David Morganstein, Robert H. Hanson, and Greg Binzer Westat, Inc.

1. INTRODUCTION

This paper describes a computer package which operates in the Statistical Analysis System (SAS) to compute sampling errors using balanced repeated half-sample replications (BRR). An important requirement in developing the package was to provide estimates and sampling errors for statistics involving unspecified transformations (for example sums, ratios, differences, logarithms of ratios) of the survey variables. Another objective was to incorporate the use of ratio adjustments applied separately to two stages of sampling into the BRR computation of error estimates. A third feature of the approach was to permanently affix weight factors used for the estimation and error computations to the sampling unit records, thereby permitting users of the survey data to compute sampling errors for their estimates.

An interesting computational result presented deals with the preparation of a separate set of ratio-adjusted weights for each half-sample. Although the computations appear extensive, it is shown that these computations are succinctly expressed in matrix terms. By using a language or computer package containing matrix operations, these numerous computations can be accomplished with little effort.

The software discussed in this paper can be adapted by the user to reflect weighting systems for full sample estimates, and for replicated half samples as well; thus, sampling error estimates for complex weighting systems may be computed. Any stratified sample design featuring a selection of pairs of primary sampling units (PSU's) from each stratum can be accommodated; self-representing PSU's can be adapted by designating pairs of half samples within each of these PSU's.

A knowledgeable statistician can use this package as an effective tool. The user must be familiar with the sample design and the methods of computing sampling errors. Specifically, the user must determine: (a) the appropriate methods of defining half samples that simulate the original design and reflect all stages of sampling and estimation; (b) the number of halfsample replications desired for variance estimation; (c) the modifications necessary in the full sample estimation procedure that may be called for by samples half as large; and (d) the method for defining the records and weights to be used for each of the half samples. The use of the package is illustrated by an example.

The system involves an estimation module, called NASSTIM, and a sampling errors module, called NASSVAR. An initial pre-processing operation is also needed to organize the data file as required for NASSTIM and NASSVAR. At a minimum, the estimation module requires the data file to show the selection probability for each record; the sampling errors module requires sufficient information to enable assignment of records to half samples. Records comprising the half samples are defined by a matrix of replication codes to specify records that make up the half samples; the matrix of codes is supplied by the user. The user must also supply and incorporate ancillary information used in estimation procedures (ratio estimate factors for the full sample and for each replicate, for example).

The NASSTIM estimation module prepares weighted totals of the records and transformations of the estimated totals. The transformations may be any of a wide range of the transformations contained in the SAS package. If desired, the estimation module may incorporate factors to modify the weights that appear on the records, as in ratio estimation. In the example given in this paper, we illustrate a weighting system involving two stages of ratio estimation. Additional stages of estimation may be added.

The NASSVAR sampling error computation module performs all of the computations of the estimation module and repeats the estimation computations for each half sample. The half-sample estimates are used to compute a variance about the full-sample estimate. The individual half-sample estimates are displayed for outlier examination and, as an option, are saved in a SAS data set.

2. AN ILLUSTRATION, THE NASS PROGRAM

The application of the package is explained by the example of the National Accident Sampling System (NASS) (2). This survey was designed to provide a representative source of accident data for use by regulatory agencies and accident researchers. The following is a brief summary of pertinent elements of the sample design and estimation procedure.

The universe from which cases are selected for investigation consists of motor vehicle accidents occurring on public highways for which a police accident report is completed and filed. The survey is not intended to represent other vehicle accidents. The sample is selected in several steps. First, a sample of one primary sampling unit (PSU) is selected from each of a set of strata into which the PSU's are grouped; PSU's are counties or groups of counties. Second, police jurisdictions in each sample PSU are stratified by size and an equal probability sample of jurisdictions is selected within the jurisdiction size strata. Finally, accidents reported at the sample jurisdictions are listed and a systematic sample of accidents is selected within the sample jurisdiction.

National estimates of accident data may be produced by an inflation estimator; that is, by weighting the sample records by the inverse of the probability of selection. Ratio adjustments are performed to reduce the variance introduced at the several steps in sampling.

The NASS estimation procedure routinely uses two stages of ratio estimation. At the first stage, data known about all PSU's in a stratum are used to reduce the between-PSU variance. Similarly, variables known about all police jurisdictions are used to reduce the within-PSU sampling errors. Further stages of ratio estimation can also be introduced using characteristics obtained from independent sources for which consistent estimates can be prepared from the NASS that are expected to be correlated with the key variables of interest.

3. PREPARING ESTIMATES FROM SAMPLE DATA

The estimation module, NASSTIM, is used to prepare weighted estimates from the sample records. The sampling error module, measures the precision of the complete estimation procedure by applying the estimator to each of the replicated half samples. To approximate the effect of the precision of such adjustments, the factors in the ratio estimate should be recomputed separately for each half sample. This recomputation can be tedious and expensive if special purpose programs must be written to perform the work. A separate program, part of the pre-processing operation, performs these computations; in the version provided, the user must supply only the known subgroup totals.

The programs compute adjustment factors as a pre-processing step; thus, the half-sample weights are permanently incorporated into the survey records. This procedure has several advantages over the approach of re-computing the factors for each request. First, a reduced cost of processing can be expected since the constant recomputation of weights is avoided. Second, the user has a file of the survey results with half-sample weights attached. The application of the estimation and sampling error programs, written as any other SAS procedure, is then straight forward and can be accomplished with a minimum of technical assistance.

Although the computation of separate ratio adjustment factors for each half sample appears to be formidable, the factors can be obtained easily through a series of matrix operations. Appendix A contains a development of the computations using operators available in the SAS procedure MATRIX. The matrices which are required include a design matrix defining the PSU's belonging to each half sample and a series of totals used as the numerators and denominators of the ratio factors. The definitions of these matrices and several others needed for the computations are given in Appendix A. In the next two sections, the first and second stage factors are discussed with references to the formulation given in Appendix A as required.

Substantial secondary data exist for counties making up all of the first stage sampling units (PSU's) in the country. These data are used in ratio estimation to reduce the component of variance contributed by confining the investigation to a sample, rather than to all PSU's.

The numerator of a first stage ratio factor consists of the known group total for all strata in the group. The denominator consists of an estimate of this total obtained by inflating the sampled PSU information to the stratum level (using the inverse of the PSU selection probability), and then summing across all strata in the groups. For a half sample, the denominator is based on data from the PSU's in the half sample. These totals are precomputed and used in the matrix operations shown in Appendix A. In the appendix notation, the known group totals are denoted as matrix A and the estimates of the totals denoted as matrix B.

The second stage of ratio estimation is introduced to reduce the variance component that arises because the accident investigations are conducted for a sample rather than for all accidents within the PSU. The sampling procedure produces a complete listing of all police reported accidents so that, for the PSU, a complete census of all accidents in each of the separate accident category strata is available for the survey period. The numerator of each within PSU ratio factor consists of the known total number of accidents of a specific type weighted up to the total of the stratum from which the PSU was selected. (These figures are stored in a matrix denoted as C in Appendix A). The denominator consists of the estimate of this total based on the sample from the appropriate accident category stratum. (These figures are stored in a matrix denoted as D in the Appendix). Ratios developed in this manner for each of the accident category strata for each NASS PSU would be very unstable due to small numbers of accidents of particular types expected to occur. The matrix routines allow the combining of accidents across PSU strata, however, to form a more stable set of ratios.

In the previous section it was pointed out that primary strata used in the selection of PSU's are collapsed to form between-PSU ratio factors; a similar procedure has been performed for within-PSU ratio factors. The criteria for combining the PSU strata are different so that the PSU groups for the two stages of ratio estimation may not be the same.

4. ESTIMATION OF SAMPLING ERRORS

The package uses the Balanced Half Sample Repeated Replication (BRR) method of variance estimation. This method was chosen for its generality and its ease of use. Variances can be estimated for a wide variety of statistics of interest, linear or non-linear. This paper does not discuss the BRR method in detail; the subject is treated in a number of articles, for example (4) and (5). The programs supplied for the illustration have been written to incorporate several practical problems faced in analyzing the results of a survey using the BRR method.

The application of the BRR method for a design having two PSU's selected from each stratum involves the repeated re-estimation of the statistics using one half of the full survey PSU's. Each half sample contains one of the two PSU's selected from each stratum.

The first step in the application of the BRR method is to define the half samples. Several papers have been written which provide guidance in this task, the illustration employs the method of Plackett and Burman (6). The result of this step is a design matrix defining the half samples. The columns of the matrix identify each half sample (the first column is labelled replicate zero and is used to produce full-sample design. There are two rows for each stratum, one for each of the PSU's in the pair selected from the stratum. This matrix is denoted as "R" in Appendix A.

To more adequately reflect the impact of the estimation procedures on the variance of the estimates, it is necessary to apply the estimator to each of the estimates prepared from the half samples. This involves the preparation of ratio adjustment factors for each half sample. A major stumbling block to the application of such adjustments is the extensive amount of computation required to repeat the computations for each half sample.

Two programs have been written within the SAS system to complete these pre-processing tasks. The first calls on the matrix operations of the SAS procedure, PROC MATRIX. This program performs the matrix operations described in Appendix A using matrices supplied by the user. The second program, a SAS Macro, merges the results of the first program with the survey records.

The use of matrix operations to perform the computations greatly simplifies the preparation of half-sample weights. The steps delineated in Appendix A allow fairly complex rules to be used in the construction of ratio adjustments. Separate variables may be used to adjust different sampling units (post-stratification). In the preparation of ratio factors, strata are pooled; numerators and denominators are prepared within each of these "collapsing groups" of strata. The matrix procedure allows for easy definition of strata to be collapsed; these definitions are realized through the "F" and "G" matrices discussed in the Appendix. If the number of cases in any of the factors is found to be insufficient or if the resulting ratios are too extreme, changes in the "F" or "G" matrices permit easy redefinition of the pooling groups.

5. EXECUTING PROC NASSTIM AND PROC NASSVAR

This section describes the SAS procedures, NASSTIM and NASSVAR. The procedure grammar is similar to that used in standard SAS procedures. The user must specify the variables for which estimates are to be computed, the weight variables to be used and optionally, any transformations required. The full range of SAS arithmetic operators and functions may be used in specifying the computation of new variables from estimates computed by the procedures. Estimates and their associated statistics may be computed for any number of subgroups of the input file through the use of a "BY" statement.

The procedures NASSTIM and NASSVAR both compute estimates of user-specified characteristics. The procedures prepare estimates as weighted totals; however, the user specifies the weights to be employed when the procedure is invoked. The procedures therefore can accommodate the selection of specific characteristics for estimation, and, on separate executions of the procedure, the use of various estimation methods. NASSTIM and NASSVAR prepare estimates and NASSVAR, in addition, computes sampling errors and variances for each given characteristic.

NASSVAR prepares estimates for each characteristic specified by the user within each of the half-sample replicates required for the sample design and also for the full sample. (The full sample is called replication zero.) After these estimates are calculated the following statistics are displayed for each characteristic:

- 1. Estimate;
- Number of cases missing for replication zero;
- Weighted number of missing cases for replication zero;
- Relvariance (ratio of variance to the square of estimate);
- 5. Variance;
- 6. Standard error;
- Approximate lower 95 percent confidence bound;
- Approximate upper 95 percent confidence bound; and
- 9. Coefficient of variation (%) (square root of relvariance).

The half-sample replicate to which a particular observation belongs is defined implicitly to NASSVAR through the use of a WEIGHT statement. The presence and order of variables (representing weights) on the WEIGHT statement define for NASSVAR the half-sample replicates to which a particular observation belongs. These weights are precomputed to reflect the estimation procedure employed. The user identifies the weights to be used and, by this process, defines the estimation procedure.

NASSVAR by default produces sampling errors based upon estimates of TOTAL variance; to produce estimates of sampling errors within firststage sampling units, the user must specify the 'WITHIN' procedure option and supply the set of weights which define half samples within each first-stage unit. In the NASS illustration, the weights associate odd-numbered cases separately from even-numbered cases.

Both procedures have been designed to produce total estimates, ratios of estimates and almost any other arithmetic function available to SAS computed from the estimates. NASSVAR also computes associated sampling errors for these computed estimates. These arithmetic evaluations may include any estimates specified on the COMPVAR statement and/or user specified constants. The results of these computations are stored in variables specified on the OUTVAR statement discussed below. (User specified constants may be included in expressions to allow a third stage of ratio adjustments.)

The annotated listing in Figure 5-1 provides an example of running the SAS procedures NASSTIM and NASSVAR. Three national estimates are computed from the NASS 1979 Analysis File: total number of urban accidents, total number of accidents, and the ratio of the first to the second of these two estimates.

To obtain an estimate of the total number of accidents, a dummy variable, ACCS, is set equal to "1" for all accident records (see line 28).

To obtain an estimate of the total number of urban accidents, a dummy variable, URBAN, is defined in lines 30-32. This variable is a recoding of the NASS variable A21. URBAN is set equal to "1" for all accident records describing urban accidents and zero otherwise. NASSTIM and NASSVAR sum the weights of each of these created "dummy variables" (NASSVAR sums the weighted estimates at the replicate level).

To obtain an estimate of the proportion of URBAN accidents to total accidents, a new variable is created by the procedures; U RATIO is defined (see lines 53 and 66) as the ratio of URBAN to ACCS.

The output resulting from invoking NASSTIM (lines 48-54) is shown in Figure 5-2. Three lines are displayed; one for each statistic. The sum of the appropriate weights is given for ACCS and for URBAN and their ratio is given as U_RATIO. Also shown are the number of records coded as missing for each variable and the weighted sum of the missing records.

The call to PROC NASSVAR appears in lines 60-66 and is similar to PROC NASSTIM. In the example, NASSVAR is to compute estimates and sampling errors for the same characteristics as NASSTIM. The output resulting from invoking NASSVAR IS SHOWN IN Figure 5-3.

An output file, TWO, is constructed which will contain one record for each replicate; the record contains an estimate for each user-specified statistic based on one half-sample. Line 62 provides the names of the weight variables required. Since this example applies to a survey using 10 PSU's (see line 39), five paired strata are necessary with eight replicates to be generated. Thus, nine weights are required; the first weight "R_WGTO", is used to estimate replicate zero, the full sample estimate. Line 66 defines a transformation, the ratio of urban accidents to total accidents.

At the user's option (lines 70-71), the output data set can be printed (Figure5-4). Figure 5-4 contains nine lines, one for each replicate (REPL_ID). By using this option, the full sample estimate and the half sample results can be examined for conformity. Unusual values, outliers, might suggest further investigation in certain PSU's present in an unusual half sample.

Figure 5-2. NASSTIM output.

BEST

OPTIONS USED:

Figure 5-1. Example of NASSTIM and NASSVAR usage.

NOTE: THE JOB LUCKYSOO HAS BEEN RUN UNDER MELEASE 79.5 OF SAS AT INFORMATICS INC. NOTE: SAS DPTIONS SPECIFIED ANE: SOUTH SAS DPTIONS SPECIFIED ANE:

ASSUME THE FOLLOWING ESTIMATES AME TO BE PRODUCED FROM THE 70 AMALYSIS FILE ANUMBER TOTAL ACCIDENTS (MATIONAL LEVEL) A. NUMBER TOTAL ACCIDENTS (MATIONAL LEVEL) A. NUMBER TOTAL ACCIDENTS. A. RATIO OF URBAN TO TOTAL ACCIDENTS. A. RATIO OF URBAN ACCIDENTS. A. ACCS=1 I A. ASSIGN REUNINED VAHIABLE 'MUMPSU' THE VALUE ID A. ASSIGN REUNINED VAHIABLE 'MUMPSU' THE VALUE ID A. ASSIGN REUNINED VAHIABLE IN MUMPSU' THE VALUE ID A. ASSIGN REUNINED VAHIABLE IN MUMPSU' THE VALUE ID A. ASSIGN REUNINED VAHIABLE IN MUMPSU' THE VALUE ID A. ASSIGN REUNINED VAHIABLE IS REGULARED AF ANALYZED. A. NUMPSUALD I A. ASSIGN IN THE SAMPLE DESIGN BEING ANALYZED. A. AND THE INPUT OATA SET & ARPAESENTS THE NUMBER A. AND THE NAMPLE DESIGN BEING ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVISED ANALYZED. A. AND THE INPUT OATA SET SA DEVIS DEVI	1 2 3	/* /* Example of Running Nasstim & Nassvar	•/
<pre>2. AUMBER TOTAL URBAN ACCIDENTS. 3. AUTO OF UNAN TO TOTAL ACCIDENTS. 4. ANTIO OF UNAN TO TAKA ACCIDENTS. 4. READ THE 1979 HASS ANALYSIS FILE. 4. COUNT ACCIDENTS. 4. COUNT ACCIDENTS. 4. COUNT UNBAN ACCIDENTS. 4. COUNT UNBANN ACCIDENTS. 4. COUNT UNBANN I CLSS UNBANNOI 4. COUNT UNBANN ACCIDENTS. 4. COUNT UNBANNOI CLSS UNBANNOI 4. COUNT ACCIDENTS THE ANALYSIS THE NUMBER 4. COUNT UNBANN ACCIDENTS. 4. COUNT ACCIDENTS TO FACTOR MASS AND ANSAL TO RESIDE 4. COUNT UNBANNOI AND SET A REPAREMENT THE NUMBER 4. COUNT ACCIDENTS TO FACTOR AND ANALYZED. 5. COUNTAR UNBANNOI I ANALYZED. 5. COUNTAR UNBANNOI I ANALYZED. 5. COUNTAR UNBANNOI I ANALYZED. 5. COUNTAR UNASSIIN USED 1.33 SECONDS AND ISAA. 5. COUNTAR UNASSIIN USED 1.33 SECONDS AND ISAA. 5. TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES I 5. COUNTAR ULATION IN 5. COUNTAR ULATION IN 5</pre>	4		:/
<pre>2. AUMBER TOTAL URBAN ACCIDENTS. 3. AUTO OF UNAN TO TOTAL ACCIDENTS. 4. ANTIO OF UNAN TO TAKA ACCIDENTS. 4. READ THE 1979 HASS ANALYSIS FILE. 4. COUNT ACCIDENTS. 4. COUNT ACCIDENTS. 4. COUNT UNBAN ACCIDENTS. 4. COUNT UNBANN ACCIDENTS. 4. COUNT UNBANN I CLSS UNBANNOI 4. COUNT UNBANN ACCIDENTS. 4. COUNT UNBANNOI CLSS UNBANNOI 4. COUNT ACCIDENTS THE ANALYSIS THE NUMBER 4. COUNT UNBANN ACCIDENTS. 4. COUNT ACCIDENTS TO FACTOR MASS AND ANSAL TO RESIDE 4. COUNT UNBANNOI AND SET A REPAREMENT THE NUMBER 4. COUNT ACCIDENTS TO FACTOR AND ANALYZED. 5. COUNTAR UNBANNOI I ANALYZED. 5. COUNTAR UNBANNOI I ANALYZED. 5. COUNTAR UNBANNOI I ANALYZED. 5. COUNTAR UNASSIIN USED 1.33 SECONDS AND ISAA. 5. COUNTAR UNASSIIN USED 1.33 SECONDS AND ISAA. 5. TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES I 5. COUNTAR ULATION IN 5. COUNTAR ULATION IN 5</pre>	6 7	/* FROM THE 79 ANALYSIS FILE /*	:/
DATA ACCIDENT I ST INGOLACCIDENT I '' PEDD THE 1970 NASS ANKLYSIS FILE. '' PEDD THE 1970 NASS ANKLYSIS FILE. '' PETLICATE AND RATID FACTOR HAVE BEEN '' COUNT UNDER NO CLETE I '' COUNT UNDER ACCIDENTS. '' COUNT UNDER ACCIDENTS (TUTAL) '' COUNT UNDER AND I LABEL '' COUNT ACCIDENTS (TUTAL) '' INVOKE NASSTIM TU PRODUCE 'CHEAP' ESTIMATES. '' NUMPSUNG I LABEL '' INVOKE NASSTIM TU PRODUCE 'CHEAP' ESTIMATES. '' NOTE: NAS STATEMENT OWNER ACCIDENT BEST I '' AT ACCE UNDER I' '' INVOKE NASSTIM TU PRODUCE 'CHEAP' ESTIMATES. '' NOTE: NASSTIM IS AN UNSUPPONTED, EXPERIMENTAL PROCEDURE. ''' INVOKE NASSTIM TU PRODUCE ESTIMATES & SAMPLING '' '' ENNORS. ''' INVOKE NASSTIM TU PRODUCE ESTIMATES & SAMPLING '' ''' ENNORS. ''' INVOKE NASSTIM USED I46 SECONDS AND 10AK AND PHINTED PAGE 1. '''' ENNORS. ''''''''''''''''''''''''''''''''''''	6 9	 /* 1. NUMBER TOTAL ACCIDENTS (NATIONAL LEVEL) /* 2. NUMBER TOTAL URBAN ACCIDENTS. 	•/
DATA ACCIDENT : ST INDO: ACCIDENT S ST INDO: ACCIDENTS ST INDO: ACCIDENT ACCIDENT BEING ANALYZED. ST INDO: ACCIDENT ACCIDENT ACCIDENT ACCIDENT BEING ANALYZED. ST INVOCE ANASSING TO PACCIDENT ACCIDENT BEING ANALYZED. ST INDO: ACCIDENT ACCIDENT ACCIDENT ACCIDENT BEING ANALYZED. ST INDO: ACCIDENT ACCIDENT ACCIDENT ACCIDENT BEING ANALYZED. ST INTER ACCIDENT ACCIDENT ACCIDENT ACCIDENT BEING ANALYZED. ST INTER ACCIDENT ACCIDENT ACCIDENT ACCIDENT BEING ANALYZED. ST INCLEAS ACCIDENT ACCIDENT ACCIDENT ACCIDENT BEING ANALYZED. ST INDO: ACCIDENT ACCIDENT ACCIDENT A	10 11	/•	
<pre>15 // HEAD THE 1070 MASS ANULYSIS FILE.</pre>	12 13 14	DATA ACCIDENT \$	-*/
<pre>20 /* ADDED IN A PARYIOUS SIEP. ** OELETE THUCK UNDERHIDE ACCIDENTS FROM ANALYSIS */ 1F HOZ * 44900 THEN DELETE ! ** COUNT ACCIDENTS */ ACCS1 ! ** COUNT ACCIDENTS **/ ** COUNT UNBAR ACCIDENTS. ** COUNT UNBAR ACCIDENTS INTE UNDER ** COUNT ACCIDENTS ** OF PSUS IN THE SAMPLE DESIGN BEING ANALYZED. ** INVORE NASSTIM TO PHODUCE 'CMEAP' ESTIMATES. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** ENHORS. ** ENHORS. ** ENHORS. ** INVORE NASSTIM TO PHOTOLE ESTIMATES & SAMPLING ** ** ENHORS. ** ENHORS. ** ENHORS. ** INVORE NASSTIM TO PHOTOLE ESTIMATES & SAMPLING ** ** ENHORS. ** INVOR ACCS UNBAN ! ** ENHORS. ** ENHORS. ** INVOR NASSTAM TO PROCEDURE. ************************************</pre>	16	/•	:/
<pre>20 /* ADDED IN A PARYIOUS SIEP. ** OELETE THUCK UNDERHIDE ACCIDENTS FROM ANALYSIS */ 1F HOZ * 44900 THEN DELETE ! ** COUNT ACCIDENTS */ ACCS1 ! ** COUNT ACCIDENTS **/ ** COUNT UNBAR ACCIDENTS. ** COUNT UNBAR ACCIDENTS INTE UNDER ** COUNT ACCIDENTS ** OF PSUS IN THE SAMPLE DESIGN BEING ANALYZED. ** INVORE NASSTIM TO PHODUCE 'CMEAP' ESTIMATES. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** INVORE NASSTIM TO PHODUCE ESTIMATES & SAMPLING ** ** ENHORS. ** ENHORS. ** ENHORS. ** ENHORS. ** INVORE NASSTIM TO PHOTOLE ESTIMATES & SAMPLING ** ** ENHORS. ** ENHORS. ** ENHORS. ** INVORE NASSTIM TO PHOTOLE ESTIMATES & SAMPLING ** ** ENHORS. ** INVOR ACCS UNBAN ! ** ENHORS. ** ENHORS. ** INVOR NASSTAM TO PROCEDURE. ************************************</pre>	16	-WEIGHT- VARIABLES TO IMPLICITLY DEFINE	•/
	20	/* ADDED IN A PREVIOUS SIEP.	
a IF HOZ > *4900 THEN OELET 1 a count Accodents */ a count Accodents count Accodents a count Accodents countaccontactons a	22	/* DELETE TRUCK UNDERRIDE ACCIDENTS FROM ANALYSIS	
26 /* COUNT ACCIDENTS */ 27 ACCS=1 1 */ 28 ACCS=1 1 */ 29 ACCS=1 1 */ 20 ACCS=1 1 */ 20 ACCS=1 1 */ 20 ACCS=1 1 */ 20 ACCS=1 1 */ 21 IF A21-2 THEN UNBANA 11 */ 23 ACSSIGN REPUIPED VARIABLE 'NUMPSU' THE VALUE 10 23 */ ON THE INPUT DATA SET & MEMPED VARIABLE 'NUMPSU' THE VALUE 10 24 ACCSACCIDENTS */ 25 */ 26 27 28 29 20 20 20	24	IF HOR > +4990+ THEN DELETE #	
Accsal 1 /* Accsa		/ COUNT ACCIDENTS	•/
30 /* COUNT UNBARN ACCIDENTS. */ 31 IF A 212 THEN UNBARN 1 */ 32 ELSE UMBARNO 1 */ 33 /* ASIGN REQUIRED YAMIABLE 'MUMPSU' THE YALUE 10 */ 33 /* ASIGN REQUIRED YAMIABLE 'MUMPSU' THE YALUE 10 */ 34 /* ASIGN REQUIRED YAMIABLE OBSIGN BELMO ANALYZED. */ 35 /* OF PSUS IN THE SAMPLE DESIGN BELMO ANALYZED. */ 36 /* OF PSUS IN THE SAMPLE DESIGN BELMO ANALYZED. */ 36 /* OF PSUS IN THE SAMPLE DESIGN BELMO ANALYZED. */ 36 /* OF PSUS IN THE SAMPLE DESIGN BELMO ANALYZED. */ 37 /* OF PSUS IN THE SAMPLE DESIGN BELMO ANALYZED. */ 38 /* INVOKE NASSITH DATA-ACCIDENT BELMO ANALYZED. */ 39 /* INVOKE NASSITH DATA-ACCIDENT BEST I */ 40 /* INVOKE NASSITH DATA-ACCIDENT BEST I */ 41 /* OUMPAN ACCIDENT ACCI I */ 42 /* INVOKE NASSITH DATA-ACCIDENT BEST I */ 43 /* OUMPAN ACCIDENT ACCIDENT BEST I */ 44 PROC MASSITH DATA-ACCIDENT BEST I */ */ 45 /* INV	28	ACCS=1	
22 ELSE UMBAND 1 23 /* ASIGN REUNIZED VAMIABLE 'MUMPSU' THE VALUE 10 */ 24 ON THE IMPUTO TATA SET A REPARSENTS THE VALUE 10 */ 25 /* OF PSUS IN THE SAMPLE DESIGN BEING ANALYZED. 26 /* OF PSUS IN THE SAMPLE DESIGN BEING ANALYZED. 27 OF PSUS IN THE SAMPLE DESIGN BEING ANALYZED. 28 /* OF PSUS IN THE SAMPLE DESIGN BEING ANALYZED. 29 /* OF PSUS IN THE SAMPLE DESIGN BEING ANALYZED. 20 /* INVUKE NASSI'N TO PRODUCE 'CMEAP' ESTIMATES. */ 20 /* INVUKE NASSI'N TO PRODUCE 'CMEAP' ESTIMATES. */ 21 /* INVUKE NASSI'N DATA-ACCIDENT BEST ' 25 /* INVUKE NASSI'N DATA-ACCIDENT BEST ' 26 /* INVUKE NASSI'N DATA-ACCIDENT BEST ' 27 /* INVUKE NASSI'N DATA-ACCIDENT ACCI ' 28 /* INVUKE NASSI'N DATA-ACCIDENT ACCI ' 29 /* INVUKE NASSI'N TO PRODUCE ESTIMATES & SAMPLING */ 29 /* INVUKE NASSI'N DATA-ACCIDENT BEST ' 20 /* INVUKE NASSI'N DATA-ACCIDENT SAMPL' ACCI ' 29 /* INVUKE NASSI'N TO PRODUCE ESTIMATES & SAMPLING */ 29 /* INVUKE NASSI'N TO PRODUCE ESTIMATES & SAMPLING */ 29 /* ENHORS. */ 20 /* ACCS UNBAN I 20 /* ENHORS. */ 20 /* /* ENHORS. */ 20 /* ENHORS. */ 20 /* /* ENHORS. */ 20 /* /* /* /* /* /* /* /* /* /* /* /* /*	30		•/
34 /* ASSIGN REQUIRED VARIABLE 'NOPENDI THE VALUE 10 35 /* ON THE INPUT DATA BET & REDETED THASSUTS THE WALLE 10 36 /* ON THE INPUT DATA BET & REDETED THASSUTS THE WALLE 10 37 /* ON THE INPUT DATA BET & REDETED THASSUTS THE WALLE 0 38 /* ON THE INPUT DATA BET & REDETED THASSUTS THE WALLE 0 39 NUMPSUBID 1 40 LABEL 41 LABEL 42 ACCSALCIENTS (TUTAL) 43 /* 44 /* 45 /* 46 PROC MASSTIM DATA-ACCIDENT BET 1 47 NOTE: DATA STATEMENT USED 1.31 SECONDON AND 184A. 46 PROC MASSTIM DATA-ACCIDENT BET 1 47 VAR ACCS UNBAN 1 48 PROC MASSTAN TO PRODUCE ESTIMATES 4 49 UTVAH URATID 1 51 CUMPAR ACCS UNBAN 1 52 UTVAH URATID 1 53 TITLE SELECTED MATIDAL LEVEL ACCIDENT ESTIMATES 4 54 TITLE SELECTED MATIDAL LEVEL ACCIDENT ESTIMATES 1 55 /* 56 /* 57 /*	32	ELSE URBAN=0 1	
35 NUMPSUAID 1 40 LAREL 41 LAREL 42 ACCSMACCIDENTS 43 UNRANHOWBAN ACCIDENTS (TUTAL) 44 * 45 /* 45 /* 46 /* 47 * 48 PROC NASSIM DATAACCIDENT MAS AND 61 VARIABLES. 55 085/TMM 49 /* 44 PROC NASSIM DATAACCIDENT BEST (45 /* 46 PROC NASSIM DATAACCIDENT BEST (47 UNTAT URATION 48 PROC NASSIM DATAACCIDENT BEST (49 UNTAT URATION 40 UNTAT URATION 41 UNTAT URATION 52 UNTAT URATION 53 UNTAT URATION (54 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES (55 /* 56 /* 57 /* 58 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES (59 /* 50 PROC MASSYAR DATAACCIDENT ESTIMATES & SAMPLING (50 <t< th=""><th>34</th><th>ASSIGN REQUIRED VARIABLE INUMPSUI THE VALUE 10</th><th>:/</th></t<>	34	ASSIGN REQUIRED VARIABLE INUMPSUI THE VALUE 10	:/
35 NUMPSUAID 1 40 LAREL 41 LAREL 42 ACCSMACCIDENTS 43 UNRANHOWBAN ACCIDENTS (TUTAL) 44 * 45 /* 45 /* 46 /* 47 * 48 PROC NASSIM DATAACCIDENT MAS AND 61 VARIABLES. 55 085/TMM 49 /* 44 PROC NASSIM DATAACCIDENT BEST (45 /* 46 PROC NASSIM DATAACCIDENT BEST (47 UNTAT URATION 48 PROC NASSIM DATAACCIDENT BEST (49 UNTAT URATION 40 UNTAT URATION 41 UNTAT URATION 52 UNTAT URATION 53 UNTAT URATION (54 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES (55 /* 56 /* 57 /* 58 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES (59 /* 50 PROC MASSYAR DATAACCIDENT ESTIMATES & SAMPLING (50 <t< td=""><td>36</td><td>/* ON THE INPUT DATA SET & REPRESENTS THE NUMBER</td><td>ź</td></t<>	36	/* ON THE INPUT DATA SET & REPRESENTS THE NUMBER	ź
LABEL ACCSHACCIDENTS ACCSHACCIDENTS UPRANNUMBAN ACCIDENTS (TUTAL) /* NOTE: DATA SET NUME, ACCIDENT AS STIT U PRODUCE 'CHEAP' ESTIMATES. */ NOTE: DATA SET NUME, ACCIDENT MAS STIT U PRODUCE 'CHEAP' ESTIMATES. */ * NOTE: THE DATA STATEMENT USED 1.31 SECUNDS AND 184A. * PROC MASSIENT DATA-ACCIDENT BEST : VAR ACCS UNBAN ! SO UUMPVAR ACCS UNBAN ! SO UUMPVAR UPATID I / ACCS ! SI CUMPVAR ACCS UNBAN ! SO /* ENHORS. */ NOTE: THE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES ; SO /* ENHORS. */ NOTE: NASSIENT IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. */ */ */ */ */ */ */ */ */ */	38		,
A3 UNBANEUHBAN ACCIDENTS (TUTAL) 43 44 45 45 46 47 47 47 47 47 48 49 49 49 49 40 40 40 40 40 40 40 40 40 40	40		
44 1 45 /* INVUKE NASSTIM TO PRODUCE 'CMEAP' ESTIMATES. */ 46 /* INVUKE NASSTIM TO PRODUCE 'CMEAP' ESTIMATES. */ 47 NOTE: DATA STATEMENT USED 1.3 SECONDS AND 164X. 46 PROC MASSTIM DATA-ACCIDENT BEST ! 47 VAR ACCS URGAN ! 48 PROC MASSTIM DATA-ACCIDENT BEST ! 49 VAR ACCS URGAN ! 50 URATION URATIO 51 URATIONUENT VARIAN ! 52 URATIONUENT VARIAN ! 53 URATIONUENT VARIAN ! 54 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES ! 55 /* INVOKE NASSVAN TU PRODUCE ESTIMATES & SAMPLING */ 56 /* ENNORS. 57 /* ENNORS. 58 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES & SAMPLING */ 59 /* ENNORS. 50 /* ENNORS. 50 /* ENNORS. 51 INVOKE NASSYAR DATA-ACCIDENT BEST TOTAL OUTPUT OUTDATA-TWO ! 52 /* ENNORS. 53 URATIO URATIO ! 54 URATIOURAN / ACCS ! 55 URATIOURAN / ACCS ! 56 URATIOURAN / ACCS ! 57 /* AR ACCS URGAN ! 58 URATIOURAN / ACCS ! 50 URATIOURAN / ACCS !	42	ACCS=ACCIDENTS	
A INVOKE NASSTIM TO PRODUCE TOTALPY ESTIMATES. */ NOTE: DATA SET WORK, ACCIDENT HAS 3331 ORSENVATIONS AND BI VARIABLES. 55 OBS/THM NOTE: THE DATA STATEMENT USED 1.31 SECUNDS AND BAK. A PROC MASSTIM DATA-ACCIDENT BEST 1 */ */ */ */ */ */ */ */ */ */		t	
46 PROC MASSTIM DATA-ACCIDENT BEST : 47 VAR ACCS UNDAN I 48 OUTVAN ULRATIO I 53 OUTVAN ULRATIO I 53 ULRATIO-UNDARAN / ACCS I 54 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES ; 55 /* INVOKE NASSVAN TU PRODUCE ESTIMATES & SAMPLING */ 56 /* ENKORS. 57 /* ENKORS. 58 /* ENKORS. 59 /* ENKORS. 50 /* ENKORS. 50 /* ENKORS. 50 /* ENKORS. 50 /* ENKORS. 51 /* ENKORS. 52 /* ENKORS. 53 /* ENKORS. 54 MOTE: NASSTIM USUPPORTED, EXPENIMENTAL PROCEDURE. 55 MOTE: NASSTAN DATA-ACCIDENT BEST TOTAL OUTPUT OUTDATA-TWO I 53 /* MORATILEZENCO UNBAN / ACCS I 53 /* OUTVAR ULRATIO I 54 OUTVAR ULRATIO I STATIONARAN / ACCS I 55 /* OUTVAR ULRATIO I	46 47		
49 VAR ACCS URBAN 1 50 WEIGHT A WORD 1 51 CUMPAR ACCS URBAN 1 51 CUMPAR ACCS URBAN 1 51 CUMPAR ACCS URBAN 1 53 UNUETIONUPAN ACCS 1 54 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES 1 55 ** 56 /* 57 /* 58 ** 59 /* 50 /* 50 /* 51 /* 52 /* 53 /* 54 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES 4 SAMPLING */ 55 /* 56 /* 57 /* 58 /* 59 /* 50 /* 51 /* 52 /* 53 UNASSYAR DATA=ACCIDENT BATA 54 OUTVAR UATA 55 UNAR ACCIDENT BATA 56 WAR ACCIDENT BATA 57 WAR ACCIDENT BATA 58 OUTVAR UA			OBS/THE
11 CUMPAR ALLS DUBAT 13 UNATIONUPAN / ACCS I 14 UNATIONUPAN / ACCS I 15 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES I 15 INVOKE NASSVAN TU PRODUCE ESTIMATES & SAMPLING '/ 15 /* ENHORS. 15 /* ENHORS. 15 /* ENHORS. 160 /* ENHORS. 150 RESEARCH BLVD 150 RESEARCH BLVD 150 RESEARCH BLVD 00 PAOC NASSYAR DATA=ACCIDENT BEST TOTAL OUTPUT OUTDATA=TWO I 151 VAR ACCS URBAN I 00 PAOC NASSYAR DATA=ACCIDENT BEST TOTAL OUTPUT OUTDATA=TWO I 01 VAR ACCS URBAN I 02 WEIGHT M.WOTO-MEGNE I 031 OUTVAR U_ATIO I 04 OUTVAR U_ATIO I 05 UTVAR U_ATIO I 05 UTVAR U_ATIO I 05 UTVAR U_ATIO I 05	49	PROC NASSTIM DATA=ACCIDENT BEST F Var ACCS Urban F	
33 U_MATIO-URBAN / ACCS 1 54 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES 1 55 /* INVOKE NASSVAN TU PRODUCE ESTIMATES 4 SAMPLING */ 56 /* EMNORS. 57 /* EMNORS. 58 /* EMNORS. 59 /* EMNORS. 59 /* EMNORS. 50 /* EMNORS. 59 /* 50 /* EMNORS. 51 /* EMNORS. 52 /* 53 /* 54 /* 55 /* 56 /* 57 /* 58 /* 59 /* 50 PROC MASSVAR DATA-ACCIDENT BEST TOTAL OUTPUT OUTDATA-TWO I 51 VAR ACCS URBAN 1 52 VAR ACCS URBAN 1 53 COMPVAR ACCS UNBAN 1 54 UNATIO-URBAN / ACCS 1 <td></td> <td>WEIGHT R_WGTD 1 Compvar accs urban 1</td> <td></td>		WEIGHT R_WGTD 1 Compvar accs urban 1	
55 56 57 57 57 57 57 57 57 57 57 57	53	U_RATIO=URBAN / ACCS 4	
57 /* INVORE NASSVAR TU PRODUCE ESTIMATES & SAMPLING */ 58 /* ENHORS. */ 50 /* ENEMORS. */ 60 NOTE: NASSTIM USED 1.48 SECONDS AND 184K AND PRINTED PAGE 1. */ 61 YMA ACCE UNGAN 1 */ */ 62 WEIGHT M_WOTO-*, WOTE 1 */ */ */ 63 COMPARA ACCE UNBAN 1 */ */ */ 64 OUTVA U_RATIO */ */ */ */ */ 65 U_RATIO */ MOTE NASSVAR 15 AN UNSUPPORTED. */ */ */ */ 70 NOTE: NASSVAR IS AN UNDAPORTED. */ */ */ */ */ */ */ 71 ITLE SELECTED NATIO+INAL LEVEL ACCIOUNT ESTIMATES. */ <t< td=""><td>55</td><td>TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES F</td><td></td></t<>	55	TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES F	
59 60 NUTE: MASSIIM IS AN UNSUPPORTED, EXPERIMENTAL PROCEDURE. VESTAT INC 1650 RESEARCH BLVD ROCKVILLE-MD 20850 13011 251-1500 NOTE: THE PROCEDURE NASSIIM USED 1.48 SECONDS AND 184K AND PRINTED PAGE 1. 60 PROC NASSVAR DATA-ACCIDENT BEST TOTAL OUTPUT OUTDATA-TWO 1 61 VAR ACCS UNBAN 1 62 VEIGHT N_WGTO-N_WGTE 1 63 COMPARA ACCS UNBAN 1 64 OUTVAR U_RATIO 1 65 0 66 U_RATIO=UNBAN / ACCS 1 67 TILE SELECTED NATIOHAL LEVEL ACCIDENT ESTIMATES. 1 68 0 70 NOTE: NASSVAR IS AN UNSUPPORTED, EXPERIMENTAL PROCEDURE. 70 NOTE: NASSVAR IS AN UNSUPPORTED, EXPERIMENTAL PROCEDURE. 71 TILE SELECTED NATIOHAL LEVEL ACCIDENT ESTIMATES. 361 UBS/TRK. WESTAT INC 1550 TESEARCH BLVD 1550	57	/* INVOKE NASSVAR TO PRODUCE ESTIMATES & SAMPLING	•/
NOTE: NASSTIM IS AN UNSUPPORTED, EXPERIMENTAL PROCEDURE. WESTAT INC ISSU RESEARCH BLVD MOTE: THE PROCEDURE NASSTIM USED 1.48 SECONDS AND I84K AND PRINTED PAGE 1. 00 PROC NASSYAR DATA=ACCIDENT BEST TOTAL OUTPUT OUTDATA=TWO 1 11 VAR ACCS URBAN 1 12 VAR ACCS URBAN 1 13 VAR ACCS URBAN 1 14 VAR ACCS URBAN 1 15 OUTVAR U_RATIO 1 15 OUTVAR U_RATIO 1 16 U_RATIO=URBAN / ACCS 1 17 TILE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES. 1 18 OTE: NASSYAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 19 NOTE: NASSYAR USED 4.58 SECUNDS AND I88K AND PRINTED PAGE 2. 10 PROC PRINT OWED 4.58 SECUNDS AND I88K AND PRINTED PAGE 2. 11 TITLE HEVELCATE LEVEL ESTIMATES IOUTPUT OS FROM NASSYARI 1 NOTE: SAS USED IBAR MEMONY. NOTE: SAS USED IBAR MEMONY. NOTE: SAS USED IBAR MEMONY. NOTE: SAS USED IBAR MEMONY. 10 TITLE INC. 10 SAS OWED LEVEL ESTIMATES IOUTPUT OS FROM NASSYARI 1 10 TITLE INC. 10 SAS OWED LEVEL ESTIMATES IOUTPUT OS FROM NASSYARI 1 10 TITLE INC. 10 SAS USED IBAR MEMONY. 10 SECIRCLE 10 AGOOD 10 CARY, M.C. 27511 EYEL ACCIDENT ESTIMATES	58 59	/* EKHORS.	•/
WESTAT INC 1650 RESEARCH BLVD ACCVILLE-MD 20050 1301) 251-1500 NOTE: THE PROCEDURE NASSTIM USED 1.48 SECONDS AND 184K AND PRINTED PAGE 1. 60 PROC MASSVAR DATA=ACCIDENT BEST TOTAL OUTPUT OUTDATA=TWO I 61 VAR ACCS URBAN 1 62 COMPTAR ACCS URBAN 1 63 COMPTAR ACCS URBAN 1 64 COMPTAR ACCS URBAN 1 65 U_RATIO=URBAN / ACCS 1 67 70 NOTE: NASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. NOTE: NASSVAR USED A.58 SECUNDS AND 188K AND PRINTED PAGE 2. 70 PROC PRINT DATA=TWO 1 1 TITLE HEPLICATE LEVEL ESTIMATES IOUTPUT DS FROM NASSVARI 1 NOTE: SAS USED IBAK MEMONY. NOTE: SAS USED			
1450 RESEARCH BLYD NOTE: THE PROCEDURE NASSTIM USED 1.46 SECONDS AND 184K AND PRINTED PAGE 1. 50 PROC MASSVAR DATA=ACCIDENT BEST TOTAL OUTPUT OUTDATA=TWO I 51 VAR ACCS URBAN 1 52 WEIGHT M_WOTA_WOTB 1 53 COMPVAR ACCS UNBAN 1 54 OUTVAR U_RATIO 1 55 OUTVAR U_RATIO 1 56 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES. 1 57 70 NOTE: NASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 50 NOTE: MASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 50 NOTE: NASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 50 NOTE: INASSVAR USED 4.56 SECUNDS AND 1884 AND PRINTED PAGE 2. 70 PROC PRINT DATA=TWO 1 71 TITLE HEVELGATE LEVEL ESTIMATES IOUTPUT OS FROM NASSVARI 1 53 NOTE: SAS USED 188K MENONY. 54 NOTE: SAS USED 188K MENONY. 55 CIRCLE 50 A000 55 CIRCLE 50 A000 55 CIRCLE 56 AND 151 MATES IMATES EVEL ACCIDENT ESTIMATES			
NOTE: THE PROCEDURE NASSTIM USED 1.48 SECONDS AND 184K AND PRINTED PAGE 1. 60 PROC NASSYAR DATA-ACCIDENT BEST TOTAL OUTPUT OUTDATA-TWO ; 61 VELORIN 1 62 VELORIN 1 63 COMPARA ACCS UNBAN 1 64 OUTVAR U_RATIO : 65 U_RATIO=UNBAN / ACCS 1 61 TITLE SELECTED NATIOHAL LEVEL ACCIDENT ESTIMATES. 1 66 U_RATIO=URBAN / ACCS 1 67 TOTE: NASSYAR IS AN UNSUPPORTED, EXPERIMENTAL PROCEDURE. 67 NOTE: DATA SET NORK.TWO HAS 9 ORSERVATIONS AND 4 VARIABLES. 361 UBS/TRK. 65 VESTAT INC. 66 VESTAT INC. 67 PROC PHINT OATA-TWO : 70 NOTE: NASSYAR USED 4.58 SECUNDS AND 188K AND PRINTED PAGE 2. 70 PROC PHINT DATA-TWO : 71 TITLE: LEVEL ESTIMATES (OUTPUT OS FHOM NASSVARI 1 100TE: SAS USED 18AK MEMOHY. 875FI SAS USED 18AK MEMOHY. 875FI SAS USED 18AK MEMOHY. 875FI SAS USED 18AK MEMOHY. 875FI SAS CIRCLE 800 8000 CARY, N.C. 27511 EYEL ACCIDENT ESTIMATES			
60 PROC NASSVAR DATA=ACCIDENT BEST TOTAL OUTPUT OUTDATA=TWO ; 61 VAR ACCS URBAN ; 62 WEIGHT #_NOTA_MORE ; 63 OUTVAR U_RATIO ; 64 OUTVAR U_RATIO ; 65 OUTVAR U_RATIO ; 66 U_RATIO=URBAN / ACCS ; 67 TILE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES.; 68 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES.; 69 OUTVAR U_RATIONS AND ; 70 NOTE: NASSVAR IS AN UNSUPPORTED.; EXPERIMENTAL PROCEDURE. 800TE: TOATA SET WORK.TWO HAS © ORSERVATIONS AND ; VARIABLES. 361 005/TAK. WESTAT INC 1860 RESEARCH BLVD 800TE: THE PROCEDURE NASSVAR USED 4.56 SECUNDS AND 186K AND PRINTED PAGE 2. 70 PROC PHINT DATA=THO ; 801E: THE PROCEDURE PRINT USED 0.16 SECONDS AND 176K AND PRINTED PAGE 3. 801E: SAS USED 18AK MEMONY. 801E: SAS USED 18AK MEMONY. 801E: SAS USED 18AK MEMONY. 802 FORL 804 0800 CARY, N.C. 27511			1.
64 OUTVAR U_RATIO : 65 U_RATIO = URBAIN / ACCS I 66 U_RATIO = URBAIN / ACCS I 67 TITLE SELECTED NATIONAL LEVEL ACCIOENT ESTIMATES. I 69 TITLE SELECTED NATIONAL LEVEL ACCIOENT ESTIMATES. I 60 TO 70 NOTE: NASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 1850 RESEARCH BLVD 1851 TITLEI NED ZOASZ (301) 251-1500 NOTE: THE PROCEDURE NASSVAN USED 0.58 SECUNDS AND 1884 AND PRINTED PAGE 2. 70 PRUC PHINT DATA=TWO I 11 TITLEI NEPLICATE LEVEL ESTIMATES (OUTPUT OS FHOM NASSVARI I NOTE: SAS USED 18AR MEMOHY. SAS CIRCLE 800 000 CARY, N.C. 27511		PROC NASSVAR DATA=ACCIDENT BEST TOTAL OUTPUT OUTDATA=	
64 OUTVAR U_RATIO : 65 U_RATIO = URBAIN / ACCS I 66 U_RATIO = URBAIN / ACCS I 67 TITLE SELECTED NATIONAL LEVEL ACCIOENT ESTIMATES. I 69 TITLE SELECTED NATIONAL LEVEL ACCIOENT ESTIMATES. I 60 TO 70 NOTE: NASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 1850 RESEARCH BLVD 1851 TITLEI NED ZOASZ (301) 251-1500 NOTE: THE PROCEDURE NASSVAN USED 0.58 SECUNDS AND 1884 AND PRINTED PAGE 2. 70 PRUC PHINT DATA=TWO I 11 TITLEI NEPLICATE LEVEL ESTIMATES (OUTPUT OS FHOM NASSVARI I NOTE: SAS USED 18AR MEMOHY. SAS CIRCLE 800 000 CARY, N.C. 27511	61 62	VAR ACCS URBAN I Weight R_wgto-k_wgtb I	
65 U_RATID=URBAN / ACCS I 66 U_RATID=URBAN / ACCS I 67 TITLE SELECTED NATIOHAL LEVEL ACCIDENT ESTIMATES. I 68 TITLE SELECTED NATIOHAL LEVEL ACCIDENT ESTIMATES. I 69 TITLE SELECTED NATIOHAL LEVEL ACCIDENT ESTIMATES. I 60 NOTE: INASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 60 NOTE: INASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 60 NOTE: INASSVAR IS O PAREVATIONS AND ISSX AND INTED PAGE 2. 70 PROC PRINT OATAFTNO I 71 TITLE I REPLICATE LEVEL ESTIMATES (OUTPUT OS FMOM NASSVARI I 72 PROC PRINT OATAFTNO I 73 TITLEI REPLICATE LEVEL ESTIMATES (OUTPUT OS FMOM NASSVARI I 74 TITLEI NEPLICATE LEVEL ESTIMATES (OUTPUT OS FMOM NASSVARI I 75 NOTE: SAS USED IBAR MENONY. 807E: SAS USED IBAR MENONY. 8080: CARY, N.C. 27511	63 64	COMPVAR ACCS URBAN 1 Outvar u_ratio 1	
67 TITLE SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES. 1 69 70 NOTE: NASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE. 1650 RESEARCH BLVD NOTE: THE PROCEDURE NASSVAR USED 4.58 SECUNDS AND 188K AND WRINTED PAGE 2. 70 PROC PLINT DATAFINO 1 71 TITLE1 MEPLICATE LEVEL ESTIMATES IOUTPUT DS FNOM NASSVARI 1 NOTE: THE PROCEDURE PRINT USED 0.16 SECONDS AND 176K AND PRINTED PAGE 3. NOTE: SAS USED 18AK MENONY. NOTE: CARLE 800 CARY. N.C. 27511		_	
69 70 NOTE: NASSVAR IS AN UNSUPPORTED, EXPERIMENTAL PROCEDURE. NOTE: DATA SET NORK.THO HAS 9 ORSERVATIONS AND 4 VARIABLES. 361 UBS/TRK. VESTAT INC. 1650 RESEARCH BLVD NOTE: THE PROCEDURE NASSVAR USED 4.58 SECUNDS AND 188K AND WRINTED PAGE 2. 70 PROC PRINT DATAFIND 1 71 TITLEI HEPLICATE LEVEL ESTIMATES IOUTPUT DS FMOM NASSVARI 1 NOTE: SAS USED 18AK MEMONY. NOTE: SAS USED 18AK MEMON	67		
MOTE: DATA SET MORK.TWO HAS 9 DASERVATIONS AND 4 VARIABLES. 361 UBS/TAR. WESTAT INC 1050 VILLE-ARCM BLVD 1050 VILLE-ARCM 20852 (301) 251-1500 NOTE: THE PROCEDURE NASSVAN USED 4.58 SECUNDS AND 1884 AND PRIMTED PAGE 2. 70 PROC PHINT DATA-TWO : 11 ITLE: MEPLICATE LEVEL ESTIMATES IOUTPUT DS FROM NASSVARI I 11 ITLE: LEVEL ESTIMATES NOTE: SAS USED 188K MEMORY. NOTE: SAS USED 188K MEMORY. NOTE: SAS INSTITUTE INC. SAS CIRCLE 807 8000 CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES	69		
WESTAT INC 1850 RESEARCH BLVD MOCVILLE-MD 20052 (301) 231-1500 NOTE: THE PROCEDURE NASSVAR USED 4.56 SECUNDS AND 188K AND PRINTED PAGE 2. 70 PROC PHINT DATA-THO I 71 TITLEI MEPLICATE LEVEL ESTIMATES (DUTPUT DS FROM NASSVARI I NOTE: THE PROCEDURE PRINT USED 0.16 SECONDS AND 176K AND PRINTED PAGE 3. NOTE: SAS USED 186K MEMORY. NOTE: SAS USED 186K MEMORY. NOTE: SAS USED 186K MEMORY. NOTE: SAS USED 186K MEMORY. NOTE: SAS USET 18C. SAS CIRCLE BOX 8000 CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES	NOTES	NASSVAR IS AN UNSUPPORTED. EXPERIMENTAL PROCEDURE.	
1450 RESEARCH BLVD ROCVILLE-MD 20652 (301) 231-1500 NOTE: THE PROCEDUKE NASSVAR USED 4.58 SECUNDS AND 188K AND WRINTED PAGE 2. 70 PROC PLINT DATAWING I 71 TITLEI HEPLICATE LEVEL ESTIMATES (DUTPUT OS FHOM NASSVARI I NOTE: THE PROCEDUME PRINT USED 0.16 SECONDS AND 176K AND PRINTED PAGE 3. NOTE: SAS USED 188K MEMOHY. NOTE: SAS USED 188K MEMOHY. NOTE: SAS INSTITUTE INC. SAS CIRCLE BOX 6000 CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES			•
NOTE: THE PROCEDURE NASSVAN USED 4.58 SECUNDS AND 1884 AND PRINTED PAGE 2. TO PRUC PHINT DATA-THO : TI TITLE! MEDLICATE LEVEL ESTIMATES (DUTPUT OS FHOM NASSVARI I NOTE: THE PROCEDURE PRINT USED 0.16 SECONDS AND 1764 ANU PHINTED PAGE 3. NOTE: SAS USED 1884 MENDHY. NOTE: SAS INSTITUTE INC. SAS CIRCLE BOA 8000 CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES	WESTA 1650 ROCKV (301)	T INC Research BLVD Ille.WD 20052 251-1500	
TO PROC PHINT DATA-THO I TI TITLEI MEPLICATE LEVEL ESTIMATES IOUTPUT OS FROM NASSVARI I NOTE: THE PROCEDURE PRINT USED 0-16 SECONDS AND 176K ANU PHINTED PAGE 3. NOTE: SAS USED 188K MENONY. NOTE: SAS INSTITUTE INC. SAS CIPCLE BOX BOOD CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES			2.
TI TITLEI MEPLICATE LEVEL ESTIMATES (QUIPUI OS FROM MASSVARI) NOTE: THE PROCEDUME PRINT USED 0.16 SECONDS AND 176K AND PRIMIED PAGE 3. NOTE: SAS USED 186K MEMORY. NOTE: SAS USED 186K MEMORY. SAS CIRCLE BOX 8800 CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES	70	BRID BUINT DATA-THO I	
NOTE: SAS USED IBAR MENDAY. NOTE: SAS INSTITUTE INC. SAS CIRCLE BOX 8000 CARY. N.C. 27511 EVEL ACCIDENT ESTIMATES		TITLE1 REPLICATE LEVEL ESTIMATES (OUTPUT OS FROM NASS	
NOTE: SAS INSTITUTE INC. SAS CIRCLE BOX BOOD CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES			•
SAS CIRCLE BOX BOOD CARY, N.C. 27511 EVEL ACCIDENT ESTIMATES			
EVEL ACCIDENT ESTIMATES Ion procedure	NOTEI	SAS CIRCLE BOX 8000	
·- <u>-</u>	EVEL	- ACCIDENT ESTIMATES PROCEDURF	

	3331 OBSERVATIONS PROCESSE 645 WEIGHTED OBSERVATIONS			
NAME	LABEL	ESTIMATE	MISSING	WEIGHTED MISSING
ACCS	ACCIDENTS	6704645	0	0
URBAN	URBAN ACCIDENTS (TOTAL)	4674048	0	0
U RATIO	COMPUTED ESTIMATE	0.697136	N/A	N/A

SELECTED NATIONAL NASS ESTIMA Figure 5-3. NASSVAR output.

OPTIONS USED:

ONS USED: BEST TOTAL OUTPUT 3331 ORSERVATIONS PROCESSED 6704645 WEIGHTEO OBSERVATIONS PROCESSED 8 REPLICATES IN 10 PSU DESIGN

SELECTED NATIONAL LEVEL ACCIDENT ESTIMATES. NASS SAMPLING ERRORS PROCEDURE

ACCS	ACCIDENTS	5						
		WEIGHTED		REL-		STANDARD	LOWER 95%	HIGHER 959
ESTIMATE	MISSING	MISSING	VARIANCE	VARIANCE	CA(#)	EBHOH	CONF INTVL	CONF INTVL
6704645	0		1.742E+11	0.00387527	6.22517	417376	5886589	7522701
URBAN	URBAN AC	LIDENTS (TO	UTAL)	REL-				
ESTIMATE	MISSING	MISSING	VARIANCE	VARIANCE	CV (%)	STANDARD	LOWER 95% CONF INTVL	HIGHER 959 CONF INTVL
4674048	0		8.093E+11	0.0370456	19.2472	899625	2910782	6437314
U_RATIO	COMPUTED	ESTIMATE		REL-				
ESTIMATE	MISSING	WEIGHTED MISSING	VARIANCE	VARIANCE	CV (%)	STANDARD ERROR	LOWER 95% CONF INTVL	HIGHER 953 CONF INTVL
0.697136			0.00972521	0.0200108	14.1459	0.0986165	0.503848	0.890424

Figure 5-4. Listing of NASSVAR output data set

REPLIC	ATE LEVEL	ESTIMATES	(OUTPUT DS	FROM NASSVAR)
085	REPL_ID	ACCS	URBAN	U_RATIO
1	0	6704645	4674048	0.697136
2	1	6021238	3154835	0.523951
з	2	6605781	4514185	0.683369
4	3	7269834	5317400	0.731434
5	4	7387759	6134438	0.830352
6	5	6572466	4754515	0.723399
7	6	6478077	3668768	0.566336
8	7	6650030	5263451	0.791493
9	8	6947396	5153569	0.741799

APPENDIX A

COMPUTATIONS REQUIRED FOR FIRST-AND SECOND-STAGE RATIO ADJUSTMENTS

This appendix describes in matrix terms the computations required to obtain ratio adjustment factors to reduce within- and between-PSU variances. Factors are developed for the full sample (replicate zero) and for two sets of half-samples: one for total variance and one for within variance (replicates one through "k"). The numbers of half-sample replicates vary by sample design.

- A.1 We begin by defining the following matrices used in the computation:
- A_{2hxu} Known stratum totals for the variables selected to adjust each record type to reduce between-PSU variance.
- ^B_{2hxu} Estimated totals for the variables contained in the A matrix (e.g., estimates of A obtained by multiplying PSU Census totals by the PSU weight).
- ^C2hxu Census counts of total records appearing in the sampled PSU weighted up to estimate the stratum total. These are used in the numerator of the ratio factors prepared to reduce the withinvariance component.

- D_{2hxu} Estimated stratum total numbers of odd and even records for the categories contained in the C matrix.
- F_{2hxc} Matrix of 1's and 0's defining groupings of PSU's used to reduce between-PSU variances. Columns of F add to a vector of 1's.
- G_{2hxg} Matrix of 1's and 0's defining groupings of PSU's used for reducing within-PSU variances. Columns of G add to a vector of 1's.
- R_{2hx(k+1)} Matrix of 0's, 1's, and 2's defining replicates. First column is all 1's (replicate zero) and remaining columns are 0's or 2's defined for variance computation.
- I_F Matrix of 1's and 0's used to collapse (k+1)x over c between-PSU ratio groups: [cx(k+1)]

- $I_G \qquad \begin{array}{ll} Matrix of 1's and 0's used to collapse \\ (k+1)_X & over g between-PSU ratio groups (see \\ [gx(k+1)] I_F \end{array} .$
- ^I_{2hx(k+1)} Matrix of 1's used to reproduce F in step 1b in A.4 below.
- A.2 The subscripts used in A.1 are defined below:
- h = number of strata; 2h indicates two rows per PSU, first for odd cases, second for even cases within PSU. Note that for estimates of total variance, the cases are combined in nonself-representing PSU's.
- u = number of record types used in preparing within-PSU ratio factors.

- c = number of groups of PSU's for which between-PSU factors are prepared.
- g = number of groups of PSU's for which within-PSU factors are prepared.
- k = number of half-sample replicates required. Different for estimating total variance and within-variance for the various sample designs.
- A.3 Several types of matrix operations are required below. These operations are defined as follows:
- a. Matrix term-by-term addition:

 $M_{axb} + N_{axb} = 0_{axb}$

b. Matrix term-by-term multiplication:

 $M_{axb} # N_{axb} = 0_{axb}$

c. Matrix transpose:

d. Matrix multiplication (dot products):

$$M_{axb} * N_{bxc} = 0_{axc}$$

- e. Horizontal direct product:
 - $M_{axb} @ N_{axc} = 0_{ax(bxc)}$

NOTE: In SAS, the result of this operation is a matrix with the same number of rows as M and N, and a number of columns equal to the product of the number of columns of M times the number of columns of N.

f. Matrix term-by-term division:

 $M_{axb} \# N_{axb} = 0_{axb}$

- A.4 Using the above definitions, the required computations are given below.
- 1. Compute factors to reduce the between-PSU variance:
- a. Compute between-PSU design matrix:

 $J_{2hx[cx(k+1)]} = R_{2hx(k+1)} @ F_{2hxc}$

b. Compute between-PSU numerator terms:

 $NUM_{ux[cx(k+1)]} = A'_{ux2h} * (I_{2hx(k+1)} @ F_{2hxc})$

c. Compute between-PSU denominator terms:

$$DEN_{ux[cx(k+1)]} = B' * J_{2hx[cx(k+1)]}$$

d. Compute between-PSU ratio terms:

 $\frac{\text{RATIO}_{ux[cx(k+1)]}}{= \text{NUM}_{ux[cx(k+1)]} \# \text{DEN}_{ux[cx(k+1)]}}$

e. Expand between-PSU ratio factors over all PSU by record type cells in the between-PSU design matrix:

PROD = RATIO' @ [cx(k+1)x(ux2h)] = [cx(k+1)]xu SQRT(J') [cx(k+1)x2h]

NOTE: The square root is taken since two multiplicative adjustment factors will be computed (one for between and one for within) and each contains a factor of two used with each half sample.

f. Record the between-PSU factor applicable to records identified by replication, PSU, and record type. This step removes redundant zeros generated in previous steps:

$$F_{B}_{(k+1)x(ux2h)} = I_{F}_{(k+1)x[cx(k+1)]}$$

$$* PROD_{[cx(k+1)]x(ux2h)}$$

2. Compute factors to reduce the within-PSU variance.

Repeat la through lf above to produce within-PSU factors by substituting as follows:

C for A, D for B, G for F, I_G for I_F , F_W for F_B .

In step 1b, substitute R @ G for I @ F because (contrary to the between-PSU factors) the numerators of within-PSU factors vary by replicate.

3. Compute final ratios as:

 $F_{T(k+1)x(ux2h)} = F_W \# F_B$

BIBLIOGRAPHY

(1) NASS Estimation - Final Technical Report, National Highway Traffic Safety Administration, Washington, D.C. Contract Number DTNH-80R-07561, July 1982.

(2) National Accident Sampling System (NASS) Final Report Volume I -Final Technical Report, National Highway Traffic Safety Administration, Washington, D.C. Contract number DOT-HS-7-01706, November 1979.

(3) National Accident Sampling System-Estimation, DOT DTNH 22-80R-07561.

(4) McCarthy, Philip J. (1966) "Replication, An Approach to the Analysis of Data from Complex Surveys" Public Health Service Publication No. 1000-Series 2-No. 14.

(5) McCarthy, Philip J. (1969) "Pseudoreplication, Further Evaluation and Application of the Balanced Half-Sample Technique" Public Health Service Publication No. 1000-Series 2-No. 31.

(6) Plackett, R. L. and Burman, J. P., "The Design of Optimum Multifactorial Experiments" Biometrika 33:305-325, 1943-1946.