 |
| 15 | 100. | 0.01 | 0.11 | -0.51 | 0.29 | -0.68 | 0.81 |
| 16 | 110. | 0.02 | 0.17 | -0.50 | 0.28 | -0.68 | 0.79 |
| 17 | 120. | 0.00 | 0.30 | -0.46 | 0.26 | -0.65 | 0.77 |
| 18 | 130. | 0.00 | 0.38 | -0.45 | 0.21 | -0.60 | 0.73 |
| 19 | 140. | -0.01 | 0.48 | -0.42 | 0.20 | -0.53 | 0.70 |
| 20 | 150. | -0.02 | 0.54 | -0.40 | 0.18 | -0.48 | 0.69 |
| 21 | 160. | -0.03 | 0.57 | -0.37 | 0.14 | -0.44 | 0.67 |
| 22 | 170. | -0.05 | 0.60 | -0.34 | 0.12 | -0.40 | 0.64 |
| 23 | 180. | -0.07 | 0.64 | -0.31 | 0.08 | -0.38 | 0.65 |
| 24 | 190. | -0.07 | 0.70 | -0.29 | 0.07 | -0.35 | 0.69 |
| 25 | 200. | -0.07 | 0.75 | -0.26 | 0.05 | -0.31 | 0.72 |
| 26 | 220. | -0.06 | 0.79 | -0.25 | 0.03 | -0.27 | 0.75 |
| 27 | 240. | -0.04 | 0.82 | -0.23 | 0.01 | -0.22 | 0.77 |
| 28 | 260. | -0.02 | 0.86 | -0.22 | 0.00 | -0.18 | 0.81 |
| 29 | 280. | -0.03 | 0.89 | -0.18 | 0.01 | -0.15 | 0.84 |
| 30 | 300. | -0.03 | 0.91 | -0.15 | 0.00 | -0.12 | 0.86 |
| 31 | 320. | -0.04 | 0.92 | -0.12 | -0.01 | -0.10 | 0.88 |
| 32 | 340. | -0.04 | 0.93 | -0.10 | -0.02 | -0.10 | 0.89 |
| 33 | 360. | -0.04 | 0.95 | -0.08 | -0.03 | -0.08 | 0.91 |
| 34 | 380. | -0.03 | 0.96 | -0.06 | -0.03 | -0.08 | 0.93 |
| 35 | 400. | -0.03 | 0.97 | -0.05 | -0.02 | -0.06 | 0.94 |

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TABLE ENTRIES REPRESENT THE MAXIMUM VALUE OF THE STANDARDIZED RANK REGRESSION COEFFICIENT OVER ALL STEPS FOR EACH COMBINATION OF SELECTED INDEPENDENT VARIABLE AND SELECTED DEPENDENT VARIABLE, GIVEN IN THE PREVIOUS TABLE

| | POOLTEMP | HXFER |
|---|---|---|
| TMALL | | |
| TMFE | .97 | -.45 |
| GAMMAO | -.61 | .51 |
| MTCONC | | .69 |
| VBUB | -.71 | .82 |

```
              INPERR=INPERR + 1
          ELSE IF(NDV .GT. MXNDV) THEN
              WRITE(6,9004) PNDV, MXNDV
              INPERR=INPERR + 1
          ENDIF
          GO TO 10
C*****NOBS RECORD
      ELSE IF(CRDTYP(1:5) .EQ. PNOBS) THEN
          READ(TMPCRD,FRMTI,ERR=7000) NOBS
          IF(NOBS .LE. 0) THEN
              WRITE(6,9003) PNOBS
              INPERR=INPERR + 1
          ELSE IF(NOBS .GT. MXNOBS) THEN
              WRITE(6,9004) PNOBS, MXNOBS
              INPERR=INPERR + 1
          ENDIF
          GO TO 10
C*****STEPS RECORD
      ELSE IF(CRDTYP(1:6) .EQ. PSTEPS) THEN
          NINT=IT / (3*LENTC)
          READ(TMPCRD,FRMTR,ERR=7000) (XB(I), XE(I), DX(I),I=1,NINT)
          GO TO 10
C*****FILE TYPE RECORD
      ELSE IF(CRDTYP(1:10) .EQ. PFT) THEN
          DO 19 I=LENC,11,-1
              IF(CARD(I:I) .EQ. STAR(2)) THEN
                  CARD(I:I)=BLANK
                  LSTR=1
                  GO TO 20
              ENDIF
   19     CONTINUE
          LSTR=0
   20     CONTINUE
          CALL DATSQZ(CARD, CRDTYP, TMPCRD, IT, 0)
          READ(TMPCRD,FRMTAI,ERR=7000) DUM, IFT
          IF((IFT .LE. 0) .OR. (IFT .GT. 5)) THEN
              WRITE(6,9005) IFT
              INPERR=INPERR + 1
          ENDIF
          GO TO 8
C*****IND VARS RECORD
      ELSE IF(CRDTYP(1:9) .EQ. PIV) THEN
          NSIV=IT/LENTC - 1
          READ(TMPCRD,FRMTAI,ERR=7000) DUM, (IWKIV(I),I=1,NSIV)
          IF(NSIV .LE. 0) THEN
              WRITE(6,9003) PIV
              INPERR=INPERR + 1
          ELSE IF(NSIV .GT. MXNIV) THEN
              WRITE(6,9004) PIV, MXNIV
              INPERR=INPERR + 1
          ENDIF
          GO TO 10
C*****IV LABELS RECORD
      ELSE IF(CRDTYP(1:7) .EQ. PXL) THEN
          NVAR=IT / LENTC
          READ(TMPCRD,FRMTA,ERR=7000) (LABIV(I),I=1,NVAR)
          DO 50 IVAR=1,NVAR
              DO 40 IL=1,LLAB
                  IF(LABIV(IVAR)(IL:IL) .NE. BLANK) THEN
                      LABIV(IVAR)=LABIV(IVAR)(IL:LLAB)
                      GO TO 45
                  ENDIF
   40         CONTINUE
   45         CONTINUE
```

```
      SUBROUTINE CENTER(LABEL, ICENTR)
C*****CENTER LABELS ABOUT COLUMN ICENTR
      CHARACTER*(*) LABEL
      CHARACTER*1 BLANK
      CHARACTER*100 TEMP
      DATA BLANK / ' ' /
C
C
      LENGTH=LEN(LABEL)
C*****FIND FIRST NON-BLANK CHARACTER IN LABEL
      DO 1000 I=1,LENGTH
           IF(LABEL(I:I) .NE. BLANK) THEN
                ISTART=I
                GO TO 1100
           ENDIF
 1000 CONTINUE
      GO TO 9999
 1100 CONTINUE
C*****FIND LAST NON-BLANK CHARACTER IN LABEL
      DO 2000 I=LENGTH,1,-1
           IF(LABEL(I:I) .NE. BLANK) THEN
                IEND=I
                GO TO 2100
           ENDIF
 2000 CONTINUE
 2100 CONTINUE
C*****CALCULATE ACTUAL LENGTH OF LABEL
      NCHAR=IEND - ISTART + 1
C*****CALCULATE HALF-LENGTH OF LABEL
      NCHAR2=NCHAR / 2
C*****CALCULATE POSITION OF LAST BLANK IN LABEL
      LB=ICENTR - NCHAR2 - 1
C*****CALCULATE NUMBER OF BLANKS REQUIRED TO FILL END OF LABEL
      NB=LENGTH - NCHAR - LB
C*****ENCODE LABEL
      WRITE(TEMP,2101) (BLANK,I=1,LB),
     1                 (LABEL(I:I),I=ISTART,IEND),
     2                 (BLANK,I=1,NB)
C*****TRANSFER LABEL
      LABEL=TEMP
 9999 CONTINUE
      RETURN
C*****FORMAT STATEMENTS
 2101 FORMAT(100A1)
      END
```

```
      SUBROUTINE DATSQZ(CARD, CRDTYP, TMPCRD, IT, ICONT)
C*****PROCESS KEYWORD RECORDS WHICH REQUIRE CONVERSION OF
C*****CHARACTER DATA TO FLOATING POINT OR INTEGER DATA
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      CHARACTER*(*) CARD, CRDTYP, TMPCRD
      CHARACTER*1 BLANK, MINUS, PERIOD
      PARAMETER (BLANK=' ', MINUS='-', PERIOD='.')
C
C
      IC=0
      IF(ICONT .EQ. 0) THEN
           IT=0
           TMPCRD=BLANK
           CRDTYP=CARD
  500      CONTINUE
           IC=IC + 1
           IF(CARD(IC:IC) .NE. BLANK) THEN
                GO TO 500
           ENDIF
      ENDIF
C*****SEARCH FOR BEGINNING OF NON-BLANK CHARACTER STRING
 1000 CONTINUE
      IC=IC + 1
      IF(IC .GT. LENC) GO TO 9999
      IF(CARD(IC:IC) .EQ. BLANK) GO TO 1000
      IBEG=IC
C*****SEARCH FOR ENDING OF NON-BLANK CHARACTER STRING
 2000 CONTINUE
      IC=IC + 1
      IF((CARD(IC:IC) .NE. BLANK) .AND. (IC .LE. LENC)) GO TO 2000
C*****MOVE NON-BLANK CHARACTER STRING INTO TMPCRD RIGHT-JUSTIFIED
 3000 CONTINUE
      IEND=IC - 1
      ILEN=IEND - IBEG + 1
      IF(ILEN .GT. LENTC) THEN
           WRITE(6,9001) CRDTYP, ILEN, LENTC
           STOP 'DATSQZ'
      ENDIF
      IT=IT + LENTC - ILEN
      DO 4000 I=IBEG,IEND
           IT=IT + 1
           TMPCRD(IT:IT)=CARD(I:I)
 4000 CONTINUE
      GO TO 1000
 9999 CONTINUE
      RETURN
C*****FORMAT STATEMENTS
 9001 FORMAT('0',5('>'),'THE DATA ON KEYWORD RECORD ',A,' CONTAINS ',
     1       I2,' CHARACTERS',
     2      /6X,'THE MAXIMUM NUMBER OF CHARACTERS ALLOWED IS ',I2)
      END
```

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```
C*****WRITE Y-AXIS LABEL (DISSPLA)
      CALL YNAME(LABY, NCHAR)
C*****SET UP LINEAR AXES (DISSPLA)
      IF (LLX .EQ. 0) THEN
         XSTEP=(XMAX - XMIN) / 5.0
         YSTEP=(YMAX - YMIN) / YAX
         CALL GRAF(XMIN, XSTEP, XMAX, YMIN, YSTEP, YMAX)
C**********DRAW SECONDARY TICK MARKS (DISSPLA)
         CALL XNONUM
         CALL YNONUM
         CALL XGRAXS(XMIN, XSTEP, XMAX, XAX, BLANK, -1, 0.0, YAX)
         CALL YGRAXS(YMIN, YSTEP, YMAX, YAX, BLANK, -1, XAX, 0.0)
      ELSE
C*****SET UP LOGX, LINY AXES (DISSPLA)
         XCYCLE=XAX / AINT(ALOG10(XMAX/XMIN)+0.99)
         YSTEP=(YMAX - YMIN) / YAX
         CALL XLOG(XMIN, XCYCLE, YMIN, YSTEP)
C**********DRAW SECONDARY TICK MARKS (DISSPLA)
         CALL XNONUM
         CALL YNONUM
         CALL XLGAXS(XMIN, XCYCLE, XAX, BLANK, -1, 0.0, YAX)
         CALL YGRAXS(YMIN, YSTEP, YMAX, YAX, BLANK, -1, XAX, 0.0)
      ENDIF
C*****SET PLOT SYMBOL (DISSPLA)
      IF (IMARK .NE. 0) CALL MARKER(8)
      MARK=MIN(IMARK, 1)
      IF (IMARK .EQ. 2) THEN
         CALL DASH
         MARK=0
      ENDIF
C*****PLOT POINTS (DISSPLA)
      CALL CURVE(X, Y, NPTS, MARK)
C*****TERMINATE CURRENT PLOT (DISSPLA)
      CALL ENDGR(0)
      RETURN
C*****FORMAT STATEMENTS
 1001 FORMAT(15A)
      END
```

```
      SUBROUTINE SIFT(N, IXV)
C*****PERFORM ASCENDING SORT ON ARRAY IXV
      DIMENSION IXV(N)
C
C
      M=N
 1000 CONTINUE
      M=M / 2
      IF (M) 3000, 9000, 3000
 3000 CONTINUE
      K=N - M
      J=1
 4000 CONTINUE
      I=J
 5000 CONTINUE
      L=I + M
      IF (IXV(I)-IXV(L)) 7000, 7000, 6000
 6000 CONTINUE
      A=IXV(I)
      IXV(I)=IXV(L)
      IXV(L)=A
      I=I - M
      IF (I) 7000, 7000, 5000
 7000 CONTINUE
      J=J + 1
      IF (J-K) 4000, 4000, 1000
 9000 CONTINUE
      RETURN
      END
```

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TURC1SS SENSITIVITY ANALYSIS
RANKS OF STANDARDIZED RANK REGRESSION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -POOLTEMP-
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | |
|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB |
| 1 | 5.00 | 4 | 5 | 1 | 3 | 2 |
| 2 | 10.0 | 4 | 5 | 1 | 3 | 2 |
| 3 | 15.0 | 4 | 5 | 1 | 3 | 2 |
| 4 | 20.0 | 4 | 5 | 2 | 3 | 1 |
| 5 | 25.0 | 4 | 5 | 2 | 3 | 1 |
| 6 | 30.0 | 4 | 5 | 2 | 3 | 1 |
| 7 | 35.0 | 4 | 5 | 2 | 3 | 1 |
| 8 | 40.0 | 4 | 5 | 2 | 3 | 1 |
| 9 | 45.0 | 4 | 5 | 2 | 3 | 1 |
| 10 | 50.0 | 4 | 5 | 2 | 3 | 1 |
| 11 | 60.0 | 4 | 5 | 2 | 3 | 1 |
| 12 | 70.0 | 4 | 5 | 2 | 3 | 1 |
| 13 | 80.0 | 4 | 5 | 2 | 3 | 1 |
| 14 | 90.0 | 5 | 4 | 2 | 3 | 1 |
| 15 | 100. | 5 | 4 | 2 | 3 | 1 |
| 16 | 110. | 5 | 4 | 2 | 3 | 1 |
| 17 | 120. | 5 | 3 | 2 | 4 | 1 |
| 18 | 130. | 5 | 3 | 2 | 4 | 1 |
| 19 | 140. | 5 | 2 | 3 | 4 | 1 |
| 20 | 150. | 5 | 1 | 3 | 4 | 2 |
| 21 | 160. | 5 | 1 | 3 | 4 | 2 |
| 22 | 170. | 5 | 1 | 3 | 4 | 2 |
| 23 | 180. | 5 | 1 | 3 | 4 | 2 |
| 24 | 190. | 5 | 1 | 3 | 4 | 2 |
| 25 | 200. | 4 | 1 | 3 | 5 | 2 |
| 26 | 220. | 4 | 1 | 3 | 5 | 2 |
| 27 | 240. | 4 | 1 | 2 | 5 | 3 |
| 28 | 260. | 4 | 1 | 2 | 5 | 3 |
| 29 | 280. | 4 | 1 | 2 | 5 | 3 |
| 30 | 300. | 4 | 1 | 2 | 5 | 3 |
| 31 | 320. | 4 | 1 | 2 | 5 | 3 |
| 32 | 340. | 4 | 1 | 2 | 5 | 3 |
| 33 | 360. | 4 | 1 | 3 | 5 | 2 |
| 34 | 380. | 4 | 1 | 3 | 5 | 2 |
| 35 | 400. | 4 | 1 | 3 | 5 | 2 |

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```
END OF DISSPLA 9.0 -- 23415 VECTORS GENERATED IN 5 PLOT FRAMES.
    PROPRIETARY SOFTWARE PRODUCT OF ISSCO, SAN DIEGO, CA.
7022 VIRTUAL STORAGE REFERENCES; 6 READS; 0 WRITES.
```

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```
   50      CONTINUE
C*****DEP VARS RECORD
      ELSE IF(CRDTYP(1:9) .EQ. PDV) THEN
           NSDV=IT/LENTC - 1
           READ(TMPCRD,FRMTAI,ERR=7000) DUM, (IWKDV(I),I=1,NSDV)
           IF(NSDV .LE. 0) THEN
                WRITE(6,9003) PDV
                INPERR=INPERR + 1
           ELSE IF(NSDV .GT. MXNDV) THEN
                WRITE(6,9004) PDV, MXNDV
                INPERR=INPERR + 1
           ENDIF
           GO TO 10
C*****DV LABELS RECORD
      ELSE IF(CRDTYP(1:7) .EQ. PYL) THEN
           NVAR=IT / LENTC
           READ(TMPCRD,FRMTA,ERR=7000) (LABDV(I),I=1,NVAR)
           DO 70 IVAR=1,NVAR
                DO 60 IL=1,LLAB
                     IF(LABDV(IVAR)(IL:IL) .NE. BLANK) THEN
                          LABDV(IVAR)=LABDV(IVAR)(IL:LLAB)
                          GO TO 65
                     ENDIF
   60           CONTINUE
   65           CONTINUE
   70      CONTINUE
C*****PCC RECORD
      ELSE IF(CRDTYP(1:4) .EQ. PPCC) THEN
           LPCC=1
           GO TO 10
C*****PRCC RECORD
      ELSE IF(CRDTYP(1:5) .EQ. PPRCC) THEN
           LPRCC=1
           GO TO 10
C*****SRC RECORD
      ELSE IF(CRDTYP(1:4) .EQ. PSRC) THEN
           LSRC=1
           GO TO 10
C*****SRRC RECORD
      ELSE IF(CRDTYP(1:5) .EQ. PSRRC) THEN
           LSRRC=1
           GO TO 10
C*****TABLE CUTOFF RECORD
      ELSE IF(CRDTYP(1:13) .EQ. PTC) THEN
           READ(TMPCRD,FRMTAR,ERR=7000) DUM, TC
           IF((TC .LT. 0.0) .OR. (TC .GT. 1.0)) THEN
                WRITE(6,9006) PTC, TC
                INPERR=INPERR + 1
           ENDIF
           GO TO 10
C*****PLOT CUTOFF RECORD
      ELSE IF(CRDTYP(1:12) .EQ. PPC) THEN
           READ(TMPCRD,FRMTAR,ERR=7000) DUM, PC
           IF((PC .LT. 0.0) .OR. (PC .GT. 1.0)) THEN
                WRITE(6,9006) PPC, PC
                INPERR=INPERR + 1
           ENDIF
           GO TO 10
C*****PLOT TITLE RECORD
      ELSE IF(CRDTYP(1:11) .EQ. PPT) THEN
           READ(CARD(12:LENC),9001) PTITLE
           GO TO 8
C*****PLOT XLABEL RECORD
      ELSE IF(CRDTYP(1:12) .EQ. PPXL) THEN
```

```
      SUBROUTINE CORCAL(IY, CORINV, IWKIV, RS, RSRC, RXCORR, X, Y)
C*****CALCULATE CORRELATIONS BETWEEN SELECTED INDEPENDENT VARIABLES
C*****AND CURRENT DEPENDENT VARIABLE
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      COMMON /SPRC/ SPRC1, SPRC2, SPRC3
      DIMENSION CORINV((MXNIV+1)*(MXNIV+2)/2), IWKIV(MXNIV),
     1          RS(MXNSTP,MXNIV), RSRC(MXNSTP,MXNIV),
     2          RXCORR(MXNIV*(MXNIV+1)/2), X(MXNOBS,MXNIV),
     3          Y(MXNOBS,MXNDV,MXNSTP)
C*****STATEMENT FUNCTION
      LOC(I,J)=J+(I*I-I)/2
C
C
      ROBS=FLOAT(NOBS)
C*****LOOP TO CALCULATE CORRELATIONS BETWEEN SELECTED INDEPENDENT
C*****VARIABLES AND CURRENT DEPENDENT VARIABLE
      DO 4000 I=1,NSIV
           IX=IWKIV(I)
           DO 3000 ISTEPS=1,NSTEPS
C****************IF RAW VALUES ARE USED FIND MEANS OF SELECTED DEPENDENT
C****************VARIABLE AND CALCULATE CORRELATION CONSTANTS
                IF (LRAW .NE. 0) THEN
                     SX=0.0
                     SY=0.0
                     DO 1000 IOBS=1,NOBS
                          SX=SX + X(IOBS,IX)
                          SY=SY + Y(IOBS,IY,ISTEPS)
 1000                CONTINUE
                     SPRC1=-SX * SX / ROBS
                     SPRC2=-SY * SY / ROBS
                     SPRC3=-SX * SY / ROBS
                ENDIF
C****************CALCULATE SUMS OF SQUARES AND CROSS PRODUCTS
                SXY=0.0
                SX2=0.0
                SY2=0.0
                DO 2000 IOBS=1,NOBS
                     SXY=SXY + X(IOBS,IX)*Y(IOBS,IY,ISTEPS)
                     SX2=SX2 + X(IOBS,IX) ** 2
                     SY2=SY2 + Y(IOBS,IY,ISTEPS) ** 2
 2000           CONTINUE
C****************CHECK FOR CONSTANT INDEPENDENT OR DEPENDENT VARIABLE
C****************IN INPUT DATA
                V=SXY + SPRC3
                V1=SX2 + SPRC1
                V2=SY2 + SPRC2
                IF ((V1 .NE. 0.0) .AND. (V2 .NE. 0.0)) THEN
C*********************CALCULATE SPEARMANS RHO AND STORE IT TEMPORARILY
C*********************IN PARTIAL CORRELATION COEFFICIENTS ARRAY
                     RS(ISTEPS,I)=V / SQRT(V1 * V2)
                ELSE
                     RS(ISTEPS,I)=0.0
                ENDIF
 3000      CONTINUE
 4000 CONTINUE
C*****LOOP TO CALCULATE PARTIAL CORRELATION COEFFICIENTS
      DO 9000 ISTEPS=1,NSTEPS
C**********COPY CORRELATIONS INTO MATRIX TO BE INVERTED
           DO 7500 I=1,NSIV
                DO 7000 J=1,I
```

```
      SUBROUTINE DMFSD(A, N, IPARM)
C*****PERFORM ERROR CHECKING ON MATRIX TO BE INVERTED
      DIMENSION A(1)
C
C
      KPIV=0
      DO 8000 K=1,N
          KPIV=KPIV + K
          IND=KPIV
          LEND=K - 1
          TOL=ABS(0.01 * (A(KPIV)))
          DO 7000 I=K,N
              DSUM=0.0
              IF (LEND.EQ.0) GO TO 2000
              DO 1000 L=1,LEND
                  LANF=KPIV - L
                  LIND=IND - L
                  DSUM=DSUM + A(LANF)*A(LIND)
 1000         CONTINUE
 2000         CONTINUE
              DSUM=A(IND) - DSUM
              IF (I .NE. K) GO TO 5000
              IF (DSUM - TOL) 3000, 3000, 4000
 3000         CONTINUE
              IF (DSUM .LE. 0.0) GO TO 9000
              KT=K - 1
              WRITE(6,80) KT
 4000         CONTINUE
              DPIV=SQRT(DSUM)
              A(KPIV)=DPIV
              DPIV=1.0 / DPIV
              GO TO 6000
 5000         CONTINUE
              A(IND)=DSUM * DPIV
 6000         CONTINUE
              IND=IND + I
 7000     CONTINUE
 8000 CONTINUE
      RETURN
 9000 CONTINUE
      WRITE(6,90) K
      IPARM=-K
      STOP 'DMFSD'
C*****FORMAT STATEMENTS
   80 FORMAT(20X,'ROUNDING ERROR IN ROW ',I2)
   90 FORMAT(20X,'MATRIX IS SINGULAR AT ROW ',I2)
      END
```

```
      SUBROUTINE PRINT(IPS, IWKDV, IWKIV, LAB, LABDV, LABIV, TABLE,
     1                 TITLE)
C*****PRINT TABLE OF MAXIMUM PARTIAL CORRELATION COEFFICIENTS
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      COMMON /PARAM/ LLN, LPCC, LPRCC, LSRC, LSRRC, LRAW, NDV, NIV,
     1               NINT, NOBS, NPLOTS, NSDV, NSIV, NSIVP1, NSTEPS,
     2               PC, TC, YMIN, YMAX
      DIMENSION IWKIV(MXNIV), IWKDV(MXNDV)
      CHARACTER*(*) LAB, LABDV(MXNDV), LABIV(MXNIV), TABLE(MXNIV,MXNDV),
     1              TITLE
      CHARACTER*10 IDATE, ITIME
      DATA IFIRST / 0 /
C
C
      IF(IFIRST .EQ. 0) THEN
           CALL DATE(IDATE)
           CALL TIME(ITIME)
           IFIRST=1
      ENDIF
C*****LOOP TO PRINT OUT TABLE OF MAXIMUM PART. CORRELATION COEFFICIENTS
      JEND=(NSDV-1)/10 + 1
      DO 3000 JY=1,JEND
           JB=((JY-1) * 10) + 1
           JE=JB + 9
           IF (JE .GT. NSDV) JE=NSDV
           IB=1
           IE=40
           IF (IE .GT. NSIV) IE=NSIV
 1000      CONTINUE
           IPAGE=IPAGE + 1
           IF(IPS .EQ. 0) THEN
                WRITE(6,1001) TITLE, IDATE, ITIME, IPAGE, LAB, TC
           ELSE
                WRITE(6,1005) TITLE, IDATE, ITIME, IPAGE, LAB
           ENDIF
           WRITE(6,1002) (LABDV(IWKDV(J)),J=JB,JE)
           WRITE(6,1003)
           DO 2000 IX=IB,IE
                WRITE(6,1004) LABIV(IWKIV(IX)), (TABLE(IX,J),J=JB,JE)
                IF (MOD(IX,5) .EQ. 0) WRITE(6,1003)
 2000      CONTINUE
           IF (IE .GE. NSIV) GO TO 3000
           IB=41
           IE=NSIV
           GO TO 1000
 3000 CONTINUE
      RETURN
C*****FORMAT STATEMENTS
 1001 FORMAT('1',//6X,A,5X,A,5X,A,5X,'PAGE',I3,
     1      //6X,'TABLE ENTRIES REPRESENT THE MAXIMUM VALUE OF THE ',
     2        A,'COEFFICIENT OVER ALL STEPS ',
     3       /6X,'FOR EACH COMBINATION OF SELECTED INDEPENDENT ',
     4        'VARIABLE AND SELECTED DEPENDENT VARIABLE, PROVIDED ',
     5       /6X,'THAT THE ABSOLUTE VALUE OF THIS COEFFICIENT IS ',
     6        'GREATER THAN ',F5.3,/)
 1002 FORMAT(16X,10(A,2X))
 1003 FORMAT(6X,110('-'))
 1004 FORMAT(6X,11(A,2X))
 1005 FORMAT('1',//6X,A,5X,A,5X,A,5X,'PAGE',I3,
     1      //6X,'TABLE ENTRIES REPRESENT THE MAXIMUM VALUE OF THE ',
     2        A,'COEFFICIENT OVER ALL STEPS ',
     3       /6X,'FOR EACH COMBINATION OF SELECTED INDEPENDENT ',
     4        'VARIABLE AND SELECTED DEPENDENT VARIABLE, GIVEN IN ',
```

```
      SUBROUTINE USRINP(LSDV, LSIV, STEPS, X, Y)
C*****SUBROUTINE USRINP IS PROVIDED BY THE USER TO INPUT DATA FILES
C*****OF INDEPENDENT AND DEPENDENT VARIABLES THAT ARE OF DIFFERENT
C*****FORMS THAN THOSE DESCRIBED IN THE USER MANUAL
C*****THE COMMON AND DIMENSION STATEMENTS ARE REQUIRED
      COMMON /MAXDIM/ LENC, LENTC, LLAB, MXNDV, MXNINT, MXNIV,
     1                MXNOBS, MXNSTP
      DIMENSION LSDV(MXNDV), LSIV(MXNIV), STEPS(MXNSTP),
     1          X(MXNOBS,MXNIV), Y(MXNOBS,MXNDV,MXNSTP)
      RETURN
      END
```

TURC1SS SENSITIVITY ANALYSIS
PARTIAL RANK CORRELATION COEFFICIENTS VS STEPS
DEPENDENT VARIABLE -HXFER -
UNITS = TIME (SEC)

| | | INDEPENDENT VARIABLES | | | | | |
|---|---|---|---|---|---|---|---|
| STEPS | UNITS | TMALL | TMFE | GAMMA0 | MTCONC | VBUB | R-SQUARE |
| 1 | 5.00 | -0.14 | 0.01 | 0.33 | 0.23 | 0.84 | 0.73 |
| 2 | 10.0 | 0.08 | -0.07 | 0.70 | 0.48 | 0.90 | 0.84 |
| 3 | 15.0 | -0.05 | -0.01 | 0.79 | 0.39 | 0.90 | 0.86 |
| 4 | 20.0 | -0.01 | -0.05 | 0.81 | 0.39 | 0.91 | 0.87 |
| 5 | 25.0 | -0.01 | -0.08 | 0.80 | 0.41 | 0.91 | 0.88 |
| 6 | 30.0 | 0.00 | -0.03 | 0.80 | 0.38 | 0.89 | 0.86 |
| 7 | 35.0 | -0.06 | 0.03 | 0.79 | 0.35 | 0.90 | 0.86 |
| 8 | 40.0 | 0.00 | 0.08 | 0.69 | 0.40 | 0.85 | 0.79 |
| 9 | 45.0 | -0.01 | 0.06 | 0.77 | 0.41 | 0.87 | 0.83 |
| 10 | 50.0 | -0.03 | -0.10 | 0.79 | 0.40 | 0.89 | 0.85 |
| 11 | 60.0 | 0.00 | -0.11 | 0.60 | 0.43 | 0.75 | 0.68 |
| 12 | 70.0 | -0.01 | -0.16 | 0.51 | 0.48 | 0.56 | 0.54 |
| 13 | 80.0 | -0.08 | -0.13 | 0.46 | 0.53 | 0.50 | 0.50 |
| 14 | 90.0 | -0.10 | -0.12 | 0.37 | 0.60 | 0.38 | 0.48 |
| 15 | 100. | 0.01 | -0.20 | 0.31 | 0.70 | 0.23 | 0.54 |
| 16 | 110. | 0.08 | -0.34 | 0.22 | 0.73 | 0.02 | 0.57 |
| 17 | 120. | 0.05 | -0.45 | 0.03 | 0.71 | -0.18 | 0.57 |
| 18 | 130. | 0.08 | -0.53 | -0.15 | 0.71 | -0.34 | 0.61 |
| 19 | 140. | 0.03 | -0.58 | -0.23 | 0.75 | -0.48 | 0.68 |
| 20 | 150. | 0.02 | -0.58 | -0.27 | 0.76 | -0.51 | 0.70 |
| 21 | 160. | 0.07 | -0.60 | -0.29 | 0.73 | -0.56 | 0.70 |
| 22 | 170. | 0.05 | -0.64 | -0.33 | 0.72 | -0.60 | 0.71 |
| 23 | 180. | 0.02 | -0.64 | -0.33 | 0.71 | -0.61 | 0.71 |
| 24 | 190. | -0.01 | -0.62 | -0.35 | 0.71 | -0.63 | 0.71 |
| 25 | 200. | 0.00 | -0.60 | -0.35 | 0.71 | -0.65 | 0.71 |
| 26 | 220. | -0.03 | -0.61 | -0.34 | 0.70 | -0.67 | 0.71 |
| 27 | 240. | -0.01 | -0.58 | -0.40 | 0.65 | -0.66 | 0.69 |
| 28 | 260. | -0.01 | -0.59 | -0.43 | 0.63 | -0.66 | 0.69 |
| 29 | 280. | -0.06 | -0.61 | -0.40 | 0.54 | -0.64 | 0.66 |
| 30 | 300. | -0.08 | -0.58 | -0.41 | 0.46 | -0.63 | 0.62 |
| 31 | 320. | -0.07 | -0.49 | -0.40 | 0.33 | -0.56 | 0.53 |
| 32 | 340. | 0.01 | -0.42 | -0.40 | 0.16 | -0.53 | 0.45 |
| 33 | 360. | 0.08 | -0.31 | -0.40 | 0.06 | -0.45 | 0.36 |
| 34 | 380. | 0.03 | -0.14 | -0.37 | 0.04 | -0.41 | 0.28 |
| 35 | 400. | 0.04 | -0.11 | -0.34 | 0.05 | -0.36 | 0.23 |