Census Transportation Planning Products Margin of Error ToolKit

Tutorial

NCHRP Project 8-36C, Task 135

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Census Transportation Planning Products Margin of Error ToolKit

User Guidance

The purpose of the Census Transportation Planning Products (CTPP) Margin of Error (MOE) ToolKit presented in this Excel file is three-fold:

- to estimate MOE for totals and proportions for combined subgroups ("CombineSubgroups" worksheet);
- to compare proportions between two subgroups ("CombineSubgroups" worksheet); and
- to create replicated tables to reflect the MOEs in a given table, for use in subsequent sensitivity travel demand analysis

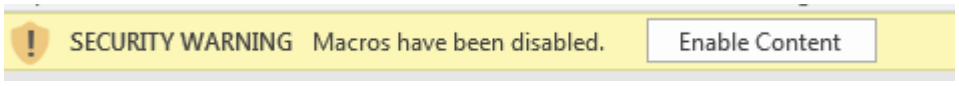
Colored cells indicate the following:

- orange provides the fixed parameter inputs for variance estimation purposes, as a result of research described in the NCHRP 08-36 Task 135 Final Report;
- yellow is where user input is needed;
- green is where the output is given.

The methodology for the computations is provided in the NCHRP 08-36 Task 135 Final Report. Two CTPP examples are provided for each purpose of the ToolKit.

Important notes:

- Be sure to enable the use of macros when the ToolKit is being used.



- Save this tutorial in the same directory as the ToolKit. The tutorial file will pop up when the "Tutorial" button in the ToolKit is clicked.

"CombineSubgroups" Worksheet 1

The purpose of this spreadsheet is to estimate the MOE for a combination of subgroups (levels) from the CTPP tables. The MOE is estimated for the aggregated total X from the combined subgroups. Combined subgroups can be areas, such as groups of Traffic Analysis Zones (TAZs) or levels of a variable (e.g., categories of Measure of Transportation).

Inputs

To estimate the proportion (p) for the combined estimate, enter the denominator Y value where indicated. For example, suppose the proportion of the population driving alone in a combined group of TAZs is desired. Enter the total number of workers (Y) for the combined group of TAZs.

Copy and paste the CTPP estimated totals (X) and MOEs for the subgroups to be combined. In the example above, provide the number of workers driving alone for each of the TAZs to be combined, along with their associated MOE values from the CTPP tables. **The ToolKit allows up to 10,000 subgroups to be combined.**

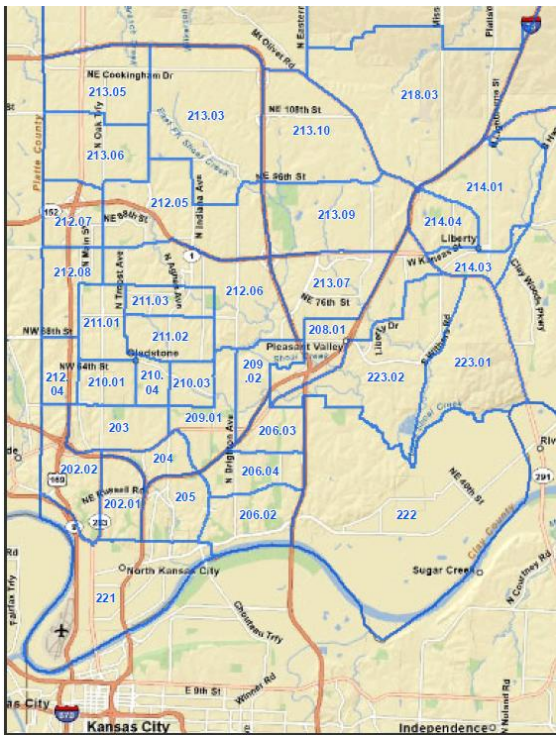
Outputs

Treating each subgroup independently when combining is susceptible to overestimating the MOE for the combined subgroup. Therefore, the MOEs is computed for each of the four methods discussed in the NCHRP 08-36 Task 135 Final Report.

Note: The weighted adjusted GVF estimator is recommended when calculating the MOE of an aggregate estimate, especially when the naïve estimate is much larger than the weighted adjusted GVF estimate, which is a signal that the naïve estimate may be significantly overestimating.

Example 1-1

The first example is from the Kansas City suburbs near Liberty, Missouri in Clay County, along Interstate 35. The table of interest is Table B102216C3 - Time leaving home (10) by Means of transportation (4) (Workers 16 years and over). We want to combine the following eight neighboring tracts along the I35 corridor shown in Figure 1-1A to determine the number of workers driving alone when leaving home for work between 6:00 am and 6:59 am: 208.01, 213.07, 213.09, 213.10, 214.01, 214.03, 214.04, 218.03, 223.02.



Source: Mid-America Regional Council GIS

Figure 1-1A. Kansas City Tracts Along I35 Corridor in Northeast Suburbs

The data table was downloaded from the American Association of State Highway and Transportation Officials CTPP website, and is shown in Table 1-1A.

Table 1-1A. B102216C3 - Time leaving home (10) by Means of transportation (4) (Workers 16 years and over) from select Clay County, Missouri tracts; 6:00 a.m. to 6:59 a.m.; Car, truck, or van – Drove alone

Census Tracts in Clay County, Missouri	Estimate	Margin of Error
208.01	895	220
213.07	610	158
213.09	285	82
213.10	520	120
214.01	405	115
214.03	265	117
214.04	415	154
218.03	780	155
223.02	470	122

Source: U.S. Census Bureau, American Community Survey 2006-2010 Five-year estimates. Special Tabulation: Census Transportation Planning

Step 1. Copy the estimates and MOEs from Table 1-1A into the ToolKit under the columns with headings X and MOE, as shown in Figure 1-1B. These are the estimates to aggregate, and their associated MOEs.

Enter estimates to be aggregated

X	MOE
895	220
610	158
285	82
520	120
405	115
265	117
415	154
780	155
470	122

Figure 1-1B. Estimates to Aggregate

Step 2. Enter the denominator Y and associated published MOE for the estimated proportion (p) for the combined set of cells, as shown in Figure 1-1C. The denominator is the total for the county.

To estimate the proportion (p) for the combined estimate, enter the denominator Y value and its MOE:

Y	*MOE*
20300	914

Enter estimates to be aggregated

X	MOE
895	220
610	158
285	82
520	120
405	115
265	117
415	154
780	155
470	122

Figure 1-1C. Denominator Y and its MOE for the estimated proportion

Step 3. The last step is to review the output. Figure 1-1D shows the combined estimate for the total number of workers 16 years and older equal to 4,645, and the final results from the four methods. From the evaluation results in the NCHRP 08-36 Task 135 Final Report, it is recommended to use the GVF-w adj MOE, which is equal to 403.9. The combined estimate for the proportion in the eight tracts is 0.229 with an MOE equal to 0.0170 from the GVF-w adj method. That is, with 90 percent confidence, the true proportion of workers 16 and older in the county who leave for work between 6:00 am and 6:59 am and come from the eight tracts is contained in the interval 22.9 percent +/- 1.70.

If no result is given for the naïve, GVF unweighted adjustment, or GVF weighted adjustment approaches, it is likely due to relative variance of the base estimate causing negative variance, in which case the variance of the proportion is not estimable.

CTPP Margin of Error Toolkit

Tutorial

Estimating MOE for Combined Subgroups

We emphasize that the Toolkit's GVF-based approaches should be used only when the aggregated total (X) is between 0 and 100,000, which is within the range of the mo

Generalized Variance Function parameters

a	-0.00023
b	24.8988

User Inputs

To estimate the proportion (p) for the combined estimate, enter the denominator Y value and its MOE:

Y	MOE
20300	914

Enter estimates to be aggregated

X	MOE
895	220
610	158
285	82
520	120
405	115
265	117
415	154
780	155
470	122

Outputs

Aggregated estimate	MOE(x)			
X	Naïve	GVF	GVF- uw adj	GVF- w adj
4645	429.0	547.3	398.6	403.9

	MOE(p)			
p	Naïve	GVF	GVF- uw adj	GVF- w adj
0.2288177	0.01845	0.02682	0.01672	0.01702

Figure 1-1D. Final results from combining eight tracts

Example 1-2

The second example is from the Transportation Analysis District (TAD) representing Annapolis, Maryland (TAD 00000029, MPO 24199200). The table of interest is Table B102217C3 - Travel time (12) by Means of transportation (4) (Workers 16 years and over) for workers who drive alone. We want to combine four Travel Time categories to compute the MOE for the number of workers who commute 45 minutes or more. The data table was downloaded from the American Association of State Highway and Transportation Officials CTPP website, and is shown in Table 1-2A.

Table 1-2A. Table B102217C3 - Travel time (12) by Means of transportation (4) (Workers 16 years and over) for workers who drive alone, starting from the Annapolis, Maryland TAD; Car, truck, or van – Drove alone

Travel Time	Estimate	Margin of Error
45 to 59 minutes	1,440	345
60 to 74 minutes	870	247
75 to 89 minutes	190	119
90 minutes or more	250	102

Source: U.S. Census Bureau, American Community Survey 2006-2010 Five-year estimates. Special Tabulation: Census Transportation Planning

Step 1. Copy the estimates and MOEs from Table 1-2A into the ToolKit under the columns with headings X and MOE, as shown in Figure 1-2A. These are the estimates to aggregate, and their associated MOEs.

Enter estimates to be aggregated

X	MOE
1,440	345
870	247
190	119
250	102

Figure 1-2A. Estimates to Aggregate

Step 2. Enter the denominator Y and its MOE for the estimated proportion (p) for the combined set of cells, as shown in Figure 1-2B. The denominator in this example is the total for the TAD for those who do not work at home.

To estimate the proportion (*p*) for the combined estimate, enter the denominator *Y* value and its MOE:

Y	MOE
12200	805

Enter estimates to be aggregated

X	MOE
1,440	345
870	247
190	119
250	102

Figure 1-2B. Denominator Y for the estimated proportion

Step 3. The last step is to review the output. Figure 1-2C shows the combined estimate for the total number of workers 16 years and older equal to 2,750, and the MOE from the recommended GVF-w adj approach, which is equal to 440.2. The combined estimate for the proportion is 0.225 with an MOE equal to 0.03287 from the GVF-w adj method. That is, with 90 percent confidence, the true proportion of workers 16 and older in the Annapolis TAD who travel 45 minutes or more to work is contained in the interval 22.5 percent +/- 3.29.

CTPP Margin of Error Toolkit Tutorial

Estimating MOE for Combined Subgroups

We emphasize that the Toolkit's GVF-based approaches should be used only when the aggregated total (X) is between 0 and 100,000, which is within the range of the moc

Generalized Variance Function parameters

a	-0.00023
b	24.8988

User Inputs

To estimate the proportion (p) for the combined estimate, enter the denominator Y value and its MOE:

Y	*MOE*
12200	805

Enter estimates to be aggregated

X	MOE
1,440	345
870	247
190	119
250	102

Outputs

Aggregated estimate	MOE(x)			
X	Naïve	GVF	GVF- uw adj	GVF- w adj
2750	452.3	424.9	411.0	440.2

	MOE(p)			
p	Naïve	GVF	GVF- uw adj	GVF- w adj
0.2254098	0.03396	0.03465	0.03023	0.03287

Figure 1-2C. Final results from combining Travel Time categories

"CompareSubgroups" Worksheet 2

The purpose of this spreadsheet is to compare proportions between two subgroups. To statistically compare two subgroups, the MOE of the estimated difference in proportions needs to be computed. There are two scenarios that impact the MOE computations:

- The two subgroups that are being compared are independent from each other.
- The two subgroups that are being compared are dependent on each other.

The following is an illustration of each scenario. Consider the following two-way table:

		Means of Transportation		Total
		Drive alone	Other	
TAZ	1	10	20	30
	2	30	40	70
Total		40	60	100

An independent test compares two column proportions, that is, the proportion among those who drive alone in TAZ 1 compared to the proportion among those who use other Means of Transportation in TAZ 1. The computation of the difference is (10/40 – 20/60).

Two dependent subgroups are compared by using two row percentages in the same row, such that they have the same denominator. That is, the proportion in TAZ 1 driving alone compared to the proportion in TAZ 1 using other Means of Transportation. The computation of the difference is (10/30 – 20/30).

Inputs

To compare the proportions between two subgroups, simply enter the proportion and MOE for each subgroup where indicated. If the MOE for the proportion is not known, then use the CombineSubgroups worksheet to compute the MOE. Then indicate if the subgroups are independent from each other or dependent. The ToolKit will take care of the rest.

Outputs

The output contains the resulting difference between the two proportions, the MOE of the difference, and an indication of a significant difference assuming a 0.05 level of significance and a normal distribution.

Example 2-1 Independent subgroups

For this example, we expand on the table in Example 1-1 from Clay County, Missouri. The data for this example is shown in Table 2-1A.

Table 2-1A. B102216C3 - Time leaving home (10) by Means of transportation (4) (Workers 16 years and over) from select Clay County, Missouri tracts; 6:00 a.m. to 6:59 a.m.

	Drove alone		Carpool				Other			Total	
Tract	Estimate	MOE	Estimate	MOE	Estimate	MOE	Estimate	MOE			
208.01	895	220	10	13	15	22	920	219			
218.03	780	155	115	100	15	26	915	189			
...											
Clay County, Missouri	20,300	914	2,420	370	640	191	23,355	983			

The comparison of interest in this example is for Tract 218.03, specifically, to compare the proportion in the tract among those who carpool to the proportion in the tract among those who drove alone.

Step 1. Use the "Combine Subgroups" worksheet to compute the proportion who carpool in Tract 218.03 in Clay County, Missouri. As shown in Figure 2-1A, enter the X (115) and MOE (100) from Table 2-1A, and enter the denominator Y and its associated MOE. The outputs show the proportion p equal to 0.0475 with an MOE from the recommended GVF-w adj approach equal to 0.0407. Repeat the same for the proportion and MOE for those who drove alone. Figure 2-1B shows that the proportion who drove alone is 0.0384 and the associated MOE equal to 0.0074.

User Inputs

To estimate the proportion (p) for the combined estimate, enter the denominator Y value and its MOE:

Y	MOE
2420	370

Enter estimates to be aggregated

X	MOE
115	100

Outputs

Aggregated estimate	MOE(x)			
X	Naïve	GVF	GVF- uw adj	GVF- w adj
115	100.0	88.0	100.0	100.0

	MOE(p)			
p	Naïve	GVF	GVF- uw adj	GVF- w adj
0.0475207	0.04068	0.03635	0.04068	0.04068

Figure 2-1A. Estimated proportion and MOE for Tract 218.03, carpool

User Inputs

To estimate the proportion (p) for the combined estimate, enter the denominator Y value and its MOE:

Y	MOE
20300	914

Enter estimates to be aggregated

X	MOE
780	155

Outputs

Aggregated estimate	MOE(x)			
X	Naïve	GVF	GVF- uw adj	GVF- w adj
780	155.0	228.4	155.0	155.0

	MOE(p)			
p	Naïve	GVF	GVF- uw adj	GVF- w adj
0.0384236	0.00744	0.01125	0.00744	0.00744

Figure 2-1B. Estimated proportion and MOE for Tract 218.03, drove alone

Step 2. Use the "CompareSubgroups" worksheet and enter in the two proportions and their MOEs. Then enter an "I" to designate the test among two independent subgroups. The results in Figure 2-1C shows that there is not enough evidence to say the tract proportion among county carpoolers is difference from the tract proportion among county residents who drive alone.

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Comparing Two Proportions Between Subgroups

User Inputs

Subgroup 1

Proportion =	0.04752
MOE =	0.04132

Subgroup 2

Proportion =	0.03842
MOE =	0.00764

Enter I for independent subgroups or D for dependent subgroups:

I

Outputs

Difference =	0.01
MOE =	0.026
Significant?	No

Figure 2-1C. Test for difference in proportions among independent subgroups

Example 2-2 Dependent Subgroups

For this example, we use Table 2-1A for the comparison of interest, which is to compare Tracts 208.01 and 218.03 on the proportion who drive alone.

Step 1. Use the "Combine Subgroups" worksheet to compute the proportion who drive alone in Tract 208.01 in Clay County, Missouri, and likewise for Tract 218.03. For Tract 208.01, the estimated proportion is 0.0383 with an MOE equal to 0.0093. For Tract 218.03, the estimated proportion is equal to 0.0334 with and MOE of 0.0065.

Step 2. Use the "CompareSubgroups" worksheet and enter in the two proportions and their MOEs. Then enter an "D" to designate the test among two dependent subgroups. The results in Figure 2-2A show that there is not enough evidence to detect a difference between the proportion in Tract 208.01 who drive alone and Tract 218.03 who drive alone.

CTPP Margin of Error Toolkit

Comparing Two Proportions Between Subgroups

User Inputs

Subgroup 1	
Proportion =	0.03832
MOE =	0.00928
Subgroup 2	
Proportion =	0.03339
MOE =	0.00649

Enter I for independent subgroups or D for dependent subgroups:

D

Outputs

Difference =	0.00
MOE =	0.012
Significant?	No

Figure 2-2A. Test for difference in proportions among dependent subgroups

"ReplicatedTables" Worksheets 3

The purpose of this spreadsheet is to generate a set of replicated tables for a given CTPP table or an aggregated table. The methodology of generating replicated tables is designed for reflecting the sampling error and perturbation error in the transportation models and evaluating the sensitivity of models to data quality. There are six worksheets related to generating replicated tables:

- 3a. Replicated Table Parameters
- 3b. Random Numbers
- 3c. Results - GVF
- 3d. Results – Distance Function
- 3e. Graphs - GVF
- 3f. Graphs – Distance Function

Inputs

To generate replicated tables, enter the relevant parameters in worksheet "3a. Replicated Table Parameters." Copy and paste the cell estimates (Xk) and corresponding MOEs (MOE.Xk) as well as the table total (X) and its MOE (MOE.X) from a given CTPP table or an aggregated table. Both estimates and MOEs need to be positive numbers. The ToolKit allows **up to 1,000 table cells**. The overall and cell estimates should be **no more than 100,000**. Enter the number of replicated tables to be generated as **an integer between 1 and 10,000**.

Random numbers are needed to generate the replicated tables. The ToolKit will randomly generate these numbers and display them in "3b. Random Numbers." If a user prefers the use of pre-specified random numbers, these numbers can be copied to "3b. Random Numbers." The ToolKit conducts two checks before using the pre-specified random numbers. First, the random numbers should be available for generating the overall total and every cell estimates in each replicated table. Inadequate random numbers will incur an error message. For example, if a user intends to generate 5 replicated tables with each having 10 cells, he needs to provide random numbers in 5 columns and

11 rows. Second, the pre-specified random numbers should be between 0 and 1, exclusively. Any violation may incur an error message.

Outputs

The replicated tables generated by the ToolKit are displayed in "3c. Results – GVF" and "3d. Results – Distance Function" using the GVF method and the distance function method, as illustrated in the NCHRP 08-36 Task 135 Final Report. Meanwhile, three types of graphs are created and displayed in "3e. Graphs – GVF" and "3f. Graphs – Distance Function". The graphs are based on up to the first five replicated tables. The scaled bar chart shows the relative magnitude of the five replicated estimates for each table cell. Each bar chart or pie chart reflects the magnitude of cell estimates in each replicated table.

Example 3-1

The first example is from Tract 202.01, Clay County, Missouri. The table of interest is Table B102216C3 - Time leaving home (10) by Means of transportation (4) (Workers 16 years and over), from which we want to generate 5 replicated tables.

Table 3-1A. B102216C3 - Time leaving home (10) by Means of transportation (4) (Workers 16 years and over) from Tract 202.01, Clay County, Missouri

Time Leaving Home	Means of transportation	Estimate	Margin of Error
5:00 a.m. to 5:59 a.m.	Drove alone	320	267
5:00 a.m. to 5:59 a.m.	Carpooled	45	66
5:00 a.m. to 5:59 a.m.	Public transportation	0	114
6:00 a.m. to 6:59 a.m.	Drove alone	475	156
6:00 a.m. to 6:59 a.m.	Carpooled	50	45
6:00 a.m. to 6:59 a.m.	Public transportation	20	32
7:00 a.m. to 7:59 a.m.	Drove alone	575	243
7:00 a.m. to 7:59 a.m.	Carpooled	95	93
7:00 a.m. to 7:59 a.m.	Public transportation	0	114
8:00 a.m. to 8:59 a.m.	Drove alone	375	204
8:00 a.m. to 8:59 a.m.	Carpooled	25	38
8:00 a.m. to 8:59 a.m.	Public transportation	15	24
9:00 a.m. to 9:59 a.m.	Drove alone	140	130
9:00 a.m. to 9:59 a.m.	Carpooled	0	114
9:00 a.m. to 9:59 a.m.	Public transportation	0	114
10:00 a.m. to 3:59 p.m.	Drove alone	225	137
10:00 a.m. to 3:59 p.m.	Carpooled	15	117
10:00 a.m. to 3:59 p.m.	Public transportation	0	114
4:00 p.m. to 4:59 a.m.	Drove alone	435	183
4:00 p.m. to 4:59 a.m.	Carpooled	100	79
4:00 p.m. to 4:59 a.m.	Public transportation	60	56
Worked at home		15	25
Total		2,985	463

Source: U.S. Census Bureau, American Community Survey 2006-2010 Five-year estimates. Special Tabulation: Census Transportation Planning

Step 1. Copy the cell and total estimates and MOEs from Table 3-1A into the sheet "3a. Replicated Table Parameters" under the columns with headings X/Xk and MOE.X/MOE.Xk, as shown in Figure 3-1A. The cell estimates that are equal to zero are excluded. Enter the number of replicated tables to generate, 5, as shown in Figure 3-1B.

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	X		MOE.X
Total	2985		463
	Xk	Pk	MOE.Xk
Cells 1	320	10.72%	267
2	45	1.51%	66
3	475	15.91%	156
4	50	1.68%	45
5	20	0.67%	32
6	575	19.26%	243
7	95	3.18%	93
8	375	12.56%	204
9	25	0.84%	38
10	15	0.50%	24
11	140	4.69%	130
12	225	7.54%	137
13	15	0.50%	117
14	435	14.57%	183
15	100	3.35%	79
16	60	2.01%	56
17	15	0.50%	25

Figure 3-1A. Estimates to generate replicated tables

Number of Replicated Tables
5

Figure 3-1B. Enter number of replicated tables

Step 2. Enter the random numbers into the sheet "3b. Random Numbers", as shown in Figure 3-1C. If left blank, the random numbers will be generated by the ToolKit in the process of generating replicated tables. When the random numbers are entered into the sheet, be sure to check that the values are between 0 and 1, and enough random numbers are provided to generate the requested number of replicated tables.

		Rep1	Rep2	Rep3	Rep4	Rep5
Total		0.9112	0.0319	0.4590	0.0171	0.9613
Cells	1	0.4739	0.2026	0.5913	0.1116	0.0055
	2	0.7115	0.3774	0.3263	0.3070	0.5701
	3	0.1590	0.2297	0.6635	0.7213	0.7222
	4	0.5229	0.2303	0.2129	0.1640	0.9157
	5	0.7493	0.4935	0.3192	0.7168	0.8231
	6	0.8032	0.0968	0.4240	0.6028	0.3245
	7	0.3790	0.5453	0.7757	0.7494	0.0872
	8	0.6268	0.1118	0.9095	0.5838	0.1862
	9	0.3958	0.6138	0.3791	0.1950	0.1652
	10	0.2391	0.6913	0.0453	0.2055	0.0876
	11	0.1957	0.1458	0.7587	0.0791	0.6799
	12	0.0538	0.4083	0.6697	0.4310	0.0119
	13	0.7331	0.6807	0.2208	0.3948	0.1270
	14	0.6218	0.8717	0.4034	0.6317	0.1362
	15	0.1131	0.7114	0.2854	0.9735	0.9828
	16	0.3545	0.6414	0.5373	0.4784	0.0077
	17	0.9221	0.4414	0.5254	0.3105	0.6758

Figure 3-1C. Enter random number of replicated tables

Step 3. Click the "Run" button as shown in Figure 3-1D. A window pops up, as in Figure 3-1E, asking the user to confirm the use of pre-selected random numbers. After clicking "Yes", the ToolKit will start to generate the replicated tables as requested, with a progress to show how far the user is in a process. If there are any problems with the data entered in Step 1, error messages will pop up to guide the user to fix the problems.

Figure 3-1D. Run button

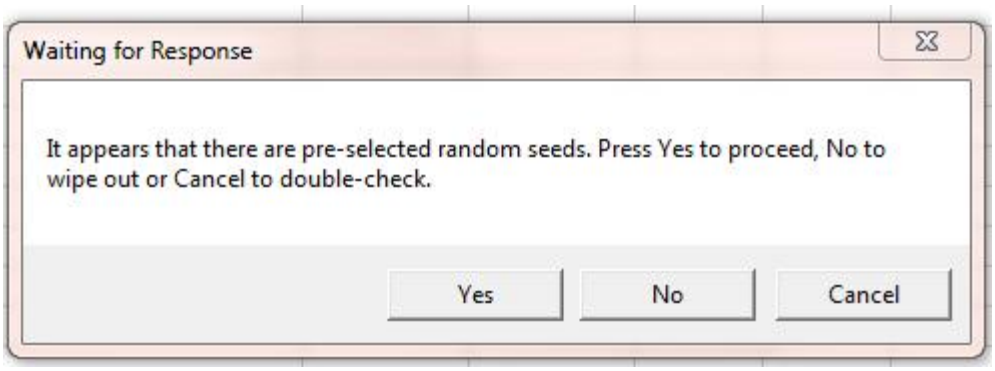

Figure 3-1E. Pop up window about pre-selected random numbers

Step 4. The last step is to review the output. Figure 3-1F shows two sets of five replicated tables that are generated from the GVF method the distance function method, which are displayed on "3c. Results – GVF" and "3d. Results – Distance Function", respectively. The results also show the standard deviations and MOEs among the generated replicated tables. Note that the MOEs among the five replicated tables may be quite different from those in the input table in Figure 3-1A. When a large number of replicated tables are generated, the standard deviations and MOEs converge to their theoretical values (details about the theoretical values are illustrated for each method in the NCHRP 08-36 Task 135 Final Report). In this example the two methods give similar results in some but not all cells. Users may choose the method that more closely reflects the MOEs in the original table.

Replicated Tables - GVF Method

		Rep1	Rep2	Rep3	Rep4	Rep5	SD among 5 replicated tables	MOE among 5 replicated tables
Total		3364	2463	2956	2389	3482	501.25	824.55
Cells	1	371	234	322	176	190	84.73	139.38
	2	68	27	24	19	59	22.19	36.50
	3	444	376	497	433	736	139.99	230.28
	4	53	22	21	15	142	53.19	87.49
	5	33	12	6	20	49	17.31	28.47
	6	817	409	527	486	709	168.27	276.81
	7	89	89	123	99	53	25.25	41.54
	8	483	252	494	315	397	105.00	172.73
	9	15	23	12	4	6	7.42	12.20
	10	2	16	0	1	0	6.60	10.86
	11	107	77	170	54	221	68.77	113.13
	12	144	192	243	166	124	46.03	75.72
	13	23	15	2	4	1	9.74	16.03
	14	557	533	389	376	446	82.27	135.34
	15	55	116	65	177	321	108.66	178.75
	16	48	63	54	41	8	21.26	34.98
	17	54	6	8	3	21	21.01	34.56

Replicated Tables - Distance Function Method

		Rep1	Rep2	Rep3	Rep4	Rep5	SD among 5 replicated tables	MOE among 5 replicated tables
Total		3364	2463	2956	2389	3482	501.25	824.55
Cells	1	372	227	322	157	151	98.54	162.09
	2	70	23	19	15	56	24.58	40.43
	3	423	373	504	445	774	158.43	260.61
	4	50	17	15	10	164	64.99	106.91
	5	33	9	3	19	52	19.48	32.04
	6	865	394	517	491	706	188.88	310.70
	7	82	90	128	103	40	32.33	53.18
	8	498	238	526	316	379	121.25	199.45
	9	11	21	8	2	3	7.68	12.64
	10	1	14	0	0	0	6.19	10.19
	11	95	68	177	43	231	78.78	129.59
	12	122	193	246	161	96	59.15	97.31
	13	21	13	1	2	0	9.46	15.56
	14	574	589	379	381	422	104.40	171.73
	15	43	124	57	205	387	140.40	230.96
	16	42	65	50	37	3	22.97	37.78
	17	62	4	6	1	18	25.28	41.58

Figure 3-1F. Replicated tables generated from the GVF method the distance function method

The graphs based on the generated replicated tables are shown on "3e. Graphs – GVF" and "3f. Graphs – Distance Function." The scaled bar chart, as shown in Figure 3-1G, shows the relative magnitude of the five replicated estimates for each table cell. If the variation among the five replicates is very small, each replicate accounts for approximately 20% of the bar. Additionally, bar charts and pie charts are generated for each replicated table with each bar or slice representing a cell estimate.

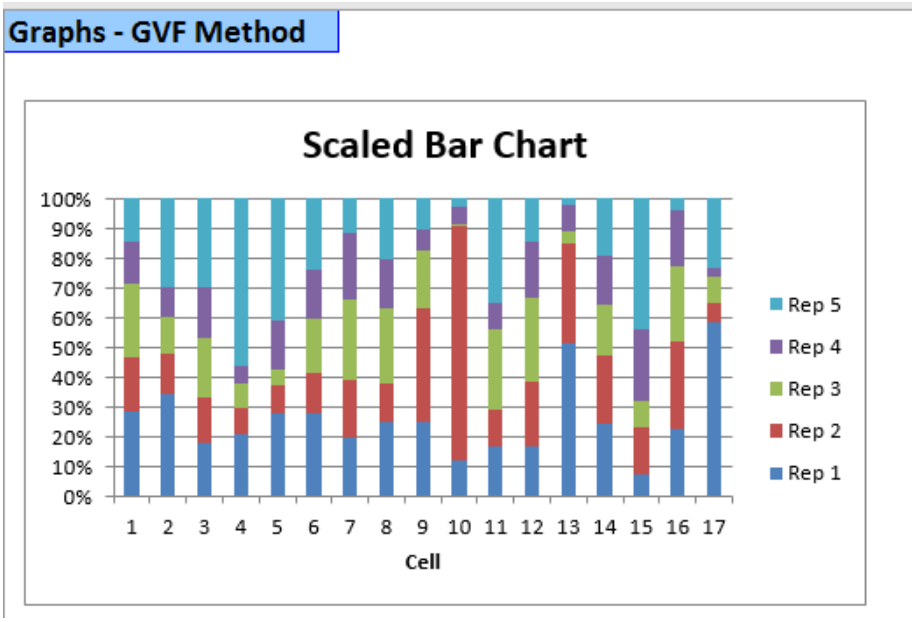

Figure 3-1G. Graphs based on the replicated tables generated from the GVF method

Example 3-2

The second example is from the Transportation Analysis District (TAD) representing Annapolis, Maryland (TAD 00000029, MPO 24199200). The table of interest is Table B102217C3 - Travel time (12) by Means of transportation (4) (Workers 16 years and over), as shown in Table 3-2A.

Table 3-2A. B102217C3 - Travel time (12) by Means of transportation (4) (Workers 16 years and over) from Annapolis, Maryland (TAD 00000029, MPO 24199200)

	Drove alone		Carpooled		Public transportation	
	Estimate	MOE	Estimate	MOE	Estimate	MOE
Did not work at home:	12,200	805	1,875	398	3,725	469
Less than 5 minutes	235	117	0	127	485	146
5 to 14 minutes	3,460	395	525	150	1,080	204
15 to 19 minutes	1,410	307	300	138	580	176
20 to 29 minutes	1,975	401	500	311	770	167
30 to 44 minutes	2,375	440	205	119	210	84
45 to 59 minutes	1,440	345	105	82	140	101
60 to 74 minutes	870	247	75	52	185	87
75 to 89 minutes	190	119	60	73	70	48
90 minutes or more	250	102	105	82	205	99

Source: U.S. Census Bureau, American Community Survey 2006-2010 Five-year estimates. Special Tabulation: Census Transportation Planning

Step 1. Copy the cell and total estimates and MOEs from Table 3-2A into the sheet "3a. Replicated Table Parameters" under the columns with headings Xk or X and MOE.Xk or MOE.X, as shown in Figure 3-2A. Enter the number of replicated tables to generate, 10, as shown in Figure 3-2B.

CTPP Replicated Tables Toolkit

	X		MOE.X
Total	17805		942
	Xk	Pk	MOE.Xk
Cells 1	235	1.32%	117
2	3460	19.43%	395
3	1410	7.92%	307
4	1975	11.09%	401
5	2375	13.34%	440
6	1440	8.09%	345
7	870	4.89%	247
8	190	1.07%	119
9	250	1.40%	102
10	525	2.95%	150
11	300	1.68%	138
12	500	2.81%	311
13	205	1.15%	119
14	105	0.59%	82
15	75	0.42%	52
16	60	0.34%	73
17	105	0.59%	82
18	485	2.72%	146
19	1080	6.07%	204
20	580	3.26%	176
21	770	4.32%	167
22	210	1.18%	84
23	140	0.79%	101
24	185	1.04%	87
25	70	0.39%	48
26	205	1.15%	99

Figure 3-2A. Estimates to generate replicated tables

Number of Replicated Tables
10

Figure 3-2B. Enter number of replicated tables

Step 2. Click the Run button. Allow the ToolKit to generate the random numbers for this run. In the case that a user forgets to delete the random numbers used for previous runs, the ToolKit will pop up a message, as shown in Figure 3-2C, asking the user if those random numbers can be wiped out.

Figure 3-2C. Pop-up message about random numbers

Step 3. The last step is to review the output. Figure 3-2D shows two sets of ten replicated tables that are generated from the GVF method the distance function method, which are displayed on "3c. Results – GVF" and "3d. Results – Distance Function", respectively. The two methods give similar results in this example, except that the standard deviations for the GVF method are slightly larger than those for the distance function method.

Replicated Tables - GVF Method

	Rep1	Rep2	Rep3	Rep4	Rep5	Rep6	Rep7	Rep8	Rep9	Rep10	SD among	MOE among 10 replicated tables
Total	17418	17738	17350	17435	18773	17802	17122	16883	18321	18081	574.23	944.61
Cells 1	176	259	241	148	123	133	296	245	187	267	61.52	101.20
2	3429	3559	3103	3390	4006	3599	2668	3188	3580	3343	355.20	584.31
3	1379	1464	1208	1345	1601	1460	1575	1084	1507	1298	163.43	268.84
4	2217	1739	2247	2105	2263	1902	2011	2241	2084	2226	175.05	287.96
5	2568	2775	2301	2520	2222	2589	2290	2469	2402	2848	205.67	338.32
6	1265	1355	1335	1580	1369	1680	1213	1442	1356	1409	139.42	229.35
7	840	849	747	1085	893	1183	802	600	983	810	168.05	276.45
8	174	197	188	315	175	142	370	175	271	207	72.87	119.88
9	227	214	239	104	217	180	214	343	235	318	66.44	109.30
10	367	501	518	525	492	450	418	421	562	537	62.34	102.55
11	265	304	160	304	609	161	411	357	258	225	132.62	218.16
12	642	696	534	450	389	544	315	583	574	528	114.22	187.90
13	203	126	239	147	109	159	100	138	177	209	45.71	75.19
14	122	68	72	18	259	216	45	120	102	99	74.29	122.20
15	152	74	50	58	14	67	38	77	103	166	48.22	79.32
16	24	46	150	55	68	31	85	9	16	65	41.34	68.01
17	181	106	207	92	44	37	53	26	102	132	61.38	100.97
18	350	423	496	504	503	343	590	416	572	487	84.03	138.24
19	935	893	1103	935	1219	949	1171	1084	947	1087	114.08	187.66
20	506	519	508	500	592	586	484	511	652	560	53.54	88.08
21	737	1009	825	609	800	626	1000	457	696	627	175.06	287.97
22	189	78	230	232	143	154	291	201	273	99	70.87	116.58
23	62	89	81	99	78	109	151	176	127	70	36.87	60.64
24	144	173	289	159	383	100	146	281	408	198	106.41	175.04
25	70	19	36	10	67	215	36	66	48	30	58.30	95.90
26	193	204	243	145	136	187	351	173	99	237	69.95	115.07

Replicated Tables - Distance Function Method

	Rep1	Rep2	Rep3	Rep4	Rep5	Rep6	Rep7	Rep8	Rep9	Rep10	SD among	MOE among 10 replicated tables
Total	17418	17738	17350	17435	18773	17802	17122	16883	18321	18081	574.23	944.61
Cells 1	177	258	241	150	125	134	295	245	188	266	60.60	99.69
2	3428	3557	3107	3390	4001	3598	2679	3190	3580	3345	351.08	577.53
3	1379	1463	1210	1346	1599	1460	1571	1088	1506	1300	161.31	265.36
4	2213	1742	2241	2102	2261	1903	2009	2235	2084	2223	172.20	283.26
5	2564	2768	2302	2517	2227	2585	2290	2465	2403	2841	202.14	332.52
6	1267	1357	1336	1578	1371	1676	1216	1441	1358	1410	137.23	225.75
7	841	849	749	1081	894	1177	803	603	982	811	165.49	272.23
8	174	197	188	312	176	143	366	175	270	207	71.49	117.61
9	227	215	239	106	217	181	214	342	236	317	65.46	107.68
10	369	502	518	525	493	451	419	422	562	537	61.54	101.23
11	266	304	162	304	603	163	409	356	259	226	130.42	214.53
12	640	692	534	451	392	544	317	582	573	528	112.36	184.83
13	203	128	238	148	110	160	101	139	178	209	45.09	74.18
14	122	68	72	18	256	214	46	120	102	99	73.10	120.26
15	150	74	50	59	14	67	38	77	102	165	47.45	78.05
16	25	47	148	55	68	32	85	10	16	65	40.71	66.97
17	180	106	205	93	45	38	54	27	102	132	60.45	99.44
18	352	424	496	503	504	345	588	417	571	488	82.78	136.17
19	937	896	1102	937	1217	951	1169	1083	950	1088	112.38	184.86
20	508	520	509	502	592	586	485	512	651	561	52.94	87.08
21	737	1005	824	611	800	628	995	461	698	629	172.31	283.45
22	190	79	230	232	144	155	290	201	273	100	69.87	114.93
23	63	90	82	99	79	110	151	175	127	71	36.34	59.78
24	144	173	288	160	380	101	146	279	403	198	104.51	171.92
25	70	19	36	11	68	212	37	66	48	30	57.27	94.21
26	193	204	243	146	137	188	348	174	101	236	68.77	113.12

Figure 3-2D. Replicated tables generated from the GVF method the distance function method

The graphs, shown on "3e. Graphs – GVF" and "3f. Graphs – Distance Function", are based on only the first five replicated tables. In the pie charts, the legend may be partially displayed if the original table has a large number of cells. The user may manually adjust the size of the legend box to

avoid truncation. The user may also choose to create his own graphs using all ten replicated tables generated by the ToolKit.